Chapter 1

Object-Oriented Analysis and Design

Disclaimer

- Slides come from a variety of sources:
  - Craig Larman-developed slides; author of this classic textbook.
  - Dr. Constantinos Constantinides, University of London
  - Slides from the University of Pittsburg
  - Slides from many of my existing slides on these same topics
  - New slides from sources unknown…

Chapter 1

- Chapter one covers a host of many topics central to today's technologies.
- These skills are essential in today's professional community.
- We will talk about (in some detail) iterative development, evolutionary development, the Unified Process, agile approaches, UML,
- Later on we will advance into more complex concepts that address framework design and architectural analysis.
- Please note that the materials are meant to be foundational.

Thinking in Objects and UML - 1

- The Unified Modeling Language (UML) is a standard diagramming notation; sometimes referred to as a blueprint.
- It is NOT OOA/OOD or a method
- **Only a notation for capturing objects and the relationships** among objects (dependency; inheritance; realizes; aggregates, . .)
- UML is language-independent
- Analysis and design provide software "**blueprints**" captured in UML.
- Blueprints serve as a tool for thought and as a form of communication with others.

Thinking in Objects and UML – 2

- But it is far more essential to 'think' in terms of **objects** as providing '**services**' and accommodating '**responsibilities**.'

- **Discuss**: What is meant by 'services?' How indicated?
  - How might you think these 'services' impact the design of classes?
  - How might a client access these services?
  - What is encapsulation? How does it relate to reusability? Self-governance? Design?

- **Discuss**: What is meant by 'responsibilities?'
  - Encapsulation of data and services?

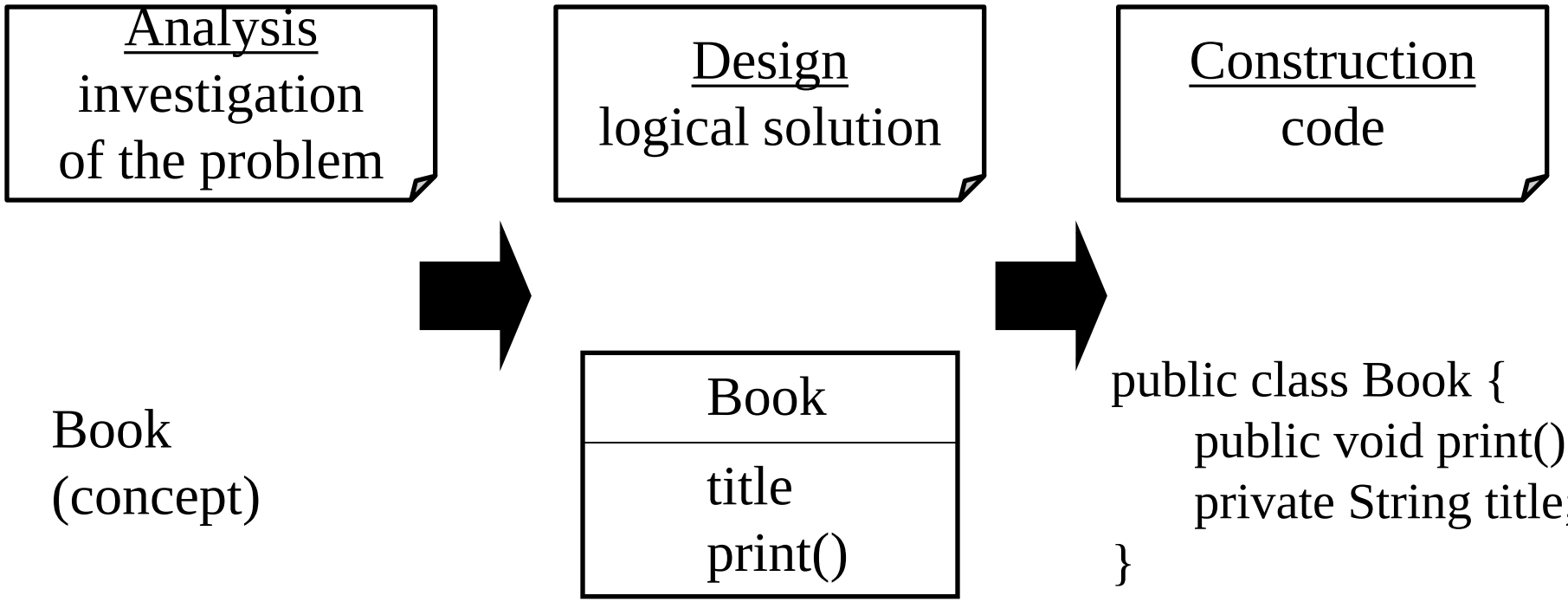
Thinking in Terms of Objects and UML - 3

- **Object-Oriented Analysis (Overview)**
  - An **investigation** of the **problem** (rather than how a solution is defined)
  - During OO analysis, there is an emphasis on finding and describing the objects (or concepts) in the **problem domain**.
  - For example, concepts in a Library Information System include *Book*, and *Library*.
  - High level views found in the application domain.
  - Oftentimes called **domain objects; entities.**

Thinking in Terms of Objects and UML - 4

- **Object-Oriented Design**
  - Emphasizes a conceptual **solution** that fulfills the requirements.
  - Need to define sof**tware objects** and how they **collaborate** to meet the requirements.
  - For example, in the Library Information System, a *Book* software object may have a *title* attribute and a *getChapter* method.
    - What are the methods needed to process the attributes?
- Designs are **implemented** in a programming language.
  - In the example, we will have a *Book* class in Java.

Thinking in Terms of Objects and UML – 5
From Design to Implementation



Can you see the services / responsibilities in the Book class?

Thinking in Objects and UML-6

- Then too, there are sets of **proven design solutions** to problems that are considered ‘best practices.’
  - Certain ‘groupings’ of classes with specific responsibilities / interfaces.
  - These provide specific solutions to specific problems.
  - Called **Design Patterns**

- We will discuss (much later) these standard patterns and how to **apply** them to develop solutions to common design problems.

Thinking in Objects and UML-7

- Of course, design (solution to requirements) ‘assume’ a robust **requirements analysis** has taken place.

- **Use Cases** are often used to capture **stories** of requirements and are often views as ‘constituting’ the **functional** requirements, but NOT the software quality factors (non-functional requirements).

- Use Cases are **not specifically designed** to be object-oriented, but rather are meant to capture how an application will be used.

- Many methods for capturing requirements.
- We will concentrate on Use Cases (ahead).

Basic Terms: Iterative, Evolutionary, and Agile

1. Introduction

- ***Iterative*** - the entire project will be composed of min-projects and will iterate the same activities again and again (but on different part of the project AND with different emphases) until completion.
- ***Evolutionary (*or *incremental)*** - the software grows by increments (to be opposed to the traditional, and somewhat old-fashioned, Waterfall model of software development).
- ***Agile*** - we will use a light approach to software development rather than a very rigid one (which may be needed for a safety-critical system for example)
- This kind of approach seems better at treating software development as a **problem solving activity**; also the use of objects makes it amenable.

Our Approach:

•We need a Requirements Analysis approach with OOA/OOD need to be practiced in a framework of a development process.

•We will adopt an agile approach (light weight, flexible) in the context of the Unified Process, which can be used as a sample iterative development process.

- Within this process, the principles can be discussed.

•Please note that there are several other contexts that may be used, such as Scrum, XP, Feature-Driven Development, Lean Development, Crystal Methods and others…and we will look at a few of these.

Why the Unified Process:

- The Unified Process is a popular iterative software development process.

- Iterative and evolutionary development involves relatively early programming and testing of a partial system, in repeated cycles.

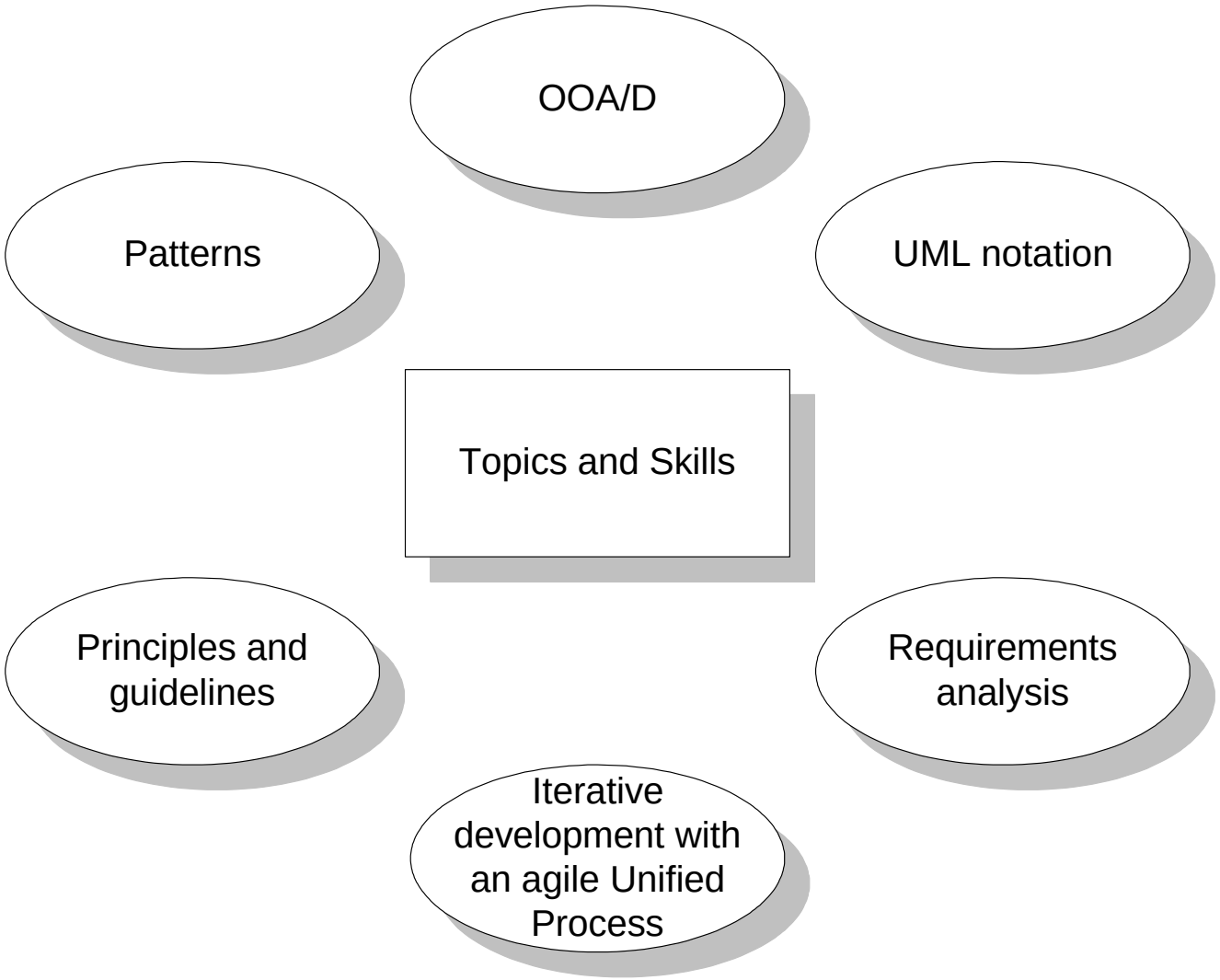
- It typically also means that development starts before the exact software requirements have been specified in detail;

- Feedback (based on measurement) is used to clarify, correct and improve the evolving specification:
- This is in complete contrast to what we usually mean by engineering!

2. What is the Unified Process?

- The UP is very flexible and open and can include other practices from other methods such as Extreme Programming (XP) or Scrum for example.
  - e.g. XP's test-driven development, **refactoring** can fit within a UP project; So can Scrum's **daily meeting**.
  - Being **pragmatic** in adapting a particular process to your needs is an important skill : all projects are different.

We will be studying all of the topics found in Fig. 1.1



The Rush to Code

- Critical ability to develop is to think in terms of objects and to artfully **assign responsibilities to software objects**.
- Talk at great length in COP 3538 about encapsulation and assigning methods to objects where the data is defined…
- One cannot design a **solution** if the **requirements** are not understood.
- One cannot **implement** the design if the **design** is faulty.
- If I could only stop my students….☺

The Rush to Code

- Analysis: - investigate the **problem** and the **requirements.**
  - What is needed? Required functions? Investigate domain objects.
  - Problem Domain
  - The **Whats** of a system.
  - **Do the right thing (analysis)**

- Design:
  - Conceptual solution that meets requirements.
  - Not an implementation
  - E.g. Describe a database schema and software objects.
  - Avoid the CRUD activities and commonly understood functionality.
  - The Solution Domain
  - The '**Hows**' of the system
  - **Do the thing right (design)**

What is Object-Oriented Analysis and Design

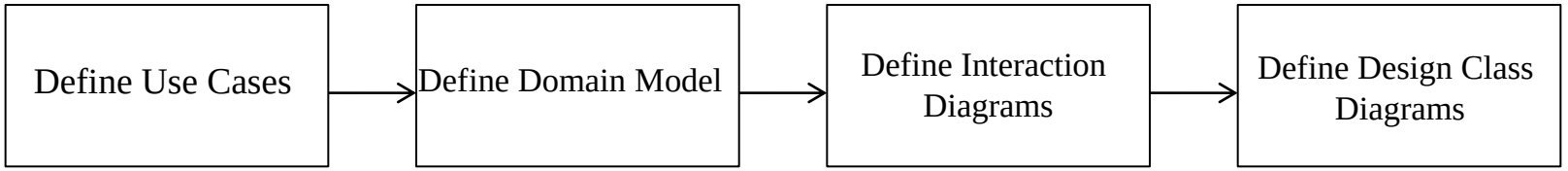
- OOA: we find and describe **business objects** or concepts in the **problem domain**

- OOD: we define how these **software objects <u>collaborate</u>** to meet the requirements.
  - Attributes and methods.

- OOP: Implementation: we implement the design objects in, say, Java, C++, C#, etc.

Homework Assignment #1
due: 19 Sep start of class. Hardcopy please.

- Using the model below, develop a two-three page discussion



outlining the four activities listed and present the major features of each.

A short definition and example of a domain model, interaction diagram, and class diagram is sufficient, but be prepared to discuss each of these.

Also, have a general idea about use cases – what they are designed to do and what they are not designed to do.

Homework Assignment #1 (continued)

- Be aware that this concludes chapter 1. But there are a number of pages in this chapter that I have not explicitly discussed in class. You are responsible for these, and some of this may appear in your midterm exams.