广东技术师范大学
Guangdong Polytechnic Normal University

《系统分析与设计》课程

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系统分析与设计

第2讲：需求分析及建模

提纲

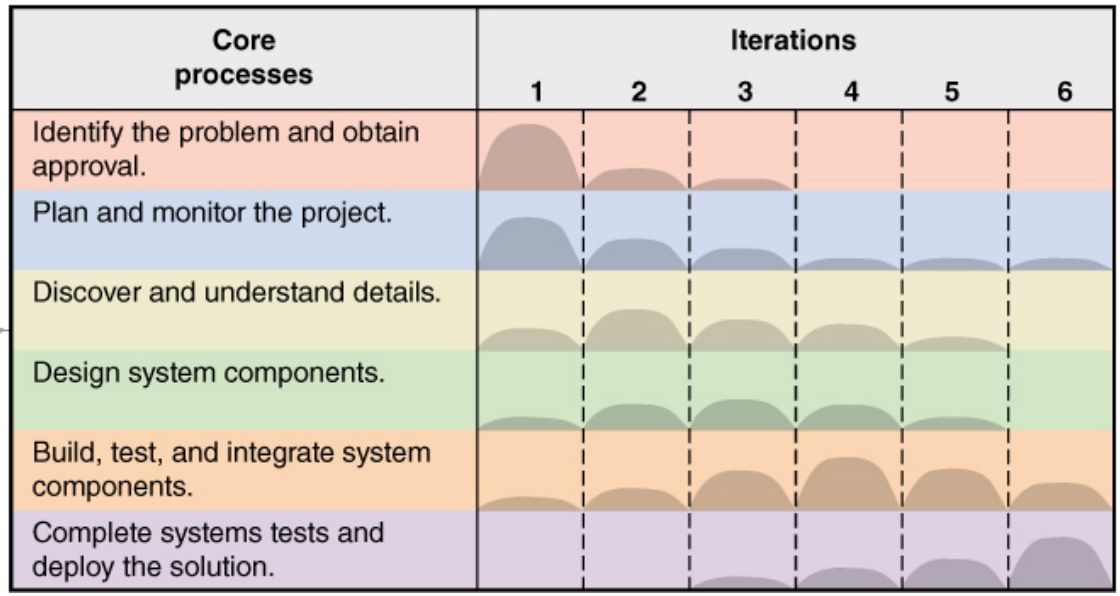
- 需求获取方法
  - 访谈
  - 问卷
  - 文档
- 需求建模技术
  - 用户故事
  - 用例模型
  - 领域模型

需求获取方法
Requirements Acquirement

系统分析活动

- Systems Analysis Activities【系统分析活动】
  - Gather detailed information（收集详细信息）
  - Define requirements（定义需求）
  - Prioritize requirements（确定需求优先级）
  - Develop user-interface dialogs（探讨用户界面）
  - Evaluate requirements with users（与客户验证需求）

Analysis activities
Gather detailed information.
Define requirements.
Prioritize requirements.
Develop user-interface dialogs.
Evaluate requirements with users.



需求的概念

- System Requirements【系统需求】
  - Functional Requirements（功能需求）
    - Business uses, functions the users carry out
      业务功能方面
  - Non-Functional Requirements（非功能需求）
    - Constraints and performance goals
      约束和性能方面
- 识别和分类需求的思路：FURPS+

Requirement categories	FURPS categories	Example requirements
Functional	Functions	Business rules and processes
Nonfunctional	Usability	User interface, ease of use
	Reliability	Failure rate, recovery methods
	Performance	Response time, throughput
	Security	Access controls, encryption

项目关联人员

- Stakeholder【项目关联人员 / 利益相关人员】
  - Internal stakeholders（内部关联人员）
  - External stakeholders（外部关联人员）
  - Operational stakeholders（操作关联人员）
  - Executive stakeholders（行政关联人员）

- 例如：
  - 一个贸易公司的账务系统关联人.

信息获取技术

- Information-Gathering Techniques【信息获取技术】
  - Interviewing users and other stakeholders
    与用户和其他关联人员访谈（面谈）
  - Distributing and collecting questionnaires
    分发和收集调查问卷
  - Reviewing inputs, outputs, and documentation
    查阅输入、输出和文档
  - Observing and documenting business procedures
    观察和记录业务流程
  - Researching vendor solutions
    研究软件供应商的方案
  - Collecting active user comments and suggestions
    收集用户的意见和建议

访谈【Interview】

- 访谈时系统分析员做如下事情：
  - Prepare detailed questions
    准备好访谈的详细问题
  - Meet with individuals or groups of users
    会见单个用户或一组用户
  - Obtain and discuss answers to the questions
    获取并讨论问题的答复
  - Document the answers
    记录问题的答复
  - Follow up as needed in future meetings or interviews
    根据需要计划后续的会议或访谈

调查问卷【Questionnaire】

- Distribute and Collect Questionnaires
  【发布和收集问卷】

RMO Questionnaire

This questionnaire is being sent to all telephone-order sales personnel. As you know, RMO is developing a new customer support system for order taking and customer service.

The purpose of this questionnaire is to obtain preliminary information to assist in defining the requirements for the new system. Follow-up discussions will be held to permit everybody to elaborate on the system requirements.

Part I. Answer these questions based on a typical four-hour shift.

1. How many phone calls do you receive?_____
2. How many phone calls are necessary to place an order for a product?_____
3. How many phone calls are for information about RMO products, that is, questions only?_____
4. Estimate how many times during a shift customers request items that are out of stock._____
5. Of those out-of-stock requests, what percentage of the time does the customer desire to put the item on back order?_____%
6. How many times does a customer try to order from an expired catalog?_____
7. How many times does a customer cancel an order in the middle of the conversation?_____
8. How many times does an order get denied due to bad credit?_____

Part II. Circle the appropriate number on the scale from 1 to 7 based on how strongly you agree or disagree with the statement.

Question	Strongly Agree						Strongly Disagree
It would help me do my job better to have longer descriptions of products available while talking to a customer.	1	2	3	4	5	6	7
It would help me do my job better if I had the past purchase history of the customer available.	1	2	3	4	5	6	7
I could provide better service to the customer if I had information about accessories that were appropriate for the items ordered.	1	2	3	4	5	6	7
The computer response time is slow and causes difficulties in responding to customer requests.	1	2	3	4	5	6	7

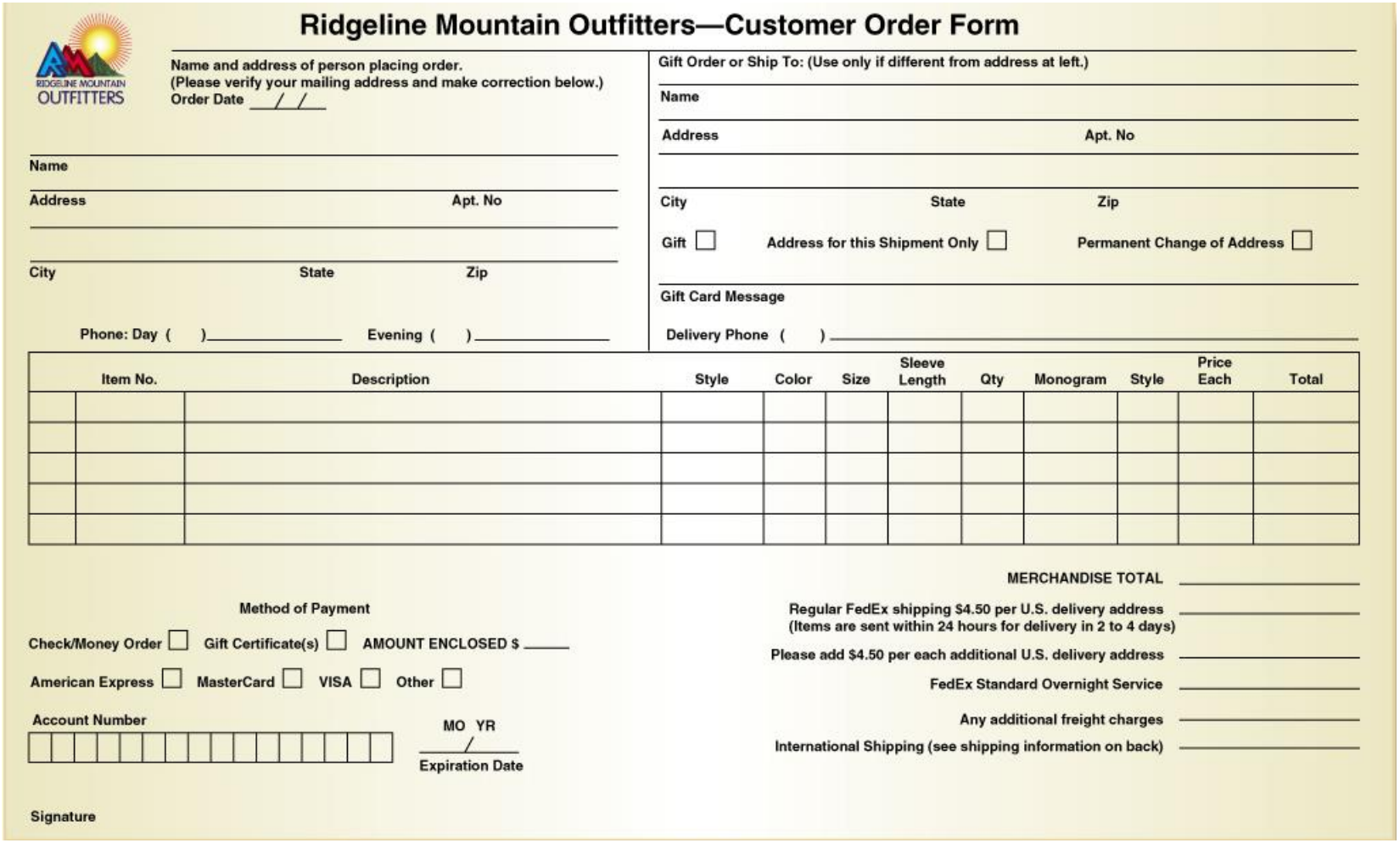
Part III. Please enter your opinions and comments.

Please briefly identify the problems with the current system that you would like to see resolved in a new system.

_____
_____
_____

查阅输入、输出和流程

- Review Inputs, Outputs, and Procedures



Ridgeline Mountain Outfitters—Customer Order Form

RIDGELINE MOUNTAIN OUTFITTERS

Name and address of person placing order.
(Please verify your mailing address and make correction below.)
Order Date ___/___/___

Name

Address Apt. No

City State Zip

Phone: Day ( ) Evening ( )

Gift Order or Ship To: (Use only if different from address at left.)

Name

Address Apt. No

City State Zip

Gift ☐ Address for this Shipment Only ☐ Permanent Change of Address ☐

Gift Card Message

Delivery Phone ( )

	Item No.	Description	Style	Color	Size	Sleeve Length	Qty	Monogram	Style	Price Each	Total

Method of Payment

Check/Money Order ☐ Gift Certificate(s) ☐ AMOUNT ENCLOSED $ ____

American Express ☐ MasterCard ☐ VISA ☐ Other ☐

Account Number

MO YR
___/___
Expiration Date

Signature

MERCHANDISE TOTAL

Regular FedEx shipping $4.50 per U.S. delivery address
(Items are sent within 24 hours for delivery in 2 to 4 days)

Please add $4.50 per each additional U.S. delivery address

FedEx Standard Overnight Service

Any additional freight charges

International Shipping (see shipping information on back)

其他信息获取技术

- 其他信息获取技术
  - Observe and documenting business procedures【观察和记录业务流程】
    - Watch and learn
  - Research vendor solutions【研究软件供应商的方案】
    - See what others have done for similar situations
    - White papers, vendor literature, competitors
  - Collect active user comments and suggestions【收集用户的意见和建议】
    - Feedback on models and tests
    - Users know it when they see it

需求建模：概述
Requirements Modeling

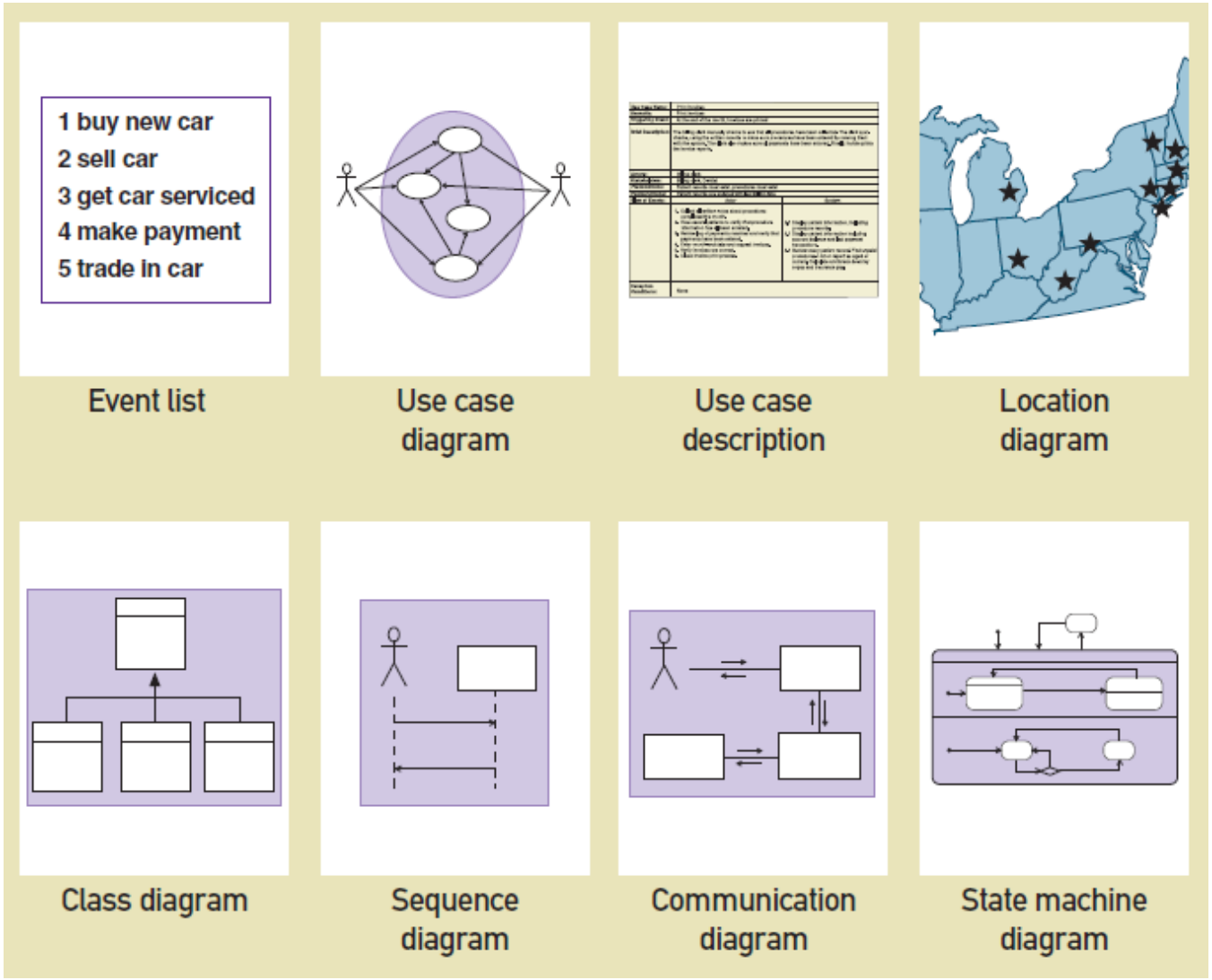
模型和建模【Models and Modeling】

- 我们怎样定义需求？
  - 收集完信息后，建立模型
- 模型【Model】
  - A representation of some aspect of the system being built
- 模型的类别【Types of Models】
  - 文本模型（Textual model）
  - 图形模型（Graphical models）
  - 数学模型（Mathematical models）
- Unified Modeling Language (UML)
  - Standard graphical modeling symbols/terminology used for information systems

为何要建模？

- 建模的理由【Reasons for Modeling】
  - Learning from the modeling process
    从建模中学习
  - Reducing complexity by abstraction
    通过抽象降低复杂度
  - Remembering all the details
    记住所有细节
  - Communicating with other development team members
    用于和其他开发团队成员的交流
  - Communicating with a variety of users and stakeholders
    用于和各类用户及关联人员的交流
  - Documenting what was done for future maintenance / enhancement
    记录所做的东西以备将来维护时所用

模型的例子


1 buy new car
2 sell car
3 get car serviced
4 make payment
5 trade in car
Event list
Use case diagram
Use case description
Location diagram
Class diagram
Sequence diagram
Communication diagram
State machine diagram

需求建模：用户故事、用例模型
User Story，Use Case

用户故事

- 用户故事【User Story】
  - One short sentence in the everyday language of the end user that states what a user does as part of his or her work
    用户以简短的日常语言描述其日常工作所做的事情，也即其希望使用系统拟实现的目标
  - 用户故事是敏捷开发中的基本概念
  - 用户故事重点在于每个功能的Who、What、Why（3W）

用户故事

- 用户故事的标准模板【Template】
  - As a <role played>, I want to <goal or desire> so that <reason or benefit>.
    作为一位 <角色>，我想 <目标或期望>，从而 <原因或好处>。
- 用户故事的验收标准【Acceptance Criteria 】
  - Features that must be present in the final system for the user to be satisfied
    最终系统实现的、用户满意的功能所应有的特征
  - 用户故事实现后，验收标准用于测试

用户故事

- 用户故事举例：银行柜台职员

User Story

As a teller, I want to make a deposit to quickly serve more customers.

Acceptance Criteria:

1. *Customer lookup must be by name or by account number.*
2. *Nice to display photo and signature of customer.*
3. *Any check hold requirements must be indicated.*
4. *Current balance and new balance must be displayed.*

用户故事

- 用户故事举例：物流职员

User Story

As a shipping clerk, I want to ship an order as accurately as possible as soon as the order details are available.

Acceptance Criteria:

1. *Available order details must pop up on the screen when available.*
2. *Portable display and scan device would cut time in half.*
3. *Sort the items by bin location.*
4. *Indicate number of items in stock for each item and mark backorder for those not available.*
5. *Recommend shipper based on weight, size, and location.*
6. *Print out shipping label for selected shipper.*

用例

- 用例【Use Case】
  - An activity that the system performs in response to a request by a user
    对于用户的一个请求，系统所执行的活动
  - 用于定义功能需求
  - 用例的名称一般采用“动词+名词”命名
- 确定用例的两种技术【Techniques】
  - 根据用户目标确定用例【User Goal Technique】
  - 通过事件分解确定用例【Event Decomposition Technique】

根据用户目标确定用例

- 根据用户目标确定用例【User Goal Technique】
  - A technique to identify use cases by determining what specific goals or objectives must be completed by the system for the user
    通过系统必须为用户实现的具体目标来确定用例

- 根据用户目标确定用例的步骤：
  1. 确定系统的所有潜在用户
  2. 根据潜在用户的功能角色将其分类
  3. 根据潜在用户的职位层级将其分类
  4. 与各类用户访谈以确定他们的具体目标
  5. 按用户类型创建初步的用例列表

根据用户目标确定用例

- 根据用户目标确定用例的步骤：（续）
  6. 找出具有类似用例名的重复用例并解决不一致性
  7. 标出为不同类型用户所需要的相同用例
  8. 复查每类用户的完整用例列表

- 举例：

User	User goal and resulting use case
Potential customer	Search for item Fill shopping cart View product rating and comments
Marketing manager	Add/update product information Add/update promotion Produce sales history report
Shipping personnel	Ship order Track shipment Create item return

通过事件分解确定用例

- 通过事件分解确定用例【Event Decomposition Technique】
  - A technique to identify use cases by determining the business events to which the system must respond
    通过确定系统必须回应的业务事件来确定用例

- 事件类型
  - 外部事件【External Event】
    - 在系统外部发生的事件，通常由外部代理发起
  - 时态事件【Temporal Event】
    - 当到达某个时间点时发生的事件
  - 状态事件【State Event】（也叫内部事件）
    - 在系统内部发生某事时触发某个流程的事件

通过事件分解确定用例

- 外部事件清单【Checklist】

External events to look for include:

√ External agent wants something resulting in a transaction
√ External agent wants some information
√ Data changed and needs to be updated
√ Management wants some information

- 时态事件清单【Checklist】

Temporal events to look for include:

√ Internal outputs needed
  √ Management reports (summary or exception)
  √ Operational reports (detailed transactions)
  √ Internal statements and documents (including payroll)
√ External outputs needed
  √ Statements, status reports, bills, reminders

通过事件分解确定用例

- 通过事件分解确定用例的步骤：
  1. 考虑那些需要系统回应的外部事件
  2. 对于每个外部事件，确定并命名用例
  3. 考虑那些需要系统回应的时态事件
  4. 对于每个时态事件，确定并命名用例，并确定触发该用例的时间点
  5. 考虑那些系统可能回应的状态事件，特别是对于实时系统中设备或内部状态的变迁
  6. 对于每个状态事件，确定并命名用例，然后定义状态的变迁
  7. 当事件和用例定义好后，检查看看它们是否是系统所要求的用例（不要包含与系统控制有关的事件，如登录、注销、改密码、备份和恢复数据库等）

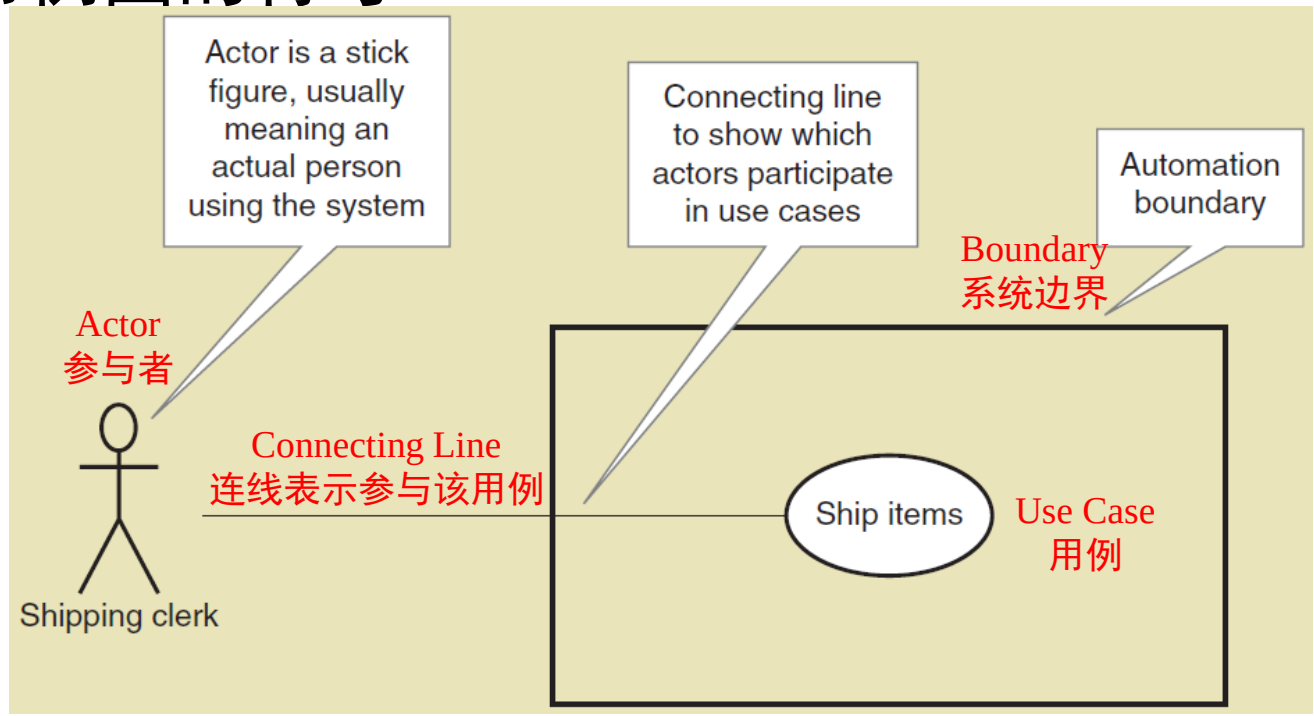
用例描述

- 用例描述【Use Case Description】
  - 用文字描述用例的细节
  - 描述的详细程度是随着开发阶段的推进而逐步演化的
  - 刚开始时，通常是用一两句话简要描述的
  - 例如：

Use case	Brief use case description
Create customer account	User/actor enters new customer account data, and the system assigns account number, creates a customer record, and creates an account record.
Look up customer	User/actor enters customer account number, and the system retrieves and displays customer and account data.
Process account adjustment	User/actor enters order number, and the system retrieves customer and order data; actor enters adjustment amount, and the system creates a transaction record for the adjustment.

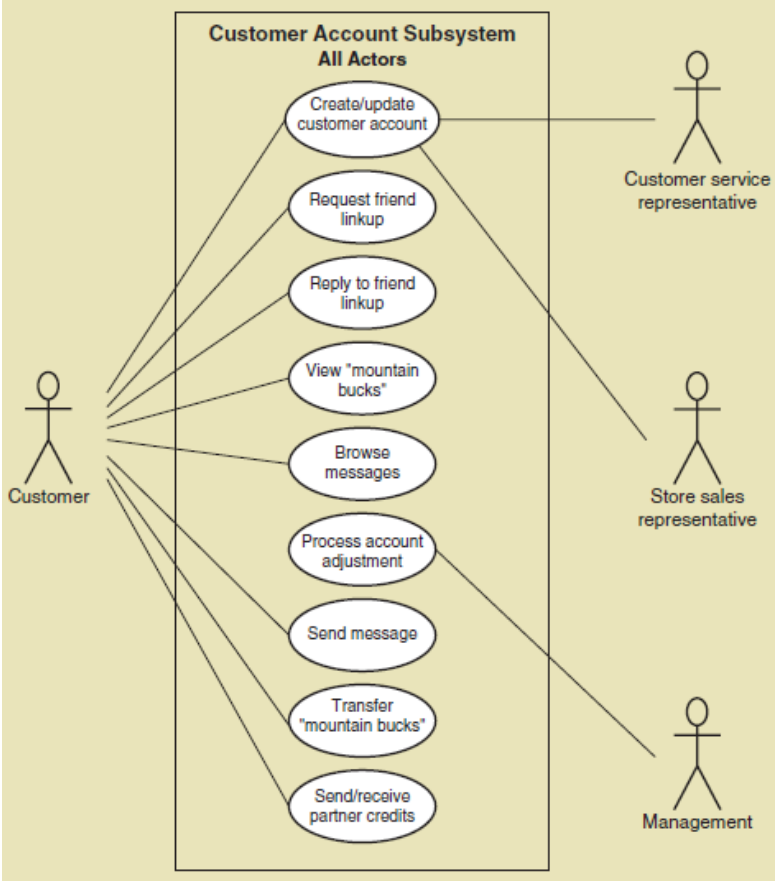
用例图

- 用例图【Use Case Diagram】
  - The UML model used to illustrate use cases and their relationships to actors
    用于表明用例及其与参与者之间的关系的UML图
- 用例图的符号



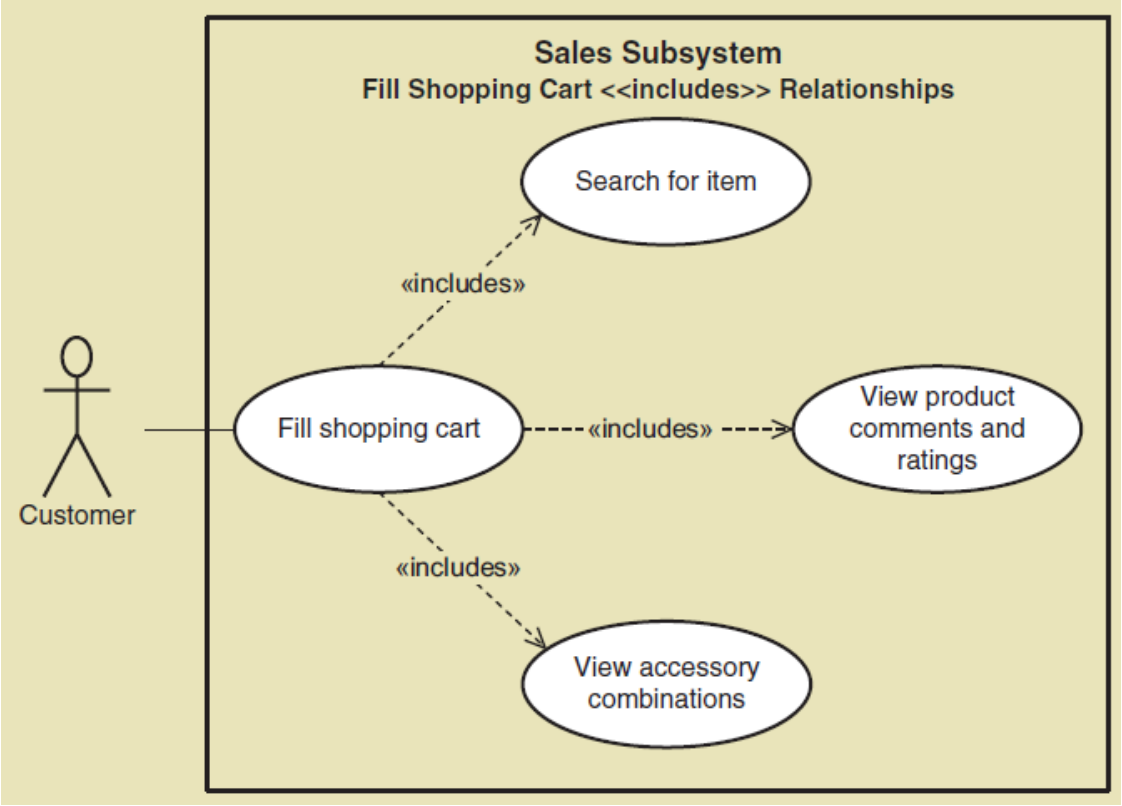
用例图

- 案例：
  - 注：一般一个子系统开发一个用例图（也可只画出某个Actor的用例便于访谈时使用）



用例图

- <<includes>>关系【<<includes>> relationship】
  - A relationship between use cases in which one use case is stereotypically included within the other use case
    该关系表达一个用例包含/使用另一个用例



详细的用例描述

- 详细的用例描述【Fully Developed Use Case Descriptions】
  - “创建客户账户”内容：
    - 用例名【Use case name】
    - 场景【Scenario (if needed)】
    - 触发事件【Triggering event】
    - 简洁描述【Brief description】
    - 参与者【Actors】
    - 相关用例【Related use cases】
    - 关联人【Stakeholders】
    - 前置条件【Preconditions】
    - 后置条件【Postconditions】
    - 活动流【Flow of activities】
    - 异常条件【Exception conditions】

Use case name:	*Create customer account*.	
Scenario:	Create online customer account.	
Triggering event:	New customer wants to set up account online.	
Brief description:	Online customer creates customer account by entering basic information and then following up with one or more addresses and a credit or debit card.	
Actors:	Customer.	
Related use cases:	Might be invoked by the *Check out shopping cart* use case.	
Stakeholders:	Accounting, Marketing, Sales.	
Preconditions:	Customer Account subsystem must be available. Credit/debit authorization services must be available.	
Postconditions:	Customer must be created and saved. One or more Addresses must be created and saved. Credit/debit card information must be validated. Account must be created and saved. Address and Account must be associated with Customer.	
Flow of activities:	**Actor**	**System**
	1. Customer indicates desire to create customer account and enters basic customer information.	1.1 System creates a new customer. 1.2 System prompts for customer addresses.
	2. Customer enters one or more addresses.	2.1 System creates addresses. 2.2 System prompts for credit/debit card.
	3. Customer enters credit/debit card information.	3.1 System creates account. 3.2 System verifies authorization for credit/debit card. 3.3 System associates customer, address, and account. 3.4 System returns valid customer account details.
Exception conditions:	1.1 Basic customer data are incomplete. 2.1 The address isn't valid. 3.2 Credit/debit information isn't valid.	

详细的用例描述

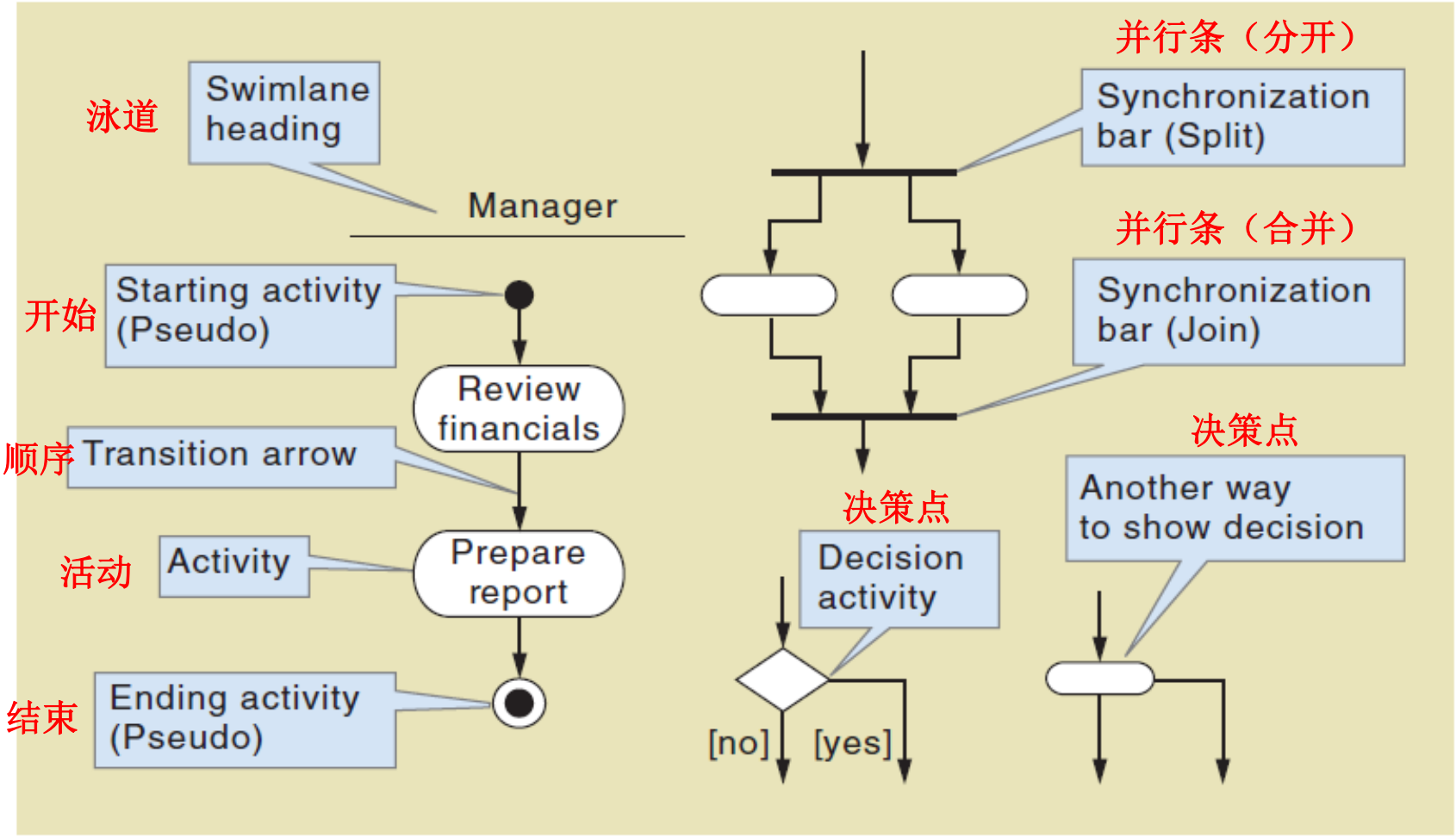
- 详细的用例描述
  - 例：Ship item用例

Use case name:	*Ship items*.	
Scenario:	Ship items for a new sale.	
Triggering event:	Shipping is notified of a new sale to be shipped.	
Brief description:	Shipping retrieves sale details, finds each item and records it is shipped, records which items are not available, and sends shipment.	
Actors:	Shipping clerk.	
Related use cases	None.	
Stakeholders:	Sales, Marketing, Shipping, warehouse manager.	
Preconditions:	Customer and address must exist. Sale must exist. Sale items must exist.	
Postconditions:	Shipment is created and associated with shipper. Shipped sale items are updated as shipped and associated with the shipment. Unshipped items are marked as on back order. Shipping label is verified and produced.	
Flow of activities:	**Actor**	**System**
	1. Shipping requests sale and sale item information.	1.1 System looks up sale and returns customer, address, sale, and sales item information.
	2. Shipping assigns shipper.	2.1 System creates shipment and associates it with the shipper.
	3. For each available item, shipping records item is shipped.	3.1 System updates sale item as shipped and associates it with shipment.
	4. For each unavailable item, shipping records back order.	4.1 System updates sale item as on back order.
	5. Shipping requests shipping label supplying package size and weight.	5.1 System produces shipping label for shipment. 5.2 System records shipment cost.
Exception conditions:	2.1 Shipper is not available to that location, so select another. 3.1 If order item is damaged, get new item and updated item quantity. 3.1 If item bar code isn't scanning, shipping must enter bar code manually. 5.1 If printing label isn't printing correctly, the label must be addressed manually.	

用活动图描述工作流（或用例的活动流）

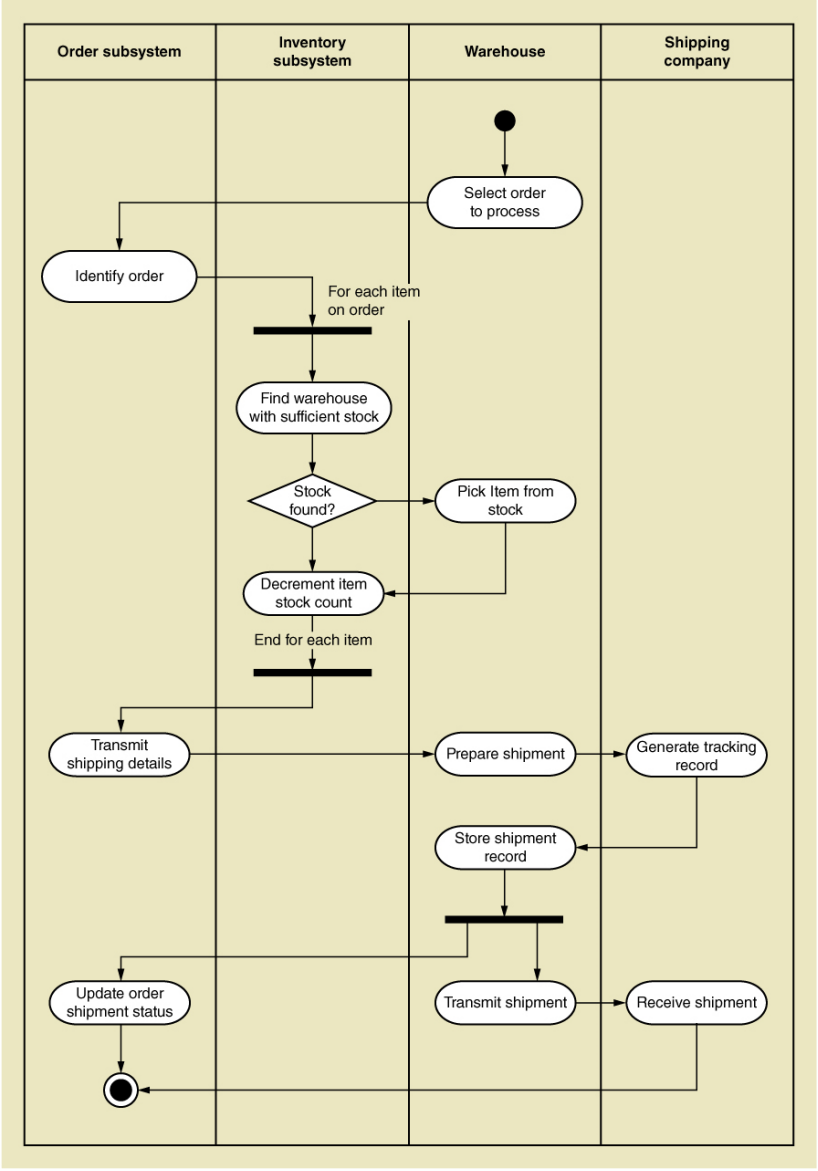
- 工作流【Workflow】
  - Sequence of processing steps that completely handles one business transaction or customer request
- 活动图【Activity Diagram】
  - Describes user (or system) activities, the person who does each activity, and the sequential flow of these activities
  - Useful for showing a graphical model of a workflow
  - A UML diagram

活动图的符号


泳道
Swimlane heading
Manager
开始
Starting activity (Pseudo)
Review financials
活动顺序
Transition arrow
活动
Activity
Prepare report
结束
Ending activity (Pseudo)
并行条（分开）
Synchronization bar (Split)
并行条（合并）
Synchronization bar (Join)
决策点
Decision activity
[no]
[yes]
决策点
Another way to show decision

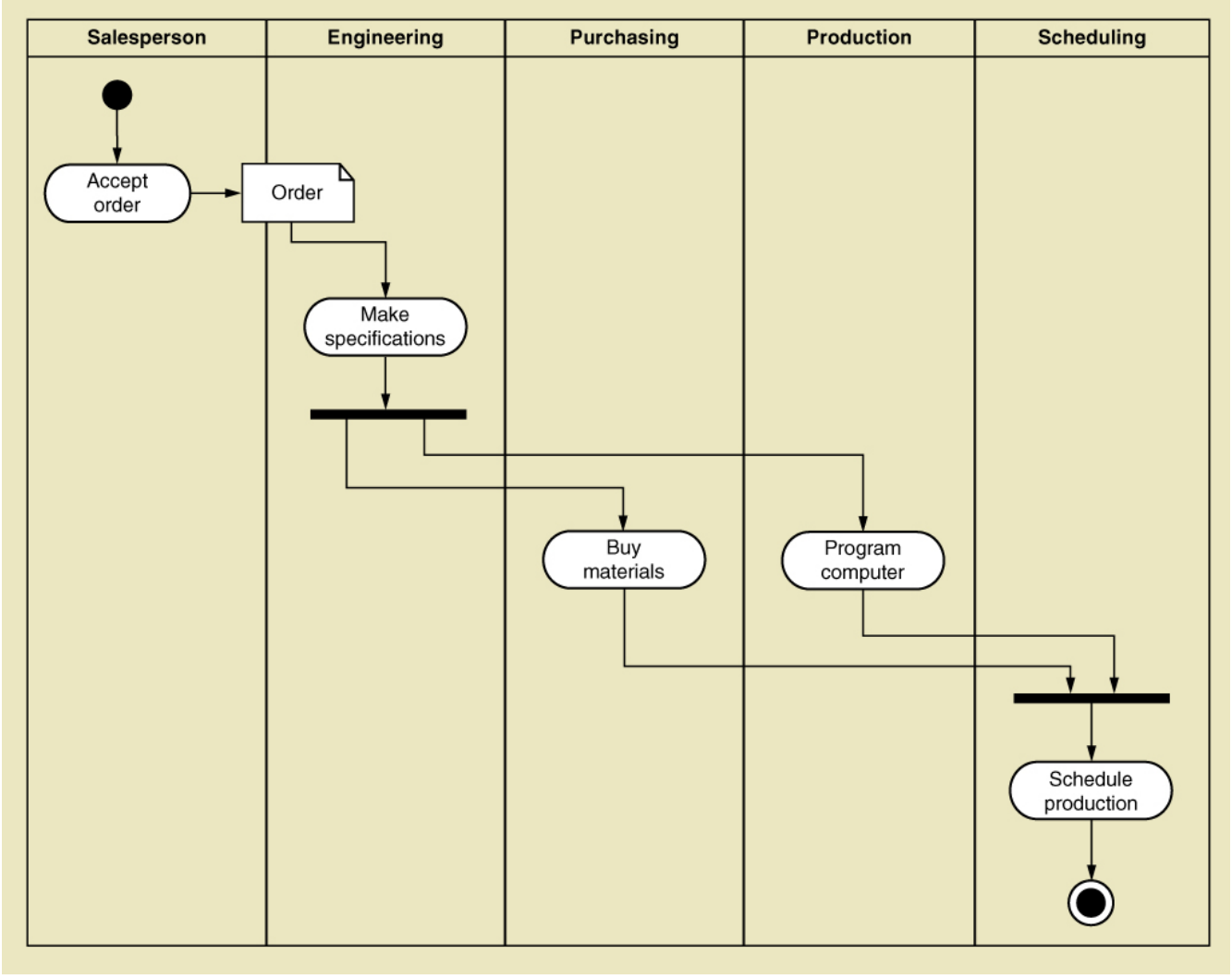
活动图的例子

- 订单履行过程



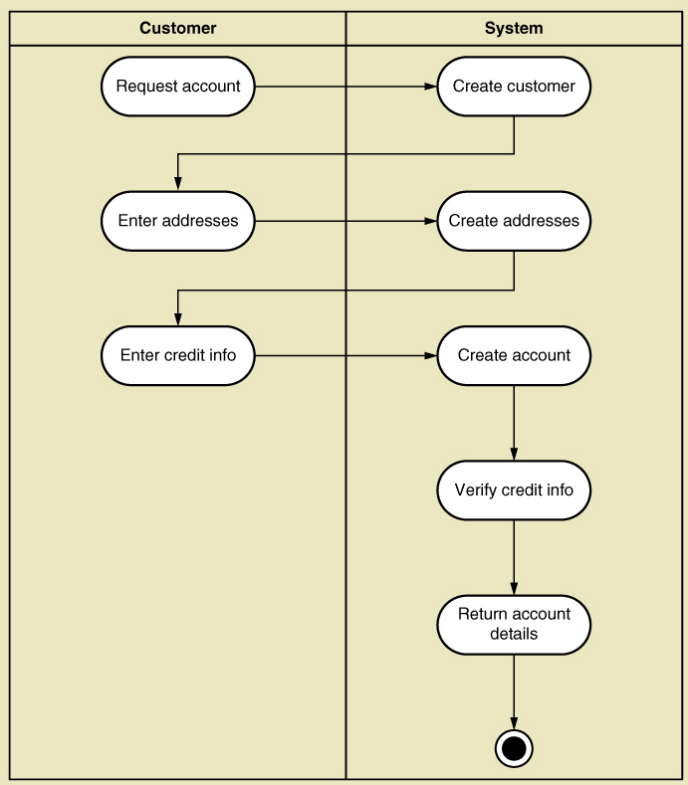
活动图的例子

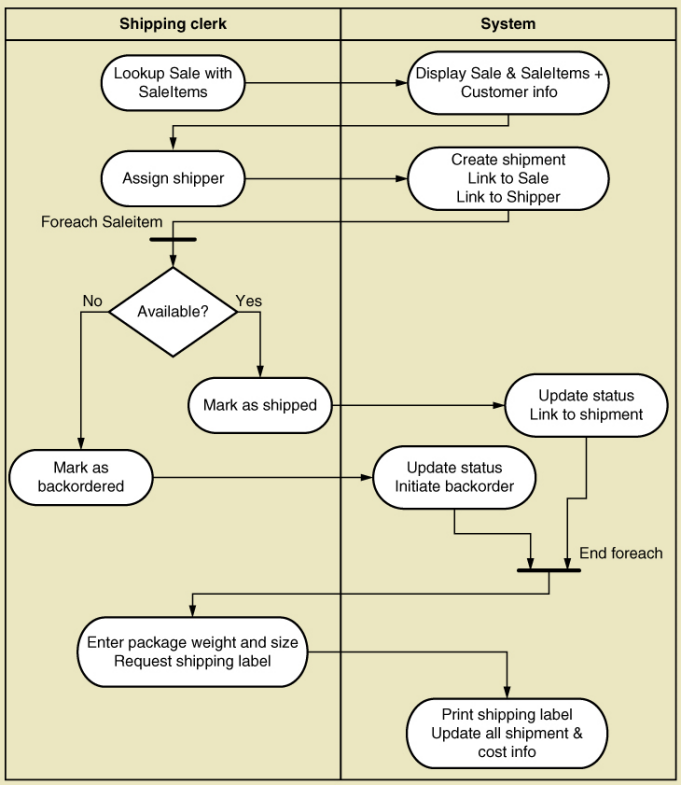
- 并行条的例子



用例的活动图

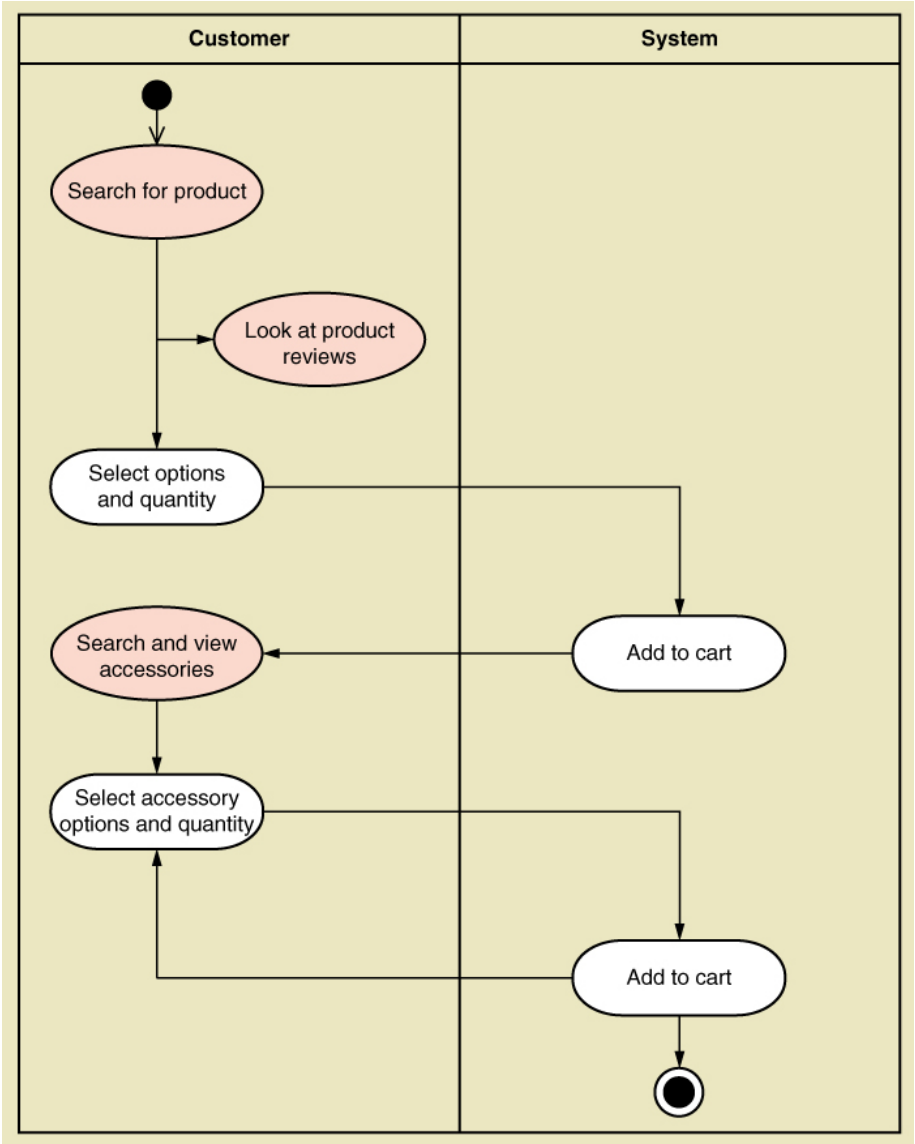
- 用例的活动图【Activity Diagram for Use Case】
  - 活动图可用于建模工作流
  - 活动图也可以用于建模一个用例的活动流
    - 可替代用例描述中活动流，或作为用例描述的补充





用例的活动图

- 复杂用例的活动图
  - 用例的活动流中涉及了其他用例
  - 如：Fill shopping cart用例使用了3个其他用例

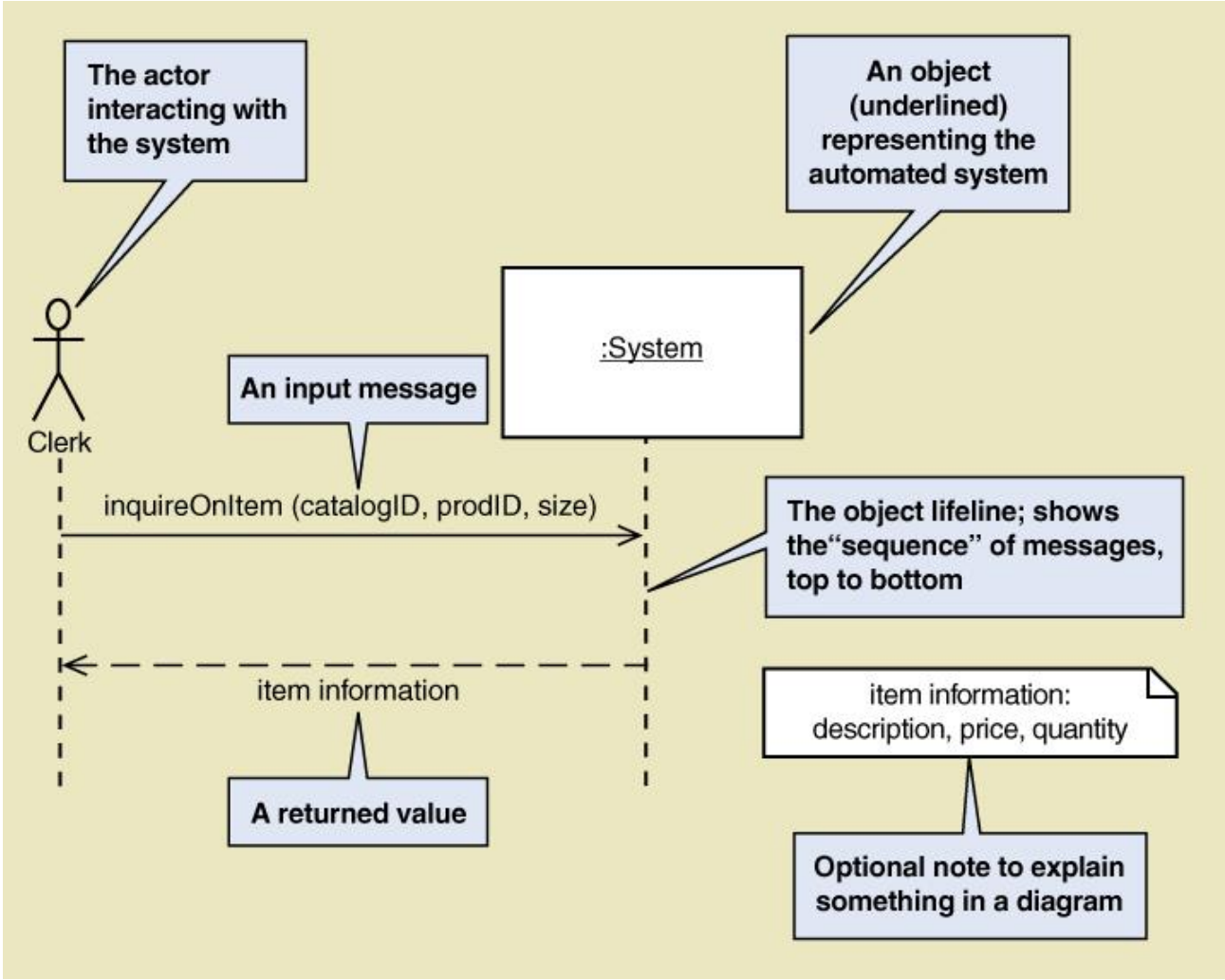


系统顺序图

- 系统顺序图【System Sequence Diagram, SSD】
  - A diagram showing the sequence of messages between an actor and the automated part of the system during a use case or scenario
    表示在一个用例中，参与者与系统之间的消息流
  - SSD图建模参与者和系统之间交互的输入与输出消息
  - SSD图通常和用例描述一起用，以表示一个用例的输入输出情况；SSD图也有助于后续用户界面的设计
  - SSD图是UML顺序图的一种特殊形式（即把系统看成是一个对象，也只显示一个参与者）

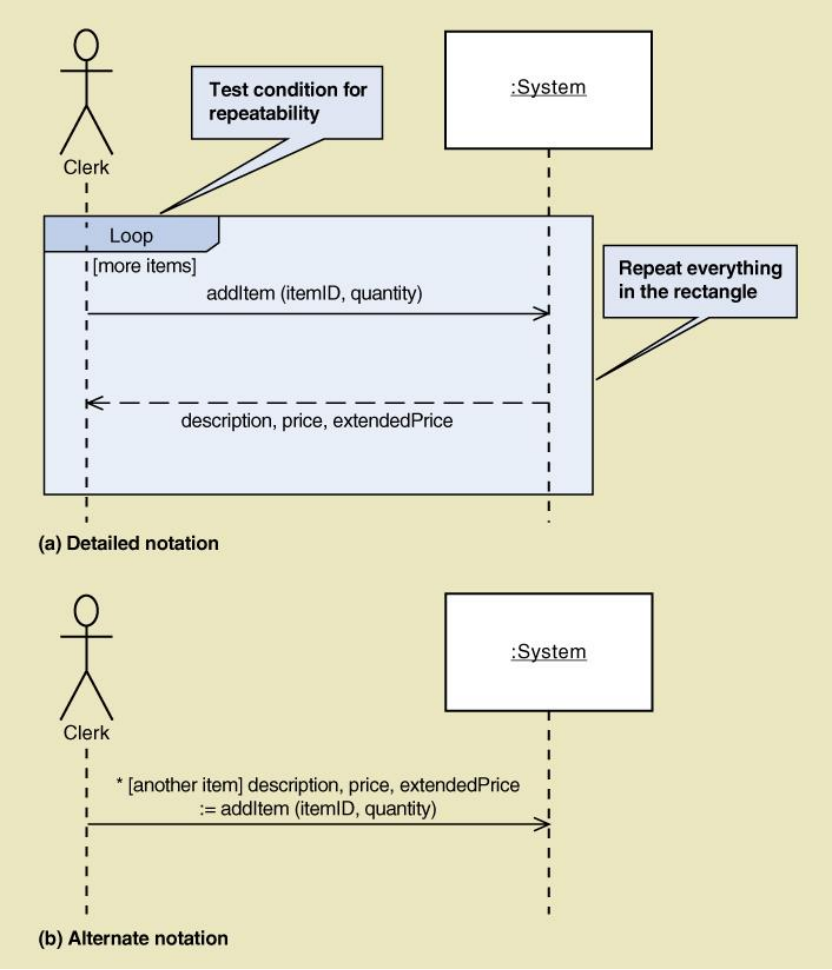
系统顺序图

- 系统顺序图的标记符号



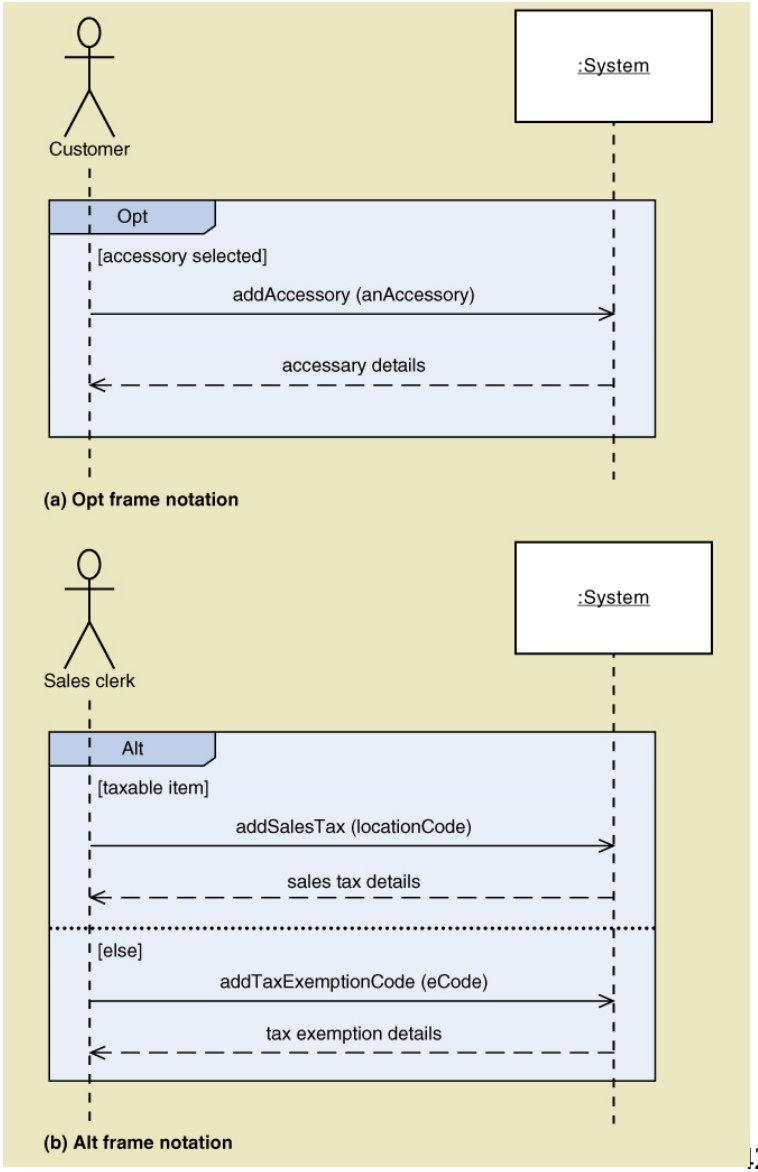
系统顺序图

- 系统顺序图的标记符号
  - 循环片段【Loop frame】
    - Notation on a sequence diagram showing repeating messages
  - (b)是表示循环的另一种方式
    - *[ ]表示中括号内的条件满足时重复该消息
    - :=前面的是返回数据
    - [true/false condition] return-value := message-name (parameter-list)



系统顺序图

- 系统顺序图的标记符号
  - 可选片段【Opt frame】
    - Notation on a sequence diagram showing optional messages
  - 选择片段【Alt frame】
    - Notation on a sequence diagram showing if-then-else logic

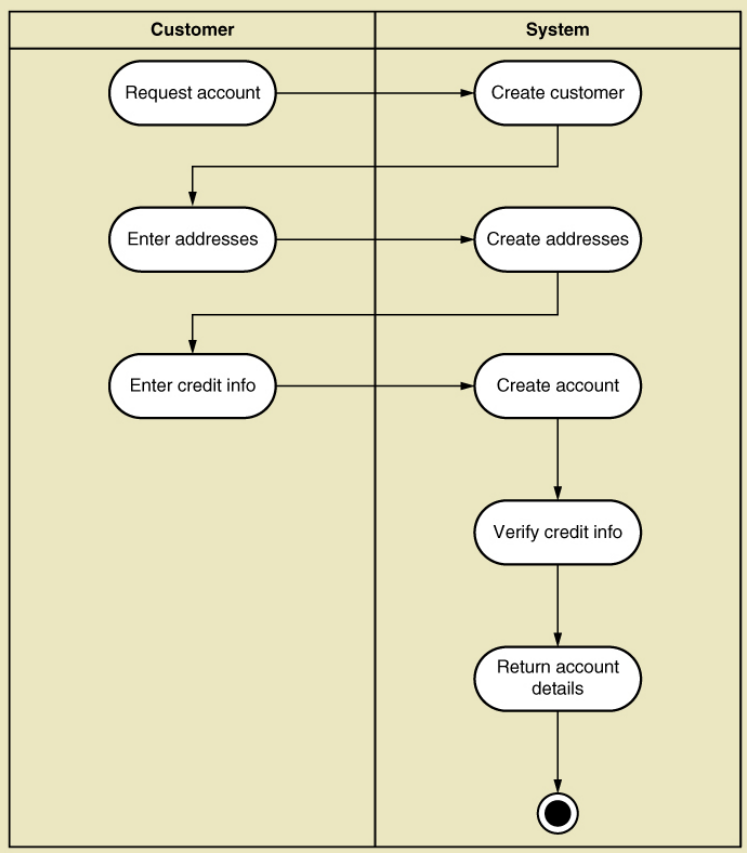


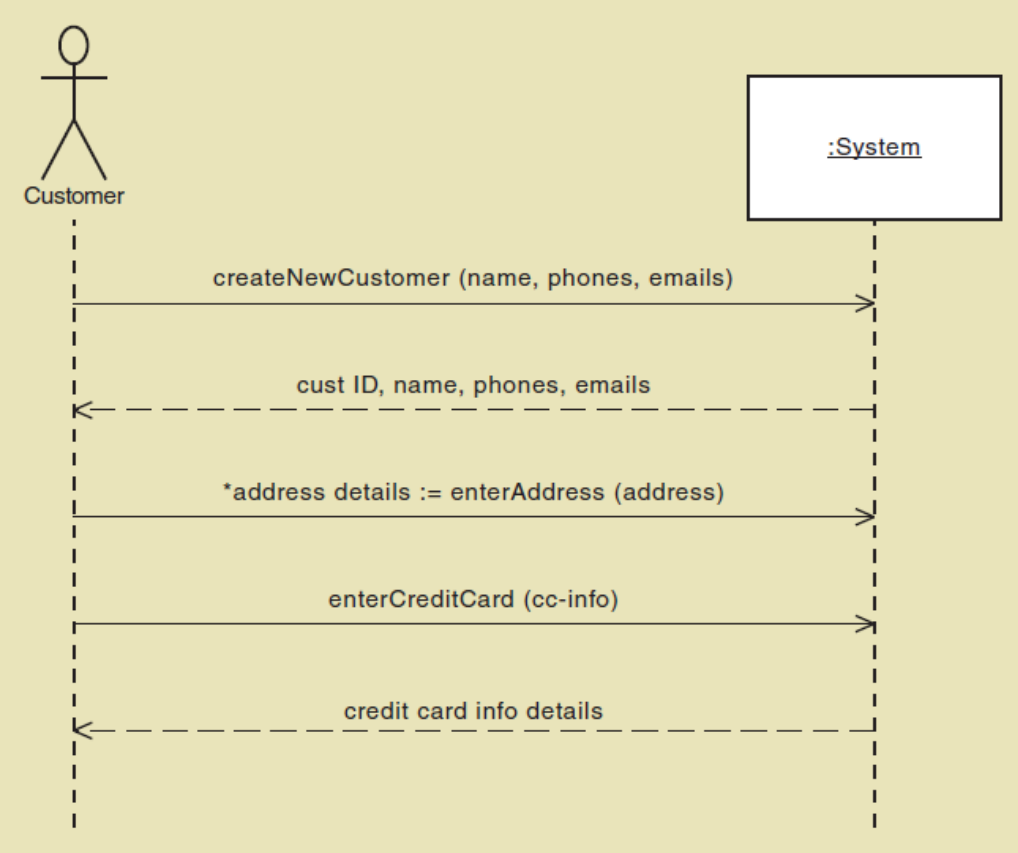
系统顺序图

- 建模系统顺序图
  - 在详细的用例描述（或用例活动图）基础上进行SSD建模
  - 步骤：
    1. 标识输入消息
       - 观察用例描述中的活动流，或者活动图的活动流
    2. 描述从外部参与者到系统的消息
       - 消息命名：动词+名词
       - 参数
    3. 检查输入消息是否含特殊条件
       - 看是否需要循环/选项/选择片段（loop/opt/alt frame）
    4. 标记输出消息的返回值
       - 用虚线
       - 有时也可能没有返回值

系统顺序图

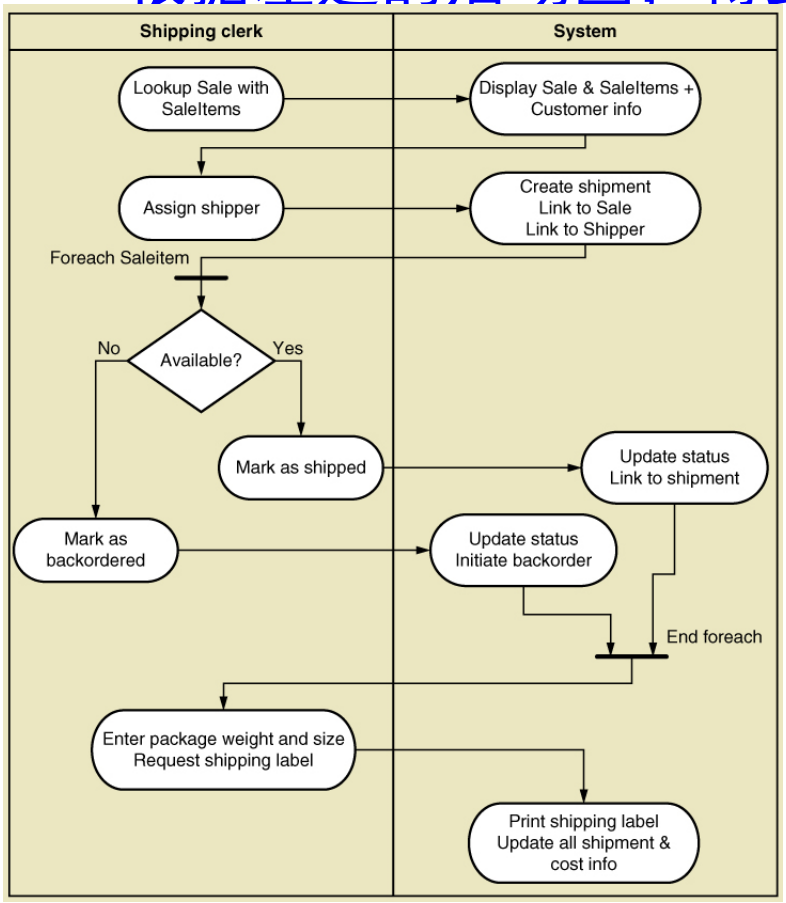
- 建模系统顺序图
  - 例如：为用例“Create customer account”建模SSD

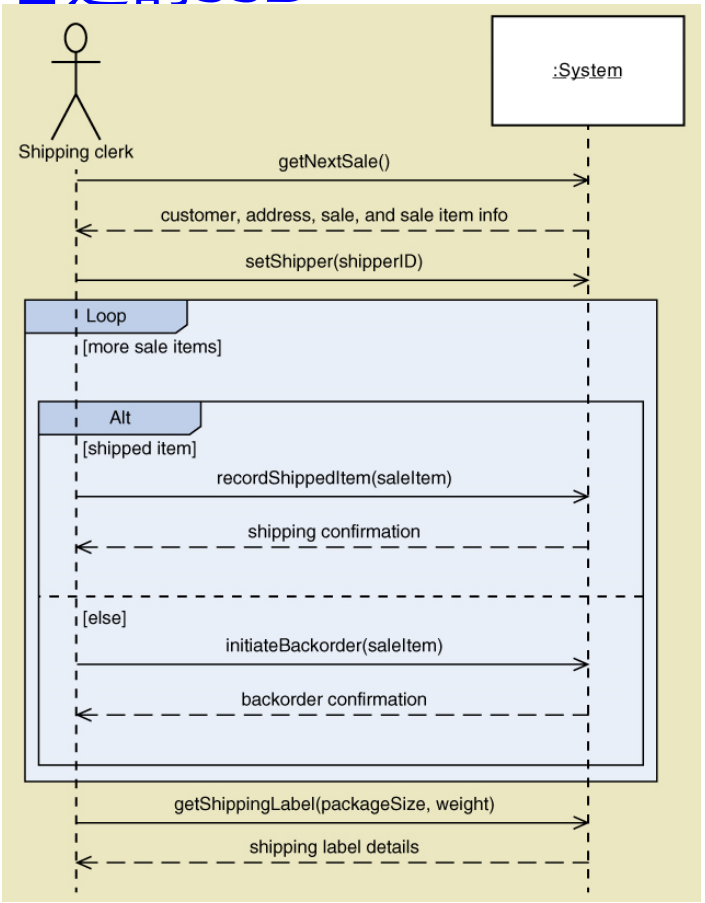




系统顺序图

- 建模系统顺序图
  - 再例如：为用例“Ship item”建模SSD
  - 根据左边的活动图，得到右边的SSD





用例和CRUD技术

- CRUD技术
  - An acronym for Create, Read/Report, Update, and Delete; a technique to validate or refine use cases
    CRUD技术可用于确认和提炼用例
  - 例如：

Data entity/domain class	CRUD	Verified use case
Customer	Create	Create customer account
	Read/report	Look up customer Produce customer usage report
	Update	Process account adjustment Update customer account
	Delete	Update customer account (to archive)

用例和CRUD技术

- CRUD技术验证和提炼用例的步骤：
  1. 标识所有的领域类【注：后面的领域建模章节会讲解】
  2. 对于每个类，确认存在一个用例实现下面的操作：
     - 创建新的实例
     - 更新已存在的实例
     - 读或者报告实例的值
     - 删除或者存档实例
  3. 如果发现有遗漏的用例，则添加新的用例并标识其关联人员
  4. 确保弄清楚哪个应用负责增加和维护数据、哪个负责使用数据

用例和CRUD技术

- CRUD表
  - 显示用例和相应的领域类

Use case vs. entity/domain class	Customer	Account	Sale	Adjustment
Create customer account	C	C		
Look up customer	R	R		
Produce customer usage report	R	R	R	
Process account adjustment	R	U	R	C
Update customer account	UD (archive)	UD (archive)		

- Sale的实例由谁创建？更新？删除/存档？

用户故事 vs. 用例

- 共同点
  - 都可用于定义系统的功能需求，指明系统需要实现的功能列表，反映用户的目标
- 不同点
  - 体现的需求细节程度不同：用户故事较简洁，用例则较详细
    - 用户故事一般用于敏捷开发方法（开发人员在设计和编码阶段再从用户处获取详尽的需求细节）
    - 用例则多用于传统的分析方法，当然在实践中，用例也可以写得非常简洁

需求建模：领域模型
Domain Modeling

问题域

- 问题域【Problem Domain】
  - The specific area (domain) of the user's business need that is within the scope of the new system
    在新系统的范围内，与用户的业务相关的特定领域

- 问题域中的“事物”【Things】
  - “事物”（Things）指用户完成工作任务时需要记住（存储）的事项
  - 如：产品、销售、承运人、客户、发票、支付等

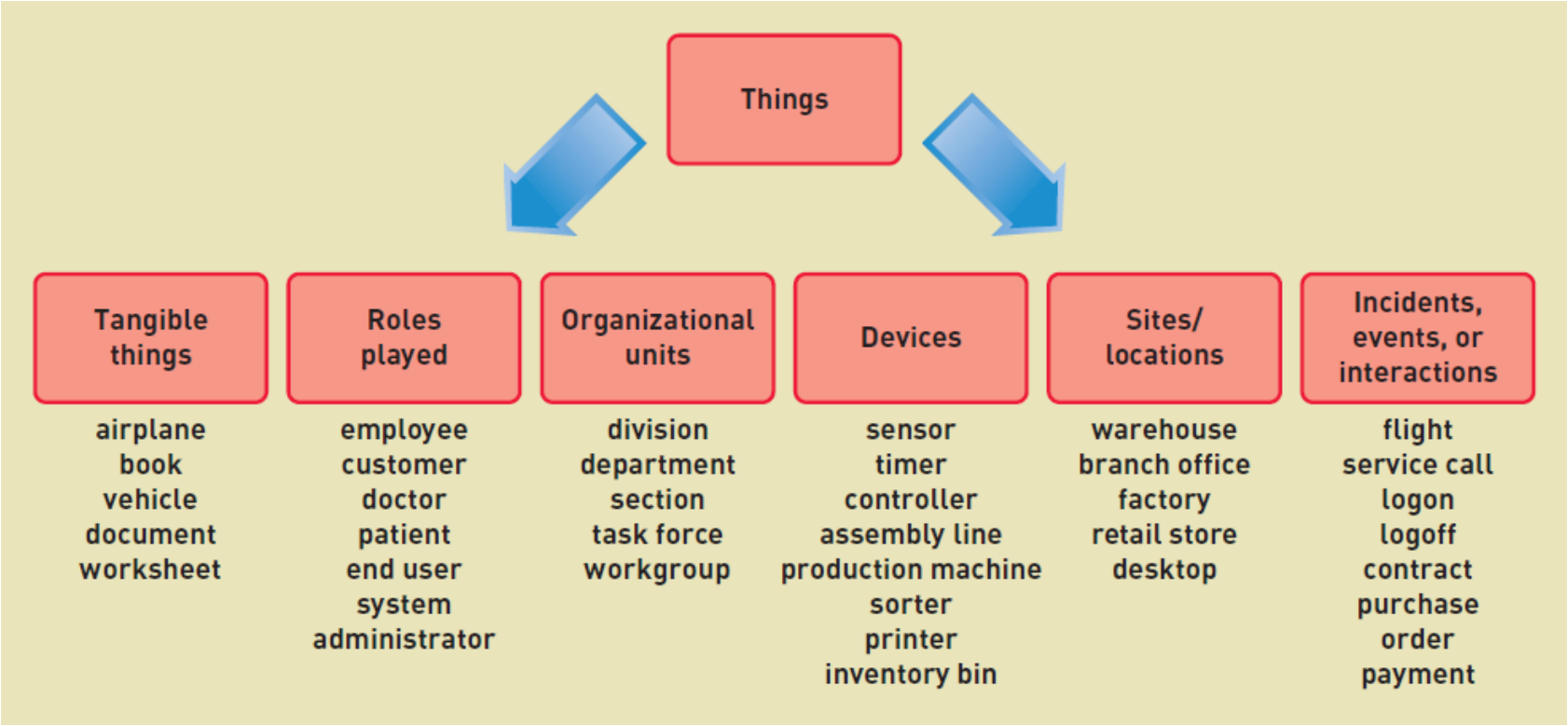
  - 这些“事物”通常建模为领域类（domain classes）或数据实体（data entities）

问题域

- 识别问题域中的重要“事物”【Identifying “Thing”】
  - 两种技术：头脑风暴技术、名词技术
  - 头脑风暴技术【Brainstorming Technique 】
    - A technique used to identify problem domain classes in which developers work with users to identify classes by thinking about different types of things they use in their work
  - 名词技术【Noun Technique】
    - A technique used to identify things in the problem domain by finding and classifying the nouns in a dialog or description

头脑风暴技术

- 头脑风暴时可从多个角度识别“Thing”
  - 有形物体、角色、组织、设备、地点、事件、交互等
  - 例如：



头脑风暴技术

- 用头脑风暴技术识别问题域中的“事物”的步骤：
  1. 标识一个用户以及一组相关的用例或用户故事
  2. 与用户进行头脑风暴，以识别完成一个用例所涉及的事物，即：系统需要取得这些事物的信息
  3. 根据事物的类别系统地就潜在事物进行提问
  4. 重复以上过程以覆盖所有的用户和关联人员，并扩展头脑风暴得到的结果列表
  5. 合并结果，消除重复的结果，得到初始事物列表

名词技术

- 用名词技术识别问题域中的“事物”的步骤：
  1. 使用用例、参与者和其他关于系统的信息（包括输入输出），标出全部名词
  2. 使用当前系统、当前流程、当前报告或表单的其他信息，增加信息条目或类别
  3. 对得到的名词列表进行提炼
  4. 创建一个包含全部名词的总清单，表明每个名词是否应采纳或仍需进一步研究清楚
  5. 与用户、关联人员、项目团队成员一起审查名词列表，提炼问题域中的事物列表

名词技术

- 案例：使用名词技术

Identified noun	Notes on including noun as a thing to store
Accounting	We know who they are. No need to store it.
Back order	A special type of order? Or a value of order status? Research.
Back-order information	An output that can be produced from other information.
Bank	Only one of them. No need to store.
Catalog	Yes, need to recall them, for different seasons and years. Include.
Catalog activity reports	An output that can be produced from other information. Not stored.
Catalog details	Same as catalog? Or the same as product items in the catalog? Research.
Change request	An input resulting in remembering changes to an order.
Charge adjustment	An input resulting in a transaction.
Color	One piece of information about a product item.
Confirmation	An output produced from other information. Not stored.
Credit card information	Part of an order? Or part of customer information? Research

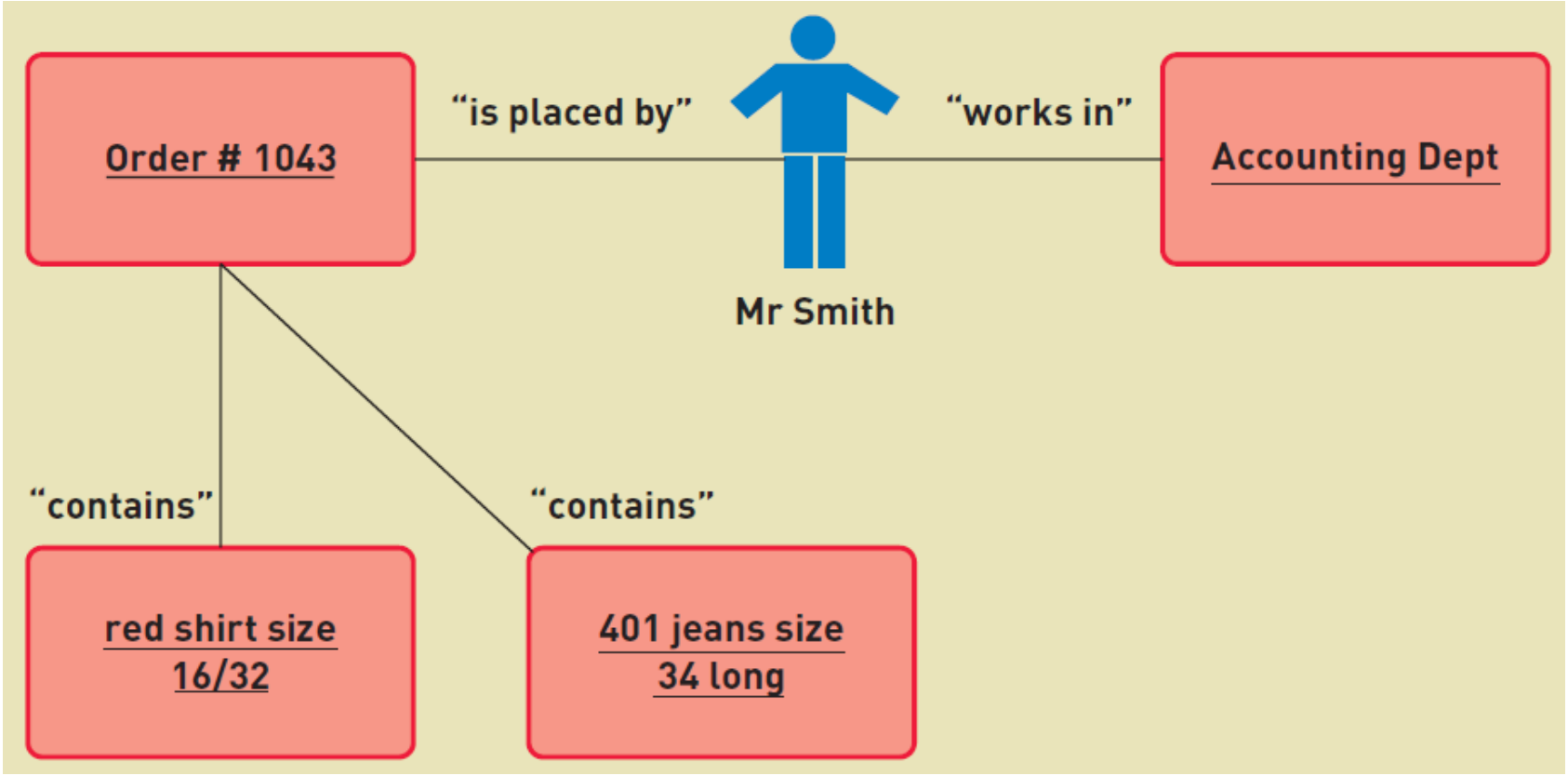
“Thing”的属性、键

- 属性【Attribute】
  - Descriptive pieces of information about things or objects
- 键【Key / Identifier】
  - The attribute that uniquely identifies the thing

All customers have these attributes:	Each customer has a value for each attribute:		
Customer ID	101	102	103
First name	John	Mary	Bill
Last name	Smith	Jones	Casper
Home phone	555-9182	423-1298	874-1297
Work phone	555-3425	423-3419	874-8546

“Things”之间的关联

- 关联【Association】
  - Describes a naturally occurring relationship between specific things

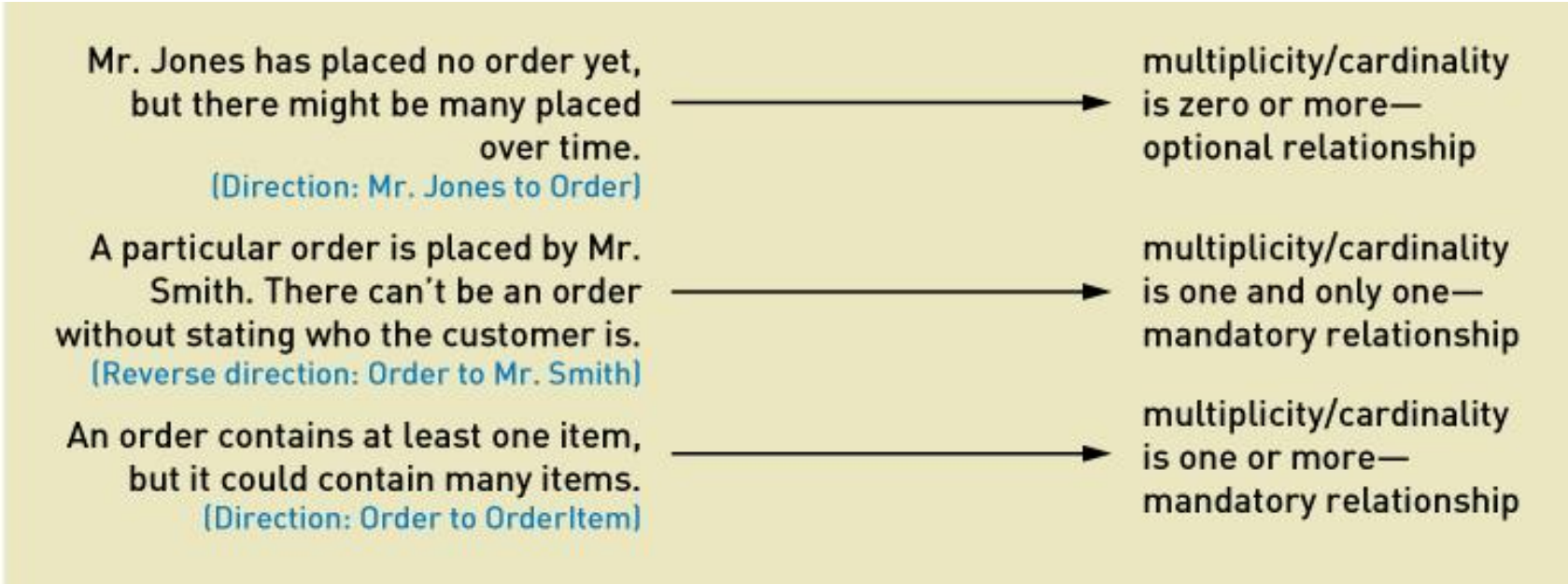


“Things”之间的关联

- 关联【Association】 or 关系【Relationship】?
  - 两者意思相同，只是使用的场合不同
  - 关联（Association）这个术语用于UML模型
  - 关系（Relationship）这个术语用于数据库模型
- 多重性【Multiplicity】
  - 表示关联的事物之间的数量关系
- 多重性【Multiplicity】 or 基数【Cardinality】?
  - 两者意思类似
  - 多重性（Multiplicity）用于UML模型
  - 基数（Cardinality）用于数据库模型

“Things”之间的关联

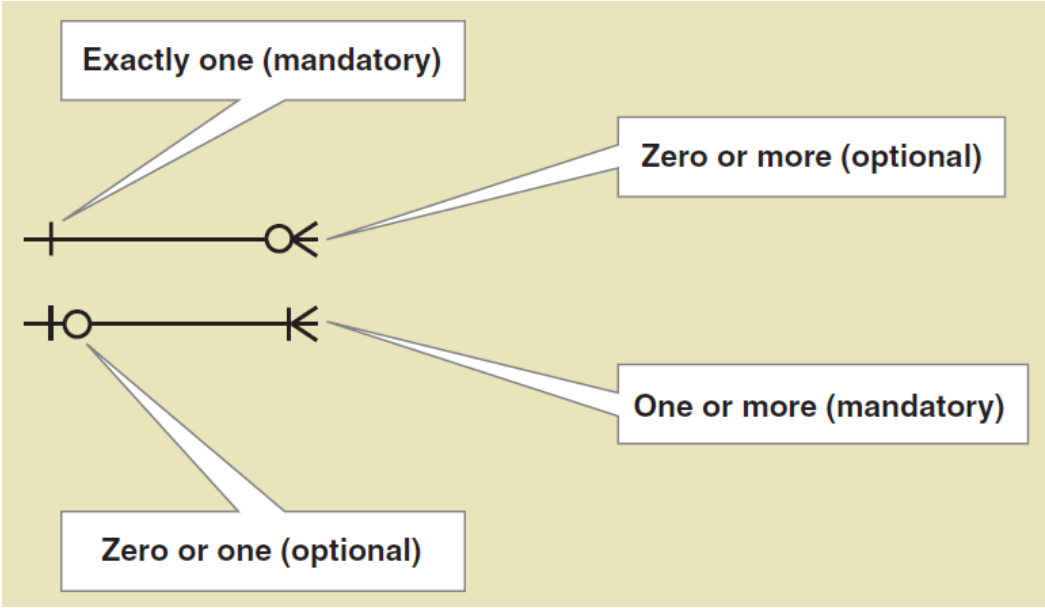
- 多重性约束【Multiplicity Constraints】
  - The actual numeric count of the constraints on things (UML objects) allowed in an association
    在一个关联中事物（UML对象）允许出现的个数



实体关系图

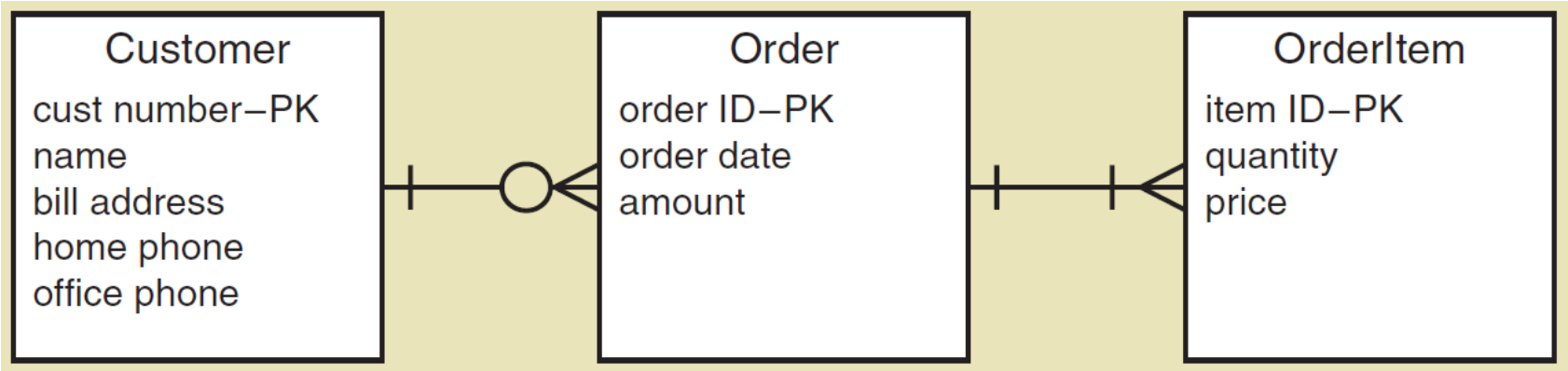
- 实体关系图【Entity Relationship Diagram, ERD】
  - A diagram consisting of data entities, their attributes, and their relationships
    ER图由数据实体、实体属性和实体间的关系组成

- ER图的基数符号



实体关系图

- ER图举例：


Customer
cust number–PK
name
bill address
home phone
office phone
Order
order ID–PK
order date
amount
OrderItem
item ID–PK
quantity
price

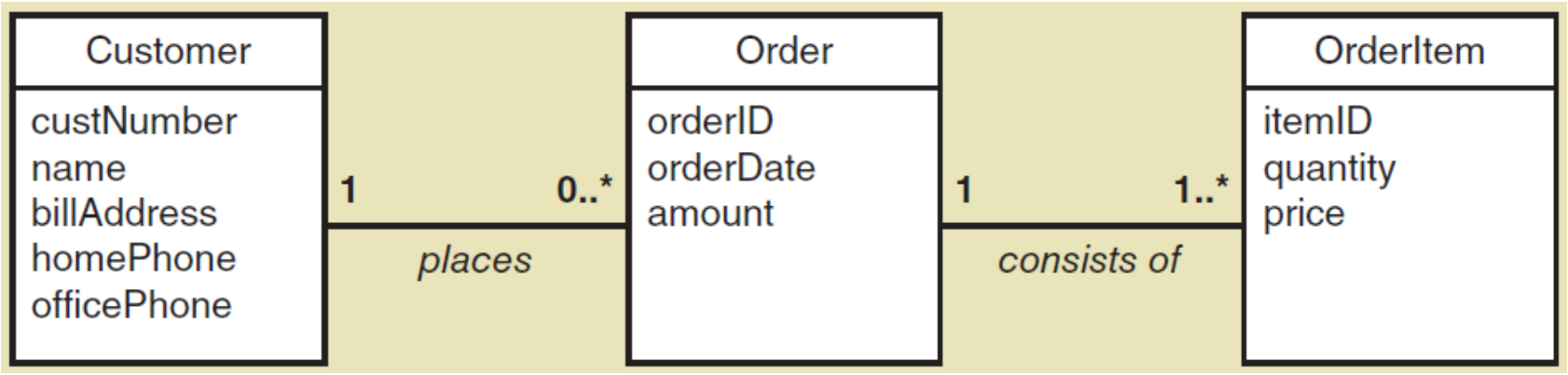
领域类图

- 类【Class】
  - A category or classification of a set of objects or things
- 领域类【Domain Class】
  - Classes that describes objects from the problem domain
    描述来自问题域的对象的类
- 类图【Class Diagram】
  - A diagram consisting of classes (i.e., sets of objects) and associations among the classes
- 领域类图【Domain Model Class Diagram】
  - A class diagram that only includes classes from the problem domain
    只包含问题域的类的类图

领域类图

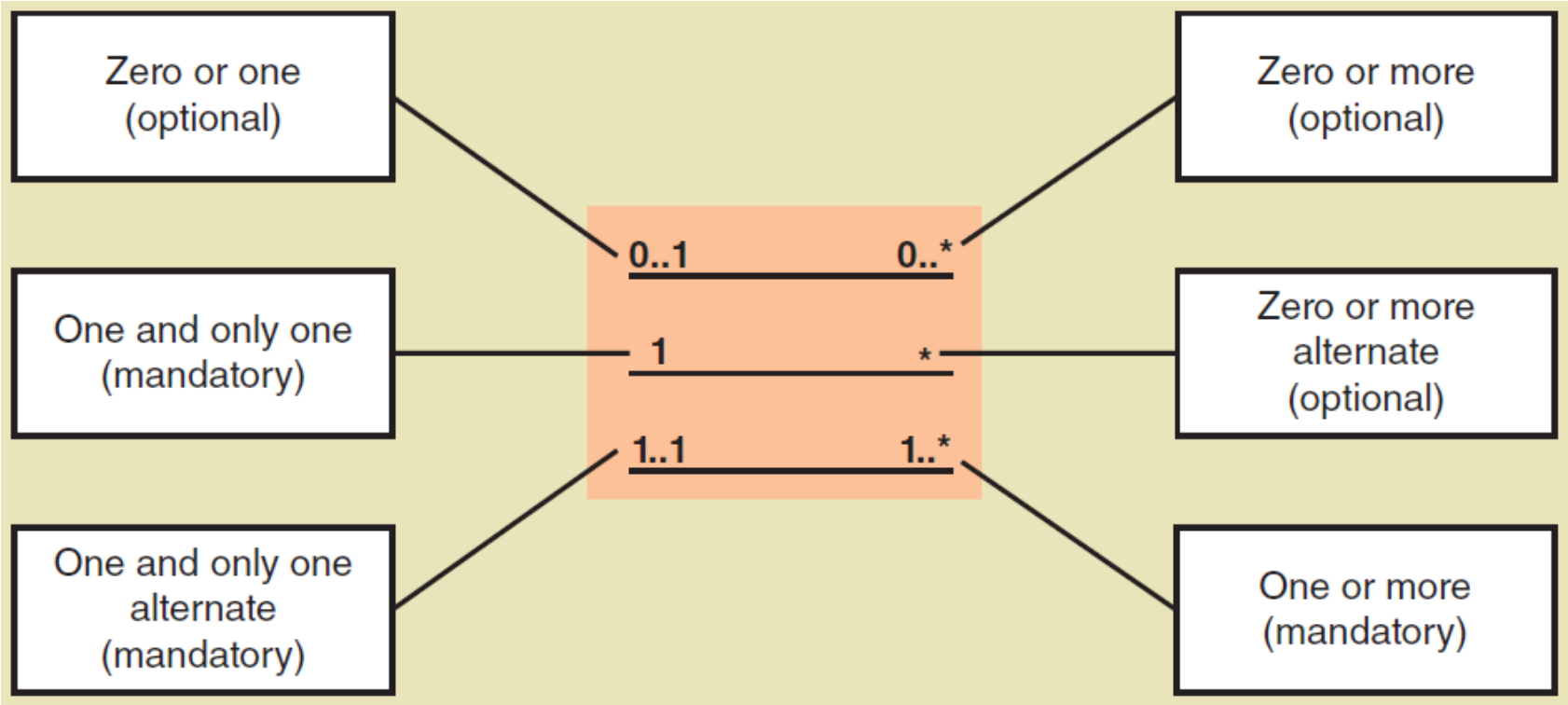
- 类的表示符号【Class】
  - 类名首字母大写，若由多个单词构成，则每个单词首字母均大写（驼峰命名法）
  - 属性名小写，若由多个单词构成，则第2个起每个单词首字母大写（驼峰命名法）
  - 注意：领域类只有属性，没有方法

- 一个简单的领域类图的例子：



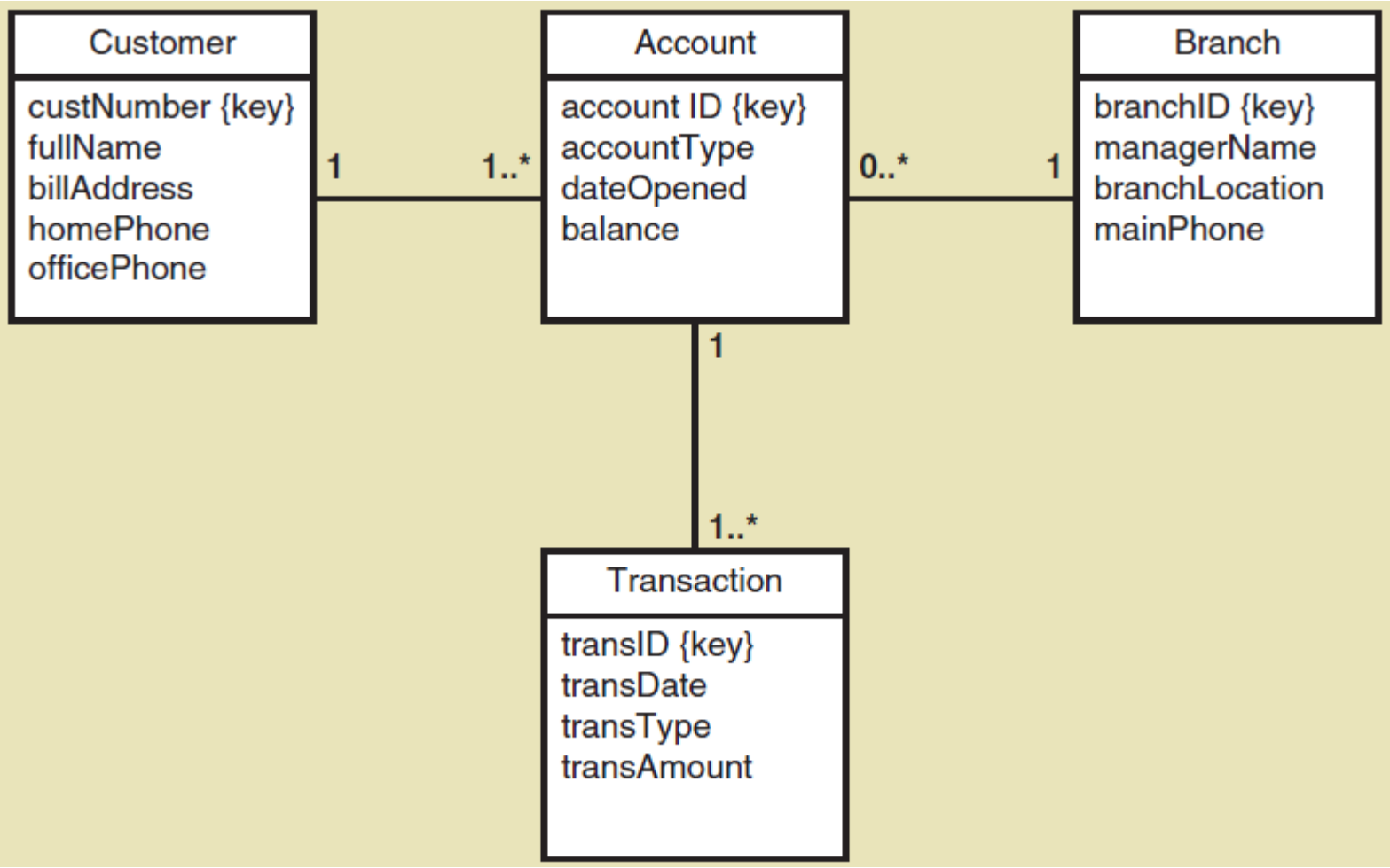
领域类图

- 关联关系的多重性的表示符号【Multiplicity】



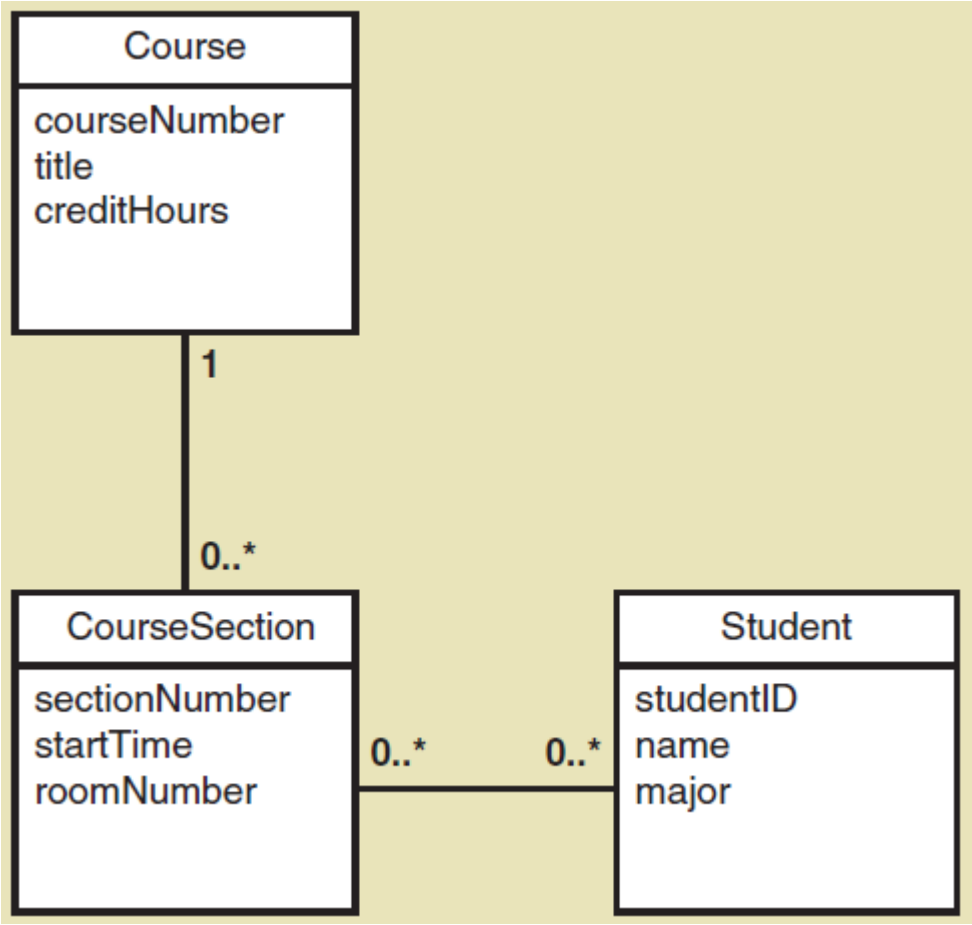
领域类图

- 领域类图的例子：（标明了键、多重性）



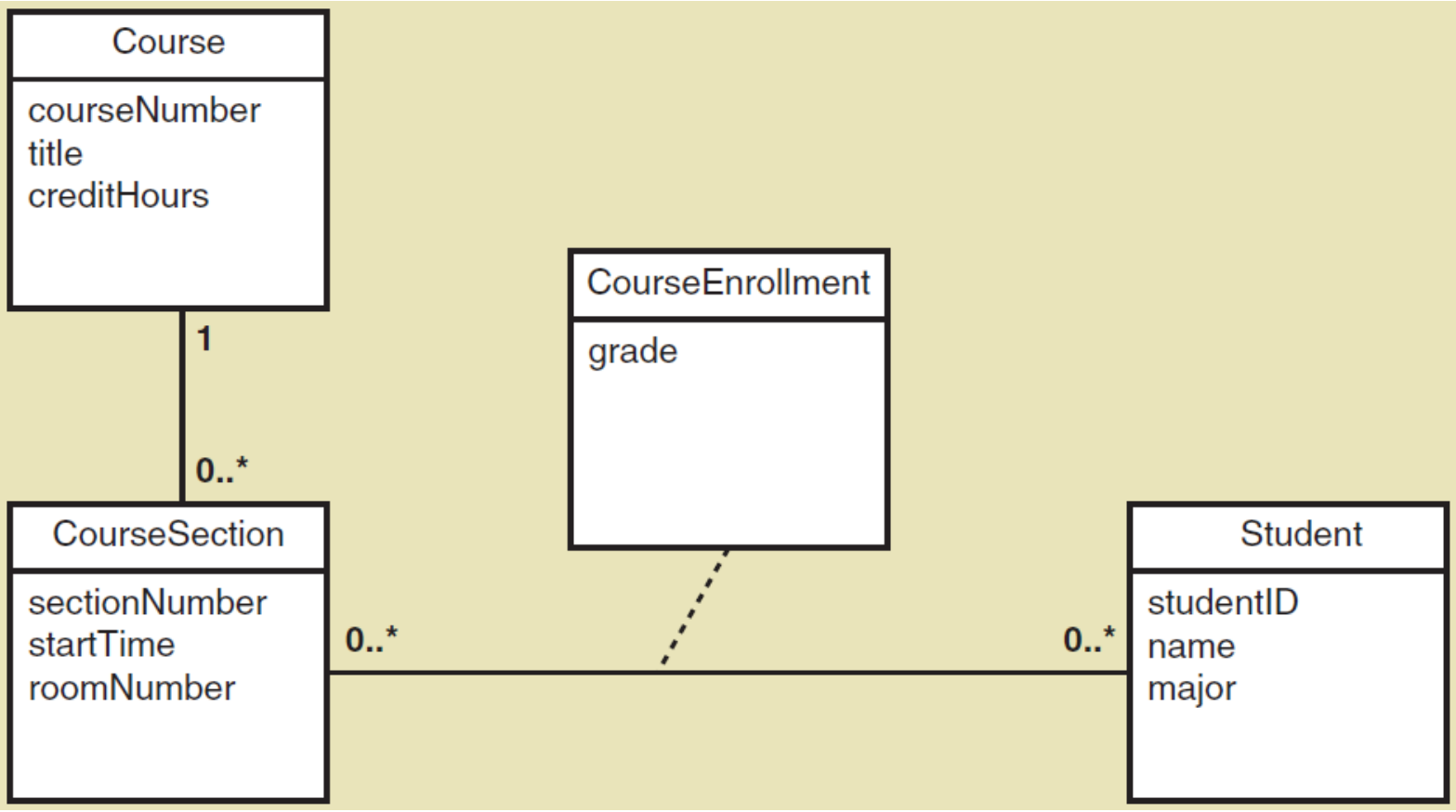
领域类图

- 多对多关联关系【Many-to-many Association】
  - 课程成绩呢？
    - 该属性放哪好？
    - 放CourseSection?
    - 放Student?
    - 均不可
    - 需引入新的类



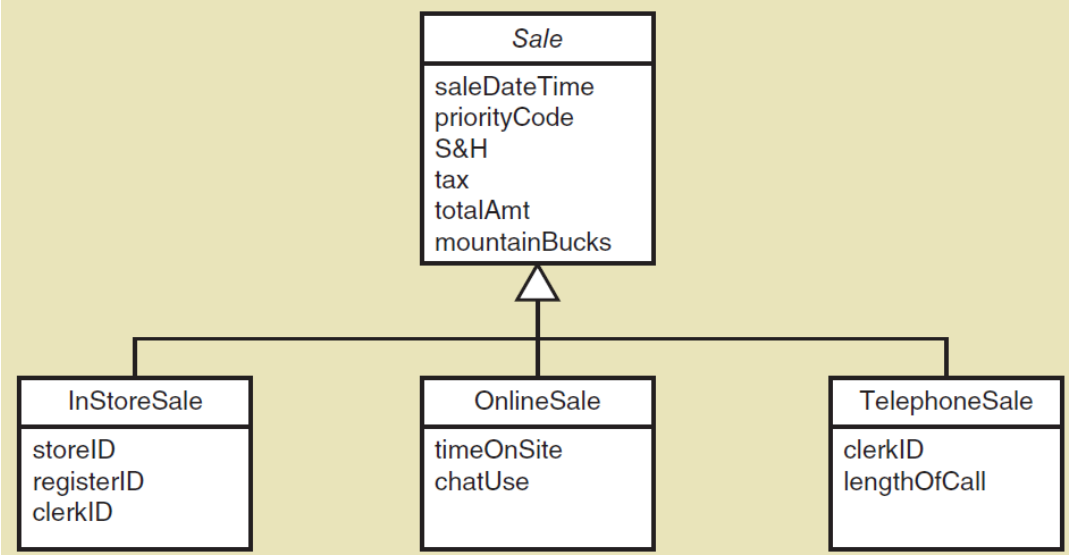
领域类图

- 关联类【Association Class】
  - An association that is also treated as a class; often required in order to capture attributes for the association



领域类图

- 泛化关系【Generalization / Specialization】
  - A type of hierarchical relationship in which subordinate classes are subsets of objects of the superior classes; an inheritance hierarchy
  - 父类【SuperClass】、子类【SubClass】
  - 继承【Inheritance】
  - 抽象类【Abstract Class】、具体类【Concrete Class】

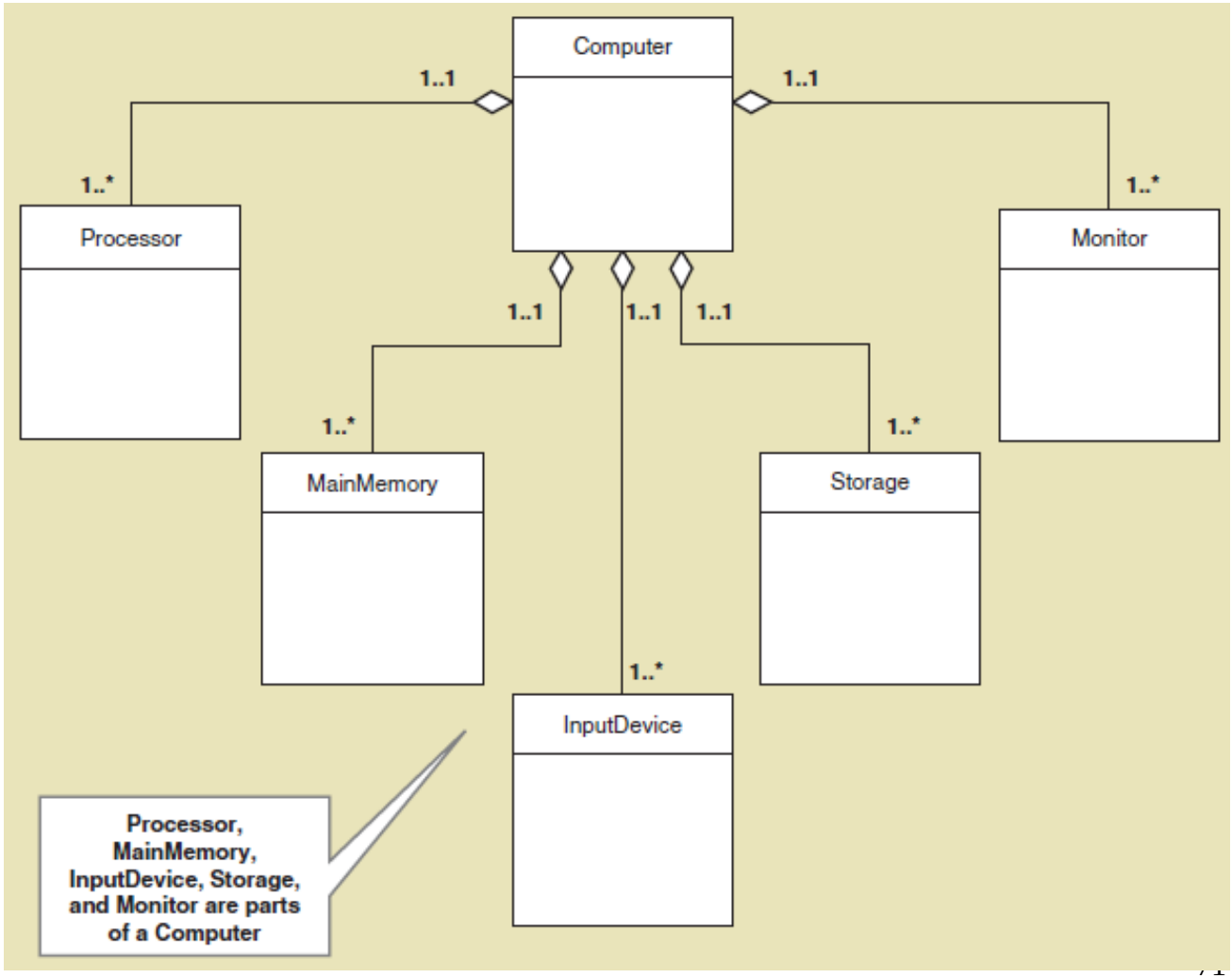


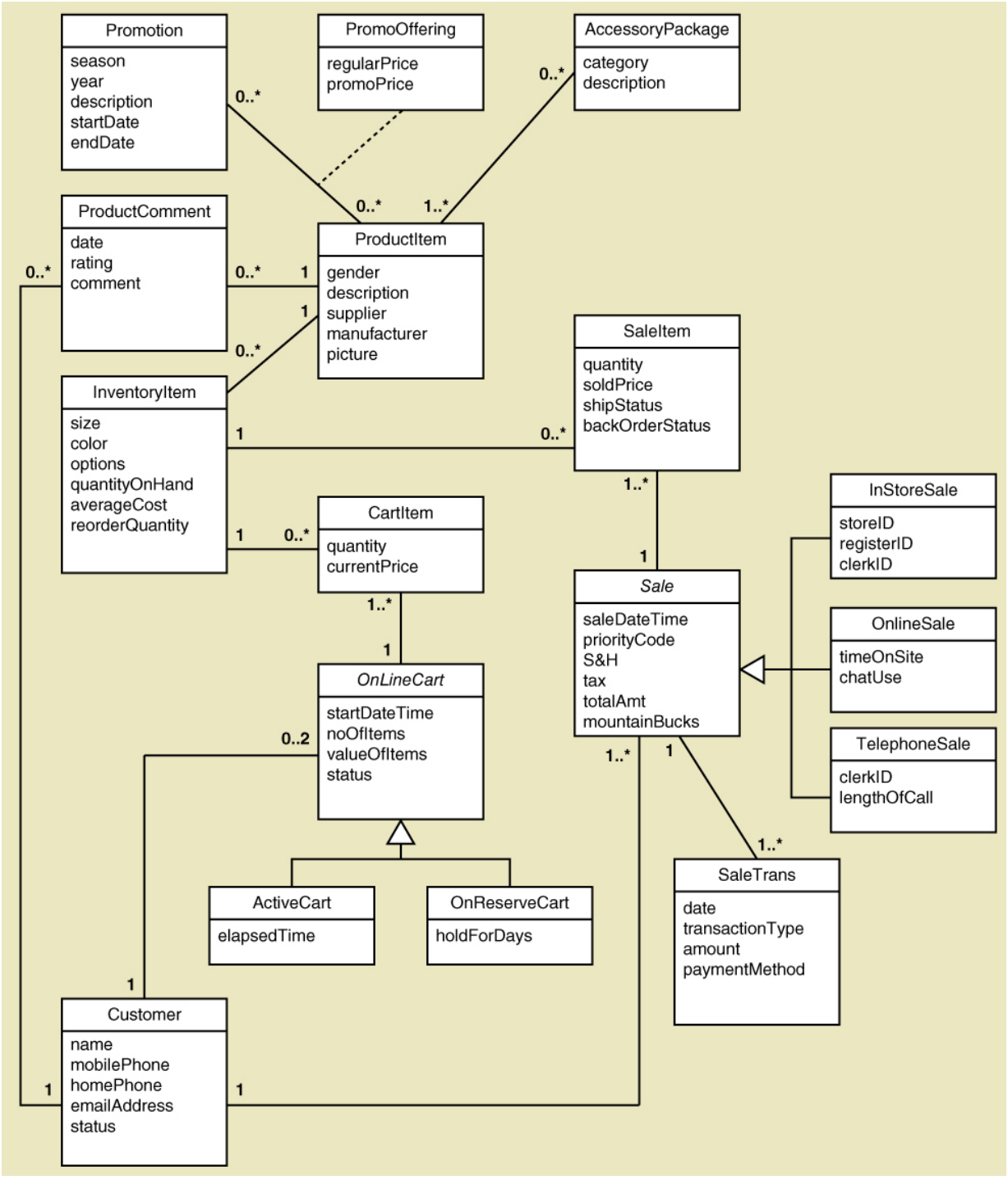
领域类图

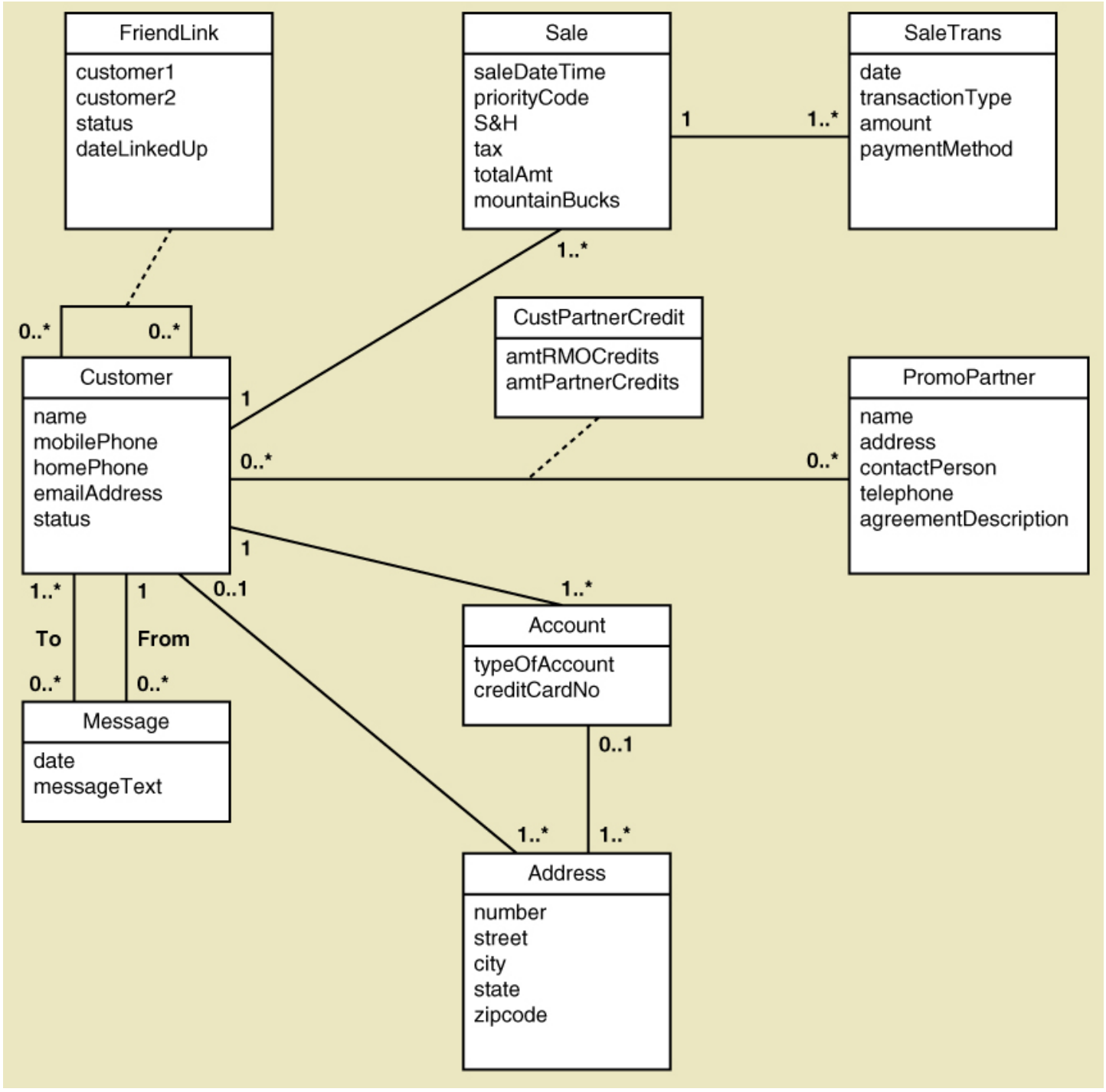
- 整体-部分关系【Whole-Part】
  - Relationships between classes in which one class is a part or a component portion of another class
    一个类是另一个类的组成部分
  - 聚合【Aggregation】
    - “部分”离开“整体”后仍可继续存在
      - 例如：汽车和轮子（Car has wheels），课程和教师，班级和学生
  - 组合【Composition】
    - “部分”不能离开“整体”而存在
      - 例如：订单和订单项（OrderItem on an Order）

领域类图

- 整体-部分关系【Whole-Part】
  - 聚合
    空心菱形
  - 组合
    实心菱形




Promotion
season
year
description
startDate
endDate
PromoOffering
regularPrice
promoPrice
AccessoryPackage
category
description
ProductComment
date
rating
comment
ProductItem
gender
description
supplier
manufacturer
picture
SaleItem
quantity
soldPrice
shipStatus
backOrderStatus
InventoryItem
size
color
options
quantityOnHand
averageCost
reorderQuantity
CartItem
quantity
currentPrice
InStoreSale
storeID
registerID
clerkID
Sale
saleDateTime
priorityCode
S&H
tax
totalAmt
mountainBucks
OnlineSale
timeOnSite
chatUse
TelephoneSale
clerkID
lengthOfCall
OnLineCart
startDateTime
noOfItems
valueOfItems
status
ActiveCart
elapsedTime
OnReserveCart
holdForDays
SaleTrans
date
transactionType
amount
paymentMethod
Customer
name
mobilePhone
homePhone
emailAddress
status
0..*
1
1..*
0..2


FriendLink
customer1
customer2
status
dateLinkedUp
Sale
saleDateTime
priorityCode
S&H
tax
totalAmt
mountainBucks
SaleTrans
date
transactionType
amount
paymentMethod
1
1..*
1..*
0..*
0..*
CustPartnerCredit
amtRMOCredits
amtPartnerCredits
Customer
name
mobilePhone
homePhone
emailAddress
status
PromoPartner
name
address
contactPerson
telephone
agreementDescription
1
0..*
0..*
1
1..*
0..1
1..*
To
From
0..*
0..*
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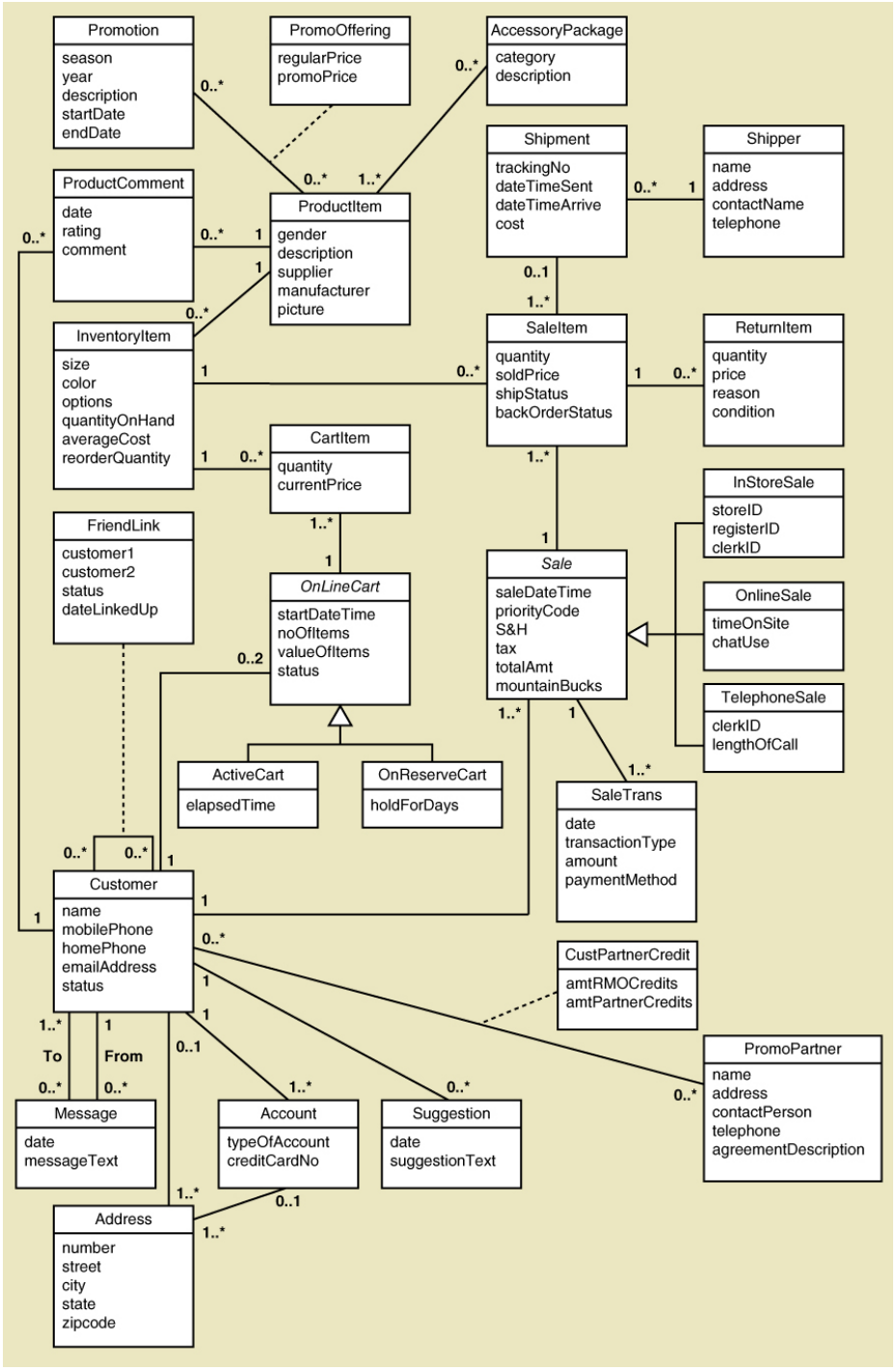
Message
date
messageText
0..1
1..*
1..*
Address
number
street
city
state
zipcode


Promotion
season
year
description
startDate
endDate
PromoOffering
regularPrice
promoPrice
AccessoryPackage
category
description
Shipment
trackingNo
dateTimeSent
dateTimeArrive
cost
Shipper
name
address
contactName
telephone
ProductComment
date
rating
comment
ProductItem
gender
description
supplier
manufacturer
picture
InventoryItem
size
color
options
quantityOnHand
averageCost
reorderQuantity
SaleItem
quantity
soldPrice
shipStatus
backOrderStatus
ReturnItem
quantity
price
reason
condition
CartItem
quantity
currentPrice
FriendLink
customer1
customer2
status
dateLinkedUp
OnLineCart
startDateTime
noOfItems
valueOfItems
status
Sale
saleDateTime
priorityCode
S&H
tax
totalAmt
mountainBucks
InStoreSale
storeID
registerID
clerkID
OnlineSale
timeOnSite
chatUse
TelephoneSale
clerkID
lengthOfCall
ActiveCart
elapsedTime
OnReserveCart
holdForDays
SaleTrans
date
transactionType
amount
paymentMethod
Customer
name
mobilePhone
homePhone
emailAddress
status
CustPartnerCredit
amtRMOCredits
amtPartnerCredits
PromoPartner
name
address
contactPerson
telephone
agreementDescription
To
From
Message
date
messageText
Account
typeOfAccount
creditCardNo
Suggestion
date
suggestionText
Address
number
street
city
state
zipcode

状态机图—确定对象的行为

- 状态机图【State Machine Diagram】
  - 状态【State】
    - A condition during an object's life when it satisfies some criterion, performs some action, or waits for an event
  - 转换/变迁【Transition】
    - The movement of an object from one state to another state
  - 状态机图【State Machine Diagram】
    - A diagram showing the life of an object in states and transitions

状态机图—确定对象的行为

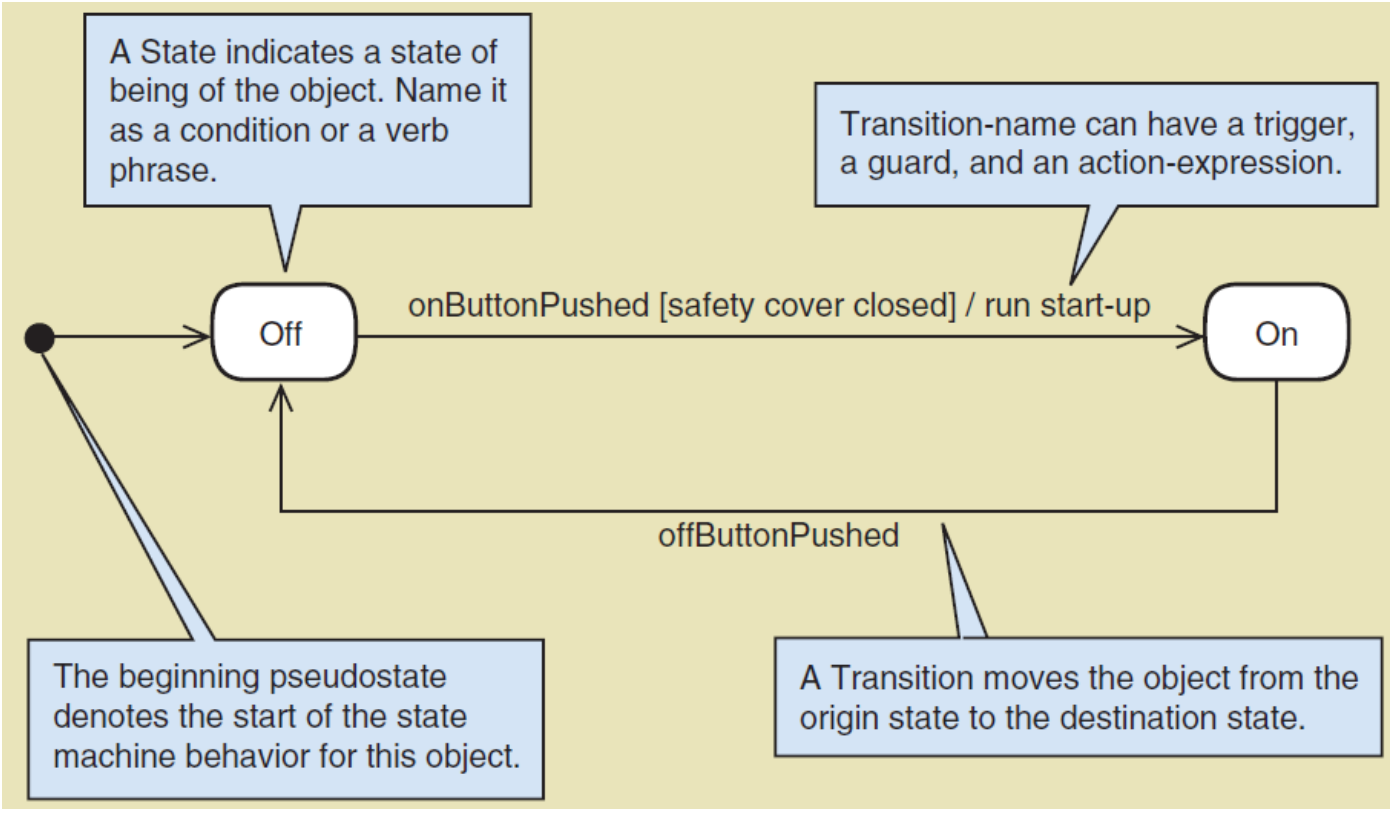
- 状态机图的基本标记元素及术语
  - 初始伪状态【Initial Pseudostate】 
  - 终止状态【Final State】 
  - 状态【State】 （用圆角矩形表示）
  - 转换【Transition】 （用箭头表示）

  - 原状态【Origin State】
    - The original state of an object from which the transition occurs
  - 目标状态【Destination State】
    - The state to which an object moves after completing a transition
  - 动作表达式【action-expression】
    - Descriptions of the activities performed as part of a transition
  - 触发条件【guard-condition】
    - A true/false test to see whether a transition can fire

状态机图—确定对象的行为

- 状态机图中Transition的标注语法：
  - transition-name (parameters, …) [guard-condition] / action-expression
    转换的名称(参数, …) [触发条件] / 动作表达式

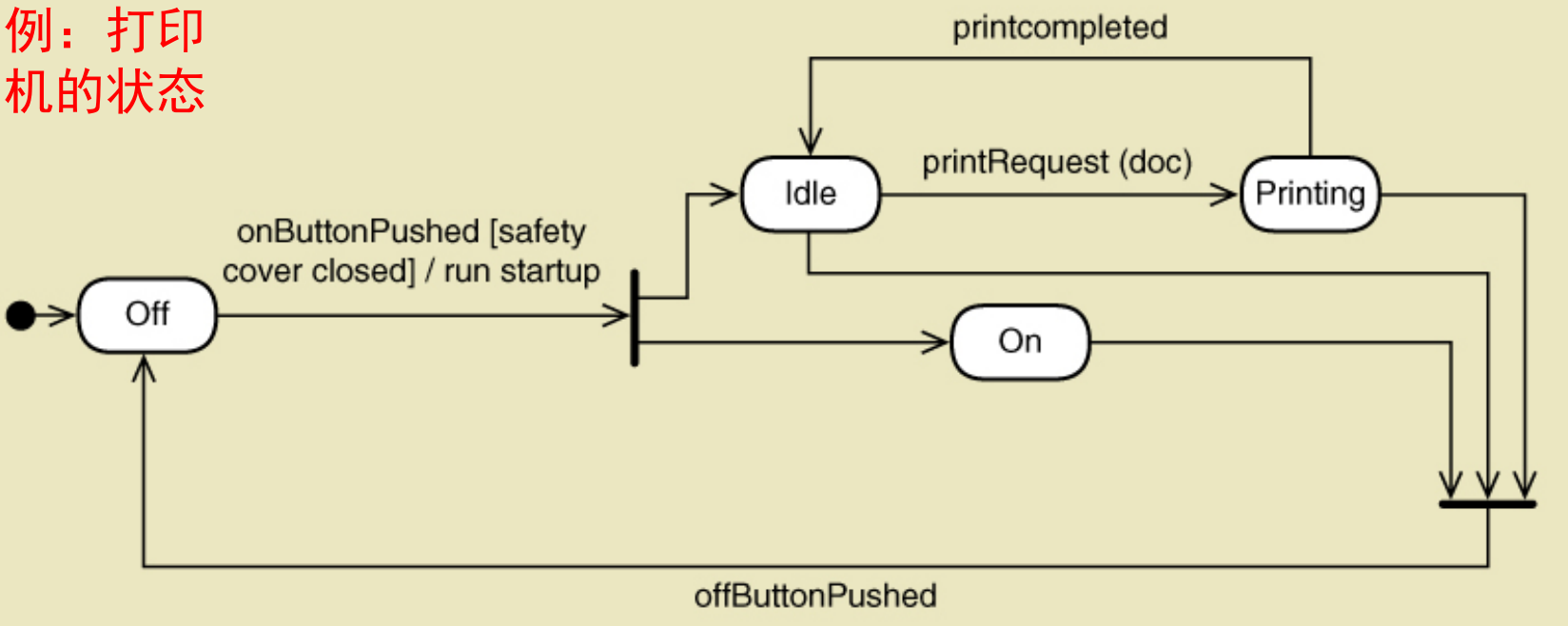
例：打印机的状态



状态机图—确定对象的行为

- 状态机图中的并发状态【Concurrency】
  - 并发的符号与活动图的一样

例：打印机的状态



状态机图—确定对象的行为

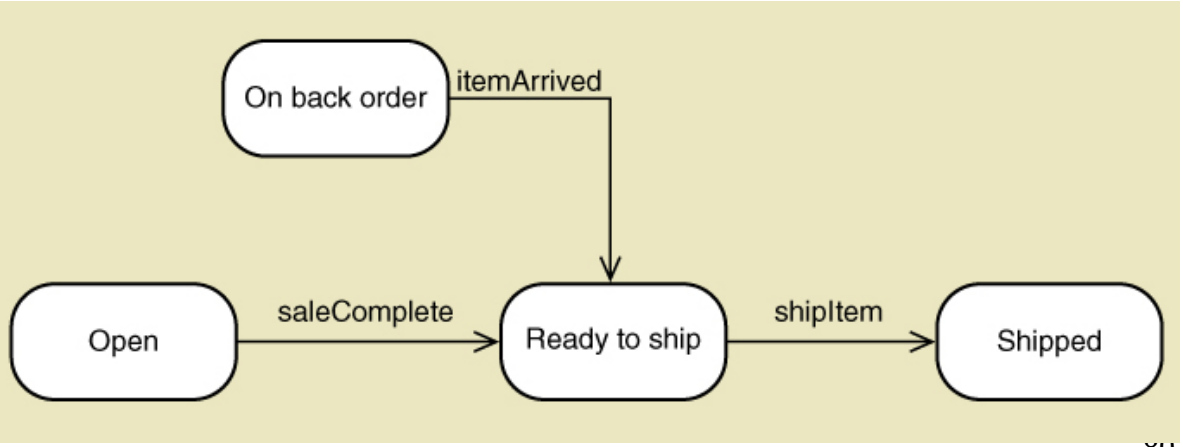
- 创建状态机图的步骤：
  1. 审查类图，选择可能需要状态机图的类
  2. 对于所选的每个类，列出它的所有状态条件
  3. 通过确定使对象状态改变的转换（事件），开始创建状态机图的片段
  4. 将这些片段按正确的顺序连起来
  5. 审查状态的路径，看看是否有独立的、并发的路径
  6. 寻找额外的转换
  7. 扩展每个转换，为其标注合适的消息事件、触发条件和动作表达式
  8. 审查和测试每个状态机图

案例：创建状态机图

- 以SaleItem类为例：
  1. 从类图中选择SaleItem类
  2. 列出其所有状态及转换

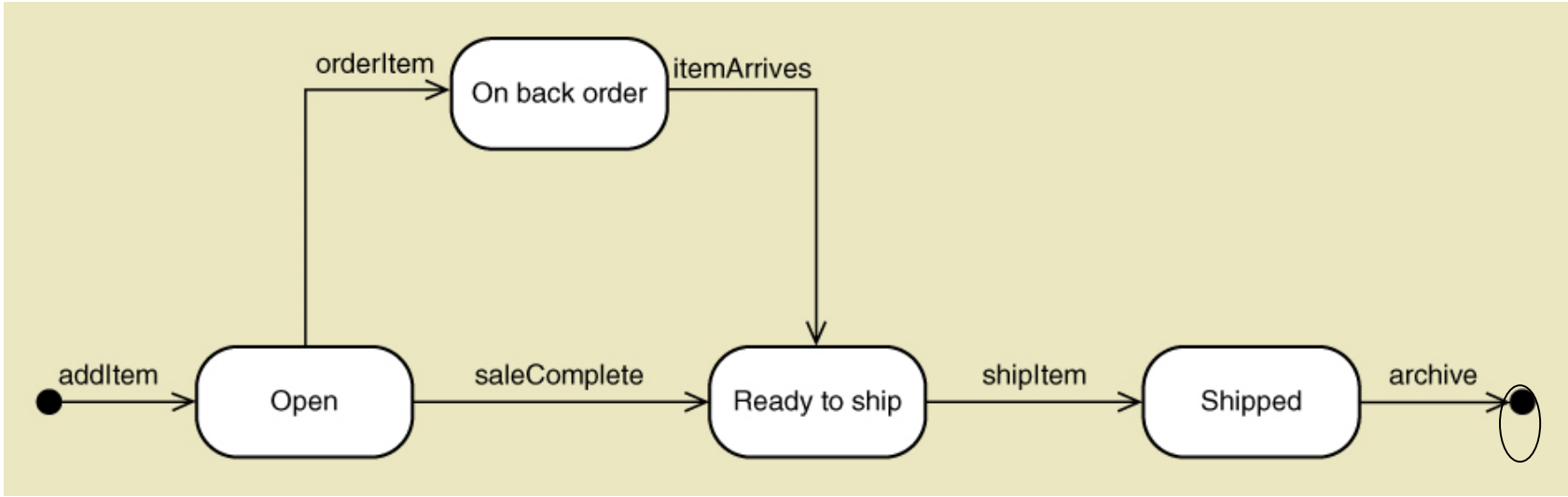
State	Transition causing exit
Open	saleComplete
Ready to Ship	shipItem
On back order	itemArrived
Shipped	No exit transition defined

3. 创建片段
4. 连接片段
5. 寻找并发路径（未发现）



案例：创建状态机图

6. 添加其他必需的转换
7. 扩展触发条件、动作表达式等
8. 审查和测试

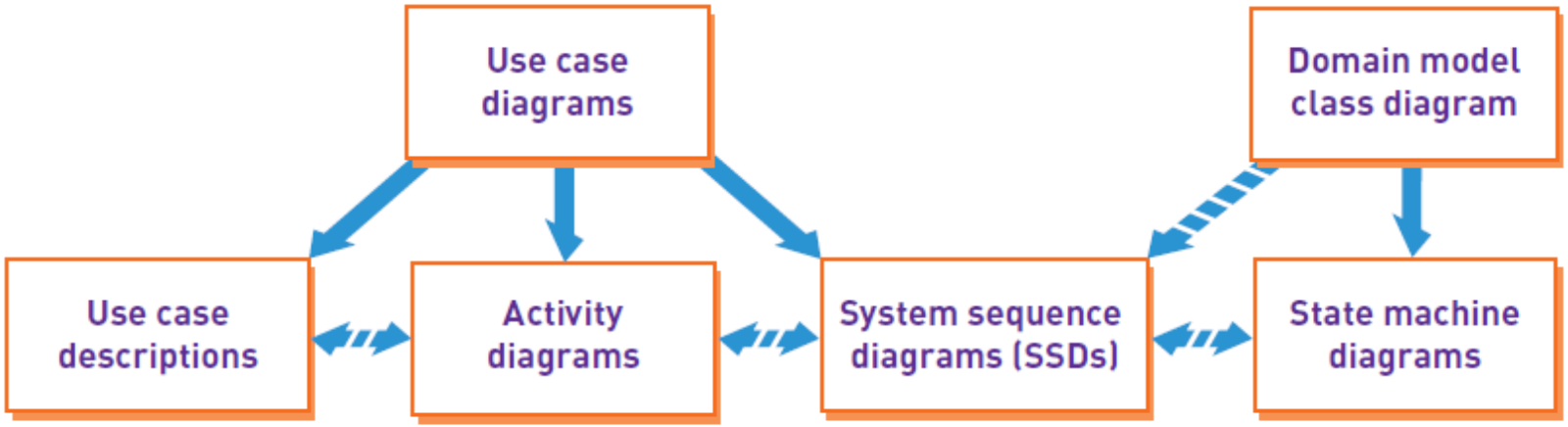


整合需求模型

- 对于迭代开发，需求模型要注意如下几点：
  - 在项目早期，绘制一个完整的用例图有利于界定系统的边界
  - 对于用例的更多细节，如：用例描述、活动图、系统顺序图等，则只需要搞清楚当前迭代涉及的用例即可
  - 类似地，在项目早期绘制一个完整的领域类图也有助于标明系统的范围，也有助于数据库的设计
  - 对于类的细化和实现，则放在后续的迭代中涉及时再做

整合需求模型

- 需求模型之间的关系



  - 实箭头表示主要的依赖关系，虚箭头表示次要的依赖关系，双箭头表示互相依赖关系

Thank you!