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. Afterward, groups compare their responses and discuss how the different representations of the meal data affected how they 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. They then create messages with their systems and exchange with other groups to ensure the system worked as intended. Finally, 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 students to 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 then learns about the ASCII system for representing text using binary symbols and practices using this system. Finally, they encode 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 an entire image. After doing a short set of challenges using the Pixelation Widget, students make connections between the system for representing images and the ASCII system for representing text that they learned about in the previous lesson.

Lesson 5: Representing Numbers

This lesson introduces students to 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.

Week 2

Lesson 6: Combining Representations

Unplugged

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

Lesson 7: 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 8: Create a Representation

Unplugged | Project

The class designs structures 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, students decide how a punch card of bytes of information will be interpreted to represent those pieces of information. Afterwards, they use the ASCII, binary number, and image formats they have learned to represent their perfect days and 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?

Lesson 9: Problem Solving and Data

Unplugged

This lesson covers how the problem solving process can be tailored to deal with data problems. 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: Structuring Data

This lesson goes further into the interpretation of data, including how to clean and visualize raw data sets. The class first looks at 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, students look at which parts of this process can be automated, and which parts need a human.

Week 3

Lesson 11: Interpreting Data

Students begin the lesson by looking at a cake preference survey where respondents specified 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. Students 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 12: Making Decisions with Data

Unplugged

This lesson gives students 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 need to collect more data. The lesson concludes with a discussion about how different people could draw different conclusions from the same data, and how collecting different data might have affected the decisions they made.

Lesson 13: Automating Data Decisions

In this lesson, the class looks 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 suggests a vacation spot. They 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. Next, they use 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.

Lesson 14: Problem Solving with Big Data

This lesson covers how data is collected and used by organizations to solve problems in the real world. Students look at three scenarios that could be solved using data and brainstorm the types of data they would want to use to solve each problem, as well as strategies they could use to collect the data. Each scenario also includes a video about a real-world service that has solved a similar problem with data.

Lesson 15: Data and Machine Learning

Question of the Day: How can machines "learn"?

Week 4

Lesson 16: Project - Make a Recommendation

Unplugged | Project

To conclude this unit, the class designs ways to use data to make recommendations or predictions to help solve a problem. In the first several steps, students brainstorm problems, perform simple research, and define 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.

English

Lesson 1: Representation Matters

Overview

Question of the Day: How does data affect decisions we make everyday?

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.

Assessment Opportunities

1. **Provide examples of how representing data in different ways can affect its ability to solve different problems.**

   WIn the discussion at the end of the activity, students should identify how the nature of each problem lent itself to a particular representation.

2. **Choose the best way to represent some information based on how it will be used.**

   In the discussion at the end of the activity, students should justify the "better" and "worse" representations within the context of the various problems they were asked to solve.

Agenda

Warm Up (5 mins)

Journal

Activity (40 mins)

Person 1
Person 2

View on Code Studio

Objectives

Students will be able to:

- 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 the Meals Data resource so that each group can get one of the four pages
- [ ] Print one copy of the activity guide for each group

Links

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

For the Teachers

- **Unit 5 Data & Society** - Slides
- **Representation Matters** - Exemplar
- **Meals Data** - Resource

For the Students

- **Representation Matters** - Activity Guide
  Make a Copy

- Person 3
- Person 4
- Reflection

Wrap Up (5 mins)

- Journal

Teaching Guide

Warm Up (5 mins)

Remarks

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

Journal

Prompt:

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

Discuss: 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 down in the front of the classroom.

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.

Discussion Goal

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.

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."

Question of the Day: How does data affect decisions we make everyday?

Activity (40 mins)

Group: Put students into groups of 3-5.

Distribute: Give each group a copy of the 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.

Display: Read through the instructions for this activity. Each group of students will make a meal recommendation to four different people, and they must justify their recommendation with only their group's data. Because different groups have different data sets, the difficulty of the recommendations will vary from group to group.

Circulate: Allow students to complete the activity in their groups. Monitor conversations to ensure groups are discussing each others ideas, and making reference to the data they have.

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.

Representation Matters

> 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.

Reflection

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

Share-Out: When all groups have completed the worksheet, come back together as a class and ask one person from each group to share the answers and reasoning for each recommendation. As the groups share answers and reasoning, allow them to see each other's data sets.

Display: As groups share the datasets they used, use the slides to highlight their data so the entire class can see

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?

Assessment Opportunity

Goal: Students should understand that different representations are good for solving different problems. As they explain which representations are better or worse, make sure that they are justifying their choices within the context of particular problems they were asked to solve in the activity. They should recognize that each representation had advantages and disadvantages for different problems, and identify how the nature of each problem lent itself to a particular representation.

Discuss: Allow students to reflect on their own before discussing with a partner. Ask a few partners to share with the class.

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.

Wrap Up (5 mins)

Journal

Prompt: 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 (2017)

- **DA** - Data & Analysis

Lesson 2: Patterns and Representation

Overview

Question of the Day: How can we create a system for representing information?

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 uses 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.

Assessment Opportunities

1. **Describe the necessary features of a system for representing information**

   Wrap up: students should identify key features that their systems needed to be effective.

2. **Create and use a system for representing information**

View on Code Studio

Objectives

Students will be able to:

- Describe the necessary features of a system for representing information
- Create and use a system for representing information

Preparation

- [ ] Print one copy of the activity guide for each group of 2-3
- [ ] Print and cut up one copy of the manipulative resource for each group of 2-3

Links

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

For the Teachers

- **Unit 5 Data & Society** - Slides
- **Representing Information** - Exemplar

For the Students

- **Representing Information** - Activity Guide Make a Copy
- **Animal Shapes** - Manipulative 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

Activity Guide: There should be a unique code for each letter on the activity guide, with a system for determining when one letter stops and the other begins. During the activity, you may also want to circulate to see the codes in use.

Agenda

Warm Up (5 mins)

- **Journal**

Activity (35 mins)

Wrap Up (5 mins)

- **Journal**

Teaching Guide

Warm Up (5 mins)

Journal

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 one possible pair of responses you could use so your friend understood, but there are many more possible pairs.

List as many many different ways that you could write, say, or represent the answer to a "Yes-No" question.

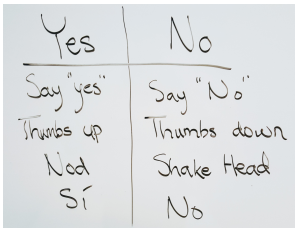
Discuss: Students should brainstorm silently, then share with their tables, then finally share as a class. Write down ideas in a table at the front of the room as ideas are shared.

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

Ask students to discuss with a partner before asking a few students to share with the class. There is no one right or wrong answer to this prompt.

Discussion Goal

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

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.

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.

Question of the Day: How can we create a system for representing information?

Activity (35 mins)

Group: Place students in groups of two or three.

Distribute: Give each group a copy of the activity guide and a set of animal shapes. If possible, try to have them cut beforehand to save time - otherwise, have the group cut their own set.

Activity Guide - Representing Information

Display: Review the rules of the activity with the class. Students are asked to create rules that let you represent any word you want using a single row of cards. Another person should be able to use the rules you write on the activity guide to read the words represented by your row of cards without talking to you.

Brainstorm: 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.

Circulate: Monitor group progress, listening for groups working together and listening to each other's ideas. Offer tips or starter-patterns if a group appears particularly stuck in coming up with their initial set of rules.

Test Rules: Once students have finished developing their rules, have them pick a new short word to represent and carefully make a single row of cards to represent their word. Groups should trade with each other by either rotating around the room to visit other groups, or passing their rules and cards around the room. Groups should then carefully decode the word using the rules from the other group.

When they are finished, groups should check with the original rule creators to see if they successfully decoded the word.

Circulate: Monitor groups as they exchange cards & rules, making sure no cards get jumbled in the process. Encourage groups to follow the rules exactly as written, even if they are different from the rules their group came up with.

Feedback & Revision: 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 using the phrases "I Like..." and "I Wish...". Provide some time for each group to revise their rules if necessary.

Test Rules Again: Have groups prepare a row 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.

Content Corner

Understanding the Activity: The fact that there are only six 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 row means that they will need to indicate when one pattern stops and the next begins. Computer scientists run up against these same challenges when designing 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. There is no one "best" system and so what matters is that each group collectively decides to use the same one. Again this is true of representation systems students will see in coming lessons.

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 feel their system is still incomplete.

Wrap Up (5 mins)

Journal

Prompt:

- 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?

Assessment Opportunity

Students should recognize that even very different sets of systems for representing this information could work, but that each system must share key features to work. For example:

- Each letter needs a separate pattern
- We need to know when one pattern stops and the next starts.

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 "understand" the world the way humans do. 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.

Vocabulary: Introduce the following terms

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

Standards Alignment

CSTA K-12 Computer Science Standards (2017)

▶ **DA** - Data & Analysis

Lesson 3: ASCII and Binary Representation

Overview

Question of the Day: What system do computers use to represent letters and words?

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.

Assessment Opportunities

1. **Define a binary system as one that uses just two possible states to represent information**

   Activity Guide: Students create their own binary system to create their own encoded messages.

2. **Use the ASCII system to encode and decode text information in binary**

   Activity Guide: The messages should be encoded and decoded correctly on the activity guide. Check to make sure students are only using two elements in the encoding challenge, and that there are no spaces in the encoded message.

Agenda

Warm Up (5 mins)

Journal

Activity (35 mins)

Wrap Up (5 mins)

View on Code Studio

Objectives

Students will be able to:

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

Preparation

- [ ] Print copies of the activity guide - 1 per student
- [ ] Print copies of the ASCII text resource - 1 for each pair of students

Links

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

For the Teachers

- **Unit 5 Data & Society** - Slides
- **ASCII** - Exemplar

For the Students

- **ASCII Text** - Resource Make a Copy
- **ASCII Challenges** - Activity Guide Make a Copy

Teaching Guide

Warm Up (5 mins)

Journal

Prompt: Yesterday's activity used six different animal symbols to represent letters. Do you think we could do the same activity with only two symbols instead? Would that change the patterns you used yesterday?

Discuss: Have students discuss their answers with a neighbor but don't worry about sharing out as a full group. Instead, begin transitioning to the main activity.

> Teaching Tip
>
> **Jump to the Activity:** This introductory prompt 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.

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 or off. 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.

Question of the Day: What system do computers use to represent letters and words?

Activity (35 mins)

Group: Place students in pairs

Distribute: one copy of the ASCII Text resource per pair of students, and copies of the ASCII Challenges activity guide to each individual student

ASCII Text Resource

> **ASCII Text:** Read this section of the resource as a class. Help students with the pronunciation of ASCII (ask-ee). After reading both paragraphs, display the vocabulary for the class to see.
>
> **Vocabulary:**
>
> - **Binary System:** a way of representing information using only two options
> - **ASCII:** a popular system for representing text in binary
>
> **Display:** Review the ASCII table with students, emphasizing that this table is one way to solve the problem introduced in the warm-up journal prompt. Inform students that ASCII is the system that likely every computer they've ever used uses to represent letters. Once the table has been discussed, have students use the table to solve the challenges in the activity guide.

ASCII Challenges Activity Guide

> **Display:** Have students decode the three messages in pairs, checking answers with each other as they work.
>
> **Circulate:** Be on the lookout for strategies pairs use to decode the messages. Encourage pairs to check their answers with you before continuing to the back of the activity guide.
>
> **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 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 (5 mins)

Share-out: Ask students to share the symbols they used for their binary system when creating their own messages. Have several students share their ideas.

Remarks

> All of these are valid binary systems, where we can represent letters with just two pieces of information. Computers have their own binary system - they use 0's and 1's to represent information. This is why you may have heard that computer science is all "0's and 1's". When you have a single 0 or 1, that is called one **bit** of information.

Vocabulary:

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

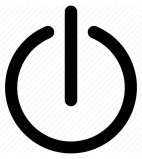
Remarks

> 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 the characters are often associated with the binary number system, which is presented in a later lesson. If this comes up, acknowledge there's lots of extra information to know about that we'll continue to explore in later lessons.

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



Standards Alignment

CSTA K-12 Computer Science Standards (2017)

- **DA** - Data & Analysis

Lesson 4: Representing Images

Overview

Question of the Day: What system do computers use to represent images?

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.

Assessment Opportunities

1. **Create and manipulate binary patterns to represent black and white images**

   Code Studio: In bubble 3, the student should have created a smiley face with the widget.

2. **Describe common features of systems used to represent information in binary**

   Wrap up: Students should identify key shared features of the binary systems they have seen.

Agenda

View on Code Studio

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 Teachers

- **Unit 5 Data & Society** - Slides

Warm Up (5 mins)

- Journal

Activity (35 mins)

Wrap Up (5 mins)

- Journal

Teaching Guide

Warm Up (5 mins)

Display: Show the images of the bicycle and tree to students from the first slide

Journal

Prompt: What would be challenging about representing these two pictures 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: What strategy is being used with these examples that might help a computer 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

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

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.

Question of the Day: What systems do computers use to represent images?

Activity (35 mins)

Vocabulary: Briefly introduce the following vocabulary

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

Code Studio: Have students navigate to this lesson in Code Studio beginning on Level 2.

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.

Pixelation Widget

> **Level 2:** Students learn to type 0s and 1s to turn on the pixels of a 10 by 10 X-pattern.
>
> **Level 3:** Students make a 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.
>
> **Level 4:** Students change the width slider to "find" the image from a set of bits.

Level 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.

Level 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 time students can always come back to finish their drawings.

Share-Out: As students begin to finish up, have them share the images they created with one another. Consider creating a digital gallery for students to post their images and share beyond the classroom.

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.

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 (5 mins)

Journal

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.

Assessment Opportunity

The first discussion calls out that both systems were breaking down complex information such as 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. Students should recognize that 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. Students should recognize that for any system to work, it must be known to everyone who needs to use it. They may also recognize that this system should be unambiguous, so that there is only one way to interpret a given sequence of bits.

Standards Alignment

CSTA K-12 Computer Science Standards (2017)

▶ **DA** - Data & Analysis

Lesson 5: Representing Numbers

Overview

Question of the Day: What system do computers use to represent numbers?

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.

Assessment Opportunities

1. **Use a binary system to represent numbers.**

   Activity Guide, page 1: Student answers should match the key, noting that the last three questions may have different answers student to student.

2. **Extend a representation system based on patterns.**

   Activity Guide, page 1: On the bottom of the page, students should correctly extend the pattern to 5- and 6-bit numbers.

Agenda

Warm Up (5 mins)

Journal

Activity (35 mins)

Wrap Up (5 min)

View on Code Studio

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 Teachers

- **Unit 5 Data & Society** - Slides
- **Number Cards** - Digital Manipulative
- **Representing Numbers** - Exemplar

For the Students

- **How Computers Work - Data and Binary** - Video (**download**)
- **Representing Numbers 2021** - Activity Guide Make a Copy
- **Number Cards** - Manipulative Make a Copy

Teaching Guide

Warm Up (5 mins)

Journal

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

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.

Question of the Day: What system do computers use to represent numbers?

Activity (35 mins)

Group: Put students into pairs.

Distribute: Give each student a copy of the activity guide and a set of number cards.

Representing Numbers Activity Guide

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)

Do This: Allow students to complete the rest of the front page of the activity in pairs. Instruct students to check with you before moving to the back page.

Circulate: Monitor students as they progress through the activity, looking for students working well in pairs. If students get stuck, suggest they use the number card manipulatives to help themselves out.

Share-Out: Ask students to share out their responses as a way of checking their answers. In particular, make sure the entire class agrees on the last few questions where they predict the pattern for 5-bit and 6-bit numbers.

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

Discuss: Allow students to check with other pairs and try to find another way to represent the numbers before regrouping and discussing as a class.

Teaching Tip

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

Teaching Tip

Digital Manipulatives: A digital version of the binary cards are provided in the teacher resources for you to make your own copy. To use with students: have the presentation open but not in “present” mode - this will let you move the cards as if you are covering or uncovering different cards.

Focus on Binary System: 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.

Display: Have students flip to the back of their worksheet. In the top section, students will create a Binary Profile by answering a few questions and encoding their answers as binary numbers. Once completed, they will trade with a partner and use the widget to decode their binary profile to reveal the answers so humans can understand them.

Code Studio: Send students to the Binary Number widget.

Discussion Goal

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.

Circulate: Allow students to complete the top half of the worksheet with the support of the widget. When both students in a pair have finished, have them trade papers to decode the other person's profile. When they finish, have them trade back and verify the answers were correct.

Challenge: If students have finished encoding and decoding their Binary profiles, have them create a new question that they can trade with another student in the room.

Prompt: The last question on this activity guide uses an 8-bit number, even though we haven't talked about how to represent these numbers yet. Do you think we can figure out what numbers are needed for 8-bit numbers? How?

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

Discussion Goal

Goal Students should recognize that the patterns of the numbers and the rules that they follow can help them determine the next numbers in the sequence. For an 8-bit number, starting from the left, the pattern goes **128 | 64 | 32 | 16 | 8 | 4 | 2 | 1**.

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.

Wrap Up (5 min)

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?

Allow 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.

Standards Alignment

CSTA K-12 Computer Science Standards (2017)

- **DA** - Data & Analysis

Lesson 6: Combining Representations

Overview

Question of the Day: How do computers tell the difference between binary codes for letters, numbers, or images?

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.

Assessment Opportunities

1. **Use multiple binary systems to decode information.**

   Activity Guide, page 2: In the chart at the bottom of the page, the data should be decoded as in the answer key.

2. **Determine the most appropriate encoding system for a given piece of information.**

   Activity Guide, page 2: The method of encoding the new information should be appropriate for the information type (e.g. numbers for height, ASCII for location).

Agenda

Warm Up (5 mins)

Journal

Activity (35 mins)

Wrap Up (5 mins)

Journal

View on Code Studio

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.

Preparation

- [ ] Have the 8-Bit Binary Widget and Binary to ASCII Table ready to model with the class

Links

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

For the Teachers

- **Unit 5 Data & Society** - Slides
- **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 (5 mins)

Journal

Display: Show students the binary code in the slides

Prompt: A friend sent you the binary message above, but did not send any encoding system to help you decide what it means. Using what you already know about binary systems: write down at least 2 things that this message could represent

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

Prompt: Tell students that this friend has told you that this code represents a number, but nothing else. What do you think this number could represent for your friend?

Discussion Goal

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.

Discussion Goal

Goal: Push students past the answer that the number is just 67. One way to do this to note that if a stranger approached them and said "67" out of the blue, would they know what that person was talking about?

Students should come up with some different possible meanings of the number, such as an age, a temperature, an address, etc. The larger realization should be that, 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.

Question of the Day: How do computers tell the difference between binary codes for letters, numbers, or images?

Activity (35 mins)

Remarks

> In our last lesson, we made binary profile's by answering a few questions about ourselves. Imagine that we now work for our school and we need to come up with a similar system to hold information about students in the class.

Prompt: What types of information would the school want to know about each student? How should it keep track of all this information?

Discuss: Let students talk with a partner before bringing to a full group. Ask a few students to share their ideas before continuing to the student record example.

Display: Display the binary student record and the rules for encoding it. Explain that this is one possible student record system

Discussion Goal

Goal Encourage students to make connections between the previous lesson, where they made numerical binary profiles as practice, and this more realistic scenario of keeping track of student information for a school. Encourage students to think beyond just numerical data - for example, a school may need to keep a picture of you for your ID, and your name and address, and other information.

It’s okay for students to be less sure about how the information should be tracked. Students may suggest keeping a long list or having a large table. When punchcards are introduced later, make connections back to these suggestions and note any similarities between students’ ideas and the punchcard.

Model: Show students how to decode this record as a class. You should use the new **8-bit binary widget in Code Studio (UPDATE LATER)** for the numerical rows, and the ASCII to Binary Table for the letter rows. Encourage the class to assist you with the correct steps in using these resources.

Remarks

> This is a pretty good start for a student record, and there are many different rows we can add to this. Let's look at another example where keeping a record is important: keeping track of information for animals when we take them to the vet.

Group: Put students into pairs.

Distribute: Give a copy of the activity guide and Binary to ASCII Tabkle. Ensure each group has access to the 8-bit binary widget in Code Studio

Pet Records Activity Guide

Display: Read through the first section of the activity guide as a class and clarify any questions from students.

Do This: 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.

Circulate: Make sure students are using their resources to help solve this problem, especially the Binary widget and the ASCII to Binary Table. Students can check their answers to the first page with you before continuing to the second page.

Display: As students finish up the first page, discuss the new record on the second page of the activity guide. The image is replaced with a new integer and characters, because the image itself did not hold enough information to be very useful. Clarify any questions about this new record before having students continue.

Do This: Have students decode the second punchcard.

Circulate: Monitor student progress to check on how they are decoding the punchcard. This can also be an opportunity to ask students about their own pets and what a punchcard for their animals might look like.

Share Out: On the bottom of 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.

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 this lesson, we looked at two topics that could involve personal information - your student data and medical history. In the next lesson, we'll look at how we can keep that information safe and protected. We don't want just anyone to be able to look up sensitive information about ourselves!

Content Corner

8-Bit Consistency: In previous lessons, ASCII has used 7 bits and numbers were between 4 and 8 bits. In this lesson, we begin to organize the information into sets of 8 bits, called a **byte**. This is a standard unit for binary information that is used in many different contexts.

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

Punchcards in History: Punchcards were used frequently in the early days of computer science - stories of their use can be researched online. Remnants of this technology can still be found when students fill in bubble sheets for standardized tests - the way these exams are graded mimics how a computer decodes a punchcard.

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.

Wrap Up (5 mins)

Journal

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

Standards Alignment

CSTA K-12 Computer Science Standards (2017)

- ▶ **DA** - Data & Analysis

Lesson 7: Keeping Data Secret

Overview

Question of the Day: How can we keep data secret and protect it from misuse?

Students continue to explore how data is represented in a punchcard, and begin considering whether some data should be protected from public view because it is too personal or sensitive. Once students understand the reasons for protecting data, they learn a binary encryption system that lets them encrypt and decrypt data in their punchcards, and eventually they are able to send secret messages to one another using this method. Class concludes with a discussion on the importance of protecting our information and how encryption is one way we can accomplish this.

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 even when that information has been highly personal or sensitive (such as addresses or phone numbers). In this lesson, they begin to think about how they can ensure that only the intended recipient can read the data that they send. The lesson is framed around the real-world issues of keeping medical history protected, allowing students to see how this issue extends to real-world scenarios and may be impacting their lives without them being aware of it.

Assessment Opportunities

1. **Describe the reasons encryption is needed to protect personal data**

   Activity Guide Page 1: Students describe the data within a medical card that should be kept secret because it is too personal and brainstorm ways personal data could be used inappropriately if revealed.

2. **Apply a method of encryption to ensure the secure transmission of data**

   Activity Guide, page 2: Students decrypt several medical records to reveal the conditions of their users. Use the answer key to check whether students have completed each decryption successfully.

Agenda

Warm Up (5 mins)

Journal

View on Code Studio

Objectives

Students will be able to:

- Describe the reasons encryption is needed to protect personal data
- Apply a method of encryption to ensure the secure transmission of data.

Links

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

For the Teachers

- **Unit 5 Data & Society** - Slides

For the Students

- **Medical Records** - Activity Guide
  Make a Copy
- **Secret Messages 2021** - Activity Guide
  Make a Copy

Vocabulary

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

Activity (35 mins)

Wrap Up (5 mins)

Journal

Teaching Guide

Warm Up (5 mins)

Journal

Prompt: A school keeps track of several pieces of information about each student, including:

- Their name
- Their age
- Their address
- A home phone number
- Any allergies they have
- Emergency contact information

What information in this list do you think is okay to be accessed by anyone who is interested? What about just your teachers? What about only you and your family?

Discussion Goal

Goal: Students should determine that not all information in this record should be made public, but that there are also times when this information could be useful to specific people. For example: maybe allergies or emergency contact shouldn't be available widely, but they could be useful for a teacher in case there's an issue. There is no definitive right-or-wrong answer to this - it's more important to let students explain their reasoning and hear different opinions that may cause them to consider new situations for how this information could be used.

Discuss: Have students write their responses individually in their journals, then share with a neighbor before finally having a full-class discussion.

Remarks

> We've seen how to represent data using different binary systems, but we haven't talked about who has access to this data or how it could be used. In today's lesson, we'll look at situations where it could be important to protect our data and strategies we can use to keep data secret.

Question of the Day: How can we keep data secret and protect it from misuse?

Activity (35 mins)

Distribute: Medical Record Activity Guide. Read through the introduction of the activity guide together, introducing the new Medical Punchcard.

Medical Record Activity Guide

Display: Show the example of the medical punchcard, emphasizing how to decode the last row of Medical History. Emphasize that each square corresponds to a specific question, and that white represents a "yes" answer and black represents a "no" answer.

Teaching Tip

Teaching Tip: The focus in this lesson is on the Medical History section of the card, which is why students are not asked to decode the Binary numbers or ASCII codes. However, if students still need a bit more practice with these skills, this can also be an opportunity to reinforce these skills by talking through the other rows of the medical card.

Additional Practice: Ask students to talk with a partner to decode two more examples of medical history displayed in the unit slides. Clicking the animation in the slide will reveal the answers when ready.

Prompt: What are situations where this information would be useful for someone when making a decision? What are situations where this information could be inappropriate for someone when making a decision?

Discuss: Have students write their thoughts in their activity guide first, then share with a partner and then bring to a full-class discussion.

Remarks

> Keeping track or personal or sensitive data is important for very specific uses, but it's also important to protect that data to make sure only the right people can view it. One way we can do that is using a process called encryption.

Vocabulary: Display the following vocabulary terms:

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

Display: Have students turn to the second page of their activity guide. Read through the introduction together to define algorithm and key

Display: Model the encryption algorithm as a class and demonstrate how the first four boxes of the example have been done for students. Have students complete the next four boxes on their own, then click the animation in the slide to check the answer together.

Do This: Have students complete the other four examples, decrypting each row of medical history and using it to answer the questions below.

Circulate: Monitor student progress, checking to make sure students are correctly applying the algorithm to the first square before continuing to the others. Encourage students to check in with their partners and talk through any inconsistencies between their work.

Discussion Goal

Goal: Students may discuss useful situations where doctors or nurses can use the medical information within the hospital. They may also mention that the information could be used in emergency situations outside of the hospital.

When brainstorming inappropriate situations, try to guide the conversation towards places where these decisions can be exclusionary or discriminatory. For example, when applying for a job, it is inappropriate for an employer to not hire you if you have asthma. Or, when trying out for a sports team, it is inappropriate to be rejected because you broke a bone several years ago but it's healed up now.

Content Corner

Content Corner: Students may be initially confused about 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 can 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 using a secret key that only they know. It is used for security and privacy.

Extension: For students who finish up early, distribute copies of the Secret Messages activity guide. Encourage students to create their own secret messages using ASCII, then trade them with another student and challenge them to decrypt it.

Wrap Up (5 mins)

Journal

Prompt: What is another piece of personal information you think should be protected? How could it be used inappropriately when making a decision if it ever became public?

Discuss: Have students reflect individually before sharing with a partner and as a class.

Discussion Goal

Goal: Students may come up with a variety of ideas beyond medical or personal information, such as personal profile pictures, family income information, or ancestral or historical information. Encourage them to reflect on situations where it would be inappropriate for that information to be used to make a decision.

Standards Alignment

CSTA K-12 Computer Science Standards (2017)

- **NI** - Networks & the Internet

English

Lesson 8: Create a Representation

Overview

Question of the Day: How can I represent complex information using binary systems?

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 decode 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.

Assessment Opportunities

Use the project rubric attached to this lesson to assess student mastery of learning goals of this chapter.

Agenda

Warm Up (5 mins)

Journal

Activity (35 mins)

Wrap Up (5 mins)

View on Code Studio

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 Teachers

- **Unit 5 Data & Society** - Slides
- **Create a Representation** - Exemplars

For the Students

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

Teaching Guide

Warm Up (5 mins)

Journal

Prompt: Throughout this unit, we've used binary systems to represent a wide variety of information from our world. Make a list of all the information we've represented in this unit so far.

Discuss: Have students write in their journals individually, then call on different students to share items from their list with the whole class. Keep track of the items they suggest in front of the room.

Discussion Goal

Goal: Students may remember that they've represented personal information like names, age, weight, etc using binary systems. They've also represented images using pixels, and represented text using ASCII. This brainstorm helps students review all of the tasks from this past unit, which they will need to rely on for today's project.

Remarks

> This is a great list, and it shows that there are a lot of things in our lives that we can represent using the binary systems we've learned. Today, we're going to challenge ourselves and try to represent something more complex using just binary: we're going to try and represent a story about our perfect day using just a binary system.

Question of the Day: How can I represent complex information using binary systems?

Activity (35 mins)

Group: Have students sit in pairs so they can work collaboratively on this project.

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. You don't need to write down anything yet.

Distribute: Give students copies of the Project Guide

Project Guide - Create a Representation

> **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 - Choose Representations:** 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 Representations: The goal here is to break up the "perfect day" into individual items, which can then be represented individually with a binary system. 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.

Remarks

> Hopefully you noticed both you and your partner had some common information when describing your perfect day. I wonder if there are more things we have in common as an entire class? Let's see if we can find enough pieces of common information that we can use to create class-wide punchcard for all of us to represent our perfect day.

Display: Display the punch card from the project guide. Emphasize that the card has space for three numbers, an eight character word, and an image. 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 5 - Full Class Activity - Agree on Classwide Punch Card: Have partners share the categories of information they wish to represent, recording them in the front of the room. Have the class decide what information they want to use for each number, their word, and their image.

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 on their punchcard. 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?

Discussion Goal

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.

Wrap Up (5 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.

Code Studio: 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.

Standards Alignment

CSTA K-12 Computer Science Standards (2017)

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

Lesson 9: Problem Solving and Data

Overview

Question of the Day: How can we use data to solve problems in our community?

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 to 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.

Assessment Opportunities

1. **Use the problem solving process to answer a question using data.**

   Journal Prompt: As students reflect on the problem solving process that they used, they should identify how they used each step in solving their problem.

2. **Identify and collect relevant data to help solve a problem.**

   Activity Guide, page 1: In the "Prepare" section, relevant data should be identified and recorded.

3. **Use data to draw conclusions.**

   Activity Guide, page 2: The reasons justifying the student's choice should be clearly related to the cited data.

Agenda

Warm up (5 mins)
Activity (35 mins)
- **Define**
- **Prepare**
- **Try**
- **Reflect**

Wrap Up

View on Code Studio

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 Teachers

- **Unit 5 Data & Society** - Slides
- **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 In your journal, when was the last time that you looked for information on the Internet? Why did you need it?

Discuss: Have students journal individually, then share with a neighbor, and finally discuss as a whole class.

Discussion Goal

The goal of this discussion is 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.

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.

Question of the Day: How can we use data to solve problems in our community?

Activity (35 mins)

Introduce students to the scenario they will encounter in in the activity guide. You should aim to choose a location in your city or town that your students will be familiar with. If this isn't possible, you can use use an example location such as the Columbia Mall in Columbia, Missouri (MO).

Remarks

> For this activity, we're going to be experts hired to give advice on what they should build in a new location by the local mall. The city has the money to build something nearby, 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. We will use the Problem Solving Process to solve this problem.

The Problem Solving Process: Remind students of the problem solving process: Define, Prepare, Try, Reflect. We will use this process to solve today's problem.

Group: Put students into groups of 3-4

Distribute: Distribute copies of **Problem Solving with Data - Activity Guide**, one per student.

Solving a Data Problem

Define

Prompt: What is the problem you are trying to solve? Ask students to write down the problem in their activity guide, then allow them to discuss with a partner.

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

Discussion Goal

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

Prompt: What data do you need to solve your problem? Write down three types of data that might help you to decide what the city needs the most. In a moment, you'll be sharing these ideas with a group and deciding which ones to investigate.

Circulate: Give students a few minutes to complete this individually, then ask students to share their ideas with 2-3 other classmates in small groups. Encourage groups to continue adding types of data to their list as they get more ideas from their classmates.

Remarks

> I heard some really great ideas - this is a lot of data! We may not be able to find it all, but we're going to split into groups and look for this data on the internet.

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)

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

Share Out: Bring the class back together to share the data. Record the results of the research somewhere public and in front of the classroom so everyone can see. When this is finished, you should have a class list of facts and information that students can use to help make a decision.

Try

Discussion: Allow each group to discuss 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.

Share Out: Have groups share out their decisions, as well as the reasons and data that support them. Assure them that it's fine to have multiple answers, as long as data is being used to support their ideas.

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 Goal

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.

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 (2017)

- **DA** - Data & Analysis

Lesson 10: Structuring Data

Overview

Question of the Day: how can we make it easier for computers to process data?

In this lesson, students go further into the collection and interpretation of data, including cleaning and visualizing data. Students first look at how presenting data in different ways can help people to understand it better, and they then create visualizations of their own data. Using 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 discuss 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 see how data must be structured in particular ways to be used by a computer.

Assessment Opportunities

1. **Identify and remove irrelevant data from a data set.**

   As students clean their data in the digital activity, circulate and ask them about the choices that they are making. You may also use the discussion afterwards as a time for them to explain what data they identified as irrelevant.

2. **Create a bar chart based on a set of data.**

   Activity Guide: The bar chart should be filled in. Answers may vary slightly, but should overall be approximately the same as in the exemplar.

3. **Explain why a set of data must be cleaned before a computer can use it.**

   Activity Guide: Students should identify data that needs to be cleaned and explain why it is problematic in its raw form. You can also use the discussion afterwards to prompt students to give a more explicit explanation of why it is necessary.

Agenda

Warm Up (5 mins)

Journal

View on Code Studio

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 Teachers

- **Unit 5 Data & Society** - Slides
- **Structuring Data** - Exemplar

For the Students

- **Structuring Data 2021** - Activity Guide
  Make a Copy

Activity (35 mins)

Wrap Up (5 mins)

Journal

Teaching Guide

Warm Up (5 mins)

As students enter, have the warm-up slide projected on the board which contains 3 different representations from a "Best Class Pet" survey.

Journal

Prompt Which one of these 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?

Discuss: Have students journal individually, then share with a neighbor, and finally discuss as a whole class. You can record their ideas on the board to refer back to later in the class.

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.

Question of the Day: how can we make it easy for computers to process data?

Discussion Goal

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.

Activity (35 mins)

Group: Put students into pairs and give each pair a copy of **Structuring Data 2021 - Activity Guide**.

Structing 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).

Do This: Have students create the bar chart for the set of raw data given. Some of the answers will intentionally not easily fall into the given choices.

Circulate: 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. Listen for students discussing & collaborating with their partners as they make these decisions.

Assessment Opportunity

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 students don't bring it up.

Reflect: Have students answer the reflection questions on the bottom of the activity guide.

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. What would happen if the computer tried to make a chart with the same data you started with? Do you think it will look the same as yours?

Discuss: Ask students to discuss this prompt with a neighbor. As they do this, pull up the **Pizza Party Data App (TEMP LINK)** so all students can see it.

Pizza Party Data App: Demonstrate the app to the class, explaining that this app has the same data you all had plus a little more. You can scroll through the first screen to see all of the data available, pointing out some new answers that may also be hard to categorize.

Emphasize the "Show Chart" button at the top of the app and ask students to predict what the chart will look like on the next screen. You can ask students to share their ideas, but don't interpret them as "right" or "wrong" - let students brainstorm a few guesses before clicking the button and revealing the next screen.

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

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.

Discussion Goal

Students should notice that the computer used all the answers in the chart, even the ones that were irrelevant. Students should also notice that it didn't correct any spelling or fix any differences in capitalization - for example, "Cheese" and "cheese" appear as two separate rows on the chart.

Have students turn to the next page in their Activity Guide. We will use this page to help "clean" the data for a computer so it will be easier to interpret.

Do This: Ask students to finish in pairs, cleaning the data and narrowing in on at most 7 choices from the answers. Then decide which pizza topping is the best choice.

Prompt: What changes did you need to make to the data? Was there any that you just needed to throw away completely? Why?

Prompt: This was a lot of work, and it was only about twenty 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.

Assessment Opportunity

Students should notice that some data, such as minor misspellings, could be easily "cleaned" into an appropriate category, but that other data, such as "I will be absent", needed to be removed from the set entirely.

Discussion Goal

In the end, students should realize that constraining a user's choices can help with this - for example, by using multiple choice rather than a write in answer. They may also bring up ignoring capitalization so "cheese" and "Cheese" aren't two different results.

Remarks

> When we work with large amounts of data, we want to automate as much of the problem solving 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 (5 mins)

Journal

Prompt: Can you think of a time in the past when you had data collected about you, maybe by filling out a form? What do you think were some strategies this form used to help make sure it collected clean data?

Standards Alignment

CSTA K-12 Computer Science Standards (2017)

▶ **DA** - Data & Analysis

English

Lesson 11: Interpreting Data

Overview

Question of the Day: How can patterns in data help us make decisions?

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 lesson, students used data visualization to help them make decisions using a single data source (toppings on a pizza). 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.

Assessment Opportunities

1. **Visually organize data to highlight relationships and support a claim.**

   Activity Guide: The charts on the left side of the page should be filled out to reflect the given data. (See exemplar)

2. **Use cross tabulation to find patterns and relationships in data**

   Activity Guide: The relationships on the right side should demonstrate accurate analysis of the frequency table. (See exemplar)

Agenda

Warm Up (5 mins)
- **Journal**

Activity (40 mins)

Wrap Up (5 mins)
- **Journal**

View on Code Studio

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 Teachers

- **Unit 5 Data & Society** - Slides
- **Interpreting Data** - Exemplar

For the Students

- **Interpreting Data** - Activity Guide
  Make a Copy
- **Interpreting Data** - Resource
  Make a Copy

Teaching Guide

Warm Up (5 mins)

Display: As students enter, have the Warm-Up slide displayed on the board

Remarks

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

Journal

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

Share Out: Have students share their choices and why.

Remarks

> 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 Goal

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.

Question of the Day: How can patterns in data help us make decisions?

Activity (40 mins)

Group: Put students in groups of 2-3.

Distribute: Give each group a copy of the activity guide and data resource.

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.

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.

Interpreting Data Activity Guide

> Read the instructions as a class, then direct students to look at the first table on the activity guide.
>
> **Slides:** Display the Finding Relationships Example slide then click-through the animations in the slide to model how to fill in the the chart with the class. For each row of the survey results, add one tally to the chart. After modeling the first five rows, allow students to complete the rest of the chart on their activity guide.
>
> **Prompt:** If someone likes cats, what activity is probably their favorite? What is one more interesting relationship between favorite pet and favorite activity?
>
> **Share-Out:** Allow students time to write down their answer, then check with their group before sharing out as a class.

Discussion Goal

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.

Do This: Direct students to complete the worksheet in their groups.

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 the last chart on activity and sport preferences.

Share Out: Before moving on to the reflection question, give students a chance to share out 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?

Give students time to answer this on their activity guide, then have students share their thoughts with the class.

Teaching Tip

Students may be tempted to think of reasons that different preferences 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.

Discussion Goal

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.

Wrap Up (5 mins)

Journal

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?

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 12: Making Decisions with Data

Overview

Question of the Day - how can patterns in data help make a decision?

In this lesson students get practice making decisions with data based on 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, 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.

Assessment Opportunities

1. **Use tables and visualizations summarizing data to support a decision**

   Activity Guide: The decision recorded on each page should be logically connected to the given data. You may also use the discussion to have students further explain or justify their decisions.

2. **Identify additional data that could be collected to improve a decision**

   Activity Guide: The extra data should be relevant to the given problem. The final discussion can also be used for insight into how students might use the data to improve their decisions.

Agenda

View on Code Studio

Objectives

Students will be able to:

- Use tables and visualizations summarizing data to support a decision
- Identify additional data that could be collected to improve a decision

Preparation

- [ ] Print copies of the activity guide
- [ ] Print copies of the Problem Solving Process with Data - one per group

Links

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

For the Teachers

- **Unit 5 Data & Society** - Slides
- **Making Decisions With Data** - Exemplar

For the Students

- **Making Decisions with Data** - Activity Guide Make a Copy
- **Problem Solving Process with Data** - Resource Make a Copy

Warm Up (5 mins)

- Journal

Activity (40 mins)

Wrap Up (10 mins)

- Journal

Teaching Guide

Warm Up (5 mins)

Journal

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

Discuss: Invite a few students to share some of what they wrote 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

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 Problem Solving Process with Data and how this process can help us make a decision.

Question of the Day - how can patterns in data help make a decision?

Activity (40 mins)

Group: Have students sit in groups of 3-4

Distribute Pass out one copy of the Problem Solving Process for Data to each group.

Prompt: Which steps have we taken while solving problems over the last few lessons? Ask one person in each group to circle the answers they discuss.

Circulate: Check in with groups as they circle different answers on the paper. As you finish checking in with each group, pass out a copy of the Making Decisions with Data activity guide.

Activity Guide - Making Decisions with Data

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.

Thought Partners: Even though students are working in groups, there's no need for groups to come to shared decisions.

> **Problem 1 - When to Post:** Read the Define and Prepare sections of the problem as a class. Give groups a chance to look at the data presented to them and reflect on the questions at the bottom of the activity guide.
>
> **Do This:** Students should start by making a personal decision without writing it down. Then give groups a chance to discuss their decision with the group.
>
> Once groups have had a chance to discuss they should record their decisions, even if they are different from one another. Let students know that one person from each group will share out a summary of their group discussion.
>
> **Share Out:** Have a member of each group share a summary of their group discussion. It's okay if the group didn't all gree
>
> **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 Out:** Again have one member of each group share out a summary of their discussion.

Problem 3 - Locker Selection: Repeat the process a final time with this problem.

Share Out: Have students share the results of their conversation with the class.

Wrap Up (10 mins)

Discuss: Do two people need to make the same decision from the same data? Have students reflect and share their responses with the class

Journal

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

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)

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

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

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 (2017)

- **DA** - Data & Analysis

English

Lesson 13: Automating Data Decisions

Overview

Question of the Day: How can computers help us make decisions about data?

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 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.

Assessment Opportunities

1. **Design and implement an algorithm for making decisions using data as inputs**

   Activity Guide: The points assigned to each vacation spot on the first page are consistent with how the algorithm is implemented on the second page.

2. **Explain the benefits and drawbacks of using computers for automated decision making**

   Wrap Up: Students should identify multiple advantages and disadvantages to automated decision making.

3. **Interpret collected data to identify patterns**

   Activity Guide, page 1: The points assigned to each vacation spot should reasonably reflect the given data. (see exemplar)

Agenda

Warm Up (5 mins)

View on Code Studio

Objectives

Students will be able to:

- Design and implement 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 Teachers

- **Unit 5 Data & Society** - Slides
- **Automating Data Decisions** - Exemplar

For the Students

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

- Journal

Activity (35 mins)

- Making The Algorithm
- Testing the Algorithm

Wrap Up (5 mins)

Teaching Guide

Warm Up (5 mins)

Journal

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 in their journals, then share in small groups, then discuss with the whole class.

Discussion Goal

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.

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 how 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.

Question of the Day: How can computers help us make decisions about data?

Activity (35 mins)

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

Automating Data Decisions

Making The Algorithm

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 different rule?

Discussion Goal

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.

Do This: 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.

Circulate: Monitor student progress. Students only need to complete the first page of the activity guide for now. As most students finish, the class can transition to the next section of this activity.

Testing the Algorithm

Group: Assign students into groups of 3-4

Do This: Have students in groups poll each other record their answers on the second page of the worksheet. They then use their algorithms to recommend a vacation spot for that person.

Share Out: Ask students to share out some of the vacation spots they were recommended and if they agree with the recommendations. This discussion connects the reflection questions where students consider changes they could make to improve their recommendations.

Reflect: Have students individually complete the reflection questions at the bottom of the activity guide, then share with their groups to compare responses.

Wrap Up (5 mins)

Prompt: Students can respond either in the Reflection section of the activity guide or in their journals:

- 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

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 (2017)

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

Lesson 14: Problem Solving with Big Data

Overview

Question of the Day: How is our data collected and why is it useful?

In this lesson, students look at how data is collected and used by organizations to solve problems in the real world. Students are presented with three scenarios that could be solved using data and brainstorm the types of data they would need 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.

Assessment Opportunities

1. **Give examples of how data is collected from sensors and tracking user behavior.**

   Activity Guide, page 2: There should be multiple examples of tracking user behavior and sensor data in the second and third columns of the chart.

2. **Determine data that would be helpful in solving a problem, and how that data could be collected.**

   Activity Guide: On each page, there should be reasonable descriptions of relevant data and how it could be collected. These do not need to be the same as the data actually collected by the companies, but should be relevant to the given problem and possible to collect.

3. **Distinguish between data that users intentionally and unintentionally produce.**

   Activity Guide, page 2: The first and second columns should give multiple examples of data that has been actively and passively collected.

View on Code Studio

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 the 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 Teachers

- **Unit 5 Data & Society** - Slides
- **Amazon Video** - Video (**download**)
- **Waze Video** - Video (**download**)
- **Netflix Video** - Video (**download**)
- **Data in the Real World** - Exemplar

For the Students

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

Agenda

- **Warm Up (5 mins)**
  - Journal
- **Activity (35 mins)**
  - Web Pix
  - Routz
  - Nyle
  - Reflection
- **Wrap Up (5 mins)**
  - Journal

Teaching Guide

Warm Up (5 mins)

Journal

Prompt: In the last lesson, we saw how data could be collected through questions and used to make a recommendation. There are other ways our data can be collected that are happening all around us every day. What are some ways that apps, companies, or governments could be collecting data about you?

Discuss: Have students journal individually, then share with a neighbor, and finally discuss as a whole 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.

Question of the Day: How is our data collected and why is it useful?

Discussion Goal

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 (35 mins)

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

Distribute: Give students copies of activity guide

Data in the Real World

Web Pix

Web Pix: Read the introduction to Web Pix 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.

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

Teaching Tip

Accessing Videos: These videos are embedded in the slides for this lesson and can also be downloaded from within this lesson plan. They can also be found in their own levels on Code Studio so students have access to these videos if they wish to them on their own or if they are absent for this lesson.

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.

Display: Watch the Netflix video

Discuss: Have students answer the third question about Netflix. 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

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.

Share Out: Allow students to quickly share out some ideas, then introduce the Waze video.

Display: Watch the Waze video.

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.

Discussion Goal

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.

Discussion Goal

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.

Nyle

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.

Share Out: Allow students to quickly share out some ideas, then introduce the Amazon video.

Display: Watch the Amazon video.

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.

Discussion Goal

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.

Reflection

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.

Reflection: Ask students to fill out the chart at the bottom of the page that categorizes the different types of data. Allow students to compare their answers with a partner.

Wrap Up (5 mins)

Journal

Prompt: 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. This also means these websites are collecting lots and lots of data - usually this is too much for a human to analyze! In the next lesson, we'll look at how we can help computers make decisions and learn from all

of this data.

Discussion Goal

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 (2017)

- **IC** - Impacts of Computing

Lesson 15: Data and Machine Learning

Overview

Question of the Day: How can machines "learn"?

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

Purpose

In previous lessons, students have seen how we can use data to make decisions. We've also seen that data can be collected about us constantly, leading to a larger amount of data to analyze - more than a human can handle! This tutorial is designed to quickly introduce students to machine learning, a type of artificial intelligence that can be used to make decisions about large amounts of data. Students will explore how training data is used to enable a machine learning model to classify new data.

Agenda

Warm Up (5 mins)
- **Journal**

Activity (35 mins)

Wrap Up (5 mins)
- **Journal**

View on Code Studio

Objectives

Students will be able to:

- Train and test a machine learning model.
- Reason about how human bias plays a role in machine learning.

Preparation

- [ ] Review and complete the online tutorial yourself. If you are not going to use AI for Oceans, explore the other options listed below.

Links

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

For the Teachers

- **Unit 5 Data & Society** - Slides

Teaching Guide

Warm Up (5 mins)

Journal

Prompt: Has a computer ever made a recommendation for you? How do you think it learned how to do this?

Discuss: Have students brainstorm silently on their own, then have them share with neighbors, and finally have them share out with the room.

Discussion Goal

Goal: Answers may vary and may depend on prior experiences students have with recommendation systems or other types of artificial intelligence. Try to stear the discussion towards conversations around the role that humans play in machines learning. It's ok if the discussion here is short - you are setting the stage for the upcoming activity.

Remarks

> Today we're going to be learning more about Machine Learning and its impacts.

Question of the Day: How can machines "learn"?

Activity (35 mins)

Video: Play the video "What is Machine Learning".

Remarks

> Machine learning refers to a computer that can recognize patterns and make decisions without being explicitly programmed. In this activity you're going to supply the data to train your own machine learning model. Imagine an ocean that contains creatures like fish, but also contains trash dumped by humans. What if we could train a computer to tell the difference and then use that technology to help clean the ocean?

Do This: Direct students to Levels 3-5 on Code Studio. Students should spend around five minutes total on these levels. Prompt their thinking with the "Consider" on the slide. To program A.I., use the buttons to label an image as either "fish" or "not fish". Each image and label becomes part of the data used to train A.I. to do it on its own. Once trained, A.I. will attempt to label 100 new images on its own, then present a selection that it determined have the highest probability of being "fish" based on its training. Students who consistently label things correctly should see an ocean full of different types of sea creatures, without much (or any) other objects.

Discuss: How well did A.I. do? How do you think it decided what to include in the ocean?

Video: Play the video "Training Data & Bias".

Prompt: How do you think your training data influenced the results that A.I. produced?

Remarks

> In the second half of the activity, you will teach A.I. about a word of your choosing by showing it examples of that type of fish. As before, A.I. doesn't start with any training data about these labels. Even though the words in this level are fairly objective, it's possible that you will end up with different results based on their training data. You might even intentionally train A.I. incorrectly to see what happens!

Do This: Direct students to Levels 7-8 on Code Studio. Students should spend around five minutes total on these levels. Prompt their thinking with the "Consider" on the slide. Here, as before, students will use training data to teach A.I. to recognize different types of fish. The words in this list are intentionally more subjective than what students will have seen so far. Encourage students to decide for themselves what makes a fish look "angry" or "fun". Two students may choose the same label and get a very different set of results based on which fish traits were their focus. Encourage students to discuss their findings with each other or go back and choose new words. Each student will rely on their own opinions to train A.I. which means that A.I. will learn with the same biases held by the students. As students begin to see the role their opinion is playing, ask them to reflect on whether this is good or bad, and how it might be addressed.

Prompt: How could biased data result in problems for artificial intelligence? What are ways to address this?

Video: Play the video "How I'm fighting bias in algorithms" with Joy Buolamwini.

Prompts:

- What are other ways human bias could appear in Machine Learning?
- How can we try to avoid that bias?

Allow students to discuss these prompts with a neighbor, then share out ideas to the full class. This may be the first time students are considering issues of bias in technology, so it's okay to not arrive at any solid conclusions and leave with more questions.

Display Display the Problem Solving Process graphic with Empathy in the center.

Remarks

> Machine learning have led to innovations in medicine, business, and science but information discovered in this way has been used to harm or exclude groups of individuals.
>
> As we've seen, problems of bias are often created by the type or source of data being collected. Collecting more data does not mean that the bias is removed.
>
> Programmers (that includes you!) should take action to reduce bias in the apps and websites we use. An important strategy for this is at the center of our Problme Solving Process: empathizing with others and making sure no groups are excluded from our work. Be on the lookout for bias, and be emphathetic and inclusive to try and avoid it!

Review: Play the video "Impact on Society" which recaps the concepts discussed today.

Wrap Up (5 mins)

Journal

Prompt: What is your biggest takeaway from today's lesson, either about machine learning or how bias appears in technology?

Discuss: Time may be running short at this point in the class. Encourage students to share with a neighbor or share out with the room.

Teaching Tip

Alternatives to AI For Ocenas: AI for Oceans was orginally developed as an Hour of Code activity that can be completed by students with any device available. We have modified it for its usage here. Depending on your classroom situation, you might opt to replace the activity with:

- **Teachable Machines** - *Teachable Machine is a web-based tool that makes creating machine learning models fast, easy, and accessible to everyone. Teachable Machine is flexible – use files or capture examples live. It's respectful of the way you work. You can even choose to use it entirely on-device, without any webcam or microphone data leaving your computer.*
  - If your classrooms devices have cameras, Teachable Machines offers an engaging way to create training sets. Encourage students to teach the machine to represent rock, paper, or scissors with hand gestures. What are some possible ways for bias to enter in?
- **Machine Learning for Kids** - *This free tool introduces machine learning by providing hands-on experiences for training machine learning systems and building things with them. It provides an easy-to-use guided environment for training machine learning models to recognise text, numbers, images, or sounds.*
  - Machine Learning for Kids is a great option if your students want to work with text samples. Teach the machine to recognize words or passages that are happy or sad. Lots to play around with here!

Content Corner

Every image in this part of the tutorial is fed into a neural network that has been pre-trained on a huge set of data called **ImageNet**. The database contains over 14 million hand-annotated images. ImageNet contains more than 20,000 categories with a typical category, such as "balloon" or "strawberry", consisting of several hundred images. When A.I. is scanning new images and making its own predictions in the tutorial, it is actually comparing the possible categories for the new image with the patterns it found in the training dataset.

Discussion Goal

Goal: Get students to reflect on their experience so far. It is important at this point that they realize the labeling they are doing is actually programming the computer. The examples they show A.I. are the "training data".

Content Corner

The fish in this tutorial are randomly generated based on some pre-defined components, including mouths, tails, eyes, scales, and fins, with a randomly chosen body color, shape, and size. Rather than looking at the actual image data, A.I. is now looking for patterns in these components based on how the student classifies each fish. It will be more likely to label a fish the same way the student would have if it has matching traits.

Discussion Goal

Goal: At this point, students should have some preliminary thoughts on how biased data leads to problems for artificial intelligence. They may bring up that if the data sets are trained incorrectly, there will be incorrect or misinterpreted conclusions. It can be addressed through diverse training sets. The following video dives into this subject further.

Teaching Tip

You can share these stories with your class to help them see how AI will impact the future.

- **Food Waste Is a Serious Problem. AI Is Trying to Solve It**
- **AI tech can identify genetic disorders from a person's face**
- **How an AI Startup Designed a Drug Candidate in Just 46 Days**
- **MIT AI tool can predict breast cancer up to 5 years early**
- **The Army steps up its pace on self-driving cars**
- **San Francisco says it will use AI to reduce bias when charging people with crimes**
- **AI is helping scholars restore ancient Greek texts on stone tablets**

Lesson 16: Project - Make a Recommendation

Overview

Question of the Day: How can I use data to make my own recommendations?

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.

Assessment Opportunities

Use the project rubric attached to this lesson to assess student mastery of learning goals of this unit. You may also choose to assign the post-project test through Code Studio.

Agenda

Warm Up (5 mins)

Journal

Day 1 Activity (40 mins)

Prepare

Day 1 Wrap-Up

Day 2 Activity (45 mins)

Day 2 Warm-Up

View on Code Studio

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 the project guide
- [ ] Print copies of the rubric
- [ ] Print copies of the peer review guide

Links

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

For the Teachers

- **Unit 5 Data & Society** - Slides
- **Make a Recommendation** - Exemplars

For the Students

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

- Day 2 Wrap-Up

Day 3 Activity (45 mins)

- Day 3 Warm-Up
- Day 3 Wrap-Up

Days 4 and 5 Activity (90 mins)

- Day 4 Warm-Up

Wrap Up (10 mins)

Teaching Guide

Warm Up (5 mins)

Journal

Prompt: Thinking back over the last several lessons, list all of the times we've seen data that is used to make a recommendation. Here's an example: we used survey data to make a recommendation about what pizza to order.

Discuss: Have students write independently first, then have students share with a partner and add any new examples to their list. Then ask students to share with the whole class.

Discussion Goal

Goal: 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. Some examples that students may come up with include:

- 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?

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, we're going to start a project where you're going to use data to make your own recommendation, based on something that you are interested in.

Question of the Day: How can I use data to make my own recommendations?

Day 1 Activity (40 mins)

Group: Group students into pairs. If there is an odd number of students, a group of 3 can be made or a student can complete this project individually.

Distribute: Give students copies of the project guide

Project Guide - Make a Recommendation

Overview: Read through the Overview of the project with students and answer any questions.

Sample App: Display the Sample App. Have the class participate in the quiz multiple times.

Starting Off: Have students answer the following question on their project guide:

- 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?

Discussion Goal

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. You'll be working with a partner, and your first step will be to 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.

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

Prepare

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.

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.

Day 1 Wrap-Up

Collect: Collect Project Guides and look over them for any issues that could cause problems for students in the next portion of the lesson. Before tomorrow's lesson, students may also use this time to collect survey data from people outside the classroom.

Day 2 Activity (45 mins)

Day 2 Warm-Up

Distribute: Re-distribute the Project Guide's from yesterday. If you have any feedback for students, make time to talk to them individually. Otherwise, students can jump straight into the next steps for their project.

Project Guide - Make a Recommendation

Step 4 - Collect Your Survey Data: Have students survey each other in the classroom. Ideally, 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. This will take a large portion of this class period.

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.

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.

Day 2 Wrap-Up

Collect: Collect students' project guides and again do a quick check-in to make sure students are on track.

Day 3 Activity (45 mins)

Day 3 Warm-Up

Distribute: Re-distribute the Project Guide's from yesterday. If you have any feedback for students, make time to talk to them individually. Otherwise, students can jump straight into the next steps for their project.

Project Guide - Make a Recommendation

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.

Step 8 - Peer Review: Read the instructions on for Step 8 in the Project Guide. Clarify that the intent is to generate new ideas for how to improve your recommendation algorithm by having another team peer review it.

Distribute: Pass out the Peer Review - Make a Recommendation worksheet to each student.

Peer Review - Make a Recommendation

Peer Review: Have teams trade projects and complete a Peer Review for the other team. They should complete the chart and offer feedback to the team on their recommendation algorithm.

Creator's Reflection: Have teams look over the feedback and complete the Creator's Reflection section of the activity guide. Teams should make edits to their Project Guide based on the feedback provided by another team.

Day 3 Wrap-Up

Collect: Collect students' project guides and again do a quick check-in to make sure students are on track.

Days 4 and 5 Activity (90 mins)

Day 4 Warm-Up

Distribute: Re-distribute the Project Guide's from yesterday. If you have any feedback for students, make time to talk to them individually. Otherwise, students can jump straight into the next steps for their project.

Step 9 - Finalize and Present: Students should 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. The presentation should include:

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 rubric to fit your exact needs.

- What choice you are helping the user to make
- The types of data you collect to help the user make that choice
- The relationships that you found when interpreting your survey data
- The way you used this information to create your recommendation algorithm
- The results of testing the algorithm on users

Presentations: Give teams time to present. Projects can be assessed using the rubric based on their presentation and project guide.

Wrap Up (10 mins)

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.

Standards Alignment

CSTA K-12 Computer Science Standards (2017)

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