# *lecture 4: sequence & use case diagrams*

csc302h
winter 2014

## *administrative*

*last call for groups!*

## *misc. announcements*

Robots Among Us?
Socially assistive human-robot interaction

Maja Mataric

Chan Soon-Shiong Chair, Computer Science, Neuroscience and Pediatrics; Vice Dean for Research, Viterbi School of Engineering; Founding Director, USC Center for Robotics and Embedded Systems; Director, USC Robotics Research Lab

Tuesday, January 14

Mataric's lab focuses on enabling robots to help people through social rather than physical assistance. Her research into socially assistive robotics is developing robot-aided therapies for autism, stroke rehabilitation, dementia, and obesity mitigation by developing algorithms for human-robot interaction that involve embodiment, social dynamics, and long-term adaptation. Among other honors, Mataric is a Fellow of the AAAS and IEEE, recipient of the Presidential Mentoring Award, the Okawa Foundation Award, NSF Career Award, MIT TR35 Innovation Award, and the IEEE Robotics and Automation Society Early Career Award.

BA1180 @ 11:00 am today!

## *misc. announcements (2)*

your department turns 50 this year!

check out this article in UofTMagazine:
[http://www.magazine.utoronto.ca/time-capsule/paving-the-way-for-the-information-highway-calvin-gotlieb-j-n-patterson-hume-beatrice-worsley/](http://www.magazine.utoronto.ca/time-capsule/paving-the-way-for-the-information-highway-calvin-gotlieb-j-n-patterson-hume-beatrice-worsley/)

## *recap from last time*

- reverse-engineering models from software & design discovery
- software evolution
  - (Lehman) program types
  - S/P/E-type: only really care about E-type (embedded) when discussing software evolution
  - laws of software evolution (also Lehman)
- cost of software aging. ways to improve longevity. reducing maintenance costs for each type of development (recall pie chart)

## *recap from last time (2)*

- how tools can help
  - code browsing
  - refactoring (for greater clarity)
  - documentation
  - design discovery (uml model generation)
- what tools can't do
  - tell you what the developer was thinking
  - make a bad developer good

## *sequence diagrams*

## Modeling Software Behaviour

→ (briefly: making UML abstractions…)

→ UML sequence Diagrams

→ Comparing Traces

→ Explaining Design Patterns

→ Style tips

# Uses of UML

## As a sketch

- Very selective - informal and dynamic
- Forward engineering: describe some concept you need to implement
- Reverse engineering: explain how some part of the program works

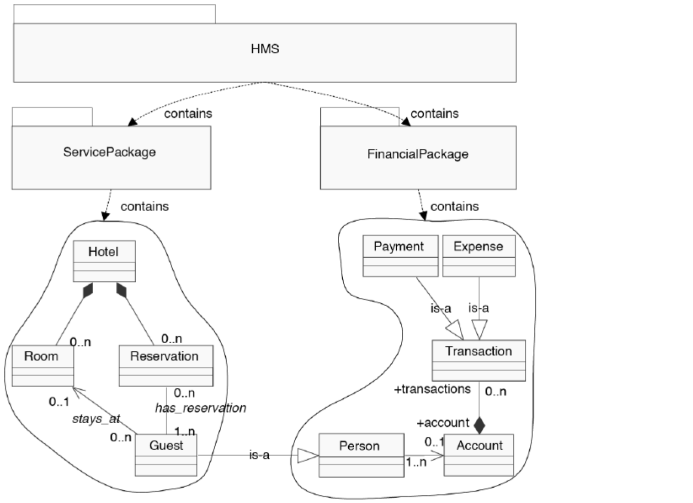
## As a blueprint

- Emphasis on completeness
- Forward engineering: model as a detailed spec for the programmer
- Reverse engineering: model as a code browser
- Roundtrip: tools provide both forward and reverse engineering to move back and forth between program and code

## As a Programming language

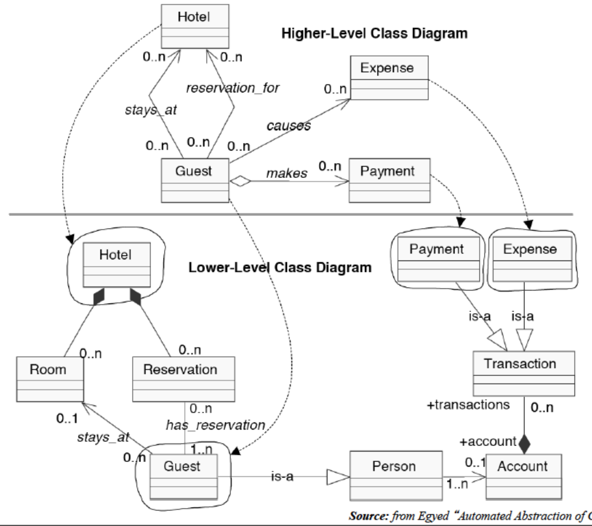
- UML models are automatically compiled into working code
- Requires sophisticated tools
- "tripless" - the model is the code

# Package Decomposition



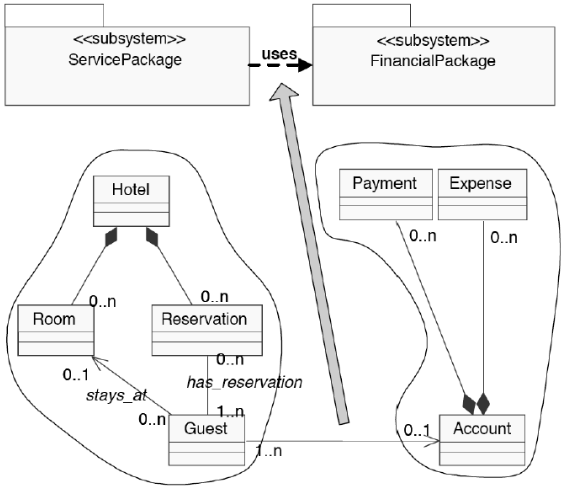
*Source:* from Egyed "Automated Abstraction of Class Diagrams, TSE 2002

# Class Abstraction



*Source:* from Egyed "Automated Abstraction of Class Diagrams, TSE 2002

# Finding Dependencies



*Source:* from Egyed "Automated Abstraction of Class Diagrams, TSE 2002

# Things to Model

## E.g. Structure of the code

- Code Dependencies
- Components and couplings

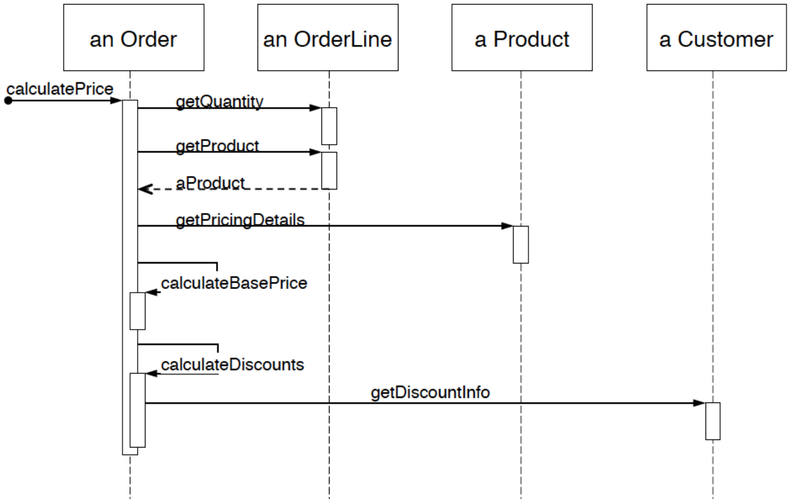
## E.g. Behaviour of the code

- Execution traces
- State machines models of complex objects

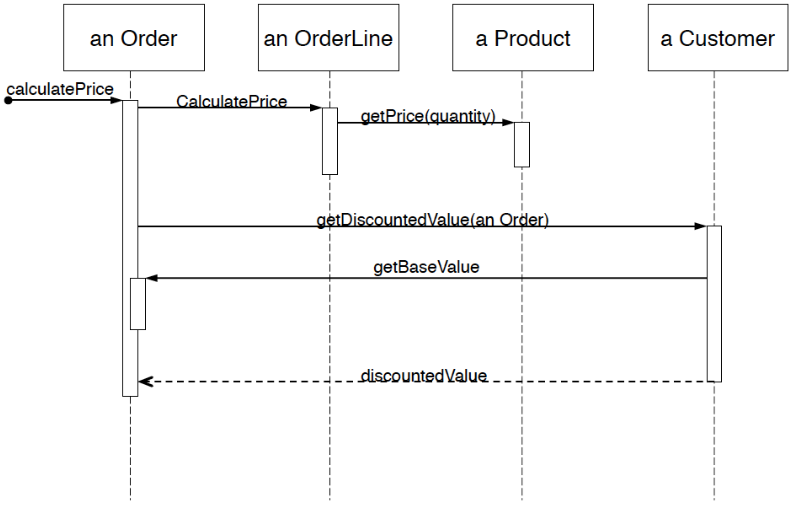
## E.g. Function of the code

- What functions does it provide to the user?

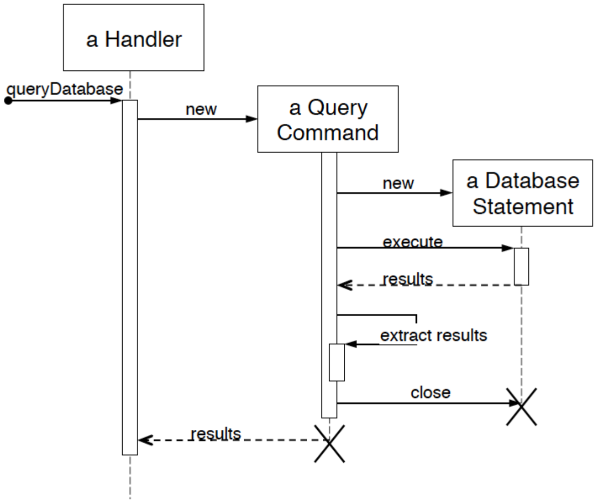
# Sequence Diagrams



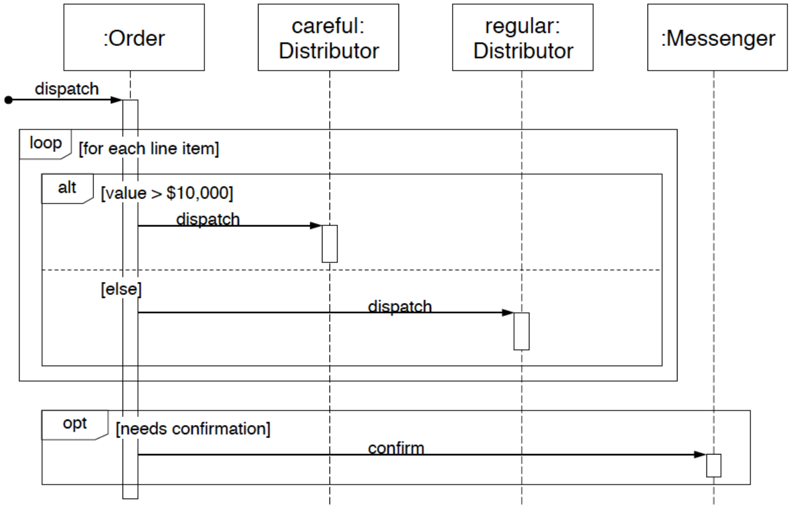
# Design Choices...



# Creating and Deleting Objects



# Interaction Frames



# Interaction Frame Operators

| Operator | Meaning |
|---|---|
| alt | Alternative; only the frame whose guard is true will execute |
| opt | Optional; only executes if the guard is true |
| par | Parallel; frames execute in parallel |
| loop | Frame executes multiple times, guard indicates how many |
| region | Critical region; only one thread can execute this frame at a time |
| neg | Negative; frame shows an invalid interaction |
| ref | Reference; refers to a sequence shown on another diagram |
| sd | Sequence Diagram; used to surround the whole diagram (optional) |

# When to use Sequence Diagrams

## Comparing Design Options

- Shows how objects collaborate to carry out a task
- Graphical form shows alternative behaviours

## Assessing Bottlenecks

- E.g. an object through which many messages pass

## Explaining Design Patterns

- Enhances structural models
- Good for documenting behaviour of design features

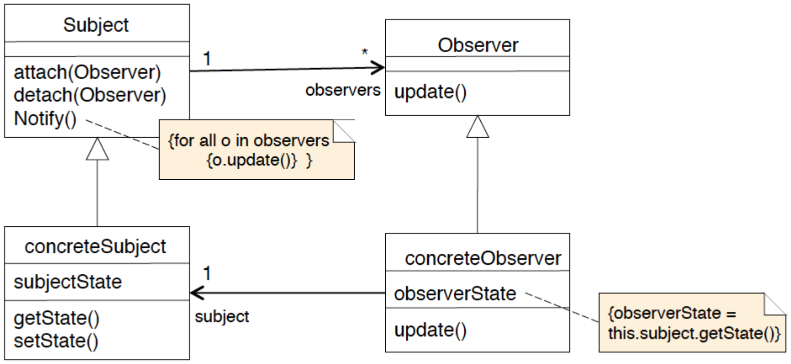
## Elaborating Use Cases

- Shows how the user expects to interact with the system
- Shows how the user interface operates

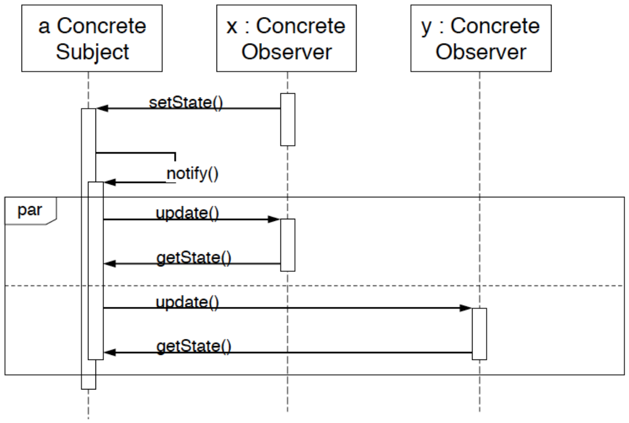
# Modeling a Design Pattern

## E.g. Observer Pattern

- For a one-to-many dependency, when you need to maintain consistency
- The subject pushes updates to all the observers



# Sequence Diagram for Observer



# Style Guide for Sequence Diagrams

## Spatial Layout

Strive for left-to-right ordering of messages

Put proactive actors on the left

Put reactive actors on the right

## Readability

Keep diagrams simple

Don' t show obvious return values

Don' t show object destruction

## Usage

Focus on critical interactions only

## Consistency

Class names must be consistent with class diagram

Message routes must be consistent with (navigable) class associations

# *use case diagrams*

# "Use Case"-Driven Design

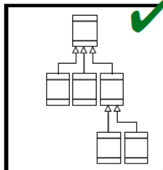
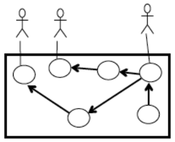
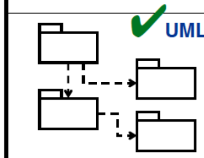
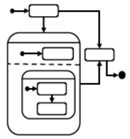
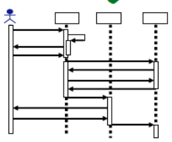
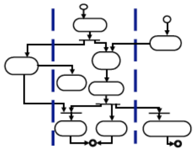
→ User Stories in Agile Development

→ Introducing UML into the Software Process

→ Domain Models

→ Use Cases

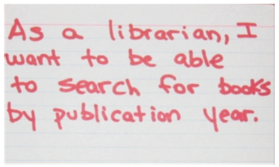
# Refresher: UML Notations

| | |
|---|---|
|  ✓ **UML Class Diagrams**<br>information structure<br>relationships between data items<br>modular structure for the system |  **Use Cases**<br>user' s view<br>Lists functions<br>visual overview of the main requirements |
|  ✓ **UML Package Diagrams**<br>Overall architecture<br>Dependencies between components |  **(UML) Statecharts**<br>responses to events<br>dynamic behavior<br>event ordering, reachability, deadlock, etc |
|  ✓ **UML Sequence Diagrams**<br>individual scenario<br>interactions between users and system<br>Sequence of messages |  **Activity diagrams**<br>business processes;<br>concurrency and synchronization;<br>dependencies between tasks; |

# What do users want?

## User Stories

- Used in XP, Scrum, etc.
- Identify the user (role) who wants it
- Typically written on notecards



As a librarian, I want to be able to search for books by publication year.

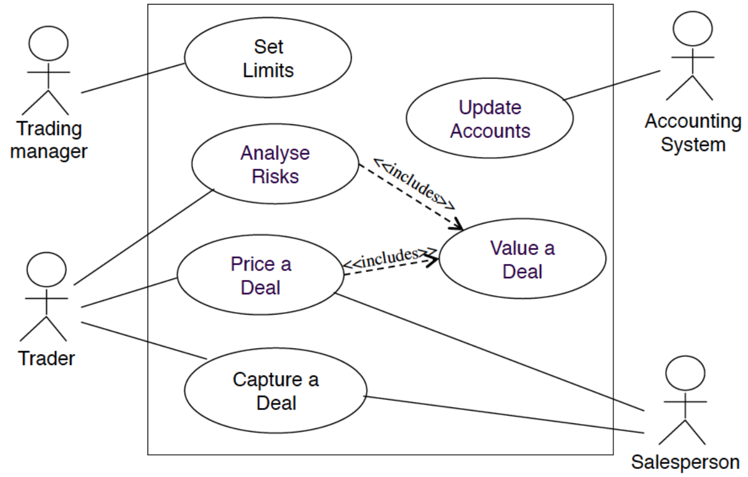
## (User Interface) Storyboards

- Sketch of how a user will do a task
- Shows the interactions at each step
- Commonly used in UI Design

## Use Cases

- Sets of user features
- UML diagram shows inter-relationships

# Use Case Diagram



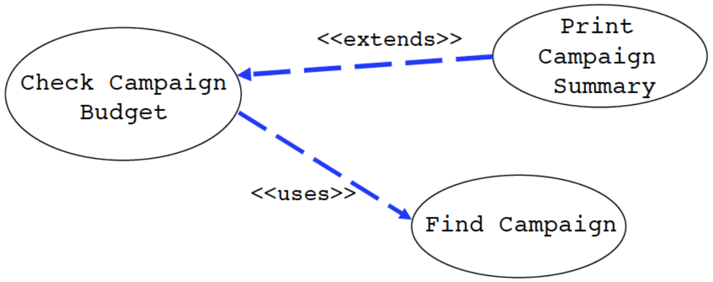
# Relationships between Use Cases

**<<extends>> when one use case adds behaviour to a base case**

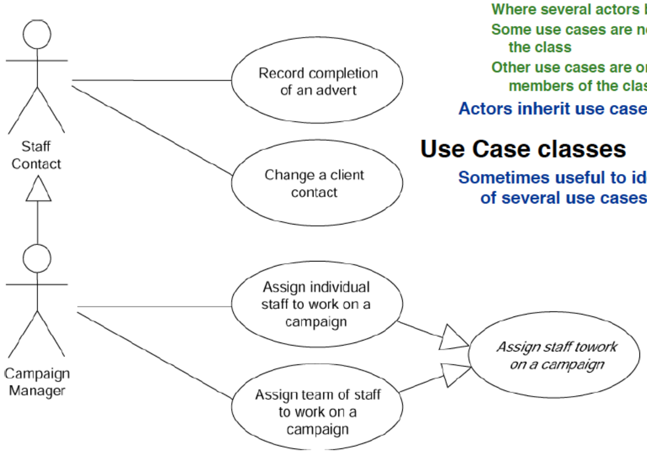
- used to model a part of a use case that the user may see as optional system behavior;
- also models a separate sub-case which is executed conditionally.

**<<uses>>: one use case invokes another (like a procedure call);**

- used to avoid describing the same flow of events several times
- puts the common behavior in a use case of its own.



# Using Generalizations



## Actor classes

- Identify classes of actor
  - Where several actors belong to a single class
  - Some use cases are needed by all members in the class
  - Other use cases are only needed by some members of the class
- Actors inherit use cases from the class

## Use Case classes

- Sometimes useful to identify a generalization of several use cases

# Describing Use Cases

## For each use case:

- a "flow of events" document, written from an actor's point of view.
- describes what the system must provide to the actor when the use case is executed.

## Typical contents

- How the use case starts and ends;
- Normal flow of events;
- Alternate flow of events;
- Exceptional flow of events;

## Documentation style:

- Choice of how to elaborate the use case:
  - English language description
  - Activity Diagrams - good for business process
  - Collaboration Diagrams - good for high level design
  - Sequence Diagrams - good for detailed design

# Detailed Use Case

**Buy a Product**

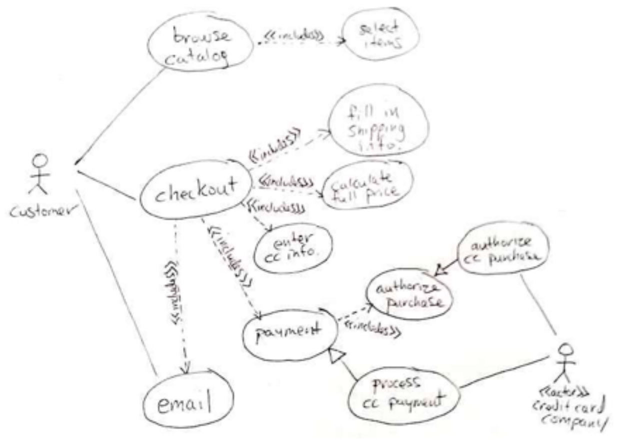
Main Success Scenario:

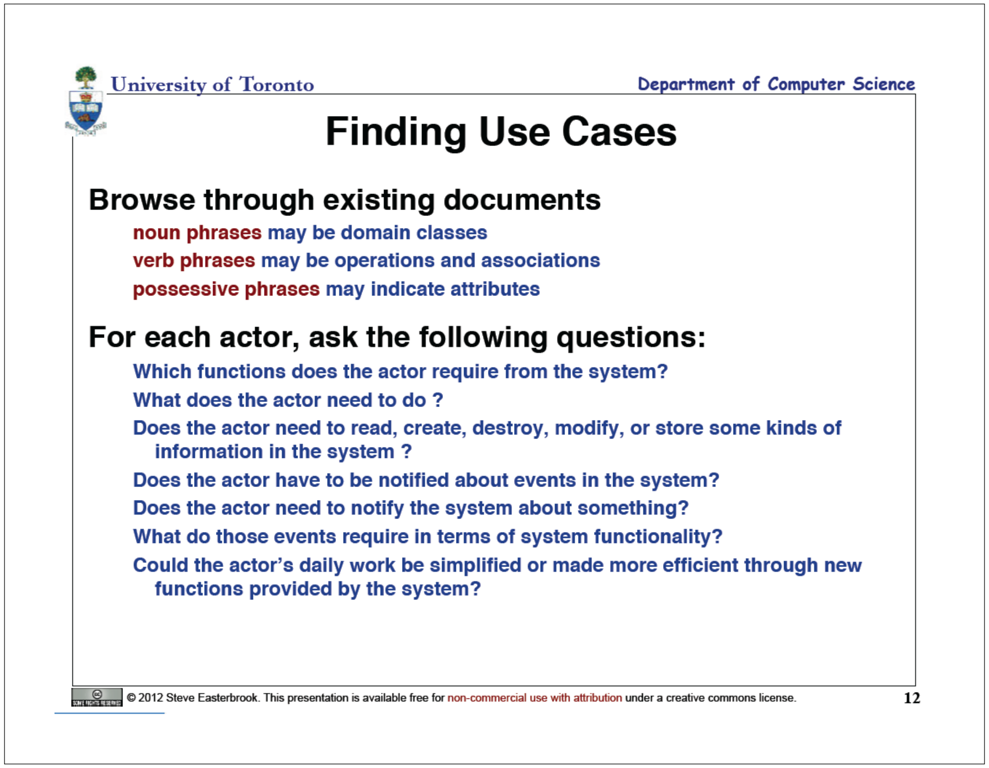
1. Customer browses catalog and selects items to buy
2. Customer goes to check out
3. Customer fills in shipping information (address, next-day or 3-day delivery)
4. System presents full pricing information
5. Customer fills in credit card information
6. System authorizes purchase
7. System confirms sale immediately
8. System sends confirming email to customer

Extensions:

3a: Customer is Regular Customer
  .1 System displays current shipping, pricing and billing information
  .2 Customer may accept or override these defaults, returns to MSS at step 6
6a: System fails to authorize credit card
  .1 Customer may reenter credit card information or may cancel

# *detailed use case to diagram*





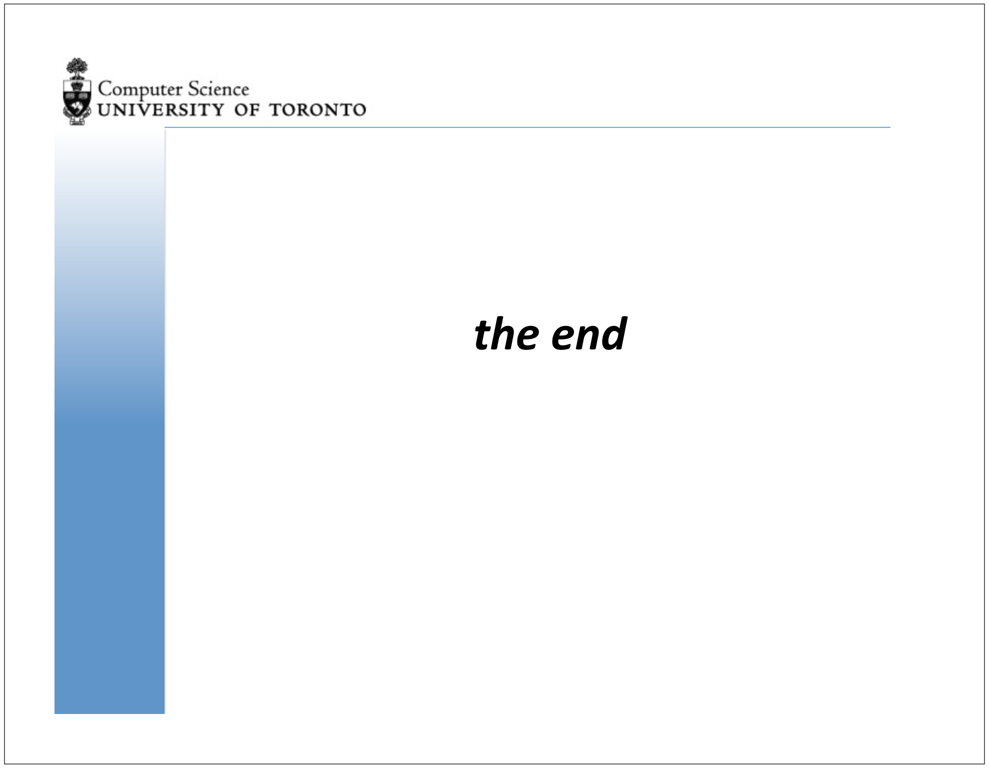
# Finding Use Cases

## Browse through existing documents

- noun phrases may be domain classes
- verb phrases may be operations and associations
- possessive phrases may indicate attributes

## For each actor, ask the following questions:

- Which functions does the actor require from the system?
- What does the actor need to do ?
- Does the actor need to read, create, destroy, modify, or store some kinds of information in the system ?
- Does the actor have to be notified about events in the system?
- Does the actor need to notify the system about something?
- What do those events require in terms of system functionality?
- Could the actor's daily work be simplified or made more efficient through new functions provided by the system?



***the end***