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:
    longStringWithShortStringInIt ← *placeholder*
    ShortString ← ε
    placeholder ← *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:
longStringWithShortStringInIt ← *placeholder*
ShortString ← ε
placeholder ← *longStringWithShortStringInIt*

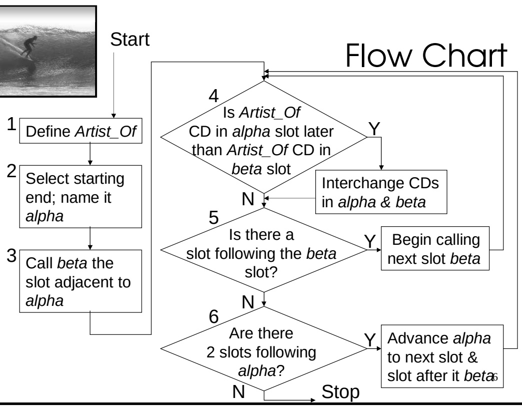
∗ Program: ↲↲ ← #
↲ ← ε
# ← ↲↲

Alphabetize CDs

```
 Spoon
Beethoven
 Hampton
 Wynette
Pearl Jam
```

1. **Def *Artist_of* Use *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 *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

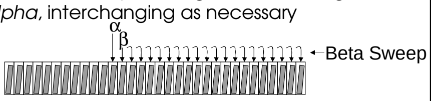

Start
1 Define *Artist_Of*
2 Select starting end; name it *alpha*
3 Call *beta* the slot adjacent to *alpha*
4 Is *Artist_Of* CD in *alpha* slot later than *Artist_Of* CD in *beta* slot
Y
Interchange CDs in *alpha & beta*
N
5 Is there a slot following the *beta* slot?
Y
Begin calling next slot *beta*
N
6 Are there 2 slots following *alpha*?
Y
Advance *alpha* to next slot & slot after it *beta*
N
Stop

Demonstration

Abstraction

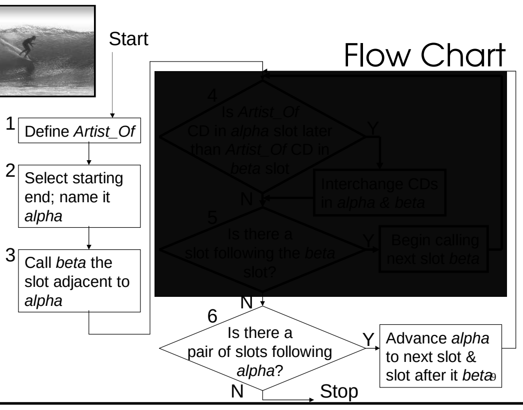
Abstraction means removing an idea or process form a situation

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


Start
1 Define *Artist_Of*
2 Select starting end; name it *alpha*
3 Call *beta* the slot adjacent to *alpha*
N
6 Is there a pair of slots following *alpha*?
Y
Advance *alpha* to next slot & slot after it *beta*
N
Stop
[redacted]

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

Alpha Sweep

The alpha sweep...

Process of sweeping through all of the CDs (but the last) performing the beta sweep

- ***Exhausitve*** **-- considers all but last CD**
- ***Non-redundant*** **-- a slot is** ***alpha*** **only once**
- ***Progressive*** **-- when** ***beta*** **sweep completes the alphabetically next CD in** ***alpha***
- ***Complete*** **-- when last** ***beta*** **sweep is done the last slot's CD is later than next to last slot**
- ***Effective*** **-- the** ***alpha*** **sweep alphabetizes**

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