Tutorial on BoxScript: A Component-Oriented Language

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Outline

- What are Components?
- How to Componentize a System?
- What is BoxScript?
- How to use BoxScript?

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- **What are Components?**
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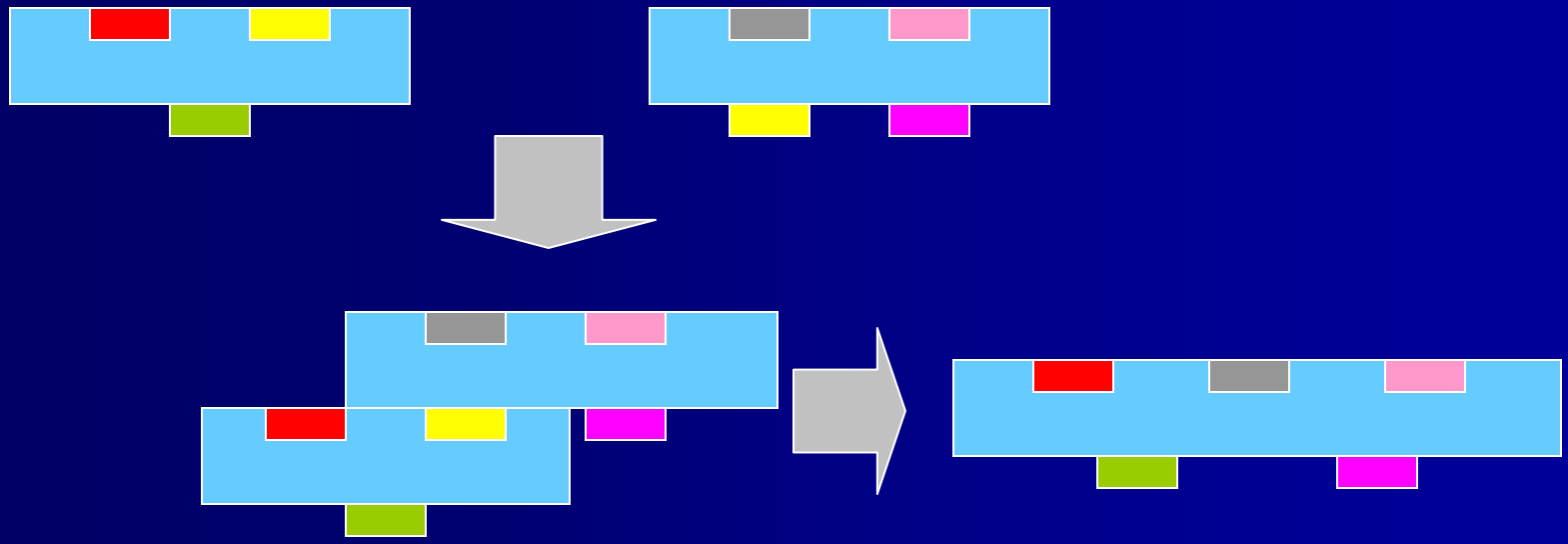
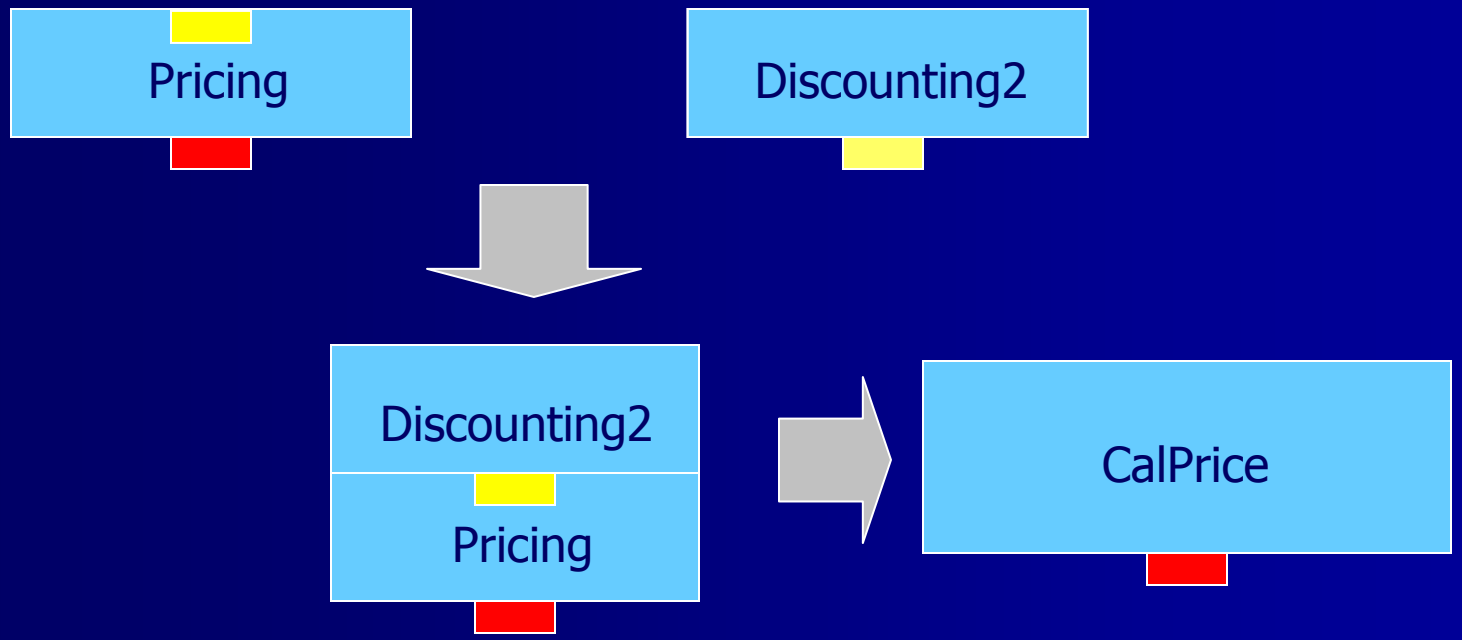
Software Components



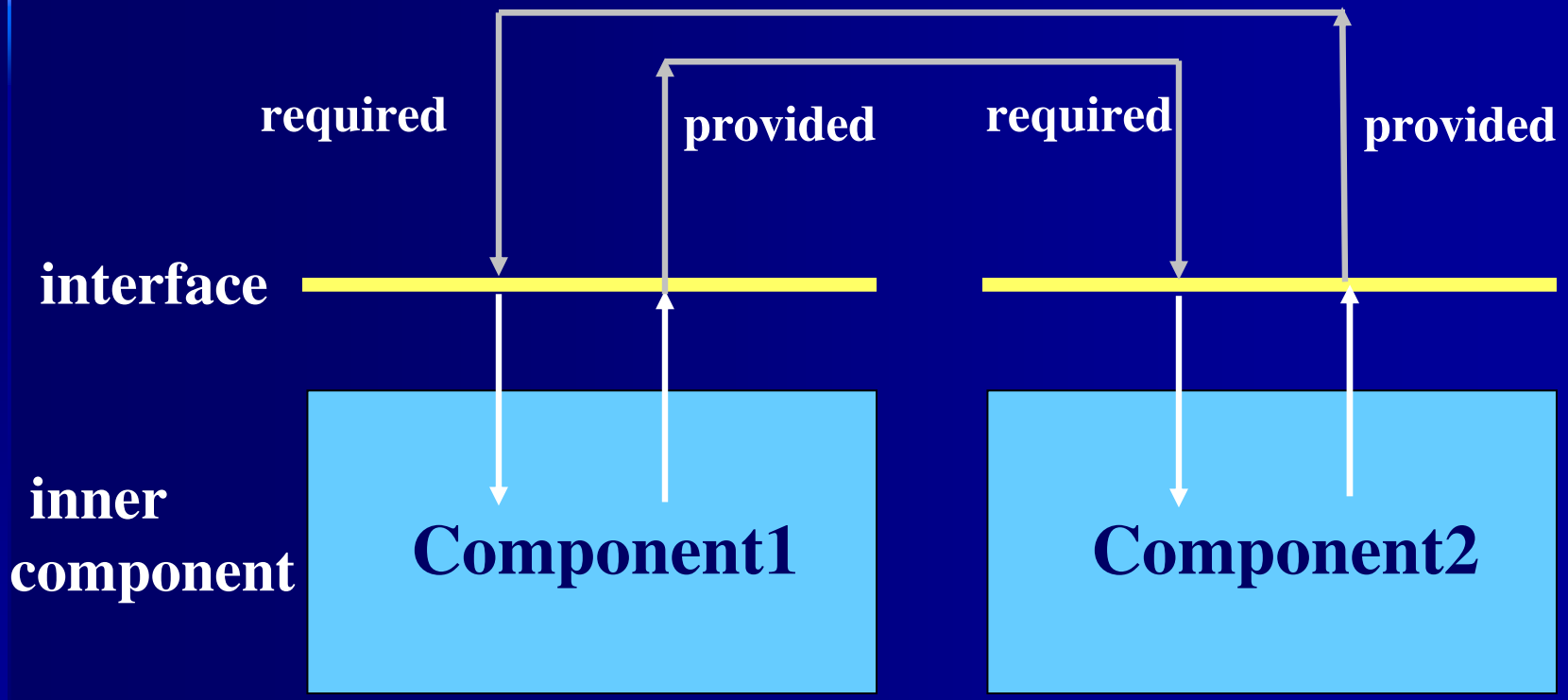
A Simple Example



Compositionality

Flexibility

Components – A Closer Look



Components vs. Objects

	Component	Object
Strong Encapsulation	Yes	Some Yes Some No
Compositionality	Yes	Need extra programming
Flexibility	Yes	Need extra programming

Outline

- What are Components?
- **How to Componentize a System?**
- What is BoxScript?
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Goals of Component Design

- **Components should be**
  - **cohesive: a**ll functionality fits together for coherent, easily understandable purpose
  - **independent:** components are decoupled from each other
  - **changeable:** implementation of one component can be changed without affecting others
- **Component system should be robust with respect to change**
  - Likely changes should affect only a few components
  - Unlikely changes might affect overall structure

Design Guidelines

Decomposition:

- If some design issue is likely to change, hide it inside one component – information hiding
- Define interfaces of components to be stable in the face of likely changes – abstraction

Specification:

- Precisely define everything one component may assume about another
- One component should assume no more than necessary about others

Examples

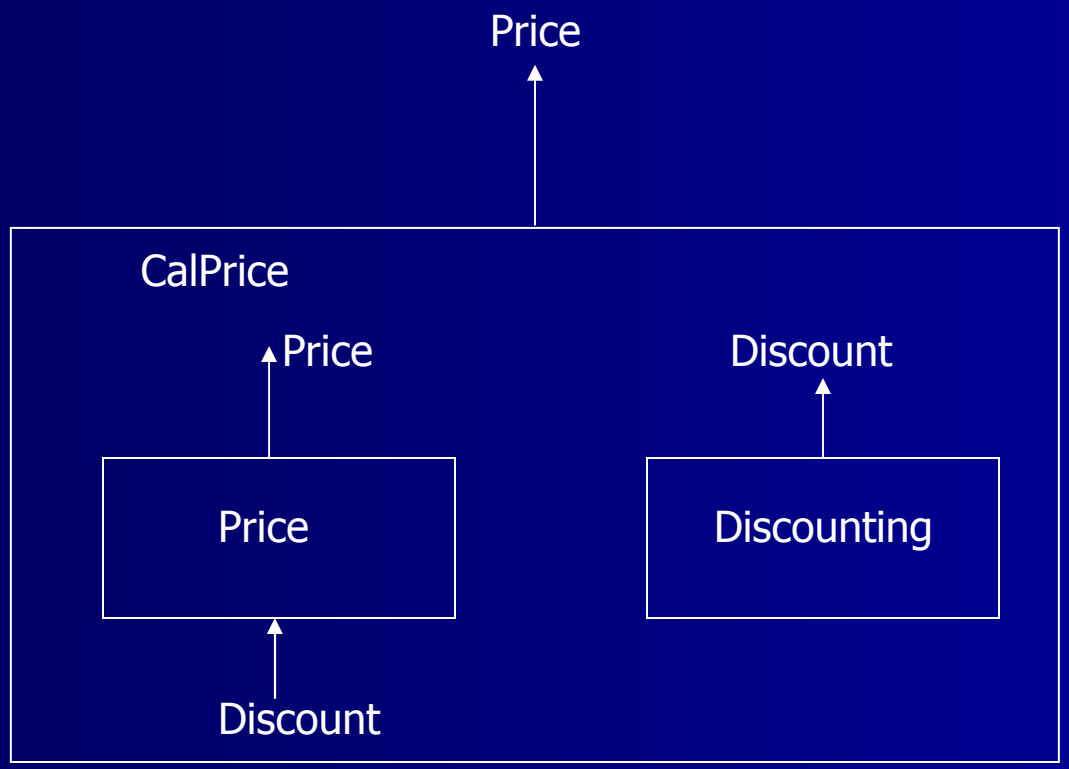
- **Example1**

Single component

```
public interface Price
{  double getPrice(int client, int item, int quantity);
}
```

Examples

- **Example2**



Outline

- What are Components?
- How to Componentize a System?
- **What is BoxScript?**
- How to use BoxScript?

BoxScript

- A language for component-oriented programming

Main Purposes of BoxScript

- **Introducing component concepts**
- **Providing simple environment to user**
- **Supporting main properties of COP**
  - Compositionality
  - Flexibility

Outline

- What are Components?
- How to Componentize a System?
- What is BoxScript?
- **How to use BoxScript?**

Key Concepts

- **Built on top of Java**
- **Component**
  - Box
  - Blackbox entity
    - No externally visible state
    - Only interfaces exposed

Key Concepts
Interfaces

- **Interface**
  - Java Interface

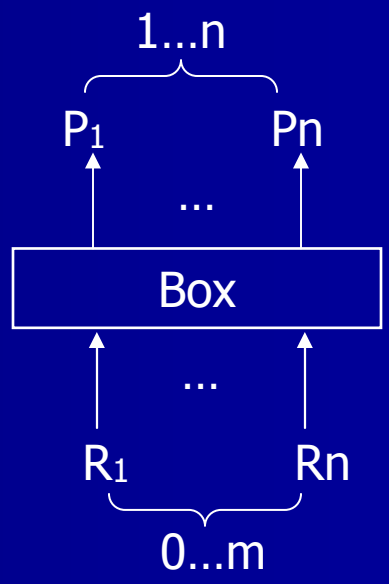
Price.java

```
public interface Price
{  double getPrice(int client, int item, int quantity);
}
```

- **Provided interface**
  - Describes operations that a box implements and that other boxes may use
- **Required interface**
  - Describes operations that the box uses and that must be implemented by another box

Key Concepts
Boxes

- **General characteristics of boxes**
  - Contains the descriptions of provided interfaces and required interfaces (.box)
  - 1..n provided interfaces
  - 0..m required interfaces
- **Types of boxes**
  - Abstract box
  - Concrete box
    - Atomic box
    - Compound box



Key Concepts
Abstract Box

- **Abstract box**
  - No implementations of the provided interfaces
  - Should be implemented by concrete boxes

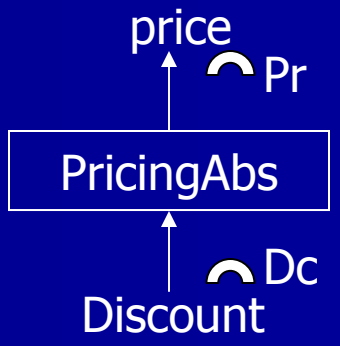
Key Concepts
Abstract Box Example

PricingAbs.box

```
abstract box PricingAbs
{  provided interfaces Price Pr;
   required interfaces Discount Dc;
}
```

Interface type

Interface Handle



Key Concepts
Boxes

- **Abstract box**
- **Concrete box**
  - Atomic box
  - Compound box

Key Concepts
Atomic Box

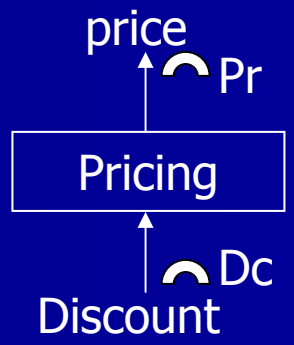
- **Atomic box**
  - Does not contain any other boxes
  - Supplies implementations of the provided interfaces

Pricing.box

```
box Pricing implements PricingAbs
{  provided interfaces Price Pr;
   required interfaces Discount Dc;
}
```

Interface type

Interface handle



Key Concepts
Interface Implementation of Atomic Box

PrImp.java

Default name for interface implementation:

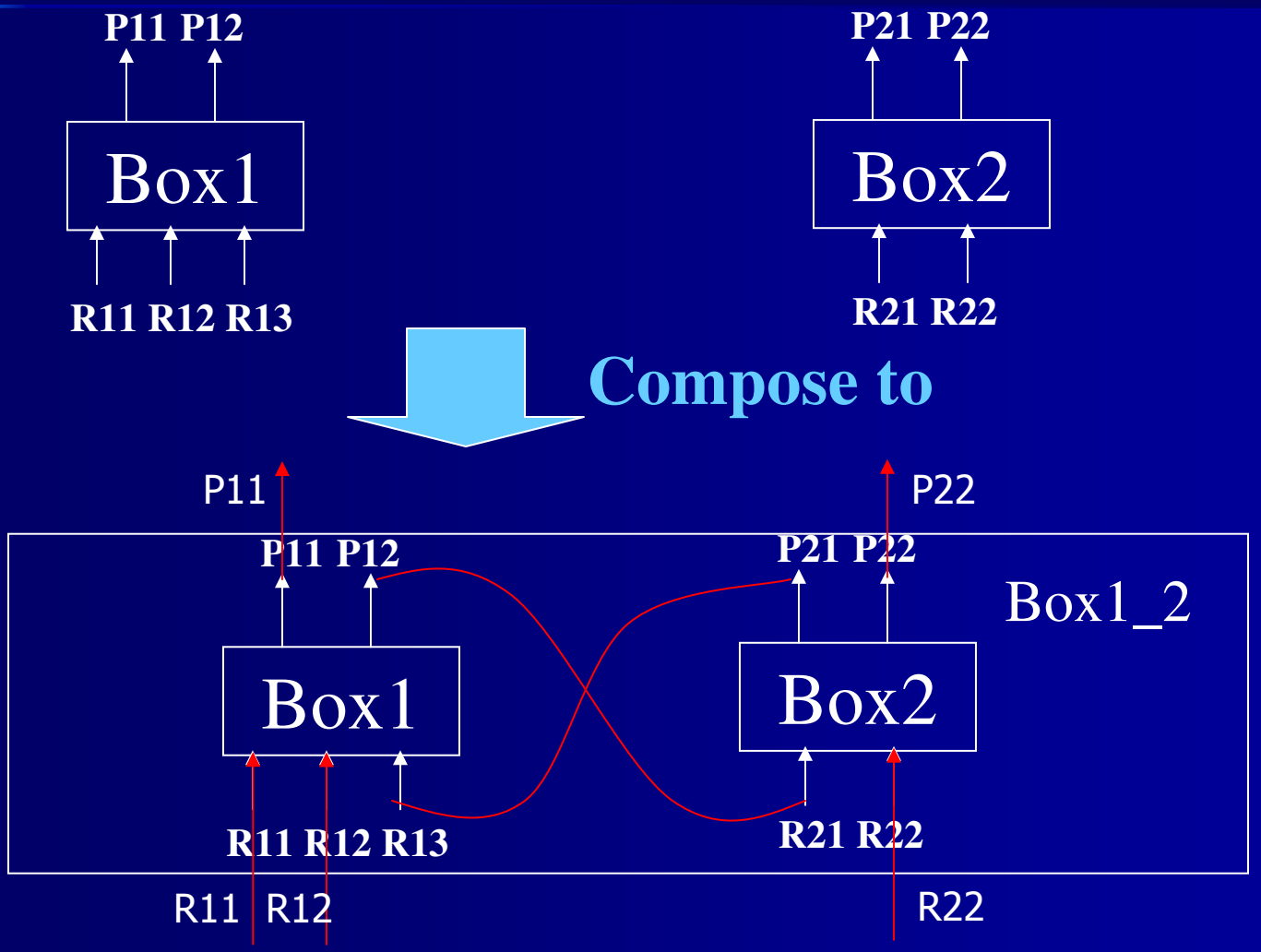
Interface handle name + Imp


```
public class PrImp implements Price
{  private BoxTop _box;
   Discount dc;    // required interface
   public PrImp(BoxTop myBox)
  {   _box = myBox;
     InterfaceName name = new InterfaceName("Dc");
     dc = (Discount)_box.getRequiredItf(name);
  }
  public double getPrice(int client,int item,int quantity)
  {  double disc = dc.getDiscount(client, item, quantity);
     return PriceList.p[item] * (1 - disc* 0.01) * quantity;
  }
}
```

Key Concepts
Compound Box

- **Compound Box**
  - Composed from atomic boxes or other compound boxes
  - Follow composition rules
    - By default, all provided interfaces are hidden unless explicitly exposed
    - Expose a required interface of a constituent if not wired to a provided interface of another

Key Concepts
Composition Strategy

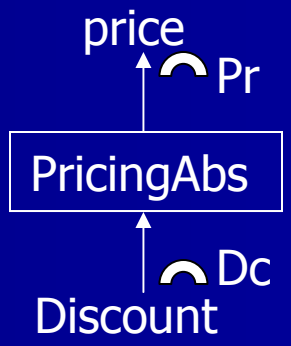


Key Concepts
Compound Box Example

- **Two boxes**

[PricingAbs.box]

```
abstract box PricingAbs
{  provided interfaces Price Pr;
   required interfaces Discount Dc;
}
```



[DiscountingAbs.box]

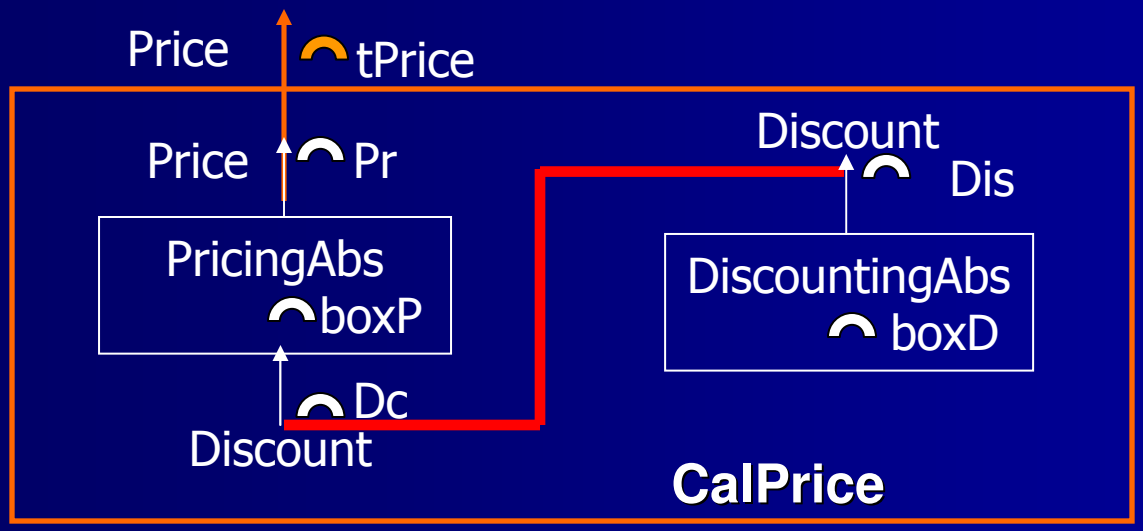
```
abstract box DiscountingAbs
{  provided interfaces Discount Dis;
}
```

Key Concepts
Compound Box Example (cont.)

- Compose two boxes

box handle

```
box CalPrice implements CalPriceAbs
{  composed from PricingAbs boxP, DiscountingAbs boxD;
   provided interfaces Price tPrice from boxP.Pr;
   connect boxP.Dc to boxD.Dis;
}
```



Box Elements

- **For all boxes**
  - Interfaces (.java) *by user*
  - Box description file (.box) *by user*
- **For atomic boxes only**
  - Interface implementation (.java) *by user*
- **For concrete boxes only**
  - Configuration information (.conf) *by user*
  - Box manager code (.java) *by compiler*

Box Elements
Configuration Information

- If abstract boxes participate in composition

```
box CalPrice implements  CalPriceAbs
{   composed from PricingAbs boxP,
                  DiscountingAbs boxD;
    provided interfaces Price tPrice from boxP.Pr;
    connect boxP.Dc to boxD.Dis;
}
```

Box Handle

Directory for PricingAbs

Directory for Pricing

[CalPrice.conf]

```
(boxP, "D:\warehouse_root\boxes\PricingAbs\", "Pricing\Pricing");
(boxD, "D:\warehouse_root\boxes\DiscountingAbs\",
"Discounting\Discounting");
```

Box Elements
Configuration Information

- If concrete boxes participate in composition

```
box CalPrice implements  CalPriceAbs
{   composed from Pricing boxP,
                  Discounting boxD;
    provided interfaces Price tPrice from boxP.Pr;
    connect boxP.Dc to boxD.Dis;
}
```

[CalPrice.conf]

(boxP, "D:\warehouse_root\boxes\PricingAbs\Pricing\Pricing");

(boxD,
"D:\warehouse_root\boxes\DiscountingAbs\Discounting\Discounting");

Box Elements
Configuration Information

- **Configuration for interface implementation when implementation file name is not default**

```
[Pricing.box]
box Pricing implements PricingAbs
{  provided interfaces Price Pr;
   required interfaces Discount Dc;
}
```

Box Pricing has *Priceimp.java* implementing interface type Price.

```
[Pricing.conf]
(Pr, "Priceimp");
```

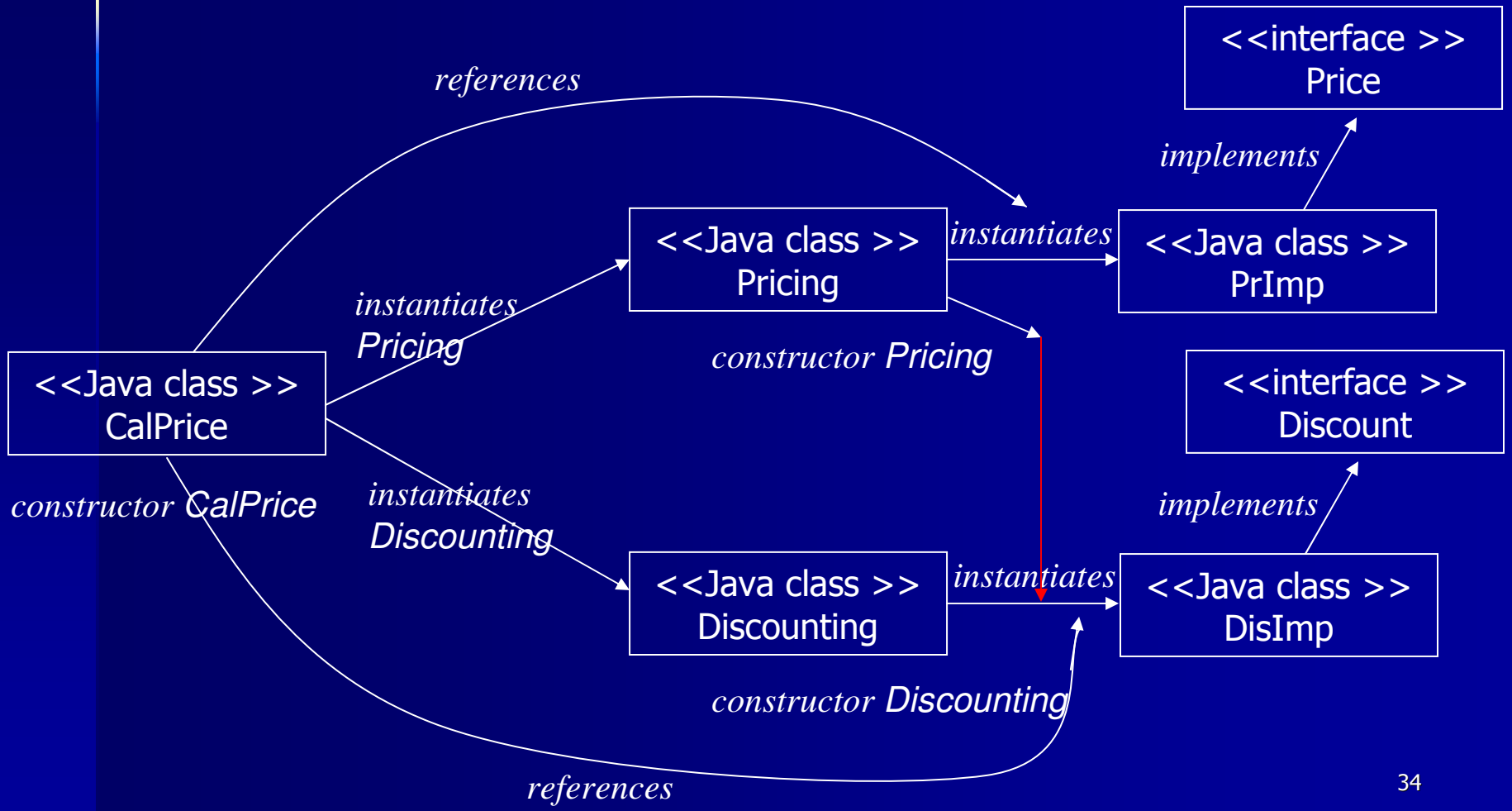
Interface Handle

Implementation location

Box Elements
Box Manager Code

- **Generated by compiler**
  - To initiate box instances
  - To assign references to interface handles

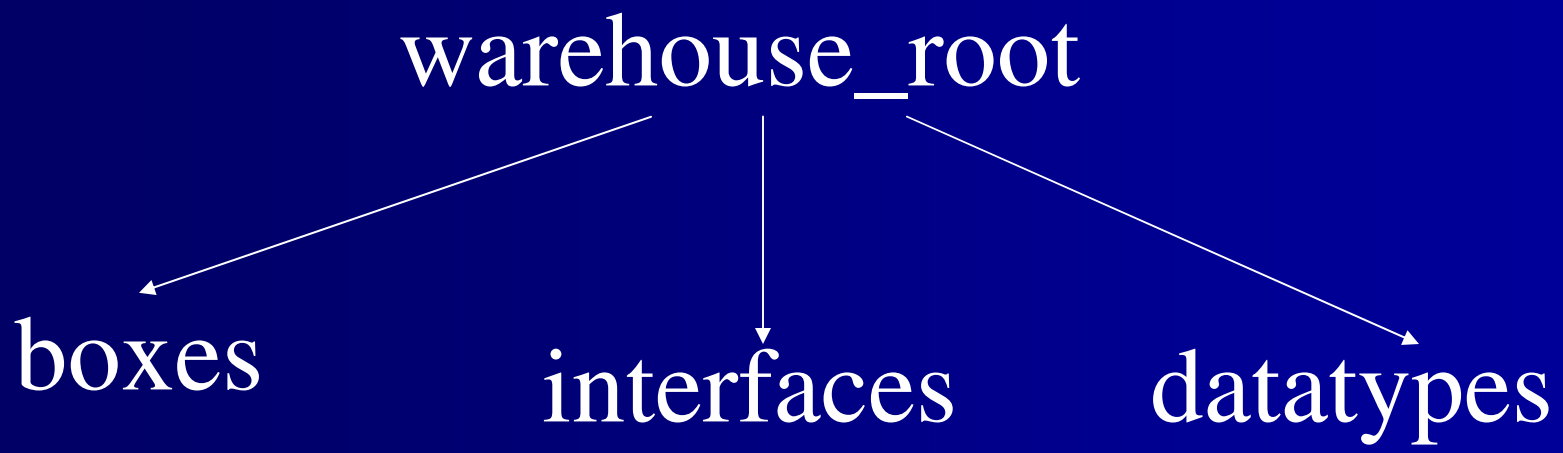
Box Run-time Structure



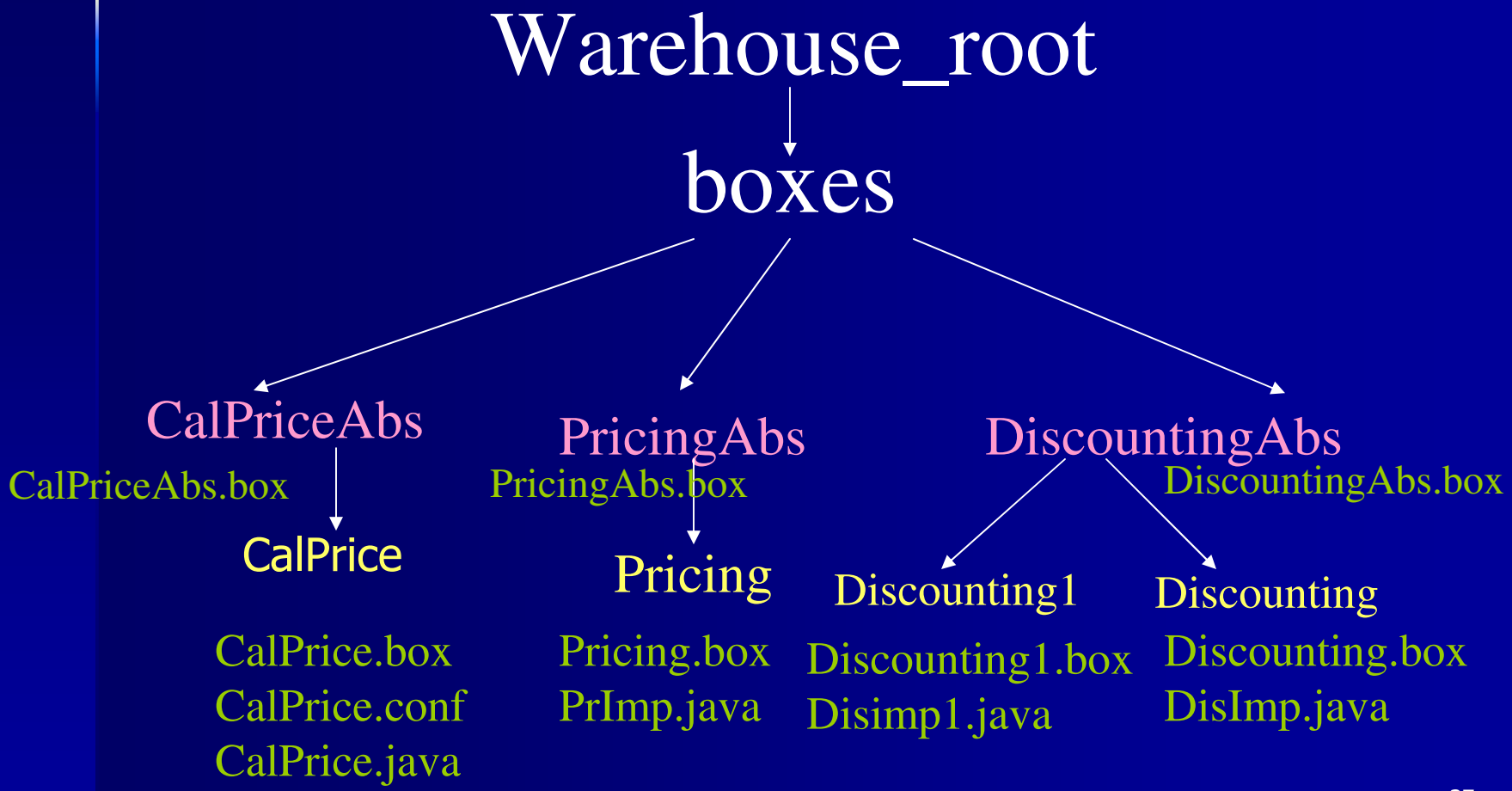
Box Processing Stages

- Locate
- Compile

Locate



Locate


Warehouse_root
boxes
CalPriceAbs
CalPriceAbs.box
CalPrice
CalPrice.box
CalPrice.conf
CalPrice.java
PricingAbs
PricingAbs.box
Pricing
Pricing.box
PrImp.java
DiscountingAbs
DiscountingAbs.box
Discounting1
Discounting1.box
Disimp1.java
Discounting
Discounting.box
DisImp.java

Locate

For an atomic box, the implementation of an interface needs to

- specify the full path of its package name
- import interfaces and datatypes

[d:\warehouse_root\boxes\PricingAbs\Pricing\PrImp.java]

```
package boxes.PricingAbs.Pricing;
import interfaces.Price;
Import interfaces.Discount;
Import datatypes. systems.*;
public class PrImp implements Price
{  private BoxTop _box;
   Discount dc;    // required interface
   public PrImp(BoxTop myBox)
  {   _box = myBox; }  …..  ….
```

Locate

Warehouse_root

interfaces

Price.java

Discount.java

Locate

[d:\warehouse_root\interfaces\Discount.java]

```
package interfaces;
public interface Discount
{
        double getDiscount(int client, int item, int quantity);
}
```

Locate

Warehouse_root

datatypes

PriceList.java

Locate

[d:\warehouse_root\datatypes\PriceList.java]

```
package datatypes;
public final class PriceList extends Object
{
        public static double [] p = new double []
        { 120.00, 14.45, 16.99, 23.78, 130.89, 239.99,
          18.99, 234.70, 3.99, 6.78, 76.50, 1299.99,
          34.67, 54.20, 67.89, 89.10, 17.50, 22.70
        };

}
```

Compile

BoxCompiler

- **Implemented in BoxScript**
- **Checks the syntax of the source code**
- **Generates box manager code**
- **Usage**

  boxc <box descrption>

  Eg. boxc <dir>CalPrice.box

Box Variants

- Support flexibility

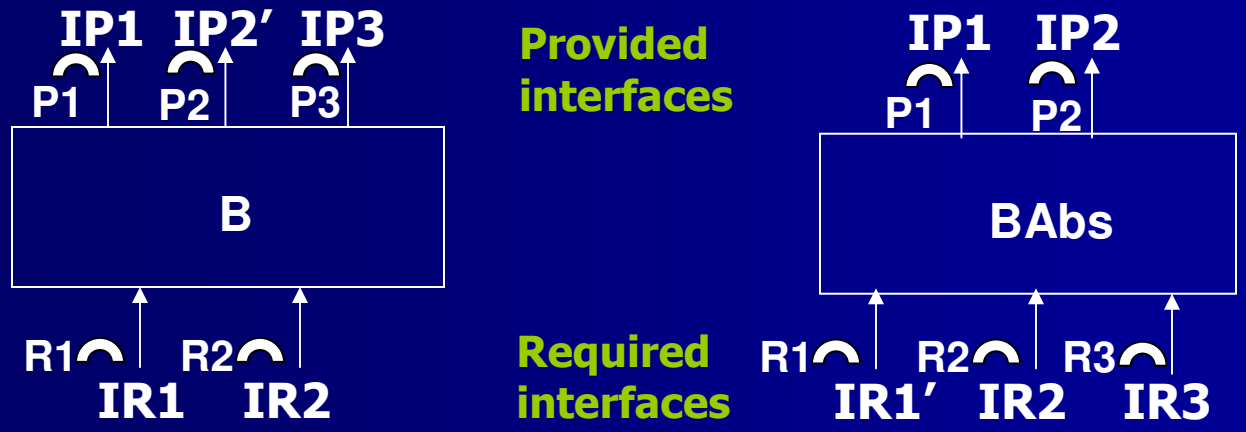
Variants

- One box is variant of another
  if implementations of same abstract box
- One box variant can be substituted by another variant where their abstract box is used
- Variant should conform to its abstract box

Box Conformity

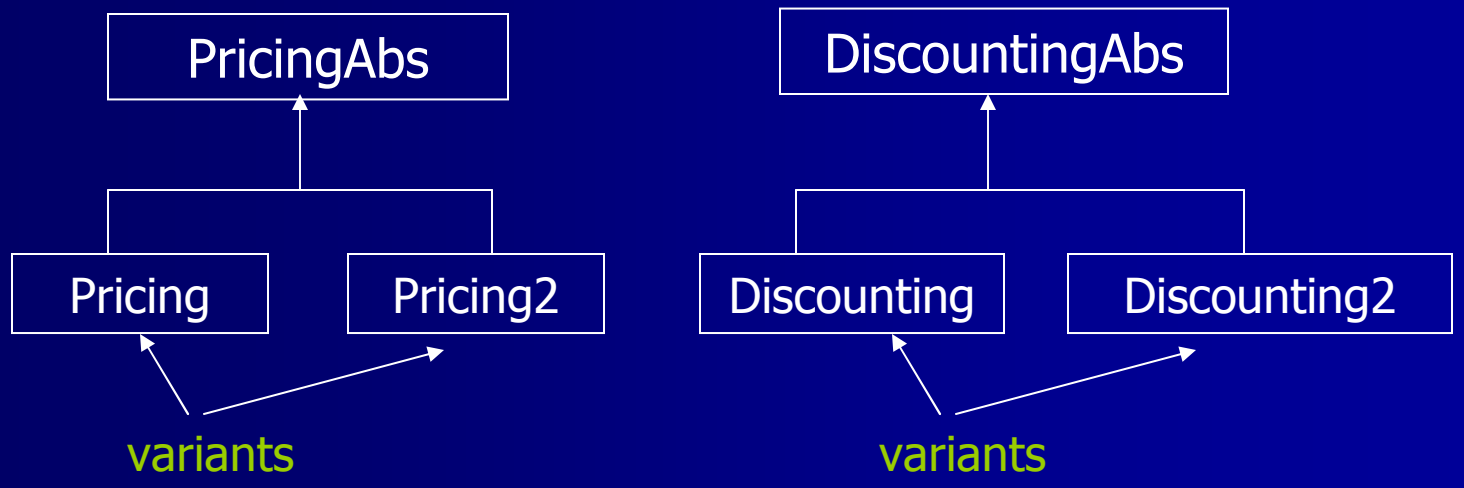
Suppose

- IP2' extends IP2
- IR1' extends IR1



B conforms to BAbs

Box Variant Example



Replacing Components

```
box CalPrice implements  CalPriceAbs
{   composed from PricingAbs boxP,
                  DiscountingAbs boxD;
    provided interfaces Price tPrice from boxP.Pr;
    connect boxP.Dc to boxD.Dis;
}
```

[CalPrice.conf]

(boxP, "D:\warehouse_root\boxes\PricingAbs\", "Pricing\Pricing");

(boxD, "D:\warehouse_root\boxes\DiscountingAbs\",

"Discounting\Discounting");

Now, we want to use Pricing1 to substitute for Pricing

Replacing Components

Things we need to do:

- Update conf file for CalPrice
- Re-compile CalPrice

[CalPrice.conf]

(boxP, "D:\warehouse_root\boxes\PricingAbs\",”Pricing1\Pricing1");

(boxD, "D:\warehouse_root\boxes\DiscountingAbs\",”Discounting\Discounting");

Demo

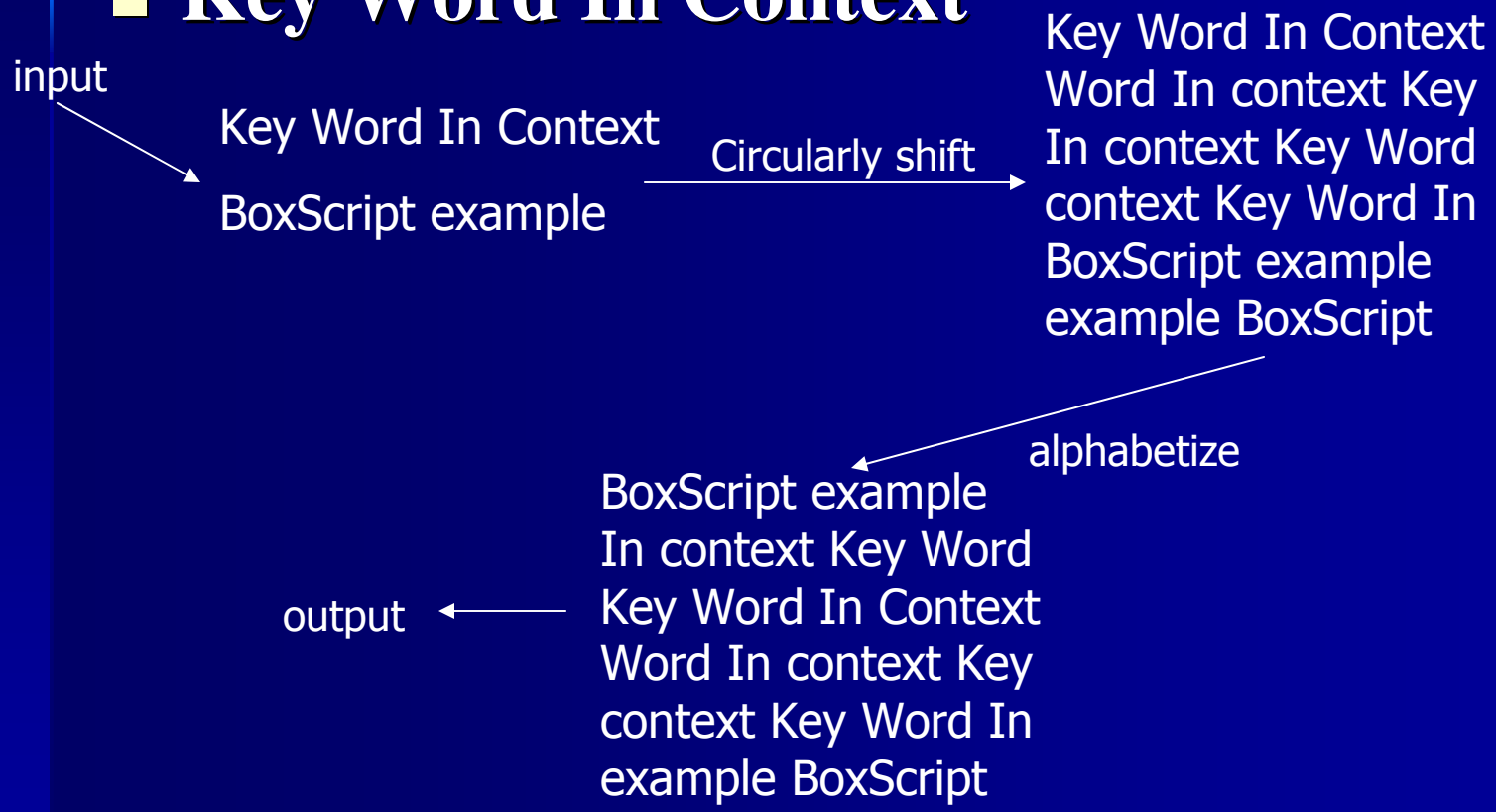
- Make an abstract box
- Make an atomic box
- Make a compound box

Example – KWIC

- **Key Word In Context**
  - ***Accepts*** an ordered set of lines
    - each line is an ordered set of words
  - ***Circularly shifts*** each line
    - repeatedly removes first word and appends it at end of line
  - ***Outputs*** all lines in ***alphabetical order***

Example – KWIC

- **Key Word In Context**

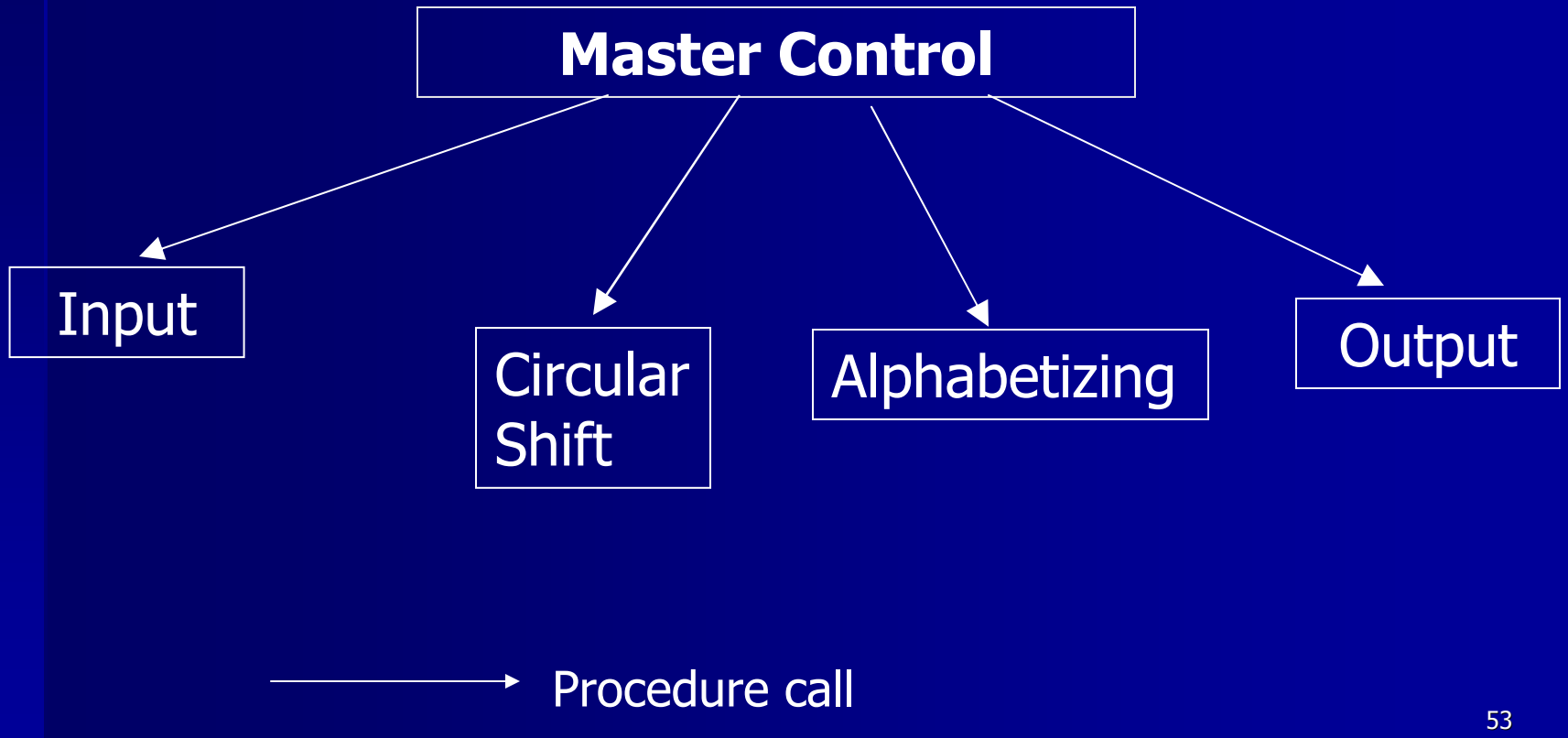


Example – KWIC

- **Design Decisions [Parnas 72]**
  - Changes in algorithm
  - Changes in data representation

Example – KWIC

- Design I

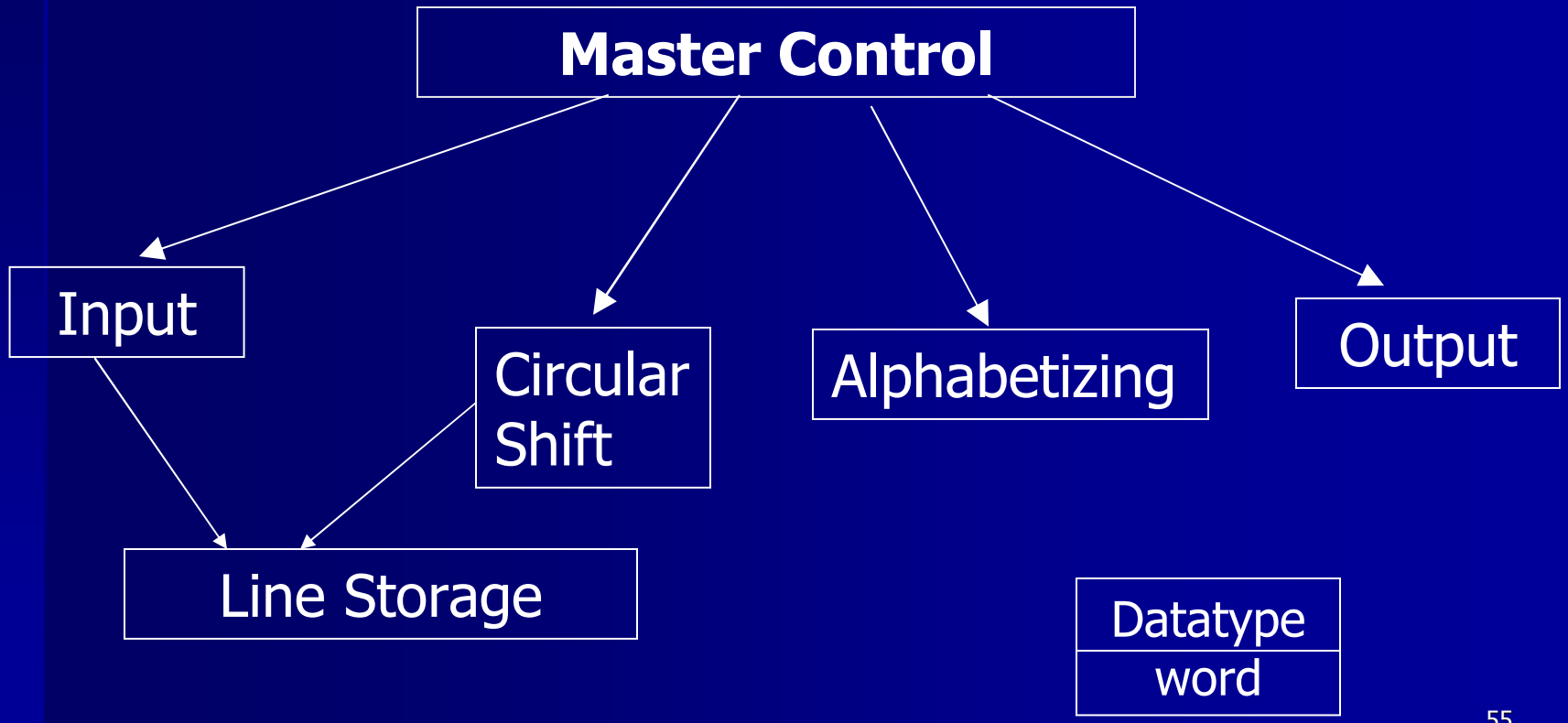


Example – KWIC

- **Possible changes**
  - Input format
  - Have lines partially stored in memory
  - Take different formats for Word
  - Partially alphabetize lines

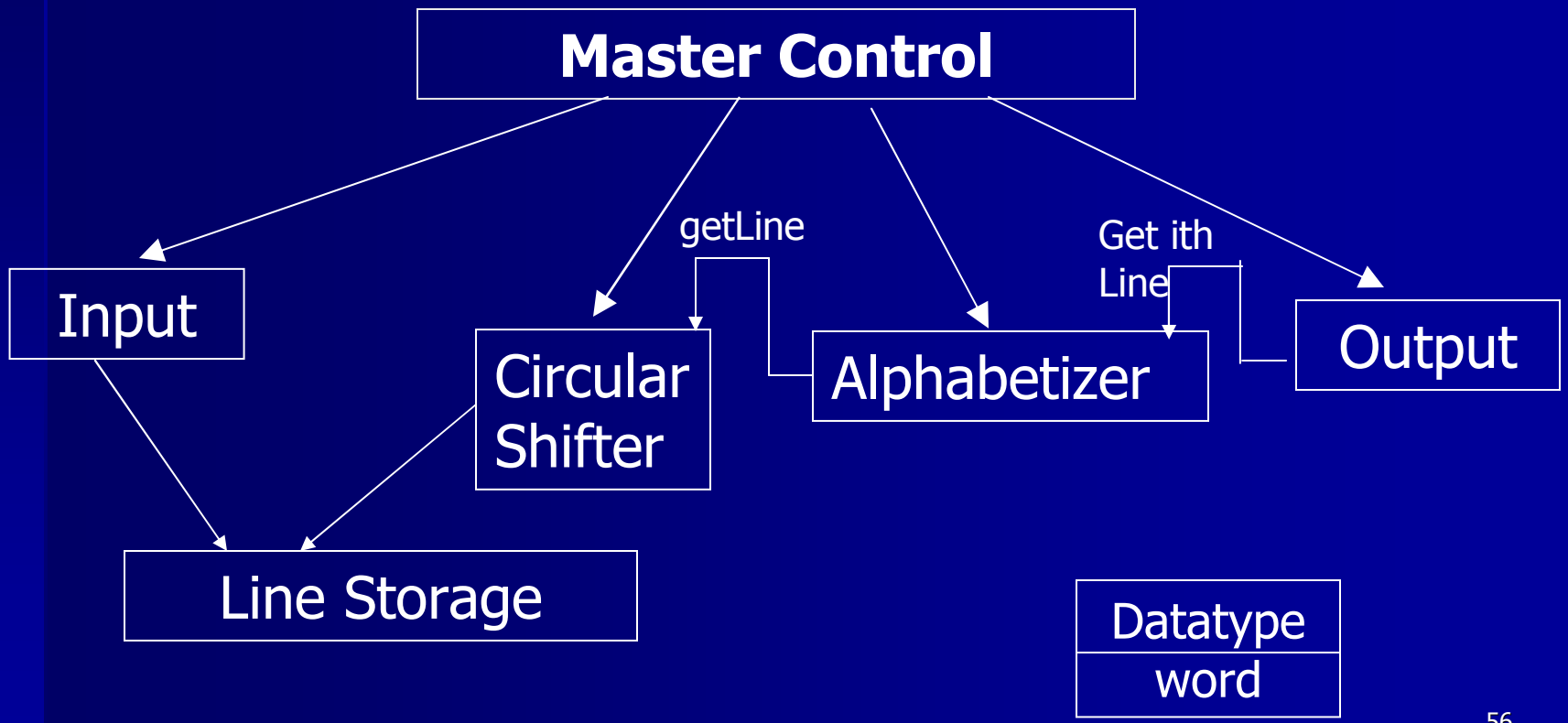
Example – KWIC

- Design II



Example – KWIC

- Design II



Example – KWIC

- **Possible changes**
  - Input format
  - Have lines partially stored in memory
  - Take different formats for Word
  - Partially alphabetize lines

KWIC in BoxScript