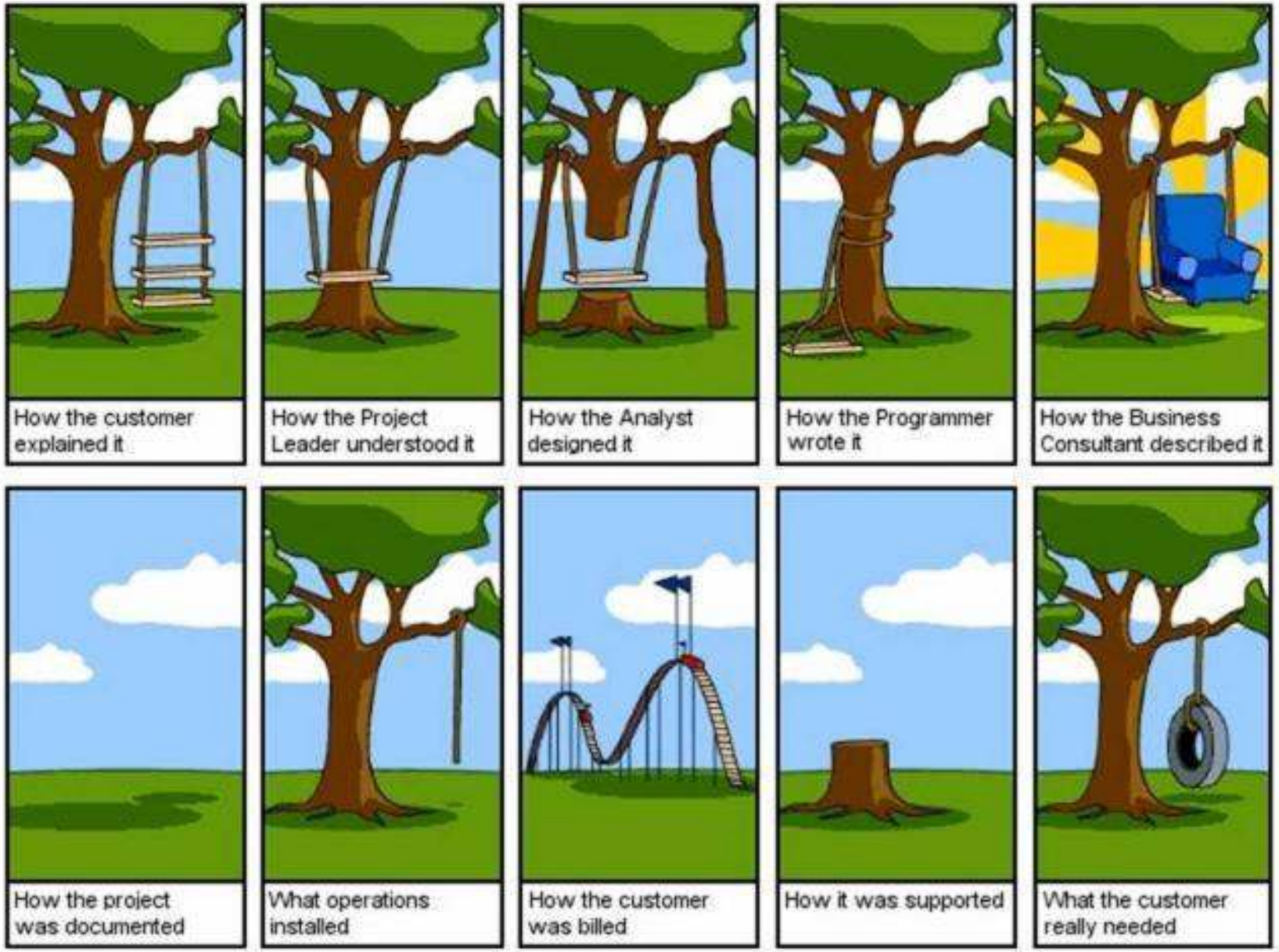
# Requirements



# Lecture outline

- What are requirements?
- How can we gather requirements?
- How can we document requirements?
- Use cases

# Software requirements

Requirements specify what to build

- tell “what” and not “how”
- tell the problem, not the solution
- reflect system design, not software design

# "what vs. how": it's relative

- One person's *what* is another person's *how*.
  - "One person's constant is another person's variable." [Perlis]

- Input file processing is the what, parsing is the how
- Parsing is the what, a stack is the how
- A stack is the what, an array or a linked list is the how
- A linked list is the what, a doubly linked list is the how
- A doubly linked list is the what, `Node*` is the how

# Why requirements?

- Some goals of doing requirements:
  - understand precisely what is required of the software
  - communicate this understanding precisely to all development parties
  - control production to ensure that system meets specs (including changes)

- Roles of requirements
  - customers: show what should be delivered; contractual base
  - managers: a scheduling / progress indicator
  - designers: provide a spec to design
  - coders: list a range of acceptable implementations / output
  - QA / testers: a basis for testing, validation, verification

# Classifying requirements

- The classic way to classify requirements:
  - **functional**: map inputs to outputs
    - "The user can search either all databases or a subset."
    - "Every order gets an ID the user can save to account storage."
  - **nonfunctional**: other constraints
    - ilities: dependability, reusability, portability, scalability, performance, safety
    - "Our deliverable documents shall conform to the XYZ process."
    - "The system shall not disclose any personal user information."
- Another way to classify them (S. Faulk, U. of Oregon)
  - **Behavioral (user-visible)**: about the artifact (often measurable)
    - features, performance, security
  - **Development quality attributes**: about the process (can be subjective)
    - flexibility, maintainability, reusability

# General classes of requirements

Example requirements types:

- Feature set
- GUI
- Performance
- Reliability
- Expansibility  (support plug-ins)
- Environment (HW, OS, browsers)
- Schedule

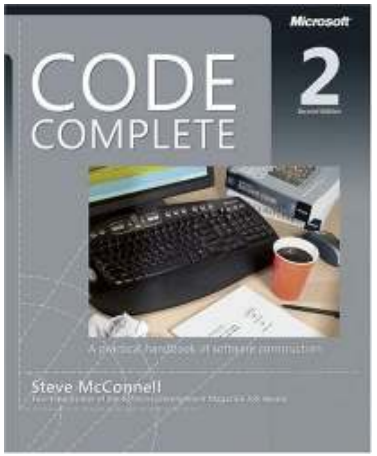
# Gather requirements from users

The #1 reason that projects succeed is user involvement

– Standish group survey of over 8000 projects

Easy access to end users is one of three critical success factors in rapid-development projects

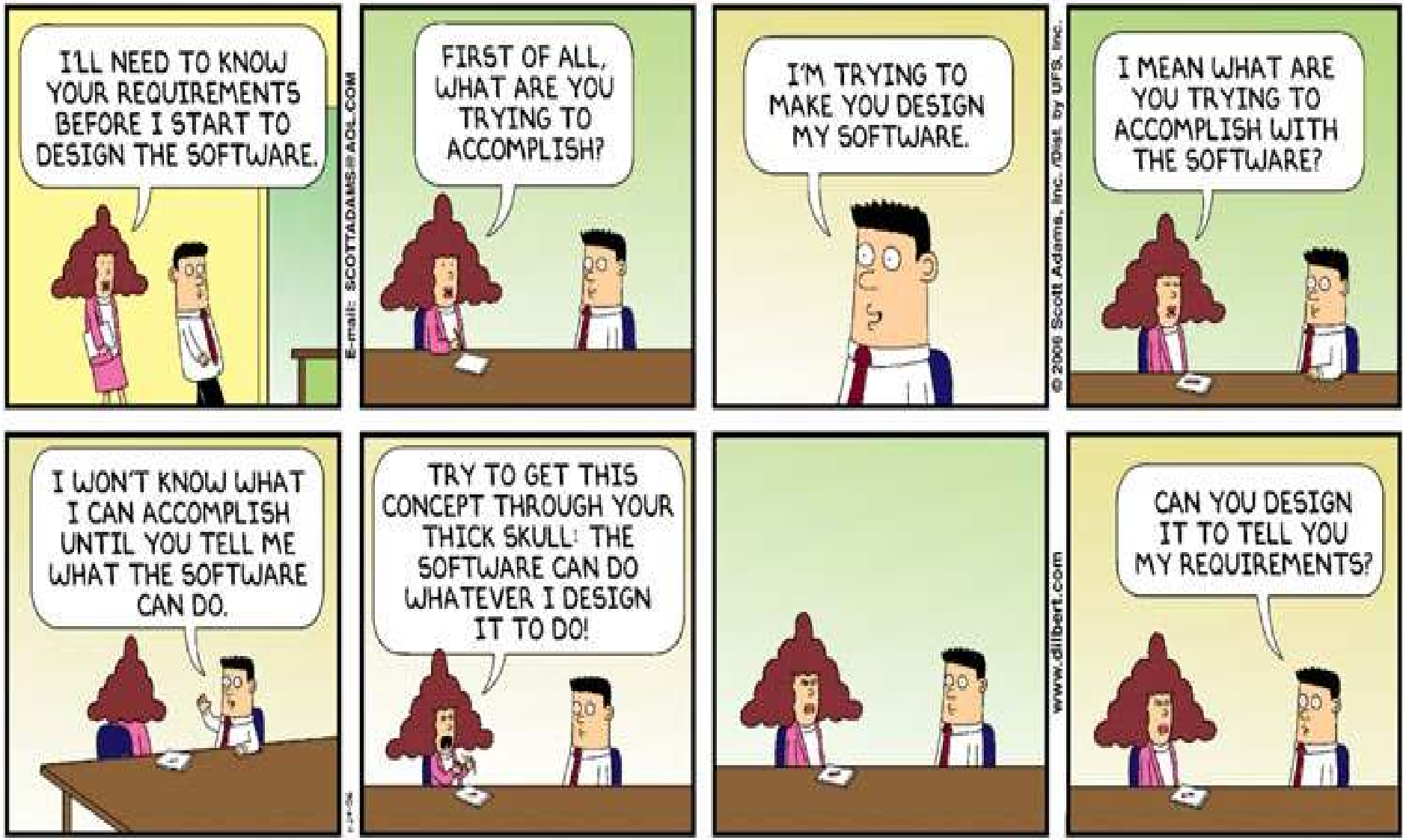
– Steve McConnell



# How do we gather requirements?

Benefits of working with customers:

- Good relations improve development speed
- Improves perceived development speed
- They don’t always know what they want
- They do know what they want, and it changes over time



# "Digging" for requirements

How does one find out the requirements for a project?

- Do:
  - Talk to the users, or work with them, to learn how they work.
  - Ask questions throughout the process to "dig" for requirements.
  - Think about *why* users do something in your app, not just what.
  - Allow (and expect) requirements to change later.
- Don't:
  - Describe complex business logic or rules of the system.
  - Be too specific or detailed.
  - Describe the exact user interface used to implement a feature.
  - Try to think of everything ahead of time.  (You will fail.)
  - Add unnecessary features not wanted by the customers.

# Feature creep/bloat

- **feature creep**: Gradual accumulation of features over time.
  - Often has a negative overall effect on a large software project.

- Why does feature creep happen? Why is it bad?
  Can you think of any products that have had feature creep?
  - Because features are "fun"
    - developers like to code them
    - marketers like to brag about them
    - users (think they) want them
    - ... but too many means more bugs, more delays, less testing, ...

- "stone soup" and "boiled frog" analogies

# DRY and abstractions

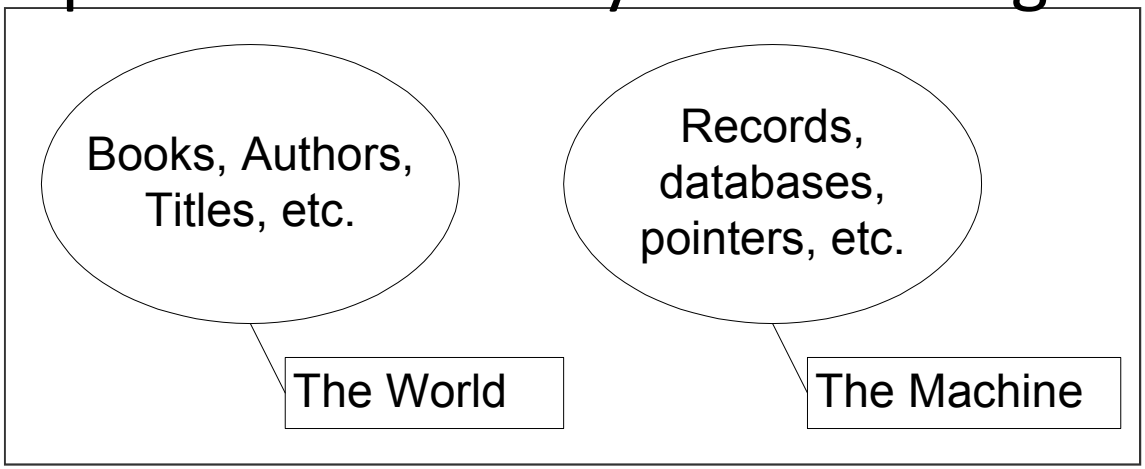
- Y2K was (in a sense) a requirements problem.
  - coders didn't consolidate date logic in one place for easy change
  - should have had a requirement such as:
    - "The system will be designed for expandability such that it can be easily modified later to work in years 2000 and beyond."

- **DRY principle**: Don't Repeat Yourself.
  - Abstractions live longer than details.
  - A good abstraction allows you to change/fix details later.

- "Premature optimization is the root of all evil." -- Donald Knuth

# The machine and the world

- The requirements are in the application domain
- The program defines the machine that has an effect in the application domain
- Example: a database system dealing with books




- There are things in the world not represented by a given machine
  - Book sequels or trilogies
  - Pseudonyms
  - Anonymous books
- There are things in the machine that don't represent anything in the world
  - Null pointers
  - Deleting a record
  - Back pointers

# Good or bad requirements? (and why?)

- The system will enforce 6.5% sales tax on Washington purchases.
- The system shall display the elapsed time for the car to make one circuit around the track within 5 seconds, in hh:mm:ss format.
- The product will never crash. It will also be secure against hacks.
- The server backend will be written using PHP or Ruby on Rails.
- The system will support a large number of connections at once, and each user will not experience slowness or lag.
- The user can choose a document type from the drop-down list.

# How do we specify requirements?

- Prototype
- Use Cases
- Feature List
- Paper UI prototype

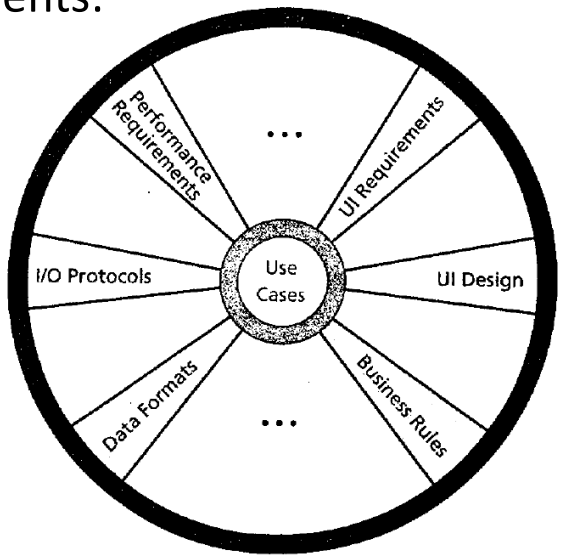
You will create a

System Requirements Specification document

# Cockburn's requirements template

Alistair Cockburn's suggested outline for functional requirements:

1. purpose and scope
2. terms / glossary
3. **use cases (the central artifact of requirements)**
4. technology used
5. other
   - 5a. development process - participants, values (fast-good-cheap), visibility, competition, dependencies
   - 5b. business rules / constraints
   - 5c. performance demands
   - 5d. security (now a hot topic), documentation
   - 5e. usability
   - 5f. portability
   - 5g. unresolved / deferred
6. human issues: legal, political, organizational, training



# Use cases

- A use case is an example behavior of the system
- A use case characterizes a way of using a system
- It represents a dialog between a user and the system, from the user's point of view
- It captures *functional* requirements

- Example:
  - Jane has a meeting at 10AM; when Jim tries to schedule another meeting for her at 10AM, he is notified about the conflict

- Similar to CRC (class responsibility collaborator) cards and Extreme Programming "stories"

# Qualities of a good use case

- starts with a request from an actor to the system
- ends with the production of all the answers to the request
- defines the interactions (between system and actors) related to the function
- takes into account the actor's point of view, not the system's
- focuses on interaction, not internal system activities
- doesn't describe the GUI in detail
- has 3-9 steps in the main success scenario
- is easy to read
- summary fits on a page

# Benefits of use cases

- Establish an understanding between the customer and the system developers of the requirements (success scenarios)
- Alert developers of problematic situations (extension scenarios)
- Capture a level of functionality to plan around (list of goals)

# Terminology

Actor: someone who interacts with the system

Primary actor: person who initiates the action

Goal: desired outcome of the primary actor

Level: top-level or implementation

- summary goals
- user goals
- subfunctions

# Use cases and actors

- *Use cases* represent specific flows of events in the system
- Use cases are initiated by *actors* and describe the flow of events that these actors are involved in
  - Anything that interacts with a use case
  - It could be a human, external hardware (like a timer), or another system

# Do use cases capture these?

Which of these requirements should be represented directly in a use case?

1. Order cost = order item costs * 1.065 tax
2. Promotions may not run longer than 6 months
3. Customers only become Preferred after 1 year
4. A customer has one and only one sales contact
5. Response time is less than 2 seconds
6. Uptime requirement is 99.8%
7. Number of simultaneous users will be 200 max

# Styles of use cases

1. Use case diagram
   - often in UML, the Unified Modeling Language
2. Informal use case
3. Formal use case
   (≠ formal specification)

Let's examine each of these in detail...

# 1. Use case summary diagrams

The overall list of your system's use cases can be drawn as high-level diagrams, with:

- actors as stick-men, with their names (nouns)
- use cases as ellipses, with their names (verbs)
- line associations, connecting an actor to a use case in which that actor participates
- use cases can be connected to other cases that they use / rely on

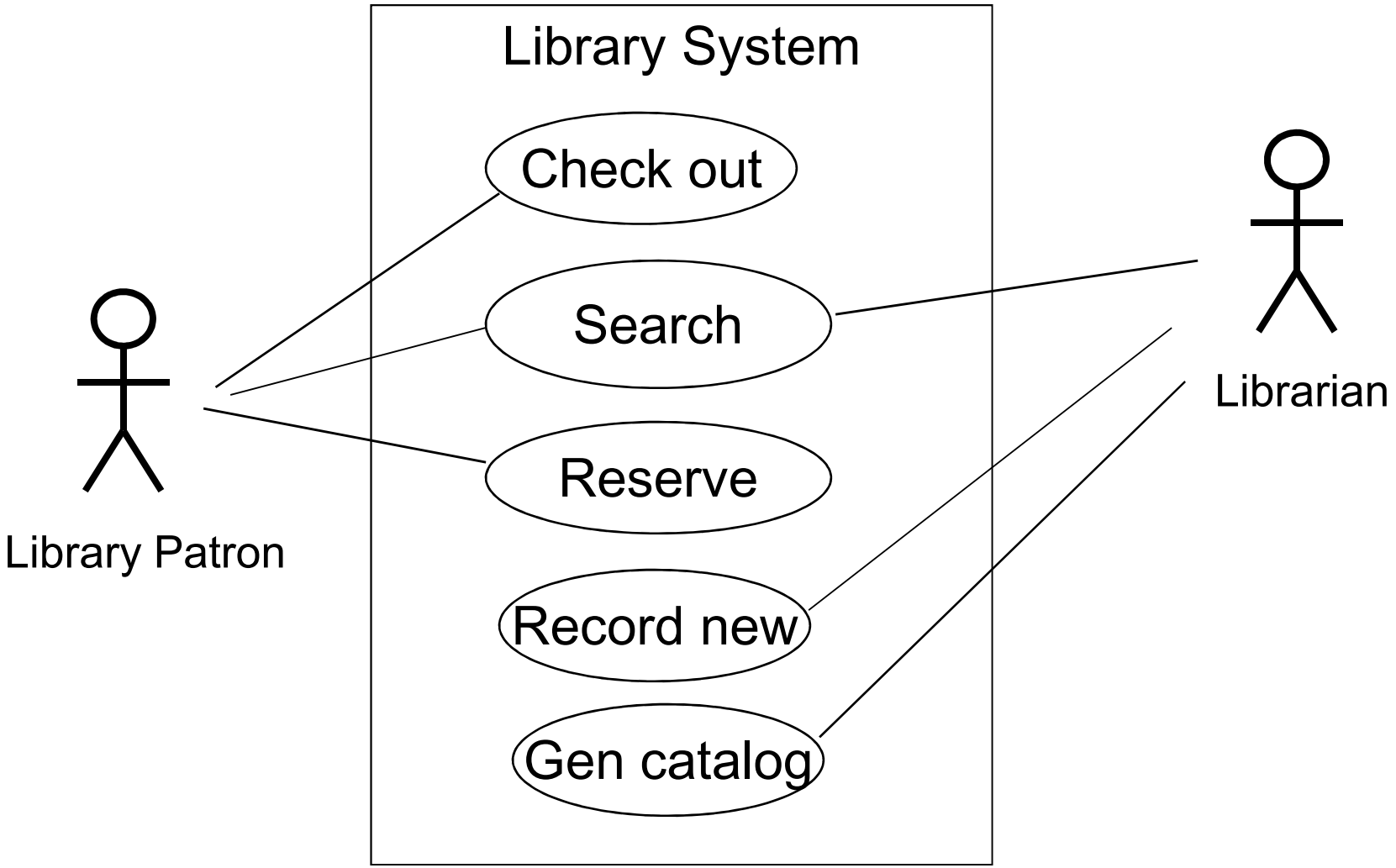

Library patron

# Use case summary diagrams

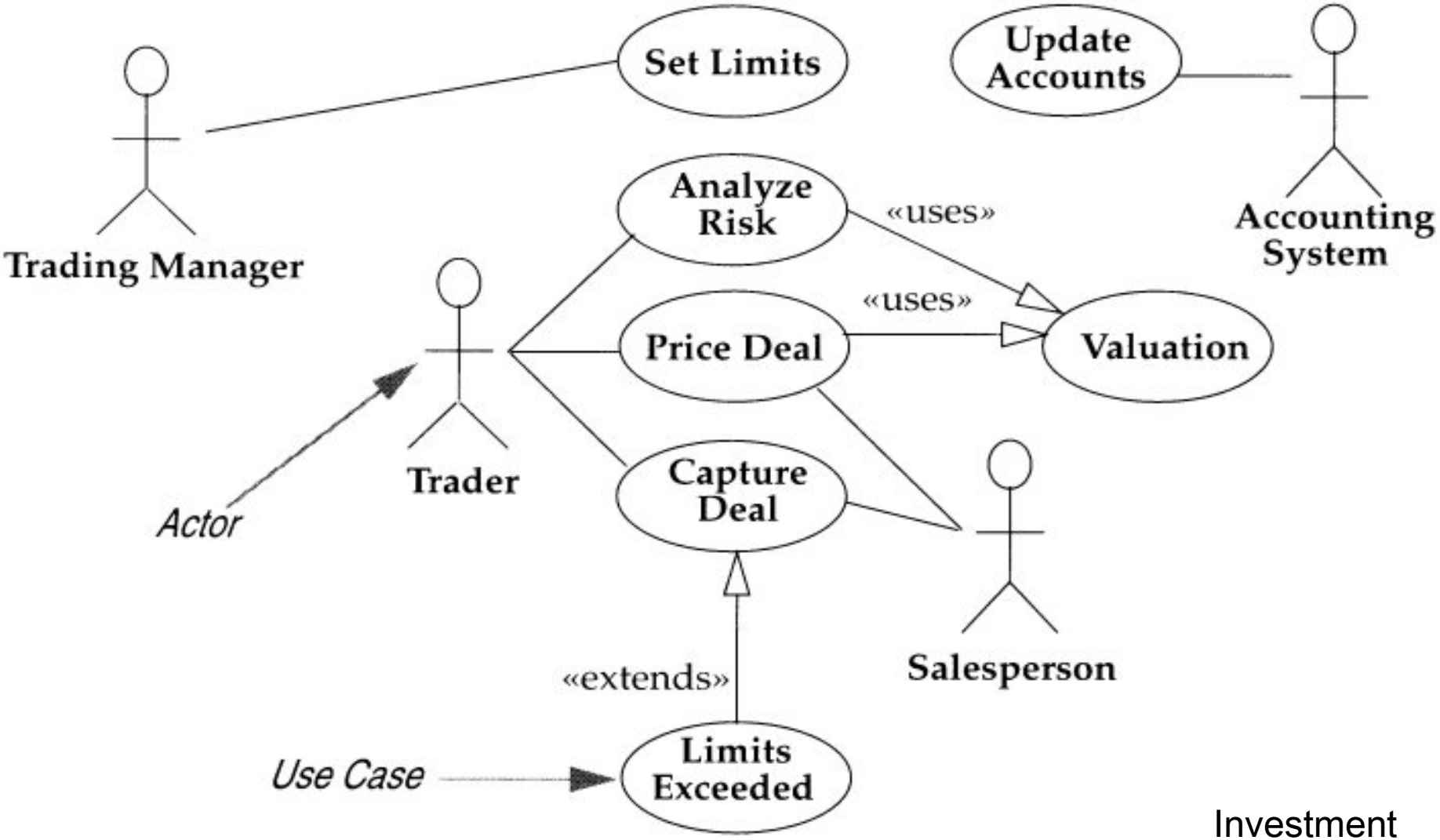
It can be useful to create a list or table of primary actors and their "goals" (use cases they start). The diagram will then capture this material.

| Actor | Goal |
|---|---|
| Library Patron | Search for a book |
| | Check out a book |
| | Return a book |
| Librarian | Search for a book |
| | Check availability |
| | Request a book from another library |

# Use case summary diagram 1



# Use case summary diagram 2




Investment System

# 2. Informal use case

**Informal use case** is written as a paragraph describing the scenario/interaction

- Example:
  - Patron Loses a Book
    The library patron reports to the librarian that she has lost a book.
    The librarian prints out the library record and asks patron to speak with the head librarian, who will arrange for the patron to pay a fee.
    The system will be updated to reflect lost book, and patron's record is updated as well.
    The head librarian may authorize purchase of a replacement book.

# Structured natural language

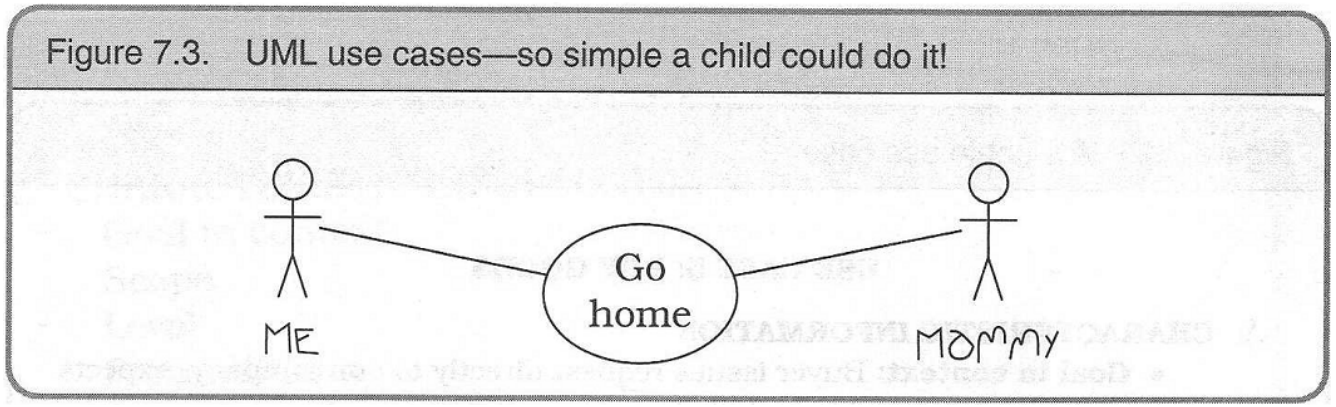
- I
  - I.A
    - I.A.ii
      - I.A.ii.3
        - » I.A.ii.3.q
- Although not ideal, it is almost always better than unstructured natural language
  - Unless the structure is used as an excuse to avoid content
- You will probably use something in this general style

# 3. Formal use case

| | |
|---|---|
| **Goal** | **Patron wishes to reserve a book using the online catalog** |
| **Primary actor** | **Patron** |
| **Scope** | **Library system** |
| **Level** | **User** |
| **Precondition** | **Patron is at the login screen** |
| **Success end condition** | **Book is reserved** |
| **Failure end condition** | **Book is not reserved** |
| **Trigger** | **Patron logs into system** |

| | |
|---|---|
| **Main Success Scenario** | 1. Patron enters account and password<br>2. System verifies and logs patron in<br>3. System presents catalog with search screen<br>4. Patron enters book title<br>5. System finds match and presents location choices to patron<br>6. Patron selects location and reserves book<br>7. System confirms reservation and re-presents catalog |
| **Extensions (error scenarios)** | 2a. Password is incorrect<br>2a.1 System returns patron to login screen<br>2a.2 Patron backs out or tries again<br>5a. System cannot find book<br>5a.1 … |
| **Variations (alternative scenarios)** | 4. Patron enters author or subject |

# What notation is good?




- There are standard templates for requirements documents, diagrams, etc. with specific rules. Is this a good thing? Should we use these standards or make up our own?
  - Good: standards are helpful as a template or starting point; Others are more likely to understand
  - But don't be a slave to formal rules or use a model/scheme that doesn't fit your project's needs.

# Steps in creating a use case

# 1. Identify actors and their goals

What computers, subsystems and people will drive our system? (actors)

What does each actor need our system to do? (goals)

Exercise: actors/goals for your projects

# Identify actors/goals example

- Consider software for a video store kiosk that takes the place of human clerks.
  - A customer with an account can use their membership and credit card at the kiosk to check out a video.
  - The software can look up movies and actors by keywords.
  - A customer can check out up to 3 movies, for 5 days each.
  - Late fees can be paid at the time of return or at next checkout.

- Exercises:
  - Come up with 4 use case names for such software, and draw a UML use case summary diagram of the cases and their actors.
  - Write a formal (complete) use case for the Customer Checks Out a Movie scenario.

# 2. Write the success scenario

- Main success scenario is the preferred "happy path”
  - easiest to read and understand
  - everything else is a complication on this
- Capture each actor's intent and responsibility, from trigger to goal delivery
  - say what information passes between them
  - number each line

# 3. List the failure extensions

- Usually, almost every step can fail (bad credit, out of stock)
- Note the failure condition separately, after the main success scenario
- Describe failure-handling
  - recoverable: back to main course (low stock + reduce quantity)
  - non-recoverable: fails (out of stock, or not a valued customer)
  - each scenario goes from trigger to completion
- Label with step number and letter:
  - 5a  failure condition
    - 5a.1 use case continued with failure scenario
    - 5a.2  continued

- Exercise: What happens if a student looks up a course, and it doesn't exist?

# 4. List the variations

- Many steps can have alternative behaviors or scenarios
- Label with step number and alternative
  - 5’. Alternative 1 for step 5
  - 5’’. Alternative 2 for step 5

# Use case description

- How and when it begins and ends
- The interactions between the use case and its actors, including when the interaction occurs and what is exchanged
- How and when the use case will need data from or store data to the system
- How and when concepts of the problem domain are handled

# Jacobson example: recycling

The course of events starts when the customer presses the “Start-Button” on the customer panel. The panel’s built-in sensors are thereby activated.

The customer can now return deposit items via the customer panel. The sensors inform the system that an object has been inserted, they also measure the deposit item and return the result to the system.

The system uses the measurement result to determine the type of deposit item: can, bottle or crate.

The day total for the received deposit item type is incremented as is the number of returned deposit items of the current type that this customer has returned...

# Another example: Buy a product

http://ontolog.cim3.net/cgi-bin/wiki.pl?UseCasesSimpleTextExample

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

- Alternative: **Authorization Failure**
  - At step 6, system fails to authorize credit purchase
  - Allow customer to re-enter credit card information and re-try
- Alternative: **Regular Customer**
  - 3a. System displays current shipping information, pricing information, and last four digits of credit card information
  - 3b. Customer may accept or override these defaults
  - Return to primary scenario at step 6

# Pulling it all together

*How much is enough?*

You have to find a balance

- comprehensible vs. detailed
- graphics vs. explicit wording and tables
- short and timely vs. complete and late

Your balance may differ with each customer depending on your relationship and flexibility