Unit 5 - Data and Society

The Data and Society unit is about the importance of data in solving problems and highlights how computers can help in this process. The first chapter explores different systems used to represent information in a computer and the challenges and tradeoffs posed by using them. In the second chapter students learn how collections of data are used to solve problems, and how computers help to automate the steps of this process. In the final project, students gather their own data and use it to develop an automated solution to a problem.

Chapter 1: Representing Information

Big Questions

- Why is representation important in problem solving?
- What features does a representation system need to be useful?
- What is necessary to create usable binary representation systems?
- How can we combine systems together to get more complex information?

Week 1

Lesson 1: Representation Matters

Unplugged

This first lesson provides an overview of what data is and how it is used to solve problems. Groups use a data set to make a series of meal recommendations for people with various criteria. Afterwards, groups compare their responses and discuss how the different representations of the meal data affected how the students were able to solve the different problems.

Lesson 2: Patterns and Representation

Unplugged

This lesson looks closer at what is needed to create a system of representation. Groups create systems that can represent any letter in the alphabet using only a single stack of cards, then create messages with their systems and exchange with other groups to ensure the system worked as intended. The class discusses commonalities between working systems while recognizing that there are many possible working solutions.

Lesson 3: ASCII and Binary Representation

Unplugged

This lesson introduces a formal binary system for encoding information, the ASCII system for representing letters and other characters. At the beginning of the lesson the teacher introduces the fact that computers must represent information using either "on" or "off". The class is then introduced to the ASCII system for representing text using binary symbols and practices using this system before encoding their own messages using ASCII.

Lesson 4: Representing Images

Widget

This lesson continues the study of binary representation systems, this time with images. The class is introduced to the concept of splitting images into squares or "pixels" which can then be turned on or off individually to make the entire image. After doing a short set of challenges using the Pixelation Widget, the class makes connections between the system for representing images and the system for representing text they learned in the previous lesson.

Week 2

Lesson 5: Representing Numbers

Widget

This lesson introduces the binary number system. With a set of cards that represent the place values in a binary (base-2) number system, the class turns bits "on" or "off" by turning cards face up and face down, then observes the numbers that result from these different patterns. Eventually, the pattern is extended to a generic 4-bit system.

Lesson 6: Keeping Data Secret

Students have a discussion on the different levels of security they would like for personal data. Once the class has developed an understanding of the importance of privacy, they learn about the process of encrypting information by enciphering a note for a partner and deciphering the partner's note. The class concludes with a discussion about the importance of both physical and digital security.

Lesson 7: Combining Representations

Unplugged

This lesson combines all three types of binary representation systems (ASCII characters, binary number, and images) to allow for the encode of more complex types information in a record. After seeing a series of bits and being asked to decode them, the class is introduced to the idea that understanding binary information requires understanding both the system that is being used and the meaning of the information encoded.

Lesson 8: Create a Representation

Unplugged | Project

The class designs structure to represent their perfect day using the binary representation systems they've learned in this chapter. After deciding which pieces of information the record should capture, the class will decide how a punch card of bytes of information will be interpreted to represent those pieces of information. Afterwards, everyone will use the ASCII, binary number, and image formats they have learned to represent their perfect days try to decipher what a partner's perfect day is like.

Chapter Commentary

This chapter focuses on data representation and its role in solving information problems. Students learn what a representation system needs to be useful, and how computers are able to represent different types of information using binary systems. For the chapter project, students represent their perfect day in a binary punch card and trade with classmates to decipher.

Chapter 2: Solving Data Problems

Big Questions

- How does data help us to solve problems?
- How do computers and humans use data differently?
- What parts of the data problem solving process can be automated?
- What kinds of problems do computers use data to solve in the real world?

Week 3

Lesson 9: Problem Solving and Data

Unplugged

This lesson covers how the problem solving process can be tailored to deal with data problems, in particular. The class is tasked with deciding what a city most needs to spend resources on. They must find and use data from the Internet to support their decision.

Lesson 10: Problem Solving with Big Data

This lesson covers how data is collected and used by a organizations to solve problems in the real world. The class looks at three scenarios that could be solved using data and brainstorms the types of data they would want to solve them and how they could collect the data. Each scenario also includes a video about a real-world service that has solved a similar problem with data.

Lesson 11: Structuring Data

Widget

This lesson goes further into the interpretation of data, including cleaning and visualizing raw data sets. The class first looks at the how presenting data in different ways can help people to understand it better. After seeing how cleaning and visualization can help people make better decisions, the class looks at what parts of this process can be automated, and what need a human.

Week 4

Lesson 12: Making Decisions with Data

Unplugged

This lesson gives the class a chance to practice the data problem solving process introduced in the last lesson. Not all questions have right answers and in some cases the class can and should decide that they should collect more data. The lesson concludes with a discussion of how different people could draw different conclusions from the same data, or how collecting different data might have affected the decisions they made.

Lesson 13: Interpreting Data

Students begin the lesson by looking at a cake preference survey that allows respondents to specify both a cake and an icing flavor. They discuss how knowing the relationship between cake and icing preference helps them better decide which combination to recommend. They are then introduced to cross tabulation, which allows them to graph relationships to different preferences. They use this technique to find relationships in a preference survey, then brainstorm the different types of problems that this process could help solve.

Lesson 14: Automating Data Decisions

In this lesson students look at a simple example of how a computer could be used to complete the decision making step of the data problem solving process. Students are given the task of creating an algorithm that could suggest a vacation spot. Students then create rules, or an algorithm, that a computer could use to make this decision automatically. Students share their rules and what choices their rules would make with the class data. They then use their rules on data from their classmates to test whether their rules would make the same decision that a person would. The lesson concludes with a discussion about the benefits and drawbacks of using computers to automate the data problem solving process.

Week 5

Lesson 15: Project - Make a Recommendation

Project

To conclude this unit the class designs ways to use data to make a recommendations or predictions to help solve a problem. In the first several steps the class brainstorms problems, performs simple research, and defines a problem of their choosing. They then decide what kind of data they want to collect, how it could be collected, and how it could be used, before exchanging feedback and giving a final presentation.

Chapter Commentary

Students explore how data can be used to answer interesting questions and solve problems. Using a modified version of the general Problem Solving Process, students look at how computers and humans use data differently and the pros and cons of automating problem solving. After learning ways that computers use data in the real world, students choose their own problem and use data to address it.

Lesson 1: Representation Matters

Unplugged

Overview

In the first lesson of the data unit, students get an overview of what data is and how it is used to solve problems. Students start off with a brief discussion to come to a common understanding of data. They then split into groups and use a data set to make a series of meal recommendations for people with various criteria. Each group has the choices of meal represented in a different way (pictures, recipes, menu, nutrition) that gives an advantage for one of the recommendations. Afterwards, groups compare their responses and discuss how the different representations of the meal data affected how the students were able to solve the different problems.

Purpose

This lesson introduces a number of important ideas that students will explore in this chapter. They'll see that the same objects can be represented in a number of different ways. In Chapter 1 they'll learn the different representation systems that computers use to represent information. They'll also see in this lesson that representation matters when we use data to make decisions. In Chapter 2 of this unit students will explore more deeply how data can be used by humans and computers to make decisions.

Agenda

Warm Up (10 mins)

Activity (40 mins)

- **Person 1**
- **Person 2**
- **Person 3**
- **Person 4**

Wrap Up (5 mins)

Objectives

Students will be able to:

- Define data as information collected from the world to help make a recommendation or solve a problem.
- Provide examples of how representing data in different ways can affect its ability to solve different problems.
- Choose the best way to represent some information based on how it will be used.

Preparation

- [ ] Print copies of **Meals Data - Resource** so that each group can get one of the four pages
- [ ] Print one copy of **Representation Matters - Activity Guide** for each group

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teacher

- **Meals Data** - Resource
- **Representation Matters** - Exemplar

For the Students

- **Representation Matters** - Activity Guide

Make a Copy

Teaching Guide

Warm Up (10 mins)

Prompt: Today we're going to start talking about data and how it's used in computer science. Before we start, we're take a few minutes to think about what data is.

Display: Show the following questions and prompt students to jot down their answers silently.

- What is data?
- How do you use data in your life?
- How can data help you solve problems?

Give students a few minutes to think on their own about what data is, and then allow them to share quietly with a partner. After all students have had a chance to speak to each other, share as a whole class, writing the ideas onto the board.

Teaching Tip

Offer Encouragement: If students have a hard time getting started, remind them that this is really just a brainstorm, and they will be working on answering these questions for the entire unit. Data may have different definitions depending on context (mobile phone plan, math class, etc.). Encourage the students to think of different situations in which they have used data, and remind them that there is no one "right" answer.

Remarks

> These are all great ideas. We're going to spend the rest of the unit looking more closely at what data is, where it comes from, and how it can help us in computer science. For now, we're going to define data as "Information that's been collected to help us to answer a question or solve a problem."

Discussion

Goal: Students should understand that data is information that has been collected about the world. They should see that data could be any type of information, not just numbers.

Activity (40 mins)

Group: Put students into groups of 3-5.

Distribute: Give each group a copy of the **Representation Matters - Activity Guide** and one of the four versions of the **Meals Data - Resource**. Make sure at least one group has a picture resource, one the menu resource, one group the nutrition resource, and one group the recipe resource.

Using Data

Each group of students will make a meal recommendation to four different people, and they must justify their recommendation with their data. Because different groups have different data sets, the difficulty of the recommendations will vary from group to group.

After making the recommendations, groups should choose the recommendation that they thought was the easiest to make, and explain their reasoning.

When all groups have completed the worksheet, come back together as a class and share the answers and reasoning for each recommendation. As the groups share answers and reasoning, allow them to see each other's data sets.

Teaching Tip

Dealing with Frustration: Because each group will only have adequate information for one of the four recommendations, students may become frustrated that they cannot find the "right" answer. Reassure them that there's not always a "right" recommendation, and that the most important part of the exercise is for them to explain why they made their choice.

Person 1

“I am allergic to eggs.”

Although the menu and pictures may help somewhat, the recipe data set is the only one that tells the students the ingredients in each meal.

Person 2

"My doctor said to eat less sodium."

Those with the nutrition data should see which meal has the lowest sodium content.

Person 3

"I'm trying to save money."

Those with the menu data set should see prices for each meal.

Person 4

"I want to post a nice picture of it online."

While the recommendation for this one is more subjective, the group with the picture data set is in the best position to make an informed recommendation.

Teaching Tip

Questions and Assumptions about the Given Data: During the discussion, some students may note that chilaquiles often have eggs. This is a good chance to point out that if the data about the meal was collected in a way that didn't include information about the ingredients, then they didn't have enough information and made the best decision based on the data that they had. Remind students that although it's reasonable to make certain assumptions, that only with the relevant data can they be confident in their decisions.

Teaching Tip

Using the Data You Have: For any of these questions, students may have reasons to choose a different answer, or complain that it's not fair that they did not have all the information that they needed. Remind them that the activity is about using the data they have in a reasonable way, not necessarily getting a particular answer.

Prompt: Now that you've seen all of the different ways we represented the four meals, think about what makes a way of representing something good or bad. Do you think any of the representations were better or worse than others? What made them better or worse?

Remarks

When we collect information about the world, we have to make choices about what is important for us to include in our representations. The choices that we make affect what kinds of problems we can solve with our data. In the next few lessons, we'll talk about how computers represent data and how we use that data to solve problems.

Discussion

Goal: Students should understand that different representations are good for solving different problems.

Wrap Up (5 mins)

Prompt Ask students to reflect on the following questions in their journals.

Today, you saw four different ways of representing a meal, and how those different representations were useful for solving different problems.

- Why were some representations more useful than others?
- If you were to create a way of representing a meal, what would be the most important things for you to think about?

Standards Alignment

CSTA K-12 Computer Science Standards

- **DA** - Data & Analysis

Lesson 2: Patterns and Representation

Unplugged

Overview

In this lesson students create their own system for representing information. They begin by brainstorming all the different systems they already use to represent yes-no responses. They then work in small groups to create a system that can represent any letter in the alphabet using only a single stack of cards. The cards used have one of 6 different possible drawings (6 animals, 6 colors, etc.) and so to represent the entire alphabet students will need to use patterns of multiple cards to represent each letter. Students create messages with their systems and exchange with other groups to ensure the system worked as intended. In the wrap-up discussion the class reviews any pros and cons of the different systems. They discuss commonalities between working systems and recognize that there are many possible solutions to this problem and what's important is that everyone use the same arbitrary system to communicate.

Purpose

In this lesson students get to explore for themselves the qualities of a good system for representing information. They should find through creating and testing their systems that

1. there are typically many possible systems for representing information
2. people must agree on a common set of rules for a system to work

The features of the systems students create in this lesson serve as a reference point in coming lessons when students explore the representation systems actually used in computers.

In the next lesson students will be introduced to the concept of binary and how computers use on-off signals or "0's and 1's" to represent information. Even though this concept is hinted at in the introductory yes-no activity, it shouldn't be introduced until the next lesson.

Agenda

Warm Up (10 mins)

Systems to Answer Yes-No Questions

Activity (40 mins)

Representing the Alphabet

Wrap Up (10 mins)

Group Discussion

Objectives

Students will be able to:

- Describe the necessary features of a system for representing information
- Create, use, and provide feedback on a system for representing information
- Iteratively improve upon a system for representing information by testing and responding to feedback

Preparation

- [ ] Print one copy of the **Representing Information - Activity Guide** for each group of 2-3
- [ ] Print and cut up one copy of **Animal Shapes - Manipulative** for each group of 2-3

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teacher

- **Representing Information** - Exemplar
- **Animal Shapes** - Manipulative

Make a Copy

For the Students

- **Representing Information** - Activity Guide

Make a Copy

Vocabulary

- **Decode** - to change how information is represented so that it can be read by a person
- **Encode** - to change how information is represented so that it can be read by a computer

Teaching Guide

Warm Up (10 mins)

Systems to Answer Yes-No Questions

Prompt: Imagine your friend asked if you could hang out later. This is a yes-no question and so one way you could respond is by saying "Yes" or "No". This is a pair of responses your friend could understand, but there's a lot more possible pairs.

How many different ways do you know that you could write, say, or represent the answer to a "Yes-No" question. Write down as many ideas as you can.

Discuss: Students should brainstorm silently, then share with their tables, then finally share as a class. Write down ideas at the front of the room as ideas are shared.

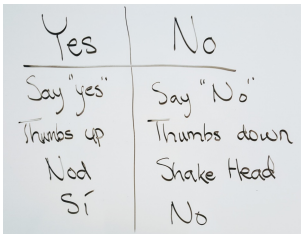
Prompt: Each row in our table is a different "system" but they all represent the same information. Why do we have so many different systems to represent the same information?

Remarks

> What we're seeing here is that there are many "systems" that we could choose to use to represent the same information. The information of a "Yes" could be a head nod or a thumbs up, and a "No" might be a minus sign or a down arrow. As humans we've created lots of systems because they are better or worse depending on the situation. In a loud room a thumbs up works better than shouting. People speak many different languages. We've made lots of systems because we want to communicate information in lots of different situations.
>
> Computers need systems to represent information too, and today we're going to start exploring what kinds of systems a computer would need to represent information. Today we're going to focus more on what makes good systems, and tomorrow we'll start zooming in on the specific systems computers use.

Discussion

Goal: Students should see that the same information can be represented in lots of different ways. They might come up with saying "Yes" or "No" in many different languages, thumbs up vs. thumbs down, plus or minus, up arrow vs. down arrow, shaking head up and down vs side to side etc. Prompt students with examples if they don't understand that they need pairs of responses.



Your board might look like this after writing responses.

Discussion

Goal: This conversation sets you up to make another important point, that different systems are created for different contexts. Today you're going to ask students to make a system for what will seem like a very arbitrary context, a deck of animal cards. Lean on the fact that they'll have brainstormed lots of "weird arbitrary systems" in this warm-up. That's because there's different contexts in which they're used. In the subsequent lesson you can call out how designing systems for wires with electricity in them is just as weird and arbitrary.

Activity (40 mins)

Representing the Alphabet

Group: Place students in groups of 2 or 3

Distribute: Give each group a copy of **Representing Information - Activity Guide** and a set of **Animal Shapes - Manipulative**. You can cut them beforehand or have the group cut their own set.

Activity Guide - Representing Information

> **Review Activity:** Review the rules of the activity with the class.
>
> **Develop Rules**: Give students a few minutes to brainstorm their rules. Encourage them to test their ideas with their group members since they know exactly how the test will run. Ask them to choose a couple short words and test them with their group members before sharing with another group.

Test Rules: Once students have finished developing their rules have them pick a new short word to represent. They should carefully make a single stack of cards to represent their word, leave the cards on the table and then either pass their rules and stack of cards or rotate around the room. Groups should then flip the stack of cards at their tables back over and carefully decode the word.

Groups should check with the original rule creators to see if they successfully decoded the word.

Review and Revise Rules: Based on the test, have groups decide if the rules make sense or if they need to be improved in some way. Ask groups to provide constructive feedback and provide some time to revise the rules.

Test Rules Again: Have groups prepare a stack of cards to represent a new word before repeating the test. They should switch rules with a different group this time.

Review and Revise Rules: Give students one more opportunity to provide feedback and make final edits to their rules.

Teaching Tip

Encourage Students to Problem Solve: There are many possible solutions to this activity and it is intentionally very open-ended. Remind students that problem solving doesn't always mean getting something to work the first time, and that they'll need to iteratively test their solutions before being sure they're correct.

Common Misconception: Students may come up with patterns of different lengths. For example "A = 1 Elephant, B = 2 Elephants, C = 3 Elephants ...". They'll find that then they won't know if a word has 2 A's in a row or a single B. Let students find this for themselves by testing their system (an important part of the problem solving process).

Teaching Tip

How Many Tests: This activity gives students a chance to experience for themselves the challenges of creating a system to represent information. After two tests students should have enough experience to participate in the wrap-up discussions and see the important points of the activity, even if they had some issues with their own systems.

Wrap Up (10 mins)

Group Discussion

Prompt: Take a minute at your tables and talk about the following prompts. Be ready to share your thoughts.

- What was the same and what was different about the different sets of rules you saw?
- Are there some things that every group needed to account for to complete the challenge?

Remarks

Today you created your own systems to represent information. We saw that there are many different systems we could use to represent the same information. What's important is that there are clear rules for how to use the systems, and that everyone knows the rules.

Computer scientists care about systems for representing information because a computer doesn't magically "understand" the world. It needs to be given information using a system that takes into account the fact that it's just a box of wires.

When we change the way that we represent information so that it's easier for a computer to use, we encode that information. When we change it back so that it's easier for a human to understand, we decode that information.

Content Corner

Understanding the Activity: The fact that there are only 6 types of cards means students will need to make patterns of multiple cards to represent each letter. The fact that the cards are all placed in a neat stack means each pattern will need to be the same length. Otherwise it will be difficult to know when one pattern ends and another begins. Computer scientists run up against these same challenges when desiging their own representation systems.

The simplest solutions to the activity will be to assign each letter a unique pattern of two shapes (e.g. A = "Pig Pig", B = "Pig Elephant" and so on). Nevertheless there are still an enormous number of systems possible systems with these qualities and likely no two systems in your class will be the same. None is "better" than the other and so what matters is just that we all arbitrarily decide to use the same one. Again this is true of representation systems students will see in coming lessons.

Vocabulary: Introduce the following terms

- **Encode:** to change how information is represented so that it can be read by a computer
- **Decode:** to change how information is represented so that it can be read by a person

Remarks

> In the rest of this chapter, we're going to look at ways that we can encode information so that it can be used by a computer.

Discussion

Goal: This discussion is aimed to highlight the fact that there were many possible solutions to this problem. It may be the case that some groups found problems with their rules as a result of testing them. Point out, however, that even very different sets of systems for representing this information could work.

In wrapping up the second prompt try to call out similarities across rules e.g.

- Each letter needs a separate pattern
- Each letter should use the same number of cards (likely two) or else you can start to run into issues of not knowing where one letter ends and the next begins

Standards Alignment

CSTA K-12 Computer Science Standards

▸ **DA** - Data & Analysis

Lesson 3: ASCII and Binary Representation

Unplugged

Overview

In this lesson students learn to use their first binary system for encoding information, the ASCII system for representing letters and other characters. At the beginning of the lesson the teacher introduces the fact that computers must represent information using either "on" or "off". Then students are introduced to the ASCII system for representing text using binary symbols. Students practice using this system before encoding their own message using ASCII. At the end of the lesson a debrief conversation helps synthesize the key learning objectives of the activity.

Purpose

This lesson is an opportunity to make some real world connections from the previous lesson and review some of the concepts students saw in that activity. Students are formally introduced to the concept of binary, learn what a bit of information is, and get practice using a binary system. Students review the fact that patterns of bits can be used to represent information and consider why having patterns that are all the same length (in this case 7 bits) makes it easier to use a system.

Agenda

Warm Up (5 mins)

- **Review Binary Cards Activity**

Activity (40 mins)

- **Using ASCII**

Wrap Up (10 mins)

Objectives

Students will be able to:

- Define a binary system as one that uses just two possible states to represent information
- Define a bit as a single piece of binary information
- Use the ASCII system to encode and decode text information in binary

Preparation

- [ ] Print copies of **ASCII - Activity Guide**

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teacher

- **ASCII** - Exemplar

For the Students

- **ASCII** - Activity Guide **Make a Copy**

Vocabulary

- **ASCII** - American Standard Code for Information Interchange; the universally recognized raw text format that any computer can understand
- **Binary** - A way of representing information using only two options.
- **Bit** - A contraction of "Binary Digit"; the single unit of information in a computer, typically represented as a 0 or 1

Teaching Guide

Warm Up (5 mins)

Review Binary Cards Activity

Remarks

> Modern computers are electronic devices filled with lots of tiny wires. These wires carry electricity, and at any moment a wire can be on (high voltage), or off (low voltage). In fact all the information you've ever used on a computer like documents, videos, and pictures, eventually need to be translated down into these "on" and "off" signals. This is a really big challenge and it's one we're going to explore for the next few lessons.

Teaching Tip

Jump to the Activity: This introductory comment is important to justify the patterns students will see on the activity guide. Otherwise, however, most of the discussion in this lesson can happen after the activity.

Activity (40 mins)

Using ASCII

Group: Place students in pairs

Distribute: ASCII - Activity Guide to each pair of students

ASCII Text Activity Guide

> **Why Binary?:** As a class read this section
>
> **Vocabulary:** Review the definition of the terms.
>
> - **Binary:** a way of representing information using only two options
> - **ASCII:** a popular system for representing text in binary
>
> **ASCII:** Review the ASCII table. Inform students that ASCII is the system that likely every computer they've ever used uses to represent letters. Today they're going to get some practice using this system.
>
> **Challenges:** Have students decode the three messages.
>
> **Make Your Own:** Have students design their own simple binary system by designing what the "On" symbol and the "Off" symbol will be. Then have them write their messages using ASCII, trade with a partner, and decode. If there's time have students exchange with multiple groups.

Content Corner

Why Not Split the Symbols: When sending information down a wire with electricity, there's no way to put a "space" between signals. At any moment you're either sending electricity or you're not. This is the primary reason why characters are an agreed-upon length, in this case 7 bits long.

Wrap Up (10 mins)

Share: What symbols did you use for your binary system? Have the class share their ideas.

Prompt: Why do you think that we sometimes hear people say computer science is "0's and 1's"? Does it need to be 0's and 1's?

Discuss: Have students individually develop responses, then share in small groups, then with the whole group.

Vocabulary: Introduce the vocabulary of

Discussion

Goal: 0 and 1 is just another binary pair that can be used to mean on-off. Students have seen many binary pairs in this lesson that can be used for the ASCII encoding system. Going forward, however they'll use 1 and 0. Since all information in a computer must become on-off signals in a wire, we say all information is 0s and 1s.

- **Bit:** a single piece of binary information

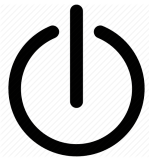
Remarks

> We saw bits of information represented in many ways today like dogs/cats or apples/bananas. These are all equally valid ways of representing Ons and Offs. Going forward we'll use 1's and 0's, but this just means On and Off.

Content Corner

Ignore Numbers for Now: The ASCII system as presented here is just **a system for representing characters with patterns of bits**. In reality there is an intermediate step in which the binary number system is used to represent each letter. If this comes up acknowledge there's lots of extra information to know about that system but stick to that definition.

On-Off Symbol: Students may have seen this on-off icon before. It's just a 0 and a 1 combined!



Research: If you have more time head online, e.g. to the Wikipedia page for ASCII and have students examine what other symbols are included in the ASCII system. Are they surprised by anything they see there? Are there symbols they hadn't thought they'd need to represent?

Standards Alignment

CSTA K-12 Computer Science Standards

- **DA** - Data & Analysis

Lesson 4: Representing Images

Widget

Overview

In this lesson students learn how computers represent images. To begin the lesson they consider the challenge of turning all the complexity of vision into a binary pattern. Through a series of images showing how this transformation is made students are introduced to the concept of splitting images into squares or "pixels" which can then be turned on or off individually to make the entire image. Students then do a short set of challenges using the Pixelation Widget in order to draw black and white images. Puzzles are designed to call out some of the challenges of representing images in this way. In the wrap up students make connections between the system for representing images and the system for representing text they learned in the previous lesson.

Purpose

This lesson introduces another commonly used system of representing information in binary. The most obvious takeaways from the Pixelation Widget will obviously be that a 1 means an "On" and a 0 means an "Off". What might be less obvious, however, is that the width and height of the image need to be agreed upon in order to interpret the binary image information as well. Finally this is an opportunity to explore how systems for representing information are created. A "raw" image is really hard to represent. The idea to turn an image into a grid of black and white squares significantly simplifies this challenge and makes it into the kind of problem that computer scientists knew how to solve. While the activity in this lesson may feel like just typing 0s and 1s, it actually reveals a lot about how people think about representing information in binary, and what challenges and tradeoffs are created as a result.

Agenda

Warm Up (5 mins)
Activity (40 mins)
Wrap Up (10 mins)

Objectives

Students will be able to:

- Create and manipulate binary patterns to represent black and white images
- Describe common features of systems used to represent information in binary

Preparation

- [ ] Practice using the Pixelation Widget for ~10 mins to prepare to respond to questions

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teacher

- **Images Examples** - Slides

Vocabulary

- **Pixel** - short for "picture element", the fundamental unit of a digital image, typically a tiny square or dot that contains a single point of color of a larger image.

Teaching Guide

Warm Up (5 mins)

Display: Show the images of the bicycle and tree to students from the first slide of**Images Examples - Slides**

Prompt: Look at these two pictures. What would be challenging about representing them to a computer? Do you think it's easier or harder than representing letters?

Discuss: Have students brainstorm silently, then share with a partner, then discuss as a whole class.

Display: Show the second slide showing different versions of the same image in more pixelated forms.

Prompt: Do you think it's now easier. What's the "big idea" here that might help us represent images.

Discuss: You may choose to run this as a second silent brainstorm or else just immediately discuss as a whole class.

Discussion

Goal: The aim is to point out how daunting representing this complex piece of information might be. Be prepared as you're presenting students this challenge to normalize the fact that it is really hard but still give them a chance.

Discussion

Goal: These images are intended to visually demonstrate the idea of breaking images up into smaller pieces. Students should hopefully recognize that what they are looking at is a binary system (black and white) and so with the right system they should be able to represent the last images. You should be prepared to acknowledge that while the last image is lower quality, the same ideas could probably be used to make the original. It is on their screen after all!

Remarks

> Solving a big problem usually means breaking it into smaller ones. A big picture might be hard to represent, but if we break it into smaller pieces it's suddenly less intimidating. Today we're going to look more closely at how this system works.

Activity (40 mins)

Demonstrate: It can be hard to see pixels in modern screens since they're so small. Sometimes projector screens work well, using a magnifying glass, or even just putting a drop of water or a computer screen to create a lens effect. Whatever you choose, find some way to show students that all the images on their computers are actually just being broken down into tiny squares. Then introduce the vocabulary below which is the name of these squares.

Vocabulary: Briefly introduce the following vocabulary

- **Pixel:** a tiny square or dot which contains a single point of color of a larger image.

Teaching Tip

You Can't Break It: Widgets are designed to enforce rules so that students can freely explore concepts. Encourage students to experiment and not to worry about breaking it.

Giving Students Space to Problem Solve: As a teacher you also will likely find that students learn more by playing with the tool themselves than having it explained. Try setting a timer for 5-10 minutes after which computers are put down to discuss what they're seeing. A little struggle at first should be expected but generally leads to the payoff of students solving problems on their own.

Code Studio levels

- Levels
- **2**
- **3**
- **4**
- **5**

Student Instructions

View on Code Studio

Do This

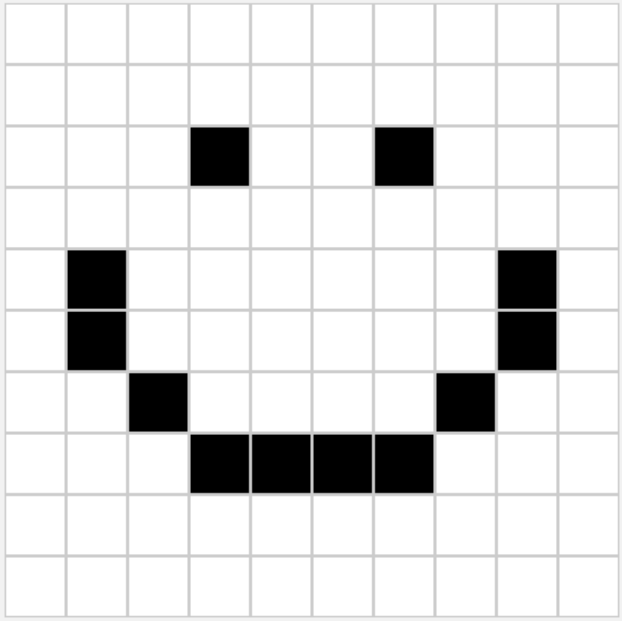
Complete the "X" shape by typing 0s and 1s. You can always click "Readable Format" if you want to clean up your work.

Student Instructions

View on Code Studio

Do This

Use the pixelation widget to draw a smiley face

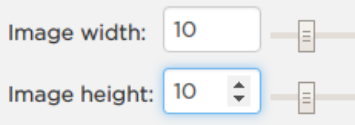


Student Instructions

View on Code Studio

Do This

The width and height sliders are set incorrectly for this image so it doesn't look like anything. Change them until you find the image.

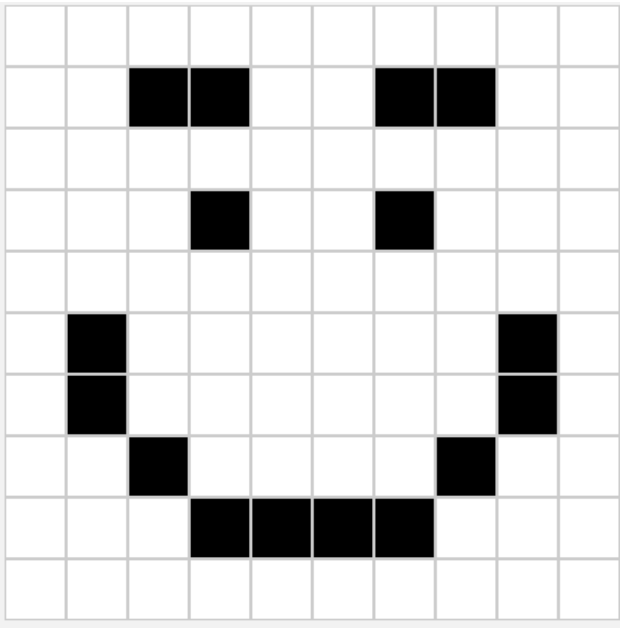


Student Instructions

View on Code Studio

Do This

Add eyebrows to this smiley face. Remember to use the "Readable Format" if you get stuck.



Pixelation Widget

Puzzle 2: Students learn to type 0s and 1s to turn on the pixels of a 10 by 10 X-pattern

Puzzle 3: Students make an 10 by 10 smiley.

- Show students the "Clean Format" vs. "Raw Format" buttons if they don't see it. This is a very helpful way to make the tool easier to use.

Puzzle 4: Students change the width slider to "find" the image from a set of bits.

Puzzle 5: Students "edit" an image to add eyebrows to a smiley face.

- This activity demonstrates that the bits are being read in sequence. If you delete or add one earlier on the computer doesn't "know" that the rest aren't supposed to move.

Puzzle 6: Free-play. Students should create at least an 8 by 8 image (though ideally larger). You will probably want to time-box this activity and let students know in advance how long they'll have. 10-15 minutes before doing the class discussion is probably fine. If you have more times students can always come back to finish their drawings.

Content Corner

Knowing The System Being Used: This puzzle demonstrates the importance of knowing the exact "system" being used to interpret a string of bits. Reading an 8-bit wide image as though it is 10 bits wide will lead to a garbled image. This is one place where students clearly see this phenomenon but may miss it if it's not pointed out. While it is not explored in this curriculum, the image width and height could also be represented in binary as part of a more flexible system for representing images.

Teaching Tip

Have Ideas Ready: Many students may need help deciding what to draw. Have a couple of ideas ready to share like their hobby, their favorite animal, a personal logo, etc.

Wrap Up (10 mins)

Share: Have students share the images they created with one another.

Prompt:

- Think about the ASCII system we learned yesterday and the image representation system we learned today. How are both examples of breaking down big problems into small ones that we are able to solve?
- What information BESIDES the 0s and 1s do you need in order to decode a binary message.

Discuss: Give students a minute to write their ideas before sharing with a neighbor. Eventually run a whole class discussion.

Remarks

> Computer scientists are problem solvers. They need to work with the tools available. Representing something as complex as a picture using just ons and offs can seem really challenging. By breaking up a problem into smaller pieces, however, you can find solutions. Next time we're going to look at one more system for representing a new kind of information.

Discussion

Goal: This first discussion calls out that both systems were breaking down complex information like words or images into small pieces that are easier to represent. With text this is already done for us since a page of words is already broken into letters. With images we needed to get a bit more creative to break the image into pixels. In both cases, however, once this is done the problem gets much simple.

The second prompt is designed to call out that a series of binary information doesn't actually mean anything if you don't know the system used to encode it. Today students saw that even image data could be for images of any width, and so without this information it could be difficult or impossible to find the correct image.

Standards Alignment

CSTA K-12 Computer Science Standards

- **DA** - Data & Analysis

Lesson 5: Representing Numbers

Widget

Overview

In this lesson, students learn about the binary number system. With a set of cards that represent the place values in a binary (base-2) number system by a collection of dots, students turn bits "on" or "off" by turning cards face up and face down, then observe the numbers that result from these different patterns. Eventually, students extend the pattern to a generic 4-bit system.

Purpose

Students learn how to use the binary system to represent integers. Unlike ASCII, which is presented as an arbitrary mapping of bit patterns to characters, binary numbers are introduced within the context of patterns of numbers. Students use the patterns to determine the binary representations of different numbers, rather than simply looking them up in a table.

This lesson borrows heavily from a similar activity in **CS Unplugged**.

Agenda

Warm Up (10 mins)
Activity (40 mins)
    Using the Pattern
Wrap Up (10 mins)

Objectives

Students will be able to:

- Use a binary system to represent numbers.
- Extend a representation system based on patterns.

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teacher

- **Representing Numbers** - Exemplar

For the Students

- **Representing Numbers** - Activity Guide
  Make a Copy
- **Number Cards** - Manipulative
  Make a Copy

Teaching Guide

Warm Up (10 mins)

Prompt: Create a list of all the information you might want to represent to a computer as a number. Here's some ideas to get you started

- An online store (what kinds of numbers does a store keep track of?)
- A social media profile (what things about you or your friends are numbers?)

Discuss: Students should brainstorm independently, then share with a partner, then finally discuss as a whole class.

Discussion

Goal: In this and the following lessons students will be learning a new system to represent numbers using on-off signals. Motivate this activity by thinking back to the kinds of information students eventually will want to represent with this system. If students need help brainstorming give them a couple examples, e.g. age, their height, their birthday, the number of friends they have, the cost of items, an item's rating, etc.

Remarks

> Numbers are a really useful and important way to represent all kinds of information. If we want to represent numbers to a computer, we're going to have to learn a new system that allows us to do that.

Activity (40 mins)

Group: Put students into pairs.

Distribute: Give each pair a copy of **Representing Numbers - Activity Guide** and a set of **Number Cards - Manipulative**.

Teaching Tip

For younger students, you may want to stop the activity after they have finshed the first page of the worksheet. This means that they will not need to go online for any of the lesson.

Binary Cards

Model: Go through the example problem as a class. Ask students to arrange cards face up and face down so that exactly thirteen dots are showing. (It is important that each group uses only one set of cards.) After some trial and error, students should see that the 8, 4, and 1 cards should be face up, and the 2 card should be face down. (U U D U)

Allow students to complete the rest of the page in pairs.

When all students have finished the page, ask them to come back together as a class and share their answers.

Teaching Tip

This activity models a base-2 number system for the student. However, it is not necessary for the students to understand the math behind the patterns that they are creating. Students should focus on the fact that they are using a binary system (face up/face down) to represent information.

Prompt: Was there more than one possible answer for any of the problems?

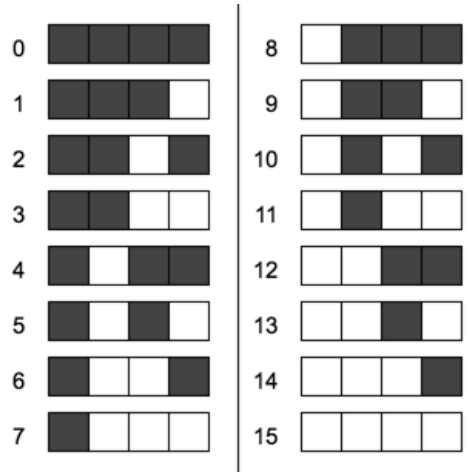
Allow students to check with other pairs and try to find another way to represent the numbers.

Prompt: What is the smallest number you can make? The largest number you can make?

Using the Pattern

Allow students to complete the second half of the worksheet.

For the second half of the page, student answers may vary. You can use the following guide to check their work.



Prompt: When we learned ASCII, you had to use a table to look up each letter. For binary numbers, you were able to represent your numbers without a table. How did you do that? Could you figure out what the binary might be for a number higher than 15?

Allow students to discuss their ideas in pairs before bringing them back to the group.

Discussion

Goal After some discussion, students should note that there is only one way to represent any particular number in this system. This is an important point to bring out because it would be confusing if two patterns meant the same thing.

The smallest number that students can make with the cards is 0 (not 1). This will be referenced in a later activity.

Discussion

Goal Students should recognize that the patterns of the numbers and the rules that they followed to get them allowed them to figure out how a number would be represented, without using a table, as they did in ASCII. If they extend the patterns, they should be able to get much higher numbers.

Remarks

With these cards, we've created a binary system to represent numbers. Because we used a pattern that we can follow as our numbers get bigger, our system can work for as high as we can count. Of course, our cards will eventually run out of space to put the dots, so we're going look at a tool that will help us to use binary numbers in the hundreds.

Send students to the online lesson.

Code Studio levels

- Levels
- 2
- 3
- 4
- 5
- 6
- 7

Student Instructions

View on Code Studio

5-Bit Number

When you only had four bits, the highest number that you could make was fifteen. Now you'll have a chance to work with more bits to make higher numbers.

Teaching

Answers for this level can be found in the exemplar linked on **Level 1**.

In this activity, the dots are replaced with numbers, but you still add up everything that's showing to see what number the binary code stands for. The left-most bit doesn't have a number yet, so you'll have to give it one.

Do This

- Click on the bits to turn them on and off, and see the different numbers you can make.
- With your partner, discuss the pattern in the numbers. Decide what number you think should go in the left most box.
- Click "Edit" to change the value of the left most bit.

- Once you've decided on the value, try to make the following numbers: 16, 27, 31

Student Instructions

View on Code Studio

6-Bit Number

Teaching Tip

Answers for this level can be found in the exemplar linked on **Level 1**.

This widget helps you to calculate 6-bit binary numbers.

Do This

- With your partner, answer the following questions:
- What's the biggest number you can make with this widget?
- The record for most skips by a dog and person in one minute is 59. How would you encode 59 in binary?

Student Instructions

View on Code Studio

Decoding multiple numbers

Teaching Tip

Answers for this level can be found in the exemplar linked on **Level 1**.

Here's a widget that can calculate numbers of 4, 5, or 6 bits. You can use it to find the two world records encoded in the binary string below.

1. Most number of people lifted and thrown in two minutes. (4 bits)
2. Most canned drinks opened by a parrot in one minute. (6 bits)

Do This

- Decode the two numbers from the binary string.

Student Instructions

View on Code Studio

Decoding multiple numbers

Teaching Tip

Answers for this level can be found in the exemplar linked on **Level 1**.

Here's a widget that can calculate numbers up to to eight bits. You can use it to find the values of the two world records below.

Don't forget to make sure that the "1" bit is always the right most bit. If you have extra bits on the left side of the widget, just keep them turned off.

1. Longest tail on a dog (in inches) (5 bits)
2. Most spoons balanced on someone's face (5 bits)

Do This

- Decode the two numbers from a the binary string.

Student Instructions

View on Code Studio

Decoding multiple numbers

Here's a new bit string. This time, you don't know the bit length of the two numbers. Try to decode the numbers without knowing the bit length.

Teaching Tip

Without knowing the length of each of the numbers, students will not be certain of their answers, but they should be able to at least find one possible solution. Allow students to discuss any differences in their answers. They should eventually see that they need to know the bit length of each number to answer the question.

1. Largest wind chime, in feet (? bits)
2. Furthest arrow shot with someone's feet (in feet) (? bits)

Do This

- Try to decode the two numbers from the binary string.
- Discuss with your partner why you cannot know for sure whether your answer is correct.

Student Instructions

View on Code Studio

Bit Length

Teaching Tip

Answers for this level can be found in the exemplar linked on **Level 1**.

If you don't know how many bits long each number is, you won't be able to decode a string of numbers.

For example, the following binary string could be decoded many different ways.

If you split the string like this, the string reads 10, 84.

If you split it like this, the string reads 42, 20.

To solve this problem, people agree on a fixed length for every number. The following string uses the same two numbers, but each number takes up exactly eight bits, no matter how many bits it actually needs.

Do This

- Use the binary widget to decode the string that uses eight bit numbers.
- Check you answer with a partner to see whether you got the same answer.

Wrap Up (10 mins)

Prompt: So far, we've looked at how we could represent text, images, and numbers in binary. Are there any other types of data that you use on your computer that need to be represented?

All students to call out different types of data, such as music, videos, etc.

Remarks

> Those are all types of data that need to be represented in binary. We're going to watch a video that explains a little bit more about how this works.

Display: Play the "Binary and Data" video.

Code Studio levels

- Binary and Data
- **Student Overview**

View on Code Studio

Standards Alignment

CSTA K-12 Computer Science Standards

▸ **DA** - Data & Analysis

Lesson 6: Keeping Data Secret

Overview

Students have a discussion on the different levels of security they would like for personal data. Once the class has developed an understanding of the importance of privacy, they learn about the process of encrypting information by enciphering a note for a partner and deciphering the partner's note. The class concludes with a discussion about the importance of both physical and digital security.

Purpose

As students have been encoding and decoding with data, they have not been worried about the securing of the data that they are using. In this lesson, they begin to think about how they can ensure that only the intended recipient can read the data that they send. They will use a simple cipher to encode a message. Students should understand that in order to encrypt a message, they need both an algorithm and a key, and that it is important that the key be kept secret.

Agenda

Warm Up (5 mins)

Activity (40 mins)

- **Encoding and Decoding**
- **Encryption and Decryption**
- **Encrypt Your Own Message**
- **Reflection**

Wrap Up (5 mins)

Objectives

Students will be able to:

- Apply a method of encryption to ensure the secure transmission of data.
- Use both physical and digital security measures to secure data.

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teacher

- **Keeping Data Secret** - Exemplar

Vocabulary

- **Decrypt** - to change information so that its hidden meaning is shown
- **Encrypt** - to change information so that its meaning is hidden

Teaching Guide

Warm Up (5 mins)

Display the binary string from Code Studio Level 2.

Code Studio levels

- Levels
- **2**

Student Instructions

View on Code Studio

Decoding Binary Strings

- Can you decode this binary string?
- What do you need to know before you can decode it?

Prompt: Here's an example of a message that someone might send over the Internet to a friend. What do you need to decode this message?

Discussion

The prompt serves to kick off the review of what someone needs in an encoding system. Students should understand that without knowing the system used to encode the string into binary, they have no way of knowing what it would mean.

Remarks

> In the last few lessons, we've seen lots of different types of data that can be encoded into binary. All of our encoding systems have a couple of things in common, though.

Review: Briefly review the characteristics of an encoding system:

1. It needs to be unambiguous.
2. Everyone needs to agree on it.

Display the binary string and decoding key on Code Studio Level 3.

Code Studio levels

- Levels
- **3**

Student Instructions

View on Code Studio

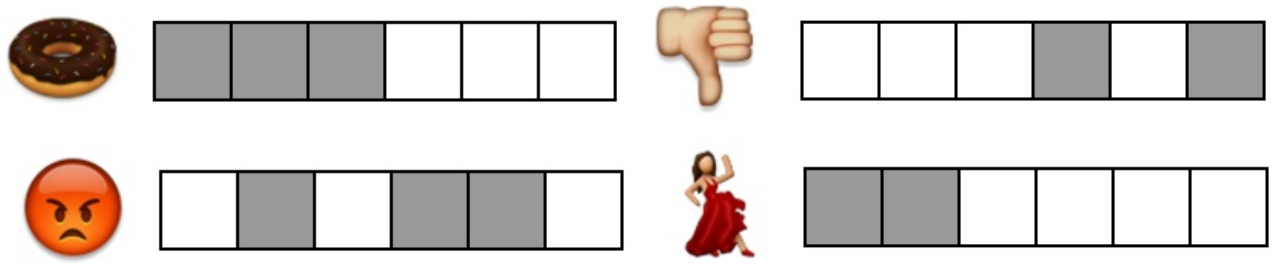
Decoding Binary Strings

Encoding system:

Teaching

The message itself is a doughnut, thumbs down, and angry face. Students may have fun coming up with their own interpretations of the emojis. One possible interpretation is that the sender expected a doughnut, didn't get one and became angry, but there is no "right" answer to what the emojis mean.

(Hide this message by going to your teacher panel on the right and choosing to view as a student.)



Give students time to decode the binary string and discuss what they think it means.

Prompt What if I wanted to send a message that was secret, so only my friend could understand it?

Today we're going to look at a system that will let us keep all types of messages secret.

Discussion

Allow students to brainstorm ideas to keep message a secret. In most cases, students may think of using a secret code rather than one publicly available. This could work, but it's a lot of work to make a new code for every type of data, and you would have to repeat that work if your code was accidentally revealed.

Activity (40 mins)

Group: Put students into pairs.

Distribute one copy of **Keeping Data Secret - Activity Guide** to each student.

Teaching Tip

Reducing Paper This activity can be done online. Rather than coloring in the squares, students can type an "X" into each square that would be colored black.

Encoding and Decoding

Remarks

> Here's the same system that we saw before, but with more emojis. With your partner, decode the binary string and decide what you think the message means.

Allow students to share out what they have found and their own interpretations of the emojis.

Encryption and Decryption

Remarks

> The next binary string uses the same emoji code you saw earlier, but the sender didn't want other people to read it. With your partner, try to decode the message.

Allow students to try to decode the message. They may note that the binary codes are not in the encoding system that they have been given.

Remarks

> This message has been encrypted. That means that someone changed it so that we cannot read it. In order to read the message, we'll first need to decrypt it.

Vocabulary: Introduce the following terms.

- **Encrypt:** to change information so that its meaning is hidden

- Someone has **encrypted** the message, so we cannot understand it.

- **Decrypt:** to change information so that its hidden meaning is shown
  - We need to **decrypt** the message before we can read it.

Model the decryption of the first message.

1. Copy the rest of the binary string into the first row of the chart.
2. Continue to repeat the key until you have reached the end of the chart. (The last repetition will only have two bits.)
3. For each bit on the third row of the chart, color in the square if and only if the two bits above it are the same. For example, if the two bits above it are both white OR both black, color in the square. Do not color in the square if the two bits are different.

Once the message has been decrypted, allow students to decode it and discuss what they think it means.

Circulate: Support students as they decrypt the message on the second page.

Content Corner

Students may not understand the difference between encoding/decoding and encryption/decryption. The main thing for students to understand is that the intentions between the two are very different.
Encoding is used to change the form of data, not to hide its meaning from others. For example, ASCII is used to encode characters into binary, but the intention is that everyone should be able to decode the information. The purpose is to make it easier to store and process information. Encryption is used to ensure that only the intended recipient of the information can read it. It is used for security and privacy.

Encrypt Your Own Message

Partners create their own emoji message and key, then encode and encrypt it.

Students should post their encrypted messages publicly, while keeping their unencrypted messages and keys a secret. Allow students time to look at their classmate's messages and try to decrypt them without a key.

Prompt Everyone has shared their encrypted data. Do you think that you could decrypt anyone's data without the key? How? What makes it difficult?

Pair up different groups and ask them to secretly trade keys. They should then be able to decrypt the other group's message.

Allow each of the groups to share out the emoji message they decrypted and what they think it means.

Content Corner

In this encryption system, the method of encryption and decryption are identical and use the same key. In most encryption systems, that is not the case. This once has been chosen for the same of simplicity.

Teaching Tip

To share the message online, students can type "B" for every black square and "W" for every white square in the row.

Discussion

The goal of this discussion is to highlight the value of encryption, and that even with knowledge of the algorithm, it's difficult to crack a code without the key. Allow students the opportunity to share their ideas for how to crack this code and try them out, then have students dicuss what makes it difficult.

Reflection

Prompt How did you you keep your key safe when giving it to your partner?

Student should share out how they ensured that no one else could see the key they used to encrypt their data.

Remarks

> You used physical security to keep your key safe, by making sure that no one could physically access it.

Prompt What is one way that you use physical security to keep your online data safe?

Allow students to discuss the questions with their partners before sharing out to the class.

Remarks

> To keep our data safe, we need to pay attention to digital and physical security. Digital security includes using encryption or protecting things with passwords. Physical security is keeping our devices and passwords physically safe.

Wrap Up (5 mins)

Prompt: When people communicate on the Internet, they cannot rely on physical security to keep their keys safe. Try to think of a way that they could still communicate securely, even if someone could read everything that they sent.

Allow students to brainstorm on their own, then share their ideas with a classmate.

Discussion

The goal of the first discussion is to introduce the idea of physical security, which includes everything we do in the physical world, such as preventing physical access to computers and passwords.

Students should understand that physical security is as important as digital security when safeguarding information. Some things students may do to keep their information safe might be to keep passwords in a safe place (or avoid writing them down entirely) and to keep devices locked away when they aren't in use.

Discussion

The goal is not for students to come up with a viable solution, but for them to brainstorm different ways that they might try to solve the problem.

Standards Alignment

CSTA K-12 Computer Science Standards

- **NI** - Networks & the Internet

Lesson 7: Combining Representations

Unplugged

Overview

In this lesson, students use all three types of binary representation systems (ASCII characters, binary number, and images) to decode information in a record. After seeing a series of bits and being asked to decode them, students are introduced to the idea that in order to understand binary information, they must understand both the system that is being used and the meaning of the information encoded. They then decode a record representing a pet based on a given structure.

Purpose

In previous lessons, students used different representation systems in isolation. Here, they see various representation systems used together within the same record. They should see that it's important not only to know the various codes, but to create rules about which codes are being used at which points in the record. Without this structure, it is impossible to decode a series of bits.

Agenda

Warm Up (10 mins)
Activity (40 mins)
Wrap Up (5 mins)

Objectives

Students will be able to:

- Use multiple binary systems to decode information.
- Determine the most appropriate encoding system for a given piece of information.
-

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teacher

- **Pet Records** - Exemplar

For the Students

- **Activity Guide - Pet Records** - Activity Guide **Make a Copy**
- **ASCII to Binary Table** - Reference **Make a Copy**

Teaching Guide

Warm Up (10 mins)

Review: Quickly review the types of binary encoding systems that have been covered: ASCII, images, and binary numbers.

Prompt: Show students the binary code on Code Studio Bubble 2.

Ask them to use what they know about binary codes to figure out what it means.

Give students a chance to think on their own, then talk in table groups before opening up to a full class discussion.

Discussion

Goal: Students should note that without knowing which code is being used, they can't know for sure what the binary means. Specifically, they may see that the code could be the character "C" in ASCII or the number 67 as a binary number. In fact, it could be a code that they haven't seen before, in which case it could mean anything.

Code Studio levels

- Levels
- **2**

Student Instructions

View on Code Studio

Can you decode this binary string?

1000011

What information do you need to help you decode it?

Prompt: Next, tell students that the code is a number, and ask them whether they know what it means. Push them past the answer that the number is 67. If a stranger approached them and said "67" out of the blue, would they know what that person was talking about?

Discussion

Goal: Students should come up with some different possible meanings of the number, such as an age, a temperature, etc. Again, without context, the number could mean many things.

Remarks

> When we use codes, we need to know two things: The system that is being used and the meaning of the information itself. That means that when we store something in a computer, we have to organize it so that we know these things for each part of our binary code.

Activity (40 mins)

Prompt: Imagine that you were creating a system to hold information about students in the class. What types of information would you want to know about each student? What system would you use to encode those types of information into binary?

Display: Go to the third bubble in Code Studio, entitled "Student Record", and review the bulleted information on the left hand side of the screen.

Discussion

Goal The goal of this discussion is just to get the students thinking about the different types of representation that could be used in a wider context, as well as to prime them for the example in Code Studio.

Code Studio levels

- Levels
- 3

Student Instructions

View on Code Studio

Student record

The student record holds information according to the following rules:

- **The first eight bits store the student's grade as a binary number.**
- **The second eight store the student's age as a binary number.**
- **The next eight store the student's first initial in ASCII.**
- **The last eight store the student's last initial in ASCII.**

0

1

2

3

Teaching

View on Code Studio to access answer key(s)

To hide this box when you display the level, click the teacher panel on the right hand side of this page and choose the "View as Student" option.

Model: Model the decoding of the student record with the class.

Group: Put students into pairs.

Distribute: Give a copy of **Activity Guide - Pet Records - Activity Guide** and **ASCII to Binary Table - Reference** to each pair. Ensure each group has access to the binary widget from earlier in the chapter.

Students should use the binary widget to decode the numbers and their ASCII to Binary tables to decode the letters. There is no need to decode the image because it is already in the correct formatting to see it directly.

On the second page, the image is replaced with a new integer and characters, because the image itself did not hold enough information to be very useful.

Prompt: On the worksheet, students are also asked to think of a new piece of information and how it will be encoded. Ask students to share out their ideas and write them on the board.

Content Corner

7 versus 8 bit ASCII: In previous lessons, ASCII has used 7 bits, and numbers have used 8 bits. In this lesson, we begin to organize the information into sets of 8 bits, called a **byte**. This makes it easier for us to organize the information so that we can read it. Because ASCII only uses 7 bits, we add a 0 at the beginning of the code to fill the extra space.

Starting at 0: In our records, we start at row 0 rather than row 1. This is a common way of number in Computer Science.

Content Corner

Because the name does not fill up all the space it has available, student may wonder why bytes 06 and 07 exist. Remind them that without the structure of the record, the computer will not know where to look. If the image were to start at Byte 06, the computer would interpret it as a character in the name.

Remarks

When we represent something on the computer, we have to make decisions about what aspects we want to record and how those aspects will be recorded. In the next lesson, you're going to have a chance to make up your own representation of something and encode it in binary.

Wrap Up (5 mins)

Journal Prompt

- Which type of information (number, character, image) did you find most useful?
- What made it so useful?

Lesson 8: Create a Representation

Unplugged | Project

Overview

In this lesson students design a structure to represent their perfect day using the binary representation systems they've learned in this chapter. Students will first write a short description of their perfect day and then review with a partner to identify the key pieces of information they think a computer could capture. As a class students will decide how a punch card of bytes of information will be interpreted to represent those pieces of information. Students will then use the ASCII, binary number, and image formats they have learned to represent their perfect days. Students then trade punch cards and try to decipher what the other student's perfect day is like. The lesson ends with a reflection.

Purpose

This lesson forces students to grapple with some of the challenges of representing information to a computer. Computers are good at representing some kinds of information like numbers or characters, but this forces people to represent information in ways that might not always capture the full analog experience of an object or event. The project also serves as a cumulative project for the chapter, bringing together the different representation systems students have learned. As students move into the next chapter they'll look more closely at how information is used to make decisions once it's in a format that can be input to a computer.

Agenda

Warm Up (5 mins)
Activity (40 mins)
Wrap Up (10 mins)

Objectives

Students will be able to:

- Choose and justify the use of different binary representation systems depending on the information being represented
- Encode and decode information represented in binary numbers and ASCII text
- Create a generalized representation system for many instances of a complex type of information

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teacher

- **Create a Representation** - Exemplar

For the Students

- **Create a Representation** - Project Guide
  Make a Copy
- **Create a Representation** - Rubric
  Make a Copy

Teaching Guide

Warm Up (5 mins)

Review: You may wish to begin this lesson with a quick review of the representation systems students have learned in this chapter. You may wish to point on in particular that a byte of information (8 bits) on has meaning if you know

1. The system that is being used.
2. The meaning of the information itself.

Without 1. you could not distinguish a number from a character from a line in an image. Even if you know what the information is (e.g. the number 8) you don't know necessarily if that number means a shoe size, an age, or a movie rating. These should be points that you can make based on the previous lesson.

Teaching Tip

Jump to the Project: Assess for yourself, based on students' understanding of the previous lesson, if you think these points from the previous lesson need to be reviewed. If not then just jump into the project.

Activity (40 mins)

Group: Students will need to work collaboratively on this project

Distribute: Give students copies of the Project Guide

Project Guide - Create a Representation

Prompt: Close your eyes and think about your perfect day. What is the weather like? What will you do? Who's there with you? Spend a minute thinking about as many details as you can.

Step 1 - Describe Your Perfect Day: Have students write down all the key details of their perfect day on their activity guides. It is fine for students to mix between bullets and complete sentences.

Step 2 - Share with a Partner: Have students pick a neighbor to share their perfect day with. They should continue to update their information from Step 1 as they come up with more information about their perfect day.

Step 3 - Identify Information: Have students assign the information about their perfect day to one of three categories, Numbers, Characters, or Images.

Step 4 - Review Information Choices: Students should get back together with their partner and compare notes on how they assigned different pieces of information to different categories.

Teaching Tip

Choosing Categories: This will likely prove a difficult step for some students. You may wish to model how to assign different information to different categories or as a class assign information from a few volunteers' perfect days.

Step 5 - Full Class Activity - Agree on Classwide Punch Card: Display the punch card from the project guide somewhere the whole class can see it. Have partners share the categories of information they wish to represent. Explain that the class will need to agree how they are going to use each row from the numbers, characters, and image sections of the punch card.

Step 6 - Fill Out Punch Card: Display the system somewhere all students can see it. Have students fill out their punch cards using this class system.

Step 7 - Trade and Decode Punch Cards: Students should find a new partner who is unfamiliar with their perfect day. They should trade punch cards and decode the information encoded their. There is space on the back of the activity guide to write

- The number information and its meaning
- The character information and its meaning
- What they believe the image is showing

Afterwards students should write what they believe happens in their classmate's perfect day in the space provided

Step 8 - Share and Reflect: Partners should meet back up and compare their description of their classmate's perfect day to what they originally intended. what were they still able to capture? What was lost?

Wrap Up (10 mins)

Collect: Students' project guides and punch cards. Make sure to keep track of who students have partnered with so that you can grade both their encoding and decoding work.

Prompt: If you wish you may use the following prompts to debrief the project.

- If you had been given another byte of information (another line on the punch card) how would you have wanted to use it?
- If you could move one byte from one category (numbers, images, characters) to another, which would you switch?

Discuss: Have students silently write their ideas before sharing with a partner and eventually the whole class.

Discussion

Possible Systems: Here's one possible system for the punch cards

- Number 1: Temperature that day
- Number 2: How many other people are there
- Number 3: How long you're there in hours
- Characters 1-10: Name of activity or location
- Image: Image of the activity

Facilitating the Discussion: Students will likely want to create systems that work really well for their information but not a classmates. Emphasize that systems are only useful if they're universal. A system that only works for one person isn't very useful and all systems will involve some tradeoffs.

Discussion

Goal: These questions should help you assess on a high level whether students have understood the challenges of this activity. In their justifications for the first question they should be describing what information they'd want to capture and how they'd want to represent it. In the second question you should push them on why it's ok to lose the byte from one category and why that loss of information will be made up for by the new byte in another category.

Send students to Code Studio to complete their reflection on their attitudes toward computer science. Although their answers are anonymous, the aggregated data will be available to you once at least five students have completed the survey.

Code Studio levels

- Levels
- **2**

Student Instructions

View on Code Studio

Standards Alignment

CSTA K-12 Computer Science Standards

- **AP** - Algorithms & Programming
- **DA** - Data & Analysis

Lesson 9: Problem Solving and Data

Unplugged

Overview

In this lesson, students use the problem solving process from earlier in the course to solve a data problem. After reviewing the process, the class is presented with a decision: whether a city should build a library, pet shelter, or fire department. Students work in teams to collect information on the Internet to help them decide what should be built, then use this information build an argument that will convince the city council of their choice. They then map what they have done to the problem solving process that they have been using throughout the course, comparing the general problem solving process to its specific application to data problems.

Purpose

Students have spent the first half of the unit exploring how computers represent different types of information, or data. In this lesson, they learn how data can be used to solve real word problems, revising the problem solving process through the lens of data analysis.

Agenda

Warm up (5 mins)

Problem Solving with Data (70 min)

- **Define**
- **Prepare**
- **Try**
- **Reflect**

Data Problem Solving Process

Wrap Up

Objectives

Students will be able to:

- Use the problem solving process to answer a question using data.
- Identify and collect relevant data to help solve a problem.
- Use data to draw conclusions.

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teacher

- **Problem Solving with Data** - Exemplar

For the Students

- **Problem Solving with Data** - Activity Guide

Make a Copy

Teaching Guide

Warm up (5 mins)

Remarks

> In the first half of this unit, we talked about different types of data, or information, that are stored on the computer. Now we're going to look at how we use data to solve different problems.

Prompt When's the last time that you looked for information on the Internet? Why did you need it?

Remarks

> All of these things are data, and they all helped us to solve a problem in our lives. Today, we're going to look at our problem solving process and how it can be used together with data.

Discussion

The goal of this discussion if for students to realize that they use the Internet as an information resource to help them solve problems in their own lives. As the students brainstorm why they go online, encourage them to frame their information search as one step in problem solving.

Problem Solving with Data (70 min)

Group: Put students into groups of 3-4

Introduce students to the scenario as explained in the activity guide. You can choose a location best for your classroom, or use the example location of the Columbia Mall in Columbia, MO.

Remarks

> For this activity, we're going to be experts hired by the Columbia, MO City Council to give advice on what they should build in a new location. The city has the money to build something near the Columbia Mall, but the council can't agree on what the city needs most. Some members want a fire station, others want an animal shelter, and others want a library. Our job is to research data and use the problem solving process to help us make a convincing recommendation to the council.

Review: Review the problem solving process: Define, Prepare, Try, Reflect.

Hand out **Problem Solving with Data - Activity Guide** and let students know that they will be working through it as a class.

Define

Ask students to take a few moments to write down what the problem is, then allow them to discuss with a partner.

Allow students to share out their responses and discuss as a class.

Discussion

Students should understand that it's not just about having an opinion about what should be built, but to use data data to help decide what the city needs most.

Prepare

Remarks

> Now that we understand the problem, we need to decide what data will be useful to us. Everyone write down three types of data that might help you to decide what the city needs the most.

Allow students to share out the different types of data and list them on the board. As more data is suggested, ask students where they think they might find this data, focusing on information that is readily available online.

Remarks

> This is a lot of data, and we may not be able to find it all. We're going to split into groups to look for this data

Assign every group a particular type of data to research online, ensuring each knows where to look for it.

Circulate: Support groups as they try to locate the data online and record what they have found on the Activity Guide.

After each group has finished, bring the class back together to share the data, putting the results of the research on the board.

Teaching Tip

If students are having trouble coming up with relevant data, you can try to lead them to some of the following:

- What libraries, fire stations, or animal shelters are in the area? (map sites, such as Google Maps)
- Are people happy with the existing services? (review sites, such as Yelp)
- How many people live in the city? How large is the city? (City web site, or Wikipedia)

Try

Once all the groups have shared their data, allow each group to decide what they think should be at the location and fill out the chart with their reasons and data. Make sure students understand that they are allowed to use the data from the **whole class**, and not just that of their particular group. They should use at least two types of data to support their decision.

Circulate: Support groups as they decide what should be built at the location. If groups cannot come to an agreement, assure them that there is no "right" answer for this problem, but they should try to figure out what they can support with two types of data.

Have groups share out their decisions, as well as the reasons and data that support them. Assure them that it's fine to have difference between and within groups.

Remarks

> Even people with the same data can sometimes come to different conclusions. When you make a decision with data, you have to know what the data means and what is important to you.

Discussion

Students should understand and be comfortable with the fact that the decisions that we make from data involve interpretation and prioritization. They should be able to support their decisions using the data the class found.

Reflect

Ask students to fill out the last portion of the worksheet, reminding them that more data might help them make a better decision.

Data Problem Solving Process

Remarks

> We were able to use the problem solving process to help us make a decision with data, but there were some parts of it that may have felt new.

Journal: In your journal, write one thing that felt the same about using the problem solving process, and two things that felt different.

After students have finished writing, give them a few minutes to share with a partner, then draw them back for a group discussion.

Discussion

Students should note that the "Define" step of the process was very similar, but that "Prepare" step asked students to **Collect** data, and the "Try" step asked them to **Interpret** data.

Allow students to share out their answers, and list them on the board, then display the **Problem Solving Process for Data**.

Remarks

> Even though we're using the same general problem solving process, we do some specific things when we work with data. The steps to the Data Problem Solving Process are Define, Collect, Interpret and Reflect. We'll be using this process through the rest of the chapter to help us solve problems.

Wrap Up

Journal: Ask students to think of a problem in their lives or community that they might be able to solve with data. They should answer the following three questions:

- What is the problem?
- What data could help you solve it?
- Where could you find that data?

Standards Alignment

CSTA K-12 Computer Science Standards

▸ **DA** - Data & Analysis

Lesson 10: Problem Solving with Big Data

Overview

In this lesson, students look at how data is collected and used by organizations to solve problems in the real world. The lesson begins with a quick review of the data problem solving process they explored in the last lesson. Then students are presented three scenarios that could be solved using data and brainstorm the types of data they would want to solve them and how they could collect the data. Each problem is designed to reflect a real-world service that exists. After brainstorming, students watch a video about a real-world service and record notes about what data is collected by the real-world service and how it is used. At the end of the lesson, students record whether data was provided actively by a user, was recorded passively, or is collected by sensors.

Purpose

In this lesson students see three examples of how the data problem solving process is used to solve real-world problems. This lesson expands the types of problems students think of as data problems and helps them to relate what they know about data to their real world experiences with common Internet services. The examples also provide an opportunity to reflect on the fact that in their own lives they are intentionally and unintentionally producing data that companies collect and use.

Agenda

Warm Up (5 mins)

Activity (40 mins)

- **Web Pix**
- **Routz**
- **Nyle**
- **Reflection**

Wrap Up (10 mins)

Objectives

Students will be able to:

- Give examples of how data is collected from sensors and tracking user behavior.
- Determine data that would be helpful in solving a problem, and how that data could be collected.
- Distinguish between data that users intentionally and unintentionally produce.

Preparation

- [ ] Print copies of **Data in the Real World - Activity Guide**
- [ ] Prepare projector if you will show videos to the whole class

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Students

- **Data in the Real World** - Activity Guide
  Make a Copy

Teaching Guide

Warm Up (5 mins)

Prompt: In the last lesson, we looked at the data problem solving process using data that we found on the Internet. We didn't worry about how that data got online. There are lots of ways that apps, companies, or governments might collect data, though. What ways to collect data are you already aware of?

Discuss: Have students brainstorm their ideas before sharing with the class. You can record their ideas on the board to refer back to later in the class.

Remarks

> Great work. Today we're going to look at some real-world examples of how data is collected to solve problems. Keep an eye out for these ideas and think about whether you're seeing any new ones.

Discussion

Goal: This is primarily a brainstorm. Some students may bring a lot more prior knowledge than others to the class and at this point they haven't been explicitly taught anything about data collection outside of surveys. Aim primarily just to get ideas out and set the stage for the lesson. You're aiming to change focus from surveys that 10-20 people take to the vast amounts of data they might know is collected by modern technological tools.

Activity (40 mins)

Group: Students may complete this activity individually or in pairs.

Distribute: Give students copies of **Data in the Real World - Activity Guide**

Data in the Real World

Web Pix

Introduce students to the "Web Pix" problem as defined on the first page. Give students a few minutes to write down their ideas and/or share them with a partner. Let students know that they will **not** be able to answer the question about Netflix yet. If students finish early, ask them to think of other types of data and how they could be collected.

Allow students to quickly share out some ideas, then introduce the Netflix video.

Teaching Tip

Accessing Videos: It's recommended that the class watch the videos in this lesson together on a large screen or projector. They can be found in their own levels on Code Studio. Students also have access to these videos and so if they wish can watch them on their own too.

Remarks

> Many companies, such as YouTube, Facebook and Netflix, recommend videos and posts to users based on the data that they have collected about them. We're going to watch a short video about how Netflix does this. Pay attention to Netflix collects data to help it recommend good videos.

Code Studio levels

- Levels
- **2**

Student Instructions

View on Code Studio

Watch this video to learn how this problem is solved by Netflix. As you watch think about what data is being collected and where it's coming from.

Discuss: Allow students to share with a partner, then discuss with a group the types of data that Netflix collects to help it make recommendations.

Routz

Ask students to move on to the Routz problem. Again, they should take a few minutes to work individually or in pairs on the first two problems. After students have shared in their pairs, introduce the Waze video.

Teaching

Check that students have answered the first two "Web Pix" questions on their activity guide before showing this video. After the video, they should answer the third question.

You can hide the "For Teachers Only" box in Code Studio by clicking the Teacher Panel on the right side of the page and choosing the "View as Student" option.

Discussion

Goal: Students should understand that Netflix bases its suggestions not only on the survey data that users create, but also on the behavior of users as they use the site, such as what they watch and the ratings they give various videos.

Code Studio levels

- Levels
- 3

Student Instructions

View on Code Studio

Watch this video to learn how this problem is solved by Waze. As you watch think about what data is being collected and where it's coming from.

Discuss: Allow students to share with a partner, then lead a short discussion on the types of data that Waze collects to help it find the best route.

Teaching

Check that students have answered the first two "Routz" questions on their activity guide before showing this video. After the video, they should answer the third question.

Nyle

Ask students to move on to the Nyle problem. Again, they should take a few minutes to work individually or in pairs on the first two problems. After students have shared in their pairs, introduce the Amazon video.

Discussion

Goal: Students should note that while some data is being intentionally added by the users, Waze also collects GPS/location data on each user without the user's active input. Sensor data, such as time, temperature, and location, are automatically collected by computers without a user actively adding them.

Code Studio levels

- Levels
- 4

Student Instructions

View on Code Studio

Watch this video to learn how this problem is solved by Amazon. As you watch think about what data is being collected and where it's coming from.

Discuss: Allow students to share with a partner, then lead a short discussion on the types of data that Amazon collects to help it find the best products to suggest.

Reflection

Review the different ways that data can be collected.

Remarks

> We've found lots of different ways that the computer can collect data. In general, data can be collected automatically from sensors, as the Waze app collects GPS data; it can be collected from users who are intending to produce data, as when people rate Netflix videos; and it can be collected from users who are not intended to produce data, as when Amazon records which products you look at.

Types of Data Collection: Ask students to fill out the chart at the bottom of the page that categorizes the different types of data. Afterwards, allow students to compare their answers.

Wrap Up (10 mins)

Journal: Today we looked at three companies that collect data to solve problems. Brainstorm some other websites, apps, or companies you use or know about. What data are they collecting? How are they using it to solve a problem?

Discuss: Ask students to share their ideas with their classmates.

Remarks

> Today we saw some examples of different sources of data that real-world apps and websites use to solve problems. Websites often ask you directly for data, but they might record your behavior online to collect data as well. In fact sometimes sensors like a GPS signal can collect data without you even knowing it. In the next class we're going to look at how we'll be collecting data for the rest of the unit.

Teaching

Check that students have answered the first two "Nyle" questions on their activity guide before showing this video. After the video, they should answer the third question.

Discussion

Goal: There are a few different aspects of the Amazon video that may be of interest.

- Just looking at something online produces data that can be used by advertisers or others.
- Amazon decides what you might buy by looking at similar users and using their behavior to predict yours
- Different types of data, such as "clicks", "likes" and "purchases", may be weighted differently
- The user's needs are not the priority. The advertiser's needs are.

Any of these topics are relevant to the lesson, but the most important thing for students to realize is that they are not always aware when they are producing data.

Discussion

Goal: This prompt is meant to help students make connections between their personal experiences with data collecting services and what they have learned in this lesson. The goal here is to connect the examples students saw in today's lesson to other apps, websites, or services that they may be aware of. If you need to prompt students you might suggest they think of social media websites, media websites, useful apps they or their family uses, etc.

Standards Alignment

CSTA K-12 Computer Science Standards

▸ **IC** - Impacts of Computing

Lesson 11: Structuring Data

Widget

Overview

In this lesson, students go further into the collection and interpretation of data, including cleaning and visualizing data. Students first look at the how presenting data in different ways can help people to understand it better, and they then create visualizations of their own data. Using a the results of a preferred pizza topping survey, students must decide what to do with data that does not easily fit into the visualization scheme that they have chosen. Finally, students look at which parts of this process can be automated by a computer and which need a human to make decisions.

Purpose

This lesson demonstrates that raw data must be interpreted in some way to help people use it to make decisions. Students engage in both visualization and cleaning of data, and they see how data can be misinterpreted if it is not cleaned properly. Students also experience working with data by hand and with computational tools, and they see how data must be structured in particular ways to be used by a computer.

Agenda

Warm Up (5 mins)
Visualizing Data (70 mins)
Wrap Up (15 min)
    Journal

Objectives

Students will be able to:

- Identify and remove irrelevant data from a data set.
- Create a bar chart based on a set of data.
- Explain why a set of data must be cleaned before a computer can use it.

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teacher

- **Pizza Data (csv download)** - Optional Resource
- **Pizza Data (GSheets)** - Optional Resource
- **Structuring Data** - Exemplar

For the Students

- **Structuring Data** - Activity Guide
  Make a Copy

Teaching Guide

Warm Up (5 mins)

Prompt Show Code Studio Level 2 at the front of the room.

Teaching Tip

It's possible to have students look at this level themselves, but they will be off the computer for the next activity, so it may be easier to display the level on the board.

Code Studio levels

- Levels
- **2**

Student Instructions

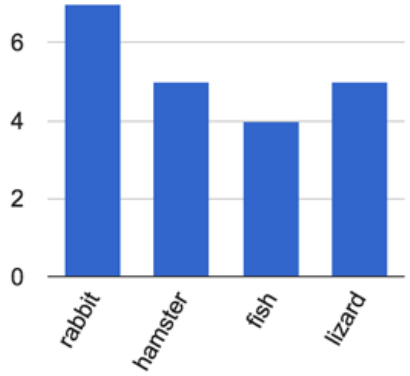
View on Code Studio

Best Class Pet

Here are three different ways to show the results of a vote for best class pet.

All Votes

rabbit	rabbit	hamster
hamster	rabbit	hamster
fish	lizard	fish
lizard	rabbit	hamster
fish	rabbit	fish
lizard	hamster	rabbit
rabbit	lizard	lizard



rabbit	7
hamster	5
fish	4
lizard	5

Which one makes it easiest for a human to make a decision about which pet is the most popular?

Which one makes it easiest for a computer to make a decision?

Ask students to think for themselves for a moment, then discuss their answers with a partner.

Discuss Have students share out their answers for the questions on the board.

Discussion

Students should understand that different forms of data make it easier for people to make decisions. They should also see that people often do best with visuals, such as the bar chart, while computer do better with numbers, such as the table.

Remarks

> Sometimes the "raw" data, the way the information is first collected, needs to be put in a different form so that humans and computers can more easily understand what it means.

Visualizing Data (70 mins)

Group students into pairs and give each pair a copy of the**Structuring Data - Activity Guide** .

> Read the instructions together as a class, ensuring that students understand the problem that they are trying to solve (choosing a pizza topping for the pizza party).
>
> Students are asked to create the bar chart for the set of raw data given. Some of the answers will not easily fall into the given choices. Encourage students to use their best judgment on the answers that are difficult to put into the chart, and that these challenges are a normal part of the data problem solving process.

Discussion

Students should see that there are several ways that answers might be difficult to categorize, whether they are completely irrelevant, not specific enough, or not a given choice. Ignore spelling for now if kids don't bring it up.

Discuss: After students finish making the chart and filling out the reflection questions, have students share their answers with the class.

Remarks

> We've made this chart by hand, but it's also possible for the computer to make it for us. This is especially useful when you have lots of data.

Send students to Lesson 11, Puzzle 3, and ask them to follow the instructions on the level.

Teaching Tip

You can also complete this activity using Google Sheets or Excel. The relevant spreadsheet files are linked in Level 3 of the online lesson or in the resource links area of this lesson plan.

Code Studio levels

- Levels
- 3

Student Instructions

View on Code Studio

Pizza Party

The pizza party data has been put into an app for you, and the answers from another class have been added. Because this is an app, we can automate the creation of the bar chart from the given data.

Do This

- Click "Run" to see the list of answers that the classes have given.
- Discuss with a partner what you think the chart of this data will look like.
- Click "Show Chart" to see for yourself.

Spreadsheet Version

The pizza party data has also been put into a spreadsheet for you, if you would like to use it instead. To use the spreadsheet, you'll need to make your own copy of it.

- This link will make you your own copy of the "Pizza Topping Choices" data:**Pizza Topping Choices**
- You can also download a CSV version of the file**here**.

Prompt Ask students to discuss in pairs why the chart looks the way it does, then share their answers with the class. Why wasn't the computer able to put everything into the correct category?

Discussion

Students should note that the computer used all the answers in the chart, even ones that were irrelevant. They should also note that different spellings of the same choice were not grouped together.

Remarks

> When we created our charts, we knew that we needed to leave off some of the answers that didn't make sense, and that some answers, such as "peppers" and "green peppers", actually meant the same thing. We also put everything that had been misspelled into the correct category. Computers don't know how to do this, because they don't actually understand what a "pepper" is, or that a misspelled word is the same as a correctly spelled word. That means that we have to clean the data before the computer is able to use it.

Tell students that they will create a new column of "clean" data that will be easier for the computer to interpret.

Send students on to Puzzle 4.

Code Studio levels

- Levels
- 4

Student Instructions

View on Code Studio

Pizza Party

When people work with data, they know to leave off answers that don't make sense, and that some answers, such as "peppers", "pepppers" and "green peppers", actually meant the same thing. Computers don't know how to do this, so we have to clean the data before the computer is able to use it.

This version of the app has a second column for data to be cleaned.

Do this

- Click "Run" to see the new list of answers to be cleaned.
- Click on each answer that needs to be cleaned and correct it so that the computer will chart it properly. (You may want to delete some answers entirely.)
- When you are finished, click "Show Chart" to see the new chart of cleaned answers.

Model Clicking on a topping in the "Cleaned Data" list and editing or deleting it. Demonstrate that when you delete/change answers in the clean data column, the chart automatically changes.

Ask students to finish in pairs, cleaning the data until only the seven original choices are shown, then decide which pizza topping is the best choice.

Remarks

> This was a lot of work, and it was only about fifty votes. How much time do you think it would take to clean the data for a nationwide survey? Can you think of any ways to make sure that we got clean data from the beginning, to save us all of this work?

Allow students to discuss in pairs, then share out with the class.

Discussion

In the end, students should realize that constraining a user's choices by using multiple choice rather than a write in answer makes it easier for a computer to use the data.

Remarks

> When we work with large amounts of data, we want to automate as much of the problem soving process as we can. Because computers can't make the same connections that people can, that means that people have to help organize data in a way that computers can understand it. That means either cleaning the data, or collecting data in a way that makes sure it's clean when we get it.

Wrap Up (15 min)

Journal

Prompt: Have students reflect on their development of the**five practices of CS Discoveries** (Problem Solving,

Persistence, Creativity, Collaboration, Communication). Choose one of the following prompts as you deem appropriate.

- Choose one of the five practices in which you believe you demonstrated growth in this lesson. Write something you did that exemplified this practice.
- Choose one practice you think you can continue to grow in. What's one thing you'd like to do better?
- Choose one practice you thought was especially important for the activity we completed today. What made it so important?

Standards Alignment

CSTA K-12 Computer Science Standards

▸ **DA** - Data & Analysis

Lesson 12: Making Decisions with Data

Unplugged

Overview

In this lesson students get practice making decisions with data based on some problems designed to be familiar to middle school students. Students work in groups discussing how they would use the data presented to make a decision before the class discusses their final choices. Not all questions have right answers and in some cases students can and should decide that they should collect more data. The lesson concludes with a discussion of how different people could draw different conclusions from the same data, or how collecting different data might have affected the decisions they made.

Purpose

Students begin exploring the data problem solving process in this lesson at the end, making decisions with data that has already been collected and interpreted. Students likely do not come into this course with a lot of experience making decisions based on data in this way. This lesson intends to contextualize this step of the process inside of decisions that may be familiar to their daily lives.

Making decisions with data is not a formulaic process. Different people might draw different conclusions with the same data. It's important that students ground their decisions in the data collected, but there's usually not a "right answer". This lesson is an opportunity to introduce the nuances of making decisions in a controlled and shared context before students go off to start collecting more information of their own.

Agenda

Warm Up (5 mins)
Activity (40 mins)
Wrap Up (10 mins)

Objectives

Students will be able to:

- Use tables and visualizations summarizing data to support a decision
- Present and critique interpretations of tables and visualziations
- Identify additional data that could be collected to improve a decision

Preparation

- [ ] Print copies of **Making Decisions with Data - Activity Guide**

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teacher

- **Making Decisions With Data** - Exemplar

For the Students

- **Making Decisions with Data** - Activity Guide **Make a Copy**

Teaching Guide

Warm Up (5 mins)

Prompt: What decisions in your life are your already collecting data to help make? Are there any decision you think data could help you make better?

Discuss: Students should brainstorm ideas silently before sharing either in small groups or just directly with the class. There's no need to explore this question in great detail since you'll be able to return to it at the end of the class.

Discussion

Goal: This should be a really quick opening conversation and it's entirely fine if students don't have any decisions they're currently making using data. You might point out a couple of examples (e.g. looking at weather to decide what to wear or review data about a product online) but it's fine to just use this to open the class and return to the question later.

Remarks

> We make decisions every day but we're not always making decisions using data. Today we're going to start exploring the data problem solving process we learned about in the last class by skipping to the last step, making a decision.

Activity (40 mins)

Activity Guide - Making Decisions with Data

> **Group:** Students can complete this activity in groups of 3 or 4 so that they have partners to talk with. There's no need, however, for groups to come to shared decisions.
>
> **Distribute: Making Decisions with Data - Activity Guide**, one copy to each student
>
> **Problem 1 - When to Post:** Read the Define and Prepare sections of the problem as a class. Then give groups a chance to look at the data presented to them and reflect on the questions at the bottom of the activity guide. Students should reflect individually on their responses to each question, then discuss the decision they would make with the group. Once groups have had a chance to discuss they should record their decisions, even if they are different from one another.
>
> **Share:** Have a member of each group share the results of their discussion.
>
> **Problem 2 - Making Meals:** Have students repeat the process for this second problem. They should review the problem, make a personal decision without writing it, discuss with a group, record their final decision, and then be prepared to share out as a group.
>
> **Share:** Again have groups share out how they would approach this decision.
>
> **Problem 3 - Locker Selection:** Repeat the process a final time with this problem.
>
> **Share:** Have students share the results of their conversation with the class.

Teaching Tip

Assign Roles: Have groups assign someone responsible for sharing out the results of their discussion before looking at each decision. Alternate roles between problems.

Teaching Tip

Focus on the Data: Early on reinforce the importance of students referring to the data as the source of their decision. If students think there's reasons not represented by the data that they'd want to make their decision ask them if there's other data they'd want to collect. For example:

- Data from the weekend
- Data from more than just one week
- Data about what people are posting about (here there's no way to tell)

Wrap Up (10 mins)

Prompt: Do two people need to make the same decision from the same data?

Discuss: Have students share their responses

Prompt: For the problems we looked at today is there different data you would have wanted to collect to make your decision?

Discuss: Have students share their responses

Remarks

> We just looked at ways that data can help us to make a decision. We saw that different decisions might come from the same data. We also know that we're in the last step of the data problem solving process here. Depending on what data that we had collected we might have approached these decisions very differently. Going forward we're going to explore those earlier steps in more detail and look at how they affect our decisions.

Teaching Tip

Interpreting the Chart: The second and third problems have more complex tables of information that may be challenging for students to understand without some guidance. You may want to model how to read the charts in these two activities before asking students to use them for decision making. For example, ask students what a particular cell in a table means.

Where are my friends?: Students often react to problem 3 by saying they care about other data, like where their friends' lockers are. Don't be afraid to say that for now they need to decide with the data they have. One of the goals of the lesson is to reflect on how data shapes the way we make decisions.

Discussion

Goal: This is a fairly nuanced question masquerading as a simple yes / no. Ask students to reflect on moments in today's activities where they think the data was more open to interpretation (e.g. locker decisions) and when it might be more cut and dried (e.g. when to post). While the goal of this discussion is to highlight the fact that two people shouldn't need to come to same conclusion from the same data, follow-ups are necessary to make this conversation most effective.

Discussion

Goal: This conversation can look back at moments when students wanted more or different data to help make their decisions. For example you might want to know where your friend's lockers are before deciding which one you want. This discussion leads into the concluding remarks of the lesson.

Standards Alignment

CSTA K-12 Computer Science Standards

- **DA** - Data & Analysis

Lesson 13: Interpreting Data

Overview

Students begin the lesson by looking at a cake preference survey that allows respondents to specify both a cake and an icing flavor. They discuss how knowing the relationship between cake and icing preference helps them better decide which combination to recommend. They are then introduced to cross tabulation, which allows them to graph relationships to different preferences. They use this technique to find relationships in a preference survey, then brainstorm the different types of problems that this process could help solve.

Purpose

In the previous two lessons, students used data visualization to help them make decisions about a single variable (what locker to choose, which topping to order, etc.). In this lesson, they learn how to find relationships between variables using cross tabulation in the responses to different survey questions. Determining how answer choices relate to each other will allow them to make predictions about users based on previous responses. In the final project, they will use this same type of analysis to help them to design an algorithm for their recommendation generator.

Agenda

Warm Up (10 mins)
Activity (40 mins)
Wrap Up (5 mins)
Journaling

Objectives

Students will be able to:

- Visually organize data to highlight relationships and support a claim.
- Use cross tabulation to find patterns and relationships in data

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Students

- **Interpreting Data** - Activity Guide
- **Interpreting Data** - Resource

Teaching Guide

Warm Up (10 mins)

Display: Show students the table on Level 2 of Code Studio.

Code Studio levels

- Cake Survey
- **Student Overview**

Cake Survey

View on Code Studio

For this survey, people got to choose a cake flavor and an icing flavor.

	Cake Flavor	Icing Flavor
1	Chocolate Cake	Chocolate Icing
2	Red Velvet Cake	Cream Cheese Icing
3	Chocolate Cake	Chocolate Icing
4	Carrot Cake	Cream Cheese Icing
5	Carrot Cake	Vanilla Icing
6	Chocolate Cake	Chocolate Icing
7	Chocolate Cake	Cream Cheese Icing
8	Carrot Cake	Cream Cheese Icing

If these people had to agree on one cake and icing combination for a party, what should it be?

What if they were able to order two cakes with icing?

How does knowing both choices help us better understand what sort of cakes we should order?

Remarks

> Here are some more survey results, but this time instead of looking at pizza toppings, we're looking at cake and icing flavors.

Prompt: If you could choose one cake with icing, what would it be?

Prompt: What if you could choose two cakes with icing?

Prompt: How does knowing both choices together help us better understand what sort of cake we should order?

Sometimes it's not enough to look at just one type of data. You need to look at how different types of data relate together. Today, we're going to look at one way that we can find relationships in data to help us solve problems.

Discussion

There is no one recommendation that is correct, but make sure students understand that although chocolate was the most popular cake flavor and cream cheese was the most popular icing flavor, only one person chose a chocolate cake with cream cheese icing.

It's not enough to look at the two answers in isolation. For example, if two cakes are chosen, chocolate cake with chocolate icing and carrot cake with cream cheese icing is much better than chocolate with cream cheese and carrot with chocolate. Looking at the relationships between answers helps to see which choices go well together.

Activity (40 mins)

Group: Put students in groups of 2-3.

Distribute: Give each group a copy of **Interpreting Data - Activity Guide** and **Interpreting Data - Resource**.

Teaching Tip

Even though each of these sheets is only one page, it's best to print them separately, so that students can look at the survey results while they fill in the chart.

Classes who complete these activities online may want to use two computers per group, one to display the survey results and another to fill in the chart.

Remarks

> For our cake and icing example, there were only eight results, so we could look at the answers and get a good idea of the relationships between them. In this survey, we have a lot more results, so we're going to use a chart to count them up.

Read the instructions as a class, then direct students to look at the first table on the activity guide.

Model: Display the first chart on the board, and model how to fill in the chart with the class. For each row of the survey results, add one tally to the chart.

Prompt: If someone likes cats, what activity is probably their favorite?

Allow students time to write down their answer, then check with their group before sharing out.

Prompt: How would your answer change if I told you that the person likes dogs instead?

Prompt: What is one more interesting relationship between favorite pet and favorite activity?

Discussion

Students should use the chart to find relationships between the preferences so that they can differentiate between subgroups. They may note that although people who chose cats tended to choose art, people who chose dogs tended to like music.

Make sure that the class produces examples of the predictions working in both directions (pet to activity and activity to pet). For example, people who like video games are likely to prefer dogs.

Direct students to complete the worksheet in their groups.

Teaching Tip

Students may be tempted to think of reasons that different preference are related. Remind them that there is nothing in the survey that helps them to understand **why** a relationship is true, only that the relationship exists.

The next chart relates pets and sports. Students fill out the chart, then find two interesting relationships between pet preferences and sport preferences.

The students repeat the activity for activity and sport preferences.

Before moving on to the reflection question, give students a chance to share our anything interesting that they learned about the relationships between the different preferences.

Prompt: How could knowing relationships between these types of preferences help you to address a real world problem?

Wrap Up (5 mins)

Journaling

Prompt:

1. What's another data problem you could think of that you could use this method to help solve?
2. What questions would you ask?
3. What relationships would you look for?

Discussion

Although there is no "right" answer to this question, students should realize that finding relationships between preferences may help them to predict one preference from knowing another. This could be for a recommendation engine, to place ads, or to promote particular social media posts.

Teaching Tip

This journal prompt looks forward to the end of chapter project, when students will use this process to solve a data problem of their choosing.

Lesson 14: Automating Data Decisions

Overview

In this lesson students look at a simple example of how a computer could be used to complete the decision making step of the data problem solving process. Students are given the task of creating an algorithm that could suggest a vacation spot. Students then create rules, or an algorithm, that a computer could use to make this decision automatically. Students share their rules and what choices their rules would make with the class data. They then use their rules on data from their classmates to test whether their rules would make the same decision that a person would. The lesson concludes with a discussion about the benefits and drawbacks of using computers to automate the data problem solving process.

Purpose

This lesson demonstrates to students that the last step in the data problem solving process, making a decision, is something that a computer can do automatically if it's given an algorithm. It builds off the previous lesson which demonstrates the importance of designing the way you collect data in order for it to be usable for interpretation. This is especially true for computers which are much better suited for the multiple choice style data they will see in this lesson.

Agenda

Warm Up (5 mins)

Activity (40 mins)

- **Creating the Algorithm**
- **Testing the Algorithm**

Wrap Up (5 mins)

Objectives

Students will be able to:

- Design an algorithm for making decisions using data as inputs
- Explain the benefits and drawbacks of using computers for automated decision making
- Interpret collected data to identify patterns

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Students

- **Automating Data Decisions** - Resource **Make a Copy**
- **Automating Data Decisions** - Activity Guide **Make a Copy**

Teaching Guide

Warm Up (5 mins)

Prompt: Imagine you were going to program a computer to automatically select clothing from your closet for you in the morning. What kinds of data would this computer need? What kinds of rules would you want it to use?

Discuss: Students should silently develop responses, then share in small groups, then discuss with the whole class.

Remarks

> For a computer to make a decision it needs data as input and an algorithm to process it. This is just the input-output-store-process model we learned about before. In the last class we learned hwo to interpret data to understand more about the world. Today we're going to look at how to design algorithms so that a computer can use what we understand to make decisions automatically.

Discussion

Goal: This discussion may be hard to keep small but the point is just to get students thinking about the fact that computers need data (inputs) and rules (i.e. an algorithm) for making a decision (output). So long as students have had a chance to see an example of those three components of the input-output-store-process model of the computer it's fine to move on. That said, here's some ideas students might mention

- Inputs: The temperature, the weather, what kinds of events you have today, etc.
- Rules: If temperature less than 60 bring a jacket, if fancy event put out fancy clothes, if sunny bring sunglasses, etc.

Activity (40 mins)

Creating the Algorithm

Distribute: Copies of **Automating Data Decisions - Activity Guide** and **Automating Data Decisions - Resource**.

Remarks

> Imagine you wanted to use a computer to analyze someone's answers and make a recommendation automatically. A computer doesn't know what "the beach" or "the big city" is and doesn't have an opinion of its own. It will just be able to see which answer someone chose, not the significance of that answer. It needs a person to tell it what to do to turn the answer choices into a recommendation.

Introduce Activity: Read through the instructions as a class, ensuring that students understand how the algorithm works.

Prompt: Based on what you see in the cross-tabulation tables, why do you think that someone created the first rule of the algorithm? Can you think of a better rule?

Make Rules: Have students individually decide on the rules for their algorithms. For each possible answer choice, the students should add points to at least one of the four options of beach, amusement park, national park, or big city.

Discussion

Ensure that students understand that the rule is based on the first row of the "Vacation and Food" table. There is no one "correct" rule based on the data, but someone who prefers ice cream seems very likely to prefer the beach and somewhat likely to prefer an amusement park.

Testing the Algorithm

Group: Assign students into groups of 3-4

Once students have completed the algorithm, they should poll two other students and record their answers on the second page of the worksheet. They then use their algorithms to recommend a vacation spot for that person.

Share Decisions: Have groups share out what vacation spots were chosen based on different answer choices, and whether they feel the algorithm made a good recommendation. If they were not satisfied with the recommendations, encourage them to suggest changes to the algorithm.

Wrap Up (5 mins)

Review: This activity is closely tied with the data problem solving process. Review with students that process quickly and ask them to point out where they see data being collected, interpreted, and a decision being made. Ask them to point out any differences in the process now that a computer is making the decision.

Prompt: Use the Reflection section of the activity guide to have students reflect on the following three prompts

- What is a disadvantage of using an algorithm to make decisions?
- What types of decisions would you not want a computer to make automatically?

Discussion

Goal: This discussion can be used to continue to review the data problem solving process and also make connections between this activity and places where students may have seen computers making decisions. Students should understand that automating decisions is convenient in many situations but may lose some elements that humans would consider in a decision. For example

- Collecting data that's already clean limits what you might collect.
- Automating decisions means sometimes you get a decision you wouldn't have made on your own

There are cases where we might want to automate a decision though. For example

- Where a human might forget / get bored (e.g. automatically re-ordering food when your fridge is low, turning on / off A/C as temperature changes)
- When there's lots of data to consider for a simple decision (e.g. looking through lots of products to find the one with the lowest price)

Standards Alignment

CSTA K-12 Computer Science Standards

- **AP** - Algorithms & Programming
- **DA** - Data & Analysis
- **IC** - Impacts of Computing

Lesson 15: Project - Make a Recommendation

Project

Overview

To conclude this unit, students design a recommendation engine based on data that they collect and analyze from their classmates. After looking at an example of a recommendation app, students follow a project guide to complete this multi-day activity. In the first several steps, students choose what choice they want to help the user to make, what data they need to give the recommendation, create a survey, and collect information about their classmates' choices. They then interpret the data and use what they have learned to create the recommendation algorithm. Last, they use their algorithms to make recommendations to a few classmates. Students perform a peer review and make any necessary updates to their projects before preparing a presentation to the class.

Purpose

This project serves as an assessment for the second chapter of the unit. Students should demonstrate that they can apply the data problem solving process to a problem or domain that they are interested in. Students complete many of the same activities, but linked together in one comprehensive project. For example, students have previously used cross tabulation to find relationships between preferences and have created recommendation algorithms, but in this project, they will use the relationships that they find in the data to create their algorithms. The last step in the activity is intentionally vague on how students will present their work so that you may choose the method that makes the most sense for your classroom.

Agenda

Warm Up (10 mins)

Activity (150 mins)

- **The Sample App**
- **Define**
- **Prepare**
- **Peer Review**
- **Presentation**

Wrap Up (10 mins)

Programming Extension (120 mins)

- **In Design Mode:**
- **In Code Mode:**

Objectives

Students will be able to:

- Apply the data problem solving process to a personally relevant topic
- Determine appropriate sources of data needed to solve a problem

Preparation

- [ ] Print copies of **Make a Recommendation - Project Guide**
- [ ] Print copies of **Make a Recommendation - Peer Review**

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teacher

- **Make a Recommendation** - Exemplars

For the Students

- **Make a Recommendation** - Project Guide **Make a Copy**
- **Make a Recommendation** - Peer Review **Make a Copy**
- **Make a Recommendation** - Rubric **Make a Copy**

Teaching Guide

Warm Up (10 mins)

Review: Quickly review the different problems that students have seen in the chapter so far:

- Which pizza should we order?
- Which ice cream should we choose?
- What video should WebPix recommend?
- Which route should a driver take?
- Which product should Nyle recommend?

Teaching Tip

A quick review: This quick review serves to remind students of the types of problems that they can solve with data before they move onto defining their own data problem. Students should move into working on the project as soon as possible.

Point out that every data decision so far involves a recommendation or prediction, and introduce the project, in which students will use data to make a recommendation for a topic of their choice.

Remarks

> We've looked at many different types of data problems, but they all have to do with making recommendations (such as the Top Video) or predictions (such as the shortest route). Today, you're going to have a chance to use data to make your own recommendation, based on something that you are interested in.

Activity (150 mins)

Solve a Data Problem

Group: This project can be completed individually, but it is recommended that students work in pairs or at most groups of 3.

Distribute: Give students copies of the project guide **Make a Recommendation - Project Guide** and review the instructions on the top of first page with students.

The Sample App

Send students to look at the sample app.

Teaching Tip

If students look at the code, most of it should be comprehensible. The majority of the code works by sending users to new screens, which the students should remember from Unit 4. The app also adds points to different vacation choices as the user clicks on different buttons. This type of functionality should be familiar to students from Unit 3. The only unfamiliar code should be the "recommend()" function, which finds the choice with the most points, then sends the user to that choice's screen.

Code Studio levels

- Sample App
- **Teacher Overview**
- **Student Overview**

Students can see and remix the code to this app at the following URL:

View on Code Studio

https://studio.code.org/projects/applab/Xb03UxRLDJ8BnVIMEhb3iTL1MG1HErh1Xy5Fl5IyqdA/view

Sample App

View on Code Studio

Here is an example of an app that uses data to help the user solve a problem. With a partner, play through the app a few times to see how it works.

Discuss the following questions with your partner:

- What choice does the app help the user to make?
- What data does it use to make that recommendation?
- How do you think the creators of the app decided on the algorithm that they use to make the choice?

You may choose to ask students to look at the code, or just take the quiz to see how it works from the user perspective.

Prompt What choice does the app help the user to make? What data does it use to make that recommendation?

Prompt How do you think the creators of the app decided on the algorithm that they use to make the choice?

Discussion

The first two questions are fairly straightforward. The app helps the user to choose a vacation spot, and it uses data about the user's food, superpower, and animal preferences.

The next question asks students to think about how algorithms are chosen. In a previous lesson, students designed an algorithm for this app by looking at cross tabulation tables for people who had expressed different preferences. Remind students that the creators can use data they have collected to create their algorithm, rather than just making up their rules from their assumptions about the world.

Remarks

> In this project, we're going to use the data problem solving process to help us create our algorithm. We'll survey people to find the relationships between their preferences, then use what we've learned to create an algorithm that can recommend something to the user. First, you and your partner should think about the type of recommendation that you want to make, and the three questions that you will ask to help you make that recommendation.

Define

Step 1 - Define Your Problem: Give students a few minutes to decide on their recommendation topic with their partner.

Prepare

Teaching Tip

The lesson plan assumes a very rigid structure for the algorithm, with four possible recommendations based on three multiple choice questions, each with four answer choices. You may want to give students more freedom in creating their survey and algorithm.

Step 2 - Decide What Data You Need

Give students time to think of the data that they need to help them make the recommendation to the user.

Step 3 - Create Your Survey

Once students have decided on the data, they should put it in survey form. In the initial survey, they will also need to include a question that asks about what they plan to recommend (e.g. a vacation spot). They will use this data to make connections between a user's stated preferences and what they will eventually recommend.

Step 4 - Collect Your Survey Data

Teaching Tip

When to Break: After Step 3 or Step 4 is a good place to break after a first day. Collecting Project Guides at this point will allow you to look over them for any issues that could cause problems for students in the next portion of the lesson. Students may also use this time to collect survey data from people outside the classroom.

Students should give the survey to at least twenty people, in order to make sure there is enough data to interpret in the next step.

Step 5 - Interpret Your Data

Guide students in using cross tabulation to find relationships between the different user preferences. If students are having trouble with this part of the project, you may want to share the exemplar with them or complete a few tables as a class.

Step 6 - Define Your Algorithm

Students use the relationships to create rules for their recommendation algorithm.

Step 7 - Try Out Your Algorithm

Give students time to use their algorithm to make a recommendation to three of their classmates, then reflect on whether they believe the algorithm is effective.

Teaching Tip

This step is slightly different from the algorithm assignment earlier in the chapter. Make sure students understand that they should be creating rules based on the survey data that they have collected and interpreted, not what they believe to be true about the world.

Peer Review

Distribute: peer review worksheet **Make a Recommendation - Peer Review**

Step 8 - Peer Review: Students should complete this peer review for another student's project guide.

Teaching Tip

Another Break: Just before Step 7 is another ideal place for a break. Collect students' project guides and again do a quick check-in to make sure students are on track.

Presentation

Step 9: Students should incorporate their peer feedback by making edits in their project guides. Students should then design some kind of presentation of their work to share with their classmates. While you may choose many different formats, suggested content for the presentation is provided.

Teaching Tip

What kind of presentation? The presentation can take any form you think best for your class: slides, poster, paper, etc. Feel free to update the presentation rubic to fit your exact needs.

Wrap Up (10 mins)

Collect: The rubric is designed to help grade the completed project guide, presentation, and peer review rubric.

Journal: To close the unit either as a full class discussion or individual journal reflection ask students to write about

- What's one thing you like about the way data is being used to solve problems in your life?
- What's one thing you either don't like or concerns you about how data is being used to solve problems in your life?

Send students to Code Studio to complete their reflection on their attitudes toward computer science. Although their answers are anonymous, the aggregated data will be available to you once at least five students have completed the survey.

Discussion

Goal: These prompts are one way you could bring the whole unit to a close. Students have explored the data problem solving process and now should be able to reflect more broadly on the implications of its widespread application. Many services students use every day and that make their lives easier or more interesting involve data problem solving. They have probably seen by now, however, that a lot of information about them, including information they didn't realize they were providing, is being collected. This final journal is a chance to reflect on these and other tradeoffs they've seen in this chapter.

Code Studio levels

- Levels

Programming Extension (120 mins)

Students can also "Remix" the sample app to create their own recommendation app based on this project.

The following will need to be altered in order for the student apps to work.

In Design Mode:

1. Change the "intro" screen to reflect the new topic.
2. Change the text on the three "question" screens to reflect the new questions.
3. Change the answer choices on each "question" screen.
   - Students may choose a text button or an image.
   - Each answer's element id will need to be changed, or the old element deleted and a new element created.
4. Change the "choice" screens to reflect the new recommendation choices.
   - Change the text and the image.

In Code Mode:

1. Change the variable names of the choices.
2. Change the rules to use the new variables and reflect the student's algorithm.
3. In the rules for Question 3, update the list of choices passed to the "recommend()" function.

Standards Alignment

CSTA K-12 Computer Science Standards

- **AP** - Algorithms & Programming
- **DA** - Data & Analysis
- **IC** - Impacts of Computing