Introduction to Software Engineering (ISAD1000)

Lecture 5: Agile Project Management

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Discipline of Computing
School of Electrical Engineering, Computing and Mathematical Sciences (EECMS)

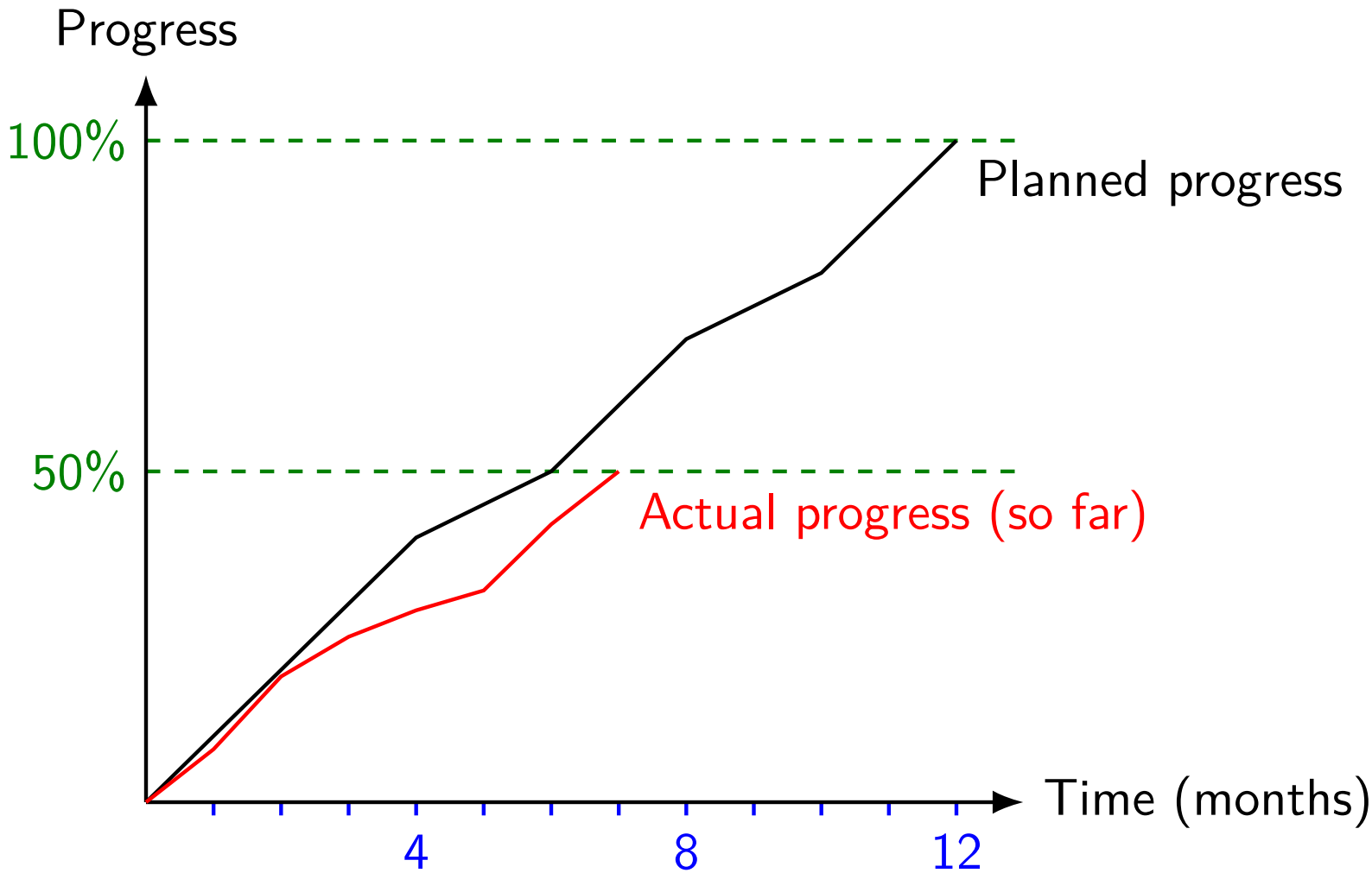
Outline

Project Management

- In lecture 1, we discussed planning a software project.
- Now we must follow that up. How do we keep control of a project while we're *doing* it?
- How do we know if we're on track?
  - Because if we don't know, we're heading for disaster!
- Project Management applies to software and non-software projects, *but*...
  - There are a few software-specific practices.

Burn-Up (Earned Value) Chart

- "Burn-up charts" show us the big picture:



Burn-Up Charts: Explanation

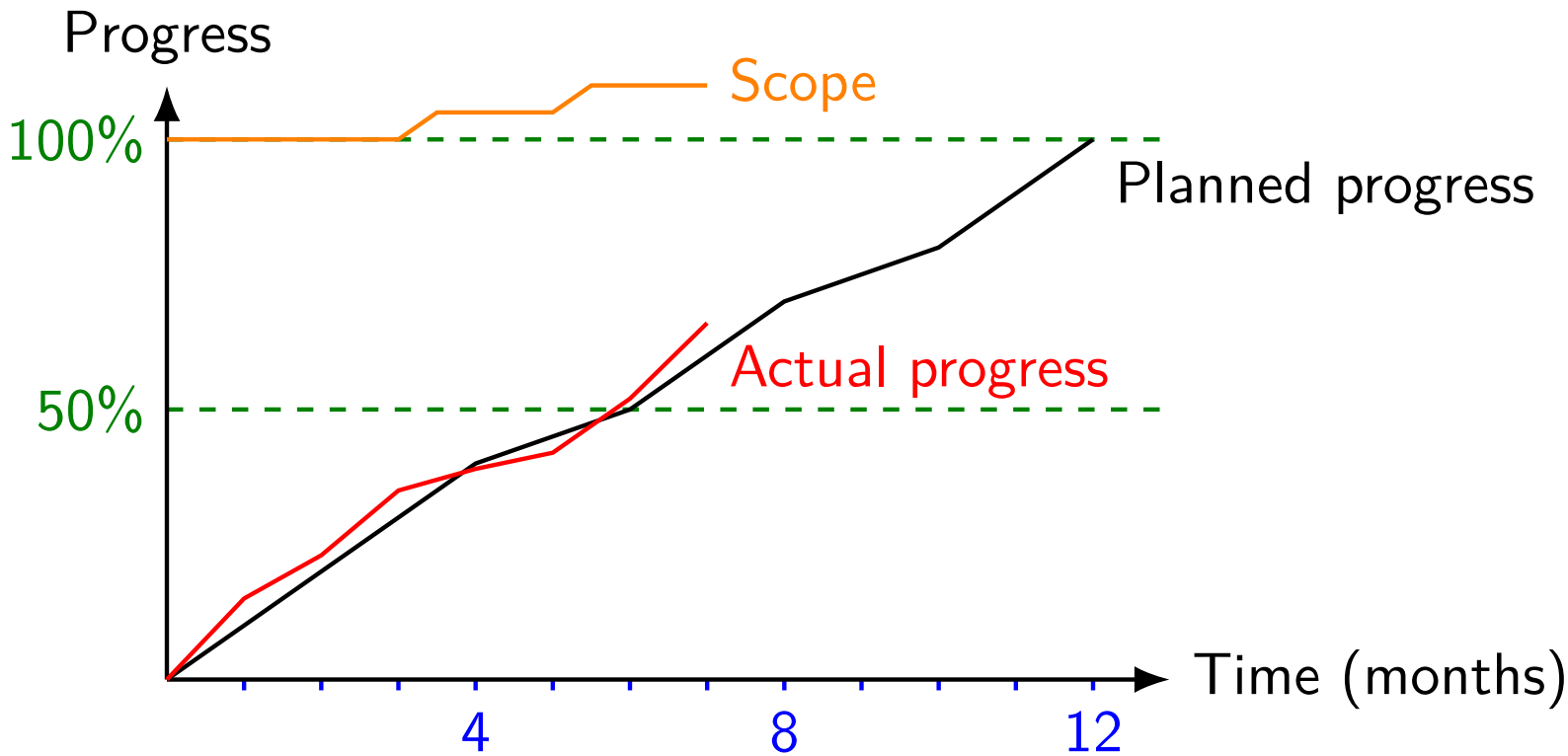
- Burn-Up charts show "planned" vs "actual" progress.
- Planned progress:
  - How far through the project did you *expect* to be at time t?
  - Probably a straight line in many cases.
  - May have non-straight bits if you plan for certain interruptions to occur, or for people to join/leave your team.
- Actual progress:
  - How far through are you *really* at time t?
  - What tasks have you completed?
  - How much "value" is each completed task worth?
    - The "value" of a task is the original estimated duration (remember planning poker?).
    - Some tasks are "worth more" than other tasks, because they were expected to take longer.

Burn-Up Charts: What's the Situation?

- Compare the planned and actual progress.
- Is actual progress higher than planned progress?
  - Good times! Your project is ahead of schedule.
- What if actual is lower than planned?
  - Bad news. You're behind. Time for some tough choices.
  - Put in more work. Sounds virtuous, but overwork can cause disasters too.
  - And/or... negotiate with the client for more time.
  - And/or... negotiate with the client for less scope; i.e., will they accept a product with less functionality or lower quality?
  - And/or... accept a lower payment.
- Knowing things are going badly is better than *not knowing until it's too late*.
  - If you know, you can make the right decision!

Burn-Up Charts: Scope

- Burn-up charts often have a "scope" line too.
- In agile project management, we often get extra work to do mid-way through a project.



Completing Tasks

- How do you actually know if you've "completed" a task?
- Sounds obvious, but it's not!
  - Tasks are all connected. They build on each other.
  - You can't just *say* you've finished one. If you haven't finished it *properly*, it will wreck other tasks that follow on.
- Part of SE project management is about the "definition of done".
  - How does your team *verify* a task is done?
  - Different organisations might do this differently.
  - But whatever the criteria, apply it consistently.

Workflows

Coding tasks typically go through several steps, like this:

- **Todo**
- **Selected for development**
- **Coding and testing**
- **Review** (“pull request”)
- **Ready to merge** (into the main development/master branch)
- **Done**

Processes

- "Process" is a loaded word.
  - In science: a transformation that happens over time.
  - In engineering: a procedure, or a broad set of instructions, for how to conduct a task.
- If you work for a software company, they will have a "process" (of the engineering form).
  - A large-scale process for undertaking the whole project.
  - Various smaller-scale processes for different parts of it.
- Processes vs lifecycle models (waterfall, spiral, etc.)?
  - Lifecycle models are broad approaches to organising software projects.
    - They let us understand how SE works in general.
  - Processes are specific and instructive.
    - They *actually tell you what to do!*

Types of Processes

- There are many well-known processes; e.g.:
  - Scrum, Lean Development, Extreme Programming, the Unified Process, the Team Software Process, etc.
  - Kanban may be considered a process, or at least *part* of a process.
- Many (most?) organisations will use a hybrid/customised process.
  - Borrowing ideas from several processes and models.
  - What happens in practice is never *exactly* what you read about in books.
- Most organisations will try to be "agile".
  - "Agility" means that you can deal well with changing situations.
  - Scrum is one of the best-known agile processes.
  - These often look a lot like a case of the spiral model.
  - Lots of very quick cycles/iterations.

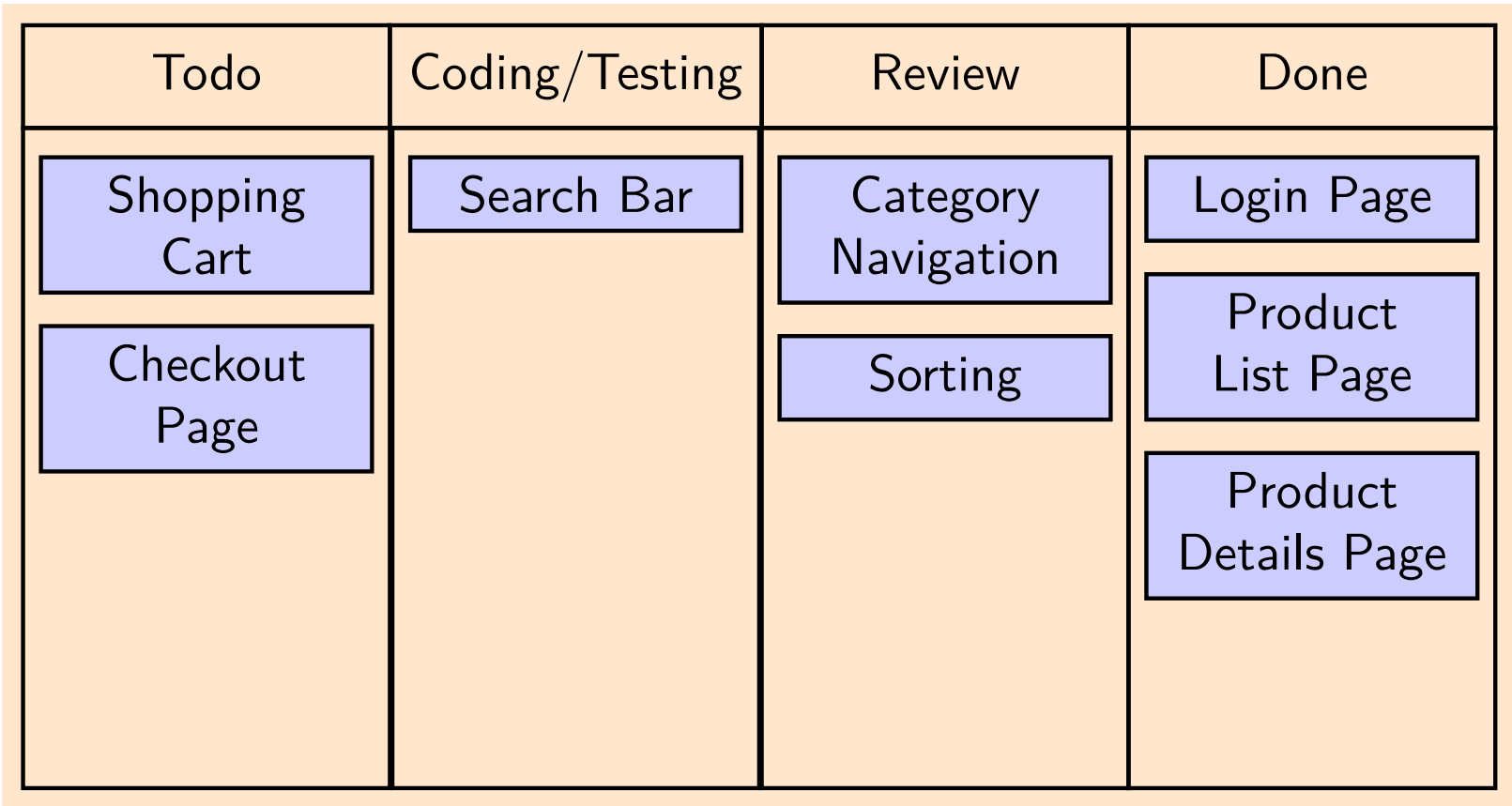
Kanban

- Kanban boards are another way to visualise your project.
  - Burn-up charts show the big picture.
  - Kanban shows the status of individual tasks.
- Kanban boards contain columns.
  - One column for each workflow step, arranged left-to-right; e.g. “Todo”, “Selected”, “Coding/testing”, “Review”, “Ready to merge” and “Done”.
- Columns contain “cards”.
  - Each card represents a task.
- Each card (task) is moved from left-to-right (from column to column) as it progresses through its steps.

[0] https://www.atlassian.com/agile/kanban

Example Kanban Board

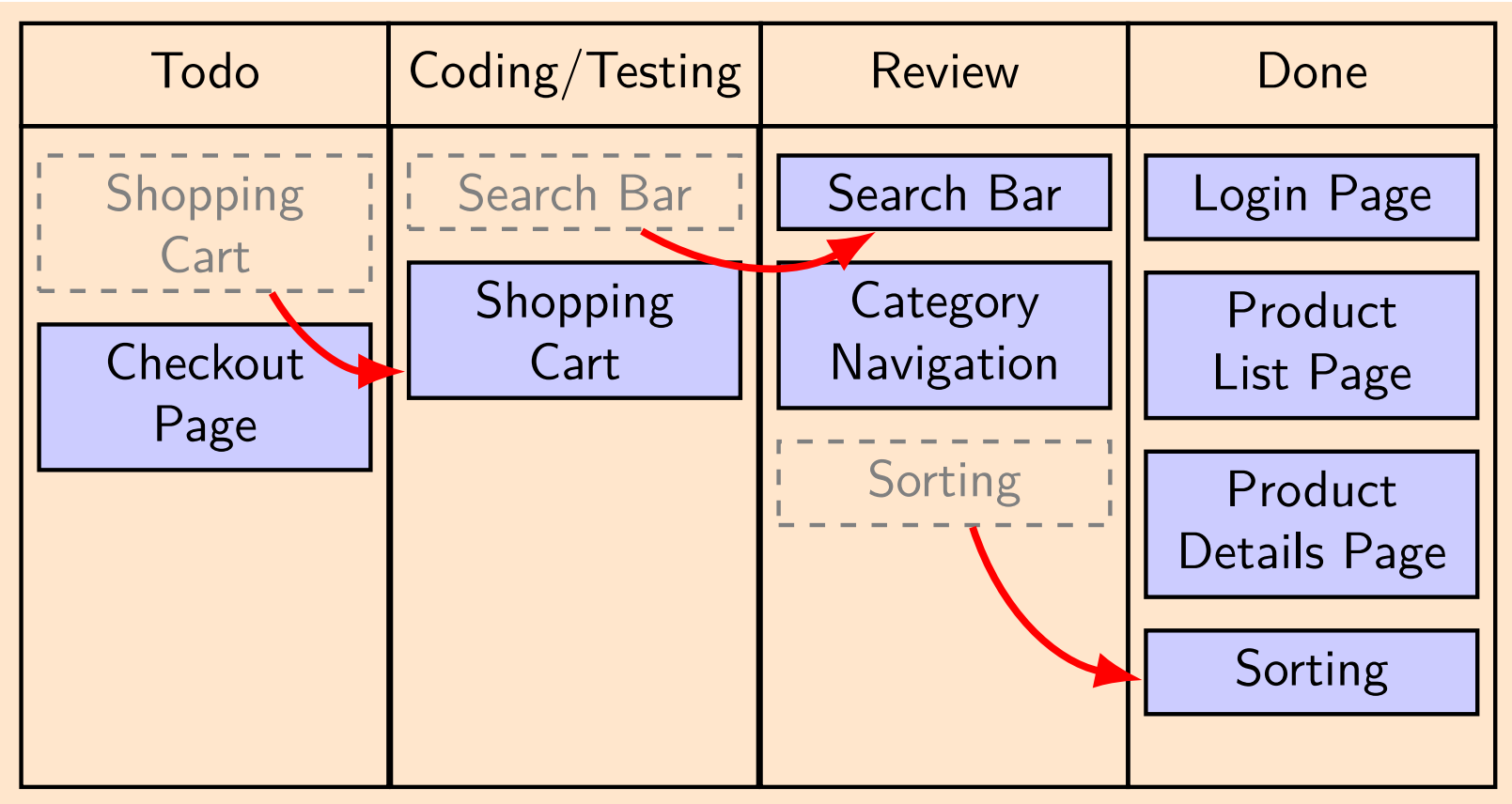
All cards start on the left ("todo"), and move rightwards.



(We're only showing four columns for simplicity.)

Moving Kanban Cards

You move each card right one column at the appropriate time.



- (Don't draw the red lines – those are just to illustrate how the chart gets changed.)

Work in Progress (WIP)

- "Work in progress" is everything between "todo" and "done".
- We want to limit WIP – only work on a few tasks at a time.
- Some important principles[1]:
  1. A "culture of done".
     - Tasks are either finished completely, or still WIP. There's no such thing as "almost" done.
  2. Using our brains efficiently.
     - "Multitasking" is inefficient. Your brain needs time to switch from doing one thing to doing another.
  3. Identify (and solve) problems ASAP.
     - Some tasks will turn out to be much harder than we thought.
     - Some parts of our *process* may not work well.
     - Easier to see these problems if you have only a few tasks.

[1] https://www.atlassian.com/agile/kanban/wip-limits

Work In Progress: Enforcing Limits

- We might put a limit of (say) 3 tasks in the coding/testing, and 3 in review.
- So, if there are already 3 tasks under review. . .
  - We *can't* move another task from coding/testing to review.
  - One of the existing reviews has to complete first.
- This may cause a "pile-up" in an earlier column.
  - But, in a sense, this is actually a good thing, because it lets us see an underlying problem.
  - We can identify parts of our process that are "bottlenecks" (slow points), and re-assign team members to deal with them.
  - The review stage is holding everything up? Then we need more reviewers and fewer coders.

"Bugfixes" as Tasks

- You can add more cards to the "todo" column, mid-project.
- The client may (all of a sudden) want more functionality.
- Or you might discover problems (bugs) that need to be fixed.

Todo	Coding/Testing	Review	Done
Shopping Cart	Search Bar	Bugfix: page layout issue	Login Page
Bugfix: login not working	Bugfix: incorrect pricing	Category Navigation	Product List Page
Checkout Page			Product Details Page
			Sorting

Scrum

- Scrum is one of the most popular SE processes.
  - Think of the spiral model, but with more details nailed down.
  - We focuse on Scrum in ISE because we can't cover everything!
- Scrum revolves around "sprints" (in other contexts called "iterations").
  - Each sprint is a mini-project
  - Each has a fixed length; say 4 weeks.
  - Sprints *do not* go over time. You simply deliver what you have at the end.
  - Each sprint creates something concrete/useful for the customer, even if it's only small.

[1] https://www.scrumguides.org/scrum-guide.html
[1] https://www.atlassian.com/agile/scrum

The Two Backlogs

- A backlog is a list of user stories not yet implemented.
  - Remember user stories? Each user story represents a piece of software functionality for a particular kind of user.
- In Scrum, you keep track of two backlogs.
- The "**Product Backlog**" – a todo list for the overall product.
  - Everything the customer wants the software to do that has not yet been implemented.
- The "**Sprint Backlog**" – a todo list for the current sprint.
  - Select *a few* user stores from the product backlog, at the start of the sprint.
  - Each user story takes time to implement, and you only have 4 weeks.
  - Go for the "highest priority" user stories.
  - You may not necessarily finish them all in this sprint.
  - Each user story *may* need to be broken down into sub-tasks!

Scrum and Kanban

- Scrum and Kanban are not the same thing.
  - e.g. Kanban has no fixed-length sprints, and instead delivers each user story by itself incrementally.
- *But* they can be joined into a single process – "Scrumban".
- The sprint backlog could be the left-most column on your kanban board.
- What ends up in the "done" column is what you deliver, at the end of the sprint.

Sprint Meetings ("Ceremonies")

Each sprint has several key meetings between the people involved:

- **Sprint Planning** is a day-long meeting at the start of a sprint.
  - The developers talk to the customer and figure out what to do for the next 4 weeks.
- **Sprint Review** is a $\frac{1}{2}$-day meeting at the end of a sprint.
  - The developers show the customer what has been done.
- **Sprint Retrospective** is another $\frac{1}{2}$-day meeting right after the sprint review.
  - The developers discuss how well things went, and what might be improved.
  - This is about the team itself, not the product.
- **Daily Scrum (or "stand-up")** is a 15-minute meeting at the start of each day.
  - The developers discuss their planned work for the day.

Scrum Roles

- Scrum assigns special roles to people.
- The **Product Owner** helps the team make the right product.
  - They make sure user stories are correct, and decide which have the highest priority.
  - (The PO is not the customer though.)
- The **Scrum Master** helps the team follow Scrum.
  - They must be on top of all the Scrum practices.
  - They must understand what should happen when, and make sure everyone else is aware of this.
- The **Development Team** writes the software.
  - 3–9 software developers.
  - They take user stories and implement them.

Other Processes

- There are other approaches to this too.
- Other processes require different working arrangements.
  - In "Extreme Programming", all development work is done in pairs – **pair programming**.
- Often there are other roles; e.g.:
  - A "team lead" – a senior developer with with overall responsibility.
  - A "configuration manager" may have responsibility for the tools and libraries used by the team.
    - (Not an IT support issue. This is part of the software development process.)
  - Security specialists.
  - Artists (e.g., for games).
  - Particular "domain" specialists who understand the requirements more clearly than the software engineers.

Pull Requests and Code Reviews

- Typically, a developer makes a "pull request" when they think they've finished a task.
  - Remember version control?
  - A pull request is a formal request to pull/merge your changes into the master branch (or some other main development branch).
  - You can't do this merge without approval.
  - Your code will be discussed, and your request accepted or rejected.
- Pull requests typically trigger a "code review".
  - Another team member will look through your code in detail.
  - They'll check:
    - Whether your changes do what is needed.
    - Whether they break other things.
    - Whether they're otherwise up-to-standard.
  - They often find defects, and will ask you to fix them.

Code Review

- A collection of techniques for achieving two ends:
  1. for one person (or the rest of the team) to understand another's work, and
  2. to find faults in that work.
- Different techniques:
  - Inspection – formal group-based fault-detection process,
  - Walkthrough – informal meeting to understand the code,
  - Review – fault-detection process with varying formality,
  - Pair Programming – programmers write all code in pairs, with one reviewing the other's work in real-time. (And roles swapping as needed.)
- In all cases, you requires someone *other* than the author of the work.
  - . . . *but* someone who is familiar with the project.
  - A peer.

Code Review vs. Testing

- Testing and peer review are *both* essential – they are not alternatives.
- Very different fault-detection processes.
- Testing:
  - Automated (once the test cases are written).
  - Only applicable to *executable* things (i.e. code).
  - Finds failures – extra effort required to isolate faults.
- Peer Review:
  - Manual – human effort required all the way through.
  - Applicable to anything – code, documentation, use cases, design diagrams, etc.
  - Finds faults directly, not failures.
- Testing and peer review find *different kinds* of faults.

Communication via Peer Review

- Peer review is a two-way communication.
- The reviewer gains an understanding of your work and your ideas.
- The reviewer offers advice, on:
  - Faults found.
  - Efficiency issues – could your code be faster, or use less memory?
  - Maintenance issues – could your code be simpler?
  - Style issues – could your code be more readable?
  - Test case issues – do your test cases cover enough of the system's behaviour?

Fault Reporting

- The reviewer *does not* fix faults, but just reports them.
- Every fault found must be carefully recorded.
- There are fault-reporting forms (paperwork) for this purpose.
- Each fault is recorded with a variety of information:
  - The reviewer.
  - The type of fault.
    - Faults can be categorised in various ways:
    - By criticality; e.g. minor, major, critical.
    - By checklist question (see later).
  - The location of the fault.
    - Which source code file? Which method? Which line number?
    - Some faults concern *relationships* between multiple parts of a system.
  - A description of the fault.
    - Might include its effects, or how to fix it, if these are simple to describe.

Reading Techniques

- There are a few techniques for reviewers or inspectors to find faults.
- They try to support or manipulate the way that you take in the information.
- Checklists are a common technique:
  - Reviewers work through a list of potential faults.
  - Check off each one as they go.
  - Mainly useful for relatively inexperienced reviewers.
  - For experienced reviewers, checklists just get in the way.

Guidelines for Checklist Questions

- Each checklist item should be a yes/no question:
  - A "yes" answer means everything is okay.
  - A "no" answer means there is a problem.
  - Phrase each question so that "yes" and "no" have these meanings. This helps avoids confusion.
- Number the questions sequentially (1, 2, 3, . . .), so reviewers can refer to them easily.
- Each question should represent a potential *type* of fault.
  - Reviewers may find many such faults, or none at all.
  - Questions should be generic. They *should not* refer to a single, specific fault in a single part of the system.
- *Don't* list syntax errors.
  - These will be found anyway by compiling / running the code.
  - Don't waste human effort checking things that can be checked automatically.

Checklists – How Long?

- Checklists should be no more than one page in length.
  - Otherwise, the process is too cumbersome.
- However, there are an infinite variety of possible faults.
- Obviously, you cannot list them all.
- Make a judgement call:
  - Which types of faults are more likely to occur?
  - Which types of faults would cause more damage if they occurred?
- Put the most important and relevant fault types on the checklist.
- Any *previously-reported* fault types are a good candidate for the checklist.
  - Faults can often re-occur, after being fixed.

Checklist Questions – Examples

1. Is each "/" operator working with the correct datatype? **[Java-specific]**

Yes? Then everything is good.

No? Then we may need to convert the datatypes from integers to reals (or the other way around).

2. Are the correct datatypes passed to functions/methods? **[Python-specific]**

Yes? Then everything is good.

No? Then we need to re-consider what the function/method's purpose is, and supply it the kind of data it needs.

Checklist Questions – More Examples

3. Do all string comparisons use the "`equals`" method (and not the "==" operator)? **[Java-specific]**

- If "no", then we're really comparing object references, not string values (see PDI/OOPD).

4. Do calls to a function/method supply parameters in the *right order*?

5. For functions/methods that return a value, is the returned value being used (and not just discarded)?

6. Where real numbers are compared for equality, is a "tolerance" value used (to deal with rounding errors)?

Formal Software Inspection

- Invented by Michael Fagan (1976).
- Requires a team of about 4 people, headed by a moderator.
- Several rigidly-defined steps.
- Often a criterion for transitioning from one *phase* to another.
  - Large-scale projects are often (and traditionally) separated into separate phases, starting with requirements, then design, then implementation.
  - Move from design to implementation once the design passes inspection (and not before).
  - This doesn't really happen with agile methods.

Inspection Steps

Planning: the moderator schedules a time/venue, and ensures the code/design is ready.

Overview: the team shares existing insights into the system.

Preparation: team members *individually* read the code/design.

Inspection: the team *collectively* searches for defects.

Rework: those responsible fix the defects.

Follow-up: the team verifies the fixes.

Re-inspect: if more than 5% of the code/design has been changed.

That's all for now!