



# CodeHS

## AP Computer Science Principles Course Syllabus In JavaScript

### Introduction

AP Computer Science Principles is the newest AP® course from the College Board. This course introduces students to the foundational concepts of computer science and explores the impact computing and technology have on our society.

With a unique focus on creative problem solving and real-world applications, the CodeHS AP Computer Science Principles course gives students the opportunity to explore several important topics of computing using their own ideas and creativity, use the power of computing to create artifacts of personal value, and develop an interest in computer science that will foster further endeavors in the field.

### Course Overview

**Prerequisites:** There are no official prerequisites for the CodeHS AP Computer Science Principles course. This course is meant to be a first-time introduction to computer science and does not require students to come in with any computer programming experience. However, we recommend that students take our Introduction to Computer Science prior to our AP courses (more info at [codehs.com/library](https://codehs.com/library)). Students who have completed our Intro to CS course will be able to apply knowledge of concepts covered in the Intro course to the more advanced setting of the AP courses. We also recommend that students complete a first-year high school algebra course prior to taking this course. Students should be comfortable with functions and function notation such as  $f(x) = x + 2$  as well as using a Cartesian  $(x, y)$  coordinate system to represent points in a plane.

### Overarching Goals:

- Increase and diversify participation in computer science
- Students, regardless of prior experience in computing, will develop confidence using computer science as a tool to express themselves and solve problems, and this confidence will prepare them for success in future endeavors in the field of computer science

- Students will understand the core principles of computing, a field which has and continues to change the world
- Students will be able to develop computational artifacts to solve problems, communicate ideas, and express their own creativity
- Students will be able to collaborate with others to solve problems and develop computational artifacts
- Students will be able to explain the impact computing has on society, economy, and culture
- Students will be able to analyze existing artifacts, identify and correct errors, and explain how the artifact functions
- Students will be able to explain how data, information, or knowledge is represented for computational use
- Students will be able to explain how abstractions are used in computation and modeling
- Students will learn to be informed and responsible users of technology

**Learning Environment:** The course utilizes a blended classroom approach. The content is a mix of web-based and physical activities. Students will write and run code in the browser, create websites and digital artifacts, and engage in in-person collaborative exercises with classmates. Teachers utilize tools and resources provided by CodeHS to leverage time in the classroom and give focused 1-on-1 attention to students. Each unit of the course is broken down into lessons. Lessons consist of video tutorials, short quizzes, example programs to explore, written programming exercises, free response exercises, collaborative creation projects, and research projects.

**Programming Environment:** Students write and run programs in the browser using the CodeHS editor. Students will be able to write both text-based and block-based JavaScript programs, and students will use Processing.js to create graphical programs. Students gain programming experience early on in the course that will enable them to explore the rest of the course topics through computational thinking practices.

**Course Resources:** Access to a computer and high-speed internet is required. There is also an online textbook available for many modules and topics which can be accessed through the lesson plans or at <https://codehs.gitbooks.io/introcs/content/>

**Quizzes:** At the end of most units, students take a summative multiple choice unit quiz in the style of the AP Exam that assesses their knowledge of the concepts covered in the unit. The course also provides an AP Test Practice unit with a cumulative AP Practice Multiple Choice Test.

## Course Objectives

This course is based directly on the College Board AP Computer Science Principles Framework. We recommend reading the curriculum framework [here](#) for context. The main course objectives are summarized below in the six computational thinking practices and five big ideas for the course.

### **Computational Thinking Practices:**

The six computational thinking practices represent important aspects of the work that computer scientists engage in, and are denoted here by P1 through P6:

- **Practice 1: Computational Solution Design**
  - *Design and evaluate computational solutions for a purpose.*
- **Practice P2: Algorithms and Program Development**
  - *Develop and implement algorithms.*
- **Practice P3: Abstraction in Program Development**
  - *Develop programs that incorporate abstractions.*
- **Practice P4: Code Analysis**
  - *Evaluate and test algorithms and programs.*
- **Practice P5: Computing Innovations**
  - *Investigate computing innovations.*
- **Practice P6: Responsible Computing**
  - *Contribute to an inclusive, safe, collaborative, and ethical computing culture.*

### **Big Ideas:**

The five big ideas of the course encompass foundational ideas in the field of computer science, and are denoted here by B1 through B5:

- **Big Idea 1: Creative Development (CRD)**

*When developing computing innovations, developers can use a formal, iterative design process or experimentation. While using either approach, developers will encounter phases of investigating and reflecting, designing, prototyping, and testing. Additionally, collaboration is an important tool to use at any phase of development because considering multiple perspectives allows for improvement of innovations.*
- **Big Idea 2: Data (DAT)**

*Data is central to computing innovations because it communicates initial conditions to programs and represents new knowledge. Computers consume data, transform data, and produce new data, allowing users to create new information or knowledge to solve problems through the interpretation of this data. Computers store data digitally, which means that the data must be manipulated in order to be presented in a useful way to the user.*
- **Big Idea 3: Algorithms and Programming (AAP)**

*Programmers integrate algorithms and abstraction to create programs for creative purposes and to solve problems. Using multiple program statements in a specified order, making decisions, and repeating the same process multiple times are the building blocks*

*of programs. Incorporating elements of abstraction, by breaking problems down into interacting pieces, each with their own purpose, makes writing complex programs easier. Programmers need to think algorithmically and use abstraction to define and interpret processes that are used in a program.*

- **Big Idea 4: Computing Systems and Networks (CSN)**

*Computer systems and networks are used to transfer data. One of the largest and most commonly used networks is the Internet. Through a series of protocols, the Internet can be used to send and receive information and ideas throughout the world. Transferring and processing information can be slow when done on a single computer but leveraging multiple computers to do the work at the same time can significantly shorten the time it takes to complete tasks or solve problems.*

- **Big Idea 5: Impact of Computing (IOC)**

*Computers and computing have revolutionized our lives. To use computing safely and responsibly, we need to be aware of privacy, security, and ethical issues. As programmers, we need to understand how our programs will be used and be responsible for the consequences. As computer users, we need to understand how to protect ourselves and our privacy when using a computer.*

### **The AP Create Performance Task:**

The through course assessment is a performance task designed to gather evidence of student proficiency in the learning objectives. The AP Create Performance Tasks (PT) is an in-class assessment, administered by the teacher, that allows students to exemplify their learning through an authentic, “real-world” creation. In the Create Performance Task, students will design and implement a program to solve a problem, enable innovation, explore personal interest, or express creativity. Their development process should include exploration, investigation, reflection, design, implementation, and testing your program. For more information about the AP Create Performance Task, refer to the [curriculum framework](#).

Students will gain the experience necessary to complete the Create Performance Task in class. Each unit comes with practice PTs in which students will research topics in computing, and create their own digital artifacts. Sufficient time is set aside in the course for students to prepare for and complete the Create Performance Task.

### **The AP Exam:**

This course will prepare students for the multiple-choice AP Computer Science Principles examination. Each lesson comes with quizzes to test essential knowledge for the AP Exam. Each unit includes a cumulative AP style multiple-choice exam to test understanding of the concepts in the unit and provide immediate feedback to the student.

## Course Breakdown

### Unit 1: Introduction to Programming with Karel the Dog (3 weeks, 15 hours)

This course begins with a strong focus on programming in order to allow students to create computational artifacts early on in the course. Students will be able to use their knowledge of programming to explore future topics in the course.

We use Karel, a dog that only knows how to move, turn left, and place tennis balls in his world, to show students what it means to program, and allow students to focus on computational problem-solving. Students will learn about the need for programming languages, the uses of programs, how to write programs to solve computational problems, how to design algorithms, how to analyze and compare potential solutions to programming problems, and learn the value and challenges involved in collaborating with others to solve programming problems. Students will use the grid coloring functionality of Karel to create a digital painting and embed this program in their portfolio website.

Subsection	EKs	Lessons / Topics
<b>Abstraction</b>  <u>Lessons:</u> <i>Abstraction</i>	AAP-3.B.1    AAP-3.B.7 AAP-3.B.2    CRD-2.G.1 AAP-3.B.3    DAT-1.A.2 AAP-3.B.4    DAT-1.A.5 AAP-3.B.6	Procedural Abstraction Modularity Program Reuse Digital Data (Bits) Reducing Complexity
<b>Programming Style</b>  <u>Lessons:</u> <i>Intro to Programming</i> <i>Super Karel</i> <i>Ultra Karel</i> <i>Top-Down Design</i> <i>Commenting Your Code</i>	CRD-2.G.1    CRD-2.B.5 CRD-2.G.2    AAP-3.D.1 AAP-2.M.1    AAP-3.D.2 AAP-2.M.3    AAP-3.D.3 CRD-2.B.1    AAP-3.D.4 CRD-2.B.2    AAP-3.D.5	Program Documentation Using Existing Code and Libraries APIs Commenting Code
<b>Control Structures</b>  <u>Lessons:</u>	AAP-2.G.1 AAP-2.J.1 AAP-2.K.1	If/Else Statements (Selection) For Loops and While Loops (Iteration)

<i>If/Else Statements</i> <i>For Loops</i> <i>While Loops in Karel</i>		
<b>Debugging Strategies</b>  <u>Lessons:</u> <i>Functions in Karel</i> <i>Debugging Strategies</i>	CRD-2.I.1 CRD-2.I.2 CRD-2.I.3 CRD-2.I.5	Logic Errors Syntax Errors Run-Time Error Testing
<b>Designing Algorithms</b>  <u>Lessons:</u> <i>Karel Algorithms</i>	AAP-2.A.4    AAP-2.M.2 AAP-2.B.1    AAP-4.A.2 AAP-2.B.2    AAP-4.A.4 AAP-2.B.6    AAP-4.A.5 AAP-2.B.7    AAP-4.A.6	Sequencing, Selection, Iteration Clarity and Readability Using Existing Algorithms Optimization and Efficiency
<p><b>Example Activities and Big Idea/Computational Thinking Practice</b></p> <p><i>The Two Towers:</i> In this program, students have Karel build two towers of tennis balls. Each tower should be 3 tennis balls high. In the end, Karel should end up on top of the second tower, facing East. Students need to write at least 3 functions in order to solve this problem. This activity requires students to design and create functions for repeated processes within their program. Students need to consider top-down design and decomposition through the following questions:</p> <ul style="list-style-type: none"> <li>• How can you break this problem down into smaller problems?</li> <li>• What is a subtask that Karel needs to do more than once in this problem?</li> </ul> <p><b>[Big Idea AAP][Computational Thinking Practice 1]</b></p>		

**Unit 2: Practice PT: Pair-Programming Paint (3 days, 3 hours)**

Students will use the grid coloring functionality of Karel to create a digital image. They will then embed this Karel program into their personal website portfolio.

<b>Subsection</b>	<b>EKs</b>	<b>Lessons / Topics</b>
<b>Collaboration and Communication</b>	CRD-1.A.3    CRD-2.F.7 CRD-1.A.4    CRD-2.G.1 CRD-1.B.2    CRD-2.G.3 CRD-1.C.1    CRD-2.G.4 CRD-2.F.5    CRD-2.G.5 CRD-2.F.6    CRD-2.H.1 CRD-2.H.2	Collaboration Diverse Perspectives Bias Avoidance Pair-Programming Design and Planning Program Documentation Acknowledgement of Reused Code
<p><b>Example Activity and Big Idea/Computational Thinking Practice</b></p>		

*Create Your Own UltraKarel Image:* Following the milestones and the pseudocode plan that students have laid out, students use pair-programming to write the code for their final project. They then test their code along the way to make sure they have solved each milestone. This activity allows students to develop something completely unique with their programming skills and implement a successful algorithm of their own design.

Students then reflect upon and answer the following questions:

1. Identify the programming language and purpose of your program.
2. Describe the incremental and iterative development process of your program. How did you divide the program into smaller tasks and make a plan to complete them all?
3. Describe the difficulties and/or opportunities you encountered and how they were resolved or incorporated.
4. Identify an algorithm that is fundamental for your program to achieve its intended purpose and includes two or more additional algorithms.
5. Describe how each algorithm within your selected algorithm functions independently, as well as in combination with others, to form a new algorithm that helps to achieve the intended purpose of the program.
6. Identify an abstraction you developed, and explain how your abstraction helped manage the complexity of your program.

**[Big Idea CRD][Computational Thinking Practice 2]**

### Unit 3: Programming with JavaScript (2 weeks, 10 hours)

This unit introduces students to the basics of JavaScript, including variables, user input, control structures, functions with parameters and return values, and basic graphics, how to send messages to objects.

<b>Subsection</b>	<b>EKs</b>	<b>Lessons / Topics</b>
<p><b>Programming Languages</b></p> <p><u>Lessons:</u>  <i>What is Code?</i>  <i>Uses of Programs</i></p>	<p>AAP-2.A.2                      AAP-2.A.3                      CRD-1.A.1                      CRD-1.A.2                      CRD-2.B.1</p>	<p>What is Programming?                      Pseudocode                      Programming Languages                      Computing Innovations</p>

<p><b>Variables</b></p> <p><u>Lessons:</u> <i>Variables</i></p>	<p>AAP-1.A.1    AAP-1.B.2          AAP-1.A.2    AAP-1.B.3          AAP-1.A.3    DAT-1.A.1          AAP-1.A.4          AAP-1.B.1</p>	<p>Variable Names          Assignment Operators          Data Types          Variables as Abstractions</p>
<p><b>Arithmetic Expressions</b></p> <p><u>Lessons:</u> <i>Basic Math in JavaScript</i></p>	<p>CRD-2.B.4    AAP-2.B.3          CRD-2.I.5    AAP-2.B.4          CRD-2.J.1    AAP-2.B.5          CRD-2.J.2    AAP-2.C.1          CRD-2.J.3    AAP-2.C.2          AAP-2.A.1    AAP-2.C.3          AAP-2.A.2    AAP-2.C.4          AAP-2.A.3    AAP-2.D.1          AAP-2.A.4    AAP-2.D.2</p>	<p>Program Behavior          Testing using Inputs          Arithmetic Expressions          Order of Operations          Modulus          String Concatenation</p>
<p><b>User Input</b></p> <p><u>Lessons:</u> <i>User Input</i> <i>Mouse Events: Mouse Clicked</i> <i>Key Events</i></p>	<p>AAP-1.C.4    CRD-2.C.5          AAP-3.A.6    CRD-2.C.6          AAP-3.A.9    CRD-2.D.2          CRD-2.C.2          CRD-2.C.3</p>	<p>Strings          User Input          Program Output          Events          Mouse and Key Events</p>

**Example Activity and Big Idea/Computational Thinking Practice**

*Computing Innovations* (as part of *Uses of Programs* lesson): In this activity, students perform an online search for examples of computing innovations that have had an impact on society, economy, or culture. The computing innovations must consume, produce, and/or transform data. A computing innovation can be a physical object like a self-driving car, non-physical software like a picture editing software, or a non-physical concept like e-commerce.

Students

- practice searching and evaluating sources relevant to computing innovations
- write the definition of *computing innovation* in their own words
- list 5 items that ARE computing innovations and 5 items that are NOT computing innovations. For each one, explain the reason why it is or is not a computing innovation
- identify the data used in at least one computing innovation and explain how the data is consumed, produced, or transformed by the given computing innovation. **[Computing Innovation 1, Prompt B][Big Idea IOC][Computational Thinking Practice 5]**

**Unit 4: JavaScript Control Structures (2 weeks, 10 hours)**

In this unit, students learn how to use booleans and logical operators with control structures to make more advanced programs in JavaScript.

Subsection	EKs	Lessons / Topics
<b>Comparison Operators</b>  <u>Lessons:</u> <i>Booleans</i> <i>Comparison Operators</i>	AAP-2.E.1    AAP-2.F.4 AAP-2.E.2    AAP-2.F.5 AAP-2.F.1 AAP-2.F.2 AAP-2.F.3	Booleans Relational Operators Operands
<b>Selection</b>  <u>Lessons:</u> <i>If Statements</i> <i>Random Numbers</i>	AAP-2.G.1    AAP-2.I.2 AAP-2.H.1    AAP-2.L.3 AAP-2.H.2    AAP-2.L.4 AAP-2.H.3    AAP-3.E.2 AAP-2.I.1	Selection Conditional Statements Nested Conditionals Equivalent Boolean Statements Random Numbers
<b>Iteration</b>  <u>Lessons:</u> <i>While Loops</i>	AAP-2.K.2    AAP-2.L.1 AAP-2.K.3    AAP-2.L.2 AAP-2.K.4    AAP-2.L.5 AAP-2.K.5	Iteration Loops Different but Equivalent Algorithms

**Example Activity and Big Idea/Computational Thinking Practice**

*Better Password Prompt:* Students write a program that uses a while loop to prompt a user for a password. They keep prompting the user for the password, and if they get it correct, they then break out of the loop. If they don't get it correct, they should give the user an error message. This activity requires that students use multiple program statements in a specific order to solve a problem.

**[Big Idea AAP][Computational Thinking Practice 2]**

**Unit 5: Functions and Parameters (2 weeks, 10 hours)**

In this unit, students learn to write reusable code with functions and parameters.

Subsection	EKs	Lessons / Topics
<b>Functions and Parameters</b>  <u>Lessons:</u> <i>Functions and Parameters 1</i> <i>Functions and Parameters 2</i> <i>Functions and Return Values 1</i> <i>Functions and Return Values 2</i>	CRD-2.C.6    AAP-3.A.3 CRD-2.D.2    AAP-3.A.4 CRD-2.B.3    AAP-3.B.5 CRD-2.C.4    AAP-3.C.1 AAP-3.A.1    AAP-3.C.2 AAP-3.A.2    AAP-2.M.2	User and Application Input Program Output Procedures Parameters Return Values Using Existing Algorithms

**Example Activity and Big Idea/Computational Thinking Practice**

*Pool Table:* Students write a program with a function that draws a pool ball. This function should take as parameters, the color, the number that should go on the pool ball, and the location of the center of the pool ball. Students need to consider the function abstractly as a means for taking specific data via the parameters and creating a unique graphical output based on those inputs.

**[Big Idea DAT][Computational Thinking Practice 3]**

**Unit 6: Practice PT: Tell a Story (3 days, 3 hours)**

In this project, students will write a JavaScript program that tells a graphical story

**Example Activity and Big Idea/Computational Thinking Practice**

*Tell a Story!* In this activity, students write a JavaScript program that tells a graphical story in at least 4 scenes. Following the milestones and the pseudocode plan that students have laid out prior to this exercise, students write the code for their final project. They iterate and test their code along the way to make sure they have solved each milestone.

**[Big Idea CRD][Computational Thinking Practice 4]**

**Unit 7: Basic Data Structures (2 weeks, 10 hours)**

Students learn about lists and arrays which are essential basic data structures that any program will use.

<b>Subsection</b>	<b>EKs</b>	<b>Lessons / Topics</b>
<p><b>Basic Data Structures</b></p> <p><u>Lessons:</u>  <i>Intro to Lists/Arrays</i>  <i>Indexing Into an Array</i>  <i>Removing an Element</i></p>	<p>DAT-1.A.1            AAP-1.A.1            AAP-1.C.1            AAP-1.C.2            AAP-1.C.3            AAP-1.D.6            AAP-1.D.7            AAP-1.D.8            AAP-2.N.2            AAP-2.N.1</p>	<p>Data Values            Lists and Elements            Indices            List Procedures</p>
<p><b>Data Abstractions</b></p> <p><u>Lessons:</u>  <i>Adding/Removing From Arrays</i>  <i>Array Length and Looping</i></p>	<p>AAP-1.D.1            AAP-1.D.5            DAT-2.E.4            AAP-1.D.2            AAP-1.D.3            AAP-1.D.4</p>	<p>Data Abstraction            Translating and Transforming Data            Filtering and Cleaning            Patterns</p>

	DAT-2.E.2 DAT-2.D.4 DAT-2.E.5	
<p><b>Traversing a List</b></p> <p><u>Lessons:</u> <i>Array Length and Looping</i> <i>Iterating Over an Array</i> <i>Removing an Element</i></p>	DAT-2.D.6 AAP-2.O.1 AAP-2.O.2 AAP-3.C.1 AAP-3.C.2 AAP-3.A.6 AAP-2.O.3 AAP-3.A.5 AAP-3.A.7 AAP-3.A.8 AAP-3.E.1	Extract and Modify Information Traversing a List Iteration Statements
<p><b>Algorithm Efficiency</b></p> <p><u>Lessons:</u> <i>Array Length and Looping</i> <i>Finding an Element in a List</i></p>	AAP-2.O.4 DAT-2.D.3 AAP-2.O.5 AAP-2.P.1 AAP-2.P.2 AAP-2.P.3 AAP-4.A.1 AAP-4.A.3 AAP-4.A.7 AAP-4.A.8 AAP-4.A.9	Using Existing Algorithms Search Tools Linear Search Binary Search Algorithm Efficiency Heuristics
<p><b>Simulation</b></p> <p><u>Lessons:</u> <i>Simulation</i></p>	AAP-3.F.1 AAP-3.F.2 AAP-3.F.3 AAP-3.F.4 AAP-3.F.5 AAP-3.F.6 AAP-3.F.7 AAP-3.F.8	Simulations as Abstractions Bias in Simulations Random Number Generators
<p><b>Example Activity and Big Idea/Computational Thinking Practice</b></p> <p><i>Draw a Barcode:</i> Students write a program to draw a barcode on the screen given an array that represents the data in the barcode. The array will contain a boolean in it, and if the boolean is `true`, the program will need to draw a vertical line in that position that runs from the top to the bottom of the screen. If not, the program will not draw a line. This program development requires students to use data generated from their bit array and loops and conditionals to determine where lines are drawn and where they are not drawn.</p> <p><b>[Big Idea DAT][Computational Thinking Practice 2]</b></p>		

**Unit 8: Digital Information (3 weeks, 15 hours)**

In this unit, students will learn about the various ways we represent information digitally. Topics covered include number systems, encoding data, programmatically creating pixel images, comparing data encodings, compressing and encrypting data. Students will work in pairs to develop their own data encryption algorithms and attempt to crack the encryptions of their peers. Their text encryption tool will be embedded in their portfolio websites.

<b>Subsection</b>	<b>EKs</b>	<b>Lessons / Topics</b>
<p><b>Number Systems</b></p> <p><u>Lessons:</u> <i>Intro to Digital Information</i> <i>Number Systems</i></p>	<p>CRD-2.C.1    DAT-1.A.7            CRD-2.D.1    DAT-1.B.1            CRD-2.J.2    DAT-1.B.2            CRD-2.J.3    DAT-1.B.3            CRD-2.I.4    DAT-1.C.1            DAT-1.A.2    DAT-1.C.2            DAT-1.A.3    DAT-1.C.3            DAT-1.A.4    DAT-1.C.4            DAT-1.A.5    DAT-1.C.5            DAT-1.A.6</p>	<p>Computing Devices            Abstraction            Program Input and Output            Bits and Bytes            Overflow Errors            Range of Value Limits            Binary and Decimal Systems</p>
<p><b>Data Compression</b></p> <p><u>Lessons:</u> <i>Data Compression</i> <i>Lossy Compression</i></p>	<p>DAT-1.A.8    DAT-1.D.4            DAT-1.A.9    DAT-1.D.5            DAT-1.A.10    DAT-1.D.6            DAT-1.D.1    DAT-1.D.7            DAT-1.D.2    DAT-1.D.8            DAT-1.D.3</p>	<p>Lossless Data            Lossy Data            Digital and Analog Data</p>
<p><b>Cryptography</b></p> <p><u>Lessons:</u> <i>Cryptography</i></p>	<p>AAP-4.B.1            AAP-4.B.2            AAP-4.B.3            IOC-2.B.8            IOC-2.B.5</p>	<p>Decidable Problems            Computer Viruses            Encryption</p>

**Example Activity and Big Idea/Computational Thinking Practice**

*Guess the Passcode:* Students first imagine they forgot their 4-digit passcode for their phone, and need to guess the correct passcode. They develop a program to guess passcodes for them to speed up the process. Once the correct passcode has been guessed, the program should print out how many guesses it took to reach the correct one. This activity encourages students to consider security issues which can be expanded to how we create a safer computing culture.

Students discuss the following questions with a partner:

1. How many possible passcodes will you need to guess before you've guessed every possible passcode?

2. Why is this dangerous for the security of your phone?
3. Imagine a hacker had access to your phone and had written a program to guess every possible passcode until they had broken in. What defenses could we build into the phone to keep this guess and check strategy from working? (What happens when you guess incorrectly over and over again?)
4. Can you think of any guessing strategies that might be faster than starting at 0000 and iterating all the way up to 9999

**[Big Idea IOC][Computational Thinking Practice 6]**

### **Unit 9: Practice PT: Steganography (3 days, 3 hours)**

In this project, students will be implementing a form of cryptography known as Steganography. Students can choose this practice PT or the following.

#### **Example Activity and Big Idea/Computational Thinking Practice**

*Secret Image: Steganography-* Students use a form of cryptography called steganography to hide a secret image inside of a cover image. They need to develop two functions that create filters, with one encoding and the other decoding. They are required to use a solid degree of abstraction since several functions will be required for each part of the encoding and decoding process. This also continues their consideration and discussions of privacy issues in computing.

**[Big Idea IOC][Computational Thinking Practice 3]**

### **Unit 10: Practice PT: Create Your Own Image Filter (3 days, 3 hours)**

In this project, students pair up with a partner to develop a novel image filter that can be applied to any digital image of their choosing. They will describe their image filter, and their development process, and embed their image filter along with its description on their personal portfolio website. Students can choose this practice PT or the previous.

#### **Example Activity and Big Idea/Computational Thinking Practice**

*Create an Image Filter:* In this activity, students work with a partner to develop functions for creating unique image filters. They share their creative solutions designs with others and incorporate feedback for improvement.

**[Big Idea CRD][Computational Thinking Practice 1]**

### **Unit 11: The Internet (2 weeks, 10 hours)**

This unit explores the structure and design of the internet, and how this design affects the reliability of network communication, the security of data, and personal privacy. Students will learn about the protocols and algorithms used on the internet and the importance of cybersecurity. Students will choose an innovation that was enabled by the Internet and explore the positive and negative impacts of their innovation on society, economy, and culture. Students

will develop a computational artifact that illustrates, represents, or explains the innovation’s purpose, its function, or its effect, and embed this artifact in their personal portfolio website.

<b>Subsection</b>	<b>EKs</b>	<b>Lessons / Topics</b>
<p><b>Internet Hardware and Addresses</b></p> <p><u>Lessons:</u>  <i>Welcome to the Internet</i>  <i>Internet Hardware</i>  <i>Internet Addresses</i></p>	<p>CSN-1.A.1    CSN-1.A.8            CSN-1.A.2    CSN-1.B.3            CSN-1.A.3    CSN-1.B.4            CSN-1.A.4            CSN-1.A.7</p>	<p>Protocols            Computing Devices            Computer Networks            Bandwidth</p>
<p><b>Routing</b></p> <p><u>Lessons:</u>  <i>Routing</i></p>	<p>CSN-1.A.5    CSN-1.E.2            CSN-1.A.6    CSN-1.E.3            CSN-1.B.5    CSN-1.E.4            CSN-1.B.6    CSN-1.E.5            CSN-1.B.7    CSN-1.E.6            CSN-1.E.1    CSN-1.E.7</p>	<p>Routing            Scalability            Fault-Tolerance            Redundancy</p>
<p><b>Packets and Protocols</b></p> <p><u>Lessons:</u>  <i>Packets and Protocols</i></p>	<p>CSN-1.B.1    CSN-1.D.1            CSN-1.B.2    CSN-1.D.2            CSN-1.C.1    CSN-1.D.3            CSN-1.C.2    DAT-2.B.1            CSN-1.C.3    DAT-2.B.3            CSN-1.C.4    DAT-2.B.5</p>	<p>Datastreams            Packets            IP, TCP, UDP            HTTP            Metadata</p>
<p><b>Computing Systems</b></p> <p><u>Lessons:</u>  <i>Sequential, Parallel &amp; Distributed</i></p>	<p>DAT-2.C.7    CSN-2.A.6            DAT-2.C.8    CSN-2.A.7            CSN-2.A.1    CSN-2.B.1            CSN-2.A.2    CSN-2.B.2            CSN-2.A.3    CSN-2.B.3            CSN-2.A.4    CSN-2.B.4            CSN-2.A.5    CSN-2.B.5</p>	<p>Parallel Systems            Scalability of Systems            Sequential Computing            Parallel Computing            Distributed Computing            Efficiency of Solutions            Speedup</p>
<p><b>Impact of the Internet</b></p> <p><u>Lessons:</u>  <i>The Impact of the Internet</i>  <i>Creative Credit and Copyright</i></p>	<p>IOC-1.A.1    IOC-1.E.2            IOC-1.A.3    IOC-1.E.3            IOC-1.A.4    IOC-1.E.4            IOC-1.A.5    IOC-1.E.5            IOC-1.B.1    IOC-1.E.6            IOC-1.B.2    IOC-1.F.1            IOC-1.B.3    IOC-1.F.2            IOC-1.B.4    IOC-1.F.3            IOC-1.B.5    IOC-1.F.4            IOC-1.B.6    IOC-1.F.5</p>	<p>Computing Innovations            Unintended Effects            Impact on Society            Rapid Sharing            Digital Divide            Citizen Science            Crowdsourcing            Creative Credit and Copyright</p>

	IOC-1.C.1 IOC-1.C.2 IOC-1.C.3 IOC-1.C.4 IOC-1.C.5 IOC-1.E.1	IOC-1.F.6 IOC-1.F.7 IOC-1.F.9 IOC-1.F.10 IOC-1.F.11	
<b>Cybersecurity</b>  <u>Lessons:</u> <i>Cybersecurity</i>	IOC-1.F.8 IOC-2.A.1 IOC-2.A.7 IOC-2.A.8 IOC-2.A.9 IOC-2.A.11 IOC-2.A.12 IOC-2.A.13 IOC-2.A.15 IOC-2.B.1 IOC-2.B.2 IOC-2.B.3 IOC-2.B.4	IOC-2.B.5 IOC-2.B.6 IOC-2.B.7 IOC-2.B.9 IOC-2.B.10 IOC-2.B.11 IOC-2.C.1 IOC-2.C.2 IOC-2.C.3 IOC-2.C.4 IOC-2.C.5 IOC-2.C.6 IOC-2.C.7	Legal and Ethical Concerns Personally Identifiable Info (PII) Digital Footprint Authentication Certificate Authorities (CAs) Computer Viruses Malware Phishing Keylogging Rogue Access Points Encryption

**Example Activity and Big Idea/Computational Thinking Practice**

*Reflection: Unintended Effects* - Students consider the WWW, targeted advertising and machine learning and data mining as examples of computing innovations. They also learn that responsible programmers try to consider the unintended ways their computing innovations can be used and the potential beneficial and harmful effects of these new uses although it may not be possible for a programmer to consider all the ways a computing innovation can be used.

They then consider *Pokemon Go* (from the previous video) or research another innovation that had unintended effects. Students answer in their reflections:

1. What were the intended effects and what were the unintended effects?
2. Explain beneficial and harmful effects of at least one other computing innovation on society, economy, or culture.

**[Computing Innovation 2, Prompt A][Big Idea IOC][Computational Thinking Practice 5]**

*Packets and Protocols: The Story of the Internet* - In their own words, students tell the story of downloading an image from a website on the internet. They tell the story step by step of how their computer finds the relevant server, requests information from the server, and receives it. Students are required to include distinctions between the internet and the World Wide Web, such as:

- The World Wide Web is a system of linked pages, programs, and files.
- HTTP is a protocol used by the World Wide Web.

- The World Wide Web uses the Internet.

**[Big Idea CSN][Computational Thinking Practice 5]**

**Unit 12: Practice PT: The Effects of the Internet (3 days, 3 hours)**

In this project, students will choose an innovation that was enabled by the Internet and explore the positive and negative impacts of their innovation on society, economy, and culture. Students will develop a computational artifact that illustrates, represents, or explains the innovation’s purpose, its function, or its effect, and embed this artifact in their personal portfolio website.

**Example Activity and Big Idea/Computational Thinking Practice**

*The Effects of the Internet:* Students provide evidence of the extensive knowledge they have developed about a chosen Internet-based innovation and its impact(s). Students include citations, as applicable, within their written responses.

Within their computational artifact, students explain at least one beneficial effect and at least one harmful effect the Internet-based innovation has had, or has the potential to have, on society, economy, or culture. They also identify data privacy, security, or storage concerns for the computing innovation.

**[Computing Innovation 3, Prompt C][Big Idea IOC][Computational Thinking Practice 5]**

**Unit 13: Data (1 week, 5 hours)**

In this unit, students will explore using computational tools to store massive amounts of data, manipulate and visualize data, find patterns in data, and draw conclusions from data. Students will consider how the modern wealth of data collection has impacted society in positive and negative ways. Students will work in teams to investigate a question of personal interest and use public data to present a data-driven insight to their peers. They will develop visualizations to communicate their findings, and embed their visualizations in their portfolio websites.

<b>Subsection</b>	<b>EKs</b>	<b>Lessons / Topics</b>
<p><b>Visualizing and Interpreting Data</b></p> <p><i>Lessons:</i>  <i>Getting Started with Data</i>  <i>Visualizing and Interpreting Data</i></p>	<p>DAT-2.A.1    DAT-2.D.5            DAT-2.A.2    DAT-2.D.6            DAT-2.C.1    DAT-2.E.1            DAT-2.D.1    DAT-2.E.2            DAT-2.D.2    DAT-2.E.3            DAT-2.D.3    DAT-2.E.5            DAT-2.D.4</p>	<p>Filtering and Cleaning Data            Patterns and Trends            Search Tools            Tables, Diagrams and Displays            Interactive Visualizations            Combining Data Sources</p>
<p><b>Collecting Data and Data Limitations</b></p>	<p>DAT-2.A.3    DAT-2.C.2            DAT-2.A.4    DAT-2.C.3</p>	<p>Metadata            Correlation</p>

<u>Lessons:</u> <i>Data Collection and Limitations</i>	DAT-2.B.1    DAT-2.C.4 DAT-2.B.2    DAT-2.C.5 DAT-2.B.3    DAT-2.C.6 DAT-2.B.4    DAT-2.D.6 DAT-2.B.5    CRD-2.F.3	Using a Variety of Sources Incomplete or Invalid Data Bias Surveys, Testing, Interviews
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**Example Activity and Big Idea/Computational Thinking Practice**

*Importance of Metadata:* Students consider how metadata can increase the effective use of data or data sets by providing additional information. They consider the importance of metadata and reflect on why metadata is important for a data set, how metadata help in finding specific data, and what metadata should reveal about the data.

**[Big Idea DAT][Computational Thinking Practice 5]**

**Unit 14: Practice PT: Present a Data-Driven Insight (3 days, 3 hours)**

In this project, students will work with a partner to answer a question of personal interest using a publicly available data set. Students will need to produce data visualizations and explain how these visualizations led to their conclusions. They will develop a computational artifact that illustrates, represents, or explains their findings, communicate their findings to their classmates, and embed their artifact in their personal portfolio website.

**Example Activity and Big Idea/Computational Thinking Practice**

*Present a Data-driven Insight:* Students consider how the amount of collected data impacts our lives in ways that require considerable study and reflection for us to fully understand them. Students explore a question that can be answered by analyzing a dataset. They form a question and use visualization techniques to analyze the data to answer the question.

**[Big Idea DAT][Computational Thinking Practice 6]**

**Unit 15 & 16: Explore MCQ Practice and Create Performance Task (3 weeks, 15 hours)**

This time is set aside for students to prepare for the Explore MCQ and create their AP Create Performance Task. Students will be given the chance to review course content and practice the skills necessary to complete the Create Performance Task. The Create PT will be administered over 12 hours of class time.

<b>Subsection</b>	<b>EKs</b>	<b>Lessons / Topics</b>
<b>AP CSP Explore Task Practice</b>	IOC-2.A.2    IOC-2.A.10 IOC-2.A.3    IOC-2.A.14 IOC-2.A.4    IOC-1.F.11 IOC-2.A.5    CRD-1.A.1 IOC-2.A.6    CRD-1.A.2	Artifact Creation Computing Innovations Data Input and Output Data Privacy and Security

<b>Prepare for Create PT</b>	ALL	Review Course Content Incremental Development Documentation Debugging Collaborative Development
<b>Create PT</b>		12 hours of class time to conduct Create PT
<b>Example Activity and Big Idea/Computational Thinking Practice</b> <i>Create Performance Task:</i> Students develop a program of their choice. Their development process includes iteratively designing, implementing, and testing their program. Students are strongly encouraged to work with another student in their class. <b>[Big Idea AAP][Computational Thinking Practices 1-4]</b>		

**Unit 17: Review for the AP Exam (1 week, 5 hours)**

This unit gives students a review of the topics covered in the course and provides practice solving AP Exam style multiple-choice questions.

<b>Subsection</b>	<b>Lessons / Topics</b>
<b>Prepare for Practice Exam</b>	Review course content What to expect on the exam
<b>Practice AP Exam</b>	Cumulative Final AP Review Multiple Choice Test

**Unit 18: Creative Development (Remainder of the school year, 2-4 weeks, 10-20 hours)**

In this unit, students will brainstorm their own final project, discuss their ideas with their peers, scope their project to fit within the time constraints of the class, plan out milestones for incremental development, and create their own final product from scratch. This project allows students to think creatively about the applications of the concepts covered in the course, and create something of personal value.

<b>Subsection</b>	<b>EKs</b>	<b>Lessons / Topics</b>
<b>Design Thinking</b>  <u>Lessons:</u> <i>Intro to Design Thinking</i>	CRD-1.A.4    CRD-2.E.4 CRD-1.A.5    CRD-2.F.1 CRD-1.A.6    CRD-2.F.2 CRD-2.A.1    CRD-2.F.5 CRD-2.A.2    CRD-2.F.6 CRD-2.E.1    CRD-2.F.7 CRD-2.E.2    IOC-1.A.2	Computing Innovations Development Process Program Specifications Design Phase Communication Collaboration
<b>Brainstorm, Prototype &amp; Test</b>  <u>Lessons:</u> <i>Prototype Test</i>	CRD-2.E.2    CRD-2.F.4 CRD-2.F.7    CRD-2.F.3 CRD-1.A.5    IOC-1.D.1 CRD-1.A.6    IOC-1.D.2 CRD-1.A.4    IOC-1.D.3 CRD-2.E.3    IOC-1.F.11	Development Process User Testing User Research Diverse Perspectives Iterative Development Human Biases Legal and Ethical Concerns
<b>Project Prep and Development</b>  <u>Lessons:</u> <i>Project Prep and Development</i>	CRD-1.B.1	Online Collaboration Tools
<b>Example Activity and Big Idea/Computational Thinking Practice</b> <i>User Interface Scavenger Hunt:</i> Students search for 2 websites or apps, one with a good UI and one with a not-so-good UI. They learn to discriminate features of solid UI design in terms of accessibility and more before moving onto prototyping their creative project for the unit. <b>[Big Idea CRD][Computational Thinking Practices 6]</b>		

AP Computer Science Principles 2020 Supplemental Materials

<b>Supplementary Units</b>	<b>Prerequisite/Recommended Unit(s)</b>	<b># of activities</b>
Extra Karel Practice	Intro to Programming	12
Extra Karel Puzzles	Intro to Programming	11
Karel Challenges	Intro to Programming	7
Web Development	After Pretest	79
Functions and Parameters Practice	Functions & Parameters	8

Extra Console Challenges - Prime Numbers	Javascript Control Structures	10
Animation and Games - Timers - Random Circles - Random Ghosts - Bouncing Ball - Mouse Events: Mouse Clicked - Mouse Events: Mouse Moved - Drawing Lines - Key Events - Crazy Ball Game	Functions & Parameters	51
Project: Breakout	Functions & Parameters	4
Data Structures Challenge Problems - Conway's Game of Life - Connect Four	Basic Data Structures	6
Visualizing Music	Basic Data Structures	9
Project: Tic Tac Toe	Basic Data Structures	4
Project: Helicopter	Basic Data Structures	24
More Basic Data Structures	Basic Data Structures	38