基于面向对象的类的设计

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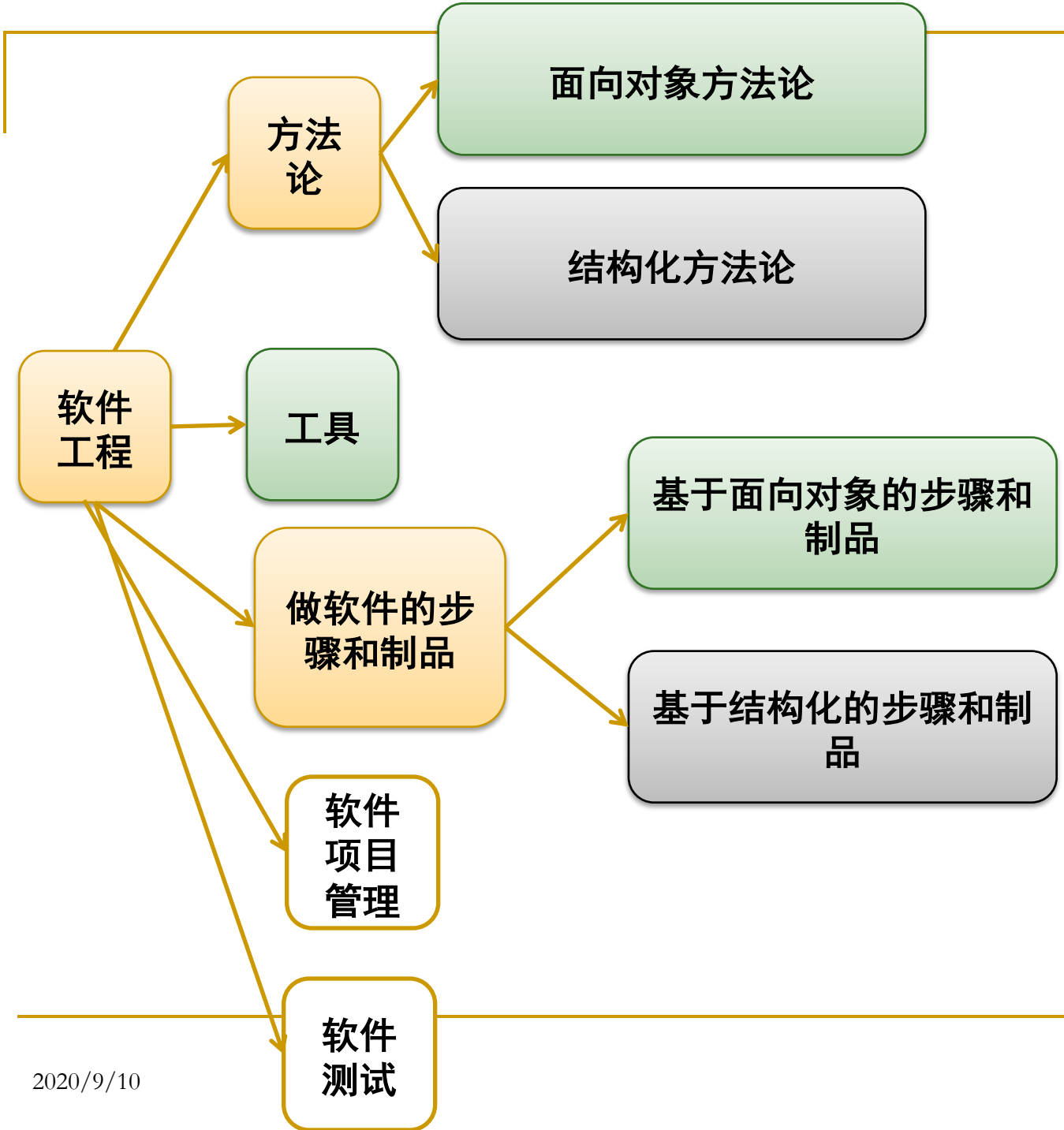
软件工程理论与实践课程内容



基于面向对象的类的设计

（用例分析）

主要内容

- 用例分析总述
- 补充用例规约
- 查找类
- 将用例行为分配给类
- 描述类
- 描述分析机制
- 合并类

类（用例分析）的设计的步骤

1. 用例分析总述
2. 补充用例规约
3. 查找类
4. 将用例行为分配给类
5. 描述类
6. 描述分析机制
7. 合并类

例子：选课系统

- 1补充用例规的
  - 返回到需求分析，找到用例规约，审核每个用例规约，确保所有事件流、辅助事件流、参数都写完整，一般不遗漏任何类的操作和属性。
  - 这个补充，是针对所有的用例的，全局性的。
  - 下面开始，是一个用例一个用例的找类，当所有用例的类都找完之后，把所有类合并一起，形成整个系统的类图。
  - 在我们作业里面，大家写3-5个用例的类的析取就好了。
  - 你们 在需求分析的用例规约里面写了几个用例，在这里，类的设计，就去解决上面的用例的类。

例子：选课系统（接前页）

- 3 关闭注册用例类的析取
  - 查找类
    - 边界类：只要有一对角色-用例，就有一个边界类，可能是人机接口（界面）、软件接口或者硬件接口；
    - 控制类：完成这个用例的操作；一个用例可以有1-多个控制类，但是，至少有一个；
    - 数据类：这个用例需要存储的信息；

例子：选课系统（接前页）

- 3 关闭注册用例类的析取
  - 查找类
  - 确定类的操作（将用例行为分配给类）
    - 经验+时序图
  - 确定类的属性
    - 领域知识，那些没有被成为类的需要存储是信息
  - 形成本用例类图

例子：选课系统例子（接前页）

- 4 学生管理用例类的析取
  - 查找类
  - 确定类的操作（将用例行为分配给类）
  - 确定类的属性
  - 形成本用例类图

例子：选课系统（接前页）

- 5 描述分析机制
  - 从需求开始，里面包括：功能需求（登录、注册、选课、人员管理）+非功能需求（安全、并发、效率、界面友好。。。）；
  - 每个用例析取了类，做了什么?答：把功能需求的要求解决了。
  - “描述分析机制”是设计的一步，目标是：解决非功能需求。

例子：选课系统（接前页）

- 6合并类
  - 这里，就是把上面所有用例得到的类，合并到一起
  - 给出整个系统的类图
  - 布局合理，字体字形字号恰当，看得清晰

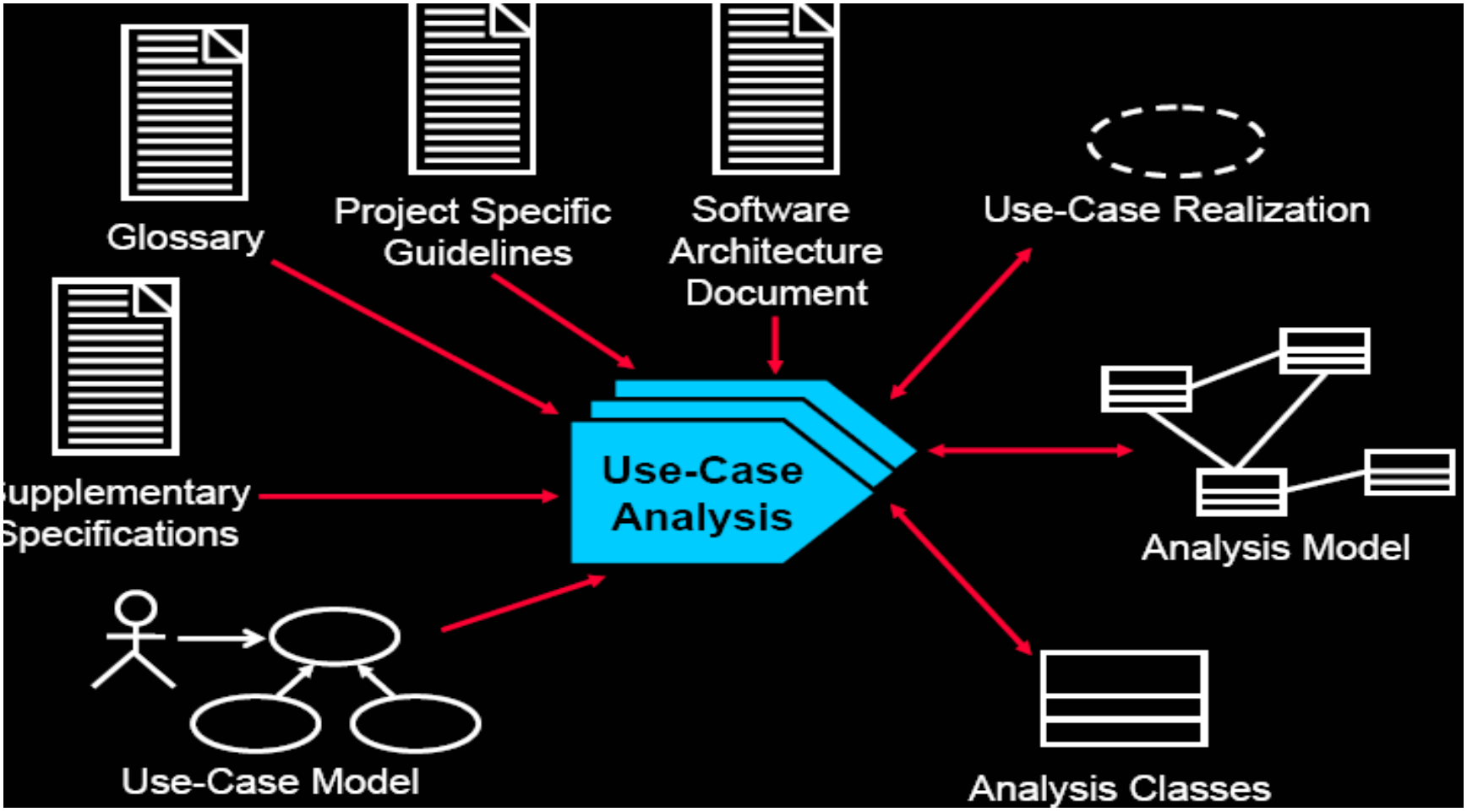
例子：选课系统（接前页）

- 2 注册课程用例的类析取
  - 查找类
  - 确定类的操作（将用例行为分配给类）
  - 确定类的属性
  - 形成本用例类图

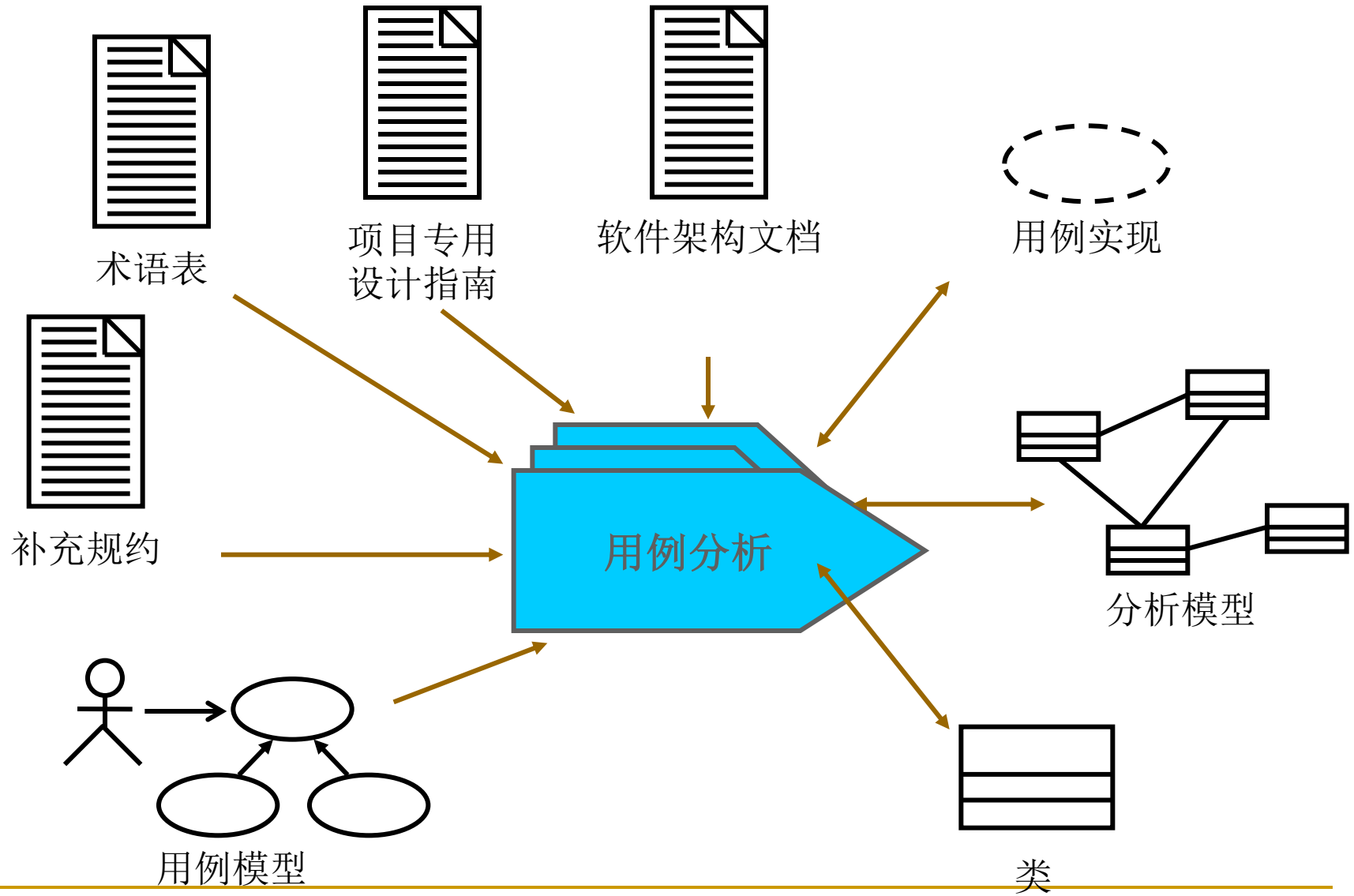
Objectives: Use-Case Analysis

- Explain the purpose of Use-Case
- Analysis and where in the lifecycle it is performed
- Identify the classes which perform a usecase flow of events
- Distribute the use-case behavior to those classes, identifying responsibilities of the classes
- Develop Use-Case Realizations that model the collaborations between instances of the identified classes

总揽


Glossary
Project Specific Guidelines
Software Architecture Document
Use-Case Realization
Supplementary Specifications
Use-Case Analysis
Analysis Model
Use-Case Model
Analysis Classes

基于面向对象的类的设计（用例分析）



第八章　用例分析

主要内容

用例分析总述

补充用例规约

查找类

将用例行为分配给类

描述类

描述分析机制

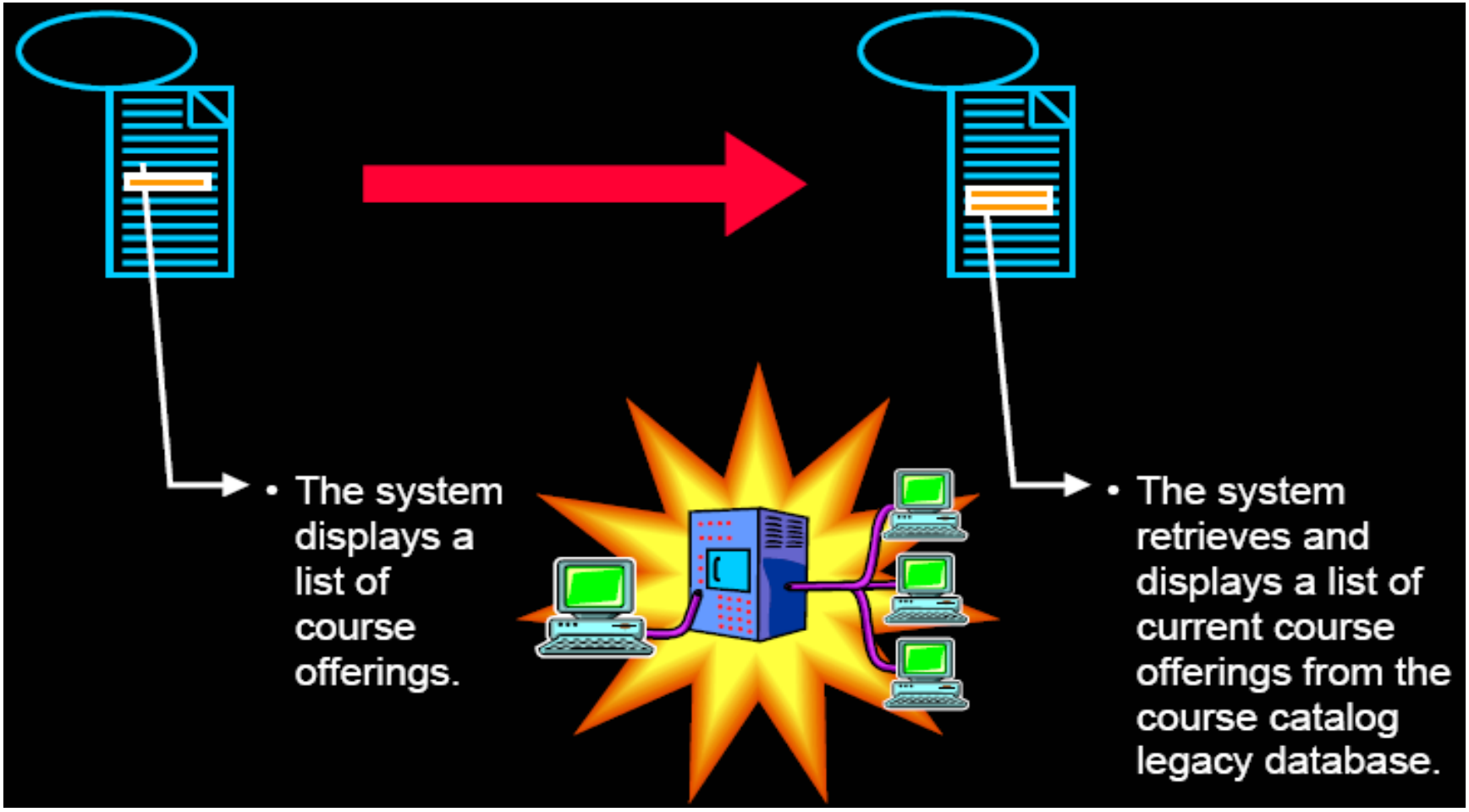
合并类

案例实践

Use-Case Analysis Steps

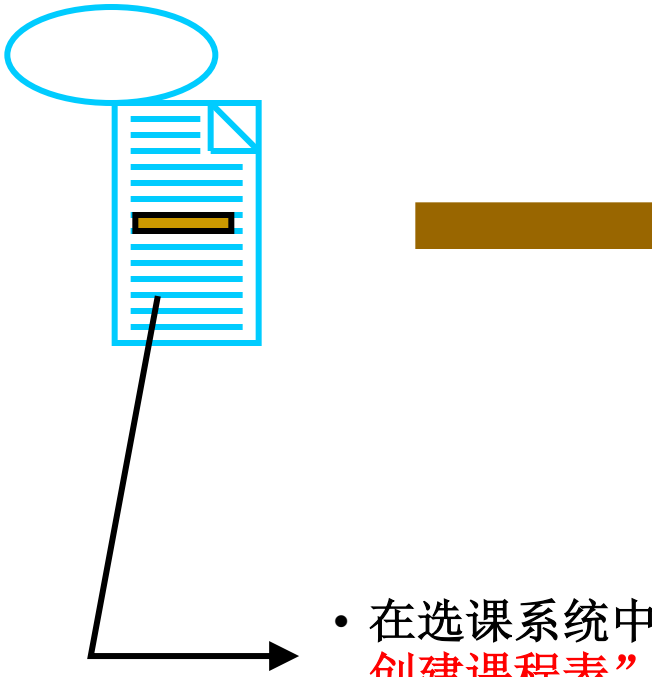
- Supplement the Use-Case Description
- For each Use-Case Realization
  - Find Classes from Use-Case Behavior
  - Distribute Use-Case Behavior to Classes
- For each resulting class
  - Describe Responsibilities
  - Describe Attributes and Associations
  - Qualify Analysis Mechanisms
- Unify classes
- Checkpoints

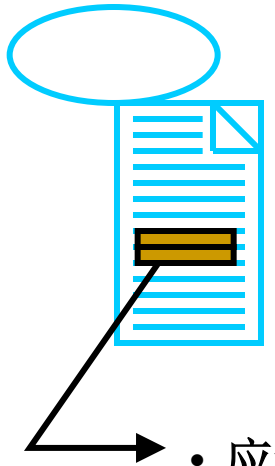
Supplement the Use-Case Description

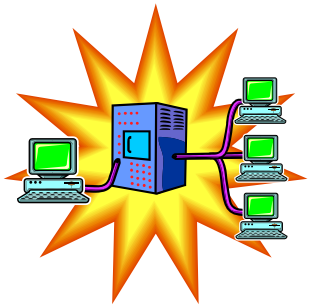


补充用例规约

步骤1：修改完善需求分析中的用例规约







- 在选课系统中，学生点击“创建课程表”
- 系统显示课程列表

- 应该：系统找到并列出课程目录数据库（遗留系统）提供的课程列表，共学生选择

上面这样写，可以吗？
不可以！

补充用例规约，到底是啥意思

- 需要打开前面的需求分析，对所有用例规约进行审核
- 看看，是否有某些输入、输出，没有写全
- 是否，有某些操作，是“拐弯抹角”的，需要详细写出流程
- 以便程序员能够理解并且写出完整的代码
- 语言描述要简洁、清晰

Use-Case Analysis Steps

- Supplement the Use-Case Description
- For each Use-Case Realization
  - Find Classes from Use-Case Behavior
  - Distribute Use-Case Behavior to Classes
- For each resulting class
  - Describe Responsibilities
  - Describe Attributes and Associations
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- Unify classes
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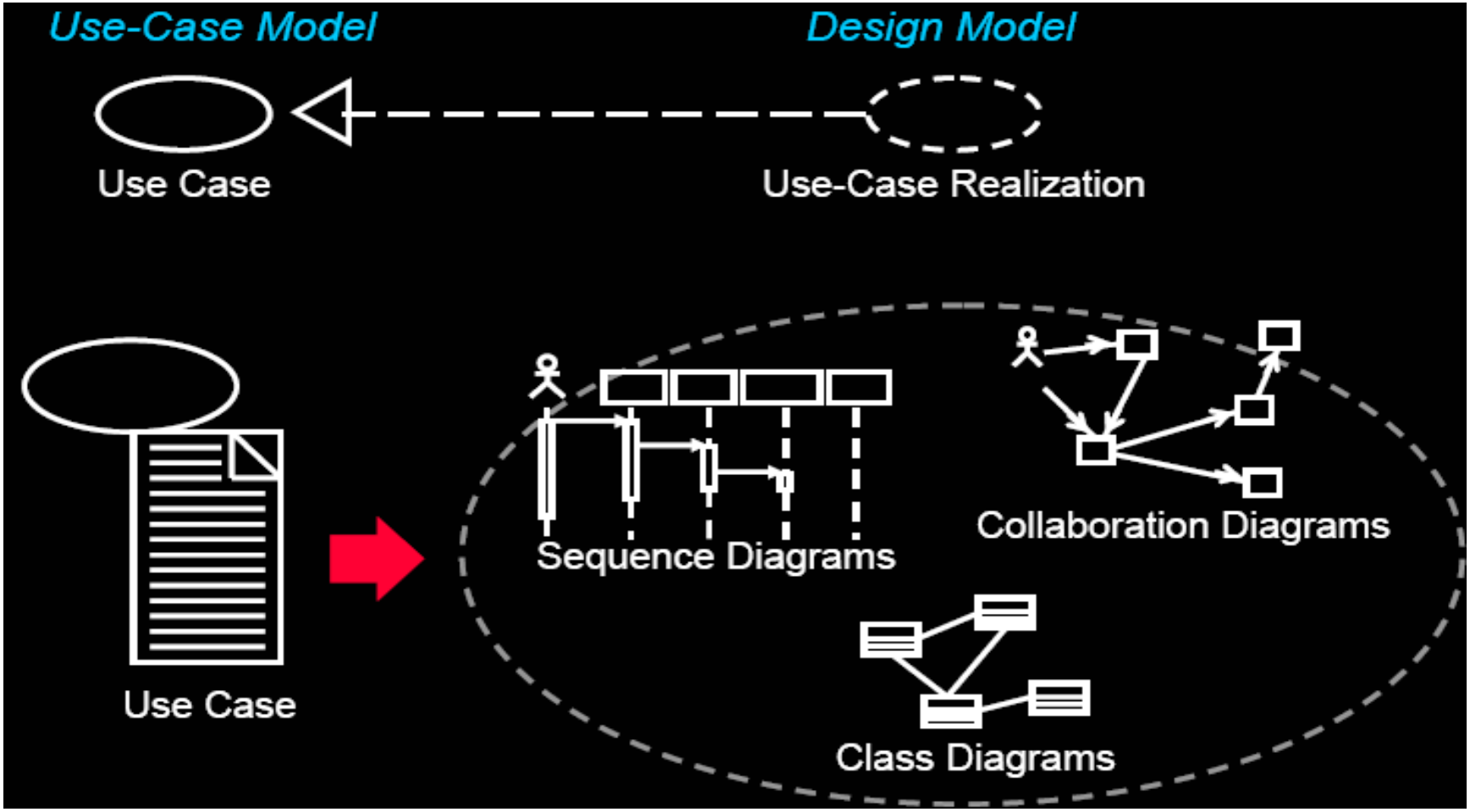
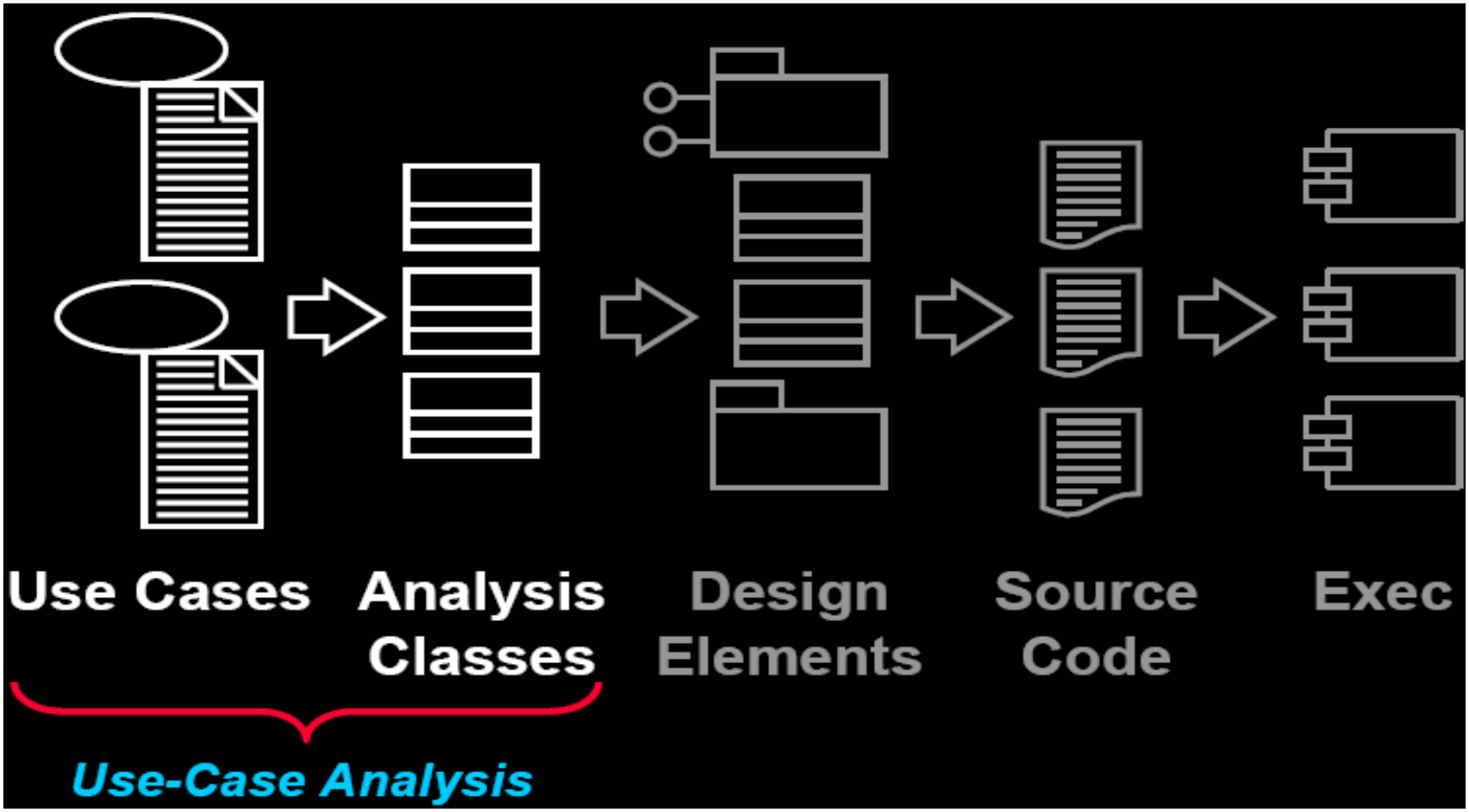
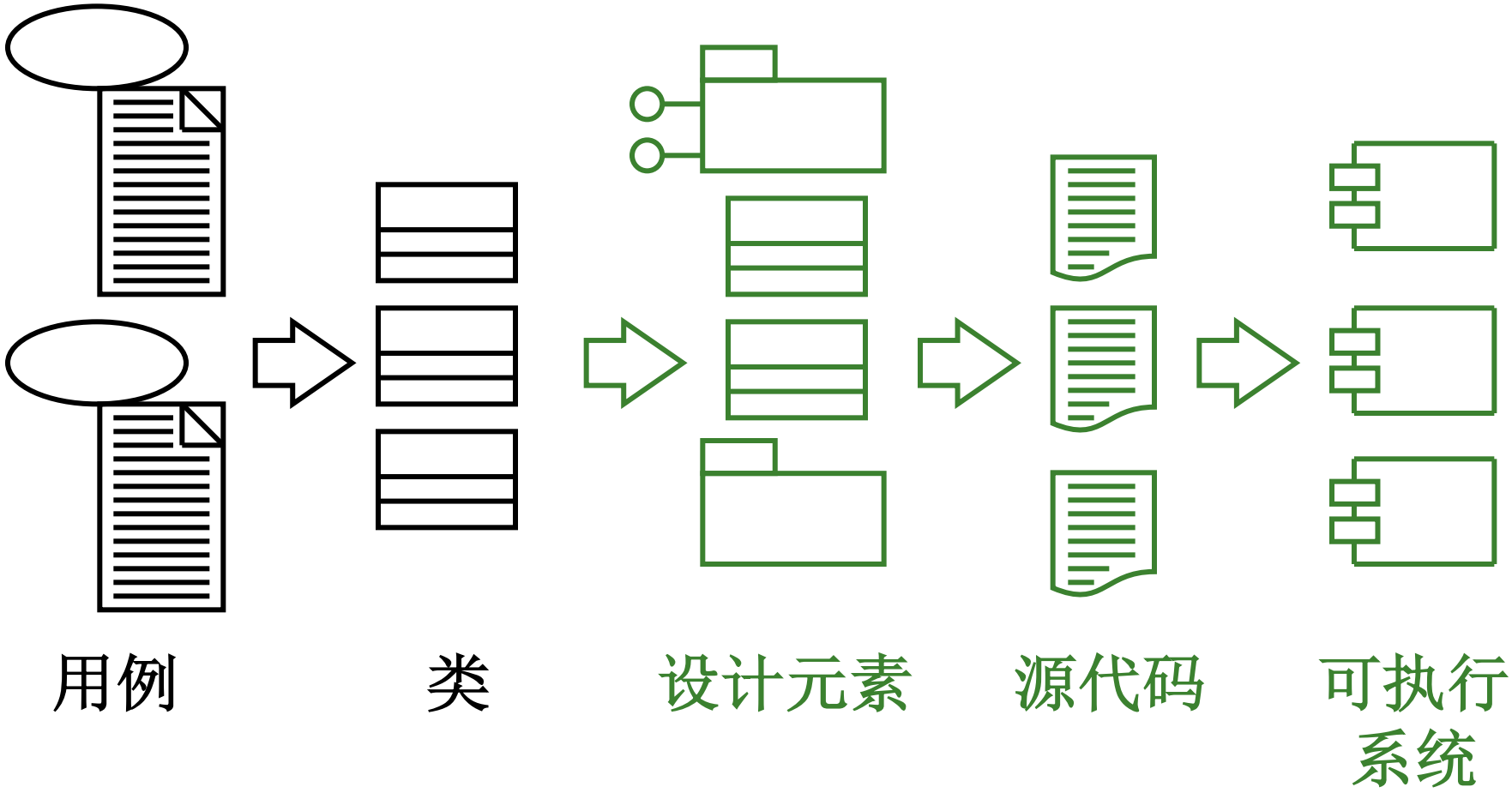
Review: Use-Case Realization



classes: A First Step Toward Executables



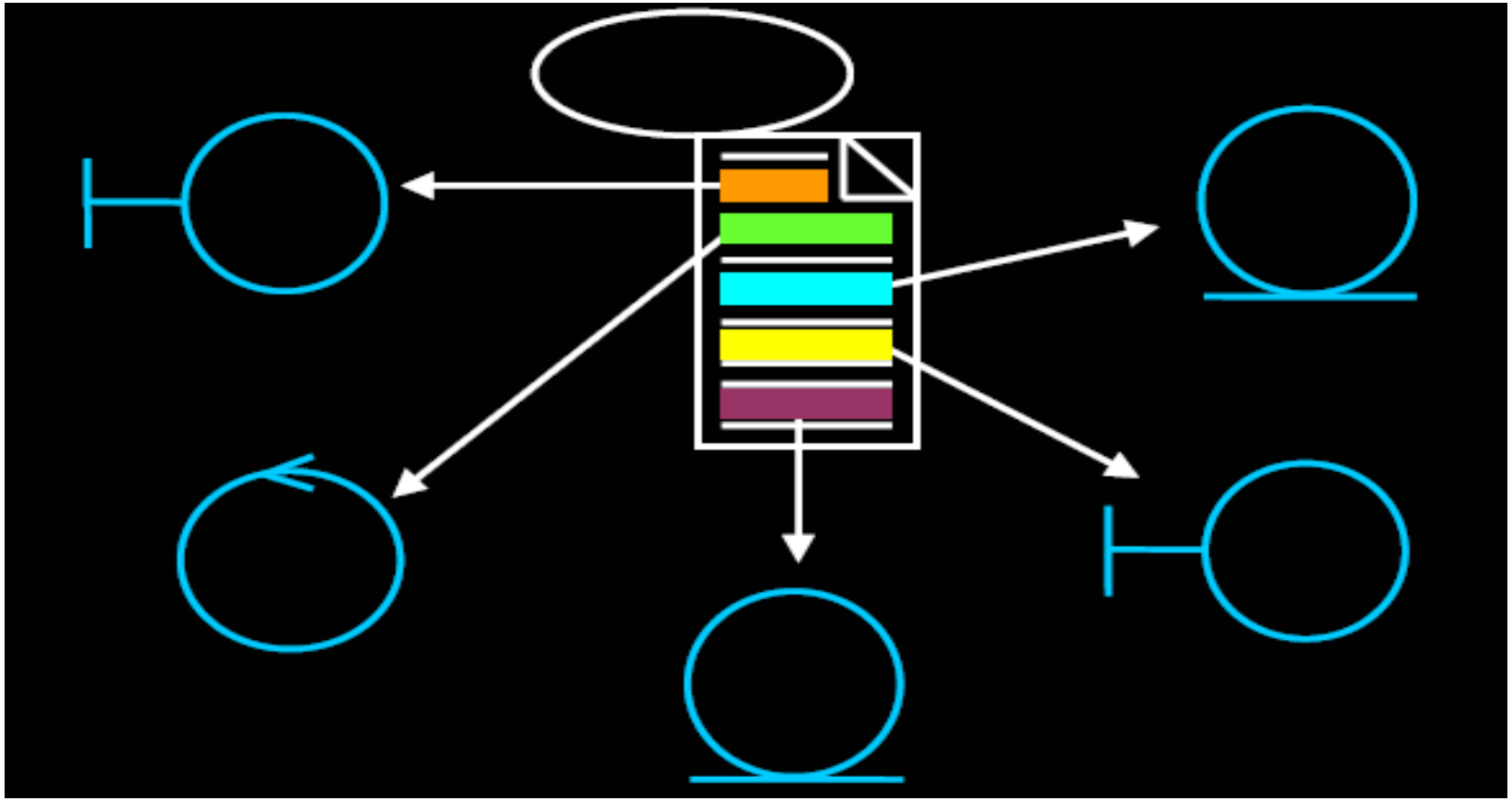
类：可执行系统的第一步



类的构造型（sterotype）

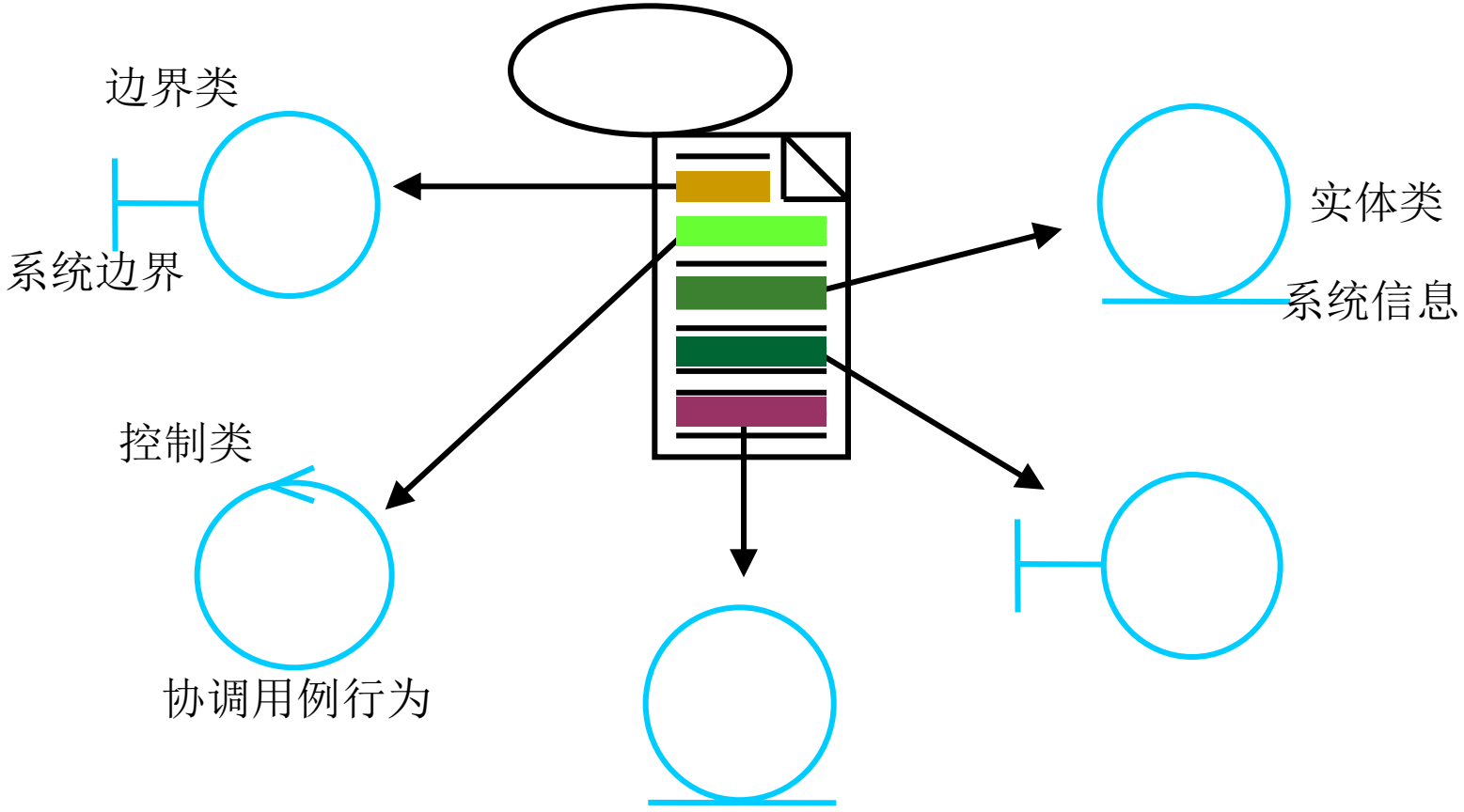
- UML中，类的符号是一至三个矩形构成
- 在MVC框架下，为了进一步区分View、Controller、Model里面的类，一目了然，分别给它们命名并且赋予了新的图形符号

Find Classes from Use-Case Behavior



The complete behavior of a use case has to be distributed to classes

从用例行为中查找类

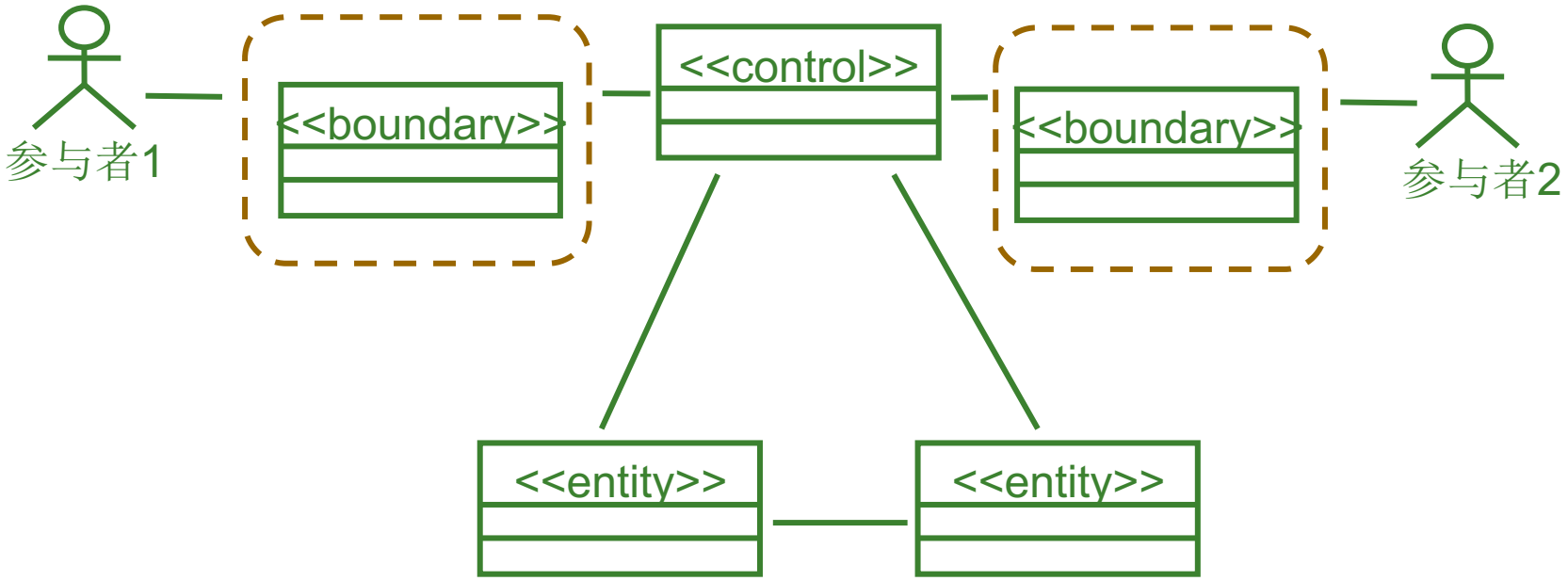


Boundary Class

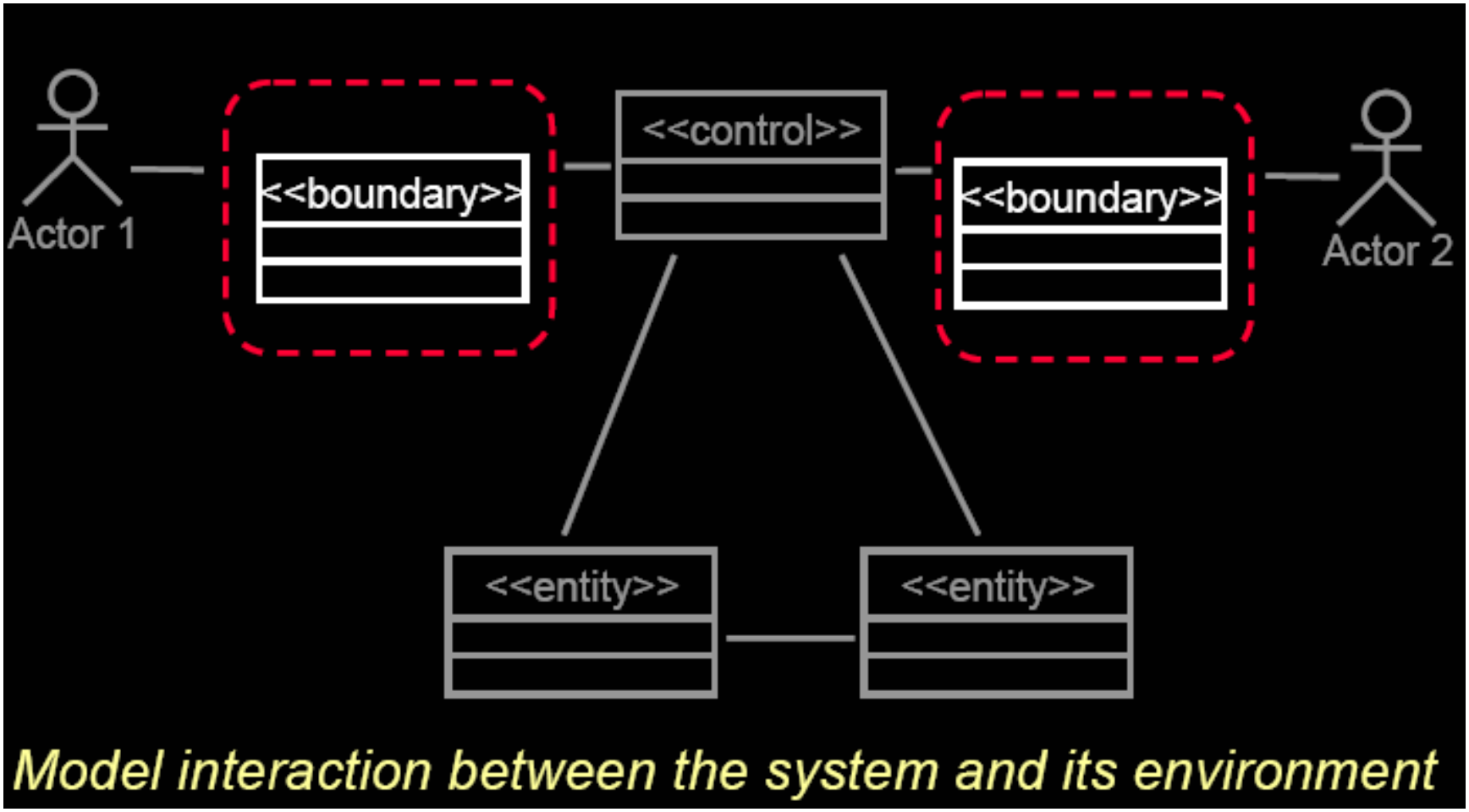
- **Inter mediates between the interface and something outside the system**
- **Several Types**
  - **User interface classes**
  - **System interface classes**
  - **Device interface classes**
- ***One boundary class per actor/use-case pair***

边界类

- 提供了对参与者或外部系统交互协议的接口
  - 如用户界面，http://protocols

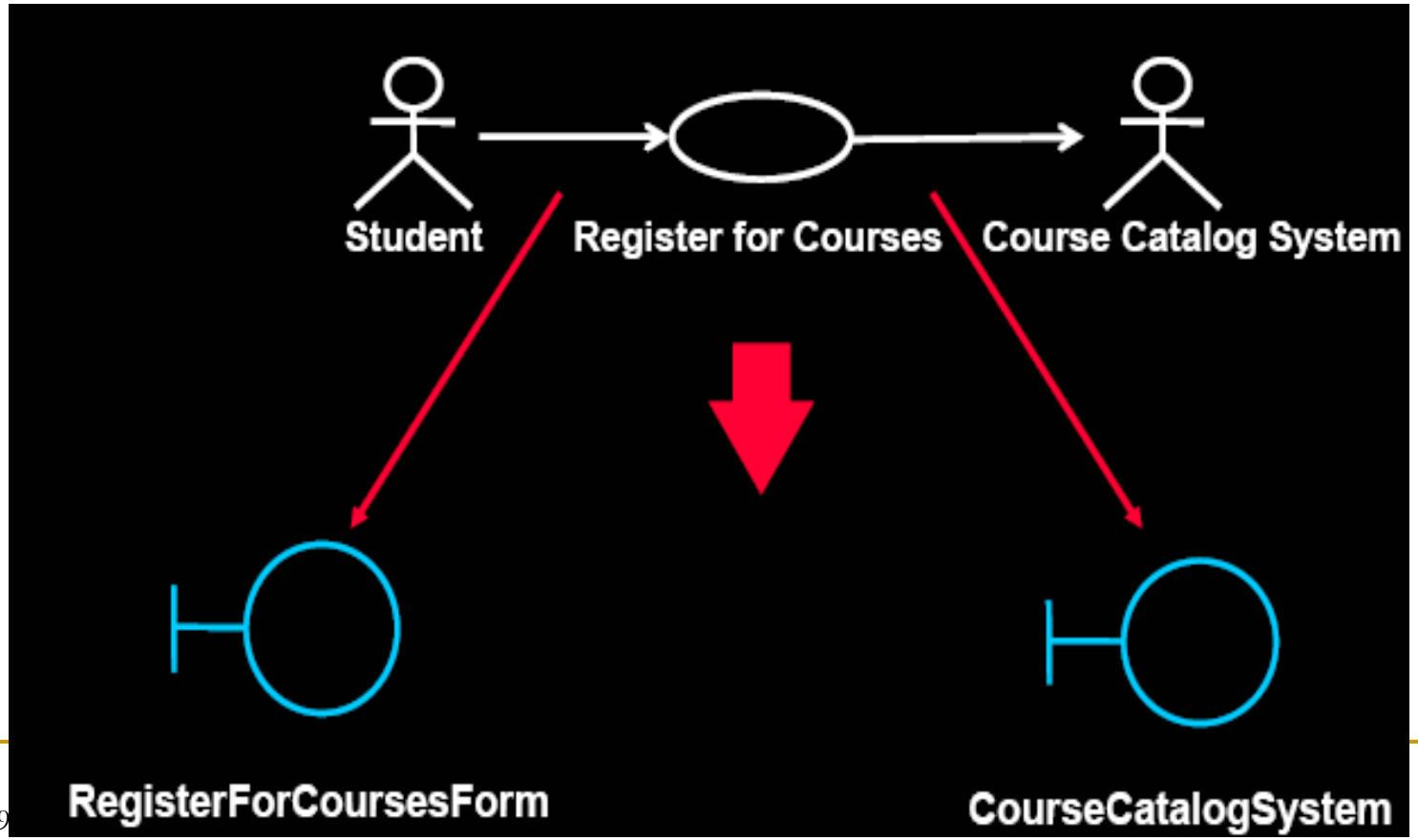


The Role of a Boundary Class



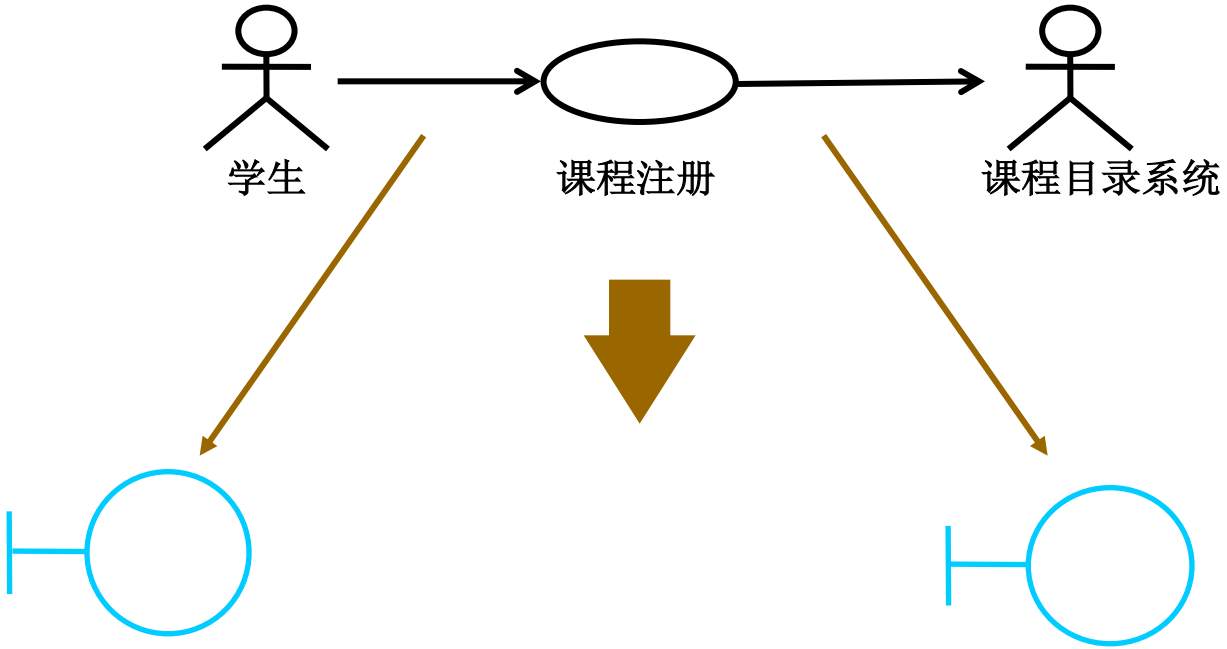
Example: Finding Boundary Classes

- **One boundary class per actor/use case pair**



如何确定边界类

- 为用例中涉及到的每对参与者/用例设计一个边界类来封装面向这个参与者的接口



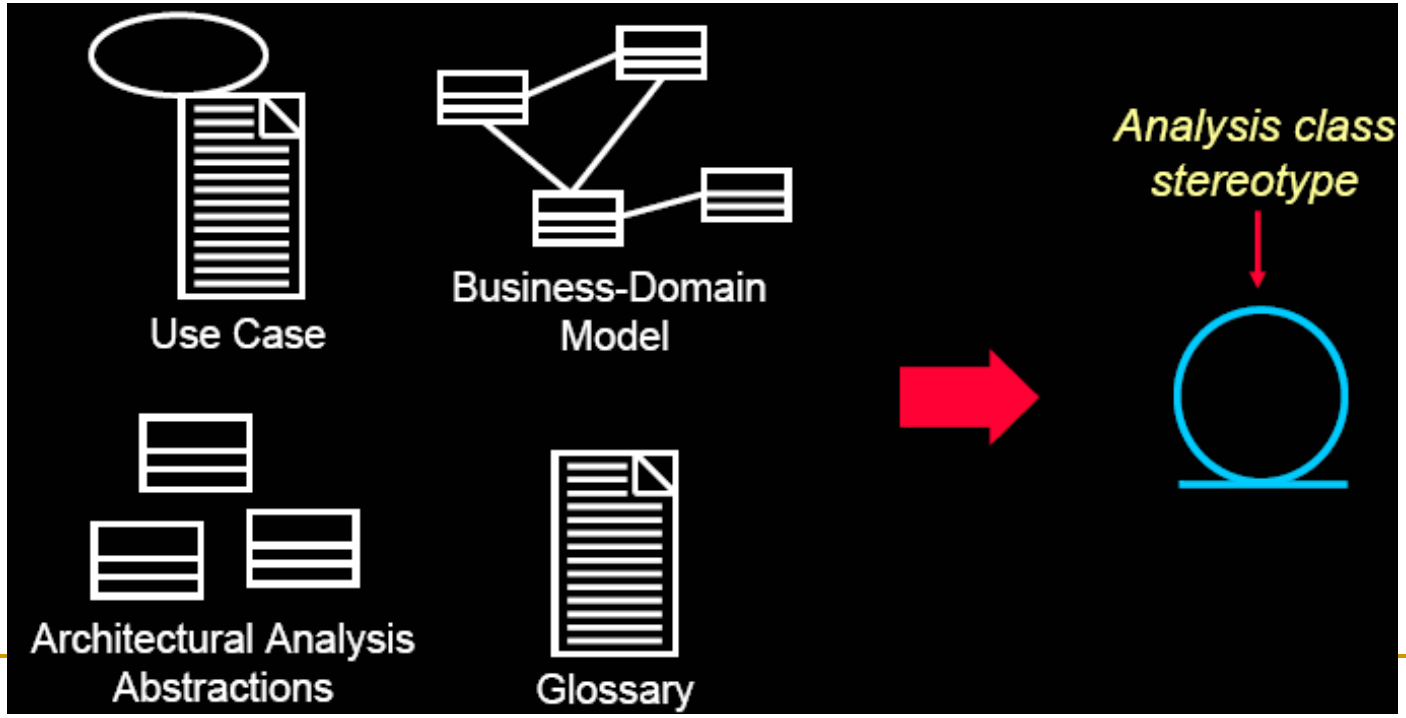
Guidelines: Boundary Class

- User Interface Classes
  - Concentrate on what information is presented to the user
- Do NOT concentrate on the UI details
- System and Device Interface Classes
  - Concentrate on what protocols must be defined
  - Do NOT concentrate on how the protocols will be implemented

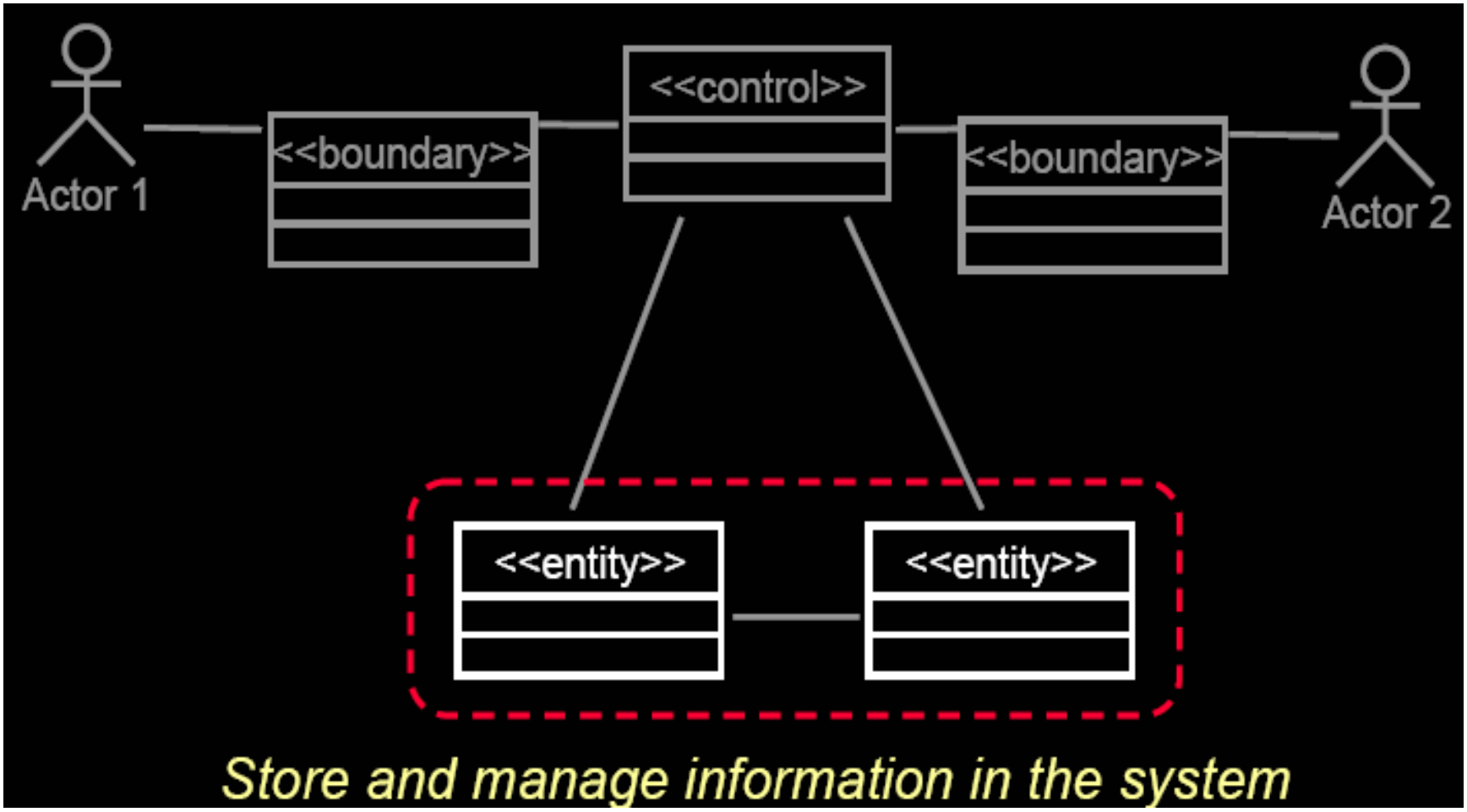
- 边界类的三种类型
  - 用户接口类
  - 系统接口类
  - 设备接口类
- 设计边界类的指导原则
  - 对于用户接口类，关注于用户界面的交互内容；不是具体窗体构件
  - 对于系统和设备接口类，关注于定义什么通信协议；不要关注协议的实现细节

Entity Class

- **Key abstractions of the system**



The Role of an Entity Class

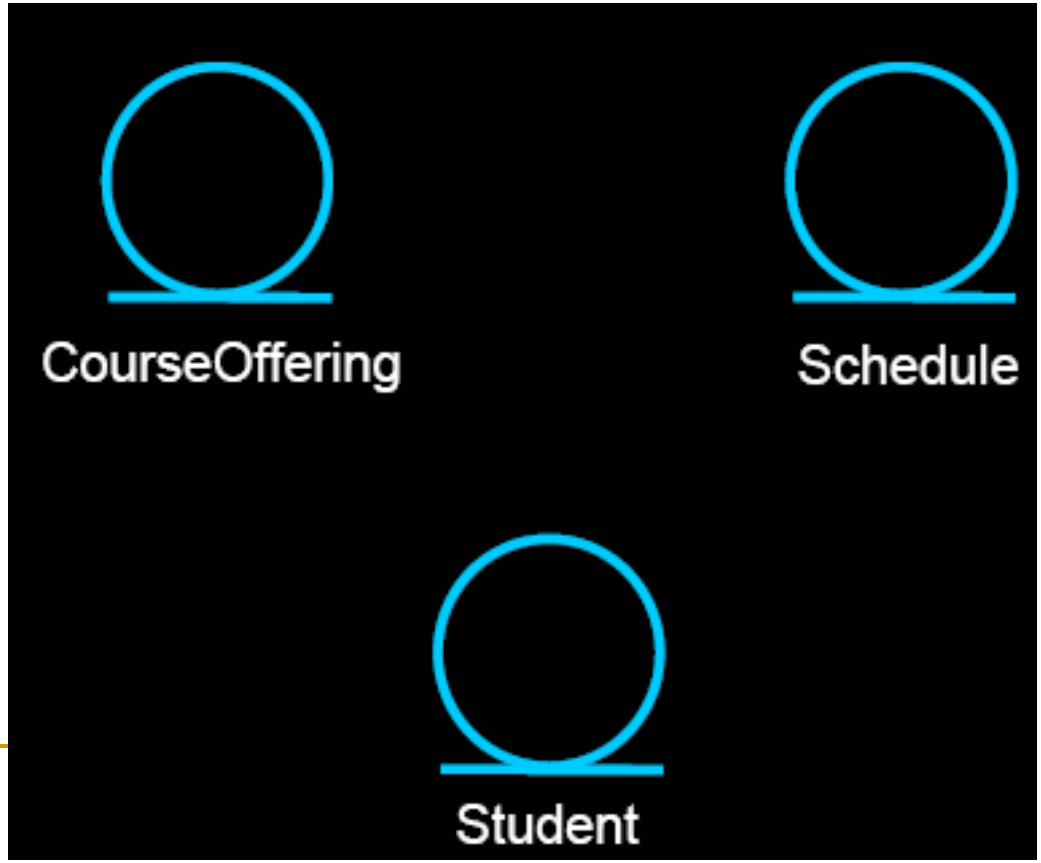


Example: Finding Entity Classes

- Use use-case flow of events as input
- Key abstractions of the use case
- Traditional, filtering nouns approach
  - Underline noun clauses in the use-case flow of events
  - Remove redundant candidates
  - Remove vague candidates
  - Remove actors (out of scope)
  - Remove implementation constructs
  - Remove attributes (save for later)
  - Remove operations

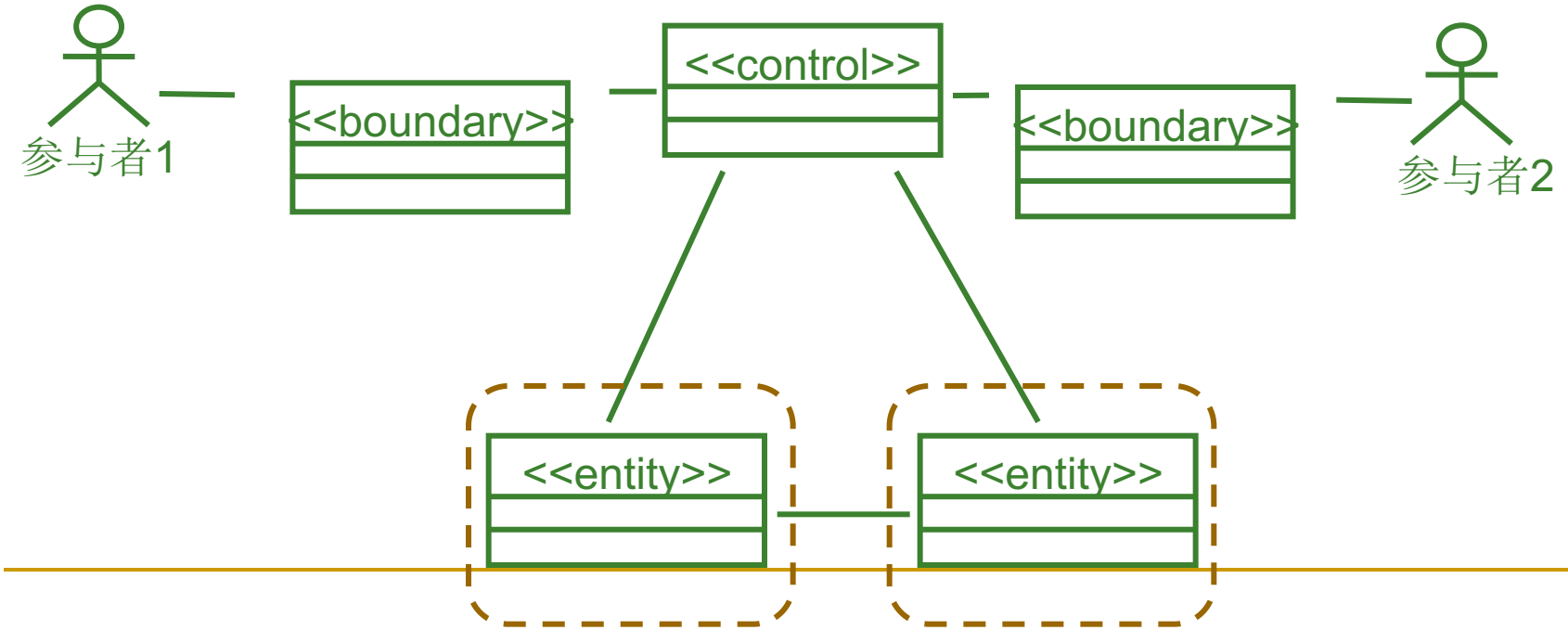
Example: Candidate Entity Classes

- **Register for Courses (Create Schedule)**



实体类

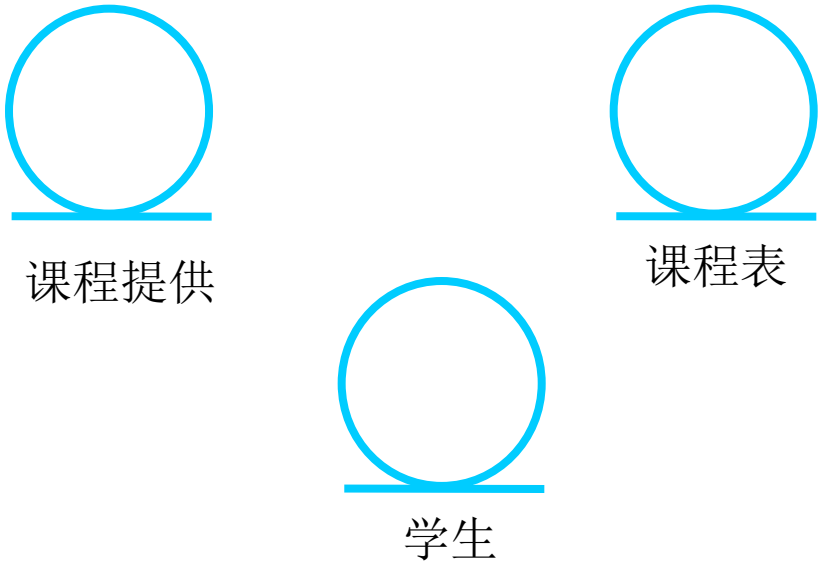
- 存储（通常具有持久性）一些现象的信息，并包含与这些信息相关的业务规则
  - 如学生，计划表，课程清单



如何确定实体类

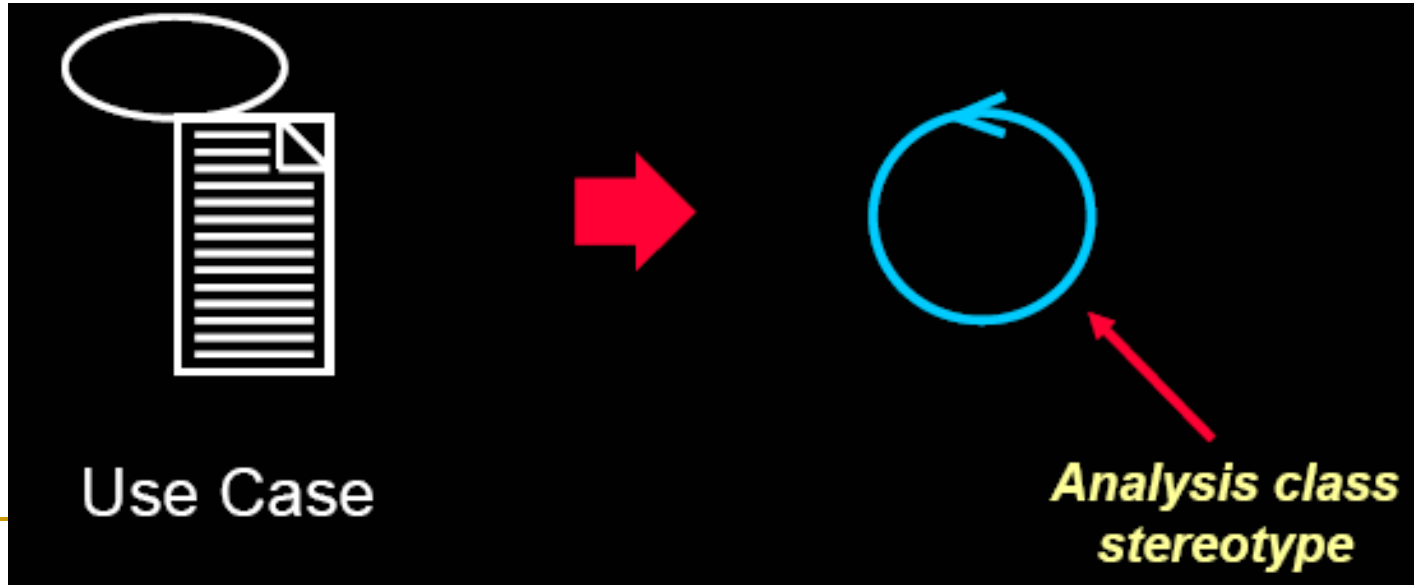
- 将用例的事件流作为输入
- 获取用例的关键抽象
- 过滤名词的方法：
  - 对事件流中的名词加下划线
  - 去除冗余的候选名词
  - 去除含义不明确的候选名词
  - 去除参与者
  - 去除实现结构
  - 去除属性
  - 去除操作

- **课程注册(建立课程表)中的实体类**

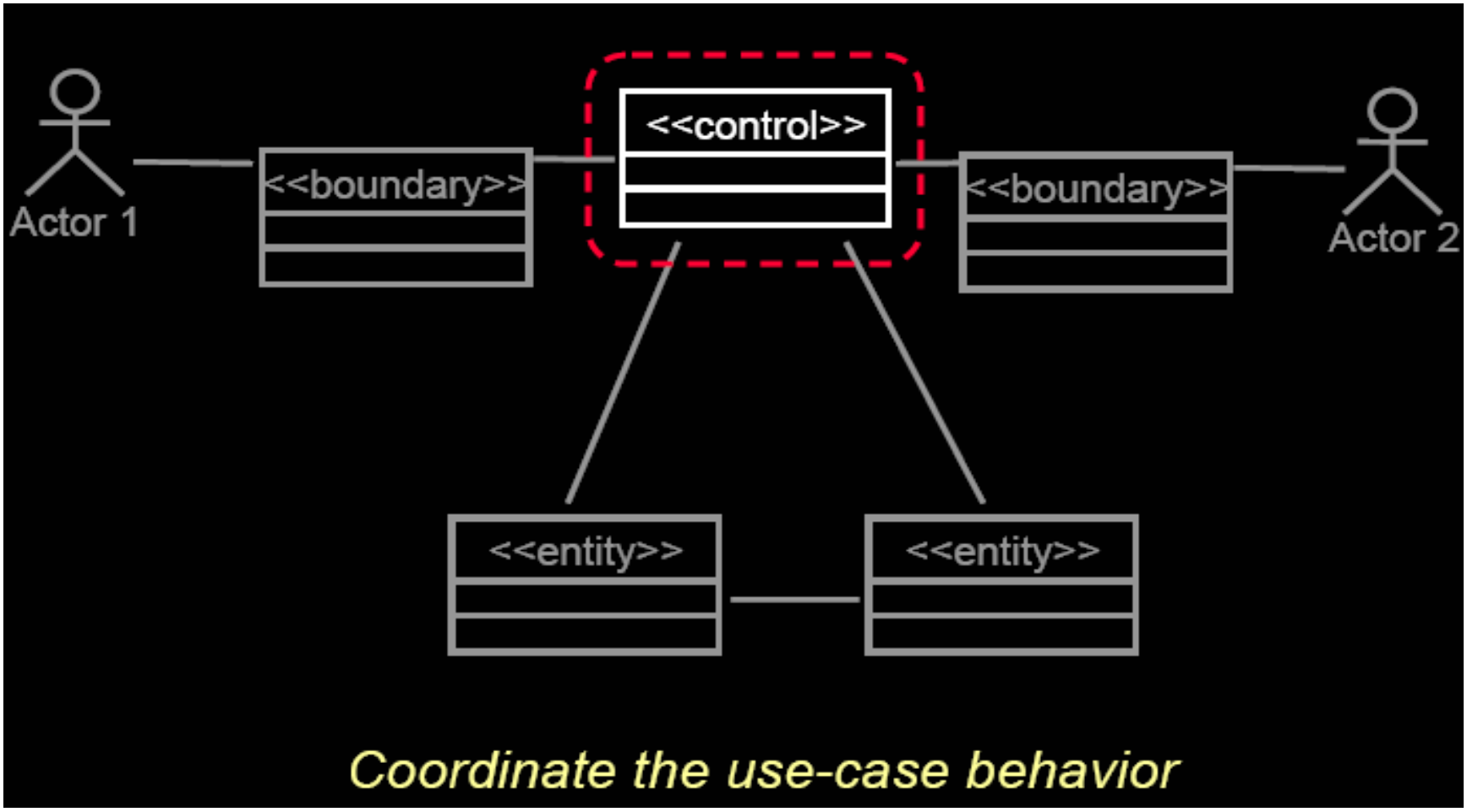


Control Class

- **Use-case behavior coordinator**
- **More complex use cases generally require one or more control cases**

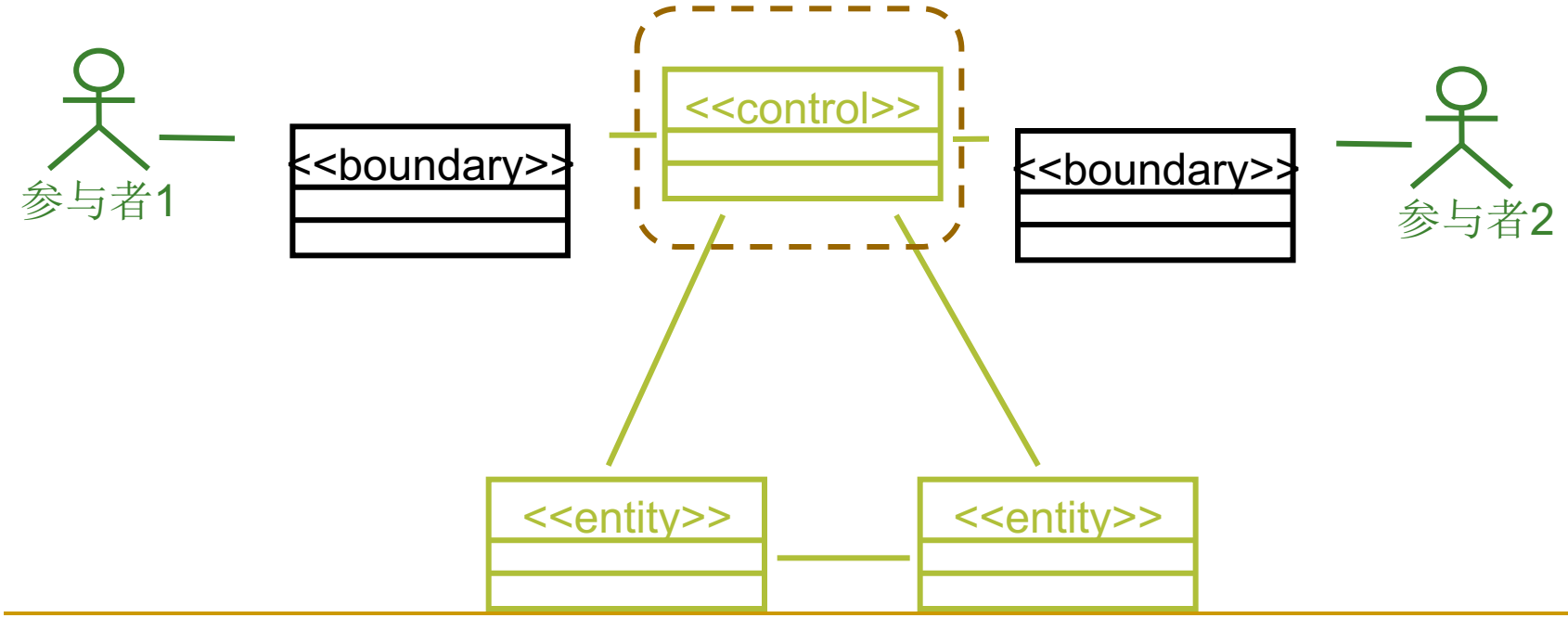


The Role of a Control Class



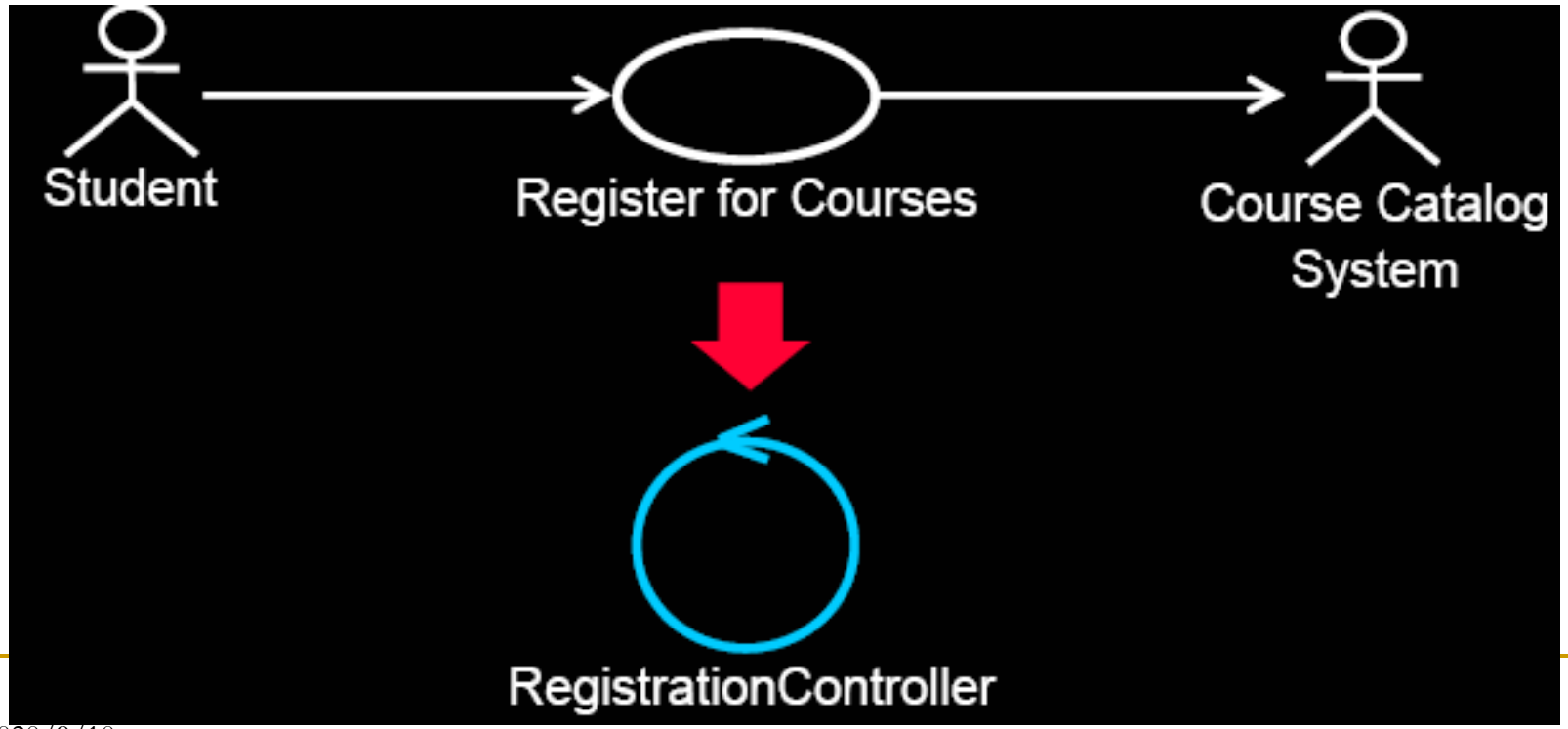
控制类

- 封装一个或多个用例所特有的控制行为
- 控制类有效地分离了边界对象和实体对象，使系统更能承受系统边界的变更



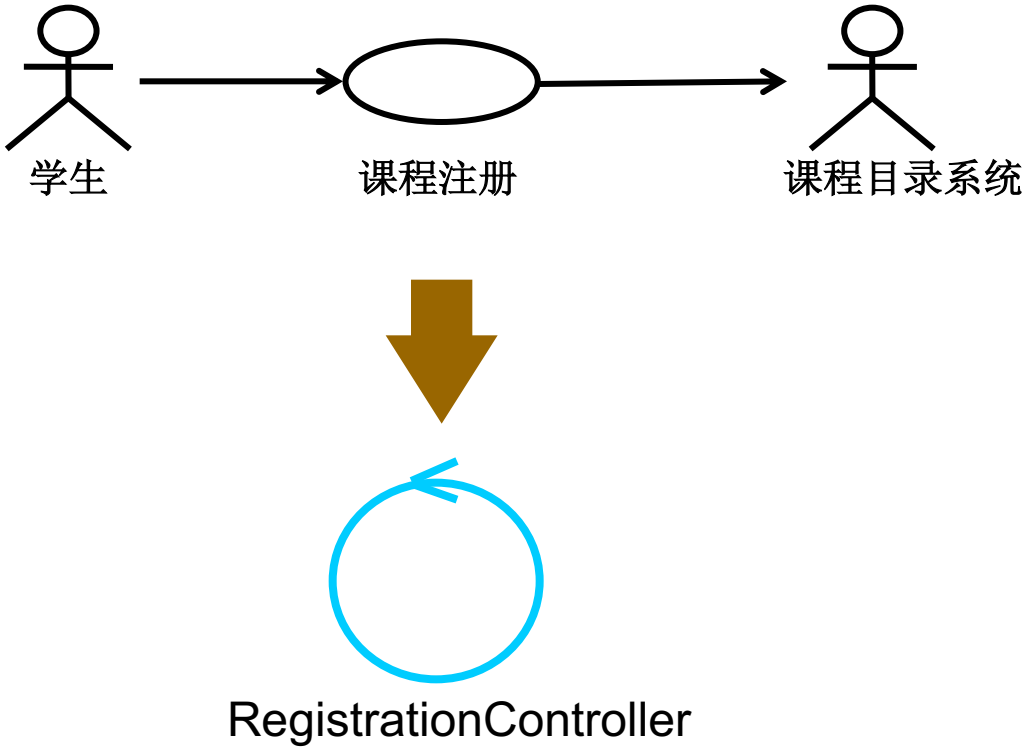
Example: Finding Control Classes

- **In general, identify one control class per use case.**
  - **As analysis continues, a complex use case's control class may evolve into more than one class**

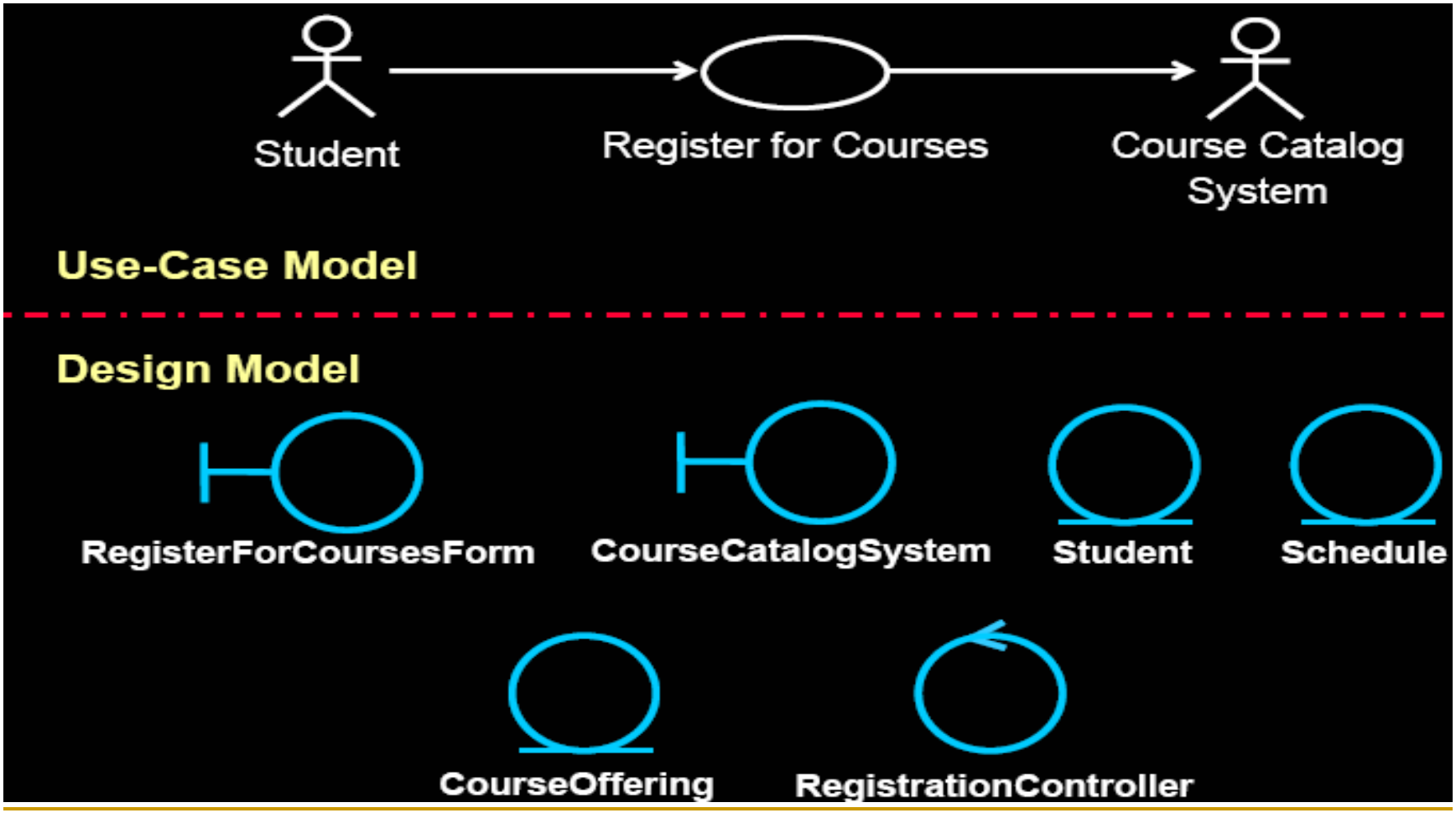


如何确定控制类

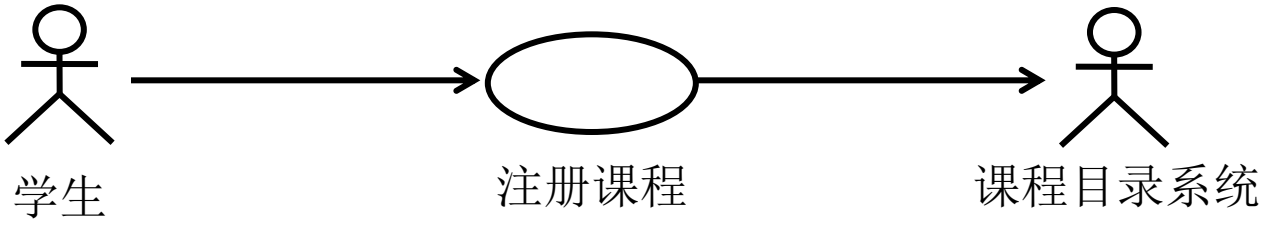
- **通常为每个用例设计一个控制类，封装这个用例的顺序**



Example: Summary: classes

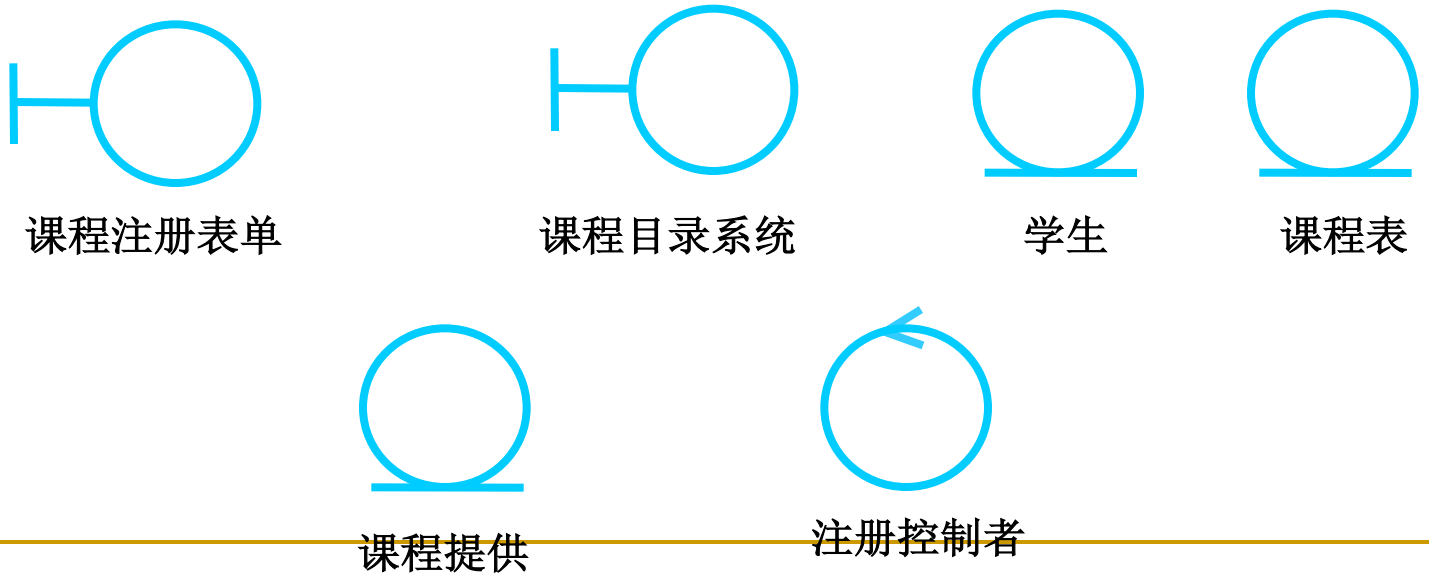


类总览



用例模型

设计模型



Use-Case Analysis Steps

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- For each Use-Case Realization
  - Find Classes from Use-Case Behavior
  - Distribute Use-Case Behavior to Classes
- For each resulting class
  - Describe Responsibilities
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  - Qualify Analysis Mechanisms
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主要内容

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补充用例规约

查找类

将用例行为分配给类

描述类

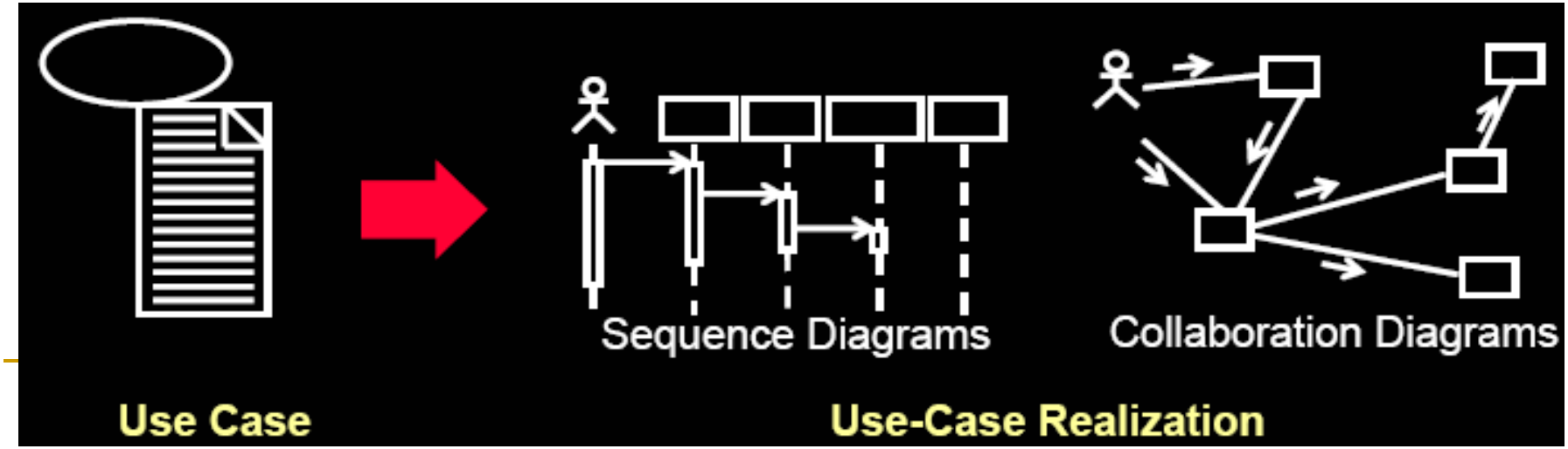
描述分析机制

合并类

案例实践

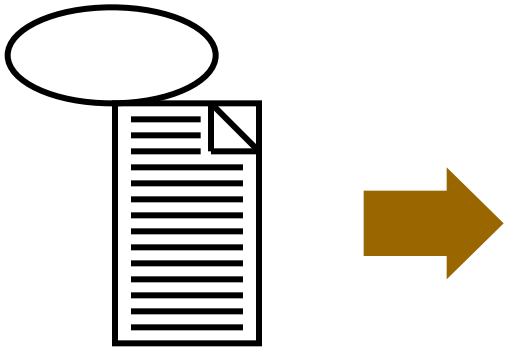
Distribute Use-Case Behavior to Classes

- **For each use-case flow of events:**
  - **Identify classes**
  - **Allocate use-case responsibilities to classes**
  - **Model class interactions in Interaction diagrams**

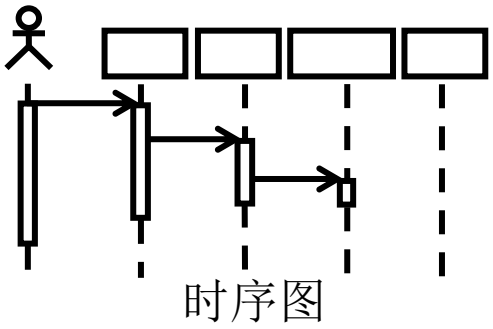


将用例行为分配给类

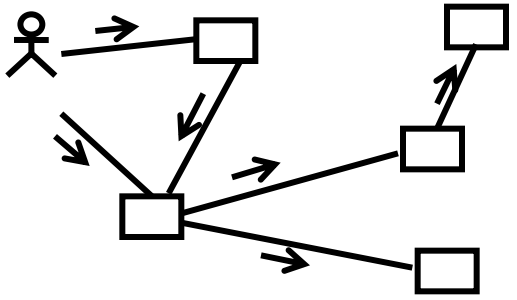
- 对于每个用例的事件流：
  - 确定类
  - 将用例的职责分配给类
  - 在交互图中为类建模



用例图



时序图



协作图

用例实现

Guidelines: Allocating Responsibilities to Classes

- Use class stereotypes as a guide
- Boundary Classes
  - Behavior that involves communication with an actor
- Entity Classes
  - Behavior that involves the data encapsulated within the abstraction
- Control Classes
  - Behavior specific to a use case or part of a very important flow of events

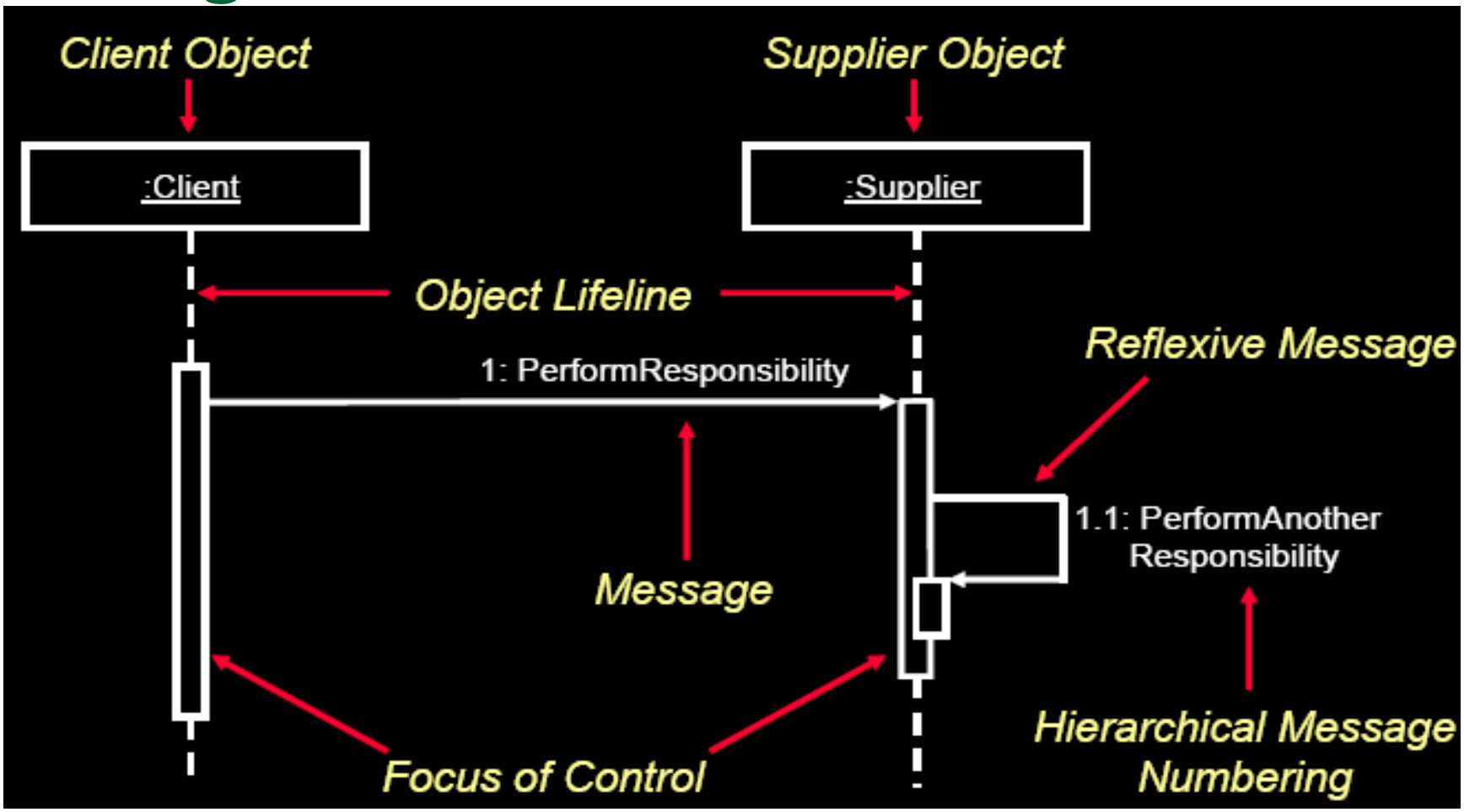
将职责分配给类

- 用类的构造型做指导
- 边界类
  - 行为包括与参与者的联系
- 实体类
  - 行为包括封装数据
- 控制类
  - 用例或事件流特有的行为

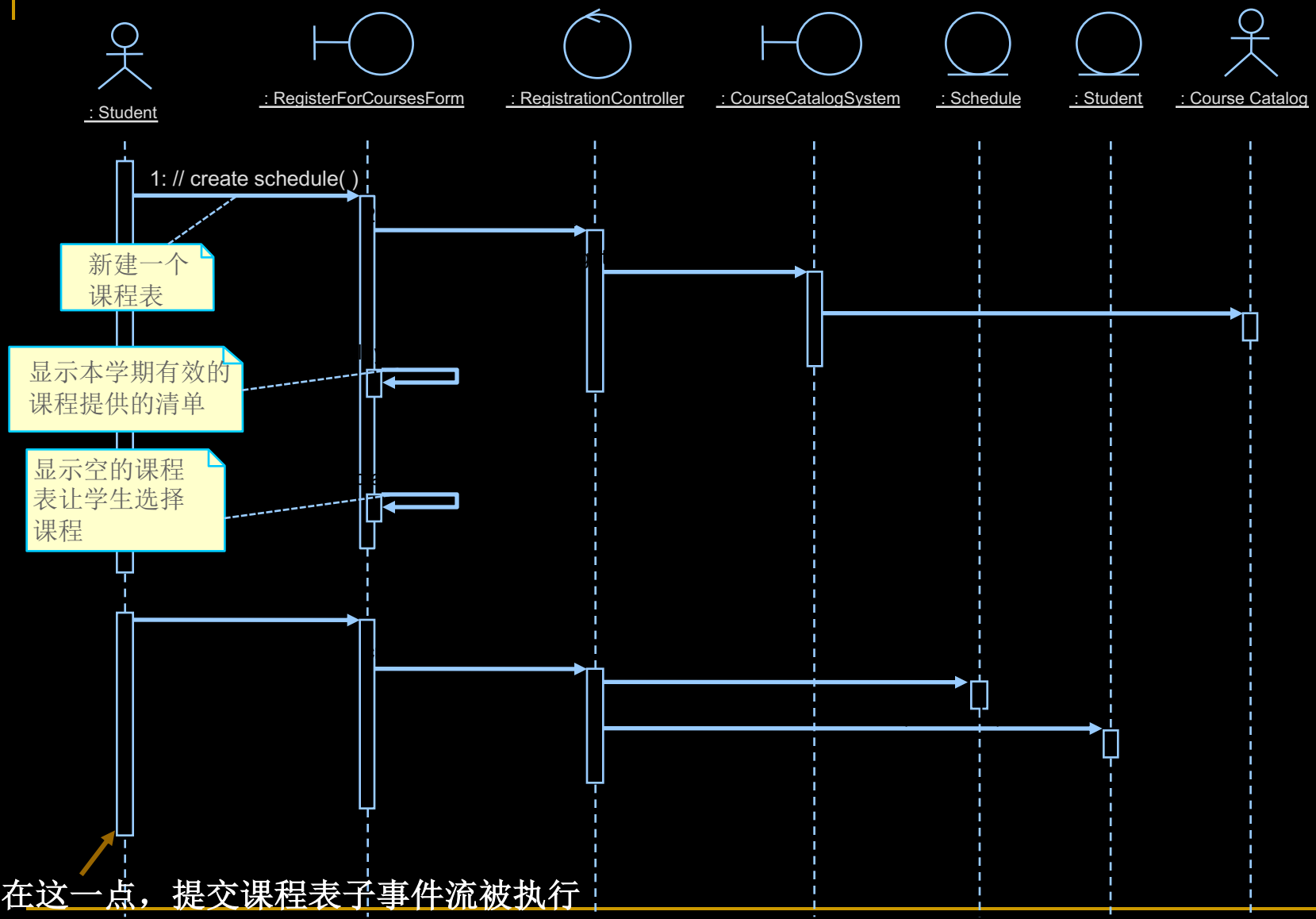
Guidelines: Allocating Responsibilities to Classes (cont.)

- Who has the data needed to perform the responsibility?
  - If one class has the data, put the responsibility with the data
  - If multiple classes have the data:
    - Put the responsibility with one class and add a relationship to the other
    - Create a new class, put the responsibility in the new class, and add relationships to classes needed to perform the responsibility
    - Put the responsibility in the control class, and add relationships to classes needed to perform the responsibility

The Anatomy of Sequence Diagrams

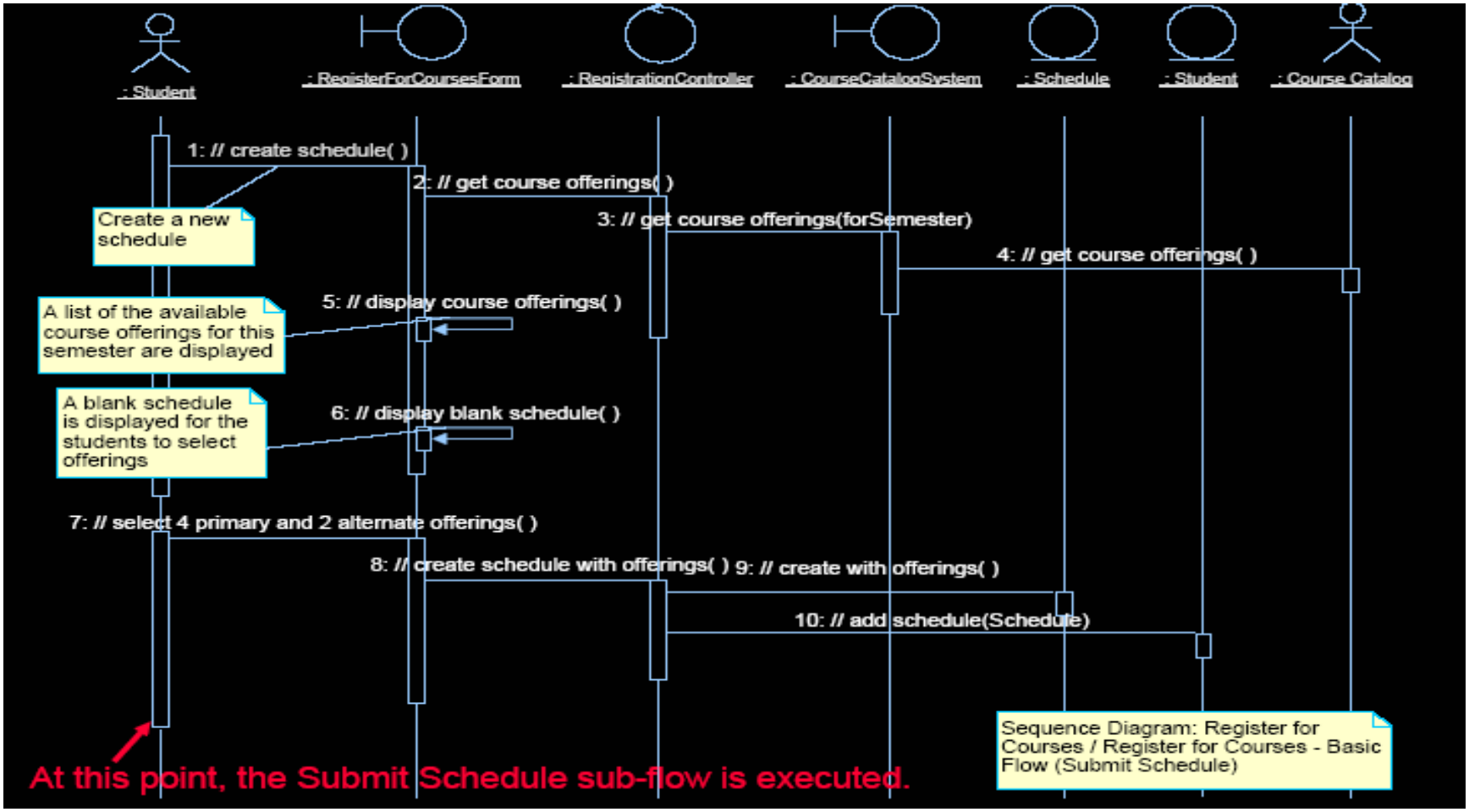


时序图示例

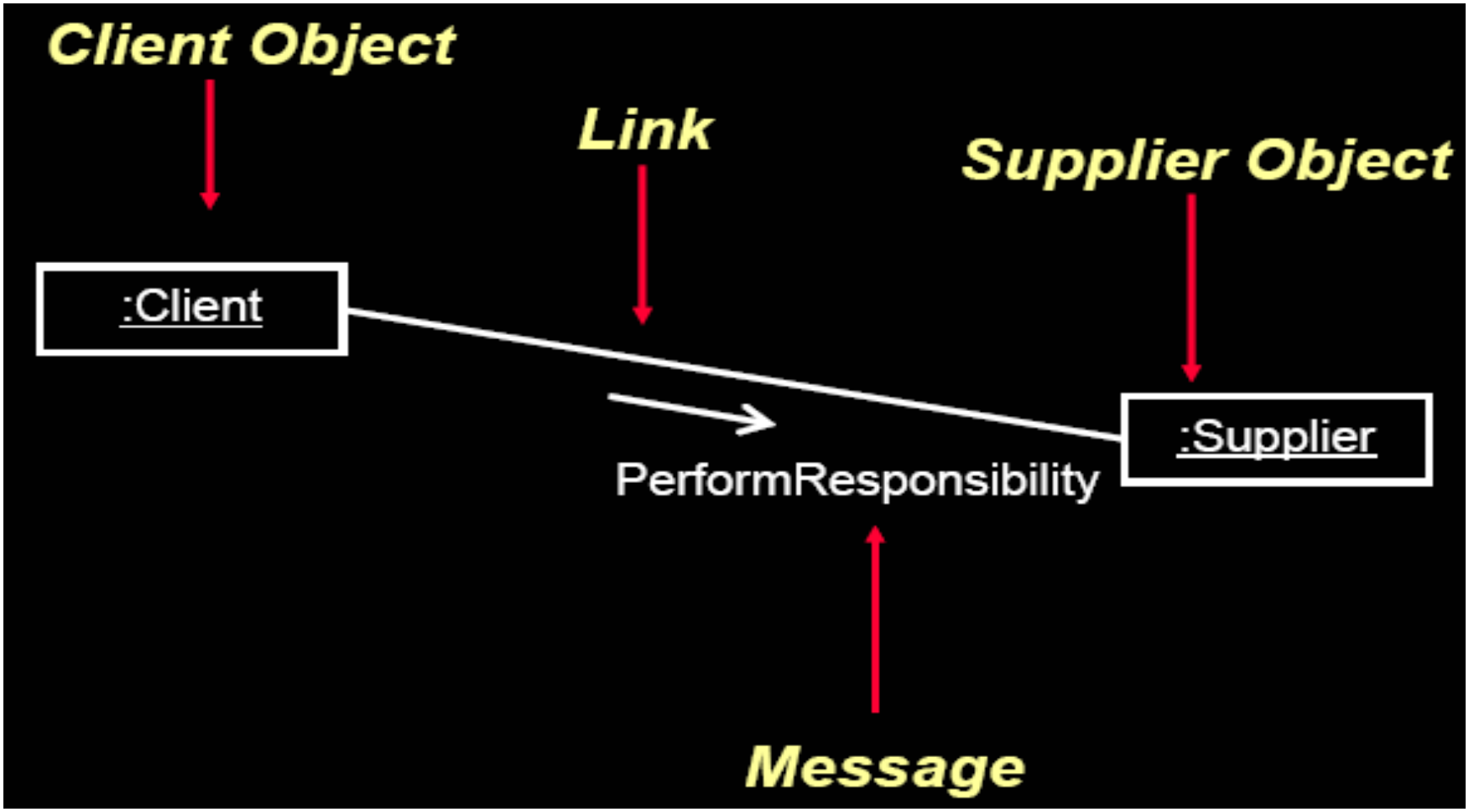


在这一点，提交课程表子事件流被执行

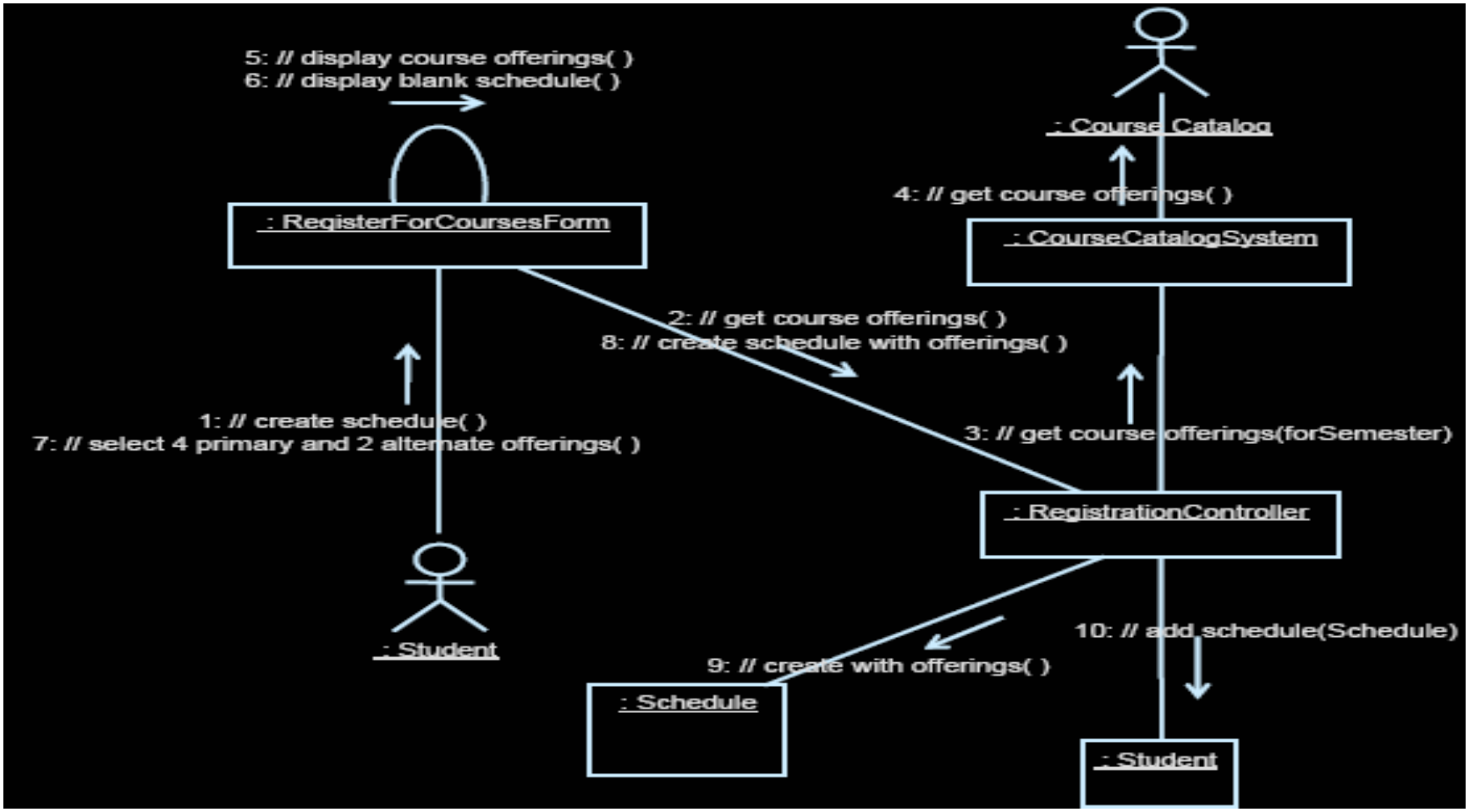
Example: Sequence Diagram



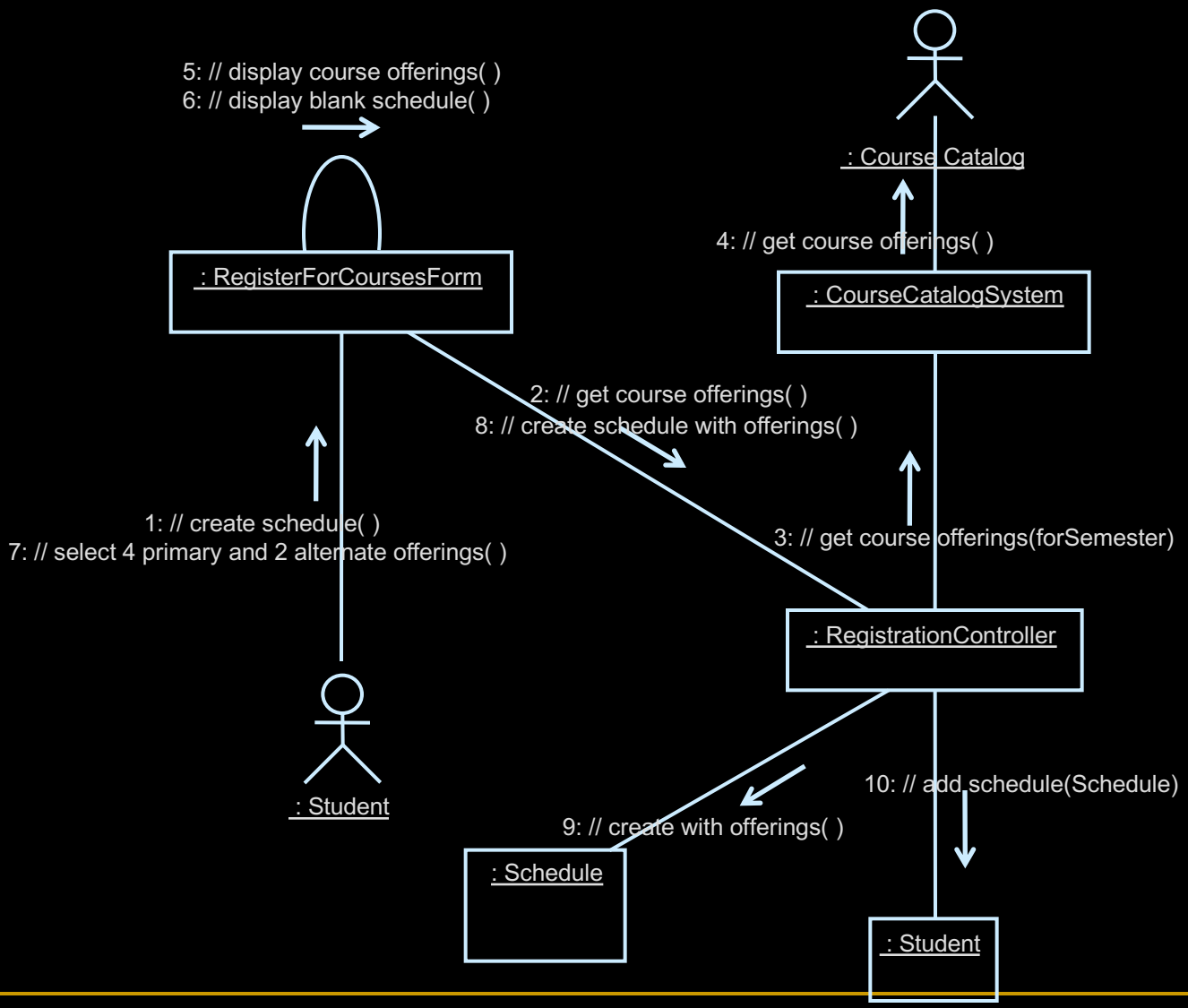
The Anatomy of Collaboration Diagrams



Example: Collaboration Diagram



协作图示例


5: // display course offerings( )
6: // display blank schedule( )
: Course Catalog
4: // get course offerings( )
: RegisterForCoursesForm
: CourseCatalogSystem
2: // get course offerings( )
8: // create schedule with offerings( )
1: // create schedule( )
7: // select 4 primary and 2 alternate offerings( )
3: // get course offerings(forSemester)
: RegistrationController
: Student
10: // add schedule(Schedule)
9: // create with offerings( )
: Schedule
: Student

Use-Case Analysis Steps

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第八章　用例分析

主要内容

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将用例行为分配给类

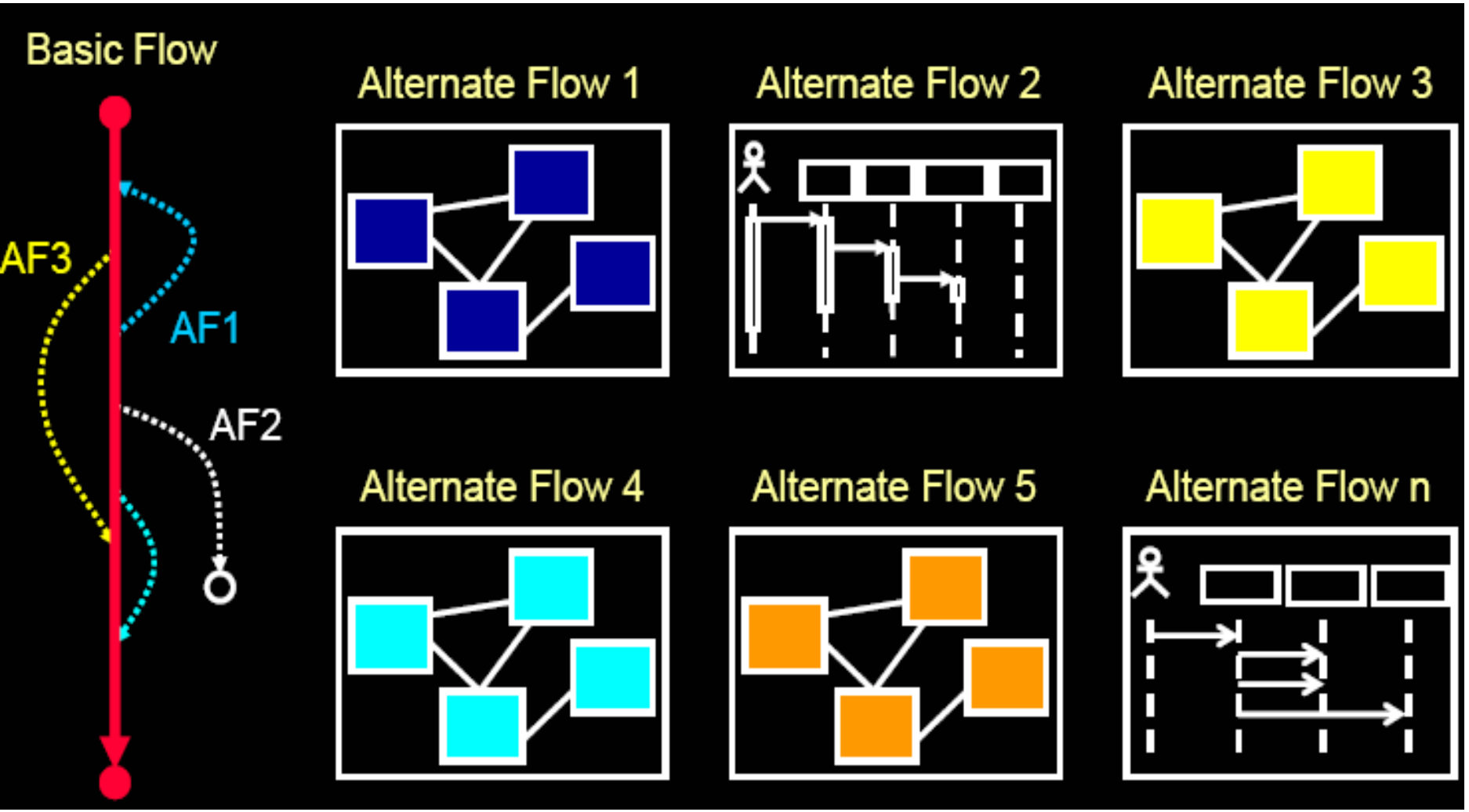
描述类

描述分析机制

合并类

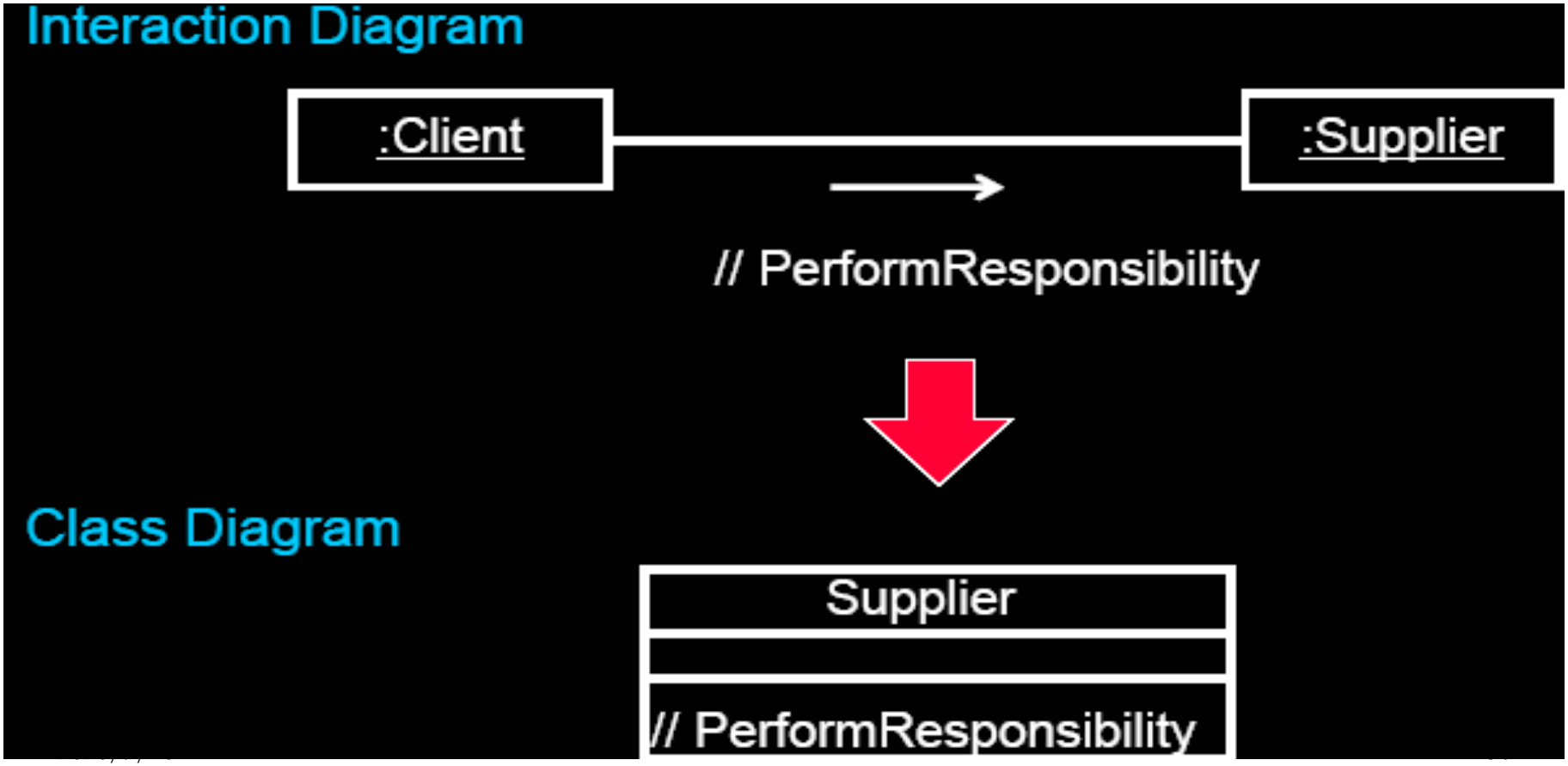
案例实践

One Interaction Diagram Is Not Good Enough

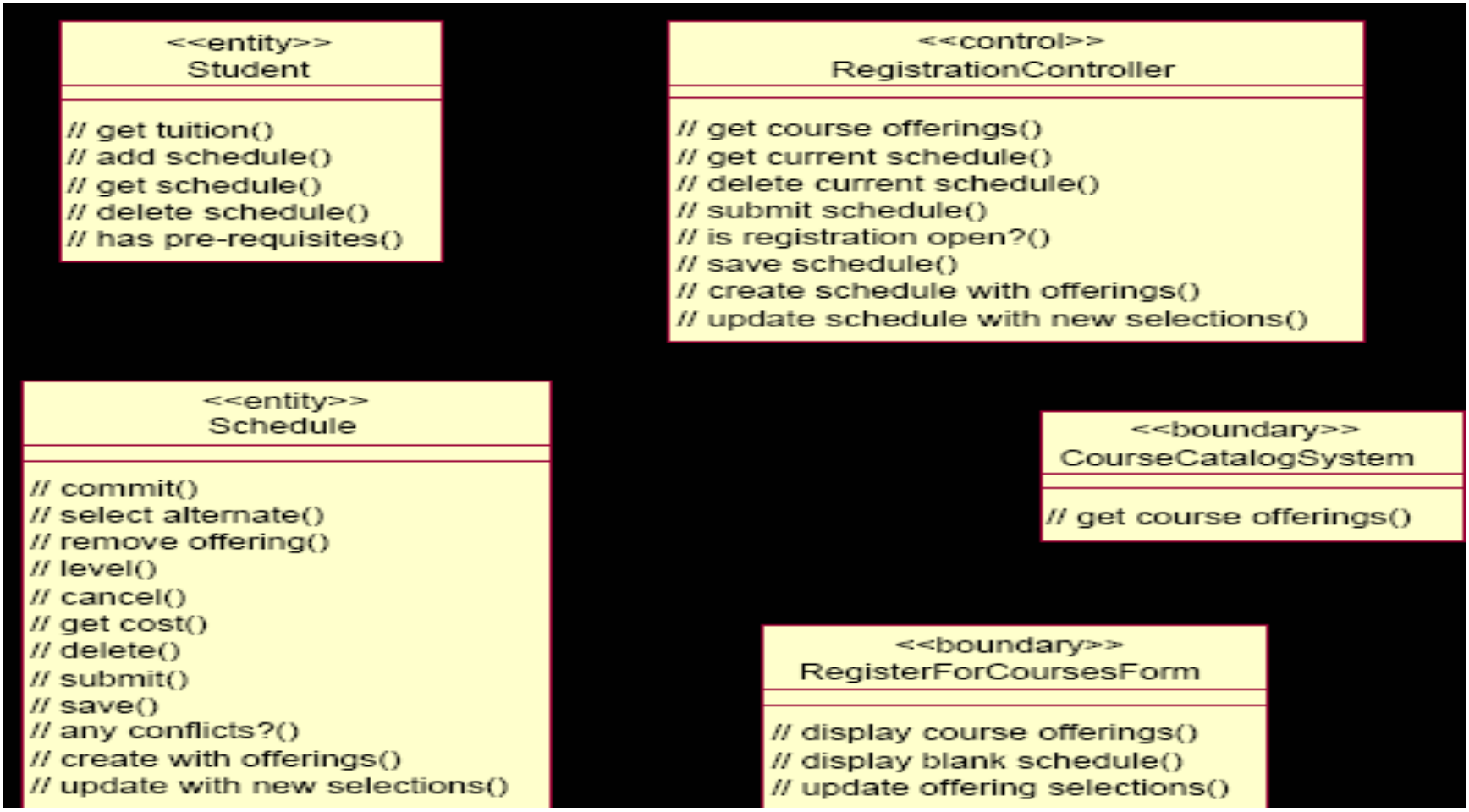


Describe Responsibilities

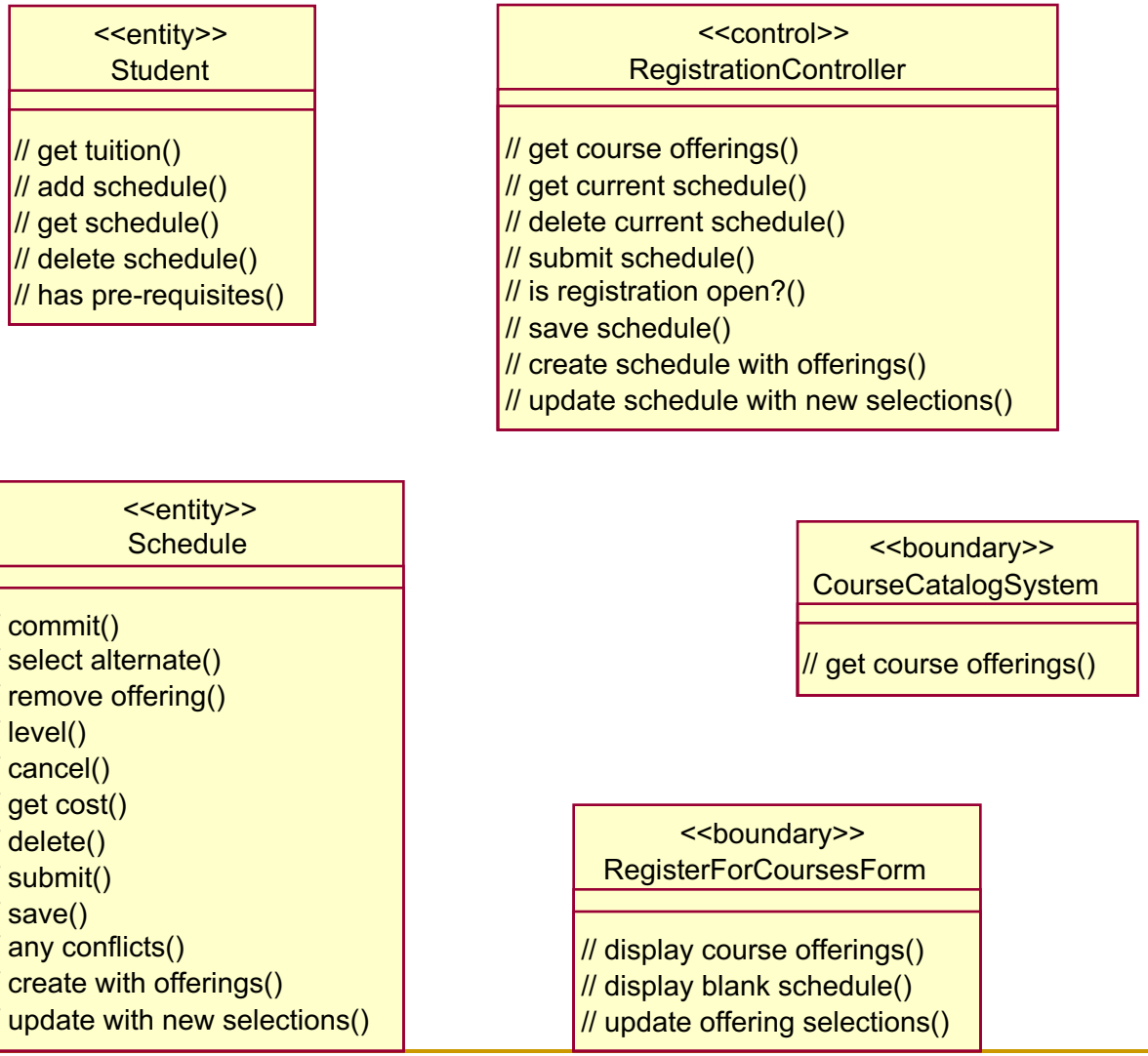
- **What are responsibilities?**
- **How do I find them?**



Example: View of Participating Classes (VOPC) Class Diagram



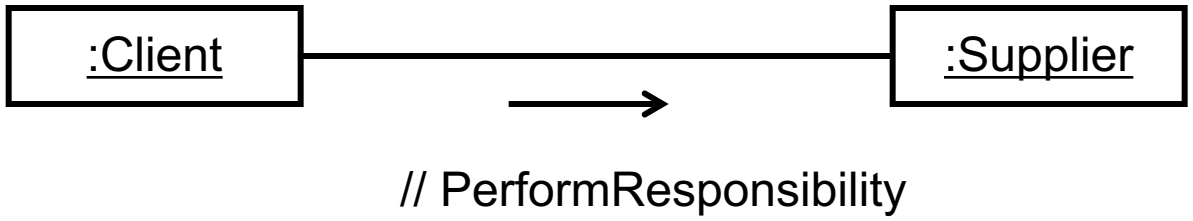
参与类图示例


<<entity>>
Student
// get tuition()
// add schedule()
// get schedule()
// delete schedule()
// has pre-requisites()
<<control>>
RegistrationController
// get course offerings()
// get current schedule()
// delete current schedule()
// submit schedule()
// is registration open?()
// save schedule()
// create schedule with offerings()
// update schedule with new selections()
<<entity>>
Schedule
// commit()
// select alternate()
// remove offering()
// level()
// cancel()
// get cost()
// delete()
// submit()
// save()
// any conflicts()
// create with offerings()
// update with new selections()
<<boundary>>
CourseCatalogSystem
// get course offerings()
<<boundary>>
RegisterForCoursesForm
// display course offerings()
// display blank schedule()
// update offering selections()

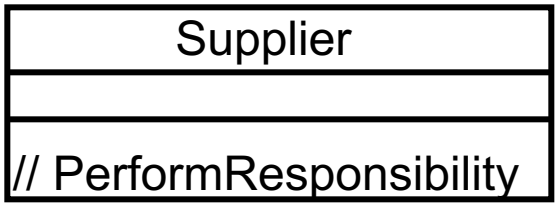
说明职责

- **什么是职责**
- **怎样找到职责**

交互图



类图



Maintaining Consistency: What to Look For

- In order of criticality
  - Redundant responsibilities across classes
  - Disjoint responsibilities within classes
  - Class with one responsibility
  - Class with no responsibilities
  - Better distribution of behavior
  - Class that interacts with many other classes

维持一致性

- 类中多余的职责
- 类中分离的职责
- 只有一个职责的类
- 没有职责的类
- 更好的行为分配方式
- 与许多其他类有交互作用的类

Use-Case Analysis Steps

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Finding Attributes

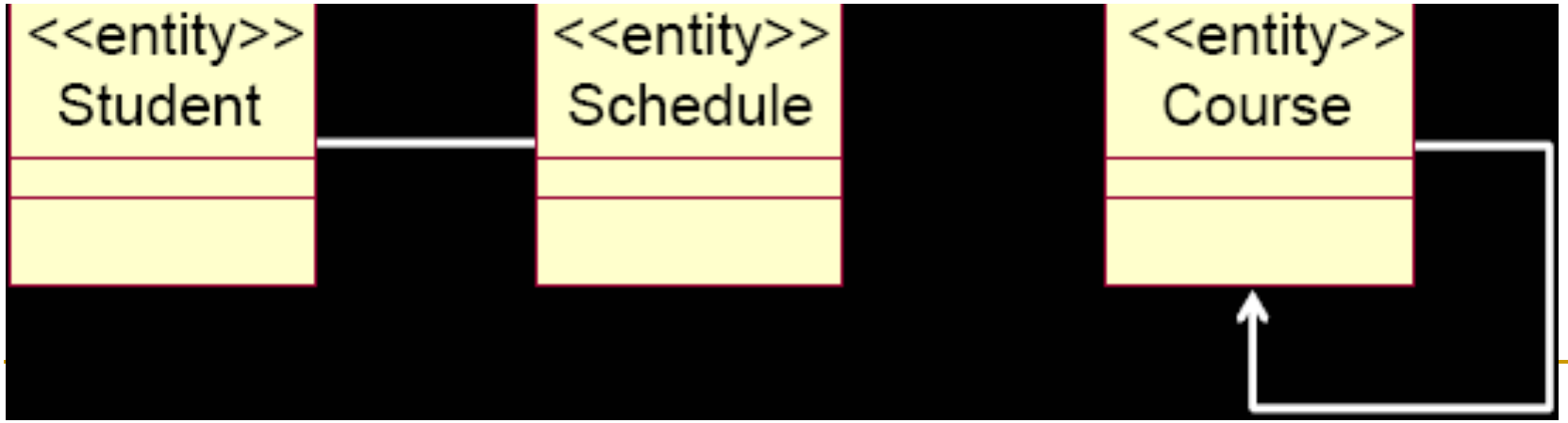
- Properties/characteristics of identified classes
- Information retained by identified classes
- “Nouns” that did not become classes
  - Information whose value is the important thing
  - Information that is uniquely "owned” by an object
  - Information that has no behavior

确定属性

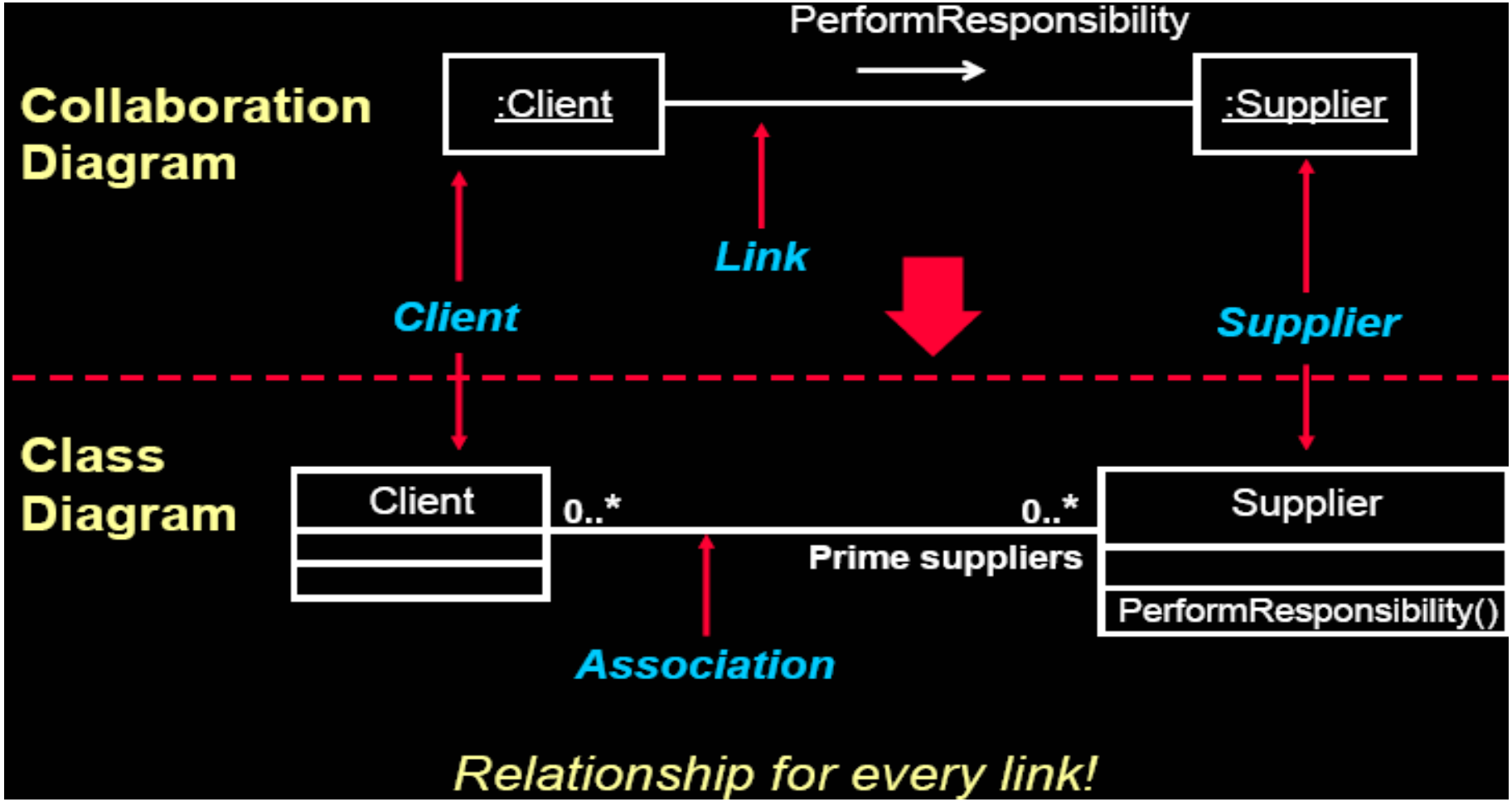
- 类的特征
- 类要保留的信息
- 不能成为类的名词
  - 值很重要的信息
  - 某个对象独有的信息
  - 没有行为的信息

Review: What Is an Association?

- **The semantic relationship between two or more classifiers that specifies connections among their instances**
  - **A structural relationship, specifying that objects of one thing are connected to objects of another**

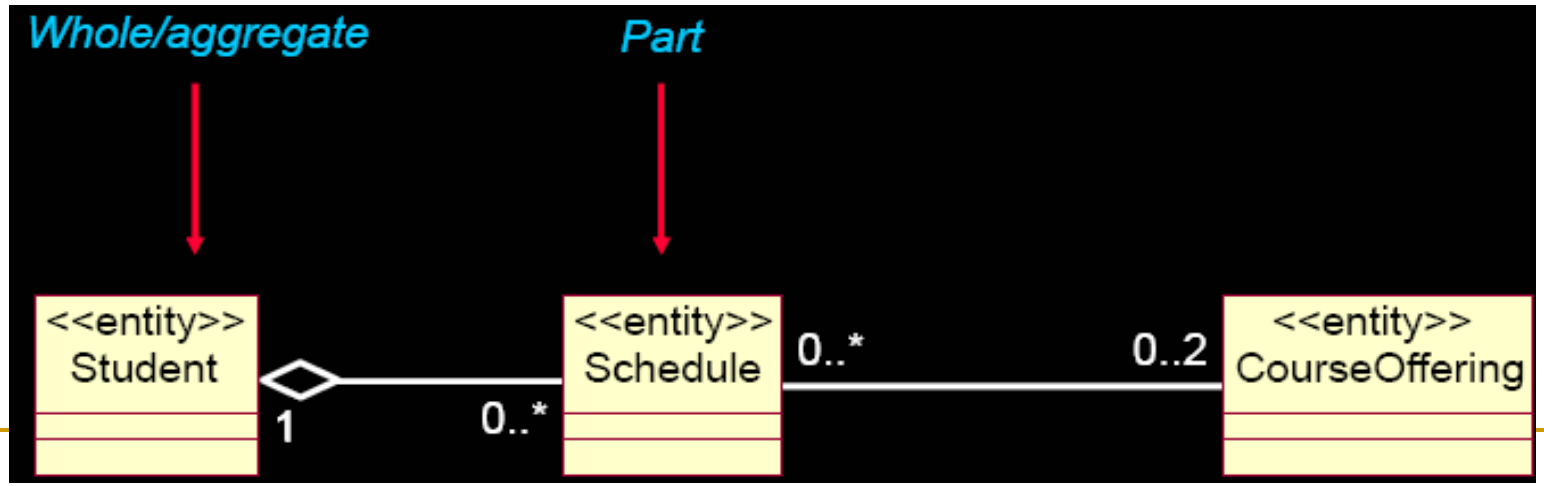


Finding Relationships



Review: What Is Aggregation?

- **A special form of association that models whole-part relationship between an aggregate (the whole) and its parts**



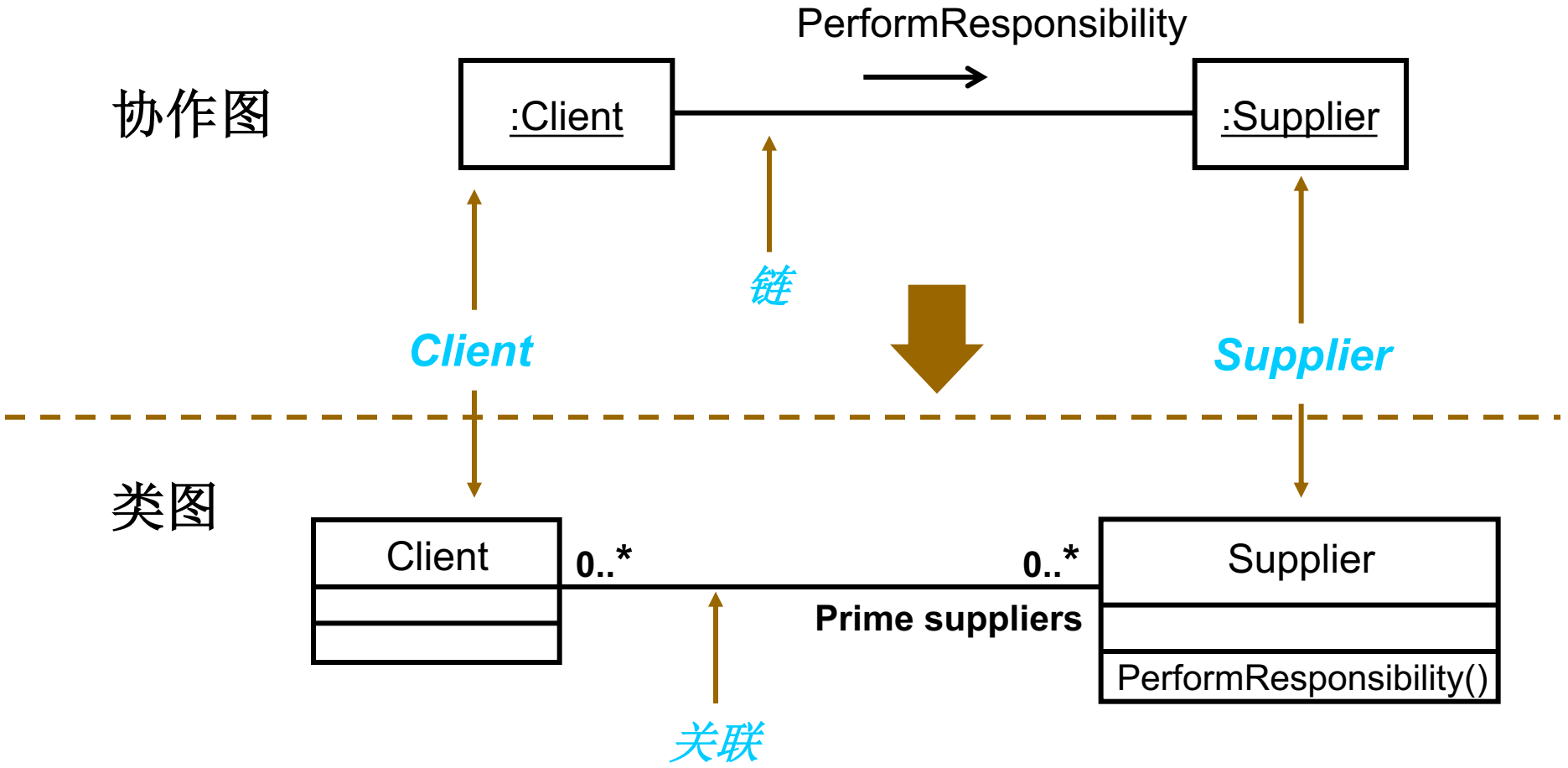
Association or Aggregation?

- If two objects are tightly bound by a whole-part relationship
  - The relationship is an aggregation.

- If two objects are usually considered as independent, although they are often linked
  - The relationship is an association.

When in doubt use association

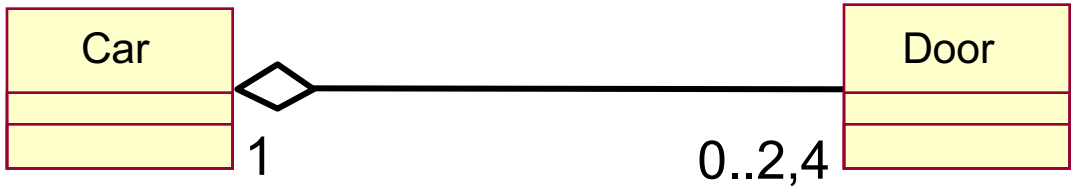
确定关联



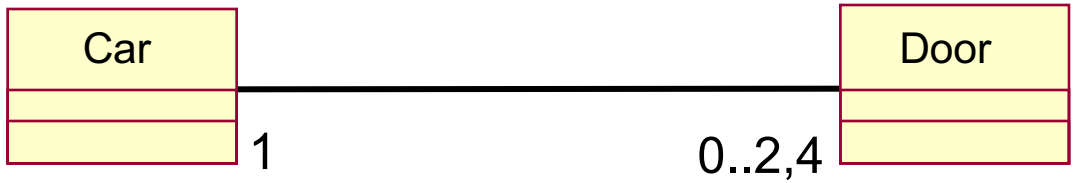
每条链都转换为一个关联

关联还是聚集

- 两个对象有整体-部分的关系
  - 是聚集关系

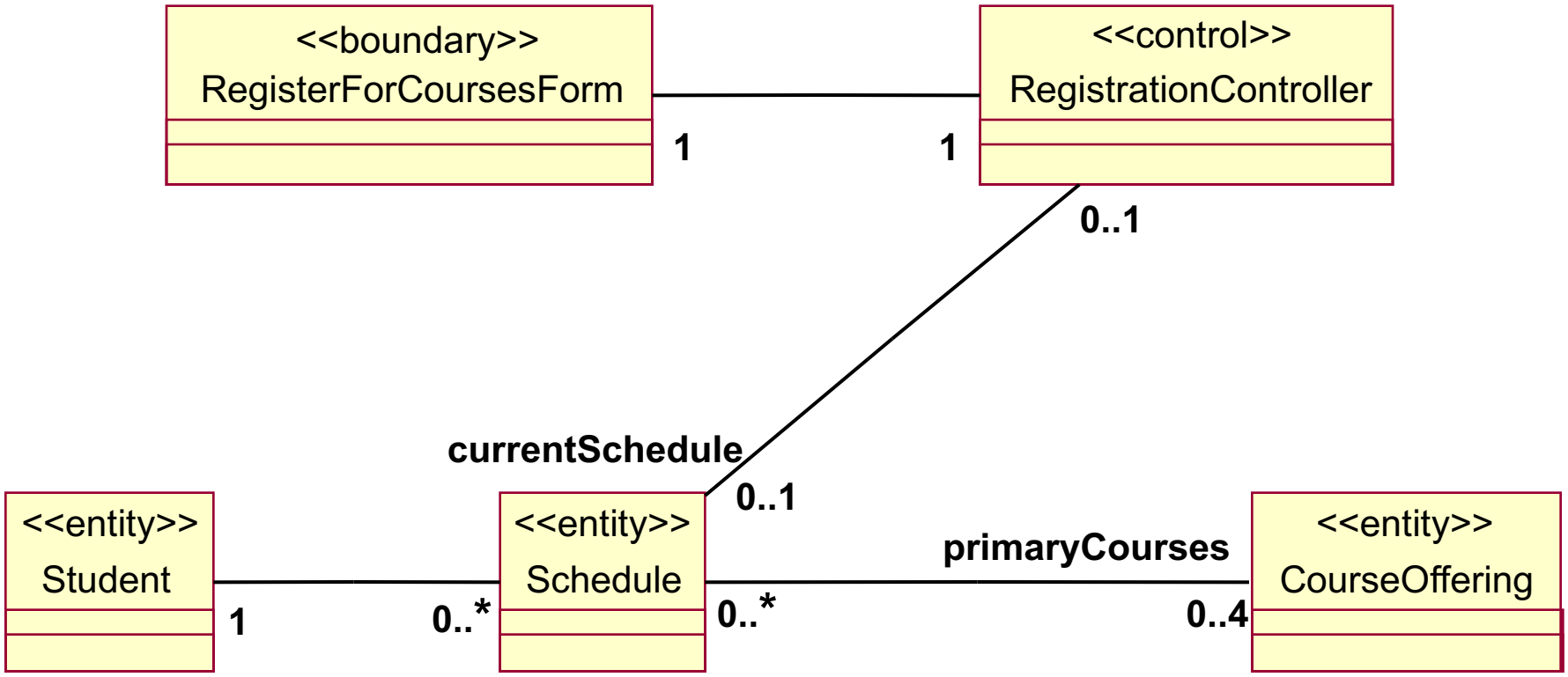


- 两个对象被认为是独立的
  - 是关联关系



不确定时使用关联关系

参与类图：关联关系示例


<<boundary>>
RegisterForCoursesForm
<<control>>
RegistrationController
1
1
0..1
currentSchedule
0..1
<<entity>>
Student
<<entity>>
Schedule
<<entity>>
CourseOffering
primaryCourses
1
0..*
0..*
0..4

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第八章　用例分析

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将用例行为分配给类

描述类

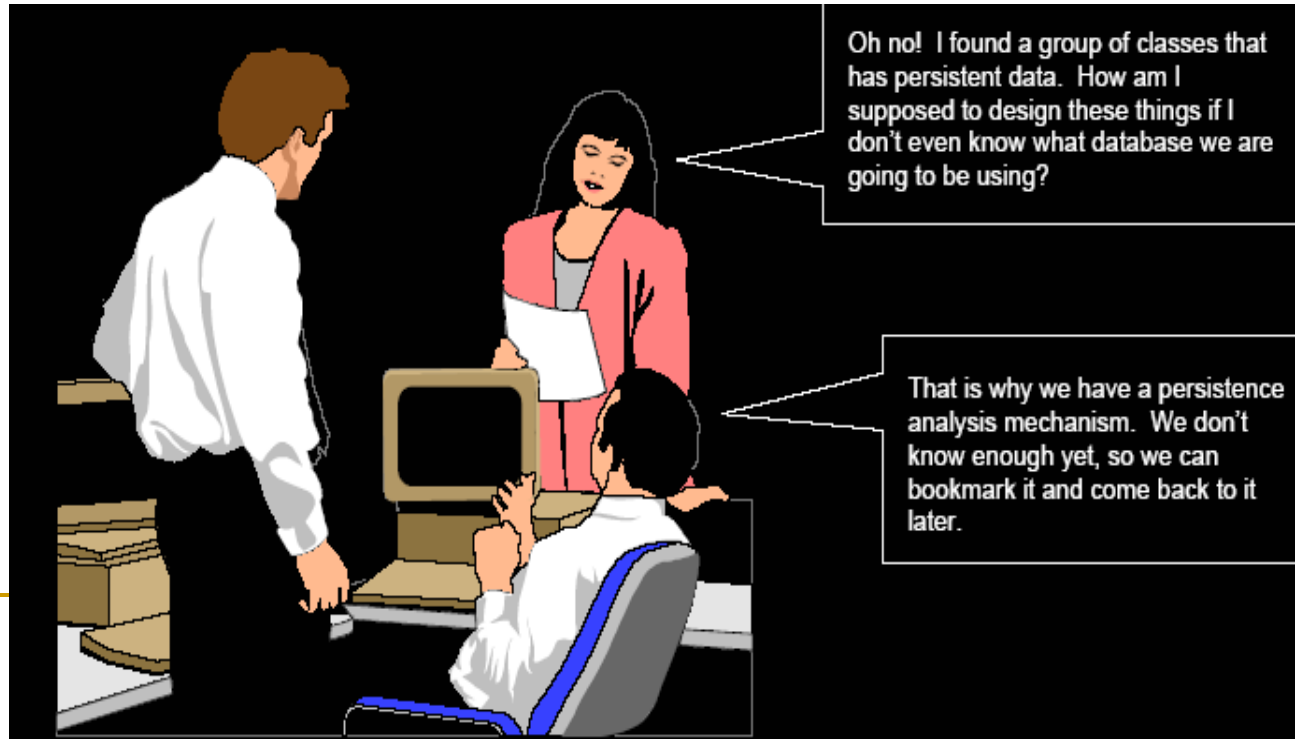
描述分析机制

合并类

案例实践

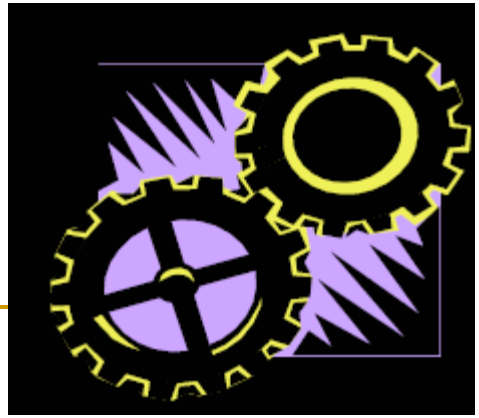
Review: Why Use Analysis Mechanisms?

- *Analysis mechanisms are used during analysis to reduce the complexity of analysis, and to improve its consistency by providing designers with a shorthand representation for complex behavior.*



Describing Analysis Mechanisms

- Collect all analysis mechanisms in a list
- Draw a map of the client classes to the analysis mechanisms
- Identify characteristics of the analysis mechanisms



描述分析机制

- 收集所有分析机制形成列表
- 绘制客户类到分析机制的映射图
- 确定分析机制的特征

Example: Describing Analysis Mechanisms

- class to analysis mechanism map

Analysis Class	Analysis Mechanism(s)
Student	Persistency, Security
Schedule	Persistency, Security
CourseOffering	Persistency, Legacy Interface
Course	Persistency, Legacy Interface
RegistrationController	Distribution

描述分析机制示例

类到分析机制的映射图

类	分析机制
学生	持久性, 安全性
课程表	持久性, 安全性
课程提供	持久性, 遗留界面
课程	持久性, 遗留界面
注册控制器	分布性

Example: Describing Analysis Mechanisms (cont.)

- Analysis mechanism characteristics
- Persistency for Schedule class:
  - Granularity: 1 to 10 Kbytes per product
  - Volume: up to 2,000 schedules
  - Access frequency
    - • Create: 500 per day
    - • Read: 2,000 access per hour
    - • Update: 1,000 per day
    - Delete: 50 per day
  - Other characteristics

描述分析机制示例

课程表类使用的持久性：

- 粒度：每张课程表占用1到10千字节
- 容量：上限为2,000张课程表
- 访问频率
  - 创建：每天500次
  - 读取：每小时2000次
  - 更新：每天1000次
  - 删除：每天50次
- 其它特征

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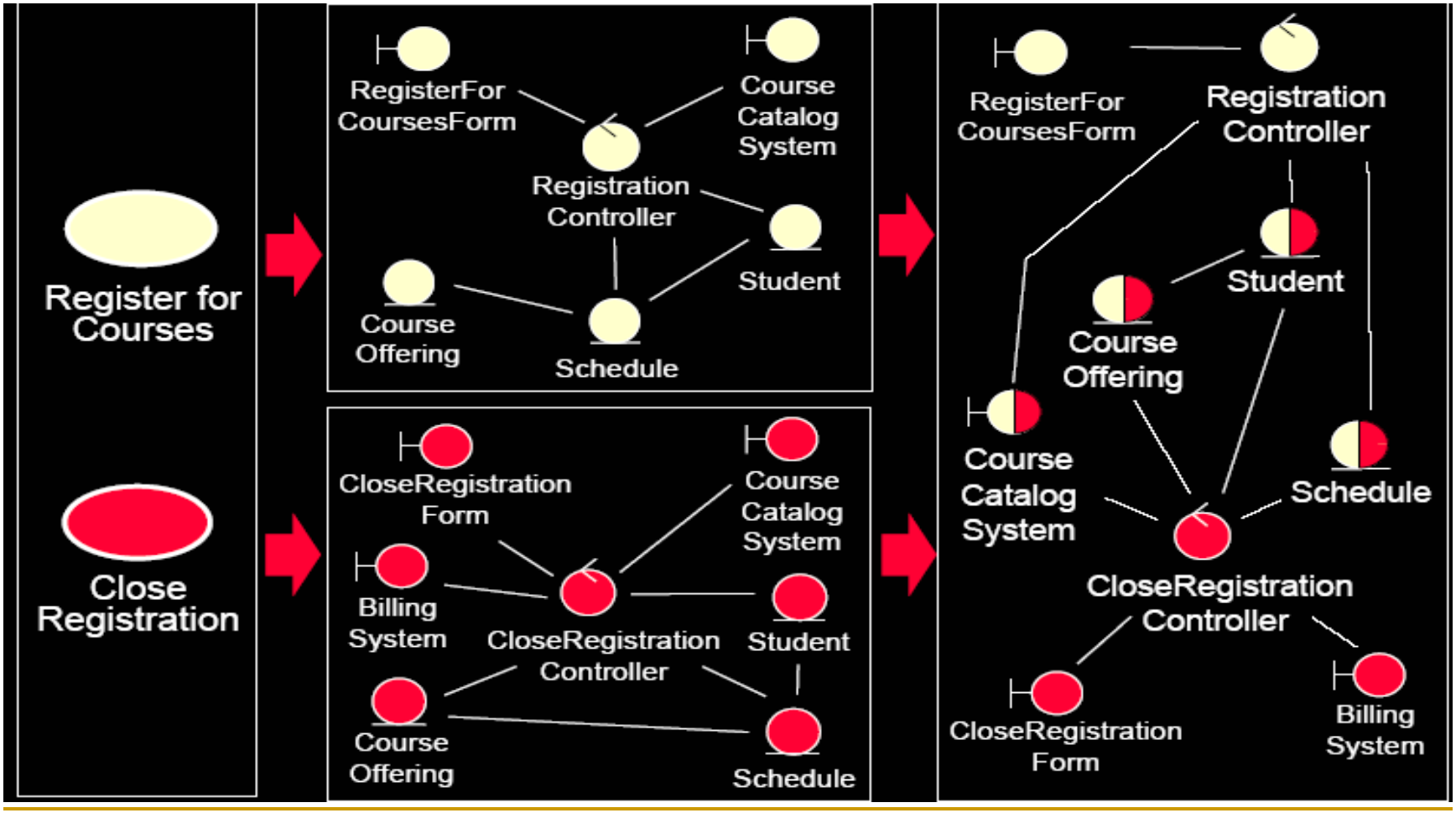
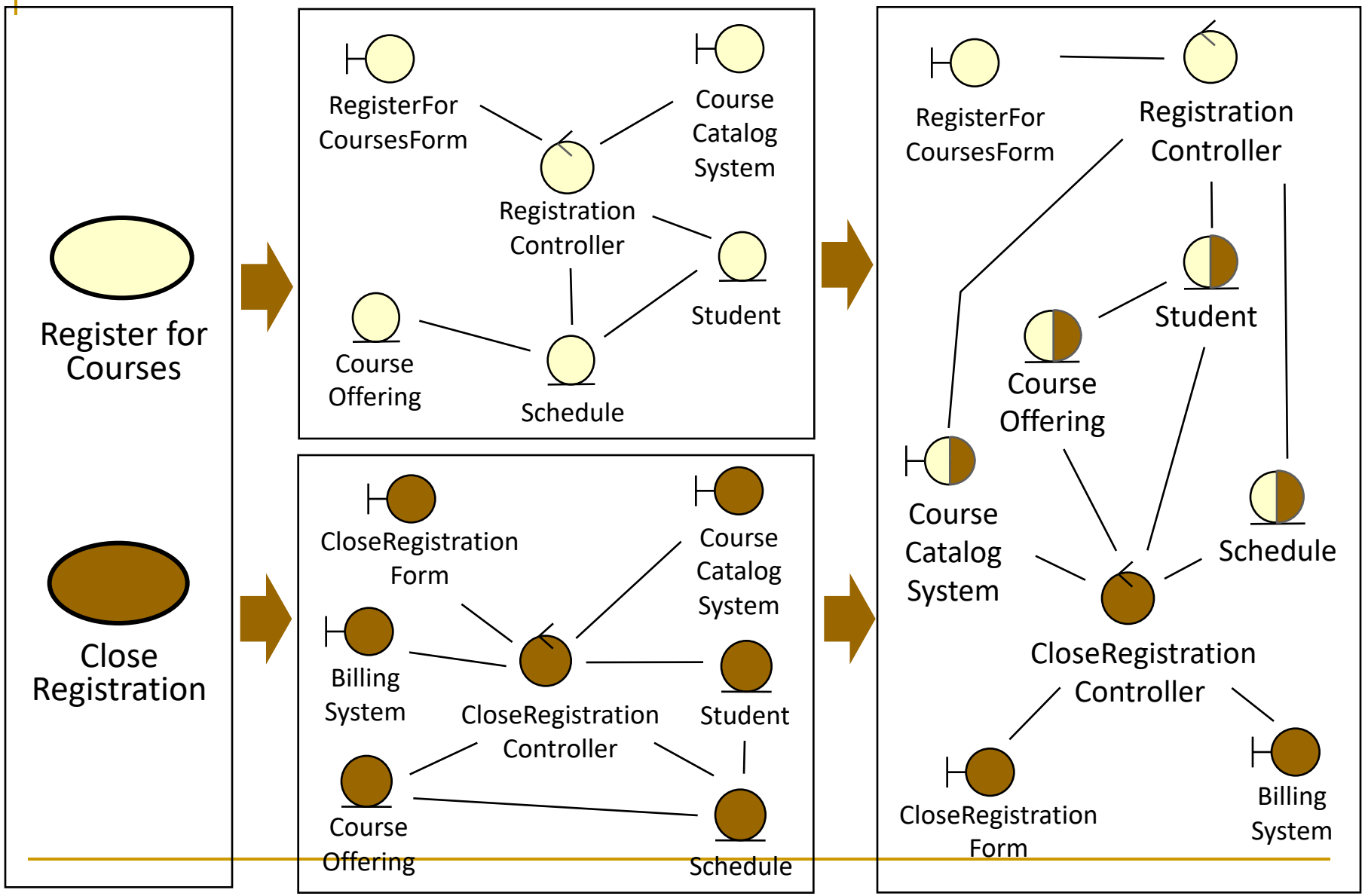
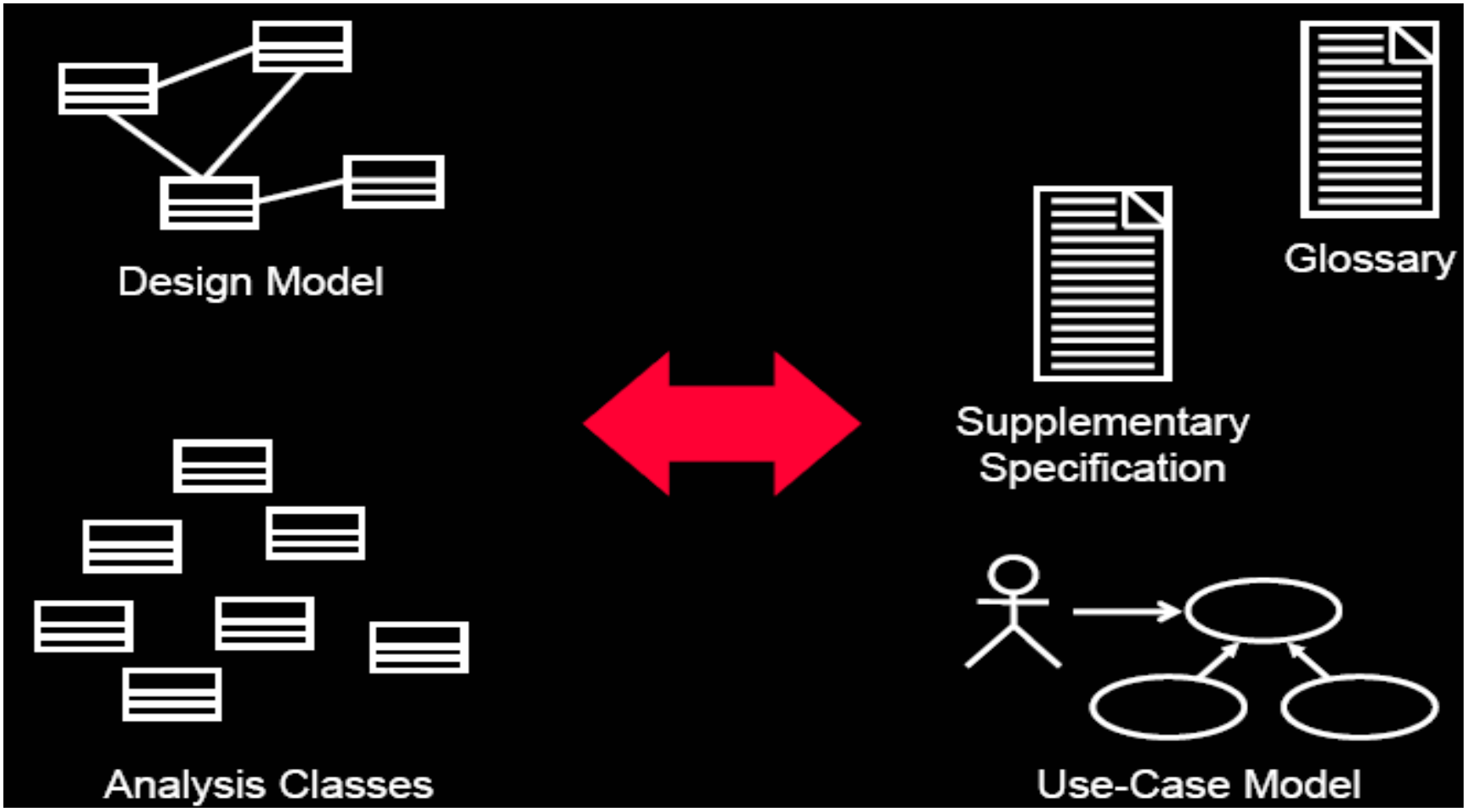
Unify classes



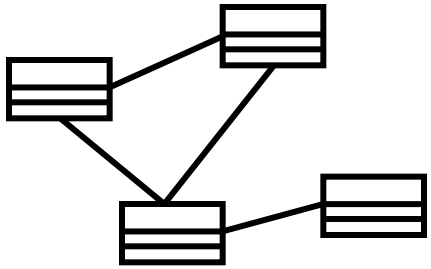
合并类


Register for Courses
Close Registration
RegisterFor CoursesForm
Course Catalog System
Registration Controller
Student
Course Offering
Schedule
CloseRegistration Form
Billing System
CloseRegistration Controller
Student
Course Offering
Schedule
RegisterFor CoursesForm
Registration Controller
Student
Course Offering
Course Catalog System
Schedule
CloseRegistration Controller
CloseRegistration Form
Billing System

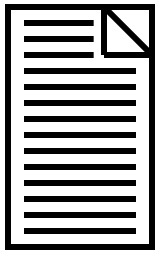
Evaluate Your Results



评估用例分析结果

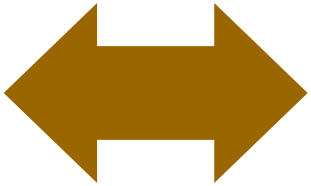


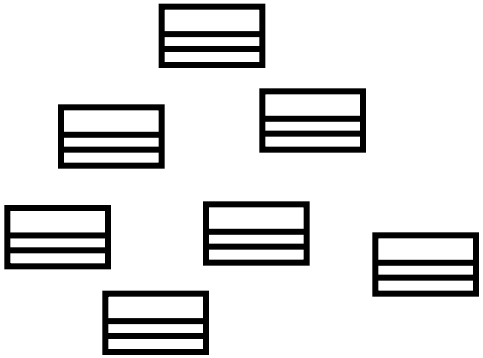
设计模型



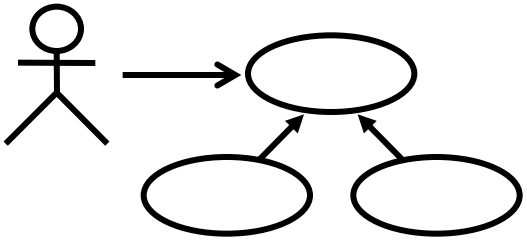
术语表

补充规约





类



用例模型

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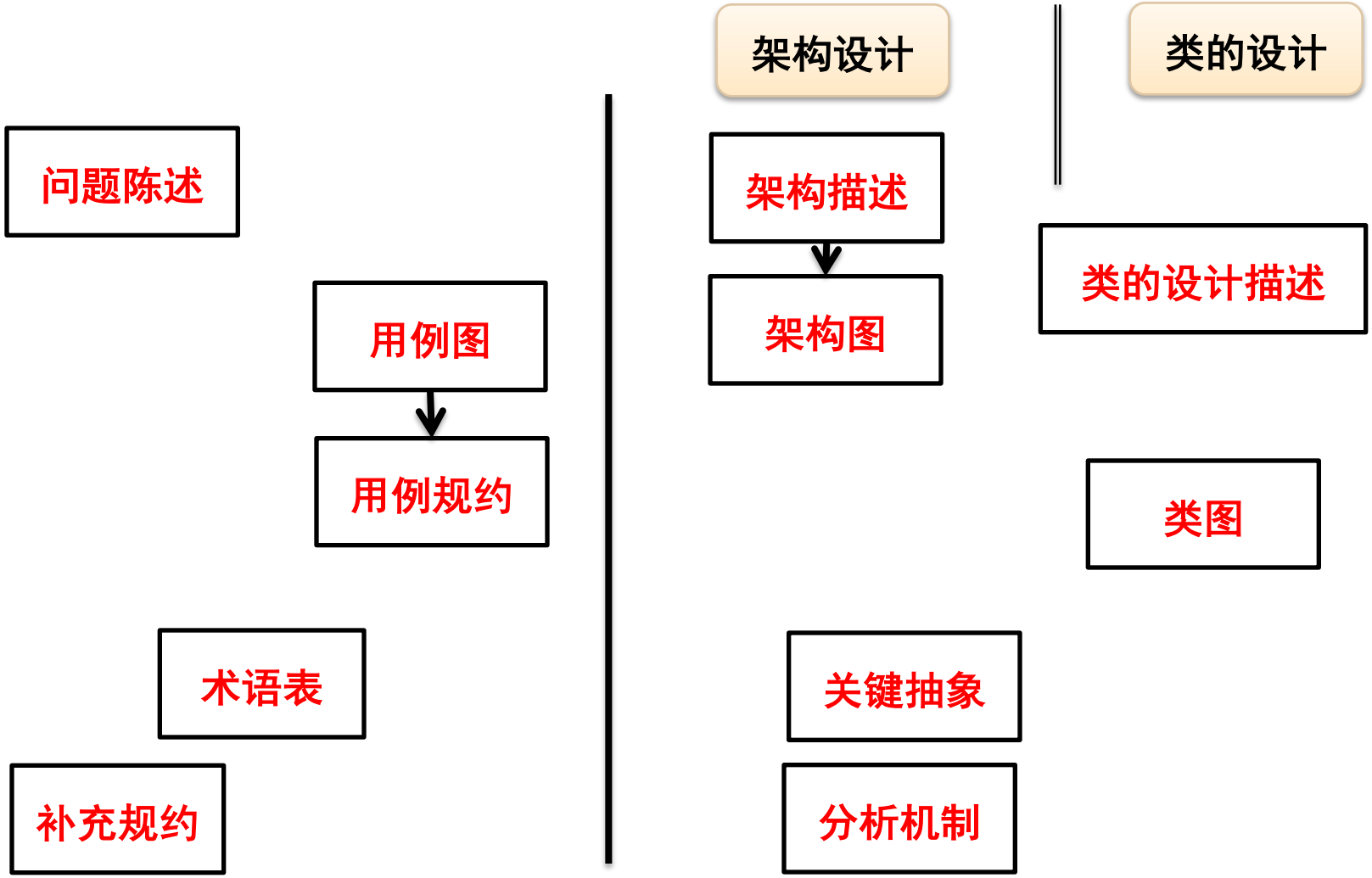
Checkpoints: classes

- Are the classes reasonable?
- Does the name of each class clearly reflect the role it plays?
- Does the class represent a single well-defined abstraction?
- Are all attributes and responsibilities functionally coupled?
- Does the class offer the required behavior?
- Are all specific requirements on the class addressed?

Checkpoints: Use-Case 功能的实现

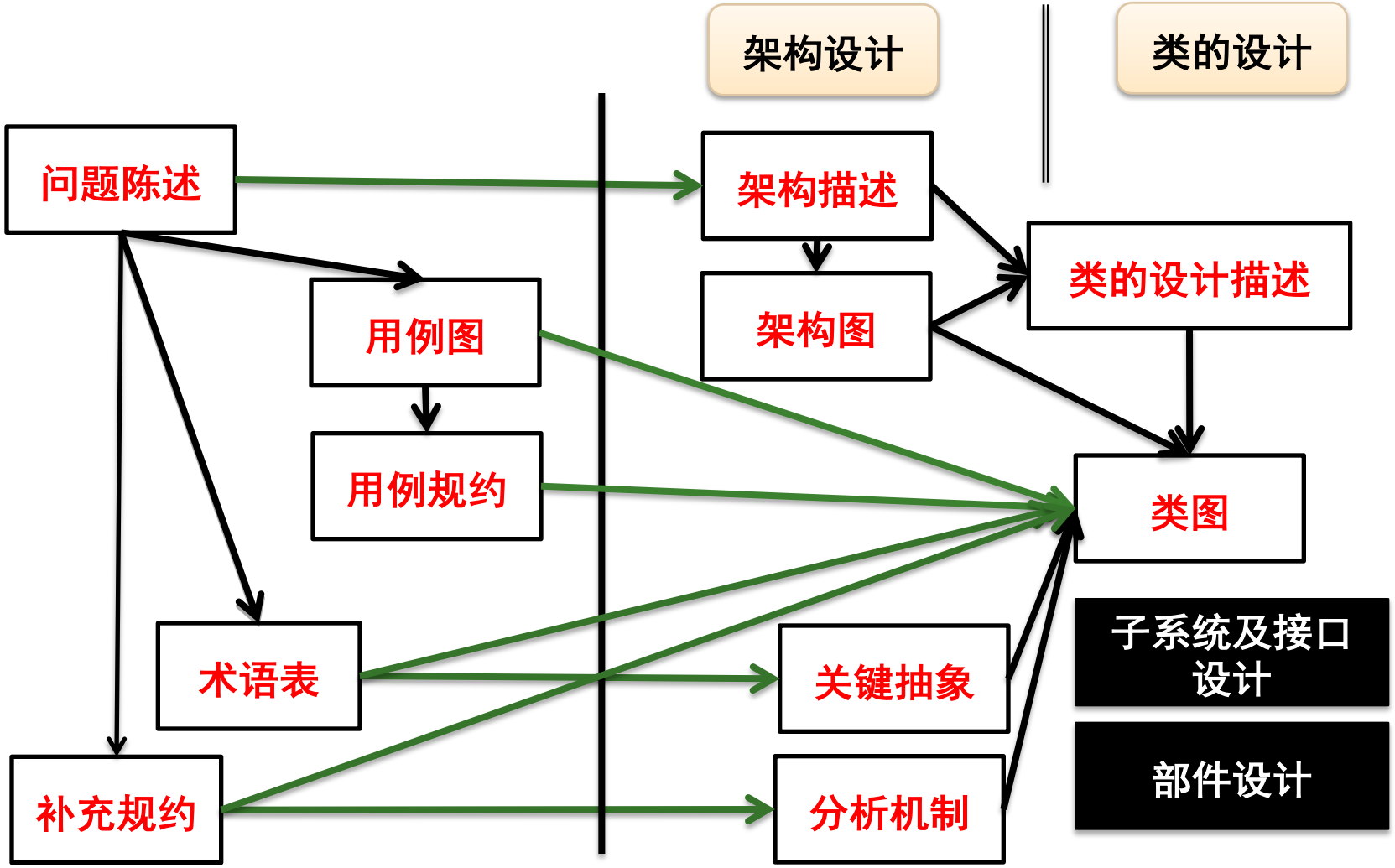
- Have all the main and/or sub-flows been handled, including exceptional cases?
- Have all the required objects been found?
- Has all behavior been unambiguously distributed to the participating objects?
- Has behavior been distributed to the right objects?
- Where there are several Interaction diagrams, are their relationships clear and consistent?

基于面向对象的分析. vs. 设计



基于面向对象的需求分析 → 基于面向对象的设计

基于面向对象的分析. vs. 设计



基于面向对象的需求分析 → 基于面向对象的设计

Exercise: Use-Case Analysis (cont.)

- Given the following:
  - Use-Case Model, especially the use-case flows of events
  - Key abstractions/classes
  - The Supplementary Specification
  - The possible analysis mechanisms

实验：Use-Case Analysis

- Identify the following for a particular use case:
  - The classes, along with their:
    - • Brief descriptions
    - • Stereotypes
    - • Responsibilities
  - The collaborations needed to implement the use case
  - class attributes and relationships
  - class analysis mechanisms

实验: Use-Case Analysis (cont.)

- Produce the following for a particular use case:
  - VOPC class diagram, containing the classes, their stereotypes, responsibilities, attributes, and relationships
  - class to analysis mechanism map

实验：Use-Case Analysis （cont.）

- 提交的制品
  - 补充用例规约
  - 用例分析
    - 针对用例的类的析取
    - 3-5个用例
    - 每个用例的类图须有类的名称、属性、操作
  - 分析机制
  - 系统总的类图（包括类及其关系）

理论作业 8th

1. 用例分析(类的析取）的目标是什么？
2. 用例分析的步骤和制品是什么？
3. 分析机制存在的意义是什么？
4. 类的操作是怎样确定的？
5. 类的属性是怎样确定的？
6. 类的命名有哪些需要注意的？