CS189A - Capstone

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https://capstone.cs.ucsb.edu/cs189a/cs189a_sched.html
1. **Software specification**
   - Customers and engineers define the software that is to be produced and any constraints on its operation

2. **Software design**
   - Software spec is designed and prototyped

3. **Software implementation, validation, and testing**
   - Software is programmed and checked to ensure that it is what the customer requires

4. **Software maintenance and evolution**
   - Software is maintained (bug fixes, upgrades) and modified to reflect changing customer and market requirements
Discussion/\textit{debate} on the functionality, input and output formats, types of users, etc. is called \textit{requirements analysis}

- Product managers and/or software developers \textit{try} to figure out the functionality required by the client
- Functional and non-functional requirements
Discussion/debate on the functionality, input and output formats, types of users, etc. is called requirements analysis:

- Product managers and/or software developers try to figure out the functionality required by the client
- Functional and non-functional requirements

Writing precise requirements specifications can be challenging:

- Formal (mathematical) specifications are precise, but hard to read/write
- English is easy to read and write, but ambiguous
- Today’s solutions employ a combination of
  - IEEE Software Requirements Specification (SRS), Product Requirements & Design (PRD) – combined with system modeling, user stories, case studies
  - Should be a “living document” that evolves over time
    - Starts with a vision statement
(2) Software Design

- Product managers/owners do **not** develop the software
  - Software developers use requirements doc to understand what to build

- Sketch out the functionality in the requirements specification
- Model the system and its components
  - Context, interactions, structural, behavioral
  - User interfaces, user experience
  - Use cases, sequencing, event response, system state, classes/objects

- Define software architecture: **drawings, evolving docs, coding**
  - Components with interfaces (application programming interfaces: APIs)
  - High level and low level
    - Dependencies, modules, alternatives
    - Patterns
  - Prototype components -- **mock out / simulate** missing pieces
(3) Implementation and Testing

• Decide on technologies to incorporate/integrate/reuse

• Implement modules defined by architectural design & detailed design
  – Typically as prototypes that evolve over time into production-quality SW

• As part of prototyping and evolving testing happens **concurrently**
  – That requirements are met, assumptions are held, bugs are minimized
  – Be **defensive**! Prevent cases that you haven't considered from ever executing (assert! exit! return error!)

• Use a set of inputs/actions to **test** the program
  – When are you done with testing?
  – Test parts of the program in isolation
  – Unit tests, functional tests, integration tests
Validation, Verification and Testing

• Reviews, walkthroughs, inspections

• Software testing:
  – black-box vs. white-box; functional vs. structural
  – random testing, exhaustive testing
  – domain testing, boundary conditions
  – coverage criteria: statement, branch & path coverage, condition coverage, multiple condition coverage
  – unit testing, stubs, drivers
  – integration & testing: top-down vs. bottom-up integration and testing
  – regression testing
(4) Maintenance & Evolution

- We finished implementation, tested it, fixed all the bugs, are we done?

- No, we (client) may say, “I would like to add …” or “I found a bug when I was using it” or “You know, it would be nice if we could also …” etc.
  - Ease of changing depends on how SW is designed and implemented

- Phase in which the software is continually modified to adapt to the changing needs of the customer and the environment

- At some point, the software’s lifetime ends
  - It is decommissioned, deprecated (APIs) and/or no longer supported
  - Typically this is a business decision
Stages of software engineering: **requirements specification**, design, implementation, testing, maintenance

Software process (software life-cycle) models
- Determine the stages (and their order)
- Establish the transition criteria for progressing from one stage to the next
Software Process Models

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- Software process models answer the questions:
  - What shall we do next?
  - How long shall we continue to do it?

- Models we’ll discuss: **waterfall, spiral, evolutionary:** agile/extreme
  - Waterfall (70s, 80s) when all software was “shrink wrapped and shipped”
  - Spiral (late 80s) risk-driven and iterative
  - Evolutionary (late 90s, early 00s) as SW becomes increasingly online
Waterfall Model

The waterfall model

Software product is not only the executable file: source code, test data, user manual, requirements specification, design specification...
The waterfall model

Software product is not only the executable file: source code, test data, user manual, requirements specification, design specification, test-plan, these documents are crucial in achieving maintainability, traceability and visibility.
Problems with waterfall model

- Because of the restricted feedback loops, waterfall model is essentially sequential
  - for example, requirements must be stated completely before implementation starts
  - it is often difficult for the customer to state all requirements explicitly
  - hard to handle changes in the requirements

- A working model of the software is not available until late in the project life-span
  - an undetected mistake can be very costly to fix
  - the delivered program may not meet the customer’s needs

- For interactive, end-user applications, document-driven approach may not work
  - for example, it is hard to document a GUI
Spiral Model (late 80s origin)

Risk driven, iterative
BUT: software delivered only after many iterations

Determine objectives, alternatives, constraints

Plan next phase

radial dimension shows the cumulative cost
angular dimension shows the progress in each cycle

cumulative cost

progress in each cycle

Evaluate alternatives, identify, resolve risks

Develop, verify next-level product

Attack the highest risk part (usually obtaining proper user requirements)
of the project first, iterate over next highest risk sub-problem
Evolutionary Software Development

- Software is built iteratively and incrementally by first providing an initial version and then improving/extending it based on the user feedback until an adequate system has been developed (late 90s, early 00s origin)
  - Agile software development, extreme programming
  - Triggered by change in application type (consumer, phones, web)
- All activities are executed concurrently with fast feedback among them
- Specifics impacted by application domain and deployment strategy (e.g. cloud/SaaS, web app)
“We are uncovering better ways of developing software by doing it and helping others do it. Through this work we have come to value:

<table>
<thead>
<tr>
<th>Individuals and interactions</th>
<th>over</th>
<th>processes and tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working software</td>
<td>over</td>
<td>comprehensive documentation</td>
</tr>
<tr>
<td>Customer collaboration</td>
<td>over</td>
<td>contract negotiation</td>
</tr>
<tr>
<td>Responding to change</td>
<td>over</td>
<td>following a plan</td>
</tr>
</tbody>
</table>

That is, while there is value in the items on the right, we value the items on the left more”
Principles of Agile Software Development

• Our highest priority is to **satisfy the customer** through early and **continuous delivery** of valuable software.

• Welcome changing requirements, even late in development. Agile processes **harness change** for the customer's competitive advantage.

• **Deliver working software frequently**, from a couple of weeks to a couple of months, with a preference to the shorter timescale.

• **Business people and developers must work together** daily throughout the project.

• Build projects around **motivated individuals**. Give them the environment and support they need, and trust them to get the job done.

• The most efficient and effective method of conveying information to and within a development team is **face-to-face conversation**.
Principles of Agile Software Development

- **Working software** is the primary **measure of progress**.

- Agile processes promote sustainable development. The sponsors, developers, and users should be able to **maintain a constant pace indefinitely**.

- Continuous attention to **technical excellence and good design** enhances agility.

- **Simplicity** -- the art of maximizing the amount of work not done -- **is essential**.

- The best architectures, requirements, and designs emerge from **self-organizing teams**.

- At regular intervals, the team **reflects** on how to become more effective, then **tunes** and adjusts its behavior accordingly.
Extreme Programming

- Extreme programming (XP) is a type of agile software development process proposed by Kent Beck (~late 90’s)
- XP follows the agile software development principles as follows
  - Software is built *iteratively*, with *frequent releases*
  - Each release implements the set of *most valuable features/use-cases/stories* that are chosen by the customer
  - Each release is implemented in a *series of iterations*, each iteration adds more features/use-cases/stories
  - Programmers turn the stories into *smaller-grained tasks*, which they individually accept responsibility for
  - The programmer turns a task into a set of *test cases* that will demonstrate that the task is finished
  - Working as *pairs*, the programmers make the test cases run, evolving the design in the meantime to maintain the simplest possible design for the system as a whole
Scrum

- An evolutionary/iterative/incremental/agile software process implementation
  - See: *Scrum and XP from the Trenches* -- free online book by Kniberg
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• The main roles in Scrum are:
  – Scrum team: Team of software developers
  – Scrum master: Project manager
  – Product owner: Client

• Characteristics of Scrum:
  – Self-organizing teams
  – Product development in two to four week sprints
  – Requirements are captured as items in a list of product backlog
    • Yours will come from your requirements document (PRD)

• Homework: read the links on webpage under today’s date
Scrum Roles

- **Product owner**
  - Defines the features of the product
  - Decides on release date and content
  - Prioritize features according to market value
  - Adjust features and priority every iteration as needed
  - Accepts or rejects work results

- **Scrum Master**
  - Represents management of the project
  - Responsible for following the Scrum process
  - Ensures that the team is fully functional and productive
  - Shields the team from external influences
Scrum Roles

- **Scrum Team**
  - Typically 5 to 9 people
  - Cross-functional team that does the software development including designing, programming and testing
  - Co-location and verbal communication among team members
  - Teams are self-organizing, no titles
  - Team membership should not change during a sprint
Scrum Meetings

- **Sprint Planning** (at most 8 hours)
  - This is done at the beginning of every sprint cycle (2 to 4 weeks)
  - Team selects items from the product backlog they can commit to completing
  - Sprint backlog is created
    - Tasks for this sprint are identified and each is estimated (1 to 16 hours).
      This is done collaboratively, **not** by Scrum Master
  - High-level design is discussed

- **Daily Scrum** (at most 15 minutes)
  - Daily, stand-up meeting
  - Not for problem solving
  - Every team member answers three questions:
    - What did you do yesterday?
    - What will you do today?
    - Is anything in your way? (Scrum Master is responsible for following up and resolving the impediments)
Scrum Meetings

- **Sprint Review** (at most 4 hours)
  - Team presents what it accomplished during the sprint
  - Typically a demo of new features or underlying architecture
    - Incomplete work should not be demonstrated
  - Informal meeting, no slides
  - Whole team participates
  - Open to everybody
Scrum Meetings

• **Sprint Retrospective** (at most 3 hours)
  – Periodically take a look at what is and is not working
  – Done after every sprint
  – Scrum Master, Product owner, Team and possibly customers and others can participate
  – One way of doing sprint retrospective is to ask everyone what they would like to
    1) Start doing, 2) Stop doing, 3) Continue doing
  Or 1) What worked, 2) What didn't, 3) What should change
Scrum Artifacts

- **Product Backlog**
  - These are the requirements – in your requirements document (PRD)
  - A list of all desired work on the project
  - Prioritized by the product owner
    - Reprioritized at the start of each sprint
  - Each backlog item also has an estimated time it will take to complete it
Scrum Artifacts

### Sprint Backlog
- Team members sign up for work of their own choosing
- Estimated work remaining is updated daily
- Any team member can add, delete or change the sprint backlog
- Each sprint backlog item has daily estimates for the amount of time that will be spent on that item each day

### Burn Down Chart
- A daily updated chart displaying the remaining cumulative work on the sprint backlog. It gives a simple view of the sprint progress.

### Many tools on the web to track sprint
- Backlogs, burndown
- Trello, PivotalTracker
More on Scrum

• More information about Scrum process is available at:
  – www.mountaingoatsoftware.com/scrum
  – www.scrumalliance.org
  – www.controlchaos.com

• Required reading
  – "Scrum/XP From the Trenches" by H. Kniberg. (Free with registration).
Four sprints this quarter: 2 weeks each (see web calendar)

Wk 2: sprint 1 planning: next Weds, sprint 1 starts next Thurs
  - Vision statement (due Oct 16)
  - Requirements & initial design specification, technology experimentation

Wk 4: sprint 1 retro, sprint 2 planning (W Oct 25), start Oct 26
  - Designing, prototyping, testing, and evolving the specs (PRD)
  - PRD v1 due F Nov 3 by noon

Wk 6: sprint 2 retro, sprint 3 planning (W Nov 8), start Nov 9
  - Designing, prototyping, testing, and evolving the specs
  - Shortened sprint (b/c of Thanksgiving)

Wk 8: sprint 3 retro, sprint 4 planning (M Nov 20), start Nov 21
  - Sprint 4 is the demo prep sprint
  - PRD v2 due F Dec 1 by noon

Demos: Dec 4, 6, 7 (in class and discussion section)
• Leading a team requires people skills. Unless there is some understanding of people, management will be unsuccessful.

• Poor people management can lead to project failure. Keys:

  • Consistency
    – Team members should all be treated in a comparable way without favourites or discrimination.

  • Respect
    – Different team members have different skills and these differences should be respected.

  • Inclusion
    – Involve all members and ensure that everyone’s views are considered.

  • Honesty
    – Be honest about what is going well and what is going badly in a project.
Motivating people

- The group leader serves as the external interface of the group, to motivate and guide, but not necessarily allocate work items
  - Motivation means organizing the work and the working environment to encourage people to work effectively.
  - Members choose what they work on, but teams decide priorities together.
  - If people are not motivated, they will not be interested in the work they are doing. They will work slowly, be more likely to make mistakes and will not contribute to the broader goals of the team or the organization.

- Motivation is a complex issue but it appears that there are different types of motivation based on:
  - Basic needs (e.g. food, sleep, etc.);
  - Personal needs (e.g. respect, self-esteem);
  - Social needs (e.g. to be accepted as part of a group).
Personality types

• Motivation should also take into account different personality types:
  – Task-oriented.
    • The motivation for doing the work is the work itself;
  – Self-oriented.
    • The work is a means to an end which is the achievement of individual goals - e.g. to start a company, get a job, achieve “street cred”
  – Interaction-oriented
    • The principal motivation is the presence and actions of co-workers. People work because they like being part of something

• Balance can change depending on personal circumstances and external events

• Team make up should be a balance across these
Teamwork

• Most software engineering is a group activity
  – The development schedule for most non-trivial software projects is such that they cannot be completed by one person working alone.

• A good group is cohesive and has a team spirit. The people involved are motivated by the success of the group as well as by their own personal goals.

• Group interaction is a key determinant of group performance.

• Flexibility in group composition is limited
  – Lead must do the best they can with available people.

• Good communications across team is essential for success
  – Promotes trust & understanding
What’s Next

• **This Friday**
  – Pitch night – 13 companies come to try to sell you on their project
    • They will be your mentors for the quarter
  – Consider the metrics on which the Capstone winners will be based
  – Have fun!
  – 3:30-6:30pm in HFH 1104

• **Monday**
  – Form teams, submit your requests, decisions by Tuesday

• **Wednesday**
  – Setup team, project, meeting schedule
  – Develop sprint plan and select tasks for Sprint 1, vision statements

• **Thursday**
  – Including: Write vision statement (due Monday; send to Mentors *today*)
  – Start working together on Sprint 1
2-Page Vision Statement

• PDF via email to TA by end of discussion this Friday
  – Project Title / Name (can change)
  – Team name, members names/emails
  – Team lead
  – what the project is about
    • What problem the project is solving (what is innovation, the science, and new core technical advance)?
    • Why the problem is important
    • How the problem is solved today (if it is)
  – Identify the outcome of the project
  – Define initial project milestones: specification, design, prototyping
  – How do you plan to articulate and design a solution
    • List the implementation platform and technologies you plan to use to develop the solution
    • Overview the process model you will employ to achieve the milestones