Unit 7 - AI and Machine Learning ('23-'24)

Teacher resources | Printing Options

This unit is a hands-on introduction to developing a machine learning model with tabular data. Students explore how computers learn from data to make decisions, then develop machine learning projects around real-world data. The unit culminates in designing a machine learning app to solve a personally relevant problem.

- ▶ Chapter 1 Overview
- ▶ Chapter 2 Overview
- ▶ Implementation Guidance for the AI and Machine Learning Unit
- ▶ Professional Development

Finished Teaching This Unit?

Answer this short survey to let the Code.org curriculum team know how the unit went.

Week 1	Lesson 1: Intro to App Lab	Lesson 2: Introduction to Machine Learning	Lesson 3: Types of Machine Learning	Lesson 4: Innovations in AI	Lesson 5: Patterns in Data
Week 2	Lesson 6: Classification Models	Lesson 7: Introduction to AI Lab	Lesson 8: Importing Models in App Lab	Lesson 9: Model Cards	Lesson 10: Saving Models in AI Lab
Week 3	Lesson 11: Model Cards in App Lab	Lesson 12: Numerical Models	Lesson 13: Numerical Data in AI Lab	Lesson 14: Customizing Apps	Lesson 15: AI Code of Ethics
Week 4	Lesson 16: Project: Make a Machine Learning App	Lesson 17: Issue Statements	Lesson 18: Survey Planning	Lesson 19: Survey Data in AI Lab	Lesson 20: Troubleshooting Models
Week 5	Lesson 21: Creating an App	Lesson 22: Project - Design an AI App			
Week 6					

Key	☐ Instructional Lesson ✔ Assessment ✂ Unplugged Lesson

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Intro to App Lab

Description

This unit assumes students are already familiar with App Lab, so we recommend starting with the App Lab Hour of Code which is included below. If your students are already familiar with App Lab, you may decide to skip this lesson. **Click here to learn more about skipping this lesson**, allowing your classes to start right away with Creating Apps for Devices.

Lesson 1: Intro to App Lab

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This tutorial is designed to quickly introduce the App Lab programming environment as a powerful tool for building and sharing apps. The tutorial itself teaches students to create and control buttons, text, images, sounds, and screens in JavaScript using either blocks or text. At the end of the tutorial, students are given time to either extend a project they started building into a "Choose Your Own Adventure", "Greeting Card", or "Personality Quiz" app. They can also continue on to build more projects featured on the code.org/applab page.

1 App Lab Intro - Video

2-4 Setting Properties

2 3 4

5-7 Make it Interactive

5 6 7

8-9 Images and Sounds

8 9

10-13 Design Mode

10 11 12 13

14-15 Share Your App

14 15

Chapter 1: Understanding Machine Learning

Lesson 2: Introduction to Machine Learning

In this lesson students are introduced to a form of artificial intelligence called machine learning and how they can use the Problem Solving Process to help train a robot to solve problems. They participate in three machine learning activities where a robot - A.I. Bot - is learning how to detect patterns in fish.

Question of the Day: How can we use the Problem Solving Process to solve a problem with machine learning?

1 Recognizing Fish

2 Recognizing Fish Features

3 Recognizing Expressions

4 Check-In Survey

Lesson 3: Types of Machine Learning

In this lesson students will consider how they create “mental” models when learning new concepts, and how those can be similar to a “machine learning” model. They participate in a color pattern activity to simulate building a machine learning model without help, then they play a game called "Green Glass Door" as an example of supervised learning, and finally, they will sort several scenarios into “supervised” or “unsupervised” learning.

Question of the Day: What are different types of machine learning?

1 Looking for Patterns

2 Green Glass Door

Lesson 4: Innovations in AI

In this lesson, students explore an application of AI called Seeing AI and examine how it is supporting people with visual impairments. Then, students research other examples of how AI is impacting society, focusing on users who are impacted by the examples they find. Finally, students share their findings with each other.

Question of the Day: How is AI helping to solve problems around the world?

This lesson contains no levels.

Lesson 5: Patterns in Data

In this lesson students will examine several apps that make decisions about what shoes to wear, ultimately building up to an understanding of how machine learning can help make this decision. Students are guided to the conclusion that surveying their users can help them make the best decision by looking for patterns in the data and basing their decisions on these patterns.

Question of the Day: What strategies do computer models use to make decisions?

1 **Shoe Recommender**

2 **Improved Shoe Recommender**

3 **Shoe Recommendation Survey**

4 **Ultimate Shoe Recommender**

Lesson 6: Classification Models

In this lesson students will participate in an unplugged activity simulating one of the machine learning algorithms computers use to separate data into groups to help make decisions. Students will be tasked with helping a computer learn to classify food as fruits or vegetables, graph 20 different fruits on two axes comparing “sweetness” to “easy to eat”, and then try to separate the data into groups - a fruit area, and a veggie area.

Question of the Day: How do computers learn to classify data?

This lesson contains no levels.

Lesson 7: Introduction to AI Lab

In this lesson students will dive into the AI Lab tool for the first time, where they select features to train a model that predicts a given label. They start by exploring AI Lab and training a model to recognize shapes. Then they pretend they have been hired by several restaurants who would like to make recommendations to new customers based on survey data they’re collected, go through each dataset, and use data visualization tools to identify features with high relationships in the data.

Question of the Day: How can we use machine learning to make recommendations?

- 1 Fruit and Veggie Explorer
- 2 Recognizing Shapes
- 3 Pizza Recommendations
- 4 You Choose: Restaurant Recommendations

Lesson 8: Importing Models in App Lab

In this lesson students are introduced to importing their models into App Lab and linking their model to their screens. They help create a book recommendation app and learn how to add a welcome screen and events to their code. This lesson assumes students are already familiar with App Lab - for classrooms that have not seen App Lab before, consider extending this lesson and including additional videos or activities that are recommended in the lesson plan.

Question of the Day: How can I create an app using machine learning?

- 1 Book Recommender App
- 2 Import a Model
- 3-6 Customize Your App
  - 3
  - 4
  - 5
  - 6
- 7 Choice Levels: Customize Your App

Lesson 9: Model Cards

In this lesson, students will investigate a model for bias and be introduced to a Model Card, which is a way of representing important information about a trained model that could help uncover bias. They will be investigating a Medical Priority app, which helps a hospital decide how soon to view patients based on their symptoms. As students go through the activity, they realize that the app is biased based on personal information and examine how this could happen.

Question of the Day: How can we evaluate machine learning models once they've been trained?

- 1 Medical Priority App

2 Book Recommender Model Card

3-5 Medical Dataset Model Cards

3 4 5

Lesson 10: Saving Models in AI Lab

Students complete the full process of training and saving a model, then importing into App Lab. For the first time, students are able to choose the label they would like to predict and spend time deciding the features they will use to help predict their label of choice. Students also create a model card for their models in order to save them and import it into App Lab

Question of the Day: How can I use Model Cards to document my decisions when training a machine learning model?

1-3 Zoo Predictions

1 2 3

4 Importing Your Model

5 Customizing Your App

Lesson 11: Model Cards in App Lab

In this lesson, students practice importing their models into App Lab, this time including models that have numerical data and using model cards to help improve the user experience of filling out their form. They will then learn how to view the model card within App Lab and use this to add more descriptive elements to an app. Next, they focus on improving the user experience by adding informational text to help guide users through completing the form and adding a style to their app to improve the user experience.

Question of the Day: How can I use a Model Card to improve my app?

1 Example App: Zoo Classification

2-4 Pet Recommender

2 3 4

5-7 Adding New Screens

5 6 7

8 Practice

9 Assessment

10 Challenge

Lesson 12: Numerical Models

In this lesson, students participate in an unplugged activity simulating a zombie outbreak. Students must predict which parts of town have the least amount of zombies using data from a neighboring town. Students will use degrees of similarity and averages to make predictions about the number of zombies at a particular location. Then, students are rescued and get to compare their predictions to the actual numbers as a way to discuss how accuracy is different for numerical data compared to categorical data.

Question of the Day: How do computers learn to make predictions with numerical data?

This lesson contains no levels.

Lesson 13: Numerical Data in AI Lab

In this lesson, students will be introduced to numerical data which represents a range of values. Students are presented with a scenario where every feature and label is represented with numerical data, and they learn to use the new data visualization tools within AI Lab to help find patterns.

Question of the Day: How can we use AI Lab to predict numerical data?

1 Safari Model

2 Safari App

Lesson 14: Customizing Apps

In this lesson, students will explore how to customize the code of their app to make additional changes to the design of their app. They will start by exploring a single-screen app and then practice expanding the app to two-screens and updating the code to use the new design mode elements. After this, students help create a Driver Alert app that requires changes to the code using new design mode elements. Using the skills from this lesson, students will be able to create multi-screen apps where questions can appear on multiple screens instead of a single screen.

Question of the Day: How can I customize the code for a machine learning app?

1 Raspado Recommender

2-8 Driver Alert System

2 3 4 5 6 7 8

9 You Choose: Improve Your App

Lesson 15: AI Code of Ethics

In small groups, students conduct research using articles and videos that expose ethical pitfalls in an Artificial Intelligence (AI) area of their choice. Afterward, each group develops at least one solution-oriented principle that addresses their chosen area. These principles are then assembled into a class-wide “Our AI Code of Ethics” resource (e.g. a slide presentation, document, or webpage) for AI creators and legislators everywhere.

Question of the Day: What are guidelines we can use to create ethical machine learning apps?

This lesson contains no levels.

Lesson 16: Project: Make a Machine Learning App

In this one or two day project, students apply their skills from the unit so far and create a machine learning app using real-world data. Students are provided with several real-world datasets from a variety of contexts, and they choose which dataset they would like to investigate. They train and save their model, then make a simple App Lab app that uses the model. This mini-project is an opportunity to assess how well students can use features to create accurate machine learning models, and how well they can create apps that use machine learning.

Question of the Day: Can I use real-world data to create an app that uses machine learning?

1 Train a Model in AI Lab

2 Create an App in App Lab

3 Reflection

Chapter 2: Design a Machine Learning App

Lesson 17: Issue Statements

This is the first of a five-day sequence of lessons that prepare students for the final project. In this lesson, students meet a team of fictional students who want to use machine learning to address an issue in their community. Students participate in an issue brainstorm using the 5 Why's strategy, then they help evaluate the ideas that the other student team came up with. The steps students take in this lesson are identical to the steps students will take in their final project.

Question of the Day: How can machine learning be used to address an issue in your community?

This lesson contains no levels.

Lesson 18: Survey Planning

This is the second in a five-day sequence of lessons that prepare students for the final project. In this lesson, students learn that the other team of students would like to create a club recommender app based on the clubs at their school. Students imagine what questions would be most useful to help make this recommendation, then they learn how to use a Google Form template to create a survey. The steps students take in this lesson are identical to the steps students will take in their final project.

Question of the Day: How can I create a survey to gather data for a machine learning app?

1 **Create a Google Form**

Lesson 19: Survey Data in AI Lab

This is the third in a five-day sequence of lessons that prepare students for the final project. In this lesson, students learn how to view survey data in Google Sheets and save the data to their computer as a csv file. Then, they upload the saved data to AI Lab and examine the survey results from one of the students to train a model using their data. Then, students use Google Sheets to examine data from another student where the data has errors and then try to fix the errors. The steps students take in this lesson are identical to the steps students will take in their final project, and the problem-solving strategies they develop will help them overcome challenges in their own final project.

Question of the Day: How can I import data into AI Lab to train a machine learning model?

1 **Kim's Survey**

2 **Kim's Survey Data**

3 **AI Lab and Kim's Data**

4 **Isaac's Survey Data**

5 **AI Lab and Isaac's Data**

Lesson 20: Troubleshooting Models

This is the fourth of a five-day sequence of lessons that prepare students for the final project. In this lesson, students examine survey data from other members of the student team and analyze why their models are not working correctly. In examining the data, students develop strategies for avoiding these issues in the future and strategies for coping with these issues should they happen again. These are skills students will use in the final project as they develop their own surveys and collect data.

Question of the Day: What are strategies to make sure our data generates an accurate model?

1 **Club Datasets**

2 **Alternative Datasets**

Lesson 21: Creating an App

This is the fifth of a five-day sequence of lessons that prepare students for the final project. In this lesson, students import the club recommender app into App Lab and begin customizing the app. Students add a welcome screen and update the descriptions of each feature, then they can decide how they would like to further customize the app. The steps students take in this lesson are identical to the steps students will take in their final project.

Question of the Day: How can I create a friendly, easy-to-use machine learning app?

1-3 **Import Your Model**

1 2 3

4-5 **Add a Welcome Screen**

4 5

6 **Customize Your App**

7 **Review Your App**

Lesson 22: Project - Design an AI App

To conclude this unit, students develop an AI app that addresses the social issue of their interest. Students follow a project guide to complete this multi-day activity. In the first step, students prepare the data they will use to train their model in AI Lab. After training, testing, and generating a model card, they export their model into App Lab for development. Here they use their model to create a user-friendly app. Students perform a peer review and make any necessary updates to their projects while reflecting on the outcome.

Question of the Day: How can I create an AI App the solves a problem in my community?

1 **Design an AI App - AI Lab**

2 **Design an AI App - App Lab**

3 **End-Of-Unit Survey**

Lesson 1: Intro to App Lab

45 minutes

Overview

This unit assumes students are already familiar with App Lab, so we recommend starting with the App Lab Hour of Code which is included in this lesson. If your students are already familiar with App Lab, you may decide to skip this lesson, which requires hiding it from students in the unit overview page. **Click here to learn more about hiding this lesson**, allowing your classes to start right away with Physical Computing

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Standards

Full Course Alignment

CSTA K-12 Computer Science Standards (2017)

▶ **AP** - Algorithms & Programming

Agenda

Before The Lesson
- **Preparing for the Unit**

Warm Up (5 minutes)
- **Introduction**

Activity (35 minutes)
- **Intro to App Lab**

Wrap Up (5 minutes)
- **Celebrate and Keep Going!**

Objectives

Students will be able to:

- Build and share their own apps in App Lab using features like buttons, text, images, sound, and screens.

Preparation

- Review and complete the online tutorial yourself
- Print one or more of the **Exit Ticket examples** at the end of this lesson plan, or create your own.

Teaching Guide

Before The Lesson

Preparing for the Unit

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Warm Up (5 minutes)

Introduction

Motivate: Explain to students the goals of today's activity. They are going to start using a new tool that will let them quickly make apps they can instantly send to themselves or friends to use.

Teaching Tip

Hour of Code: This lesson is mostly identical to the **App Lab Hour of Code activity**, and many of the tips below reference the hour of code. It can be fun to lean-into the "Hour of Code" especially if it's your students first introduction to programming. You may decide to review the **Hour of Code Educator Guide** and **Best Practices from Successful Educators** in order to begin to plan your Hour of Code event.

Slides and Videos: This lesson is designed to be mostly self-paced and completed within Code Studio, so there isn't a Slide Deck for this lesson and the videos are included within the levels that students go through. In future lessons, we provide slide decks with the videos embedded to be watched as a class rather than interrupting a student experience.

Video: The first level of this activity is a video that should both motivate students to complete the activity and explain how it will work. Consider watching it as a class and quickly debriefing afterwards to answer questions.

1 **App Lab Intro - Video**

Activity (35 minutes)

Intro to App Lab

General Support: As a teacher your role is primarily to support students as they make their way through the tutorial. Here are a few tips that should help students regardless of the level they're working on

- **Checking Correctness:** This tutorial will not tell students whether they completed the level correctly. Encourage students to use the target images and directions provided in every level to know if they are on the right track. If students want to move on past a particularly tricky level they can simply click "Finish" and continue on.
- **Collaborate with Neighbors:** Encourage students to check in with a neighbor when they're getting stuck. Since this tutorial includes videos and students may be wearing headphones it can get easy to "go into a bubble". Help break those barriers by actively pairing students if they seem like they need help.
- **Read the Instructions:** The instructions usually provide helpful tips on how to complete the level. Before completing a level for a student ensure they've actually looked closely at the target image and read all the text there.
- **Stuck? Click here:** Each level includes a GIF showing exactly how to complete the level. If students want help they can and should use these GIFs. If they only want to use them as a hint, just have them close the GIF once they've seen the first part.
- **Move On and Come Back:** Sometimes students will benefit more from coming back to a tricky level. Except for the "Design Mode" sequence, all levels are independent of one another, though they do rely to some degree on previously introduced concepts.

Setting Properties - Levels 2-4

These levels are all about learning to use the `setProperty()` block. The dropdowns in this block make it easy to know exactly what it is capable of changing. That said, there's a couple tips that can help

- **When to use Double Quotes:** The `setProperty()` block automatically changes the final dropdown when you select what properties you want to change, including whether they use double quotes. When in doubt, students should first change the first two dropdowns, then use the last one as a model for what values work there. The most common error is failing to use double quotes around a color name.
- **Hover to Read IDs:** By hovering over an element in your app you can read its ID. This will help students when they're trying to change multiple elements on their screen.

2-4 **Setting Properties**

2 3 4

Make It Interactive - Levels 5-7

This sequence introduces the `onEvent()` block. Here's some helpful tips if students are getting stuck.

- **onEvents Don't Go Inside One Another:** Students just starting out may try to put one block inside of the others. This is never the intended behavior for this tutorial. Even though this is mentioned in the videos, a quick reminder might help get kids unstuck.
- **Check Your IDs:** You need to change the `"id"` property in `onEvent()` so that it detects events with the correct element.
- **You Can Use Multiple Blocks in an `onEvent()`:** If you want multiple things to happen when you click the same button, just add more blocks to the same `onEvent()`. You should never have a program that has two `onEvent()` blocks for the combination of element (e.g. "button1") and event type (e.g. "click").

5-7 **Make it Interactive**

5 6 7

Teaching Tip

Finding Images: Students do not need to search for images or sounds online in order to complete this lesson, but they may wish to. You'll likely want to prepare in advance to advise responsible and appropriate searching for images.

This section has a single level that has students add an animal to a soundboard. This level is a little more involved that the previous ones, so expect that students may need to either rewatch the video beforehand or read instructions carefully to complete all the steps.

Images and Sounds - Levels 8-9

- **Images Use `setProprety()`:** To add an image to a screen element students can use the `"image"` property. There is no new block.
- **Link to Images:** Students can copy the URL of images they find directly into the `setProperty()` block in order to add them to their apps. There's no need to download them to their computers and upload them to App Lab if they don't wish to.

8-9 **Images and Sounds**

8 9

Design Mode - Levels 10-13

In the last sequence students are working on the same project for three bubbles in a row. They are now learning to add screen elements themselves which means that the total number of things they can do in App Lab has grown a lot. Assume that some students will spend some time exploring at this point as they try out all the new tools.

- **Using Good IDs:** An important part of programming in App Lab is giving your elements good IDs. Up to this section students have had their IDs created for them, so they haven't had a chance to practice this skill. This is a useful reminder for the teacher to reinforce during this section.

10-13 **Design Mode**

10 11 12 13

Share Your App - Levels 14-15

This section is very open-ended. The tutorial itself is designed to give students ample time to keep working on this project, either making Choose Your Own Adventure, or one of their own creation.

- **Try the Samples:** Students are provided 3 sample apps that should help them brainstorm their own ideas.
- **Encourage Sharing:** If students have cell phones with a data plan they can quickly text a link to their projects to their own phone or a friend's. If your school policy allows it, encourage them to do so here.
- **Encourage Creativity:** Compared to other activities in this lesson, this section asks students to be much more creative. Ask students to think "what will your story be about?" or do a quick group brainstorm so that classmates can hear ideas from one another.

14-15 **Share Your App**

14 15

Wrap Up (5 minutes)

Celebrate and Keep Going!

code.org/applab: At the end of the lesson encourage students to head to the App Lab home page where they can get ideas for more ways to keep their adventure with App Lab going.

Exit Ticket: Distribute the Exit Tickets to collect feedback on how the day felt for students.

(Optional) Certificates: You may decide to print certificates to celebrate students who completed the entire tutorial - printable certificates can be found here: **http://code.org/certificates**

Lesson 2: Introduction to Machine Learning

45 minutes

Overview

In this lesson students are introduced to a form of artificial intelligence called machine learning and how they can use the Problem Solving Process to help train a robot to solve problems. They participate in three machine learning activities where a robot - A.I. Bot - is learning how to detect patterns in fish.

Question of the Day: How can we use the Problem Solving Process to solve a problem with machine learning?

Standards

Full Course Alignment

AI4K12 National Guidelines 2021

- ▶ **BI-3** - Computers can learn from data

CSTA K-12 Computer Science Standards (2017)

- ▶ **AP** - Algorithms & Programming
- ▶ **IC** - Impacts of Computing

Agenda

Before the Lesson
- **Preparing for the Unit**

Warm Up (10 minutes)
- **Journal**

Activity (30 minutes)
- **Level 1 - Recognizing Fish**
- **Level 2 - Recognizing Fish Features**
- **Level 3 - Recognizing Fish Expressions**

Wrap Up (5 minutes)
- **Reflection**
- **Journal**

Objectives

Students will be able to:

- Apply the Problem Solving Process to train a computer to solve a problem

Preparation

- Review the Code Studio levels before the lesson
- Print copies of the activity guide for each student
- Check the **"Teacher's Lounge"** forum for verified teachers to find additional strategies or resources shared by fellow teachers

Links

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

For the teachers

- **Introduction to Machine Learning** - Slides ▾ Make a Copy

For the students

- **AI: What is Machine Learning?** - Video (**Download**)
- **Classifying Fish** - Activity Guide ▾ Make a Copy

Vocabulary

- **Machine Learning** - How computers recognize patterns and

make decisions without being explicitly programmed

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Warm Up (10 minutes)

Journal

Prompt: *Today we begin a unit on Artificial Intelligence, or AI. What's an example of AI either in your personal life or that you've seen in a movie or book?*

Teaching Tip

What Is AI? At a basic level, artificial intelligence is when a computer program mimics the intelligence of a human being. This can appear as solving a problem, engaging in conversations, displaying emotions, and many other forms. Shortly after this prompt, students will watch a video that further defines AI and the focus of this unit, Machine Learning.

Have students brainstorm silently on their own, then share with their neighbors, and finally share with the whole class.

Discussion Goal: Try to surface any personal connections students may already have with AI. Students may come up with examples from their personal lives, such as recommendation systems or facial recognition. Or they may think of examples in the media, such as the robots in movies like Wall-E or personal assistants like Siri. Students may also come up with examples that aren't strictly AI - for now, add them to the list anyway. Keep track of any suggestions that students surface without validating them as right or wrong - let students brainstorm freely first.

Display: Display the slide with the large venn diagram that includes AI and many applications.

Remarks

> Artificial Intelligence is used in a lot of different places in our lives - from facial recognition in our phones to personal recommendations when we browse the web, and even in driverless cars. For the next few weeks, we're going to focus on a specific type of artificial intelligence called machine learning.

Video: Show students the **AI: What is Machine Learning?** video in the slides

Teaching Tip

Videos are used throughout the curriculum to spark discussions, supplement key concepts with additional explanations and examples, and expose students to the various roles and backgrounds of individuals in computer science.

While interacting with the video, turn on closed captioning so students can also read along as they watch.

To encourage active engagement and reflection, use one or more of the strategies discussed in the **Guide to Curriculum Videos**.

Vocabulary: Display the following vocabulary

- **Machine Learning:** How computers recognize patterns and make decisions without being explicitly programmed

Remarks

> Machine learning helps us solve important problems in society. In the next few weeks, we'll look at how we can create our own machine learning apps to solve problems. To help accomplish our goals, we will use the Problem Solving Process - Define, Prepare, Try, Reflect, and always Empathize. Let's take a look at how these steps appear for Machine Learning in particular

Display: Show the slide with the Problem Solving Process. Read through the additional lines that represent how the process connects to Machine Learning.

Question of The Day: How can we use the Problem Solving Process to solve a problem with machine learning?

Activity (30 minutes)

Remarks

> In today's activity, we're going to use machine learning to help a robot clean up the ocean and learn how to identify fish. We'll give it lots of examples of fish, give it time to learn from those examples, and then see how well it does in cleaning up the ocean.

Distribute: Pass out the Activity Guide for this lesson

Assessment Opportunity

The responses in the activity guide can be used to formatively assess how well students have met the objectives of the lesson.

Level 1 - Recognizing Fish

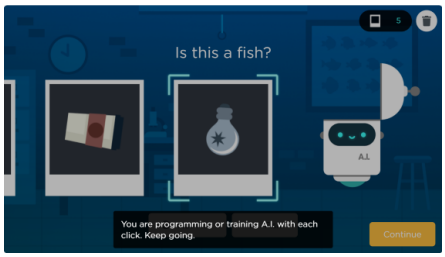
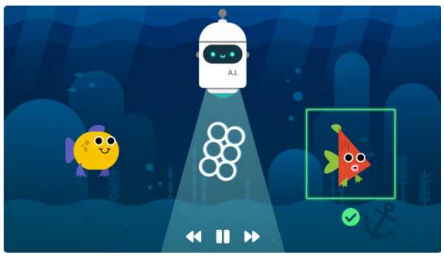
Code Studio: In front of the classroom, navigate to Level 1 in Code Studio - Recognizing Fish.

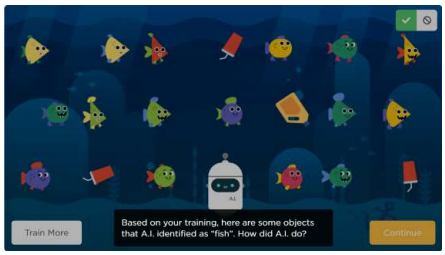
1 **Recognizing Fish**

Do This: As a class, go through this level which guides you through the process of training A.I. Bot to recognize fish. As you do, fill in the first part of the activity guide as a class. Consider the following strategies at different stages of the level:

Teaching Tip

A.I. Bot and Pronouns: These levels purposefully use A.I. Bot's full name and avoid gendering A.I. Bot as "he" or "she". Even though some AI systems take on personified gendered roles - such as Siri or Jarvis - actual machine learning programs don't have genders because they're just computer programs. Model this same behavior with students by referring to A.I. Bot by it's full name or using "it" as its pronoun.

Activity	As a Class
Training Screen 	• Informational text will frequently pop up on the screen. Consider asking students to read the prompts aloud to the class, possibly in their best robot voice, for a little fun • Ask students to use thumbs up / thumbs down to decide as a class whether something is a fish • At 30 images, the level will ask if you would like to continue or keep training. Ask students to help with this decision and follow their lead - either continue training, or go to the next screen. • Before continuing, have students record on their activity guide how many images they used to train the A.I. Bot.
Testing Screen 	• A.I. Bot will probably misidentify a few objects. Make sure students notice this, and ask them to individually consider why they think this might be happening. This ties in to the discussion at the end of this level.

Activity	As a Class
Evaluation Screen 	• Have students count the number of fish that it identified correctly. Record this on the activity guide. • It's okay if A.I. Bot misidentifies some trash as fish - this sets the stage for the discussion.

Discuss: *If we wanted A.I. Bot to become better at recognizing fish, how do you think we could help it do that?*

Discussion Goal: Help students understand that A.I. Bot learns better when it has more examples. The best way we can improve its ability to recognize fish is by giving it more examples to look at. Students may also make the connection that this is how humans learn, especially young children - the more examples we have, the better we learn.

Remarks

> This is one example of how the Problem Solving Process and Machine Learning can be used to solve a problem. We prepared our data, used it to train A.I. Bot, then reflected on the results and decided what to do next. In this next level, you will follow this process and train A.I. Bot to detect certain kinds of fish - like red fish or blue fish or triangle fish.

Level 2 - Recognizing Fish Features

Code Studio: Have students navigate to Code Studio Level 2 - Recognizing Fish Features. This level lets students train A.I. Bot to recognize a fish by its color or body type.

2 **Recognizing Fish Features**

Do This: Have students choose a word that they want to train A.I. Bot to recognize, and record this information on their Activity Guide. Students should progress through the level on their own, recording information on their activity guide.

Circulate: Check that students are filling in their activity guide as they complete the stages. After briefly checking in with each student, complete this stage yourself in front of the room and pause at the last screen.

Teaching Tip

Activity Guides and Code Studio: Students may struggle initially to keep track of information on their activity guide as they complete levels in Code Studio. One way to help students think about this is similar to being a scientist performing a lab experiment: they are performing an experiment in Code Studio, and keeping track of their results in their Activity Guide. This is a pattern that will continue throughout the unit, so this is a great opportunity to help students manage both the activity guide and Code Studio.

Display: As students reach the final stage, have them press the white Information icon in the upper-right corner. This displays the features that A.I. Bot is using to help make its decision. In the example here, A.I. Bot has learned that the color matters the most when making a decision and the eyes matter the least.

Have students record the most important and least important features on their activity guide.

Discuss: *What features did A.I. Bot think were the most important? Are those the features you were expecting to be most important?*

Discussion Goal: Students may find that A.I. Bot thinks some features are important when they're actually completely unrelated to their word. For example, thinking that the mouth of a fish is important when trying to determine if the fish is red. Students can verify this by looking for patterns in the fish that A.I. Bot has accepted - maybe all of their example fishes happened to have the same type of mouth and A.I. Bot mistakenly thought this was important.

Remarks

> Some of you noticed that A.I. Bot was learning about parts of the fish that aren't actually important, like the mouth or eyes or dorsal fin. This happens in real life too - machines can learn patterns we don't intend even with lots of data, which can cause A.I. Bot to make mistakes. For this situation, it's pretty easy to tell if A.I. Bot made a mistake - we can quickly see if a fish isn't actually red or circular. Let's try a slightly harder challenge - trying to recognize expressions!

Level 3 - Recognizing Fish Expressions

Code Studio: Have students navigate to Code Studio Level 3 - Recognizing Fish Expressions. This level lets students train A.I. Bot to recognize a fish by its expression, such as "silly" or "serious" or "angry".

3 **Recognizing Expressions**

Do This: Have students choose an expression that they want to train A.I. Bot to recognize, and record this information on their Activity Guide. Students should progress through the level on their own, recording information on their activity guide. On the final screen, have students press the information icon and record the features that A.I. Bot learned were most important.

Circulate: Check that students are filling in their activity guide as they complete the stages. Ask students what features they're looking at to determine if a fish meets their criteria. Students will probably say they primarily use eyes and mouth to help determine expression, but when they click the Information icon on the final screen, A.I. Bot may be using additional features such as color and body to make its decision. Prompt students to think about how they feel about this and compare it to their personal experience - For example, if someone thought they were "silly" or "angry" primarily based on their clothing.

Display: Show the slide of A.I. Bot learning how to identify fish as "Angry". Have students discuss the prompt on the screen: *Looking at this screen, why do you think color appeared as the second most important feature?*

Discussion Goal: Students should notice that even though the eyes and mouth tend to appear "angry" on every fish, there also appears to be a lot of purple fish on the screen. As a result, A.I. Bot may start to think that the color "purple" is another way to tell if a fish is angry or not.

Discuss: *Do you think it's okay to consider a fish "angry" by its color?*

Discussion Goal: For the first part of the question, guide students to notice that there are a lot of purple fish on the screen so A.I. Bot might think that purple fish are more likely to be angry than other fish.

Teaching Tip

Job Interviews: If there is time available, consider showing students **Objective or Biased: On the questionable use of Artificial Intelligence for job applications**. This is a real-life example of a similar situation where unintended factors, such as wearing glasses or a headscarf, are influencing how an AI system rates job applicants. This can be a useful resource to make a connection between this fish activity and the real-world, but this resource is not designed for a middle-school audience and requires some adjustments and decisions for how to best present to your students.

The second part of the question is more open-ended. Students should explore their own ideas and feelings about whether this kind of labeling is appropriate based on the color of the fish. In particular, A.I. Bot has learned “purple fish are angry fish”, which students may have strong reactions to. They may describe similar situations outside of the classroom, such as moments where they’ve been judged by their appearance, gender, or race, to help explain their opinions. This question is designed to start a conversation and connect students’ experiences to the potential pitfalls of machine learning, and it’s okay if the discussion doesn’t come to a firm conclusion. You can let students know that they will continue to learn about and discuss these issues in the rest of the unit. Use the remarks below to help wrap up the discussion.

Remarks

> Even with a small example like this, we see that machine learning can get into trouble and learn something that’s harmful to a particular type of fish. Having more data and making sure it represents all types of fish can help solve this problem. These types of examples happen in real life too and can have serious consequences, such as whether or not you receive medical care or get a job offer. Throughout this unit, as we learn how to use machine learning to solve problems, we need to always be thinking about: What is the impact, and who is being included or excluded?

Wrap Up (5 minutes)

Reflection

Code Studio: Have students answer 5 quick survey questions at the beginning of this unit on AI and Machine Learning. Once at least 5 students have completed the survey you will be able to view the anonymized results in the Teacher Dashboard. Some of these questions will be asked again at the end of the first project, which can be helpful in seeing student growth and shifts in attitudes throughout the unit.

Check-In Survey

Journal

Prompt: *What is something new you learned about machine learning today? What is a new question you have about machine learning?*

Encourage students to choose one of these to share with you on the way out the door, or to write their responses on a post-it note that can be displayed in the classroom. If possible, keep track of these items throughout the unit and refer back to them in later lessons when they are addressed.

Lesson 3: Types of Machine Learning

45 minutes

Overview

In this lesson students will consider how they create “mental” models when learning new concepts, and how those can be similar to a “machine learning” model. They participate in a color pattern activity to simulate building a machine learning model without help, then they play a game called "Green Glass Door" as an example of supervised learning, and finally, they will sort several scenarios into “supervised” or “unsupervised” learning.

Question of the Day: What are different types of machine learning?

Purpose

- Review the Code Studio levels before the lesson so you know how to play the game called “the Green Glass Door”
- Print or prepare to share online copies of the activity guide for each student

Standards

Full Course Alignment

AI4K12 National Guidelines 2021

▶ **BI-3** - Computers can learn from data

Agenda

Warm Up (5 minutes)
- **Journal Prompt**

Activity (35 minutes)
- **Unsupervised Learning**
- **Supervised Learning**
- **Supervised and Unsupervised Learning**

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

Objectives

Students will be able to:

- Describe the differences between supervised and unsupervised learning.

Preparation

- Review all materials for today’s lesson.
- Check the **"Teacher's Lounge"** forum for verified teachers to find additional strategies or resources shared by fellow teachers

Links

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

For the teachers

- **Types of Machine Learning** - Slides ▾ Make a Copy

For the students

- **Types of Machine Learning** - Activity Guide ▾ Make a Copy

Vocabulary

- **Features** - The inputs that a model uses to make decisions
- **Label** - the output you are trying to decide or predict with a model
- **Model** - a computer program designed to make a decision
- **Supervised Learning** - When a human trains a model to learn with examples

- **Training** - giving examples to a model so it can learn
- **Unsupervised Learning** - Finding patterns in data that doesn't have any labels

Teaching Guide

Warm Up (5 minutes)

Journal Prompt

Prompt: *Think of a skill you commonly use, like speaking, tying your shoes, cooking, or playing a game. How did you learn this skill?*

Allow students a minute or two to write their responses, then ask for volunteers to share their ideas with the class. As students share, keep a list of themes that emerge in the front of the room.

Discussion Goal: Hopefully student responses will fall into one of three categories:

- They learned it with the help of someone else (like tying your shoes or playing an instrument)
- They learned it on their own just by observation and chance (like how to speak, or hidden rules like if a family member has you take your shoes off before entering a house)
- They learned it through trial and error and adjusting based on their mistakes (like scoring a goal or shooting a ball in certain sports, or improving at a game)

Remarks

> This is a great list, and we can see there are a variety of ways that we learn new things as humans. Today, we're going to talk more about how computers learn new things and think about how they might be similar or different from how we learn.

Question of the Day: What are different types of machine learning?

Activity (35 minutes)

Preparation: Have students keep their journal out so they can take notes on the vocabulary from today.

Teaching Tip

Vocabulary: This lesson introduces a lot of vocabulary that is used throughout the unit. Introducing it early gives students a chance to familiarize themselves with these terms so they can begin using them to describe their work. But, it's still a lot of vocabulary, which can be challenging. Consider some of the following strategies to help students internalize these words:

- Create a Word Wall that contains the word, a definition, and a drawing illustrating the concept
- Have students record each vocabulary word in their journal along with a sketch
- Have students read the slides aloud and practice saying the vocabulary words as they are presented.

Unsupervised Learning (10 minutes)

Display: Show the next slide, which displays a graphic comparing A.I. Bot and a human brain.

Remarks

> When we learn something new, we create a “Mental Model” in our brain to help represent information and break it down into pieces. For example, when learning about the solar system, we think of small orbs rotating around each other to represent the planets. Computers do this too - when they learn something new, they create a “Machine Learning Model” to help represent the information. This model helps them make a decision. Yesterday, we helped A.I. Bot develop a model for deciding whether something is a fish or not.

Vocabulary:

- **Model:** a computer program designed to make a decision

Remarks

> We’re going to simulate how a computer might create it's first model to learn someting new. In this example, we don't really know what we're learning yet - much like a young child, we’re trying to notice patterns and see what we can discover.

Distribute: Pass out a copy of the Types of Machine Learning Activity Guide to each student. Students will use this activity guide while working through levels in Code Studio.

Teaching Tip

Answer Keys & Exemplars: An answer key or exemplar is provided for verified teachers as part of the resources in this lesson plan. If you do not see an answer key or exemplar listed as a resource, **follow these steps** to become a verified teacher.

Assessment Opportunity

The responses in the activity guide can be used to formatively assess how well students have met the objectives of the lesson.

Code Studio: Have students log into Code Studio. Students will follow the directions on the level, clicking and dragging to group the rectangles together in whatever way makes sense to them. After completing this and pressing the “Next” button, students will see that they’ve created groupings of colors. Remind students to complete the activity guide as they work through this level.

1 Looking for Patterns

Teaching Tip

Colors and Data: The triplets of numbers in each box represents Red, Green, and Blue color values. Students may have seen this before in previous units, but it's also okay if they haven't - that's what makes this an example of unsupervised learning. After the lesson, if students want to learn more about colors and data, consider showing them this **video on colors and pixels** to help explain what is happening.

Discuss: *What groupings did you create? Is there a pattern?*

Discussion Goal: Have several students share or call on a few that you noticed while circulating around the classroom. Students may find that they unintentionally grouped cards together by color (red, green, blue) or by shade (light vs dark) or other factors. It's okay for students to have many different answers to this, and it's also okay for students to not have any noticeable patterns.

Vocabulary:

- **Unsupervised Learning:** Finding patterns in data that doesn't have any labels
- **Features:** The inputs that a model uses to make decisions

Remarks

> This is really fascinating! Just by grouping similar numbers together, we were able to find patterns and create different color groupings. This is an example of **Unsupervised Learning**, where we were able to learn something using just the data itself. The only thing we paid attention to were the numbers on the cards, called the **features**. This is similar to how online recommendations work - computers try to find patterns in the items we buy so they can suggest new items for us.

Discuss: *Which examples from the warm-up are similar to unsupervised learning?*

Have students reflect on the examples shared during the warm-up, trying to identify which ones are are likely to be unsupervised learning. Try to identify situations where students were noticing patterns without clear directions, such as the unspoken rules of their home or community. They will likely think of situations from when they were much younger, especially when they thought they learned something from observation, but it didn't actually end up being true.

Supervised Learning (10 minutes)

Remarks

> Unsupervised Learning is one way that computers can learn something new. But this isn't like what we did yesterday - yesterday we helped the computer learn something new by providing examples. This is like when you get older and a coach or mentor can help teach you something new. In the next level, we're going to try and learn something new with somebody's help.

Code Studio: Have students continue to the next level in Code Studio, where they will play a game called the Green Glass Door. The goal is to notice patterns in different types of words to try and get words accepted through the door.

2 **Green Glass Door**

Circulate: Check in with students as they complete this activity. This activity can frustrate students, especially if they're not sure what to be looking for. Encourage students to click the "See all results" button to see which words have been accepted and which words have been rejected. Help them notice what all the accepted words have in common, and what makes them different from the rejected works. If students figure out the secret early, encourage them to keep it a secret until the class discussion.

Remind students to complete the activity guide as they work through this level.

Teaching Tip

Green Glass Door: The secret of the game is: words with double letters are accepted and all others are rejected. Some students may have seen this game before - if so, encourage them to keep the secret to themselves until others have discovered it. If students get stuck, encourage them to look at the name of the game - green, glass, and door all have two of the same letters in a row and will be accepted.

Discuss: *What's the secret - which words are accepted or rejected? How did you figure it out?*

Discussion Goal: This should be an exciting moment, as students finally share the secret to how the game works. Ask a few students to share how they figured out the secret. Focus on responses that highlight how they looked for similarities within each group (like noticing the double letters) and differences between groups. Highlight how the wizard was helpful in noticing the pattern - without their examples, it would have been a lot more difficult to determine the pattern.

Vocabulary: These words are spread across two slides. Use the visualizations to help explain each concept as students record the vocabulary in their notes.

- **Supervised Learning** - When a human trains a model to learn with examples.
- **Label** - the output you are trying to decide or predict with a model
- **Training** - giving examples to a model so it can learn

Remarks

> This activity is an example of **Supervised Learning**, where we learn something new by looking at examples. The wizard was helping to **train** us by providing **labels** for each of the words - either accept or reject. After looking at enough examples, we can start to figure out the pattern ourselves. This is similar to the activity we did yesterday, or when you're asked to identify street lights or stop signs from an image - we're helping to train a driverless car by providing more data.

Discuss: *Which examples from the warm up are supervised learning?*

Discussion Goal: Have students reflect on the examples shared during the warm-up, trying to identify which ones are supervised learning. Help students understand that the key distinction is that learning happens by examples from someone who is helping or coaching during the learning.

Supervised and Unsupervised Learning (15 minutes)

Do This: On the second page of the activity guide, students are given several scenarios to identify as supervised or unsupervised learning. Have students read through the scenarios and complete the task individually, then have students pair-up to compare answers and talk through their reasoning.

Circulate: Monitor students as they complete this activity, checking that they can reason through the differences between supervised and unsupervised learning. An answer key is provided to help check student responses.

Teaching Tip

Human Learning vs Machine Learning: These scenarios are provided as a way for students to think about how their own learning experiences may be similar to machine learning and to help internalize the vocabulary in this lesson, but human learning and machine learning are still fundamentally very different.

For now, guide students to see how scenarios where someone is learning by training with a teacher or mentor is similar to Supervised Learning, and scenarios where they learn independently by drawing their own conclusions is similar to Unsupervised Learning.

Display: Cycle through the next several slides and invite students to share their responses. This is an opportunity to have a discussion about each scenario and hear why students think certain scenarios are similar to supervised or unsupervised learning.

Discussion Goal: These discussion are less about being absolutely right or wrong, and more about the reasoning being used to compare why certain situations are supervised or unsupervised. Encourage students to discuss with each other, especially if they disagree about a certain scenario. Students may be unsure about some scenarios, which is a good opportunity to clarify the differences between supervised and unsupervised learning as a full class.

Remarks

> Today we've seen two examples of machine learning, and how they can be similar to some of our own learning experiences as humans. Tomorrow, we'll have a chance to research examples of machine learning and see how this type of learning can be used to solve problems in the world.

Wrap Up (5 minutes)

Journal

Discuss: *How are human learning and machine learning similar? How are they different?*

Discussion Goal: This is an opportunity to summarize the learning from today and apply vocabulary correctly. While discussing, try to have students use the vocabulary from the lesson (feature, label, training, etc) correctly.

Have students record their thoughts in their journals, and invite a few students to share their examples with the class.

Assessment Opportunity

Formative Assessment: Reading through student responses to this prompt can help determine how well students internalized the differences between supervised and unsupervised learning. The activity guide from today can also be used as a formative assessment with students.

Lesson 4: Innovations in AI

45 minutes

Overview

In this lesson, students explore an application of AI called Seeing AI and examine how it is supporting people with visual impairments. Then, students research other examples of how AI is impacting society, focusing on users who are impacted by the examples they find. Finally, students share their findings with each other.

Question of the Day: How is AI helping to solve problems around the world?

Assessment Opportunities

1. **Describe how Artificial Intelligence is having an impact on society**

   See the activity guide for this lesson as a way to measure each step of the problem solving process.

Standards

Full Course Alignment

CSTA K-12 Computer Science Standards (2017)

▶ **IC** - Impacts of Computing

Agenda

Before the Lesson

Warm Up (5 minutes)
  Journal

Activity (35 minutes)

Wrap Up (5 minutes)

Objectives

Students will be able to:

- Describe how Artificial Intelligence is having an impact on society

Preparation

- Print copies of the activity guide for each student
- Prepare to digitally distribute the AI Research Areas resource to students.
- Check the **"Teacher's Lounge"** forum for verified teachers to find additional strategies or resources shared by fellow teachers

Links

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

For the teachers

- **Innovations in AI** - Slides
  ▾ Make a Copy
- **Seeing AI** - Video

For the students

- **Innovations in AI - Activity Guide** - Activity Guide ▾ Make a Copy
- **Innovations in AI Research Areas - Student Resource** - Resource
  ▾ Make a Copy

Teaching Guide

Before the Lesson

Students will be researching applications of artificial intelligence and machine learning on the internet. You can provide students with copies of the **Innovations in AI Research Areas - Student Resource** guide to help students in their research. We haven't provided these directly to students because sometimes these sites are blocked by district filtering programs, or the latest news-worthy application of AI may not be middle-school appropriate. **We strongly suggest you check each site for inappropriate content and to make sure it will load on classroom computers before sharing it with students.**

Warm Up (5 minutes)

Journal

Prompt: *What are some examples we've seen so far in class of how AI is being used to solve problems? Or, what are some examples you might know of from outside of class?*

Have students write in their journals, then discuss with a neighbor before sharing as a full class. Keep a list of ideas at the front of the room.

Discussion Goal: This prompt helps focus attention on how Artificial Intelligence specifically is helping to solve problems, as opposed to other forms of technology. Many of the videos so far have mentioned ways that AI is being used, such as helping to screen for cancer or being used in driverless cars. Students may also draw in examples of AI from outside the classroom, especially if there has been a recent story in the news. Make sure to focus on examples that use AI specifically, especially examples that involve making decisions from data (as have been shown in class).

Remarks

> These are excellent examples, and they show a wide range of issues that artificial intelligence can help solve. Today, we'll have a chance to dive in and see other ways that AI is making an impact on the rest of the world.

Question of the Day: How is AI helping to solve problems around the world?

Activity (35 minutes)

Display: Show students the slide with the Problem Solving Process

Remarks

> **Remarks**: When we use artificial intelligence to solve problems, we still go through the problem-solving process - define, prepare, try, and reflect. As we do that, it's important to empathize with our users and ask "Who is included? Who is excluded?". This can be harder to think about - let's look at an example of how AI can help include people who are sometimes left out of the latest technology.

Video: Show students the **Seeing AI** video in the slides. Prompt students with the Questions to Consider before starting the video.

Discuss:

- *What problems does this app help Andre solve?*
- *What data does it use?*
- *How does Andre interact with the app?*

Discussion Goal: Students should recall several examples from the video, such as describing the outside world while riding in a taxi or recognizing handwriting or reading social media posts. Students should also be able to describe how Andre interacts with the app - usually by pointing at an object and having it recognize it. Students may struggle describing the data that it uses, but guide students to realize that it probably had to look at a lot of similar images of the world as training data before it could recognize what Andre was looking at.

Discuss: *What could be an unintended consequence of this app? For example, maybe it could be helpful and used in a different way to solve another problem. Or, maybe it could have unintended consequences that could be harmful for users?*

Clarify for students that, for this question, they do not have to refer to anything in the video - they can come up with their own ideas using their imaginations or drawing from personal experiences. Have students discuss with a neighbor first before sharing as a full group.

Discussion Goal: There is no single right answer to this question - it's more important that students share the reasoning behind their thoughts. Students may comment on how image recognition isn't perfect and it may incorrectly identify something for Andre that could be harmful. Students may also wonder if this app could be used for deaf people as well, using audio from their environment to tell what's going on. Or, they may remember the handwriting comment from the video and suggest that the app could be used to help students improve their handwriting.

Remarks

> This is one example of how artificial intelligence is making an impact on the world. Today, you'll have a chance to investigate other examples of AI as we investigate these same questions.

Distribute: Pass out the **Innovations in AI - Activity Guide** to each student.

Display: Display the instructions for the activity guide. Have students choose a topic they would like to research. They can change topics during class, but selecting one initially is helpful when starting their research.

Research: Have students log into a computer to begin researching. Digitally distribute a copy of the **Innovations in AI Research Areas - Student Resource** so students have access to some starting resources to begin their search. Students can also find this in the Student Resources section of this lesson on Code Studio.

Circulate: Monitor students as they research different applications of AI. Make sure students are finding examples that truly involve artificial intelligence, especially making decisions from data.

Display: Have students begin filling out the back of their activity guide, where they will describe the innovation that they found. Remind students that the final question is their opinion based on their imagination or other experiences - it does not have to come from a video or news article.

Circulate: Monitor students as they answer the questions on the their activity guide. If students are struggling to write down responses, ask them to explain their innovation to you and then prompt them to write down some of their responses on the activity guide.

Pair-Share: Have students find one other person in the class. Each person takes turns describing the innovation that they found, summarizing their responses to the activity guide. This activity can be repeated several times, but students should have at least one other example of an AI innovation that isn't their own.

Assessment Opportunity

The responses in the activity guide can be used to formatively assess how well students have met the objectives of the lesson. Consider collecting the guides and reviewing them, and incorporating some of the examples into lessons later in the unit as students learn more about machine learning and creating their own apps and machine learning models.

Wrap Up (5 minutes)

Prompt: *Describe one other AI innovation you heard about during today's lesson. What problem was it solving? What data did it use?*

Students shouldn't summarize the innovation they researched - instead, they should summarize one of the innovations they heard from their peers.

Assessment Opportunity

Formative Assessment: Consider using this prompt as an exit "ticket out the door" where students can describe the innovation they heard from a partner. Alternatively, these responses can be collected and read later to determine how well students were able to research different applications of AI.

Lesson 5: Patterns in Data

45 minutes

Overview

In this lesson students will examine several apps that make decisions about what shoes to wear, ultimately building up to an understanding of how machine learning can help make this decision. Students are guided to the conclusion that surveying their users can help them make the best decision by looking for patterns in the data and basing their decisions on these patterns.

Question of the Day: What strategies do computer models use to make decisions?

Standards

Full Course Alignment

AI4K12 National Guidelines 2021

▶ **BI-3** - Computers can learn from data

CSTA K-12 Computer Science Standards (2017)

▶ **DA** - Data & Analysis

Agenda

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

Activity (35 minutes)
- **Shoe Recommender**
- **Improved Shoe Recommender**
- **Shoe Recommendation Survey**

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

Objectives

Students will be able to:

- Describe how a model makes a decision (for example: with randomness, or a decision tree, or using data)
- Look for patterns in data to help make a decision

Preparation

- Review the Code Studio levels before the lesson
- Print copies of the activity guide for each student
- Check the **"Teacher's Lounge"** forum for verified teachers to find additional strategies or resources shared by fellow teachers

Links

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

For the teachers

- **Patterns in Data** - Slides
  ▾ Make a Copy
- **Shoe Survey** - Resource

For the students

- **Finding Patterns in Data** - Video
- **Patterns in Data** - Activity Guide
  ▾ Make a Copy

Teaching Guide

Warm Up (5 minutes)

Journal

Prompt: *Choose one question to respond to:*

- *When browsing the internet, what's the weirdest thing an ad has ever tried to get you to buy?*
- *When sending a message, what's the funniest thing autocomplete has suggested to finish a sentence?*

Have students journal individually first, then discuss with a neighbor. Then invite students to share as a full class, and write a list of their answers where everyone can see it.

Discussion Goal: This is a playful prompt that invites students to make personal connections to their experience with AI, and consider the ways that AI can sometimes make incorrect decisions. Invite students to explore why these situations felt wrong and what information was incorrect or missing in how AI was making its decision. Once several examples have been shared, use the remarks below to transition to the activity.

Remarks

> This is a great list, and it shows that computers make recommendations for us pretty often but they aren't always very effective. Today, we'll see how we can improve the way a computer makes recommendations. We'll ask a computer to recommend what type of shoes we should wear for the day, and see several ways a computer might make this decision.

Question of the Day: What strategies do computer models use to make decisions?

Activity (35 minutes)

Display: Show students the slide revisiting the definition for **model**.

Remarks

> Remember that a machine learning model is just a computer program designed to make a decision. In this lesson, we're going to look at several apps and try to understand the model they are using to make decisions. Some of these apps may be making decisions in very clever and sophisticated ways - and others... not so much.

Shoe Recommender

Code Studio: Have students log into the first level of Code Studio. This level contains a basic program that helps students decide what shoes to wear. Have students run the program a few times.

1 **Shoe Recommender**

Discuss: *Is this program helpful for deciding shoes? Why or why not?*

Have students quickly discuss with a partner, then share out as a class.

Discussion Goal: This should be a quick discussion - students should predict that the program is randomly selecting shoes, which doesn't make it a very good program for recommending shoes.

Display: Show students the basic description of this app, confirming that the model is just randomly making decisions.

Teaching Tip

Preview of Model Cards: The format used on this slide is a precursor to Model Cards, which students will see in later lessons. For now, you can describe these descriptions like a name tag or nutrition label on a model - it helps identify and describe how the model works for anyone who uses the app.

Discuss: *What would improve this model to help it make better decisions?*

Discussion Goal: Guide students towards the conclusion that this app could be improved if it used user input and asked questions to help it make decisions. Try to make connections back to the warm-up discussion and how apps can make bad choices when they don't have strong examples from their users. This will help connect to the next app that students will preview.

Improved Shoe Recommender

Code Studio: Have students continue to the next level in Code Studio, where there is another shoe recommender app. This one asks several questions before making a recommendation. Have students run the app several times, trying to determine how this model is making its prediction.

2 Improved Shoe Recommender

Discuss: *How do you think this program is making its decision? Is it more or less helpful for deciding shoes than the last program?*

Have students quickly discuss with a partner, then share out as a class.

Discussion Goal: Students may realize that they can only get certain answers based on certain decisions, and may intuitively describe some sort of "flow" through the program that leads to certain decisions. They may also question or criticize the decisions behind how some shoes are chosen. This is a good point to return to in a later discussion.

As students narrow-in on the branching structure of this app, show students the following slide which shows the tree that the app uses to make its recommendations.

Display: Show students the basic description of this app, confirming that the model is using a process called a Decision Tree to make its recommendations.

Discuss: Do you agree with the questions that were asked and how the shoes were assigned? Who do you think decided which shoes went with each answer?

Discussion Goal: Students might notice that some selections are hidden behind other choices that may not be ideal - for example, this model only has you wear sneakers when it's raining and sports cleats when it's not raining. Students may suggest that the tree needs to be rearranged based on their own experiences for when to wear shoes, or that these decisions may not represent all people who may want to use the app. Try to highlight this idea of getting input from our users to help make our decision, rather than relying on your own personal experiences since they may not represent all situations. This helps transition to the next activity.

Assessment Opportunity

Use class discussions as a way to assess how well students understand the different ways computers can make decisions

Shoe Recommendation Survey

Code Studio: Have students continue to the next level in Code Studio, where they will take a survey asking several questions about their day and what shoes they are wearing. Students can take the survey multiple times to represent different situations, such as:

- Pretending it's the weekend
- Pretending you're going to a birthday party
- Pretending you're sick and not feeling well

3 Shoe Recommendation Survey

Once students have taken the survey, redirect them to the front of the room to see what happens with all of the data they've been generating.

Video: Show students the **Finding Patterns in Data** video.

Teaching Tip

Videos for Students: Videos are intended to be watched and discussed as a class, and so they are not provided as individual levels in Code Studio. If a student needs to re-watch a video, they can be found in the Help and Tips section of levels or by visiting the Student Resources page of each lesson.

To encourage active engagement and reflection, use one or more of the strategies discussed in the **Guide to Curriculum Videos**.

Distribute: pass out the **Patterns in Data** Activity Guide to each student.

Do This: Have students complete the activity by finding patterns and trends in the data using the Cross Tab charts. An answer key is provided for you to check answers.

Circulate: Monitor students as they complete this activity guide. The sentence starters for each table should correlate with the hot spots in the data, while the final two answers can be more open ended and depend more on how well students justify their answers.

Assessment Opportunity

Formative Assessment: As you see students filling in the sentence starters, ask them to explain why they picked these two answers. Students should be able to refer back to the data and use the row to highlight how choosing a particular answer has a strong relationship with a certain shoe.

Share Out: *Using trends from all five questions, what are some shoes we can recommend based on the patterns in the data?*

Discussion Goal: Students should combine several trends together to help recommend a shoe. For example, if someone says they'll spend time indoors, with sunny weather, wearing socks: then we can recommend tennis shoes to this person. Have several students share and try to hear recommendations for each type of shoe. If possible, record some of the responses at the front of the room to use in the next level.

Vocabulary: Display a slide to remind students of the following definitions

- **Feature:** an input that the model uses to make decisions
- **Label:** the output you are trying to decide or predict with a model

Emphasize that in this data, each of the questions are the features which are being used to predict what type of shoe to recommend, which is the label.

Display: Show students the description of the app they're about to look at, which uses the data shown to make its recommendations. Highlight that this app has a new section about the data that it used to create its model.

Code Studio: Have students continue to the next level in Code Studio, where this app is available to test. Have students answer the questions and see if the recommendations match what they saw in the data.

4 Ultimate Shoe Recommender

Display: Advance to the next slide, which shows an arrow connecting how Data becomes a Model. With this slide displayed, transition to the remarks below.

Remarks

> Today, we saw how you can take data and use it to help create a model that makes recommendations. But analyzing that data took some time, even for a short survey like this - imagine if there were 20 questions instead of 3! Or if you were recommending a whole outfit instead of just shoes! In the next lesson, we'll see one of the strategies that a computer uses to make it easier to turn data into a model.

Wrap Up (5 minutes)

Journal

Prompt: *If you could add another question to the shoe survey, what question would you ask? Why do you think that question would be helpful in deciding a shoe?*

Have students journal individually, then share with a partner. If time remains, invite a few students to share with the class.

Discussion Goal: Students will have a variety of possible questions and it's important to listen to their reasoning as to why that question is useful. Hopefully students will choose questions that they think will help separate the data - for example, a question that might strongly indicate tennis shoes or work boots versus sandals and crocs. This bridges to tomorrow's activity, where we compare examples of questions that are helpful in making a decision versus ones that aren't helpful.

Lesson 6: Classification Models

45 minutes

Overview

In this lesson students will participate in an unplugged activity simulating one of the machine learning algorithms computers use to separate data into groups to help make decisions. Students will be tasked with helping a computer learn to classify food as fruits or vegetables, graph 20 different fruits on two axes comparing “sweetness” to “easy to eat”, and then try to separate the data into groups - a fruit area, and a veggie area.

Question of the Day: How do computers learn to classify data?

Standards

Full Course Alignment

AI4K12 National Guidelines 2021

- ▶ **BI-3** - Computers can learn from data

CSTA K-12 Computer Science Standards (2017)

- ▶ **DA** - Data & Analysis

Agenda

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

Activity (35 minutes)
- **Creating Our Model**
- **Testing Our Model**

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

Objectives

Students will be able to:

- Explain how computers can separate data to make a decision

Preparation

- Review all materials for today’s lesson.
- Cut out fruit & veggie cards - one set of cards for each group
- Ruler or straightedge for each student
- Check the **"Teacher's Lounge"** forum for verified teachers to find additional strategies or resources shared by fellow teachers

Links

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

For the teachers

- **Classification Models** - Slides ▾ Make a Copy

For the students

- **Classification Models** - Activity Guide ▾ Make a Copy
- **Fruit & Veggie Cards** - Resource ▾ Make a Copy

Vocabulary

- **Categorical Data** - data that can be separated into groups

- **Classification** - predicting a category based on other features

Teaching Guide

Warm Up (5 minutes)

Journal

Prompt: *How many colors are in the image below? Try finding "yellow". Where does it start? Where does it end?*

Allow students to share their ideas with a neighbor before sharing with the class. Students will probably have different opinions about where yellow "starts" and "stops" - encourage several students to share their descriptions. It's okay to not come to a consensus - the main purpose of the discussion is to motivate the following prompt.

Discuss: *If you could teach a computer to separate the colors, how would you do it?*

Have a few students share their ideas with the class, building off of the language they used in the last prompt. There is no right answer here - it's more important for students to generate ideas and practice describing a process to a computer.

Vocabulary: Display the slide with today's vocabulary on it:

- **Classification:** predicting a category based on other features.
- **Categorical Data:** data that can be separated into groups.

Remarks

> Colors are an example of categorical data, which means they can be grouped into different categories like "yellow" or "green" or "blue". When we ask a computer to look at a color and tell us what it is, we're asking the computer to classify which color it belongs to. Classification is something we learn how to do with our senses, but computers must be taught to do. Today we're going to investigate how computers can use classification to solve problems. We're going to start with a simple example: determining if something is a fruit or a vegetable.

Question of the Day: How do computers learn to classify data?

Activity (35 minutes)

Creating Our Model

Discuss: Let's say you go to a friend's house and they make a meal that you've never eaten before, so you're not sure if you'll like it or dislike it. What are some qualities you look for in foods that you think help decide whether you'll like it or dislike it?

Discussion Goal: This prompt helps seed ideas that we'll return to later in the lesson. The goal is to brainstorm as many food qualities that students can think of. Some examples might include:

- how sweet the food is
- what color the food is

- whether it's hot or cold
- whether it's crispy or mushy
- how spicy the food is

It may be helpful to share some of your own answers as a way to jump-start the conversation with students.

Remarks

> This is a great list! What we've basically come up with are different features of food - things we can use to help make decisions. Today, we're going to see if we can teach a computer to decide if a food is a fruit or vegetable. For now, we're going to focus on only two features: how sweet the food is, and how easy it is to eat. We've also got 20 foods that we can use to train the computer to help it tell the difference between fruits and veggies.

Distribute: Pass out a copy of the Fruit or Veggie Worksheet to each student. Pass out a set of Fruit and Veggies Cards to each group of students. If possible, have the cards cut-out ahead of time to make it easier to share between students in the same group.

Teaching Tip

Create a Class Graph: If you have the classroom space available, we recommend adapting this activity to be completed physically as an entire class on a graph that has been created on the floor of the classroom. The flow of the activity remains the same, except each student takes a card and physically stands in their recommended spot on the graph. The class then decides on how to use string to divide the students into "fruit" and "vegetable" groups. Any remaining students then take on the role of the "test" foods and see how they would be classified as either a fruit or vegetable.

Assessment Opportunity

The responses in the activity guide can be used to formatively assess how well students have met the objectives of the lesson.

Display: Show students the directions for this task and walk through them with students. Point out that students will need to use the food cards to create the points on their graphs.

Model: Graph at least one fruit or vegetable. Emphasize that students can use the recommended values, or they can use their own judgement to rate how sweet and easy to eat a food item is - this helps create slightly different graphs that can be compared in the next part of the activity.

Teaching Tip

Graphing Skills: Consider this an opportunity to reinforce skills that students are learning in their math class, and be careful not to assume students are already fluent with graphing points. You may decide to model several points to help students graph their points, and you may encourage them to use the labels on the graphs to help place their points.

Circulate: Monitor students as they graph their points. For fruits and veggies that students have eaten before, encourage them to make their own decisions about how "sweet" and "easy to eat" the foods are. If a student hasn't heard of the food before, encourage them to use the recommended values instead.

Display: Show students the example graph that you get when using only the recommended values. Point out that it appears that fruits and veggies seem to naturally group together. Ask students to raise their hands if their graphs also have fruits and vegetables clustered together.

Teaching Tip

Imperfect Groups: since students have the option to use their own judgement on where to place their fruits, they may end up in a situation where some foods are intermixed with the opposite group. This is okay, and reflects what happens in the real-world where sometimes data is messy and can't be perfectly separated.

Remarks

> It looks like we picked two really great features to focus on - these are doing a really great job of separating our foods into fruits and veggies. This is really great for a computer - if it wants to determine whether a food is a fruit or a vegetable, it just needs to see where it is on the graph! Things get a little tricky in the middle of the graph though, so we need to make a decision: how can we divide our graph into a fruit side or a veggie side?

Model: Demonstrate on the slide how there are many different lines you could draw that separate the graph into a fruit-side and a veggie side. The most important factors to consider are that you have as many fruits as you can on one side, and as many vegetables as you can on the other. As a class, decide on a line you want to use to divide the example graph on the slides and draw it in.

Do This: Have students draw their own line to split the graph into a fruits side and a veggies side.

Remarks

> Congratulations! We just created a model that we can use to help a computer make a decision! When a computer sees a new food, it will plot a new point on the graph and use that to decide whether it's a fruit or a vegetable. Let's see how our models do with some test foods!

Content Corner

This activity simulates the **Support Vector Machine (SVM)** machine learning algorithm for making predictions based on data. This algorithm focuses on separating data while maximizing the margin of separation.

If you would like to learn more about SVM and other machine learning algorithms, **ml-playground.com** has an interactive widget and links to additional resources. This website is intended for adults looking to learn more about machine learning, especially considering the amount of math involved, so we do not recommend sharing this with students.

Testing Our Model

Display: The next several slides have different foods to test against the model. These examples have been designed to motivate certain conversations. Have students keep track of how many examples their models get correct and incorrect.

Display - Raspberry & Pumpkin: These two examples are designed to match the expectations of the model. Most students' models should correctly identify the Raspberry as a fruit and the pumpkin as a vegetable.

Display - Tomato and Cucumber: These two examples are more ambiguous and, even within your classroom, students may not know whether these are fruits or vegetables. Both of these items are technically fruits because they contain seeds, but are usually used as vegetables when making foods. Ask the class to share how their models classified these items, noting that students may have different answers depending on how they drew their lines.

Teaching Tip

Right on the Line: Depending on how your students draw their lines, they may have a situation where a test fruit is exactly on the line they drew. If this happens, remind students that the model has to make some kind of decision, so they need to come up with their own rule for what happens when a point lands right on the line - is it always a fruit? Or always a vegetable?

Discuss: *Without looking at anyone else's paper, why do you think some people got different answers than others?*

Discussion Goal: Students should realize that how they decided to draw their line impacts the decision that their model makes. You can model this in the front of the room with the example graph on the slides - if the line becomes a little more tilted or goes completely vertical, it can change the way that some foods are classified. Emphasize that this is why testing is important - it helps make sure the decisions we're making are correct.

Display - Lemon and Sweet Potato: These two examples are intentionally designed to be incorrect. Students will likely misclassify these two items - their model will think a lemon is a vegetable and that a sweet potato is a fruit.

Remarks

> Most models will probably get this answer incorrect, which means our foods were misclassified. This happens in real-life too - sometimes models make mistakes and get incorrect answers. For something like classifying fruits and vegetables, it may not be a huge deal. But if we were making decisions about people instead, this could be a really big deal. This is why testing is so important - we need to make sure our models are doing a good job before letting them make decisions for us.

Display - Ice Cream and Flaming Hot Cheetos: These two examples are deliberately silly and fun, and you should lean-in to how the model will likely classify Ice Cream as a fruit and Flaming Hot Cheetos as a vegetable.

Remarks

> I think we can all agree these examples are pretty silly. They're an example of using a model for something other than what it was intended for. Since we trained our model only on fruits and vegetables, it doesn't work very well on other types of foods. If we wanted to improve our model, we'd probably need a lot more data and a lot more features - more than just how sweet and easy-to-eat food is. This gets a lot harder for us as humans to understand, and we couldn't use our graph paper anymore. Luckily, computers can help us with this! Tomorrow we'll see how a computer looks at lots of data and lots of features to help make decisions

Wrap Up (5 minutes)

Journal

Prompt: *If you were to break down the process we went through today to create a model and use it into steps for a computer to follow, how would you describe those steps?*

Discussion Goal: This prompt bridges today's lesson to tomorrow's, where a computer will be doing most of this work behind-the-scenes. Read through student responses to see how well they understood the process of today. Answers could be as simple as:

- Graph the data

- Draw a line to separate the data into zones
- When new data comes, see which zone it lands in to make a decision

Lesson 7: Introduction to AI Lab

45 minutes

Overview

In this lesson students will dive into the AI Lab tool for the first time, where they select features to train a model that predicts a given label. They start by exploring AI Lab and training a model to recognize shapes. Then they pretend they have been hired by several restaurants who would like to make recommendations to new customers based on survey data they're collected, go through each dataset, and use data visualization tools to identify features with high relationships in the data.

Question of the Day: How can we use machine learning to make recommendations?

Standards

Full Course Alignment

AI4K12 National Guidelines 2021

- ▶ **BI-3** - Computers can learn from data

CSTA K-12 Computer Science Standards (2017)

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

Agenda

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

Activity (35 minutes)
- **Recognizing Shapes**
- **Restaurant Recommendations**

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

Objectives

Students will be able to:

- Use AI Lab to select features to train a model
- Use data visualization tools to decide which features to include when training a model

Preparation

- Review the Code Studio levels before the lesson
- Watch the two videos in this lesson and be familiar with AI Lab
- Print or prepare to share online copies of the activity guide for each student
- Check the **"Teacher's Lounge"** forum for verified teachers to find additional strategies or resources shared by fellow teachers

Links

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

For the teachers

- **Introduction to AI Lab** - Slides ▾ Make a Copy

For the students

- **Accuracy in AI Lab** - Resource
- **Introduction to AI Lab** - Video
- **Selecting Features** - Resource
- **Training a Model in AI Lab** - Activity Guide ▾ Make a Copy
- **Training and Testing in AI Lab** - Video

- **Using Data with Categorical Features** - Resource

Teaching Guide

Warm Up (5 minutes)

Journal

Prompt: *Yesterday we compared fruits based on how sweet they were and how easy they were to eat. What is another feature we could have used to compare foods?*

Have students journal individually, then share with a neighbor before having several students share with the class

Discussion Goal: This prompt is meant to bridge yesterday's activity to today's lesson. Have some students share out, but keep this discussion brief so students can move into the widget portion of the warm up.

Code Studio: Have students log into Code Studio. The first level has a Fruit Explorer widget, which recreates some of the experience students had yesterday classifying fruits and veggies by hand.

1 **Fruit and Veggie Explorer**

Model: Read through the directions on the level and demonstrate how the widget works. As you explore the available features, refer back to the discussion especially if some student responses appear in the widget.

Teaching Tip

Exploring, Not Mastering: This widget has a lot going on and students aren't expected to master how to use it. The complexity of the widget is part of the point - as the lesson continues, students will see how AI Lab can simplify this process of exploring and analyzing data.

Do This: Using the dropdowns to adjust the features, draw a line that creates a model that correctly classifies at least 80% of the fruits and 80% of the veggies. An example is provided of what this can look like.

Teaching Tip

Overlapping Points: Sometimes a model will *look* like it's 100% accurate, but may not display as 100% accurate. This is because some points may overlap when they're drawn on the graph. This isn't always easy for students to see, since hovering over the points will only show one of the points. If students are struggling with this, have them watch the graphing process carefully to see the points overlap with each other.

Share Out: Ask students to quickly share out the features they used to create accurate models. Students should be able to find many different combinations of features and many possible lines that can create accurate models.

Remarks

> This activity shows how, just adding a few more features and a few additional foods to our data, it becomes much more complex for us to create the same types of models as yesterday. Sometimes this process can become overwhelming as we try to keep track of all of our data and all of our features. Today, we'll learn how machines can make this process easier for us using a new tool called AI Lab

Question of the Day: How can you use AI Lab to create an accurate machine learning model?

Activity (35 minutes)

Recognizing Shapes (20 minutes)

Display: Show the the slide with the grid of 100 images

Discuss: *We're going to practice using AI Lab to classify shapes. Based on these images, what are some features you think we can use in AI Lab to train a machine learning model?*

Discussion Goal: Encourage students to notice different properties of the shapes. Some of them may be geometric, like number of sides or angle measurements. Also encourage students to identify visual features that a machine learning model might pick up on, like the border color or fill color.

Video: Watch the (5:25) video as a class. **Introduction to AI Lab**

Teaching Tip

Videos for Students: Videos are intended to be watched and discussed as a class, and so they are not provided as individual levels in Code Studio. If a student needs to re-watch a video, they can be found in the Help and Tips section of levels or by visiting the Student Resources page of each lesson.

To encourage active engagement and reflection, use one or more of the strategies discussed in the **Guide to Curriculum Videos**.

Code Studio: Have students advance to the next level in Code Studio, which has the shapes dataset preloaded. Point out the features that are included in the dataset especially if they match the predictions from the earlier discussion.

2 **Recognizing Shapes**

Do This: Click on each column and look at the right-panel to notice patterns that AI Bot found in the data. Try to create sentences like "When a AI Bot sees [blank], it tends to be a [blank] shape" Do *not* press the Train button yet!

Discuss: *What types of patterns did AI Bot notice?*

Discussion Goal: Hopefully students will notice that the number of sides has a 100% relationship with each shape, which shouldn't be surprising. However, students may also notice additional patterns in the data, for example: small shapes tend to be triangles, or circles are only pink or yellow.

As students share their responses, refer back to the grid of shapes and ask them to notice if they can see the same patterns in the grid. Point out how quickly AI Bot was able to discover patterns, and that we can verify those patterns in the data - for example, when you focus just on the small shapes in the grid, most of them are triangles just like AI Bot identified.

Do This: Using the hot spots in data as a guide, select one or two features to use in your model. Then press the Train button to train your model

Circulate: As students press the train button, they will be taken to the second half of AI Lab - the training, testing, and accuracy screens. Students can explore these screens and may have questions, but reserve explanations for now. Once the majority of the class has trained a model, regroup and continue to the next slide.

Video: Watch the **Training and Testing in AI Lab** (3:59) video as a class.

Distribute: pass out a copy of **Training a Model in AI Lab** to each student.

Assessment Opportunity

The responses in the activity guide can be used to formatively assess how well students have met the objectives of the lesson.

Do This: Explore AI Lab to create models that can classify a shape. You should train multiple models from the same dataset and keep track of the accuracy by filling in the table on your activity guide

Once students have completed the table, regroup for a class discussion

Discuss: *This model is trained only on colors and is 90% accurate. What would happen if we tried to use this model in the real-world? Do you think it would be just as accurate?*

Teaching Tip

Widget Fluency: For now, focus on helping students become fluent with AI Lab by making sure they can click columns and buttons, focus on appropriate panels, and navigate between screens. Students can also get help by reading the instructions, which update with each panel, or using the Help and Tips section to read help documents or re-watch the video.

Iterating on Features: Students should remain in this same level and not press the Continue button until told to do so. This represents how students will typically use AI Lab with more complex datasets - training multiple models in the same level and comparing accuracy, rather than training a model just once and continuing.

Do We Really Need AI For This? No - probably not for this particular problem. However, this exercise helps students become fluent with the flow of AI Lab while still cross-referencing with a visual dataset to confirm their understanding. This exercise also surfaces some important problems that will be important throughout the unit, such as when too much conflicting data can confuse AI Bot and lower accuracy or when AI Bot *thinks* it knows something with high accuracy but with features that are not practical in the real-world.

Discussion Goal: Guide students to realize that just because this dataset has patterns with how the shapes are drawn doesn't mean it will represent shapes in the real world. Students can also verify this by testing the data in AI Lab - it shouldn't feel intuitive that our model can predict a shape just from its size and colors, especially if we tried showing it a wider variety of shapes. Remind students of the video, where high accuracy only means that the model can reproduce patterns in the data and that we - as humans - have control over deciding what features are important.

Teaching Tip

Human Responsibility in AI: Focusing on our role in selecting data and features for machine learning models foreshadows future lessons where students consider whether it is appropriate to include demographic features, such as race or gender, in machine learning models. Trying to classify a shape

based on an unrelated property like its color can be analogous to trying to make a decision where unrelated features like race or gender are taken into consideration. This shouldn't be a focus in this discussion, but it can be helpful to refer back to this moment in later lessons.

Prompt: *Training with all possible features created a model that was less accurate than just training on one feature. Why do you think this happened?*

Discussion Goal: Students may have a hard time articulating this particular phenomenon, and it's okay to keep this discussion short and not come to a firm conclusions. Instead, use this brief brainstorm to transition to the next slide where it will be easier to explain how this happened.

Teaching Tip

Misconception Alert: This prompt and the following remarks are directly addressing the misconception that that training with all of the features will lead to the most accurate model. Breaking students of this habit now will lead to more fruitful investigations in future levels as students iterate and experiment in AI Lab to find the best models.

Display: Show the following slide, which has a picture of the shape that AI Bot identified incorrectly and a picture of the shape grid that was used to train AI Bot.

Discuss: *Looking at the training data, why did AI Bot think this small brown shape with a red border was a triangle?*

Discussion Goal: Encourage students to refer to the training data and see patterns with each of these features individually. For example:

- most small shapes in the training data were triangles with very few squares
- most shapes with a red outline in the training data were triangles with very few squares
- there aren't a lot of brown squares in the training data

If students don't notice these patterns explicitly, that's okay - you can summarize these observations in the remarks below.

Remarks

> In this example, AI Bot thought this small brown square with a red border was a triangle. If we look at the rest of the training data, we see a lot of small shapes are triangles, a lot of triangles have red borders, and not a lot of squares are brown. With all these extra features, AI Bot got confused and thought these other patterns were more important than the number of sides. This is why it's important to only use data with a strong relationship to your model and not include extra features that don't have strong relationships.

Restaurant Recommendations (15 minutes)

Display: Show students the next slide, which introduces a new problem of creating recommendations based on user survey data. The class has been hired by a pizza restaurant to help figure out what customers like best based on the toppings they pick.

Code Studio: Have students continue to the next level in Code Studio. If they are on a different panel in AI Lab, they can use the bubbles at the top of their screen and click the next bubble to jump straight to the level.

3 **Pizza Recommendations**

Do This: Have students train a model to with at least 80% accuracy using the pizza data. They should record their results on their activity guide.

Circulate: Monitor students as they complete this task, focusing on how they are using the cross tab tables to inform their decisions. Students are able to continue to the next level only if they've trained a model with 80% accuracy.

Teaching Tip

Feature Selection: Now that students are familiar with AI Lab, this dataset emphasizes the decision making process involved with training machine learning models. Students should be using the cross-tab visualizations to make decisions about which features are useful for making recommendations, noticing when features have strong relationships and when features appear “random”. Help students see that choosing all the features or choosing features at random isn’t useful if it leads to an inaccurate model.

Order Matters: Students may discover that the order they select their features can sometimes matter - for example, choosing "peppers, fried chicken" may end up with different accuracy than "fried chicken, peppers". This is not a vital topic for using AI Lab fluently, and happens more often in these early levels because of the smaller dataset sizes. If students ask, one way to think about it is that the first feature represents how AI Bot first tries to separate the data before continuing on to the other features. Therefore: the stronger the relationship is with the first feature you pick, the stronger the patterns AI Bot will find.

Do This: The final level has several choices for datasets that students can investigate. All of them are similar to the ones we just investigated, with different foods available that they can make recommendations for. Students should select a dataset, then investigate how they can train a recommendation model for their situation. They should also keep track of their model on their Activity Guide.

4 **You Choose: Restaurant Recommendations**

Teaching Tip

Activity Completeness: It’s important for students to feel like investigators and experimenters as they try to find an accurate machine learning model, which means they may run out of time to finish the activity guide. This is okay, especially if they spend a long time investigating their data and deciding which features to choose. Even if they don't finish, make sure they complete the last question about the strategy they used to select their features.

Wrap Up (5 minutes)

Journal

Prompt: *What is one example from today of how humans can influence the machine learning process?*

Discussion Goal: Student answers may vary, but may focus on how the choice of data and features is something humans influence when creating a machine learning model. Students may also comment on our role in deciding to use a model even when it's highly accurate, such as with the shapes dataset from the first part of the lesson.

Lesson 8: Importing Models in App Lab

45 minutes

Overview

In this lesson students are introduced to importing their models into App Lab and linking their model to their screens. They help create a book recommendation app and learn how to add a welcome screen and events to their code. This lesson assumes students are already familiar with App Lab - for classrooms that have not seen App Lab before, consider extending this lesson and including additional videos or activities that are recommended in the lesson plan.

Question of the Day: How can I create an app using machine learning?

Standards

Full Course Alignment

CSTA K-12 Computer Science Standards (2017)

- ▶ **AP** - Algorithms & Programming
- ▶ **IC** - Impacts of Computing

Agenda

Warm Up (5 minutes)
- Pre-Work
- Journal

Activity (35 minutes)
- Survey Analysis
- Importing a Model

Wrap Up (5 minutes)
- Journal

Objectives

Students will be able to:

- Add screens and events in App Lab
- Create an app that uses machine learning

Preparation

- Review the Code Studio levels before the lesson so you will be familiar with importing a model into App Lab
- Decide if you would like to provide additional resources for students to become familiar with App Lab, as outlined in the lesson plan.
- Check the **"Teacher's Lounge"** forum for verified teachers to find additional strategies or resources shared by fellow teachers

Links

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

For the teachers

- **Importing Models in App Lab** - Slides
  ▼ Make a Copy

For the students

- **Events in App Lab** - Video
- **Importing a Model in App Lab** - Resource
- **Intro to Design Mode** - Video

Introduced Code

- `addPair(object, key, value)`
- `getPrediction(name, id, data, callback)`

- `getText(id)`
- `onEvent(id, type, function(event)){ ... }`
- `setText(id, text)`
- `var x = __;`

Teaching Guide

Warm Up (5 minutes)

Pre-Work

Student Survey: Students will be interacting with a survey as part of this lesson. Before class, you can create your own copy of the survey here: **click to make a copy**. Once you make a copy, you can have students take this version of the survey rather than the generic one in the lesson plan. Interacting with this version of the survey can be more personalized, since students can see data from other students within the class.

App Lab Experience: This is the first lesson where students will use App Lab. If students have not seen App Lab before, you might consider postponing this lesson and instead spending a few extra class periods introducing students to App Lab and Design Mode. **Click here** to read more about our recommendations for how to introduce students to App Lab.

Journal

Display: A class is interested in making a book recommendation app for new students. The app will ask several questions and, based on the responses, will recommend a book that other people in the class have read.

Prompt: *What is a question you think they should ask to help recommend a book?*

Have students journal individually, then share their answers with a neighbor. Ask students to share-out with the whole class and keep track of responses at the front of the classroom.

Discussion Goal: Students may suggest that the class ask about other books students have read before, or types of books people like reading. They may also suggest questions based on interest or hobby. Ask students to explain their questions, and listen for responses where students hope to find a relationship between the answers and the book recommendation. For example, someone who is interested in magic may be more likely to read a fantasy book - this is an example where gathering data can be useful in seeing if this relationship will be true.

Digitally Distribute: Have students log into a computer and digitally distribute the **Book Recommender Quiz**. Once they have completed the quiz, they can click the "See Previous Responses" link to view the data from the quiz.

Teaching Tip

Using Your Own Quiz: Rather than taking the generic survey available to everyone, you can also make a copy of the survey so it contains just data from your classes. To do this, **Click Here to make a copy of the survey**. You can then use this survey with your students and they will be able to view the results just from their class.

Why Google Forms? Later on in the unit, students will have the opportunity to create their own surveys using Google Forms. Even if you usually use a different survey tool for your classes, we using Google Forms for this lesson since it will help familiarize students with the tool by the time they get to their final project.

Display: Show the slide with the Data --> Model --> App process

Remarks

> So far, we've explored how Data can be used to create a Model. Today, we'll see how you can use the Model to create an App that people can use. We're going to help create this Book Recommender app and learn how to use machine learning models in App Lab.

Question of the Day: How can I create an app using machine learning?

Activity (35 minutes)

Survey Analysis (15 minutes)

Code Studio: Have students log into Code Studio. The first contains a working version of the app that students will create today. Have students run the program a few times.

1 **Book Recommender App**

Discuss: *What design elements did you see in this app?*

Have students brainstorm on their own or record a list in their journals, then invite them to share as a full class.

Discussion Goal: Students will probably notice that buttons, images, and text labels are used extensively. Be sure to remind students that each screen is an element as well. If students are missing any elements, use this as an opportunity to remind students of design mode in App Lab.

Teaching Tip

Design Mode Reminder: If students need a reminder of design mode, you can provide copies of this handout or project it for students:

- **Design Mode**
- **Design Mode Elements**

You can also show students this video: **Intro to Design Mode**

Discuss: *What coding commands would you expect to see in this app?*

Have students brainstorm on their own or record a list in their journals, then invite them to share as a full class.

Discussion Goal: Students should predict that onEvent is being used for each button, and that setScreen is used to switch between screens. If students have been through Unit 3 of CS Discoveries, they may also predict that if-statements are used to generate the final answer, but it is okay if this isn't discussed.

Teaching Tip

Events Reminder: If students need a reminder of events in App Lab, you can provide copies of this handout or project it for students:

- **Responding to User Input**
- **Changing Screens**

You can also show students this video: **Events in App Lab**

Prompt: *The app is missing two questions from the survey:*

- *Which type of sandwich is your favorite?*
- *What kind of day do you like?*

Why do you think those questions didn't make it into the model?

Discussion Goal: Guide students towards the conclusion that these questions probably didn't have strong relationships in the data or lead to an accurate model. Students may hypothesize that this is because the questions didn't seem to be related to books, but we'll never know for sure without seeing the actual data.

Prompt: *This class considered asking about gender on the survey to help recommend a book, but decided against it.*

Do you think there is any harm in including a question about gender in the survey? Why or why not?

Discussion Goal: This is an opportunity to explore how demographic features, like gender or race or age, should or shouldn't be used in machine learning models. Some students may think it's harmless to include gender in the survey, since it may have a strong relation to certain types of books. Other students may bring up how about gender can lead to stereotypes, or how there may not be enough data to be gender inclusive in the survey especially for non-binary students.

Guide students to consider whether or not it feels like the best type of question to ask considering that the class is trying to predict a book recommendation. Have the class consider whether gender feels like a necessary question, or if other questions will also lead to accurate recommendations. In this way, asking about gender is similar to the previous two questions about which sandwich you like or the type of day you're having: the other questions are probably better predictors of what type of book you may read.

Content Corner

Additional Resources: Even though including gender on a survey may feel innocent to some students, studies have shown that gender bias can creep into recommendation and selection processes in unintended and unexpected ways. For example, a machine learning algorithm designed to screen job candidates in the tech industry was discovered to be **biased against against women** and perpetuating stereotypes in the tech industry. Importantly, this phenomenon can exist even without AI and Machine Learning, such as a study showing how **gender bias was impacting selection for symphonic orchestras**.

If students are interested in this topic, consider having them explore the **Survival of the Best Fit** game which simulates a similar phenomenon.

Importing a Model (20 minutes)

Code Studio: Have students continue to the next level in Code Studio. Here they will import a model into their app and test that it works correctly. Have them follow the instructions on the screen to import their first model.

2 Import a Model

Teaching Tip

This Can Be Overwhelming: When models are imported into App Lab, a lot of code is pre-generated and this can be overwhelming. Students may feel nervous about needing to understand everything that's happened. You may want to reassure students in the following way:

- Remind students that they already know a lot of what's happening based on the discussion they just had! All of the design mode elements are familiar, and the code uses the same onEvent blocks they were expecting
- Assure students that we'll uncover what most of this code does throughout the unit, and they don't have to understand every little piece of it right now

Text-to-Speech Options: The instructions panel includes two options that can support comprehension for students.

- **Text to Speech** which reads aloud the instructions for students
- **Microsoft Immersive Reader** which opens a new panel for the instructions and gives controls to change the text size, contrast, or translate to another language.

Click here to learn more about these options

Discuss:

- *Can you identify the line where the button press happens?*
- *Can you identify where all of our data is collected into a variable?*
- *Can you identify the line where our prediction happens?*

Have students talk with a partner first before having a full-class discussion. Students will likely be unsure about some of their answers - encourage them to think of these as predictions rather than definite answers.

Discussion Goal: Help students identify the following information:

- The button press happens on line 2 with the yellow `onEvent` block
- The data is collected on lines 3 through 6 with the `addPair` blocks and the yellow `getText` blocks
- The prediction happens on line 8 with the green `getPrediction` block

Code Studio: Have students continue to the next level. As they progress, they will update the style of their app using Themes and will add a "Welcome Screen" to the app for when a user first loads the app.

Teaching Tip

Facilitating Programming Levels: These levels are designed to continue teaching new skills and blocks through exploration, trial-and-error, and using worked examples from pre-supplied code. Students are still getting familiar with the concepts in the lesson and will need strong support throughout these levels to build confidence, debug their code, and cement their understanding.

Consider having students complete these levels in pairs using **Pair Programming**, which has students use one computer and trade between being a Driver or a Navigator. This process is highlighted in **this video**, which you can show to the class. You can have students switch roles based on a timer, or switch every time they complete a level.

3-6 Customize Your App

3 4 5 6

Teaching Tip

Using Resources: Below you can find recommendations for using the many resources students are introduced to in the lesson. You could consider creating a "Resource Chart" to keep track of these options and support students to be self-sufficient as they progress through levels.

- **Videos:** Watched as a class, but students can always return to them.
- **Help and Tips Tab:** This tab contains all of the relevant videos and reference guides for a particular level.
- **Reference Guides:** Contain text and diagrams explaining content. These are intended as helpful student resources, not class readings. They are a good place to go for review after learning content or when students get stuck in levels. You may decide to print these and have them available for students as they work through levels.
- **Documentation and Examples:** Hovering over a block will show a short description of what the block does. Clicking the "See Examples" link will open the documentation for that block.
- **Level Instructions:** Instructions may introduce small pieces of new content. Each level features a "Do This" section explaining what students are supposed to do in that level. Set the expectation early that reading these instructions, not just the "Do This" section, is important.

Circulate: As students complete these levels, they will continue automatically to keep customizing their apps. Here are some tips for how to support students in each level:

- **Level 3:** Students will update the text on their app so it is easier for a user to understand. Instead of the one or two word description from the pre-generated design elements, students will use the same questions they saw in the survey.
- **Level 4:** Students will choose a theme to update the design of their app. For now, just have them choose a theme. Later on, they can continue to customize their app with Design Mode
- **Level 5:** Students add a home screen to their app. The instructions for this level may be difficult to keep track of - encourage students to “check off” each step as they complete it. They can also use the animated example on the level as a guide for how to complete this task.
- **Level 6:** Students add a button from the home screen to the predict screen, and add an event to connect the two screens together. Support students in reading through the instructions and “checking off” each piece as they go along. They can also click the “Show Me How” lines in the instructions for screenshots of what each step can look like.

Assessment Opportunity

Formative Assessment: This level can be used as a formative assessment. A rubric is provided in the level, and written feedback can be given to students. **Click here to learn more about giving feedback to students**.

Choice Levels: Once students have created their Book Recommender app, they can choose from several example activities to continue improving their app. Each level uses the same Book Recommender app they’ve already built as a template to add to. Students can choose to complete as many of these levels as they would like - each one lets them continue to customize and improve their app.

Teaching Tip

Student Choice and Practice Levels: Having students choose their own practice levels are one way to differentiate instruction with your students. To learn more about how these levels support differentiation, as well as other strategies, you can review the **CSD Guide to Differentiation**

Wrap Up (5 minutes)

Journal

Prompt:

1. *What was a moment from today where you felt successful?*
2. *What is a question or point of confusion you still have from today?*

Have students write their responses in their journal. They can also share one of their responses with you as they leave for the day, or you can check their journals later.

Assessment Opportunity

Formative Assessment: There are a lot of places in this lesson where students may get lost or confused and not feel comfortable speaking up, especially if other students in the class have prior App Lab experience. Use this prompt as a way to determine if you need to check in with students at a later lesson, or revisit a concept from today. This is especially true if students have varied levels of experience with App Lab before this unit.

Lesson 9: Model Cards

45 minutes

Overview

In this lesson, students will investigate a model for bias and be introduced to a Model Card, which is a way of representing important information about a trained model that could help uncover bias. They will be investigating a Medical Priority app, which helps a hospital decide how soon to view patients based on their symptoms. As students go through the activity, they realize that the app is biased based on personal information and examine how this could happen.

Question of the Day: How can we evaluate machine learning models once they've been trained?

Standards

Full Course Alignment

AI4K12 National Guidelines 2021

- ▶ **BI-3** - Computers can learn from data

CSTA K-12 Computer Science Standards (2017)

- ▶ **IC** - Impacts of Computing

Agenda

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

Activity (35 minutes)
- **Medical Priority App**
- **Prompt 1**
- **Prompt 2**
- **Analyzing Model Cards**

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

Objectives

Students will be able to:

- Read a model card and use it to evaluate a model

Preparation

- Review the Code Studio levels before the lesson
- Anticipate how you will guide the discussion on racial and gender bias, considering that some students may have experiences similar to those discussed in this lesson.
- Check the **"Teacher's Lounge"** forum for verified teachers to find additional strategies or resources shared by fellow teachers

Links

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

For the teachers

- **Model Cards** - Slides
  - ▼ Make a Copy

For the students

- **AI: Training Data & Bias** - Video (**Download**)
- **Model Cards** - Activity Guide
  - ▼ Make a Copy

Vocabulary

- **Bias** - When a decision favors some things and de-prioritizes or

excludes others

Teaching Guide

Warm Up (5 minutes)

Journal

Discuss: *Imagine you are babysitting a young cousin and they run up to you from playing looking upset and asking for help. They show you that they skinned their knee and it isn't bleeding, but it's very pink. If you had to choose only one way to react, which would you pick?*

(1) Tell them to deal with it and go back to playing

(2) Tell them to wait a minute while you go get some band-aids

(3) Call 911 and ask for an ambulance

Have students journal individually, then have students share by showing on their fingers which option they chose. This situation is purposefully vague, and the class may find itself split between option (1) and option (2).

Teaching Tip

Not A Realistic Choice: Students may point out that this is not a realistic way to choose your reaction. There are plenty of other choices you could make, and the situation doesn't provide any additional context that might be important - for example, perhaps the location where they were playing has an important role in the decision they would make. These feelings are valid and can lead to a nuanced conversation about how difficult it is to make decisions without full context, especially for a machine. For now, encourage students to choose the best of the possible options while acknowledging that the realistic version of this choice can be much more complex.

Discuss: *What kind of injury would lead you to make a different choice?*

Have students think individually first, then share with a partner before having a full-group discussion.

Discussion Goal: Students should describe how different situations call for different decisions. As students share, highlight the features that they are using to make these decisions - for example, whether or not there is blood or whether or not their cousin is crying. Allow several students to share their answers so a wide variety of ideas are heard. Use some of what you heard as examples in your remarks to transition to today's activities.

Remarks

> Thank you all for sharing your ideas! I heard a lot of different features that helped you make a decision, but I also heard some people make different decisions even in the same situation. This same thing can happen with computers too - the decisions it makes can be different from the ones we expect, even in very similar situations. Today, we'll look at how we can test a computer model to see what kinds of decisions its making and make sure those decisions are fair.

Question of the Day: How can we evaluate machine learning models once they've been trained?

Activity (35 minutes)

Medical Priority App (15 minutes)

Code Studio: Have students log into Code Studio. The second level contains an app that they will use for the first part of this lesson.

1 **Medical Priority App**

Display: Show students the information about this app and read it aloud. Demonstrate how to use the app by entering different feature information then pressing predict and seeing the result. Clarify for students what the racial abbreviations mean:

- BAM: Black / African American
- W: White
- A: Asian
- AIAN: American Indian / Alaskan Native
- NHPI: Native Hawaiian / Pacific Islander

Once students see how the app works, continue to the next slide with specific tasks to investigate

Prompt 1

Display: *Change the features of the app and test what happens when different people enter the hospital.*

- *Find a person who will be admitted as "priority".*
- *Find a person who will be admitted as "normal"*
- *Find a person who will be admitted as "return later"*

Circulate: Circulate around the room as students engage with the app. Ask them what features they're selecting to try and get a "priority" recommendation, or a "return later" recommendation. Students will probably notice that certain features are more likely to lead to a priority recommendation, specifically: a patient that is bleeding, is short of breath, and has pain in their head or chest is highly likely to have a priority recommendation. Students may also notice that certain demographic information also seems to affect the recommendation, but it's okay if they don't bring this up.

Teaching Tip

What's My Priority? Students may try to use their own demographic information in the app, but this is explicitly *not* the purpose of this exercise. Remind students that we want to test this in a wide variety of scenarios, which means testing with a wide variety of people and not just people who match their age, gender, and race.

Share Out: Ask a few students to share what features led to priority recommendations, and if that recommendation seems to make sense.

Prompt 2

Display: The hospital wants to check the result under very specific situations. The table in the slide shows four different groups. Each column represents a different person that the group will test.

Assign students to different groups: A, B, C, or D. Each person will only test the person in their group. Everyone in the same group should get the same result.

Share Out: Give students a few minutes to find their results, then ask a person from each group to share the results with the class. Record the results somewhere prominent where students can see them. Students should report out the following answers:

- Group A: normal
- Group B: priority
- Group C: priority
- Group D: priority

Display: Go to the next slide with Prompt 2A and read the directions aloud. Have students re-run the app on this new person. Students should only need to change one or two features to generate the new priority, so this shouldn't take very long.

Share Out: Give students a few minutes to find their results, then ask a person from each group to share the results with the class. Draw a line through the previous answers and write the new ones next to them - however, make sure both answers are clearly visible for the next discussion. Students should discover the following answers:

- Group A: normal --> priority
- Group B: priority --> normal
- Group C: priority --> return later
- Group D: priority --> return later

Discuss: *All of the results changed. Do those changes seem like they make sense? Or do some of them seem surprising?*

Have students talk with a neighbor first before asking students to discuss as a full group. Give students space to share their own observations and reflect on each other's responses, and try to avoid validating responses as "right" or "wrong".

Discussion Goal: Students may try to rationalize the changes to Group A and Group B as making medical sense. Students may struggle to justify the changes to Group C and Group D, since none of the medical information changed - only the personal information. Encourage students to consider what this means in the real world - for example, with Group D: a man with these symptoms can walk into a hospital and be seen as a priority, but a woman with the same symptoms would be told to return later.

Teaching Tip

Lived Experience: Students may have strong reactions to this prompt as it highlights how a decision is being made based on personal information rather than objective information. They may have their own stories and experiences where they've seen different decisions being made based on someone's age or gender or skin tone. This personal connection is an important part of the lesson, and letting students share these stories can be a powerful bridge to the next activity.

When facilitating this discussion, a good mantra to keep in mind is: **assume there's someone in the room who is your data point**. Sometimes a discussion can slip into focusing on data and numbers and hypotheticals without acknowledging that there may be students with firsthand experience with medical discrimination in the room. Consider how you would like to address this and create an inclusive space for discussion in your classroom.

Remarks

> It's a good thing we were hired to investigate this app, because it looks like we've uncovered some disturbing trends in how it was designed. We've now seen a few situations where the app is making different decisions based on your personal information rather than the medical condition you're in. For something as important as a hospital visit, this is unacceptable. This is an example of how machine learning can be biased

Teaching Tip

Medical Priority in the Real World: The Medical Priority example is based on a real example of algorithmic bias in how people were recommended for treatment. You can hear Dr. Ruha Benjamin explain the real-life example in this clip from the Glad You Asked show, from 15:48-17:52: **Click Here for Video**. Rather than voicing over the data in the slide deck, you may decide to show this video clip to your students instead. This video isn't intended for a middle school audience, so you may have to follow-up with a discussion prompt or additional explanations to help clarify the clip.

Video: Watch the **AI: Training Data & Bias** video

Key Vocabulary:

- **Bias:** When a decision favors some things and de-prioritizes or excludes others

Teaching Tip

To encourage active engagement and reflection, use one or more of the strategies discussed in the **Guide to Curriculum Videos**.

Analyzing Model Cards (20 minutes)

Remarks

> Having a biased model is clearly a problem, and it's another reason our role as evaluators and testers of machine learning models are so important. This is also a problem that people in the machine learning community are trying to solve. Let's listen to one possible solution, then we'll talk about how we can use this idea when creating our own machine learning models.

Video: Have students watch the Model Card video in the slides. This video is part of a longer show - the clip in the slides is pre-set to only play the relevant clip from 18:33 - 19:26

Content Corner

Model Cards: Model Cards were initially proposed as part of the academic paper **Model Cards for Model Reporting**. One of the co-authors of this paper, Deb Raji, is featured in this video clip discussing Model Cards.

Since the publication of this paper, additional efforts have been made to focus on accountability and documentation in machine learning. A good overview of these efforts can be found in the **About ML** project, which includes real-world examples of Model Cards used in the machine learning industry.

Distribute: Pass out the **Model Cards** activity guide to each student.

Code Studio: Have students advance to the next level in Code Studio, which shows the Book Recommender app from yesterday and a partially completed model card.

2 Book Recommender Model Card

Do This: Show students the directions for the first page of the activity guide. Students will help create a model card for the Book Recommendation app from yesterday

Circulate: Check in with students as they fill in the model card. Encourage them to consider how the data was collected and which features were used as the basis for filling in the Intended Uses and Limitations sections. For limitations, students may notice that more data should be collected since only 120 students were surveyed, or they may notice that it was only collected in computer science classes and may not represent students from outside those classes.

Display: Have students turn to the back of their activity guide and display the slides with the overview:

Even though we discovered bias in our original model, there is still a need to help nurses and medical professionals in the ER. Several other companies have created medical priority models that can be used to replace the biased one that we discovered. They've also sent along the Model Cards for us to evaluate. Looking at these model cards, can we find a model that we would recommend to the hospital to help decide medical priority?

Do This: Have students continue to Levels 3-5 in Code Studio. Each level has a model card that students can evaluate. Students should progress through each level independently, evaluating each model card and recording their recommendation on their activity guide.

Teaching Tip

Stations: Instead of having students examine the model cards in Code Studio, you could consider creating a stations activity where each model card is printed around the room. Students would still complete the activity guide, but can choose which model card to examine and move around the room while doing so.

3-5 Medical Dataset Model Cards

3 4 5

Circulate: Check in with students as they look through the model cards. Help students understand the format of the card and how the information can be used. Each model is intended to have a flaw in them that makes it difficult to recommend, but it's okay if not every student notices these flaws when first reading the card. Instead, students will have a chance later to discuss their findings with partners and possibly change their minds.

- **Level 3: ER Recommender V1** - this model is only 33% accurate which makes it hard to recommend.
- **Level 4: Northern Lights ER Priority** - this model has features that appear very specific. If students look at the Data Information section, they may notice that the model was trained in a rural hospital in Alaska. This means it probably won't do very well outside of Alaska and in other more diverse areas.
- **Level 5: AI Medical Recommender** - this model is only trained on 10 rows of data (or 10 people in the hospital). Even though it has high accuracy, it probably doesn't have enough data in a real-world scenario

Share Out: Have students share their recommendations for each model. Encourage students to talk to each other and provide different justifications as to why a model should or shouldn't be recommended. Let students know there is a spot on the bottom of the activity guide to reflect, and they have permission to change their minds based on what they hear from their peers.

Content Corner

Real-World Connection: These example model cards are exaggerated for pedagogical purposes, but similar phenomena can be seen in this article: **Hundreds of AI tools have been built to catch covid. None of them helped**. A few relevant quotes from the article are:

- "Many unwittingly used a data set that contained chest scans of children who did not have covid as their examples of what non-covid cases looked like. But as a result, the AIs learned to identify kids, not covid."
- "In yet other cases, some AIs were found to be picking up on the text font that certain hospitals used to label the scans. As a result, fonts from hospitals with more serious caseloads became predictors of covid risk."

As an extension of this lesson, you may choose to share this article with students. However, the article is not intended for a middle-school audience, so additional scaffolds and supports may be necessary to support student understanding and connecting back to today's lesson.

Wrap Up (5 minutes)

Journal

Prompt: *If you could offer guidance to these companies training machine learning models, what advice would you give them to help create useful and unbiased machine learning models?*

This prompt is provided on the bottom of the activity guide that students were using in class. Students should reflect on the reasons why these models weren't great fits for the hospitals and translate that into advice. Some suggestions might include:

- Avoid demographic information in your model to help avoid bias
- Make sure the data represents the community that will be using the model
- Make sure enough data is collected to ensure it is accurate

Assessment Opportunity

Formative Assessment: The activity guide from today can be collected as form of formative assessment. The reflection question can provide insight into how well students understand how model cards can be useful for evaluating models.

Lesson 10: Saving Models in AI Lab

45 minutes

Overview

Students complete the full process of training and saving a model, then importing into App Lab. For the first time, students are able to choose the label they would like to predict and spend time deciding the features they will use to help predict their label of choice. Students also create a model card for their models in order to save them and import it into App Lab

Question of the Day: How can I use Model Cards to document my decisions when training a machine learning model?

Standards

Full Course Alignment

AI4K12 National Guidelines 2021

- ▶ **BI-3** - Computers can learn from data

CSTA K-12 Computer Science Standards (2017)

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

Agenda

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

Activity (35 minutes)
- **Model Cards in AI Lab**
- **Zoo Predictions**
- **Importing Your Model**

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

Objectives

Students will be able to:

- Create model cards in AI Lab to save machine learning models
- Use data visualizations and feature iteration to train machine learning models

Preparation

- Review the Code Studio levels before the lesson to be familiar with investigating columns in AI Lab and training their model
- Print copies of the activity guide for each student
- Check the **"Teacher's Lounge"** forum for verified teachers to find additional strategies or resources shared by fellow teachers

Links

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

For the teachers

- **Saving Models in AI Lab** - Slides
  ▾ Make a Copy

For the students

- **Model Cards in AI Lab** - Video
- **Selecting a Label** - Resource
- **Zoo Models** - Activity Guide
  ▾ Make a Copy

Teaching Guide

Warm Up (5 minutes)

Journal

Prompt: *People often post information about themselves on social media like:*

- *Their name and age*
- *The school they go to*
- *Where they live*
- *Movies they like*
- *Restaurants they've been to*
- *Their birthday*

If all of this data was collected, what is one thing you think a machine learning model could try and predict from this data?

Discussion Goal: Answer will vary, but could include local movie or restaurant recommendations, names of people with similar interests, how much money they spend, a birthday present they should buy. There is no single correct answer to this prompt - instead, focus on the choices that students are making about what features to emphasize and what they want to predict in the first place. Even with the same set of data, students may make dramatically different choices about what a model could look like with this data.

Remarks

> This is a common situation in machine learning - people have a dataset that they've collected, and then they have to decide what they want to predict from the data. And there are a lot of decisions that go into training a model like this! Today, we'll see how you can use model cards to help keep track of all the decisions that go into training a machine learning model

Question of the Day: How can I use Model Cards to document my decisions when training a machine learning model?

Activity (35 minutes)

Model Cards in AI Lab (5 minutes)

Video: Show students the **Model Cards in AI Lab** video, which summarizes Model Cards that students saw yesterday and shows how they can be saved in AI Lab.

Teaching Tip

Black Boxes: This video references how AI models are sometimes referred to as "black boxes" and how difficult it can be to uncover how a model works once it's trained. Examples of this can be seen in the **ProPublica Breaking the Black Box** journalism series. This is a 4-part series that includes short videos and additional resources about different investigations into machine learning algorithms. One of the videos on pricing calls out how online products can have different prices depending on the zip code of the user, which is a common issue involving bias in machine learning models where a zip code can be used as a proxy for race or socio-economic status.

These videos aren't intended for classroom use, but you may decide to share some of these videos with students to continue conversations around bias in machine learning and the need for transparency via Model Cards.

To encourage active engagement and reflection, use one or more of the strategies discussed in the **Guide to Curriculum Videos**.

Code Studio: Have students log into Code Studio. The first three levels represent the zoo dataset in AI Lab where students can train a model.

Distribute: Pass out the **Zoo Models** activity guide to each student.

Display: Display the slide with the scenario for today's task, where we've been hired by a zoo to create different apps for customers to interact with around the zoo. Have students read the slide aloud.

Zoo Predictions (20 minutes)

Do This: Have students complete the first three levels of Code Studio. Students will train and save 3 models using the Zoo dataset. They will also record some of their responses on the activity guide.

1-3 **Zoo Predictions**

1 2 3

Circulate: Check in with students as they train their models. Students should spend time iterating on the features they are selecting. The "Previous Results" section of the results screen can be helpful for students to find feature combinations that will work with their label. Students should also use the activity guide to practice filling in their model card.

Teaching Tip

Selecting a Label: This is the first time students can choose the label for their model. The process is identical to selecting features, but be aware that some students may be initially surprised by this extra step in the process. Students can access a resource in the Help and Tips section of Code Studio that explains how to select a label in AI Lab

Revisiting Past Screens: Let students know it's okay to go back and revisit past screens to improve their model or make different decisions - this is an important part of the process and something students should practice in this level. Students may find themselves starting to move fluently between the testing, feature, and label screens as they refine and improve their machine learning model.

Level 2 - Where Are The Tables? In level 2, students predict the type of animal that they are looking at (like mammal, reptile, etc). This column has too many possible values, and so many data visualization tables won't appear. This is intentional, since it challenges students to use feature iteration and the Previous Results screens intentionally to find features that work. They need to trust that, if there are patterns in the data, AI Bot will find them and produce an accurate model even when there's too much data to visualize. This also prepares students for more realistic examples where there are typically more than 4 or 5 values for a feature.

Accuracy and Data Representation: Students may be able to discover some curious combinations that give 100% accuracy. This may be because the particular features they chose are not well represented in the dataset - for example, only 8 out of the 100 animals are considered Venomous. This could lead to inflated accuracy, especially if those animals are not well represented in the testing set. If you notice

students training models like this, ask them to thoroughly test their models and compare the results to their real-world experiences to make sure the model matches reality. Remind them that just because a model has high accuracy on its testing data doesn't mean it will have high accuracy in the real world.

Importing Your Model (10 minutes)

Code Studio: Have students continue to the next level. This is an App Lab level where students can import their trained model and begin customizing their app.

Circulate: Help students import their app and verify that the model works correctly before continuing to level 3. Students should use the remaining time to customize their app, reinforcing the skills they learned in the last lesson on how to make their app more user friendly.

Teaching Tip

Focus on AI Lab, not App Lab: Even though students may be excited about using their models in App Lab, the larger goal of this lesson is to practice training accurate models in AI Lab and using Model Cards to document those decisions. These final levels are provided to complete the full cycle of importing a trained model to App Lab, but students are not expected to complete a fully-designed app in the time they have. Instead, tomorrow's lesson focuses entirely on App Lab which is where students can create an app more fully.

4 **Importing Your Model**

Assessment Opportunity

Formative Assessment: This level can be used as a formative assessment.

Assessment Opportunity

Formative Assessment: This level can be used as a formative assessment. A rubric is provided in the level, and written feedback can be given to students. **Click here to learn more about giving feedback to students**.

5 **Customizing Your App**

Wrap Up (5 minutes)

Journal

Reflection: *Why is a model card useful when creating a model in AI Lab? How is a model card useful when creating an app in App Lab?*

Students can answer this on their activity guide or as an exit ticket.

Discussion Goal: Students may relay similar points as the opening video - that a model card helps document decisions and provide transparency, and it can be used in App Lab to help add to the design - but their responses should be more grounded in their experiences in this lesson, especially after selecting

their own label and training their own model.

Lesson 11: Model Cards in App Lab

45 minutes

Overview

In this lesson, students practice importing their models into App Lab, this time including models that have numerical data and using model cards to help improve the user experience of filling out their form. They will then learn how to view the model card within App Lab and use this to add more descriptive elements to an app. Next, they focus on improving the user experience by adding informational text to help guide users through completing the form and adding a style to their app to improve the user experience.

Question of the Day: How can I use a Model Card to improve my app?

Standards

Full Course Alignment

CSTA K-12 Computer Science Standards (2017)

▶ **AP** - Algorithms & Programming

Agenda

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

Activity (35 minutes)
- **Model Cards in Apps (15 mins)**
- **If-Statements in Apps**

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

Objectives

Students will be able to:

- Use a model card to update the user interface of an app
- Use if-statements to change the behavior of an app

Preparation

- Review the Code Studio levels before the lesson
- Check the **"Teacher's Lounge"** forum for verified teachers to find additional strategies or resources shared by fellow teachers

Links

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

For the teachers

- **Model Cards in App Lab** - Slides
  ▾ Make a Copy
- **Printable Model Cards** - Resource
  ▾ Make a Copy

For the students

- **If-Statements in App Lab** - Video

Introduced Code

- `if (condition) { statement }`

Teaching Guide

Warm Up (5 minutes)

Journal

Display: Show a screenshot of an app that has imported a model into App Lab with no changes to design mode.

Prompt: *What changes could you make to this app to make it easier for people to use? Write a list of changes to the design or to the app flow that you would recommend for this app.*

Have students journal individually first, then share in small groups before bringing the full class together.

Discussion Goal: Students may comment on style elements, such as using colors to liven up the page. Students may comment on the descriptions to the user, like how the generated prompts aren't very descriptive. Students may comment on the flow of the app, such as suggesting that it be broken up into multiple screens or adding a "welcome" screen to the beginning. All of these are valuable brainstorm ideas that will carry into today's lesson.

Code Studio: Have students log into Code Studio. The first level has students explore an enhanced version of this same app, with many of the improvements implemented. As the class explores, highlight any improvements that matched their suggestions. Emphasize that this app does one thing we haven't seen before: it changes screens based on the animal that is predicted.

1 **Example App: Zoo Classification**

Remarks

> As we can see, there are a lot of ways to improve our app - and you all predicted many of the improvements we see here. Some improvements aren't only with the design - even adding additional information can make an app more helpful to its users. Today we'll learn more about how we can make our apps easier to use with the help of a Model Card.

Question of the Day: How can I use a Model Card to improve my app?

Activity (35 minutes)

Model Cards in Apps (15 mins)

Code Studio: Have students continue to the next level in Code Studio. In this first sequence of levels, students will see how to use a Model Card to update their app.

2 **Pet Recommender**

Teaching Tip

Purposefully Mysterious: This app is deliberately mysterious and requires a lot of guessing to understand. This is purposeful, since we will work to improve this app in the next few levels. If students ask questions or express uncertainty about how the app is working: validate their instincts, but avoid revealing too much about the app - instead, encourage them to keep these thoughts in mind as the lesson continues.

Discuss: *Some of the features use dropdowns and others use text boxes. What do you think is the difference between these two types of features?*

Discussion Goal: Guide students to notice that the text boxes require numbers, and the dropdown boxes use words. Once this point is made, transition to the next slide with the definitions for Categorical and Numerical data.

Vocabulary: Show students the vocabulary for the lesson, which includes the new term for Numerical data.

- **Categorical Data:** data that can be separated into groups
- **Numerical Data:** data that can be counted or measured

Teaching Tip

Numbers in Dropdowns: Students may notice that the NO feature has a dropdown that contains the numbers 1-4, and they may ask why this is represented as a dropdown instead of a text input. This is a valid question that will get cleared up in the next level - for now, confirm with students that this feels confusing and prompt them to consider: what extra information do you wish you had to help understand what's happening here?

Discuss: *This app isn't very easy to understand. What do you think the features represent? How many different pets can it recommend?*

Let students share their guesses, but be careful not to validate as "right" or "wrong". Instead, let the class come to their own conclusions before continuing.

Remarks

> If we're going to create this app, we'll need to add more information to make it easier for the user to understand how this app is making decisions. Luckily, we have a Model Card that's included with our app and has this information. Let's look at the model card and see what extra information it can tell us about our features and label.

Code Studio: Have students continue to the next level in Code Studio, which displays the model card. Have students read the labels and features to better understand how the app is working. If students guessed any of these in the earlier discussion, circle back and validate those answers from before.

3 Pet Recommender

Teaching Tip

Printing Model Cards: You may decide to print the model card as well so students can read it on paper. If possible, the model card is designed to be printed two-sided so it appears as a single sheet of paper that you can flip back and forth.

Discuss: *How can you tell the difference between categorical features and numerical features in the model card?*

Discussion Goal: Students should notice that numerical features have a min and a max on their card, while categorical features have a bulleted list of the possible values.

Remarks

> Let's use the information from this model card to improve our app, especially the questions for each feature. We'll also start improving the look and design of our app to be more user friendly in the next few levels.

Code Studio: Have students continue to the next level, where they can still access the model card for this app and use it to update the user interface.

4 **Pet Recommender**

Circulate: Monitor students as they update their app, ensuring that they can access the Model Card to determine the correct labels

Teaching Tip

Updating Labels Only: Students should only be updating the design of their app - they don't need to update the code, which still uses the shorter one-or-two letter abbreviations from the original app. This is because it's common to use much shorter abbreviations with data, and use longer explanations in places like the model card. If a student updates the `addPair()` section of their code, it may cause errors in their app.

If-Statements in Apps (20 minutes)

Remarks

> You may have noticed that in this app, the prediction appears on the home screen. But in the app we tested, we went to a whole new screen based on the result! In order to have our app change screens, we'll need to check the result of our prediction. This means our code will need to use a new type of block called an **if-statement**.

Video: Show the Conditionals video in the slide deck.

Teaching Tip

Videos for Students: Videos are intended to be watched and discussed as a class, and so they are not provided as individual levels in Code Studio. If a student needs to re-watch a video, they can be found in the Help and Tips section of levels or by visiting the Student Resources page of each lesson.

To encourage active engagement and reflection, use one or more of the strategies discussed in the **Guide to Curriculum Videos**.

Code Studio: Have students go to the next level in Code Studio, where they will add if-statements to their code to change the screen. They will continue to work through the remaining levels as well, adding new elements to their app along the way.

5-7 **Adding New Screens**

5 6 7

Teaching Tip

Normalizing Mistakes and Supporting Debugging: As programming levels become more complex, students may find themselves with bugs in their code that they need to untangle. If this happens frequently, this can be a demoralizing experience for students and can affect their self-perception of how capable they are in class.

To counter this, we recommend normalizing bugs and mistakes as something that happens to everyone - it's just part of the process. You can show students our **Debugging Video**, which includes several students normalizing mistakes and discussing debugging strategies that students can use. Additionally, consider displaying the **Student Guide to Debugging** for students to reference throughout the unit and having **Bug Report Quarter-Sheets** available for students to use.

Practice Levels: Have students choose one or two practice levels to complete in order to deepen their understanding of model cards and if-statements. Students don't need to complete all practice levels - once they feel comfortable, they can continue to the next level to see how well they've mastered the concepts in this lesson.

8 Practice

Teaching Tip

Student Choice and Practice Levels: Having students choose their own practice levels are one way to differentiate instruction with your students. To learn more about how these levels support differentiation, as well as other strategies, you can review the **CSD Guide to Differentiation**

9 Assessment

Assessment Opportunity

Formative Assessment: This level can be used as a formative assessment. A rubric is provided in the level, and written feedback can be given to students. **Click here to learn more about giving feedback to students**.

Choice Levels: Once students have created their Pet Recommender app, they can choose from several example activities to continue improving their app. Each level uses the same Pet Recommender app they've already built as a template to add to. Students can choose to complete as many of these levels as they would like - each one lets them continue to customize and improve their app.

Teaching Tip

Deja Vu? Students may notice that the choice levels look familiar in this lesson - they're the same levels that students could choose from in Lesson 7. This is intentional, since it gives students a chance to learn a different piece of code than they learned previously. For students who have explored each option already, encourage them to apply their knowledge to this new app.

10 Challenge

Wrap Up (5 minutes)

Journal

Prompt: *What is one example of how a model card can be useful when making an app?*

Discussion Goal: Look for responses that highlight how a model card can help communicate the purpose of an app to a user. Some examples from today may include:

- Using label or feature descriptions to help clarify choices in an app
- Using the “Intended Uses” section to help create a welcome screen for an app
- Including the possible values for categorical features in an app

Lesson 12: Numerical Models

45 minutes

Overview

In this lesson, students participate in an unplugged activity simulating a zombie outbreak. Students must predict which parts of town have the least amount of zombies using data from a neighboring town. Students will use degrees of similarity and averages to make predictions about the number of zombies at a particular location. Then, students are rescued and get to compare their predictions to the actual numbers as a way to discuss how accuracy is different for numerical data compared to categorical data.

Question of the Day: How do computers learn to make predictions with numerical data?

Standards

Full Course Alignment

AI4K12 National Guidelines 2021

- ▶ **BI-3** - Computers can learn from data

CSTA K-12 Computer Science Standards (2017)

- ▶ **DA** - Data & Analysis

Agenda

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

Activity (35 minutes)

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

Objectives

Students will be able to:

- Explain how accuracy calculation for numerical data is different from categorical data
- Explain how computers can make decisions by comparing similarities in data

Preparation

- Review all materials for today's lesson.
- Print or prepare to share online the activity guide - one per student or group.
- Check the **"Teacher's Lounge"** forum for verified teachers to find additional strategies or resources shared by fellow teachers

Links

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

For the teachers

- **Numerical Models** - Slides ▾ Make a Copy

For the students

- **Numerical Accuracy** - Activity Guide ▾ Make a Copy
- **Zombie Prediction** - Activity Guide ▾ Make a Copy

Teaching Guide

Warm Up (5 minutes)

Journal

Prompt: *You all make plans to hang out at a park over the weekend.*

- *Zoey lives 12 minutes away from the park*
- *Isaac lives 24 minutes away from the park*
- *Hawa lives 5 minutes away from the park*
- *Nico lives 30 minutes away from the park*
- *Kim lives 13 minutes away from the park*

Aaron lives closest to Zoey, Isaac, and Nico. How long do you predict it will take Aaron to get to the park? Explain your reasoning.

Have students journal individually first, then share with a neighbor.

Share Out: Have students share out their responses to both prompts.

Discussion Goal: Even though students can't be 100% sure about the answer, students should use the clues about the friends Aaron is "closest to" to help guide their answers. Students may have a wider variety of answers, but they should all rely on using the values from Zoey, Isaac, and Nico to help predict how long it will take Aaron to get to the park.

Remarks

> In both of these situations, we can use information about Aaron's friends to help predict something about Aaron. It may not be 100% correct, but our prediction will probably be close enough. This is another way that computers can find patterns in data with machine learning - looking at similar data to make predictions. Today, we'll explore how machines can make decisions using this same technique.

Question of the Day: How do computers learn to make predictions with numerical data?

Activity (35 minutes)

Distribute: Pass out the **Zombie Prediction** activity guide to each student.

Assessment Opportunity

The responses in the activity guide can be used to formatively assess how well students have met the objectives of the lesson.

Display: Show students the overview from the activity guide, which explains how there has been a zombie uprising and we are working to figure out safe places to hide.

Do This: Have students look over the data showing how many zombies are at eight different locations. They should record their observations at the bottom of the activity guide.

Teaching Tip

Answer Key: An answer key to this activity is provided to verified teachers in the links section of the lesson plan

Share Out: Have students share out their answers to the questions at the bottom of the activity guide.

Discussion Goal: Students may notice that zombies tend to group at loud, outdoor areas. Students may also notice zombies tend to group at locations where there are humans or animals, like schools or zoos. Students may try to justify this pattern by making references to zombies in pop culture, but it's okay if this doesn't come up.

Display: Have students flip to the next page of the activity guide, which is also represented on a slide. This activity guides students through the process of turning the zombie data into a model that can make predictions about how many zombies are in a particular location.

Model: Help students track how similar each row of the table is similar to Location A. This involves counting each time a cell from Location A matches a cell in the table. For example, if the only thing both locations have in common is that they are indoors, then we would write a 1 for the similarities with Location A. Or, if both locations are indoors, loud, and have sidewalks: then we would write a 3 for the similarities with Location A.

Model: Help students predict how many zombies will be at Location A by finding the three most similar locations, then averaging the number of zombies at each location. It can be helpful to model this process for Location A, since students will repeat this process for Locations B and C on the back of the activity guide.

Content Corner

This activity simulates the **K-Nearest Neighbors (KNN)** machine learning algorithm for making predictions based on data. The **K** represents how many neighbors you look for - in this activity, we're using **K=3** because students find the three most similar data points to calculate the average.

If you would like to learn more about KNN and other machine learning algorithms, **ml-playground.com** has an interactive widget and links to additional resources. This website is intended for adults looking to learn more about machine learning, especially considering the amount of math involved, so we do not recommend sharing this with students.

Do This: On the next page of the activity guide, students are given two new locations to predict the number of zombies. They will repeat this same process for these locations: determine the three most similar locations, then find the average to predict the number of zombies.

Circulate: Monitor students as they complete this process. An answer key is provided to help check answers.

Share Out: Ask students to share out only their predictions for locations B and C, and which location has the least number of zombies.

Remarks

> This is an example of how we can take new data and compare it to our existing data, then use those similarities to make predictions. This happens a lot in machine learning apps where we are trying to predict how much something should cost, or how many people will be at a location, or how often an event will happen. But - it’s not enough to just make a prediction: we should also be able to check our accuracy to see how we did.

Distribute: Pass out the **Numerical Accuracy** to each student

Assessment Opportunity

The responses in the activity guide can be used to formatively assess how well students have met the objectives of the lesson.

Display: Show the slide with the overview of this task - the class has been rescued and can now see how many zombies were actually at Locations A, B, and C. Using this information, students can start to calculate the accuracy of their results.

Teaching Tip

Accuracy and Numerical Data: Accuracy is calculated differently for numerical data than it is for categorical data. This part of the activity is important for building conceptual understanding so when students see these same calculations in AI Lab, they'll have a reference for understanding what it means. Skipping too fast through this section may mean students are confused when they see accuracy in AI Lab with numerical data.

Discuss: Based on the results, what was the accuracy of our model? How many locations did it predict exactly correct?

Discussion Goal: Students should notice that our model is 0% accurate if we were expecting it to be perfectly correct. Guide students to consider whether it's okay for the model to be "close enough" - for example, when weather apps predict the temperature, we let it be okay if they're off by a few degrees as long as they are close enough.

Discuss: What would the accuracy of our model be if it was okay that we were within 5 of the actual value? If we were within 20?

Discussion Goal: Students should notice that if the number is too large (like within 20), then the model appears highly accurate, and if the number is lower than the model appears less accurate.

Do This: Look at the data in the table below and calculate the accuracy of our model using these three different approaches.

Circulate: Check in with students as they calculate the remaining accuracy. An answer key is provided with the correct answers.

Remarks

> When making predictions with numerical data, it's rare for the prediction to be an exact match with the actual number. Instead, we can check if the prediction is "close enough" to the actual value and base our accuracy from that. But, deciding what "close enough" is depends on the situation. Tomorrow, we'll see how AI Lab makes predictions with numerical data and how to understand it's accuracy.

Discuss: In one of the rows, the model predicted 0 but the actual value was 2. Is this close enough to count as a correct prediction?

Discussion Goal: This should be a quick discussion, where students will likely say that yes - this is close enough to count as correct.

Discuss: In one of the rows, the model predicted 0 **zombies** but the actual value was 2 **zombies**. Even though this is close enough to be correct, is that okay for the people in this situation?

Discussion Goal: Guide students to remembering that even though the data represents numbers, the situation involves people under specific circumstances. Even though the situation is from a science fiction story, if we put ourselves in the shoes of the people in this city: this means they likely went to a location where they weren't expecting any zombies and instead found two. Even though the numbers were close enough to be correct, this small margin of error had a huge effect on the people involved.

Teaching Tip

AI Accuracy in the Real World: This situation introduces issues involving inaccurate calculations from machine learning models, such as false positives or false negatives. Students may have experience with this when an important email is marked as spam by an email program, or they ignore a phone call from an important person because they don't recognize the number - both of these are examples of false positives, where a piece of data was incorrectly marked as unimportant.

Not all false positives have the same impact on people in the real world. These resources can be helpful in giving examples of how issues of accuracy can have large impacts for people in the real world:

- **Medical News and Life Sciences** - this article explains how artificial intelligence is routinely used to help identify cancer in the medical field to great success, but the risks of a false-positive identification can be devastating.
- **Wrongfully Accused by an Algorithm** - this article explains how inaccurate facial recognition software was used to wrongfully arrest a man for a crime he didn't commit.

Wrap Up (5 minutes)

Journal

Prompt: *What are other situations where you think machine learning models should be exactly accurate because close-enough isn't okay?*

Discussion Goal: Students may call on examples from the news such as:

- Medical diagnosis, such as cancer detection
- Facial recognition for criminal prosecution

Lesson 13: Numerical Data in AI Lab

45 minutes

Overview

In this lesson, students will be introduced to numerical data which represents a range of values. Students are presented with a scenario where every feature and label is represented with numerical data, and they learn to use the new data visualization tools within AI Lab to help find patterns.

Question of the Day: How can we use AI Lab to predict numerical data?

Standards

Full Course Alignment

AI4K12 National Guidelines 2021

- ▶ **BI-3** - Computers can learn from data

CSTA K-12 Computer Science Standards (2017)

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

Agenda

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

Activity (35 minutes)
- **Categorical vs Numerical**
- **Investigating Data**
- **Feature #1: Antelopes**
- **Feature #2: People**
- **Feature #3: Day of the Month**
- **Feature #4: Temperature**
- **Training a Model**

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

Objectives

Students will be able to:

- Compare and contrast categorical data versus numerical data
- Use data visualizations to find patterns in numerical data

Preparation

- Check the **"Teacher's Lounge"** forum for verified teachers to find additional strategies or resources shared by fellow teachers

Links

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

For the teachers

- **Numerical Data in AI Lab** - Slides ▾ Make a Copy

For the students

- **Numerical Data in AI Lab** - Activity Guide ▾ Make a Copy
- **Numerical Data in AI Lab** - Video
- **Using Data with Numerical Features** - Resource

Vocabulary

- **Numerical Data** - data that can be counted or measured

Teaching Guide

Warm Up (5 minutes)

Journal

Prompt: *Brianna and Mikayla are movie critics who use different systems to recommend movies. Brianna recommends movies as either "Go see it!" Or "Don't bother". Mikayla recommends movies on a scale from 1-10, such as 7.2 or 4.1. How are these two systems similar? How are they different?*

Have students journal individually first, then share with a partner before inviting students to a full-class discussion.

Discussion Goal: Students may notice that you can tell "good movies" from "bad movies" in both systems, but the scale system allows a lot more possible values and it's easier to compare movies based on their values. Students may notice that Brianna's system uses categorical data with two categories, but they may struggle to define Mikayla's system and initially say it is also categorical but with many more categories.

Remarks

> Both of these systems help us make decisions, but in different ways. Brianna's system looks similar to the type of recommendations we've seen so far because it simplifies the data into just two categories. Mikayla's system is a little different, using a range of values to make a recommendation - this is called numerical data. Today, we'll learn how to use numerical data in AI Lab to make new kinds of recommendations and predictions.

Question of the Day: How can we use AI Lab to predict numerical data?

Activity (35 minutes)

Categorical vs Numerical (25 minutes)

Vocabulary:

- **Numerical Data:** data that can be counted or measured

Discuss: *What are other examples of Numerical Data?*

Have students discuss with a partner before having several students share with the full group. Keep a list of responses at the front of the room

Discussion Goal: If students seem stuck on coming up with other examples, remind them that we sometimes apply categories in order to simplify our data. For example, "tall" and "short" are simplified categories for something we could represent numerically - our height.

A few examples students may think of:

- Age, Weight, Height
- Cost, or anything money related
- Rating systems, similar to the warm-up
- Anytime you are counting "how much" of something

Remarks

> This is a great list! I can tell that there's numerical data all around us! Today, we're going to take a look at numerical data in AI Lab and how we can use it train a model.

Investigating Data

Video: Show the **Numerical Data in AI Lab** video, which outlines how numerical data can be used in AI Lab and how accuracy is calculated.

Teaching Tip

To encourage active engagement and reflection, use one or more of the strategies discussed in the **Guide to Curriculum Videos**.

Code Studio: Have students log into Code Studio and open the first level. Students will spend most of the lesson exploring data in the first panel and recording their results on the activity guide.

Distribute: Pass out **Numerical Data in AI Lab** to each student.

Safari Model

Feature #1: Antelopes

Do This: Have students click on the antelopes column. This column represents how many antelopes were seen in the park on a given day. Look at the graph that appears in AI Lab, which lets you compare the antelope data with the lion data

Teaching Tip

Model Reading Graphs: It's a good idea to model the first graph with the class and fill in the activity guide together, especially since students are still learning how to interpret graphs in their other classes. As students practice this skill, the goal is to become confident identifying relationships in data and discerning if a pattern really exists, or if the data has a random relationship that isn't good for predictions.

Discuss:

- *If there are a low number of antelopes in the park, what does that mean for how many lions could be in the park?*
- *If there are a high number of antelopes in the park, what does that mean for how many lions could be in the park?*
- *Why do you think this is?*

Discussion Goal: Students should notice the less antelopes there are, the less lions there are and vice versa. They may imagine this has to do with predator / prey relationships - the lions eat the antelope, so if there are less antelope, there are less lions. Students should record their responses on their activity guide, even if the class discussed the answers together.

Feature #2: People

Do This: Have students click on the people column. This column represents how many people were seen in the park on a given day. Have students answer the questions on their activity guide first before discussing as a group.

Circulate: Check in with students and help them interpret the graphs. Encourage students to use sentence starters like "When the number of people are... then the number of lions are...".

Discuss:

- *If there are a low number of people in the park, what does that mean for how many lions could be in the park?*
- *If there are a high number of people in the park, what does that mean for how many lions could be in the park?*
- *Why do you think this is?*

Content Corner

Associations: The antelope graph represents a positive association and the people graph represents a negative association. which are a part of the **Common Core 8th grade math standards**. Students don't need to know these terms to be successful in this unit, so we do not recommend using this vocabulary unless it directly supports their study in other classes.

Discussion Goal: Students should notice the less people there are, the more lions there are and vice versa. They may imagine this has to do with natural behavior and they may think back to their own experiences visiting zoos or wildlife - if there are more strangers in the park, they are less likely to come out. The opposite may also be true - the less people around, the more they may roam free.

Feature #3: Day of the Month

Do This: Have students click on the dayOfMonth column. This column represents what day of the month you went to the park. Have students answer the questions in their activity guide

Discuss:

- *What happens if you visit on a day early in the month? How many lions do you think you'll see?*
- *What happens if you visit on a day late in the month? How many lions do you think you'll see?*

Discussion Goal: Students may get a little stumped with this one because there is no pattern in this data. You might see a lot of lions early in the month and you might also see a lot of lions late in the month, and vice versa. Students may imagine this is because the day of the month doesn't change the lions behaviors, especially compared to some of the other features.

Feature #4: Temperature

Do This: Have students click on the temperature column. This column represents the weather that day and how hot or cold it was. Have students answer the questions on their activity guide before discussing as a class.

Discuss:

- *If there are a low temperature in the park, what does that mean for how many lions could be in the park?*

- *If there are a high temperature in the park, what does that mean for how many lions could be in the park?*
- *Why do you think this is?*

Discussion Goal: Students should notice that both high temperatures and low temperatures mean you won't see very many lions. Instead, midrange temperatures lead you to seeing a lot of lions. This may be because lions won't come out in extreme temperatures and instead prefer nicer weather. The same can also be said for human beings - we avoid extreme weather.

Remarks

> We can use AI Lab to train a machine learning model to predict how many lions we'll see when visiting the park. We want to make sure we use features that have a relationship with our lions. Based on the ones we've seen so far, which column would not make a good feature?

Discuss: *Which graph would not make a good feature?*

Discussion Goal: Students should explain that the dayOfMonth column is not a good candidate because the data appears random. Instead, the other columns have a relationship with the label that they can describe, almost like a story within the data.

Training a Model (10 minutes)

Do This: Continue to explore the data by clicking on the remaining features in the dataset. Record your observations on your activity guide.

Circulate: Check in with students as they explore data, making sure to check with any students who appeared to be struggling to read graphs during the previous exercises. Ask students to explain why they think certain columns could be good features.

Do This: Using our investigation, train a model with 80% accuracy.

Teaching Tip

80% Accuracy: Students may struggle to find a model that is at least 80% accurate. This is by design, so they can really experiment with which features to use in their model. One example that will satisfy these requirements is a model using the features [trees, overgrowthPercent, antelopes, temperature].

Order Matters: Students may discover that the order they select their features can sometimes matter - for example, choosing "temperature, antelopes" may end up with different accuracy than "antelopes, temperature". This is not a vital topic for using AI Lab fluently, and happens more often in these early levels because of the smaller dataset sizes. If students ask, one way to think about it is that the first feature represents how AI Bot first tries to separate the data before continuing on to the other features. Therefore: the stronger the relationship is with the first feature you pick, the stronger the patterns AI Bot will find.

Assessment Opportunity

Formative Assessment: Because this level requires 80% accuracy to continue, completing this level can help determine how successful students are with the objectives from this lesson.

Code Studio: Students who finish training their model can import into App Lab and begin customizing their app. They won't have enough time to truly finish their app, but the next lesson focuses more on App Lab where they will be able to customize their apps more completely.

Wrap Up (5 minutes)

Journal

Prompt: *What is one way categorical data and numerical data are similar? What is one way they are different?*

Discussion Goal: Student answers should feel similar to the definitions of these two terms. Both categorical and numerical data represent data, but categorical data can be separated into discrete categories while numerical data is represented along a continuum. Students may also provide examples of categorical or numerical data to help describe their answers.

Lesson 14: Customizing Apps

45 minutes

Overview

In this lesson, students will explore how to customize the code of their app to make additional changes to the design of their app. They will start by exploring a single-screen app and then practice expanding the app to two-screens and updating the code to use the new design mode elements. After this, students help create a Driver Alert app that requires changes to the code using new design mode elements. Using the skills from this lesson, students will be able to create multi-screen apps where questions can appear on multiple screens instead of a single screen.

Question of the Day: How can I customize the code for a machine learning app?

Standards

Full Course Alignment

CSTA K-12 Computer Science Standards (2017)

▶ **AP** - Algorithms & Programming

Agenda

Warm Up (5 minutes)
Journal

Activity (35 minutes)
Driver Alert System

Wrap Up (5 minutes)
Journal

Objectives

Students will be able to:

- Update the default model code to use new inputs in a machine learning app
- Use the Model Card to create new input elements for a machine learning app

Preparation

- Review the Code Studio levels before the lesson to be familiar with changing the input element
- Check the **"Teacher's Lounge"** forum for verified teachers to find additional strategies or resources shared by fellow teachers

Links

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

For the teachers

- **Customizing Apps** - Slides
  ▼ Make a Copy

Teaching Guide

Warm Up (5 minutes)

Journal

Display: Show students the example app, Raspado Recommender

Prompt: *What changes would you make to this app to improve how easy it is to use?*

Have students journal individually, then discuss with a neighbor before regrouping

Discussion Goal: Students can pull from previous lessons to make suggestions on how to improve this app: add a theme to improve the design, create a home-screen that the user sees first, add images or other visuals, etc. In addition to these suggestions, guide students to consider that there are too many options on one screen and that the app should be multiple screens instead. This will segue into today's lesson, where we look at additional ways to customize and improve our apps.

Remarks

> There comes a point where our AI apps have too many features for a single screen. In these cases, it can be useful to split up our app into multiple screens and spread out the questions that we ask users. This makes the app easier to use, and makes it easier to group questions together. Today, we'll learn how to split up our apps into multiple screens and how to update the code in our app to match the new screens.

Question of the Day: How can I customize the code for a machine learning app?

Activity (35 minutes)

Driver Alert System

Code Studio: Have students log into Code Studio Level 1. In this app, they see a similar Raspado Recommender as in the warm up - however, the questions have been split across 2 screens instead of just 1.

Circulate: Monitor students as they follow the instructions on this screen. They can click on the images within the instructions of the level for hints. This is the first time students are editing the pre-generated code for models, so be sure to check in with students before continuing to ensure they understand how to complete this level.

1 **Raspado Recommender**

Teaching Tip

Design Elements Off the Screen: This level prepares students for a situation they may encounter in their chapter project: having so many features that the design elements appear off the screen. This tends to happen when using more than 6 features in a model. If students encounter this in later levels, referring them back to this level can be useful to remind students how to problem-solve and rearrange the elements on the s creen.

Remarks

> Now that we know how to edit our code to use new design mode elements, let's take a look at a more advanced example. In the next series of levels, we're going to help build a Driver Alert System that can be used by cars to help warn drivers of dangerous conditions.

Code Studio: Have students continue to the next level in Code Studio. In these next set of levels, students will customize an app so each question is on a separate screen, which allows you to add more information for the user. As students complete each level, they will learn how to update their code to use custom design elements rather than the ones that were generated by default.

2 Driver Alert System

Discuss:

- *How many features does this app have? What are they?*
- *What is the label for this app? What are the possible outputs?*

Discussion Goal: Students should realize there are 4 features - number of cars, weather, temperature, and time of day. As students respond, ask them to identify whether the features are categorical or numerical, and how do they know? Students may respond based on the design elements on the screen (dropdowns for categorical, text boxes for numerical), or they may have looked at the Model Card for this information. They should also identify three possible label values - danger, warning, and normal. Point out that this information is easier to see in the model card rather than testing the app over and over again.

Code Studio: Have students continue through the next several levels in Code Studio, where they will recreate this app.

3-8 Driver Alert System

3 4 5 6 7 8

Assessment Opportunity

Formative Assessment: This level can be used as a formative assessment. A rubric is provided in the level, and written feedback can be given to students. **Click here to learn more about giving feedback to students**.

Circulate: Monitor students as they recreate this app. Students won't be able to test the app until it is fully complete, which may be a challenge for some students. Here are some things to be on the lookout for as students work:

- **Level 3:** Students practice deleting the default elements that are generated when you first import a model. This is a step that will be important when students create their own custom apps in later projects.
- **Level 4 and 5:** Students are only updating the code of their app to use the new design elements for the Number of Cars and Weather features. They can use the hints within the level instructions for clues on what to do in each step.
- **Level 6:** Students update both the design and the code of their app to collect data for the Temperature feature. Help students keep track of the new text input element they add to the temperature screen, and make sure the ID of the element matches the one they use in the `getText` block of their code.
- **Level 7:** Students update both the design and the code of their app to collect data for the Time of Day feature. Adding the design element and updating the code is similar to the last level, but this step has the added requirement of using the Model Card to check the possible values are for this categorical feature. Students may make spelling or capitalization errors that can effect their code - encourage students to be very careful to match their dropdown options exactly with the model card.
- **Level 8:** Students have a chance to run their app and verify that it works. Students will only need to make changes to the code on this level if their program doesn't work. Otherwise, if the app works correctly, students can continue to the next level.

Choice Levels: Once students have created their Driver Alert System App, they can choose from several example activities to continue improving their app. Each level uses the same Driver Alert app they've already built as a template to add to. Students can choose to complete as many of these levels as they would like - each one lets them continue to customize and improve their app.

Teaching Tip

Repeated Levels: The choices in this level are identical to the choices in the last lesson. This is intentional, so students have multiple opportunities to learn the new design tricks or code blocks, or continue to practice the new blocks they learned last lesson. Encourage students to choose a new challenge for today's app that's different from the ones they chose yesterday.

9 **You Choose: Improve Your App**

Wrap Up (5 minutes)

Journal

Prompt: *What is one benefit to having features spread across multiple screens in an app? What is one drawback to having features on multiple screens in an app?*

Discussion Goal: Student answers may vary, but some examples are:

- Students may realize that having features on multiple screens can make it easier to describe the feature and easier for the user to focus on a single question.
- Students may also realize that this increases how "long" the app is, and it adds additional work to update the code with the new elements.

Lesson 15: AI Code of Ethics

45 minutes

Overview

In small groups, students conduct research using articles and videos that expose ethical pitfalls in an Artificial Intelligence (AI) area of their choice. Afterward, each group develops at least one solution-oriented principle that addresses their chosen area. These principles are then assembled into a class-wide “Our AI Code of Ethics” resource (e.g. a slide presentation, document, or webpage) for AI creators and legislators everywhere.

Question of the Day: What are guidelines we can use to create ethical machine learning apps?

Standards

Full Course Alignment

CSTA K-12 Computer Science Standards (2017)

▶ **IC** - Impacts of Computing

Agenda

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

Activity (35 minutes)
- **Research and Reflect**
- **Draft “Our AI Code of Ethics” Resource**

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

Extension Activities
- **Ethics in AI**
- **Critically Conscious AI**

Objectives

Students will be able to:

- Create at least one guiding principle that addresses an AI ethics issue.
- Define artificial intelligence (AI) in their own words, using technologies they encounter in their daily lives as examples.
- Describe at least one example of an ethical issue pertaining to AI, along with its impact on society.

Preparation

- Prepare to share online one **AI Ethics Research Areas** handout per group.
- Print or prepare to share online one **AI Ethics Research Reflection** handout per group.
- Prepare a shareable web document, slide presentation, video template, or any other form of media to be used to comprise your class’ “Our AI Code of Ethics” resource.
- Check the **"Teacher's Lounge"** forum for verified teachers to find additional strategies or resources shared by fellow teachers

Links

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

For the teachers

- **AI Code of Ethics** - Slides Make a Copy
- **Our AI Code of Ethics [Template]** - Slides Make a Copy

For the students

- **AI Ethics Research Areas** - Activity Guide Make a Copy
- **AI Ethics Research Reflection** Make a Copy
- **Ethics & AI: Equal Access and Algorithmic Bias** - Video

Vocabulary

- **Ethics** - guidelines for good behavior.

Teaching Guide

Warm Up (5 minutes)

Journal

Discuss: *What are examples of artificial intelligence you've seen either in real life or in fiction, like movies or music or television?*

Have students record their responses in their journals, then share with a neighbor. Before having a full-group discussion, transition to the next prompt.

Discuss: *Can you think of times when these examples were used for good? Can you think of times when these examples were used for bad, even if unintended? Are there things they do we might consider "right" or "wrong"?*

Have students think to themselves first, then discuss with a neighbor before asking students to share as a full group. Have students share the example they thought of, then the situation they thought of that could be used for good or bad.

Discussion Goal: This prompt is intentionally open-ended and vague with how we define "good", "bad", "right", and "wrong". Give students space to explore how they would describe artificial technology and find examples of "good" or "bad". Try to hear from a wide variety of voices in your classroom. When ready, advance to the next slide and use the remarks below to wrap up the discussion.

Vocabulary:

- **Ethics:** guidelines for good behavior.

Remarks

> When we discuss right and wrong, good and bad, we are discussing “ethics”. As we create our own apps using machine learning and AI, it's important to consider the ethical impact of our decisions. No matter how “intelligent” machines may appear, they are still tools that humans create. If created or used without

> the right guidelines, machines with AI can easily make unethical decisions, such as being biased against someone's gender or race. The more aware we are of ethical issues involving AI, the better we will be able to make sure that AI benefits everyone in society.

Question of the Day: What are guidelines we can use to create ethical machine learning apps?

Activity (35 minutes)

Video: Show students the **Ethics & AI: Equal Access and Algorithmic Bias** video to setup the activity they will complete today.

Teaching Tip

To encourage active engagement and reflection, use one or more of the strategies discussed in the **Guide to Curriculum Videos**.

Research and Reflect

Groups: Place students in groups of three or four.

Remarks

> Roleplay time! Today you are a group of AI experts. Each group specializes in a particular area of AI ethics. You are holding a meeting to write an "AI Code of Ethics", which will be a set of rules for people who work on AI machines and lawmakers worldwide! One example of a rule might be, "AI must treat all people fairly." Before you begin writing these rules, you will research your area and discuss it with your group members.

Distribute: Digitally share the **AI Ethics Research Areas** document with each group.

Do This: Explain that this document lists research areas in AI ethics, along with sample articles and videos students may read and watch. Have groups choose an area of specialization. Encourage students to pick different topics if possible.

Distribute: Provide each group with one copy of the **AI Ethics Research Reflection** handout.

Assessment Opportunity

The responses in the activity guide can be used to formatively assess how well students have met the objectives of the lesson.

AI Ethics Research Reflection

Work: Have groups research their area with their fellow group members, answering questions on the handout along the way. Encourage students to skim longer articles for key ideas, take notes, pose additional questions, and use a search engine to investigate further if time permits.

Share: Ask groups to share what they learned, along with a few answers to the questions on the handout.

Draft “Our AI Code of Ethics” Resource

Display: Once students have completed their research, share an example of an AI code of ethics similar to what they will be creating, such as those by **Microsoft** and **Google**.

Discuss: *Your next task is to create a similar resource, an “AI Code of Ethics”. Based on what you’ve read and discussed, what are the most important ethical principles (rules) you believe all current and future AI must follow?*

Work: Allow groups time to write at least one principle for the class code of ethics. Ideally, their principles should be written as a sentence followed by a short paragraph that provides more context to the reader (see Google’s page). The format of the resource is completely up to you and your students. For example, you might ask groups to create a poster, or for each take a single slide from a shared presentation, or a page from a shared document. You might even ask students to use their webcams to record short video clips that you can compile and publish as a single video. Be as creative as you wish!

Wrap Up (5 minutes)

Journal

Prompt: *How would you describe “AI ethics” to a family member or friend who didn’t participate in today’s lesson?*

Extension Activities

Ethics in AI

Ethics in AI is a large, complex topic that is invaluable for students to experience, discuss, and wrestle with their own understandings of artificial intelligence. In fact, this topic may overflow beyond just a single lesson and require more time and attention with students.

If you would like to extend the focus on ethics in AI, consider adapting some of the resources from the **MIT AI + Ethics curriculum**, which is an ethical AI curriculum specifically designed for middle school and many of the activities can be done without a computer if needed.

Critically Conscious AI

This lesson provides an opportunity for students to be critical of existing AI programs, developing a Code of Ethics as a potential solution to existing issues in the industry. This critical lens can be extended to additional learning objectives and activities as outlined in the **Artificial Intelligence** chapter of the **Critically Conscious Computing: Methods for Secondary Education** online textbook from Dr. Amy Ko.

This chapter provides an overview of additional concepts related to AI and Machine Learning, and ends with a "unit sketch" which outlines additional lessons and activities that could be introduces in a unit on AI and Machine Learning from a critical lens. These activities could be appropriate if you would like to continue exploring artificial intelligence from a critical lens with your students.

Lesson 16: Project: Make a Machine Learning App

45 minutes

Overview

In this one or two day project, students apply their skills from the unit so far and create a machine learning app using real-world data. Students are provided with several real-world datasets from a variety of contexts, and they choose which dataset they would like to investigate. They train and save their model, then make a simple App Lab app that uses the model. This mini-project is an opportunity to assess how well students can use features to create accurate machine learning models, and how well they can create apps that use machine learning.

Question of the Day: Can I use real-world data to create an app that uses machine learning?

Standards

Full Course Alignment

AI4K12 National Guidelines 2021

- ▶ **BI-3** - Computers can learn from data

CSTA K-12 Computer Science Standards (2017)

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

Agenda

Warm Up
- **Get Started**

Activity (40 minutes)

Wrap Up (5 minutes)
- **Submit Projects**
- **(Optional) Why AI Matters**
- **Reflection**

Objectives

Students will be able to:

- Create a machine learning model using a real-world dataset
- Create an app that uses a machine learning model

Preparation

- Review the Code Studio levels before the lesson
- Print copies of the activity guide for each student
- Check the **"Teacher's Lounge"** forum for verified teachers to find additional strategies or resources shared by fellow teachers

Links

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

For the teachers

- **Make a Machine Learning App** - Slides ▾ Make a Copy

For the students

- **Create an ML App** - Rubric ▾ Make a Copy
- **Create an ML App - Project Guide** ▾ Make a Copy

Teaching Guide

Warm Up

Get Started

Teaching Tip

Start Right Away: Get students started on this project right away so they have time to finish. Even though this mini-project is scheduled for only a single class period, you can consider spreading this project out over two days - one day for training a model and making a model card, and one day for customizing the app.

Distribute: Pass out a copy of **Create an ML App - Project Guide** to each student.

Display: Show students the slide with the Overview of the project. Read through the overview on the project guide and through the next few slides.

Activity (40 minutes)

Code Studio: Have students log into Code Studio and open the first level. Students can choose from several real-world datasets to train a model.

1 **Train a Model in AI Lab**

Circulate: Monitor students as they walk through the project guide. Slides are provided with the same instructions to help focus and direct students as they work.

Step 1 - Examine Your Data: Students will choose a dataset from the provided list in AI Lab

Step 2 - Train your Model: Students will choose at least 2 features to train their model. They will record their choices on their project guide.

They should aim to get at least 70% accuracy to earn full credit on the rubric.

Teaching Tip

Slight Changes in Accuracy: Students may notice that if they train on the exact same features over and over again, they may get slightly different accuracy calculations each time. This is because, in this level, AI Bot is randomizing the 10% testing data rather than always using the last 10% of the dataset. This is typically how machine learning accuracy is calculated with real-world datasets, since it avoids issues where the end of the dataset may not represent the entire data.

If students ask about this, you can use a similar explanation as above - that AI Bot is randomizing the testing data each time. This also means students may get slight variations in their accuracy, but the model being created is still essentially the same.

Step 3 - Save Your Model, Create a Model Card: Students will create a model card in AI Lab and save their model. They will also record some of their answers on their project guide.

Step 4 - Create Your App: Students will create their app in App Lab. Apps should have at least a theme and a welcome screen to earn full credit on the rubric.

Teaching Tip

Design Elements Off the Screen: Depending on the number of features that your students use in their model, some of their design elements may appear off of the screen. This tends to happen when using more than 6 features in a model.

There are two strategies you can use to help students fix this:

Strategy #1: Make New Elements. Students can use design mode to drag out new elements to use in their app. They may also decide to move the elements to different screens to help make the app easier to use. After adding these new design mode elements, students will need to update their code to use the new elements as well. Students can refer to **Lesson 13**, especially level 1, as an example of how to update their code to fix this problem.

Strategy #2: Reposition Elements. Even though the elements are off the screen, you can use Design Mode to manually select them and re-position them so they are on the screen. This involves changing the y-position property to 0 so it is on the screen, and then re-arranging the element like you would normally.

2 **Create an App in App Lab**

Step 5 - Reflect: Students will reflect on their model and how it could be improved. Students should also review the rubric to verify they met all of the requirements for the project.

Wrap Up (5 minutes)

Submit Projects

Make sure students submit their projects in App Lab. Collect their project guides to review along with the project rubric.

Assessment Opportunity

A rubric is provided to assess the mini-project

(Optional) Why AI Matters

If this is the last lesson students will be completing in this unit, consider showing the **Why AI Matters** video as the final act of this unit. This video acts as a call-to-action for students to stay informed and get involved in AI efforts in their life, especially since the field needs diverse perspectives (like those of your students!)

Reflection

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. Some questions are the same as the pre-survey at the start of the unit, which can show student growth or changes in student attitudes towards computer science.

Lesson 17: Issue Statements

45 minutes

Overview

This is the first of a five-day sequence of lessons that prepare students for the final project. In this lesson, students meet a team of fictional students who want to use machine learning to address an issue in their community. Students participate in an issue brainstorm using the 5 Why's strategy, then they help evaluate the ideas that the other student team came up with. The steps students take in this lesson are identical to the steps students will take in their final project.

Question of the Day: How can machine learning be used to address an issue in your community?

Standards

Full Course Alignment

AI4K12 National Guidelines 2021

- ▶ **BI-3** - Computers can learn from data

CSTA K-12 Computer Science Standards (2017)

- ▶ **AP** - Algorithms & Programming

Agenda

Preparing for the Week

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

Activity (35 minutes)
- **Issue Statement**
- **App Brainstorm**

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

Objectives

Students will be able to:

- Develop a problem observation into a core issue using brainstorming strategies

Preparation

- Check the **"Teacher's Lounge"** forum for verified teachers to find additional strategies or resources shared by fellow teachers

Links

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

For the teachers

- **Issue Statements** - Slides
  - ▾ Make a Copy

For the students

- **5 Why's - Activity Guide**
  - ▾ Make a Copy
- **App Brainstorm - Activity Guide**
  - ▾ Make a Copy

Teaching Guide

Preparing for the Week

This lesson is the first in a series of five that helps prepare students to complete the final project in this unit. The tasks that students complete this week are identical to the tasks they will complete for their project. As such, it may be helpful to read the project guide for the final project so you can see how each lesson

connects to the final project - **click here to access the lesson plan for the final project**

Students will also be creating their own surveys during this week using Google Forms. This requires students to have a Google account. If your students do not have a Google account, consider incorporating that into part of your lesson today or tomorrow.

Warm Up (5 minutes)

Journal

Prompt: *What is something you see regularly in your community that you wish you could improve?*

Have students journal individually first, then ask an additional prompt:

Prompt: *Who are the people affected by this?*

Have students write in their journal, then invite students to share their observations with the group. It's okay if no one shares what they wrote down.

Discussion Goal: This discussion foreshadows the activity that students will do today, where they help brainstorm issues to address in a community. As students share, focus on the observation that students are making that influences their desire to improve their community. Some examples might be:

- Observing trash on the street or dead greenery next to a highway
- Observing that some buildings or streets are difficult to navigate for people with wheelchairs or mothers with strollers
- Observing stray animals or other wildlife that struggle in busy areas

Display: Show the slide with the Problem Solving Process, including the central Empathy component

Remarks

> This exercise emphasizes a key part of the problem solving process: empathy. In the next few weeks, you're going to have a chance to design a machine learning app that can address an issue in our community. This requires taking an issue we see in the world and finding a way that data and machine learning can help solve it. This week, we're going to help another team of students create an app to solve a problem in their community.

Question of the Day: How can machine learning be used to address an issue in your community?

Activity (35 minutes)

Issue Statement (15 minutes)

Display: Show the slide with the student team introductions. These are imaginary students that the class will be working with all week to help develop a machine learning app.

Teaching Tip

Real or Fake Students? If students ask, you can tell students that this is a fictional group of students as part of this exercise. This can be important because the outcomes from this week are scripted and ultimately the class will be following along with what these students decide and help them solve specific

problems along the way.

Remarks

> This is Kim, Nico, Isaac, Zoey, and Hawa. They'd like our help creating an app that uses machine learning to help solve a problem in their community. The first step is to identify an issue that we'd like to help with. This starts with a specific observation, then broadens out to something we can use machine learning to help solve

Go through the next three slides together, indicating that these students are progressing from an initial observation to a deeper issue by asking "Why?" over and over.

Display: When we sit together at lunch, we spend most of the time on our phones and don't really talk to other people"

Display: Show slide with the next Why: "It's easier to just be on our phones, especially when we don't know other people very well yet"

Display: Show slide with the list of 5 Why's.

Remarks

> In order to get to larger issues, we sometimes need to ask "Why". This is a strategy called the 5 Why's. The goal is to keep asking why until we get to a core issue that might be causing this problem. Once we've discovered the core issue, we can try to create a machine learning app to help solve it

Distribute: Pass out copies of **5 Why's - Activity Guide**. The first two boxes are filled out to match the slides. The remaining three boxes should be filled in by students.

Assessment Opportunity

The responses in the activity guide can be used to formatively assess how well students have met the objectives of the lesson.

Do This: Fill out the answers to the remaining "Why" questions. Try to get to the core of why this problem may be happening.

Circulate: Have students continue to fill in the remaining 5 Why's. As students progress down the chart, their answers may start to diverge from each other as they focus on different aspects of the problem. Some students may focus on the phones as a core issue, while others may focus on the difficulty of talking to new people.

As you notice students finishing up with the 5 Why's, regroup so you can show them how to construct an issue statement.

Display: Show students the definition of Issue Statement. Continue to the next slide and offer students tips for how to write an issue statement.

Teaching Tip

Issue Statements are a component of Design Thinking, which is a larger framework for creatively addressing community issues. For more tips and background on Issue Statements, consider reading these articles **here** and **here**

Do This: Have students identify a core issue that they discovered from the 5 Why's exercise, then have them write their own issue statement on the bottom of their 5 Why's worksheet.

Share Out: Invite 2-3 students to share out the issue statements they came up with.

Display: Show students the 5 Why's example that was filled out by the other team of students.

Remarks

> You all shared some really great examples of how this one observation can lead to a variety of different issues we could address. Let's take a look at the issue statement that our other team of students came up with, and let's see if we can brainstorm some app ideas that can help address this issue.

App Brainstorm (20 minutes)

Distribute: Pass out copies of the **App Brainstorm - Activity Guide**. The issue statement at the top has already been filled in.

Display: Show students the slide describing that machine learning apps use data to do one of three things: make a decision, a recommendation, or a prediction. Offer some examples of these from previous lessons in the course, such as:

- The Driver Assistance app which **decided** how safe it was to drive based on road conditions.
- The Class Book app which **recommended** a book based on personal interests.
- The Safari app which **predicted** how many animals you would see based on other factors in the park.

Do This: Brainstorm different types of apps that could be created to address this issue.

Circulate: Monitor students as they complete this task. Prompt students to consider how their app would use data. Students don't need to think of the specific datasets they would use or how they would collect they data, but they should be able to articulate that the app would require data somehow.

Teaching Tip

Brainstorm, Not Perfection: This part of the lesson is still a brainstorm, so it's okay for students to struggle coming up with ideas. Encourage students to share with each other, but it's also okay for them to not have a ton of ideas yet. The next part of the activity provides some example apps for students to discuss so they can see examples.

Display: The next five slides show suggestions from the team of other students. As a class, discuss whether or not the app uses data to make a decision. If so, what data would it need?

Discussion Goal: Even though all of these apps address the core issue of isolation, not all of these apps would make a good machine learning app. Here are some of the expected discussion points:

- Nico, Isaac, and Hawa's apps all require the user to answer questions in order to get a recommendation. These three apps could all use machine learning.
- Kim's App requires users to interact, but it doesn't use any of their data to make decisions. This isn't a good machine learning app.
- Zoey's app might require some data to create the app and generate the icebreakers, but it doesn't require any information from the user once it's being used. This means it would not require machine learning to create.

Remarks

> When creating our own apps, it's important to know the issue we're trying to address, and it's important to know that the solution we come up with actually requires machine learning. We'll see which one of these apps the team decides to make and tomorrow we'll help them plan how they want to collect data.

Wrap Up (5 minutes)

Journal

Prompt: Why is it useful to brainstorm a core issue rather than just using an initial problem observation?

Have students journal individually, then either share in a class discussion or share as a ticket out the door.

Discussion Goal: Students should realize that focusing on a broader core issue means you're more likely to develop a solution that uses machine learning. If you just focus on your own observations, machine learning may not be the best way to solve that problem. Students may also realize that it's easier to brainstorm app ideas around a broader problem rather than a narrower observation.

Lesson 18: Survey Planning

45 minutes

Overview

This is the second in a five-day sequence of lessons that prepare students for the final project. In this lesson, students learn that the other team of students would like to create a club recommender app based on the clubs at their school. Students imagine what questions would be most useful to help make this recommendation, then they learn how to use a Google Form template to create a survey. The steps students take in this lesson are identical to the steps students will take in their final project.

Question of the Day: How can I create a survey to gather data for a machine learning app?

Standards

Full Course Alignment

AI4K12 National Guidelines 2021

- ▶ **BI-3** - Computers can learn from data

CSTA K-12 Computer Science Standards (2017)

- ▶ **AP** - Algorithms & Programming
- ▶ **IC** - Impacts of Computing

Agenda

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

Activity (35 minutes)
- **Designing Questions**
- **Creating a Form**

Wrap Up (5 minutes)

Objectives

Students will be able to:

- Develop survey questions that can be used to create a machine learning app
- Use a template to create a Google Form survey

Preparation

- Print copies of the activity guide for each student
- Review the video on how to use a template to create a Google Form
- Check the **"Teacher's Lounge"** forum for verified teachers to find additional strategies or resources shared by fellow teachers

Links

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

For the teachers

- **Survey Planning** - Slides
  - ▾ Make a Copy

For the students

- **Creating a Survey** - Resource
- **Creating a Survey in Google Forms** - Video
- **Survey Planning - Activity Guide**
  - ▾ Make a Copy
- **Survey Template [Google Form]**

Teaching Guide

Warm Up (5 minutes)

Journal

Display: Show the description for Hawa's app from yesterday, the Club Recommender.

Prompt: *The team has decided to go with the Club Recommender app. The next step is to gather the data they need to create their model. They plan to interview different people to determine what kind of club their app should recommend. What kind of questions do you think they should ask to help recommend a club to join?*

Discussion Goal: Answers will vary, but could include:

- Demographic information, like age or gender
- Interests or Hobbies, like if they prefer a certain sport
- Media preferences, like what kind of books or movies or music someone likes
- Personality type, like introvert or extrovert or types of moods

One important question to make sure they ask is about what club someone is in, which will eventually be the label in our model. This is an important point that students may forget when designing their own surveys for their project.

Remarks

> This is a great list of possible questions! The larger goal here is to make sure we ask questions that help group the data so AI Bot can find patterns in the data and use those patterns to make a recommendation. If we ask a bunch of unrelated questions, AI Bot won't be able to make a clear decision. Today, we'll pick the questions for our survey and create an example survey using a Google Form.

Question of the Day: How can I create a survey to gather data for a machine learning app?

Activity (35 minutes)

Designing Questions (15 minutes)

Distribute: Pass out a copy of the **Survey Planning - Activity Guide** to each student. Part of the activity guide has already been filled in.

Remarks

> After yesterday's brainstorm, the team started to develop questions they will ask people to help gather the data they need for their machine learning app. The first page shows all of the questions they've decided to include so far.

Display: Show the slide that has the label question, including the club choices for the school: Hiking Club, Band Club, Art Club, Science and Technology Club, World Cultures Club.

Discuss: *What is a question that you think will have a strong relationship with the label question?*

Have students share with a neighbor first before sharing full group

Discussion Goal: Students may predict that Kim's question about activities appears highly related to the choice of clubs, and may even be able to compare certain answers to the clubs themselves. Students may also predict that Nico's question about free time may help separate the clubs, since some clubs may require more time than others.

Discuss: *What is a question that you don't think will have a strong relationship with the label question?*

Have students share with a neighbor first before sharing full group.

Discussion Goal: Students may predict Zoey's question about the elements doesn't appear related to the label question. This is a valid observation, but be careful not to completely discount the question - sometimes unexpected patterns appear in the data that AI Bot can find, even if we aren't able to see them ourselves.

Remarks

> Asking the right questions and gathering the right features is an important part of designing a machine learning app. Even though we might not know ahead of time what patterns are out there, if we design good questions, it can help separate the data and make it easier for AI Bot to identify patterns. Let's add a few questions of our own that we think will help AI Bot determine a pattern in the data.

Do This: Have students create 3 questions of their own to include in the survey. They should mark the questions as categorical or numerical, then list the possible choices or expected range of values for the responses.

Teaching Tip

Scientist Mentality: You can encourage students to think like scientists in this part of the process - they are designing questions that they think are related to their label question, then giving the survey to help investigate that relationship.

Circulate: Monitor students as they come up with their own questions. You can prompt students and ask "Why did you choose this question?" to gauge how intentional they're being with their question selection. Students may explain that they expect certain answers to match with certain clubs, or they may have a vague hypothesis that the question is related to the choice of clubs but not be able to fully articulate it - this is also fine.

Creating a Form (20 minutes)

Remarks

> Now that we have our questions, it's time to create our survey. We're going to use a Google Form and follow a template. This is important so we make sure our data follows the plan we made on this activity guide - we want categorical data to have certain choices, and we want numerical data to only be numbers.

Code Studio: Send students to Code Studio. In the first level, they will click a link to make a copy of a Google Form. Students will need their own Google Account to create a copy of the form.

1 **Create a Google Form**

Teaching Tip

Creating a Copy: Students need to create a copy of this form. Unlike other Google documents, students cannot make a copy while viewing the form directly and requesting access to the form won't allow them to make a copy. Instead, students need to click the specific link on the Code Studio page to be prompted to make their own copy of the form.

Video: Show the video on how to create a Google Form from the provided template. Students will need to be careful about using the template questions so they can make sure their data is usable in AI Lab.

Teaching Tip

To encourage active engagement and reflection, use one or more of the strategies discussed in the **Guide to Curriculum Videos**.

Do This: Have students create their survey using Google Forms. They can use the checklist on their activity guide to help keep track of their progress.

Circulate: Monitor students as they complete their forms. There are a lot of new skills to manage in Google Forms, especially if students have never used it before. Students may be tempted to create their own questions, but encourage them to use the template questions instead since they already have the proper settings to help make sure their survey data can be used in AI Lab in the next lesson.

Assessment Opportunity

Completing a Google Form using the template is an important skill for next week when students will be collecting their own data. Even though it may appear tedious to add 9 questions to the survey, this practice is important so students don't get frustrated at this step when completing their own projects.

Collect Data: As students finish creating their forms, they should begin collecting data by filling out the form themselves and having other classmates fill out the form. Even though the first six questions are the same, the final three questions will be different for each student. You may decide to have students pull up the form on their computer, then invite other classmates over to fill it out. Or, students can interview each other and fill out the survey on their behalf.

Teaching Tip

Where Does This Data Go? Even though students are collecting data now, the actual data that will be used the rest of the week will be pre-supplied by [team name]. It's valuable to have students take the data collection seriously and not try to "mess up" a classmates data, but it also will not interrupt the rest of the week of the data from these surveys becomes unreliable

Assessment Opportunity

You can fill out a student's google form as a way to check that they used the template correctly and generated their questions in a way that won't cause problems for AI Lab later. Some key items to look for are:

- All questions should be required (with the red asterisk)
- Categorical questions shouldn't have an "Other" option where you can type in a custom response
- Numerical questions should only accept numbers - if you try to type a letter, it will generate an error

Wrap Up (5 minutes)

Prompt: *Today in class, only the people in this room filled out the survey. Who are the other people in your community you would want to fill out this survey? What strategies can you use to try and get them to participate?*

Discussion Goal: This question ties into an exercise students will do as part of their final project - design a plan for making sure a diverse group of their community is represented in their survey. Students should consider which types of students are represented in their classroom, especially if a certain demographic group is over-represented (such as by age or gender or race). They should consider how they can get a more diverse group of people participating in the survey, such as reaching out beyond their classroom or interviewing other members of their community. As students come up with a variety of answers, consider recording these on a poster to refer back to later when students consider this question in their own project.

Lesson 19: Survey Data in AI Lab

45 minutes

Overview

This is the third in a five-day sequence of lessons that prepare students for the final project. In this lesson, students learn how to view survey data in Google Sheets and save the data to their computer as a csv file. Then, they upload the saved data to AI Lab and examine the survey results from one of the students to train a model using their data. Then, students use Google Sheets to examine data from another student where the data has errors and then try to fix the errors. The steps students take in this lesson are identical to the steps students will take in their final project, and the problem-solving strategies they develop will help them overcome challenges in their own final project.

Question of the Day: How can I import data into AI Lab to train a machine learning model?

Standards

Full Course Alignment

AI4K12 National Guidelines 2021

- ▶ **BI-3** - Computers can learn from data

CSTA K-12 Computer Science Standards (2017)

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

Agenda

Warm Up (5 minutes)
Survey

Activity (35 minutes)

Wrap Up (5 minutes)

Objectives

Students will be able to:

- Analyze and clean data in Google Sheets
- Download a csv file from Google Sheets
- Upload a csv file to AI Lab

Preparation

- Check the **"Teacher's Lounge"** forum for verified teachers to find additional strategies or resources shared by fellow teachers

Links

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

For the teachers

- **Survey Data in AI Lab** - Slides
  ▼ Make a Copy

For the students

- **Cleaning Survey Data** - Video
- **Isaac's Survey Data - Student Resource**
- **Kim's Survey Data - Student Resource**
- **View and Download Survey Data** - Video

Teaching Guide

Warm Up (5 minutes)

Survey

Code Studio: Have students log into Code Studio. The first level links to a survey that students can take.

1 **Kim's Survey**

Prompt: *What are two questions on this survey that you think will be related? You might use a sentence like "I think people who answer ... would probably want to join club ..."*

Discussion Goal: It's most important to get students into Code Studio and participating in the survey, since they will use the data from this survey in the lesson. The prompt helps prime students to look for patterns when they get into AI Lab. As students share responses, there are no right or wrong answers - instead, take note of the ideas that students have and be ready to reference them later when using AI Lab to analyze the data.

Remarks

> Yesterday we helped our team create a survey - today we're going to look at the data and use AI Lab to start training a model. Kim has already been collecting data, so we'll start by learning how to import their data into AI Lab and see what patterns we can find.

Question of the Day: How can I import data into AI Lab to train a machine learning model?

Activity (35 minutes)

Code Studio: Have students continue to the next level in code studio. This level has students click a link to make a copy of a Google Sheet that represents the survey data from this form.

2 **Kim's Survey Data**

Teaching Tip

Which Row Is Mine?: Even though students just filled out this form, their data won't be represented here. Instead, this is a snapshot of the data from different students that is used just for this lesson. This means the size of the dataset won't match the number of students who just took the survey, and if students try to reverse-engineer the data to find their particular entry, they won't be able to.

Video: Show students the **View and Download Survey Data** video in the alides. This video shoes students how to view data in Google Sheets, save their data as a CSV, and upload to AI Lab.

Teaching Tip

To encourage active engagement and reflection, use one or more of the strategies discussed in the **Guide to Curriculum Videos**.

Do This: Rename the headings for each column to something more descriptive. Aim to have one or two words in each column heading. Then save the file as a csv to your computer.

Teaching Tip

Data Overload: Looking at all this data at once can be overwhelming! Luckily, students only need to do two things on this screen:

- Type in the first row of the table to rename the headers
- Save the file as a CSV

Students don't need to explore the data or try to discover patterns - that's what AI Lab is for!

Circulate: Check in with students as they complete this process. Encourage students to check in with each other as well to help get more familiar with Google Sheets, especially the process of saving as a csv.

Code Studio: Have students continue to the next level in code studio. In this level, students will upload their data to AI Lab and train a model from the data.

3 AI Lab and Kim's Data

Do This: Follow the instructions at each stage in AI Lab. Over the course of this level, your goals are:

- Train a model with at least 70% accuracy that uses the least amount of features
- Fill out the model card and save your model

Circulate: Monitor students as they work through AI Lab. Focus on how students are selecting their features, ensuring they are balancing both accuracy and simplicity. Encourage students to try multiple features, and to ask questions that make sense in the context of having a club recommended.

As students get close to completing the model cards, regroup and share the next slide.

Display: Show students the slide showing the model card screen.

Remarks

> Since we uploaded our own data, we have some new fields to fill out on our model card! We need to describe where this data came from, and we need to describe each of the columns we're using as features and label. This is a great place to write the question from the survey!

Do This: Have students complete the model card. Have students use the questions from the survey for the description of each column, and the information from the slide for the data description.

Remarks

> This is great - we were able to help Kim create a machine learning model for her data! But - Kim isn't the only person collecting data! Let's also check in with Isaac and see how they're doing

Display: Show the next slide, which shows Isaac and some of their data

Discuss: *What do you notice about Isaac's data?*

Discussion Goal: Students should notice that the numerical data has a large range that doesn't make sense, and they should notice that the categorical data includes extra values that weren't supposed to be a part of the survey.

Discuss: *Why do you think the data ended up like this?*

Discussion Goal: This discussion should focus on two areas: how Isaac setup his form, and how he collected his data.

- If Isaac wasn't careful with his form from yesterday, he could have accidentally allowed people to type in their own responses or leave answers blank which is why the categorical data has issues. This can be a good opportunity to reinforce yesterday's lesson and how important it is to setup the form correctly to make sure students collect accurate data.
- If Isaac forced people to take his survey that didn't want to, they may not have taken it seriously and given fake answers like we see with the numerical data. Students may contrast this with what Kim did, where she asked people to participate rather than forced them to.

Remarks

> Now that we understand why Isaac's data might look like this, let's see if we can help him clean up his data.

Code Studio: Have students continue to the next level in code studio. In this level, students will download Isaac's data and be given instructions for cleaning the data.

4 Isaac's Survey Data

Video: Show students the **Cleaning Survey Data** video in the slides. This video guides students through how to clean up data in a spreadsheet so it can be used in AI Lab.

Teaching Tip

Don't Repeat Mistakes: Ideally, students won't need this skill in later lessons when they are creating their own surveys. Hopefully they will be able to use the template correctly, which will avoid the issues Isaac is facing right now. With that in mind, it's okay if students don't master the ability to edit spreadsheets - instead, emphasize how important it is to make sure your data is being collected in a controlled way that avoids this kind of situation.

Do This: Fix the errors in Isaac's data so it will work with AI Lab. Once you've fixed the errors, download the file as a CSV and upload to AI Lab to verify that the data works correctly again.

5 AI Lab and Isaac's Data

Assessment Opportunity

Save as CSV: This exercise is another opportunity for students to practice saving their data as a csv file and uploading to AI Lab. If students don't fix all of the errors in their first try, they may need to re-download and re-upload the CSV file multiple times. This may feel tedious now, but becoming familiar with this process now will help save students time and frustration during their final project.

There are 6 intentional errors in Isaac's data. As students work, feel free to offer this as a hint to students.

Teaching Tip

Saving a Model: Students aren't able to create a model from Isaac's data. If students ask, it's because the sample size is too small and Isaac should collect more data before feeling comfortable training a model from it.

Remarks

> Getting our survey data prepared for AI Lab is an important step. Kim had her data ready to go because her form was setup correctly, but Isaac needed some help cleaning his data. This is an important lesson to keep in mind next week when you'll be preparing your own survey data.

Wrap Up (5 minutes)

Prompt: *What is a situation where you think it's okay to make a change to your survey data to help clean it up? What's a situation where you think it's not okay?*

Discussion Goal: Based on today's activity, students may think it's okay to adjust data when it's clearly a typo that is similar to another answer. Students may think it's not okay to completely change an answer to something else. In general, there's a lot of gray area in these situations, which is another reason it's important to have human's involved in machine learning to use their judgement with these decisions.

Lesson 20: Troubleshooting Models

45 minutes

Overview

This is the fourth of a five-day sequence of lessons that prepare students for the final project. In this lesson, students examine survey data from other members of the student team and analyze why their models are not working correctly. In examining the data, students develop strategies for avoiding these issues in the future and strategies for coping with these issues should they happen again. These are skills students will use in the final project as they develop their own surveys and collect data.

Question of the Day: What are strategies to make sure our data generates an accurate model?

Standards

Full Course Alignment

AI4K12 National Guidelines 2021

- ▶ **BI-3** - Computers can learn from data

CSTA K-12 Computer Science Standards (2017)

- ▶ **AP** - Algorithms & Programming
- ▶ **IC** - Impacts of Computing

Agenda

Warm Up (5 minutes)
Journal

Activity (35 minutes)

Wrap Up (5 minutes)
Journal

Objectives

Students will be able to:

- Explain how choices in data collection can lead to issues when training a machine learning model

Preparation

- Check the **"Teacher's Lounge"** forum for verified teachers to find additional strategies or resources shared by fellow teachers

Links

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

For the teachers

- **Troubleshooting Models** - Slides ▾ Make a Copy

For the students

- **Troubleshooting Models - Activity Guide** ▾ Make a Copy

Teaching Guide

Warm Up (5 minutes)

Journal

Display: Show the slide that shows Zoey explaining that they've tried training their model, but they can never get higher than a 60% accurate model.

Prompt: *What are some reasons Zoey might not be able to train an accurate model?*

Discussion Goal: This prompt prepares students for today's main activity - strategies for what to do when your data doesn't lead to an accurate model. Students should draw on their experiences from the unit when they've trained their own models. Some answers may include:

- Zoey hasn't chosen enough features - if they select more features, it might become more accurate
- Zoey is selecting features that aren't strongly related to their label. They should use the data visualizations to get a better idea of what features will be best for the label.
- Zoey may not have enough data - if they collect more data, they might get better results.

Remarks

> Even after creating our survey and gathering our data, it's still possible that we might not be able to train an accurate model from our data. There are a lot of reasons this could happen - today, we're going to talk about reasons this might happen and some strategies for how to adapt if our data doesn't lead to good results.

Question of the Day: What are strategies to make sure our data generates an accurate model?

Activity (35 minutes)

Code Studio: Have students log in to Code Studio and go to the first level of this lesson. Students will see several datasets they can choose from.

1 **Club Datasets**

Distribute: Pass out the **Troubleshooting Models - Activity Guide**. Students will record data from their investigation here.

Assessment Opportunity

The responses in the activity guide can be used to formatively assess how well students have met the objectives of the lesson.

Display: Show students the slide explaining the first part of today's task - Kim, Nico, Isaac, and Zoey are having trouble training accurate models and the class needs to help troubleshoot. Students will investigate each student and try to describe what is causing the issue, and a recommendation for how to solve it or how to avoid it next time.

Do This: Investigate each person's data in AI Lab and record your findings on your activity guide.

Circulate: Monitor students as they complete this task. Students should read the description from each student for clues as to why their data may not be working, then explore the data and results screens. Students should experiment with different features and testing the models to see where the issues may be.

Teaching Tip

Troubleshooting Models: Here are some tips to help students discover the issues with these models:

- **Zoey's Data:** Zoey's models will always have a 0% or 33% accuracy because she didn't collect enough data - students should notice the dataset only has 25 rows. Students might suggest that Zoey collects more data before trying to train her model again.

- **Isaac's Data:** Isaac's models will always be low because none of his features have a strong relationship to his label - students should notice that none of the Cross Tab charts have strong hot spots with any question. If students look at the questions themselves, they may notice that they don't seem to have a strong relationship to the label Isaac is trying to predict. Students may recommend Isaac choose different questions and collecting his data again.
- **Kim's Data:** Kim's models can be very accurate, but when students test the model they may find the questions and answer choices very specific and not inclusive - for example, the "favorite lunch food" question only contains meat options. Students may suggest that, even though the model is accurate, Kim may want to choose different questions that are more broad and inclusive rather than so specific.
- **Nico's Data:** Nico's models can be very accurate, but when students test the model they may find that the majority of the recommendation is for the "Band Club" no matter what they pick. Students may need some prompting to notice this, but the data selection screen shows that Nico collected data primarily from people in a band, which biased his model towards recommending the Band club. Students may recommend Nico can avoid this next time by making sure he has a wide variety of people complete his survey.

Share out: Invite students to share their responses. As they do, you may decide to pull up the data in front of the class and emphasize what students discovered about the model.

Prompt: *Hawa hasn't started collecting data yet. What are three strategies you would offer her so she doesn't make some of the mistakes as her peers?*

Have students record their answers on their activity guide. They can also share with a partner to help generate more ideas.

Discussion Goal: Students should make suggestions related to gathering data from diverse sources, making sure she has enough data, and making sure the survey is representative and general enough to get interesting results.

Teaching Tip

Survey Planning: This discussion and focus on planning a survey is similar to part of the project that students will complete next week - they will need to plan how they will collect data to ensure their data can generate an accurate model. It may be helpful to cue students to remember this when they start their own project next week.

Display: Show the next slide, which has the following text: *Isaac is worried he has time to generate a whole new survey and ask all new people, but he still wants to make an app. What are some other options he can consider?*

Have students consider this individually and share with a partner, then continue to the next slide.

Display: Show the next slide, which shows Isaac referring back to his planning guide and remembering a different idea he had for the project - an isolation predictor.

Remarks

> Since Isaac's initial plan didn't work out, one strategy he could try is to look back at his initial brainstorm ideas and see if there are any other apps he might be able to make that could still address this issue. Even though Isaac may not be able to collect his own data, he may be able to use someone else's data to help solve his problem.

Code Studio: Have students continue to the next level in Code Studio, where they will see several datasets available to them.

2 Alternative Datasets

Do This: Isaac has found some additional student survey datasets from a public website that he thinks he can use to create the Loneliness Score app from his brainstorm. Isaac has already selected "Loneliness" as the label, but each dataset has different features he could choose from (like music or movies). Choose one of the datasets to investigate and see if you can create an accurate model to predict how lonely someone might be.

Circulate: Monitor students as they look through the datasets. They may try different datasets depending on their interests.

Teaching Tip

Using Stock Datasets: This activity represents a situation students may find themselves in during the project next week: they may want to use one of the example datasets to investigate their issue, especially if they aren't able to collect enough data from their survey or their survey doesn't lead to an accurate model. In this situation, finding an alternative dataset is a viable option for students as long as they document this choice in their model card.

Remarks

> Even when we don't get an accurate model, this doesn't mean it's the end of the world. Sometimes we can find an alternative dataset to use. Or - remember that we can think of ourselves as scientists: we're experimenting and investigating how our data is related to help make a model. And, just like scientists, sometimes an experiment fails - and that's okay! Sometimes talking about why the experiment failed is just as important as talking about why an experiment succeeded! Let's see how Isaac could do this with a Model Card from his original data.

Wrap Up (5 minutes)

Journal

Prompt: *If Isaac were to still use his data to create an app or use this example dataset, what do you think he should put in the Intended Uses section? What should go in the Limitations section?*

Discussion Goal: Students should realize that when using these alternative datasets, they should still be careful about documenting their decisions in their model cards.

Lesson 21: Creating an App

45 minutes

Overview

This is the fifth of a five-day sequence of lessons that prepare students for the final project. In this lesson, students import the club recommender app into App Lab and begin customizing the app. Students add a welcome screen and update the descriptions of each feature, then they can decide how they would like to further customize the app. The steps students take in this lesson are identical to the steps students will take in their final project.

Question of the Day: How can I create a friendly, easy-to-use machine learning app?

Standards

Full Course Alignment

CSTA K-12 Computer Science Standards (2017)

- ▶ **AP** - Algorithms & Programming

Agenda

Warm Up (5 minutes)
Journal

Activity (35 minutes)

Wrap Up (5 minutes)
Journal

Objectives

Students will be able to:

- Create an app that uses machine learning

Preparation

- Check the **"Teacher's Lounge"** forum for verified teachers to find additional strategies or resources shared by fellow teachers

Links

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

For the teachers

- **Creating an App** - Slides
  - ▾ Make a Copy

Teaching Guide

Warm Up (5 minutes)

Journal

Prompt: *Hawa is ready to start building her app! She wants it to look better than some of the single-screen, black-and-white apps she's seen. How can she design her app so it's friendly and easy to use?*

Discussion Goal: This prompt prepares students for the task they will complete today - designing an app from the data and model they prepared earlier in the week. Students should recall experiences from previous lessons. Some answers may include:

- Adding a theme

- Adding a welcome screen
- Expanding the feature text beyond the one or two word default labels
- Creating a new screen to show the result of the prediction

Remarks

> This is a great list of ways to make an app friendly and easy to use! Today, we're going to help [team name] design and customize their apps using the model we prepared earlier this week.

Question of the Day: How can I create a friendly, easy-to-use machine learning app?

Activity (35 minutes)

Code Studio: Have students log into code studio. The next series of levels will have students import their model into App Lab, then begin to customize the app to make it easier to use.

Circulate: Monitor students as they complete the levels in Code Studio. Refer students to Help and Tips section if they need a refresher on App Lab's features.

1-3 **Import Your Model**

1 2 3

4-5 **Add a Welcome Screen**

4 5

6 **Customize Your App**

Teaching Tip

Supporting Students: These levels are similar to similar customizations students completed in previous lessons. If students get stuck, consider referring them to these previous lessons:

- Adding multiple screens for each feature: **Lesson 13 - Customizing Apps**
- Adding multiple screens for the resulting prediction: **Lesson 10 - Model Cards in App Lab**

7 **Review Your App**

Assessment Opportunity

This level can be used as a formative assessment. A rubric is provided in the level, and written feedback can be given to students. **Click here to learn more about giving feedback to students**.

Wrap Up (5 minutes)

Journal

Prompt: *If you were to create your own machine learning app, what problem would you want it to try and solve?*

Discussion Goal: This prompt foreshadows how students will start their project tomorrow, where they will investigate their own problem to solve using a machine learning app. Treat this prompt like a brainstorm, letting students suggest ideas. Use this as a segue into the project tomorrow where students will decide an idea they would like to pursue.

Lesson 22: Project - Design an AI App

225 minutes

Overview

To conclude this unit, students develop an AI app that addresses the social issue of their interest. Students follow a project guide to complete this multi-day activity. In the first step, students prepare the data they will use to train their model in AI Lab. After training, testing, and generating a model card, they export their model into App Lab for development. Here they use their model to create a user-friendly app. Students perform a peer review and make any necessary updates to their projects while reflecting on the outcome.

Question of the Day: How can I create an AI App the solves a problem in my community?

Standards

Full Course Alignment

AI4K12 National Guidelines 2021

- ▶ **BI-3** - Computers can learn from data

CSTA K-12 Computer Science Standards (2017)

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

Agenda

Day 1 (45 minutes)
- Warm Up
- Activity
- Step 1 - Choose an Issue Statement
- Step 2 - App Planning
- Wrap Up

Day 2 (45 minutes)
- Warm Up
- Step 3 - Plan Your Data Collection
- Step 4 - Create Your Survey
- Wrap Up

Day 3 (45 minutes)
- Warm Up
- Step 5 - Data Reflection

Objectives

Students will be able to:

- Apply the Problem Solving Process to create an AI for Social Good App

Preparation

- Print copies of the Project Guide.
- Print copies of the Rubric.
- Print copies of the Peer Review Guide.
- Check the **"Teacher's Lounge"** forum for verified teachers to find additional strategies or resources shared by fellow teachers

Links

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

For the teachers

- **Design an AI App** - Slides
  ▾ Make a Copy

For the students

- **Design an AI App** - Rubric
  ▾ Make a Copy
- **Design an AI App - Project Guide**
  ▾ Make a Copy
- **Model Card - Digital Template** - Resource ▾ Make a Copy
- **Model Card - Printable Template** - Resource ▾ Make a Copy
- **Survey Template [Google Form]**
- **[Template] 5 Why's** - Resource
  ▾ Make a Copy

Teaching Guide

Day 1 (45 minutes)

Warm Up

Prompt: What is an issue you'd like to address with machine learning?

Discussion Goal: This is a big question! Have students journal individually, but don't have them share as a full group. Instead, use this to transition into the main activity where students will begin a project to create a machine learning app.

Remarks

> Throughout the unit, we've tackled each part of building an AI app individually. For the next few days, we're going to use the Problem Solving Process to see an entire project through. We're going to decide on an issue we want to address, design a survey, collect data, then use AI Lab to analyze that data and create a machine learning app.

Question of the Day: How can I create an AI App the solves a problem in my community?

Activity

Distribute: Give students copies of the **Design an AI App - Project Guide**.

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

Teaching Tip

Facilitating Group Projects: If students are working in pairs or small teams to complete projects, consider showing these two videos to the class:

- **How Teamwork Works**
- **Dealing with Disagreements**

Depending on your goals with this project, consider having teams complete a **Student Guide to Team Planning**, which reinforces the message in the video

Step 1 - Choose an Issue Statement

Do This: Have students brainstorm an issue statement they would like to address with machine learning. Encourage students to use the 5 Why's strategy from the previous lessons. You may even decide to have some copies of the **5 Why's - Activity Guide** available for students.

Teaching Tip

Issues vs Problems: Encourage students to think broadly and consider issues they would like to address, since these are more likely to have solutions that can use data and machine learning. If students focus too narrowly on specific problems, they may have chosen something where machine learning may not be an appropriate solution. If you notice a student has a too narrow issue, encourage them to use the 5 Why's strategy to investigate the core issue and broaden their options.

Class Brainstorm: Before diving into individual projects, consider leading a class brainstorm of what some example projects could look like that fit this criteria. You may also decide to show an example app **like the ones available here** to help inspire the brainstorm. Using these ideas, students may find it easier to latch onto an initial idea for their project

Step 2 - App Planning

Do This: Have students brainstorm types of apps they can use to address their issue. They can research potential apps that they could use as inspiration

Teaching Tip

Flexibility: It's important for students to come up with at least once option in each box, so they have some flexibility later on if they need to pivot when developing their app. Encourage students to really brainstorm here, rather than putting all of their hope in a single app idea.

Timing: Students should finish Step 1 and 2 today, and potentially start on Step 3. If not, students can begin Step 3 today.

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. Students may also use the time before the next lesson to brainstorm additional app ideas.

Day 2 (45 minutes)

Warm Up

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

Step 3 - Plan Your Data Collection

Do This: Have students begin brainstorming how they will collect data and ensure they have enough data and a representative sample of data. Remind students of the previous lesson where students had flawed datasets and weren't able to train accurate models - this section of the project guide help them avoid those types of mistakes in the future.

Step 4 - Create Your Survey

Do This: Have students make a copy of **Survey Template [Google Form]**. This is the same template from the previous lesson to create their survey. Students can re-watch the video on how to use the template and make sure their data is protected.

Students should create their survey in Google Forms. Once the survey is ready, they can plan how they would like to distribute it. Once students reach this stage, they may need to pause while people complete their survey and they collect data.

Teaching Tip

Pausing to Collect Data: Even though this project is scheduled for a week, it may be worthwhile to extend the project so students can collect enough data for their surveys. You might consider planning some supplemental activities while students are collecting data, then regrouping back to the project once their data is collected. AI4All offers several **Bytes of AI activities** that can fit as supplemental lessons while students collect data.

Wrap Up

Collect: Collect students' project guides and model cards. Do a quick check-in to make sure students are on track.

Day 3 (45 minutes)

Warm Up

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

Step 5 - Data Reflection

Do This: Students should analyze the results of their survey and record their answers in their project guide.

Step 6 - Train Your Model

Do This: Have students train their model in AI Lab. Students should download their survey data as a csv and upload it to AI Lab. They can re-watch the videos from previous weeks as a reminder of how to do this.

Teaching Tip

Adapting to Troublesome Data: Steps 5 and 6 are key moments in determining if the survey students designed and the data they collected can be used to create a machine learning model. There are a variety of factors that could make this difficult, especially if students didn't have a chance to collect enough data or the data doesn't lead to accurate models. Here are some strategies to help students move past these issues:

- **Documenting in the Model Card**: Even if the data doesn't appear to create an accurate model, students can still use this data to complete the project as long as they document their decisions in the Model Card, especially in the Limitations section. Even though this means they are creating an app without an accurate model, it provides an opportunity for reflection on what could have gone differently in a future project.
- **Use a pre-supplied dataset:** Several datasets are available in AI Lab for students to use if their survey data isn't leading to fruitful results. Students can use one of these datasets instead to complete their project. This may require adjusting the focus of their app, but students will at least be able to complete the project
- **Exploring Advanced Datasets:** AI Lab is designed to work with machine learning datasets from several common websites, such as **Kaggle**. Students can explore this website to find a dataset that fits their needs, then use the dataset in AI Lab to train their model. An account is required to download datasets - we recommend having a teacher create an account and manage downloading datasets for students.

In general, this project focuses on students' ability to plan and execute an AI app that addresses an issue they care about, from ideation to data collection to app creation. Completing this cycle is ultimately more important than having an accurate app, especially since students have previously completed the mini-project which focuses more on training an accurate model and since students can document the intended uses and limitations on a Model Card.

Complete a Model Card: Once their model is trained and saved from AI Lab, they should spend time creating the model card for their data. You can provide two options for students to create their model card:

- **Model Card - Printable Template** - You can print out a model card for each student, or provide poster paper for a student to use to create their model card. They should use previous model cards as examples of what to include. Students can also use post-its or notecards to complete the Label and Features section of their model cards. These cards can then be displayed around the room as a tangible representation of their work during this unit
- **Model Card - Digital Template** - Have students make a copy of the Model Card digital template that they can edit. Any *italicized* text in [brackets] can be replaced with their own words. They can also create copies of the digital post-it notes for the Label and Features screen. These digital versions can be posted on a virtual gallery along with their apps as a way to represent their work during this unit.

Wrap Up

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

Day 4 (45 minutes)

Warm Up

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

Step 7: Develop Your App

Do This: Have students develop their app in App Lab. A rubric is provided to guide students through what their project should look like. At the very least, it need to have:

- A design theme
- A welcome screen
- Descriptive feature and label text elements

2 **Design an AI App - App Lab**

Teaching Tip

Design Elements Off the Screen: Depending on the number of features that your students use in their model, some of their design elements may appear off of the screen. This tends to happen when using more than 6 features in a model.

There are two strategies you can use to help students fix this:

Strategy #1: Make New Elements. Students can use design mode to drag out new elements to use in their app. They may also decide to move the elements to different screens to help make the app easier to use. After adding these new design mode elements, students will need to update their code to use the new elements as well. Students can refer to **Lesson 13**, especially level 1, as an example of how to update their code to fix this problem.

Strategy #2: Reposition Elements. Even though the elements are off the screen, you can use Design Mode to manually select them and re-position them so they are on the screen. This involves changing the y-position property to 0 so it is on the screen, and then re-arranging the element like you would normally.

Step 8 - Test and Reflect

Do This: Before students leave, encourage them to find at least one intended user of their app to get some feedback. Students can fill in the testing information with their user, then fill in the reflection during the next class period.

Wrap Up

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

Day 5 (45 minutes)

Warm Up

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

Step 8 - Test and Reflect

Do This: Have students fill out the Test and Reflect section of their activity guide.

Teaching Tip

Timing: It's hard to predict the timing of this project considering all the directions that student projects could go in. Some students may get excited by the data collection and analysis piece, others may get excited by the app creation piece, and others may be struggling to find data that supports their creative ideas.

Consider this final day as a flexible day, where students can finish up whichever aspects of their project are in the most need. You may also consider extending this project if student interest leads to more projects and data to support their community.

Wrap Up

Submit Projects: Have students submit their projects on Code Studio

Collect: Collect student projects and supporting resources:

- Project Guide
- Model Card

Reflection

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.

3 **End-Of-Unit Survey**

Teacher End-Of-Unit Survey

We also have a teacher end-of-unit survey to learn more about how the unit went for you and your students. While students take their survey, **please complete this end of unit survey for teachers** as well. Your feedback is valued and appreciated!

After the Lesson

End-Of-Course Survey

If this is the last unit of CS Discoveries that you are teaching, also have students take the end-of-course survey. See the **CSD Instructions resource** for more information about the End-of-Course survey and how to assign and see the results.