Writing a Program

Software Engineering
CS 130

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Content adapted from Essentials of Software Engineering 3rd edition by Tsui, Karam, Bernal
Jones and Bartlett Learning

Introduction

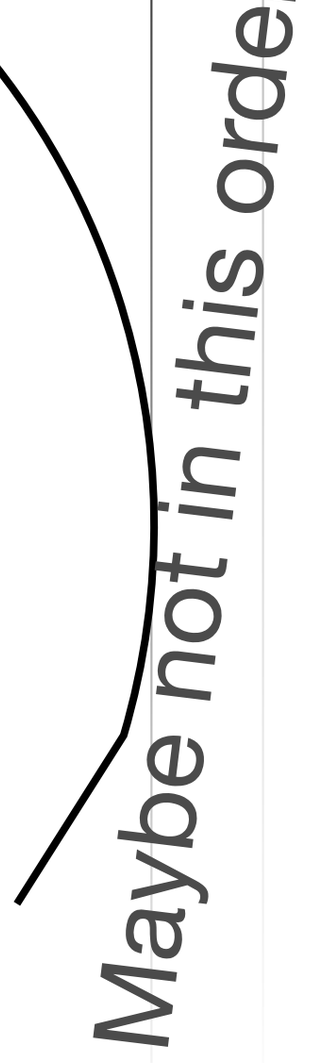
We all “start” by learning how to code in some programming language.

- With a small, hypothetical, and fairly well defined problem
- Usually the code is within one module

Introduction

We then learn that the program usually does not work on the first try, second try ------ may be even 5th or 6th try!

- We learn about “testing” the program
- We learn about re-reading and re-thinking the (problem) requirements more carefully --- then find that we may not have all the answers
- We learn about tracing and “debugging” the program
- Then ---- somehow magically ---- we decide that it’s “good enough !”



“Simple” Set of Steps

1. Understand the problem

- Contextual Inquiry
  - Study the environment in which the intervention will be deployed
- Requirements Engineering
  - Work with the client to figure out
    - Functionalities
    - Non-functionalities
      - performance, security, modifiability, marketability, etc

“Simple” Set of Steps

2. Perform Some Design

- Organizing the functionalities in some sequence;
  - possibly using some diagrams
- Focus on input/output (data, formats, organization)
- Think about some constraints (non-functionalities) such as speed, UI looks, programming language, dependencies, etc.
- any specific algorithm and improvements on sequence of functionalities.

“Simple” Set of Steps

3. Code/Implement

- Turning the design into actual code
  - Depending on how much design is completed, one may either directly engage in conversion to code (language dependent) or do some more designing.
    - Converting input/output to specific UI Interface or I/O format
    - Sequencing the processing in the desired order
    - Ensuring and converting the processing “algorithm” correctly to the target language construct.
    - figure out how to use language library (properly)

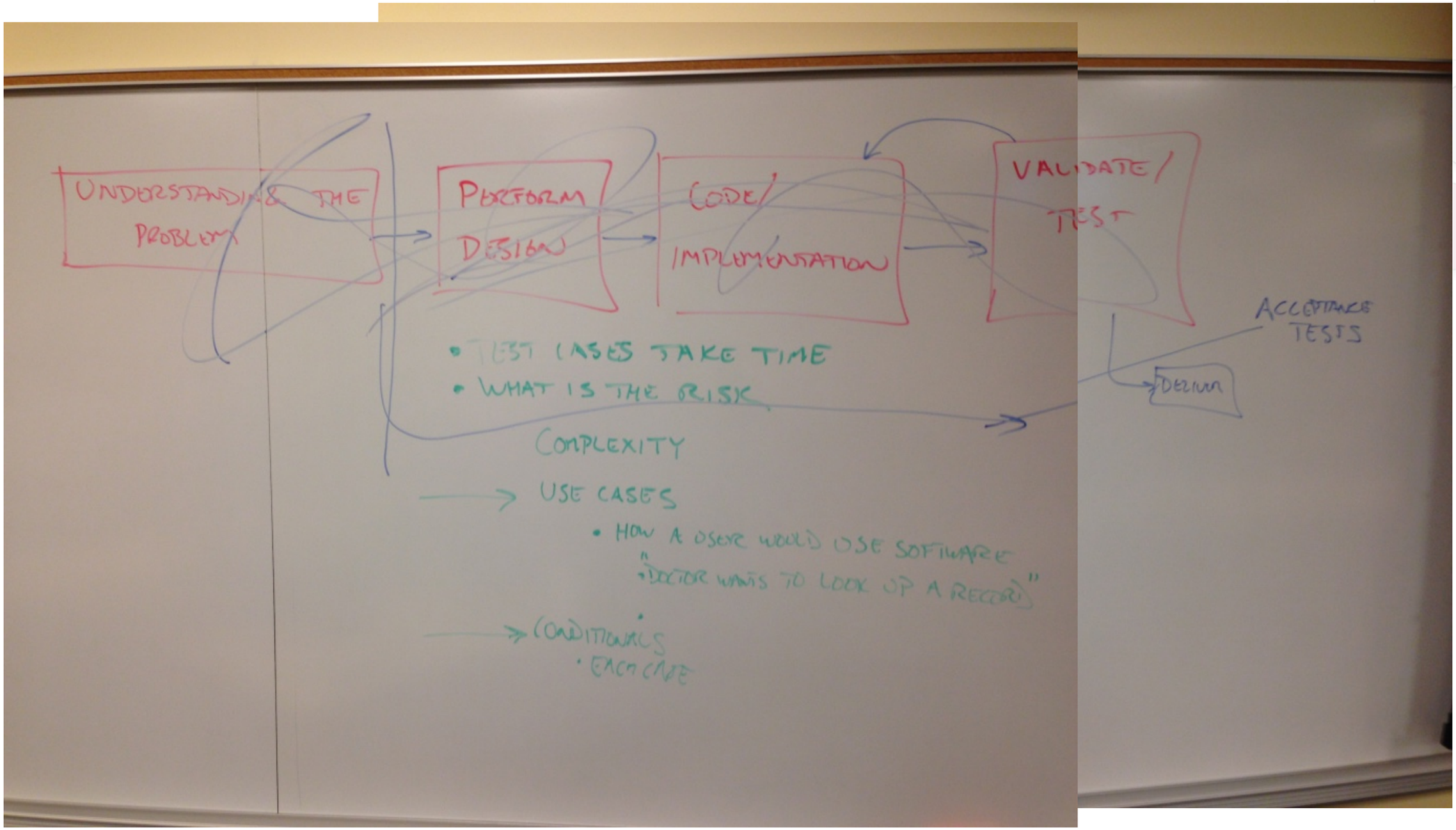
“Simple” Set of Steps

4. Validate/Test the program

- check the program results (via output) with some predetermined set of inputs.
  - The pre-determined inputs are “test cases” and requires some thinking.
- If the results do not match what is expected then:
  - “Debug”
  - Fix
  - Retest ---- revalidate
- Stop when all test cases produce the expected results.

How many test cases should we develop and run?

Narrative vs. Reality

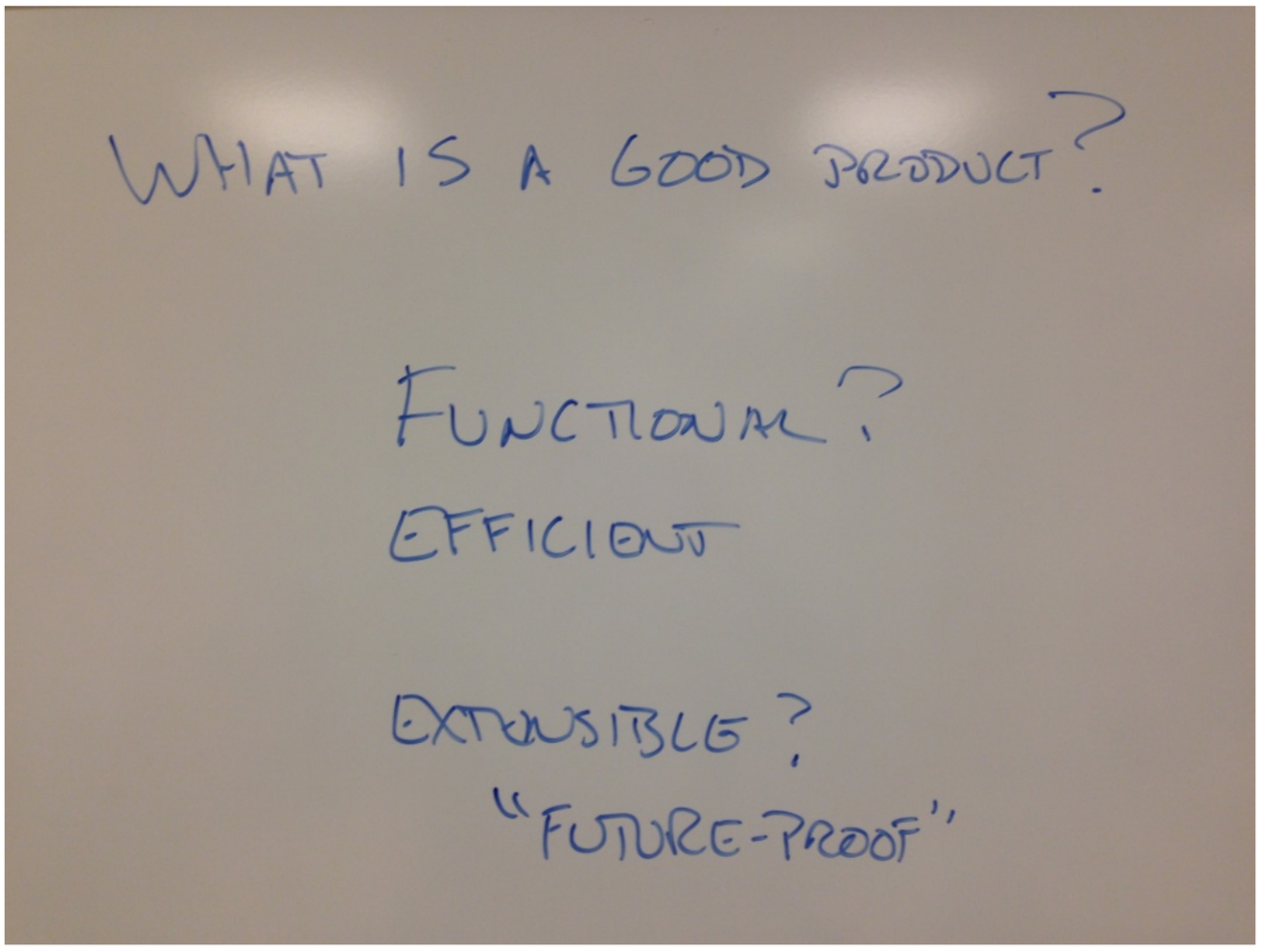


- The real process is a messy mix of the idealized process
- At the end, acceptance tests are contractual obligations

Code is “Done!” What Else Matters?

- How Long (elapsed time) did it take to complete the work?
- How much effort (total person hours) is expended to do the work?
- Does the solution solve the complete problem?
- How “good” is the work – (code, design, documentation, testing, etc.)?

How “good” is the work?



Simple Problem

Thought Experiment

- “Given a collection of lines of text stored in a file, sort them in alphabetical order, and write them to another file”

- Think about it for a second, then let’s discuss missing requirements

- 'THE FILE'
  - TYPE
  - LOCATION
- SORT BY ALPHA?
  - WORDS
  - LINES
  - NON-ALPHABETIC CHAR.
- WHAT IS A 'LINE'?

Decisions

Specifying the problem

- “Given a collection of lines of text stored in a file, sort them in alphabetical order, and write them to another file”

- It turns out that this task is under specified

- We need to clarify
  - the program requirements
  - the design constraints

Decisions

Complete specification

- The program requirements
  - State what the program does
  - Qualify what the program does
- Design constraints
  - Provide boundaries for ways in which the program can be created

Decisions

Requirements

- Not exactly the same as in common English
- Requirements cost money
  - Many are negotiable. Which ones?

Good

Fast

Cheap

Choose 2

Decisions

Requirements

- Functional Requirements
  - What the program does
- Non-functional Requirements
  - How the program behaves

Decisions

Requirements

- Functional Requirements
  - What the program does
    - “Sort a file”
- Non-functional Requirements
  - How the program behaves
    - Performance
    - Usability
    - Maintainability

Decisions

Design Constraints

- What languages can you use?
- What frameworks can you use?
- On what platforms must it run?

Decisions

Requirements vs Design Constraints

- The categories are not always clear cut
  - Functional Requirements
  - Non-functional Requirements
  - Design Constraints
- Some requirements can be de facto design constraints

Simple Problem

Thought Experiment

- “Given a collection of lines of text stored in a file, sort them in alphabetical order, and write them to another file”

- What are the function requirements?
  - Brainstorm some

Simple Problem

Thought Experiment

- “Given a collection of lines of text stored in a file, sort them in alphabetical order, and write them to another file”
- Function requirements:
  - What is the format of the input data?
  - How is the data stored?
  - What is “a character”?
  - What is “a line”?

Simple Problem

Thought Experiment

- “Given a collection of lines of text stored in a file, sort them in alphabetical order, and write them to another file”
- Function requirements:
  - What order should the sort be?
  - How should sort react to non-alphabetic characters?
  - How should sort react to numbers?
  - Upper-case vs lower-case

Simple Problem

Thought Experiment

- “Given a collection of lines of text stored in a file, sort them in alphabetical order, and write them to another file”
- Function requirements:
  - Special cases:
    - Empty file?
    - Empty line?

Simple Problem

Thought Experiment

- “Given a collection of lines of text stored in a file, sort them in alphabetical order, and write them to another file”
- Non-Functional requirements:
  - Performance Requirements:
    - How long should it take?
  - Real-time Requirements
    - What about the variability in performance? Worst-case vs. Average-case
  - Modifiability in the future?

Simple Problem

Thought Experiment

- “Given a collection of lines of text stored in a file, sort them in alphabetical order, and write them to another file”
- Design Constraints
- What’s the user interface like? GUI vs CLI? web-based?
- Typical input size?
  - How much should we worry about algorithm?
  - Will it fit in memory? on disk? on one rack?

Simple Problem

Thought Experiment

- “Given a collection of lines of text stored in a file, sort them in alphabetical order, and write them to another file”
- Platforms
- What OS?
  - Often a business decision based on licenses, other systems
  - The computational world is fragmented, but each new platform incurs additional cost

Simple Problem

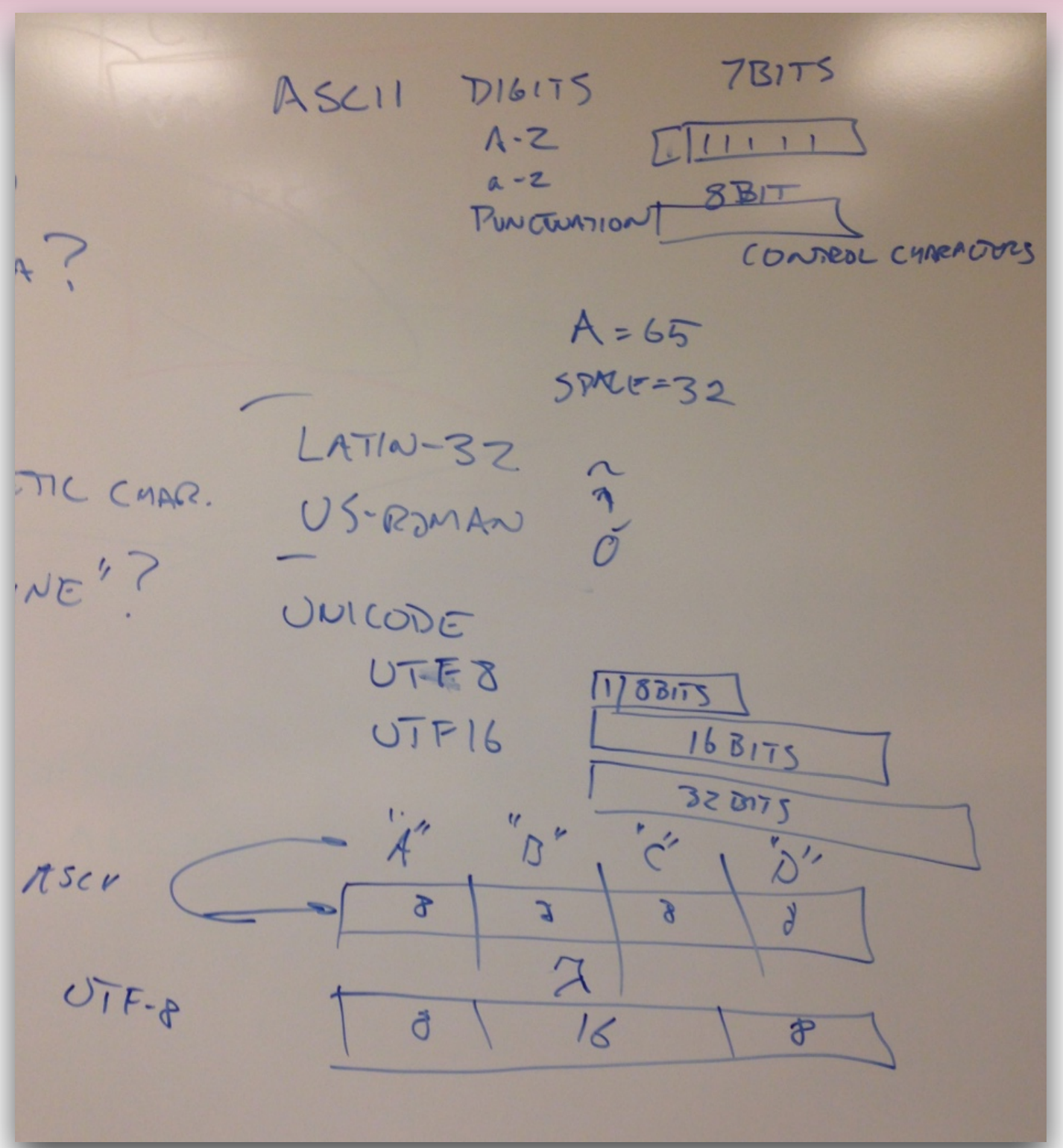
Thought Experiment

- “Given a collection of lines of text stored in a file, sort them in alphabetical order, and write them to another file”
- Schedule
- When does it have to be delivered?
  - Speed costs $$
  - $$ can’t make everything possible however

Thought Experiment

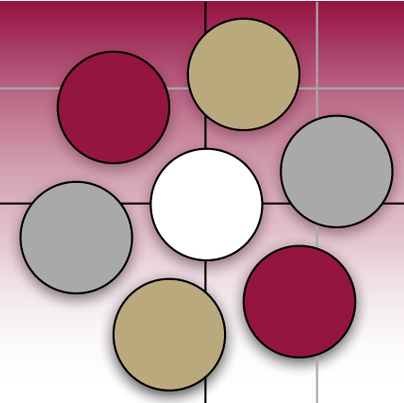
- 1 byte characters (UTF-8)
- Sort ascending, treating digits as characters, upper and lowercase differently in Unicode order
- Empty lines not special, empty files make empty files
- 1 minute to sort 100 lines of 100 characters
- no real-time requirements
- no modifiability requirements
- We should have a GUI, run on Mac, in Java
- typical input size will be 100 lines
- For Prof. Patterson: Due ASAP

Side-bar on character encoding



When in doubt use UTF-8

Prof. Patterson Experiment



I estimated 30 minutes to do the task

- 10:00 - started
- 10:15 - Eclipse crashed
- 10:30 - Decide initial design was bad
- 11:00 - laptop battery died - no charger - stop
- 13:00 - restart
- 13:21 - done debugging
- 13:36 - done writing tests
  - effort ~ 1.6 person hours
  - elapsed time ~ 3.5 hours

Decisions

Testing

- Acceptance Tests
  - High-level evaluations by a client, contractually bound
  - Do a sorting walk-through of examples
- UI Tests
  - Automated tests that simulate UI input
- Functional tests
  - Automated tests that simulate scenarios
- JUnit tests
  - Automated tests that test method and class specs

Decisions

Testing

- “Extreme Programming” methodology
  - Write the tests before you write the code

Decisions

Estimating Effort (aka Project Management)

- Breaking down a problem into sub-tasks
- Estimating the time for each
- Assigning a cost to the project

Decisions

Exercise

Write a “program” in your favorite language that will accept numerical numbers as inputs, compute the average, and output the answer.

Provide an estimate within one minute:

How long (in elapsed-time) would it take you to implement this solution?

How much overall effort (in person-hours) will this take?

How well will your solution match the problem?

How good is your code/design/documentation/testing?

Decisions

Estimating Effort

- Did you include meal breaks, rest breaks, bathroom breaks?
- Did you break down the task?
- Did you include GUI? Testing? Bug fixing?

Decisions

Estimating Effort

- This is one of the toughest problems in software project management.
- Accurate estimates are very hard to make
- Estimates should be made by the person assigned to the task
  - Hopefully after some reflection and data on performance.

- Pivotal Tracker

Previous Class Answers

- How long (in elapsed-time) would it take you to implement this solution?
  - Class Answer: 10 min. (A); 15 min (B); 1 hr. (C);
- How much overall effort (in person-hours) will this take?
  - Class Answer: 10 person min. ; 15 person min. ; 1 person hour; 3 person-hrs
- Will your solution match the problem?
  - Class Answer: YES!
- How “good” will your solution be?
  - Class Answer: Awesome!

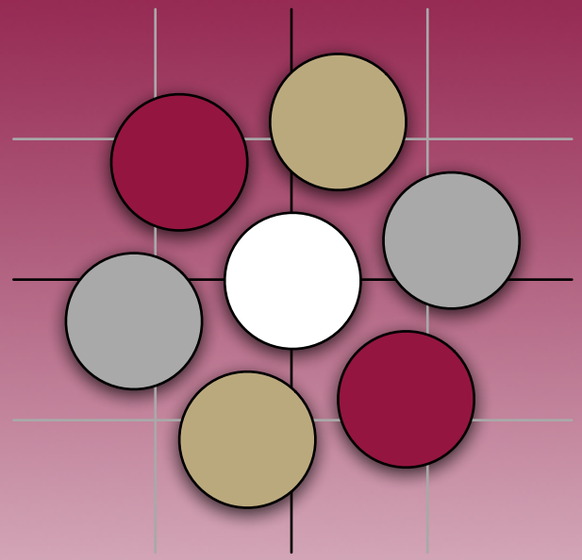
Some “Previous Class” Inputs

- How long do you think assignment #1 would take?
  - 1 hr --- 7 people
  - 2 hrs --- 6 people
  - 3 hrs --- 2 people
  - 10 hrs --- 3 people
- Real data from class:
  - Elapsed time: range was 5 days to 46 minutes – mostly between 1 to 3 hours
  - Effort: range was 8 person-hours to 40 person-minutes – mostly between 1 person-hour to 3 person-hours

Implementation

Conventions help teams move faster

- Teams need to agree on syntax conventions and stick to them
- When do you use capital letters?
- How are things named?
- How are comment utilized?
- Testing before giving code to others
- Having someone else review your code before sharing



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