Mathematics Department

AP Computer Science Principles

AP Computer Science Principles is an introductory college-level computing course that introduces students to the breadth of the field of computer science. Students learn to design and evaluate solutions and to apply computer science to solve problems through the development of algorithms and programs. They incorporate abstraction into programs and use data to discover new knowledge. Students also explain how computing innovations and computing systems—including the internet—work, explore their potential impacts, and contribute to a computing culture that is collaborative and ethical. (College Board, 2023)

Developed By: Monika Truty, College Board
Effective Date: September 2025

Scope and Sequence

September	**Summer Assignment: Unit 3 - Intro to App Design** -Basics of Iterative Development Process & App Design -Debugging Strategies -Input/Output **COMMON ASSESSMENT: Prerequisite TEST** **Unit 4: Variables, Conditionals, and Functions** -Variables -Conditionals (If, If/Else, If/Else If Statements) -Functions
October	**Unit 1: Digital Information** -Binary number systems, converting from binary to decimal and vice versa -Binary roundoff and overflow errors -Image and Data representation - Pixels -Lossy and Lossless compressions -Digital Dilemmas **Unit 2: The Internet** -Protocols of the internet: Networks, IP Addressing, Routers & Redundancy, IP Packets, HTTP & DNS, TCP
November	**Unit 2: The Internet (cont.)** -Internet Dilemmas: Net Neutrality, Digital Divide, Internet Censorship -Protocols of the internet: Networks, IP Addressing, Routers & Redundancy, IP Packets, HTTP & DNS, TCP

	Unit 5: Data -What is Metadata? -Understanding data from a bar chart, histogram, crosstab, scatter chart -Filtering and cleaning data
December	**Unit 5: Data (cont.)** -Big, Open, Crowdsourced Data -Machine Learning and Algorithmic Bias **Unit 6: Lists, Loops, and Traversals** -Lists
January	**Unit 6: Lists, Loops, and Traversals (cont.)** -For Loops, While Loops -Traversals (reduce and filtering a list) **Unit 7: Parameters, Return, and Libraries** -Parameters in a function -Return values in a function -Libraries
February	**Unit 8: Cybersecurity and Global Impacts** -Data Policies and Privacies -Security Risks & how to protect data
March	**Unit 9: Create PT Prep** **Create Performance Task** -12 class hours must be provided **COMMON ASSESSMENT: Create Task**
April	**Unit 10: Algorithms** -Algorithms Solve Problems -Algorithm Efficiency and Runtime -Parallel and Distributed Algorithms **AP EXAM REVIEW** -Using AP Classroom, albert.io, practice tests -Practice Written Responses
May	**AP EXAM REVIEW (cont.)** -Using AP Classroom, albert.io, practice tests -Practice Written Responses **AP EXAM** **FINAL ASSESSMENT PROJECT** -Learn new programming skills/language
June	**FINAL ASSESSMENT PROJECT (cont.)** -Program complex game reflecting skills learned using the Iterative Design Process

Digital Information

Summary and Rationale

Students will learn how complex information like numbers, text, images, and sound are represented in bits, how compression works, and the broader social impacts of digitizing the world's information. This unit explores the technical challenges and questions that arise from the need to represent digital information in computers.

Recommended Pacing

For recommended pacing refer to the scope and sequence for each course.

Standards

CSTA K-12 Computer Science Standards (2017)	
IC - Impacts of Computing	
2-IC-20	Compare tradeoffs associated with computing technologies that affect people's everyday activities and career options.
3A-IC-24	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
3A-IC-28	Explain the beneficial and harmful effects that intellectual property laws can have on innovation.
3B-IC-27	Predict how computational innovations that have revolutionized aspects of our culture might evolve.
AP - Algorithms & Programming	
3A-AP-21	Evaluate and refine computational artifacts to make them more usable and accessible.
DA - Data & Analysis	
2-DA-07	Represent data using multiple encoding schemes.
3A-DA-09	Translate between different bit representations of real-world phenomena, such as characters, numbers, and images.
3A-DA-10	Evaluate the tradeoffs in how data elements are organized and where data is stored.
CS - Computing Systems	
3A-CS-02	Compare levels of abstraction and interactions between application software, system software and hardware layers.
AP Computer Science Conceptual Framework	

DAT-1	The way that the computer represents data is different from the way that the data are interpreted and displayed for the user. Programs are used to translate data into a representation that is more easily understood by people.
IOC-1	While computing innovations are typically designed to achieve a specific purpose, they may have unintended consequences.
CSP Topics	
2.1	Binary Numbers
2.2	Data Compression
5.5	Legal and Ethical Concerns
Interdisciplinary Connections	
Standard	
RL.10	Read and comprehend complex literary and informational texts independently and proficiently.
W.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
9.1	All students will demonstrate the creative, critical thinking, collaboration, and problem solving skills needed to function successfully as both global citizens and workers in diverse ethnic and organizational cultures.

Enduring Understandings:	**Essential Questions:**
Computers store complex information like numbers, text, images, and sound. Binary digits are used to represent this information in a computer. Information represented digitally brings challenges, like the amount of space it takes up and quality of the data. Binary can precisely represent some fractional amounts from the decimal number system. Binary cannot precisely represent other fractional values from the decimal number system (Ex: 0.39) Digitizing information has pros and cons, such as the need to compress it (lossy or lossless), and brings questions of intellectual property. Analog Data has values that change continuously, or smoothly, over time. Some examples of analog data include music, colors of a painting, or position of a sprinter during a race. Digital Data changes discreetly through a finite set of possible values.	What are the similarities and differences between the binary and decimal systems? Describe how the process of sampling, RGB pixels, and binary sequences work together to display a digital color image. How is a Creative Commons license different from a regular copyright? Do you think there is always both a benefit and a harm to digitizing analog content?

There are two main types of compressions. Lossy Compression is a process for reducing the number of bits needed to represent something in which some information is lost or thrown away. This process is not reversible. Lossless Compression is a bit different. Lossless compression is a process for reducing the number of bits needed to represent something without losing any information. This process is reversible.

Digital information has a profound impact on modern life. Through copyright policies, digital information can be beneficial, harmful, and impacts a society, group of people, a company, or a person.

Evidence of Learning (Assessments)

Tests
Quizzes
Homework
Programs
Projects
Class participation

Objectives (SLO)

Students will know:

- Binary number systems, converting from binary to decimal and vice versa
- Binary roundoff and overflow errors
- Image and Data representation - Pixels
- Lossy and Lossless compressions
- Digital Dilemmas

Students will be able to:

- Convert between binary and decimal number systems
- Apply binary digits to storing information digitally (text, images, sound, video)
- Understand lossy or lossless compression based on the needs of a situation
- Explain how copyright and Creative Commons Licenses can be applied to digital works of creativity
- Debate issues that arise in modern society due to the digitizing of information

Suggested Resources/Technology Tools

-Programming compiler code.org - App Lab
-Online notebook/journal
-Learning Management System & Google Workspace Apps
-AP CSP Practice Tests and Released Items
-Online Textbook & AP Classroom

Modifications

Special Education-

Modifications and accommodations must be aligned to students' IEPs and uphold expectations of the plan lawfully.
● Allow additional time for skill mastery.
● Provide small group/ individualized instruction.
● Allow use of assistive technology.
● Anticipate needs; pre-teach if needed.
● Have student repeat directions to check for understanding.
● Highlight text/ visual presentation.
● Modify assessment/assignment content, format, length (benchmarks, tests and quizzes) .

ML-

● Provide additional wait time for student responses to questions
● Provide simplification of sentence structure and repetition of questions/sentences exactly as stated before trying to rephrase.
● Speak clearly, using a normal tone and rate of speed, or slightly slower.
● Use directed reading activities. Ensure preview of text before assigned/read, provide pre-reading

Gifted and Talented-

● Advance, accelerate, or compact content
● Support abstract and advanced higher-level thinking through differentiated questioning
● Allowance for adapting of content for individual student interests
● Provide assignments geared to development in areas of affect, creativity, cognition, and research skills

504-

Modifications and accommodations must be aligned to the 504 plan and uphold expectations of the plan lawfully.
● Provide additional time for in-class assignments and assessments
● Allow for computer with voice output, spelling and grammar checker
● Offer individual help throughout the lesson
● Modify readings and primary source documents

At Risk-

● Provide small group instruction for identified areas for growth
● Allow for alternate pathways for completion of assignments.
● Provide additional wait time for student responses to questions
● Pair oral instruction with visuals
● Utilize manipulatives

For a full list of Accommodations and Modifications, please click here.

-Frequently check on progress of independent work

21ST CENTURY LIFE AND CAREER STANDARDS

- ❏ Apply appropriate academic and technical skills.
- ❏ Communicate clearly and effectively and with reason.
- ❏ Demonstrate creativity and innovation.
- ❏ Employ valid and reliable research strategies.
- ❏ Utilize critical thinking to make sense of problems and persevere in solving them.
- ❏ Model integrity, ethical leadership, and effective management.
- ❏ Plan education and career paths aligned to personal goals.
- ❏ Use technology to enhance productivity.

LINKS TO CAREERS: https://career.ku.edu/computer-science

Unit 2	
The Internet	
Summary and Rationale	
Students will learn how the Internet works and discuss its impacts on politics, culture, and the economy. Students will learn how the different protocols of the Internet work and actually build a network themselves using the Internet Simulator. Students will consider the impacts the Internet has had, both good and bad, on modern life. This unit reveals how the Internet was designed to connect billions of devices and people to one another.	
Recommended Pacing	
For recommended pacing refer to the scope and sequence for each course.	
Standards	
CSTA K-12 Computer Science Standards (2017)	
IC - Impacts of Computing	
3A-IC-24	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
3A-IC-28	Explain the beneficial and harmful effects that intellectual property laws can have on innovation.
3A-IC-30	Evaluate the social and economic implications of privacy in the context of safety, law, or ethics.
3B-IC-26	Evaluate the impact of equity, access, and influence on the distribution of computing resources in a global society.
3B-IC-28	Debate laws and regulations that impact the development and use of software.
NI - Networks & the Internet	
2-NI-04	Model the role of protocols in transmitting data across networks and the Internet.
3A-NI-04	Evaluate the scalability and reliability of networks, by describing the relationship between routers, switches, servers, topology, and addressing.
3B-NI-03	Describe the issues that impact network functionality (e.g., bandwidth, load, delay, topology).

AP Computer Science Conceptual Framework	
CSN-1	Computer systems and networks facilitate the transfer of data.
IOC-1	While computing innovations are typically designed to achieve a specific purpose, they may have unintended consequences.
CSP Topics	
4.1	The Internet
4.2	Fault Tolerance
5.2	Digital Divide
Interdisciplinary Connections	
Standard	
RL.10	Read and comprehend complex literary and informational texts independently and proficiently.
W.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
9.1	All students will demonstrate the creative, critical thinking, collaboration, and problem solving skills needed to function successfully as both global citizens and workers in diverse ethnic and organizational cultures.

Enduring Understandings:	**Essential Questions:**
Computer systems and networks facilitate the transfer of data. A Computing Device is a machine that can run a program, including computers, tablets, servers, routers, and smart sensors. A group of computing devices and programs working together for a common purpose makes up a computing system. A group of interconnected computing devices capable of sending or receiving data makeup a computing network. A Path is the series of connections between computing devices on a network starting with a sender and ending with a receiver. Bandwidth is important because bandwidth is the maximum amount of data that can be sent in a fixed amount of time, usually measured in bits per second. The internet is a set of protocols. Different layers of protocols build upon and rely on one another and make up the Internet.	Why are long text messages sometimes delivered out of order? When an Internet service outage occurs in a different part of your town or city, how are you still able to access the Internet? Explain how each of the different layers is involved when you go to a link like nutleyschools.org?

A protocol is an agreed-upon set of rules that specify the behavior of some system. The system needs computers to be addressed, therefore an IP (Internet Protocol) Address, or a unique number that is assigned to each device on the Internet.

A router is a type of computer that forwards data across a network. This means that the system needs a way to make sure there is a path between devices. Redundancy is the inclusion of extra components so that a system can continue to work even if individual components fail, for example by having more than one path between any two connected devices in a network. This creates a system that is fault tolerant, where the system can continue to function even in the event of individual component failures. This is important because elements of complex systems like a computer network fail at unexpected times, often in groups.

The World Wide Web is different from the Internet. The World Wide Web are files, web pages and media. The Internet is the network we use to access those files. The DNS (the system responsible for translating domain names like example.com into IP addresses) is an important system in helping the Internet scale.

Internet Dilemmas exist and are unintended. The Digital Divide is when access to computing devices and the Internet differs, based on socioeconomic, geographic, or demographic characteristics. This can affect both individuals and groups. Net Neutrality is another dilemma, which states that all Internet traffic should be treated equally by Internet Service Providers. Internet Censorship is the control of what can be accessed, published, or viewed on the Internet. It may be carried out by governments or by private organizations or individuals. Most people believe in having some amount of both freedom of speech and censorship at the same time.

Evidence of Learning (Assessments)

Tests
Quizzes
Homework

Programs
Projects
Class participation

Objectives (SLO)

Students will know:	Students will be able to:
● The protocols of the Internet ● World Wide Web ● Fault-tolerant ● Internet Dilemma	● Explain how computing devices work together in a network. ● Explain how the Internet works. ● Explain how data are sent through the Internet via packets. ● Describe the differences between the Internet and the World Wide Web. ● For fault-tolerant systems, like the Internet: a. Describe the benefits of fault tolerance. b. Explain how a given system is fault-tolerant. c. Identify vulnerabilities to failure in a system.

Suggested Resources/Technology Tools

-Programming compiler code.org - App Lab
-Online notebook/journal
-Learning Management System & Google Workspace Apps
-AP CSP Practice Tests and Released Items
-Online Textbook & AP Classroom

Modifications

Special Education-
Modifications and accommodations must be aligned to students' IEPs and uphold expectations of the plan lawfully.
● Allow additional time for skill mastery.
● Provide small group/ individualized instruction.
● Allow use of assistive technology.
● Anticipate needs; pre-teach if needed.
● Have student repeat directions to check for understanding.
● Highlight text/ visual presentation.
● Modify assessment/assignment content, format, length (benchmarks, tests and quizzes) .
ML-
● Provide additional wait time for student responses to questions
● Provide simplification of sentence structure and repetition of questions/sentences exactly as stated before trying to rephrase.
● Speak clearly, using a normal tone and rate of speed, or slightly slower.
● Use directed reading activities. Ensure preview of text before assigned/read, provide pre-reading
Gifted and Talented-
● Advance, accelerate, or compact content
● Support abstract and advanced higher-level thinking through differentiated questioning
● Allowance for adapting of content for individual student interests
● Provide assignments geared to development in areas of affect, creativity, cognition, and research skills
504-

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- Modify readings and primary source documents

At Risk-
- Provide small group instruction for identified areas for growth
- Allow for alternate pathways for completion of assignments.
- Provide additional wait time for student responses to questions
- Pair oral instruction with visuals
- Utilize manipulatives

For a full list of Accommodations and Modifications, please click here.

21ST CENTURY LIFE AND CAREER STANDARDS

- ❏ Apply appropriate academic and technical skills.
- ❏ Communicate clearly and effectively and with reason.
- ❏ Demonstrate creativity and innovation.
- ❏ Employ valid and reliable research strategies.
- ❏ Utilize critical thinking to make sense of problems and persevere in solving them.
- ❏ Model integrity, ethical leadership, and effective management.
- ❏ Plan education and career paths aligned to personal goals.
- ❏ Use technology to enhance productivity.

LINKS TO CAREERS: https://career.ku.edu/computer-science

Unit 3	
Intro to App Design	
Summary and Rationale	
Students will learn how to design user interfaces and write event-driven programs in App Lab and then design a project that teaches their peers about a topic of their choosing. This unit is an introduction to programming and app design with a heavy focus on important skills like debugging, pair programming, and user testing.	
Recommended Pacing	
For recommended pacing refer to the scope and sequence for each course.	
Standards	
CSTA K-12 Computer Science Standards (2017)	
AP - Algorithms & Programming	
2-AP-17	Systematically test and refine programs using a range of test cases.
3A-AP-13	Create prototypes that use algorithms to solve computational problems by leveraging prior student knowledge and personal interests.
3A-AP-16	Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue by using events to initiate instructions.
3A-AP-19	Systematically design and develop programs for broad audiences by incorporating feedback from users.
3A-AP-21	Evaluate and refine computational artifacts to make them more usable and accessible.
3A-AP-22	Design and develop computational artifacts working in team roles using collaborative tools.
3A-AP-23	Document design decisions using text, graphics, presentations, and/or demonstrations in the development of complex programs.
CS - Computing Systems	
3A-CS-03	Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and

	fix errors.
AP Computer Science Conceptual Framework	
AAP-2	The way statements are sequenced and combined in a program determines the computed result. Programs incorporate iteration and selection constructs to represent repetition and make decisions to handle varied input values.
AAP-3	Programmers break down problems into smaller and more manageable pieces. By creating procedures and leveraging parameters, programmers generalize processes that can be reused. Procedures allow programmers to draw upon existing code that has already been tested, allowing programmers to write programs more quickly and with more confidence.
CRD-1	Incorporating multiple perspectives through collaboration improves the computing innovations being developed.
CRD-2	Developers create and innovate using an iterative design process that is user-focused, that incorporates implementation/feedback cycles, and that leaves ample room for experimentation and risk-taking.
CSP Topics	
1.1	Collaboration
1.2	Program Function and Purpose
1.3	Program Design and Development
Interdisciplinary Connections	
Standard	
RL.10	Read and comprehend complex literary and informational texts independently and proficiently.
W.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
9.1	All students will demonstrate the creative, critical thinking, collaboration, and problem solving skills needed to function successfully as both global citizens and workers in diverse ethnic and organizational cultures.

Enduring Understandings:	**Essential Questions:**
A program is a sequence of commands that are executed or run by a computer. Comments are used in programs as notes or documentation and do not affect how the program executes. User Interface is the inputs and outputs that allow a user to interact with a piece of software. User interfaces can include a variety of forms such as buttons, menus, images, text, and graphics. Inputs are data that are sent to a computer for processing by a	What might happen if you completed the steps in your regular morning routine to get ready and go to school in a different order? How might the reordering affect the decisions you make each morning? How do video games group the different actions for a player based on what key is pressed on the keyboard or controller? How do apps group different actions together based on user interaction, such as pressing buttons?

program. Inputs can come in a variety of forms, such as tactile interaction, audio, visuals, or text. Outputs are any data that are sent from a program to a device. Outputs can come in a variety of forms, such as tactile interaction, audio, visuals, or text. There are two different ways for programs to run. One way is Sequential Programming, where program statements run in order, from top to bottom. There is no user interaction and the code runs the same way every time. The other type of program is Event Driven Programming, where some program statements run when triggered by an event, like a mouse click or a key press. These programs run differently each time depending on user interactions.	Why is it necessary to plan out an app design?

Evidence of Learning (Assessments)

Tests
Quizzes
Homework
Programs
Projects
Class participation

Objectives (SLO)

Students will know: ● Program Design and Development ● Inputs, outputs, program purpose ● Sequential and Event Driven Programs ● Debugging ● Commenting	Students will be able to: ● Build and debug an sequential and event driven program with inputs and outputs using the Iterative Development Process. ● Describe the purpose of a code segment or program by writing documentation.

Suggested Resources/Technology Tools

-Programming compiler code.org - App Lab
-Online notebook/journal
-Learning Management System & Google Workspace Apps
-AP CSP Practice Tests and Released Items
-Online Textbook & AP Classroom

Modifications

Special Education-
Modifications and accommodations must be aligned to students' IEPs and uphold expectations of the plan lawfully.

● Allow additional time for skill mastery.
● Provide small group/ individualized instruction.
● Allow use of assistive technology.
● Anticipate needs; pre-teach if needed.
● Have student repeat directions to check for understanding.
● Highlight text/ visual presentation.
● Modify assessment/assignment content, format, length (benchmarks, tests and quizzes) .

ML-

● Provide additional wait time for student responses to questions
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● Speak clearly, using a normal tone and rate of speed, or slightly slower.
● Use directed reading activities. Ensure preview of text before assigned/read, provide pre-reading

Gifted and Talented-

● Advance, accelerate, or compact content
● Support abstract and advanced higher-level thinking through differentiated questioning
● Allowance for adapting of content for individual student interests
● Provide assignments geared to development in areas of affect, creativity, cognition, and research skills

504-

Modifications and accommodations must be aligned to the 504 plan and uphold expectations of the plan lawfully.

● Provide additional time for in-class assignments and assessments
● Allow for computer with voice output, spelling and grammar checker
● Offer individual help throughout the lesson
● Modify readings and primary source documents

At Risk-

● Provide small group instruction for identified areas for growth
● Allow for alternate pathways for completion of assignments.
● Provide additional wait time for student responses to questions
● Pair oral instruction with visuals
● Utilize manipulatives

For a full list of Accommodations and Modifications, please click here.

21ST CENTURY LIFE AND CAREER STANDARDS

- ❏ Apply appropriate academic and technical skills.
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- ❏ Demonstrate creativity and innovation.
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- ❏ Utilize critical thinking to make sense of problems and persevere in solving them.
- ❏ Model integrity, ethical leadership, and effective management.
- ❏ Plan education and career paths aligned to personal goals.
- ❏ Use technology to enhance productivity.

LINKS TO CAREERS: https://career.ku.edu/computer-science

Unit 4	
Variables, Conditionals, and Functions	
Summary and Rationale	
Students will learn how to program with three new concepts (variables, conditionals, and functions) through a sequence of collaborative activities. Students will then build their own decision maker app to share with friends and help them make a decision. This unit explores how variables, conditionals, and functions allow for the design of increasingly complex apps.	
Recommended Pacing	
For recommended pacing refer to the scope and sequence for each course.	
Standards	
CSTA K-12 Computer Science Standards (2017)	
AP - Algorithms & Programming	
2-AP-10	Use flowcharts and/or pseudocode to address complex problems as algorithms.
2-AP-11	Create clearly named variables that represent different data types and perform operations on their values.
2-AP-12	Design and iteratively develop programs that combine control structures, including nested loops and compound conditionals.
2-AP-19	Document programs in order to make them easier to follow, test, and debug.
3A-AP-15	Justify the selection of specific control structures when tradeoffs involve implementation, readability, and program performance and explain the benefits and drawbacks of choices made.
3A-AP-16	Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue by using events to initiate instructions.
3A-AP-17	Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.

3B-AP-14	Construct solutions to problems using student-created components, such as procedures, modules and/or objects.
3B-AP-21	Develop and use a series of test cases to verify that a program performs according to its design specifications.
3B-AP-23	Evaluate key qualities of a program through a process such as a code review.
AP Computer Science Conceptual Framework	
AAP-1	To find specific solutions to generalizable problems, programmers represent and organize data in multiple ways.
AAP-2	The way statements are sequenced and combined in a program determines the computed result. Programs incorporate iteration and selection constructs to represent repetition and make decisions to handle varied input values.
AAP-3	Programmers break down problems into smaller and more manageable pieces. By creating procedures and leveraging parameters, programmers generalize processes that can be reused. Procedures allow programmers to draw upon existing code that has already been tested, allowing programmers to write programs more quickly and with more confidence.
CRD-2	Developers create and innovate using an iterative design process that is user-focused, that incorporates implementation/feedback cycles, and that leaves ample room for experimentation and risk-taking.
CSP Topics	
1.4	Identifying and Correcting Errors
3.1	Variables and Assignment
3.3	Mathematical Expressions
3.5	Boolean Expressions
3.6	Conditionals
3.7	Nested Conditionals
3.15	Random Values
Interdisciplinary Connections	
Standard	
RL.10	Read and comprehend complex literary and informational texts independently and proficiently.
W.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
9.1	All students will demonstrate the creative, critical thinking, collaboration, and problem solving skills needed to function successfully as both global citizens and workers in diverse ethnic and organizational cultures.

Enduring Understandings:	**Essential Questions:**
Variables are placeholders for a value. Numbers and strings are two different types of values. Expressions evaluate to a single new value. Variables are “assigned” a new value. Evaluate first, then assign a variable. Old values which were stored in a variable, are deleted forever if reassigned. Assignment just moves information around. It does not “connect” variables. A Boolean Value is a data type that is either true or false. Values are compared using comparison operators and result in a Boolean value (true or false). Boolean expressions can also include Logical Operators (AND, OR, NOT). Both sides of the logical operator are reduced to a single Boolean value. A truth table is used to evaluate the reduced Boolean expression to a single Boolean value. A flowchart illustrates the steps of making a decision with a Boolean expression. Both a truth table and flowchart help the programmer understand the flow of logic in a program. A function is a named group of programming instructions. Also referred to as a “procedure”. Functions should only be defined once in a program. A function can be used in a program with a function Call, which is a command that executes the code within a function. Functions can be called many times in a program. Variables used in a function can have a global or local scope. This is determined by where the variable was defined and where it is being reassigned. Global variables are permanent and can be used anywhere in a program. Local variables are temporary and can be used only in the part of the code where it was created, like inside an event handler. The local variables are “deleted” once the event handler or function is done running.	What is the reason for using variables in a program? When should an if or if/else statement be used? Why and when would a programmer use a function?
Evidence of Learning (Assessments)	

Tests
Quizzes
Homework
Programs
Projects
Class participation

Objectives (SLO)

Students will know:

- Variables & types (integers, float, strings)
- Boolean Expressions
- Conditionals (If, If/Else Statements)
- Defining and Calling Functions
- Local and Global Variables

Students will be able to:

- Explain the purpose of those programming patterns with variables both in terms of how they work and what they accomplish
- Write and debug programs that use variables and expressions.
- Write and debug programs that use boolean expressions and conditional statements.
- Write and debug programs while recognizing the need for a function to reduce repeated code
- Write comments to clearly explain both the purpose and function of different segments of code within an app

Suggested Resources/Technology Tools

-Programming compiler code.org - App Lab
-Online notebook/journal
-Learning Management System & Google Workspace Apps
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At Risk-

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For a full list of Accommodations and Modifications, please click here.

21ST CENTURY LIFE AND CAREER STANDARDS

- ❏ Apply appropriate academic and technical skills.
- ❏ Communicate clearly and effectively and with reason.
- ❏ Demonstrate creativity and innovation.
- ❏ Employ valid and reliable research strategies.
- ❏ Utilize critical thinking to make sense of problems and persevere in solving them.
- ❏ Model integrity, ethical leadership, and effective management.
- ❏ Plan education and career paths aligned to personal goals.
- ❏ Use technology to enhance productivity.

LINKS TO CAREERS: https://career.ku.edu/computer-science

Unit 5	
Data	
Summary and Rationale	
In this unit, students will learn how data analysis helps turn raw data into useful information about the world. Students will learn how to use data visualization to find patterns inside of data sets and learn how this data analysis process is being used in contexts like open data or machine learning to help make decisions or learn more about our world. In the unit project, students will analyze a dataset of their choosing and present their findings.	
Recommended Pacing	
For recommended pacing refer to the scope and sequence for each course.	
Standards	
CSTA K-12 Computer Science Standards (2017)	
DA - Data & Analysis	
3A-DA-10	Evaluate the tradeoffs in how data elements are organized and where data is stored.
3A-DA-11	Create interactive data visualizations using software tools to help others better understand real-world phenomena.
3B-DA-05	Use data analysis tools and techniques to identify patterns in data representing complex systems.
3B-DA-06	Select data collection tools and techniques to generate data sets that support a claim or communicate information.
AP - Algorithms & Programming	
3B-AP-08	Describe how artificial intelligence drives many software and physical systems.
AP Computer Science Conceptual Framework	

DAT-2	Programs can be used to process data, which allows users to discover information and create new knowledge.
IOC-1	While computing innovations are typically designed to achieve a specific purpose, they may have unintended consequences.
CSP Topics	
2.3	Extracting Information from Data
2.4	Using Programs with Data
5.3	Computing Bias
5.4	Crowdsourcing
Interdisciplinary Connections	
Standard	
RL.10	Read and comprehend complex literary and informational texts independently and proficiently.
W.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
9.1	All students will demonstrate the creative, critical thinking, collaboration, and problem solving skills needed to function successfully as both global citizens and workers in diverse ethnic and organizational cultures.

Enduring Understandings:	**Essential Questions:**
When looking at visualizations, a programmer needs to consider: What does the data show? - fact, and why might that be the case? - opinion. Correlation does not equal Causation. Programmers cannot make assumptions about data. Metadata are data about data: can be changed without impacting the primary data, used for finding, organizing, and managing information, increases effective use of data by providing extra information, and allows data to be structured and organized. Charts and other visualizations can help both find and communicate what is learned from data. Bar charts and histograms are two common chart types for exploring one column of data in a table. Making data open helps spread useful knowledge or creates opportunities for others to use it to solve	How are the questions you can investigate with scatter or crosstab charts different from the ones you can investigate with bar charts or histograms? How could biased data result in problems for artificial intelligence? What are ways to address this? What are the core ideas of Big, Open, and Crowdsourced data?

problems. Crowdsourcing offers new models for collaboration, such as connecting businesses or social causes with funding. Both are examples of how human capabilities can be enhanced by collaboration via computing. When data gets too big it can no longer be processed on one computer. Cloud computing or parallel systems are sometimes used to help process all that information.

The Data Analysis Process is used in machine learning, however not fully. Some parts are conducted by the machine, some by the programmer. This leads to algorithmic bias.

Evidence of Learning (Assessments)

Tests
Quizzes
Homework
Programs
Projects
Class participation

Objectives (SLO)

Students will know:

- Representing data in a crosstab, histogram, scatter chart, bar chart to read one/two columns of data
- Filter and Reduce a dataset
- Machine Learning
- Algorithmic Bias

Students will be able to:

- Analyze, create, filter, reduce a dataset using a bar chart, histogram, crosstab, scatter chart
- Define and explain the impacts of crowdsourcing, crowdfunding, and citizen science
- Reason about how human bias plays a role in machine learning

Suggested Resources/Technology Tools

-Programming compiler code.org - App Lab
-Online notebook/journal
-Learning Management System & Google Workspace Apps
-AP CSP Practice Tests and Released Items
-Online Textbook & AP Classroom

Modifications

Special Education-
Modifications and accommodations must be aligned to students' IEPs and uphold expectations of the plan lawfully.

- Allow additional time for skill mastery.
- Provide small group/ individualized instruction.

● Allow use of assistive technology.
● Anticipate needs; pre-teach if needed.
● Have student repeat directions to check for understanding.
● Highlight text/ visual presentation.
● Modify assessment/assignment content, format, length (benchmarks, tests and quizzes) .

ML-

● Provide additional wait time for student responses to questions
● Provide simplification of sentence structure and repetition of questions/sentences exactly as stated before trying to rephrase.
● Speak clearly, using a normal tone and rate of speed, or slightly slower.
● Use directed reading activities. Ensure preview of text before assigned/read, provide pre-reading

Gifted and Talented-

● Advance, accelerate, or compact content
● Support abstract and advanced higher-level thinking through differentiated questioning
● Allowance for adapting of content for individual student interests
● Provide assignments geared to development in areas of affect, creativity, cognition, and research skills

504-

Modifications and accommodations must be aligned to the 504 plan and uphold expectations of the plan lawfully.

● Provide additional time for in-class assignments and assessments
● Allow for computer with voice output, spelling and grammar checker
● Offer individual help throughout the lesson
● Modify readings and primary source documents

At Risk-

● Provide small group instruction for identified areas for growth
● Allow for alternate pathways for completion of assignments.
● Provide additional wait time for student responses to questions
● Pair oral instruction with visuals
● Utilize manipulatives

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Unit 6	
Lists, Loops, and Traversals	
Summary and Rationale	
This unit introduces lists, loops, and traversals, and explores the way they can be used to build apps that store and process large amounts of information. Students will learn to program with the data library in App Lab and complete a project at the end of the unit where they can design a program about any topic of their choosing.	
Recommended Pacing	
For recommended pacing refer to the scope and sequence for each course.	
Standards	
CSTA K-12 Computer Science Standards (2017)	
DA - Data & Analysis	
3A-DA-12	Create computational models that represent the relationships among different elements of data collected from a phenomenon or process.
AP - Algorithms & Programming	
3A-AP-14	Use lists to simplify solutions, generalizing computational problems instead of repeated use of simple variables.
3A-AP-15	Justify the selection of specific control structures when tradeoffs involve implementation, readability, and program performance and explain the benefits and drawbacks of choices made.
3A-AP-16	Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue by using events to initiate instructions.
3A-AP-22	Design and develop computational artifacts working in team roles using collaborative tools.

3A-AP-23	Document design decisions using text, graphics, presentations, and/or demonstrations in the development of complex programs.
3B-AP-10	Use and adapt classic algorithms to solve computational problems.
3B-AP-23	Evaluate key qualities of a program through a process such as a code review.
AP Computer Science Conceptual Framework	
AAP-1	To find specific solutions to generalizable problems, programmers represent and organize data in multiple ways.
AAP-2	The way statements are sequenced and combined in a program determines the computed result. Programs incorporate iteration and selection constructs to represent repetition and make decisions to handle varied input values.
AAP-3	Programmers break down problems into smaller and more manageable pieces. By creating procedures and leveraging parameters, programmers generalize processes that can be reused. Procedures allow programmers to draw upon existing code that has already been tested, allowing programmers to write programs more quickly and with more confidence.
CRD-2	Developers create and innovate using an iterative design process that is user-focused, that incorporates implementation/feedback cycles, and that leaves ample room for experimentation and risk-taking.
CSP Topics	
3.2	Data Abstraction
3.4	Strings
3.8	Iteration
3.10	Lists
3.16	Simulations
Interdisciplinary Connections	
Standard	
RL.10	Read and comprehend complex literary and informational texts independently and proficiently.
W.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
9.1	All students will demonstrate the creative, critical thinking, collaboration, and problem solving skills needed to function successfully as both global citizens and workers in diverse ethnic and organizational cultures.

Enduring Understandings:	**Essential Questions:**
A List is an ordered collection of elements. An Element is an individual value in a list that is	How can we store data in a program to solve problems?

assigned a unique index. An index is a common method for referencing the elements in a list or string using numbers. The length of a list is how many elements it contains. Lists can grow or shrink as elements are added or removed. Lists are an example of data abstraction. They allow us to name and program with large collections of information while ignoring the low level details of how the data is stored, organized, etc. These programs are easier to develop and maintain. A while loop uses a boolean condition to repeatedly run a block of code. If it is true it runs the block of code contained within it. This process of checking the condition and running the block of code is repeated as long as the Boolean condition remains true. Once the Boolean expression becomes false it will stop. A for loop condenses the parts of a while loop into a shorter statement. Similar to the while loop, once the Boolean expression becomes false, the loop ends. A for loop controls the number of iterations for a fixed number of times. A for loop is used to traverse a list, visiting each element one at a time. Each pass through the loop, the counting variable changes - usually by one. We can access each element by evaluating list[i] in the for loop. Once we know the element at each spot in a list, we can do different things with it: -Filter (create a subset of elements from original list) -Reduce (reduce the list down to a single element, for example: the smallest number in the list)	When would a programmer have to decide between a for loop and a while loop? Why is traversal with a for loop a good method for accessing and updating items in a lengthy list?
Evidence of Learning (Assessments)	
Tests Quizzes Homework Programs Projects Class participation	
Objectives (SLO)	

Students will know:	Students will be able to:
● List (Accessing, inserting, & removing elements) ● Index value in a list ● For & While Loops ● Traversals	● Implement programming patterns with lists to develop a functioning app ● Recognize the need for programming patterns with lists as part of developing a functioning app ● Implement programming patterns with loops to develop a functioning app ● Recognize the need for programming patterns with loops as part of developing a functioning app ● Implement programming patterns with traversals to develop a functioning app ● Recognize the need for programming patterns with traversals as part of developing a functioning app

Suggested Resources/Technology Tools

-Programming compiler code.org - App Lab
-Online notebook/journal
-Learning Management System & Google Workspace Apps
-AP CSP Practice Tests and Released Items
-Online Textbook & AP Classroom

Modifications

Special Education-
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● Provide small group/ individualized instruction.
● Allow use of assistive technology.
● Anticipate needs; pre-teach if needed.
● Have student repeat directions to check for understanding.
● Highlight text/ visual presentation.
● Modify assessment/assignment content, format, length (benchmarks, tests and quizzes) .
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● Speak clearly, using a normal tone and rate of speed, or slightly slower.
● Use directed reading activities. Ensure preview of text before assigned/read, provide pre-reading
Gifted and Talented-
● Advance, accelerate, or compact content
● Support abstract and advanced higher-level thinking through differentiated questioning
● Allowance for adapting of content for individual student interests
● Provide assignments geared to development in areas of affect, creativity, cognition, and research skills
504-
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● Allow for computer with voice output, spelling and grammar checker
● Offer individual help throughout the lesson
● Modify readings and primary source documents
At Risk-
● Provide small group instruction for identified areas for growth

- Allow for alternate pathways for completion of assignments.
- Provide additional wait time for student responses to questions
- Pair oral instruction with visuals
- Utilize manipulatives

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Unit 7

Parameters, Return, and Libraries

Summary and Rationale

This unit introduces parameters, return, and libraries. Students will learn how to use these concepts to build new kinds of apps as well as libraries of code that you can share with their peers. The unit ends by designing a library of functions around any topic.

Recommended Pacing

For recommended pacing refer to the scope and sequence for each course.

Standards

CSTA K-12 Computer Science Standards (2017)	
DA - Data & Analysis	
3A-DA-12	Create computational models that represent the relationships among different elements of data collected from a phenomenon or process.
AP - Algorithms & Programming	
2-AP-14	Create procedures with parameters to organize code and make it easier to reuse.
2-AP-17	Systematically test and refine programs using a range of test cases.

3A-AP-18	Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.
3B-AP-14	Construct solutions to problems using student-created components, such as procedures, modules and/or objects.
3B-AP-16	Demonstrate code reuse by creating programming solutions using libraries and APIs.
3B-AP-23	Evaluate key qualities of a program through a process such as a code review.
AP Computer Science Conceptual Framework	
AAP-2	The way statements are sequenced and combined in a program determines the computed result. Programs incorporate iteration and selection constructs to represent repetition and make decisions to handle varied input values.
AAP-3	Programmers break down problems into smaller and more manageable pieces. By creating procedures and leveraging parameters, programmers generalize processes that can be reused. Procedures allow programmers to draw upon existing code that has already been tested, allowing programmers to write programs more quickly and with more confidence.
CRD-2	Developers create and innovate using an iterative design process that is user-focused, that incorporates implementation/feedback cycles, and that leaves ample room for experimentation and risk-taking.
CSP Topics	
3.12	Calling Procedures
3.13	Developing Procedures
3.14	Libraries
Interdisciplinary Connections	
Standard	
RL.10	Read and comprehend complex literary and informational texts independently and proficiently.
W.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
9.1	All students will demonstrate the creative, critical thinking, collaboration, and problem solving skills needed to function successfully as both global citizens and workers in diverse ethnic and organizational cultures.

Enduring Understandings:	**Essential Questions:**
Parameters are used in function definitions, which allow the function to pass a different value each time the function is called. This is efficient because it allows the function to be reusable.	What are the benefits of writing functions that use parameters and return? How do libraries let you write programs at a "higher level"? Why is testing important when building and sharing libraries?

Return statements can only be used in functions or conditionals. We will be using them in functions, to pass a certain value when the function is called. This allows for easier programming and makes the program efficient because the same algorithm is being used for different arguments (parameter values).

Functions with parameters and return values help us simplify our code. Functions can only return one value at a time.
A function can have:
-No parameters and no return values
-Parameters, but no return values
-Return values, but no parameters
-Parameters and return values

Parameters and return help us chunk programs into pieces. Each important piece can be made into its own function which can be written and tested separately from the others.

A library is a collection of functions that can be used in many different programs. A library should have documentation for each of the included functions. The detailed documentation should include:
-how each function works
-a complete list of the parameters
-what (if anything) will be returned.

This detailed type of documentation is also known as Application Program Interface (API). APIs are specifications for how the functions in a library behave and can be used.

Evidence of Learning (Assessments)

Tests
Quizzes
Homework
Programs
Projects
Class participation

Objectives (SLO)

Students will know:	Students will be able to:
● Parameters ● Return Values ● API ● Library	● Write functions with parameters and return values that meet a set of specified requirements ● Design the API for a library of functions, including the function names, purpose, and parameters, and types of values each function will return

Suggested Resources/Technology Tools

-Programming compiler code.org - App Lab
-Online notebook/journal
-Learning Management System & Google Workspace Apps
-AP CSP Practice Tests and Released Items
-Online Textbook & AP Classroom

Modifications

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● Highlight text/ visual presentation.
● Modify assessment/assignment content, format, length (benchmarks, tests and quizzes) .
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● Use directed reading activities. Ensure preview of text before assigned/read, provide pre-reading
Gifted and Talented-
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At Risk-
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Unit 8

Cybersecurity and Global Impacts

Summary and Rationale

Students will learn how computing innovations have impacted the world in beneficial and harmful ways. Students will learn how data can pose a threat to a user's privacy and security and the ways that encryption and other techniques are used to protect it.

Recommended Pacing

For recommended pacing refer to the scope and sequence for each course.

Standards

CSTA K-12 Computer Science Standards (2017)

IC - Impacts of Computing

2-IC-23	Describe tradeoffs between allowing information to be public and keeping information private and secure.

3A-IC-24	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
3A-IC-27	Use tools and methods for collaboration on a project to increase connectivity of people in different cultures and career fields.
3A-IC-29	Explain the privacy concerns related to the collection and generation of data through automated processes that may not be evident to users.
3A-IC-30	Evaluate the social and economic implications of privacy in the context of safety, law, or ethics.
3B-IC-25	Evaluate computational artifacts to maximize their beneficial effects and minimize harmful effects on society.
3B-IC-28	Debate laws and regulations that impact the development and use of software.
NI - Networks & the Internet	
3A-NI-05	Give examples to illustrate how sensitive data can be affected by malware and other attacks.
3A-NI-06	Recommend security measures to address various scenarios based on factors such as efficiency, feasibility, and ethical impacts.
3A-NI-07	Compare various security measures, considering tradeoffs between the usability and security of a computer system.
3B-NI-04	Compare ways software developers protect devices and information from unauthorized access.
AP Computer Science Conceptual Framework	
IOC-1	While computing innovations are typically designed to achieve a specific purpose, they may have unintended consequences.
IOC-2	The use of computing innovations may involve risks to your personal safety and identity.
CSP Topics	
5.1	Beneficial and Harmful Effects
5.6	Safe Computing
Interdisciplinary Connections	
Standard	
RL.10	Read and comprehend complex literary and informational texts independently and proficiently.
W.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
9.1	All students will demonstrate the creative, critical thinking, collaboration, and problem solving skills needed to function successfully as both global citizens and workers in diverse ethnic and organizational cultures.

Enduring Understandings:	Essential Questions:
A Computing Innovation includes a program as an integral part of its function. It can be physical (self-driving car), non-physical computing software (picture editing software), or non-physical computing concepts (e-commerce). Technology enables the collection, use, and exploitation of information about, by and for individuals, groups, and institutions. Geolocation, cookies, and browsing history can all be used to create knowledge about an individual. Most digital technology needs some kind of PII to work (for example street navigation needs to know your location or PII (Personal Identifiable Information) stored online to simplify making online purchases). Once data is made digital, and especially once it's shared online, it's much harder to control. PII can be used to steal the identity of a person, or stalk them online. Information that is often posted on social media can be combined to create a profile on that person. Not every effect of a computing innovation is anticipated in advance. This data can also be used by companies, governments, or criminals in ways that we didn't intend or that threatens our privacy. Encryption and decryption is used to keep our online searching secure. Encryption is a process of encoding messages to keep them secret, so only "authorized" parties can read it. Decryption is the process that reverses encryption, taking a secret message and reproducing the original plain text. There are a few different encryptions on the internet. Symmetric Key Encryption involves one key for both encryption and decryption. Public Key Encryption pairs a public key for encryption and a private key for decryption. The sender does not need the receiver's private key to encrypt a message, but the receiver's private key is required to decrypt the message. A good password is easy to remember, but hard for someone else to guess based on knowledge they have about someone. An even secure approach is enabling multifactor authentication. Multifactor Authentication	Explain how a computing innovation can have an impact beyond its intended purpose. What rules or regulations would you recommend be put in place to control how data is collected and shared? What is the difference between symmetric encryption and asymmetric (public key) encryption? Why is Multifactor Authentication a better system than Single Factor Authentication? What are the challenges with this system?

is a method of computer access in which a user has to successfully provide evidence in at least two of the following categories: knowledge (something they know), possession (something they have), and inherence (something they are). Each step provides a new layer of security.	

Evidence of Learning (Assessments)

Tests
Quizzes
Homework
Programs
Projects
Class participation

Objectives (SLO)

Students will know: ● Computing Innovation ● Phishing, Keylogging, Malware ● Encryption & Decryption ● Ciphers	Students will be able to: ● Describe the different types of data that are used and collected by modern computing innovations ● Explain how disparate pieces of personal information can be combined to identify individuals or deduce other private information. ● Explain the risks to privacy that arise from using modern computing technology ● Evaluate the benefits and harms that could potentially be caused by a computing innovation ● Explain how the benefits and harms of a computing innovation may be different in the eyes of different people ● Identify commons security risks: phishing, keylogging, malware, rogue access points ● Confidently explain security risks and their impact on society ● Explain the difference between asymmetrical and symmetrical encryption ● Identify why Caesar Cipher and Random Substitution Ciphers are not adequate for most encryption needs ● Explain the benefits of multi factor authentication

Suggested Resources/Technology Tools

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LINKS TO CAREERS: https://career.ku.edu/computer-science

Unit 9	
Create Performance Task	
Summary and Rationale	
In this unit prepare for, and complete the AP Create Performance Task. The teacher will provide helpful resources, links, documents, activities, and College Board materials to help students understand the task and develop a plan for completing it.	
Recommended Pacing	
For recommended pacing refer to the scope and sequence for each course.	
Standards	
CSTA K-12 Computer Science Standards (2017)	
Abstraction & Procedures	
3A-AP-13	Create prototypes that use algorithms to solve computational problems by leveraging prior student knowledge.

3A-AP-14	Use lists to simplify solutions, represent data, and solve problems.
3A-AP-16	Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue.
3A-AP-17	Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
3A-AP-18	Create artifacts by using procedures within a program, combinations of data and commands, and control structures.
3A-AP-19	Systematically test and refine programs using a range of test cases.
3A-AP-21	Evaluate and refine computational artifacts to make them more usable and accessible.
3A-AP-22	Design and develop computational artifacts working in team roles using collaborative tools.
3B-AP-10	Use and adapt classic algorithms to solve computational problems.
3B-AP-13	Create prototypes that use algorithms and/or simulation to model the relationships among different elements of data collected from a phenomenon, process, or system.
AP Computer Science Conceptual Framework	
CRD-1	Creative development can be an iterative process that requires collaboration, reflection, and refinement.
CRD-2	Programs are developed and implemented by people for different purposes, including creative expression, to satisfy personal curiosity, to create new knowledge, or to solve problems.
CRD-2.A	Algorithms are created to solve computational problems.
CRD-2.E	Developing correct program components can require identifying and correcting errors in algorithms and program code.
AAP-1	Programmers use variables to represent data and manage program state.
AAP-2	Programmers incorporate iteration and selection control structures to solve problems or express ideas.
AAP-3	Programmers incorporate procedures (also known as functions, methods, or subroutines) to organize code and make it more reusable and understandable.
CSP Topics	
3.7	Developing Algorithms
3.8	Expressing Algorithms
3.9	Sequencing
3.10	Selection
3.11	Iteration
3.13	Developing Procedures

3.14	Calling Procedures
3.15	Developing Abstractions
Interdisciplinary Connections	
Standard	
MP.1	Make sense of problems and persevere in solving them.
MP.4	Model with Mathematics
9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills.

Enduring Understandings:	**Essential Questions:**
At the designated end of the Task administration, students submit the three items to their AP Portfolio: Video, Written Responses, and Program Code PDF. It is finally time for students to take on the Create Performance Task. For a total of 12 class hours, students should work on their projects with only types of teacher support allowed (essentially: Advise on process, don't influence or evaluate ideas). Students may also work with a collaborative partner in development of their program - written responses must be done on their own. At the end, students will submit their program code, program video, and written responses through their AP digital portfolio.	What will you actually be turning into the College Board? If you have a grand idea, how can you narrow it down to fit CollegeBoard criteria?

Evidence of Learning (Assessments)

Create Performance Task
Checkpoints

Objectives (SLO)

Students will know:	Students will be able to:
● Create Performance Task directions and expectations	● Describe how the Create PT Scoring Guidelines will be used to assess the task ● Describe the scoring guidelines for the Create PT ● Develop strategies for narrowing down topics for the Create PT ● Complete the Create Performance Task

Suggested Resources/Technology Tools

-Programming compiler code.org - App Lab
-Online notebook/journal
-Learning Management System & Google Workspace Apps
-AP CSP Practice Tests and Released Items
-Online Textbook & AP Classroom

Modifications

Special Education-
Modifications and accommodations must be aligned to students' IEPs and uphold expectations of the plan lawfully.
● Allow additional time for skill mastery.
● Provide small group/ individualized instruction.
● Allow use of assistive technology.
● Anticipate needs; pre-teach if needed.
● Have student repeat directions to check for understanding.
● Highlight text/ visual presentation.
● Modify assessment/assignment content, format, length (benchmarks, tests and quizzes) .
ML-
● Provide additional wait time for student responses to questions
● Provide simplification of sentence structure and repetition of questions/sentences exactly as stated before trying to rephrase.
● Speak clearly, using a normal tone and rate of speed, or slightly slower.
● Use directed reading activities. Ensure preview of text before assigned/read, provide pre-reading
Gifted and Talented-
● Advance, accelerate, or compact content
● Support abstract and advanced higher-level thinking through differentiated questioning
● Allowance for adapting of content for individual student interests
● Provide assignments geared to development in areas of affect, creativity, cognition, and research skills
504-
Modifications and accommodations must be aligned to the 504 plan and uphold expectations of the plan lawfully.
● Provide additional time for in-class assignments and assessments
● Allow for computer with voice output, spelling and grammar checker
● Offer individual help throughout the lesson
● Modify readings and primary source documents
At Risk-
● Provide small group instruction for identified areas for growth
● Allow for alternate pathways for completion of assignments.
● Provide additional wait time for student responses to questions
● Pair oral instruction with visuals
● Utilize manipulatives
For a full list of Accommodations and Modifications, please click here.

21ST CENTURY LIFE AND CAREER STANDARDS

- ❏ Apply appropriate academic and technical skills.
- ❏ Communicate clearly and effectively and with reason.
- ❏ Demonstrate creativity and innovation.
- ❏ Employ valid and reliable research strategies.
- ❏ Utilize critical thinking to make sense of problems and persevere in solving them.
- ❏ Model integrity, ethical leadership, and effective management.
- ❏ Plan education and career paths aligned to personal goals.
- ❏ Use technology to enhance productivity.

LINKS TO CAREERS: https://career.ku.edu/computer-science

Unit 10

Algorithms

Summary and Rationale

This unit is an exploration of how computer scientists design algorithms to solve problems and how they analyze the speed of different algorithms. Students will learn about the concept of algorithmic efficiency through a variety of hands-on activities and learn how it's being applied in modern computing.

Recommended Pacing

For recommended pacing refer to the scope and sequence for each course.

Standards

CSTA K-12 Computer Science Standards (2017)

AP - Algorithms & Programming

3B-AP-10	Use and adapt classic algorithms to solve computational problems.
3B-AP-11	Evaluate algorithms in terms of their efficiency, correctness, and clarity.
AP Computer Science Conceptual Framework	
AAP-2	The way statements are sequenced and combined in a program determines the computed result. Programs incorporate iteration and selection constructs to represent repetition and make decisions to handle varied input values.
AAP-4	There exist problems that the computer cannot solve, and even when the computer can solve a problem, it may not be able to do so in a reasonable amount of time.
CSN-2	Parallel and distributed computing leverages multiple computers to more quickly solve complex problems or process large data sets.
CSP Topics	
3.9	Developing Algorithms
3.11	Binary Search
3.17	Algorithmic Efficiency
3.18	Undecidable Problems
4.3	Parallel and Distributed Computing
Interdisciplinary Connections	
Standard	
RL.10	Read and comprehend complex literary and informational texts independently and proficiently.
W.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
9.1	All students will demonstrate the creative, critical thinking, collaboration, and problem solving skills needed to function successfully as both global citizens and workers in diverse ethnic and organizational cultures.

Enduring Understandings:	**Essential Questions:**
An algorithm is a finite set of instructions that accomplish a task. There are usually many algorithms to solve the same problem, and many ways to write or express one algorithm including natural language, pseudocode, diagrams, and are implemented using programming code. All algorithms can be created by combining steps in three different ways.	What makes an algorithm efficient? What are the key differences between a linear search and a binary search? What is the difference between a reasonable and unreasonable time algorithm?

Algorithms have three main parts: sequencing (putting steps in an order), selection (deciding which steps to do next), and iteration (doing some steps over and over). Algorithm Efficiency is used to measure how many steps are needed to complete an algorithm. Search algorithms are algorithms used to find a value in a dataset. The two searches are linear and binary search. The Linear Search algorithm checks each element of a list, in order, until the desired value is found or all elements in the list have been checked. As more inputs are added in an algorithm, the number of steps grows at the same rate. On the other hand, a binary search algorithm starts in the middle of a sorted set of numbers and removes half of the data; this process repeats until the desired value is found or all elements have been eliminated. Binary search is faster for a numerical and sorted dataset. A linear search is faster if the data is unorganized. The dataset metadata determines which search algorithm will run in the most reasonable time. Reasonable Time Algorithms are algorithms with a polynomial efficiency or lower (constant, linear, square, cube, etc.) and are said to run in a reasonable amount of time. Unreasonable Time Algorithms are algorithms with exponential or factorial efficiencies are examples of algorithms that run in an unreasonable amount of time. We need to use a heuristic to come up with a solution that is "good enough" for most instances of the problem. There are some problems that humans can prove that no computer will ever be able to solve. This requires programmers to use a good heuristic (a "good enough" solution to a problem when an actual solution is impractical or impossible). The Halting Problem is a very famous example and in general these problems are called undecidable. There are three styles of computing that will be explored. Sequential Computing are programs that run in order, one command at a time. Parallel Computing are programs that are broken into small	What are the pros and cons of parallel and distributed computing?

pieces, some of which are run simultaneously. Distributed Computing are programs that are run by multiple devices. All of these are evaluated based on their speedup, or the time used to complete a task sequentially divided by the time to complete a task in parallel.	

Evidence of Learning (Assessments)

Tests
Quizzes
Homework
Programs
Projects
Class participation

Objectives (SLO)

Students will know:	Students will be able to:
● Algorithm Efficiency ● Heuristic ● Linear & Binary Search ● Reasonable & Unreasonable Time ● Sequential, Parallel, Distributed Computing	● Explain the formal definitions of a problem, an algorithm, sequencing, selection, and iteration ● Compare the efficiency of Linear Search and Binary Search and apply both searches ● Explain the difference between problems that run in a reasonable time and those that do not ● Determine if an algorithm runs in reasonable or unreasonable time ● Develop a heuristic to solve a problem ● Describe the benefits and explain the difference between sequential, parallel, and distributed computing

Suggested Resources/Technology Tools

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