The Beauty and Joy of Computing

Lecture #6
Algorithms I

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University students ‘made to wear anti-cheating helmets’

Students in Thailand appear to have been forced to wear helmets to prevent them from cheating during exams.

In an effort to curb rampant cheating, Bangkok's Kasetsart University created an anti-deceit paper helmet for students to wear during their midterm exams. Photo: Facebook

What is an algorithm?

- An **algorithm** is any well-defined computational procedure that takes some value or set of values as input and produces some value or set of values as output.
- The concept of algorithms, however, is far older than computers.

Algorithms You've Seen in CS10

- Length of word
- Whether a word appears in a list
- Interact with the user (ask)
- Word Comparisons (You wrote one for HW1!)
- Sort a List (see lab!)
- Make this a block!

Algorithms You Might Have Heard Of

Luhn algorithm
Credit card number validation

Deflate
Lossless data compression

PageRank
Google's way of measuring "reputation" of web pages

EdgeRank
Facebook's method for determining what is highest up on your news feed

Important Terms

Sequencing
Application of each step of an algorithm in order (sometimes: find order)

Selection
Use of Boolean condition to select execution parst

Iteration
Repetition of part of an algorithm until a condition is met

Recursion
Repeated application of the same part of algorithm on smaller problems

Properties of Algorithms

- Algorithm + Algorithm = Algorithm
- Part of Algorithm = Algorithm
- Algorithms can be efficient or inefficient given a comparison algorithm
- Several algorithms may solve the same problem

Algorithm Correctness

We don't only want algorithms to be fast and efficient; we also want them to be ***correct!***

TOTAL Correctness
Always reports, and the answer is always correct.

PARTIAL Correctness
Sometimes reports, and the answer is always correct *when it reports*.

We also have *probabilistic* algorithms that have a certain *probability* of returning the right answer.

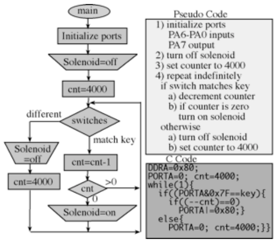
How to Express Algorithms…

A programmer's spouse tells him: "Run to the store and pick up a loaf of bread. If they have eggs, get a dozen." The programmer comes home with 12 loaves of bread.

Algorithms need to be expressed in a context-free, unambiguous way for all participants

Ways to Express Algorithms

- Natural Language
- Pseudo Code
- Programming Language



Pseudo Code

```
1) initialize ports
   PA6-PA0 inputs
   PA7 output
2) turn off solenoid
3) set counter to 4000
4) repeat indefinitely
  if switch matches key
    a) decrement counter
    b) if counter is zero
       turn on solenoid
  otherwise
    a) turn off solenoid
    b) set counter to 4000
```

C Code

```
DDRA=0x80;
PORTA=0; cnt=4000;
while(1){
  if((PORTA&0x7F==key){
    if((--cnt)==0)
      PORTA|=0x80;}
  else{
    PORTA=0; cnt=4000;}}
```

- …or in any other

information conveying way!

Programming Languages

C/C++
Good for programming that is close to hardware

Java/C#
Portable code

Python/Perl/TclTK
Fast to write and portable

BASIC/BYOB/SNAP
Good for teaching programming concepts

All programming languages can be used to implement (almost) any algorithm!

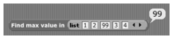
Choosing a Technique

- Most problems can be solved in more than one way, i.e., multiple algorithms exist to describe how to find the solution.
- The right language makes formulating algorithms easier and clearer
- Not all of these algorithms are created equal. Very often we have to make some trade-offs when we select a particular one.
- There are unsolvable problems!

Algorithms vs. Functions & Procedures

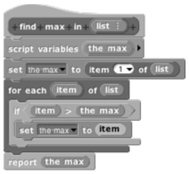
- Algorithms are conceptual definitions of how to accomplish a task and are language agnostic, usually written in pseudo-code.
- Find max value in list
  - Set (a temporary variable) the max as the first element
  - Go through every element, compare to max, and if it's bigger, replace the max
  - Return the max

- A function or procedure is an implementation of an algorithm, in a particular language.



```
Find max value in list 1 2 99 3 4
99
```

- Find max value in list



```
find max in list
script variables the max
set the max to item 1 of list
for each item of list
  if item > the max
    set the max to item
report the max
```