Algorithmic Thinking and Programming

CSE 100

Many concepts connected with computing are valuable not only when dealing with computers but in everyday situations as well. Algorithmic thinking is one such concept

CSE 100 Algorithm

- An algorithm is a procedural or systematic method for solving a problem
- An algorithm has five basic properties [Knuth] ...
  - Finiteness -- the process completes after a finite number of steps
  - Definiteness -- each step must be precisely defined
  - Input -- the data the algorithm processes
  - Output -- the result, or indication that the result is not found
  - Effectiveness -- the steps must be sufficiently primitive that they can be performed by the executing agent
- When one specifies an algorithm, one is programming … a program is an instance of an algorithm

CSE 100 Ex: Directions To Northgate Cinema

- When we give directions, we are giving a process for reaching a destination
  - To go to the Northgate Cinema, exit I-5 at Northgate, go straight through the light, take a left once in the mall parking lot and go one block.
- Weaknesses of these directions …
  - Finiteness: It is finite, at least under some circumstances
  - Definiteness: Assumes one is traveling on I-5, but doesn't say which direction; or equivalently what is Northgate's exit number; assumes a particular exit, though there are two
  - Input: Should have the starting location as input
  - Output: Ill-specified -- directions lead to back of cinema
  - Effectiveness: Is vague about navigating in mall parking lot

CSE 100 Better Directions

- The goal in giving directions is to make them doable (effective) and unambiguous (definite), attending to details such as the starting point (input) and the ending point (output)
- Can we develop better directions?

CSE 100 Key Features of Algorithms/Programs

A few primitive ideas are used in all algorithms …

- Assignment -- associating a name with a value
- Conditional operations -- mechanisms for making decisions based on input or computed data that determine the next steps in the computation
- Repetition operations -- mechanisms for repeatedly performing certain steps in the computation, that assure termination (finiteness) and the ability to reference different data on different repetitions
- Functional abstraction -- a mechanism for encapsulating the steps of a commonly used operation to become a basic unit of computation
- Functional decomposition -- a process of breaking a complex task into simpler steps

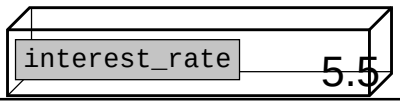
Today

CSE 100 Assignment

- Assignment is associating a name with a value … it's like naming quantities in algebra, but slightly different
- In programming we write …

```
interest_rate = 5.5
```

  - The letters "**`interest_rate`**" are called a *variable* in programming because they can take on many values
  - Variables have to be single words, always beginning with a letter, so the underscore symbol (_) connects the parts for readability … capitals work for this purpose too:
  - Example variables: **`interestRate, x15, b44zrptq261`**
  - The equal sign is read: "is assigned," "becomes" or "gets"
  - A good metaphor for a variable is a labeled container … since we speak of the "contents" of a variable, i.e. its current value



CSE 100 Conditionals

- Conditional operations allow variables to be tested to determine what the next operation should be
- The If-Then-Else is the most widely used conditional
- Structurally, the If-Then-Else has the form

```
If <condition goes here> Then
    <Then-clause instructions go here>
Else
    <Else-clause instructions go here>
End If
```

Parts of a conditional:

- Key words: **`If, Then, Else, End If`**
- Test or Predicate, between **`If`** and **`Then`**
- **`Then`** clause
- **`Else`** clause (optional)
- **`End If`** terminator

CSE 100 A Conditional Example For VB6

- The If-Then-Else used to change the month ...

```
Next_week = Today + 7
If Next_week > 30 Then
    Month = “May”
    Next_week = Next_week - 30
Else
    Month = “April”
End If
```

- An alternative ...

```
Next_week = Today + 7
Month = “April”
If Next_week > 30 Then
    Month = “May”
    Next_week = Next_week - 30
End If
```

- Another alternative …

```
Next_week = Today + 7
Month = “April”
If Next_week > 30 Then Month = “May”
If Next_week > 30 Then Next_week = Next_week - 30
```

CSE 100 Program & Algorithm Differences

We will return to this point later

- A program is an instance of an algorithm, meaning that the algorithm is a more abstract concept of a process than is the program
- The program has been created with a particular set of properties, specific representations, input assumptions, etc., but implementing the underlying logic of the algorithm
- A different set of conditions leads to a different program implementing the algorithm's logic

Fundamental principle: There can be different instances of a single abstract idea … algorithms and programs illustrate the principle