



# **CURRICULUM OUTLINE COMPUTER SCIENCE PRINCIPLES**

A Guide for Computer Science  
Principles Curriculum

# COMPUTER SCIENCE PRINCIPLES

13 - 17 YEARS

## UNIT 1

## DIGITAL INFORMATION

### DESCRIPTION

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

- Survey
  - Principles Pre-survey

#### ➤ Lesson 1: Welcome to CSP

- **DESCRIPTION:** Welcome to Computer Science Principles! The first lesson is about getting students excited about the course and connecting their own personal interests to computer science. Students are asked to share something they know a lot about and teach it to a small group. Groups make a “rapid” prototype of an innovative idea and share it. Students watch a brief video about computing innovations. The lesson ends with students logging into the Code.org CSP course web site, and answering a brief prompt about what “computer science” means to them.
  - Check For Understanding

#### ➤ Lesson 2: Representing Information

- **DESCRIPTION:** Using everyday materials, students create devices for sending information to a partner. Each group then uses its device to send an answer to a question. Following this, students modify their devices to answer more complex answers, responding with one of four possible messages, then one of eight possible messages, then one of sixteen possible messages.
  - Check For Understanding

## ➤ Lesson 3: Circle Square Patterns

○ **DESCRIPTION:** Students will create rules for ordering patterns of circles and squares. Students generate all possible messages with three place values, then create rules that explain how they ordered each message. Emphasis is placed on creating clear rules so that, if another group were to follow the rules, they would generate the same list in the same order. Using these rules, students then try to list all possible messages with four place values. As the lesson concludes, students share their rules with classmates.

- Check For Understanding

## ➤ Lesson 5: Overflow and Rounding

○ **DESCRIPTION:** Students extend their understanding of the binary number system by exploring errors that result from overflow and rounding. They use the binary odometer widget and develop their own systems for representing fractional amounts using the Flippy Do.

- Widget: Binary Odometer
- Check For Understanding

## ➤ Lesson 4: Binary Numbers

○ **DESCRIPTION:** In this lesson, students will practice representing numbers in binary (base 2), transitioning from the circle-square representations they made in the last lesson. Students will create and use a "Flippy Do", a manipulative which helps students convert between binary (base 2) and decimal (base 10) numbers. They will practice converting numbers and explore the concept of place value in the context of binary numbers.

- Check For Understanding

## ➤ Lesson 6: Representing Text

○ **DESCRIPTION:** In this lesson, students create a system for representing text using only numbers while communicating with each other. They are only allowed to send numbers back-and-forth, so they must create a system to translate between number and character. At the end of the main activity they briefly review the ASCII system for representing text. The wrap up discussion emphasizes how all of the concepts thus far have 'built' on each other and introduces the concept of abstraction to describe this progression.

- Check For Understanding

## ➤ Lesson 7: Black and White Images

- **DESCRIPTION:** Students explore how black and white images are represented. Students use the black and white pixelation widget to represent each pixel of an image with black or white light. They learn how to sample an analog image using small squares of uniform size (each represented with a black or white value) and reflect on the pros and cons of choosing a smaller or larger square size when sampling.
  - Pixelation Widget: B&W
  - Sampling an Analog Image
  - Check For Understanding

## ➤ Lesson 9: Lossless Compression

- **DESCRIPTION:** Students use the Text Compression Widget to experiment with compressing songs and poems and try to find their 'personal best' compression. A video introduces important vocabulary for the lesson and demonstrates the full features of the widget. Students pick a text they think will be 'easy' to compress and one they think will be 'difficult', paying attention to why some texts might be more compressible than others. As a wrap-up, students discuss what factors make some texts more compressible than others.
  - Widget: Text Compression
  - Check For Understanding

## ➤ Lesson 8: Color Images

- **DESCRIPTION:** This is a second opportunity for students to interact with the Pixelation Widget, but this time they will work with color pixels. Students start off learning that each pixel uses red, green, and blue lights that can be turned on or off using bits. They will create more color variants using an increasing amount of bits per pixel, and apply their learning by approximating an analog color image using the widget.
  - RGB Color
  - Pixelation Widget: Color
  - More Shades of Color
  - Pixelation Widget: Color
  - Color Sampling Widget
  - Pixelation Widget: Color
  - Check For Understanding

## ➤ Lesson 10: Lossy Compression

- **DESCRIPTION:** Students are introduced to lossy compression via the Lossy Text Compression widget. They apply this concept and their prior knowledge of sampling to create their own lossy compressions of image files using the Lossy Image Widget. Students then discuss several practical scenarios where they need to decide whether to use a lossy or lossless compression algorithm. The lesson ends with a discussion of the situations where lossless compression is important and the situations where lossy compression is important.
  - Lossy Compression Widget
  - Check For Understanding

## ➤ Lesson 11: Intellectual Property

- **DESCRIPTION:** Students are asked to reflect on who owns their creative works from this class, such as their pixel images, before reading an article describing how ownership can become complicated as analog works become digital artifacts. After reading the article, students watch several videos explaining copyright and introducing them to the Creative Commons. Students then re-read the article answering three questions about the benefits, harms, and impacts of current copyright policy. Students use their new understanding of copyright to form an opinion about current copyright policies and create a small poster justifying their opinion with a quote from the article.
  - Check For Understanding

## ➤ Lesson 13: Project Digital Information Dilemmas Part 2

- **DESCRIPTION:** In this lesson students finish designing an artifact that represents their analysis of an article on the impacts of digitizing information. Students will complete the final two quadrants of their poster in which they identify the benefits and harms highlighted in the article and then make an overall claim about whether the world has been made better or worse through the digitization of information. At the conclusion of the class students update the position of their stickies on the "better" to "worse" spectrum they designed yesterday and then discuss whether and why they changed their opinion.
  - Check For Understanding
  - End-Of-Unit Survey

## ➤ Lesson 12: Project Digital Information Dilemmas Part 1

- **DESCRIPTION:** In this lesson students begin tackling the question of whether digitizing information has made the world a better or worse place. To begin the lesson, students place stickies on a spectrum of "worse" to "better" to state their opinion prior to doing the activity. Students then choose an article they are interested in reading using a process the class completed collectively in the previous lesson. Students will discuss their preliminary reading and opinions after today's lesson and will have a chance to start making an artifact to present their findings.
  - Check For Understanding

## ➤ Lesson 14: Assessment Day

- **DESCRIPTION:** Students complete a multiple choice assessment which covers the unit topics.
  - Unit 1 Exam

## UNIT 2

## THE INTERNET

### DESCRIPTION

This unit reveals how the Internet was designed to connect billions of devices and people to one another. Learn how the different protocols of the Internet work and actually build them yourself using the Internet Simulator. Then consider the impacts the Internet has had, both good and bad, on modern life.

#### ➤ Lesson 1: Welcome to the Internet

- **DESCRIPTION:** After a short transition from representing information in Unit 1 to communicating information in Unit 2, students take time to think about their knowledge of the Internet and how it works. Following this, students are introduced to a new widget: The Internet Simulator which they will use throughout this unit to explore the inner workings of the Internet.
  - Internet Simulator
  - Check For Understanding

#### ➤ Lesson 2: Building a Network

- **DESCRIPTION:** In this lesson, students are formed into groups of 5-7 and given string so they can connect themselves together to form a computer network. Students are given several specific networks to form, along with several guidelines for how to best form computer networks. Students are also forced to wrestle with conflicting guidelines in determining the 'best' way to connect together to form a network, and will need to justify why they chose the networks that they did.
  - Check For Understanding

## ➤ Lesson 3: The Need for Addressing

- **DESCRIPTION:** Students complete a scheduling challenge three times, once unplugged, and twice on the Internet Simulator, to explore the need for addressing messages online. Students first complete a challenge where they are allowed to talk to one another to fill out a weekly schedule. They then move on to a version of the Internet Simulator where all of their messages are "broadcast" or sent to everyone in the same simulator room. This challenge forces students to develop shared rules for communicating to complete the scheduling activity a second and then third time. The wrap up helps students connect their experiences to real-life rules, or protocols, used on the Internet for addressing messages.
  - Internet Simulator
  - Check For Understanding

## ➤ Lesson 5: Packets

- **DESCRIPTION:** Students learn that large messages sent over the Internet are actually divided into individual packets and explore the challenges this creates. First students explore a version of the Internet Simulator that breaks messages into packets to get a sense for how it works. Students then use an activity guide that walks them through the challenges that dropped or out-of-order packets create. They then design their own protocol that addresses these challenges. At the end of the lesson students watch a video and learn and the User Datagram Protocol (UDP) and The Transmission Control Protocol (TCP), two different protocols for sending messages broken into packets.
  - Internet Simulator
  - Check For Understanding

## ➤ Lesson 4: Routers and Redundancy

- **DESCRIPTION:** Students spend most of today's lesson in an updated Internet Simulator that lets students send messages with a dedicated To and From IP Address. Students start by connecting to a dedicated router and sending messages only to each other. They look at the router logs to find other students on different routers, then send messages to those students. They look at the router logs again to notice that messages are being passed between routers in order to reach their destination. Students continue to send messages and view the logs one last time to notice that the messages are also taking different paths to reach the same destination. The lesson wraps-up by introducing new vocabulary and using these words to summarize today's activity.
  - Internet Simulator
  - Check For Understanding

## ➤ Lesson 6: HTTP and DNS

- **DESCRIPTION:** Students conclude their study of the layers of the Internet by learning about two top-level protocols, HTTP and DNS. The lesson begins with a review of the layers students have already learned, namely the physical Internet, IP, and TCP / UDP. The lesson then dives into the core of the unit which is "What happens when I type an address into my browser?" Students will complete two brief activities, one unplugged, and one plugged, that explore how the DNS works. Students then watch videos explaining how both DNS and HTTP work, taking notes in a provided activity guide. The lesson concludes with a review of how the different layers of the Internet work.
  - Check For Understanding



➤ **Lesson 7: Project Internet Dilemmas Part 1**

- **DESCRIPTION:** Students begin working on a two-day project exploring a dilemma at the intersection of the Internet and society.

➤ **Lesson 9: Assessment Day**

- **DESCRIPTION:** Students complete a multiple choice assessment which covers the unit topics.
  - Unit 2 Exam

➤ **Lesson 8: Project Internet Dilemmas Part 2**

- **DESCRIPTION:** Students finish working on a two-day project exploring a dilemma at the intersection of the Internet and society.
  - End-of-Unit Survey

## UNIT 3

### INTRO TO APP DESIGN

#### DESCRIPTION

This unit is an introduction to programming and app design with a heavy focus on important skills like debugging, pair programming, and user testing. Learn how to design user interfaces and write event-driven programs in App Lab and then design a project that teaches your classmates about a topic of your choosing.

#### ➤ Lesson 1: Introduction to Apps

- **DESCRIPTION:** Students explore and investigate what makes an app an app. They begin by looking at and discussing five different apps. Following this, students watch a video explaining the basics of how computers work. Finally students return to the apps and consider the various inputs and outputs.
  - App Exploration
  - App Investigation
  - Check For Understanding

#### ➤ Lesson 2: Introduction to Design Mode

- **DESCRIPTION:** Students work through a progression of levels to build an understanding of how to use Design Mode to layout an app. The final level has students setting up the screen of an app by attempting to copy an image of an app.
  - Design Mode Exploration
  - Copy an App
  - Check For Understanding

➤ **Lesson 3: Project Designing an App Part 1**

- **DESCRIPTION:** This is the first in a series of lessons where students will make progress on building their own functional app. In this lesson, students brainstorm app ideas and sketch out user interfaces in preparation for the next lesson where they will return to App Lab.

➤ **Lesson 5: The Need for Programming Languages**

- **DESCRIPTION:** In this lesson students explore the challenges of clearly communicating instructions. They build a small arrangement of blocks (LEGO® pieces or paper cutouts) and then create text instructions a classmate could follow to construct the same arrangement. Groups then trade instructions to see if they were clear enough to allow reconstruction of the original arrangement. The wrap-up discussion is used to highlight the inherent ambiguities of human language and call out the need for the creation of a programming language which leaves no room for interpretation.
  - Check For Understanding

➤ **Lesson 4: Project Designing an App Part 2**

- **DESCRIPTION:** Students continue working on the unit projects in this lesson that is primarily designed to be work time. Students continue to follow the app development process outlined in their App Development Guide by transferring their user interfaces designs from their planning guides over to App Lab
  - Sample Prototype
  - Build Your Screens

➤ **Lesson 6: Intro to Programming**

- **DESCRIPTION:** Students use and modify a series of simple apps to get familiar with a small set of programming commands. They observe the way the code runs by slowing down the code and compare programs that run all at once to those that respond to user actions like buttons clicks. At the end of the lesson students discuss what they observed and are introduced to some key vocabulary for describing the running of programs.
  - Code Investigation
  - Check For Understanding

## ➤ Lesson 7: Debugging

- **DESCRIPTION:** In this lesson students practice using the different programming concepts that they were introduced to in the last lesson. To begin, however, they are introduced to the concept of debugging and are encouraged to use and reflect on this practice throughout the lesson. At the end of the lesson students share their experiences debugging as well as an new realizations about programming.
  - Debugging
  - Practice
  - Check for Understanding

## ➤ Lesson 9: Project Designing an App Part 4

- **DESCRIPTION:** Students continue working on their apps. Halfway through class the focus of the lesson shifts to getting feedback. Students watch other groups test their apps and collect feedback that will be used to make updates.
  - Add More Code

## ➤ Lesson 8: Project Designing an App Part 3

- **DESCRIPTION:** Student learn about Pair Programming by watching a video and then practicing it themselves while working on their project apps. At this stage, students are adding their first lines of code to their app using debugging skills from the previous lesson.
  - Add Code

## ➤ Lesson 10: Project Designing an App Part 5

- **DESCRIPTION:** Students complete their apps, making any final adjustments based on feedback from their peers. Students spend some time reviewing other apps that classmates made and then complete a short set of reflection prompts before submitting their projects.
  - Submit your app
  - End-of-Unit Survey

➤ **Lesson 11: Assessment Day**

- **DESCRIPTION:** Students complete the Unit Assessment and then spend the rest of class sharing their projects.

## UNIT 4

### VARIABLES, CONDITIONALS, AND FUNCTIONS

#### DESCRIPTION

This unit explores how variables, conditionals, and functions allow for the design of increasingly complex apps. Learn how to program with these three new concepts through a sequence of collaborative activities. Then build your own decision maker app to share with friends and help them make a decision.

#### ➤ Lesson 1: Variables Explore

- **DESCRIPTION:** To begin the lesson students explore sample apps similar to the ones they'll be able to build by the end of the unit. Then students complete an unplugged activity with plastic baggies and sticky notes to build a mental model of how variables are used to move and store information. The lesson ends with a synthesizing discussion and students adding key vocabulary to their journal.
  - Sample Apps
  - Check For Understanding

#### ➤ Lesson 2: Variables Investigate

- **DESCRIPTION:** In this lesson students work with partners to investigate several versions of the "Thermostat App" to understand how variables store and update information. To begin, students examine a version of the app where the temperature displayed changes each time a button is clicked. The next two versions of the app demonstrate how variables can store strings. Students learn about the patterns they are observing, specifically "Counter Pattern with Event" and "Variables with String Concatenation Pattern". To conclude the lesson, students review and discuss the programming patterns that they will make use of in the programs they write.
  - Investigation #1: Thermostat App v.1
  - Investigation #2: Thermostat App v.2
  - Investigation #3: Thermostat App v.3
  - Assessment: Check For Understanding

## ➤ Lesson 3: Variables Practice

- **DESCRIPTION:** In this lesson students spend most of their time practicing using the skills and processes they have learned about variables. At the conclusion of the lesson students discuss the main things they realized and still have questions about at the conclusion of this lesson.
  - Assigning Numbers and Strings
  - Variables and Operators
  - Debugging Scope Issues
  - Putting it Together
  - Assessment: Check For Understanding: AP Practice

## ➤ Lesson 5: Conditionals Explore

- **DESCRIPTION:** Students learn the basics of conditionals through an unplugged activity using the sticky notes and plastic baggies from the Variables Explore lesson. Flowcharts are introduced as a way to understand how computers make decisions using Boolean expressions.
  - Assessment: Check For Understanding

## ➤ Lesson 4: Variables Make

- **DESCRIPTION:** Using Programming Patterns and a step-by-step approach students make their own version of a Photo Liker app. At the beginning of the lesson students are able to explore a working version of the app. They are then given the design elements of the app but begin with a blank screen. A progression of levels guides students on the high level steps they should use to develop their app but leaves it to them to decide how to write the code. At the end students submit their apps which can be assessed using a provided rubric.
  - Try the Photo Liker app
  - Make the Photo Liker app

## ➤ Lesson 6: Conditionals Investigate

- **DESCRIPTION:** In this lesson students work with partners to investigate three versions of the "Lemon Squeeze" app to understand how boolean expressions and conditional statements allow programs to make decisions. In each guided investigation students first watch a short video on a concept, then use a working app to predict how new features work, then investigate the code to see how those features are implemented, and finally modify the code to add expanded features. To conclude the lesson, students review and discuss common programming patterns with conditionals.
  - If-Statements
  - If-Else Statements
  - If-Else-If Statements
  - Logical Operators: AND OR
  - Patterns: If-else-if
  - Check Your Understanding

## ➤ Lesson 7: Conditionals Practice

- **DESCRIPTION:** In this lesson students spend most of their time practicing using the skills and processes they have learned about conditionals. At the conclusion of the lesson students discuss the main things they realized and still have questions about at the conclusion of this lesson.
  - Boolean expressions
  - If-Statements
  - Logical Operators
  - MOD Practice
  - Putting It Together
  - Check For Understanding: AP Practice

## ➤ Lesson 9: Functions Explore / Investigate

- **DESCRIPTION:** Students begin the lesson by considering two ways to write out the lyrics of a song, one that includes a lot of repeated text and one that does not. After exploring this example students complete a series of investigate activities in which functions have been used to remove repeated code from a program. At the conclusion of the lesson students discuss the concept of a function to synthesize their learning and add definitions to their journal.
  - Explore Functions
  - Declaring and Calling Functions
  - Update Screen Pattern
  - Check For Understanding

## ➤ Lesson 8: Conditionals Make

- **DESCRIPTION:** Using Programming Patterns and a step-by-step approach students make their own version of a Museum Ticket Generator app. At the beginning of the lesson students are able to explore a working version of the app. They are then given the design elements of the app but begin with a blank screen. A progression of levels guides students on the high level steps they should use to develop their app but leaves it to them to decide how to write the code. At the end students submit their apps which can be assessed using a provided rubric.
  - Try to the Museum Ticket Generator App
  - Make the Museum Ticket Generator App

## ➤ Lesson 10: Functions Practice

- **DESCRIPTION:** In this lesson students spend most of their time practicing using the skills and processes they have learned about functions. At the conclusion of the lesson students discuss remaining questions in anticipation of their Make project in the following lesson.
  - Declare and Call Functions
  - Function Scope
  - Putting It Together
  - When to Declare Functions
  - Check For Understanding: AP Practice



## ➤ Lesson 11: Functions Make

- **DESCRIPTION:** Using Programming Patterns and a step-by-step approach students make their own version of a Quote Maker app. At the beginning of the lesson students are able to explore a working version of the app. They are then given the design elements of the app but begin with a blank screen. Students use an Activity Guide to go through the high level steps they should use to develop their app but leaves it to them to decide how to write the code. At the end students submit their apps which can be assessed using a provided rubric.
  - Quote Maker App
  - Make the Quote Maker App

## ➤ Lesson 13: Project Decision Maker App Part 2

- **DESCRIPTION:** Students translate the plans they documented in Part 1 of the Practice PT to a working program in App Lab through a series of steps.
  - Create the Screens
  - Create the Variables
  - Create the Function
  - Add onEvents

## ➤ Lesson 12: Project Decision Maker App Part 1

- **DESCRIPTION:** Using a Project Planning Guide, students work through the stages of creating an app from scratch. This is the first day of a three-day project. This lesson is devoted to the planning phase.
  - Sample Apps

## ➤ Lesson 14: Project Decision Maker App Part 3

- **DESCRIPTION:** The final lesson in the Practice PT progression is devoted to feedback and improvements to the Decision Maker App. Students work with classmates to review and update the functionality of their apps before submitting the final project.
  - Test Your Decision Maker App
  - Submit Your Decision Maker App
  - End-of-Unit Survey

➤ **Lesson 15: Assessment Day**

- **DESCRIPTION:** Students complete a multiple choice assessment which covers the unit topics.
  - Unit 4 Exam

## UNIT 5

### LISTS, LOOPS, AND TRAVERSALS

#### DESCRIPTION

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. Learn to program with the data library in App Lab and complete a 5-day hackathon project at the end of the unit where you can design a program about any topic of your choosing.

#### ➤ Lesson 1: Lists Explore

- **DESCRIPTION:** Students will learn the ways that lists are created, accessed, and changed through a teacher-guided activity using plastic baggies and pieces of paper. The lesson begins with a brief reflection on the value of lists. Students then complete the main activity which introduces the syntax to use lists and the ways they can be used. To wrap up students watch two short videos on lists and record the main concepts in their journals.
  - Check For Understanding

#### ➤ Lesson 2: Lists Investigate

- **DESCRIPTION:** In this lesson students work with partners to investigate three different apps that use lists. Students first explore all three apps without seeing the code to notice similarities and predict how they will work. Then they explore the code itself and make additions and modifications to the apps. To conclude the lesson, students review and discuss common programming patterns with conditionals.
  - Accessing Lists
  - Changing Lists
  - List Patterns

## ➤ Lesson 3: Lists Practice

- **DESCRIPTION:** Practice the basics of lists including creating lists and accessing, inserting, and removing elements from lists.
  - Setting up Lists
  - Accessing Elements in a List
  - Strings and Indexes
  - List Operations
  - Putting It Together
  - Check For Understanding: AP Practice

## ➤ Lesson 5: Loops Explore

- **DESCRIPTION:** Students begin the lesson by discussing the purpose of loops before completing the unplugged activity. This activity involves moving a "robot" around a game board while practicing tracing blocks of code by hand. To conclude, the lesson is wrapped up with a vocabulary discussion and a video.
  - Check For Understanding

## ➤ Lesson 4: Lists Make

- **DESCRIPTION:** Using Programming Patterns and a step-by-step approach students make their own version of a Reminder app. At the beginning of the lesson students are able to explore a working version of the app. They are then given the design elements of the app but begin with a blank screen. Students use an Activity Guide to go through the high level steps they should use to develop their app but leaves it to them to decide how to write the code. At the end students submit their apps which can be assessed using a provided rubric.
  - Try the Reminders App
  - Make the Reminders App

## ➤ Lesson 6: Loops Investigate

- **DESCRIPTION:** Students practice using the for loop in order to repeatedly run pieces of code. The lesson begins with a quick investigation of an app that flips coins. After that code investigation students complete another investigation with an app that uses loops to update screen elements.
  - Coin Flipper App
  - Font Tester App
  - Check For Understanding

## ➤ Lesson 7: Loops Practice

- **DESCRIPTION:** Students practice the basics of loops including using while loops, for loops, and updating multiple screen elements with a for loop. Along the way students develop debugging practices with loops.
  - While Loop Practice
  - Putting It Together
  - For Loop Practice
  - Loops and Screen Elements
  - Check For Understanding: AP Practice

## ➤ Lesson 9: Traversals Explore

- **DESCRIPTION:** The lesson begins with a quick review of lists and loops before moving into the main activity. Here students explore the concept with the Traversal Machine, a physical model of traversal using a for loop.
  - Assessment: Check For Understanding

## ➤ Lesson 8: Loops Make

- **DESCRIPTION:** Using Programming Patterns and a step-by-step approach students make their own version of a Lock Screen Maker app. At the beginning of the lesson students are able to explore a working version of the app. They are then given the design elements of the app but begin with minimal starting code. A progression of levels guides students on the high level steps they should use to develop their app but leaves it to them to decide how to write the code. At the end students submit their apps which can be assessed using a provided rubric.
  - Try the Lock Screen Maker
  - Make the Lock Screen Maker

## ➤ Lesson 10: Traversals Investigate

- **DESCRIPTION:** In this lesson students work with partners to investigate three different apps that use traversal to access items in a lists. Students first explore all three apps without seeing the code to notice similarities and predict how they will work. Then they explore the code itself and make additions and modifications to the apps. To conclude the lesson, students review and discuss common programming patterns with traversals.
  - Mile Tracker Investigation
  - Data Tab Investigation
  - Random Dog Picker Investigation
  - Traversal Patterns
  - Check For Understanding

## ➤ Lesson 11: Traversals Practice

- **DESCRIPTION:** Students practice traversing lists, filtering and reducing lists, and using the data import tools. Along the way students develop debugging practices with traversals.
  - Traversal Practice
  - Reduce and Filter Practice
  - Putting It Together
  - Check For Understanding: AP Practice

## ➤ Lesson 13: Project Hackathon Part 1

- **DESCRIPTION:** This is the first day of a five-day unit project. Students begin the project by choosing a partner, determining a dataset to design the app around, and creating a paper prototype.

## ➤ Lesson 12: Traversals Make

- **DESCRIPTION:** Using Programming Patterns and a step-by-step approach students make their own version of a Random Forecaster app. At the beginning of the lesson students are able to explore a working version of the app. They are then given the design elements of the app but begin with a blank screen. Students use an Activity Guide to go through the high level steps they should use to develop their app but leaves it to them to decide how to write the code. At the end students submit their apps which can be assessed using a provided rubric.
  - Try the Random Forecaster App
  - Make the Random Forecaster App

## ➤ Lesson 14: Project Hackathon Part 2

- **DESCRIPTION:** This is the second day of a five-day unit project. Students continue to plan for the project by filling out tables of information on element IDs and programming constructs before each tackling a different role in the project as a designer or a programmer.
  - Hackathon Project

➤ **Lesson 15: Project Hackathon Part 3**

- **DESCRIPTION:** This is the third day of a five-day unit project. Students continue to build their apps.
  - Hackathon Project

➤ **Lesson 17: Project Hackathon Part 5**

- **DESCRIPTION:** This is the final day of a five-day unit project. Students complete a Written Response, individually answering prompts about the project. Students then share their apps during a gallery walk.
  - Hackathon Project
  - End-of-Unit Survey

➤ **Lesson 16: Project Hackathon Part 4**

- **DESCRIPTION:** This is the fourth day of a five-day unit project. Students continue to build their apps.
  - Hackathon Project

➤ **Lesson 18: Assessment Day**

- **DESCRIPTION:** Students complete a multiple choice assessment which covers the unit topics.
  - Unit 5 Exam

- **Lesson 19: CS Principles Post-Course Survey**
  - Post-Course Survey Instructions



## UNIT 6

## ALGORITHMS

### DESCRIPTION

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

#### ➤ Lesson 1: Algorithms Solve Problems

- **DESCRIPTION:** Students will complete two exploratory activities that introduce the concept of a problem and an algorithm. In the first students answer a series of questions about birthdates and names of their classmates. They then discuss the similarities and differences between the problems. In the second activity students are given six different algorithms and must analyze them to determine which they think are the same or different. At the end of the lesson they are introduced to the formal definitions of a problem and an algorithm.
  - Check For Understanding

#### ➤ Lesson 2: Algorithm Efficiency

- **DESCRIPTION:** In this lesson students follow a demonstration of Linear Search before writing their own search algorithms. Following this, students are introduced to Binary Search after which they compare graphs of the search algorithms to determine which is most efficient.
  - Widget: Ticket Generator
  - Check For Understanding

## ➤ Lesson 3: Unreasonable Time

- **DESCRIPTION:** Students investigate two different types of raffles that highlight the way seemingly small problems can quickly grow large. The first raffle asks students to hunt for pairs of tickets that add to a target value. The second raffle asks students to hunt for any group of tickets that adds to a target value. After trying out each raffle live students will try to figure out the patterns for how many total combinations need to be checked in each. At the end they discuss the difference between reasonable and unreasonable algorithms based on their experiences.
  - Widget: Reasonable or Unreasonable?
  - Check For Understanding

## ➤ Lesson 5: Parallel and Distributed Algorithms

- **DESCRIPTION:** In this lesson students explore the benefits and limitations of parallel and distributed computing. First they discuss the way human problem solving changes when additional people lend a hand. Then they run a series of demonstrations that show how simple tasks like sorting cards get faster when more people help, but there is a limitation to the efficiency gains. Later in the lesson students watch a video about distributed computing that highlights the ways distributed computing can help tackle new kinds of problems. To conclude the lesson students record new vocabulary in their journals and discuss any open questions.
  - Check For Understanding
  - End-of-Unit Survey

## ➤ Lesson 4: The Limits of Algorithms

- **DESCRIPTION:** Students explore the limits of what algorithms are able to compute. First they use a widget that exposes students to the Traveling Salesman Problem. After recognizing this problem can only be solved using an unreasonable time algorithm the develop their own good enough solutions that run more efficiently. Later in the lesson students watch a video about undecidable problems for which no algorithm can ever be developed to solve them.
  - Widget: Traveling Salesman
  - Widget: Traveling Salesman - Random Nodes
  - Check For Understanding

## ➤ Lesson 6: Assessment Day

- **DESCRIPTION:** Students complete a multiple choice assessment which covers the unit topics.
  - Unit 6 Exam

- **Lesson 7: CS Principles Post-Course Survey**
  - Post-Course Survey Instructions

## UNIT 7

### PARAMETERS, RETURN, AND LIBRARIES

#### DESCRIPTION

This unit introduces parameters, return, and libraries. Learn how to use these concepts to build new kinds of apps as well as libraries of code that you can share with your classmates. End the unit by designing a library of functions around any topic of your choosing.

#### ➤ Lesson 1: Parameters and Return Explore

- **DESCRIPTION:** Students work with envelopes and paper to model functions with parameters and return values. Students create their own physical function envelope for drawing a house that takes in different parameters, and then build another function to calculate and return the cost of building that house.
  - Check For Understanding

#### ➤ Lesson 2: Parameters and Return Investigate

- **DESCRIPTION:** In this lesson, students work with partners to investigate two different apps that use parameters and return values.
  - App Investigation
  - Check For Understanding

➤ **Lesson 3: Parameters and Return Practice**

- **DESCRIPTION:** Students practice writing programs with parameters and return values by creating and debugging functions that use them.
  - console.log Practice
  - Putting It Together: Console App Practice
  - Putting It Together: Apps
  - Check For Understanding: AP Practice

➤ **Lesson 5: Libraries Explore**

- **DESCRIPTION:** Students learn the basics of libraries while building upon the envelope model of a function with a folder to represent a library.
  - Check For Understanding

➤ **Lesson 4: Parameters and Return Make**

- **DESCRIPTION:** Students use the knowledge and skills they've developed working with parameters and return values to develop a Rock Paper Scissors App. Unlike typical Make projects, students are given a significant portion of the starter code but are given three functions with parameters and return values that they'll need to develop themselves. At the end students submit their apps which can be assessed using a provided rubric.
  - Try the Rock Paper Scissors App
  - Make the Rock Paper Scissors App

➤ **Lesson 6: Assessment Day**

- **DESCRIPTION:** Students complete a multiple choice assessment which covers the unit topics.
  - Unit 6 Exam

## ➤ Lesson 6: Libraries Investigate

- **DESCRIPTION:** In this lesson students work with partners to investigate two apps that use libraries as well as the code used to make a library. Through a series of guided discussions they learn how libraries help programmers simplify and reuse their code.
  - States App
  - Pigify App
  - Check For Understanding

## ➤ Lesson 8: Project Make a Library Part 1

- **DESCRIPTION:** In this lesson students begin a multi-day project designing a library of functions. Students will brainstorm common problems they've encountered while programming this year and begin to design functions that address those common problems.
  - Build Your Library

## ➤ Lesson 7: Libraries Practice

- **DESCRIPTION:** Students practice important skills for working with libraries, including testing and debugging libraries, and using libraries to help develop apps. After a brief introduction to these practices by the teacher, students spend the majority of their time programming in a level progression.
  - Using Libraries
  - Testing Libraries
  - Check For Understanding

## ➤ Lesson 9: Project Make a Library Part 2

- **DESCRIPTION:** Students continue to develop their library of functions. Students are encouraged to begin developing tests for their functions to make sure they return values as expected. Late in the lesson students exchange their library with a classmate for feedback.
  - Build Your Library
  - Test a Classmate's Library

➤ **Lesson 10: Project Make a Library Part 3**

- **DESCRIPTION:** Students complete their library project, finalizing their code and writing written responses explaining the way one of the functions in their library works.
  - Build Your Library
  - End-of-Unit Survey

➤ **Lesson 12: CS Principles Post-Course Survey**

- Post-Course Survey Instructions

➤ **Lesson 11: Assessment Day**

- **DESCRIPTION:** Students complete a multiple choice assessment which covers the unit topics.
  - Unit 7 Exam

## UNIT 8

### CREATE PT PREP

#### DESCRIPTION

In this unit prepare for, and do the AP Create Performance Task. Each lesson contains links to helpful documents and activities to help you understand the task and develop a plan for completing it.

#### ➤ Lesson 1: Create PT Review the Task

- **DESCRIPTION:** This lesson contains a series of activities you can use to help students familiarize themselves with Create Performance Task, how it is scored, and some example tasks created by Code.org.

Students review the Submission Requirements and Scoring Guidelines for the Create PT. Subsequently they review three example scored Create PT submissions with commentary to better understand how the Submission Requirements and Scoring Guidelines are used together. In a wrap-up conversation they identify a piece of advice, a "gotcha", and a remaining question they have about the Create PT.

#### ➤ Lesson 2: Create PT Deep Dive

- **DESCRIPTION:** This lesson is designed to introduce the nuances of the Create PT, and begin to provide some answers to the questions that will inevitably arise. The Create PT is in many ways straightforward: you complete a self-directed programming project and respond to prompts about your program and process. As you dig into the details of the task, however, you quickly come across some of the nuances of individual components of the task and how they're scored.



➤ **Lesson 3: Create PT Make a Plan**

- **DESCRIPTION:** This lesson uses the Create PT Survival Guide to help students narrow down and brainstorm ideas for their actual project. The lesson concludes by providing students with resources to make a plan to complete the task starting in the next lesson.

➤ **Lesson 5: CS Principles Post-Course Survey**

- Post-Course Survey Instructions

➤ **Lesson 4: Create PT - Complete the Task (12 hrs)**

- **DESCRIPTION:** 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 in development of their program - written responses must be done on their own.

The lesson includes reminders about how you can interact with students while they are working on their projects, and suggestions about time line. The Create PT requires a minimum of 12 hours of class time. At the end, students will submit their program code, program video, and written responses through their AP digital portfolio.

- Tech Setup and Tools for Create PT
- Create PT Coding Workspace
- End-of-Unit Survey

## UNIT 9

## DATA

### DESCRIPTION

In this unit learn how data analysis helps turn raw data into useful information about the world. 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, you'll analyze a dataset of your choosing and present your findings.

#### ➤ Lesson 1: Learning from Data

- **DESCRIPTION:** In this lesson students explore the “What’s Going on in this Graph?” site in order to tell a "data story" which explains both what the data shows and why that might be. Following this, students are introduced to the concept of metadata and look for the metadata of datasets on App Lab.
  - Exploring Metadata
  - Check For Understanding

#### ➤ Lesson 2: Exploring One Column

- **DESCRIPTION:** Students will practice making conclusions from charts and learn to use the Data Visualizer in App Lab to make create two different kinds of charts a bar chart, and a histogram. The lesson begins with a quick prompt to review the reasons charts are useful for looking at data. Students then practice reading a bar chart and review the kinds of questions it is and is not useful for answering. Afterwards they build different bar charts in the Data Visualizer and discuss why some are or are not useful. Afterwards they learn how to make histograms for building charts in instances where bar charts may not be useful. Students record their work on an activity guide. The lesson concludes with a brief review of what they learned.
  - Making Bar Charts and Histograms
  - Check For Understanding

## ➤ Lesson 3: Filtering and Cleaning Data

- **DESCRIPTION:** In this lesson, students explore the challenges of working with a messy dataset. First students learn how to identify issues using the Data Visualizer, and then manually clean the data. Following this, students learn about the filtering tools in the Data Visualizer, and use a guided activity to answer data questions that require filtering a dataset.
  - Cleaning Data
  - Filtering Data
  - Check For Understanding

## ➤ Lesson 5: Big, Open, and Crowdsourced Data

- **DESCRIPTION:** Students will complete a jigsaw of three different topics at the intersection of data, computing, and global impacts. These are topics, big data, crowdsourcing, and open data. Students will watch videos or listen to audio recordings about the different topics. Groups will each complete an activity guide about their topic before having individuals from each group share out their findings. The lesson concludes with a review of key points.
  - Check For Understanding

## ➤ Lesson 4: Exploring Two Columns

- **DESCRIPTION:** Students will practice making conclusions from charts and learn to use the Data Visualizer in App Lab to make create two different kinds of charts, a cross tab, and a scatterplot. Students will practice reading each type of chart before learning to make them in the Data Visualizer. Students will track their work using a provided activity guide. The lesson concludes with a review of key takeaways.
  - Crosstab and Scatter Charts
  - Which Type of Chart?
  - Check For Understanding

## ➤ Lesson 6: Machine Learning

- **DESCRIPTION:** In this lesson, students are introduced to the concepts of Artificial Intelligence and Machine Learning using the AI for Oceans widget. First students classify objects as either "fish" or "not fish" to attempt to remove trash from the ocean. Then, students will need to expand their training data set to include other sea creatures that belong in the water. In the second part of the activity, students will choose their own labels to apply to images of randomly generated fish. This training data is used for a machine learning model that should then be able to label new images on its own.
  - AI for Oceans - Machine Learning
  - Check For Understanding

➤ **Lesson 7: Algorithmic Bias**

- **DESCRIPTION:** In this lesson, students will practice cropping images to uncover the bias underlying the Twitter cropping algorithm. Then, students will read and watch a video about the discovery of this biased algorithm. Finally, students will discuss ways to recognize and reduce bias along with analyzing Twitter's response to the allegations of bias in their cropping algorithm.
  - Cropping Widget
  - Check For Understanding

➤ **Lesson 9: Project Tell a Data Story Part 2**

- **DESCRIPTION:** This is the second day of a project where students use the Data Analysis Process to tell a data story. Students complete the second page of the Activity Guide for this project during this lesson.
  - Data Story Workspace
  - End-of-Unit Survey

➤ **Lesson 8: Project Tell a Data Story Part 1**

- **DESCRIPTION:** This is the first day of a project where students use the Data Analysis Process to tell a data story. Students complete the first page of the Activity Guide for this project during this lesson.
  - Data Story Workspace

➤ **Lesson 10: Assessment Day**

- **DESCRIPTION:** Students complete a multiple choice assessment which covers the unit topics.

- **Lesson 11: CS Principles Post-Course Survey**
  - Post-Course Survey Instructions

## UNIT 10

### CYBERSECURITY AND GLOBAL IMPACTS

#### DESCRIPTION

In this unit learn how computing innovations have impacted our world in beneficial and harmful ways. Learn how data can pose a threat to our privacy and security and the ways that encryption and other techniques are used to protect it. Throughout the unit participate in a "school of the future" conference in which you and a team make a proposal for how best to improve school life with computing innovations.

#### ➤ Lesson 1: Project Innovation Simulation Part 1

- **DESCRIPTION:** The class begins a simulation which will continue on at different points throughout the unit. In this simulation, students take on the roles of different stakeholders in school communities converging at a convention where they eventually will deliver a proposal on the best computing innovation for the Future School. In this lesson, students explore what a computing innovation is, do a brainstorm activity, reflect on their character role, and finally learn how to research an innovation.
  - Check For Understanding

#### ➤ Lesson 2: Project Innovation Simulation Part 2

- **DESCRIPTION:** Today is focused on researching three different computing innovations and discussing these innovations with team members.
  - Check For Understanding

## ➤ Lesson 3: Data Policies and Privacy

- **DESCRIPTION:** Students learn that the apps, websites, and other computing innovations they use every day require a lot of data to run, much of which they might consider to be private or personal. In the warm up students discuss which of a list of possible information types they consider private. Then students read the data policies from a website or service they use or know about. This investigation focuses on the kinds of data that are being collected, the way it's being used, and any potential privacy concerns that arise. A brief second activity reveals that even data that may not seem private, like a birthdate or zipcode, can be combined to uniquely identify them. To conclude the lesson students prepare for a discussion in the following class about the pros and cons of sharing all this data by journaling about their current thoughts on whether the harms of giving up this privacy are outweighed by the benefits of the technology they power.
  - Check For Understanding

## ➤ Lesson 4: The Value of Privacy

- **DESCRIPTION:** Students develop their own opinions on the privacy tradeoffs inherent in many modern computing innovations. At the beginning of the lesson students watch a video on facial recognition technology that presents the tradeoffs between convenience and privacy and asks them to determine whether they think the tradeoff is worth it. Students respond to two videos that look at different tradeoffs between privacy, security, and convenience. Students then evaluate the website or app they investigated in the previous lesson to determine if they think the benefits of the service outweigh the privacy risks. At the end of the class students discuss whether they generally think convenience outweighs privacy concerns.

## ➤ Lesson 5: Project Innovation Simulation Part 3

- **DESCRIPTION:** Students make further projects on their projects while also considering the unintended consequences their proposed innovations may have. First students watch a short video about the ways technology may have unintended consequences. Students then meet with their teams to review the different proposals for computing innovations that each team member is considering. Teams review the different ideas in character and help one another consider potential benefits and harms of each plan. Collectively they narrow down their proposals to a set that seem collectively most beneficial and present a coherent vision for the Future School. With whatever time is remaining students are able to work on one-pagers for the one innovation they chose.

## ➤ Lesson 6: Security Risks Part 1

- **DESCRIPTION:** Students investigate three different common security risks (phishing, keylogging, malware) in a jigsaw activity. In groups, students create Public Service Announcement slides warning of the dangers of their assigned security risk. Then students are grouped with students who investigated other security risks and are instructed to share their slide and give a voice over. The activity ends with the class coming together to discuss the security risks as a whole.
  - Keylogging
  - Phishing
  - Malware
  - Check For Understanding

➤ **Lesson 7: Security Risks Part 2**

- **DESCRIPTION:** The lesson begins with a review of security risks by watching a video on Cybersecurity & Crime. Following this, the class does an investigation into the Equifax breach, and what went wrong. The class ends with a Kahoot quiz to review security risks.
  - Check For Understanding

➤ **Lesson 9: Protecting Data Part 1**

- **DESCRIPTION:** In this lesson students explore two different encryption widgets: The Caesar Cipher Widget and the Random Substitution Cipher. Afterwards, students watch a video that reviews these types of encryption and introduces a new concept: public key encryption.
  - Encryption Widgets
  - Check For Understanding

➤ **Lesson 8: Project Innovation Simulation Part 4**

- **DESCRIPTION:** This lesson is primarily a work day for students to complete their innovation 1-pagers. Students should work close to their teammates in case they want to discuss ways to make their proposals more aligned around a cohesive vision for the Future School. Otherwise students should have the entire class period to work independently.

➤ **Lesson 10: Protecting Data Part 2**

- **DESCRIPTION:** This lesson is a guided tour of multifactor authentication and software updates that students can use to protect their data. Following these discussions, students are introduced to a stimulus question where they will apply their knowledge gained throughout the unit to answer questions about an innovations data, benefits and harms, effects, and security or privacy concerns.
  - Check For Understanding



➤ **Lesson 11: Project Innovation Simulation Part 5**

- **DESCRIPTION:** Students meet with their groups to develop a shared artifact or presentation that presents their collective vision for the Future School.

➤ **Lesson 13: Project Innovation Simulation Part 7**

- **DESCRIPTION:** Students present the group Innovation Proposal they have been working on throughout the units. After each group does a brief presentation students do a gallery walk of their classmates' projects, asking questions and reviewing any materials. Students then vote for the unified project and overall innovation they found most compelling. At the end of the lesson students will submit their projects for grading.
  - End-of-Unit Survey

➤ **Lesson 12: Project Innovation Simulation Part 6**

- **DESCRIPTION:** Students will get feedback on their group innovation proposal from one other group. They will then have the remainder of the class to finalize their group presentation and individual proposals which will be presented and submitted in the following class

➤ **Lesson 14: Assessment Day**

- **DESCRIPTION:** Students complete a multiple choice assessment which covers the unit topics.
  - Unit 10 Exam

- **Lesson 15: CS Principles Post-Course Survey**
  - Post-Course Survey Instructions

## UNIT 11

## CS PRINCIPLES POST-COURSE SURVEY

- Survey