

# Algorithmic Thinking

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## Key Points

- 1) There are five essential properties for algorithms.
- 2) The five basic steps of development are a general approach for solving problems using a computer.

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## Algorithm

An **algorithm** is a precise, systematic method for producing a specified result.

We use algorithms all the time to complete tasks.

A common example is following assembly directions (as with IKEA assembly) or using a **recipe**. Simpler examples include how to perform arithmetic or look up a person's name in a list.

Some algorithms are so simple or ingrained that we do not consciously remember the steps. However, precision is required when communicating the algorithm to others.

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## Five Essential Properties of Algorithms

- 1) **Inputs specified** – must specify the **type**, **amount**, and **form** of **data** to be used during the algorithm
- 2) **Outputs specified** – must describe the result of the algorithm (it is possible to have no output).
- 3) **Precision** – specify precisely the **sequence of steps** to be performed including how to handle errors.
- 4) **Reasonable Operations** - The operations are doable.
- 5) **Finite** – The algorithm must eventually stop (terminate).

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## Five Essential Properties of Algorithms

**Question:** The algorithm on the shampoo bottle says: "Apply shampoo. Lather. Rinse. **Repeat**." Which one of the five essential properties does this algorithm not meet?

- A) inputs specified
- B) outputs specified
- C) precision
- D) reasonable operations
- E) finiteness

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## Group Discussions

Provide an algorithm for brushing your teeth.

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## Specifying Algorithms using Language

An algorithm must be written using a **language understood** by both the **writer** of the algorithm and the **reader** who will use it.

For computer algorithms, the writer is a human programmer, and the reader is the computer. Natural languages like English are easy for humans, but are ambiguous and often require domain knowledge and context. Instead, we **use precise programming languages** (e.g. HTML/JavaScript).

A common barrier for students with programming is that the language is unfamiliar and that the computer requires precision. Remember, **have patience!**

- ◆ Learning a computer language is similar to learning a foreign language like Spanish.

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## ★ The 5 Basic Steps of Software Development

### 1) Specification

- ◆ Determine the scope of your problem and **what** you want your program to do.

### 2) Design

- ◆ Determine the structures and algorithms necessary (**how**) to solve your problem at a high-level of abstraction.

### 3) Implementation

- ◆ Start implementing your algorithms/structures on the computer.

### 4) Testing, Execution, and Debugging

- ◆ Test your program on various data sets and fix any problems.

### 5) Maintenance

- ◆ Over time, modify your program as necessary to handle new data or more complicated problems.

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## Software Development Steps

**Question:** Which of the 5 steps is most often the cause of projects being unsuccessful?

- A) Specification
- B) Design
- C) Implementation
- D) Testing
- E) Maintenance

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## Programming - Art or Science?

There is a debate whether programming is an art or a science.

- ◆ It is similar to a **science** because **algorithms** and data structures can **be analyzed for performance** and chosen with respect to their relevance to a particular problem.

- ◆ It is like an **art** or craft because **skills of programmers vary** widely, even with similar training, and the **"best" solution to the problem is often open to debate**.

In computer science, we teach you the "science" component.

- ◆ We want you to understand the **choices you make** and the reasons for them.

- ◆ However, students will all have different **natural abilities and talents** with respect to programming.

⇒ If it is easy or natural for you, great! If not, then fall back on the science and the techniques we teach to help you. And **PRACTICE** as much as you can.

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## Programming: Art or Science?

**Question:** What do YOU think programming is most like?

- A) Art (creativity)
- B) Science (experimentation)
- C) Engineering (construction)
- D) All of the above
- E) Other or none of the above

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## Programming: Experience

**Question:** What is your programming experience?

- A) I have never programmed before.
- B) I have wrote instructions, recipes, manuals, or other precise information before (maybe not electronic).
- C) I have wrote HTML or created web sites before this class.
- D) I have experimented on my own with programming.
- E) I have taken a programming class in high school or university.

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## Conclusion

An **algorithm** is a precise sequence of steps to produce a result that is encoded in a language to produce a **program**.

The five essential properties of an algorithm are:

- ◆ Inputs specified
- ◆ Output specified
- ◆ Precision
- ◆ Reasonable operations
- ◆ Finite

Following the five basic steps for developing solutions to problems on a computer will make you more successful and efficient while programming.

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## Objectives

- ◆ Define: algorithm, program
- ◆ List and explain the five essential properties of an algorithm.
- ◆ Explain why special programming languages are used to communicate algorithms to the computer instead of English.
- ◆ List and explain the five basic steps of software development.

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