Case Study on Information Hiding: The KWIC System

15-214:

Foundations of Software Engineering

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Related Reading: D. L. Parnas. *On the Criteria To Be Used in Decomposing Systems into Modules.* CACM 15(12):1053-1058, Dec 1972.

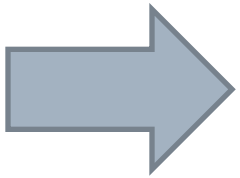
Some ideas from David Notkin's CSE 503 class

Design Case Study: Key Word In Context (KWIC)

- "The KWIC [Key Word In Context] index system accepts an ordered set of lines, each line is an ordered set of words, and each word is an ordered set of characters. Any line may be "circularly shifted" by repeatedly removing the first word and appending it at the end of the line. The KWIC index system outputs a listing of all circular shifts of all lines in alphabetical order."
  - Parnas, 1972

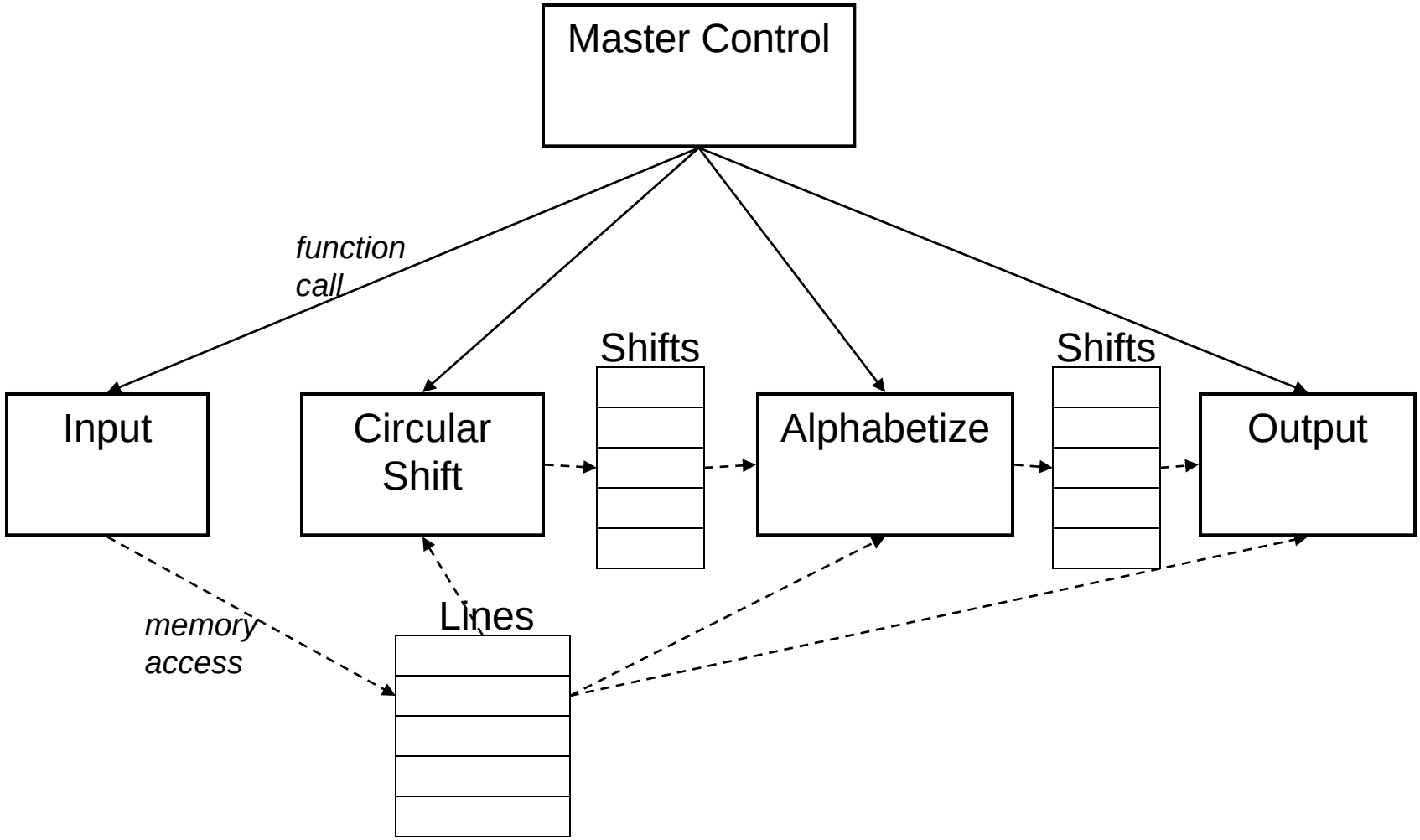
- Consider KWIC applied to the title of this slide

Design Case Study:
Case Study: Design
Study: Design Case
Key Word In Context (KWIC)
Word In Context (KWIC) Key
In Context (KWIC) Key Word
Context (KWIC) Key Word In
(KWIC) Key Word In Context

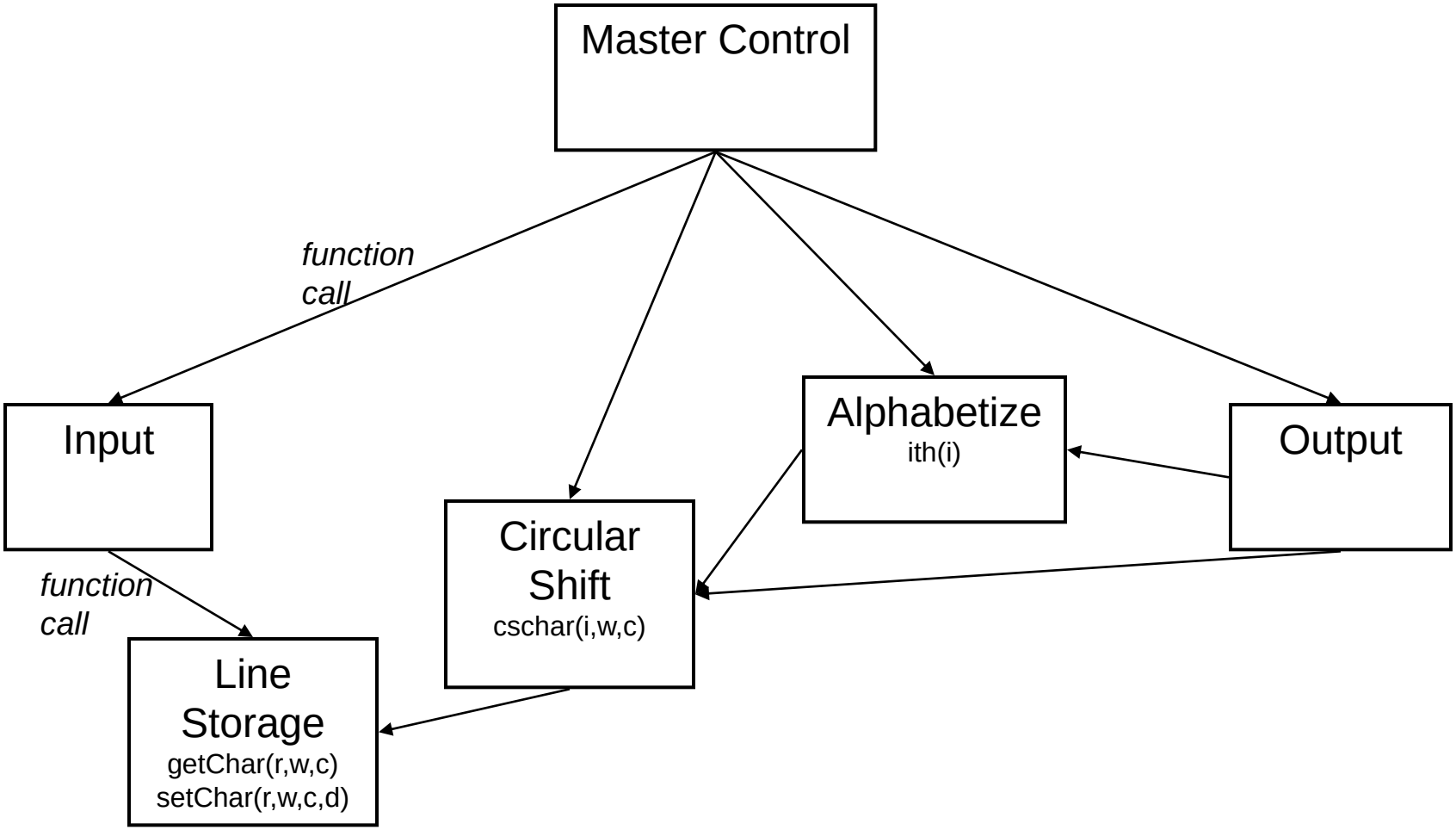


(KWIC) Key Word In Context
Case Study: Design
Context (KWIC) Key Word In
Design Case Study:
In Context (KWIC) Key Word
Key Word In Context (KWIC)
Study: Design Case
Word In Context (KWIC) Key

KWIC Modularization #1



KWIC Modularization #2

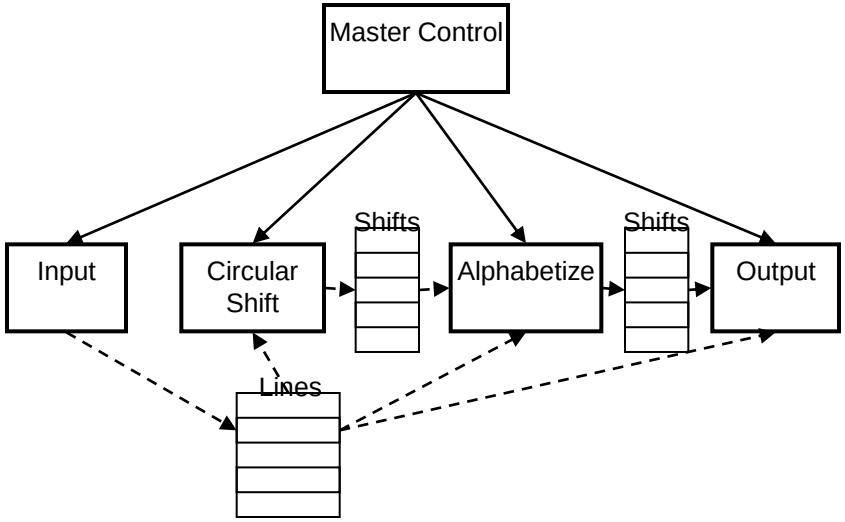


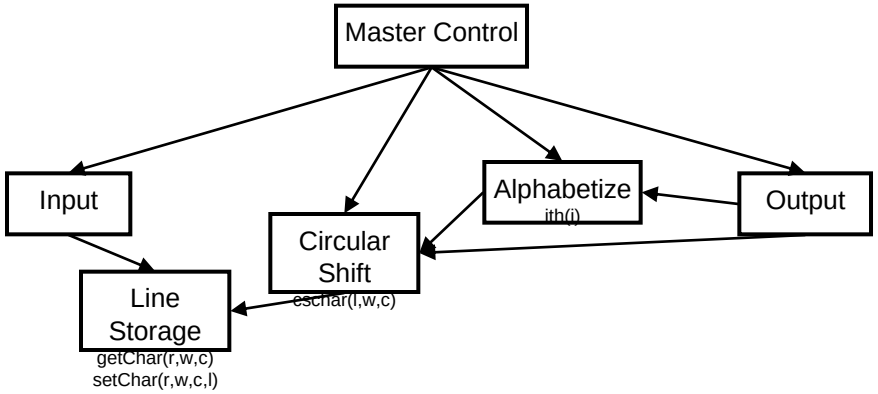
KWIC Observations

- Similar at run time
  - May have identical data representations, algorithms, even compiled code
- Different in code
  - Understanding
  - Documenting
  - Evolving

Effect of Change?

- Change input format
- Don’t store all lines in memory at once
- Use an encoding to save line storage space
- Store the shifts directly instead of indexing
- Amortize alphabetization over searches





Effect of Change?

- Change input format
  - Input module only
- Don’t store all lines in memory at once
  - Design #1: all modules
  - Design #2: Line Storage only
- Use an encoding to save line storage space
  - Design #1: all modules
  - Design #2: Line Storage only
- Store the shifts directly instead of indexing
  - Design #1: Circular Shift, Alphabetizer, Output
  - Design #2: Circular Shift only
- Amortize alphabetization over searches
  - Design #1: Alphabetizer, Output, and maybe Master Control
  - Design #2: Alphabetizer only

Other Factors

- Independent Development
  - Data formats (#1) more complex than data access interfaces (#2)
  - Easier to agree on interfaces in #2 because they are more abstract
  - More work is independent, less is shared
- Comprehensibility
  - Design of data formats in #1 depends on details of each module
  - More difficult to understand each module in isolation for #1

A Note on Performance

- Parnas says that if we are not careful, decomposition #2 will run slower
- He points out that a compiler can replace the function calls with inlined, efficient operations
- Lesson: don't prematurely optimize
  - Smart compilers enable smart designs
  - Evolvability usually trumps the overhead of a function call anyway

Decomposition Criteria

- Functional decomposition
  - Break down by major processing steps
- ***Information hiding*** decomposition
  - Each module is characterized by a design decision it hides from others
  - Interfaces chosen to reveal as little as possible about this

Information Hiding

Derived from definition by Edward Berard – concept due to Parnas

- Decide what design decisions are likely to change and which are likely to be stable
- Put each design decision likely to change into a module
- Assign each module an interface that hides the decision likely to change, and exposes only stable design decisions
- Ensure that the clients of a module depend only on the stable interface, not the implementation

- Benefit: if you correctly predict what may change, and hide information properly, then each change will only affect one module
  - That's a big if…do you believe it?

Hiding design decisions

*Information hiding is **NOT** just about data representation*

Decision

- Data representation
- Platform
- I/O format
- User Interface
- Algorithm

Mechanism