Requirements analysis

- What do *stakeholders* want from the system?
  - What should it to do?
  - What should it look like? Sound like? Be like?
- Analysis starts with a project description
  - Usually written (or otherwise expressed) by major stakeholder
    - a.k.a. "Client" – might be a customer, another department in the company, management, professor, …
    - Or project team writes it for an *anticipated* market
- Results in a series of RA artifacts: 2 purposes
  - Shows the client what they will be getting
  - Used to kick-off and guide later development activities

RA starts in UP Phase I: Inception

- Purpose is to explore project *feasibility*
- Target length: only about a week
- Identify most use cases and actors
  - And write 10-20% of use cases in detail
  - Used to make *rough* estimate of costs
- Most important requirements artifacts: vision, use cases

Project descriptions

- Client's view: system is basically a "black box"
- Probably vague, repetitive, confused, …
  - But remember: client thinks it "says it all"
- Often has too many details, or misguided focus
  - e.g., implementation details – too limiting at this stage
  - e.g., too many "ilities" – distract from the purpose
- May contain contradictions or impossible parts
  - Often just "wish lists" without clear goals
- So, always expect to re-express as requirements

Doing requirements analysis

- Basically: detailing the requirements
  - But still in language that the user understands
    - i.e., all artifacts continue to treat the system as a black box – focus on what goes in and what comes out
  - For CS 50: write a vision (beefed up) and use cases
- Study much more than the project description
  - Interview users, managers, sponsors, experts, …
  - Learn about current practices, existing systems, business rules (general and specific), memo trails, …
  - But no need to become a domain expert
    - Could take years! A “knowledgeable layperson” is sufficient.

Vision 1: problem statement

- Should answer two fundamental questions:
  - What problem(s) will the system solve?
  - How is the system expected to solve the problem(s)?
- Stakeholders must approve it before proceeding
  - Becomes basis for contract (if real client)
    - Bounds the client's expectations
    - Establishes scope of work
  - Note: might also state what the system will *not* do
- Narrows the focus of the project team
  - Limits the range of system goals

Vision 2: system goals

- Essentially, the system's *major responsibilities*
  - Should solve problems for stakeholders, inc. users
- High-level goals apply to overall system
  - What will the system do, and/or be like?
  - Typically span use cases of a complex system
  - Each stakeholder expects some value from the system – What value?
- User-level goals apply to particular actors
  - i.e., typically apply to particular use cases
  - Each user expects some result from using the system – What result?

Vision 3: system features

- What the system must be able to *do*
  - i.e., particular actions, events, processes, …
  - X is a feature only if it makes sense to say:

    "The system shall do X."
  - Usually expressed in a list like:
    - Display chess board/pieces to players
    - Allow player to move a chess piece
  - List both clarifies the system's requirements, and helps assign responsibilities to classes during design
- CS 50 note: start for assignment 2; supplement and refine later

Vision 4: other requirements and constraints

- Not functional requirements (like “features” are)
  - e.g., fast, cheap, scalable, extensible, …
  - One such characteristic may relate to several features
- Not responsibilities to assign to any class
  - Instead: things to consider throughout development
- Quantify if feasible
  - e.g., “will retrieve data record in 2 seconds or less”
- CS 50 note: this part of vision replaces most of the “supplementary specification” (section 7.4)
  - All except the functionality part of FURPS+
    - Usability, reliability, performance, supportability, plus …

The FURPS+ Model

- Functional
  - features, capabilities, security
- Usability
  - human factors, help, documentation
- Reliability
  - failure frequency, recoverability, predictability
- Performance
  - response time, throughput, accuracy,...
- Supportability
  - adaptability, maintainability, configurability,...
- + - implementation, operations, packaging, legal, …

What are use cases?

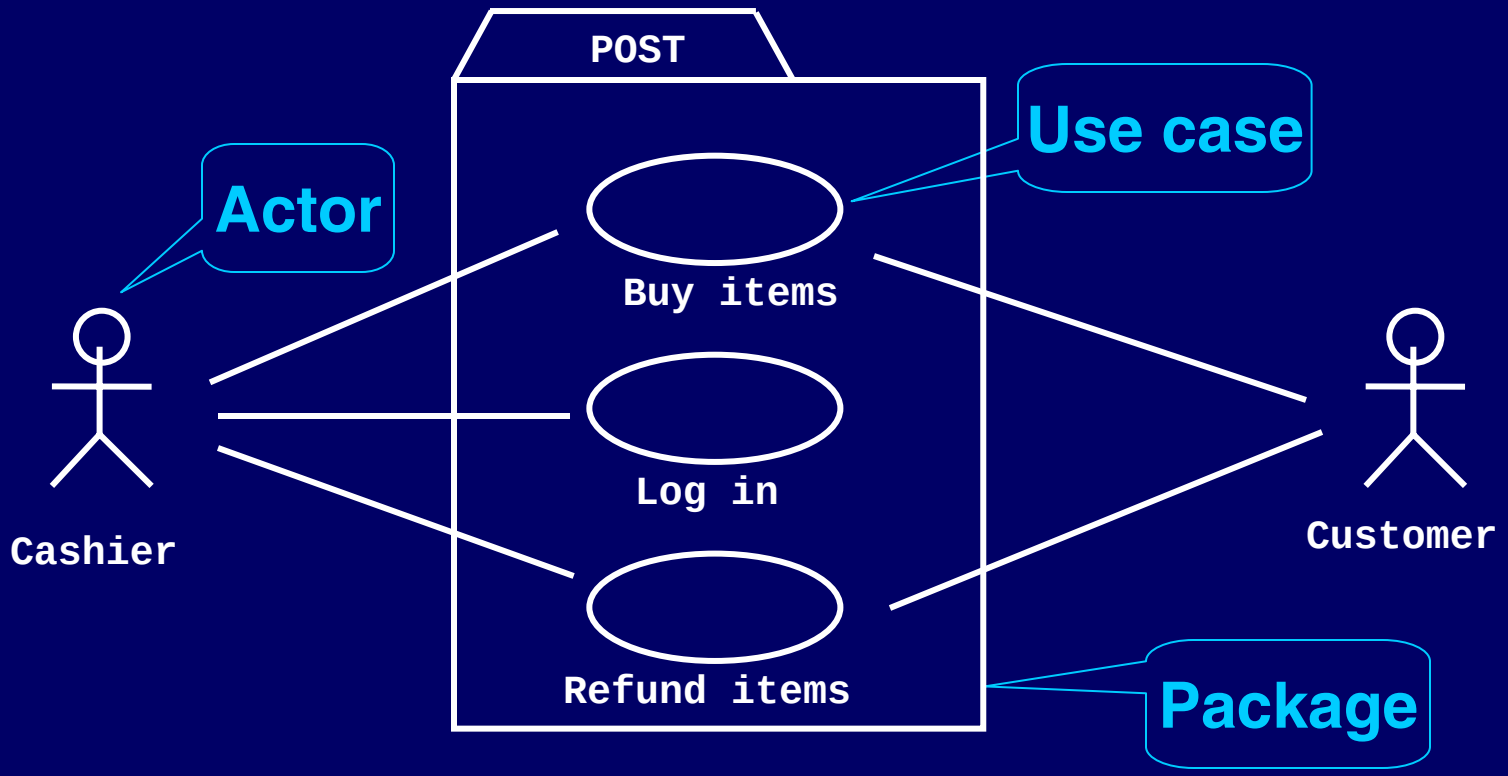
- Answer: *domain processes* in which the *system is a participant* – best described in story format
  - Note: a scenario is a particular instance of a use case
- Other participants are termed actors
  - Include users, other systems, and/or more abstract external things (like a specific date and time)
- The system interacts with these actors
  - An actor will *initiate* each use case
  - The system will *respond* in some way
  - An actor may respond to the system's response
    - And so on … until the use case terminates

Why describe use cases?

- Beneficial to the client
  - Shows exactly how the system works for users
    - Via step-by-step descriptions of user-system interactions
    - In non-technical language the client understands
  - Not as distracting as prototypes
- Can be used to *drive the process*
  - Analysis: “harvest” classes from use case descriptions
  - Design: begin/terminate system sequences, satisfy user interface needs, and more
  - Implementation/testing: insure each case is realized
- Can expose “abuse cases” and “useless cases”

Use case diagrams

- UML to show the functionality of the system from the user's point of view



Use case descriptions

- No strict format, but probably best to include at least the following:
  - Name of use case – first word should be a verb
  - Primary Actor (or actors; never including the system)
  - Main Success Scenario
    - a.k.a. “Basic Flow” or “Typical Course”
    - step-by-step *interactions* – steps are numbered for easy referencing – can be 1 or 2 columns (2 are easier to read)
  - Extensions
    - a.k.a. “Alternative Flows” or “Alternative Courses”
    - Listed at the end, and referenced by step number
    - All conditional branches should be here, not in the basic flow

About types of use cases

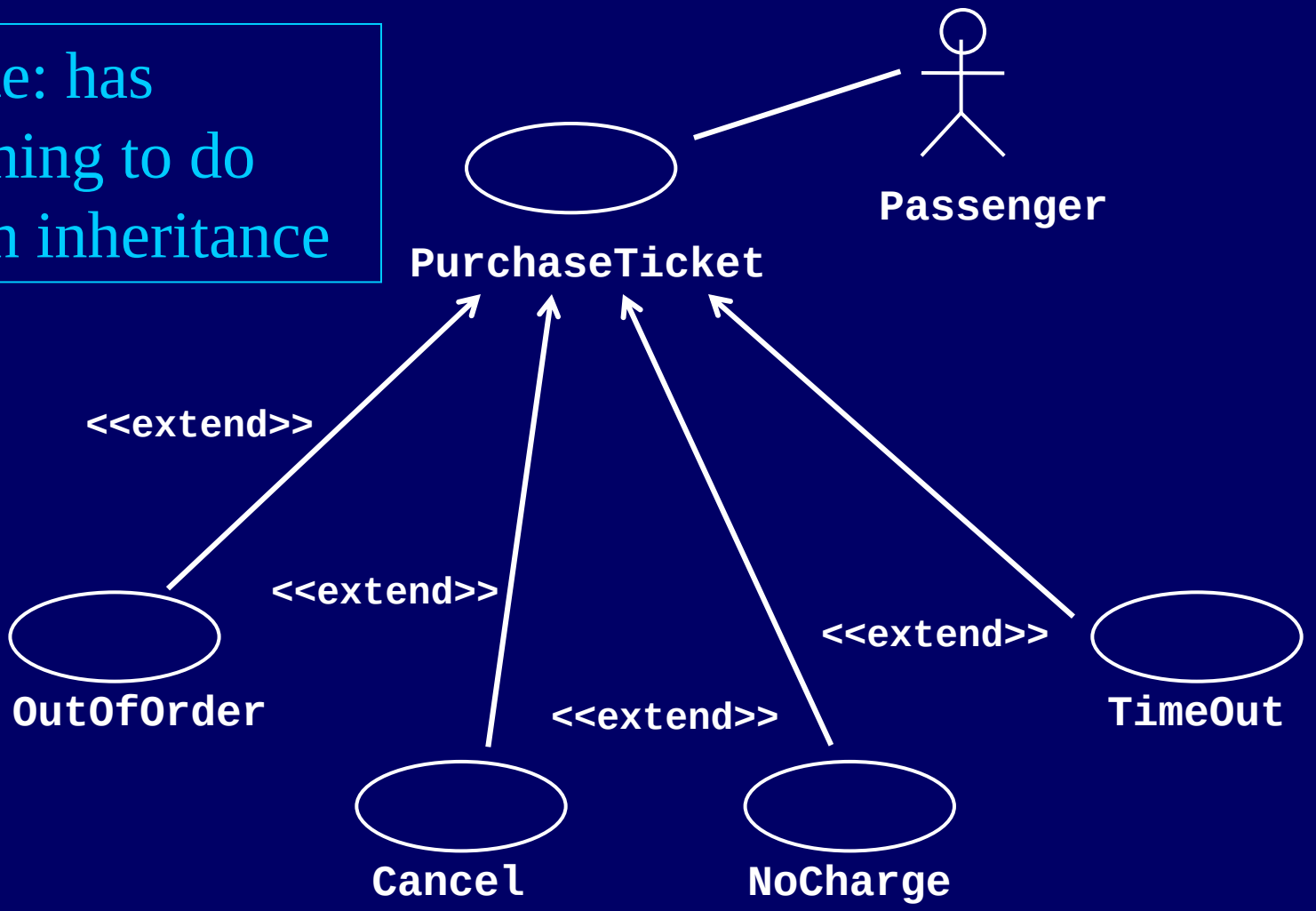
- Often useful to classify in terms of importance:
  - Primary – for major common processes, such as “Buy Items” in the POST system
  - Secondary – for minor or rare processes, such as “Request for Stocking New Product”
  - Optional – may or may not end up in the system
- And a continuum of types in terms of detail:
  - Essential (no design details) – “user identifies self”
    - Most appropriate for early stages of development
  - Real (more explicit) – “user enters ID on keypad”
    - Defer to design stage – otherwise limits design possibilities

Defining use cases in practice

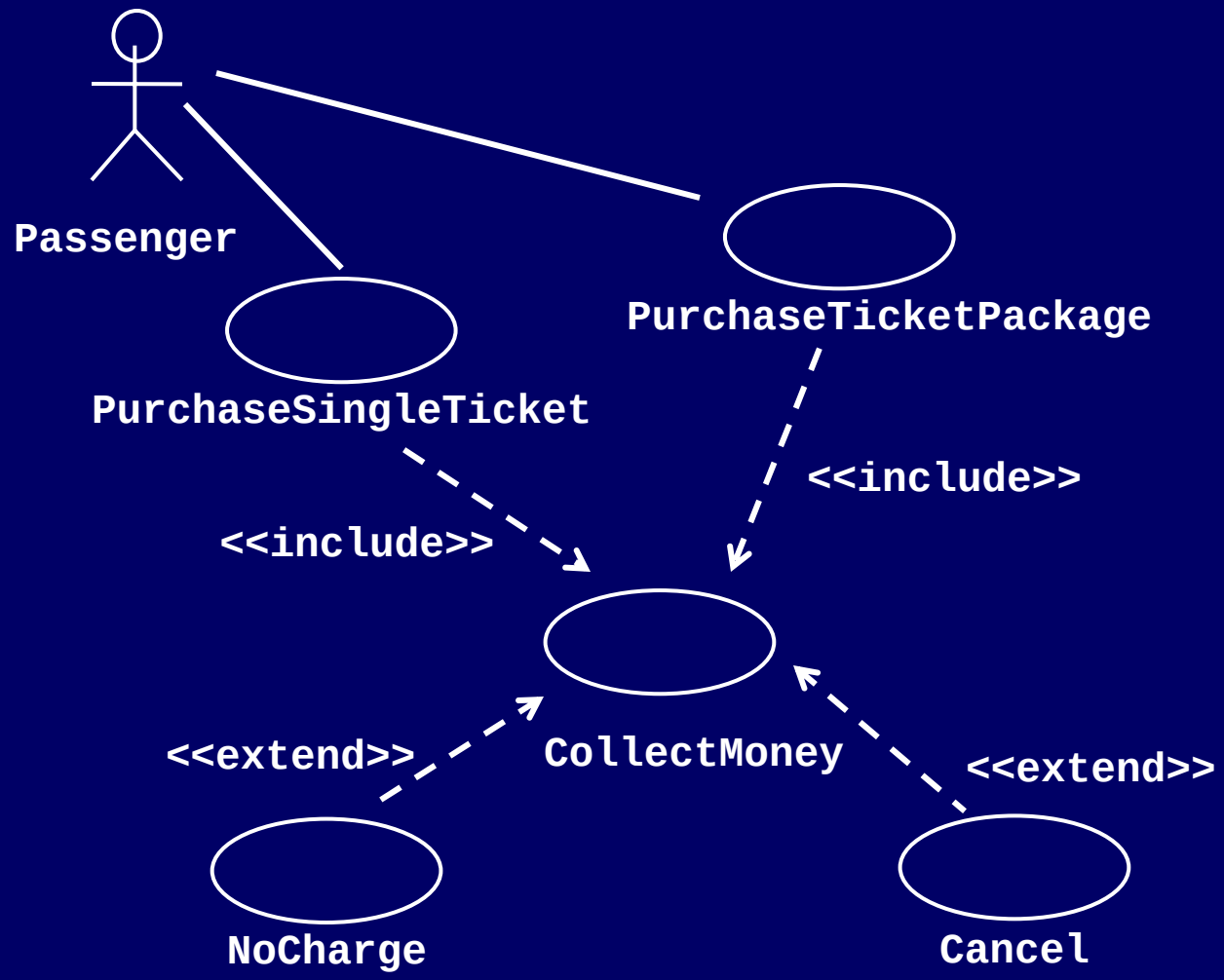
- Iteratively/incrementally – like everything else!
  - First, “façade” iterations – *brief* or *casual*, and *essential*
  - Next iterations add details – *fully dressed*, still essential
  - Later iterations get *real* – some implementation details
- Best if domain language only (no computer-speak)
  - Watch for clues of design details creeping in:
    - Too many consecutive system steps
    - References to database or other non-domain concepts
    - “if/else” structures in typical course of events
- *Extend* or *include* use cases if it simplifies things

UML <<*extend*>> stereotype

Note: has nothing to do with inheritance



UML *<<include>>* stereotype



Use cases and development

- Assign a use case to an early iteration if it
  - significantly influences core architecture
    - i.e., has many domain classes/concepts, is a primary system purpose, involves risky technology, …
  - requires lots of research, or has complex calculations
    - So might have to start it early to get it all done in time
  - is a “time-critical” case (needed early by the client)
- Secondary, and or optional use cases can be developed later (incrementally)
- So can complicated use cases (iteratively)

Planning development iterations

- One iteration includes: analyze, design, code, test
  - "Analyze and design a little, code and test a little, …"
  - Best if about 2-10 weeks (in CS 50, 3-4 weeks each, or less)
- Main reason for an iterative/incremental process: *manage complexity*
  - Can easily lose focus if iteration is too long, and/or tries to tackle too many details
- Note: also plan to synchronize artifacts to code after each iteration
  - Analysis and design occur during coding and testing too

3 implementation issues to plan

- Overall system architecture – typically "layers"
  - Top layer: Presentation
  - Middle layer: Application logic (domain, services)
  - Bottom layer: Storage
- Java `packages` necessary for CS 50 projects
  - Each class/interface belongs to a package – break system into subsystems (whole layer, or part of layer)
- Test risky ideas early
  - Especially connections to other systems
  - Also any tricky or complicated algorithms