Feedback is welcome! https://forms.gle/sitjVQAk2muwF4YU6

Algorithms as Opinions

Lesson Description

This lesson introduces students to what an algorithm is, using the making of peanut butter jelly sandwiches as an example. Students will learn that an algorithm is like a recipe and that different people tend to prefer different algorithms based on their varied interests and goals.

Link to other lessons

This lesson builds on the following lessons:

- Lesson 0.1: What is AI?

Preparation Time	Total Lesson Time
15-20 min	50 minutes

Pacing

2 min - Opening
8 min - Introduction to new material, terms, guided practice
10 min - Best PB+J Activity
10 min - Mid-workshop Mini-Lesson
10 min - Turn & Talk
10 min - Wrap-Up + Exit Ticket

Learning Objectives

Students will be able to...

- Write a simple algorithm
- Create a list of goals for an algorithm
- Create a list of stakeholders for an algorithm

Quick Links

Standards and Guidelines Addressed

CSTA 2-AP-13 (Grade 6-8):
Decompose problems and subproblems into parts to facilitate the design, implementation, and review of programs.

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Key Points

Throughout the lesson, these are the key points to emphasize...

- The term "best" (in the Best PB&J) could mean a lot of different things. "Best" is a subjective value.
- The work to design an algorithm to meet one value over another is called **optimize.**
- Computer algorithms optimize for various values and goals.

Vocabulary

We recommend making the meaning of this term very clear *during* this lesson...

Optimize *(verb)*	**To choose one value or goal over another.** We *optimize* our algorithms to make them better at achieving a particular goal or aligning with a particular value, e.g., our goal might be to *optimize* an algorithm for speed, or it might be to optimize an algorithm for a more complete (but time consuming) search. Whichever goal we *optimize* for depends on our values, e.g., do we value speed over completeness? This is an important decision students will practice making in several activities throughout this curriculum.

Teacher Resources[1]

Slides + Script
Exit Ticket Answer Key

Student Materials[1]

Teachers, feel free to choose from these ready-made activities or, if you like, adjust and remake to better align with your students' interests and learning styles.

	Worksheet for Individual Students	Worksheet for Student Groups
In person	Best PB+J In-Person Worksheet	Best PB+J In-Person Worksheet attached to chart paper + markers

[1] These materials are designed for you to tinker with, i.e., adjust, revise, and remake so as to better suit your classroom and meet your students' needs. The Student Materials section includes a few ready-made materials that you can use or treat as "seed ideas" to encourage you to make your own. ***You can find these materials in the "Student Materials" and "Teacher Resources" Sub-Folder in the same folder as this lesson plan.***

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Online	Best PB+J Online Worksheet	Best PB+J Online Worksheet create space on doc for multiple names

Assessment

Teachers, choose the exit ticket that best serves your students' needs. Two different types of Exit Tickets are included in this folder, but you should feel free to adjust these as needed.

- Exit Ticket Worksheet
- Exit Ticket Google Form

Teaching Prep.

Background Knowledge - Teachers should know that Google's search tool (using this tool is often referred to as "googling it") uses AI technology to predict which links a user will click on. These predictions help Google decide which ads to show that user (directed advertising). Thus, Google's search tool is *optimized* for Google's goal of increasing company profits.

Materials - Students need access to the "Best PB+J" activity worksheets (individual or group access), Exit Ticket (individual access). This might involve printing copies or setting individual access privileges. If you run the "Best PB+J" as an in-person group activity, you may want chart paper and markers.

Create a Student Example / Model - To save time, teachers can complete the Best PB+J Worksheet as an example to use when introducing the activity directions. For a smooth transition into guided practice, teachers might add only 2-3 steps in their algorithm, with a plan as to what the other steps in the algorithm might be. These can be written as part of guided practice with students during the lesson.

Teaching Guide

This guide is here to help teachers plan their pacing, but feel free to adjust as needed.

OPENING: **Connect to students' prior knowledge**	**2 minutes** Ask students if they remember what the three basic components of most types of AI are and if they can give an example of an AI system.
INTRODUCTION TO	**5 minutes**

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NEW MATERIAL: Introduce students to examples of an algorithm	Tell students that an algorithm is essentially a set of steps needed to change an input into certain output and that it is similar to a recipe for making a cake.
GUIDED PRACTICE: Best PB+J Student worksheet	**3 minutes** Model how to complete the activity by first writing a few directions in the Best PB+J worksheet, then asking students to help you write the next few steps.
INDEPENDENT PRACTICE: Best PB+J Activity	**10 minutes** Challenge students to create their own recipes for the best peanut butter and jelly (PB&J) sandwich
MID-WORKSHOP INTERRUPTION: **1. Share**	**5 minutes** Instruct students to share their algorithms with... a. a partner, b. a small group, or c. the class as a whole During the share, remind students to explain why they think their recipe is the *best*.
2. Mini-Lesson on "best" and "optimize"	**5 minutes** Next, guide students to recognize that... a. "best" can mean very different things for different people (tastiest, healthiest, cheapest), and b. one recipe/algorithm can be optimized for only one goal.
TURN & TALK: **1. Brainstorm 1**	**5 minutes** Ask students to brainstorm 5 goals that their PB&J sandwich algorithms could be optimized for, and share with the class. Students can do this independently, then Turn & Talk to share with a partner or a small group.

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2. **Brainstorm 2**	**5 minutes** Ask students to brainstorm 5 stakeholders who care about their PB&J algorithms and why they care, and share with the class. Students can do this independently, then Turn & Talk to share with a partner or a small group.
CLOSING: 1. **Review & Discuss**	**5 minutes** Review the Best PB+J activity as a whole class. Ask students to share the most important goal from their list of 5. Ask students which of their 5 stakeholders share this goal. Explicitly notice that not all stakeholders share the same goals.
2. **Exit Ticket**	**5 minutes**

Options for Differentiation[2]

- Assign partners or small heterogeneous ability groups of 3-4 for "Best PB+J" activity and brainstorming sessions.
- Adjust "Best PB+J" activity directions to say students should create an algorithm of 3-4 steps (making this a shorter version).
- Remind students that, if they finish early, they can continue to work on their "Explore AI Journal", which students can work on as an ongoing project.

Student Grouping

The activity "Best PB+J" is designed for individual student work.
However, this activity can also be completed by student pairs or small groups.

In-Person Teaching Strategies

- Chalk Talk - Students can collaboratively write a Best PB+J recipe / algorithm (or a recipe / algorithm for another kind of food, see Teaching Tips, Culturally relevant teaching). Teachers might attach the Best PB+J worksheet to a piece of chart paper, give each student a pencil / marker and instruct them to work together to write a recipe.

- Collaborative Task Roles - To facilitate collaborative group work, teachers might assign task roles to each student:

[2] These strategies are suggested methods for differentiating instruction and activities, they should not supersede student IEPs or modifications or accommodations provided by your students' Special Education teacher.

    - Recorder - listens to group members' ideas and writes recipe on chart paper
    - Facilitator - makes sure everyone in the group has made an equal number of contributions to the recipe
    - Questioner - asks how, what, why questions to encourage detail in each step
    - Actor - acts out each step to make sure it makes sense and the description is not missing anything (i.e., open the jar).

- Gallery Walk - When students or groups are finished writing their recipe / algorithms, have everyone stand-up, post their work somewhere in the room (add their name), and then walk around the classroom to look at others' work. Teachers can encourage students to interact with each others' work by...
    - giving students post-its to write compliments on others' work
    - giving everyone stickers to add to others' work to show they like it
    - establishing a color code for feedback with stickers or markers, e.g., red = silly, green = creative, orange = I've gotta eat this!!, etc.

Teaching Tips[3]

Pacing and focus...

★ Take time to make sure students see that there are many different ways to write an algorithm to make a PB+J sandwich. Teachers might do this by examining several different samples of student work with the whole class.

★ This is not a lesson on how to write code. Teachers do not need to give students feedback on how they wrote their algorithm. Focus instead on the diversity across student algorithms.

Culturally relevant teaching

★ Feel free to use a recipe that is more meaningful to your students than PB+J. In these early lessons it is important that students start to see themselves as designers and creators of AI systems. Having culturally relevant recipes as a model for an AI algorithm may be a way to work towards this goal.

Preserve student work

★ This lesson feeds directly into the subsequent lesson, Unit 0-3: Ethical Matrix. Students will need to reference the lists of stakeholders and values from the brainstorming activities that take place at the end of this lesson. We recommend saving, storing, and photographing student work from today's lesson for students to reference when they start

[3] Teaching tips are based on a) observations and feedback from debrief meetings with teachers who taught this material during an online summer camp in 2021, and b) feedback from a small group of expert teachers, who reviewed a sample of the materials and resources.

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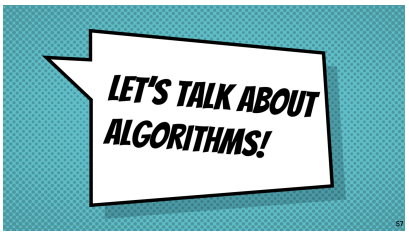
the next lesson.

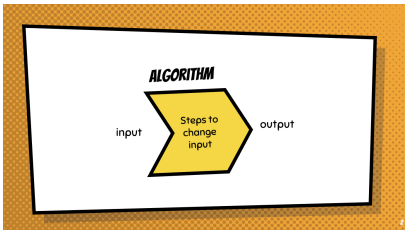
Teaching Script

This script is here to help teachers plan their presentation of the content, but feel free to adjust as needed to preserve your voice, pedagogy, and style of teaching.

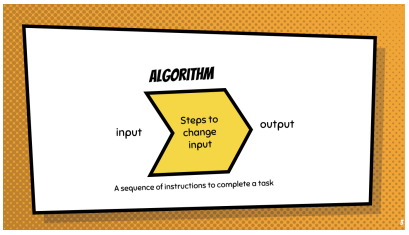


Connection: In the last activities, we talked a lot about the datasets and predictions. Now let's talk more about Algorithms. Can anyone remind me what we learned about algorithms in general?

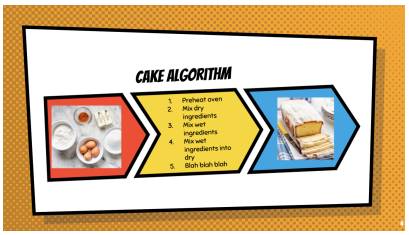
[wait for students to say input/data, specific steps to change that data, and an output]



That's correct. An algorithm needs some input data and follows specific steps or instructions to give us a desired output. To be clear, an algorithm is the"steps to change the input" (not the input or the output).



You can also think of an algorithm as a sequence of instructions to complete a task. Computers use algorithms, but so do humans. Algorithms are a lot like a recipe.



For example, if I were baking a cake, my algorithm would take in the following ingredients, like flour, sugar, salt, eggs, etc.

I would mix together my dry ingredients and then mix in the wet ingredients like eggs or milk.

I would pour into a cake pan, set the oven to 350, and put the cake pan in the oven.

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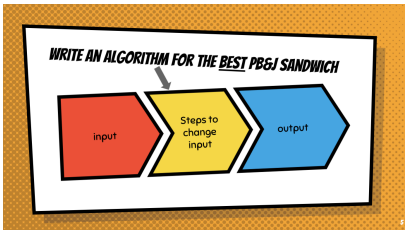
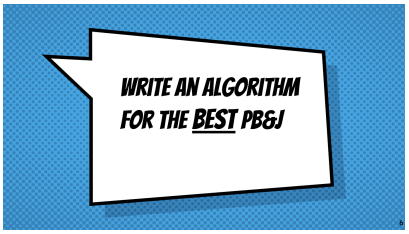
My output would be a cake!

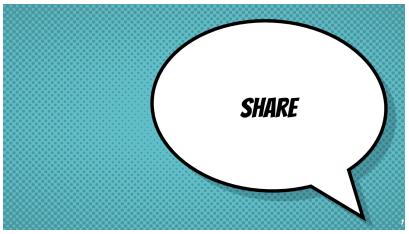


Okay, now I want you to write your own algorithms. Now let's do an activity called "Best PB&J".



I want you to take the next 10 minutes write an "algorithm" (or recipe) for a peanut butter and jelly sandwich. Be sure to specify what your inputs are.

[let time elapse for students to work]



Okay, now I am going to have you talk with your partner / small group. I want you to talk about what your algorithms have in common and how they are different.

[give students a few minutes to chat]

Who can share with the class what their algorithms had in common?

What was different?

If you have to give your algorithm a title "How to make the _____ PBJ," what adjective would you use? You can't use "best."

[most students will say yummiest/tastiest]

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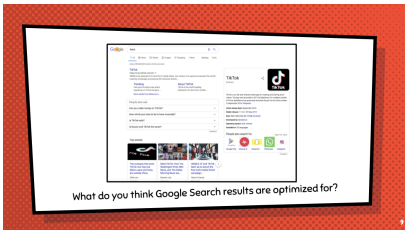
The best PBJ could mean a lot of different things. It could be the tastiest or the healthiest.

Possible questions:

1. Did any of you include instructions to put away your ingredients after you used them?
    a. Then you were optimizing for tidiness in your algorithm!
2. Did any of you cut your sandwich into fun shapes? Cut off the crust?
    a. Then you were optimizing for playfulness or aesthetics!

There's an important word that we can use to describe what best means ... when we optimize we choose one value over another to aim for.

In the sandwich on the left, we optimize for portion size or gooiest Whereas the sandwich in the middle, we optimize for health, and on the right, what do you think we are optimizing for?



Computer algorithms also optimize for various goals, but sometimes this can be hard to spot. What do you think the goal of Google's search algorithm is optimizing for?

[Students might say "best" results. If so, ask them what word they would replace with best like they did earlier. Students might also say "best results for me," so you can prompt students to ask what they mean by that, or how Google might confirm that they've shown "the best results for me." We're looking for answers like: to get us to click on links, to get us to click on advertisers links - things that

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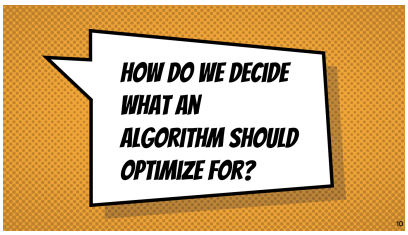
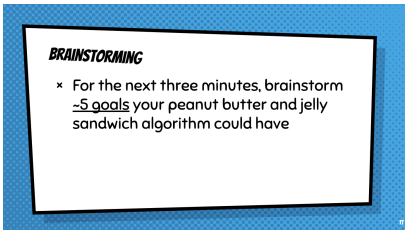
show students understand the search results benefit Google first]



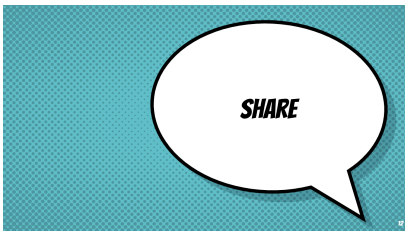
Connection: We've shown that algorithms can have different goals. What were the goals of your PB&J algorithm?

[pause for students to respond with answers like "tastiest," "healthiest," etc]

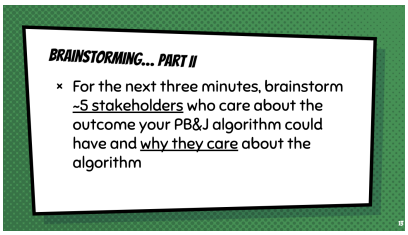


I want you to take 5 minutes to brainstorm some goals for your PB+J algorithm and write them in the chat. Try and identify at least five.

[Give students time to brainstorm. Answers could be quick, tasty, pretty/aesthetic, healthy/nutritious, cost-effective/cheap, easy to make]



Sharing out: Prompt students to share their goals with their partner, group, or with the whole class (2 minutes)



Explicit Instruction: Now, we are going to learn how we should decide what the goal of an algorithm should be.

Now, I want you to brainstorm 5 different people who might care about your PB&J algorithm. Who cares about what you eat? Who cares about what you pack for lunch at school? (3 minutes)

These people who care about your algorithms are called stakeholders.

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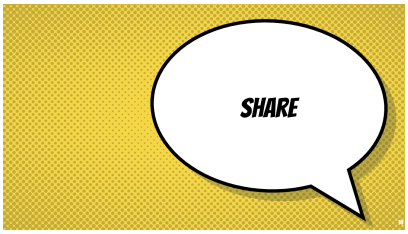
[To push students to think of more indirect stakeholders, ask them to think about their food supply. Where do you get your food? Who makes money off of what food you buy? Do you think your grocer cares about your algorithm? (Yes - the kind of peanut butter, bread, etc, are data inputs in the algorithm.) More indirect stakeholders may include: grocers, farmers, truckers, the companies who produce the peanut butter, jelly, etc]



Sharing out: Which stakeholders did you come up with? Why do they care? [Call on students who put a specific stakeholder to say what their stakeholder might want as a goal.] (2 minutes)

Closing: Review the Best PB+J activity as a whole class. Ask students to share the most important goal from their list of 5. Ask students which of their 5 stakeholders share this goal. Explicitly notice that not all stakeholders share the same goals.

Exit Ticket: Can be assigned at the end of class or as homework.

Activity Usage

Feedback is welcome! https://forms.gle/sitjVQAk2muwF4YU6

Attribution:

The original activity “Algorithms as Opinions” was created as part of the “Data Privacy Curriculum” by Stephanie Nguyen and Daniella DiPaola from the MIT Media Lab Personal Robots Group, directed by Cynthia Breazeal.