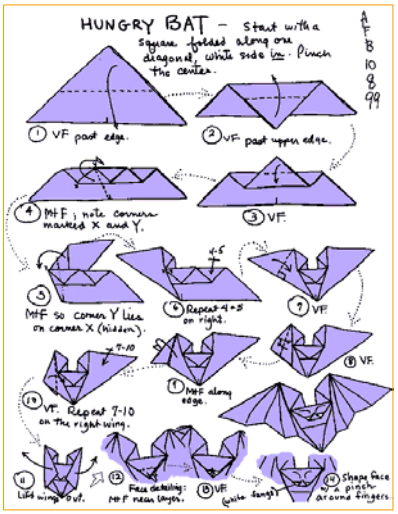
Algorithms, Part 1 of 3

Topics

- Definition of an Algorithm
- Algorithm Examples
- Syntax versus Semantics



Problem Solving

- Problem solving is the process of transforming the description of a problem into the solution of that problem.
- We use our knowledge of the **problem domain**.
- We rely on our ability to select and use appropriate problem-solving strategies, techniques, and tools.

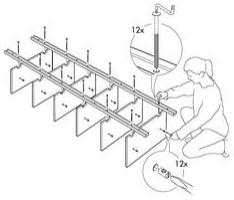
Algorithms

- An **algorithm** is a step by step solution to a problem.
- Why bother writing an algorithm?

  - For your own use in the future. You won't have to rethink the problem.
  - So others can use it, even if they know very little about the principles behind how the solution was derived.

Examples of Algorithms

- Washing machine instructions
- Instructions for a ready-to-assemble piece of furniture
- A classic: finding the greatest common divisor (GCD) using Euclid's Algorithm



Washing Machine Instructions

- Separate clothes into white clothes and colored clothes.
- Add 1 cup of powdered laundry detergent to tub.
- For white clothes:
  - Set water temperature knob to HOT.
  - Place white laundry in tub.
- For colored clothes:
  - Set water temperature knob to COLD.
  - Place colored laundry in tub.
- Close lid and press the start button.

Observations About the Washing Machine Instructions

- There are a finite number of steps.
- We are capable of doing each of the instructions.
- When we have followed all of the steps, the washing machine will wash the clothes and then will stop.

Refinement of Algorithm Definition

- Our old definition:
  - An algorithm is a step by step solution to a problem.
- Adding our observations:
  - An algorithm is a finite set of executable instructions that directs a terminating activity.

Instructions for a Ready-to-Assemble Piece of Furniture

- "Align the marks on side A with the grooves on Part F."
- How could these instructions be hard to follow?
  - Which side is A? A & B look alike -- both line up with Part F! This instruction is ambiguous.

Final Version of the Algorithm Definition

- Our old definition:
  - An algorithm is a finite set of executable instructions that directs a terminating activitv.

- Final version:

An algorithm is a finite set of unambiguous, executable instructions that directs a terminating activity.

History of Algorithms

- The study of algorithms began as a subject in mathematics.
- The search for algorithms was a significant activity of early mathematicians.
- Goal: To find a single set of instructions that can be used to solve any problem of a particular type (a **general solution**).

Euclid's Algorithm

Problem: Find the largest positive integer that divides evenly into two given positive integers (i.e., the **greatest common divisor**).

Algorithm:

1. Assign M and N the values of the larger and smaller of the two positive integers, respectively.
2. Divide M by N and call the remainder R.
3. If R is not 0, then assign M the value of N, assign N the value of R, and return to Step 2. Otherwise, the greatest common divisor is the value currently assigned to N.

Finding the GCD of 24 and 9

M	N	R
24	9	6
9	6	3
6	3	0

So, 3 is the GCD of 24 and 9.

Euclid's Algorithm (con't)

Do we need to know the theory that Euclid used to come up with this algorithm in order to use it?

What intelligence is required to find the GCD using this algorithm?

The Idea Behind Algorithms

- Once an algorithm behind a task has been discovered
  - We don't need to understand the principles.
  - The task is reduced to following the instructions.
  - The intelligence is "encoded into the algorithm."

Algorithm Representation

- Syntax and Semantics
  - **Syntax** refers to the representation itself.
  - **Semantics** refers to the concept represented (i.e., the logic).

Contrasting Syntax and Semantics

- In the English language, we have both syntax and semantics.
- **Syntax** is the **grammar** of the language.
- **Semantics** is the **meaning**.
- Given the following sentence,

  I walked to the corner grocery store.

  - Is this sentence syntactically correct?
  - Is it semantically correct?

Contrasting Syntax and Semantics

- Given the following sentence,

  I talked to the funny grocery store.

  - Is this sentence syntactically correct?
  - Is it semantically correct?
- How about

  I grocery store walked corner the to.

Contrasting Syntax and Semantics

- Conclusion: An English sentence may be syntactically correct, yet semantically incorrect.
- This is also true of algorithms.
- And it is also true of computer code.