Lecture 3

Parnas' Information Hiding

Announcement

- SSE: Students in Software Engineering
  - http://www.edge.utexas.edu/sse/
- Software Engineering Reading Group
  - 11AM - 12PM on every other friday
  - http://users.ece.utexas.edu/~miryung/teaching/SE-Seminar.Spring09.html

Announcement

- Reading assignments are due 10 PM. Sorry for confusion last time!
- We will grade ***the best 20 reviews*** instead of 24 reviews to give you more time for your project.

Announcement

- Tool evaluation paper expectation
- Tutorials on program representations are linked. (Review them before Lecture 8.)
- KWIC example code is available on the blackboard
- Can you post a thread on the discussion board?

Announcement

- Exemplary literature survey papers and tool evaluation papers are on the blackboard.
- Questions?

Example Project (1): *History-based Code Completion*

- Motivation: Programmers need assistance in remembering long API names. Most modern IDEs provide code completion feature to increase productivity and to prevent compilation errors.
- Problem: existing code completion algorithms only suggest candidate APIs based on starting alphabets but do not consider history of which code completion suggestions that programmers took in the past
- Approach: propose a new algorithm that considers the history of which code completion suggestions programmers took in the past.

Example Project (1): *History-based Code Completion*

- Implementation: implement a new code completion algorithm in Eclipse
- Evaluation Plan: Download some code from OSS, remove some API calls and see which APIs are suggested your algorithm and compare those suggestions with the ones suggested by the default code completion algorithm in Eclipse
- Identify strengths and weaknesses of your algorithm and suggest future directions

Example (2): *Library Installation Suggestion based on Open Source*

- Motivation: When programmers download open source software, they often subsequently need to identify and install libraries as some libraries' source code cannot be released together due to licensing reasons.
- Problem: Programmers currently do not have much support other than reading README files and searching for needed libraries on the web. Even when they find libraries, their versions may not be compatible with the current version of software.

Example (2): *Library Installation Suggestion based on Open Source*

- Approach: Your web-service takes the URL of OSS and README files or a web-manual. It does some keyword analysis to identify which libs are required. It automatically runs a google search to locate these libraries and rank and suggestion them. Your web-service can also accommodate users' input and maintain a set of compatible configurations.
- Evaluation Plan: Download some OSSs. Install them yourself by manually finding required libraries and checking them by running the application. Compare that results with your system's suggestions.
- Identify strengths and weaknesses of your algorithm and suggest future directions

Example Project (3): Suggestion of when to refactor

- Motivation: Code decays without refactoring.
- Problem: Programmers need to know when to refactor. Refactoring tends to take a low priority.
- Return on refactoring investment depends when to refactor.

Example Project (3): Suggestion of when to refactor

- Approach: Identify code smells and suggest refactoring opportunities. Use metrics to identify bad smells. Program invariants (precondition/post conditions)
- Implementation:
- Evaluation plan: Compare with existing IDE-refactorings. Users studies in real tasks.

Example Project (3): Suggestion of when to refactor

- Motivation: Programmers often need to refactor to prevent code decay due to duplicated code.
- Problem: The return on refactoring investments depends on how often those code actually require similar changes. If programmers refactor too early, the refactoring may turn out to be unnecessary. If programmers refactor too late, the return on refactoring investments may be marginal.

Example Project (3): Suggestion of when to refactor

- Approach: We propose an algorithm that recommends the appropriate timing for refactoring code duplicates based on their change history.
- Implementation:
  - propose several algorithms for recommending when to refactor code
- Evaluation plan:
  - Apply your algorithm to OSS history and produce cost-benefit models

Parnas' Information Hiding

- What problem did Parnas discuss in the paper?
    -

Modularization

- What does Parnas mean by a “module?”
- What do you mean by a “module” in practice? an object, or class

Modularization

- Expected Benefits
- Unexpected Pitfalls?

KWIC Requirements

- Input: an ordered set of lines where
  - each line is an ordered set of words
  - each word is an ordered set of characters
- Output: all circular shifts of all lines in alphabetical order

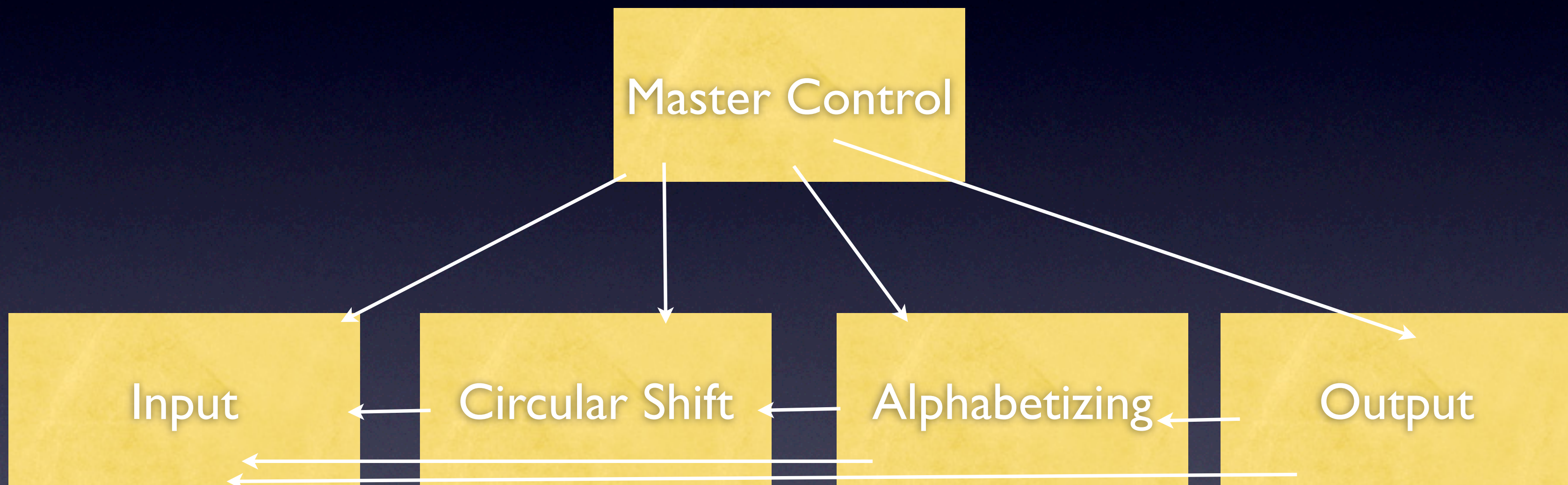
KWIC Requirements

- Input: an ordered set of lines where each line is an ordered set of words and each word is an ordered set of characters
  - *My name is Miryung Kim*
  - *Software Evolution*
- All circular shifts of all lines
  - *My name is Miryung Kim*
  - *name is Miryung Kim My*
  - *is Miryung Kim My name*
  - *Miryung Kim My name is*
  - *Kim My name is Miryung*
  - *Software Evolution*
  - *Evolution Software*

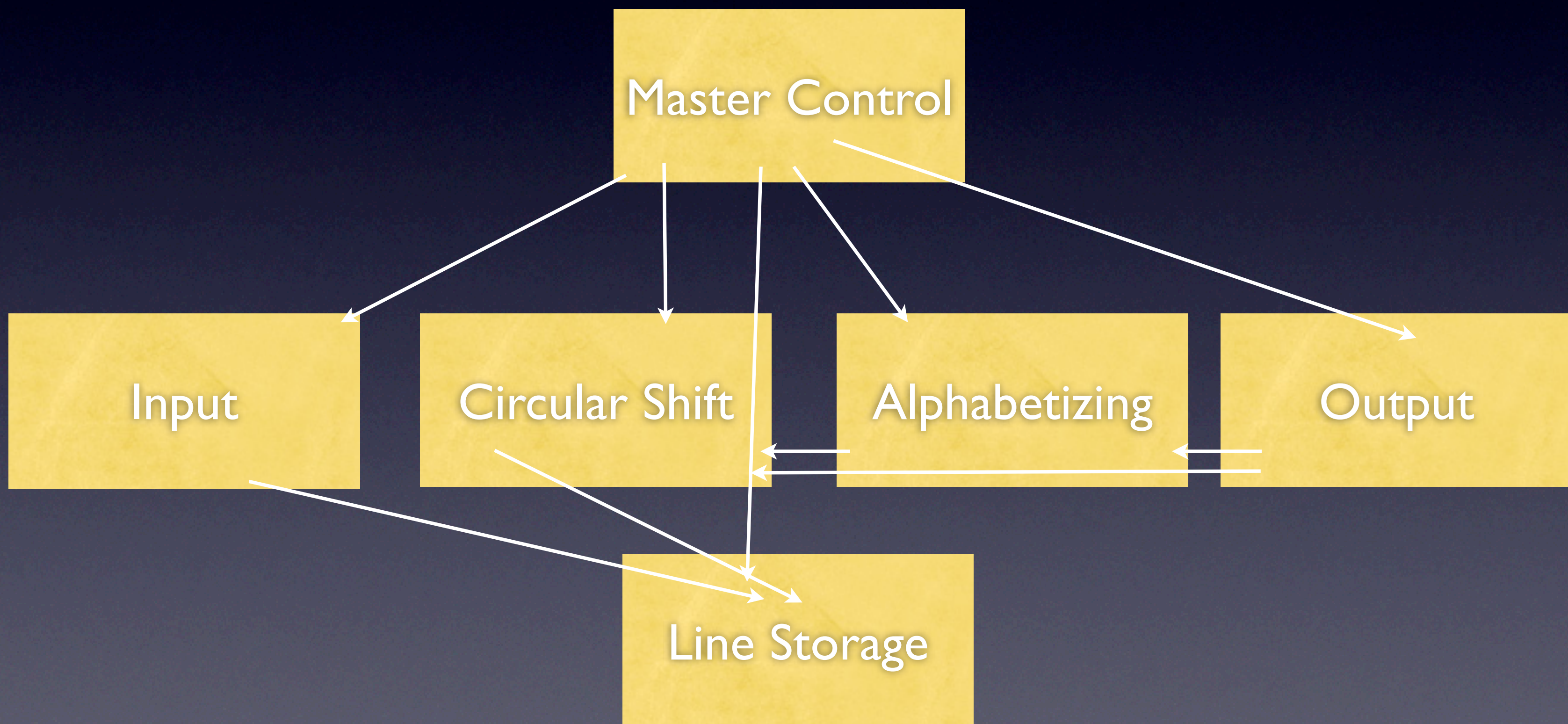
KWIC Requirements

- All circular shifts of all lines in alphabetical order
  - *Evolution Software*
  - *Kim My name is Miryung*
  - *Miryung Kim My name is*
  - *My name is Miryung Kim*
  - *Software Evolution*
  - *is Miryung Kim My name*
  - *name is Miryung Kim My*

Modularization 1

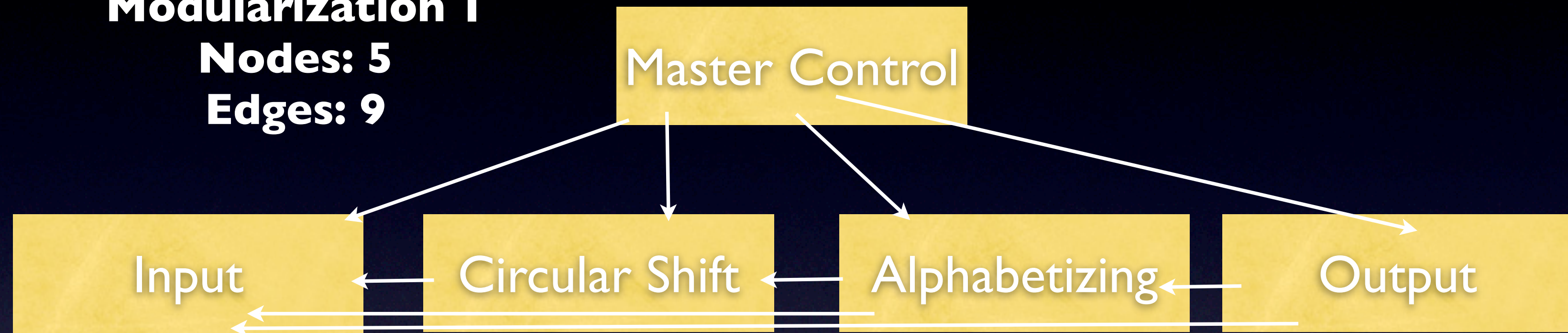


Modularization 2

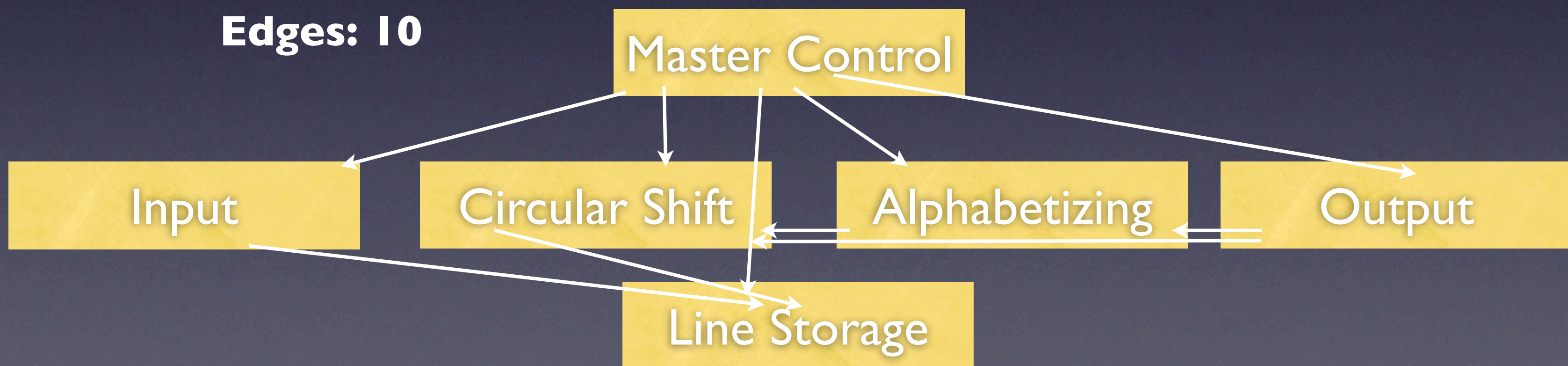


Comparison

Modularization 1
Nodes: 5
Edges: 9



Modularization 2
Nodes: 6
Edges: 10



What are differences between two alternative designs?

- Both are decompositions.
- Both share data representations and access methods
- Is the modularization 1 bad?Why?

Changeability Assessment: Modularization 1

Changes	MasterControl	Input	CircularShift	Alphabetizer	Output
InputFormat		✔			
A Single Storage	✔	✔	✔	✔	✔
Packing characters	✔	✔	✔	✔	✔
Index for CS			✔	✔	✔
Search or Partial				✔	✔

Changeability Assessment: Modularization 2

Changes	MasterControl	Input	CircularShift	Alphabetizer	Output	LineStorage
InputFormat		✔				
A Single Storage						✔
Packing characters						✔
Index for CS			✔			
Search or Partial				✔		

Changeability Comparison

Modularization 1:

Changes	MasterC ontrol	Input	CircularS hift	Alphabeti zer	Output
InputFor mat		✔			
A Single Storage	✔	✔	✔	✔	✔
Packing character s	✔	✔	✔	✔	✔
Index for CS			✔	✔	✔
Search or Partial Alphabeti				✔	✔

Modularization 2:

Change s	Master Control	Input	Circular Shift	Alphabe tizer	Output	LineSto rage
InputFo rmat		✔				
A Single Storage						✔
Packing charact ers						✔
Index for CS			✔			
Search or Partial				✔		

Independent Development

- Modularization 1: The decision to store line indices and word indices must be communicated among all module developers
- Modularization: API names and types

Functional Decomposition vs. Information Hiding

- Functional decomposition (Flowchart approach)
  - Each module corresponds to each step in a flow chart.
- Information Hiding
  - Each module corresponds to a design decision that are likely to change and that must be hidden from other modules.
  - Interfaces and definitions were chosen to reveal as little as possibles.

Connecting Design Principles to Source Code for Improved Ease of Change

Vibha Sazawal

Department of Computer Science and Engineering
University of Washington

Now a professor at University of Maryland, College Park
These slides are borrowed from Dr. Sazawal's talk.

The design snippets approach

Goals

- help programmers make decisions related to ease of change
- remain easy to use in the context of existing code

Insight: these goals can be achieved by

- **partial** views of a system
- that are **co-displayed with code**, and
- provide a **bridge** between code and design principles

These views are called **design snippets**.

- Four specific types of design snippets
  - derived from the **information hiding** principle
    - information hiding snippet
    - type assumptions snippet
  - derived from the **low coupling** principle
    - dependencies snippet
    - de facto interfaces snippet

Design principles: information hiding and low coupling

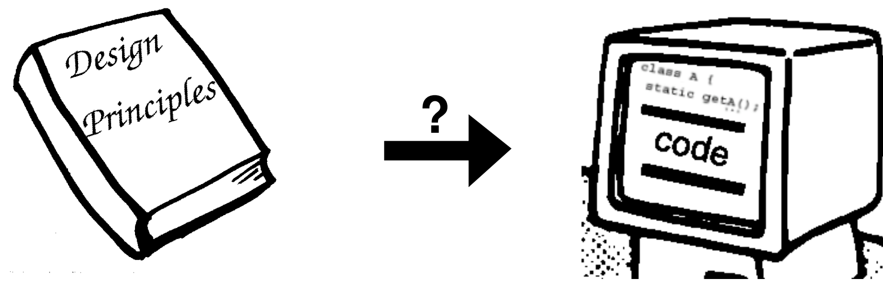
Information hiding [Parnas72, Parnas84]

- “details that are likely to change should be the **secrets** of separate modules”
- “the only **assumptions** that should appear in the **interfaces** between **modules** are those that are considered unlikely to change”

Low coupling [Yourdon78]

- helps reduce the effects of interface change
- helps programmers extract subsets of systems

Problem: a gap between design principles and code

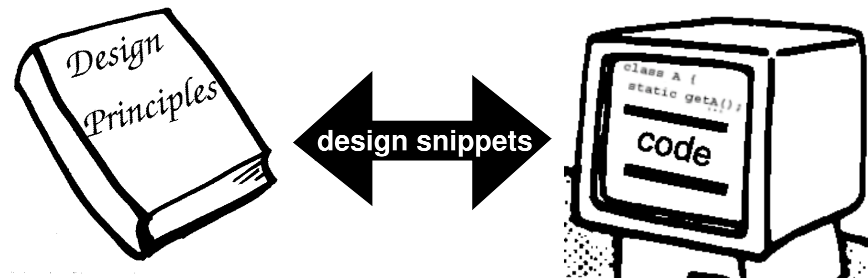


There is **no direct mapping** between design terms (such as *secret*, *volatile*, and *assumption*) and code.

The gap between design principles and code

- complicates adherence to design principles
- results in design decision errors

Design snippets bridge the gap



Design snippets approach

- accommodate common mappings between design principles and Java code
  - example: module $\Rightarrow$ class
- present information that is
  - needed to follow design principles
  - relevant to the current Java file

Information hiding snippet

Goal: help programmers hide implementation details

Side-by-side view: for comparison of interface and implementation

Secret types: non-parameter, non-field types used by a class

SNIP Information Hiding

- Interface of Money
  - public methods
    - Money takes parameters of type double;
    - getAmount takes no parameters; returns double;
    - getCurrencyType takes no parameters; returns String;

- Implementation of Money
  - private fields
    - m_amount has type double
    - m_currency_type has type String
  - secret types used (broken down by method)
    - Money(double) uses
      - class Globals (calls getCurrencyType)

Secret types

Secret types, together with private members, provide a useful, succinct view of implementation details.

```
Implementation of Bank
  private fields
    m_currency_manipulator has type CurrencyManipulator
  initializers
  secret types used (broken down by method)
    static initializer 1 uses
      class USDollarsManipulator ( calls constructor )
    main(String[]) uses
      class BankAccount ( calls makeWithdrawal, calls constructor, calls getBalance, calls makeDeposit )
      class Money ( passed to method makeWithdrawal, passed to method makeDeposit, calls constructor,
      class BankException ( catches instance, calls getMessage )
      class System ( accesses out )
      class PrintStream ( calls print )
      class String ( passed to method print )
```

Type assumptions snippet

Goal: identify assumptions that may violate information hiding

- **casts** to parameters and return values

Why focus on type assumptions?

- often symptoms of larger problems with information sharing
- casts in client code are often hidden to maintainers

Recap

- Information Hiding principle means "identify design decisions that are likely to change and hide them within each module."
- It does not mean using OO language, using abstract data types, using built-in libraries, using of message passing, etc.
- But what happens if you cannot anticipate what are likely to change?