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 $\leftarrow$ *placeholder*

ShortString $\leftarrow \varepsilon$

placeholder $\leftarrow$ *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 ← $\varepsilon$
  placeholder ← longStringWithShortStringInIt
```

- Program:

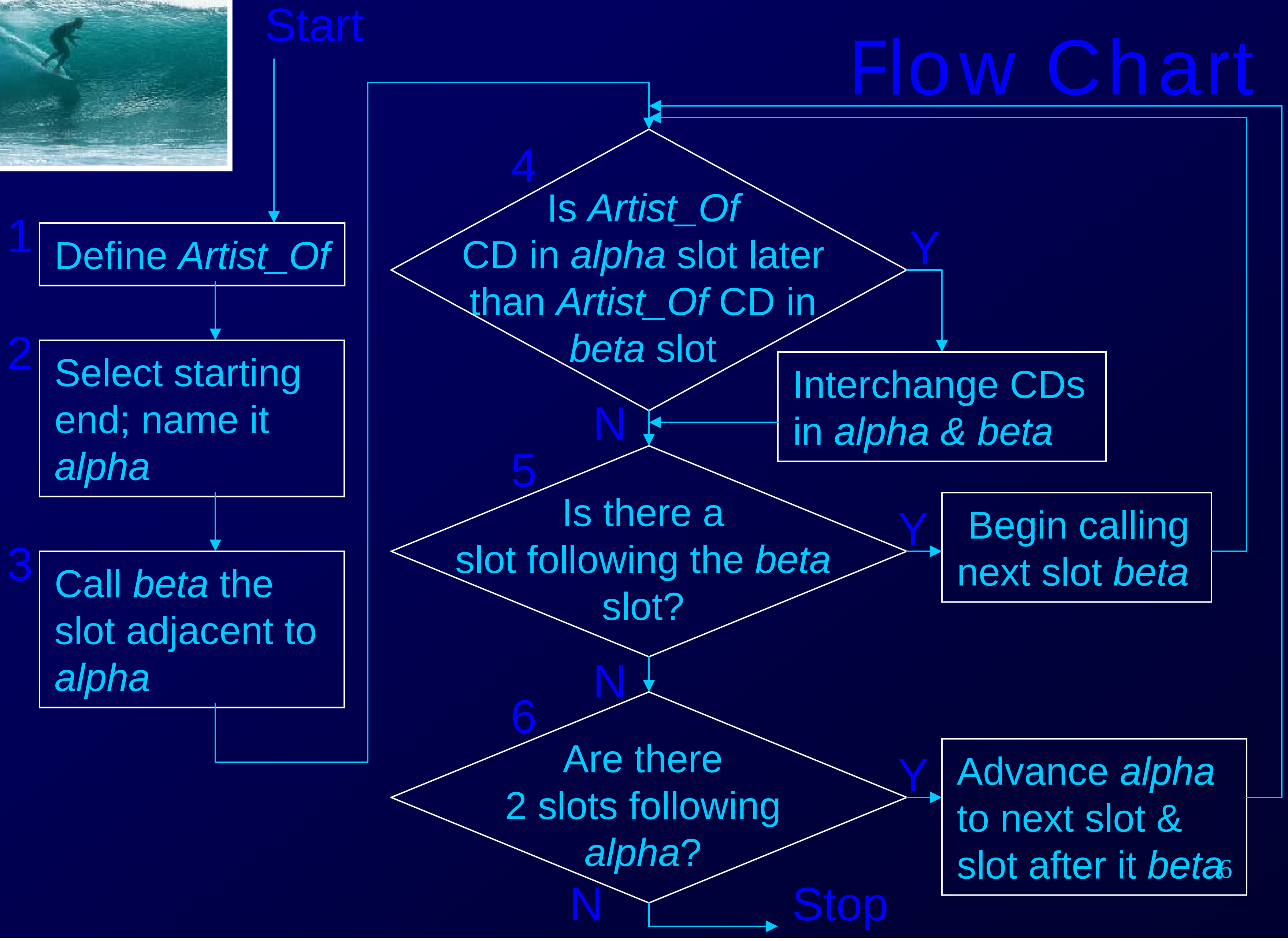
```
↲↲ ← #
↲ ← $\varepsilon$
# ← ↲↲
```

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

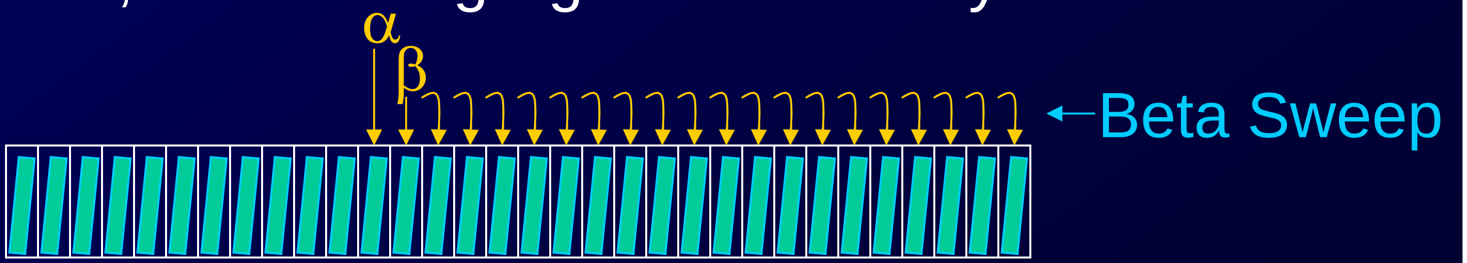
Stop

Demonstration

Abstraction

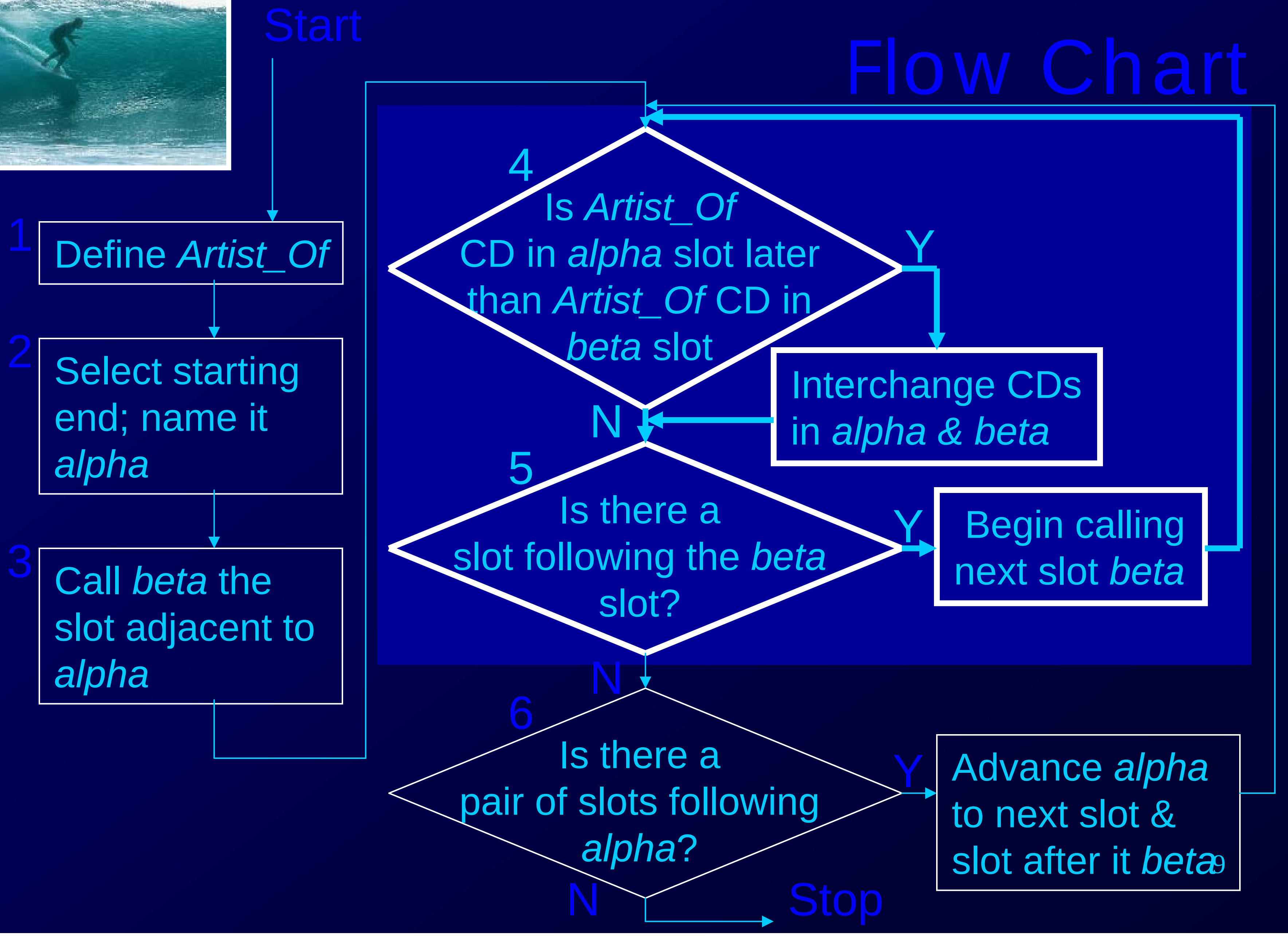
Abstraction means removing an idea or process form a situation

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*

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 Is there a pair of slots following *alpha*?

Y → Advance *alpha* to next slot & slot after it *beta*

N → Stop

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