Algorithms

Algorithms are a familiar idea. Our goal is to learn to specify them right so someone or something else does the work.

Previous Algorithms

Algorithm, a precise, systematic method to produce a specified result

- We have seen algorithms already...
  - Placeholder technique is an algorithm with an easy specification:
    \[
    \text{longStringWithShortStringInIt} \leftarrow \text{placeholder} \\
    \text{ShortString} \leftarrow \varepsilon \\
    \text{placeholder} \leftarrow \text{longStringWithShortStringInIt}
    \]

Not every process is an algorithm -- debugging

Properties of Algorithms

For an algorithm to be well specified it must have ...

- Inputs specified
- Outputs specified
- Definiteness
- Effectiveness
- Finiteness

Programs vs Algorithms

A program is an algorithm specialized to a particular situation

- Algorithm:
  \[
  \text{longStringWithShortStringInIt} \leftarrow \text{placeholder} \\
  \text{ShortString} \leftarrow \varepsilon \\
  \text{placeholder} \leftarrow \text{longStringWithShortStringInIt}
  \]

- Program:
  \[
  \text{↵↵} \leftarrow \# \\
  \text{↵} \leftarrow \varepsilon \\
  \# \leftarrow \text{↵↵}
  \]

Alphabetize CDs

1. Define Artist_of to refer to the group name
2. Pick Alpha Decide which end of rack is to be start of alphabetic sequence, and call the first slot alpha
3. Pick Beta Call the slot next to alpha, beta
4. Exchange If Artist_of the CD in the alpha slot is later in the alphabet than the Artist_of the CD in the beta slot, interchange the CDs, otherwise continue on
5. More Betas? If a slot follows the beta slot, begin calling it the beta slot and go to step 4, otherwise continue on
6. More Alphas? If two slots follow the alpha slot, begin calling the next one the alpha slot and the one following it the beta slot go to step 4; otherwise stop

Flow Chart

Start
1. Define Artist_of
2. Select starting end; name it alpha
3. Call beta the slot adjacent to alpha
4. Is Artist_of CD in alpha slot later than Artist_of CD in beta slot?
5. Is there a slot following the beta slot?
6. Are there 2 slots following alpha?
7. Begin calling next slot beta
8. Advance alpha to next slot & slot after it beta
9. Stop
Demonstration

Abstraction

Abstraction means removing an idea or process from a situation.

Beta sweep -- while alpha points to a fixed slot, beta sweeps through slots following alpha, interchanging as necessary.

The beta sweep is a concept removed based on our understanding of the operation of the algorithm.

Flow Chart

The Beta Sweep

By abstracting we can analyze parts of an algorithm...

- The beta sweep has 4 properties:
  - Exhaustive -- it considers all CDs after alpha
  - Non-redundant -- no slot pair is checked twice
  - Progressive -- the alphabetically earliest CD considered so far is always in the alpha slot
  - Effective -- at completion, the alphabetically earliest CD from alpha to end is in alpha slot

These properties apply only to Alphabetize CDs.

Summary

We figure out most algorithms on our own, abstracting from specific cases. Also we abstract parts of an algorithm or program to understand them.

- Thinking of how the program works and reasoning about its properties allows us to know why an algorithm works... and then we can let the computer do it.