CS 535 Object-Oriented Programming & Design
Fall Semester, 2011
Doc 17 Analysis
Nov 8 2011

Scale Changes Everything

Overview of Design Process

Exploratory Phase

- Finding the objects
- Determining responsibilities
- Finding collaborations

Analysis Phase

- Finding hierarchies
- Finding subsystems
- Refining the design

Analysis Phase

Finding Inheritance

- Determine which classes are related via inheritance
- Finding abstract classes
- Determine class contracts

Analysis Phase

Finding Object Interaction

- Divide responsibilities into subsystems
- Designing interfaces of subsystems and classes

Analysis Phase

Refining the Design

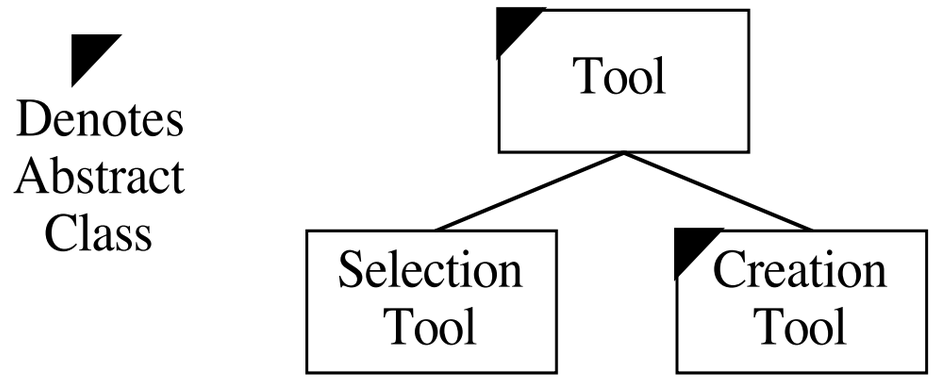
- Construct protocols for each class
- Produce a design specification for each class and subsystem
- Write a design specification for each contract

Analysis Phase

Finding Inheritance

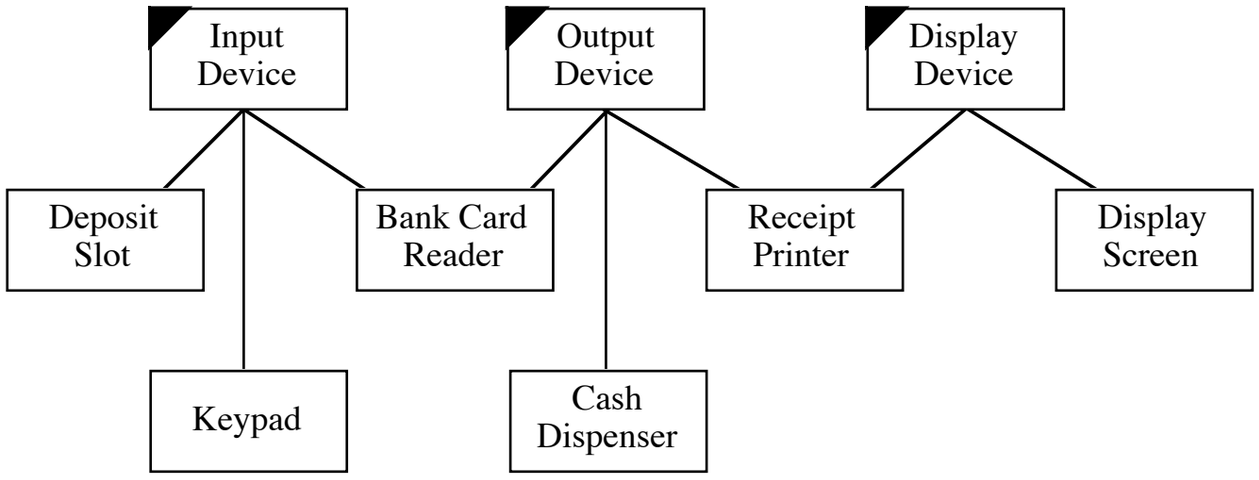
- Determine which classes are related via inheritance
- Finding abstract classes
- Determine class contracts

Hierarchies



Building Good Hierarchies

Model a "kind-of" hierarchy

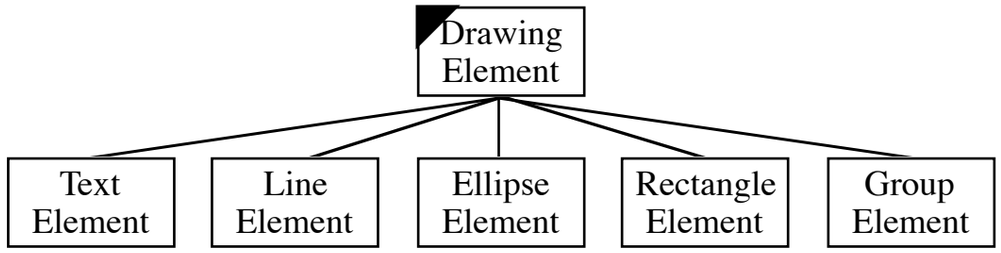


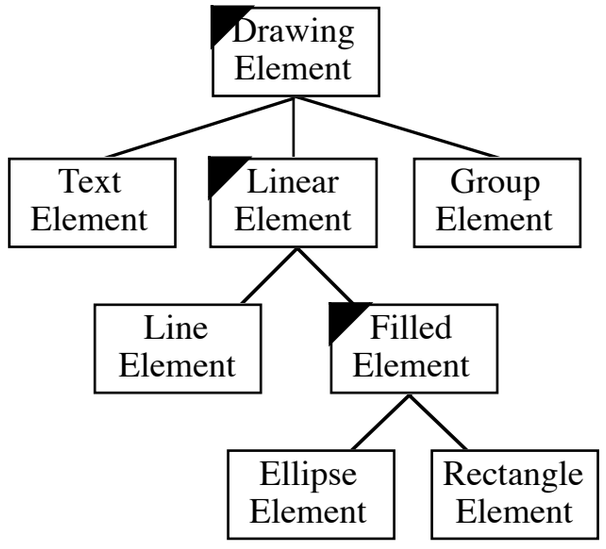
Make sure that abstract classes do not inherit from concrete classes

Eliminate classes that do not add functionality

Multiple inheritance can be used in the design even if you use an implementation language with single inheritance.

Factor common responsibilities as high as possible





Identifying Contracts

Contract

Set of requests that a client can make of a server

Cohesive set of responsibilities that a client can depend on

Abstraction of a set of responsibilities of a class

Example: Account Class

Contract: Access and modify the account balance

Responsibilities:

Know the account balance

Accept deposits

Accept withdrawals

Identifying Contracts

Group responsibilities used by the same clients

Maximize the cohesiveness of classes

Contract of a class should make sense together

Minimize the number of contracts

Use inheritance

Set of classes all supporting a common contract should inherit the contract from a common superclass

Applying the Guidelines

Start defining contract at the top of the hierarchies

Name and number each contract

For each collaboration, determine which contract represents that collaboration

Analysis Phase

Finding Object Interaction

Divide responsibilities into subsystems

Designing interfaces of subsystems and classes

Subsystems

Subsystems are groups of classes, or groups of classes and other subsystems, that collaborate among themselves to support a set of contracts

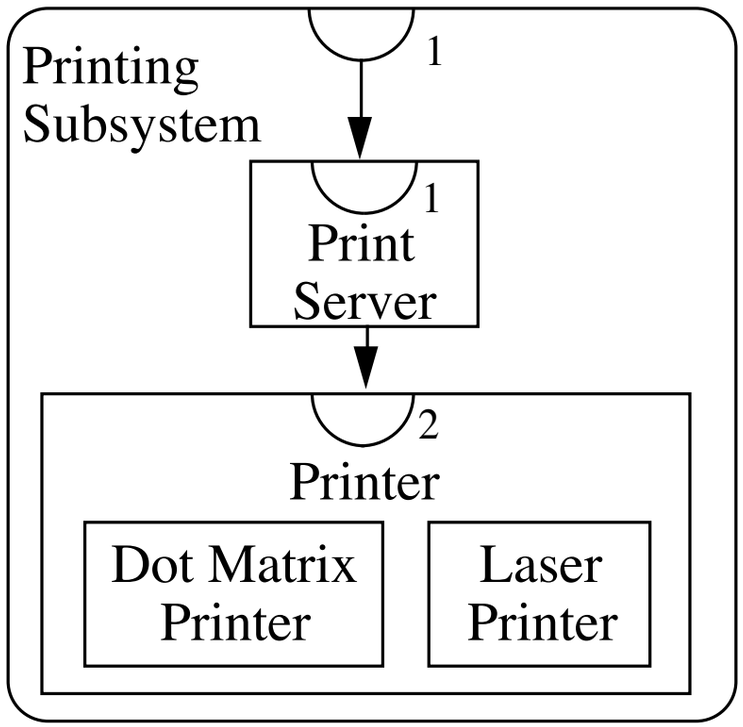
There is no conceptual difference between the responsibilities of a class and a subsystem of classes

The difference between a class and subsystem of classes is a matter of scale

Subsystems

A subsystem should be a good abstraction

There should be as little communication between different subsystems as possible



Bottom-Up

Most texts illustrate OO design "bottom-up"

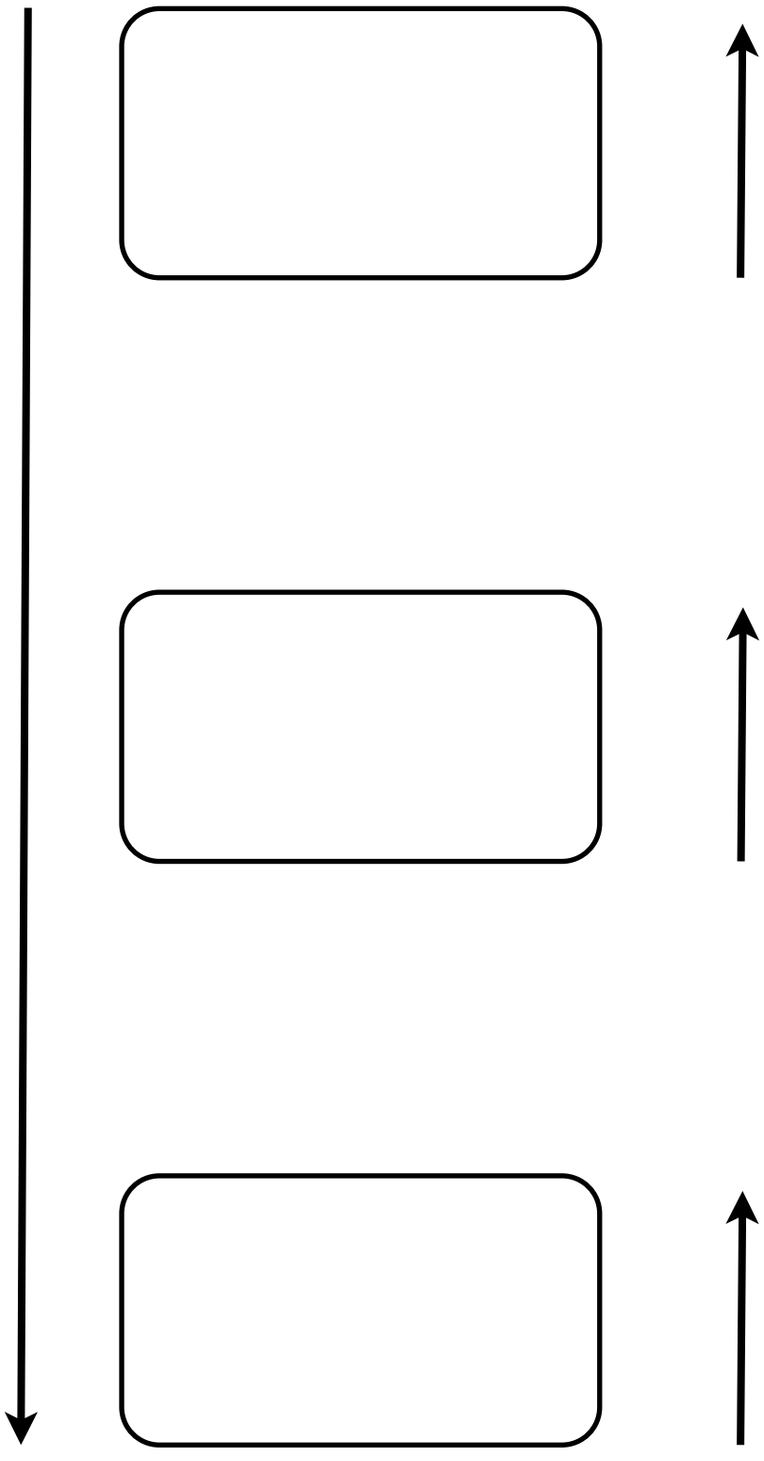
- Find objects
- Determining responsibilities
- Determine object collaboration
- Find hierarchies
- Determine subsystems

Top-Down

Large systems are designed "top-down"

- Find top level subsystems
- Determine subsystem responsibilities
- Determine subsystem collaboration
- Find hierarchies
- Iterate above steps on each subsystem

Top-Down, Bottom Up



Each level is built "bottom-up"

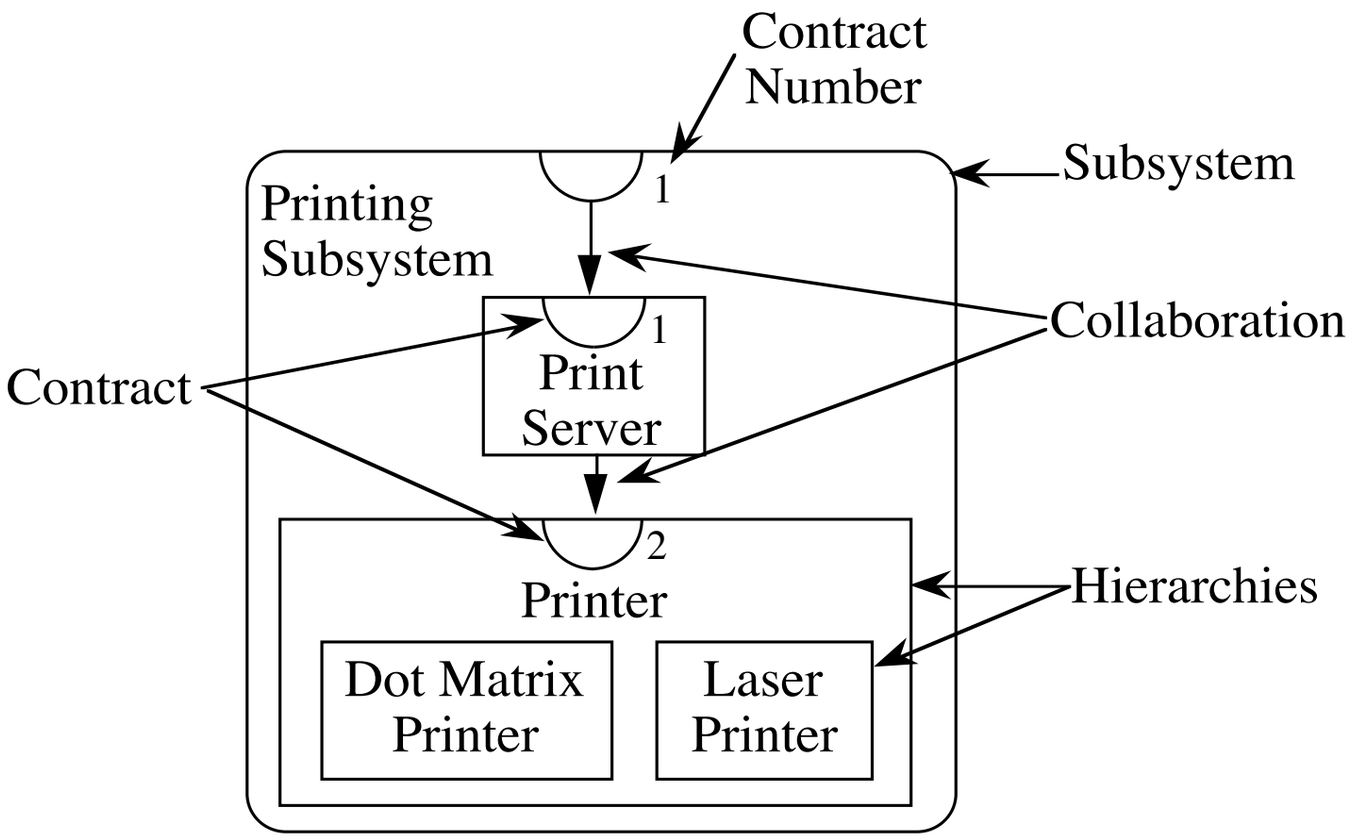
Levels are done "top-down"

Large Systems

Jacobson, 1991

"The subsystem division in small projects is normally made at the end of the analysis, when the architecture is clear. In larger projects, however, it often must be done earlier, in many cases even before the analysis model has been developed."

Collaboration Graphs



Subsystem Contracts

A subsystem contract consists of all class contracts that provide services to clients outside the system

Subsystem contracts can be extended

Subsystem Cards

Subsystem: Drawing Subsystem	
Access a drawing	Drawing
Modify part of a drawing	Drawing element
Display a drawing	Drawing

Contracts

Internal item supporting contract

Class Cards

Class: File	
Document File, Graphics File, Text File	
Know its contents Print its contents	Printing Subsystem

Identifying Subsystems

All objects which have strong coupling should be placed in the same subsystem

There should be as little communication between different subsystems as possible

Does a set of classes make sense as an abstraction?

Can you name a group of classes?

Does a group of classes interact frequently?

Simplifying Interactions

Subsystems

Reduce complexity of a design

Provide coherent structure to the design

Minimize the number of collaborations a class has with other classes or subsystems

Reassign responsibilities or expand the knowledge of another class to create fewer collaborations

Create subsystem to reduce collaborations

Analysis Phase

Refining the Design

- Construct protocols for each class
- Produce a design specification for each class and subsystem
- Write a design specification for each contract

Protocols

Construct protocols for each class

Specify the signatures for the methods that each class will implement

Write a design specification for each class and subsystem

Write a design specification for each contract

Refining Responsibilities

Turn contracts into protocols

Account contract 1

Access and modify the account balance

Know the account balance

Accept deposits

Accept withdrawals

Protocols

balance() returns Fixed Point Number

deposit(Fixed Point Number)

withdraw(Fixed Point Number)

Refining Responsibilities

Define reasonable defaults

First, define the most general message, one that allows clients to supply all possible required parameters

Next, provide default values for any parameter for which it is reasonable to do so

Finally, analyze how each client uses this general message. From that analysis, define a set of messages that allows clients to specify only some of the parameters, while relying on defaults for the others.

Define reasonable defaults

Example: Display of Drawing Elements

Parameters

- Display device – printer or screen
- Display region – clipping region
- Drawing rule – how to combine new bits with old
- Transformation – from element space to display space

Defaults

- Display device – active window
- Display region – entire medium
- Drawing rule – over, completely replace old bits
- Transformation – identity

Protocol

Protocol

display()
display(Display Device)
display(Region)
display(Display Device, Region)
display(Display Device, Region, Drawing Rule)
display(Display Device, Region, Drawing Rule, Transformation)

Specifying the Design - Classes

Class: Drawing (Concrete)
Superclasses: Displayable Object
Subclasses: none
Hierarchy Graphs: page 5
Collaborations Graph: page 8
Description: This class represents the structure of ...
Contracts

1. Display itself

   This contract is inherited from Displayable Object

2. Maintain the elements in a drawing

   Know which elements are contained in the drawing

   addElement (Drawing Element) - uses List

   This method adds a drawing element ...

   elementAt (Point) returns Drawing Element

   uses List, Drawing Element (3)

   This method returns the first drawing ...

Specifying the Design - Subsystems

Subsystem: Drawing Subsystem

Classes: Control Point, Drawing, Drawing Element, Ellipse Element, Filled Element, Group Element, Line Element, Linear Element, Rectangle Element, Text Element

Collaborations Graphs: pages 6 and 8

Description: The Drawing subsystem is responsible for displaying, maintaining the contents of a drawing. The Drawing Subsystem supports three contracts. Two are supported by ...

Contracts

1. Display itself
   This contract is defined by Displayable Object, and supported by Drawing
   Server: Drawing
2. Access and modify the contents of a drawing
   Server: Drawing
3. Modify the attributes of a Drawing Element
   Server: Control Point

Specifying the Design - Formalizing Contracts

Contract 3: Modify the attributes of a drawing element

Server: Control Point

Client: Selection Tool

Description: This contract allows modification of a drawing element through the manipulation of a control point associated with that element. The result of moving the control point is specified by the drawing element at the time the control point is created.

For each contract include:

- Contract name and number
- Server(s)
- Clients
- Description of the contract