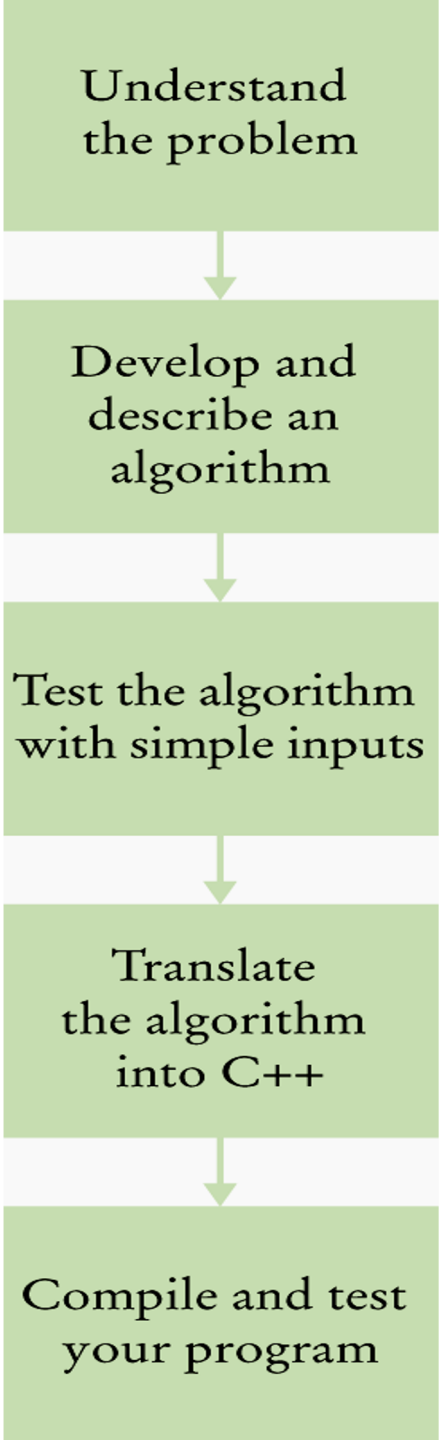
Topic 7

1. What is programming?
2. Anatomy of a computer
3. Machine code and programming
4. Becoming familiar with your programming environment
5. Analyzing your first program
6. Errors
7. Problem solving: algorithm design
8. Chapter Summary

Algorithms

- Every program is based on an algorithm, or more than one algorithm
- An algorithm is like a recipe for cooking
  - It tells the ingredients (inputs)
  - It tells the sequential steps for processing the inputs
  - It tells the serving size and style (outputs)
- The computer acts like a chef, exactly following the algorithm recipe

The Software Development Process



For each problem
the programmer goes
through these steps

You MUST write an algorithm in words, pictures, and/or equations before attempting to translate to C++

Describing an Algorithm with Pseudocode

Pseudocode

- An informal description
- Not in a language that a computer can understand, but easily translated into a high-level language (like C++).

Three Important Properties of an Algorithm

The **algorithm** described in pseudocode must be

- Unambiguous
  - There are precise instructions for what to do at each step
  - and where to go next.
- Executable
  - Each step can be carried out in practice.
- Terminating
  - It will eventually come to an end.

Example of Pseudocode

Consider this problem:

- You have the choice of buying two cars.
- One is more fuel efficient than the other, but also more expensive.
- You know the price and fuel efficiency (in miles per gallon, mpg) of both
- You plan to keep the car for ten years.
- Assume average price of gas is $4 per gallon and usage of 15,000 miles per year.
- You will pay cash for the car (no financing costs)

Which car is the better deal?

Examples of Two Cars

Cars	Purchase Price	Fuel Efficiency (in mpg)
1	25000	50
2	20000	30

- Drive 15000 miles each year in ten years. Average $4 per gallon.
  - Car 1 uses 15000 / 50 = 300 gallons annually. Annual gas price is 300 * 4 = 1200. Gas price in 10 years is 1200 * 10 = 12000.
    - Total price of A is 25000 + 12000 = 37000.
  - Car 2 uses 15000 / 30 = 500 gallons annually. Annual gas price is 500 * 4 = 2000. Gas price in 10 years is 2000 * 10 = 20000.
    - Total price of B is 20000 + 20000 = 40000.

Algorithm Pseudocode, Step 1: Determine I/O

Step 1 Determine the inputs and outputs.

In our sample problem, we have these inputs:

- *purchase price1* and *fuel efficiency1*
  the price and fuel efficiency (in mpg) of the first car
- *purchase price2* and *fuel efficiency2*
  the price and fuel efficiency of the second car

We simply want to know which car is the better buy. That is the desired output.

Algorithm Pseudocode, Step 2: Decompose

Step 2 Break down the problem into smaller tasks.

What will we do for ***each*** car?

1. The total cost for a car is
   purchase price + operating cost
2. We assume a constant usage and gas price for ten years, so the operating cost depends on the cost of driving the car for one year.
   The operating cost is
   10 x annual fuel cost
3. The annual fuel cost is
   price per gallon x annual fuel consumed
4. The annual fuel consumed is
   annual miles driven / fuel efficiency

Algorithm Pseudocode, Step 3

Step 3 Describe each subtask in pseudocode.

You will need to arrange the steps so that any intermediate values are computed before they are needed in other computations.

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For each car, compute the total cost as follows:

    annual fuel consumed = annual miles driven / fuel efficiency
    annual fuel cost = price per gallon x annual fuel consumed
    operating cost = 10 x annual fuel cost
    total cost = purchase price + operating cost

If total cost1 < total cost2
    Choose car1
Else
    Choose car2
```

Algorithm Pseudocode, Step 4: Testing

Step 4 Test your pseudocode by working a problem.

Use these sample values:

- Car 1: $25,000, 50 miles/gallon
- Car 2: $20,000, 30 miles/gallon

Cars	Purchase Price	Fuel Efficiency (in mpg)
1	25000	50
2	20000	30

FIRST CAR:

annual fuel consumed = 1500 / 50 = 300
annual fuel cost = 4 x 300 = 1200
operating cost = 10 x 1200 = 12000
total cost = 25000 + 12000 = 37000

SECOND CAR:

(let's assume you can do the math) **total cost = 40000**

If total cost1 < total cost2 …

The algorithm says: **choose the FIRST CAR**