CSE 403: Notkin
#2 of 3 on software change

Information Hiding

Today's educational objective

- Understand information hiding as a principle for decomposing systems into modules

Background

- "I assume the programmer's genius matches the difficulty of his problem and assume that he has a arrived at a suitable subdivision of the task." —Dijkstra
- "Usually nothing is said about the criteria to be used in dividing the system into modules." —Parnas

Information hiding principle

- A fundamental cost in software engineering is accommodating change
- A change that requires modifying multiple modules is more costly than a change that is isolated in a single module
- Therefore
  - Anticipate likely changes
  - Define interfaces that capture the stable aspects and implementations that capture the changeable aspects

Small examples

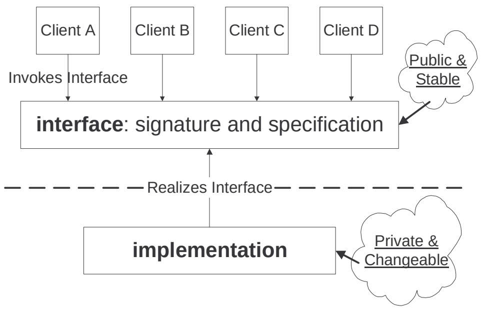
- `double sqrt (int)`
  - Can be implemented using bisection methods, factoring methods, Newton's method
  - The client doesn't care, and this can change (requiring only relinking)
- Very low level example, of course

```
type intSet is
  intSet create();
  insert(intSet,int);
  delete(intSet,int);
  bool member(intSet,int);
  int size(intSet);
end intSet;
```

- Classic example of data abstraction
  - The representation and algorithms are hidden
  - They can change without affecting clients

Hiding secrets

- These two examples show specific kinds of secrets that modules hide
  - Algorithms
  - Data representations
- The interfaces capture stable decisions
  - Clients depend on these interfaces
- The implementations encode the changeable parts
  - Clients do not depend on these



Interface

- An interface has two parts
  - The *signature*: the names and type information about the exported functions
  - The *specification*: a precise description of the semantics of the elements in the module
- Most commonly, the signature is in a programming language and the specification is in natural language
- But you cannot neglect the specification

Example

- ```
  double sqrt (int
  x) {
      a legitimate
      different
      implementation
  }
  ```

The contract with the client includes semantic information

- ```
  double sqrt (int x)
  {
     return 3.14159;
  }
  ```
- ```
  bool member
   (intSet s,int i) {
      return IsOdd(i)
  }
  ```

Design Level

- Information hiding is a design principle, not a coding principle
- Obviously, it can be reflected in code that is based on the design

Anticipating change

- It's "easy" to anticipate algorithmic and representational changes
- But you cannot and should not do this and only this
  - By blithely anticipating these changes, you may not think about another kind of change that is more likely and potentially costly
- In general, you cannot build a design that effectively anticipates all changes

Data isn't always abstracted

- Unix byte streams are pervasive
  - imagine trying to change Unix's data model from byte streams to fixed width records
  - good or bad decision?
- y2k problems arose because a date representation was exposed
  - The USPS, the DJIA and McDonald's have also faced similar problems
- Other examples?
  ```

Other kinds of secrets

- An information hiding module can hide other secrets
  - Characteristics of a hardware device
    - Ex: whether an on-line thermometer measures in Fahrenheit or Centigrade
  - Where information is acquired
    - Ex: the Metacrawler (`www.metacrawler.com`) might hide what other web search engines it uses
  - Other examples?

KWIC: the classic example

Input

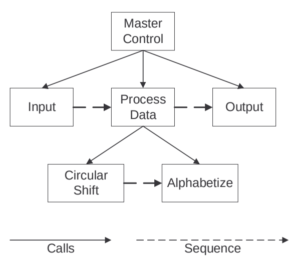
```
now is the time
for all good students
to come to the aid
of their professors
```

Output

```
aid to come to the
all good students for
come to the aid to
for all good students
good students for all
is the time now
now is the time
of their professors
professors of their
students for all good
the aid to come to
the time now is
their professors of
time now is the
to come to the aid
to the aid to come
```

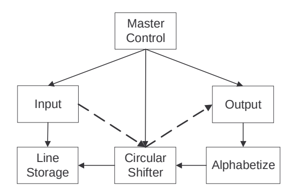
The classic decomposition

- Top-down functional decomposition
  - Stepwise refinement
- Based on the steps the actual computation will take



The data decomposition

- Not based on the actual computation steps
- Hides decisions about data representation
  - Could they be hidden in the previous decomposition?
- Hides decisions about the granularity of sorting
- The "sequence" relationship is hazier



Fundamentally different approaches

- These are really different designs
- They are equivalent in terms of the actual user experience
  - Indeed, Parnas argued that in principle a compiler could produce identical executables from these two different decompositions

What about performance?