SWE209
Object Oriented Analysis and Design

Object Design - 2 (Interface Specification)

Note

- This presentation is based on the slides and content of the course main textbook.
- Bernd Bruegge, Allen H. Dutoit, Object-Oriented Software Engineering: Using UML, Patterns and Java, 3rd Edition, Pearson, 2014
- https://ase.in.tum.de/lehrstuhl_1/component/content/article/43-books/217

Agenda

Big Picture

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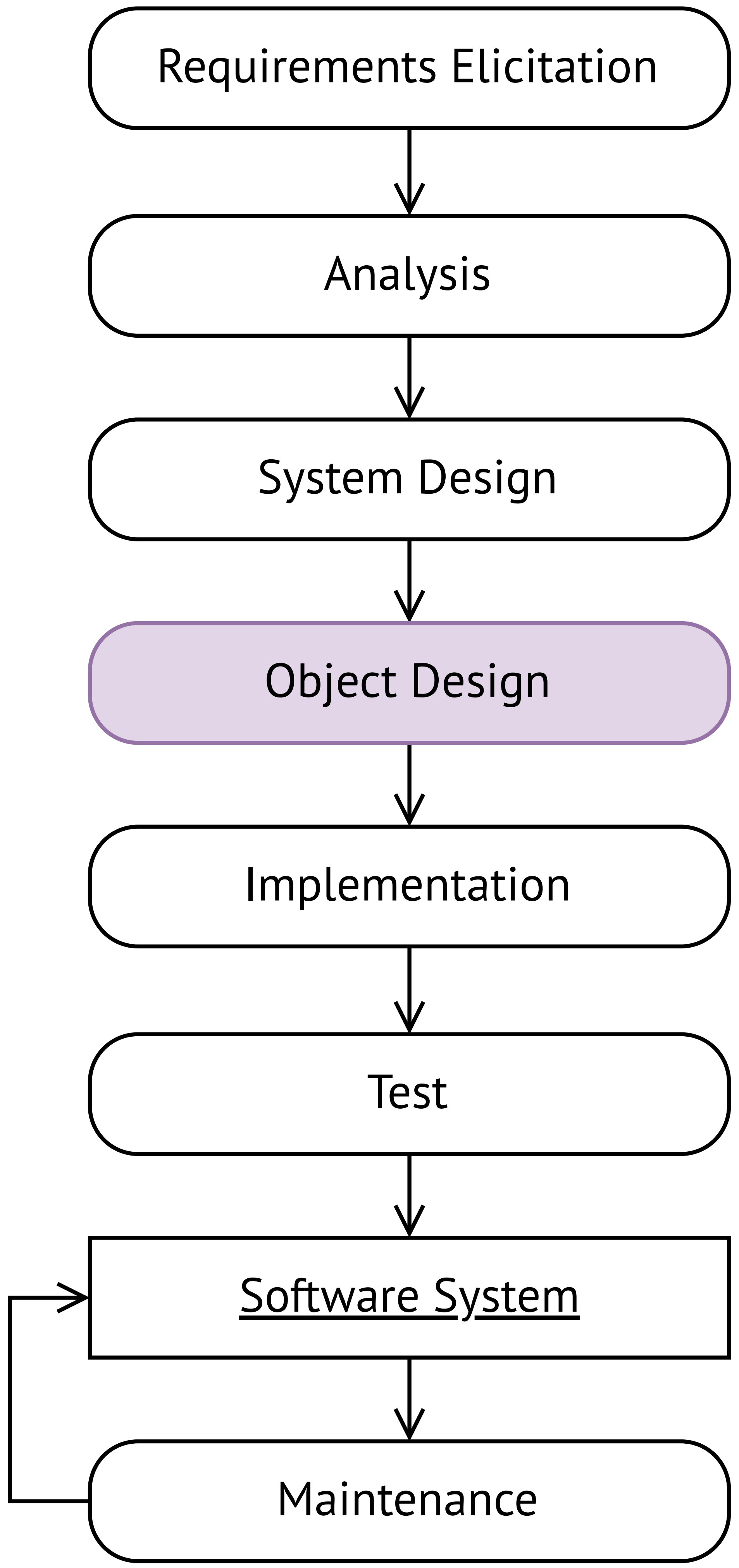
Big Picture



Requirements Elicitation

Analysis

System Design

Object Design

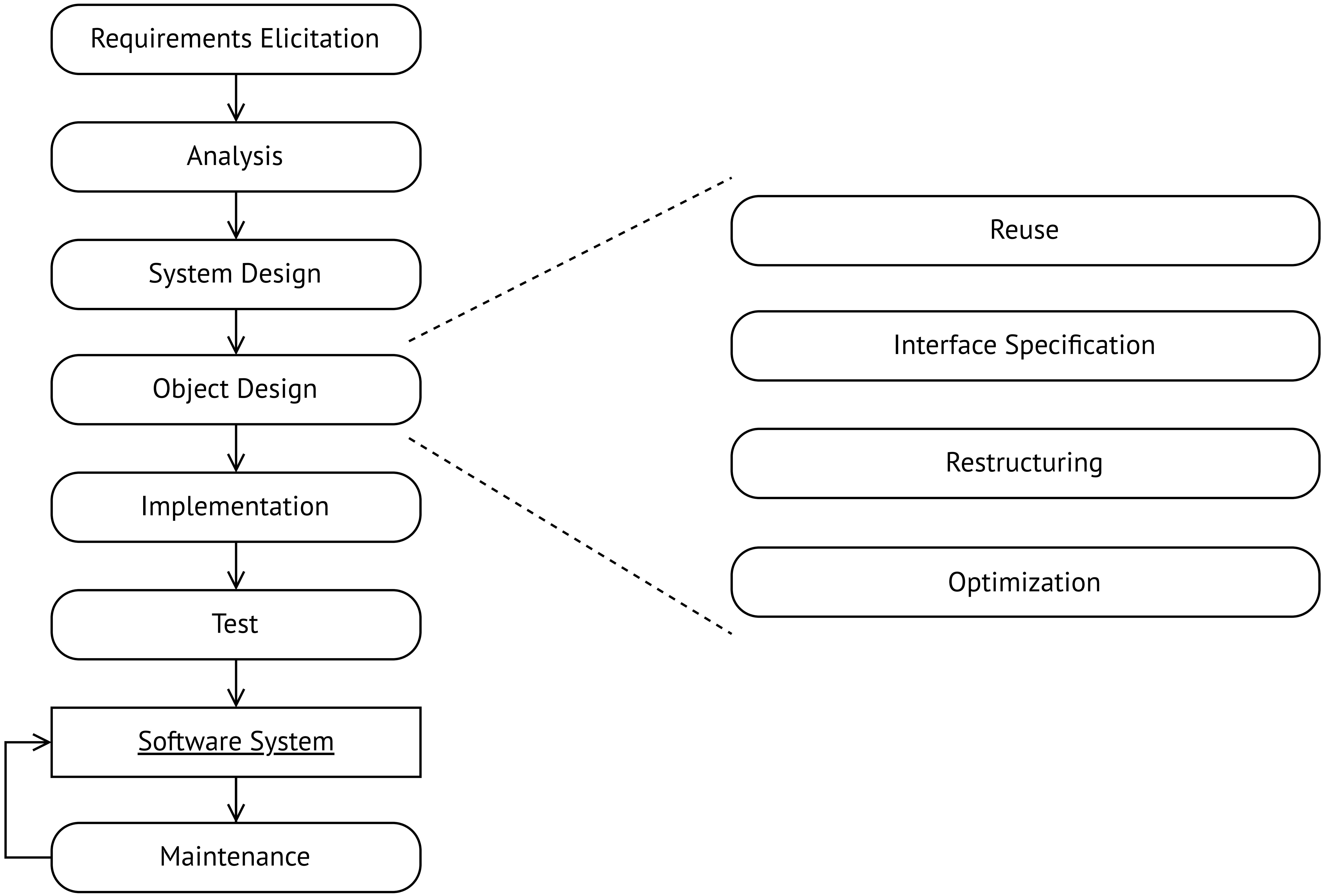
Implementation

Test

Software System

Maintenance

Introduction



Introduction

- In this slide we are going to learn **interface specification** activity of object design.
- Object design → Identify and refine solution objects to realize the subsystems defined during system design.
- Focus of system design → Identify large chunks of work that could be assigned to individual teams or developers
- Focus of object design → Specify the boundaries between objects.

Introduction

- Object design
  - Large number of developers concurrently refines and changes many objects and their interfaces.
  - The opportunity to introduce new, complex faults into the design is still there.
- Focus of interface specification → Communicate clearly and precisely about increasingly lower-level details of the system.

Introduction

Interface Specification

- Main goal:
  - Describe the interface of each object precisely
- Sub activities of interface specification:
  - Identifying missing attributes and operations
  - Specifying type signatures and visibility
  - Specifying invariants
  - Specifying preconditions and postconditions

Introduction

Interface Specification

- Identifying missing attributes and operations
  - Examine each subsystem service and each analysis object.
  - Identify missing operations and attributes.
  - Refine the current object design model and augment it with these operations.

Introduction

Interface Specification

- Specifying type signatures and visibility
  - Decide;
    - which operations are available to other objects and subsystems
    - which are used only within a subsystem
  - Specify;
    - the return type of each operation
    - the number and type of its parameters of each operation

Introduction

Interface Specification

- Specifying invariants
  - Describe behavior of the operations provided by each object in terms of constraints.
- Specifying preconditions and postconditions
  - For each operation;
    - describe the conditions that must be met before the operation is invoked
    - describe a specification of the result after the operation returns.

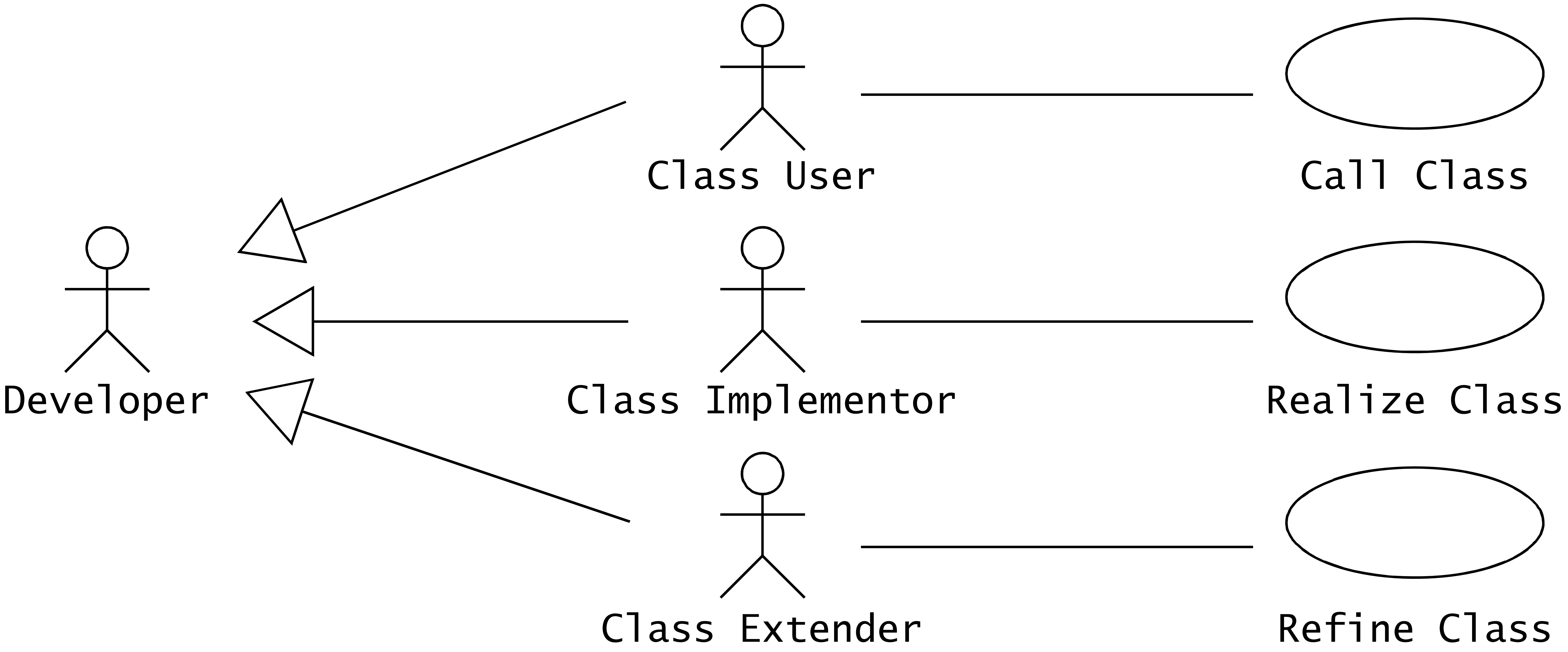
Concepts of Interface Specification

Concepts of Interface Specification

- Class Implementor, Class Extender, and Class User
- Types, Signatures, and Visibility
- Contracts: Invariants, Preconditions, and Postconditions
- Object Constraint Language

Class Implementor, Class Extender, and Class User

- Developers view the specifications from radically different point of views.



Bernd Bruegge, Allen H. Dutoit, Object-Oriented Software Engineering: Using UML, Patterns and Java, 3rd Edition, Pearson, 2014.

Class Implementor, Class Extender, and Class User

- Class implementor → Realize the class under consideration.
- Class user → Invoke the operations provided by the class under consideration during the realization of another class (client class).
- Class extender → Develop specializations of the class under consideration.

Types, Signatures, and Visibility

- Analysis activity → Identify attributes and operations without necessarily specifying their types or their parameters.
- Object design activity → Refine the analysis and system design models by completing type and visibility information.
- The **type** of an attribute;
    - specifies the range of values the attribute can take.
    - specifies the operations that can be applied to the attribute.

Types, Signatures, and Visibility

- Operation parameters and return values are typed in the same way as attributes are.
- **Signature** of the operation → The tuple made out of the types of the parameters and the type of the return value of an operation.
- Sample signatures;
  - `acceptPlayer(Player):void` → Takes one parameter of type Player, does not have a return value.
  - `getMaxNumPlayers():int` → Takes no parameters and returns an int.

Types, Signatures, and Visibility

- The **visibility** of an attribute or an operation → A mechanism for specifying whether the attribute or operation can be used by other classes or not.
- Four levels of visibility according to UML:
  - Private
  - Protected
  - Public
  - Package

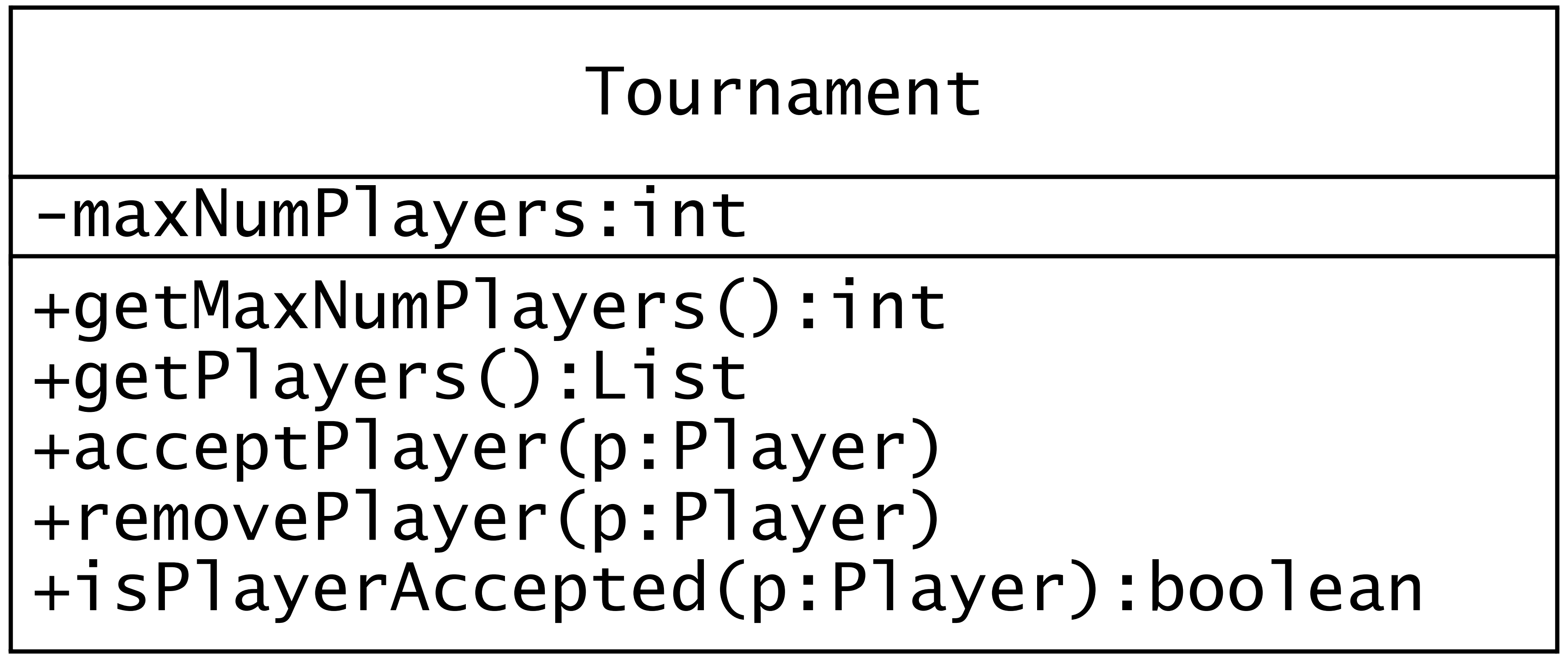
Types, Signatures, and Visibility

- **Private** → Can be accessed only by the class in which it is defined.
  - Intended for the class implementor only.
- **Protected** → Can be accessed by the class in which it is defined and by any descendant of that class.
  - Intended for the class extender.
- **Public** → Can be accessed by any class.
  - Constitute the public interface of the class.
  - Intended for the class user.

Types, Signatures, and Visibility

- **Package** → Can be accessed by any class in the nearest enclosing package.
- Visibility representation in UML
  - Prefix the name of the attribute or the operation with a character symbol.
  - – → private
  - # → protected
  - + → public
  - ~ → package

Types, Signatures, and Visibility



Tournament

-maxNumPlayers:int

+getMaxNumPlayers():int
+getPlayers():List
+acceptPlayer(p:Player)
+removePlayer(p:Player)
+isPlayerAccepted(p:Player):boolean

Bernd Bruegge, Allen H. Dutoit, Object-Oriented Software Engineering: Using UML, Patterns and Java, 3rd Edition, Pearson, 2014.

Contracts: Invariants, Preconditions, and Postconditions

- Contract → Constraint on a class that enable developers to share the same assumptions about the class.
- Three types of constraints:
  - Invariant → A predicate that is always true for all instances of a class.
  - Precondition → A predicate that must be true before an operation is invoked.
  - Postcondition → A predicate that must be true after an operation is invoked.

Contract Inheritance

- In a polymorphic language, a class can be substituted by any of its descendants.
- A class user invoking operations on a class could be invoking instead a subclass.
- The class user expects that a contract that holds for the superclass still holds for the subclass.
    - Contract inheritance

Contract Inheritance

- Contracts are inherited in the following manner:
- Preconditions.
    - A method of subclass is allowed to weaken the preconditions of the method it overrides.
    - An overwritten method can handle more cases than its superclass.
- Postconditions.
    - Methods must ensure the same postconditions as their ancestors or stricter ones.

Contract Inheritance

- Invariants.
  - A subclass must respect all invariants of its superclasses.
  - A subclass can strengthen the inherited invariants.

Object Constraint Language

- A constraint can be expressed in natural language or in a formal language.
- Object Constraint Language (OCL) is a language that allows constraints to be formally specified on model elements.
- Model elements can be;
    - single model elements (e.g., attributes, operations, classes) or
    - groups of model elements (e.g., associations and participating classes).

Interface Specification Activities

Interface Specification Activities

- Identifying Missing Attributes and Operations
- Specifying Type Signatures and Visibility
- Specifying Preconditions and Postconditions
- Specifying Invariants

Identify Missing Attributes and Operations

- Examine the service description of the subsystem and identify missing attributes and operations.
- During analysis, we may have missed many attributes. Why?
  - Focus on the application domain when constructing the object model.
  - Ignorance of the details related to the system that are independent of the application domain.

Specify Type Signatures and Visibility

- Specify the types of the attributes, the signatures of the operations, and the visibility of attributes and operations.
- Specifying types refines the object design model in two ways.
    - Add detail to the model by specifying the range of each attribute.
    - Map classes and attributes of the object model to built-in types provided by the development environment.
- Consider the relationship between the classes identified and the classes from existing components.
- Determine the visibility of each attribute and operation during this step.

Specify Preconditions and Postconditions

- Define contracts for each public operation of each class.
- Contract → Agreement between the class user and the class implementor.
- The preconditions of an operation describe the part of the contract that the class user must respect.
- The postconditions describe what the class implementor guarantees in the event the class user fulfilled her part of the contract.
- When refining a class, class extenders inherit the contract from the original class implementor.

Specify Invariants

- Invariants provide an overview of the essential properties of the class.
- Invariants constitute a permanent contract that extends and overwrites the operation-specific contracts.
- Some invariants are obvious and can be written from the start.
- Some invariants can be identified by extracting common properties from operation-specific contracts.

Documenting Object Design

Documenting Object Design

- Object design is documented in the Object Design Document (ODD).
- Describe
  - object design trade-offs made
  - guidelines followed for subsystem interfaces
- Used to exchange interface information among teams and as a reference during testing.
- The audience for the ODD → System architects, developers, and testers.

Documenting Object Design

- There are three main approaches to documenting object design:
- Self-contained ODD generated from model.
  - Write and maintain a UML model and generate the document automatically.
- ODD as extension of the RAD.
  - Treat the object design model as an extension of the analysis model.
- ODD embedded into source code.
  - Embed the ODD into the source code.

Documenting Object Design

- Currently generating the ODD from source code and focusing the RAD on the application domain is the most practical.
- Reduces the amount of redundant information to be maintained.
- Locates the object design information where it is the most accessible.
- The consistency between the source code and the analysis model must still be maintained manually.

Documenting Object Design

- Outline of the object design document
  - 1. Introduction
    - 1.1 Object design trade-offs
    - 1.2 Interface documentation guidelines
    - 1.3 Definitions, acronyms, and abbreviations
    - 1.4 References
  - 2. Packages
  - 3. Class interfaces
  - Glossary

References

- Bernd Bruegge, Allen H. Dutoit, Object-Oriented Software Engineering: Using UML, Patterns and Java, 3rd Edition, Pearson, 2014.
- Object Management Group, OMG Unified Modeling Language Superstructure, Version 2.2., http://www.omg.org/2009.

Thank you.