Patterns in Software Engineering

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Lecture 1

Earlier Patterns

Software Patterns

- Software Patterns support reuse of software architecture and design.
  - Patterns capture the static and dynamic structures and collaborations of successful solutions to problems that arise when building applications in a particular domain.
- Patterns represent solutions to problems that arise when developing software within a particular context.
  - i.e., "Pattern == problem/solution pair in a context"

Patterns: A Chronological Perspective

- 1979: Christopher Alexander's "Timeless Way of Building"
    - Alexander studied ways to improve the process of designing buildings and urban areas.
- 1987: Cunningham and Beck use Alexander's ideas to develop a small pattern language for Smalltalk.
- 1990: The Gang of Four (Gamma, Helm, Johnson and Vlissides) begin work compiling a catalog of design patterns.
- 1991: Bruce Anderson gives first Patterns Workshop at OOPSLA.
- 1992: Peter Coad introduces his OO Patterns.
- 1993: Kent Beck and Grady Booch sponsor the first meeting of what is now known as the Hillside Group.
- 1994: First Pattern Languages of Programs (PLoP) conference.
- 1995: The Gang of Four (GoF) publish the *Design Patterns* book.

Software Design Patterns

- “A *design pattern* names, abstracts, and identifies the key aspects of a common design structure that make it useful for creating a reusable object-oriented design.”
- Design Patterns capture the static and dynamic structure and collaboration among key participants in software designs.
  - They are particularly useful for articulating how and why to resolve non-functional forces.
  - Patterns facilitate reuse of successful software architectures and designs.

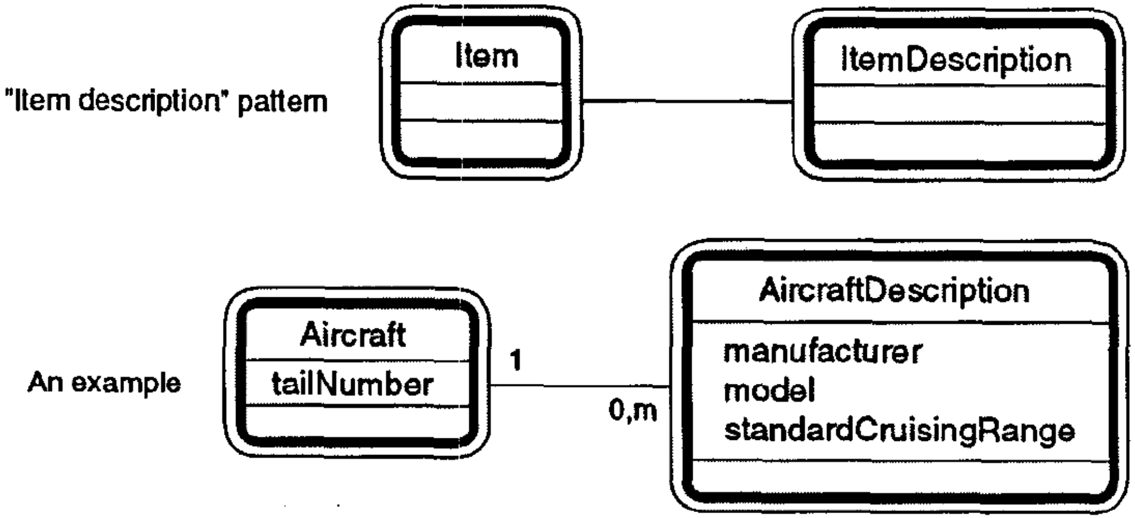
Coad's OO Patterns

- Seven basic Patterns:
  1. Item Description
  2. Time Association
  3. Event Logging
  4. Roles Played
  5. State over a Collection
  6. Behavior over a Collection
  7. Broadcast

Pattern 1: Item Description

- The item description pattern consists of an "item" object (i.e., an object of the class "item") and an "item description" object.
- An "item description" object has attribute *values* which may apply to more than one "item" object; an "item" object has its own individual assignment of attribute values.
- Use this pattern when some attribute *values* may apply to more than one object in a class.

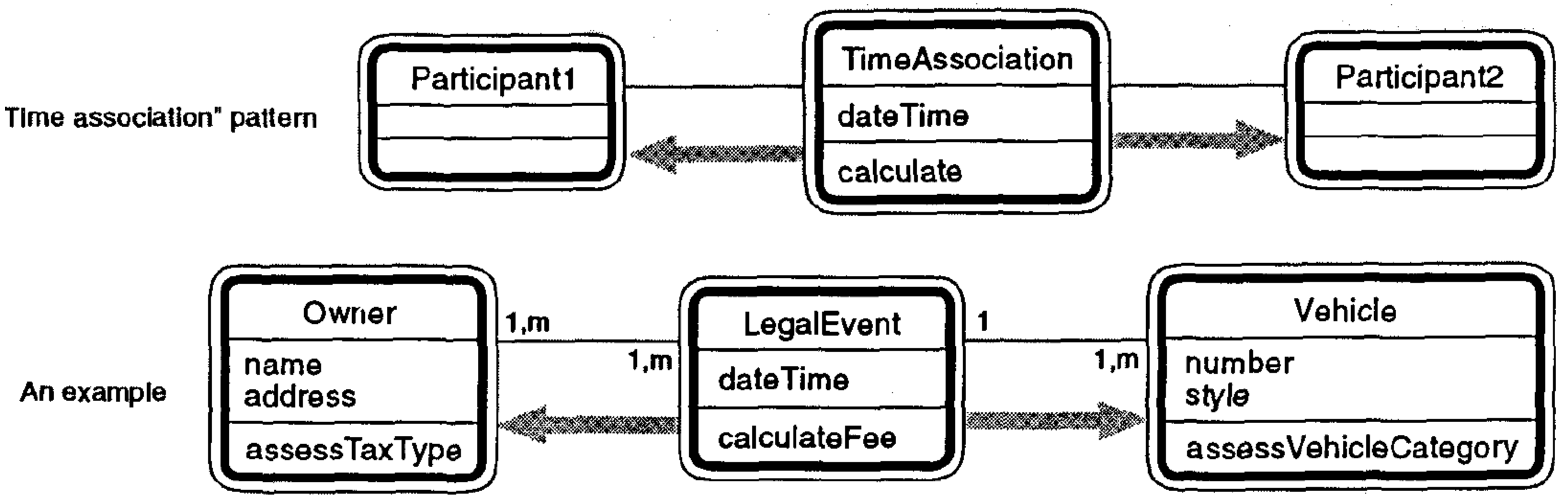
Item Description



Pattern 2: Time Association

- If one needs to express attributes or services regarding an association between two objects, then an object from "time association" is needed.
- A "time association" object often sends messages to its participating objects to get values or get a sub-calculation done on its behalf.
- Note that the association connection:
  - captures the association for future queries about these objects.
  - captures (for the sender) "to whom to send a message."
- Use this pattern whenever the system is responsible to know an association between two or more objects and to know or do something about that association.

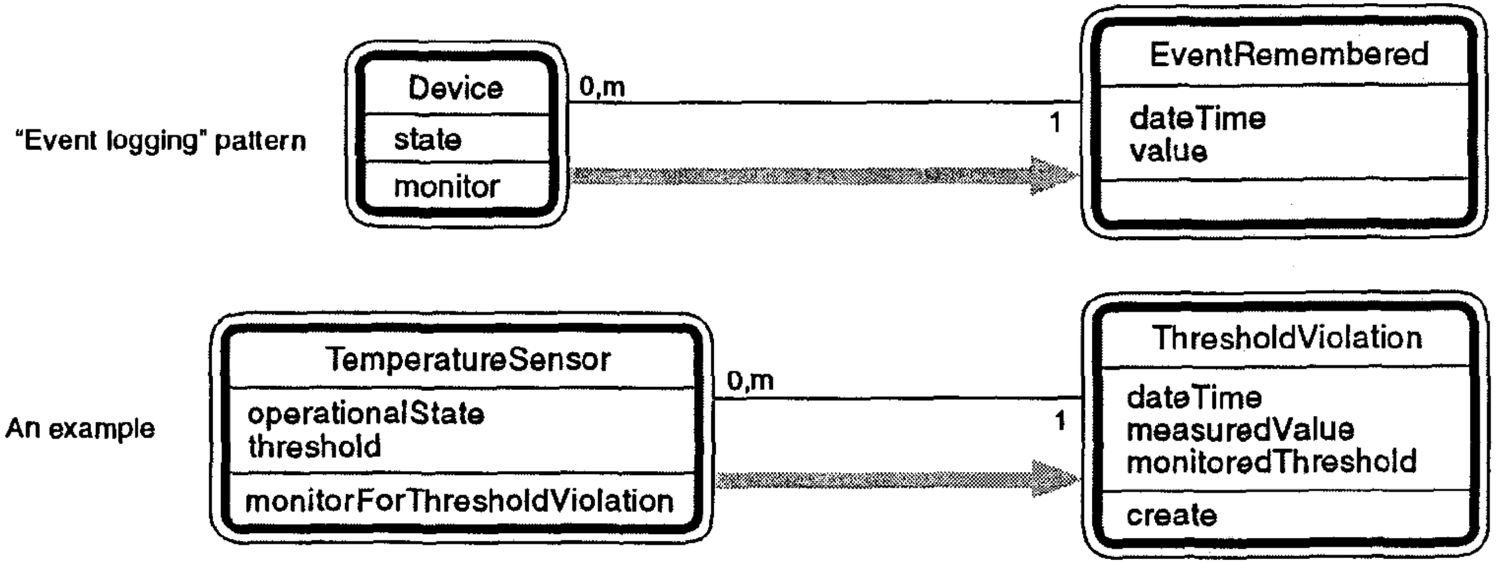
Time Association



Pattern 3: Event Logging

- A "device" object monitors an external device; the object
  - is responsible for detecting that an event has occurred;
  - is responsible for initiating a response to the event.
- Part of the response may be to log the event's occurrence; when this is the case, a "device" object sends the message "create" to the "event remembered" class to create an object with historical values.
- A "device" object may know about some number of "event remembered" objects; an "event remembered" object must know about a corresponding "device" object.
- Use whenever an event is detected, and you need to log its occurrence to support after-the-fact analysis or to meet legal requirements.

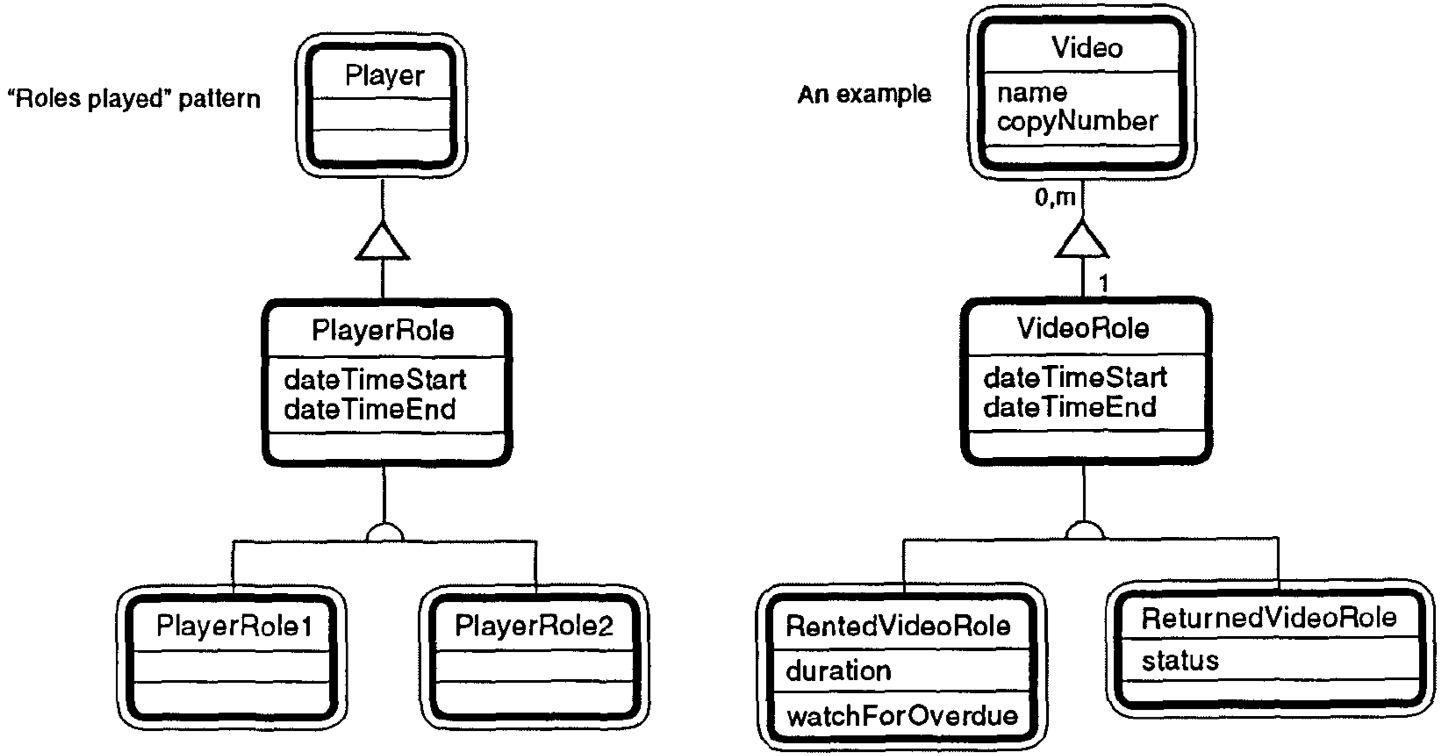
Event Logging



Pattern 4: Roles Played

- A "player" object has attribute values and services that apply over time. A player object is always a player object.
- At times, a player object "wears different hats," playing one or more roles.
- Often, starting and ending times are common to all such roles.
- Use this pattern:
  - whenever you have a player object which remains the same old player object, but has different attributes and services, depending on the "hats" the player may wear.
  - to model large numbers of roles, combinations of roles, and changes in roles; this approach is more concise and flexible than attempting to use multiple inheritance in this situation.

Roles Played

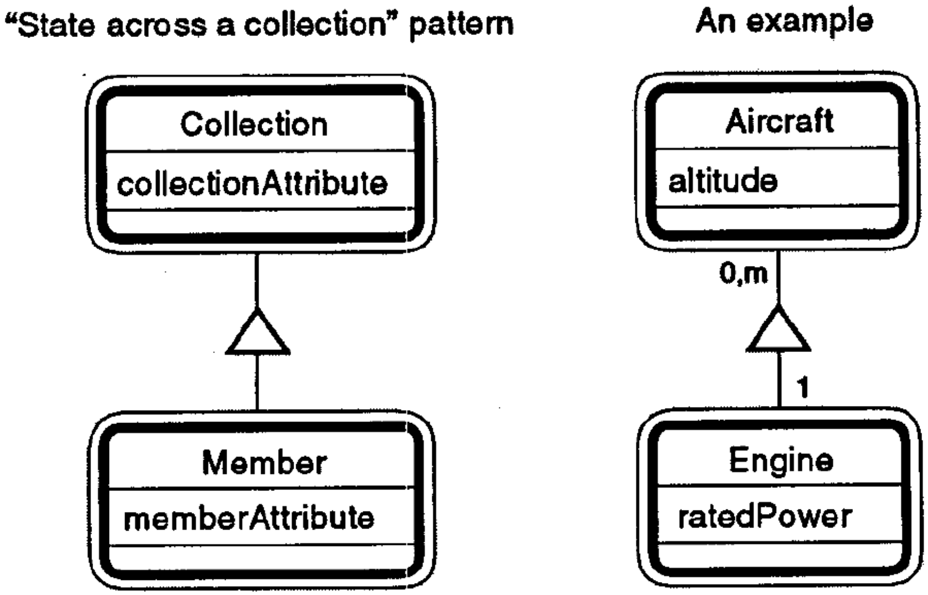


Pattern 5: State over a Collection

- A "collection" object knows its state; this state applies to the collection and may also apply to its parts, and each "member" object has its own state, too.

- Use this pattern whenever there is whole-part in a business domain or implementation domain, and one or more attributes apply to the whole (the collection).

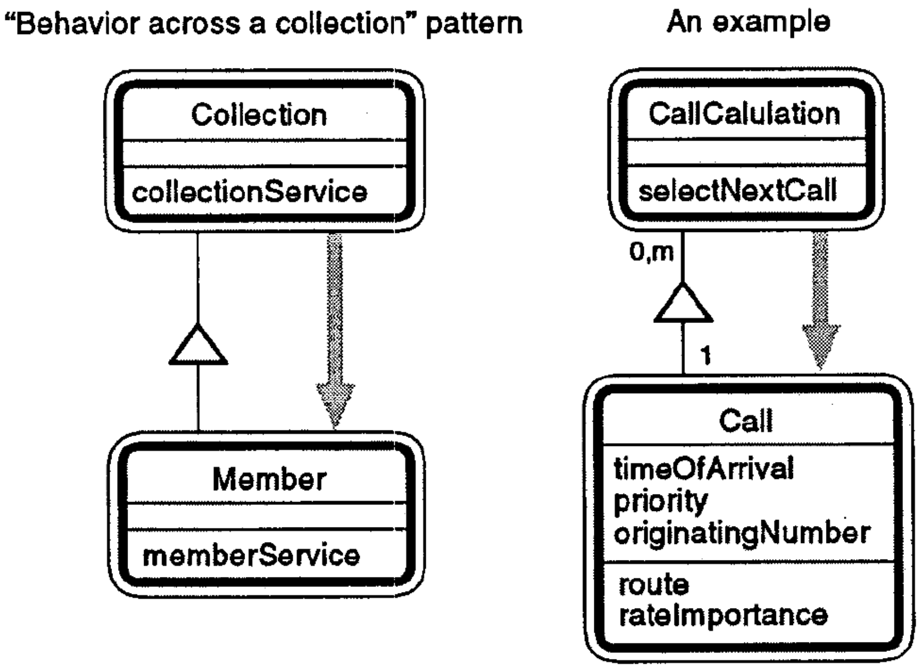
State over a Collection



Pattern 6: Behavior over a Collection

- A "collection" object has behavior that applies across an entire collection of its "member" objects.
- Each "member" object performs actions, knowing (by means of its attributes) how to perform, without needed coordination with other "member" objects.
- Use this pattern whenever there is whole-part in a domain, and a behavior (i.e., one or more services) applies across the whole collection.
- Caution: make the member objects do as much as they can with what they know; only put behavior that really applies across the collection up in the "collection" object.

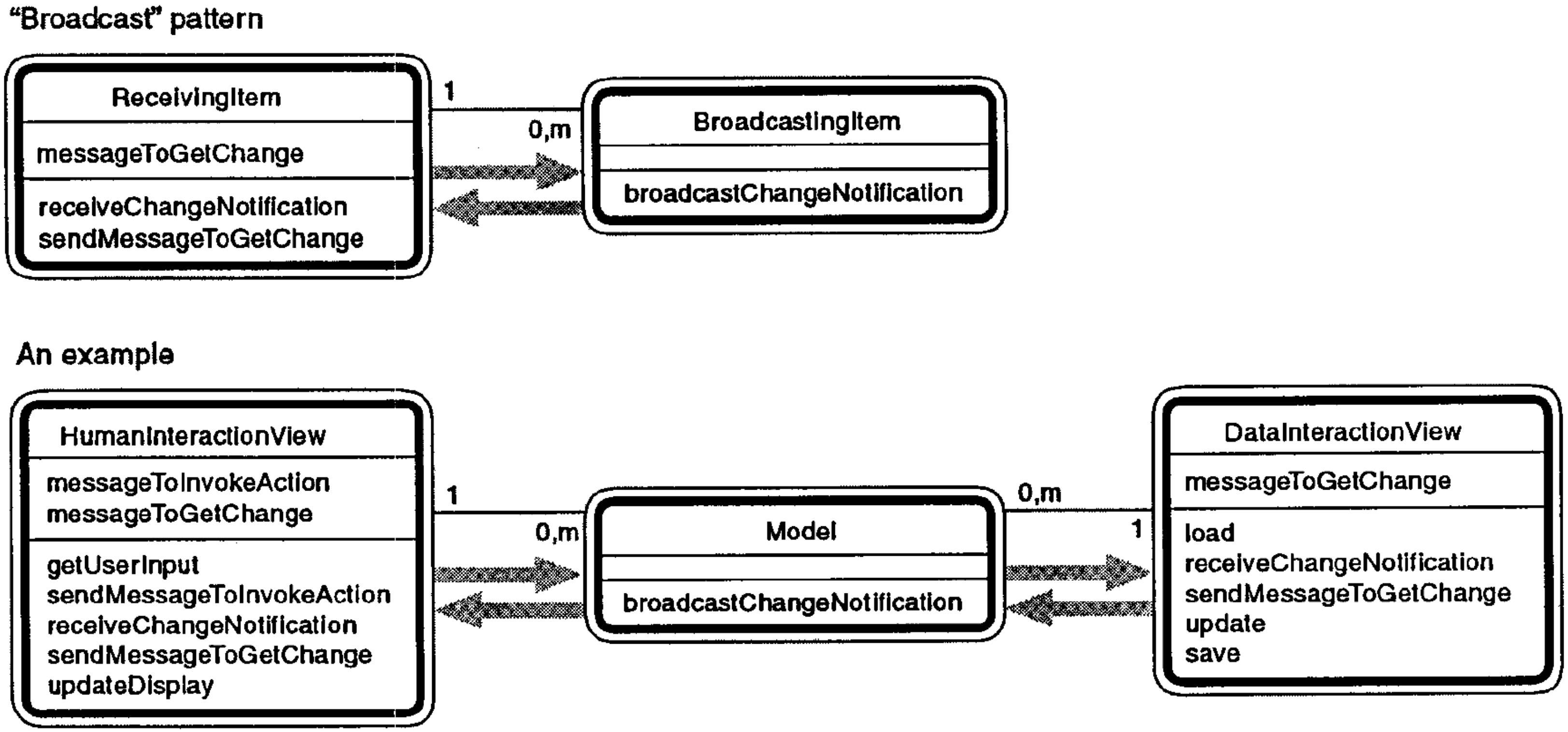
Behavior over a Collection



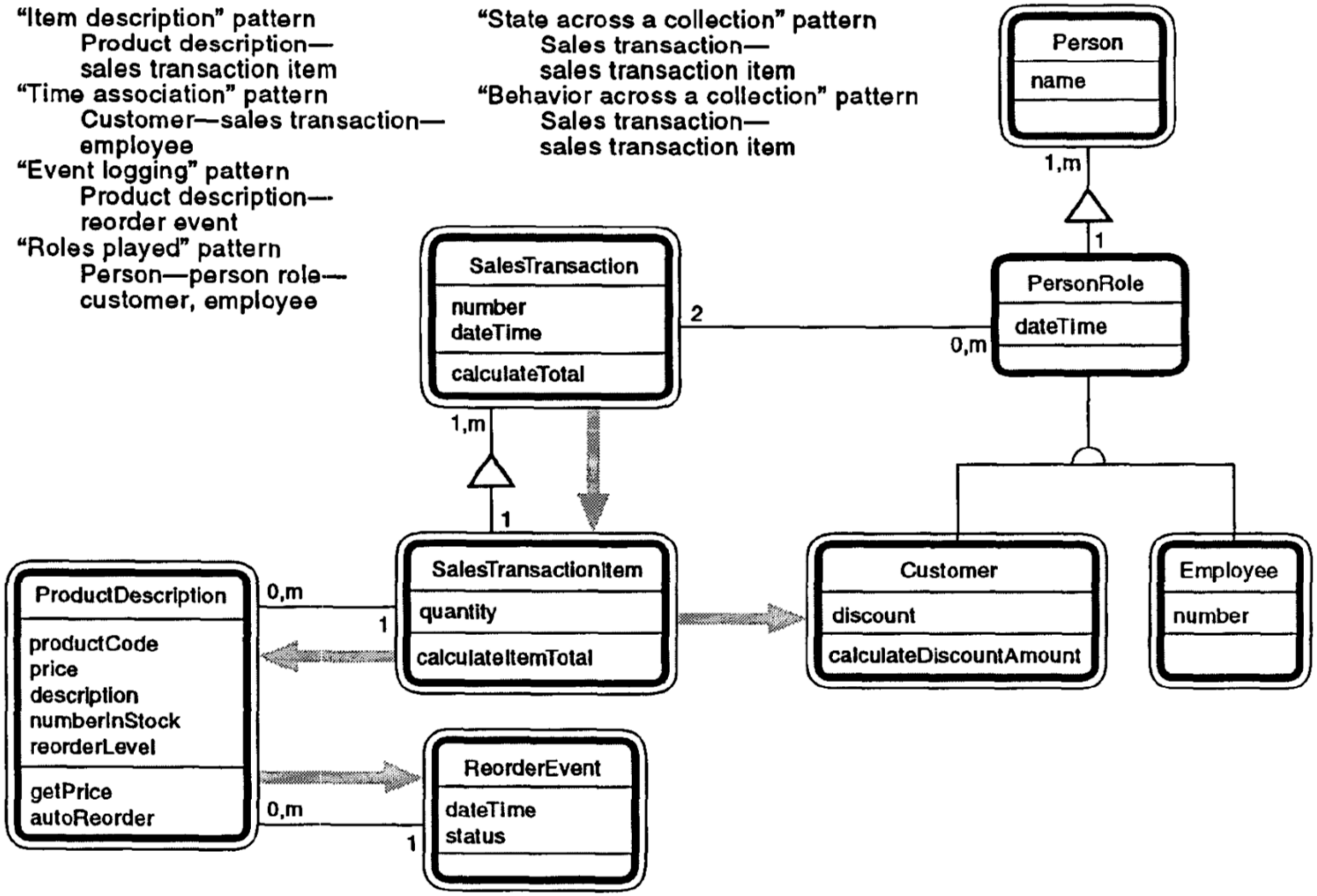
Pattern 7: Broadcast

- This pattern is used to communicate complex changes between one major section of an OOA/OOD model with another major section.
  1. Whenever it changes, a "broadcasting item" object broadcasts a change notification to the "receiving item" objects that it knows about.
  2. A notified "receiving item" object then sends a message to the "broadcasting item" to get the change.
  3. Once it gets the change, a "receiving item" object takes whatever action is necessary in light of the change.
- Use this pattern to establish interactions between major OOA/OOD parts in a way that the two sections stay cleanly separated.
- Use this pattern to separate business domain classes from human-interaction and data-management classes.

Broadcast


"Broadcast" pattern
ReceivingItem
messageToGetChange
receiveChangeNotification
sendMessageToGetChange
1
0,m
BroadcastingItem
broadcastChangeNotification
An example
HumanInteractionView
messageToInvokeAction
messageToGetChange
getUserInput
sendMessageToInvokeAction
receiveChangeNotification
sendMessageToGetChange
updateDisplay
1
0,m
Model
broadcastChangeNotification
0,m
1
DataInteractionView
messageToGetChange
load
receiveChangeNotification
sendMessageToGetChange
update
save

Coad Patterns: Example Model



"Item description" pattern
Product description—
sales transaction item
"Time association" pattern
Customer—sales transaction—
employee
"Event logging" pattern
Product description—
reorder event
"Roles played" pattern
Person—person role—
customer, employee

"State across a collection" pattern
Sales transaction—
sales transaction item
"Behavior across a collection" pattern
Sales transaction—
sales transaction item

Reference

- Coad, P., Object-oriented patterns, *Communications of the ACM 33*, 9 (September), 152-159, 1992.