National Curriculum of Pakistan

for

COMPUTER SCIENCE

(Grades IX-X and XI-XII)

2025

FOUR PARTS OF A CURRICULUM:

DIRECTORATE OF CURRICULUM & TEACHER EDUCATION

KHYBER PAKHTUNKHWA ABBOTTABAD

بسم الله الرحمن الرحيم

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Progression Grid - Computer Science

Domain A: **Computing Systems**

Standard: *Students will learn about components and interactions between computer systems, stages of software development, data representation and transmission across networks of computing systems, and the implications on usability, reliability, security, etc.*

Grade 9	Grade 10	Grade 11	Grade 12
***Benchmark I**: Students will identify and analyze components of computer systems and different levels of interactions between hardware, software, users, and computer networks*		***Benchmark I**: Students will identify and analyze logic gates in digital systems* ***Benchmark II**: Students will identify stages of system software development* ***Benchmark III:** Students will learn about scalability, reliability, and security of computer networks*	
Student Learning Outcome			
[SLO CS-09-A-01] Students will define and describe types of systems (artificial, natural), computer hardware components such as computer architecture (CPU, microprocessors, etc.),	*[SLO CS-10-A-01] Students will be able to understand and describe number systems and encoding schemes for data representation in computer systems*	*[SLO CS-11-A-01] Students will be able to understand and apply logic gates in digital systems, define and create truth tables using Boolean operators like AND, OR, NOT, NAND, XOR) and logic diagrams*	*[SLO CS-12-A-01] Students will explain the usability, security and accessibility of devices, the systems they are integrated with.* *[SLO CS-12-A-02] Explain human interaction with computer systems in terms of:* - *Usability* - *Common problems* - *Methods for improvements* - *Ethical, social, economic, and environmental implications*
[SLO CS-09-A-02] Students will be able to identify and explain system software, application software, low-level and high-level programming languages, and their uses.	*[SLO CS-10-A-02] Students will be able to explain how system software controls the flow of information between hardware components used for input, output, storage, and processing* *[SLO CS-10-A-03] Students will identify and learn common software tools such*	*[SLO CS-11-A-02] Students will be able to understand and evaluate stages of the systems design, e.g. software development life cycle (analysis, design, coding, and testing etc.), and software development methodologies*	

	as translators, integrated development environments, online and offline computing platforms, code repositories, etc.		
[SLO CS-09-A-03] Students will be able to identify and analyze data communication, computer networks, networking devices, basic networking systems and understand how data is transmitted and key concepts such as protocols, speeds, etc.		*[SLO CS-11-A-03] Students will be able to understand and explain the scalability and reliability of networking systems via network topology* *[SLO CS-11-A-04] Understand and explain the need for cybersecurity and contrast different methods of encryption to transmit data*	*[SLO CS-12-A-03] Identify and explain tradeoffs between the usability and security of computing systems, recommend cybersecurity measures by considering different factors such as efficiency, cost, privacy, and ethics*

Domain B: Computational Thinking & Algorithms

Standard: *Students will identify and decompose simple and complex problems, create & evaluate appropriate solutions using computational approaches, and understand and apply common algorithms used in solving computational problems*

Grade 9	Grade 10	Grade 11	Grade 12
Benchmark I: *Students will understand and apply computational thinking techniques to solve complex, real-world problems.*		**Benchmark I**: *Students have core concepts of basic data structures and algorithms used extensively in computer science and knowledge of how to apply these techniques toward solving more complex and real-life problems.*	
Student Learning Outcomes			
[SLO CS-09-B-01] Understand and apply techniques to decompose problems	*[SLO CS-10-B-01] Students will identify common algorithms used to develop software, store, search, or sort information*	*[SLO CS-11-B-01] Plan, develop, systematically test, and refine computational artifacts for problem-solving such as pseudocode, etc.*	*[SLO CS-12-B-01] Understand and evaluate the computational solutions in terms of efficiency, clarity, and correctness*
[SLO CS-09-B-02] Solve simple and complex problems computationally	*[SLO CS-10-B-02] Develop and apply abstractions to create generalized, modular solutions*	*[SLO CS-11-B-02] Apply common search, and sort algorithms*	*[SLO CS-12-B-02] Understand and apply complex algorithms on data structures such as trees and binary search*

Domain C: Programming Fundamentals

Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learning how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration

Grade 9	Grade 10	Grade 11	Grade 12
Benchmark I: *Students will develop, test, and debug static website (using HTML and CSS) and an interactive website (using JavaScript)*		**Benchmark I**: *Students will develop, test, debug command-line interface (CLI) applications in Python*	
Student Learning Outcomes			
[SLO CS-09-C-01] Students will understand web development and differentiate between a website and a web application	*[SLO CS-10-C-01] Students should be able to develop websites using front end development tools.*	*[SLO CS-11-C-01] Students should understand the importance of computer programming and applications*	*[SLO CS-12-C-01] Students should be able to understand and evaluate applications of various programming paradigms.*
[SLO CS-09-C-02] Students should be able to create a static website using HTML/CSS in an appropriate environment *[SLO CS-09-C-03] Students should be able to create dynamic websites using JavaScript as the frontend scripting*	*[SLO CS-10-C-02] Students should be able to use more advanced HTML/CSS features in an appropriate environment* *[SLO CS-10-C-03] Students should be able to use more advanced programming constructs using JavaScript*	*[SLO CS-11-C-02] Students should be able to write and execute simple programs in Python.* *[SLO CS-11-C-03] Students should be able to draw shapes using Turtle Graphics functions in Python* *[SLO CS-11-C-04] Students should be able to understand the need for libraries and learn the use of some simple libraries in Python.*	*[SLO CS-12-C-02] Students should be able to use more advanced programming constructs such as data structures (lists etc.), file handling (disk IO to write to storage), and databases in Python.*
[SLO CS-09-C-04] Students should be able to implement common algorithms that use sequence, selection, and repetition in JavaScript	*[SLO CS-10-C-04] Students should be able to implement complex algorithms that use more complex data structures in JavaScript*	*[SLO CS-11-C-05] Students should be able to translate simple algorithms that use sequence and repetition in Python.* *[SLO CS-11-C-06] Students should be able to decompose a problem into sub-problems and implement those sub-problems using functions in Python.*	*[SLO CS-12-C-03] Students should be able to implement complex algorithms that use lists etc. in Python*

[SLO CS-09-C-05] Students will determine ways of debugging their code in JavaScript	*[SLO CS-10-C-05] Students will determine more advanced techniques (unit tests, breakpoints, watches) for testing and debugging their code in JavaScript*	*[SLO CS-11-C-07] Students will determine ways of debugging their code in Python*	*[SLO CS-12-C-04] Students will determine more advanced techniques (unit tests, breakpoints, watches) for testing and debugging their code in Python*

Domain D: Data and Analysis

Standard 1: Students will be able to understand the scope of data science, how computer systems collect, store, process, visualize, and interpret data

Standard 2: Students will get an introduction to the relational data model, relational database engines, and SQL and how to design good schemas.

Standard 3: What is AI and machine learning, and how does it relate to data and data science

Grade 9	Grade 10	Grade 11	Grade 12
***Benchmark I**: Students will be able to define and explain how to collect, store, analyze, and visualize data*		***Benchmark I**: Students will be able to represent databases using UML diagrams and extract data using queries, and create data visualizations using software tools*	
Student Learning Outcomes			
[SLO CS-09-D-01] Students will explain the scope of the data science field as an interdisciplinary field (computer sciences, mathematics & statistics, and business knowledge & understanding).	*[SLO CS-10-D-01] Students will understand and explain the scope of data science, Artificial Intelligence (AI), and Machine Learning (ML), including types of supervised and unsupervised learning models, and their applications to common real-world problems.*	*[SLO CS-11-D-01] Students will be able to relate the role and importance of model building with their real-world applications* *[SLO CS-11-D-02] Students will understand and explain experimental design in data science*	*[SLO CS-12-D-01] Students will be able to analyze data and identify key model performance metrics of real-world machine learning models.*
[SLO CS-09-D-02] Students will define and explain data types, data collection, and data storage.	*[SLO CS-10-D-02] Students will understand and explain the types, uses, and methods of data visualizations and understand the benefits of visualizing data*	*[SLO CS-11-D-03] Students will analyze pre-existing datasets to create summary statistics and data visuals (such as bar charts, pie charts, line graphs, etc.)*	*[SLO CS-12-D-02] Students will explain and create a data visualization using Structured Query Language (SQL), or Python, or R*
[SLO CS-09-D-03] Students will be able to define and explain big data, and applications of big data in real-world business	*[SLO CS-10-D-03] Students will be able to apply stages of the data science life cycle e.g. understanding a real-world*	.	

	business problem, data gathering, building model, interpreting results).		

Domain E: Applications of Computer Science

Standard 1: Students will understand computer technologies such as Blockchain / AI / IoT / Cloud Computing / Game design and development
Standard 2: Students should be able to understand how computers learn, make decisions, and the applications, challenges, and social implications of AI

Grade 9	Grade 10	Grade 11	Grade 12
***Benchmark I**: Students learn about different popular fields in Computer Science like AI, Cloud Computing, IoT, and Blockchain.*		***Benchmark I**: Students learn about different technologies that support the latest applications of CS and their relevance to Pakistan.* ***Benchmark II**: Students learn about data techniques in AI applications and the social implications of technology.*	
Student Learning Outcome			
[SLO CS-09-E-01] Students will be able to describe uses and applications of computing like AI, Machine Learning, and Cloud Computing	*[SLO CS-10-E-01] Students will be able to describe uses and applications that are enabled by technologies like IoT, and Blockchain*	*[SLO CS-11-E-01] Students should be able to describe technologies that are the foundations of IoT systems, Cloud Computing, and Blockchain*	*[SLO CS-12-E-01] Students should be able to design ideas of applications relevant to Pakistan using IoT, Cloud computing, and Blockchain*
	[SLO CS-10-E-02] Students will be able to explain that AI can be applied to specific applications in areas like NLP, Robotics, Speech Recognition, etc.		*[SLO CS-12-E-02] Students should be able to describe deep learning and its applications*
[SLO CS-09-E-02] Students will be able to discuss the social implication of the usage of AI in decision-making that affects humans	*[SLO CS-10-E-03] Students will be able to demonstrate the social implications of AI*	*[SLO CS-11-E-02] Students should be able to evaluate how different stakeholder's culture, values, and (sometimes conflicting) interests affect AI System designs.*	*[SLO CS-12-E-03] Students should be able to assess policies that can help protect different stakeholders' interests* *[SLO CS-12-E-04] Students should be able to evaluate scenarios with data sharing and privacy conflicts and suggest policy decisions that can help achieve acceptable compromises.*

Domain F: Impacts of Computing

Standard 1: Students will be able to understand ethics and laws related to computing and the use of computing devices, media, data, the internet, and the application of personal privacy and network security.
Standard 2: The environmental, cultural, and human impact of computing and assistive technologies for the modern world.

Grade 9	Grade 10	Grade 11	Grade 12
Benchmark I: *Students will obtain knowledge of ethical and legal issues surrounding the use of computing.* **Benchmark II**: *Students will understand privacy and network security issues surrounding computing applications and devices they use everyday* **Benchmark III**: *Students will understand the role of assistive technologies and understand the implications of the digital divide*		**Benchmark I**: *Students will interpret documents related to computing systems and evaluate their legal and ethical implications.* **Benchmark II**: *Students will be able to illustrate how they can maintain privacy online and address security concerns they may encounter with the use of computing devices and applications* **Benchmark III**: *Students will demonstrate their ability to collaborate and communicate on the design of computing applications*	
Student Learning Outcomes			
[SLO CS-09-F-01] Understand and apply safe and responsible use of computers (responsible use of hardware, appropriate use of software, and safe use of digital platforms like data searches, social networking, etc.)	*[SLO CS-10-F-01] Understand and apply safe & responsible use of the internet to prevent addiction, promote information and data security*	*[SLO CS-11-F-01] Understand and apply safe & responsible use of information sources, identifying sources of reliable information compared to unreliable information and its sources*	*[SLO CS-12-F-01] Identify and apply safe practices when collaborating on digital or online platforms.*
[SLO CS-09-F-02] Analyze the beneficial and harmful effects of computing innovations such as social networking, fake news, etc.	*[SLO CS-10-F-02] Evaluate the impact of and apply strategies to prevent cyberbullying/harassment*		*[SLO CS-12-F-02] Discuss security threats and mitigation such as 2FA, biometric verification, and secure techniques for transmitting data etc.*
[SLO CS-09-F-03] Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices	*[SLO CS-10-F-03] Analyze the impacts of the digital divide on access to critical information*	*[SLO CS-11-F-02] Define and discuss how computing has increased connectivity by enabling communication between people and the environmental, cultural, and human impact of increased connectivity*	*[SLO CS-12-F-03] Collaborate on strategies to provide equity and equal access to information*

Domain G: Digital Literacy

Standard: Collect & analyze information and publish to various audiences using digital tools and media-rich resources. Use digital tools to design and develop a significant digital artefact through research design, data collection, and communication.

Grade 9	Grade 10	Grade 11	Grade 12
Benchmark I: *Collect & analyze information and publish to various audiences using digital tools and media-rich resources.*		**Benchmark I**: *Use digital tools to design and develop a significant digital artefact through research design, data collection, and communication.*	
Student Learning Outcomes			
	[SLO CS-10-G-01] Communicate and publish key ideas and details to a variety of audiences using appropriate digital tools and media-rich resources	*[SLO CS-11-G-01] Perform advanced searches to locate information and/or design a data-collection approach to gather original data (e.g., quantitative interviews, surveys, prototypes, simulations)*	*[SLO CS-12-G-01] Students will create an artifact that answers a research question, communicates results and conclusions through digital resources or tools*

Domain H: Entrepreneurship in the Digital Age

Standard: Students will create a business using design thinking with the help of digital tools

Grade 9	Grade 10	Grade 11	Grade 12
Benchmark: Students will learn how to identify problems and create and present business solutions		***Benchmark:*** Students will learn how to build successful products or services by creating and testing prototype and launching a minimum viable product	
Student Learning Outcomes			
[SLO CS-09-H-01]: Students identify a problem and create a business idea using design thinking	*[SLO CS-10-H-01]: Students will use digital tools to conduct research to collect market and customer insights for a business idea*	*[SLO CS -11-H-01]: Students will create, test, and iterate a prototype for a business idea*	*[SLO CS -12-H-01]: Students will create and test a minimum viable product for their business*

Grade 9	Grade 10	Grade 11	Grade 12
[SLO CS -09-H-02]: Students will use digital tools to create and present a business plan	*[SLO CS -10-H-02]: Students will pitch a business idea*		

Computer Science (CS) 9- 12
Curriculum Guidelines

Note: There are certain links given here for videos, websites and documents. All links were checked for authenticity during review, it has been established that these are valid. Since these are third-party links, DCTE will not be responsible if they are changed or do not work in the future.

GRADE 9

DOMAIN A: Computing Systems
[SLO CS-09-A-01]

Standard: Students will learn about component and interactions between computer systems, stages of software development, data representation and transmission across networks of computing systems and the implications on usability reliability, security etc.
Benchmark: students will identify and analyze components of computer systems and different levels of interactions between hardware, software, users, and computer networks.

Student Learning Outcome(s):
[SLO CS-09-A-01] Students will define and describe types of systems (artificial, natural), computer hardware components such as computer architecture (CPU, microprocessors, etc.)

Knowledge:
Students will understand

- Brief history of computer systems and generation of computers
- Basic concept of a system, types of systems,
- Name and identify the core components of a computer (input/output devices, system unit (motherboard, memory, CPU, power supply, etc.), and data storage devices
- Understand and identify Von Neumann Architecture
- How data is transmitted within a computer system
- What are some of the requirements for a functioning computer system and what are some key concepts.

Students will know

- The core parts of a computer system and how they all work together, including definitions and key functions of computer architecture such as Central Processing Unit (CPU), Arithmetic Logic Unit (ALU), Control Unit (CU), memory, operating system and application software, and data representation in computers (bit, byte, binary, denary/decimal, hexadecimal)
- Difference between hardware engineering and software engineering
- Difference between natural and artificial systems

Skills:
Students will be able to

- Recognize and describe key components of a computer system, such as:
    - Differentiate between natural and artificial systems
    - Outline the architecture of the Central Processing Unit (CPU), the functions of the Arithmetic Logic Unit (ALU), the Control Unit (CU), and the registers within the CPU.
    - Differentiate between primary memory, cache, and secondary memory.
    - Describe the main functions of operating systems and application software.
- Explain how the various components interact together to transmit data and instructions
- Illustrate the hierarchy of memory and storage devices with respect to their volatility/retention, speed, storage capacity, cost etc.
- Differentiate between necessary and auxiliary components of a computer system

• Types and hierarchy of memory with respect to their volatility/retention, speed, storage capacity, cost etc. • Difference between necessary and auxiliary components of a computer system	

Assessments
Formative Assessments
Quiz assessment questions on the following topics:

- Components of and data transmission within a computer system
    - What is the difference between input and output devices? Give 2 examples of each
    - What is the storage device on a computer called?
    - What are the four basic components of a computer?
    - What is the full form of RAM?
    -
    - What units is the capacity of your hard drive measured in?
    - What is the most common keyboard layout?
    - How does a computer connect to the internet?

Summative Assessments
Exam questions on:

- Recognizing the basics of a computer system
- Differentiating between hardware and software layer
- Explaining how the various components interact together to transmit data and instructions

Learning Activities

1. Share questions with students on how computers work and then show video in class to explain how computers work and what they do: https://www.youtube.com/watch?v=92TaQRBwPSs
2. Various components of a computer explained: https://www.youtube.com/watch?v=ExxFxD4OSZ0
3. Other relevant videos explaining binary, what is digital vs etc: https://www.youtube.com/watch?v=Xpk67YzOn5w&list=PLvVRXnxnXxLiJU1blLohEVhj38Q1rxoAU
4. Hands on lab: Install, configure, and maintain the major hardware components.
5. Hands on lab: Analyze problems and resolve system faults using basic troubleshooting tools.
6. **In-class activity**: Oral presentations that involve demonstration of skills such as 1. Independent research using the Internet 2. Research on product specifications 3. Downloading drivers or other information from vendor sites 4. Gathering information on new hardware devices 5. New software (third party) diagnosis tools

[SLO CS-09-A-02]

Standard: Students will understand and explain the various components of a computer system and the different levels of interactions between these. They will be able to define & explain digital logic, the different stages of the software life cycle and the concepts of scalability, reliability and security for computer systems.
Benchmark: students will identify and analyze components of computer systems and different levels of interactions between hardware, software, users, and computer networks.

Student Learning Outcome(s):
[SLO CS-09-A-02] Students will be able to identify and explain system software, application software, low-level and high-level programming languages, and their uses

<table>
<tr>
<td>Knowledge:
Students will understand
● The main functions of systems software with some examples
● The main functions of operating systems and application software
● Outline the uses of various application software.</td>
<td>Skills:
Students will be able to
● Select an appropriate medium to create artifacts (Planning the document / information flow, editing and alignment of page, paragraphs, text, tables, and graphics) to communicate ideas in various digital tools such as:
○ Image processing tools (like Photoshop, Canva.com, GIMP etc.)
○ Word processors (like MS Word, Google Docs etc.)
○ Presentations (like MS PowerPoint or Google Slides etc.)
○ Spreadsheets (like MS Excel or Google Sheets etc.)</td>
</tr>
<tr>
<td colspan="2">Assessments

Formative Assessments
Quiz questions on topics such as:
● The main functions of operating systems and application software
● Outline the uses of various application software

Summative Assessments
Exam questions on topics such asL
● Describe the main functions of an operating system.
● Outline the uses of various application software.</td>
</tr>
<tr>
<td colspan="2">Learning Activities
1. In-class discussion: Instructor to share questions on how computer science is changing everything and then request students to watch & debrief on videos on the topic, e.g.: https://www.youtube.com/watch?v=QvyTEx1wyOY
2. Hands on activity explaining how to install commonly used system software and troubleshoot any issues during installation.
3. Hands on activity explaining how to install commonly used application software and troubleshoot any issues during installation.
4. Creating a presentation on a topic using an application like MS Powerpoint
5. Creating a written report on a research topic, the submission should include cover page, title, table of contents, headers, subheadings, paragraphs in a word processor like MS Word
6. Creating a chart from a table in a spreadsheet using an application like MS Excel
7. Creating a diagram in an image procSLO CS-10-G-01essing tool like MS Paint
8. Identifying formatting errors and knowing how to fix them
9. In-class activity: Instructor-led discussions about and analysis of sample programs written in assembly language https://www.scirp.org/journal/paperinformation.aspx?paperid=94063
10. In-class activity: Instructor-led exercises requiring students to understand a given assembly language program and then walkthrough translating higher-level language to assembly language and discuss issues that arise https://oliviagallucci.com/converting-high-level-languages-to-machine-language/
11.</td>
</tr>
</table>

[SLO CS-09-A-03]

Standard: Students will understand and explain the various components of a computer system and the different levels of interactions between these. They will have a basic understanding of digital logic, the different stages of the software life cycle and the concepts of scalability, reliability and security for computer systems.
Benchmark: students will identify and analyze components of computer systems and different levels of interactions between hardware, software, users, and computer networks.

Student Learning Outcome(s): [SLO CS-09-A-03] Students will be able to identify and analyze data communication, computer networks, networking devices, basic networking systems and understand how data is transmitted and key concepts such as protocols, speeds, etc.

Knowledge:
Students will understand

- How data is transmitted across a computer network for example circuit switching, packet switching, layering, encapsulation, and protocols
- Common network topologies and transmission modes
- Outline the advantages and disadvantages of wireless networks
- Outline the advantages and evolution of the Internet
- Outline common applications of the Internet
- The internet is the largest computer network ever built and learn how it works

Explain these key terms to students: 7-layer OSI networking model, LAN, WAN, packet switching, circuits, circuit switching, router, TCP/IP, IP, UDP, DNS, DHCP, host, browsers, layering, encapsulation and protocols

Skills:
Students will be able to

- Identify common network problems and provide possible solutions

Assessments

Formative Assessments
Quiz assessment questions on topics like:

- Network types and components
- Data transmission across networks, and protocols and their uses
- Application of networks

Examples of questions:

- What is a computer network? How is it different from a standalone computer?
- Explain how the internet is a computer network and explain how it works
- What is LAN, WAN and what is the difference between them?
- Name the 7 layers of the OSI reference model and explain what each does in brief
- A router operates in which layer of the OSI model?
- DHCP is the abbreviation of what?
- What is a DNS?
- What is the meaning of bandwidth in a network?
- What is the use of bridges in a network?

Summative Assessments

- Exam questions on topics related to:
- Network types in terms of a five-layer model
- Data transmission via packet switching, and networking technologies and protocols.
- Outline the advantages and disadvantages of wireless networks
- Network security methods and their advantages and disadvantages
- Network troubleshooting tools and techniques
- Understand and describe high level overview of cloud computing, everything as a service, and cloud storage

Learning Activities

1. **Textbook:** optional to assign readings from that aid better understanding of concepts Computer Networking
2. **In-class activity**: Instructor-led in class reading and discussions about how the internet works: https://cs144.github.io/handouts/week-1-how-the-internet-works.pdf
3. **In-class activity**: Instructor-led in class video and discussions about what is IOT (Internet of things) and how networking enables IOT: https://www.youtube.com/watch?v=xQGsubJNbQw (download video to show offline if no lab or internet in class)
4. **In-class activity**: Instructor-led video and discussions about Computer Networks, their history all the way to today: https://www.youtube.com/watch?v=3QhU9jd03a0 (download video to show offline if no lab or internet in class)
5. **Video**: Internet 101 explainer videos from Khan Academy: https://www.youtube.com/playlist?list=PLSQl0a2vh4HD8wtmKZh0nKOsOvP1KYaNO (download video to show offline if no lab or internet in class)

Domain B: Computational Thinking & Algorithms

[SLO CS-09-B-01] and [SLO CS-09-B-02]

Standard : Students will identify and decompose simple and complex problems, create & evaluate appropriate solutions using computational approaches, understand and apply common algorithms used in solving computational problems.
Benchmark I: Students will understand and apply computational thinking techniques to solve complex, real world problems.

Student Learning Outcomes
[SLO CS-09-B-01] Understand and apply techniques to decompose problems
[SLO CS-09-B-02] Solve simple and complex problems computationally

Knowledge:
Students will understand

1) The importance of computational thinking and problem-solving in computer science.
2) Principles of computational thinking:
    a) Logical thinking
    b) Algorithmic thinking
3) How to identify steps of a computational problem
4) How to identify the inputs, processes, and outputs of a problem
5) Different methods to design and construct a solution to a simple/complex problem, such as flow charts, /concept maps.
6) Steps to produce simple diagrams to show:
    a) The structure of a solution
    b) Subsections and their links to other subsections

Skills:
Students will be able to

1) Explain the role of computational thinking in computer science.
2) Read and interpret simple computational problems
3) Apply computational thinking principles to define and refine problems
4) Identify the procedure appropriate to solving a problem.
5) Evaluate whether the order in which activities are undertaken will result in the required outcome.
6) Identify the inputs and outputs required in a solution.

Assessments
Formative Assessments
Quiz questions on the following topics:

- Defining & describing problem-solving methods
- Solving computational problems using flow charts or concept maps

Summative Assessments
Exam question on the following topics:

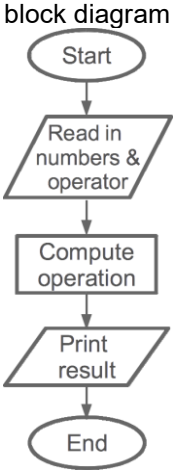
- Explaining the role of computational thinking in computer science.
- Reading and interpreting simple computational problems
- Applying computational thinking principles to define and refine problems
- Identifying the procedure appropriate to solving a problem.
- Evaluate whether the order in which activities are undertaken will result in the required outcome.
- Identify the inputs and outputs required in a solution.

Sample questions can include:

- Write logical solution steps & create a concept map and flow chart solving a word search puzzle, calculator program, or tic tac toe game

Learning Activities:

1. Describe computational thinking with examples and linking it with logical thinking.
2. Let students play simple games on paper, for example, tic tac toe, connecting dots game or traditional such as connecting dots within a group. https://kidpillar.com/games-kids-think-critically-critical-thinking/
3. Write Word search problem https://www.thesprucecrafts.com/free-word-searches-for-kids-1357174
4. Apply simple steps to solve problems such as tic tac toe.
5. Write the logical steps to find the treasure, and create concept map to find the solution https://www.javatpoint.com/the-wumpus-world-in-artificial-intelligence
6. Draw flowchart for calculator program using software like LARP
7. Activity: Spotting patterns helps programmers write better programs. https://abitofcs4fn.org/puzzles/pattern-matching-puzzles/caterpillar-puzzles-1/
8. Activity 2: Subjective questions with solving practical examples (ref Fig. 11. BCTt v.2 item example (item number 3) from https://www.semanticscholar.org/paper/Computational-Thinking-Test-for-Beginners%3A-Design-Zapata-C%C3%A1ceres-Mart%C3%ADn-Barroso/edf77fbe51d12bc76dcd5d4e7612bb047e676858
9. Make a cleaning robot: http://aimaterials.blogspot.com/p/blog-page_17.html
10. Ask students to make an algorithm for playing Tic Tac Toe
11. Critical thinking essay: https://www.studypool.com/discuss/26722703/critical-thinking-essasy
12. Importance of critical thinking & how to boost it: https://study.gov.pl/news/how-boost-your-critical-thinking
13. Computational thinking definition: https://digitalpromise.org/initiative/computational-thinking/computational-thinking-for-next-generation-science/what-is-computational-thinking/
14. Problem definition and Steps to solve an algorithm: https://ramahanishagunda.medium.com/a-search-algorithm-8233683c5d60
15. Draw a block diagram to solve calculator problem (simple example given below)



Domain C: Programming Fundamentals

[SLO CS-09-C-01]

Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learning how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration.
Benchmark I: Students will develop, test, and debug static website (using HTML and CSS) and an interactive website (using JavaScript)

Student Learning Outcome(s):
[SLO CS-09-C-01] *Students will understand web development and differentiate between a website and a web application*

Knowledge:
Students will

- Grasp the basic concepts and principles of web development, including the technologies, languages, and frameworks commonly used in building websites and web applications.
- Understand the distinctive features of web applications. They should learn that web applications are dynamic in nature, offering interactive functionalities, data processing, user authentication, and real-time updates.
- Comprehend that websites primarily provide information and content to users, while web applications offer more complex functionality, such as user input, data manipulation, and task execution.

Skills:
Students will be able to

- Distinguish between front end and back end development
- Determine which technology is appropriate for making static and dynamic web pages and web applications
- Identify and describe the features and characteristics of a website. This may include static content, informational pages, navigation menus, multimedia elements, and contact forms.
- Distinguish between websites and web applications based on specific criteria.

Assessments

Formative Assessments
Quiz / in-class assignments on the following topics:

- **Differences between a website and a web application**
- **Role of different technologies like HTML, Javascript, web browser in web development**
- **Different between a static and dynamic website**

Summative Assessments
A case study where students determine the best solution in terms of static/dynamic/interactive website and associated technologies for real-world problems

Learning Activities

- Website vs. Web Application Examples: Divide students into small groups and provide them with a list of websites and web applications. Ask each group to analyze the features and functionalities of each example and categorize them as either a website or a web application. Afterward, have groups present their findings and discuss their reasoning behind the categorizations.

- Website vs. Web Application Showcase: Assign each student or group with the task of researching and finding a real-life example of a website and a web application. In class, have students showcase their findings, explaining the key characteristics and functionalities that differentiate them. Encourage discussions on the distinguishing factors and potential use cases for each example.

- Design and Development Comparison: Provide students with a design mockup or wireframe of a website and a web application. In small groups, ask them to identify the elements and features that are unique to each type. Have them discuss and present their observations, emphasizing the user interactions, data processing, and dynamic functionality present in the web application design.

- Case Study Analysis: Provide students with a case study that involves a real-world website and web application. Ask them to examine the purpose, functionalities, and user experience of each. Have them compare and contrast the design choices, features, and development approaches used in the website and web application. Encourage critical thinking and discussions on the advantages and disadvantages of each approach.

[SLO CS-09-C-02]

<table>
<tr><td colspan="2">Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learning how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration.
Benchmark I: Students will develop, test, and debug static website (using HTML and CSS) and an interactive website (using JavaScript)</td></tr>
<tr><td colspan="2">Student Learning Outcome(s):
[SLO CS-09-C-02] Students should be able to create a static website using HTML/CSS in an appropriate environment</td></tr>
<tr><td>Knowledge:
Students will know
What is HTML
What is CSS
What is JavaScript
Students will understand
Characteristics, examples, similarities & differences between static and dynamic website
The purpose of HTML i.e. to display text and image content over the Internet
The capability of HTML documents to hyperlink to other documents/pages
The structure of an HTML document including the underlying DOM (Document Object Model) tree
How JavaScript is used to modify a website</td><td>Skills:
Students will be able to
Differentiate between a static and dynamic website
Create a static website using HTML & CSS in an IDE like Visual Studio code, Notepad++ etc.</td></tr>
</table>

Assessments

Formative Assessments
Practical / in-class exercises on the following topics:

- Share code snippets in class with bugs and ask students to point out the bug and how to fix it. Give students an assignment to make a webpage look a certain way (just share visual) and have them use CSS and HTML to create.
- What is the difference between static and dynamic websites? Illustrate with an example
- What does HTML mean and what is it used for?
- What is CSS and what is it used for?
- What is a web browser? Explain what happens when you type a website address in a browser?
- What are the main benefits of using Javascript?
- Inside which HTML element do we put the JavaScript?
- What is the correct syntax for referring to an external script called "xxx.js"?
- What will be the output of this code snippet? **console.log (String.raw`HelloTwitter\nworld`);**

Summative Assessments
Exam / quiz on following topics:

- What is the correct CSS syntax for making all the elements bold?
- How do you add a comment in a CSS file?
- The # symbol specifies that the selector is?
- How can you open the link in a new window with HTML?
- Which of the tags below must be located in the <head> section of your page?

<title>
<form>
<link>
<meta>

- Which tag is used to create an ordered list?

Learning Activities

1. Stages of website development: https://www.newperspectivestudio.co.za/website-design-process-steps/
   https://medium.com/@rachelheo/p4-case-study-9bc802f51a98
2. Create breakout groups and assign a problem to solve using HTML, CSS and Javascript.
3. Student groups present their solutions back to class
4. Demo of various debugging and testing tools for websites and share their pros and cons (some examples:https://developers.google.com/search/help/debug)
5. Begins with showing the following two websites
   i. https://funtech.co.uk/latest/why-kids-should-learn-computer-science
   ii. Search some keyword on www.google.com
   Ask students what they can observe and then explain that (i) no change in data whenever you refresh/call the page, while, (ii) search results can vary with different keywords.
6. Assign students a website project to showcase their resume and portfolio of projects (coding projects or art etc.) and have them build it using html, css, javascript. This can be a group or individual activity
7. In class assignment to use forms to build a survey website
8. How HTML is used to display content such as dividing content into divisions, different heading styles. [https://www.w3schools.com/html/]
9. The capability of HTML documents to hyperlink to other documents
   https://www.w3.org/TR/html401/struct/links.html
10. The structure of an HTML document including the underlying DOM tree (Document Object Model)
    https://www.w3.org/TR/WD-DOM/introduction.html
11. Adding pictures

https://www.w3schools.com/html/html_images.asp

12. How CSS is used to style displayed content using fonts, alignment and colors https://www.w3schools.com/css/
13. Start with defining website and share the story of first website https://www.home.cern/science/computing/birth-web
14. What Can Kids Do With HTML? https://www.codewizardshq.com/html-for-kids/]
15. code in javascript within html https://www.w3schools.com/html/html_scripts.asp
16. The structure of an HTML document including the underlying DOM tree (Document Object Model) https://www.w3.org/TR/WD-DOM/introduction.html
17. Explain the difference between static website and dynamic website https://blog.hubspot.com/website/static-vs-dynamic-website

[SLO CS-09-C-03]

Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learning how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration.
Benchmark I: Students will develop, test, and debug static website (using HTML and CSS) and an interactive website (using JavaScript)

Student Learning Outcome(s):
[SLO CS-09-C-03] Students should be able to create dynamic websites using JavaScript as the frontend scripting

Knowledge:
Students will understand

- Variables, Data Types and Arrays in JavaScript
- Variable assignment in JavaScript
- What aspects of HTML can be changed with JavaScript
- What aspects of CSS can be changed with JavaScript

Skills:
Students will be able to

- Use JavaScript to modify an HTML website to create an interactive website

Assessments Formative Assessments
Quiz / in class assignments / practical on the following topics:

- Variables, data types and arrays in JavaScript
- HTML aspects that can be changed with JavaScript
- CSS aspects that can be changed with JavaScript

Sample projects can include:

- Create a magic 8 ball game in JavaScript
- Create a todo list using an appropriate programming language
- Create a drum kit using JavaScript

Summative Assessments
Project submission / practical / Exam questions related to:

- Using JavaScript to modify the HTML to create an interactive website

Sample questions can include;

- What is dynamic typing?
- What are some basic data types in Javascript? Given an example usage of each
- Write statement to create an array of 3 elements of different data types
- Build a clock using Javascript and HTML

Learning Activities

1. Students can watch a video on how to make a website dynamic using JavaScript: https://www.youtube.com/watch?v=MkV_x-x79UI
2. In-class project build an interactive website using JavaScript:
    a. Sample 1: https://medium.com/@pearlmcphee/build-a-dynamic-app-using-javascript-html-and-css-f0dfc136007a
    b. Sample 2: https://www.htmlgoodies.com/javascript/creating-dynamic-websites-using-javascript/
3. Additional reading on concepts:
    a. https://www.udacity.com/blog/2021/06/javascript-hub.html
    b. Variables, Data Types and Arrays in JavaScript and printing values in console, https://www.edureka.co/blog/data-types-in-javascript/
    c. Variable assignment in JavaScript https://www.w3schools.com/js/js_variables.asp
    d. What aspects of HTML can be changed with JavaScript: https://www.w3schools.com/js/js_htmldom_html.asp
    e. What aspects of CSS can be changed with JavaScript: https://www.w3schools.com/js/js_htmldom_css.asp

[SLO CS-09-C-04]

Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learning how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration.
Benchmark I: Students will develop, test, and debug static website (using HTML and CSS) and an interactive website (using JavaScript)

Student Learning Outcome(s):
[SLO CS-09-C-04] Students should be able to implement common algorithms that use sequence, selection, and repetition in JavaScript

Knowledge:
Students will understand
- An algorithm is a set of instructions
- How the sequence of instructions affects the result
- Sequence, Selection and Repetition in JavaScript
- The use of Arrays in JavaScript

Students will be able to know:
- That how the APIs (e.g., chatGPT, DeepSeek, Gemini, perplexity etc.) can be used in any website using Javascript framework like jQuery, react Native, AngularJS etc.)

Skills:
Students will be able to
- Declare an array and populate its values using a loop in JavaScript
- Called different APIs to embed any facility/ service into the website.

Assessments

Formative Assessments
In-class assignments on computing problems that should be solved using JavaScript

Summative Assessments
Practical / lab exercise programming small algorithms in JavaScript
Practical / lab project creating a programming project in JavaScript

Learning Activities

1. Fun mini-applications that are great for beginners and use all the programming fundamentals:
- https://hackr.io/blog/javascript-projects
- https://skillcrush.com/blog/projects-you-can-do-with-javascript/
2. Start with using JavaScript in IDE (VS Code or Visual Studio or online interpreter) without HTML https://linuxhint.com/javascript-visual-studio-code/
3. Sequence, Selection and Repetition in JavaScript http://students.cs.ucl.ac.uk/schoolslab/projects/HT6/cooking/HT6/JavaScript_Seq_Sel_Itr.htmlL ink algorithm thinking in here from previous SLOs
4. Arrays in JavaScript https://www.w3schools.com/js/js_arrays.asp
5. Loops in javascript https://www.w3schools.com/js/js_loop_for.asp

[SLO CS-09-C-05]

Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learning how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration.
Benchmark I: Students will develop, test, and debug static website (using HTML and CSS) and an interactive website (using JavaScript)

Student Learning Outcome(s):
[SLO CS-09-C-05] Students will determine ways of debugging their code in JavaScript

Knowledge:
Students will understand

- Code written outside of a function is hard to test
- Code written inside a function can be tested
- That they can write code that calls functions to ensure the results are correct
- Using a debugger allows programmers to set a breakpoint to stop execution of their code to see the state of variables mid-execution for the purpose of discovering errors in their code

Skills:
Students will be able to

- Write code to invoke functions and check their return values for correctness
- Set a breakpoint to debug mistakes in their code

Assessments

Formative Assessments
Practical / lab exercises on identifying & resolving errors in computing problems using test functions and breakpoints.

Summative Assessments
Quiz/exam / practical on computing problems with errors and students to identify errors using test functions and breakpoints.

Learning Activities
- Basic workflow debugging for JavaScript programming (instructors can follow video and steps on this page: https://developer.chrome.com/docs/devtools/javascript/) **to use breakpoints**

Domain D: Data and Analysis
[SLO CS-09-D-01]

Standard 1: Students will be able to understand the scope of data science, how computer systems collect, store, process, visualize, and interpret data
Standard 2: Students will get an introduction to the relational data model, relational database engines, and SQL and how to design good schemas.
Standard 3: What is AI and machine learning, and how does it relate to data and data science.
Benchmark I: Students will be able to define and explain how to collect, store, analyze and visualize data.

Student Learning Outcomes: [SLO CS-09-D-01] Students will explain the scope of the data science field as an interdisciplinary field (computer sciences, mathematics & statistics, and business knowledge & understanding).

Knowledge:
1. Students will understand the key concepts and principles of data science

Students will know definitions of key terms:
data science, data analytics, computer science, mathematics, statistics, and business knowledge & understanding

Skills:
Students will be able to:
- Identify the difference between data science, data analytics, computer science, mathematics, statistics, and business knowledge & understanding

Assessments

Formative Assessments
In class (group exercise)- Students
Homework- Students

Quiz assessment/ project on:
- Identifying key concepts and principles of data science
- Identifying a business problem (e.g., from a newspaper article) that can benefit from data science.

Sample questions can include:
- Describe two business problems that could benefit from data science
- Describe similarities and differences within business problems that can be solved using computer science, mathematics, and data science.

Summative Assessments
Sample questions can include:
- Define and differentiate between data science, data analytics, computer science, mathematics, statistics, and business knowledge understanding
- Read a case study (1) identify the business problem (2) comment on how data science can solve the business problem

Learning Activities

- What is Data Science?
    a. Students construct the definition of Data Science and share it with the class
    b. Show a video [or share an article(s)] that goes over the concept of data science and exposes students to different definitions of data science.
- What is a business problem?
    a. Students draw a visual of how data science can solve a business problem
    b. Show a video [or share an article(s)] that define common business problems in data science

- Read an article about the different types of problem data science solves: https://hackernoon.com/9-unusual-problems-that-can-be-solved-using-data-science-e7dbb89aa0c4
    a. Summarize these problems
    b. Which ones replace human tasks?
- Read a newspaper article or online paper to identify a problem that can be solved using data science.
    a. Read the article: The Internet of Things Is Coming for Us - The New York Times (nytimes.com)
- Student to research, create project presentations, or discuss topics in class, e.g.,
    a. What is the Internet of Things
    b. What kind of data do Siri and Alexa collect? How is this data used?
    c. What problems/tasks are these technologies automating?
    d. What kind of everyday tasks are these technologies replacing?
- Potential curriculum resource textbook: https://curriculum.idsucla.org/IDS_Curriculum_v_5.0/1_IDS_Curriculum_v_5.0/IDS_Intro%2BUnit1_v%206.0_FINAL.pdf

[SLO CS-09-D-02]

Standard 1: Students will be able to understand how computer systems collect, store, process, visualize, and interpret data
Standard 2: Students will get an introduction to the relational data model, relational database engines, and SQL and how to design good schemas.
Standard 3: What is AI and machine learning, and how does it relate to data and data science.
Benchmark I: Students will be able to define and explain how to collect, store, analyze and visualize data.

Student Learning Outcomes: [SLO CS-09-D-02] Students will define and explain data types, data collection, and data storage.

Knowledge:
Students will understand:

1. Data is observations or measurements represented as numbers, text, or multimedia (image, sound, video, etc.) and the dataset is a collection of this data that is related in some context.
2. Different sources of data like sensors
3. The concept of database and dataset
    - Table (relation)
    - Rows (record, tuple, object)
    - Column (object attributes, properties, field)

Skills:
Students will be able to:

- Distinguish between data and dataset
- Collect data from different sources
- Identify missing data in a dataset
- Construct summary statements about the data, how it is collected, how it is used, and how to work with it
- Understand the differences between structured and unstructured data, quantitative and qualitative data)

4. Types of Object attributes or properties:
    - Categorical or Qualitative Attribute
        - Nominal
        - Binary
        - Ordinal
    - Numeric or Quantitative
        - Interval-scaled,
        - Ratio-scaled,
        - Discrete
        - Continuous
5. Data collection, analysis, and visualization.
6. Students will know how to use summary statistics to formulate sentences and describe the data, data collection methodology, how the data will be used

Students will be able to:

1. Explain how data, information, and knowledge are represented for computational use.
2. Collect, upload, and share personal data collected in class (e.g., Stick Figure exercise in Learning Activity # 2)
3. Learn about different representations of distributions using software.
4. Utilize software to begin to analyze plots of data collected
5. Interpret different types of data: Numerical and graphical summaries.
6. Understand that rows and columns are a form of data structure.

Assessments

Formative Assessments

Quiz questions/research assignments / in-class discussions on topics such as:

- Identifying data types in a given data table.
- Creating a template and assigning it data values such as a stick figure being assigned properties such as name, age, height, grades, etc.

Sample questions can include:

- What is data? Data are information or observations, that have been gathered and recorded.
- Where does data come from? Data can come from a variety of places. Some examples might include: cell phones, computers, school records, surveys, etc.
- Give an example of data. Answers will vary. One example might be information about a person – including their age, height, weight, eye color, etc.
- Give an example of something that is not data (e.g., something that was never written down). Answers will vary. One example might be just watching an event happen. If it wasn't recorded in some way, it cannot be counted as data.

Summative Assessments

Practical / Lab Exercises on load data from a .csv or .xls or to RStudio or Python
Exam question on:

- Constructing summary statements about data, how it is collected, how it is used, and how to work with it
- Defining a database, its rationale, and its purpose for managing data.
- Explain why the relationship between the variables might exist, or if there is no relationship, why that might be so.

Learning Activities

1. Data is everywhere. Identify a video/ article to introduce students to the idea that data is ubiquitous. The advent of computers has transformed the way data are collected, used, and analyzed. See how Amazon uses your data: How Amazon Uses Big Data | Future of Tech (https://youtu.be/O0DnYqkRWWQ)
2. Experience data handling using ubiquitous data and organize data using rectangular or spreadsheet format as data storage structures. Everyday activities can be observed and recorded as data. Become aware of the difference between plots used for categorical and numerical variables. Interpret and understand graphs of distributions for numerical and categorical variables. See an example of an activity that teaches students how to collect data: Lesson 6: What Do I Eat? - Introduction to Data Science Curriculum (idsucla.org)
3. Data & Variables: Data can be broken up into two parts.
    a. Observations - Observations are the who or what we are collecting data from/ about.
    b. Variables − Variables are the measurements or characteristics about our observations.
    c. If need be, re-type the command you used to view your data. Then answer the following:
        i. Based on the data, describe a few characteristics about the first observation. What does the first column tell us about our observations?
        ii. In order to describe the first observation, notice that you had to look at the first row of the spreadsheet. Each row, in this case, describes a person.
        iii. The columns of the spreadsheet represent variables.
4. Students collect data such as a. Name b. Height c. Grades d. Shoe or Shoe Type e. Sport f. Friends or Number of Friends. (See Stick Figure Exercise Lesson 2: Stick Figures - Introduction to Data Science Curriculum (idsucla.org))
    a. Discuss and define the different data types, categorical, numerical of the data collected.
    b. Identify ways to organize the data (e.g., create a data table that consists of rows and columns.) This type of organization as rectangular format, or spreadsheet format.
5. Watch a video/read an article about Structured vs Unstructured data. Structured vs. Unstructured Data: What's the Difference? | Coursera (https://www.coursera.org/articles/structured-vs-unstructured-data)& What is Big Data | Big Data Types | Types of Data | Structured Data | Unstructured Data | https://youtu.be/dK4aGzeBPkk
    a. What is big data (will be introduced again as a separate SLO)
    b. Discuss the differences between the two data types
    c. Identify examples of structured and unstructured data

[SLO CS-09-D-03]

Standard 1: Students will be able to understand how computer systems collect, store, process, visualize, and interpret data
Standard 2: Students will get an introduction to the relational data model, relational database engines, and SQL and how to design good schemas.
Standard 3: What is AI and machine learning, and how does it relate to data and data science.
Benchmark I: Students will be able to define and explain how to collect, store, analyze and visualize data.

Student Learning Outcomes [SLO CS-09-D-03] Students will be able to define and explain big data, and applications of big data in real-world business

Knowledge:
Students will understand

1. What insights big data can provide to businesses
2. What tools and systems are used by big data scientists and engineers

Students will know

1. Applications of big data
2. What makes big data valuable?
3. Characteristics of big data
4. How data science gets value out of big data
5. Introduction to concepts such as the Internet of Things (IoT) and the role of the cloud.

Skills:
Students will be able to

- Identify the different types of big data
- Recognize if big data is used to solve a business problem

Assessments

Formative Assessments
Quiz assessment questions / in class discussions on topics such as:

- Applications of big data
- What makes big data valuable?
- Characteristics of big data

Sample topics are:

- In-class discussion: Case Study of Machine-Generated Data vs. People-Generated Data
- In-class discussion: Saving Lives With Big Data and the role of big data in health
- Quiz#1: Give an example of how a company uses big data to provide a better user experience.

Summative Assessments
Exam questions on topics such as

- Identify the different types of big data
- Recognize if big data is used to solve a business problem
- Read and critique published stories by interpreting the visualizations and experimental conclusions
- Formulate questions, identify existing or similar business cases, and evaluate how the new business solutions that leverage big data stack up against the old.

Sample questions are:

- Define the characteristics of big data. Give an example of big data and how a business uses it to make better decisions.

Learning Activities

1. Definitions of Big Data: What is Big Data | Big Data Types | Types of Data | Structured Data | Unstructured Data | https://youtu.be/dK4aGzeBPkk
2. Watch this video to introduce the concept of Big Data: Big Data in 5 mins: https://youtu.be/bAyrObl7TYE
    a. After introducing the video, the instructor can decide how to structure an interactive discussion in class.

i. What are data types stored on a smartphone?
ii. Do you know anything about privacy? Do you read privacy statements before sharing your data?
iii. Should customers permit businesses to use their data, even if it improves the customer user experience?

3. Watch videos/read case studies about the San Diego Supercomputer Center
4. Watch the videos/articles & complete exercises & quizzes on Khan Academy on: Sources of big data | AP CSP (article) | Khan Academy https://www.khanacademy.org/computing/ap-computer-science-principles/data-analysis-101/big-data/a/sources-of-big-data and complete the exercise and quizzes

Domain E: Applications of Computer Science
[SLO CS-09-E-01]

Standard 1: Student will understand computer technologies such as blockchain/AI/IoT/cloud computing/game design and development.
Standard 2: Student should be able to understand how computers learn, make decisions and the applications, challenges and social implications of AI.
Benchmark I: Students learn about different popular fields in Computer Science like AI, Cloud Computing, IoT, and Blockchain.

Student Learning Outcome(s):
[SLO CS-09-E-01] Students will be able to describe uses and applications of computing like AI, Machine Learning, and Cloud Computing

Knowledge:
Students will understand
- What is AI and Machine learning and the kind of problems each is able to solve
- Different areas of AI – Speech recognition, Computer Vision, Natural Language Processing, and Expert Systems.
- Different applications of AI in domains like healthcare, education, gaming, agriculture.
- What is cloud computing and the need for it

Skills:
Students will be able to
- Identify problems that can be solved using these technologies
- Identify different applications of AI

Assessments

Formative Assessments
Quiz questions on topics such as:
- What are IoTs and applications that are enabled by IoTs.
- What are AI and Machine learning and the kind of problems each is able to solve
- What is cloud computing and the need for it

Summative Assessments
Project of Essay questions applications of various technologies like AI, Machine Learning, or Cloud Computing

Learning Activities
1. What are IoTs: Students learn examples of applications that use IoTs like energy efficiency in smart homes, healthcare through wearable devices, smart transportation with connected public transport systems.
2. What is cloud computing: Students learn what is cloud computing and its benefits. Students learn about popular platforms like AWS, Azure, GCP, etc.

3. What is AI and Machine Learning: Students will learn definitions of AI and machine learning based on simple activities based on how humans learn. Students will learn about tasks that are easy for humans but hard for computers like
    a. Recognizing emotions in voice (fear, sarcasm, anger, etc.)
    b. Finding objects in Images
4. And recognizing tasks that are easier for computers but hard for humans
    a. Hard math problems
    b. Finding a number in a large sequence

[SLO CS-09-E-02]

Standard 1: Student will understand computer technologies such as blockchain/AI/IoT/cloud computing/game design and development.
Standard 2: Student should be able to understand how computers learn, make decisions and the applications, challenges and social implications of AI.
Benchmark I: Students learn about different popular fields in Computer Science like AI, Cloud Computing, IoT, and Blockchain.

Student Learning Outcome(s):
[SLO CS-09-E-02] Students will be able to discuss the social implication of the usage of AI in decision-making that affects humans

Knowledge:
Students will understand
- AI algorithms make decisions that work for most people but harm or disadvantage others.
- Designers of AI algorithms should keep their focus on benefiting people

Students will know
- Ethical issues in some popular AI tools

Skills:
Students will be able to
- Explain what are some ethical issues when computers make decisions for humans
- Identify decisions that might harm humanity
- Identify decisions that might be biased towards certain group of individuals

Assessments

Formative Assessments
Quiz / Research projects on
- social implication of the usage of AI in decision-making that affects humans
- Ethical issues in some popular AI tools

Summative Assessments
Exam / MCQs - Ethical issues in some popular AI tools

Learning Activities
1. Students will use voice recognition software or tools like Siri and see if there are difference in performance based on students' accents
2. Students should discuss why Siri does not recognize Urdu (opinion article on the subject can be found here: https://medium.com/swlh/siri-alexa-and-other-voice-assistants-struggle-with-bilinguals-a9dc35fc0e2a)
3. Students should be shown videos of surveillance and discuss tradeoffs between privacy and security. Examples of further material on the topic

a. https://www.forbes.com/sites/forbestechcouncil/2021/06/03/how-to-balance-trade-offs-between-security-and-privacy-in-it/?sh=21a34d6c66a6
b. https://www.youtube.com/watch?v= FndBq3WAwM
c. https://www.youtube.com/watch?v=vCxEULwvMcI

Domain F: Impacts of Computing
[SLO CS-09-F-01]

Standard 1: Student will be able to understand Ethics and laws related to computing and the use of computing devices, media, data, and the internet and the applications of personal privacy and Network security.
Standard 2: The environmental, cultural and human impact of computing and assistive technologies for the modern world.
Benchmark I: Students will obtain knowledge of ethical and legal issues surrounding the use of computing.
Benchmark II: Students will understand privacy and network security issues surrounding computing applications and devices they use everyday
Benchmark IIIII: Students will understand the role of assistive technologies and understand the implications of the digital divide

Student Learning Outcomes
[SLO CS-09-F-01] Understand and apply safe and responsible use of computers (responsible use of hardware, appropriate use of software, and safe use of digital platforms like data searches, social networking, etc.)

Knowledge:
Students will understand

- The selection and use of different hardware, software, and digital platforms safely depending on the tasks to be executed
- The need for laws to protect user privacy and intellectual property (patents, trademarks, copyrights etc.)

Students will know

- What is meant by the key concepts of data ethics and intellectual property rights
- How to safely use data searches and social networking sites

Skills:
Students will be able to

- Discuss how ethics are guidelines that dictate the responsible use of computing systems
- Identify computer related laws
- Interpret software agreements, licenses and application terms

Assessments

Formative Assessments
Quiz assessment questions on:

- The selection and use different hardware, software, and digital platforms for safe use depending on the tasks to be executed
- The need for laws to protect user privacy and intellectual property
- What is meant by the key concepts of data ethics and intellectual property rights
- How to safely use data searches and social networking sites
- Legal issues related to computing such as software piracy laws

Sample questions can include:

- Quiz 1 Identify computing laws in developing vs developed nations. Why do you think accounts for their differences?

- Quiz 2 Why do we need to consider ethics in computing? Consider the impact of computing on individual privacy, freedom of speech, intellectual property, work, distribution of wealth, and the environment in your response.
- Student Self-Assessment/Reflection- Reflect on the computing devices, applications and platforms you use every day. Have you ever considered the legal and ethical issues surrounding computing before this unit?
- Case Study assignment: Students will be asked to select one online website or application and investigate how it maintains or violates users' data privacy. Students will discuss issues of ethics as part of the case study analysis.

Summative Assessments
Exam questions on topics such as:
- Ethics are guidelines for responsible use of computing systems
- Computer-related laws
- Interpreting software agreements, licenses and application terms

Sample question could be:
- How has this unit impacted your views on the ethical and legal issues surrounding the use of computing devices and applications?

Learning Activities

- Search for computer related laws in different countries and discuss how they vary.
- Students will define computer ethics and describe ethical and legal issues related to the use of computers, public/private networks, freeware, and shareware.
- Students will define key terms and differentiate between intellectual property rights, software piracy and information privacy
- Students will look at a software agreement from an application they use everyday and explain how that will impact user privacy. They will point out what data is being collected and how it will be used.
- Students will work in groups to debate laws that regulate the development of software. They will consider data privacy and user protection in their discussions.
- Students will categorize different software as open source, shareware etc. with examples

[SLO CS-09-F-02]

Standard 1: Student will be able to understand Ethics and laws related to computing and the use of computing devices, media, data, and the internet and the applications of personal privacy and Network security.
Standard 2: The environmental, cultural and human impact of computing and assistive technologies for the modern world.
Benchmark I: Students will obtain knowledge of ethical and legal issues surrounding the use of computing.
Benchmark II: Students will understand privacy and network security issues surrounding computing applications and devices they use everyday
Benchmark IIIII: Students will understand the role of assistive technologies and understand the implications of the digital divide

Student Learning Outcomes
[SLO CS-09-F-02] Analyze the beneficial and harmful effects of computing innovations such as social networking, fake news, etc.

Knowledge:
Students will understand

- Every computing innovation will solve a need but can cause harm to users as well
    - Benefits can be the need being solved and the societal & user benefits
    - Harmful effects of computing innovations on users, society, environment, etc.
- The tradeoffs between information privacy, system security and usability
- The importance of designing computing systems that will protect user privacy and increase system security

Students will know

- What is meant by following key concepts and be able to differentiate between them: scams, software piracy, freeware, shareware, opensource, malware, phishing, hacking etc.
- The tensions between censorship of internet and freedom of speech
- Common types of security problems such as spam, spyware, pharming, cookies etc.

Skills:
Students will be able to

- Explain basics of reliable and unreliable sources of information
- Distinguish between fake news and credible sources of information
- Identify malicious internet scams, phishing, pharming, fraudulent activity, fake websites, etc.
- Evaluate designs of computing technologies (e.g., social media, generative AI etc.) based on their user privacy policies and agreements

Assessments

Formative Assessments
Quiz assessment questions / in class discussions on:

- Advantages and disadvantages of computing innovations in terms of health & usage
- Tradeoffs between information privacy, system security and usability
- User privacy and increase system security
- Defining & differentiating between scams, software piracy, freeware, shareware, opensource, malware, phishing, hacking
- Tensions between censorship of internet and freedom of speech

Sample question could be:

- Student Self-Assessment/Reflection Create a diary of all the different kinds of interactions you have this week that involve computers. For each interaction, state how they would be different without the use of computers.
- Quiz 1 Assess and critique current popular sources of digital information. Which sources do you think are credible and why? Which sources do you think can be considered as providing fake news and why?
- Quiz 2 Explain how computing innovations have been beneficial to society with the use of 2 concrete examples. Can you think of any ways these innovations can also cause harm?
- Quiz 3 Summarize what we mean by intellectual property, internet security, plagiarism, and data privacy and explain how technology has impacted each of these in the modern world.

Summative Assessments
Exam questions on topics such as:

- Reliable and unreliable sources of information
- Malicious internet scams, phishing, pharming, fraudulent activity, fake websites,
- User privacy policies and agreements

Sample question could be:

- Select one computing application and system you have used personally and provide recommendations for improving data privacy and/or system security. Please include detailed reasoning for your choices.

Learning Activities

- Working in cooperative groups students will discuss how to distinguish between fake news and credible information. What strategies have you used to find credible sources of information.
- Consider how censorship works on the internet. Although it may seem the content on the internet cannot be controlled there is still a lot of censorship that takes place by repressive governments and intellectual property lawyers who can get content removed. Research some incidents where governments or IP lawyers have been successful in removing content from the internet.
- Divide your classroom into groups. Discuss the following: Anonymous posts on the internet. How does technology allow good and bad speech to exist online?
- Examining the source of any information is extremely important in this digital age where all kinds of information is posted on the internet. Select an article from the internet on a research topic you are interested in and then answer the following questions:
    - Who is the author?
    - What is the purpose of this article?
    - Who is the intended audience?
    - Where was the information published?
    - Who owns this data source or medium?
    - When was it written?
    - When was the article updated?
    - Did the author cite their sources?

[SLO CS-09-F-03]

Standard 1: Student will be able to understand Ethics and laws related to computing and the use of computing devices, media, data, and the internet and the applications of personal privacy and Network security.
Standard 2: The environmental, cultural and human impact of computing and assistive technologies for the modern world.
Benchmark I: Students will obtain knowledge of ethical and legal issues surrounding the use of computing.
Benchmark II: Students will understand privacy and network security issues surrounding computing applications and devices they use everyday
Benchmark IIIII: Students will understand the role of assistive technologies and understand the implications of the digital divide.

Student Learning Outcomes

[SLO CS-09-F-03] Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices

Knowledge:	**Skills:**
Students will understand ● Environmental impacts of computing ● Computing has changed the way we live and conduct business	Students will be able to ● Strategize on how to minimize the environmental impacts of computing

● Impact of computing on globalization and e-commerce	● Evaluate designs of computing technologies in terms of personal, environmental, ethical, legal, social, economic, and cultural impacts

Assessments

Formative Assessments
Quiz assessment questions / in class discussions on:
- Impact of computing on daily life
- Intellectual property and individual rights
- Impact of computing on globalization and e-commerce

Sample question could be:
- Quiz 1 Technological innovations have allowed greater freedom of speech in many ways as anyone with access to the internet can post information. However, this freedom can also allow for bad speech to exist. Discuss the ethical, personal and social impact of the internet by examining a situation where someone has posted information about you that you did not want shared publicly.
- Student Self-Assessment/Reflection How do you think technology has changed the way you interact with your friends and family?

Summative Assessments
Exam questions on topics such as:
- Environmental impacts of computing
- Patents, trademarks and copyright information for computing applications
- Technology design and intellectual property

Sample question could be:
- Examine the many ways in which computing innovations have had an impact on society, including privacy, freedom of speech, intellectual property, work, distribution of wealth, and the environment as well as for the many different fields in which they are used. Provide at least 3 examples.

Learning Activities
- Find two examples each of: copyrights, trademarks and patents.
- Computing has changed the way we do everything in the modern world including the world economy. The main impacts have included e-commerce, new marketing tactics, facilitation of globalization, and creation of new jobs. Select one of these areas and provide an example of how that technology has changed the way we interact with the world.
- Job insecurity is a big human impact of computing innovations. List some jobs that have become obsolete because of computing.
- Investigate and describe governmental initiatives promoting environmental awareness and sustainability such as, recycling centers, refurbishing computers, printer cartridge recycling programs etc. If none exists, create a list of suggestions to reduce environmental impact.
- List strategies to reduce impact of computer technologies on the environment including strategies like turn computers and monitors off at end of day.
- Students will be asked to find examples from their lives where violation of data ethics has been harmful to others. They will speak to family and friends about their experiences of sharing data and identify how harm can occur if data privacy is violated.

Domain H Entrepreneurship in the Digital Age

[SLO CS-09-H-01]

Standard: Students will Create a business using design thinking with the help of digital/AI tools.
Benchmark: Students will learn how to identify problems and create and present business solutions.

Student Learning Outcome(s) [SLO CS-09-H-01]: Students will identify a problem and create a business idea using design thinking

Knowledge:
Students will understand:

- Skills needed for problem solving: 4Cs of the 21st century *(collaboration, critical thinking, creativity, communication)*
- Define design thinking as a process which includes:
  - Empathizing to discover the problem
  - Defining or interpreting the problem
  - Ideating on how to solve the problem
  - Experimenting or prototyping the solution
  - Evolving the solution as insights redefine the problem
- How to define & articulate an entrepreneurial solution to address a local or global problem
- Sustainable development goals (SDGs) as the world's development goals, and linking these SDGs to potential problems that need resolving
- Growth mindset vs. fixed mindset

Skills:
Students will be able to:

- Define a problem in their local context
- Categorize the problem according to SDGs
- Use design thinking to create a solution
- Identify advantages of having a growth mindset in entrepreneurship

[Advanced] Evaluate business success using the triple bottom line (people, profit, planet)

Assessments
Formative Assessments

- Case studies: Students can look at successful businesses around the world and try to articulate the problem they are facing
- Projects: Students can define local or global problems and identify business ideas that can solve these problems
- In-class activities: Students can present business ideas that solve local or global problems

Summative Assessments

- **Exam / Quiz / case studies / project regarding:**
  - Using design thinking to create an entrepreneurial solution to address a local or global problem

Learning Activities

- Growth vs. fixed mindsets: Students can watch a video on growth mindsets and discuss learnings as a group. Examples of videos could be:
  - Growth vs. fixed mindset: https://www.youtube.com/watch?v=M1CHPnZfFmU
  - TEDx talk on what growth mindsets means for kids: https://youtu.be/66yaYmUNOx4

- The Problem-Definition Process using design thinking: https://www.theagileelephant.com/what-is-design-thinking/
- Think, pair, share: students can read and summarize an article or video on the problem-definition process (e.g., https://www.ideo.com/datascope/how-to-solve-a-problem-in-3-steps, https://hbr.org/2012/09/are-you-solving-the-right-problem or https://youtu.be/uvw-u99yj8w)
- Brainstorming: students should brainstorm on local & global problems, and link them to sustainable development goals
- Triple bottom line: Students can research & evaluate companies using the triple bottom line
- https://elearning.scranton.edu/resources/article/triple-bottom-line/
- IDEO Method cards regarding problem identification, source: https://static1.squarespace.com/static/57c6b79629687fde090a0fdd/t/58890239db29d6cc6c3338f7/1485374014340/METHODCARDS-v3-slim.pdf
- Reflection: Students should reflect on 4Cs of the 21st century *(collaboration, critical thinking, creativity, communication)* and how they applied them when they were coming up with their business idea
- Field visit to an industrial / business cluster, SMEDA, private sector institutions such as business incubation centers, or coworking spaces.
- Speaking session with an entrepreneur or representative from the entrepreneurship space like a incubation center or SMEDA representative etc

[SLO CS-09-H-02]

Standard: student will Create a business using design thinking with the help of digital/AI tools.
Benchmark: Students will learn how to identify problems and create and present business solutions.

Student Learning Outcome(s): [SLO CS-09-H-02]: Students will use digital tools to create and present a business plan for an entrepreneurial solution.

Knowledge:
Students will understand:
- Key elements of a business plan containing at least the following
  - Market size (in terms of TAM Total Addressable Market, SAM Serviceable Available Market, and SOM Serviceable Obtainable Market)
  - Solution /Product/service & unique selling proposition
  - Financial feasibility
  - Go to market strategy
- How to collect & synthesize information to create a business plan using AI tools
- How to evaluate a business plan with the help of AI tools

Skills:
Students will be able to:
- Create a business plan using digital/AI tool
- Evaluate a business plan using criteria such as communication, feasibility, market potential etc.

Assessments
.
Formative Assessments
- Case studies: Students can look at business plans of successful companies and evaluate them
- Projects: Students can create a business plan, or evaluate business plans of peers

Summative Assessments

- **Exam / Quiz / case studies / project regarding:**

Business plans to articulate an entrepreneurial solution to address a local or global problem

Learning Activities

- Market sizing: students can conduct primary and secondary research on how to identify the TAM total addressable market, SAM Serviceable Available Market, and SOM Serviceable Obtainable Market for their business
- Market sizing:
  - Students can refer to www.smeda.org.pk to get market size of various sectors
- Financial feasibility:
  - Sources of information / data for market estimation, growth trends for projections can be: Pakistan Bureau of Statistics (PBS), Chamber of commerce, trade associations, ITC's www.trademap.org etc.
  - Students can look at annual reports for listed organizations
- Solution product/service: students can identify their unique selling proposition compared to competitors
- Financial feasibility of a business idea: student should create financial projections for revenue and costs as they grow
- Go to market strategy: students should conduct some research and identify the best channel go-to-market strategy for their business
  - Students can use online selling platforms and e-commerce as part of go to market strategy
- Peer review: students should evaluate their peers business plans and give feedback
- IDEO Method cards regarding business solutions, source: https://static1.squarespace.com/static/57c6b79629687fde090a0fdd/t/58890239db29d6cc6c3338f7/1485374014340/METHODCARDS-v3-slim.pdf

Grade 10

Domain A: Computing Systems

[SLO CS-10-A-01]

<table>
<tr><td colspan="2">Standard: Students will learn about component and interactions between computer systems, stages of software development, data representation and transmission across networks of computing systems and the implications on usability reliability, security etc.
Benchmark: Students will identify and analyze components of computer systems and different levels of interactions between hardware, software, users, and computer networks</td></tr>
<tr><td colspan="2">Student Learning Outcome(s):
[SLO CS-10-A-01] Students will be able to understand and describe number systems and encoding schemes for data representation in computer systems</td></tr>
<tr><td>Knowledge:
Students will understand
What is Machine level representation of data
What are the different numbering systems (decimal, binary, hexadecimal, octal)
How text is represented digitally using common text encoding (ASCII, Unicode)
Students will know
Key terms: ASCII, Unicode, binary, signed and unsigned numbers, bit, byte, negatives in binary, 1’s complement, 2’s complement, binary arithmetic,
How computers use binary arithmetic.</td><td>Skills:
Students will be able to
Understand and explain data representation, instruction sets and addressing modes.
Demonstrate how data is encoded using ASCII and Unicode
Perform manipulations, conversions, and arithmetic at the machine level using two's-complement integers, floating point numbers, characters.</td></tr>
<tr><td colspan="2">Assessments

Formative Assessments

Quiz / In-class exercises on the topics:
How is data represented at the machine level?
What is the binary equivalent of the decimal number 10?
What is a bit in computer terminology?
In a number system, each position of a digit represents a specific power of the base, true or false?
What could be the maximum value of a single digit in an octal number system?
Convert between integer bases and encode floating-point numbers in binary
Represent any given integer number in different bases (such as base 2, 8, 10, and 16).

Summative Assessments
End of module assessment or end of term exam</td></tr>
<tr><td colspan="2">Learning Activities
In-class activity: Instructor-led video viewing and discussion about why computers use 1s and 0s and a short explanation of binary and ASCII: https://www.youtube.com/watch?v=Xpk67YzOn5w&t=97s
In-class activity: Instructor-led video viewing and discussion about why computers use binary vs. base 3 or other base systems: https://youtu.be/fXwSFhUVFmE</td></tr>
</table>

3. **In-class activity**: Instructor-led exercises in which students convert between integer bases and encode floating-point numbers in binary
4. **Out-of-class assignment**: Assigned readings on such topics as integer types represented in two's complement
5. **Video:** How to represent numbers and letters with binary: https://www.youtube.com/watch?v=1GSjbWt0c9M
6. **Video**: Converting between different number systems: https://www.youtube.com/watch?v=Fpm-E5v6ddc

[SLO CS-10-A-02]

Standard: Students will learn about component and interactions between computer systems, stages of software development, data representation and transmission across networks of computing systems and the implications on usability reliability, security etc.
Benchmark: Students will identify and analyze components of computer systems and different levels of interactions between hardware, software, users, and computer networks

Student Learning Outcome(s):
[SLO CS-10-A-02] Students will be able to explain how system software controls the flow of information between hardware components used for input, output, storage, and processing

Knowledge:
Students will understand that
- What is an operating system
- What are the different types of operating systems
- What main tasks an operating system performs
- How application programs run on top of operating systems?

Students will know
- Key terms: System calls, Processes, threads, synchronization, interrupts, system calls scheduling, deadlock, File system interface, Memory system and virtual memory.
- The primary resources managed by an operating system
- What a process is and the sequence of states/phases for a process to complete

Skills:
Students will be able to explain
- How programming languages, operating systems, and architectures interact and how to use each effectively.
- The services provided by and the design of an operating system.
- The structure and organization of the file system.
- What a process is and how processes are synchronized and scheduled.
- Different approaches to memory management.

Assessments

Formative Assessments

Quiz / In-class exercises on the topics:
- Types, purpose, application of operating systems

Sample question could be:
- What is the primary purpose of an operating system?
- What are the four main computer system resources managed by an operating system?
- What is a process? What is the difference between a job and process?
- What is a thread?

- What is a process scheduler and what are the characteristics of a good process scheduler?
- What are the differences between paging and segmentation?
- What are two hardware features that are used to support an operating system and how do they work?
- What is the sequence of events that a process goes through as it executes?

Summative Assessments
Exam questions on topics such as:
- Interaction of programming language, operating systems, and computer architecture
- Types, purpose, application of operating systems
- Structure and organization of the file system
- Computer processes
- Memory management:

Learning Activities
In-class activity: Instructor-led video viewing and discussion about what an operating system is and how it came about: https://www.youtube.com/watch?v=26QPDBe-NB8
Video: Instructor can play a video on operating systems and students can share out key learnings on operating systems and it's various components. Example videos in playlist: https://www.youtube.com/watch?v=vBURTt97EkA&list=PLBlnK6fEyqRiVhbXDGLXDk_OQAeuVcp2O

[SLO CS-10-A-03]

Standard: Students will learn about component and interactions between computer systems, stages of software development, data representation and transmission across networks of computing systems and the implications on usability reliability, security etc.
Benchmark: Students will identify and analyze components of computer systems and different levels of interactions between hardware, software, users, and computer networks

Student Learning Outcome(s):
[SLO CS-10-A-03] Students will identify and learn common software tools such as translators, integrated development environments, online and offline computing platforms, code repositories, etc.

Knowledge:
Students will understand
- The types of software and how they are different
- Where software is hosted and pros and cons of on-premises vs. cloud
- How programming software helps programmers to write code that can then get compiled.
- Explain the difference between system software, programming software, application software and driver software.
- Identify common examples of the different types of applications
- Describe uses of common productivity application software
- Describe uses of programming software such as language editors, debuggers, compilers, Arduino IDEs, source code repositories and build systems (e.g., Eclipse for Java, Coda for Mac, Visual

Skills:
Students will be able to
- Understand uses of different software and tools
- Apply common software tools such as translators, integrated development environments, online and offline computing platforms, code repositories etc.
- Know the difference between cloud and on premises hosting

Studio for multiple languages, GitHub for source code) Students will know ● Definitions of key software tools such as translators, integrated development environments, online and offline computing platforms, code repositories etc. ● Difference between on premises and hosted application software ● What applications can be used without internet(offline) and which require internet to work (online) ●	

Assessments
Formative Assessments
Quiz / In-class exercises on the topics:

- Types of software and their differences
- Pros and cons of software hosting on-premise vs. in cloud
- How programming software helps them write code that can then get compiled.

Sample question could be:

- A user calls to tell you that every time they browse the internet a window pops up on the screen even though he has not clicked anything. What is the issue here and how should you fix the problem?
- What software is designed to let the operating system talk to hardware?
- What is an application patch?
- Word processing, spreadsheets and presentation software are examples of what types of software?
- What kind of software does not require users to pay for it?
- When thinking of software compatibility, which two factors matter the most?
- What is the difference between on-premise hosted vs. cloud hosted?
- What is a debugger? Give an example
- What is a compiler? Give an example

Summative Assessments
Exam questions

- Differences between system software, programming software, application software and driver software.
- Common examples of the different types of applications, including productivity and programming software

Learning Activities

1. **In-class activity**: Instructor-led video viewing and discussion about how software works: https://youtu.be/xnyFYiK2rSY (Download and share video if no internet or lab)
2. **In-class activity**: Instructor to demonstrate how to install software and demo common programming software for students to try hands-on. Build a simple one-line hello world type program in a programming language like Python and ask students to follow along
3. **In-class activity**: Instructor-led video viewing and discussion about top 5 programming tools for new coders: https://www.youtube.com/watch?v=WWy7ZWQiG8s (Download and share video if no internet or lab)

Domain B: Computational Thinking & Algorithms
[SLO CS-10-B-01]

Standard: Students will identify and decompose simple and complex problems, create & evaluate appropriate solutions using computational approaches, and understand and apply common algorithms used in solving computational problems.
Benchmark I: Students will understand and apply computational thinking techniques to solve complex, real world problems

Student Learning Outcomes [SLO CS-10-B-01] Students will identify common algorithms used to develop software, store, search, or sort information

Knowledge:
Students will understand

1) How to solve the counting problems
    a) Basics of a counting problem
    b) Basic counting principles
        i) Multiplication
        ii) Addition
        iii) Permutation
        iv) Combination
        v) The pigeonhole principle
        vi) Inclusion and exclusion principle.

    2) Steps of an AI-based algorithm
        i. Input: Large data
        ii. Pre-processing: data arrangement & cleansing
        iii. Model selection: classification, regression, clustering, and neural networks
        iv. Training
        v. Testing & evaluation
        vi. Deployment
2) Logical reasoning and will be able to solve
    a) Boolean logic
    b) Verbal logical reasoning
    c) Nonverbal logical reasoning
3) Understand data search and sort, and briefly describe standard algorithms on linear arrays such as linear search, binary search, bubble sort etc.

Skills:
Students will be able to

1) Apply logical reasoning to refine and solve problems
2) Apply algorithmic thinking to refine and solve problems
3) Identify when & where to use key search & sort algorithms
4) Discuss an algorithm to solve a specific problem.

Assessments

Formative & **Summative Assessments**
Assessment questions on:

- Boolean logic, verbal logical reasoning, nonverbal logical reasoning
- Algorithmic thinking and will be able to solve problems by abstraction, decomposition, pattern recognition, and algorithms

Subjective questions / / in-class discussions on

- Applying logical reasoning to refine and solve problems
- Applying algorithmic thinking to refine and solve problems

Learning Activities

1. Homework: Watch video and summaries one of the algorithms mentioned here in your own words: https://www.youtube.com/watch?v=d7iGniWrRng
2. Course activities in https://www.khanacademy.org/computing/computer-science/algorithms
    a. Guessing game: https://www.khanacademy.org/computing/computer-science/algorithms/intro-to-algorithms/a/a-guessing-game
    b. Route finding: https://www.khanacademy.org/computing/computer-science/algorithms/intro-to-algorithms/a/route-finding
    c. Algorithms in your life: https://www.khanacademy.org/computing/computer-science/algorithms/intro-to-algorithms/a/discuss-algorithms-in-your-life
3. Consider a grading system where numbers are turned into letters. Activity details are here: http://ndrdmath.weebly.com/lesson-21.html
4. Verbal reasoning questions: https://irp-cdn.multiscreensite.com/16712cd9/files/uploaded/CGP%20NVR%20GL%20ALL.pdf
5. Write an algorithm to solve a word search problem and Sudoku game: https://medium.com/@george.seif94/solving-sudoku-using-a-simple-search-algorithm-3ac44857fee8
6. Common algorithms: https://u.osu.edu/cstutorials/2016/11/21/7-algorithms-and-data-structures-every-programmer-must-know/
7. Add boolean expressions to conditional statements (e.g., exercise 5.1: https://www.sccollege.edu/Departments/upwardboundms/SiteAssets/Pages/Computer-Science-/chapter5and6.pdf)
8. Searching & Sorting Algorithms Practice: https://www.101computing.net/searching-sorting-algorithms-practice/

[SLO CS-10-B-02]

Standard 1: Students will identify and decompose simple and complex problems, create & evaluate appropriate solutions using computational approaches, and understand and apply common algorithms used in solving computational problems
Benchmark I: Students will understand and apply computational thinking techniques to solve complex, real- world problems.

Student Learning Outcomes [SLO CS-10-B-02] Develop and apply abstractions to create generalized, modular solutions

Knowledge:	**Skills:**
Students will understand 1) Steps in an algorithm to solve computational problems 2) Dry run or Trace Table to run algorithm 3) Abstractions to create generalized, modular solutions	Students will be able to ● Use algorithmic approach to solve the computational simple problems ● Apply abstractions to create generalized, modular solutions ● Create and use dry runs/trace tables to follow an algorithm

Assessments

Formative Assessments
Quiz assessment questions / in class discussions on:

- Steps in an algorithm to solve computational problems
- Dry running or Trace Table to run algorithm
- Identification of logical and syntax errors
- Abstractions to create generalized, modular solutions

Sample question could be:

- Find the smallest integer in the list of 4 1 -4 0 9 9 3 5 8
- Write an algorithm to find and display the square and cube of a positive number. The execution must be terminated if a negative number is entered.
- Evaluate answers for some simple programs
- Find a logical error in the simple list of steps

Summative Assessments

Exam questions/project submissions on topics such as:

- Algorithmic approach to solve the computational simple problems
- Abstractions to create generalized, modular solutions
- Creating and using dry runs/trace tables to follow an algorithm
- Identifying syntax/logic errors in code and solve logical errors

Learning Activities

1. Activity 3 Develop a high-level algorithm from this link: http://sofia.cs.vt.edu/cs1114-ebooklet/chapter4.html
    a. Students should write steps for an activity, e.g., “send a birthday card to Mark”. Steps could be:
        i. Go to a store that sells greeting cards
        ii. Select a card
        iii. Purchase a card
        iv. Mail the card
    b. The instructor can then drill down questions that show that the instructions could be more specific:
        i. "Which store will you visit?"
        ii. "How will I get there: walk, drive, ride my bicycle, take the bus?"
        iii. "What kind of card does Mark like: humorous, sentimental, risqué?"
2. Video on specific instructions and developing algorithms. Class can watch this video and try to create their own set of instructions
    a. https://www.youtube.com/watch?v=Ct-lOOUqmyY

Domain C: Programming Fundamentals

[SLO CS-10-C-01]

Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learning how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration.
Benchmark I: Students will develop, test, and debug static website (using HTML and CSS) and an interactive website (using JavaScript)

Student Learning Outcome(s):

[SLO CS-10-C-01] Students should be able to develop website using front-end development tools

Knowledge:	**Skills:**
Students will understand ● Differentiate logical and syntax errors ● Front-end development deals with HTML/CSS/JavaScript in the browser	Students will be able to ● Identify syntax/logical errors in code and solve them ● Differentiate between back-end and front-end development

● Back-end development allows writing code that emits HTML/CSS/JavaScript	
Assessments **Formative Assessments** ● In Class activities / practical / quiz on differentiating between back-end and front-end development **Summative Assessments** ● Exam / practical	
Learning Activities ● Inspect webpage to discover code of HTML/CSS/JavaScript ● Write a webpage using HTML/CSS/JavaScript ● Differentiate between back-end and front-end development	

[SLO CS-10-C-02]

Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learning how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration. **Benchmark I:** Students will develop, test, and debug static website (using HTML and CSS) and an interactive website (using JavaScript)	
Student Learning Outcome(s): [SLO CS-10-C-02] Students should be able to use more advanced HTML/CSS features in an appropriate environment	
Knowledge: Students will understand ● How HTML tags can be used to show tabular data ● How HTML can be used to retrieve inputs from users How to apply animation	**Skills:** Students will be able to ● Create forms in HTML using an IDE like Visual Studio Code, Notepad++ etc. ● Create tables in HTML using an IDE ● Create animations in CSS using an IDE
Assessments **Formative Assessments** In class activities/practicals on the following topics: ● Create forms in HTML ● Create tables in HTML ● Create animations in CSS ○ Draw a circle with CSS **Summative Assessments** Exam/quiz on ● How HTML tags can be used to show tabular date ● How HTML can be used to retrieve inputs from users ● How to apply animation movements to HTML components	

Learning Activities

- In class / practical HTML Forms activity on this dynamic website: https://www.w3schools.com/html/html_forms.asp
- Populate form in HTML
- Populate tables in HTML
- Simple animation using CSS, i.e, change colour of button, translate a text horizontally from left to write.
- Develop three web pages, i.e., main_page.html, animation.html, and forms.html. Link all these pages and run it in the browser
- Write logical steps (algorithm) of translating text diagonally from top left corner to the bottom right corner
- In class activity / practical: Students can test out and try to recreate various CSS animation listed here: https://blog.hubspot.com/website/css-animation-examples

[SLO CS-10-C-03]

Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learning how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration.
Benchmark I: Students will develop, test, and debug static website (using HTML and CSS) and an interactive website (using JavaScript)

Student Learning Outcome(s):
[SLO CS-10-C-03] Students should be able to use more advanced programming constructs using Javascript

Knowledge:	**Skills:**
Students will understand ● How to create and use bullet points in HTML ● How to create and use arrays in JavaScript	Students will be able to ● Create bullet points in HTML that are generated from an array in JavaScript

Assessments

Formative Assessments
In class activities / practicals on the following topics

- How to create and use Arrays in JavaScript
- How to create and use bullet points in HTML

Summative Assessments
In class activities / practicals / project which includes the following component:

- Create bullet points in HTML that are generated from an array in JavaScript

Learning Activities

1. Make ordered and unordered lists in HTML, sample activities and code here: https://www.freecodecamp.org/news/html-list-how-to-use-bullet-points-ordered-and-unordered-lists/

[SLO CS-10-C-04]

Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learning how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration.

Benchmark I: Students will develop, test, and debug static website (using HTML and CSS) and an interactive website (using JavaScript)	
Student Learning Outcome(s): [SLO CS-10-C-04] Students should be able to implement complex algorithms that use more complex data structures in JavaScript	
Knowledge: Students will understand ● The array data structure is similar to a list ● Finding an element in a list requires iterating through entire list till the element is found ● That how they can implement a chatbot using any AI-based API.	**Skills:** Students will be able to ● Write an algorithm that finds an element in a list ● Implement an algorithm that finds an element in a list using JavaScript ● Implement a chatbot into a website.
Assessments **Formative Assessments** Quiz on the following topics: ● The array data structure is similar to a list ● Finding an element in a list requires iterating through entire list till the element is found **Summative Assessments** Quiz/exam / practical on the following topics: Identify algorithms that finds an element in a list Implement an algorithm that finds an element in a list using JavaScript	
Learning Activities 1. In class activity / practical: Students can test out code for search algorithms here https://www.freecodecamp.org/news/4-methods-to-search-an-array/ 2. JavaScript drills: https://jsbeginners.com/javascript-projects-for-beginners/ 3. Starter projects in JavaScript that use lists: https://hackr.io/blog/javascript-projects 4. Calculator: https://github.com/harsh98trivedi/Simple-JavaScript-Calculator 5. Alarm clock in JS: https://github.com/swasti98/JS-Clock	

[SLO CS-10-C-05]

Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learning how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration. **Benchmark I:** Students will develop, test, and debug static website (using HTML and CSS) and an interactive website (using JavaScript)	
Student Learning Outcome(s): [SLO CS-10-C-05] Students will determine more advanced techniques (unit tests, breakpoints, watches) for testing and debugging their code in JavaScript	
Knowledge: Students will understand ● The purpose of a unit test ● Debugging allows them to analyze code as it runs	**Skills:** Students will be able to ● Write simple unit tests for the functions in their code

	● Set a breakpoint and use it to analyze intermediate values of variables in JavaScript
Assessments **Formative Assessments** Practical / lab exercises on identifying & resolving errors in computing problems using test functions and breakpoints. **Summative Assessments** Quiz / exam / practical on computing problems with errors and students to identify errors using test functions and breakpoints.	
Learning Activities ● Basic workflow debugging for JavaScript programming (instructors can follow video and steps on this page: https://developer.chrome.com/docs/devtools/javascript/) **to use breakpoints and watch expressions.**	

Domain D: Data and Analysis
[SLO CS-10-D-01]

Standard 1: Students will be able to understand the scope of data science, how computer systems collect, store, process, visualize, and interpret data **Standard 2:** Students will get an introduction to the relational data model, relational database engines, and SQL and how to design good schemas. **Standard 3:** What is AI and machine learning, and how does it relate to data and data science. **Benchmark I:** Students will be able to define and explain how to collect, store, analyze and visualize data	
Student Learning Outcomes: [SLO CS-10-D-01] Students will understand and explain the scope of data science, Artificial Intelligence (AI), and Machine Learning (ML), including types of supervised and unsupervised learning models, and their applications to common real-world problems.	
Knowledge: Students will know 1. Definitions of data science, artificial intelligence and machine learning. They will also learn to differentiate between the three fields and overlapping areas. a. Machine Learning skills include i. Technique used by AI enabled systems / machines to learn from large data ii. supervised and unsupervised learning iii. automation and scalability iv. fraud detection b. Artificial intelligence skills include: i. Teaching machines to emulate human behavior e.g., natural language	**Skills:** Students will 1. Differentiate between the three fields of data science, AI, and ML and overlapping areas. 2. Decide if a problem's solution is supervised and unsupervised learning.

processing, chatbots, image recognition etc. c. Data science includes: Collecting, processing, analyzing, visualizing and understanding model outcomes (predictions / descriptive). Students will know ● The difference between data science, AI and machine learning. Recognize different types of supervised learning vs unsupervised learning models	

Formative Assessments
Quiz assessment questions / in-class discussions on:
- Definitions, differences & similarities between data science, artificial intelligence and machine learning
- Supervised learning and unsupervised learning models.
- Churn prediction and behavioral segmentation models

Sample questions/topics could be:
- In-class discussion - Describe why each field is important - can you see applications of each field in real life e.g., predicting who is going to win a cricket match (data science), automated fraud detection (machine learning) and ChatGPT (AI).
- In-class discussion - Describe different algorithms pertaining to supervised learning vs unsupervised learning approaches e.g., simple linear regression, decision trees and k-means clustering.
- In class (group exercise)- discuss 5-10 different business problems and identify which field is most relevant to solve it.
- Homework- Students can pick a business problem and explain whether it can be solved using supervised learning vs unsupervised learning algorithms.

Summative Assessments
Exam questions on topics such as:
- Differences and overlapping areas between the three fields of data science, artificial intelligence, and machine learning.
- Collecting, processing, analyzing, visualizing and understanding model outcomes (predictions / descriptive).
- Interpret the results from Churn Prediction and behavioral segmentation.
- Recognizing different types of supervised learning vs unsupervised learning models including algorithms.

Sample questions/topics could be:
- Test understanding of different definitions and in-depth understanding of skills required for each field.
- Provide 10 real business problems and identify the field (DS, ML and AI).

Learning Activities
- Focus on describing fields of data science, machine learning and artificial intelligence: https://www.youtube.com/watch?v=kNrw64dmfpk

- Case study 1: Churn Prediction: understand in detail all the steps required to build a successful churn prediction model and how it is an application of Data Science. Utilize data from : https://www.kaggle.com/c/customer-churn-prediction-2020
- Case study 2: Fraud Detection: understand in detail all the steps required to build a successful fraud detection model and how it is an application of machine learning. Utilize data from: https://www.kaggle.com/c/customer-churn-prediction-2020
- Case study 3: Chatbot: understand in detail all the steps required to build a successful chatbot and how it is an application of artificial intelligence. Utilize data from: https://www.kaggle.com/code/rajkumarl/conversational-ai-chatbot
- Potential curriculum resource textbook: https://curriculum.idsucla.org/IDS_Curriculum_v_5.0/1_IDS_Curriculum_v_5.0/IDS_Intro%2BUnit1_v%206.0_FINAL.pdf

[SLO CS-10-D-02]

Standard 1: Students will be able to understand how computer systems collect, store, process, visualize, and interpret data.
Standard 2: Students will get an introduction to the relational data model, relational database engines, and SQL and how to design good schemas.
Standard 3: What is AI and machine learning, and how does it relate to data and data science.
Benchmark I: Students will be able to define and explain how to collect, store, analyze and visualize data

Student Learning Outcomes: [SLO CS-10-D-02] Students will understand and explain the types, uses, and methods of data visualizations and understand the benefits of visualizing data

Knowledge:
Students will understand that data and data products (charts, graphs, statistics) can be analyzed and evaluated, similar to analyzing arguments.

Students will

1. Understand relational databases (entities, attributes, and keys)
2. Understand the benefits of visualizing data and appropriate methods to create visualizations.
3. Know visualization techniques such as measures of center and spread, boxplots, bar plots, histograms, scatterplots, graphical summaries of multivariate data, side-by-side bar plots and association.
4. Understand the connection of datasets to machine learning.
5. Explain sorting, visualizing, and using data.
6. Read plots (identify the name of the plot, interpret the axes, look for trends, identify confounding factors).

Skills:
Students will be able to

- Develop relational schema representing simple Entity-Relationship diagrams
- Create tables, forms, reports, and queries using SELECT, CREATE, JOIN etc. in any database tool (MS Access, MySQL etc.)
- Analyze tables in any database tool and develop simple insights (i.e. sales are increasing/decreasing over time etc.)
- Develop E-R data models, conceptual and logical design.
- Represent data with plots on the real number line (dotplots, histograms, bar plots, and boxplots) in Excel etc.
- Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers) using Excel etc.
- (Advanced) Represent data on two quantitative variables on a scatterplot and describe how the variables are related.
- (Advanced) Learn the difference between plots used for categorical and numerical variables.

	• (Advanced) Interpret and understand graphs of distributions for numerical and categorical variables.

Assessments
List one example of how visualization can be used to increase data comprehension

Formative Assessments
none

Summative Assessments
Quiz # 1: Provide students with a visualization and a prompt. Ask them to create a narrative and tell stories with data. (1) make assumptions about how the data was collected (2) identify any potential bias in the data (3) draw conclusions about the data
Quiz # 2: Read and critique a published story with visualization (taken from e.g., newspaper, economist, business insider)

Learning Activities

1. In-class activity on what is data visualization by watching and sharing key learnings from video on subject which describes the importance of graphical representations of data, sample video: https://www.youtube.com/watch?v=xekEXM0Vonc,
2. What is the value of data visualization? Watch video: (569) The Value of Data Visualization - YouTube
    a. Have a whole class discussion regarding the video's last statement: "Your message is only as good as your ability to share it." Ask students: a. What does this statement mean? b. What makes a good message in terms of data and visualizations?
3. More assessments and activities can be found here: Lesson 8: Tangible Plots - Introduction to Data Science Curriculum (idsucla.org)

[SLO CS-10-D-03]

Standard 1: Students will be able to understand how computer systems collect, store, process, visualize, and interpret data
Standard 2: Students will get an introduction to the relational data model, relational database engines, and SQL and how to design good schemas.
Standard 3: What is AI and machine learning, and how does it relate to data and data science
Benchmark I: Students will be able to define and explain how to collect, store, analyze and visualize data

Student Learning Outcomes [SLO CS-10-D-03] Students will be able to apply stages of the data science life cycle e.g., understanding a real-world business problem, data gathering, building model, interpreting results).

Knowledge:	**Skills:**
Students will understand (1) data science life cycle (2) different steps of data gathering including the source of data, query the data on a database tool (e.g., MS Access, MySQL etc.), collect & store the data, format the data to make it ready for modeling. (3) Different types of real-world business problems and how to formulate them into a data science problem.,	• Students will be able to formulate a business problem into a data science problem and link to types of problems (e.g., questions "my customers are leaving me" is a churn prediction model) • (Advanced) Calculate or generate key model metrics indicating model performance e.g., auc-roc, confusion matrix and mean squared error etc.

(4) The data gathering step e.g., from retail stores asking for the last three years of sales data. (5) What kind of algorithms are possible for example simple linear regression or decision tree? (6) Key performance metrics (for example mean squared error)	

Formative Assessments

Quiz assessment questions / in class discussions on:

- Formulation of real-world problems into data science problems
- Data gathering and analysis through linear regression and/or decision trees.
- Performance calculations using mean squared error.

Sample question could be:

- Homework- Students can pick a business problem and describe each step of the data science life cycle.
- In class discussion - Discuss 1-2 different business problems and formulate them into data science problems. E.g., for the next year sales for a retail store are going to increase to decrease, this is a sales prediction model.

Summative Assessments

Exam questions / projects on topics such as:

- Formulation of real-world problems into data science problems
- Data gathering steps
- Building a data science model
- Generating key model metrics indicating model performance e.g., auc, roc, confusion matrix and mean squared error.

Sample question could be:

- Give a business problem and ask students to describe each step of the data science life cycle.

Learning Activities

- Teach students will learn how to ask questions from data: So Many Questions [The Data Cycle: Pose Questions]**:** **Lesson 5: So Many Questions - Introduction to Data Science Curriculum (idsucla.org):**
- Describe different steps required to build a predictive sales model discussed in detail in knowledge section.
- Students can be assigned End of Year Projects such as where they are expected to use skills learnt on a known dataset. Teachers can vary the requirements based on skills level: End of Unit 3 and 4 Design Project and Oral Presentation: Water Usage - Introduction to Data Science Curriculum (idsucla.org)
- Demonstrate the use of decision trees based on our earlier activity where they recognize whether a child is boy or girl by looking at their headshots – create a decision tree for this classification.
- Demonstrate the concept of k-means clustering in our earlier activity where we ake all the students in class and measure their heights (or weights since that will provide more variance but might be too personal). Now note all the heights and use a clustering algorithm to create 3 clusters (you can use k-means clustering for this). Now we can assign labels short, medium, and tall to the three clusters. Now take the height of the teacher and classify him as short, medium or tall.
- Similarly, linear regression can be demonstrated by showing the graph of a quantity like temperatures, stock prices, house prices (based on multiple features) and predict the same quantity for future time or a new house.

Domain E: Applications of Computer Science

[SLO CS-10-E-01]

Standard 1: Students will understand computer technologies such as blockchain/AI/IoT/cloud computing/game design and development.
Standard 2: Students should be able to understand how computers learn, make decisions and the applications, challenges and social implications of AI.
Benchmark I: Students learn about different popular fields in Computer Science like AI, Cloud Computing and IoT and Blockchain.

Student Learning Outcome(s):[SLO CS-10-E-01] Students will be able to describe uses and applications that are enabled by technologies like IoT, and Blockchain

Knowledge:

Students will know
- IoT and it's foundational components
- Applications that are enabled by IoT
- Applications that are enabled by blockchain
- The benefits of cloud computing

Skills:
Students will be able to
- Analyze different technologies that use blockchains
- Evaluate if a scenario fits an application of IoTs
- Evaluate how we can use cloud computing

Assessments

Formative Assessments
Quiz assessment questions / in class discussions on:
- Different technologies that use blockchains
- Evaluate if a scenario fits an application of IoTs
- Evaluate how we can use cloud computing
- Applications that are enabled by blockchain
- Applications that are enabled by IoT
- The benefits of cloud computing

Summative Assessments
Exam questions or project on applications of IOT, BlockChain, Cloud Computing

Learning Activities
1. Students should use online tools like Google Docs and Google sheets to show them the benefits of cloud computing
2. Present to students an IoT application like smart parking. Each parking spot has a sensor that can detect if the spot is occupied and users have applications that can check open parking spots in a parking lot or garage. The students are then presented with a scenario of a smart home with Temperature sensors, fans and ACs that can be remote controlled from a smartphone, and other household items like umbrellas, lunch boxes, fridges that are connected. Ask students to imagine applications that are enabled in such an environment.

[SLO CS-10-E-02]

Standard 1: Students learn about different popular fields in Computer Science like AI, Cloud Computing, IoT, and Blockchain.
Standard 2: Students should be able to understand how computers learn, make decisions and the applications, challenges and social implications of AI.
Benchmark I: Students learn about different popular fields in Computer Science like AI, Cloud Computing, IoT, and Blockchain.

Student Learning Outcome(s): [SLO CS-10-E-02] Students will be able to explain that AI can be applied to specific applications in areas like NLP, Robotics, Speech Recognition, etc.	
Knowledge: Students will understand ● Specific applications of speech recognition like personal assistants, Quran Memorization applications, Speech-to-text typing applications, Speech recognition for authentication, Speech recognition for surveillance and national security, etc. ● Specific applications of NLP like email filtering to protect against spam and scams, Language translation, document analysis, predictive text, Sentiment analysis, etc. ● Applications of Robotics in rescue and search operations, industrial robotics for manufacturing, vacuum cleaners like Romba robotic operations, farming, etc.	**Skills:** Students will be able to ● Enumerate and explain the uses of AI techniques in different real-world applications like personal assistants, Quran Memorization applications, Speech-to-text typing applications, Speech recognition for authentication, Speech recognition for surveillance and national security, etc.
Assessments **Formative Assessments** Quiz / in class discussions and activities on AI applications **Summative Assessments** Exam questions on AI applications Research project on AI can applications in areas like NLP, Robotics, Speech Recognition, etc.	
Learning Activities Students can watch different videos on how technology in different fields is automating tasks that were once done by humans.	

[SLO CS-10-E-03]

Standard 1: Students learn about the importance of data and the social implications of using data to make decisions and provide services. **Standard 2:** Students should be able to understand how computers learn, make decisions and the applications, challenges and social implications of AI. **Benchmark I**: Students learn about different popular fields in Computer Science like AI, Cloud Computing and IoT and Blockchain.	
Student Learning Outcome(s): [SLO CS-10-E-03] Students will be able to demonstrate the social implications of AI	
Knowledge: Students will understand ● that improper use of AI tools can result in injustice to specific groups of people.	**Skills:** Students will be able to ● Show that there are instances where use of AI causes social injustices.

• AI designers have a responsibility towards ensuring that their algorithms target human benefits	• Identify the ethical norms for creating AI algorithms
Assessments **Formative Assessments** Quiz / in-class discussions and activities on social implications of AI **Summative Assessments** Quiz/exam questions on social implications of AI (improper use, biased representation of data, targeting corporate benefits vs. human benefits, social injustice)	
Learning Activities 1. Read or explain case studies of how AI has discrimination. For example the COMPAS algorithm used in US course system. Amazon's hiring system was biased against women is another case study.	

Domain F: Impacts of Computing

[SLO CS-10-F-01 and [SLO CS-10- F-02]

Standard 1: Student will be able to understand Ethics and laws related to computing and the use of computing devices, media, data, and the internet and the applications of personal privacy and Network security. **Standard 2:** The environmental, cultural and human impact of computing and assistive technologies for the modern world. **Benchmark I:** Students will obtain knowledge of ethical and legal issues surrounding the use of computing. **Benchmark II:** Students will understand privacy and network security issues surrounding computing applications and devices they use every day. **Benchmark III:** Students will understand the role of assistive technologies and understand the implications of the digital divide	
Student Learning Outcomes [SLO CS-10-F-01] Understand and apply safe & responsible use of the internet to prevent addiction, promote information and data security [SLO CS-10-F-02] Evaluate the impact of cyberbullying/harassment and apply strategies to prevent these.	
Knowledge: Students will understand • The concerns of technology addiction • The need for cybersecurity to protect data • The ways in which the internet can be used to promote information for good and bad purposes • The effects of threats to individual privacy and security of data from spam, spyware, cookies, etc. • Basics of security & privacy of cloud computing	**Skills:** Students will be able to • Analyze the impact of new technology laws on digital privacy and information security • Explain safety and security concepts and strategies including peer pressure and cyberbullying in social media influenced lives • Discuss the need for cybersecurity in relation to privacy and data security of information

Students will know ● Basics of data, network and cyber security: backups, access, network monitoring, public and private clouds ● Use of hardware and software methods to protect devices	● Compare ways software developers protect devices and information from unauthorized access ● Discuss cybercrimes laws, instances of cybercrimes, and common methods of reporting cybercrimes

Assessments

Quiz 1 What is software piracy? Can you make an argument for the ethics of software piracy in a developing nation? Consider that in developing nations the only people who can afford to pay for software may be the very rich.

Quiz 2 What are some of the ways you can ensure safety and security when designing a computer application? List some cybersecurity tactics that can be helpful in the design of this application and why it is necessary to include them.

Quiz 3 List and explain the different cybersecurity methods that can be used for the secure transmission of data.
Quiz 4 Analyze and compare the cybersecurity measures for two computing systems or applications they have used. They will then provide recommendations for improvement.

Formative Assessments
The instructor can decide which assessments to use as formative.

Summative Assessments
End-of-unit projects where students will select and use an application, they are not familiar with to assess its level of security. They will determine what kinds of cybersecurity measures are being used by the application and what kinds of security concerns they address.

Learning Activities

- Cyberbullying includes sending, posting, or sharing negative, harmful, false, or mean content about someone else. Cyberbullying and peer pressure through the internet has a real impact on human lives. Describe different ways you can think of that cyberbullying can take place in your schools.
- Divide students into groups and ask them to discuss the many things we can do to prevent cyber harassment to build a safe environment for everyone.
- Students should be advised on the best ways to report bullying in their schools. Share the school policy on preventing cyber bullying.
- Software piracy is the use or distribution of copyrighted computer software in violation of the copyright laws. Common forms include end-user piracy, counterfeiting, and hard disk loading. Give examples of software piracy.
- Cybersecurity measures can include a range of tactics, such as:
    - Using strong passwords
    - Physically controlling access to data by using locked doors, keyed entrances etc.
    - Put up a firewall
    - Updating systems and software regularly
    - Using encryption and decryption for transmitting sensitive data

Using a computer application as an example. List how these different measures have been taken to ensure security of user data.

- Cloud security has become a recent concern with the popularity of cloud computing. Students should discuss the benefits of cloud computing in class and analyze the advantages and disadvantages. They should be asked to compare different cloud platforms available to users.

- Students have learned about different types of networks in previous domains. Students should be asked to list the different types of networks and what security concerns may exist for them when transmitting data.
- Students will describe how data can be damaged due to data corruption, human errors, malware and unauthorized access
- Students will list ways they can ensure data privacy online
- Students will discuss how hardware and software can be used to ensure security
- Students will construct strategies to prevent online cyberbullying/harassment
- Working in cooperative groups students will select an online social platform to analyze the benefits and harmful effects

[SLO CS-10-F-03]

Standard 1: Student will be able to understand Ethics and laws related to computing and the use of computing devices, media, data, and the internet and the applications of personal privacy and Network security.
Standard 2: The environmental, cultural and human impact of computing and assistive technologies for the modern world.
Benchmark I: Students will obtain knowledge of ethical and legal issues surrounding the use of computing.
Benchmark II: Students will understand privacy and network security issues surrounding computing applications and devices they use every day.
Benchmark III: Students will understand the role of assistive technologies and understand the implications of the digital divide

Student Learning Outcomes
[SLO CS-10-F-03] Analyze the impacts of the digital divide on access to critical information

Knowledge:
Students will understand

- Distribution of computing resources affect the way solutions are designed
- unequal Access to information impacts human lives

Students will know
- the meaning of the digital divide

Skills:
Students will be able to

- Design computing applications that can take into consideration accessibility of information
- Strategize to alleviate the impacts of unequal access of information in creating computing solutions
- Discuss what role students can play to minimize the digital divide

Assessments

Formative Assessments
Quiz assessment questions / in class discussions on:
- What is the digital divide and how does it impact issues of equity and inclusion?
- Impact of access to information on daily lives of people
- Design solutions changing based on the distribution of computing resources

Summative Assessments
Quiz / Exam/end of term projects on:
- Digital divide and impact on issues of equity and inclusion
- Design considerations when including accessibility of information
- Impacts of unequal access of information in creating computing solutions

Sample question could be:

- Does distribution of computing resources change the way people design solutions? For example, a person who does not have international phone service, but wants to talk with people from home can use a free phone app to make an online video call when both ends are connected to Wi-Fi.

Learning Activities

- Computer distribution differs by network availability, such as whether broadband is available, as well as hardware availability such as the number of households that have computers. The distribution of computing resources can increase the digital divide. As a class, discuss the impact of these different resources on the access to information. How does this impact equity?
- People need to solve computing problems differently depending on their available resources. Compare two countries (developed vs developing) on how they may be addressing computing problems differently

Domain G: Digital Literacy
[SLO CS-10-G-01]

Standard: collect and analyze information and publish to various audiences using digital tools and media-rich resources. Use digital tools to design and develop a significant digital artifact through research design, data collection and communication.
Benchmark I: Collect & analyze information and publish to various audiences using digital tools and media-rich resources.

Student Learning Outcomes: [SLO CS-10-G-01] Communicate and publish key ideas and details to a variety of audiences using appropriate digital tools and media-rich resources

Knowledge:
Students will understand

- How to get information on simple topics and extract key ideas, and present them in different formats
- How to identify key ideas and create appropriate copy and graphics to present an idea (e.g., communicating event information in a poster, or communicating product features in a billboard)
- Appropriate use cases of social media when communicating key ideas to various audiences (e.g., using YouTube to communicate an opinion via a podcast or using Instagram to show images related to a place or a product, or Facebook to share information with a community etc.)
- Best practices in reaching audiences on various digital platforms

Skills:
Students will be able to

- Get information on simple topics, extract key ideas, and create appropriate copy & graphics to present an idea to various audiences in different formats across various social media platforms (e.g., YouTube, Facebook, Instagram, etc.)

Assessments

Formative Assessments

- In class assignments / projects using image processing tools to communicate an idea using appropriate copy and social media platform to reach the intended audience
- Quiz on case studies of successful social media advertising campaigns

Summative Assessments

- **Case studies** of digital artifacts testing student knowledge for (1) best tools to communicate various types of information (2) Appropriate use of tools (i.e. layouts, formatting, editing, graphics, appearance & alignment etc.)
- **Practical:** summative project submission of a key idea using an appropriate digital tool

Learning Activities

1. Design a graphic to put on a billboard of a popular brand
2. Create a social media post for a popular brand
3. Create a new product for a popular brand and present it to the company management using a presentation, create an Instagram post, and a short advertisement video

Domain H: Entrepreneurship in the Digital Age

[SLO CS-10-H-01]

Standard: Students will Create a business using design thinking with the help of digital/AI tools.
Benchmark: Students will learn how to identify problems and create and present business solutions.

Student Learning Outcomes: [SLO CS-10-H-01]: Students will use digital/AI tools to conduct research to collect market and customer insights for an business idea

Knowledge:
Students will *understand*

- Quantitative and qualitative research methods and when to apply them.
- How to design questions and collect results for various methodologies
- How to interpret research results, particularly in regards to bias in sample selection and correlation vs. causation
- How to use research to validate business idea
- How to use research to create customer profiles

Skills:
Students will be able to

- Create and implement a research plan to collect market insights for their business idea
- Use digital tools for survey collection, such as online questionnaires (Google forms, survey monkey) or MS excel for recording survey results
- Synthesize and present results using digital tools such as word processing applications
- Clearly link research insights to business idea
- Conduct research to create customer profiles

Assessments

Formative Assessments
Case studies on correct/incorrect interpretation of research results
Project: Create questionnaire/ survey/ interview for your business idea, conduct research, and present results

Summative Assessments
Project: presentation of research results to inform a business idea
Case studies to evaluate correct or incorrect interpretations of research results

Learning Activities

- Case studies on data biases, such as those listed below:
  - Survivorship bias: https://www.trevorbragdon.com/when-data-gives-the-wrong-solution/
  - Funny correlations: https://www.fastcompany.com/3030529/hilarious-graphs-prove-that-correlation-isnt-causation
  - Common cognitive biases: https://thebusinessprofessor.com/en_US/management-leadership-organizational-behavior/common-biases-and-errors-in-decision-making
  - Selection bias in medical trials: https://youtu.be/FIwBcvgDEHM
- Activities on questionnaire design:
  - Read & summarize learnings from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4797036/
  - Identify open ended or close ended questions
- Project: Conduct primary research such as focus groups with your classmates or quantitative survey of community, friends, and / or family members
- Project: Conduct in-depth interviews to identify customer profiles for business
- Reflection: Students should reflect on 4Cs of the 21st century *(collaboration, critical thinking, creativity, communication)* and how they applied them when they were conducting their research
- IDEO Method cards regarding research, source: https://static1.squarespace.com/static/57c6b79629687fde090a0fdd/t/58890239db29d6cc6c3338f7/1485374014340/METHODCARDS-v3-slim.pdf

[SLO CS-10-H-02]

Standard: student will Create a business using design thinking with the help of digital/AItools.
Benchmark: Students will learn how to identify problems and create and present business solutions.

Student Learning Outcomes: [SLO CS-10-H-02]: Students will learn how to pitch a business idea

Knowledge:
Students will understand

- Components of a successful business pitch
- Components of a successful elevator pitch
- Effective communication skills required to best articulate a business idea
- The difference between a business plan and a pitch document

Students will be able to:

- Know the following terms
  - Digital Payments
  - Digital Wallet

Skills:
Students will be able to

- Create an investor business pitch in a presentation software like MS PowerPoint, Google slides, or free online tools like Canva or pitch.com
- Utilize effective communication skills to deliver the pitch

Assessments

Formative Assessments
Case studies on correct/incorrect interpretation of research results
Project: Create questionnaire/ survey/ interview for your business idea, conduct research, and present results

Summative Assessments
Project: presentation of research results to inform a business idea
Case studies to evaluate correct or incorrect interpretations of research results

Learning Activities

- Case studies: Evaluate effective communication
  - Using rubrics such as:
    - 7 C's of effective communication: clear, concise, concrete, correct, coherent, complete, and courteous
    - confidence, clarity, objectiveness, consciousness, body language, attentiveness, assertiveness, diligence, emotional intelligence, decisiveness, active listening and non-verbal cues
  - Steve Jobs as an effective communicator: https://www.forbes.com/sites/tjwalker/2011/10/06/why-steve-jobs-was-the-ultimate-communicator/?sh=57b830cb5a5e
  - Simon Sinek on Nike's Phil Knight: https://youtu.be/XDFGe4cVeGM
- Evaluate business plans of successful startups, such as those listed in the following sites:
  - https://www.cbinsights.com/research/billion-dollar-startup-pitch-decks/
  - https://pitch.com/blog/15-great-pitch-decks-from-successful-startups
- Students can research design best practices and apply suggestions to best communicate business idea, using articles like: https://www.ycombinator.com/library/4T-how-to-design-a-better-pitch-deck
- Think, pair, share: Students can watch and discuss key learnings from videos on how to create a successful pitch, such as this one: https://youtu.be/XWRtG_PDRik
- Create and practice an elevator pitch, or have a competition for the best elevator pitches
- Reflection: Students should reflect on 4Cs of the 21st century *(collaboration, critical thinking, creativity, communication)* and how they applied them when they were conducting their research

Grade 11

Domain A: Computing Systems
[SLO CS-11-A-01]

Standard: Students will learn about components and interactions between computer systems, stages of software development, data representation and transmission across networks of computing systems, and the implications on usability, reliability, security, etc.
Benchmark I: Students will identify and analyze logic gates in digital systems
Benchmark II: Students will identify stages of system software development
Benchmark III: Students will learn about scalability, reliability, and security of computer networks

Student Learning Outcome(s):
[SLO CS-11-A-01] Students will be able to understand and apply logic gates in digital systems, define and create truth tables using Boolean operators like AND, OR, NOT, NAND, XOR and logic diagrams.

Knowledge:
Students will understand...

- Boolean functions
- Boolean expressions
- Boolean identities
- Duality
- What makes analog and digital signals different
- What is digital logic
- What are logic gates
- What are truth tables
- What are switches

Students will know

- How to create truth tables
- How to identify logic gates and understand their usage
- Key terms: Karnaugh maps, AND, OR, NOT, NAND, XOR gates.

Skills:
Students will be able to

- Construct Boolean functions, expressions and identities.
- Recognize duality
- Identify different logic gates and explain their uses
- Create truth tables for expressions up to 3 inputs
- Draw logic gates for a Boolean expression
- Draw a truth table for a logic gate to identify the outputs

Assessments
Formative Assessments
Quiz questions on the following topics:

- Which logic element describes 2 or more normally closed switches in parallel?
- Which logic element describes 2 or more normally closed switches in series?
- Which logic element describes a circuit with 2 normally open switches in series?
- What is a Karnaugh map?
- What is a switch?
- What is a truth table?
- Create a truth table for a given expression
- Define the term Boolean algebra.
- List the Boolean function
- Why do we need duality?

Summative Assessments
Quiz / Exam / Practicals on:

- Evaluate the Boolean identities.
- How can we differentiate Boolean expressions and Boolean functions?
- Identifying different logic gates and explain their uses

- Create truth tables for expressions
- Draw logic gates for a Boolean expression
- Draw a truth table for a logic gate to identify the outputs

Learning Activities

- **In-class activity**: Instructor-led video viewing and discussion about logic gates: https://www.youtube.com/watch?v=gI-qXk7XojA
- **In-class activity**: Instructor-led video viewing and discussion about how to create a truth table for an expression: https://www.youtube.com/watch?v=VCEYeB3bRW0
- **In-class activity**: Instructor-led video viewing and discussion about Karnaugh Maps: https://www.youtube.com/watch?v=3vkMgTmieZI
- **In-class activity**: Create truth table in class together
- **In-class activity**: Review lab on AND gate with bread-board and resistor. Discuss what is a bread-board, resistor and what other practical labs can be done (for example NOT gate practical, NAND gate etc.): https://www.youtube.com/watch?v=aMVgrSU2PLc&list=PLe_7x5eaUqtVgVnAccC-emHekNNzVbHq_&index=2

[SLO CS-11-A-02]

Standard: Students will learn about components and interactions between computer systems, stages of software development, data representation and transmission across networks of computing systems, and the implications on usability, reliability, security, etc.
Benchmark I: Students will identify and analyze logic gates in digital systems
Benchmark II: Students will identify stages of system software development
Benchmark III: Students will learn about scalability, reliability, and security of computer networks

Student Learning Outcome(s):
[SLO CS-11-A-02] Students will be able to understand and evaluate stages of the systems design, e.g., software development life cycle (analysis, design, coding, and testing etc.), and software development methodologies

Knowledge:
Students will understand that

- What is a Software Development Life Cycle (SDLC)
  - What are the different activities involved in each phase of the SDLC
  - What are functional and non-functional requirements
- (Advanced) What are basic software processes and Agile, Waterfall software process models

Students will know

- Key terms: SDLC, SRS, bug, Agile, Waterfall, debugging, testing, design patterns, UML.
- Key activities in software development and the role of software development processes

Skills:
Students will be able to

- Relate the different stages of SDLC (analysis, design, coding, testing etc.) to a case study
- Plan a software project from beginning (design) to end (test and launch)
- (Advanced) Explain common software development processes (agile etc.)
- Explain alpha and beta testing

• The engineering nature of software development	

Assessments
Formative Assessments
Quiz questions on the following topics:

- If requirements are validated against the problem, and the implemented system is verified against those requirements, then the system should indeed be addressing the problem. Why then do we still need to validate the system against the problem during testing?
  What do you think the quality expectations for an air traffic control software system might be? What about those for a personal diary mobile app? How are these different?
- Name 3 software development processes and explain their key characteristics and differences
- Give an example of a common design pattern and when should it be applied
- What is the difference between software analysis and software design? What are some techniques used to test systems?

Summative Assessments
Exam / end of module quiz questions:

- Different stages of Software Development Life Cycle (SDLC) in detail (analysis, design, coding, testing)
- Common software development processes (agile etc.)
- Common software design patterns

Practicals / activity / research project including an element of:

- Software project from beginning (design) to end (test and launch)

Learning Activities

1. **In-class activity**: Share a snippet of code with a bug in it and ask the class to identify the bug through debugging techniques that have been taught
2. **In-class activity**: Share examples of different types of applications and all the ways these can be tested
3. **In-class activity**: Design a library system to search and retrieve books. Discuss with class how to do analysis, design, implementation, testing and then launch.

[SLO CS-11-A-03]

Standard: Students will learn about components and interactions between computer systems, stages of software development, data representation and transmission across networks of computing systems, and the implications on usability, reliability, security, etc.
Benchmark I: Students will identify and analyze logic gates in digital systems
Benchmark II: Students will identify stages of system software development
Benchmark III: Students will learn about scalability, reliability, and security of computer networks

Student Learning Outcome(s):
[SLO CS-11-A-03] Students will be able to understand and explain the scalability and reliability of networking systems via network topology

Knowledge:	**Skills:**
Students will understand • Different types of network topologies • Design, common access, and use of topologies	Students will be able to • Measure availability of a system • Prepare systems so they run with high reliability and can scale well

● Scalability and reliability ● Preparing for scale and reliability through load and system testing ● Scalability and reliability in cloud computing Students will know ● Key terms: Network topology, Bus, Ring, Tree, Star, Mesh, Hybrid, Ethernet, CSMA, Token passing, client, Server, root, node… ● Advantages and disadvantages of each network topology	● Test the scalability and reliability of a system

Assessments

Quiz 1 -

What is the advantage of a star topology?

What topology uses token passing and what topology is highly reliable and why?

Quiz 2 -
What does it mean when an application has an availability of five nines?
What questions do you need to ask when you are designing a scalable and reliable solution for a system?

Formative Assessments
Use video instruction and hands-on labs to practically explain concepts. Some examples in Learning Activities below

Summative Assessments
Usually, quizzes above would come in this category.

Learning Activities (The activities below are neither listed in any particular order nor is this an exhaustive list. View them as recommendations)

1. **In-class activity**: Discuss “What features increase the scalability of the Internet?”
2. **In-class activity**: A game is tested at 5x its expected load but when it goes live the game experiences 50x the expected load. Discuss what likely happens to the system and what the experience is for the players. How can this be prevented in the future?

[SLO CS-11-A-04]

Standard: Students will learn about components and interactions between computer systems, stages of software development, data representation and transmission across networks of computing systems, and the implications on usability, reliability, security, etc.
Benchmark I: Students will identify and analyze logic gates in digital systems

Benchmark II: Students will identify stages of system software development
Benchmark III: Students will learn about scalability, reliability, and security of computer networks

Student Learning Outcome(s):
[SLO CS-11-A-04] Understand and explain the need for cybersecurity and contrast different methods of encryption to transmit data

Knowledge:
Students will understand

- Cybersecurity
- Encryption
- Ways a system can be attacked
- proactive protection of systems against cyber attacks
- Data policies and privacy policies and how they can help keep your information safe

Students will know

- Key terms: Cryptography, 2FA, firewall, cookies, DDoS, Hacking, Authentication, Authorization, Hashing, Digital signatures, Malware, Phishing, XSS, Plaintext, Ciphertext, Encryption, Decryption ….

Skills:
Students will be able to

- Protect their computers and setup online access taking into account the security risks they are prone to
- Understand how basic cyber-attacks are constructed are applied to real systems
- Understand basic encryption techniques and algorithms used to protect sensitive data
- How to protect sensitive apps and data through strong passwords, 2 Factor Authentication and encryption techniques.

Assessments

Formative Assessments
Quiz questions on the following topics:

- What is phishing and how do you protect against it?
- What is DDOS and how do you protect against it?
- What software can prevent you from getting unwanted emails?
- What are some ways a virus can infect your computer?
- When should data be encrypted?
- If the word "NEOMAN" is coded as "OGRQFT" then which word will be coded as "ZKCLUP"?
- What are 4 basic types of encryption systems?
- Name and describe 3 common cryptographic algorithms
- What is hashing?
- What are digital signatures?

Summative Assessments
Practicals on topics related to:

- Protecting computers
- Setup online access taking into account the security risks they are prone to

Exam / end of module quiz questions on topics related to:

- Basic cyber-attacks are constructed and applies to real systems
- Analyzing cyber security risk and create a plan to prioritize risk decisions
- Understand basic encryption techniques and algorithms used to protect sensitive data

Learning Activities

1. **In-class activity**: Listen to this podcast about the Equifax data breach and discuss its impact and how it could have been prevented: https://www.carbonite.com/podcasts/breach/s02e03-Equifax-data-breach

2. **In-class activity**:View and discuss this video on cybersecurity and crime: https://www.youtube.com/watch?v=AuYNXgO_f3Y
3. **In-class activity**:View and discuss this video on encryption and public keys: https://www.youtube.com/watch?v=ZghMPWGXexs
4. **In-class activity**:View and discuss 7 key cryptography concepts developers should know: https://www.youtube.com/watch?v=NuyzuNBFWxQ

Domain B: Computational Thinking & Algorithms
[SLO CS-11-B-01]

Standard: Students will identify and decompose simple and complex problems, create & evaluate appropriate solutions using computational approaches, and understand and apply common algorithms used in solving computational problems.
Benchmark I: Students have core concepts of basic data structures and algorithms used extensively in computer science and knowledge of how to apply these techniques toward solving more complex and real-life problems.

Student Learning Outcomes [SLO CS-11-B-01] Plan, develop, systematically test, and refine computational artifacts for problem-solving such as pseudocode, etc.

Knowledge:
Students will understand
1) How to use different methods to design and construct a solution to a computational problem
2) The steps required for AI-based algorithms
   i. Data collection
   ii. Data arrangement & cleansing
   iii. training a model as per situation.
   iv. testing & evaluation
   v Deployment

Skills:
Students will be able to
1) Create pseudocode to address computational problems in the correct font, size, style, indentation, case, line numbers, comments, data types, key words, variable assignments & declarations, common operators, and key commands
2) Systematically test computational artifacts
3) Analyze an algorithm presented as a flow chart in terms of tracing an algorithm as well as assessing its correctness.
4) Evaluate algorithms in terms of their efficiency, correctness, and clarity

Assessments

Formative Assessments
Quiz questions on the following topics:
1) What is the difference between pseudocode and algorithm?
2) Write a pseudocode to output odd integers from 0 to 100?
3) Write an algorithm to “rock, paper, scissor” game

Summative Assessments
Practical activities on topics such as:
1) Write down the algorithm to solve tic tac toe game

Learning Activities
1) Interpreting word problems in code: https://docs.google.com/document/d/1_Hu-ZJz2p4dyYzyYgjZeORWuLX8PVfcFn7i8MZpPFHM/edit
2) Write a Pseudo-code?
   Arrange the sequence of tasks and write the pseudocode accordingly.

Start with the statement of a pseudo code which establishes the main goal or the aim.
Example: **If case is 1 then print "I am case 1" else print "I am not case 1"**

3) Reinforcement on the previous topics i.e., algorithmic approaches with new examples

[SLO CS-11-B-02]

Standard: Students will identify and decompose simple and complex problems, create & evaluate appropriate solutions using computational approaches, and understand and apply common algorithms used in solving computational problems.
Benchmark I: Students have core concepts of basic data structures and algorithms used extensively in computer science and knowledge of how to apply these techniques toward solving more complex and real-life problems.

Student Learning Outcomes [SLO CS-11-B-02] Apply common search, and sort algorithms

Knowledge:
Students will understand

1) Problem solving methods using simple example of
    a) Abstraction
    b) Decomposition
    c) Pattern recognition
2) computational thinking to solve practical exercises of algorithms
3) When to use various search and sort algorithms such as linear search, binary search, insertion sort, bubble sort, selection sort etc.

Skills:
Students will be able to

1) Use and adapt classic algorithms to solve computational problems (e.g., sorting and searching algorithms such as linear search, binary search, insertion sort, bubble sort, selection sort etc.)

Assessments

Formative Assessments
Quiz questions on the following topics:

- Define problem solving methods?
- What are the definitions and applications of various searching & sorting algorithms?

Practical exercises such as:

- Apply algorithmic thinking to use algorithm approaches (Abstraction, Decomposition, Pattern recognition) to handle complex problems such as:
- Sort following array {1, 5, 3, 2}
- Search for the number 5 in {2, 1, 5, 3, 2, 4, 5}
- Word search problems

Summative Assessments
Practical exercises for applying algorithmic thinking to create search & sort algorithms

Learning Activities:

1) Algorithmic approaches
   https://junilearning.com/blog/guide/how-to-introduce-computational-thinking-to-kids/
   https://www.teachingexpertise.com/classroom-ideas/algorithmic-games/
2) Write pseudocode for solving simple word problems, sample exercises here:
   https://olevelcomputerscience.files.wordpress.com/2015/09/pseducode.pdf

Domain C: Programming Fundamentals
[SLO CS-11-C-01]

Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learn how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration **Benchmark I:** Students will develop, test, debug command- line interface (CLI) applications in Python.	
Student Learning Outcome(s): [SLO CS-11-C-01] Students should understand the importance of computer programming and applications	
Knowledge: Students will understand ● What is programming language ● Types of high-level programming languages ● Difference between CLI and GUI based programming languages ● Benefits of using programming languages ● Popular applications of programming languages ● Features and components of python program and its application areas.	**Skills:** Students will be able to understand ● the importance of using programming languages to solve daily life problems.
Assessments **Formative Assessments** Quiz questions on the following topics: ● Basic components of a computer program ● Agile and Waterfall processes in gathering software requirements **Summative Assessments** Practical exercises such as: ● Apply an agile / waterfall models to gather software requirements ● Take a real world problem, propose a software solution and implement it.	
Learning Activities 1. Summarize or present in groups differences between Agile & Waterfall processes. Sample analysis is here: https://www.forbes.com/advisor/business/agile-vs-waterfall-methodology/ 2. Watch a video on gathering requirements in the software development process, example: https://www.pearson.com/channels/product-management/learn/Mariya/4-requirements-gathering-and-maintenance/42-scope-management-in-agile-vs-waterfall	

[SLO CS-11-C-02]

Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learn how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration **Benchmark I:** Students will develop, test, debug command- line interface (CLI) applications in Python.
Student Learning Outcome(s): [SLO CS-11-C-02] Students should be able to write and execute simple programs in Python.

Knowledge: Students will understand ● Input/ Output handling ● Variables in Python ● Operators in Python ● Sequence, Selection, Repetition in Python	**Skills:** Students will be able to ● Write and execute a program in Python using an IDE like replit.com (online) VS Code (offline) that uses variables, sequence, selection and repetition
Assessments -Quiz questions on the following topics: ● Variables in Python ● Sequence, Selection, Repetition in Python **Summative Assessments** Practical exercises such as: ● Write and execute a program in Python that uses variables, sequence, selection and repetition	
Learning Activities ● Instructor can request students to code geginner projects in Python, examples here: https://www.dataquest.io/blog/python-projects-for-beginners/ ○ https://www.freecodecamp.org/news/python-projects-for-beginners/ ○ https://www.upgrad.com/blog/python-projects-ideas-topics-beginners/ ● Add suggested books ● Add links to suggested compilers	

[SLO CS-11-C-03]

Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learn how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration **Benchmark I:** Students will develop, test, debug command- line interface (CLI) applications in Python.	
Student Learning Outcome(s): [SLO CS-11-C-03] Students should be able to draw shapes using Turtle Graphics functions in Python	
Knowledge: Students will understand ● How to use the Python Turtle Library ○ Turtle methods ○ Methods of screen ○ Turtle motion ○ Use of events ○ Create/ draw shapes ○ Compound Shapes ● How to create shapes by means of instructions to a “turtle” to move in a given direction ● How to create more complex shapes by allowing the “turtle” to lift the pen while moving	**Skills:** Students will be able to ● Write and execute a program in Python to create complex shapes using the Turtle library

Assessments

Formative Assessments
Quiz questions on the following topics:
- How to create shapes by means of instructions to a “turtle” to move in a given direction
- How to create more complex shapes by allowing the “turtle” to lift the pen while moving

Summative Assessments
Practical exercises such as:
- Write and execute a program in Python to create complex shapes using the Turtle library

Learning Activities
1) In-class Exercises using Turtle library, example exercises:
    a) https://realpython.com/beginners-guide-python-turtle/
    b) https://www.vivaxsolutions.com/web/python-turtle.aspx

[SLO CS-11-C-04]

Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learn how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration
Benchmark I: Students will develop, test, debug command- line interface (CLI) applications in Python.

Student Learning Outcome(s):
[SLO CS-11-C-04] Students should be able to understand the need for libraries and learn the use of some simple libraries in Python.

Knowledge:	**Skills:**
Students will understand ● The concept of abstraction that allows the use of complex libraries without knowing their internal implementation ● Python libraries like NumPy, pandas, matplotlib.	Students will be able to ● Find and use a third-party Python library that is simple to use but has a complex implementation ● Identify the situation in which different libraries can be used,

Assessments

Formative Assessments
Practicals / exercises on:
- Importing & using libraries
- Find and use a third-party Python library that is simple to use but has a complex implementation

Summative Assessments
- Practical exercises that have an element of using a library or designing your own library

Learning Activities
1. In-class research project, what is a library and why are they used? https://careerfoundry.com/en/blog/web-development/programming-library-guide/
2. Top 30 Python libraries: https://www.mygreatlearning.com/blog/open-source-python-libraries/
3. In-class video on how libraries work: https://www.youtube.com/watch?v=4oXc3EpUN4E

[SLO CS-11-C-05]

Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learn how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration **Benchmark I:** Students will develop, test, debug command- line interface (CLI) applications in Python.	
Student Learning Outcome(s): [SLO CS-11-C-05] Students should be able to translate simple algorithms that use sequence and repetition in Python.	
Knowledge: Students will understand ● What are lists(e,g., arrays, dictionary, sets etc) in Python ● How to use sequence and repetition to manipulate lists in Python	**Skills:** Students will be able to ● Write and execute a Python program that uses variables, sequence and repetition to populate a list ● Write and execute a Python program that uses variables, sequence and repetition to find an element in a list
Assessments **Formative Assessments** Practical exercises such as: ● Use sequence and repetition to manipulate lists in Python ● Write and execute a Python program that uses variables, sequence and repetition to populate a list **Summative Assessments** Practical exercises such as: Write and execute a program in Python that uses variables, sequence, selection and repetition	
Learning Activities 1) Writing python script (https://www.w3schools.com/python/) 2) Sequence, Selection, Repetition in Python (https://austincode.com/itse1359/sequence-selection-repetition.php)	

[SLO CS-11-C-06]

Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learn how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration **Benchmark I:** Students will develop, test, debug command- line interface (CLI) applications in Python.	
Student Learning Outcome(s): [SLO CS-11-C-06] Students should be able to decompose a problem into sub-problems and implement those sub-problems using functions in Python	
Knowledge: Students will understand ● Why we need functions? ● How to decompose a large problem into sub-problems? ● How to identify duplication in their code?	**Skills:** Students will be able to ● Write and execute a Python program that solves a large problem by decomposing into sub problems. ● Write a Python program that invokes functions within loops

● How to move duplicated code into a function? ● How to create/ define /invoke a function? ● Types of Functions ● Function parameters/ arguments ● Scope of variables ● Returning value from a function ● Pass by value	● Write a Python program that performs some mathematical operation on a value passed to it, and returns the updated value (for example Celsius to Fahrenheit conversion etc.)

Assessments

Formative Assessments
Quiz questions / Practical exercises such as:
- How to write a function?
- Why do we need a function?
- How a function is called in the program?
- What is the scope of function?
- What is the scope of variable

Summative Assessments
Practical exercises such as: Write functions add, subtract, multiply and divide and call them in the script to perform calculations

Learning Activities
1) Revise functions
2) Establish importance of functions
3) Different terminologies to the functions
4) Define scope of variables and functions with examples
5) Define “naming conventions”, such as Camal Cascading, camel Cascading and so on.
6) Writing a function in python
7) Converting a duplicate code into a function
8) Calling a function
9) Function types
10) Passing parameters in function
11) Return type of a function
12) Passing by value
13) Practical examples

[SLO CS-11-C-07]

Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learn how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration
Benchmark I: Students will develop, test, debug command- line interface (CLI) applications in Python.

Student Learning Outcome(s):
[SLO CS-11-C-07] Students will determine ways of debugging their code in Python

Knowledge:	**Skills:**
Students will understand ● The code written outside of a function is hard to test	Students will be able to ● Write code to invoke functions and check their return values for correctness

• The code written inside a function can be tested easily • That they can write code that calls functions to ensure the results are correct • The use of debugger that allows programmers to set a breakpoint to stop execution of their code, to see the state of variables during execution for the purpose of discovering errors in their code	• Read through code and dry-run to find bugs
Assessments **Formative Assessments** Practical / lab exercises on identifying & resolving errors in computing problems using test functions and dry-run. **Summative Assessments** Quiz / exam / practical on computing problems with errors and students to identify errors using test functions and breakpoints.	
Learning Activities • Class activity for variable dry-run in Python, lesson plan here: https://teachinglondoncomputing.files.wordpress.com/2014/05/activity-assignmentdryrunpython.pdf	

Domain D: Data and Analysis
[SLO CS-11-D-01]

Standard 1: Students will be able to understand the scope of data science, how computer systems collect, store, process, visualize, and interpret data. **Standard 2:** Students will get an introduction to the relational data model, relational database engines, and SQL and how to design good schemas. **Standard 3:** What is AI and machine learning, and how does it relate to data and data science **Benchmark I:** Students will be able to represent databases using UML diagrams and extract data using queries, and create data visualizations using software tools	
Student Learning Outcomes: [SLO CS-11-D-01] Students will be able to relate the role and importance of model building with their real-world applications	
Knowledge: Students will know how • statistical modeling can find relationships between real world events and can be used to make recommendations based on statistical findings. • use case for modeling, when they can be used, which models fit which use cases and basic statistical techniques such as linear regression and multiple linear regression.	**Skills:** Students will be able to: • Use the information from one variable to make predictions about another variable (fitting a line to understand the relationship between two variables and use the correlation coefficient to assess the linear association) • Identify the slope and intercept for the linear relationship • Build their first statistical model (Microsoft Excel Python, Weka)

Students will know: ● The linear relationship between variables (using correlation coefficients and build the y= mx + c using slope and intercept) ● The structure of linear models, K-means	● (Advanced) Interpret the results of the model including statistical significance and beta values (Advanced) Draw conclusions from the model output

Assessments

Formative Assessments

Lab Exercises in R or Python (Jupiter Notebooks)

- Lab#1: Coding exercise:
- LAB 4A: If the Line Fits… - Introduction to Data Science Curriculum (idsucla.org)
- Lab#2: Coding exercise: LAB 4B: What's the Score? - Introduction to Data Science Curriculum (idsucla.org)
- Lab#3: Coding exercise: LAB 4D: Interpreting Correlations - Introduction to Data Science Curriculum (idsucla.org)

In class discussion: Using a data set, represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

1. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear models.
2. Informally assess the fit of a function by plotting and analyzing residuals.
3. Fit a linear function for a scatter plot that suggests a linear association.
4. Judge whether or not the linear model is appropriate. Learn to interpret a correlation coefficient in a linear model and interpret slope and intercept. Evaluate the strength of a linear association. Evaluate the potential error in a linear model.

Summative Assessments

Lab Quiz: Similar Labs can be given as a "Interpreting Correlations": using a different data set the students may have not seen before

Learning Activities

1. Students will identify an official data set. e.g., students will begin to analyze an official data set from 2010 provided by the Los Angeles Department of Water and Power (DWP) to help them understand how water was used in the Los Angeles area in the recent past, before the drought. Materials: Video: California Drought Crisis Reaches Worst Level as It Spreads North https://www.nbcnews.com/storyline/california-drought/california-drought-crisis-reaches-worst-level-it-spreads-north-n169516
2. Statistical Predictions using one variable: Lesson 5: Statistical Predictions Using One Variable - Introduction to Data Science Curriculum (idsucla.org)
3. Statistical Predictions using two variables: Lesson 7: Statistical Predictions Using Two Variables - Introduction to Data Science Curriculum (idsucla.org)
4. See the Labs 3.6.1-3.6.3 in Book: An Introduction to Statistical Learning: with Applications in R | SpringerLink . This book can be downloaded online via this link.
5. Potential curriculum resource textbook: https://curriculum.idsucla.org/IDS_Curriculum_v_5.0/1_IDS_Curriculum_v_5.0/IDS_Intro%2BUnit1_v%206.0_FINAL.pdf

[SLO CS-11-D-02]

Standard 1: Students will be able to understand the scope of data science, how computer systems collect, store, process, visualize, and interpret data.
Standard 2: Students will get an introduction to the relational data model, relational database engines, and SQL and how to design good schemas.
Standard 3: What is AI and machine learning, and how does it relate to data and data science
Benchmark I: Students will be able to represent databases using UML diagrams and extract data using queries, and create data visualizations using software tools

Student Learning Outcomes [SLO CS-11-D-02] Students will understand and explain experimental design in data science

Knowledge:
Students will understand
- The importance of experimentation in data science as a tool to differentiate between correlation and causation.
- Measures used in experimentation
- Real world experimentation examples

Student will know…
- data collection methods, including traditional methods of designed experiments and observational studies like surveys.
- Statistics as a process for making inferences about population parameters based on a random sample from that population.

Skills:
Students will be able to
- Differentiate between correlation and causation
- Compare and contrast population vs. sample
- Compare and contrast parameter vs. statistic.
- How to do their own experiments through in-class activities
- Apply a real-world business problem where experimentation is used. (e.g., Facebook, YouTube, online retail)
- Explain situations where one measure of central tendency or spread may be more appropriate than others.
- (Advanced) Identify reports that use special data structures (census, survey, observational study, and randomized experiment).
- (Advanced) Use RStudio/ python to re-randomize data.
- (Advanced) Compute measures of central tendency and spread in RStudio/ python

Assessments

Formative Assessments
Quiz assessment questions / in class discussions on:
- Correlation vs. causation
- Measures used in experimentation
- Real work experimentation examples
- Data collection methods, sampling error and bias
- Statistical inferences using random population samples
- Purposes of and differences among sample surveys, experiments, and observational studies and how randomization relates to each.
- Apply a real-world business problem where experimentation is used. (eg. Facebook, YouTube, online retail)

Sample question could be:
- Give students a statement similar to learning activity #7. Test on the following questions:
    - What is the headline implying with its wording?

- Is it implying causation or association?
- How can you tell the difference between causation and correlation?

- In Class Group Assignment to test understanding of Experimentation: Practicum: Music to my Ears - Introduction to Data Science Curriculum (idsucla.org)

Summative Assessments

Exam questions on topics such as:

- Differentiate between correlation and causation
- Compare and contrast population vs. sample
- Compare and contrast parameter vs. statistic
- Read/interpreting boxplots

Sample question could be:

- Give students a prompt, "How can Company X improve their website using an experiment?" Have students apply the elements of the experiment to this prompt.
- Lab Exercise: Give the students a dataset with A/B testing result data. Have them report on the results of the experiment. They should provide 2 visualizations to accompany the results.

Learning Activities

1. Read published articles on Experimental design: Statistics - Experimental design | Britannica https://www.britannica.com/science/statistics/Experimental-design
2. Give a brief introduction into "what is an experiment". Experimental Design Steps & Activities | Scientific Method Steps (storyboardthat.com) https://www.storyboardthat.com/articles/e/experimental-design
3. Create a scenario descriptive or through a video (e.g., Lesson 2: What Is an Experiment? - Introduction to Data Science Curriculum (idsucla.org)) where an experiment is conducted. Guide students to identify the elements of an experiment by referring back to the video clip:
    a. Research Question—What is the question to be answered by the experiment?
    b. Subjects – people or objects that are participating in the experiment
    c. Treatment – the procedure that is assigned to a group of subjects
    d. Treatment group – the group of subjects that receive the treatment
    e. Control group – the group that does not receive a treatment
    f. Random assignment – subjects are randomly assigned to either the treatment or control group (two out of every three subjects received the treatment)
    g. Outcome – the variable that the treatment is meant to influence.
    h. Statistic—A method for comparing the outcomes of the control and treatment groups is needed
4. Give students a real-world experimentation A/B testing example.
    a. Have a discussion about population vs. sample, parameter vs. statistic and situations where one measure of central tendency or spread may be more appropriate than others.
5. Lesson 3: Let's Try an Experiment! - Introduction to Data Science Curriculum (idsucla.org)
6. Lesson 4: Predictions, Predictions - Introduction to Data Science Curriculum (idsucla.org)
    a. As part of this exercise students will continue to read articles critically. They will anticipate visualizations about the data that will be collected from the class experiment and make predictions about the outcome.
7. In class discussion: Show students the following headlines or any others that are similar in verbiage
    1. Stop Global Warming: Become a Pirate
    2. Lack of sleep may shrink your brain
    3. Early language skills reduce preschool tantrums
    4. Dogs walked by men are more aggressive

    Discuss each headline by asking the following questions:

1. What is the headline implying with its wording? 1a is implying that you can stop global warming by becoming a pirate, 1b is implying that it's possible to shrink your brain if you aren't getting enough sleep, 1c is implying that having early language skills will decrease preschool tantrums, 1d is implying that dogs are more aggressive when they've been walked by men.
2. Is it implying causation or association? Discuss definitions of causation and association. Causation means there is a cause and effect relationship between variables. For example, heat causes water to boil; whereas association or correlation means that high values of one variable tend to be associated with high values of the other (or high values tend to be with low values). However, this is not necessarily cause-and-effect at play. For example, blanket sales in Canada are associated with brush fires in Australia - not because Canadian blankets cause the fires, but because Canadian winters cause blanket sales, and Canadian winters are Australian summers, which cause fires. 1a, 1c and 1d are implying causation and 1b is implying association.
3. How can you tell the difference between causation and correlation? What words stand out in these headlines? Answers will vary but some terms for causation include: cause, increase/ decrease, benefits, impacts, effect/ affect, etc.; and for correlation include: get, have, linked, more/ less, tied, connected, etc. In 1a, "become" stands out; in 1b, "may" stands out; in 1c, "reduce" stands out; in 1d, "are" stands out.
4. Change each causal version of a headline into a non-causal version and vice versa. Answers will vary but an example for 1a is to instead say Global Warming linked to increase of pirates.

[SLO CS-11-D-03]

Standard 1: Students will be able to understand the scope of data science, how computer systems collect, store, process, visualize, and interpret data.
Standard 2: Students will get an introduction to the relational data model, relational database engines, and SQL and how to design good schemas.
Standard 3: What is AI and machine learning, and how does it relate to data and data science
Benchmark I: Students will be able to represent databases using UML diagrams and extract data using queries, and create data visualizations using software tools

Student Learning Outcomes: [SLO CS-11-D-03] Students will analyze pre-existing datasets to create summary statistics and data visuals (such as bar charts, pie charts, line graphs, etc.)

Knowledge:
Students will understand

- Definitions and analysis of data and data products (charts, graphs, statistics)
- How to construct multiple views of data
- How to analyze data through computational tools such as Excel, Google Sheets, R, or Python

Students will

- Apply their knowledge of visualization techniques (such as measures of center and spread, boxplots, bar plots, histograms, scatterplots) to data
- Read plots (identify the name of the plot, interpret the axes, look for trends, identify confounding factors).

Skills:
Students will be able to

- Collect, clean and manipulate data using tools such as Excel, Google Sheets, R, or Python
- Analyze data using statistical techniques and create visualizations to communicate their findings
- Understand the connection of datasets to machine learning.
- (Advanced) Understand how evidence was collected, what the perspective or bias of the creator might be and look behind the scenes to the process used to create the data.

• Use visualization to tell stories about data • (Advanced) Create basic plots in RStudio/ Python • (Advanced) Create frequency tables in RStudio/Python • (Advanced) Critically read reports from media sources to evaluate their claims and communicate their evaluations in written or verbal form using different types of media	

Assessments

Formative Assessments

Quiz assessment questions / lab or practical exercise on:

- Data analysis through computational tools such as Excel, Google Sheets, R, or Python
- Apply their knowledge of visualization techniques (such as measures of center and spread, boxplots, bar plots, histograms, scatterplots, graphical summaries of multivariate data, side-by-side bar plots and association, scatterplots) to data
- Read plots (identify the name of the plot, interpret the axes, look for trends, identify confounding factors).

Sample question could be:

1. Lab # 1: Represent data with plots on the real number line (dotplots, histograms, bar plots, and boxplots).
2. Lab # 2: Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).
3. Lab # 3: and in class discussion: Represent data on two quantitative variables on a scatterplot and describe how the variables are related.
4. Using a data set shared with the students:
    a. As a class, ask students to select 2 numerical variables and 1 categorical variable from the DataSet handout whose data they would like to see in a visualization, which is a picture of the data.
    b. Create a bar graph of the categorical variable chosen by the students. Begin by showing students how to clearly label the x-axis with the categories. For instance, if salty sweet is the variable, ask students to identify the categories for that variable. Then mark the y-axis with the label frequency, which simply means the number of times an outcome occurs. Do not put tick-marks on the y-axis. The frequency will be measured by the number of labels plotted.

Summative Assessments

Exam questions / practicals on topics such as:

- Collect, clean and manipulate data using tools such as Excel, Google Sheets, R, or Python
- Analyze data using statistical techniques and create visualizations to communicate their findings
- Connections between databases and machine learning.

Sample question could be:

- Quiz # 1: Provide students with a visualization and a prompt. Ask them to create a narrative and tell stories with data. (1) make assumptions about how the data was collected (2) identify any potential bias in the data (3) draw conclusions about the data
- Quiz # 2: Read and critique a published story with visualization (taken from e.g., newspaper, economist, business insider)
- Lab Quiz: Provide students a data set. Have them build visualizations on 1 categorical and 2 numerical data. Then provide a narrative on what they learn from the visuals.

Learning Activities

1. Provide a data file to students to work with e.g., Data & Statistics | Nutrition | CDC

2. R-Studio or Python data exercise
    a. Learn to download, load, upload, and work with data using RStudio syntax and structure.
    b. Create appropriate graphical displays of data.
    c. Differentiate between observations and variables.
    d. Learn to use objects, functions, and assignments.

Domain E: Applications of Computer Science
[SLO CS-11-E-01]

Standard 1: Student will understand computer technologies such as blockchain/AI/IoT/cloud computing/game design and development.
Standard 2: Student should be able to understand how computers learn, make decisions and the applications, challenges and social implications of AI.
Benchmark I: Students learn about different technologies that support the latest applications of CS and their relevance to Pakistan.
Benchmark II: Students learn about data techniques in AI applications and the social implications of technology.

Student Learning Outcome(s):
[SLO CS-11-E-01] Students should be able to describe technologies that are the foundations of IoT systems, Cloud Computing, and Blockchain

Knowledge:
Students will understand
- The fundamentals of AI/IoT/Cloud computing/blockchain and its application in daily lives.
- The hardware components of IoT like microcontroller (Arduino, Raspberry Pi), breadboard, sensors, jumpers, actuators, and relays etc.

Skills:
Students will be able to
- Develop IoT-based projects using Arduino IDE/Tinkercad etc.
    - Blinking LED
    - Temperature monitoring
    - Water level monitoring
    - Switch ON/OFF using LDR

Assessments

Formative Assessments
Quiz questions / research projects on topics:
- IoT applications
- Technologies that enable blockchains.

Summative Assessments
Exam questions or Research projects that contain elements of:
- IoT applications
- Technologies that enable blockchains.

Learning Activities

1. Take an example of a IoT application and identify how each component of connectivity, processing, AI, cloud computing, and battery power enables that application.

2. Have the students work through a blockchain application where the students act like blockchain users and maintain a ledger through their peer-to-peer network in class.

[SLO CS-11-E-02]

Standard 1: Student will understand computer technologies such as blockchain/AI/IoT/cloud computing/game design and development.
Standard 2: Student should be able to understand how computers learn, make decisions and the applications, challenges and social implications of AI.
Benchmark I: Students learn about different technologies that support the latest applications of CS and their relevance to Pakistan.
Benchmark II: Students learn about data techniques in AI applications and the social implications of technology.

Student Learning Outcome(s):
[SLO CS-11-E-02] Students should be able to evaluate how different stakeholder's culture, values, and (sometimes conflicting) interests affect AI System designs.

Knowledge:
Students will understand

- That there are different stakeholders that have vested interests in the outcomes of an AI algorithm These different stakeholders might have conflicting requirements for these algorithms

Skills:
Students will be able to

- Explore some of the stakeholders and describe their interest in AI algorithms
- Assess policies that can help to protect different stakeholders' interests
- Evaluate how different stakeholder's culture, values, and (sometimes conflicting) interests affect AI System designs.

Assessments

Formative Assessments
Quiz questions / research projects on topics:

- Vested interest of different stakeholders in the outcomes of an AI algorithm
- Conflicting requirements for these algorithms

Summative Assessments
Essay questions / subjective analysis on:

- Evaluate how different stakeholder's culture, values, and (sometimes conflicting) interests affect AI System designs.
- Assess policies that can help protect different stakeholders' interests

Learning Activities

1. Have a discussion in class where you divide the class into groups. Each group is further divided into three roles where one role represents advertisers that are trying to sell their products on a social media platform, the second role is using social media to connect with friends, and the third role is the developer who is trying to sign up more users and trying to get the existing users to spend more time on their applications. Help the discussion on how each role has different expectations from the AI algorithms being used in the application.

Domain F: Impacts of Computing
[SLO CS-11-F-01]

Standard 1: Students will be able to understand Ethics and laws related to computing and the use of computing devices, media, data, and the internet and the applications of personal privacy and Network security.
Standard 2: The environmental, cultural and human impact of computing and assistive technologies for the modern world.
Benchmark I: Students will interpret documents related to computing systems and evaluate their legal and ethical implications.
Benchmark II: Students will be able to illustrate how they can maintain privacy online and address security concerns they may encounter with the use of computing devices and applications.
Benchmark III: Students will demonstrate their ability to collaborate and communicate on the design of computing applications

Student Learning Outcomes
[SLO CS-11-F-01] Understand and apply safe & responsible use of information sources, identifying sources of reliable information compared to unreliable information and its sources

Knowledge:
Students will understand

- Safe & responsible use of information sources
- Human bias is everywhere including data collection and information sharing
- That how a correct query helps in fetching authentic and precise information from search engine/ Generative AI

Students will know

- The difference between data source verification tasks that should be completed by humans and those that are ideally completed by computing devices/AI

Skills:
Students will be able to

- Identify sources of reliable and unreliable information
- Address issues of bias in the designs of their computing applications
- Conduct data searches/ prompts to obtain reliable information

Assessments

Formative Assessments
Subjective essay questions or student reflection on topics such as:

- What is an example of bias in computing?
- Reflect on the lives of the people around you. Can you identify a need for an assistive technology that would help a friend, family member or your community? Provide a design for this technology and how it can be of use.

Individual Project: Design a computational artifact for a problem where a computing application is needed to assist humans with a task

Summative Assessments
Group project: Collaborate on a project with others through the use of an online digital tool that shows how computing enables better communication and collaboration between people

Learning Activities

- Give examples and describe the importance of collaboration and communication in Computing.
- Identify problems that must be solved by humans and machines working together
- Illustrate how computing devices are meant to help people with tasks
- Create a digital artifact that is designed to be accessible and obtain feedback from others
- Brainstorm ways to improve accessibility and usability of technology for diverse users
- Discuss how the design and use of computing technologies effects inequitable access to information
- Students should explain how human bias comes into computing applications through the design of algorithms. Consider racial, gender and ethnic bias.
- What are disinformation campaigns? Differentiate between misinformation and disinformation.
- Verifying facts in Politifact or Snopes
- Advanced: analysis of website claim veracity using open datasets (linkage to data & analysis domain)

[SLO CS-11-F-02]

Standard 1: Student will be able to understand Ethics and laws related to computing and the use of computing devices, media, data, and the internet and the applications of personal privacy and Network security.
Standard 2: The environmental, cultural and human impact of computing and assistive technologies for the modern world.
Benchmark I: Students will interpret documents related to computing systems and evaluate their legal and ethical implications.
Benchmark II: Students will be able to illustrate how they can maintain privacy online and address security concerns they may encounter with the use of computing devices and applications
Benchmark III: Students will demonstrate their ability to collaborate and communicate on the design of computing applications

Student Learning Outcomes
[SLO CS-11-F-02] Define and discuss how computing has increased connectivity by enabling communication between people and the environmental, cultural, and human impact of increased connectivity

Knowledge:
Students will understand

- The uses of assistive technologies for people with disabilities and the elderly
- The impact of the digital divide on connectivity and how accessibility to information affects the lives of different people

Students will know

- The different technological innovations we are using to improve communication between people such as Wi-Fi networks, Bluetooth etc.

Skills:
Students will be able to

- Discuss the impact of computing technology on business and commerce
- Collaborate on strategies to provide equity and equal access to information
-

Assessments
Formative Assessments
Assessment questions on

- What are some technological tools that can be used to collaborate on a project? If you did not have this technology, what would the experience of collaborating be with people?
- Demonstrate how computing has afforded increased connectivity by enabling communication between people. Discuss how this increased connectivity has impacted modern society

Summative Assessments

- Collaborate on a project with others through the use of an online digital tool that shows how computing enables better communication and collaboration between people

Learning Activities

- Technology has made communication much cheaper and easier. Provide examples from your everyday life to exemplify the use of technology for increasing connectivity between people.
- List the benefits of collaborations between people for the future. Why is it important for us to design technologies to improve collaborations and communications?
- Give students the following prompt and lead a class discussion: Rapid innovations in technology have supported greater connectivity between people. Once people had to use the landline phone to call another person but now we have availability of free calls over Wi-Fi networks. How has this change impacted the relationships between people, our cultural practices and the way we live?

Domain G: Digital Literacy
[SLO CS-11-G-01]

Standard: collect and analyze information and publish to various audiences using digital tools and media-rich resources. Use digital tools to design and develop a significant digital artifact through research design, data collection and communication.
Benchmark I: Use digital tools to design and develop a significant digital artifact through research design, data collection, and communication.

Student Learning Outcomes: [SLO CS-11-G-01] Perform advanced searches to locate information and/or design a data-collection approach to gather original data (e.g., quantitative interviews, surveys, prototypes, simulations)

Knowledge:
Students will understand

- Definitions of data collection strategies (e.g., quantitative interviews, surveys, prototypes, simulations)
- Best practices on how to present primary & secondary data for a research question
- How to design data-collection approach to gather original (means not synthesized) data

Students will know…

- How to use appropriate data collection strategies for various types of research questions

Skills:
Students will be able to

- Design a data-collection approach to gather original data (e.g., quantitative interviews, surveys, prototypes, simulations)
- Present data using appropriate digital tools (such as graphs or infographics in worksheets, presentations, reports etc.)

Assessments
Formative Assessments

- In class assignments / projects on topics such as:
  - Design & implementation of data collection to answer a research question
  - Present data collected using appropriate digital tools
- Quiz on topics such as:
  - Case studies of successful representations of data
  - Use of data collection approaches for various cases

Summative Assessments

- **Case studies** of digital artifacts testing student knowledge for (1) best tools to communicate various types of information (2) Appropriate use of tools (i.e. layouts, formatting, editing, graphics, appearance & alignment etc.)
- **Practical:** summative project submission of a key idea using an appropriate digital tool

Learning Activities

1. Students work collaboratively to design and generate a solution to a task/problem statement.
2. Students can present primary data using graphs or infographics

Domain H: Entrepreneurship in the Digital Age

[SLO CS-11-H-01]

Standard*:* student will Create a business using design thinking with the help of digital/AI tools.
Benchmark: Students will learn how to build successful products or services by creating and testing prototype and launching a minimum viable product

Student Learning Outcomes: [SLO CS-11-H-01]: Students will create, test, and iterate a prototype for a business idea

Knowledge:
Students will understand

- What is prototyping and why is it important
- How to design and test a prototype

Skills:
Students will be able to

- Design, build and test the prototype
- Derive learnings from prototype testing
- Iterate business solution based on prototype test results

Assessments

Formative Assessments
Assessment questions on

- What is prototyping and why is it important
- How to design and test a prototype

In class activities on designing a prototype

Summative Assessments
Project: presentation of prototype, or results of prototype testing
Case studies to elements of prototyping process

Learning Activities

- Read and discuss learnings on prototyping from articles such as:
  - IDEO prototyping the shopping cart: https://youtu.be/M66ZU2PCIcM

    - Make Your Ideas Tangible Through Prototypes: https://www.ideou.com/blogs/page/make-your-ideas-tangible-through-prototypes
    - Prototyping service: https://www.ideo.com/blog/3-tips-to-help-you-prototype-a-service
    - Acumen Academy blog: https://blog.acumenacademy.org/prototyping-design-process-pressure-test-ideas
- Create a prototype for your business idea. Now iterate and create a prototype over a few weeks.
- Technical resources and colleges can be contacted for assistance in developing prototypes particularly engineering product.
- Reflection: Students should reflect on 4Cs of the 21st century *(collaboration, critical thinking, creativity, communication)* and how they applied them when they were developing & testing their prototype

Grade 12

Domain A: Computing Systems

[SLO CS-12-A-01]

Standard: Students will learn about components and interactions between computer systems, stages of software development, data representation and transmission across networks of computing systems, and the implications on usability, reliability, security, etc.
Benchmark I: Students will identify and analyze logic gates in digital systems
Benchmark II: Students will identify stages of system software development
Benchmark III: Students will learn about scalability, reliability, and security of computer networks

Student Learning Outcome(s):
[SLO CS-12-A-01] Students will explain the usability, security and accessibility of devices, the systems they are integrated with.

Knowledge:
Students will understand
- What is usability and accessibility of hardware and software systems
- Human-computer interaction is a field of study to promote efficient, effective and satisfying user interactions
- The effects of not building accessible systems can be far reaching
- How design can make interfaces effective and user friendly
- How design can affect a wide range of accessibility issues

Students will know
- What usability testing is and how to design accessible user interfaces

Skills:
Students will be able to
- Understand the social, ethical, economic and environmental implications of bad system design

Assessments

Formative Assessments
Quiz questions on the following topics:
- What are the basic principles of usability testing?
- When should you conduct usability tests?

Practical / projects on:
- Designing effective and user friendly interfaces
- Designing for accessibility
- Designing so that social, ethical, economic and environmental concerns are considered

Summative Assessments
Exam questions or end of module projects that include the following topics:
- Designing effective and user friendly interfaces
- Designing for accessibility
- Designing so that social, ethical, economic and environmental concerns are considered

Learning Activities
1. **In-class activity**: Read and discuss the differences between accessible, usable and universal design: https://www.washington.edu/accesscomputing/what-difference-between-accessible-usable-and-universal-design

2. **In-class activity**: Review the latest web content accessibility guidelines to see how information and user interface components can be made usable. Discuss in class: https://www.w3.org/WAI/WCAG21/quickref/
3. **In-class activity**: Discuss the difference between user testing and usability testing.

[SLO CS-12-A-02]

Standard: Students will learn about components and interactions between computer systems, stages of software development, data representation and transmission across networks of computing systems, and the implications on usability, reliability, security, etc.
Benchmark I: Students will identify and analyze logic gates in digital systems
Benchmark II: Students will identify stages of system software development
Benchmark III: Students will learn about scalability, reliability, and security of computer networks

Student Learning Outcome(s):
[SLO CS-12-A-02] Explain human interaction with computer systems in terms of:

- Usability
- Common problems
- Methods for improvements through AI
- Ethical, social, economic, and environmental implications

Knowledge:
Students will understand that

- What is human computer interaction
- What is meant by usability
- What are common problems faced in developing efficient interfaces.
- How to improve interfaces through AI by using NLP, Emotional Intelligence & Predictive analysis.
- What are ethical, social, economic and environmental implications of bad system design.

Skills:
Students will be able to explain human interaction with computer systems in terms of:

- Usability
- Common problems and methods for improvements
- ethical, social, economic, and environmental implications

Assessments

Formative Assessments
Quiz questions on the following topics:

- Given this user persona (provide persona details e.g a blind woman in her 60s needing to use an app for banking) gave a detailed analysis of how to design for them so that the application is both usable and accessible
- What are some impacts of badly designed software in terms of compromising safety and security

Learning Activities

1. **In-class activity**: View this video and discuss how students can do usability testing for their projects: https://www.youtube.com/watch?v=r3j_dwMbLo0
2. **In-class activity**: Discuss ways in which students can design more accessible software and hardware taking into account various accessibility issues.

[SLO CS-12-A-03]

Standard: Students will learn about components and interactions between computer systems, stages of software development, data representation and transmission across networks of computing systems, and the implications on usability, reliability, security, etc.
Benchmark I: Students will identify and analyze logic gates in digital systems
Benchmark II: Students will identify stages of system software development
Benchmark III: Students will learn about scalability, reliability, and security of computer networks

Student Learning Outcome(s): [SLO CS-12-A-03] Identify and explain tradeoffs between the usability and security of computing systems, recommend cybersecurity measures by considering different factors such as efficiency, cost, privacy, and ethics

Knowledge:
Students will understand that

- There are tradeoffs between making a system more secure vs. making it more usable.
- What the factors are around efficiency, cost, privacy and ethics when it comes to cybersecurity

Students will know

- How to implement basic cybersecurity measures that take usability into account
- What is a zero-trust approach and how to design for it

Skills:
Students will be able to

- Explain the tradeoffs between security and usability
- Understand how to consider data privacy and security when designing an application
- Design ways to simplify app security (e.g., simplified 1-click authentication, design for transparency etc.) so that the experience is more seamless
- Balance security design of application such that efficiency, cost, privacy and ethics are not compromised

Assessments

Formative Assessments
Quiz questions on the following topics:

- Explain how you would design a usability study for a software application you are working on to also take into account the security requirements? What are some of the key metrics you will use to decide if the study was useful in building a better user interface while still being appropriately secure?.
  How can you minimize the amount of personal data you collect for your app?
- How can you be transparent in how users data is being used in your app?

Summative Assessments
Exam / end of module quiz / research or presentation projects questions on:

- Tradeoffs between security and usability
- Data privacy and security considerations in application design
- Types of app security (e.g., simplified 1-click authentication, design for transparency etc.)
- Balance security design of application such that efficiency, cost, privacy and ethics are not compromised

Learning Activities

1. **In-class activity**: Discuss common examples around you of systems that are not as usable due to higher security requirements. Suggest changes that would balance the two.
2. **In-class activity**: View this talk on the Security vs. Usability tradeoff and discuss in the context of social media applications security vs. banking application security: https://www.youtube.com/watch?v=0Qq41IR3Igc

Domain B: Computational Thinking & Algorithms
[SLO CS-12-B-01]

Standard: Students will identify and decompose simple and complex problems, create & evaluate appropriate solutions using computational approaches, and understand and apply common algorithms used in solving computational problems. **Benchmark I:** Students have core concepts of basic data structures and algorithms used extensively in computer science and knowledge of how to apply these techniques toward solving more complex and real-life problems.	
Student Learning Outcomes [SLO CS-12-B-01] *understand and evaluate the computational solutions in terms of efficiency, clarity and correctness.*	
Knowledge: Students will be able to understand: 1) properties of algorithm 2) What is efficiency of algorithm? 3) Measures of efficiency 4) complexity in terms of time and space 5) what is clarity? 6) what is correctness and how to prove the correctness of algorithm? 7) how to improve the clarity of an algorithm	**Skills:** Students will be able to 1) understand and differentiate the efficiency, clarity and correctness of an algorithm
Assessments **Formative Assessments** ● Quiz questions on topics related to case studies of trees and students to solve/traverse them **Summative Assessments** ● Examination questions on identifying and applying trees algorithm	
Learning Activities ● Ask students some algorithms like bubble sort, and ask them to calculate the efficiency in terms of time and space. ● Ask students to calculate the best-case scenario and worst-case scenario for quick sort algorithm.	

[SLO CS-12-B-02]

Standard: Students will identify and decompose simple and complex problems, create & evaluate appropriate solutions using computational approaches, and understand and apply common algorithms used in solving computational problems. **Benchmark I:** Students have core concepts of basic data structures and algorithms used extensively in computer science and knowledge of how to apply these techniques toward solving more complex and real-life problems.	
Student Learning Outcomes [SLO CS-12-B-02] understand and apply complex algorithms on data structures such as trees and binary search	
Knowledge: Students will know that 1) How to define data structures such as arrays, lists, trees, stack, and queue	**Skills:** Students will be able to 1) Identify and apply tree algorithm 2) Traverse trees

2) How to traverse a tree a) In-order Traversal b) Pre-order Traversal c) Post-order Traversal 3) How to conduct a binary search 4) Application of tree data structure 5) Application of binary search algorithm	3) Explain binary search method and predict results of a binary search algorithm
Assessments **Formative Assessments** ● Quiz questions on topics related to case studies of trees and students to solve/traverse them **Summative Assessments** ● Examination questions on identifying and applying trees algorithm	
Learning Activities ● ● Tree traversal: https://www.tutorialspoint.com/data_structures_algorithms/tree_traversal.htm ● Binary search videos & online exercises: https://www.khanacademy.org/computing/computer-science/algorithms/binary-search/a/binary-search ● In class activity / practical on binary search: https://classroom.thenational.academy/lessons/binary-search-chjked ● Sample lesson plan on binary search including activities like Raffle Tickets, Ping Pong Ball and Guess My Number to learn about binary trees: http://csunplugged.mines.edu/Activities/BinarySearch/BinarySearch.pdf	

Domain C: Programming Fundamentals
[SLO CS-12-C-01]

Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learn how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration **Benchmark I:** Students will develop, test, debug command- line interface (CLI) applications in Python.	
Student Learning Outcome(s): [SLO CS-12-C-01] Students should be able to understand and evaluate applications of various programming paradigms.	
Knowledge: Students will understand ● the purpose of programming language paradigms to reduce complexity and make code easy to understand for programmers ● A high-level view and pros/cons of Object-Oriented Programming (OOP) ● A high-level view and pros/cons of functional programming	**Skills:** Students will be able to ● Write a Python program using Object Oriented Programming to define a class with properties and methods to manage states of instances (objects)
Assessments **Formative Assessments** Projects / practical / in-class activities on developing an artifact in the Python programming language that will use object-oriented programming to manage states	

Summative Assessments
Exam questions should include explanations of purpose of programming, function programming, object-oriented programming and its advantages

Learning Activities
1. In-class activity: Watch a video on OOP & Python and discuss key points, e.g., https://youtu.be/E40NqsDgYa4
2. Python OOP exercises: https://pynative.com/python-object-oriented-programming-oop-exercise/

[SLO CS-12-C-02]

Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learn how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration
Benchmark I: Students will develop, test, debug command- line interface (CLI) applications in Python.

Student Learning Outcome(s):
[SLO CS-12-C-02] Students should be able to use more advanced programming constructs such as data structures (lists etc.), file handling (disk IO to write to storage), and databases in Python.

Knowledge:
Students will understand
- The purpose of a list, to store an ordered list of elements
- The purpose of a dictionary is to store key-value pairs
- Given a key, finding a value in a dictionary is faster than in a list
- What is the use of database
- Introduction to a database tool (e.g., MS Access, MySQL, etc.)
- Data normalization up to third Normal Form (3NF)
- Primary key, secondary key, etc
- How to connect databases with python program

Skills:
Students will be able to
- Write and execute programs to create and add/remove items in a list in Python
- Construct and retrieve values from a dictionary in Python
- Write and execute a Python program that can construct a dictionary based on user input, and can print a value whose key is input from the user.
- Write and execute programs that create and write to the file
- Read existing files
- Create and manage database in Python
- Create & update tables
- Data normalization up to third Normal Form (3NF)
- Select from tables (How to add, delete and edit records)
- Select with filter (where clause)
- Sort results (Order by clause)
- (Advanced) Create GUI based programs using Pygame or Tkinter

Assessments

Formative Assessments
Quiz questions on topics such as:
- The purpose of a list
- The purpose of a dictionary
- Finding values in a dictionary vs. list

Summative Assessments
Exam questions on following topics:

- Constructing dictionaries in Python
- Retrieving values from a dictionary in Python
- Writing and executing a Python program that can construct a dictionary based on user input, and can print a value whose key is input from the user.

Learning Activities

1. Mini-drills to learn about dictionaries in Python: https://towardsdatascience.com/12-examples-to-master-python-dictionaries-5a8bcd688c6d
2. In-class activity / practical: Python projects that use dictionaries, e.g., https://favtutor.com/blog-details/7-Python-Projects-For-Beginners
3. Create a mini-game using dictionaries, e.g., Hangman: https://favtutor.com/blog-details/7-Python-Projects-For-Beginners

[SLO CS-12-C-03]

Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learn how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration
Benchmark I: Students will develop, test, debug command- line interface (CLI) applications in Python.

Student Learning Outcome(s):
[SLO CS-12-C-03] Students should be able to implement complex algorithms that use lists etc. in Python

Knowledge:	**Skills:**
Students will understand ● The concept of a nested list (list within a list) ● A list as a value within a dictionary	Students will be able to ● Write, execute and debug a Python program that reads a list and prints the number of occurrences of each letter of the alphabet in that list

Assessments

Formative Assessments
Quiz questions on topics such as:

- Nested lists (list within a list)
- A list as a value within a dictionary

Summative Assessments
Examination questions / practicals on writing, executing and debugging Python programs that read a text file from disk and prints the number of occurrences of each letter of the alphabet

Learning Activities

1. Count the number of times a letter appears in a text in Python
2.

[SLO CS-12-C-04]

Standard: Students will create and debug projects in programming languages like Python, HTML, and JavaScript, learn how to translate algorithms into code and define & apply fundamental programming constructs such as sequence, selection, and iteration

Benchmark I: Students will develop, test, debug command- line interface (CLI) applications in Python.	
Student Learning Outcome(s): [SLO CS-12-C-04] Students will determine more advanced techniques (unit tests, breakpoints, watches) for testing and debugging their code in Python	
Knowledge: Students will understand ● The purpose of a unit test, breakpoints and watches ● Debugging allows programmers to analyze code as it runs	**Skills:** Students will be able to ● Write a unit test for the functions in their code ● Use a print statement to help debug in their code
Assessments **Formative Assessments** Practical / lab exercises on identifying & resolving errors in computing problems using test functions and breakpoints. **Summative Assessments** Quiz / exam / practical on computing problems with errors and students to identify errors using test functions and breakpoints.	
Learning Activities ● Basic workflow debugging for Python programming using print statements (example step by step guide here: https://www.codementor.io/@allisonf/how-to-debug-python-code-beginners-print-line-du107ltvx) ● Instructors can use this YouTube video as a reference: https://www.youtube.com/watch?v=r0JvqH6OWKQ	

Domain D: Data and Analysis
[SLO CS-12-D-01]

Standard 1: Students will be able to understand the scope of data science, how computer systems collect, store, process, visualize, and interpret data. **Standard 2:** Students will get an introduction to the relational data model, relational database engines, and SQL and how to design good schemas. **Standard 3:** What is AI and machine learning, and how does it relate to data and data science **Benchmark I:** Students will be able to represent databases using UML diagrams and extract data using queries, and create data visualizations using software tools	
Student Learning Outcomes: [SLO CS-12-D-01] Students will be able to analyze data and identify key model performance metrics of real-world machine learning models.	
Knowledge: Students will understand ● The difference between machine learning and rule-based algorithms. ● The basics of machine learning model building, i.e., feature engineering, train-test split and model assessment	**Skills:** Students will be able to ● Apply machine learning to a real-world problem (using Excel, Python, or R, Jupyter notebooks etc.) ● Build a simple machine learning model from data collection and cleaning

• They will learn how “learning from the data” works and which algorithms best fit which data structures. • The difference between predictive outcomes vs. causality • (Advanced) Model interpretation and use cases	• Interpret the results of the model output including features with most impact • (Advanced) Evaluate the model using various metrics and assess the model with a validation dataset.
Formative Assessments In class (group exercise)- Discuss differences between predicting continuous vs categorical variables. In class (group exercise)- Which metric will be useful in performance measurement for continuous vs categorical variables. **Lab 1 Exercise:** LAB 4C: Cross-Validation - Introduction to Data Science Curriculum (idsucla.org) **Lab 2 Exercise:** LAB 4D: Interpreting Correlations - Introduction to Data Science Curriculum (idsucla.org) Lab 3 Exercise: LAB 4H: Finding Clusters - Introduction to Data Science Curriculum (idsucla.org) **Summative Assessments** Quiz 1 - Write and explain the different steps in building a predictive model. Quiz 2 - Give 10 types of different predictive models and ask students to place them as continuous or categorical.	
Learning Activities 1. Students can do further Lab work with online courses such as “Data Science Foundations” from www.coursya.com Teachers can identify activities based on student skill level. 2. Potential curriculum resource textbook: https://curriculum.idsucla.org/IDS_Curriculum_v_5.0/1_IDS_Curriculum_v_5.0/IDS_Intro%2BUnit1_v%206.0_FINAL.pdf	

[SLO CS-12-D-02]

Standard 1: Students will be able to understand the scope of data science, how computer systems collect, store, process, visualize, and interpret data. **Standard 2:** Students will get an introduction to the relational data model, relational database engines, and SQL and how to design good schemas. **Standard 3:** What is AI and machine learning, and how does it relate to data and data science **Benchmark I:** Students will be able to represent databases using UML diagrams and extract data using queries, and create data visualizations using software tools	
Student Learning Outcomes [SLO CS-12-D-02] Students will explain and create a data visualization using for example, Structured Query Language (SQL), Python, or R.	
Knowledge: Students will know: • Data storytelling • read and critique published data stories and visualizations • How to formulate questions, identify existing data sets, and evaluate how the new data stories compare against the old. • techniques of descriptive statistics, to construct multiple views of data in an attempt to uncover new insights.	**Skills:** Students will be able to • Identify their own data set from the internet or known surveys • Use R or Python to create visualization • Download open source data from Kaggle, NASA, government websites, (IRIS or TITANIC from sites such as https://www.kaggle.com/). • Set up python environment and apply Python functions • (Advanced) Do data scraping. Use HTML and XML formats.

Assessments
In class presentation of the project.
Formative Assessments
Weekly check in with teacher to monitor progress of project
Summative Assessments
Group Project or Individual Project: Students identify a data set of their choice.

1. Pick a topic and build a story using the data and create data visualizations.
2. Identify bias in data, data collection methodology and other use cases of the data.

Learning Activities

1. Identify a dataset: See the Labs and Data set in Book: An Introduction to Statistical Learning: with Applications in R | SpringerLink . This book can be downloaded online via this link.
2. If there is no access to the internet the students can access datasets within the R and Python data libraries.
3. If there is access to internet students should sign up for courses such as "Learn Python Basics for Data Analysis" on openclassrooms.com as part of Lab exercises
    a. Set up python environment
    b. Use fundamental functions and objects in Python

Domain E: Applications of Computer Science
[SLO CS-12-E-01]

Standard 1: Students will understand computer technologies such as blockchain/AI/IoT/cloud computing/game design and development.
Standard 2: Students should be able to understand how computers learn, make decisions and the applications, challenges and social implications of AI.
Benchmark I: Students learn about different technologies that support the latest applications of CS and their relevance to Pakistan.
Benchmark II: Students learn about data techniques in AI applications and the social implications of technology.

Student Learning Outcome(s):
[SLO CS-12-E-01] Students should be able to design ideas of applications relevant to Pakistan and able to use IoT, Cloud computing, and Blockchain

Knowledge:	**Skills:**
Students will understand ● That IoT applications are applicable to Pakistan able to come up with ideas on what applications are needed in the community	Students will be able to ● Brainstorm and determine if a particular idea of an application is useful in the Pakistani context

Assessments

Formative & Summative Assessments
Exam or quiz assessment questions / in class discussions / research projects on:

- Local applications of IoT
- Pros and cons of using IoT in Pakistan

Sample question could be:

- How could IoT (robots, drones, remote sensors, and computer imaging) help rural smallholder farmers in Pakistan?

Learning Activities
Recall the applications we have studied and start a discussion of how IoTs, Blockchains, and Cloud computing can be used to solve problems in Pakistan in different domains.

[SLO CS-12-E-02]

Standard 1: Students will understand computer technologies such as blockchain/AI/IoT/cloud computing/game design and development.
Standard 2: Students should be able to understand how computers learn, make decisions and the applications, challenges and social implications of AI.
Benchmark I: Students learn about different technologies that support the latest applications of CS and their relevance to Pakistan.
Benchmark II: Students learn about data techniques in AI applications and the social implications of technology.

Student Learning Outcome(s):
[SLO CS-12-E-02] Students should be able to describe deep learning and its applications

Knowledge:	**Skills:**
Students will understand ● What is a biological neuron brain? ● Activation and deactivation of neuron ● Analogy between biological neuron and artificial neuron. ● Biological neural networks and artificial neural networks. Deeper vs. wider neural networks.	Students will be able to ● Identify the artificial neural networks ● Differentiate between biological neural network and artificial neural network ● Differentiate between deeper and wider neural networks.

Assessments

Formative & Summative Assessments
Exam & quiz assessment questions on:
- Definitions, description, and relationship between neural networks and deep learning networks
- Extracting features from a given dataset using deep learning networks

Learning Activities
- Activity: Research and discuss applications of neural networks
https://www.projectpro.io/article/neural-network-projects/440
- Neural network project ideas: https://www.upgrad.com/blog/neural-network-project-ideas-topics-beginners/
- Understanding Neural Networks with High School Math: https://ai.plainenglish.io/understanding-neural-networks-with-high-school-math-8a54efe7b8fd
- In class discussion on article: A Hands On Introduction to Deep Learning from a High School Perspective https://towardsdatascience.com/a-hands-on-introduction-to-deep-learning-from-a-high-school-perspective-41be62ef00a7

[SLO CS-12-E-03] and [SLO CS-12-E-04]

Standard 1: Student will understand computer technologies such as blockchain/AI/IoT/cloud computing/game design and development.
Standard 2: Student should be able to understand how computers learn, make decisions and the applications, challenges and social implications of AI.

Benchmark I: Students learn about different technologies that support the latest applications of CS and their relevance to Pakistan.
Benchmark II: Students learn about data techniques in AI applications and the social implications of technology.

Student Learning Outcome(s):
[SLO CS-12-E-03] Students should be able to assess policies that can help protect different stakeholders' interests
[SLO CS-12-E-04] Students should be able to evaluate scenarios with data sharing and privacy conflicts and suggest policy decisions that can help to achieve acceptable compromises.

Knowledge:
Students will understand

- What is data sharing?
- What is privacy?
- What is conflict?
- Data sharing and privacy have conflicting requirements.
- Each policy decision with conflicting interests requires compromises.

Skills:
Students will be able to

- Think critically about data sharing and privacy conflicts and develop the ability to evaluate different perspectives and arguments.
- Articulate their viewpoints and respond to opposing views. They will also develop their ability to express complex ideas and information in a clear and concise manner.
- Collaborate, communicate, and negotiate with one another
- Suggest policy decisions to mitigate data sharing and privacy conflicts

Assessments

Formative Assessments
Quiz / in class discussions and activities on data sharing and privacy conflicts
Summative Assessments
Policy document on a case study of conflicts between data sharing and privacy

Learning Activities

1. Case Study Analysis: Provide students with case studies of real-life scenarios that have data sharing and privacy conflicts, such as the Cambridge Analytica scandal, and ask them to evaluate the situation and suggest policy decisions that can help achieve acceptable compromises. This exercise will allow students to practice analyzing and evaluating real-world examples of data sharing and privacy conflicts and develop their critical thinking skills.

2. Debate: Divide the class into two groups and assign each group a stance on a data sharing and privacy conflict. For example, one group could argue that social media companies should be required to share user data with the government to prevent terrorism, while the other group could argue that this would be a violation of privacy rights. This exercise will allow students to practice arguing their points of view and develop their communication and collaboration skills.

3. Policy Writing: Ask students to work in groups to draft a policy document that outlines how organizations should handle data sharing and privacy conflicts. The policy document should consider the benefits and drawbacks of data sharing, as well as the importance of protecting individuals' privacy rights. This exercise will allow students to practice working collaboratively, developing policy proposals, and understanding the nuances of data sharing and privacy.

4. Create an activity that requires taking an example of data sharing and privacy conflicts in the news or online. Students evaluate the situation and suggest policy decisions that could help resolve the conflict.

Domain F: Impacts of Computing
[SLO CS-12-F-01]

Standard 1: Student will be able to understand Ethics and laws related to computing and the use of computing devices, media, data, and the internet and the applications of personal privacy and Network security.
Standard 2: The environmental, cultural and human impact of computing and assistive technologies for the modern world.
Benchmark I: Students will interpret documents related to computing systems and evaluate their legal and ethical implications.
Benchmark II: Students will be able to illustrate how they can maintain privacy online and address security concerns they may encounter with the use of computing devices and applications
Benchmark III: Students will demonstrate their ability to collaborate and communicate on the design of computing applications

Student Learning Outcomes [SLO CS-12-F-01] Identify and apply safe practices when collaborating on digital or online platforms.

Knowledge:
Students will understand
- The necessity of security protocols for the secure storage and transmission of data
- When and how their information is collected and used

Giving away private information can make it easier for your identity to be stolen

Skills:
Students will be able to

- Apply basic security methods to computing applications they create
- Evaluate the kinds of security protocols being used by different computing systems and devices
- Identify security threats in the use of different computing applications and devices
- Troubleshooting issues to support security of systems and applications
- Find a cybersecurity threat and be able to apply strategies to correct it

Assessments

Formative Assessments
Quiz questions on topics such as:
- How can we detect intrusions? (checking logs, firewall rules, intrusion detection systems - IDS)
- What are some recommended approaches for mitigating or preventing network attacks?

Summative Assessments
Examination questions on common security protocols used for secure transmission. of data

Learning Activities
- Divide the class into groups. Ask the groups to create a protocol that will allow one classmate to send another classmate a note, without the need for talking to each other.
- Trace a website request from the server, through the network, and to your computer.

[SLO CS-12-F-02]

Standard 1: Student will be able to understand Ethics and laws related to computing and the use of computing devices, media, data, and the internet and the applications of personal privacy and Network security.
Standard 2: The environmental, cultural and human impact of computing and assistive technologies for the modern world.
Benchmark I: Students will interpret documents related to computing systems and evaluate their legal and ethical implications.
Benchmark II: Students will be able to illustrate how they can maintain privacy online and address security concerns they may encounter with the use of computing devices and applications
Benchmark III: Students will demonstrate their ability to collaborate and communicate on the design of computing applications

Student Learning Outcomes [SLO CS-12-F-02] Discuss security threats and mitigation such as 2FA, biometric verification, and secure techniques for transmitting data etc.

Knowledge:
Students will understand

- The necessity of security methods for the storage and transmission of data
    - Different security methods used: 2FA, biometric verification
    - Basics of cryptography and the common ciphers used for safe transmission of data
- When and how their information is collected and used
- Different types of cyber-attacks: DDoS attack, ransomware, spyware, viruses, phishing etc.

Skills:
Students will be able to

- understand and apply security threats and ways to avoid them such as 2FA, Biometric verification and other safe techniques.

Assessments

Formative Assessments
Quiz assessment questions on topics such as:

- Explain common network attacks and how they happen.
-
- What are some recommended approaches for mitigating or preventing network attacks?

Summative Assessments
Examination questions on topics such as:

- Common ciphers used for encryption and decryption of data?

Learning Activities

- There are many kinds of network attacks including DNS spoofing, DoS/DDoS, Waterhole attacks, fake WAP, eavesdropping. Describe each of these and give strategies to mitigate these attacks.
- Students will differentiate between cybersecurity and cryptography.
- Cryptography is the science of concealing messages with a secret code. Students should see examples of common ciphers used for encryption and decryption of information such as the ceaser cipher, shift cipher, substitution cipher.

[SLO CS-12-F-03]

Standard 1: Student will be able to understand Ethics and laws related to computing and the use of computing devices, media, data, and the internet and the applications of personal privacy and Network security.
Standard 2: The environmental, cultural and human impact of computing and assistive technologies for the modern world.
Benchmark I: Students will interpret documents related to computing systems and evaluate their legal and ethical implications.
Students will be able to illustrate how they can maintain privacy online and address security concerns they may encounter with the use of computing devices and applications
Benchmark III: Students will demonstrate their ability to collaborate and communicate on the design of computing applications

Student Learning Outcomes
[SLO CS-12-F-03] Collaborate on strategies to provide equity and equal access to information

Knowledge:
Students will understand

- The need to develop computational perspectives that are valuable for their future career
- The need for collaborations to improve designs of computing applications

Skills:
Students will be able to

- Communicate with others on the design of computing technologies
- Strategize to improve collaborations between different teammates using technology resources
- Create artifacts that address issues of equity in terms of access to information
- Explore collaborative tools for online use, for example Google workplace, Slack, Trello, Microsoft Teams etc.

Assessments

Formative Assessments
Group project: Collaborate with people who are not located in the same city as you on the creation of a digital artifact. Take memos during this process of any difficulties you encounter such as access to computers or online resources. How did you tackle these challenges during your collaboration? At the end of the unit, provide recommendations for collaborative tools that can address some of the issues you identified during the creation of your digital artifact.

Summative Assessments
Examination questions on collaborative tools used online and recommendations on how they can be improved.

Learning Activities

- Group discussions in class: How are digital applications supporting collaborations and what are some safety concerns for users?
- Test out different collaborative tools online such as google docs, GitHub.
- Brainstorm on the design of a collaborative tool that will facilitate your work while studying this unit. Come up with a list of user requirements and share with your class to get feedback from others.
- Students should be asked to reflect on why feedback from others is important during collaborations on computing applications?

Domain G: Digital Literacy
[SLO CS-12-G-01]

Standard: collect and analyze information and publish to various audiences using digital tools and media-rich resources. Use digital tools to design and develop a significant digital artifact through research design, data collection and communication.
Benchmark I: Use digital tools to design and develop a significant digital artifact through research design, data collection, and communication.

Student Learning Outcomes: [SLO CS-12-G-01] Students will create an artifact that answers a research question, communicates results and conclusions through digital resources or tools

Knowledge:
Students will understand

- How to perform advanced searches/prompts to locate information for a research topic
- How to use digital/AI tools to communicate results and conclusions

Skills:
Students will be able to

- Perform advanced searches/prompts to locate information
- comprehend and reflect the result of their online searches using digital/AI tools

Assessments
Formative Assessments

- In class assignments / projects on topics such as:
  - Design & implementation of data collection to answer a research question
  - Present data collected using appropriate digital/AI tools
- Quiz on topics such as:
  - Case studies of successful representations of data
  - Use of data collection approaches for various cases

Summative Assessments

- **Case studies** of digital artifacts testing student knowledge for (1) best tools to communicate various types of information (2) Appropriate use of tools (i.e., layouts, formatting, editing, graphics, appearance & alignment etc.)
- **Practical:** summative project submission of a key idea using an appropriate digital/AI tool

Learning Activities

1. Research Project Guide - A Handbook for Teachers and Students to using data https://www.humbleisd.net/cms/lib/TX01001414/Centricity/Domain/29/researchguideHS.pdf
2. Collecting Data in Your Classroom https://kstatelibraries.pressbooks.pub/gradactionresearch/chapter/chapt5/
3. How-To Guide for Research Projects for High School Students https://pioneeracademics.com/2022/11/20/how-to-guide-for-research-projects-for-high-school-students/
4. Teacher's Guides and Analysis Tool - Primary Source Analysis Tool for Students
   Students can use this simple tool to examine and analyze any kind of primary source and record their responses
   https://www.loc.gov/programs/teachers/getting-started-with-primary-sources/guides/

Domain H: Entrepreneurship in the Digital Age

[SLO CS-12-H-01]

Standard*:* student will Create a business using design thinking with the help of digital/AI tools.
Benchmark: Students will learn how to build successful products or services by creating and testing prototype and launching a minimum viable product

Student Learning Outcomes: [SLO CS-12-H-01]: Students will create and test a minimum viable product for their business

Knowledge:
Students will understand

- What is minimum viable product (MVP)
- Difference between MVP and prototype
- What is the Riskiest (Business Model) assumption and how to identify it
- How to design a test using an MVP
- How to identify "beachhead market" for MVP testing

Students will be able to:

- Know the following terms
  - Pros and Cons of Digital Wallet & Transactions
  - Financial Planning

Skills:
Students will be able to

- Design, create, and test an MVP for a business idea for their beachhead market

Assessments

Formative Assessments
Case studies: Review/reflection on how successful businesses first created their MVPs

Summative Assessments
Project: Create MVP and test through a soft launch of business to beachhead market

Learning Activities

- Case studies of MVP of some companies such as:
  - Dropbox: https://youtu.be/7QmCUDHpNzE
  - Door Dash https://youtu.be/MRfgomazu9o
  - AirBnB https://www.quora.com/What-did-Airbnb-MVP-look-like/answer/Kevin-Kononenko
- Class activity: Review methods on how to create a MVP and make your own MVP plan. Examples of methods of creating MVPs are:
  - https://www.teachingentrepreneurship.org/how-to-teach-mvp/
  - https://onix-systems.com/blog/how-to-build-a-successful-mvp
- Beachhead market:
  - Review articles on best strategy to identify beachhead market: https://corporatefinanceinstitute.com/resources/management/beachhead-strategy/
  - Conduct primary and secondary research on beachhead market for their business idea
- Project: create & test MVP for business
- Reflection: Students should reflect on 4Cs of the 21st century *(collaboration, critical thinking, creativity, communication)* and how they applied them when they were developing & testing their minimum viable product

Guidelines for Textbook Authors

Textbook authors play a crucial role in shaping young minds through their writing. A well-planned textbook, written by qualified and competent subject experts, and presented in an attractive and engaging manner, should captivate both teachers and students. While textbooks for lower levels typically incorporate more learning features, certain aspects should be considered in textbook writing across all levels:

- Ensure the textbook aligns with the objectives of the Curriculum.
- Maintain focus on standards and benchmarks throughout.
- Make the textbook visually appealing to sustain student interest.
- Design an attractive title page that reflects the content of the textbook.
- Use a color scheme for pictures that closely resembles real life.
- Include a detailed table of contents.
- Write clear and concise text.
- Avoid cramming information; break it into smaller, digestible parts with headings.
- Adapt to the mental level of the students.
- Keep the length of the textbook reasonable.
- Provide accurate and up-to-date information.
- Organize the text material logically, progressing from simple to complex, familiar to unfamiliar, and concrete to abstract.
- Ensure the text material is free from ambiguities and errors.
- Keep the volume of the textbook reasonable, with the number of pages restricted to approximately 180-210 pages per grade.

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