RET Module

RET Module Overview

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Introduction Activity - Machine Learning with Autonomous Driving

Activity Set-Up

- Create a path through the classroom with turns, obstacles, signs, ect.

Group Roles

1. Split class into small group of 4 students. Assign or allow students to self assign 3 individual roles.
   a. The Machine: This student will be the 'machine' that is learning. They will carry out the programming given to them from the rest of the group.
      i. The Machine cannot make any decisions on its own, they can only follow their programming given to them by the programmer.
         1. Example: If the instruction given is 'walk forward' the machine can only walk forward. They cannot stop, move left or right, follow signs, hear instructions, or even see!
   b. The Designers: These students will be the decision makers for what the machine needs to learn to be successful.
      i. The Designers should work collaboratively use problem solving skills to respond to the Machine's attempts at moving through the classroom. This discussion happens out of earshot from the Machine.
         1. Example: If the Designers watch the Machine walk forward through the classroom bumping into things they may decide the next thing the Machine needs to learn to do is stop.
   c. The Programer: This student is responsible for 'teaching' the machine what to do based on the designers instructions.
      i. The Programmer can collaborate with the designers, but is the only one who can communicate with the Machine. They will need to put the instructions in writing to give to the Machine.
         1. Example: After the discussion about teaching the Machine to stop. The programmer will need to write a one sentence instruction for the machine such as, "When you are about to run into an object, stop."

Teacher Note: Be obnoxious in specificity. A Machine that has learned to hear hasn't learned what the word 'Stop' means. A Machine that has learned to stop before hitting an object hasn't learned to move around the object or start walking again. It will take A LOT of learning for the Machine to move through the classroom successfully.

ntroduction Activity - Machine Learning with Autonomous Driving

Possible Challenge Scenarios:

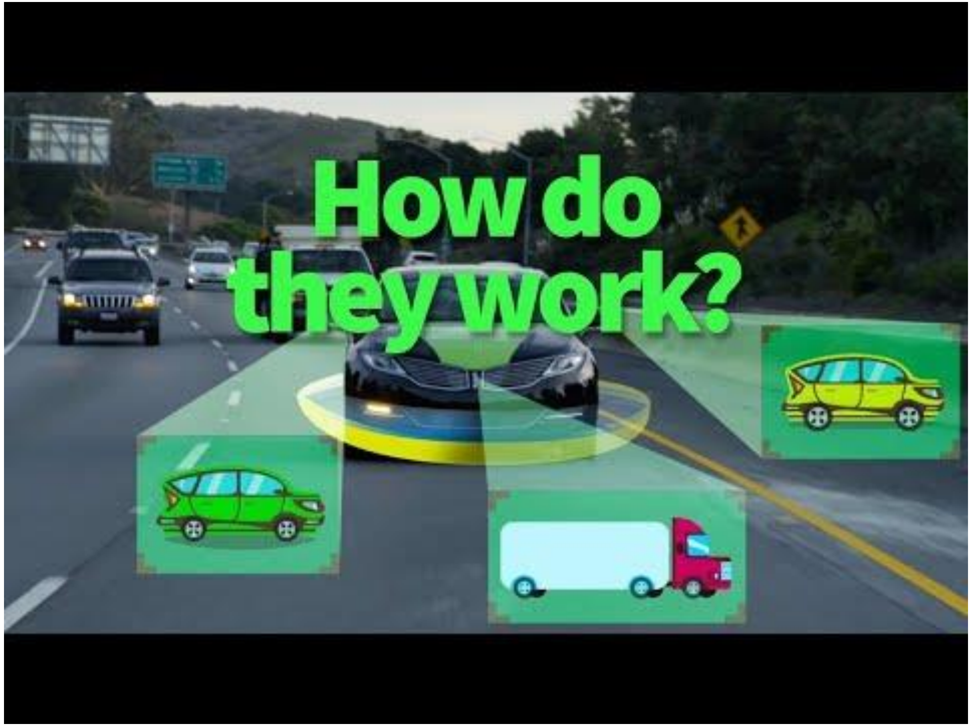
- Who can program their Machine to move through the classroom with the fewest instructions.
- Which group's Machine navigates the classroom the fastest.

Possible Reflection Questions:

1. What were some of the challenges?
2. What would you do differently if you could start over?
3. What are the benefits of machine learning?
4. Describe your groups process and reasoning at each step of the activity.

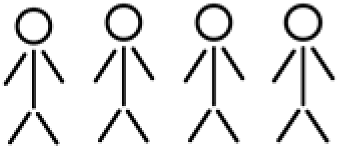
Student Slide

Machine Learning with Autonomous Driving



Machine Learning with Autonomous Driving

Form a group of 4.



Assign group roles.

Machine - A student with good listening skills.
Engineer - A student with good communication skills.
Designer (2) - Students with good problem solving skills.

Machine Learning with Autonomous Driving

Your Goal: Program your machine to reach the other side of the classroom.

Rules:

Machine

The machine can only do things it has been trained to do.
The machine cannot communicate with its programmers or designers.
The machine is always allowed to STOP if it going to hurt itself. Be safe.

Programmer

The programmer is the go between for the designers and the machine.
The programmer can only communicate with the machine in writing, one sentence at a time.
The programmer cannot watch machine's attempts to cross the classroom.

Designers

The designers cannot communicate directly with the machine.
The designers will tell the programmer what the machine needs to learn, but cannot write it down for them.

Machine Learning with Autonomous Driving

Your Goal: Program your machine to reach the other side of the classroom.

Activity Flow

Designers discuss and decide what the machine needs to learn to reach the other side of the classroom.
Programmer and Machine cannot listen to this conversation!
Designers tell Programmer what the machine needs to learn.
Machine cannot listen to this conversation!
Programmer writes a single sentence with one direction for the Machine.
Designers cannot tell them specifically what to write or read what they have written.
Programmer gives the writing to the machine.
There can be no conversation, only the exchange of the written instruction.
The machine gets in line to make an attempt to reach the other side of the classroom.
The rest of the team watches.

Then go back to A and REPEAT!

Machine Learning with Autonomous Driving

Your Goal: Program your machine to reach the other side of the classroom.

Reflection Questions

How successful was your machine in reaching the other side of the classroom?

If you could continue to teach your machine what instructions would you do next?

What part of this activity was most challenging for you?

What would you do differently if you could start over?

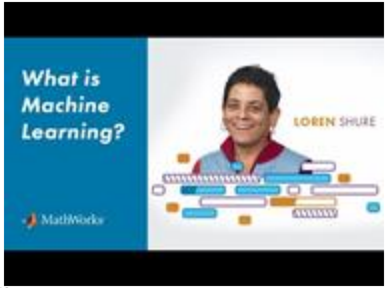
Describe your groups process and reasoning at each step of the activity.

How is this activity similar to machine learning for autonomous cars?

Introduction Activity - Machine Learning Card Sort

Activity Set-Up

- Create a jamboard with a few pictures each of dogs, cats, birds. Each student need their own slide.
    - You can create your own with different pictures.
- Alternatively you can create physical cards with the pictures.



Clustering Activity

- Ask students to sort the pictures into groups and label the groups they've created.
- All groupings are valid. This is clustering.
- Clustering segments collections of things into groups with distinct characteristics.

Classification Activity

- Ask students to group the pictures into 3 groups: dogs, cats and birds.
- Have students list features that distinguish the different groups.
- As a class decide on 3-4 features and be specific in describing each feature for each animal group.
- Present new animal pictures (some dogs, cats, and birds, and some brand new animals) and ask students to classify them based on the pre-decided features.
- Classification is used for object detection.

Regression Activity

- Regression predicts qualities on a continuum, for example speed.
- Have students list features that would be relevant to speed.
- Place animals on a continuum based on those characteristics.

Machine Learning Card Sort

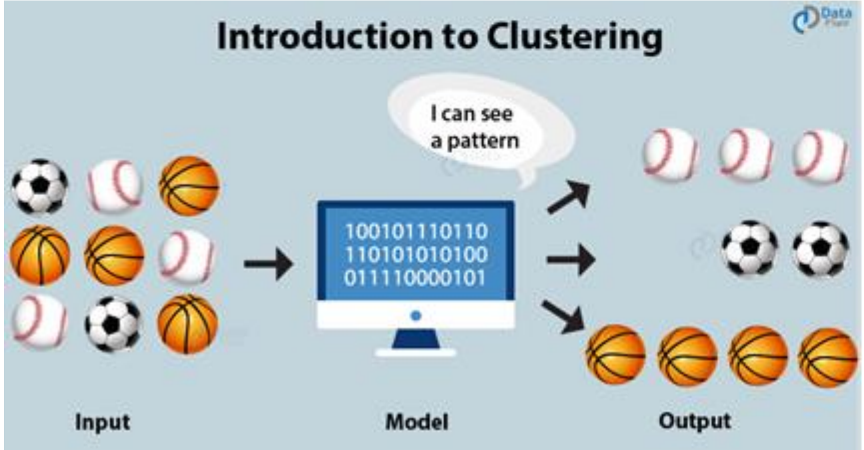
Part 1: Clustering

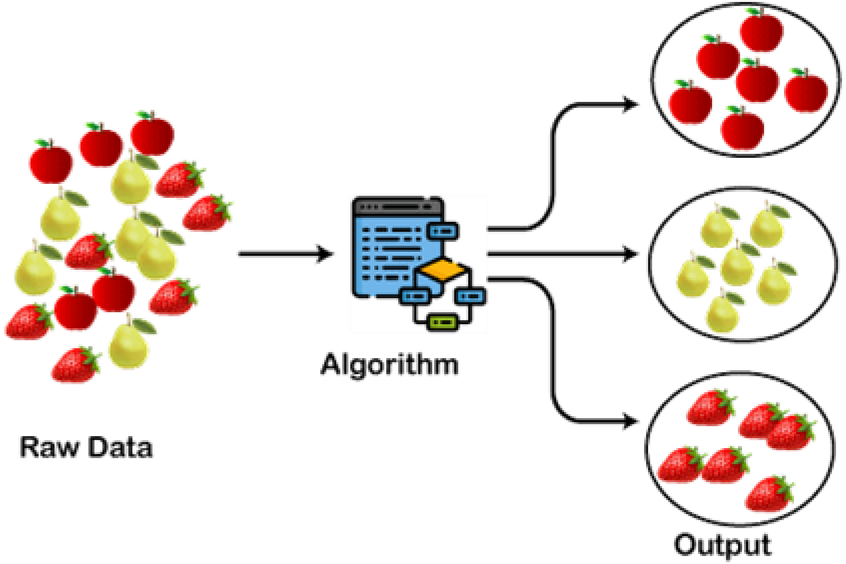
Open this link to a Jamboard: https://bit.ly/3fbc7ru
Pick a slide and type your name where it says ‘your name’. This is now your slide! Try not to accidentally work on someone else's slide.
Sort the images into groups. Create a label that describes the group using a sticky note.
Share your groups with the class and explain how you decided which images belonged in the same groups.

Student Slide

Machine Learning Card Sort

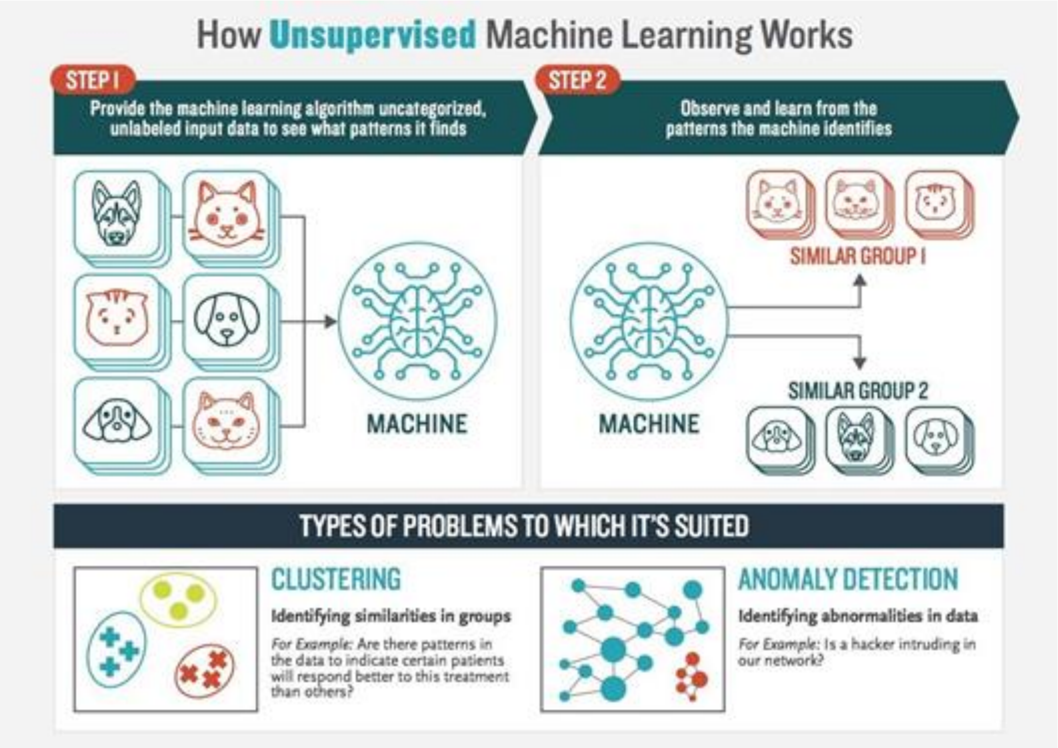
Part 1: Clustering





Machine Learning Card Sort

Part 1: Clustering



Machine Learning Card Sort

Part 2: Classification

What are the distinguishing features of each group: cats, dogs, and birds? Create a list.
Share with the class.

Using the features we've chosen decide how to classify each of the animals on the following slide.

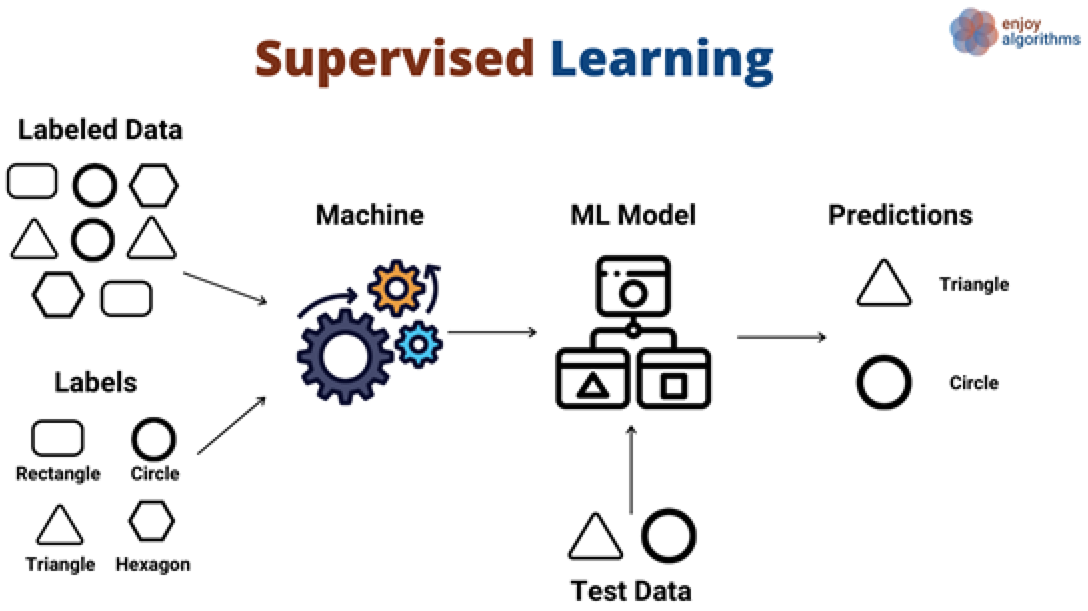
Student Slide

Machine Learning Card Sort

Using the features we've chosen classify each of these animals as a dog, cat, or bird.

Machine Learning Card Sort

Part 2: Classification



Machine Learning Card Sort

Part 3: Regression

We want to create a continuum of animal speed.
What features of animals might indicate speed? What makes an animal fast or slow? Make a list.

Slow — Fast

Machine Learning Card Sort

Part 3: Regression

Using those characteristics place these animals on the continuum.

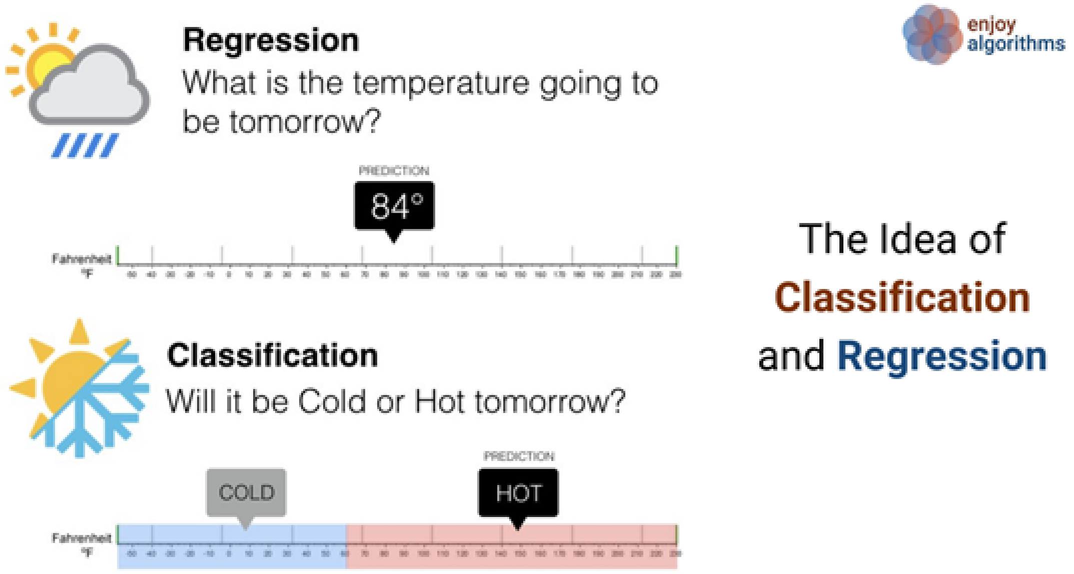
Slow

Fast

Student Slide

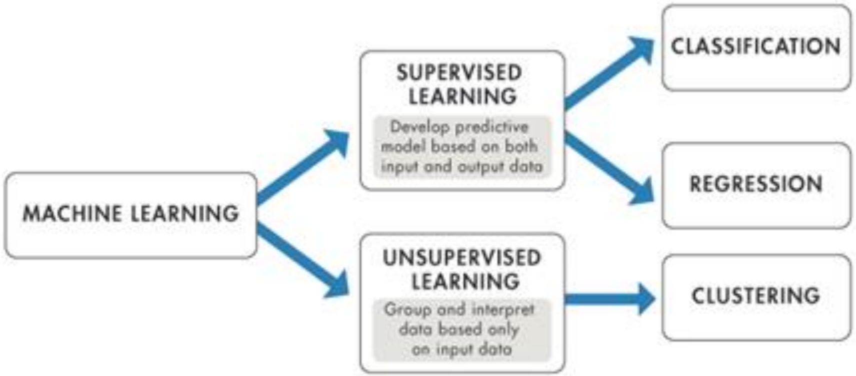
Machine Learning Card Sort

Part 3: Regression

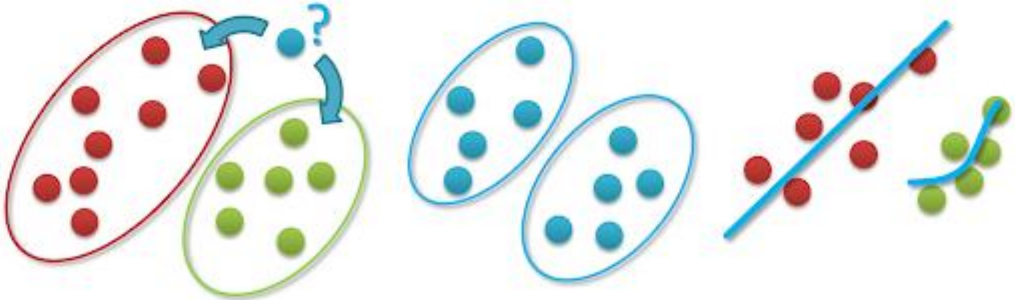


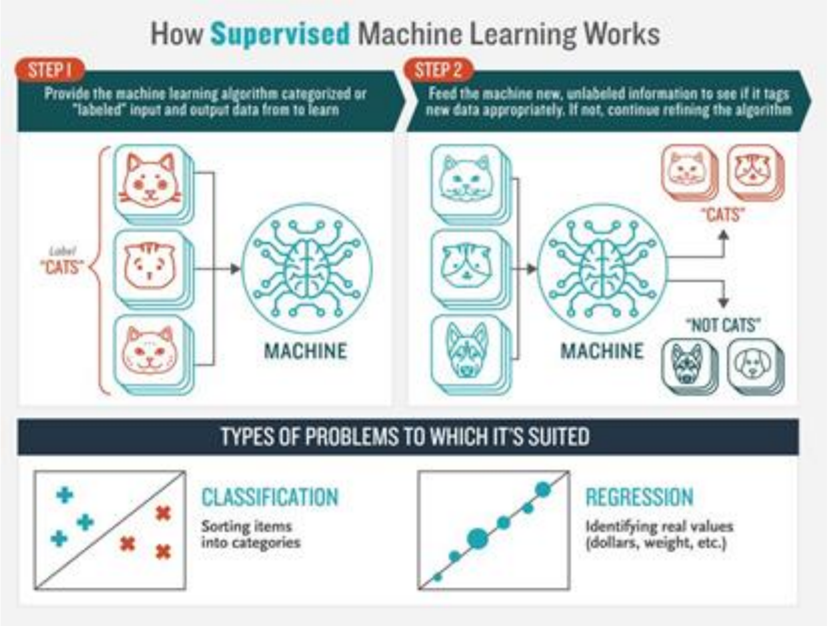
Student Slide

Machine Learning Card Sort



Classification Clustering Regression





Nevada Math & Computer Science Standards

A. Understand ratio concepts and use ratio reasoning to solve problems.
1. Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.
2. Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

- **a**. Make tables of equivalent ratios relating quantities with whole- number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios.
- **b**. Solve unit rate problems including those involving unit pricing and constant speed

C. Apply and extend previous understanding of numbers to the system of rational numbers.
5. Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g.,temperature above/below zero, elevation above/below sea level,credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts,explaining the meaning of 0 in each situation.
6. Understand a rational number as a point on the number line. Extend number line diagrams and coordinate axes familiar from previous grades to represent points on the line and in the plane with negative number coordinates.
8. Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate.

B. Summarize and Describe Distributions

4. Display numerical data in plots on a number line, including dot plots, histograms, and box plots.
5. Summarize numerical data sets in relation to their context.
   a. Reporting the number of observations.
   b. Describing the nature of the attribute under investigation including how it was measured and its units of measurement.

6-8.IC.C.1: Compare trade-offs associated with computing technologies that affect people's everyday activities and career options.
6-8.IC.C.2: Discuss and evaluate issues of bias and accessibility in the design of existing technologies.

6.RP: Ratio and Proportional Relationships

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b. Solve unit rate problems including those involving unit pricing and constant speed.

In Duckieland engineers and scientists are working together to build a self driving car, a Duckiebot. In their most recent trial run the Duckiebot drove around and they collected this data:

The Duckiebot drove 5 miles. 1 mile of its drive was through a construction site. While driving through the construction site the Duckiebot hit 6 traffic cones and did not hit 24 traffic cones. The Duckiebot encountered 4 stop signs. It stopped at 3 of those signs and failed to stop at 1 of them. The Duckiebot went through 2 intersections. The Duckiebot left its lane 10 times. It took the Duckiebot 30 minutes to complete the drive.

Describing Ratios

- What is the ratio of miles driven to stop signs? 5 to 4
- What is the ratio of traffic cones the Duckiebot hit to traffic cones the Duckiebot did not hit? 6 to 24
- What is the ratio of minutes spent driving to intersections? 30 to 2
- What is the ratio of all stop signs to all traffic cones? 4 to 30

6.RP: Ratio and Proportional Relationships

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b. Solve unit rate problems including those involving unit pricing and constant speed.

Real World Problem

- The engineers and scientists want to predict how many stop signs the Duckiebot would fail to stop at if there were 16 stop signs and the ratio remained the same. Show your answer using a ratio table, double number line, and tape diagram to show how you found your answer.

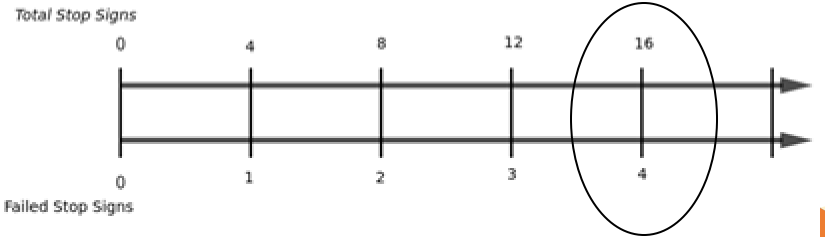
Total: 16

Total Stop Signs and Failed Stop Signs

Total Stop Signs	Failed Stop Signs
4	1
16	4

Total Stop Signs and Failed Stop Signs

Total Stop Signs	4	4	4	4
Failed Stop Signs	4	4	4	4



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Unit Rate

- What was the speed of the Duckiebot in miles per hour? 10 miles/hour.
- How long would it take the Duckiebot to drive 12 miles? 1 hour 12 minutes.

How can ratios help us predict how the Duckiebot will perform on drives that are much longer, such as 100 Miles? Based on the data we have now would you want to ride in this car for 100 miles?

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-8.IC: Impacts of Computing

6-8.IC.C.1: Compare trade-offs associated with computing technologies that affect people's everyday activities and career options.

6-8.IC.C.2: Discuss and evaluate issues of bias and accessibility in the design of existing technologies.

Autonomous Driving Questions

- Would you let this car drive you to school? Why or why not?
- If autonomous driving is perfected what jobs will change?
- Are there jobs that won't exist anymore?
- Will there be new job that don't exist now?

6.SP: Statistics and Probability

B. Summarize and Describe Distributions

4. Display numerical data in plots on a number line, including dot plots, histograms, and box plots.
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Students will be observing specific actions of the duckiebot as it drives. <u>Students will observe and record the number of time the Duckiebot leaves its lane and stays in its lane.</u> Leaving its lane will be described as crossing onto or over the yellow dotted and/or white solid lane markers. Staying in the lane will be described as staying between the lane markers. There are 19 possible tries defined by periods of driving between stops. <u>Students will also observe and record the number of 'bad' stops the Duckiebot makes.</u> A 'bad' stop will be described as stopping on or past the red line. A 'good' stop will be described as stopping behind the red line. There are 19 possible stops.

Stays In Lane	Leaves Lane
IIIII II	IIIII IIIII II
Good Stop	**Bad Stop**
IIIII IIIII IIIII III	I

Data Analysis

- How many times did the Duckiebot leave its lane?
- How many times did the Duckiebot stay in its lane?
- How was this variable measured and what is the unit of measurement?
- How many times did the Duckiebot improperly stop?
- How many times did the Duckiebot properly stop?
- How was this variable measured and what is the unit of measurement?

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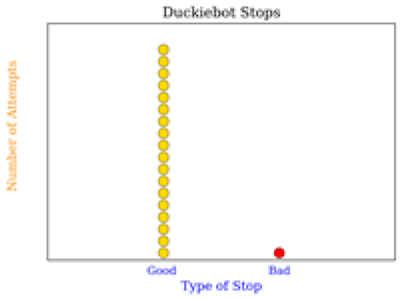
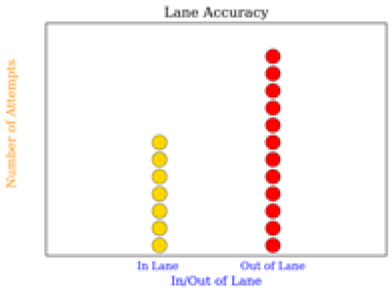
Students will determine if the data they collected can be graphed using a dot plot, histogram, and/or box plot. Students will need to determine whether their data collected is qualitative or quantitative. Students will need to determine the appropriate graphs to display their data.

Data Analysis

- Is this data qualitative or quantitative?
- Which graph(s) can be used to display this data? Why?
- Which graph(s) can NOT be used to represent this data? Why?
- Use either a dot plot, box plot, or histogram to display the data.





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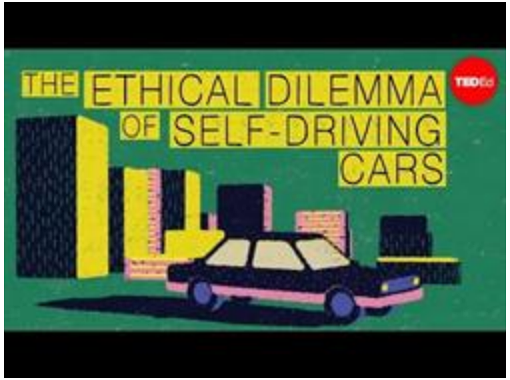
6-8.IC: Impacts of Computing

6-8.IC.C.1: Compare trade-offs associated with computing technologies that affect people's everyday activities and career options.

6-8.IC.C.2: Discuss and evaluate issues of bias and accessibility in the design of existing technologies.

Autonomous Driving Questions

- Would you let this car drive you to school? Why or why not?
- If this car drifted out of its lane and hit another car who is responsible for the accident?
- How many mistakes should a 'safe' autonomous vehicle be allowed to make?



6.NS: The Number System

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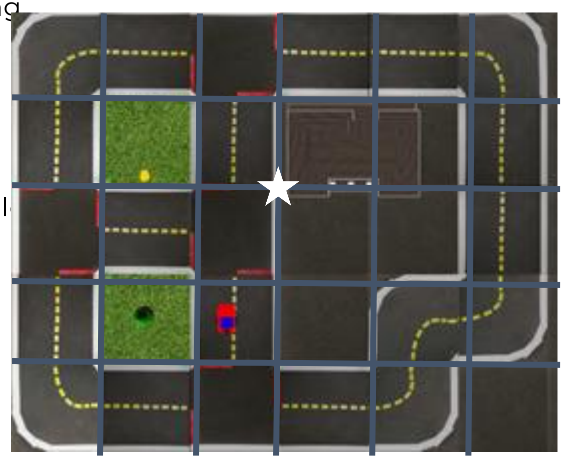
8. Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate.

Jackie has a visual impairment and is unable to drive a car. Thanks to autonomous vehicles she is now able to take a car to run errands. Jackie lives at the star on the map, which we will designate as (0,0). The grid on her neighborhood is divided into city blocks. For example moving from (0,0) to (0,1) is one block north.



Practice Questions:

- Jackie's dentist is located (0,2). How many blocks away is her dentist?
- On the opposite side of her house the same distance away as her dentist is a park. What are coordinates of the park?
- Jackie's favorite grocery store is 3 block away from the park. What are the possibl coordinates of the grocery store?
- If the grocery store is south of the park, what are the coordinates?
- How many blocks would Jackie drive to go home from grocery store?

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6-8.IC: Impacts of Computing

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Autonomous Driving Questions

- Who would have access to self driving cars?
- How could self driving cars help people?

Blind unemployment rate: 70%
US unemployment rate: 6%

Best autonomous car cost: 78,000
Average car cost: 40,000