

A.I.S. Class 7: Outline

- Learning Objectives for Chapter 8
- Entity-Relationship Models
- Extended Entity-Relationship Models
- Data Flow Diagrams
- Group Work for Chapter 8 (1)
- Event-Oriented Models
- Resource-Event-Agent Models (REA)
- Group Work for Chapter 8 (2)

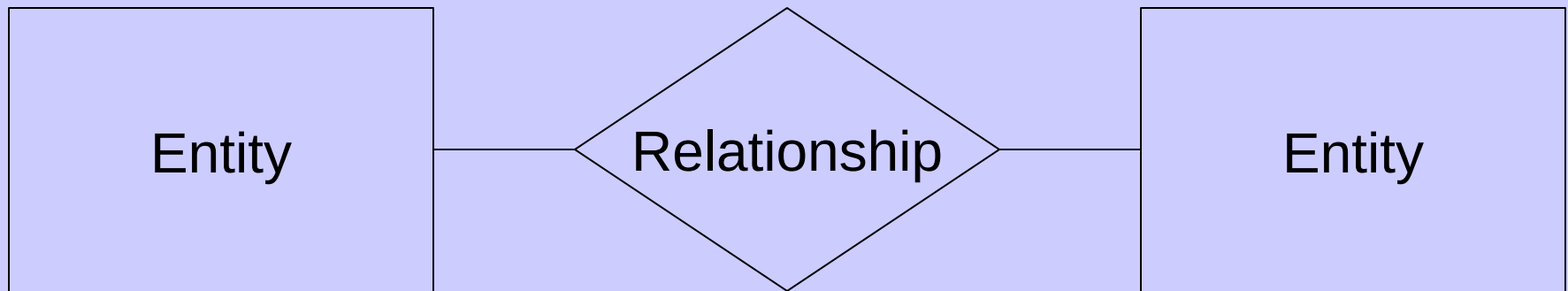
Learning Objectives for Chapter 8

- After studying this chapter you should be able to:
 - ◆ distinguish between logical and physical database models
 - ◆ describe the entity-relationship and extended entity-relationship logical modeling approaches
 - ◆ describe the elements of data-flow diagrams
 - ◆ distinguish between different levels of data-flow diagrams, such as context diagrams, Level 0, and Level 1 data flow diagrams

Learning Objectives for Chapter 8

- ◆ identify entities and relationships in a business environment using an event-oriented focus
- ◆ construct an extended entity relationship diagram based on a narrative description of a business scenario
- ◆ construct context diagrams and data-flow diagrams based on a description of a business process

Entity-Relationship Models



Extended E-R Models

■ Optionalities

- ★ optional or mandatory

■ Cardinalities

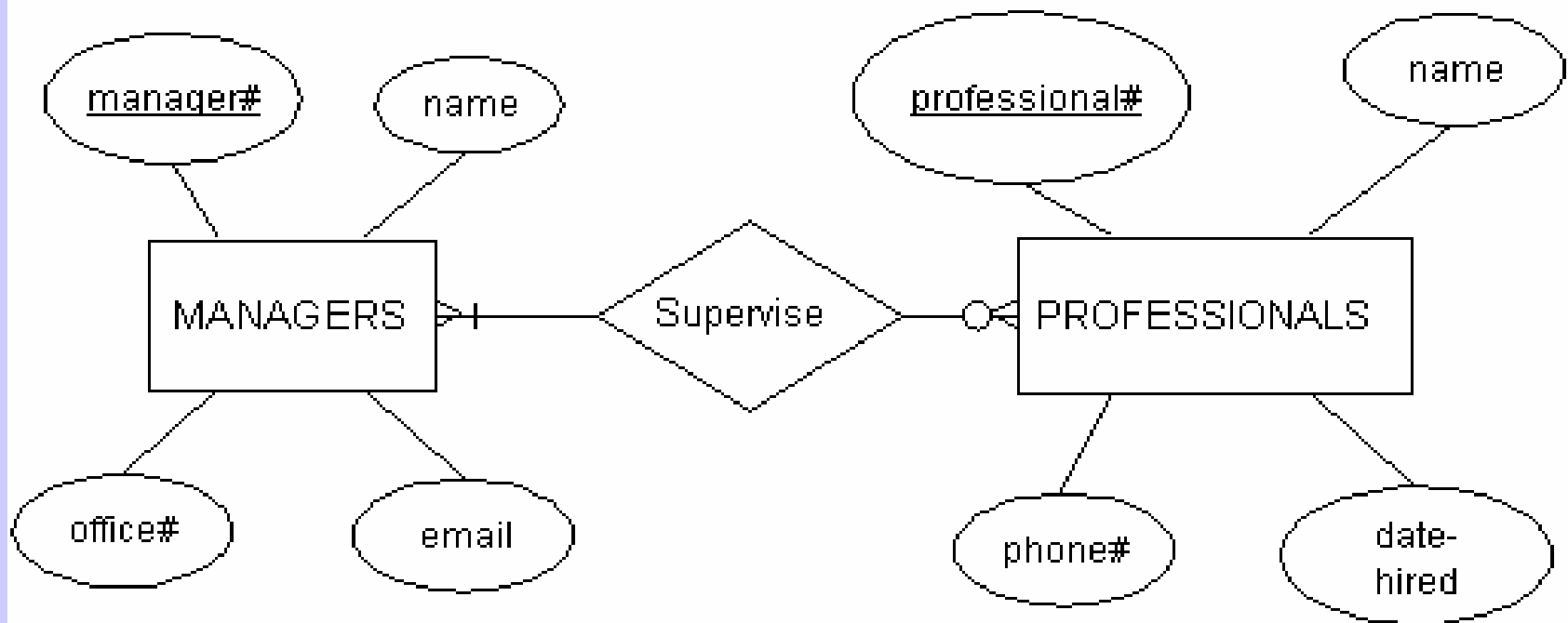
- ★ 1:1, 1:M, M:1, or M:M

■ Attributes

- ★ keys and non-key attributes

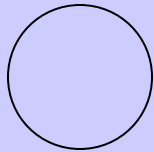
EER Models

EER Figure 7

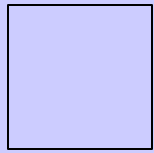


Data Flow Diagrams

DeMarco



Process



Data source / sink

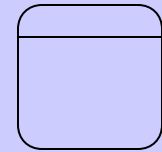


Data flow



Data store

Gane & Sarson



DFD Conventions

- Processes should have unique names and be sequentially numbered (1.0, 2.0, 3.0; 2.1, 2.2, 2.3; etc.)
- A process must have at least one input flow and at least one output flow
- A data flow has at least one end connected to a process
- Data cannot flow directly back to an earlier process
- A data store must have at least one input and at least one output data flow
- Any single DFD should not have more than about seven processes
- Omit error and exception handling from Level 0 diagrams

Data Flow Diagrams

■ Levelled DFDs

- ★ A series of DFDs used in a hierarchy

■ Balanced DFDs

- ★ The same sources, sinks and data flows appear at all levels

■ Labeling

- ★ Officially, all data flows should be labeled
- ★ Practically, we may sometimes omit labels from flows in and out of data stores

■ Data flows

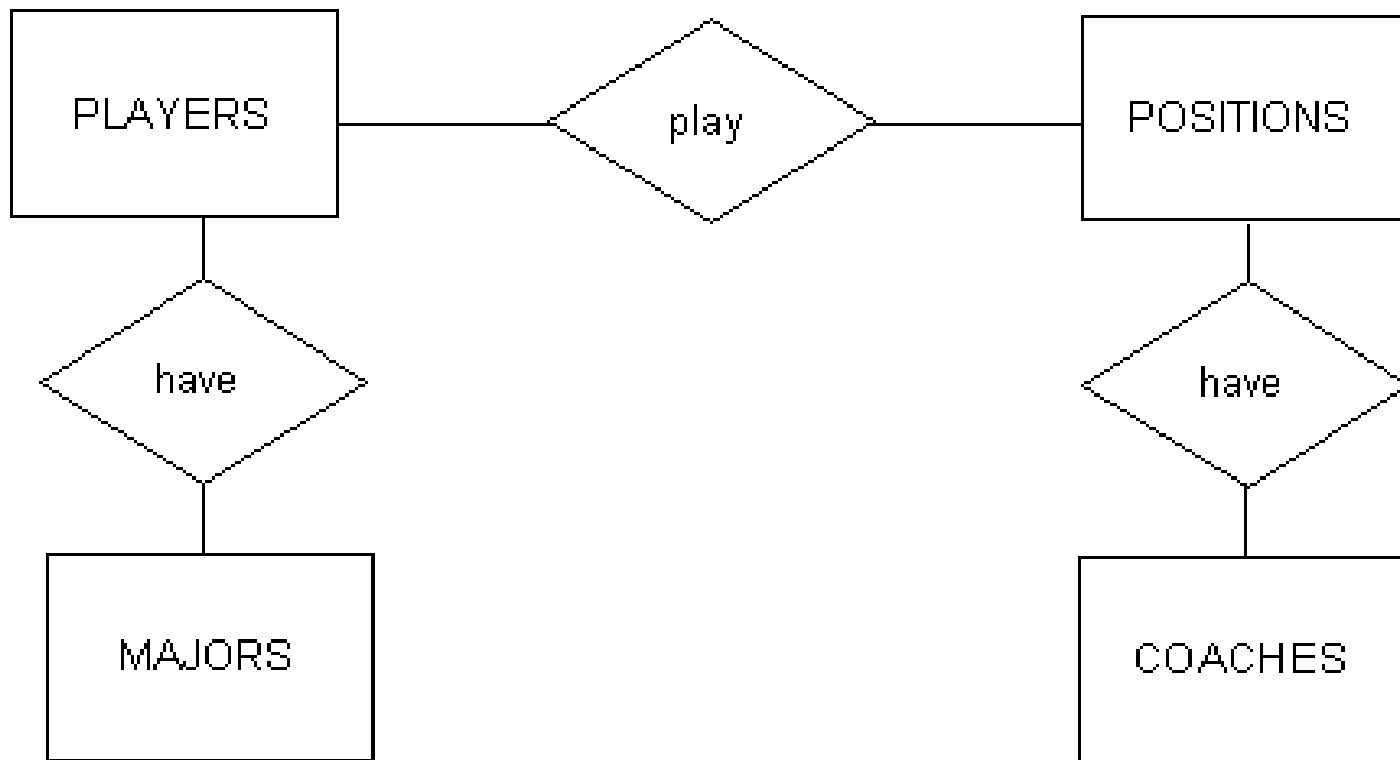
- ★ Arrows indicate direction and are significant; use double arrows or multiple data flows for read-then-update

Group Work for Chapter 8 (1)

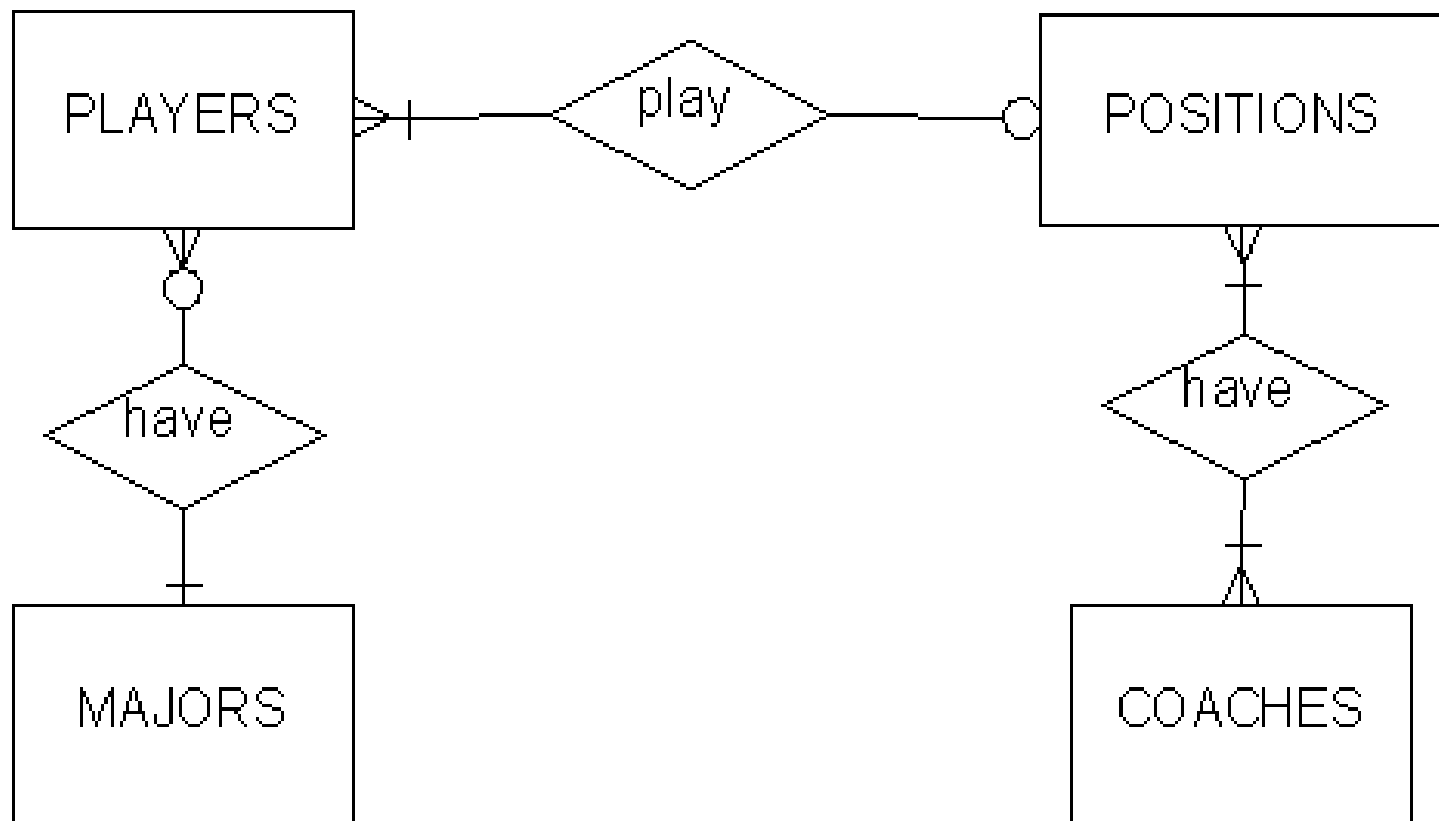
■ ER and EER Diagrams

★ Problems 1, 2 & 6

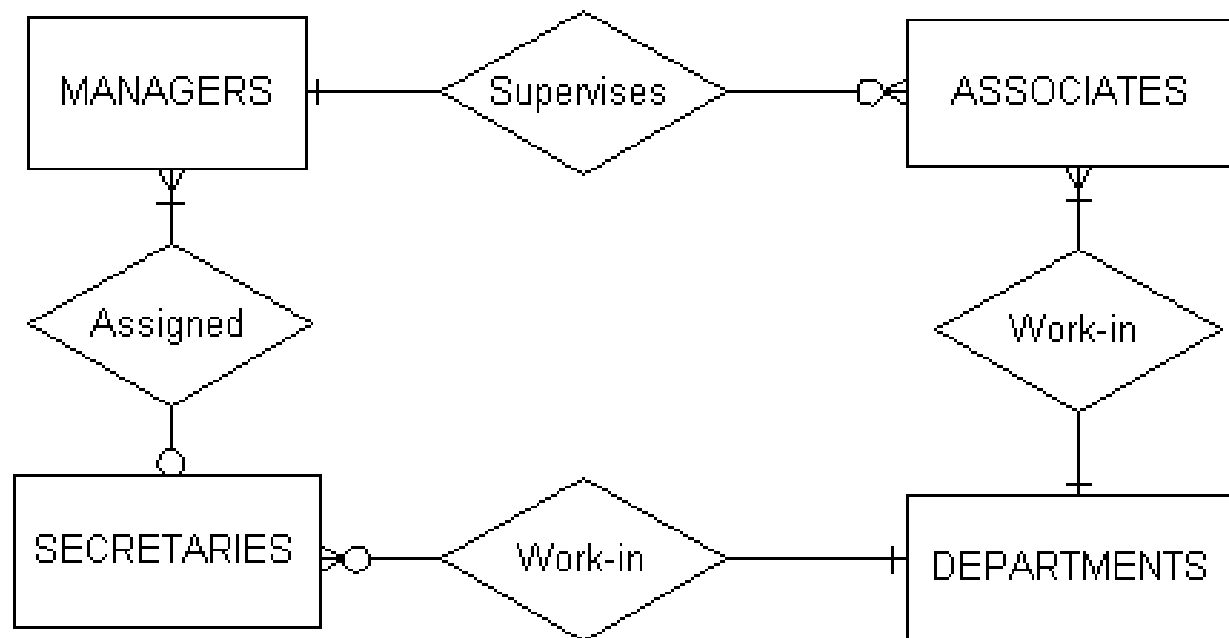
Problem 1



Problem 2



Problem 6



Event-Oriented Models

■ Abstraction:

Reality



**Symbol
(Token)**

Square

Triangle

Circle

Star

Cross

**Symbol
(Type or Category)**

Shape

Event-Oriented Models

- We store data at the level of token symbols (Nick Adams, motherboards, etc.)
- To make complexity manageable, our conceptual model represents reality at the level of type symbols (Partners, Raw Materials, etc.)
- In an RDBMS data is ultimately stored in *relations* (tables)
- To avoid various processing anomalies, we decompose the data into small, simple relations that have been *normalized* (into 3rd normal form or better)
- Peter Chen's 1976 Entity-Relationship modeling provides a conceptual bridge between reality at the type level and actual normalized tables

Event-Oriented Models

- At this level, there are only Entities, and Relationships, described by their attributes, and exemplified by their instances
- Thus “Nick Adams” is an instance of the entity “Partner”
- So if instances represent reality as tokens, Entities and Relationships represent reality as types
- But what Entities and Relationships belong in our system?
- Semantic Modeling is an attempt to answer this

Event-Oriented Models

■ The Semantic Modeling Principle

- ★ Data in an information system should model the structure of the relevant categories of reality in its application domain

Event-Oriented Models

- McCarthy's REA methodology resulted from the application of the Semantic Modeling Principle to Accounting Information Systems
- It answered the question: “what entities and relationships should there be?” with:
 - ★ Resources
 - ★ Events
 - ★ Agents
 - ★ and the relationships between them

Event-Oriented Models

- Metaphysics is the branch of philosophy dealing with the nature of reality and the fundamental principles of the universe
- Its major component is Ontology, which deals with the nature of existence or being
- The philosopher Willard Van Orman Quine has famously quipped that the question is simple:
“What is there?”;
and the answer short:
“Everything”.

Event-Oriented Models

■ Ontology in Computer Science and A.I.

- ★ The term has been co-opted by Computer Science and Artificial Intelligence in the following sense:
 - ◆ An ontology is a specification of a conceptualization
 - ◆ That is, an ontology is a description (like a formal specification of a program) of the concepts and relationships that can exist for an agent or a community of agents (Tom Gruber)
 - ◆ Now the question is not: “What is there?” but: “What should we represent in a system?”

Event-Oriented Models

- Ontology in Computer Science and A.I.
 - ★ **Generic Ontologies**
 - ◆ Specify subject-independent categories
 - ★ **Domain Ontologies**
 - ◆ Specify the basic categories arising within a particular application
- REA has been extended to be a domain ontology for accounting information systems

Event-Oriented Models

■ REA Ontology:

- ★ Economic Resources (R)
- ★ Business Events
 - ◆ Economic Events (E)
 - ◆ Commitments (C)
 - ◆ Ancillary Events (N)
- ★ Economic Agents
 - ◆ Internal Agents (A)
 - ◆ External Agents (A)

Event-Oriented Models

■ REA Ontology:

- ★ Economic Resources – e.g. Inventory
- ★ Business Events
 - ◆ Economic Events – e.g. Receiving Raw Materials
 - ◆ Commitments – e.g. Purchase Orders
 - ◆ Ancillary Events – e.g. Requisitioning Materials
- ★ Economic Agents
 - ◆ Internal Agents – e.g. Salespersons
 - ◆ External Agents – e.g. Customers

Event-Oriented Models

■ REA Ontology:

- ★ Economic Resources (R)
- ★ Business Events
 - ◆ Economic Events (E)
 - ◆ Commitments (C)
 - ◆ Ancillary Events (N)
 - ➔ Instigation (I)
 - ➔ Facilitation (F)
 - ➔ Terminal (T)
- ★ Economic Agents
 - ◆ Internal Agents (A)
 - ◆ External Agents (A)

Event-Oriented Models

■ REA Ontology:

★ Relationships

- ◆ Duality (E – E)
 - ➔ Transfer
 - ➔ Transformation
- ◆ Stock-flow (E – R)
 - ➔ Inflow
 - Take
 - Production
 - ➔ Outflow
 - Use
 - Consumption
 - Give
- ◆ Participation (E – A)
 - ➔ Inside
 - Accountability
 - ➔ Outside
- ◆ Others . . .

Event-Oriented Models

■ We will discuss:

- ★ **Three kinds of processes**
 - ◆ Business processes
 - ◆ Information processes
 - ◆ Decision processes
- ★ **A nine-step approach to REA modeling**

Business Processes and Events

- Organizations create value through managing their business and information processes
- Organizations typically have three main types of business processes (sometimes called business cycles):
 - ★ acquisition/expense/payment process
 - ★ conversion process
 - ★ sales/collection process

Business Processes and Events

■ What is a process?

★ A process is a time-dependent sequence of steps governed by a rule called a process law. All processes have five common ingredients:

- ◆ the entities participating in the process
- ◆ the elements describing the steps in a process (called *events* in business processes)
- ◆ the relationships between these elements
- ◆ the links to other processes
- ◆ the resource characteristics of the elements

Business Processes and Events

- Business processes can be described at various levels of abstraction e.g. the Sales Process:

- ★ Ship Merchandise

- ★ Receive Payment

or

- ★ Customer Places Order

- ★ Select, Inspect, and Package Merchandise

- ★ Ship Merchandise

- ★ Receive Customer Payment

Business Processes and Events

- We are interested in strategically significant events the organization wants to plan, execute, control and evaluate
- Significant business events can be classified as
 - ★ **core events that create distinctiveness**
 - ◆ e.g., for a restaurant business, cooking and providing meals are core events that create value for customers
 - ★ **support events that facilitate core events**
 - ◆ e.g., buying ingredients is a business event that does not itself create value, but without it meals could not be cooked

Business Processes and Events

- Business events may also be classified as
 - ★ **Economic events**
 - ◆ involving increases or decreases in resources
 - ➔ e.g., making sales to customers
 - ★ **Non-economic events**
 - ◆ having implications for future economic events
 - ➔ e.g., contacting prospective customers
 - ★ **Economic events participate in Duality relationships**

Business Processes and Events

- We have classified Business Events as
 - ★ **Economic events**
 - ◆ Increment or Decrement some economic resource
 - ★ **Commitments**
 - ◆ Contracts or schedules for the occurrence of future economic events
 - ★ **Ancillary events**
 - ◆ Supporting events that enable economic events or commitments to take place

Business Processes and Events

■ Characteristics of Business Events

- ★ What happened?
- ★ When did it happen?
- ★ What roles are performed and by whom?
- ★ What resources were involved, and in what quantities?
- ★ Where did the event occur?

Business Processes and Events

- We distinguish business events forming parts of business processes from information processes
- Information processes
 - ★ record data about business events
 - ★ maintain data
 - ★ report useful information to decision makers

Business Processes and Events

■ Business events

- ★ selecting a supplier
- ★ transporting and distributing goods
- ★ providing services
- ★ receiving payment

■ Information events

- ★ recording customer orders
- ★ issuing invoices
- ★ adding new suppliers to master files
- ★ printing customer statements

■ Decision events

- ★ selecting a new product line to develop
- ★ deciding to raise prices

Business Processes and Events

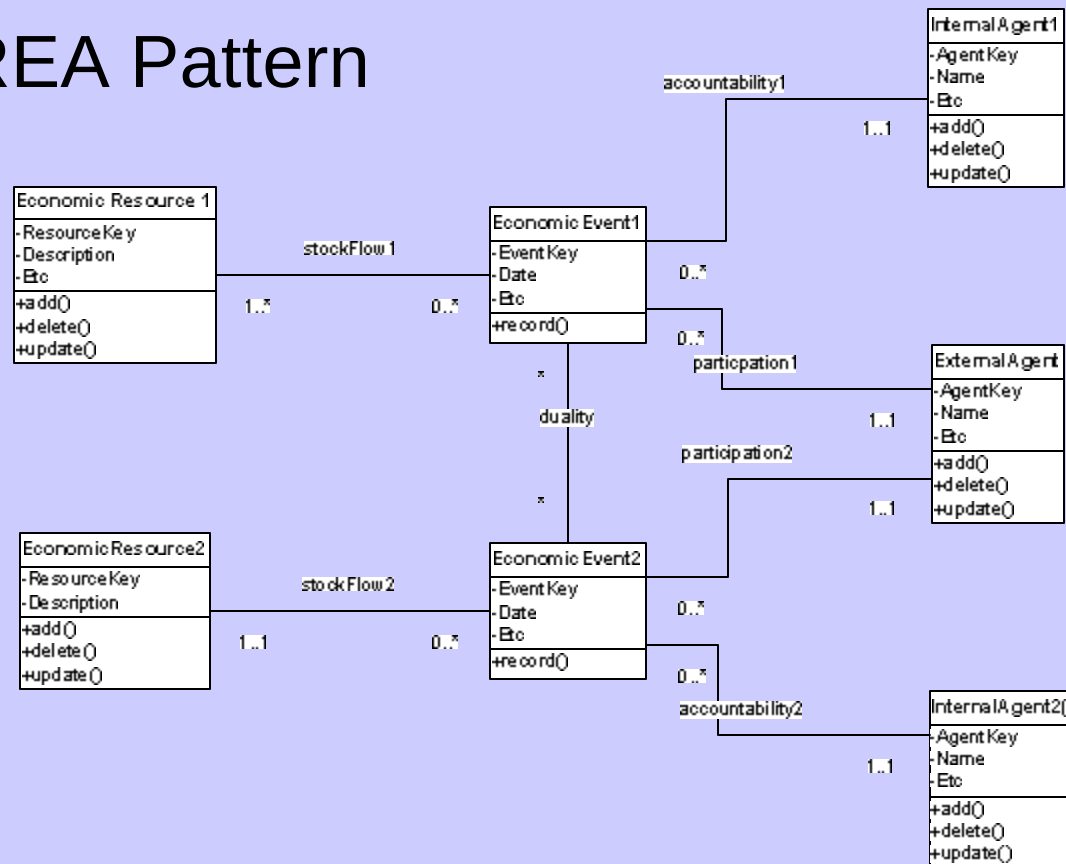
- Business processes may be linked in two ways
 - ★ by sharing common resources
 - ★ by an event in one process triggering an event in another process
- Decision processes may trigger
 - ★ Business events
 - ★ Information processes

Event-Oriented Modeling

- Applies Semantic Modeling specifically to accounting information systems
- Provides a way of identifying the relevant entities for EER diagrams
- The entities (or objects) of interest are the business events, and the resources, agents involved
- We generally do not model the information or decision processes or events

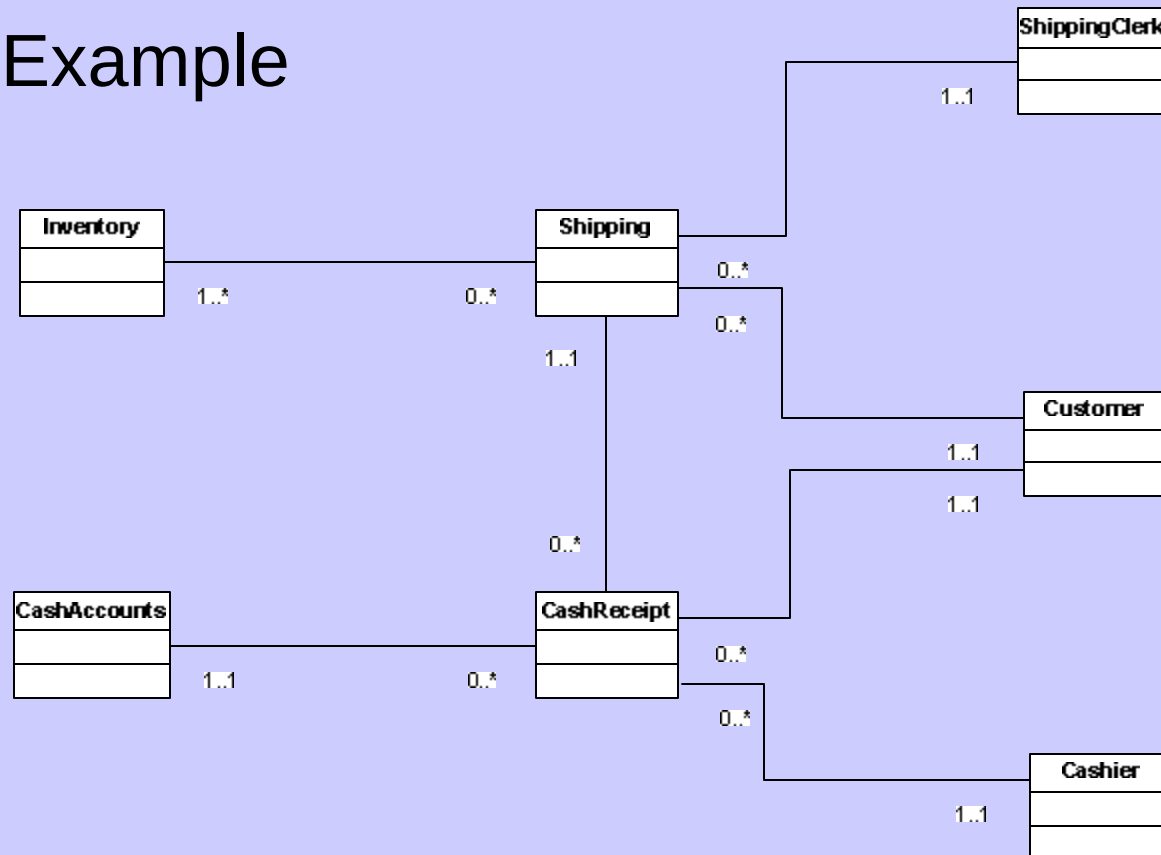
UML Class Diagram (Static Structure)

■ Core REA Pattern



UML Class Diagram (Static Structure)

■ REA Example



UML Class Diagram (Static Structure)

- We may sometimes omit the names of the relationships when our understanding would not thereby be impaired
- We show optionalities and cardinalities in the form *optionality .. cardinality*
e.g. 0 ..1 0 .. * 1 ..1 1 .. *
- We will generally use lists (data dictionaries) instead of showing attributes on diagrams
- Show primary keys underlined and foreign keys in [] when required
 - * N.B. NOT required on REA diagrams

REA Modeling Steps

- 1 Identify the significant events
- 2 Identify the related resources
- 3 Identify the related internal and external agents
- 4 Identify relationships between entities
- 5 Specify the optionalities and cardinalities of the relationships
- 6 Identify the attributes of the REA entities
- 7 Identify the information processes
- 8 Design the data repository structure
- 9 Implement the design

Group Work for Chapter 8 (2)

■ Problem 9

- ★ Add the sentence:

“Videos are either picked up from the store shelves or at the front desk where the customer may have called in to reserve a newly released video in high demand”

■ Problem 10

- ★ Work through the 9 REA steps in sequence
- ★ Use a UML Class Diagram instead of an EER

■ Narrative and flowcharts in the Chapter 1 Appendix for automated Purchases