IBM Software Group

Mastering Object-Oriented Analysis and Design with UML

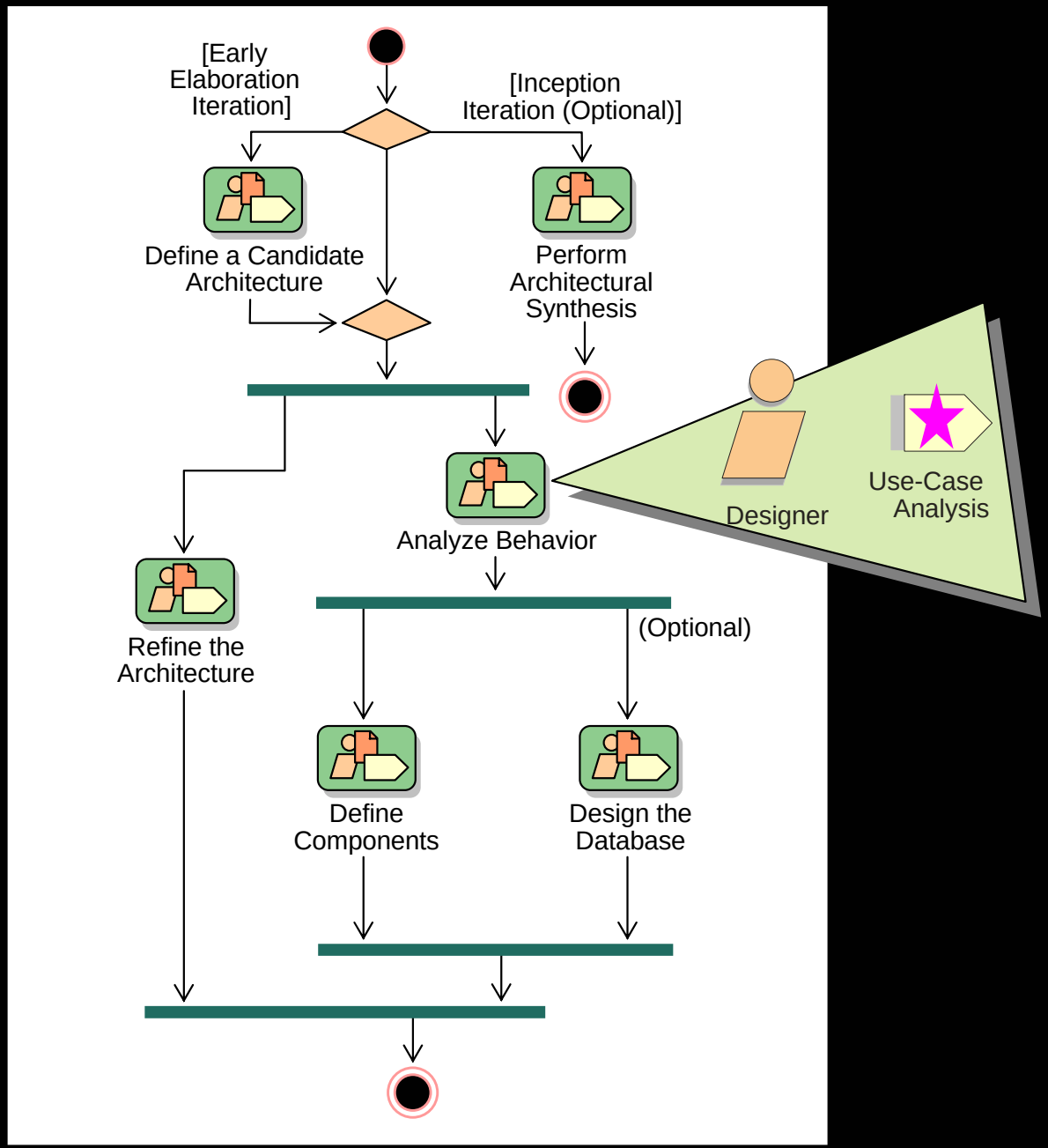
Module 5: Use-Case Analysis

Rational. software

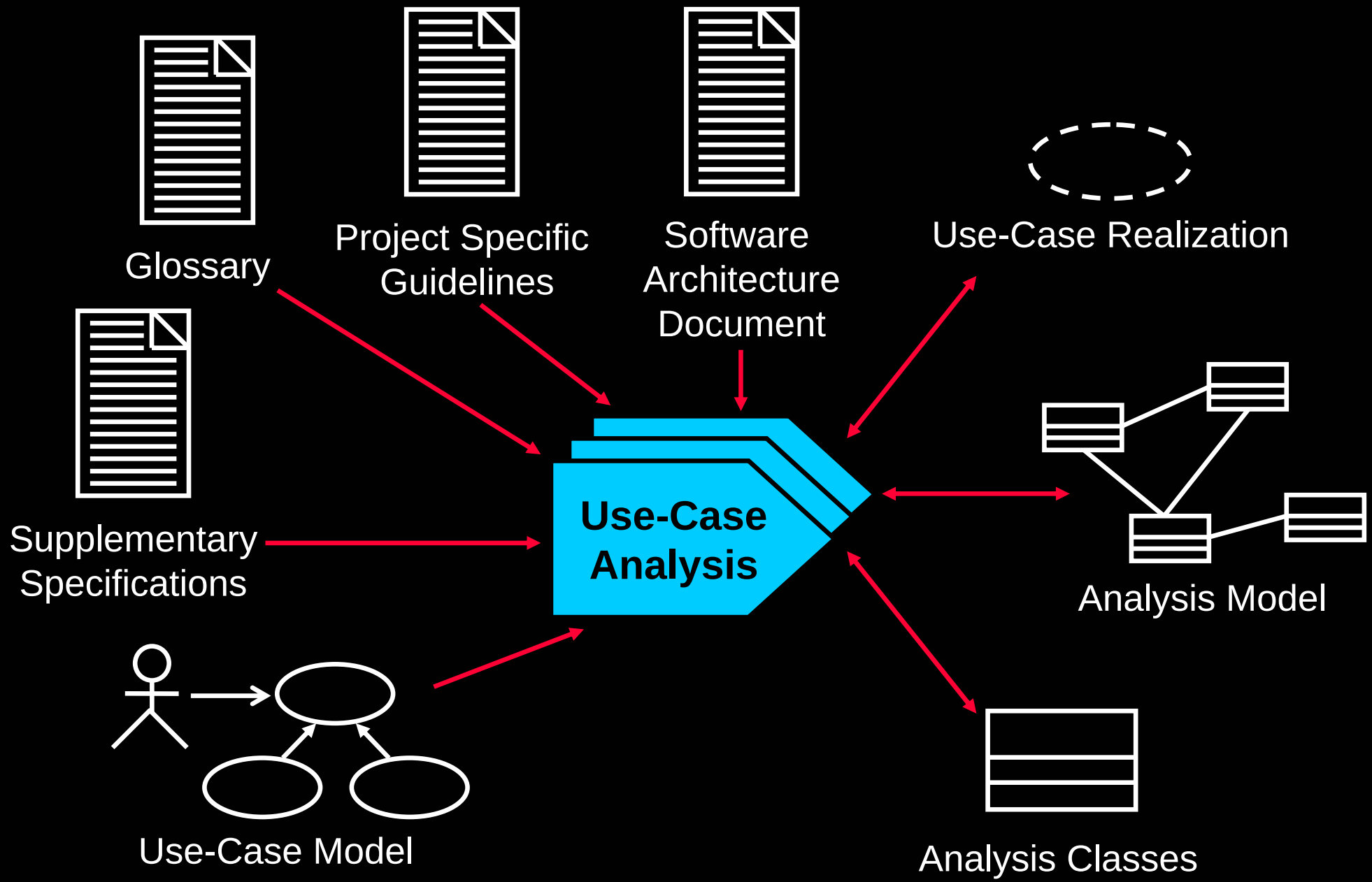
Objectives: Use-Case Analysis

- Explain the purpose of Use-Case Analysis and where in the lifecycle it is performed
- Identify the classes which perform a use-case 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

Use-Case Analysis in Context



Use-Case Analysis Overview



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 analysis class
  - Describe Responsibilities
  - Describe Attributes and Associations
  - Qualify Analysis Mechanisms
- Unify Analysis Classes
- Checkpoints

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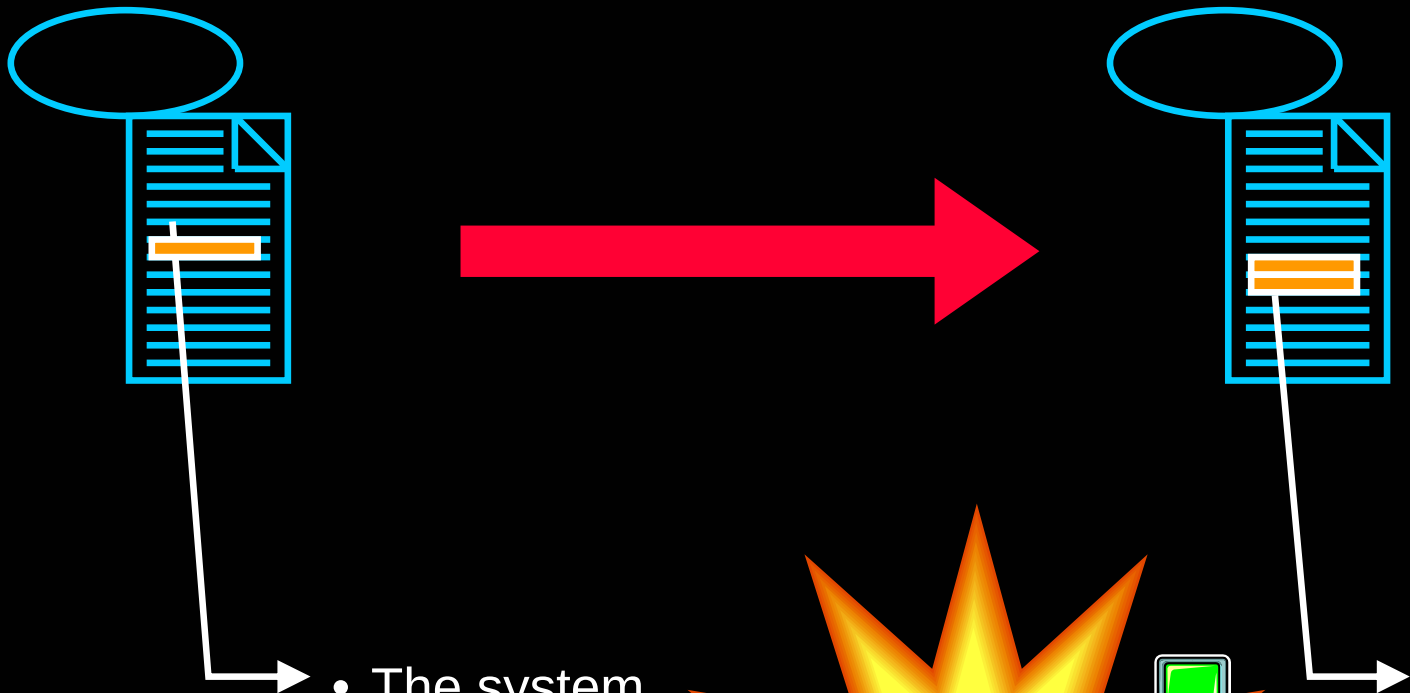
Supplement the Use-Case Description



- The system displays a list of course offerings.

- The system retrieves and displays a list of current course offerings from the course catalog legacy database.

Use-Case Analysis Steps

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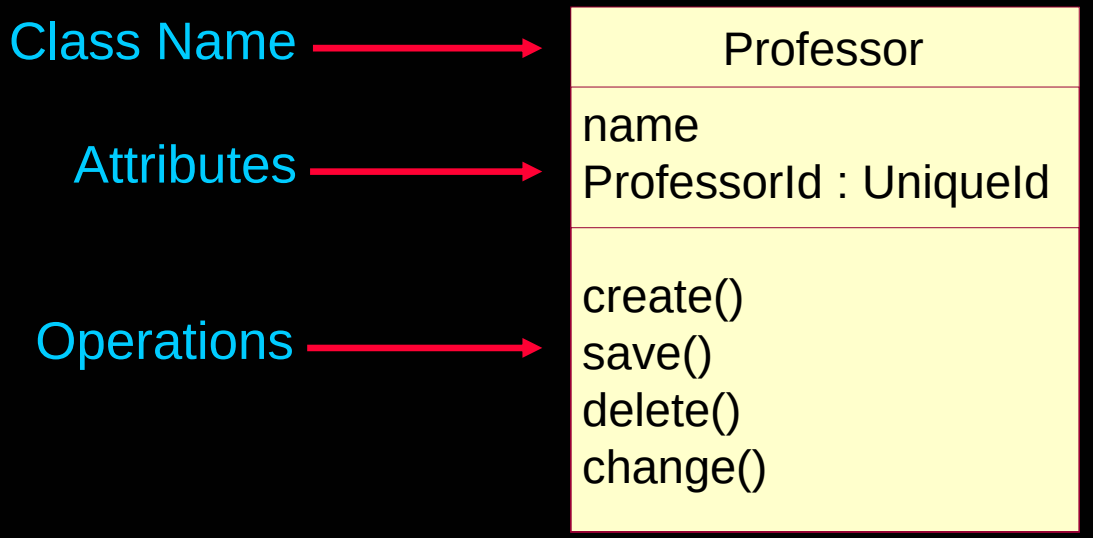
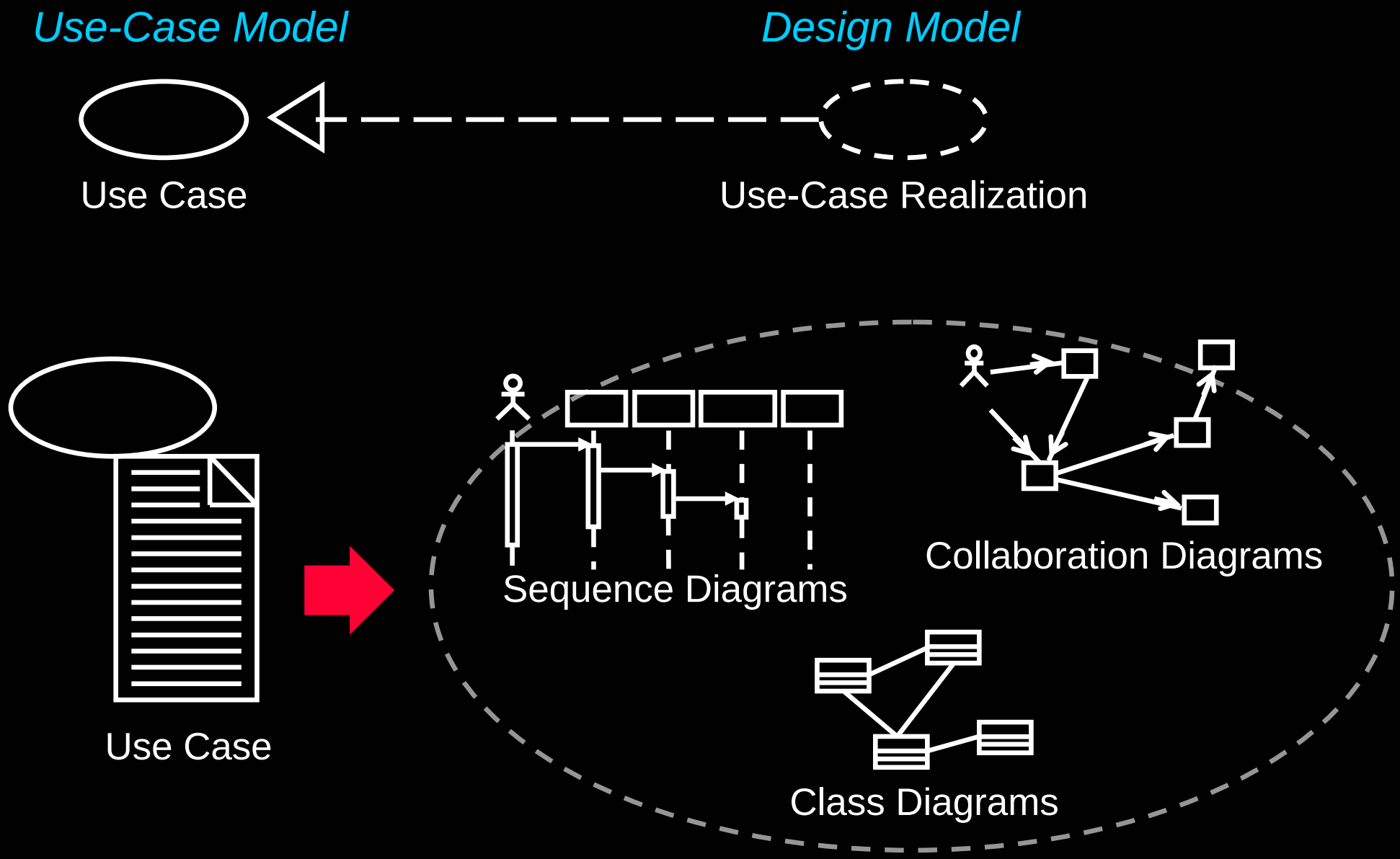
Review: Class

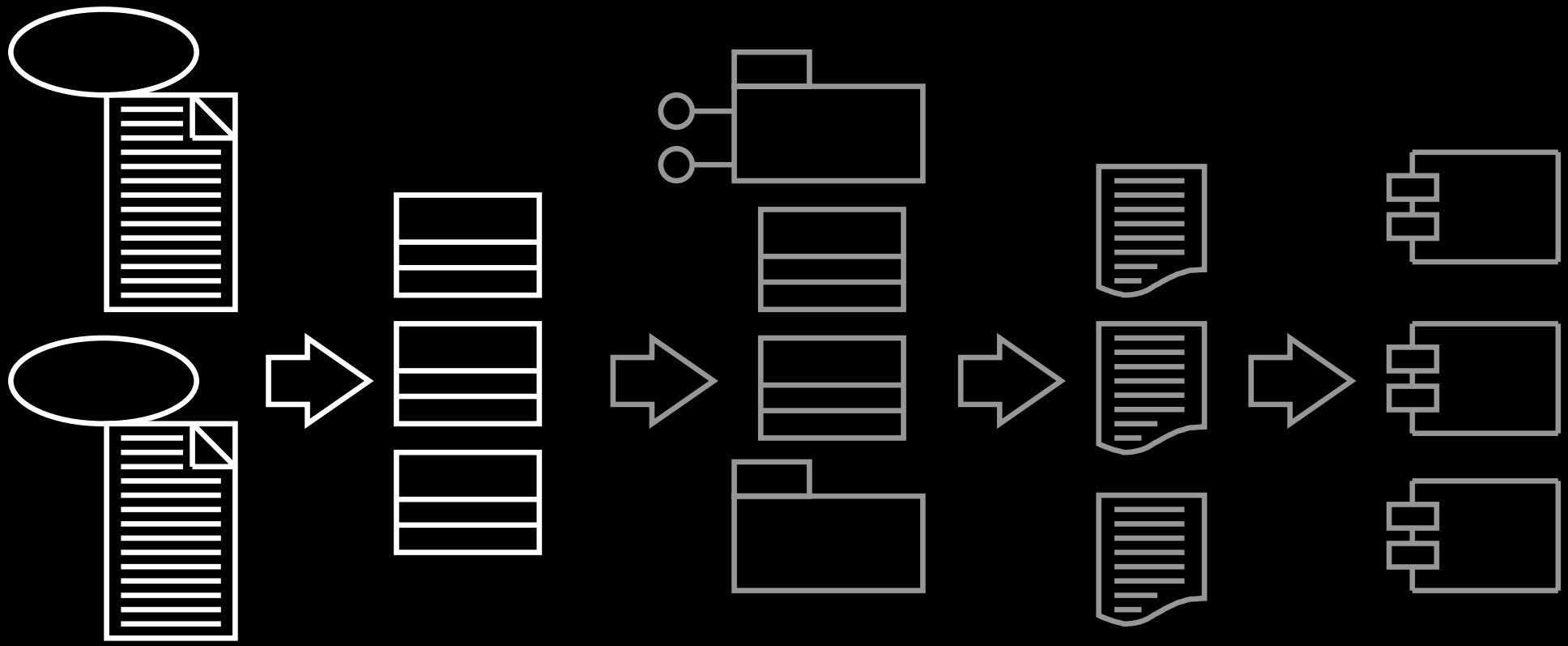
- An abstraction
- Describes a group of objects with common:
  - Properties (attributes)
  - Behavior (operations)
  - Relationships
  - Semantics



Review: Use-Case Realization



Analysis Classes: A First Step Toward Executables

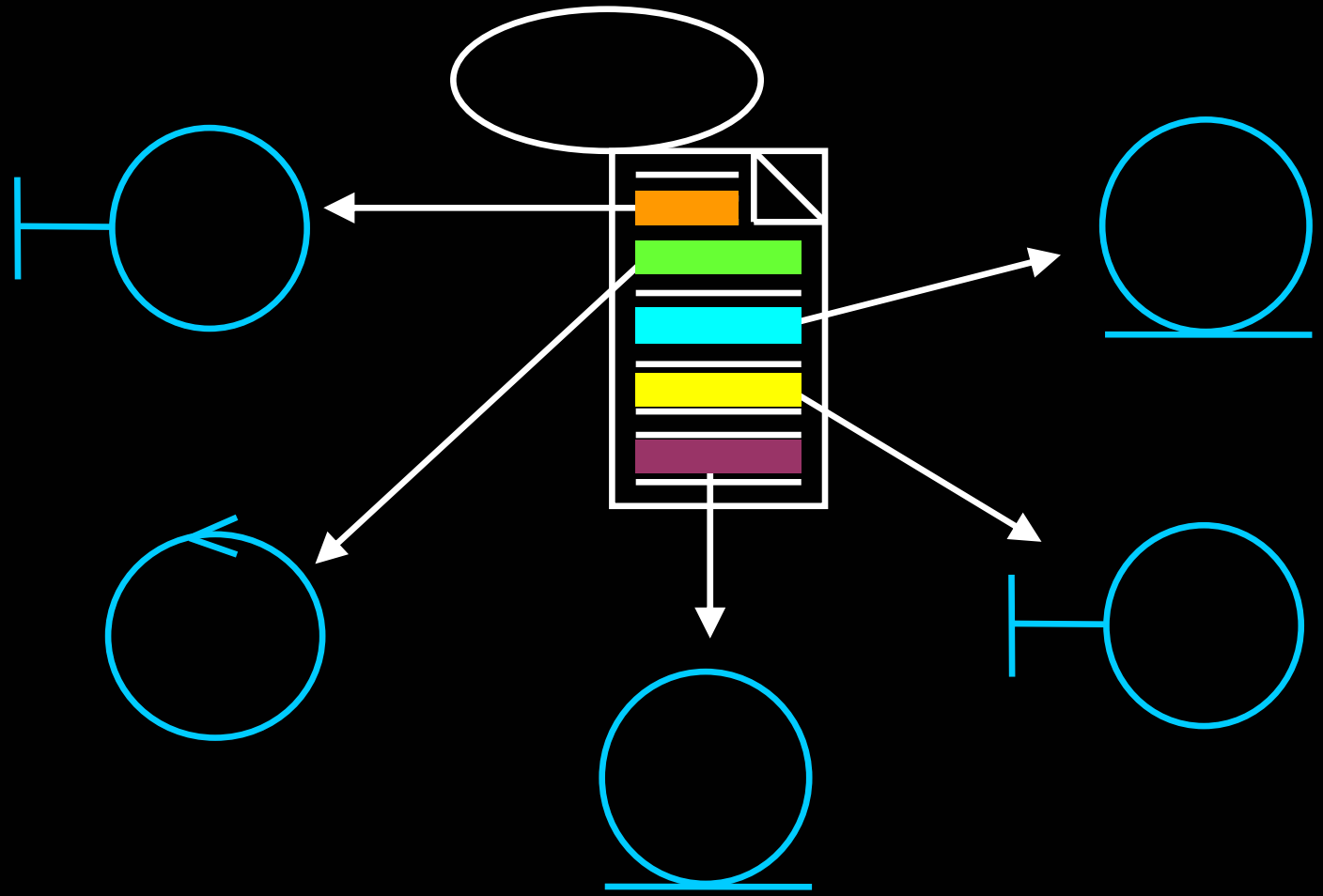


Use Cases **Analysis Classes** **Design Elements** **Source Code** **Exec**

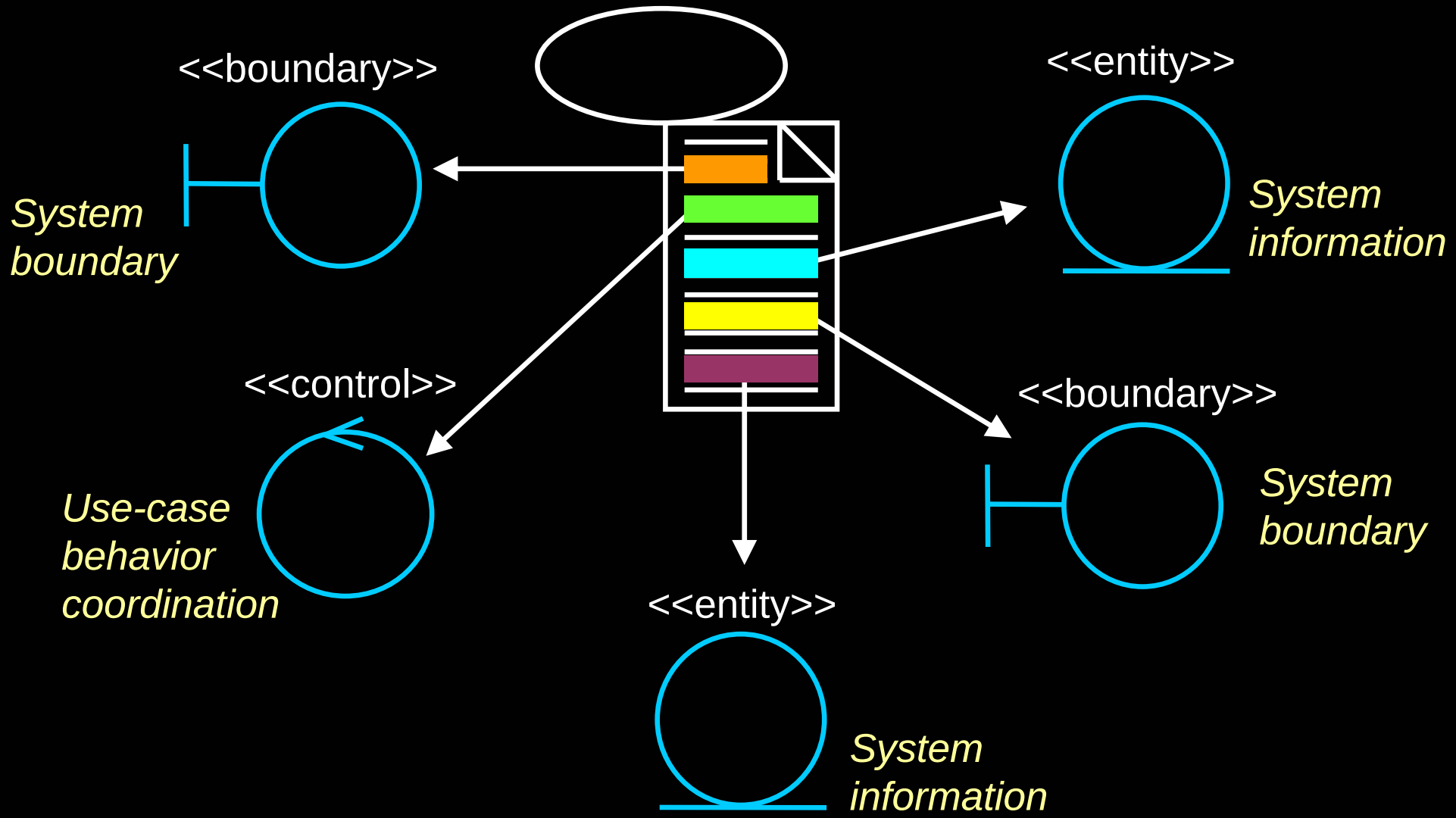
Use-Case Analysis

Find Classes from Use-Case Behavior

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



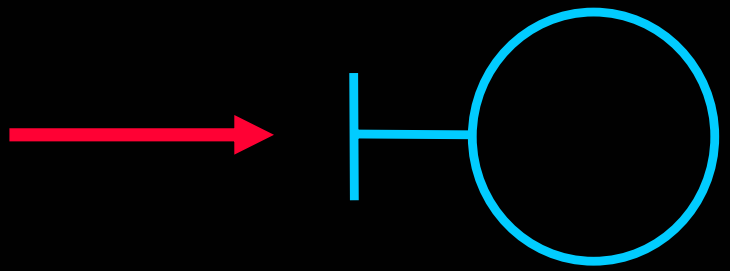
What Is an Analysis Class?



What Is a Boundary Class?

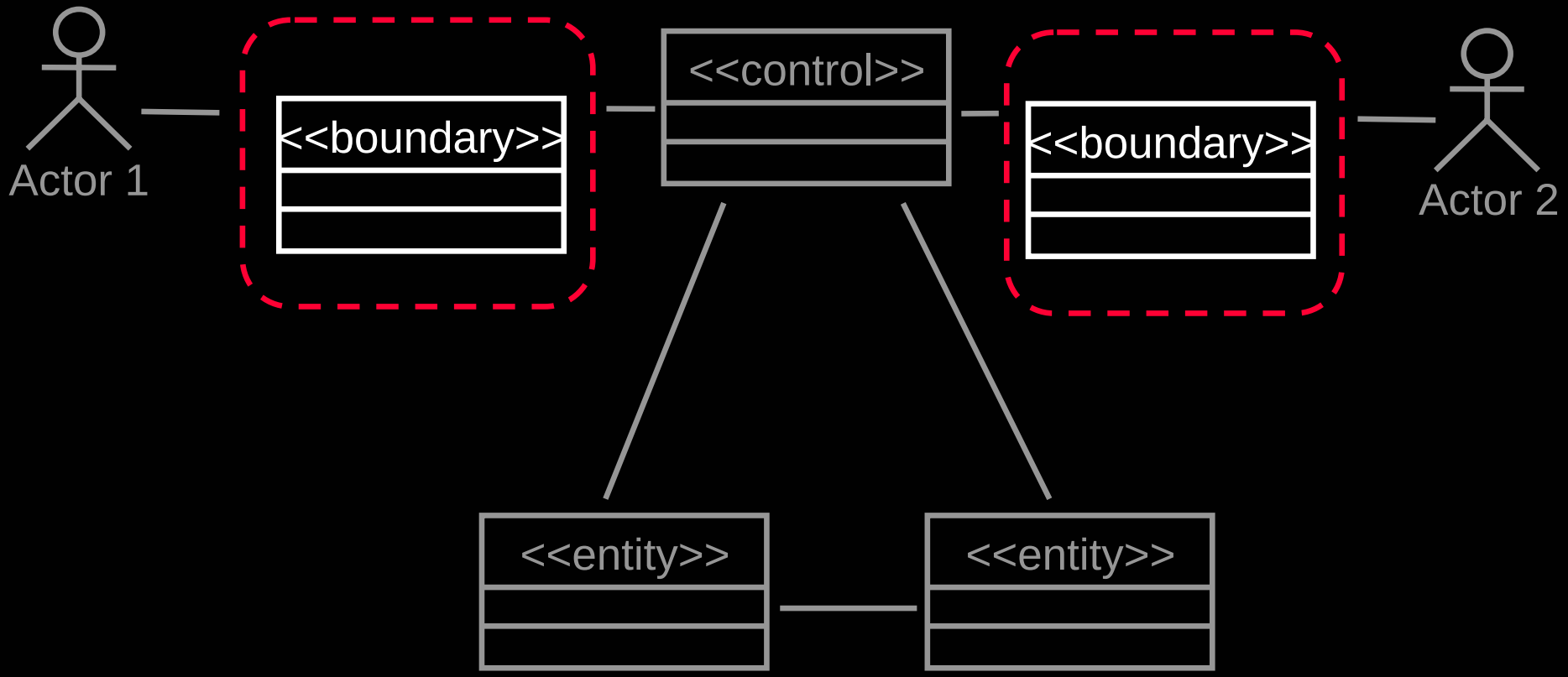
- Intermediates between the interface and something outside the system
- Several Types
  - User interface classes
  - System interface classes
  - Device interface classes
- *One boundary class per actor/use-case pair*

Analysis class stereotype



Environment Dependent

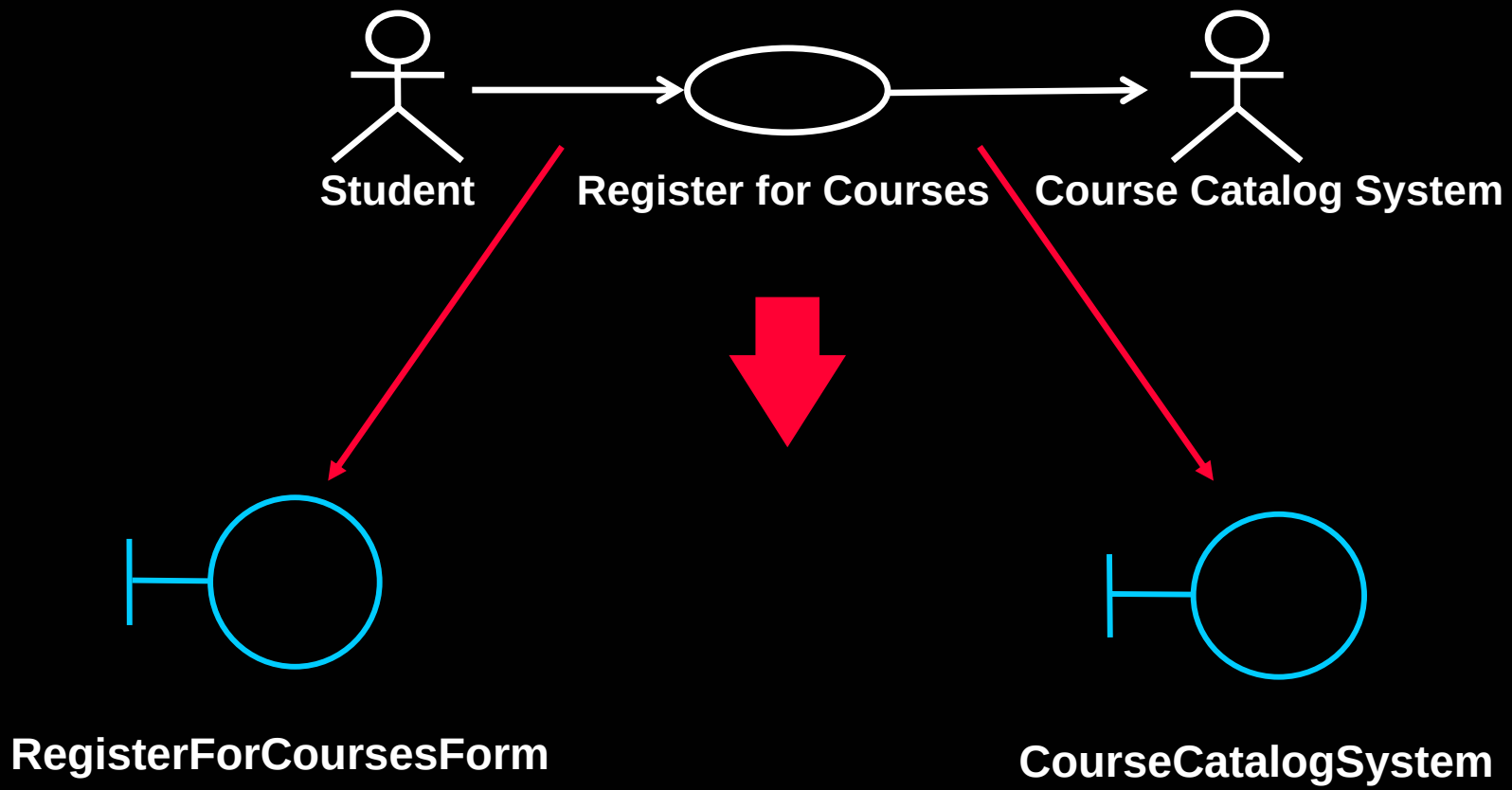
The Role of a Boundary Class



Model interaction between the system and its environment

Example: Finding Boundary Classes

- One boundary class per actor/use case pair



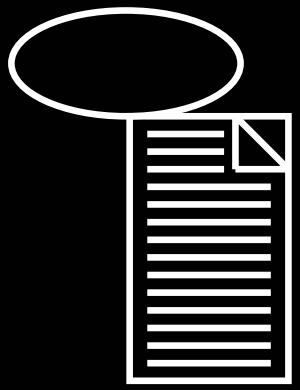
Guidelines: Boundary Class

- 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

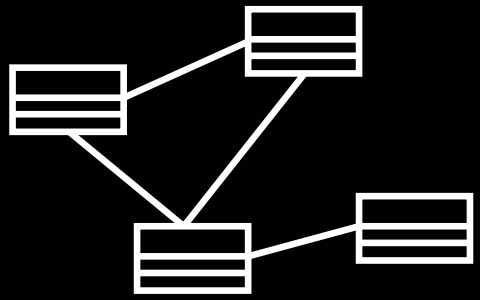
Concentrate on the responsibilities, not the details!

What Is an Entity Class?

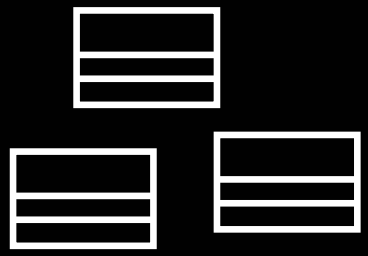
- Key abstractions of the system



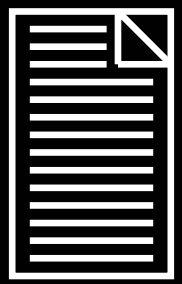
Use Case



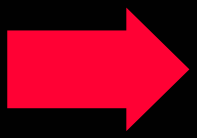
Business-Domain Model



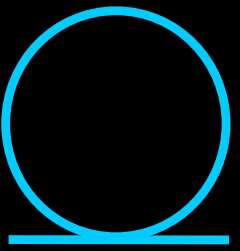
Architectural Analysis Abstractions



Glossary

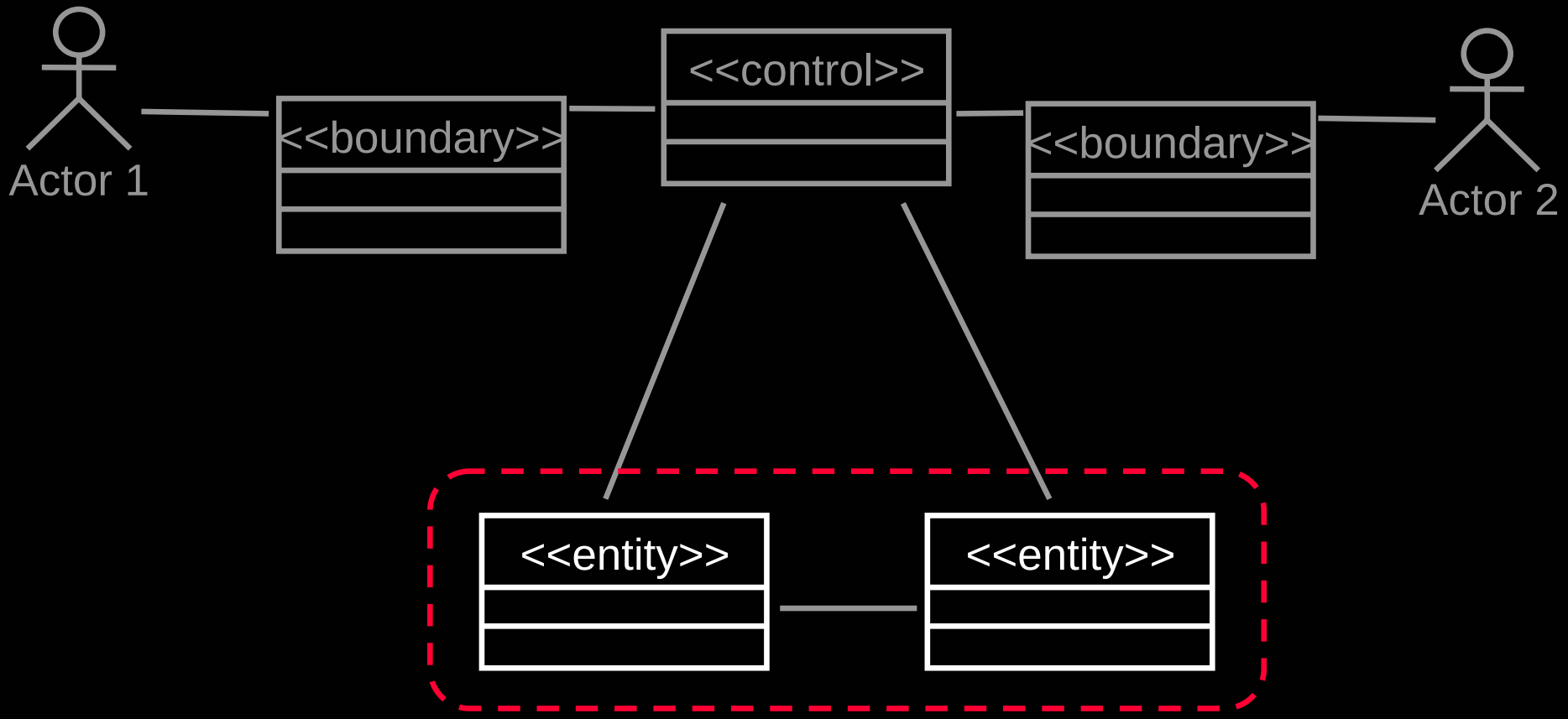


Analysis class stereotype



Environment Independent

The Role of an Entity Class



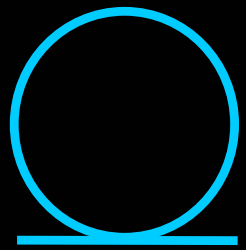
Store and manage information in the system

Example: Finding Entity Classes

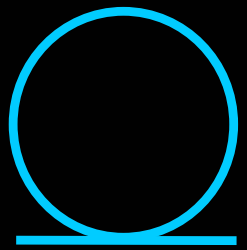
- Use use-case flow of events as input
- Key abstractions of the use case
- Traditional, filtering nouns approach
  - Underline noun clauses in the use-case flow of events
  - Remove redundant candidates
  - Remove vague candidates
  - Remove actors (out of scope)
  - Remove implementation constructs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

Example: Candidate Entity Classes

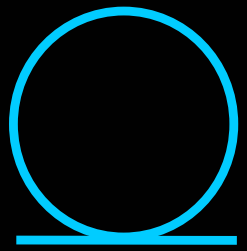
- Register for Courses (Create Schedule)



CourseOffering



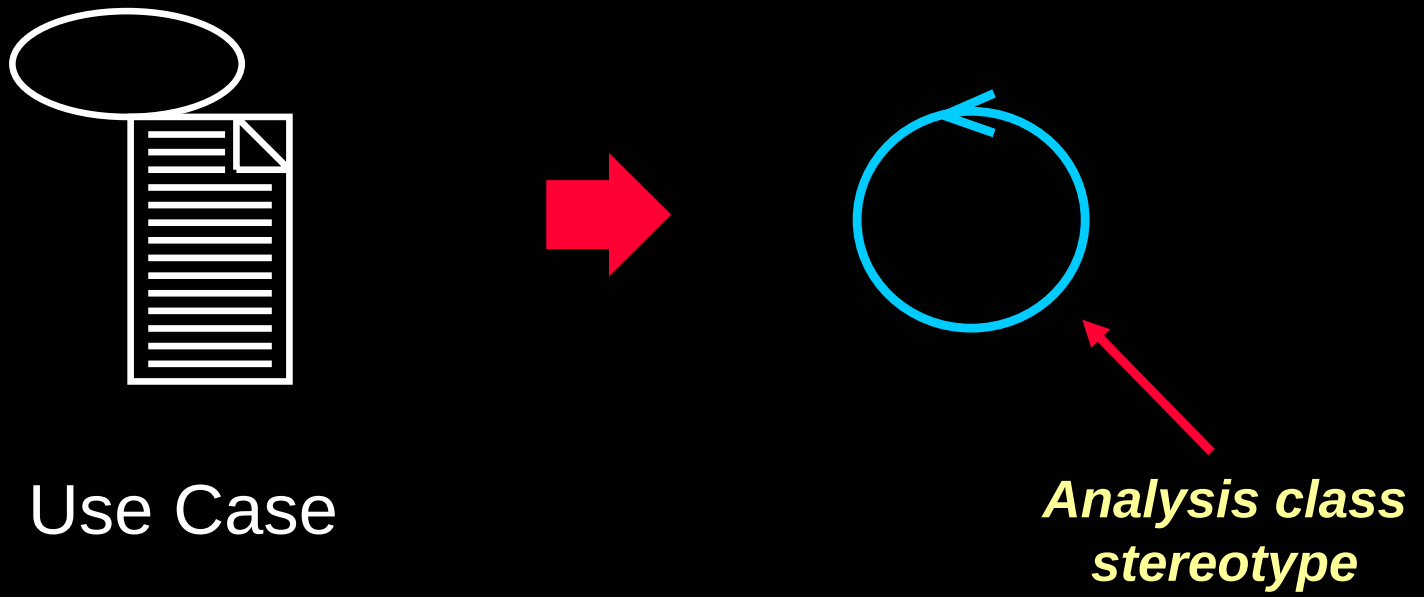
Schedule



Student

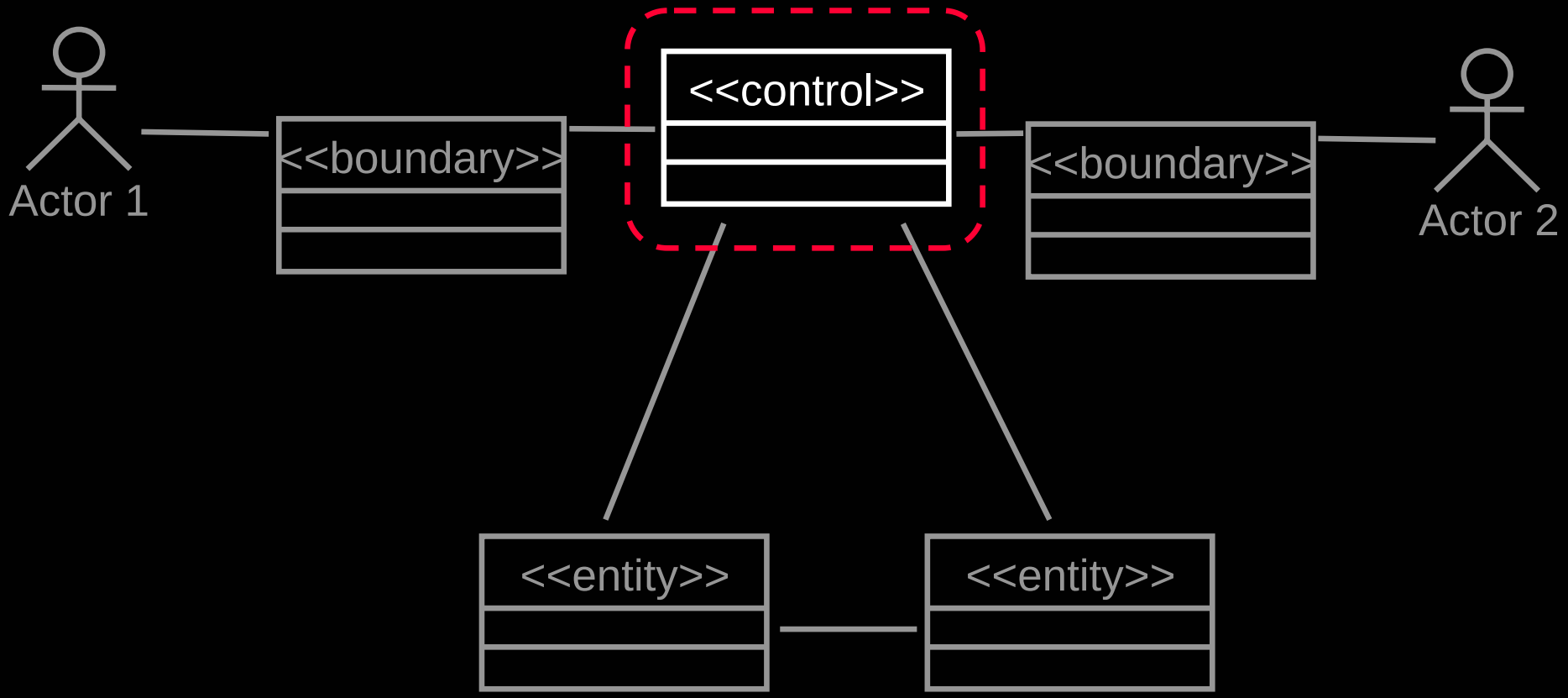
What Is a Control Class?

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



Use-case dependent, Environment independent

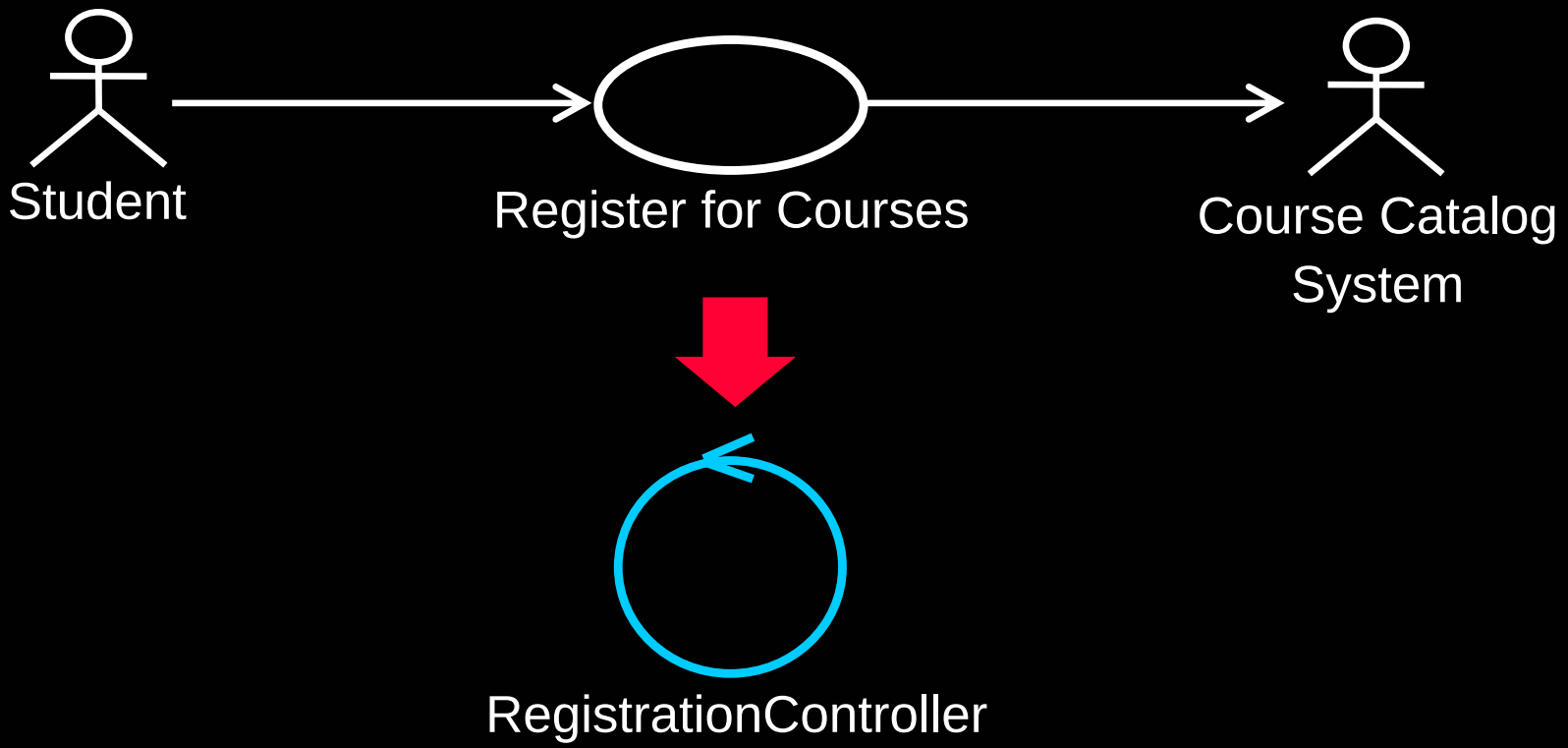
The Role of a Control Class



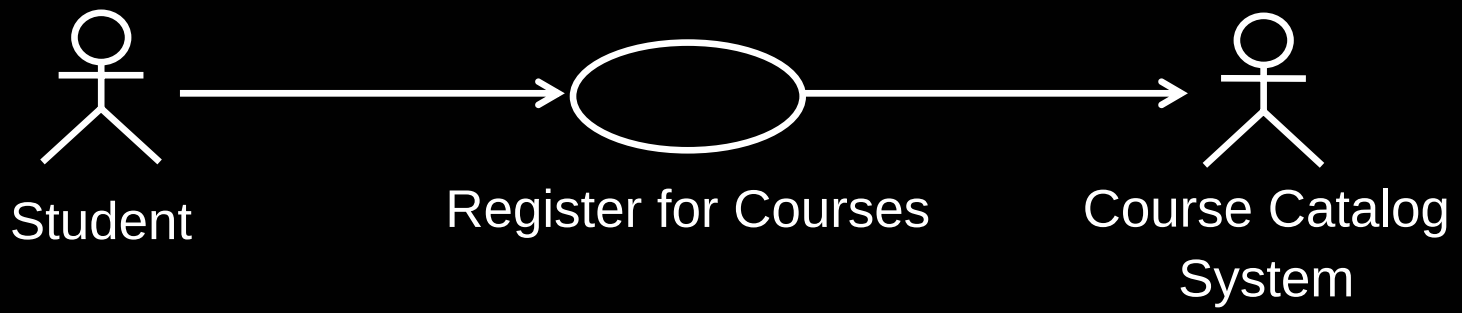
Coordinate the use-case behavior

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

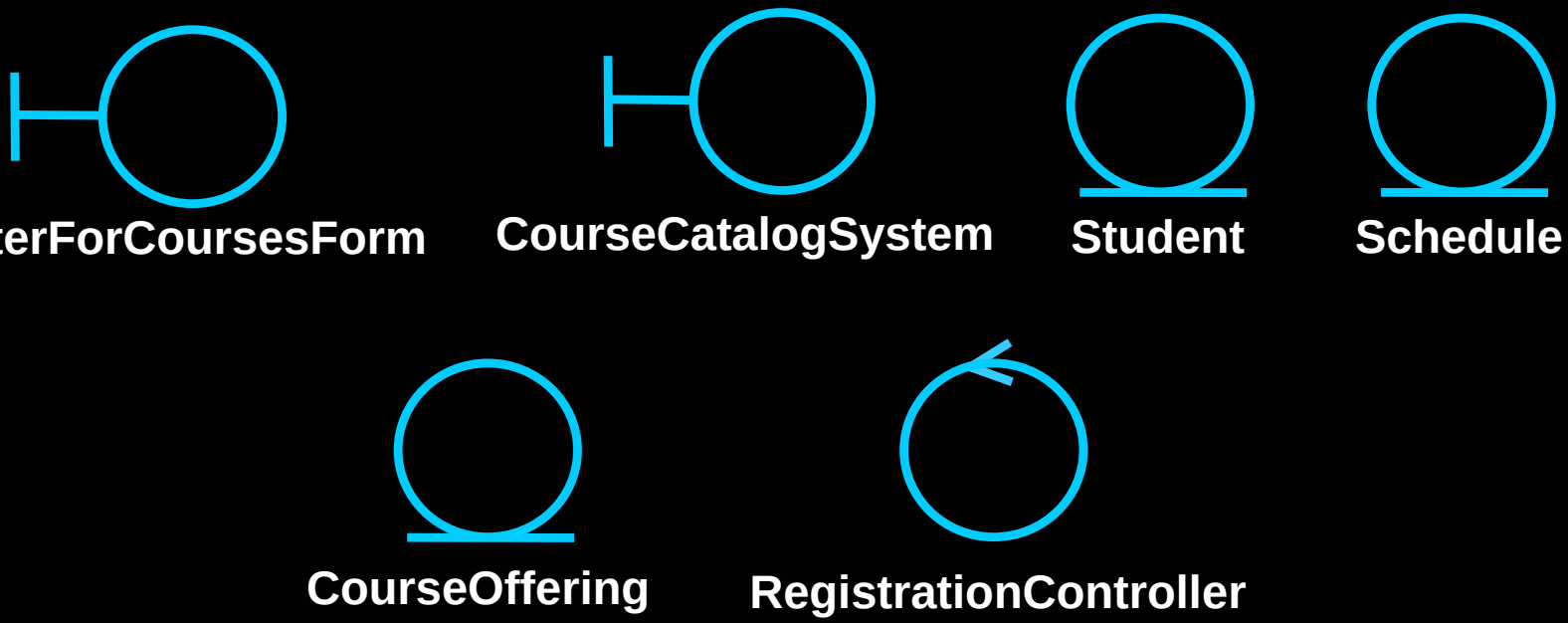


Example: Summary: Analysis Classes



Use-Case Model

Design Model



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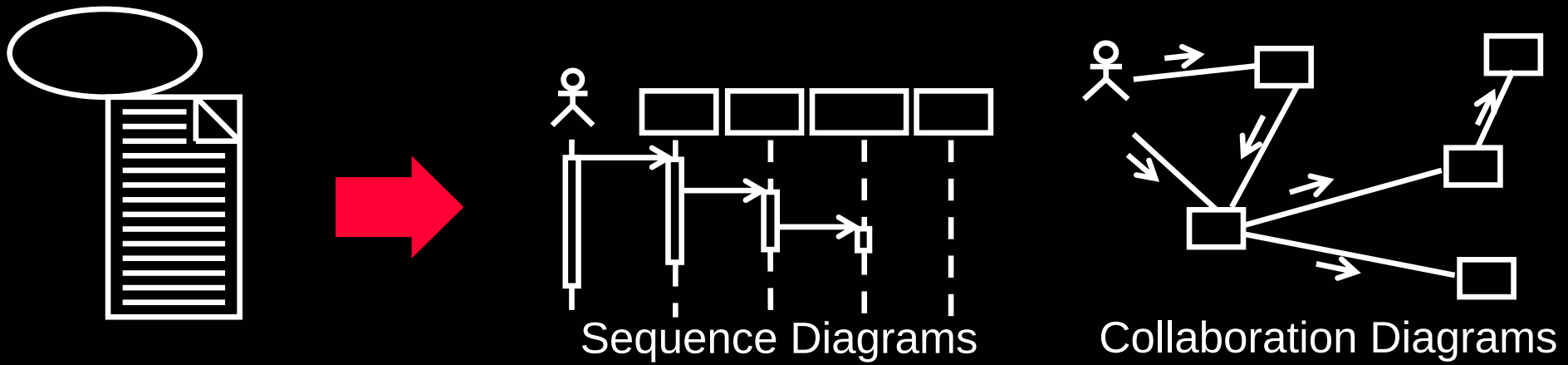
Distribute Use-Case Behavior to Classes

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



Use Case **Use-Case Realization**

Guidelines: Allocating Responsibilities to Classes

- Use analysis 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

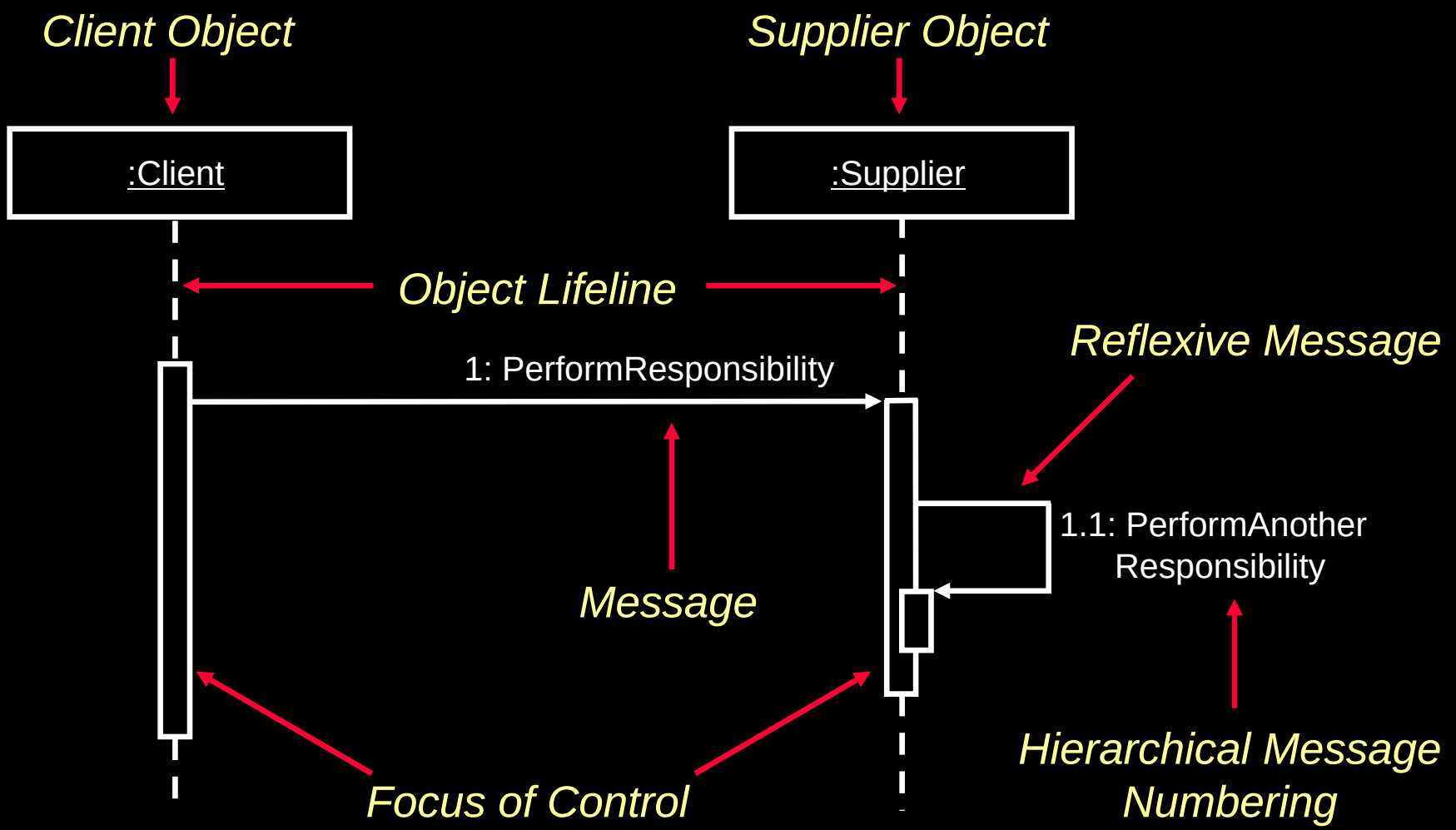
(continued)

Guidelines: Allocating Responsibilities to Classes (cont.)

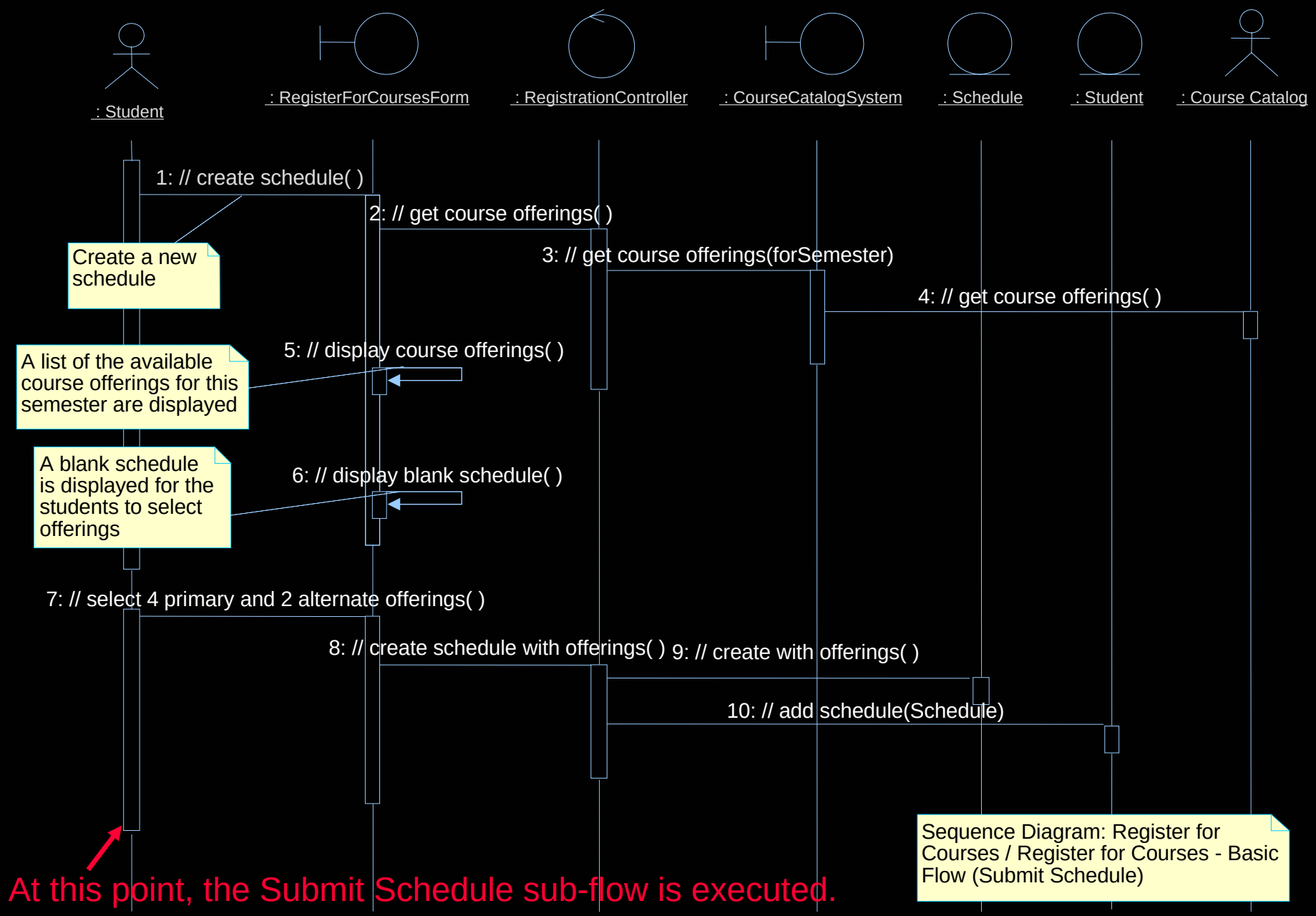
- Who has the data needed to perform the responsibility?
  - If one class has the data, put the responsibility with the data
  - If multiple classes have the data:
    - Put the responsibility with one class and add a relationship to the other
    - Create a new class, put the responsibility in the new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

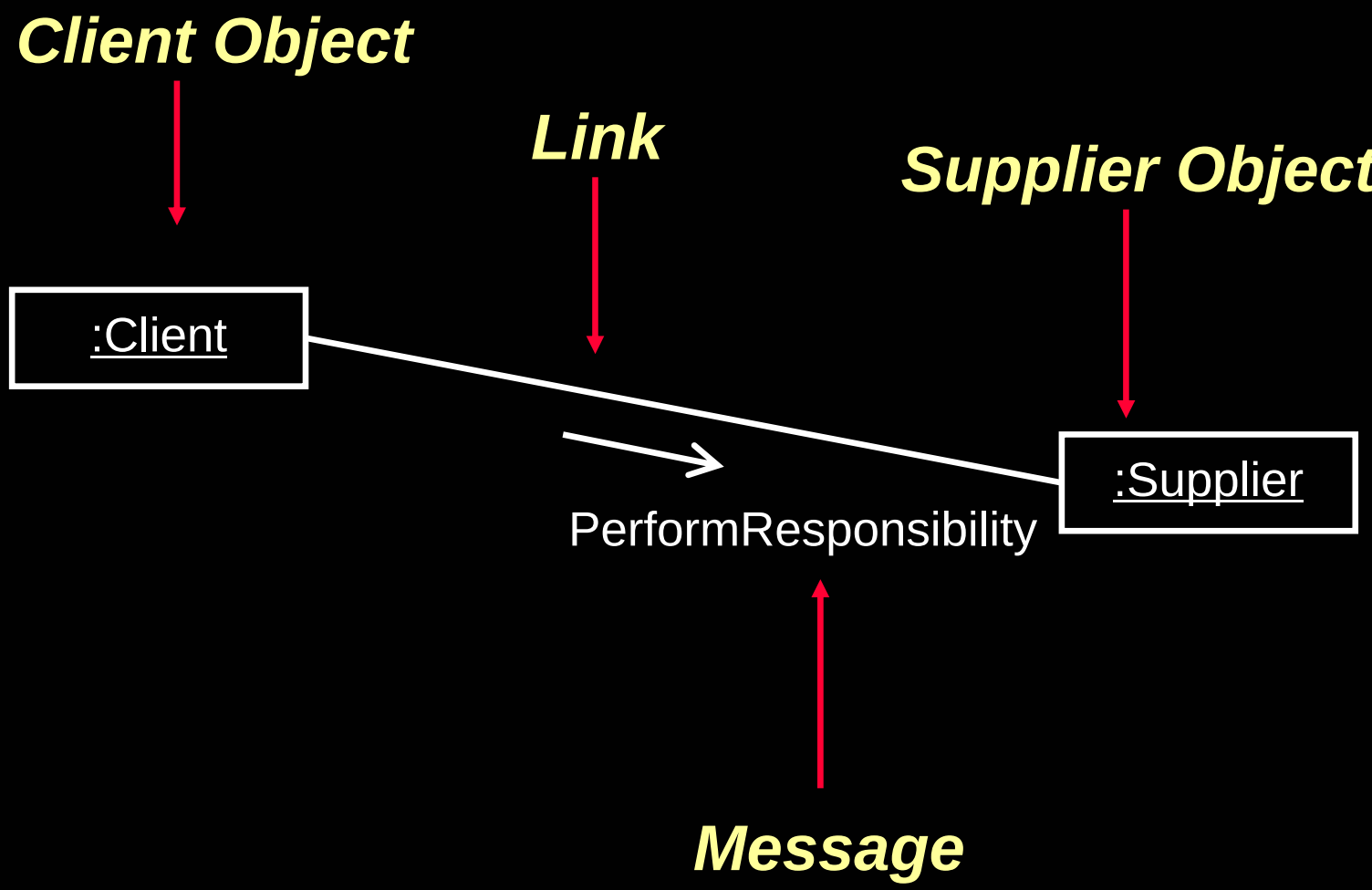
This is a sample script.



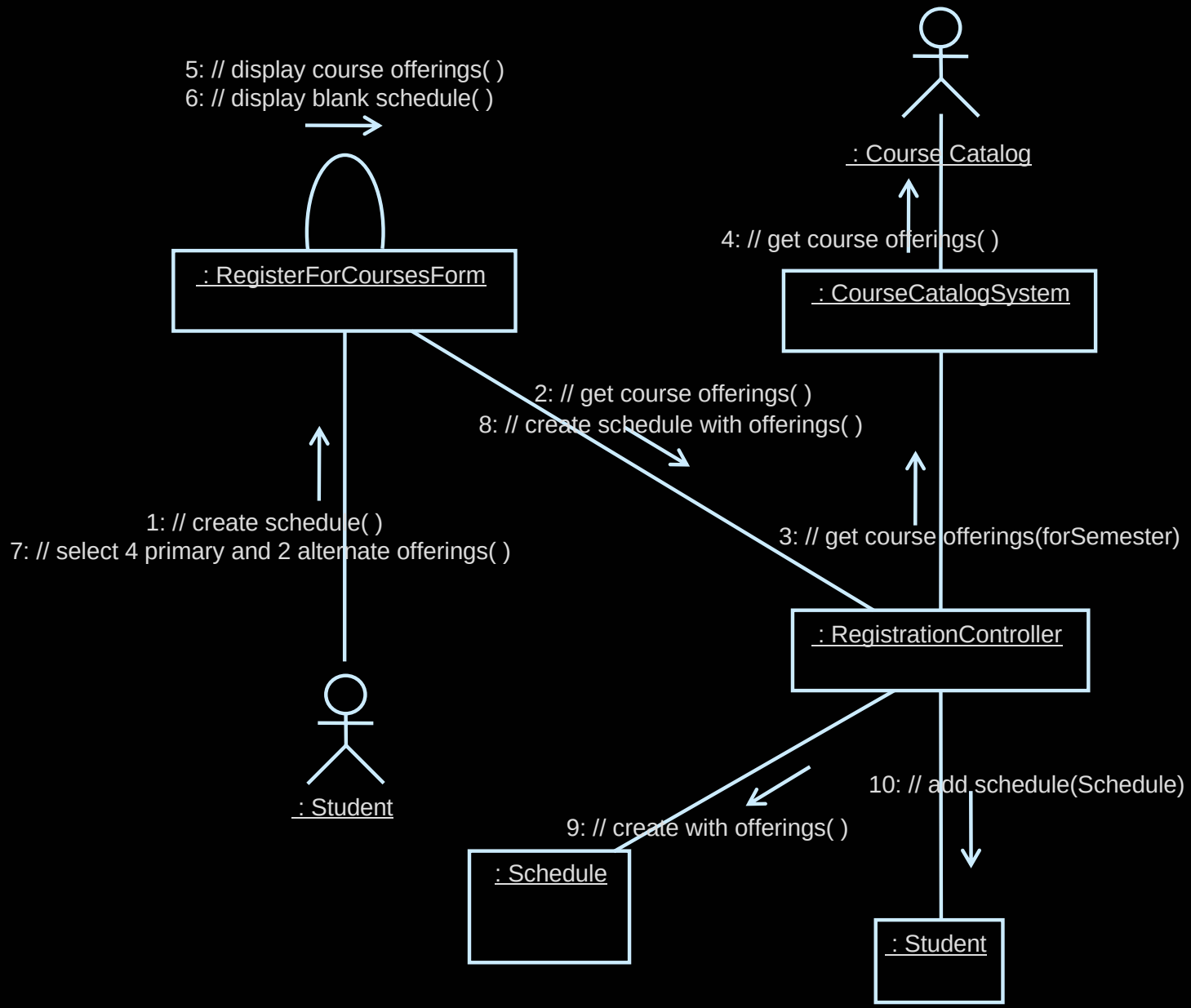
Example: Sequence Diagram



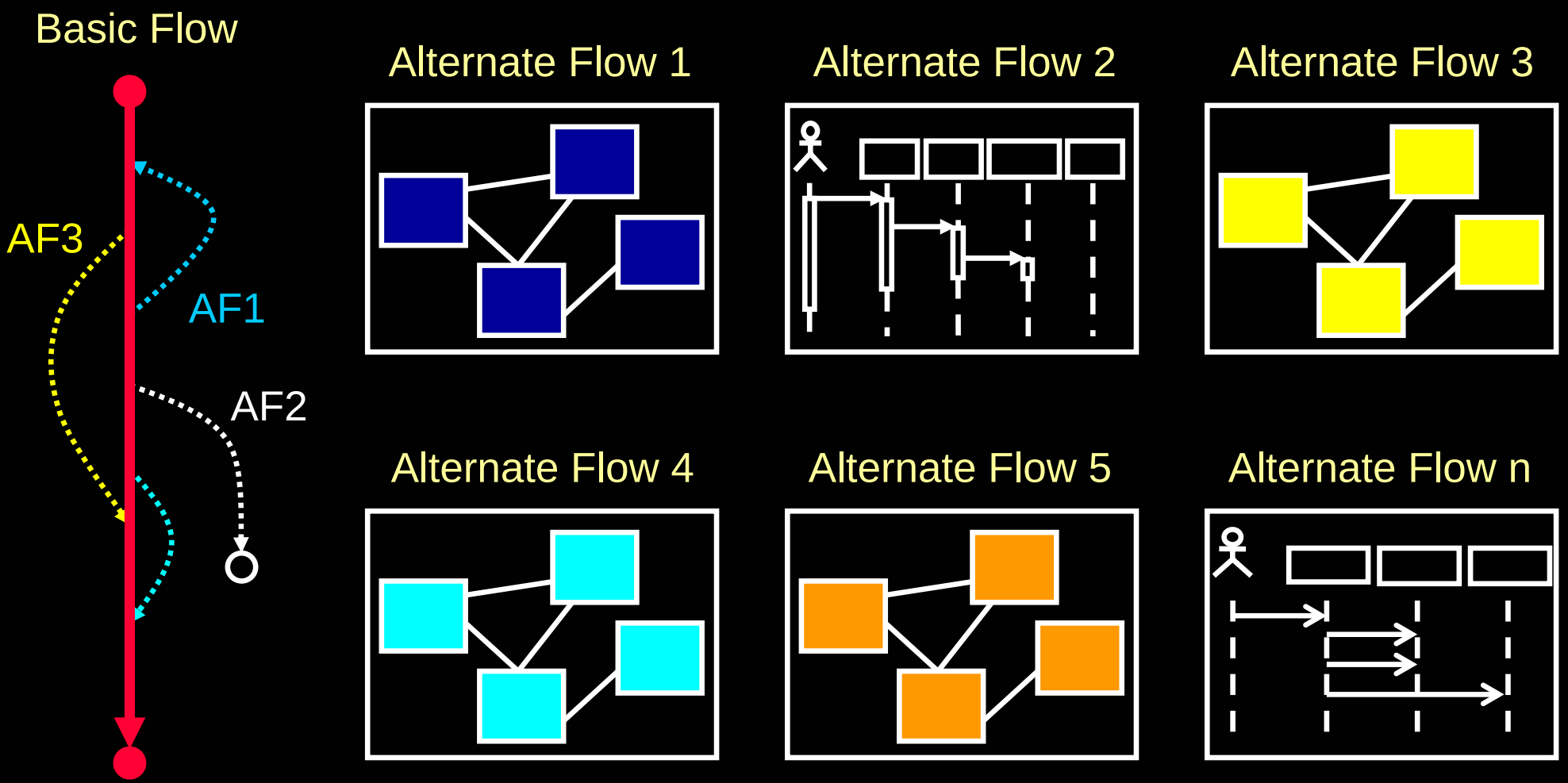
The Anatomy of Collaboration Diagrams



Example: Collaboration Diagram



One Interaction Diagram Is Not Good Enough



Collaboration Diagrams vs. Sequence Diagrams

- Collaboration Diagrams
  - Show relationships in addition to interactions
  - Better for visualizing patterns of collaboration
  - Better for visualizing all of the effects on a given object
  - Easier to use for brainstorming sessions
- Sequence Diagrams
  - Show the explicit sequence of messages
  - Better for visualizing overall flow
  - Better for real-time specifications and for complex scenarios

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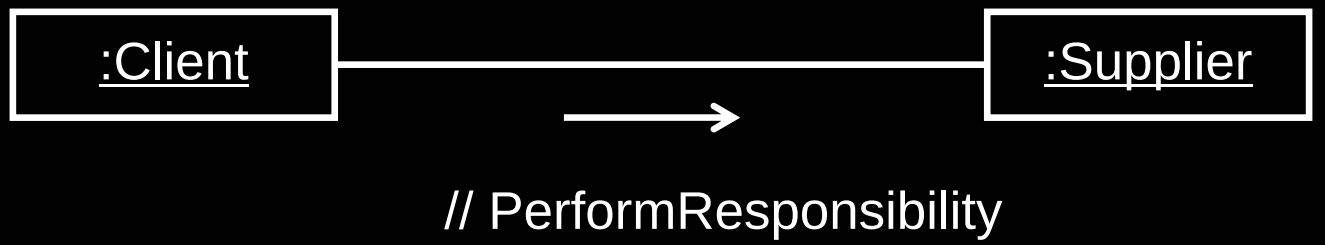
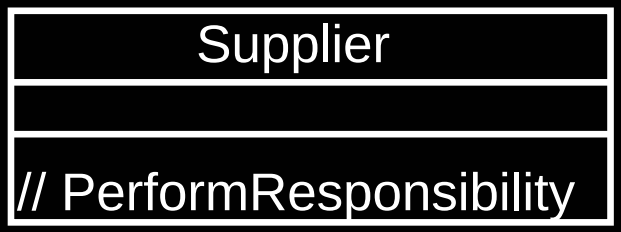
Describe Responsibilities

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

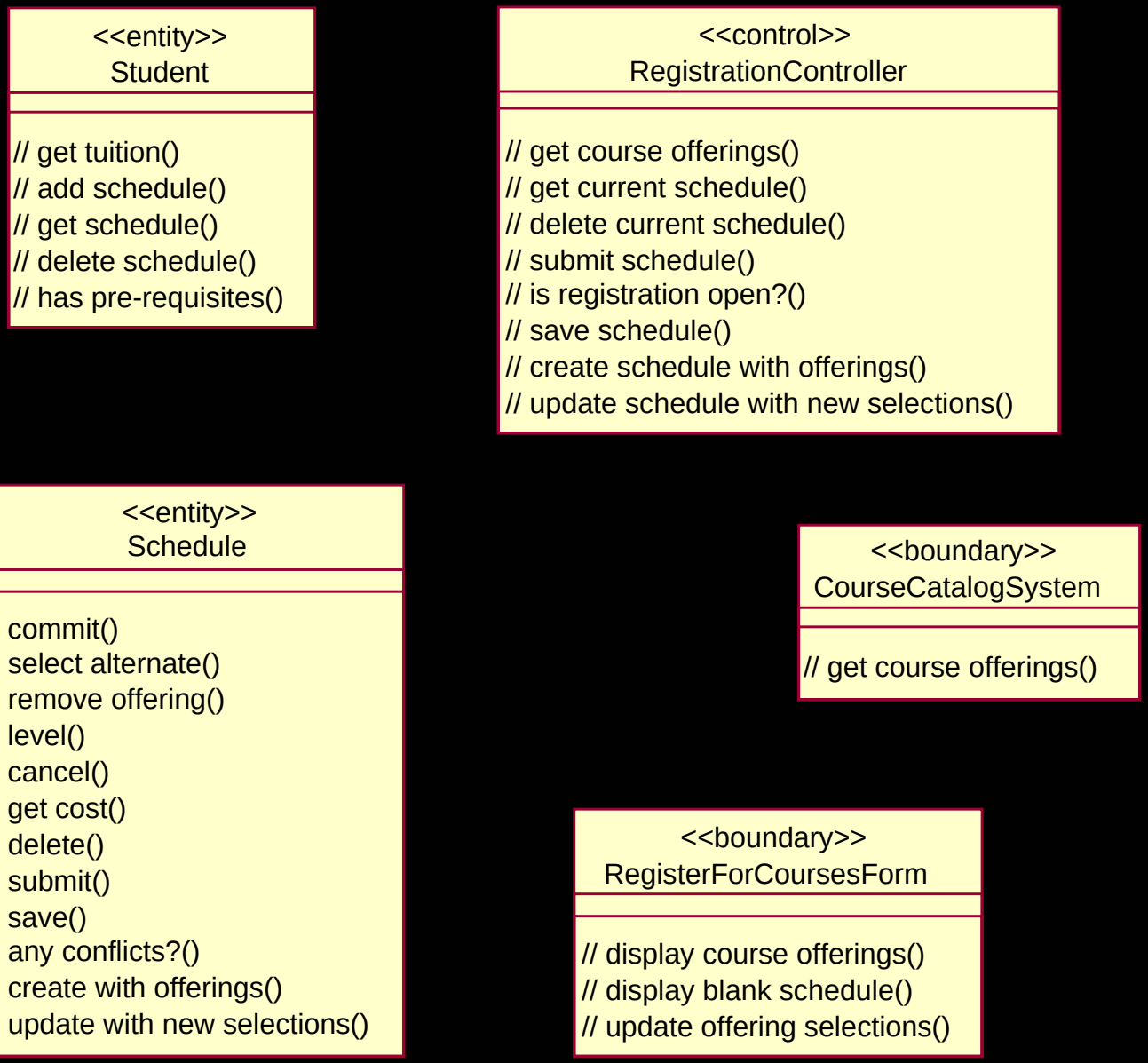
Interaction Diagram



Class Diagram



Example: View of Participating Classes (VOPC) Class Diagram



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

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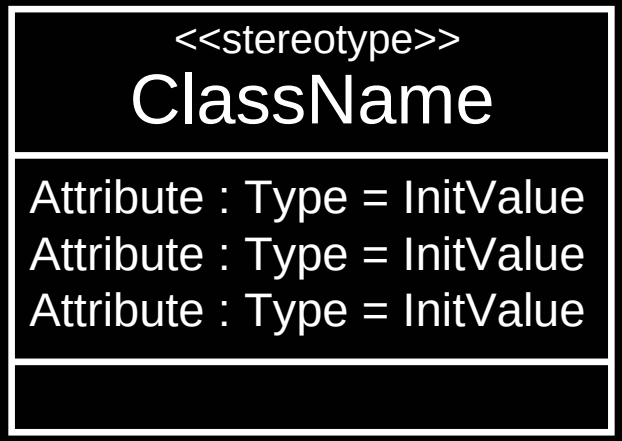
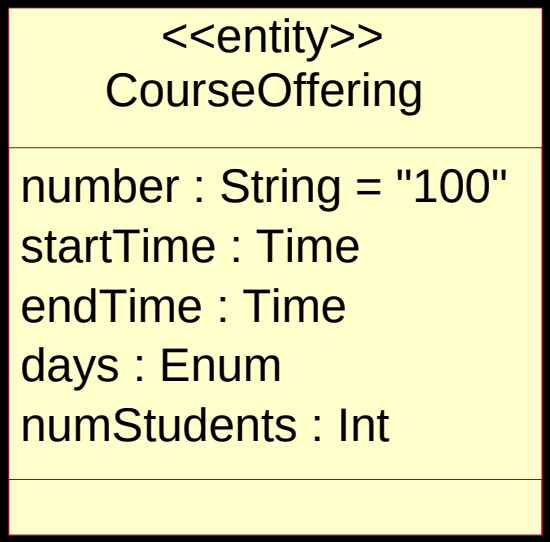
Review: What Is an Attribute?



In analysis, do not spend time on attribute signatures

attribute

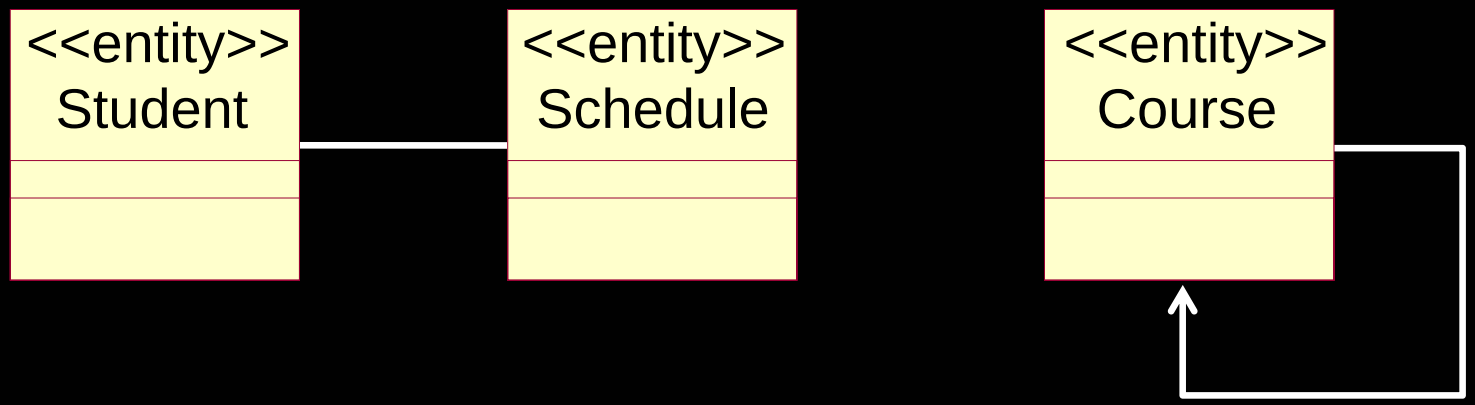


Finding Attributes

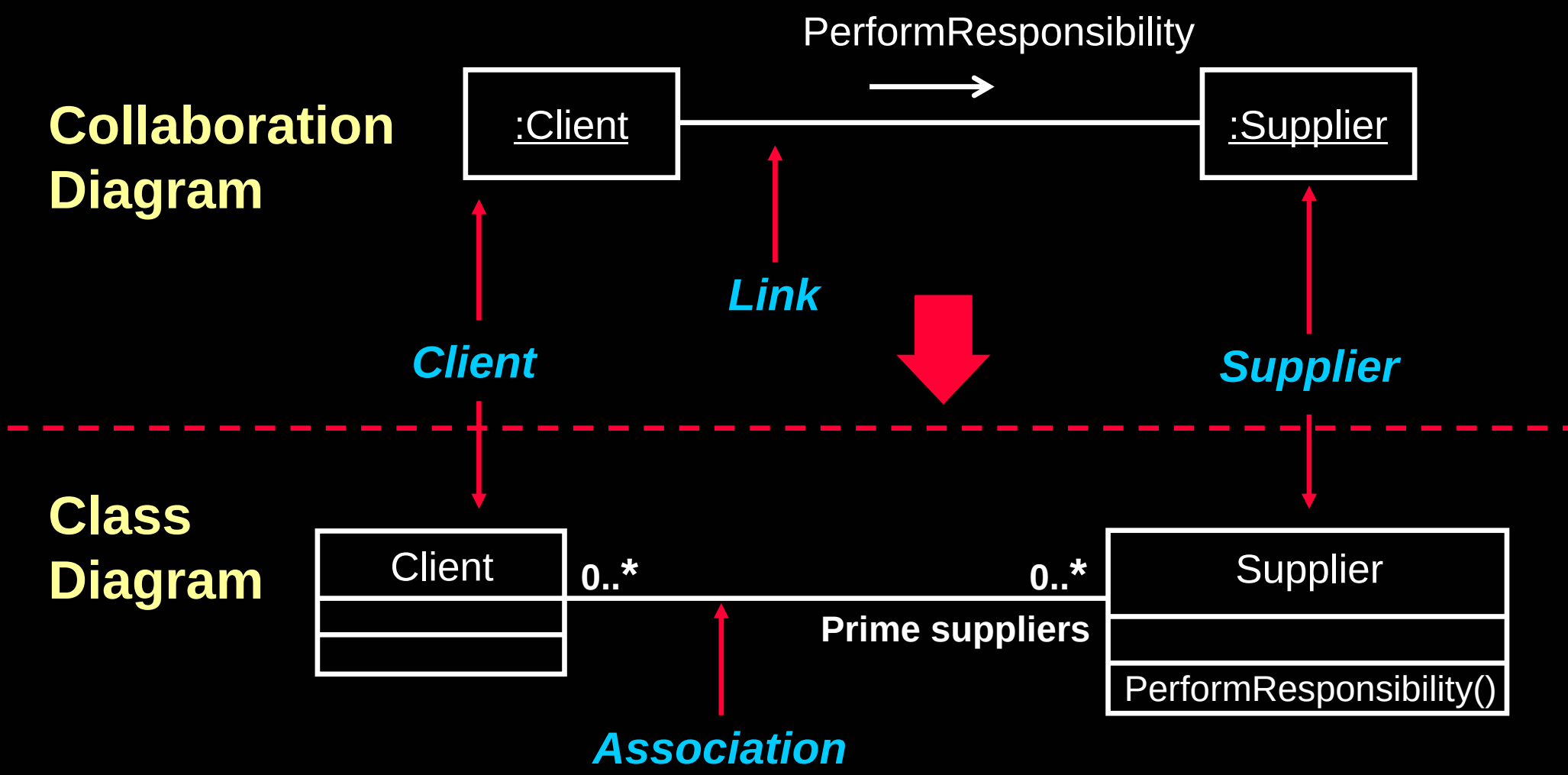
- Properties/characteristics of identified classes
- Information retained by identified classes
- “Nouns” that did not become classes
  - Information whose value is the important thing
  - Information that is uniquely "owned” by an object
  - Information that has no behavior

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



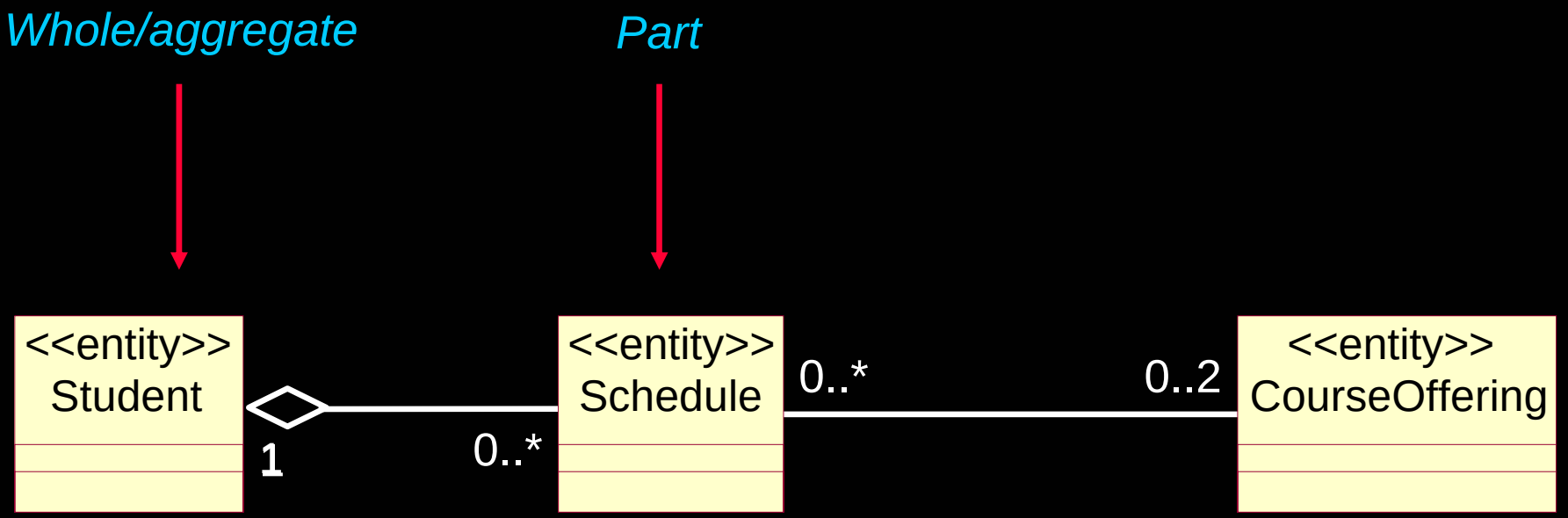
Finding Relationships



Relationship for every link!

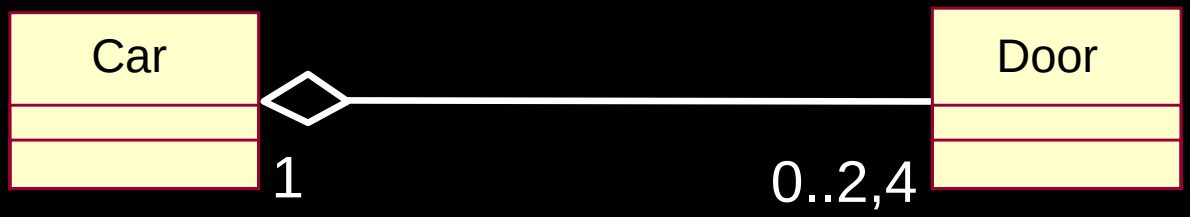
Review: What Is Aggregation?

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

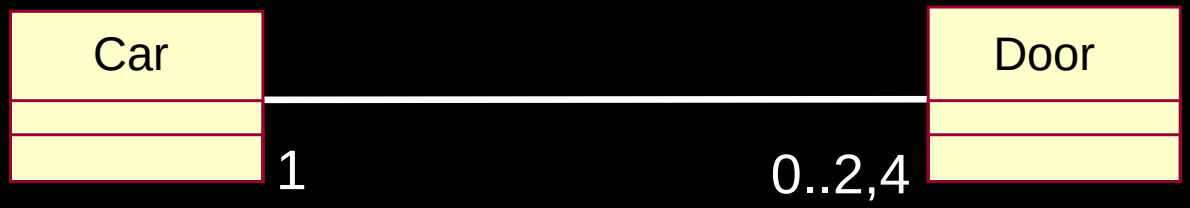


Association or Aggregation?

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



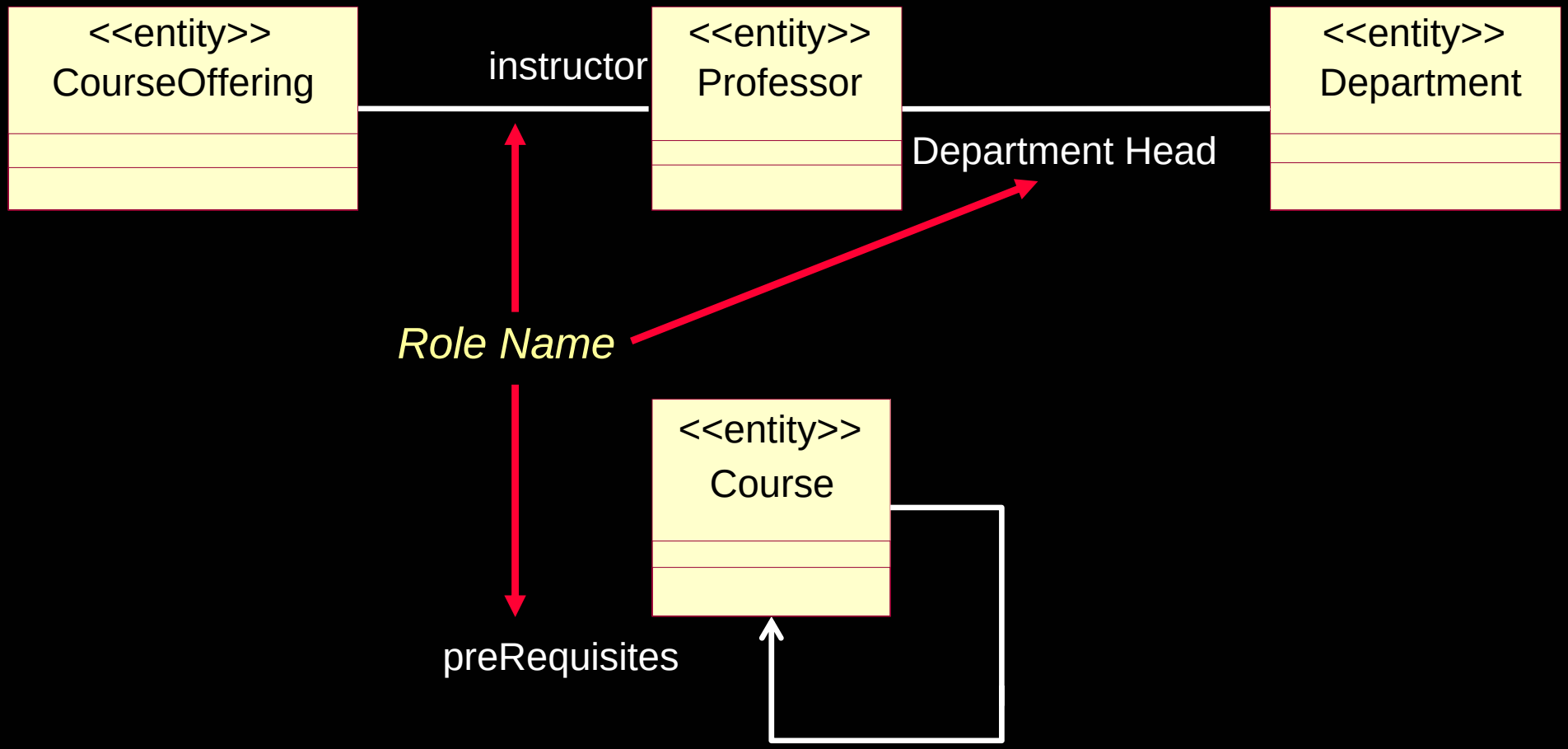
- If two objects are usually considered as independent, although they are often linked
  - The relationship is an association.



When in doubt use association

What Are Roles?

- The “face” that a class plays in the association



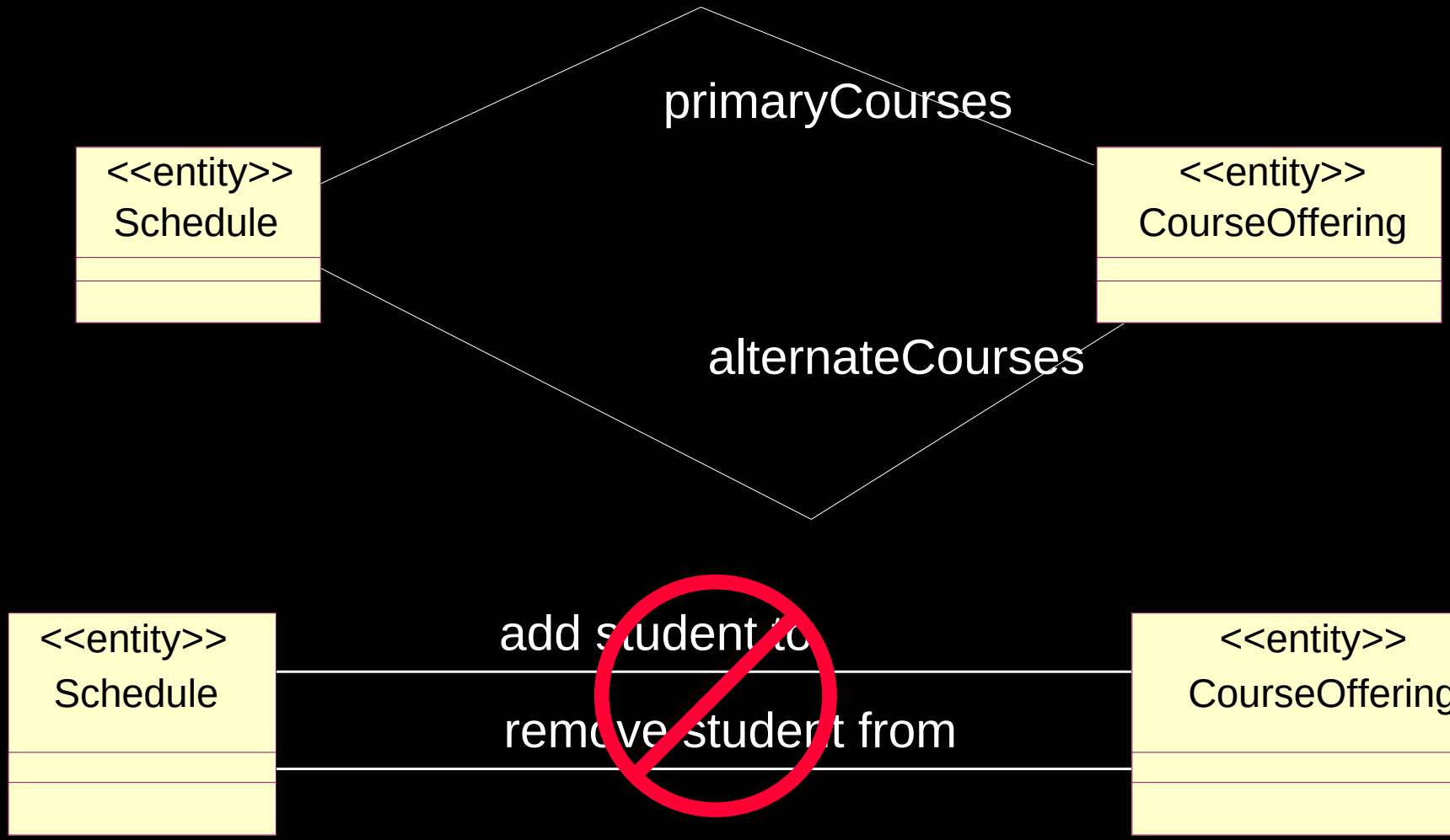
Review: Multiplicity

Unspecified	
Exactly One	1
Zero or More	0..*
Zero or More	*
One or More	1..*
Zero or One (optional scalar role)	0..1
Specified Range	2..4
Multiple, Disjoint Ranges	2, 4..6

What Does Multiplicity Mean?

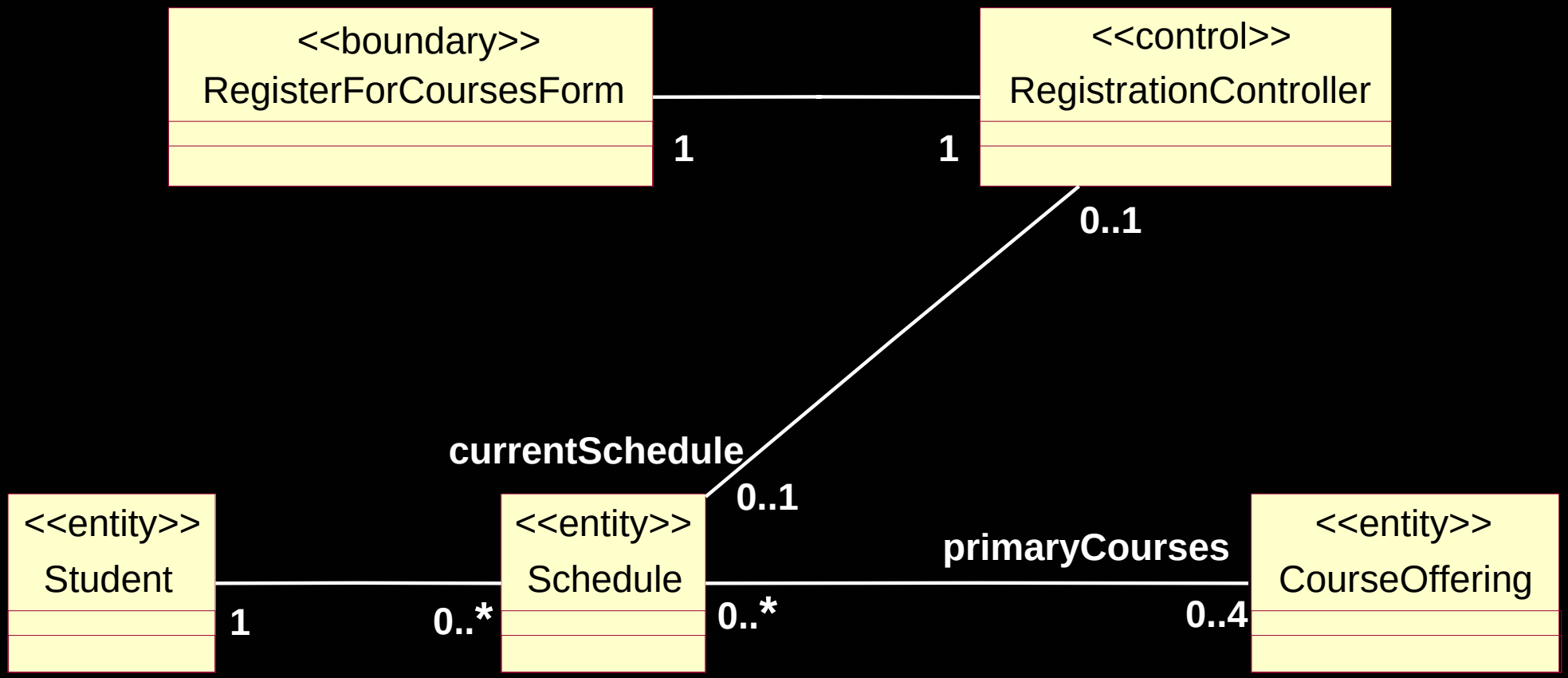
- Multiplicity answers two questions:
  - Is the association mandatory or optional?
  - What is the minimum and maximum number of instances that can be linked to one instance?

Example: Multiple Associations



Multiple associations must reflect multiple roles.

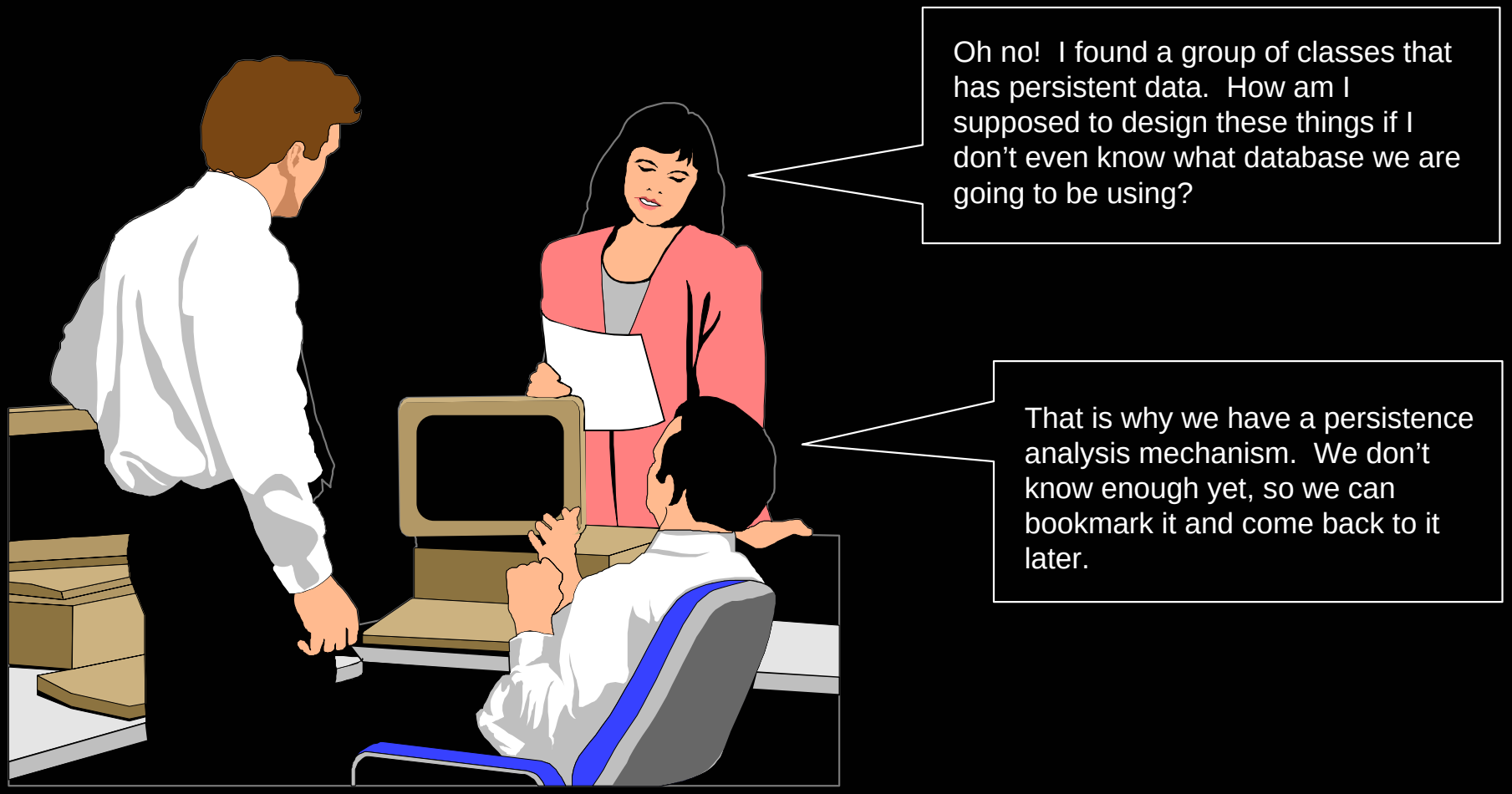
Example: VOPC: Finding Relationships



Use-Case Analysis Steps

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

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.

IBM

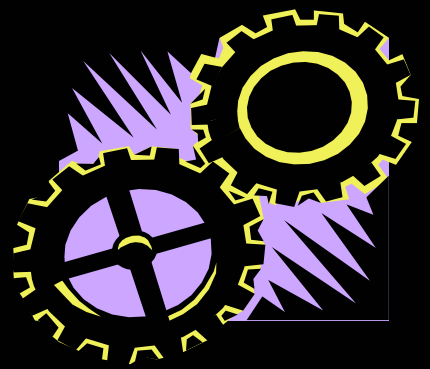
Describing Analysis Mechanisms

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

Example: Describing Analysis Mechanisms

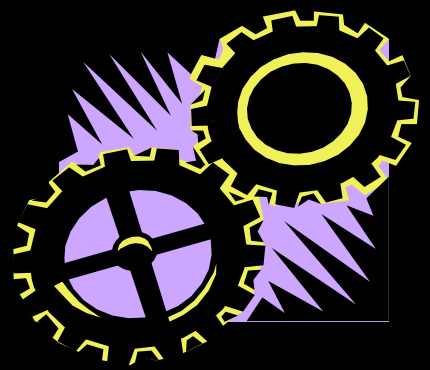
- Analysis class to analysis mechanism map

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



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



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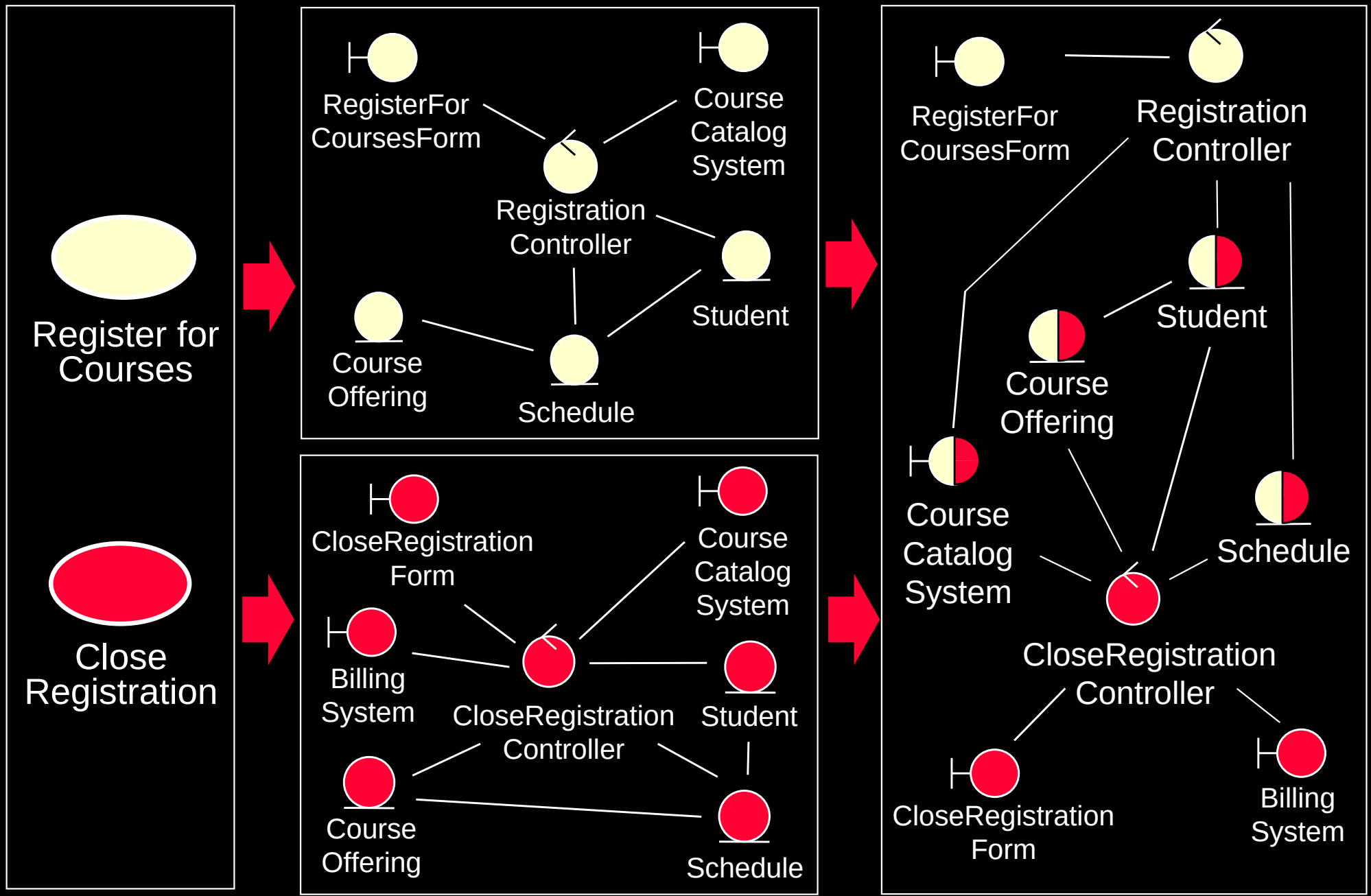
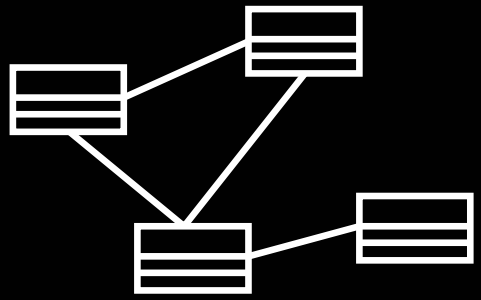
Unify Analysis Classes

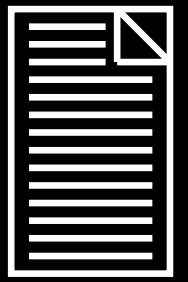


IBM

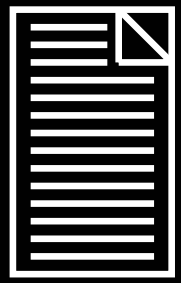
Evaluate Your Results



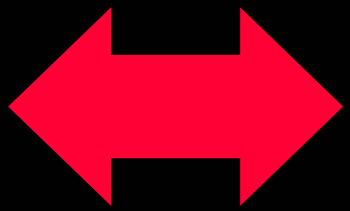
Design Model

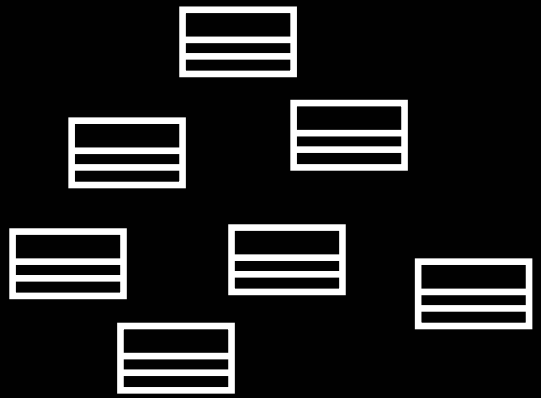


Glossary

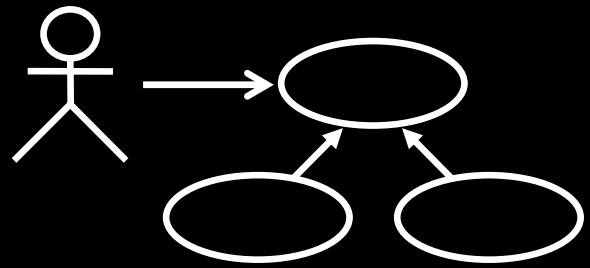


Supplementary Specification





Analysis Classes



Use-Case Model

Use-Case Analysis Steps

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- Unify Analysis Classes
- ★ Checkpoints

Checkpoints: Analysis 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?

(continued)

Checkpoints: Use-Case Realizations

- 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?

Review: Use-Case Analysis

- What is the purpose of Use-Case Analysis?
- What is an analysis class? Name and describe the three analysis stereotypes.
- What is a Use-Case Realization?
- Describe some considerations when allocating responsibilities to analysis classes.
- How many Interaction diagrams should be produced during Use-Case Analysis?

Exercise: Use-Case Analysis

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

(continued)

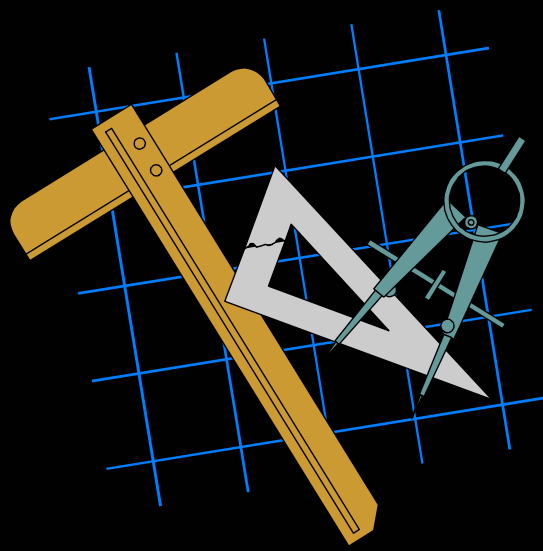
Exercise: Use-Case Analysis (cont.)

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

(continued)

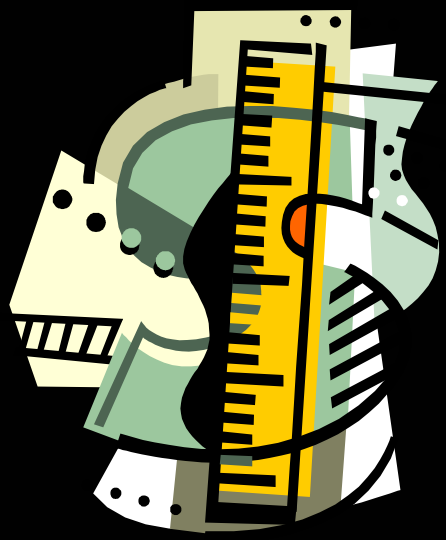
Exercise: Use-Case Analysis (cont.)

- Produce the following for a particular use case:
  - Use-Case Realization Interaction diagram for at least one of the use-case flows of events
  - VOPC class diagram, containing the analysis classes, their stereotypes, responsibilities, attributes, and relationships
  - Analysis class to analysis mechanism map



Exercise: Review

- Compare your Use-Case Realization with the rest of the class
  - Do the Interaction diagrams carry out the use-case flow of events?
  - Are the stereotypes behaving properly?
  - Is each association supported by a link?
  - Does each association have multiplicity assigned?
  - Have role names been assigned? Do they accurately represent the face the class plays in the relationship?



Payroll System