Algorithms and Algorithmic Thinking

What Is An Algorithm?

An algorithm is a description of a process of doing something, for completing some task, for calculating a result. If you think that algorithms are a newer invention, you couldn't be further from the truth! In fact, the concept of algorithms has been around since 2500 BCE! Algorithms are also found in our everyday lives. Here are some examples:

- A recipe for a cake

- The steps in completing long division

- Directions for driving from one place to another

- The steps in an experiment in chemistry

- Directions for a home COVID test

- Directions for writing a college essay

So yeah, chances are you've probably used algorithms before. As previously said, an algorithm is a description of **any** process, so you could probably make an algorithm for any task you do during your day.

What exactly is an algorithm? Algorithms
explained-
external link-YouTube

Learning Objectives

At the end of this module, you will be able to:

1. Define algorithms

2. Create your own algorithms

3. Describe the three forms a step of an algorithm can have

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You could probably make an **algorithm** for any task you do during your day.

The Parts of An Algorithm

Algorithms are essentially step by step directions, but they need a few characteristics in order to be considered an algorithm. Typically, an algorithm includes:

- Data used by the algorithm
    - The data that will be manipulated (the input)
    - The data that will be the result (the output)

- A description of the algorithm's steps

What is Algorithm?
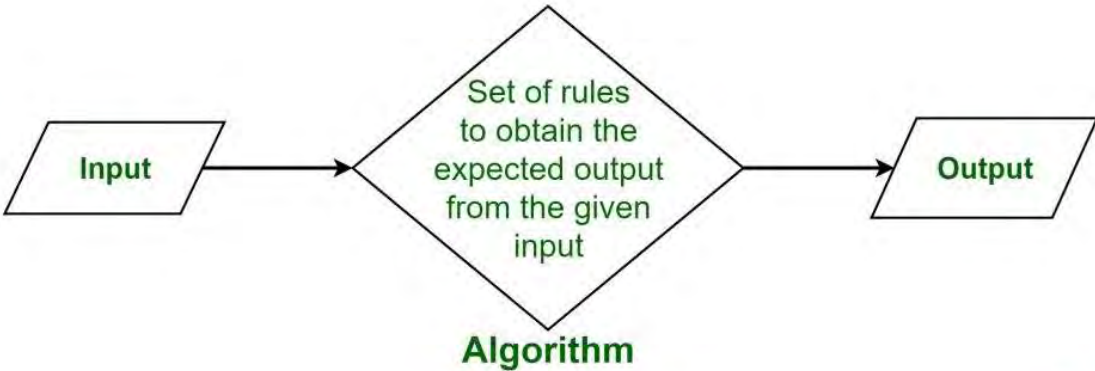
A Cake Recipe

A cake recipe is a perfect example of an algorithm. Like we mentioned above, an algorithm needs an input, output and a description of the steps, which sounds just like a recipe!

Inputs

In a recipe our inputs are the ingredients we're going to use.

- 2 sticks of unsalted butter, at room temperature, plus more for the pans

- 3 cups of all-purpose flour, plus more for the pans

- 1 tablespoon baking powder

- 1/2 teaspoon salt

- 1 1/4 cups sugar

- 4 large eggs, at room temperature

- 1 tablespoon vanilla extract

1 1/4 cups whole milk (or 3/4 cup heavy cream mixed with 1/2 cup water)

Directions

1. Preheat the over to 350 degrees F. Butter two 9-inch-round cake pans and line the bottoms with parchment paper; butter the parchment and dust the pans with flour, tapping out the extra.

2. Whisk 3 cups flour, the baking powder and salt in a bowl until combined. Beat 2 sticks of butter and the sugar in a large bowl with a mixer on medium-high until light and fluffy, about 3 minutes. Reduce the mixer speed to medium; beat in the eggs, one at a time, scraping down the bowl as needed. Beat in the vanilla. (The mixture may look separated at this point.) Beat in the flour mixture in 3 batches, alternating with the milk, beginning and ending with flour, until just smooth.

3. Divide the batter between the prepared pans. Bake until the cakes are lightly golden on top and a toothpick inserted to the middle comes out clean, 30 to 35 minutes. Transfer to racks and let cool 10 minutes, then run a knife around the edge of the pans and turn the cakes out onto the racks to cool completely. Remove the

parchment. Trim the tops of the cakes with a long serrated knife to make them level, if desired.

Output

Now that the process is completed, we get the output, which, in this case, is a nice cake!

Summary

We started with our ingredients (inputs) and then followed the directions (steps of the algorithm) and ended up with a nice cake (output)!

Long Division

Long division is another perfect example of an algorithm! Here's why:

- **Inputs**
  - Dividend
  - Divisor

- **Steps**
  - Step 1: Take the first digit of the dividend from the left. Check if this digit is greater than or equal to the divisor.

- Step 2: Then divide it by the divisor and write the answer on top as the quotient.

- Step 3: Subtract the result from the digit and write the difference below.

- Step 4: Bring down the next digit of the dividend (if present).

- Step 5: Repeat the same process.

- **Outputs**

  - Quotient and remainder

As you can see long division has all the necessary pieces to be considered an algorithm.

Algorithm For Writing An Essay

- **Input**

  - Your ideas!

- **Steps**

  - Step 1: Pick a topic

  - Step 2: Prepare an outline or diagram of your ideas.

  - Step 3: Write your thesis statement.

  - Step 4: Write the body.

  - Step 5: Write the introduction.

  - Step 6: Write the conclusion.

  - Step 7: Add the finishing touches.

- **Outputs**

  - Finished essay

Description of Steps

If you look closely, you can see that in all of these examples there is an order to the steps laid out by the algorithm. That is, there is a first step, second step, etc. The steps of an algorithm can actually have 3 forms:

1 **Sequence:** complete the steps in order starting with step #1.

2 **Selection:** there can be a choice based on some criteria

3 **Repetition:** repeat a set of steps a specific number of times or until a criterion is reached

Selection

Algorithms can include something called selections. Selections are essentially choices based on some sort of defined criterion. For example, the last step in the cake said that we could "trim the tops of the cakes with a long serrated knife to make them level, if desired."

Essentially we had a choice to trim the tops or not, and the criterion in this case is our "desire" to do so.

Repetition (or Loops)

Looping or repetition is when steps are repeated in an algorithm. A classic example of this is soap directions telling you to "rinse, lather, repeat." Essentially the steps have a built in mechanism that will

cause the process to repeat. A specific dance is another example. You have a specific set of steps, but you can continue to repeat the same dance over and over again.

Knowledge Check

An optional quiz for the Algorithms Module

Which choice best defines the word "algorithm"

○   A type of math formula

○   A description of the process of doing something

○   The way computers talk to each other

Select the three forms that algorithm steps can come in

☐ Sequence

☐ Division

☐ Selection

☐ Repetition

Match the correct definition with the correct word

Selection

A choice based off of a set of criteria.

Repetition

Steps that have a built in mechanism that will cause the process to repeat.