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*Current Topics in
Accounting Research*

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Overview

- Introductions
- Four Topics
 - * REA
 - * AI / ET
 - * Ethics
 - * 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
- Artificial Intelligence / Emerging Technologies
- Ethics in Accounting
- Behavioral Research Methodologies

The Big Picture

- Class participation counts!
- There will be a Literature Review of Accounting Ethics Research IN TEAMS
- Nine chapters of an introductory undergraduate book on Ethics are assigned for Class 9 - do yourself a favor and read one a week!
- 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

- Binary Digit (Bit)
- Byte (8 bits)
- Field (multiple bytes)
- Record (files related to one individual)
- File (collection of records)
- Database (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

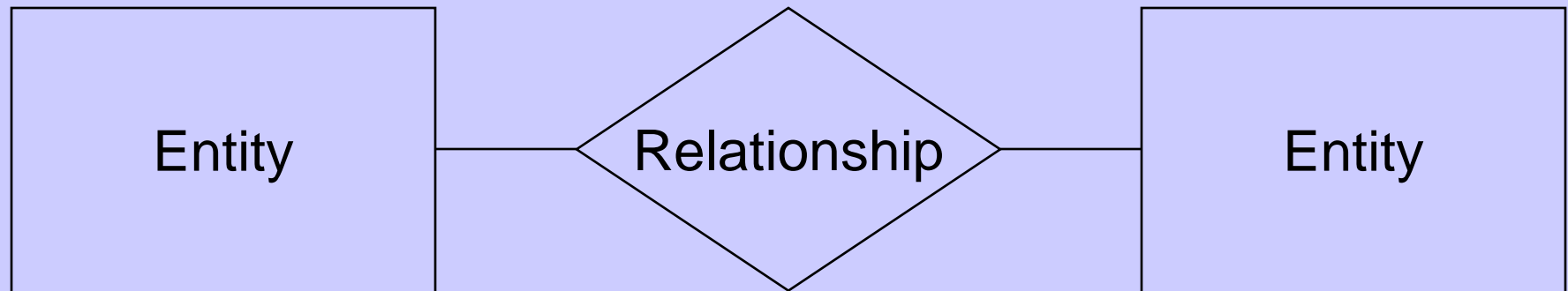
■ Entity integrity

- ◆ 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

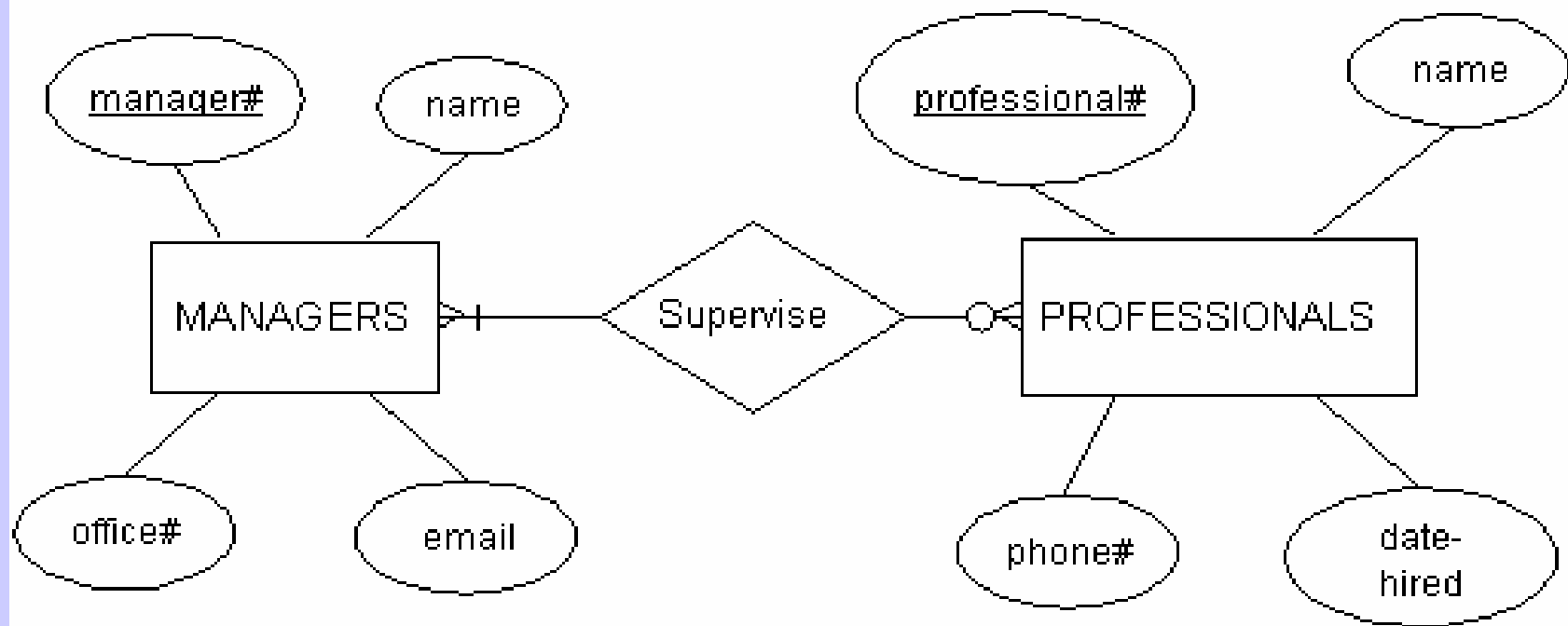
- ★ 1:1, 1:M, M:1, or M:M

■ Attributes

- ★ keys and non-key attributes

EER Models

EER Figure 7



Event-Oriented Models

■ Abstraction:

Reality



Symbol

(Token)

Square

Triangle

Circle

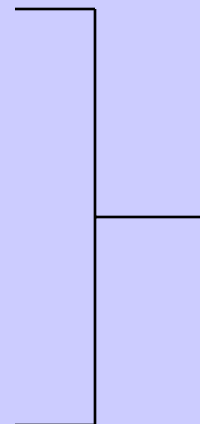
Star

Cross

Symbol

(Type or Category)

Shape



Event-Oriented Models

- We store data at the level of token symbols (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:

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

Event-Oriented Models

■ REA Ontology:

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

Event-Oriented Models

■ REA Ontology:

- ★ Resources (R)
- ★ Events
 - ◆ Economic Events (E)
 - ◆ Commitments (C)
 - ◆ Business Events (B)
 - ➔ Instigation (I)
 - ➔ Facilitation (F)
 - ➔ Terminal (T)
- ★ 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 . . .

Business Transaction

- 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

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:

- ★ Resources (R)
- ★ Events
 - ◆ Economic Events (E)
 - ◆ Commitments (C)
 - ◆ Business Events (B)
 - ➔ Instigation (I)
 - ➔ Facilitation (F)
 - ➔ Terminal (T)
- ★ 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

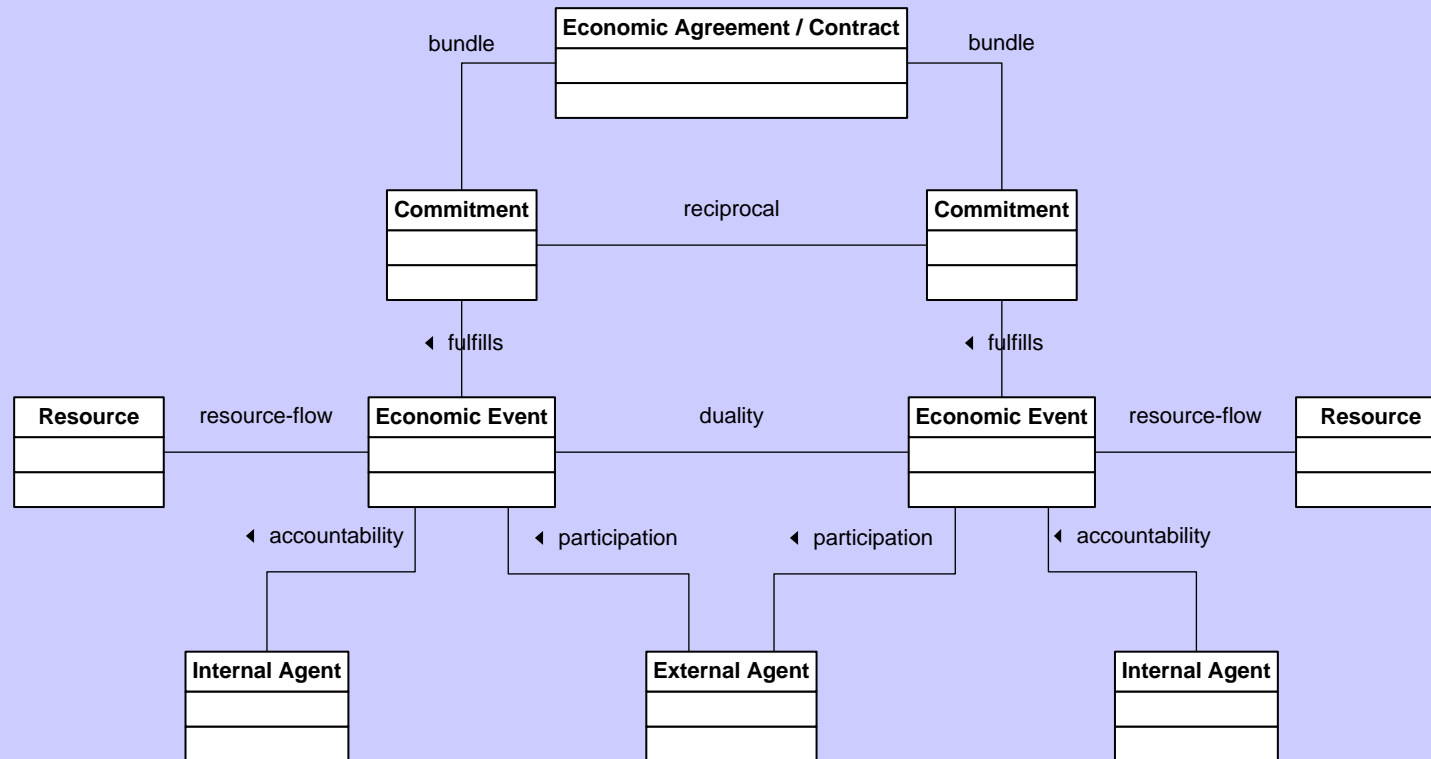
■ Economic commitments may be *bundled* into

- ★ Economic agreements (incomplete, not subject to legal enforcement)
- ★ Economic contracts (complete, enforceable)

■ We will often use informal *mutual commitments*

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
 - Consumption
 - Give
 - ◆ Participation (E – A)
 - ➔ Inside
 - Accountability
 - ➔ Outside
 - ◆ Others . . .

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

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

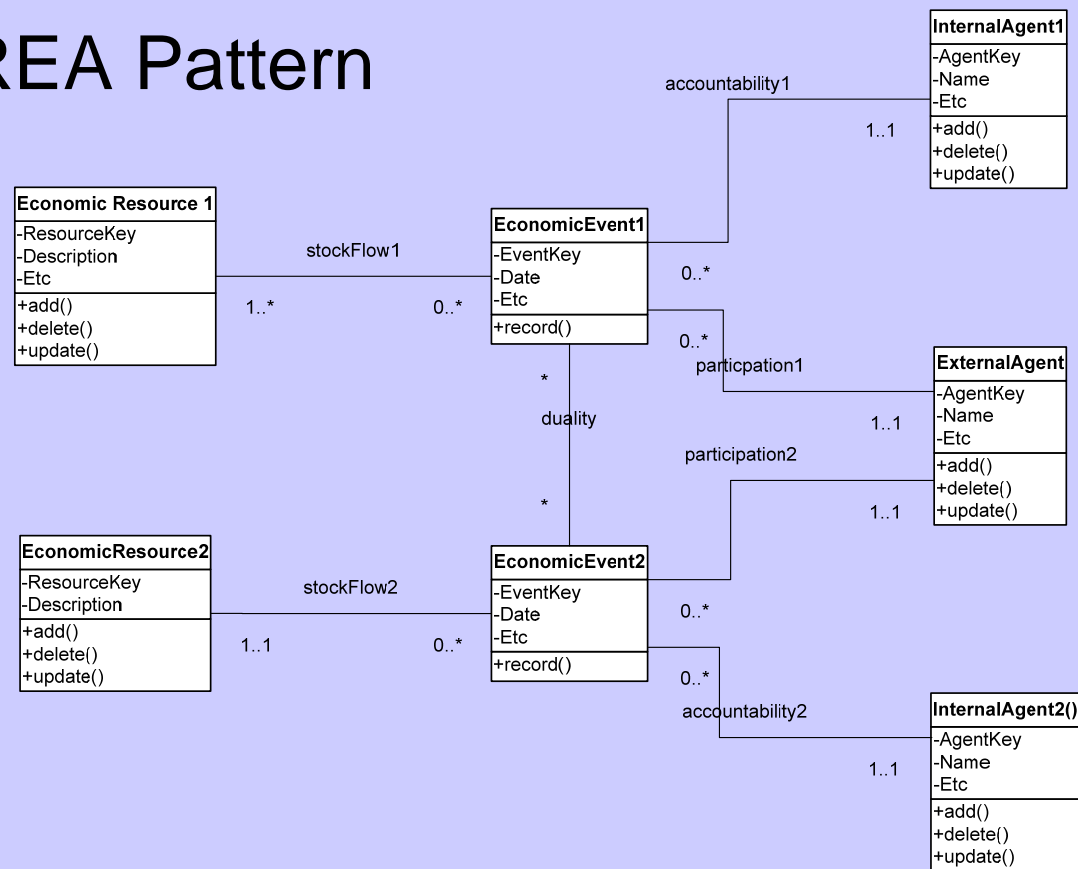
- ◆ Overview diagram
- ◆ Sequence diagram
- ◆ Communication diagram
- ◆ Timing diagram

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

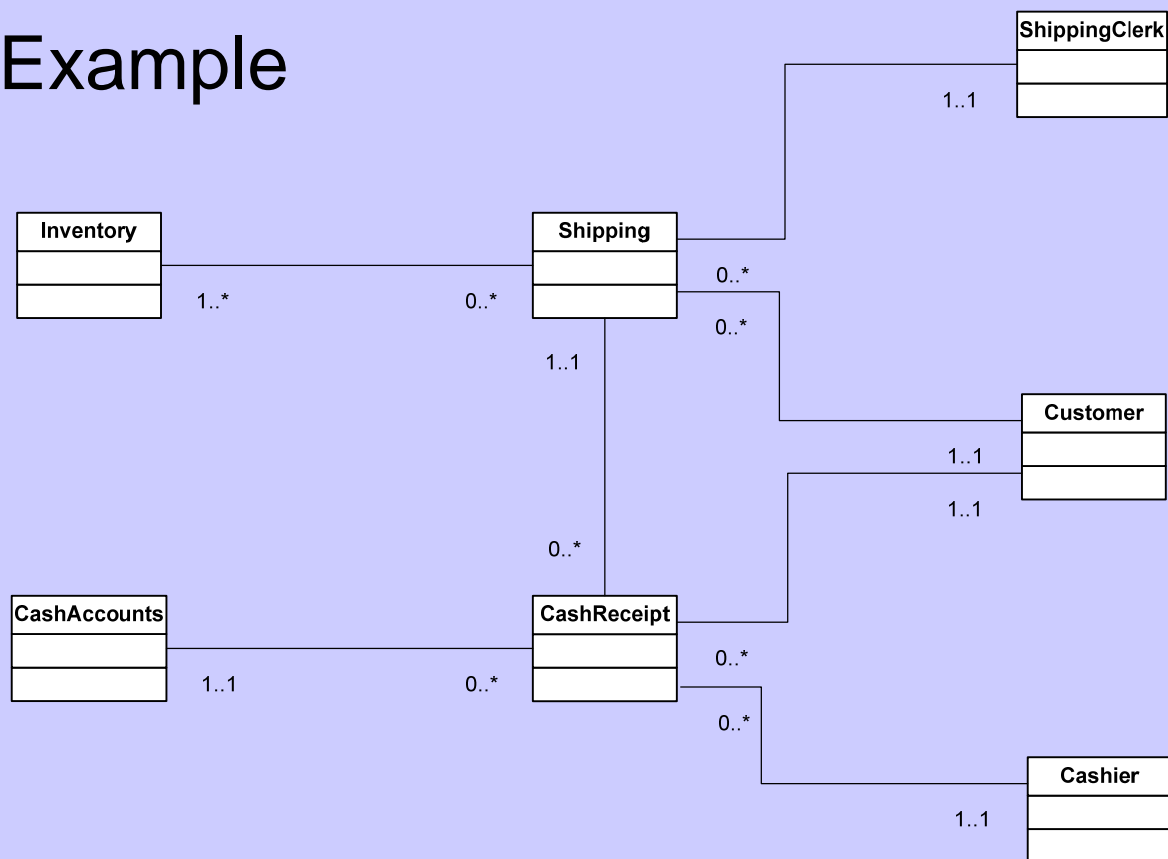
UML Class Diagram (Static Structure)

■ Core REA Pattern



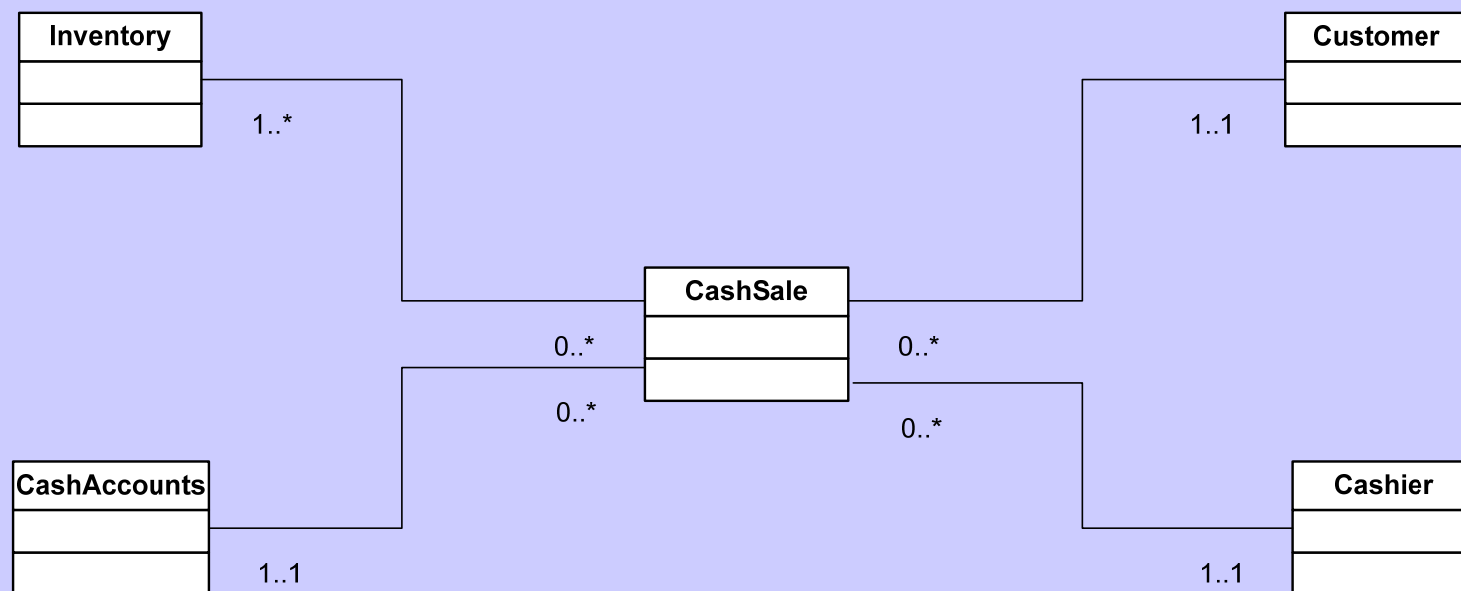
UML Class Diagram (Static Structure)

■ 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

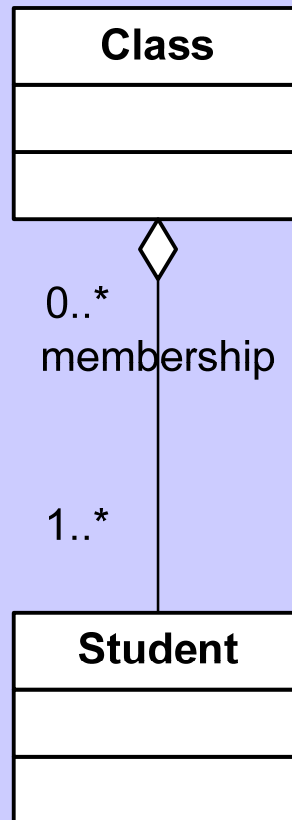
UML 2.0

■ Association



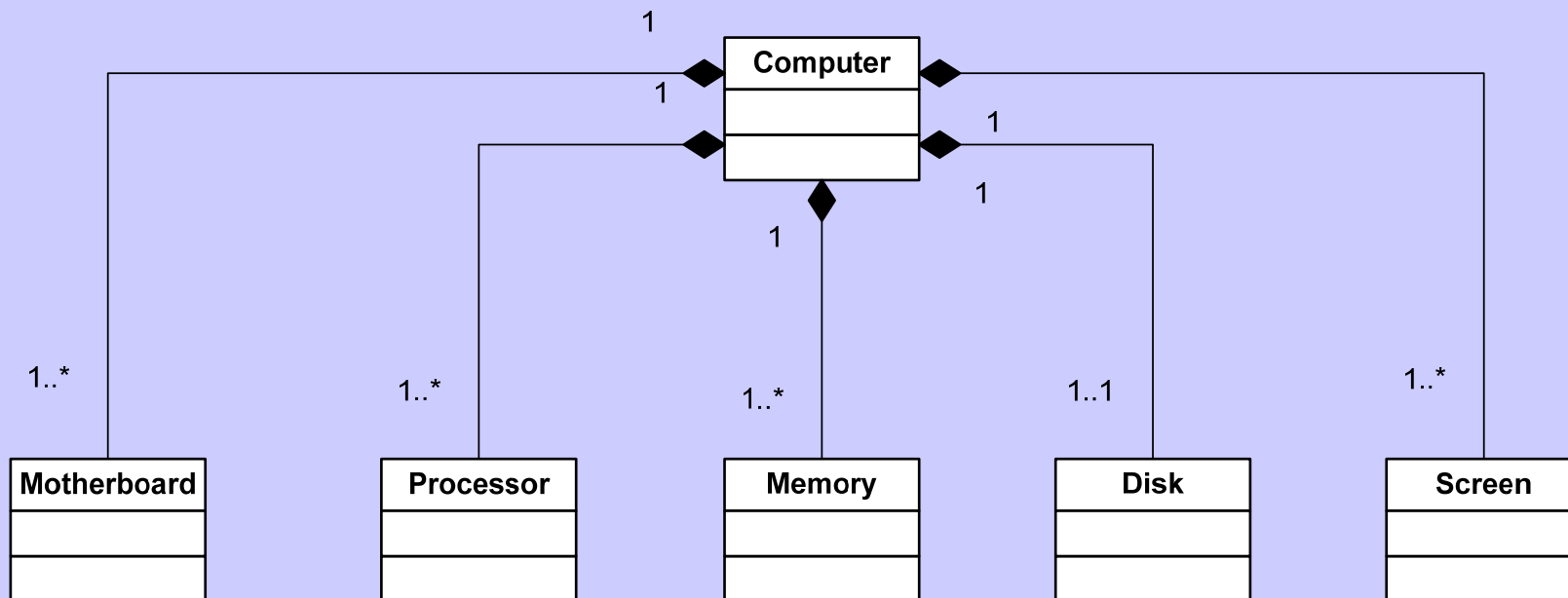
UML 2.0

■ Aggregation



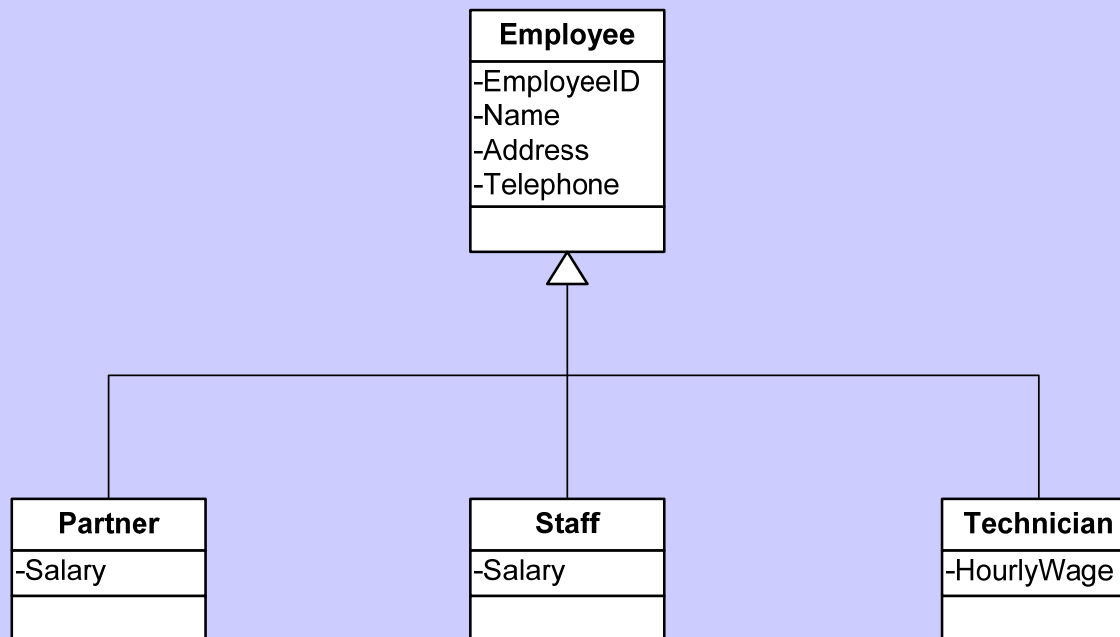
UML 2.0

■ Composition



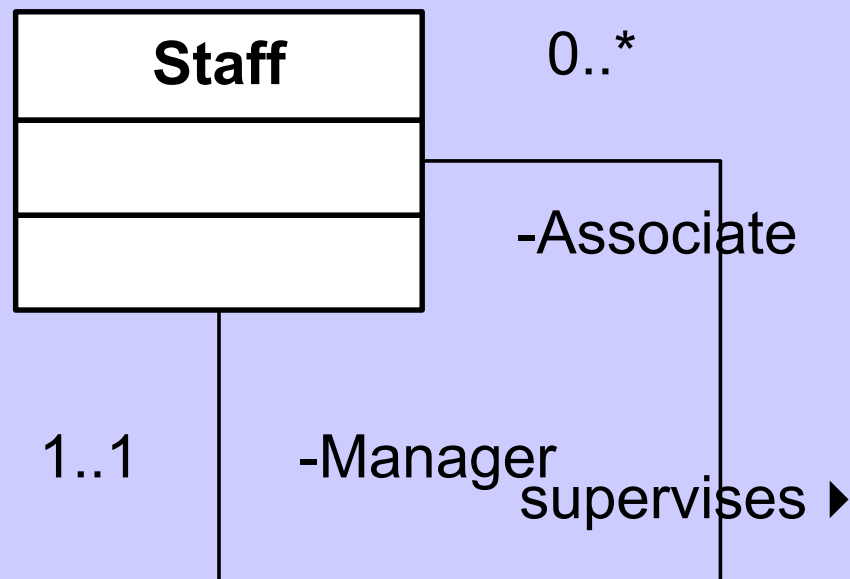
UML 2.0

■ 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**

Economic
Non-economic

Information

Denna

Core
Support

Information

David

Economic
Business

Information

McCarthy

Economic
Commitment

Information

Gillett

Economic
Commitment
Business

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*

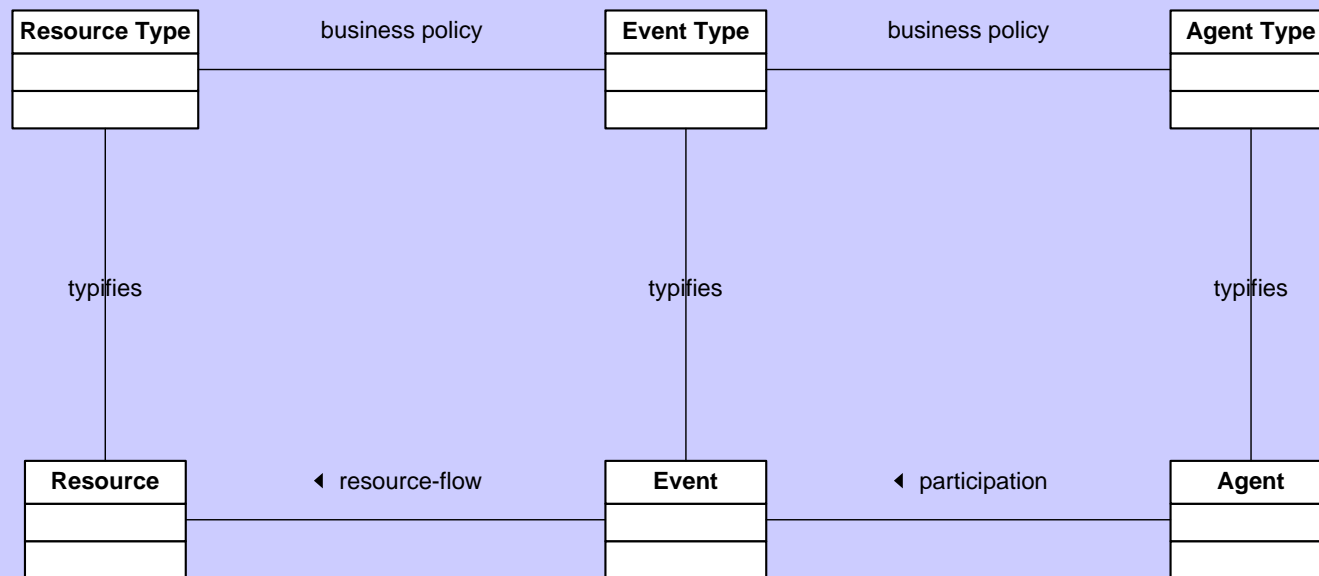
Event-Oriented Modeling

■ 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

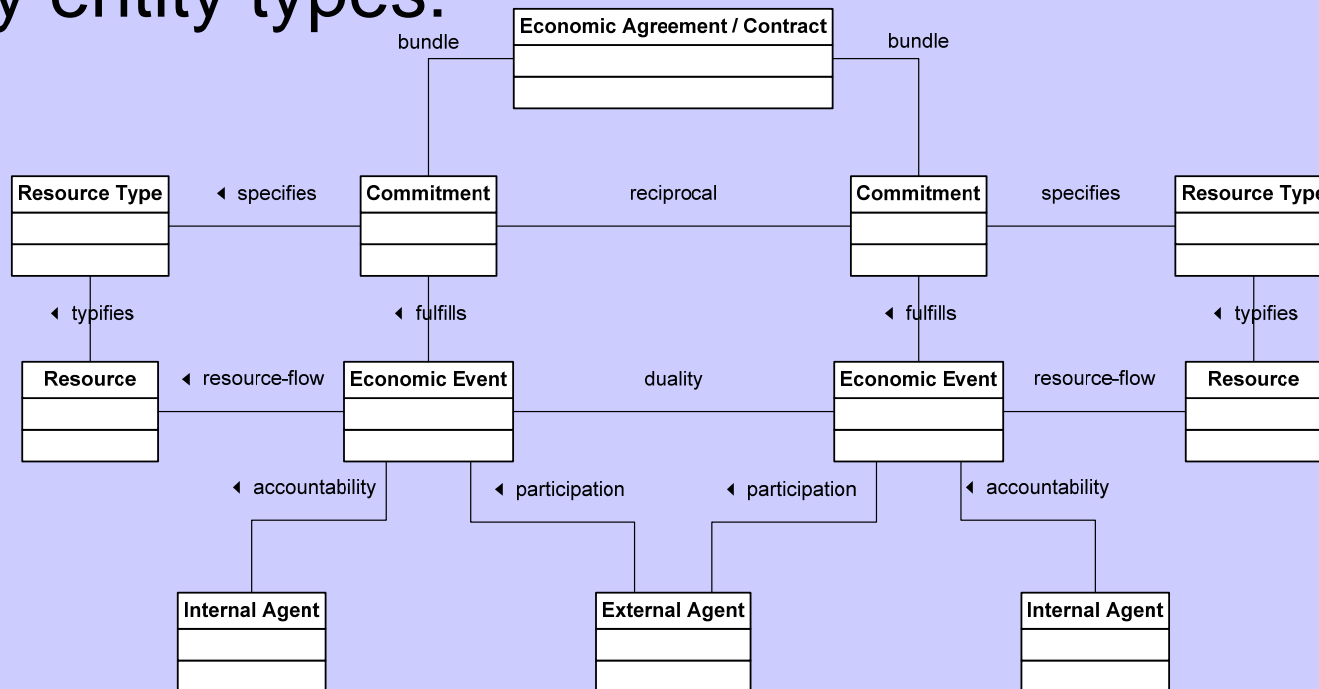
■ Typification for Business Policies



- ★ 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 EER diagram and UML diagram for problem distributed in class, and design the data repository structure
- Submit as a WORD document via the Digital Drop Box
- I recommend, but do not require, VISIO 2003