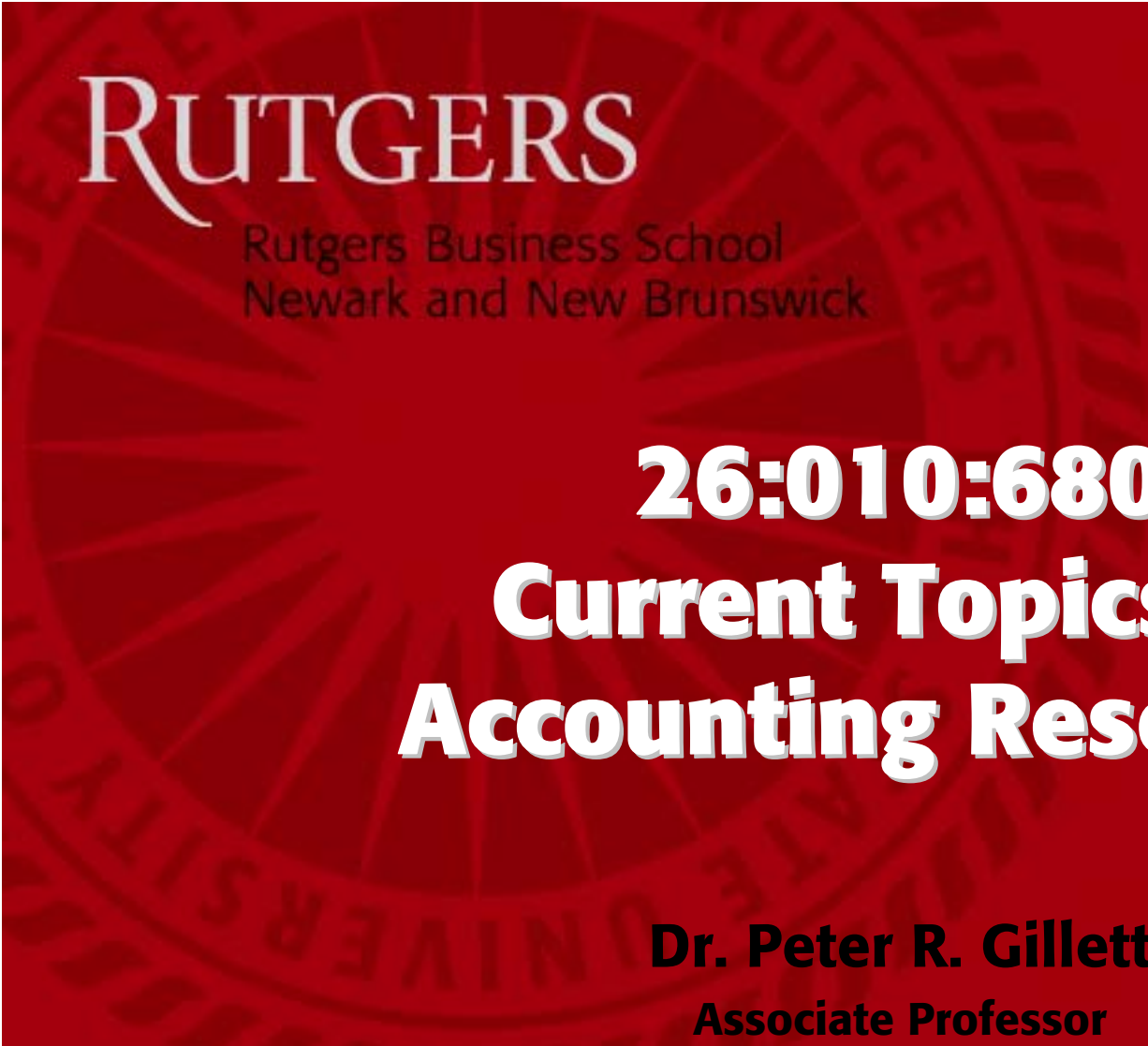




RUTGERS

Rutgers Business School
Newark and New Brunswick

26:010:680
Current Topics in
Accounting Research

Dr. Peter R. Gillett

Associate Professor

Department of Accounting, Business Ethics and Information Systems
Rutgers Business School–Newark and New Brunswick

Overview

- Introductions
- Four Topics
 - * REA and Design Science
 - * Uncertain Reasoning
 - * Strategic and Emerging Technologies
 - * Auditing Research & Behavioral Methodologies
- Syllabus
- Timetable
- The Big Picture
- Homework 1

Introductions

- Name
- Major
- Year
- Nationality
- Hobbies

Syllabus

- Memorandum
- Contact Information
- Textbooks
- Objectives
- Background
- Grading
- Assignments
- Participation
- Examinations
- Academic Integrity
- Withdrawal Policy
- University Closings
- About the Instructor

Timetable

- Class
- Date
- Topic
- Readings
- Assignments

Timetable

- REA and Design Science
- Uncertain Reasoning
- Strategic and Emerging Technologies
- Auditing Research &
Behavioral Methodologies

The Big Picture

- Class participation counts!
- There will be a Literature Review on Strategic and Emerging Technologies in Accounting Research IN TEAMS
- You will prepare a Research *Proposal* on a topic relevant to the course materials
- There will be no Midterm or Final Examinations
- *My role is to facilitate your learning*
- *You should be learning from each other not just from me, and not just by yourself – nor just in class*

The Big Picture

- Clearly the class is designed round the twin assumptions that you will all come to class prepared, and that you will all participate actively
- Trust me, there is no alternative!
- You will regularly be assigned to LEAD discussions on the various assigned papers
- As well as learning new material we will be developing and practicing the professional skills of academic researchers

Four papers for Class 1

- Chen, Peter P-S. 1976. "The Entity-relationship Model – Toward a Unified Model of Data" *ACM Transactions on Database Systems* (Vol.1, No.1): pp. 9-36.
- McCarthy, William E. 1979. "An Entity-relationship View of Accounting Models" *The Accounting Review* (Vol. LIV, No. 4): pp. 667-696.
- McCarthy, William E. 1982. "The REA Accounting Model: A Generalized Framework for Accounting Systems in a Shared Data Environment" *The Accounting Review* (Vol. LVII, No. 3): pp. 554-578.
- McCarthy, William E. 2003. "The REA Modeling Approach to Teaching Accounting Information Systems" *Issues in Accounting Education* (Vol. 18, No. 4): pp. 427-441.

Database Concepts

- Bit (Binary digit)
- Byte (usually 8 bits)
- Field (multiple bytes making a unit of data - e.g., a name, a value)
- Record (group of related fields - e.g., an individual customer)
- File (group of records - e.g., all customers)
- Database (multiple logically related files)

Database Concepts

■ Keys

- * Primary keys
- * Composite (concatenated) keys
- * Foreign keys
- * Non-key attributes

■ Cardinalities

- * 1:1
- * 1:M and M:1
- * M:M

Our Notation

- The textbook used to show primary keys underlined and foreign keys dotted underlined; sometimes they showed primary keys in italics and marked foreign keys with an asterisk. Now they show primary keys underlined and foreign keys with an asterisk. *We will stick to the notation shown here, with primary keys underlined and foreign keys in square brackets.*

Customer (Customer#, Name, Address, . . .)

Invoices (Invoice#, Date, [Customer#], . . .)

InvoiceItems ([Invoice#], Item#, Qty, UnitPrice)

or

Inventory (Inventory#, InventoryName, . . .)

InvoiceItems ([Invoice#], [Inventory#], Qty, UnitPrice)

Database Models

■ Hierarchical

- * 1:1 and 1:M relationships (parent-child)
- * single root (entry point)
- * explicit pointers

■ Network

- * 1:1, 1:M, M:1 and M:M relationships
- * multiple parents (multiple entry points)
- * explicit pointers

Database Models

■ Relational

- * Relations (tables)
- * Tuples (rows)
- * Attributes (columns)
- * Relationships between tables are *implicit*

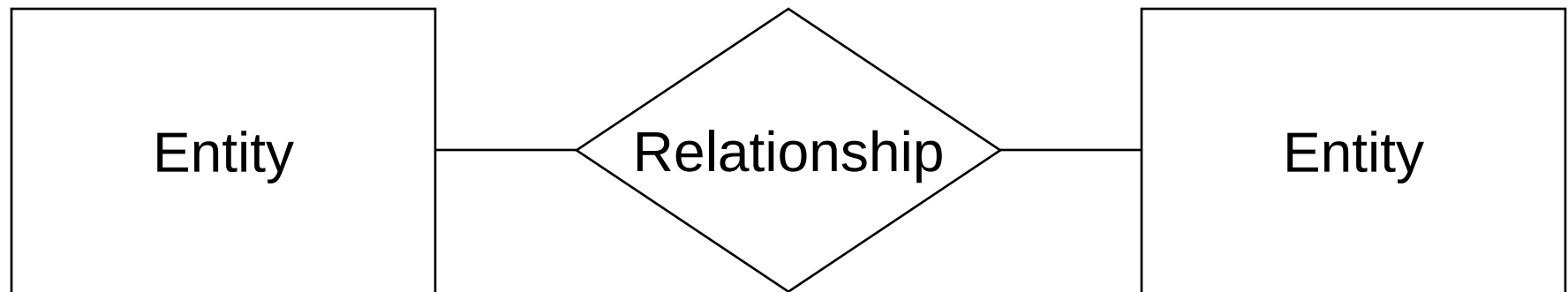
The Relational Database Model

- Relation (table) names must be unique
- Every relation must have a primary key
- Duplicate rows and columns are not allowed
- The order of rows and columns is immaterial (except by convention)
- Entity integrity
- Referential integrity

The Relational Database Model

- Entity integrity
 - * Primary key cannot be null
 - * Primary key must be unique
- Referential integrity
 - * foreign keys (when part of a composite key)
 - must match an existing value (cannot be null)
 - * foreign keys (when non-key attributes)
 - must match an existing value or be null

Entity-Relationship Models

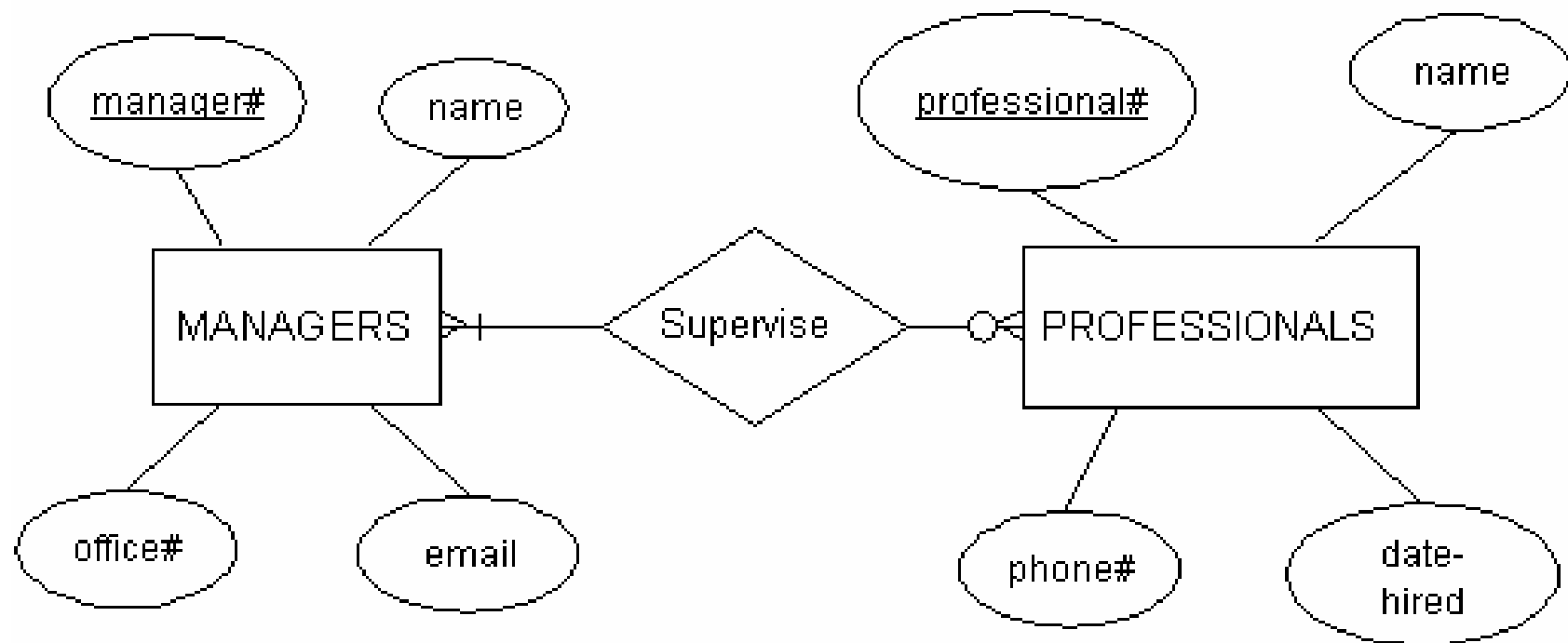


Extended E-R Models

- **Optionalities**
 - * optional or mandatory
- **Cardinalities**
 - * 1:1, 1:M, M:1, or M:M
- **Attributes**
 - * keys and non-key attributes

EER Models

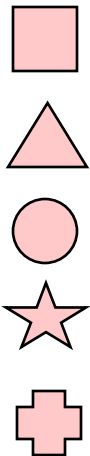
EER Figure 7



Event-Oriented Models

■ Abstraction:

Reality

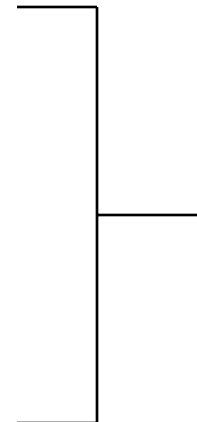


Symbol
(Token)

Square
Triangle
Circle
Star
Cross

Symbol
(Type or Category)

Shape



Event-Oriented Models

- We store data at the level of token symbols (Colin Sheldon, fabric, etc.)
- To make complexity manageable, our conceptual model represents reality at the level of type symbols (Directors, 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 “Clark Thompson” is an instance of the entity “Director”
- 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)**
 - * **Events**
 - Economic Events (E)
 - Commitments (C)
 - Business Events (B)
 - * **Economic Agents**
 - Internal Agents (A)
 - External Agents (A)

Event-Oriented Models

- **REA Ontology:**
 - * **Economic Resources** – e.g. Inventory
 - * **Events**
 - Economic Events – e.g. Receiving Raw Materials
 - Commitments – e.g. Purchase Orders
 - Business 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)**
 - * **Events**
 - Economic Events (E)
 - Commitments (C)
 - Business Events (B)
 - 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
 - Resource-flow (E – R)
 - Inflow
 - » Take
 - » Production
 - Outflow
 - » Use (entirely)
 - » Consumption (in small parts)
 - » Give
 - Participation (E – A)
 - Inside
 - » Accountability
 - Outside
 - Others . . . (more below)

Business Transaction

- A predefined set of activities and/or processes of Persons which is initiated by a Person to accomplish an explicitly shared business goal and terminated upon recognition of one of the agreed conclusions by all the involved Persons although some recognition may be implicit
 - * **Bilateral transaction**
 - The Persons include only the buyer and the seller (or agents acting for them)
 - * **Mediated transaction**
 - A third party mediates between the partners as agreed by them

Business Transaction

- Business transactions pass through five phases:
 - * **Planning**
 - Decide on action
 - * **Identification**
 - Exchange data to establish links
 - * **Negotiation**
 - Identify goods and/or services, and each other
 - * **Actualization**
 - Execute results of negotiation
 - * **Post-actualization**
 - Activities after delivery e.g. warranty coverage, service, etc.

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 monitor or control
- Significant 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

- Significant 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 Events as
 - * **Economic events**
 - Increment or Decrement some economic resource
 - * **Commitments**
 - Contracts or schedules for the occurrence of future economic events
 - * **Business events**
 - Occurrences in time that partners to a business transaction wish to monitor or control
 - Supporting events that enable economic events or commitments to take place

Business Processes and Events

- Characteristics of events in business processes
 - * 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 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

- Events in business processes
 - * 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 events in the business processes, and the resources, agents involved
- We generally do not model the information or decision processes or events

Event-Oriented Modeling

- REA Ontology:
 - * Economic Resources (R)
 - * Events
 - Economic Events (E)
 - Commitments (C)
 - Business Events (B)
 - Instigation (I)
 - Facilitation (F)
 - Terminal (T)
 - * Economic Agents
 - Internal Agents (A)
 - External Agents (A)

Event-Oriented Modeling

- **Economic Resource**
 - * Good, right, or service of value, under the control of a person
- **Economic Event**
 - * Occurrence in time wherein ownership of an economic resource is transferred from one person to another
- **Economic Agent**
 - * Persons and agencies who participate in the economic events of an enterprise or who are responsible for subordinates' participation

Event-Oriented Modeling

■ Economic Exchange

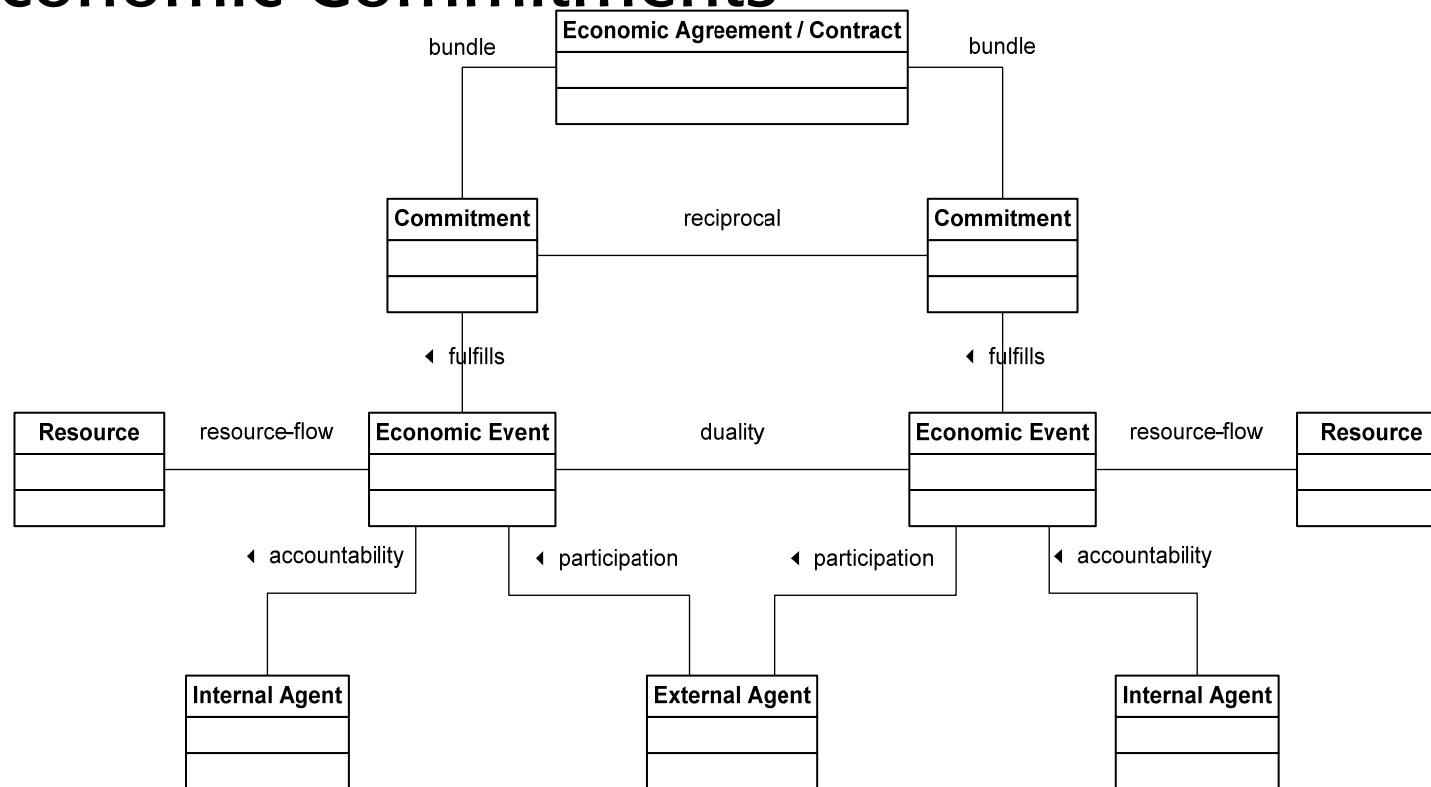
- * Type of a business transaction where the goal is an exchange of economic resources between two persons where both parties derive higher utility after the completed business transaction
 - Usually involves two economic events each incrementing or decrementing a different resource in a *duality* relationship

Event-Oriented Modeling

- Commitment
 - * Making or accepting of a right, obligation, liability, or responsibility by a person that is capable of enforcement in the jurisdiction in which the commitment is made
- Economic commitment
 - * Type of commitments by one person to transfer economic resources to another person at some specified point in the future
- Economic commitments may be *bundled* into
 - * Economic agreements (incomplete, not subject to legal enforcement)
 - * Economic contracts (complete, enforceable)
- We will often use informal *mutual commitments*
 - * *E.g., Sales Order, Purchase Order*

Event-Oriented Modeling

■ Economic Commitments



Event-Oriented Modeling

■ Economic Claims

- * Expectation of one person to receive a future inflow of economic resources from another person because of an economic exchange which is presently incomplete
 - A claim is *materialized* by an event in an economic exchange
 - It is *settled* by a requiting event in the economic exchange
 - e.g. Accounts Receivable

Event-Oriented Modeling

- REA Ontology:
 - * Relationships
 - Duality (E – E)
 - Transfer
 - Transformation
 - Resource-flow (E – R)
 - Inflow
 - » Take
 - » Production
 - Outflow
 - » Use (entirely)
 - » Consumption (in small parts)
 - » Give
 - Participation (E – A)
 - Inside
 - » Accountability
 - Outside
 - Others . . . (more next class)

Event-Oriented Modeling

- REA Ontology:
 - * Congruent events
 - Congruency occurs when both events in an exchange happen simultaneously in time and space
 - E.g., Cash Sales
 - » Selling a movie ticket
 - » Receiving payment for a movie ticket
 - » Cinemas do NOT maintain Accounts Receivable!

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

UML 2.0

- Unified Modeling Language
- Developed from combination of competing methods for designing object-oriented systems, from 1995 onwards
- Flexible system works with other methodologies (e.g., for RDBMS design)
- UML 2.0 standard adopted June 2003 (current version 2.1.2)

UML 2.0

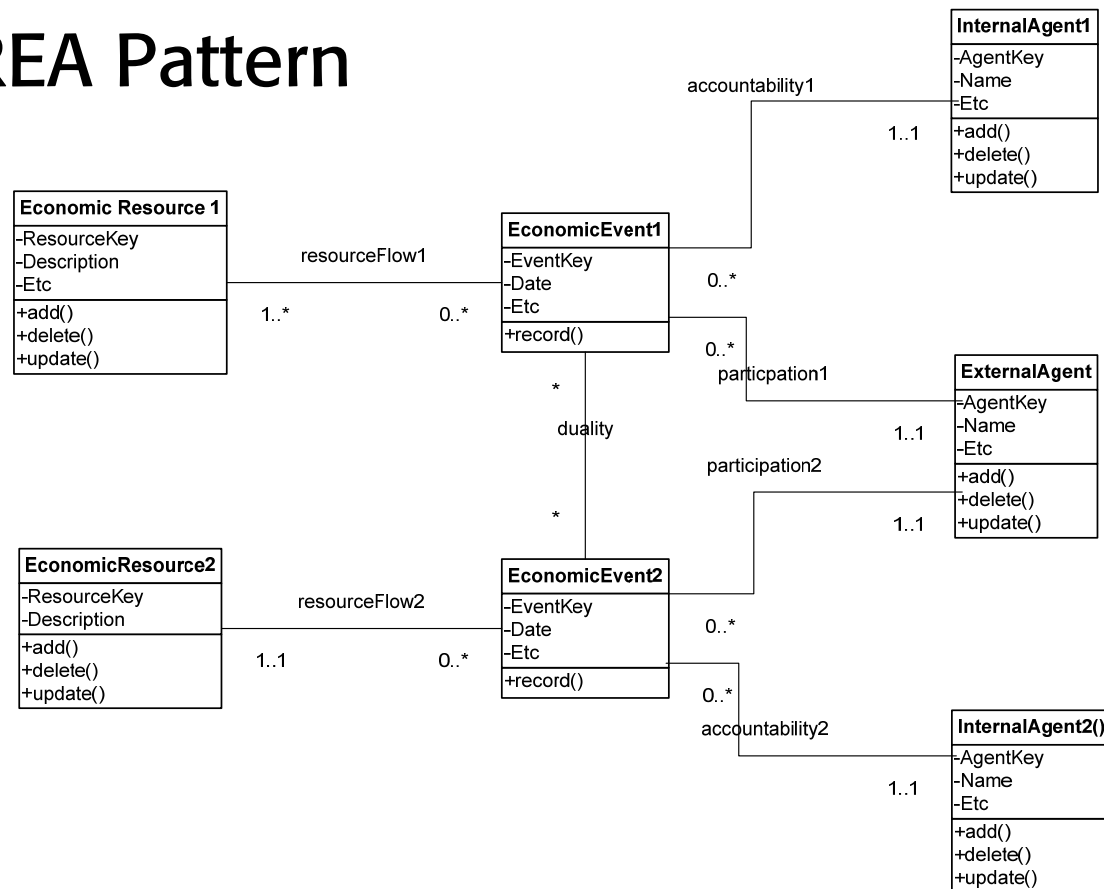
- 13 diagrams:
 - * **Structural**
 - Class diagram
 - Object diagram
 - Composite Structure diagram
 - Deployment diagram
 - Component diagram
 - Package diagram
 - * **Behavioral**
 - Activity diagram
 - Use diagram
 - State Machine diagram
 - * **Interaction**
 - Overview diagram
 - Sequence diagram
 - Communication diagram
 - Timing diagram

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

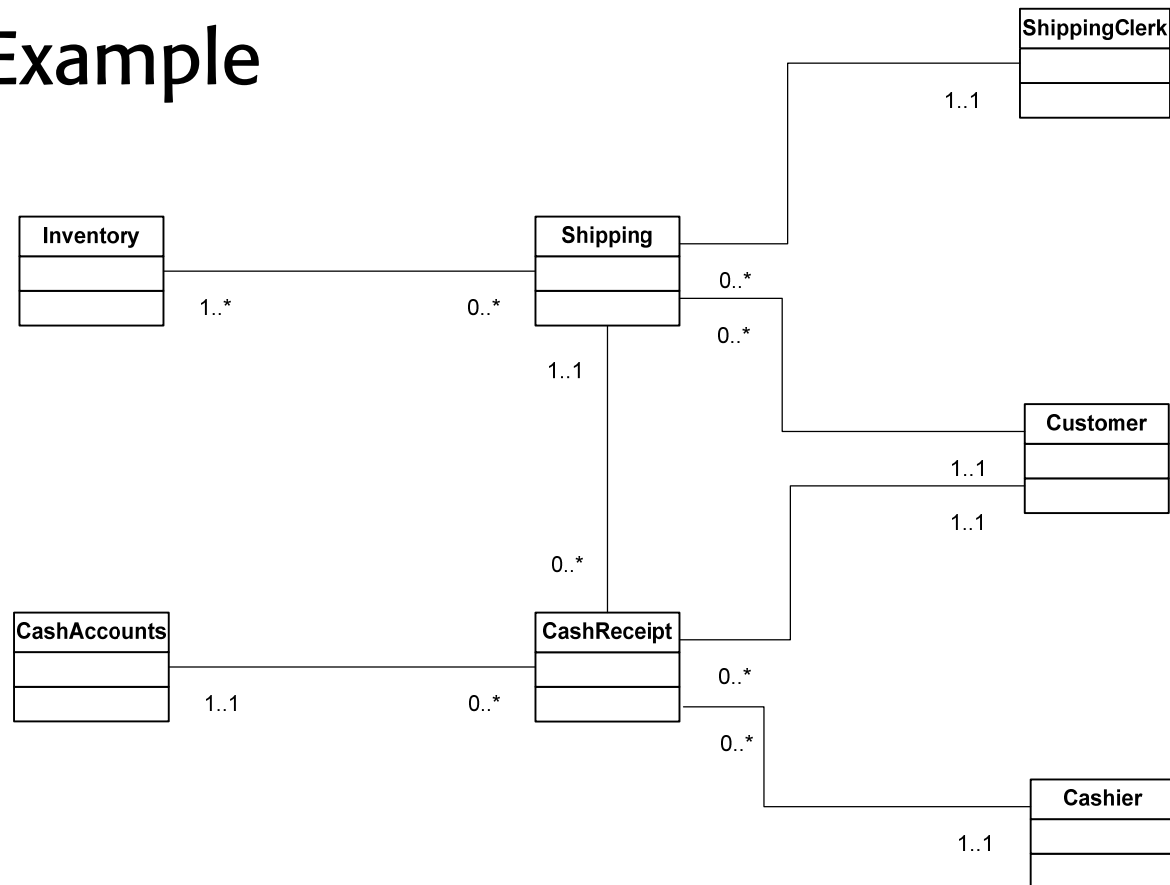
UML Class Diagram (Static Structure)

■ Core REA Pattern



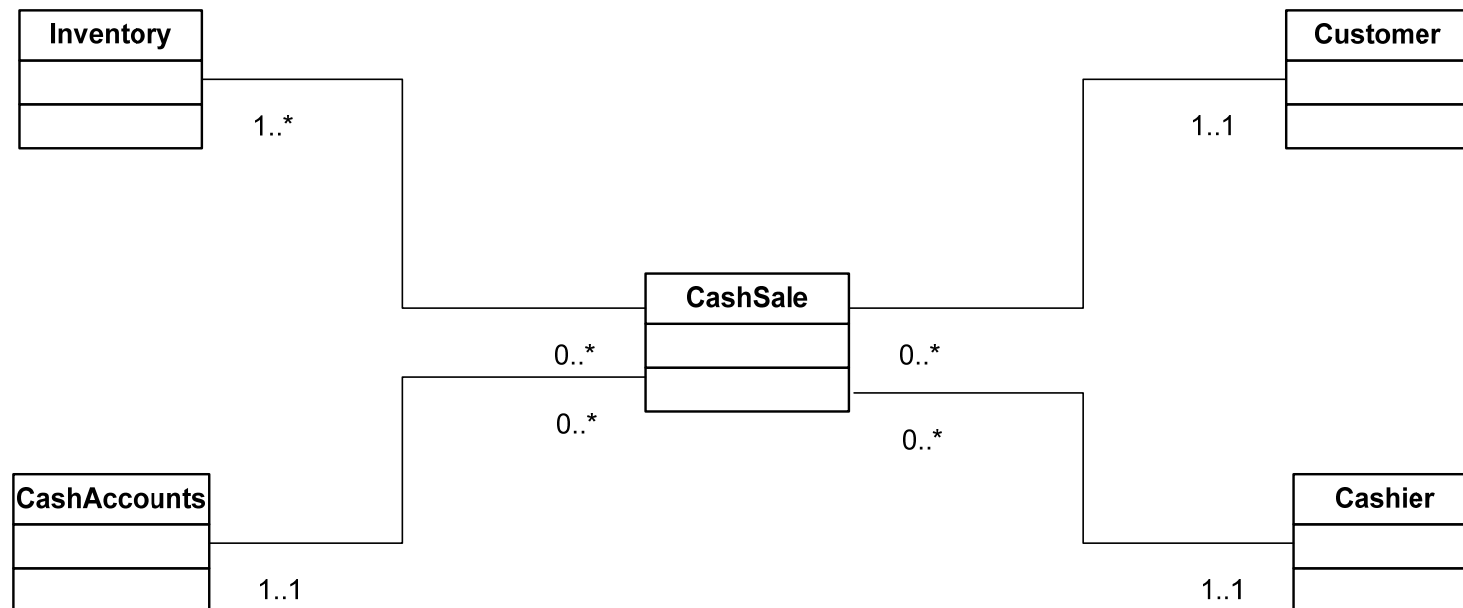
UML Class Diagram (Static Structure)

■ REA Example



UML Class Diagram (Static Structure)

- REA Example – Congruent events



REA Modeling

- **N.B:**
 - * **Official format:**
 - optionalities, cardinalities and attributes
 - * **Textbook format:**
 - omit attributes
 - * **UML format:**
 - omit attributes, omit names of relations, use 0 ..* etc. for optionalities and cardinalities

UML 2.0

■ Unified Modeling Language

* Associations

- N-ary associations e.g. binary associations
- (Aggregation) (*officially removed from UML 2.0?*)
- Composition
- Generalization
- Reflexive associations

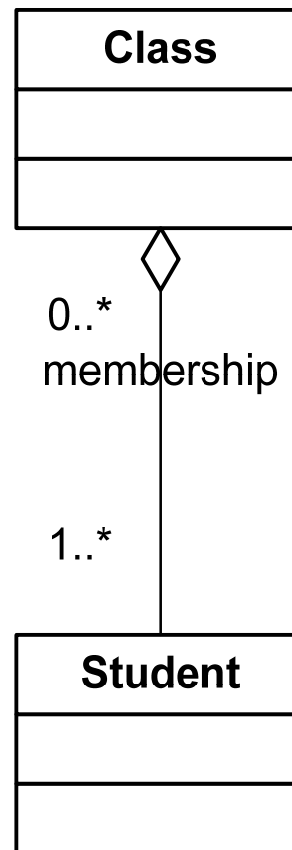
UML 2.0

■ Association



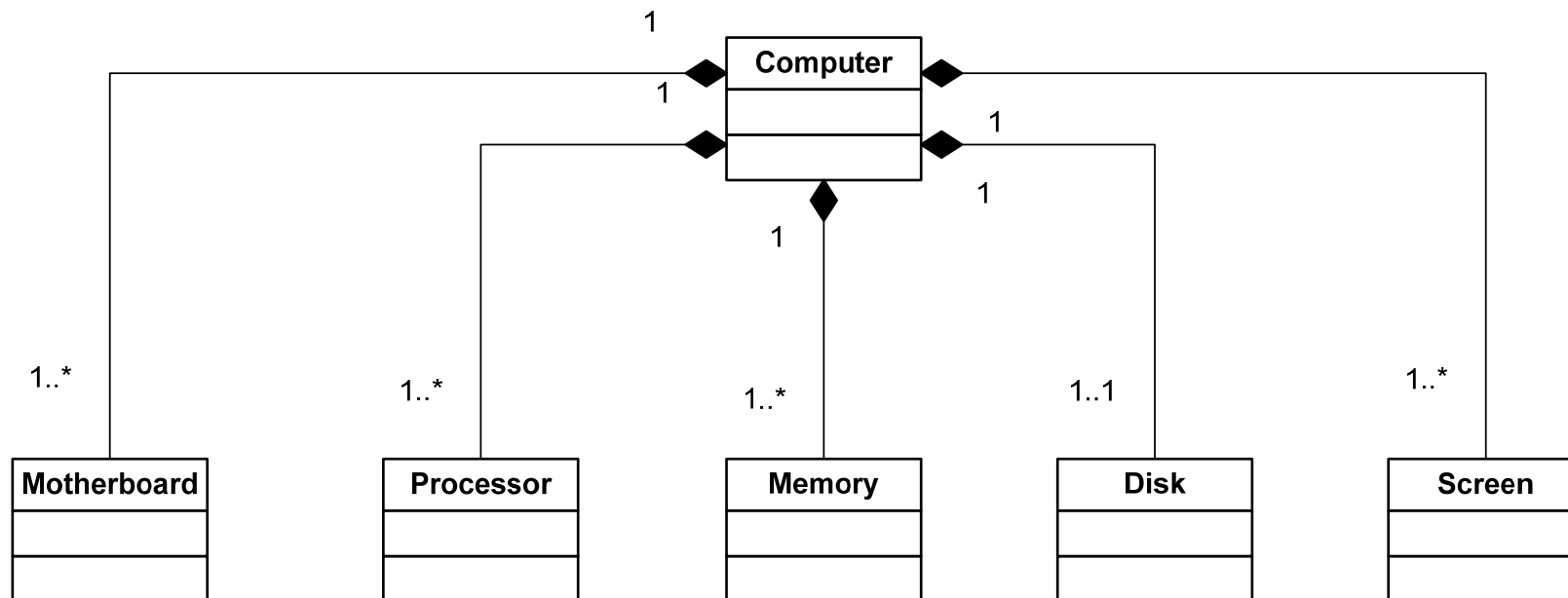
UML 2.0

■ Aggregation



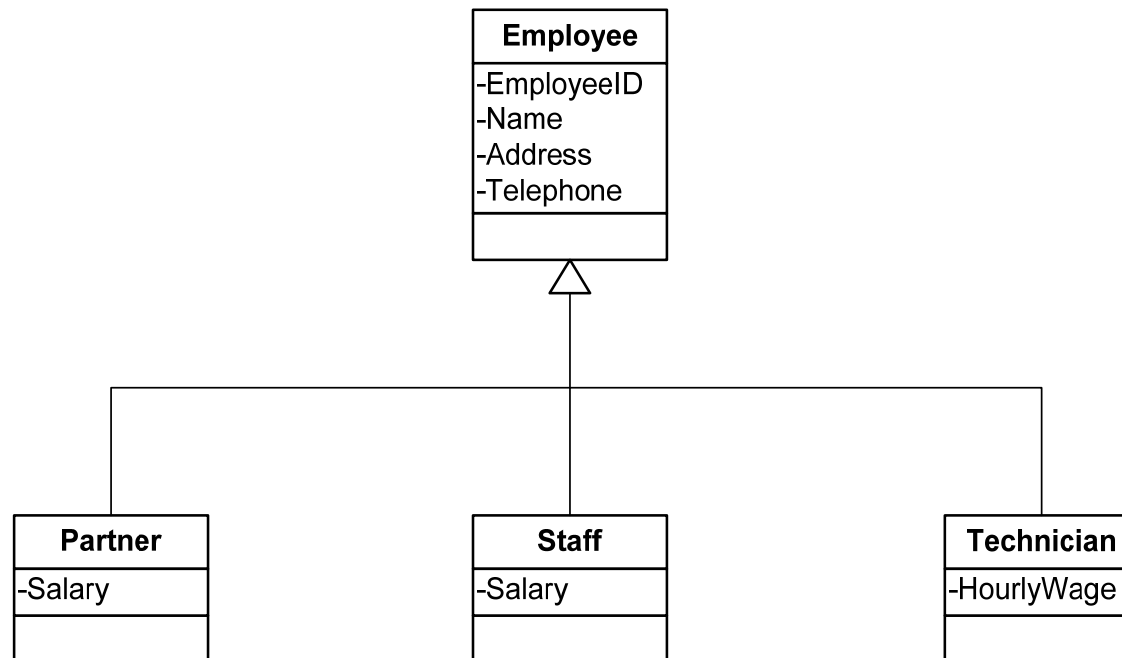
UML 2.0

■ Composition



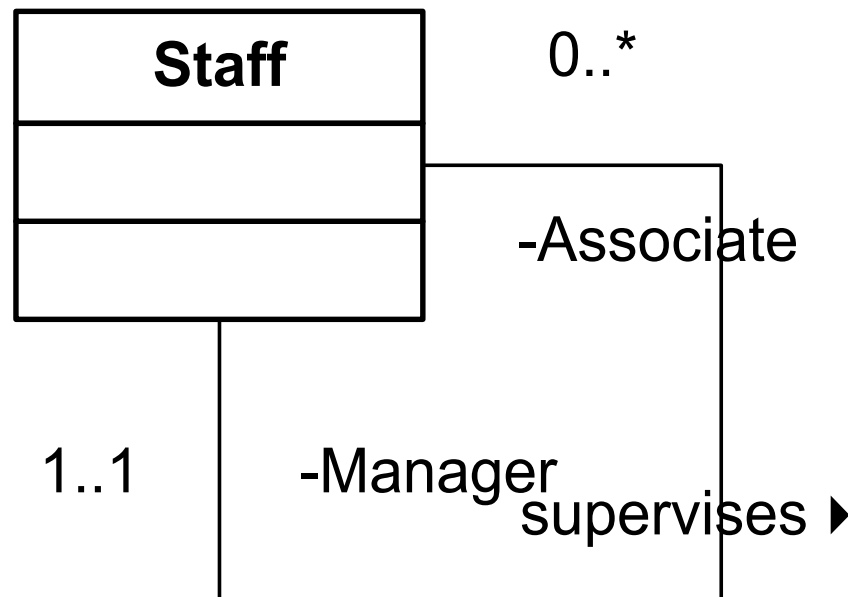
UML 2.0

■ Generalization



UML 2.0

■ Reflexive



UML & Visio

■ UML 2.0

- * Optionalities & Cardinalities (EER) are called Multiplicities (UML)
 - 1 (abbreviates 1..1 – we will NOT use)
 - * (abbreviates 0..* – we will NOT use – default)
 - 0..1
 - 0..*
 - 1..1
 - 1..*
- * “Roles” are now called “association end names”

UML & Visio

■ VISIO

- * File, New, Software
- * UML Model Diagram (US units)
- * UML Static Structure
- * You will initially need only two symbols
 - Class
 - Binary Association
- * After you have drawn the first association
 - Right click
 - Shape Display Options
 - End Options
 - Deselect “First end name” and “Second end name”
 - Select the two options at the bottom of the screen
- * To change association properties, double-click
- * To relocate multiplicities, right click and select Format, Text, Text Block

UML & Visio

■ VISIO

* EER Diagrams (ERD)

- Visio 2000 contained Templates for a variety of different ERD notations (yes, there are many variants . . .)
- Visio 2002 removed most of them, including the ones we want to use . . .
- Visio 2003 failed to put them back as expected . . .
- We can “improvise” by using the Basic Flowchart (US units) template
 - Use the “Process” symbol for Entities
 - Use the “Decision” symbol for Relationships
 - Draw Dynamic Connectors FROM Relationship diamonds TO Entities
 - Change the line endings as necessary (last icon on toolbar)

* DFDs

- Use the Data Flow Diagram (US units) template under Flowcharts

REA Modeling - a Formal Approach

Terminology for Events:

Murthy & Groomer	Denna	David	McCarthy	Gillett
Economic Non-economic	Core Support	Economic Business	Economic Commitment ---	Economic Commitment Business
Information	Information	Information	Information	Information

REA Modeling - a Formal Approach

- Economic events increase or decrease economic resources
- Resources are scarce, have utility and are under the control of an enterprise
- Agents are those who participate in events

REA Modeling - a Formal Approach

- Economic exchanges are pairs of related events
- Duality relationship
 - * In an economic exchange, one resource is incremented while another is decremented
 - * The dual events need not be simultaneous nor need one be a precursor to the other

REA Modeling - a Formal Approach

- Synergy relationships
 - * Multiple events that occur in conjunction with each other and result in the whole being greater than the sum of the parts

REA Modeling - a Formal Approach

- Identify each economic exchange
- Model each exchange using REA
- Perform view integration to consolidate exchange diagrams
- Verify that there are events to increment and decrement each resource
- Verify that every event participates in a duality relationship
- Integrate supporting business events

REA Modeling - a Formal Approach

- A more radical view of events is taken here:
 - * only needed events should be added
 - * they should be modeled in accordance with business realities rather than traditional accounting conventions
 - * this view facilitates business process reengineering

REA Modeling - a Formal Approach

- Information processes are not recorded
- Database implementations tend to filter at the reporting stage whereas traditional accounting information systems have tended to filter at the recording stage

REA Modeling - a Formal Approach

- **Key characteristics of REA Systems**
 - * Support all critical events
 - * Store a detailed history of events
 - * Store data in an integrated repository
 - * Are able to retrieve and manipulate data to meet user needs
 - * Process events as they occur
 - * Use directed REA design and implementation
 - * Prepare financial statements without journal entries and a general ledger

Event-Oriented Modeling

- Extended REA Ontology (Gillett 2003/6):
 - * Economic Resources (R)
 - * Significant Events
 - Economic Events (E)
 - Commitments (C)
 - Business Events
 - Instigation (I)
 - Facilitation (F)
 - Terminal (T)
 - * Economic Agents (A)
 - Internal Agents
 - External Agents
 - * Business Location (L)

Facilitation and Terminal events are best thought of as the beginning or end of economic events or commitments that we choose to record separately

Event-Oriented Modeling

- Extended REA Ontology (Gillett 2003/6):

- * Relationships

- Duality (E – E)
 - Transfer
 - Transformation
 - Resource-flow (E – R)
 - Inflow
 - » Take
 - » Production
 - Outflow
 - » Use (entirely)
 - » Consumption (in small parts)
 - » Give
 - Participation (E – A)
 - Inside
 - » Accountability
 - » Authorization
 - Outside
 - Site (E – L)

Event-Oriented Modeling

- Extended REA Ontology (Gillett 2003/6):
 - * **Relationships**
 - **Linkage (R – R)**
 - Composition: Shirts are composed of fabric, thread, buttons, labels, etc.
 - Substitution: White Packing Tissue substitutes for Ivory Packing Tissue
 - **Association (A – A)**
 - Responsibility: Managers are responsible for Secretaries
 - Assignment: Salespersons are assigned to Customers in their region
 - Cooperation: One Vendor cooperates with another Vendor
 - **Custody (A – R)**
 - Cashier has custody of Petty Cash
 - **Designation (A – R)**
 - Customer designates a new Ship
 - **Certification (A – R)**
 - Vendors certified to supply specific Inventory – Approved Vendors List

Event-Oriented Modeling

- Extended REA Ontology (Gillett 2003/6):
 - * Relationships
 - Fulfills (C – E)
 - Contract: Shipment fulfills the Sales Order
 - Schedule: Production fulfills the Job Order
 - Reserves (C – R)
 - Sales Order reserves Finished Goods
 - Partners (C – A)
 - Customer partners the Sales Order
 - Reciprocal (C – C)
 - Materials Requisition is the reciprocal of the Production Order

We are recording the (mutual) commitment to the (non-cash) initial event in economic exchanges; strictly, commitment events are paired in reciprocal relationships.

Event-Oriented Modeling

- Extended REA Ontology (Gillett 2003/6):
 - * **Relationships**
 - **Instigates** (I – C, I – E, I – F)
 - Requisition instigates Purchase Order
 - **Facilitates** (F – E, F – C)
 - Picking facilitates Shipping
 - **Necessitates** (E – T, C – T)
 - Receipt of goods necessitates Storage
 - **Demands** (I – R)
 - Requisition demands Inventory
 - **Authorization** (I – A)
 - Inventory Manager authorizes the Requisition
 - **Involves** (F – R), (T – R)
 - Marshals
 - » **Picking marshals Inventory**
 - **Participation** (F – A), (T – A)
 - Inside
 - » **Accountability**

Event-Oriented Modeling

- For many kinds of resources, we want to monitor and control types, as we have discussed:
 - * E.g., we may identify books by ISBN – this refers to books of a particular type (title, author, etc.), not to individual copies
- For other resources, we want to monitor and control individual items:
 - * E.g., individual ships we are building for our customers
- Sometimes, we want a mixture of both approaches:
 - * E.g., a customer orders an automobile of a particular type . . .
 - * . . . but we deliver an specific automobile with a unique VIN
- These considerations lead us to add *typification*

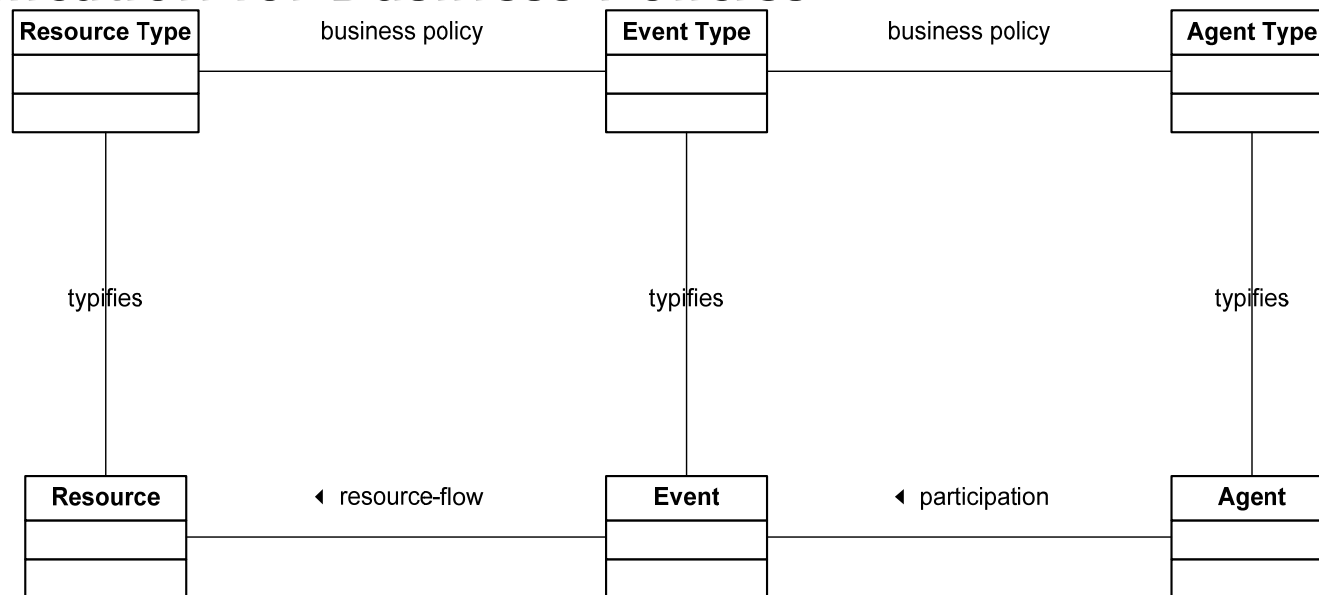
Event-Oriented Modeling

■ REA Ontology – Typification

- * Association between a concrete entity and the abstract specification of its grouped properties
- * The base classes of the REA Ontology are extended by the addition of related type classes, related to them by the relationship *typifies*
- * An entity type is a subset of all the possible instances of the entity:
 - Resource (R) – Automobile:
Resource type (RT) – Automobile model
 - Event (E) – Order:
Event type (ET) – Telephone Order
 - Agent (A) – Customer:
Agent type (AT) – Business customer
- * Types may be useful to document *business policies* – i.e., what *should* happen rather than what *did* happen

Event-Oriented Modeling

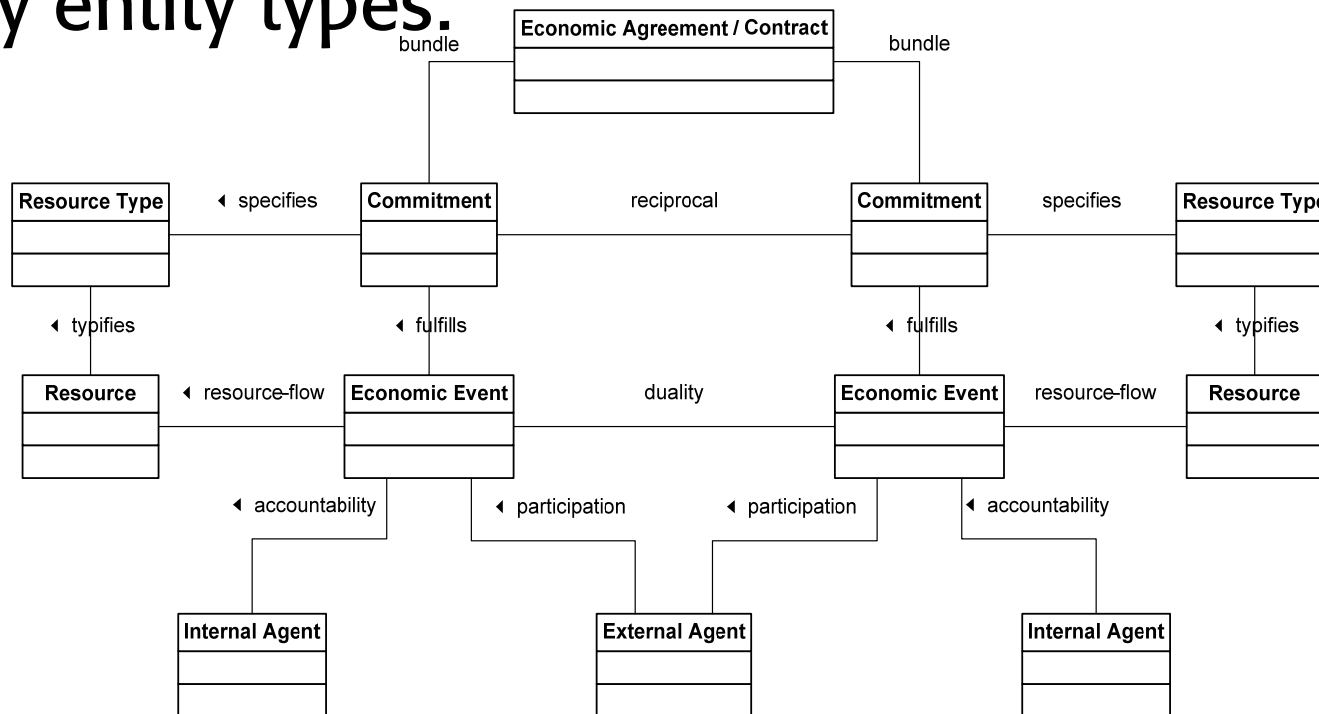
■ Typification for Business Policies



- * E.g., Only Business Customers may place telephone orders
- * E.g., Telephone orders will not be accepted for sports cars

Event-Oriented Modeling

- Economic Commitments may, minimally, specify only entity types:



Designing the Data Repository Structure for RDBMS

- There are three main issues involved in this step:
 - * Identifying the required tables
 - * Linking the tables
 - * Specifying the attributes for the tables

Identifying Required Tables

- Every entity in the REA model will require a table with a primary key (subject to a possible decision to merge certain tables together during linking, or omit tables with only one row)
- In other words, there should normally be a table for every:
 - * resource
 - * event
 - * agent

Identifying Required Tables

- Additional tables may be required to model certain types of links between entities (see next slide)
- Finally, tables may be required for reference purposes by the information system (e.g., tables of valid State Codes, Discount Codes, etc.)

Linking Tables - Choices

- Create separate Link table
 - * will always work
 - * may often be unnecessary
 - * sometimes the only choice (e.g., M:M)
- Post foreign keys
- Combine tables
- All three choices would work for 1:1

Linking Tables

- **1:1 Links**
 - * collapse the two entities into a single table
or
 - * post the primary key of either table as a foreign key in the other
- **1:M and M:1 Links**
 - * post the primary key for the '1' table as a foreign key in the 'M' table
- **M:M Links**
 - * create a new Link Table with the primary keys from the original tables forming a composite key; add any uniquely defined attributes

Linking Tables

- Except:
 - * For optional entities
 - always treat as if their cardinality were M
 - i.e., treat both (0,1) and (0,*) entities as (0,*)
 - * When modeling two events linked 1:1
 - post the key of the first event as a foreign key in the table for the second
 - * When modeling two events linked 1:M where the '1' event follows the 'M' event
 - treat the link as a M:M link – i.e., create an additional Link Table

Specifying Attributes

- Primary keys are identified when tables are formed
- Foreign keys are added in accordance with the rules for linking
- Other non-key attributes should be added based on the requirements identified at Step 6 of REA modeling

Specifying Attributes

- Proposal Table
(Proposal#, Scientist# , DateSubmitted, etc.)
- Proposal-Scientist Link Table
(Proposal#, Scientist#)
- Proposal-Equipment Link Table
(Proposal#, Equipment#)
- Proposal-Chemicals Link Table
(Proposal#, Chemical#, Quantity, Procedure)

Homework 1

- Complete both an EER diagram and a UML Class Diagram for *Le Cochon Incroyable*, and design the Data Repository Structure
- Submit your work as a WORD document via the Digital Drop Box (Add *and* Send)
- I recommend, but do not require, VISIO 2003