CS132: Software Engineering

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Lecture 1: Introduction

What is software engineering?

Science vs. Engineering

Science vs. Engineering

- Science: Theoretically how something can be achieved
  - How to generate Ammonia (NH_3)?
  - $N_2 + 3H_2 \leftrightarrow 2NH_3 \uparrow$
- Engineering: How to achieve the goal efficiently and economically with existing constraints
  - In 1774: $2NH_4Cl + Ca(OH)_2 \leftrightarrow CaCl_2 + 2NH_3 \uparrow + 2H_2O$
  - In 1898: $CaC_2 + N_2 \rightarrow CaCN_2 + C \; and \; CaCN_2 + 3H_2O \rightarrow CaCO_3 + 2NH_3 \uparrow$
  - In 1908: $N_2 + 3H_2 \leftrightarrow 2NH_3 \uparrow$ under high pressure with catalysts

Software "Science"

- Algorithm
- Theory of computation
- What problems can be solved computationally?
  - Computability theories
    - The halting problem
- How can we express the solution rigorously without ambiguities?
  - Formal languages
- Can we solve problems efficiently?
  - Computational complexity theory

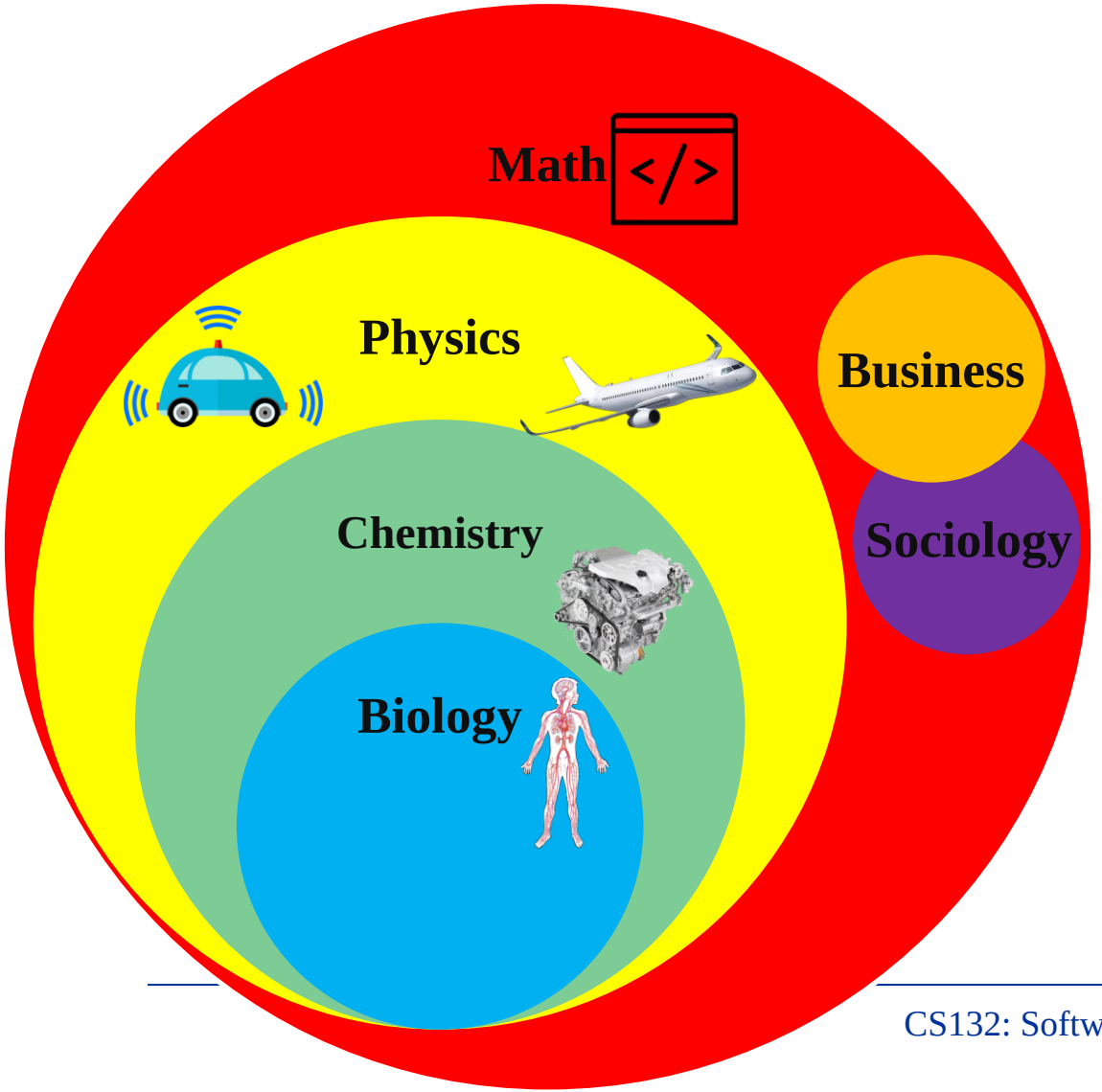
Software Engineering: Definition

- "The establishment and use of sound engineering principles in order to obtain economical software that is reliable and works efficiently on real machines …" [Fritz Bauer, at the 1st NATO Conference on Software Engineering, 1969]

"The Software Crisis"

- The need to develop larger, more diverse software systems
- 28% of software projects are "success"
  - 51% seriously late, over budget and lacking expected features
  - 18% cancelled outright
- Increasing complexity
  - Use to be one single task on a specific computer
  - More functionalities
  - In more conditions
  - On more platforms
  - By more people

An Inter-disciplinary Field



- Software is in math domain
  - Amazon negative quantity bug
- The domain specific constraints have to be encoded or considered in the software
- The domains with more constraints are also less understood

Which fake news is easier to tell?

"NASA说因为今天地球完美的重力角度，是唯一一天可以让扫把独自站立的日子。"

想看大家参与「NASA立扫把挑战 | BroomChallenge」的图 😂

Key Challenges in Software Engineering

1. Effective communication
   - Between the engineering team and other stakeholders
   - Within the engineering team

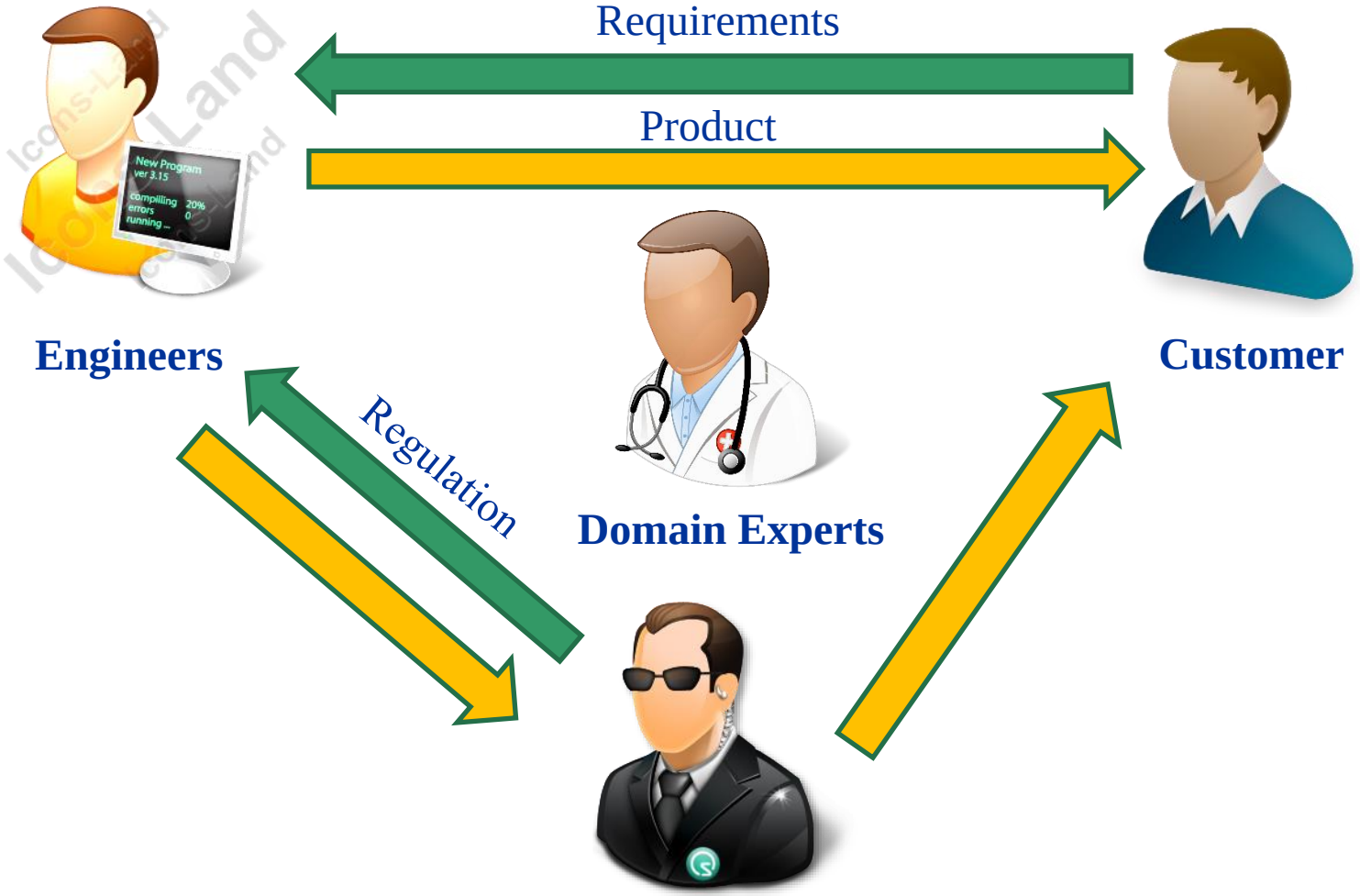
2. Risk Management
   - How to balance conflicting judging criteria?

3. Validation
   - How do you convince all stakeholders that the software is effective/safe/secure?

1. Effective communication

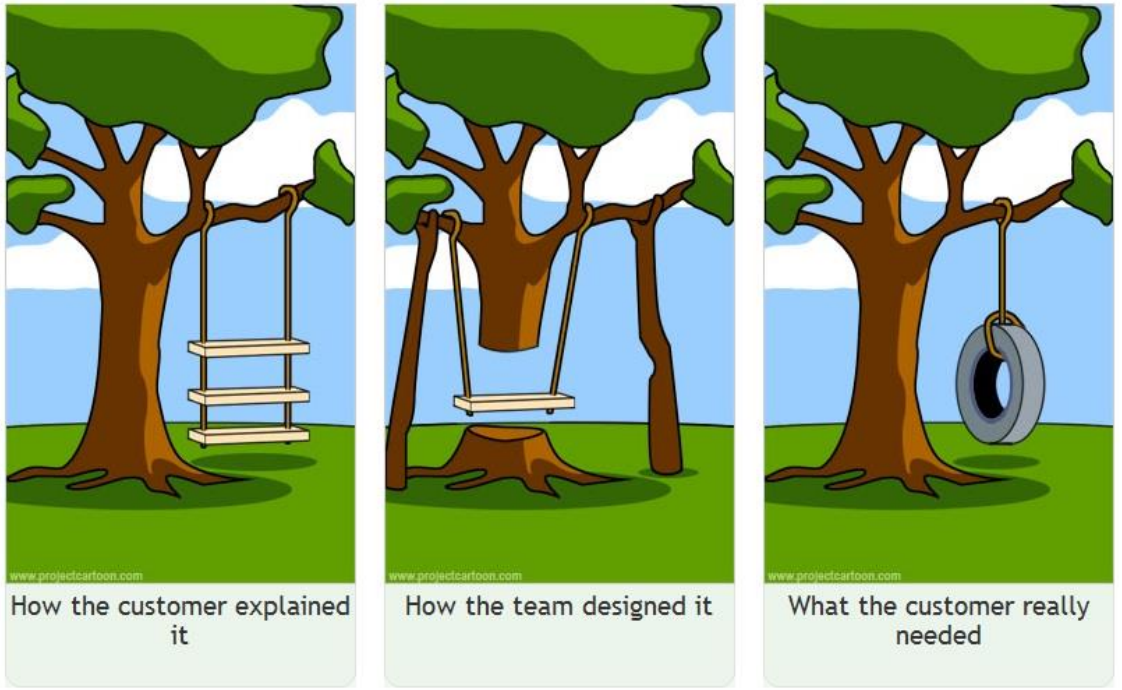
1. Effective Communication

Stakeholders for software



Miscommunications

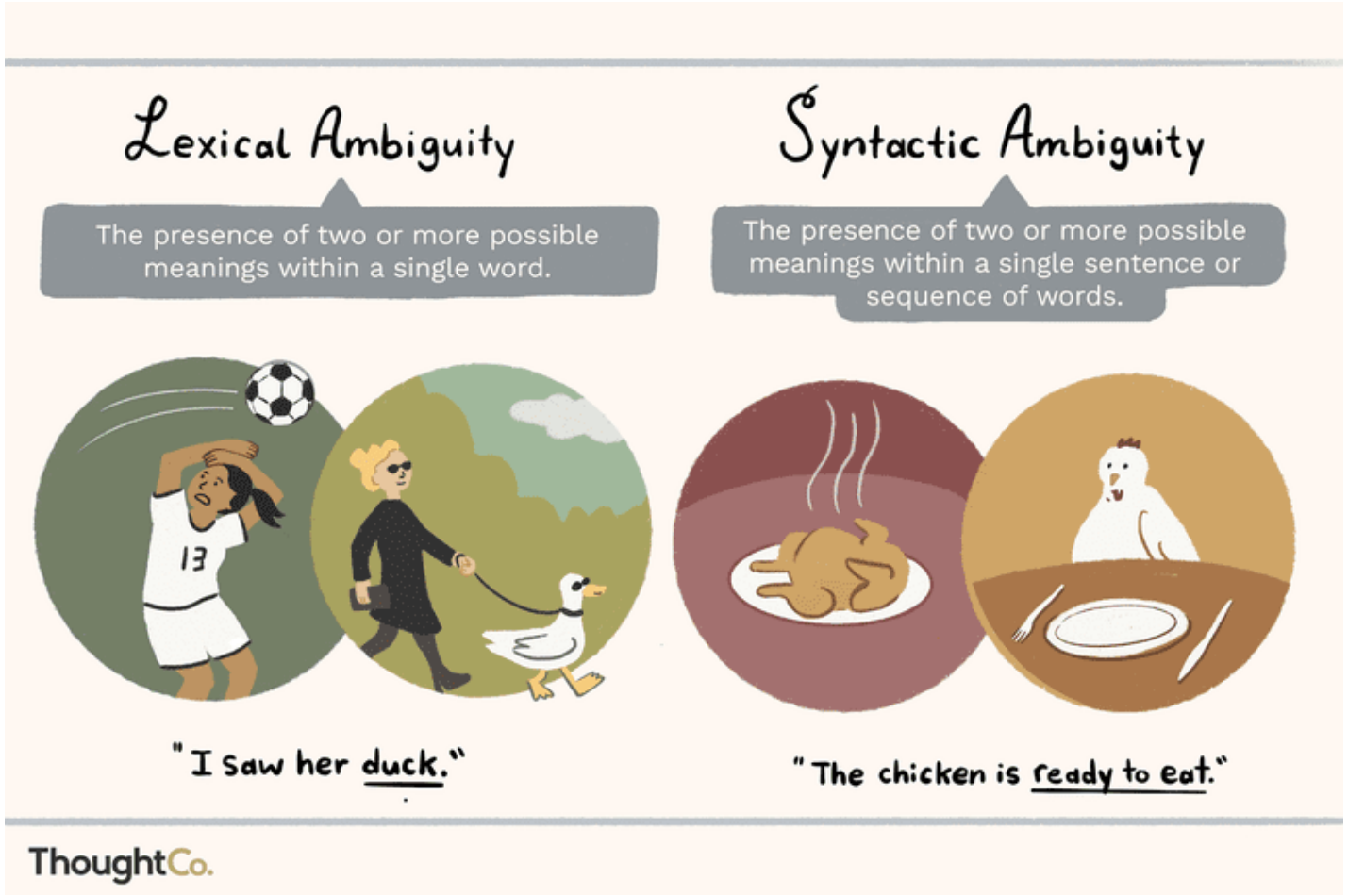
- The customer fails to explain their needs well.
- The customer may not know what he/she wants
- The analyst may not understand the customer's need.
- Your analyst may not convey the requirements to the development team



1. Effective Communication

Domain Knowledge: “The Expert”

Natural Languages Are Prone to Ambiguities



1. Effective Communication

Communications among various stakeholders

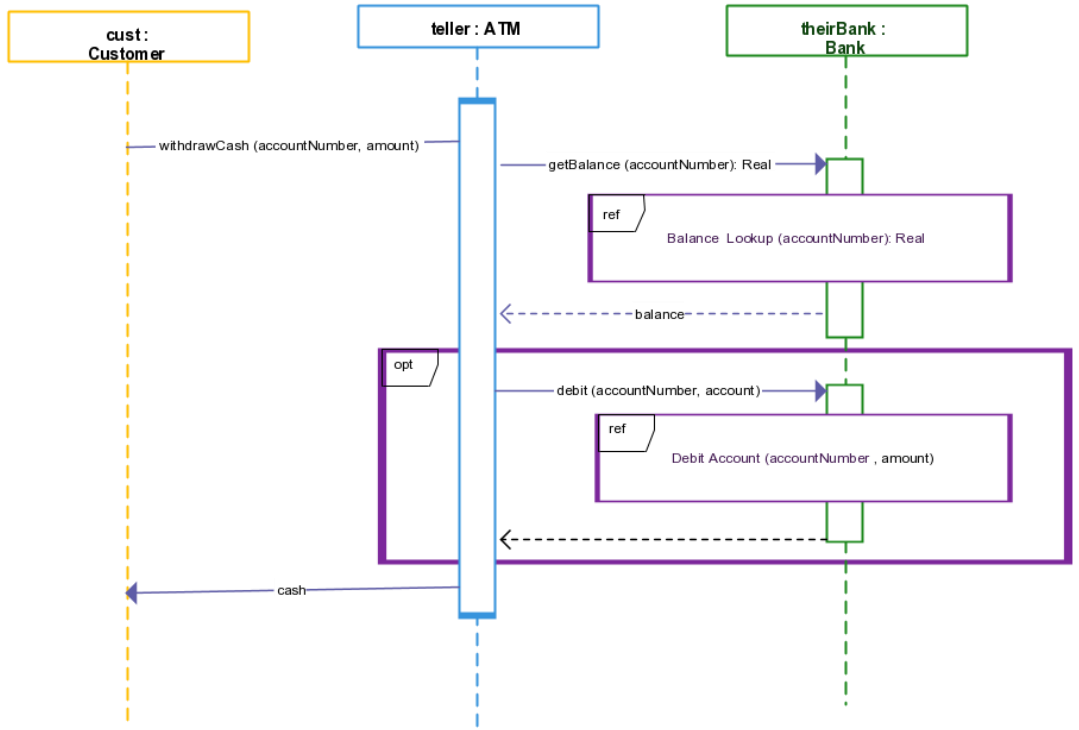
- Need a common language for communication
- Unified Modeling Language (UML)
- Recognized as an international standard
- It’s just a tool, not a solution

Examples of UML Diagrams

- Structural diagram

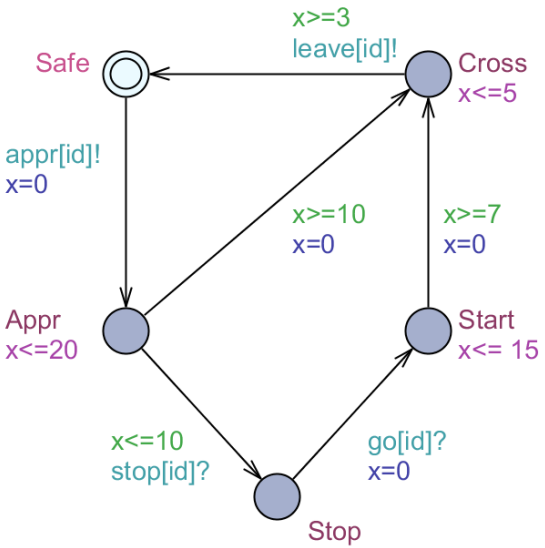
BankAccount
owner : String balance : Dollars = 0
deposit (amount : Dollars) withdrawal (amount : Dollars)

- Behavioral Diagram

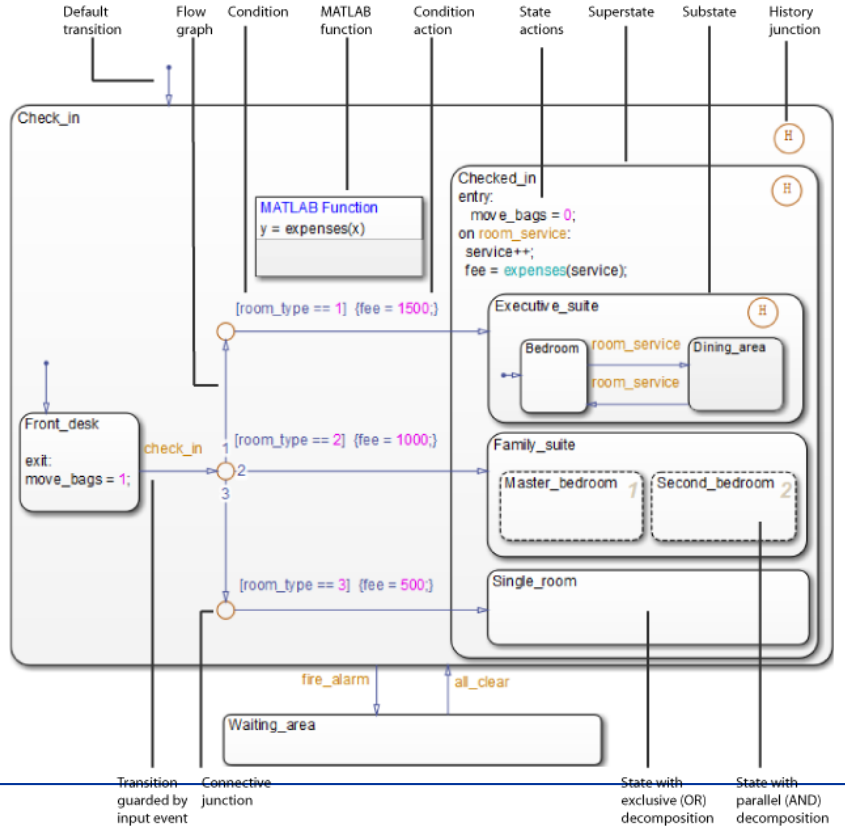


Communication within the team

- Formal models
  - Timed automata



- Simulation models
  - Simulink



The lifecycle of a successful software is long

- Other team members should understand your code and documentation
- Other team members should be able to easily “inherent” code from you

What we want you to learn in this course

- Communication skills are important no matter what you do in the future
  - Documentation
  - Meetings and presentations

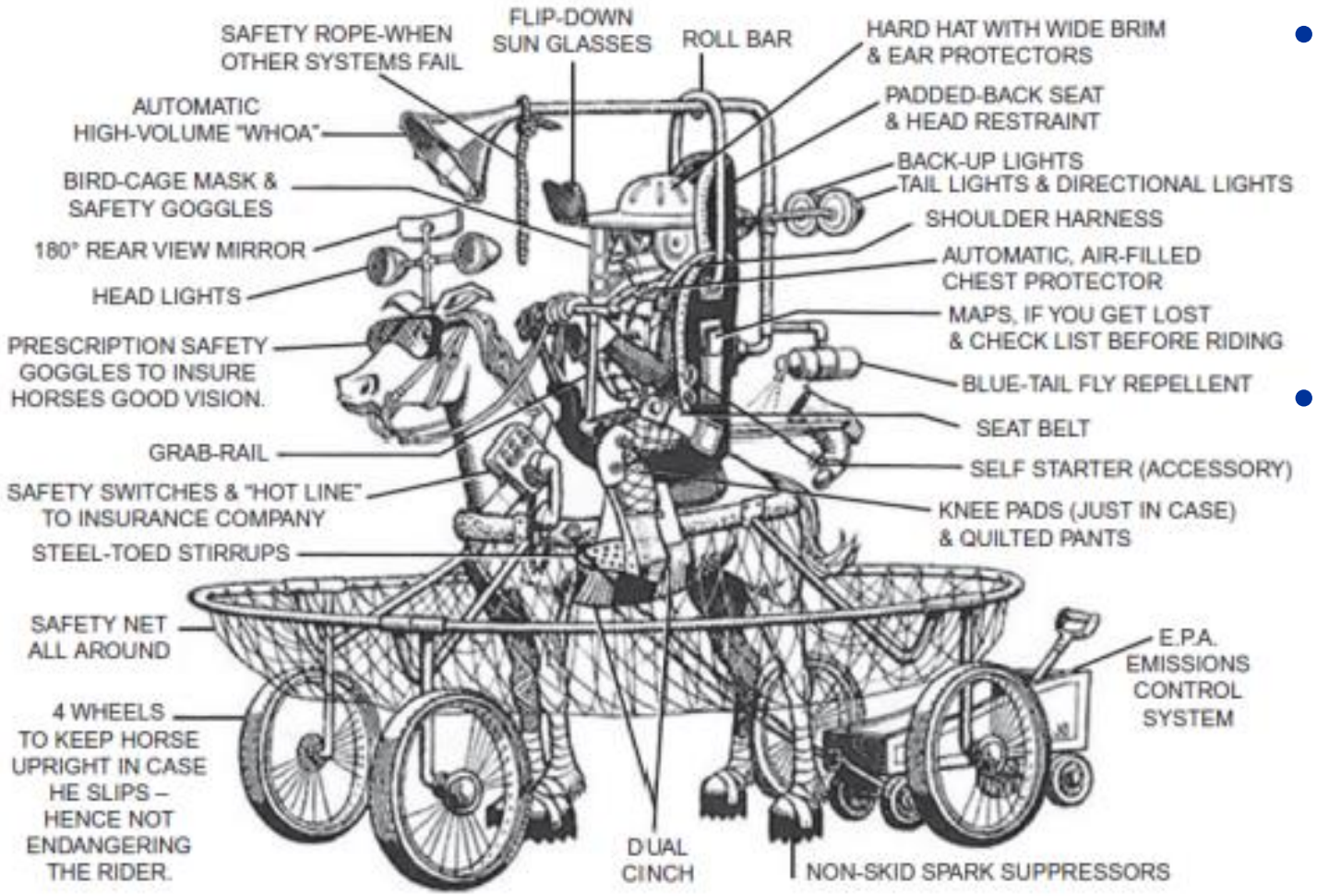
- Be mentally prepared
  - Respect other people's domain expertise
  - Accept that other people may not know what you know

- How to analyze problems in other domains?

2. Risk Management

Are they good planes?

The "All-around" Solution



- Risk control measures may affect other system properties
- Justify that benefits outweigh the risks

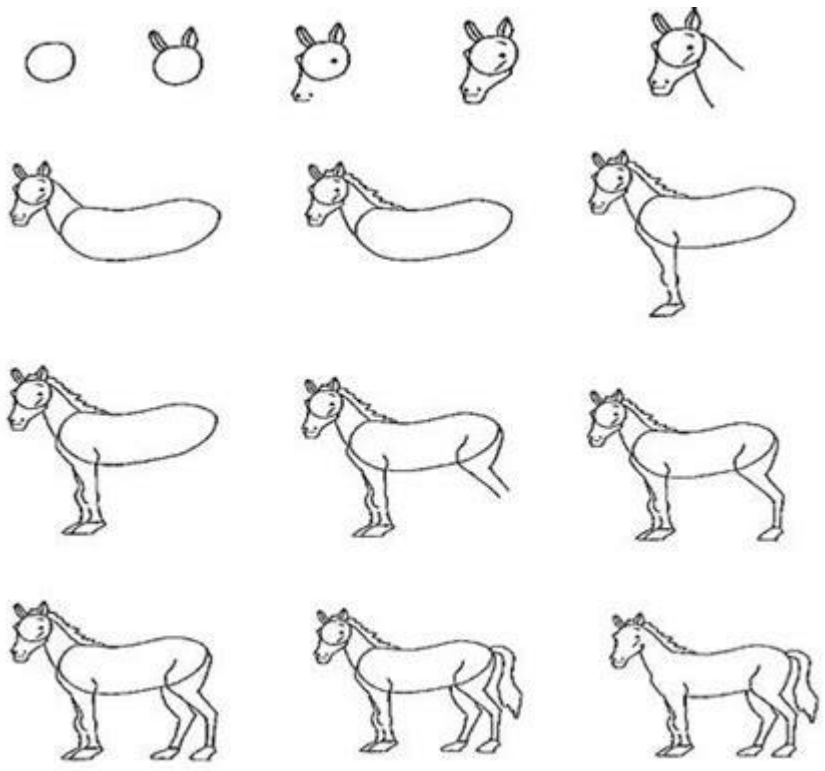
2. Risk Management

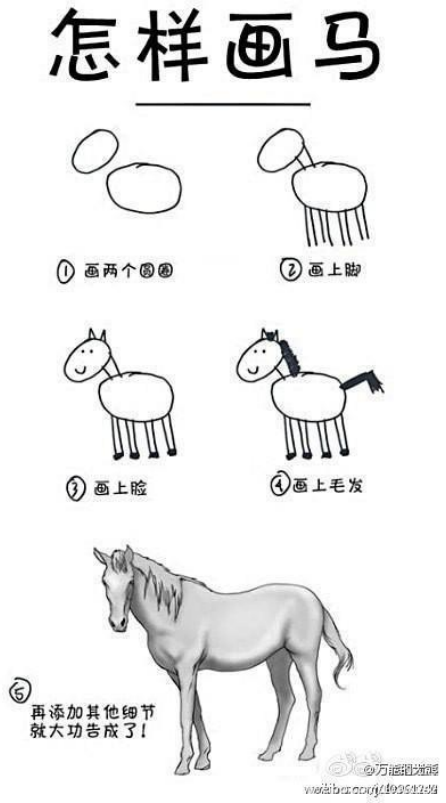
Balancing among risks

- Uber Autonomous Vehicle Accident (March 18, 2018)
- Pedestrian Identification: balancing false-positives vs. false-negatives

Iterative Software Development

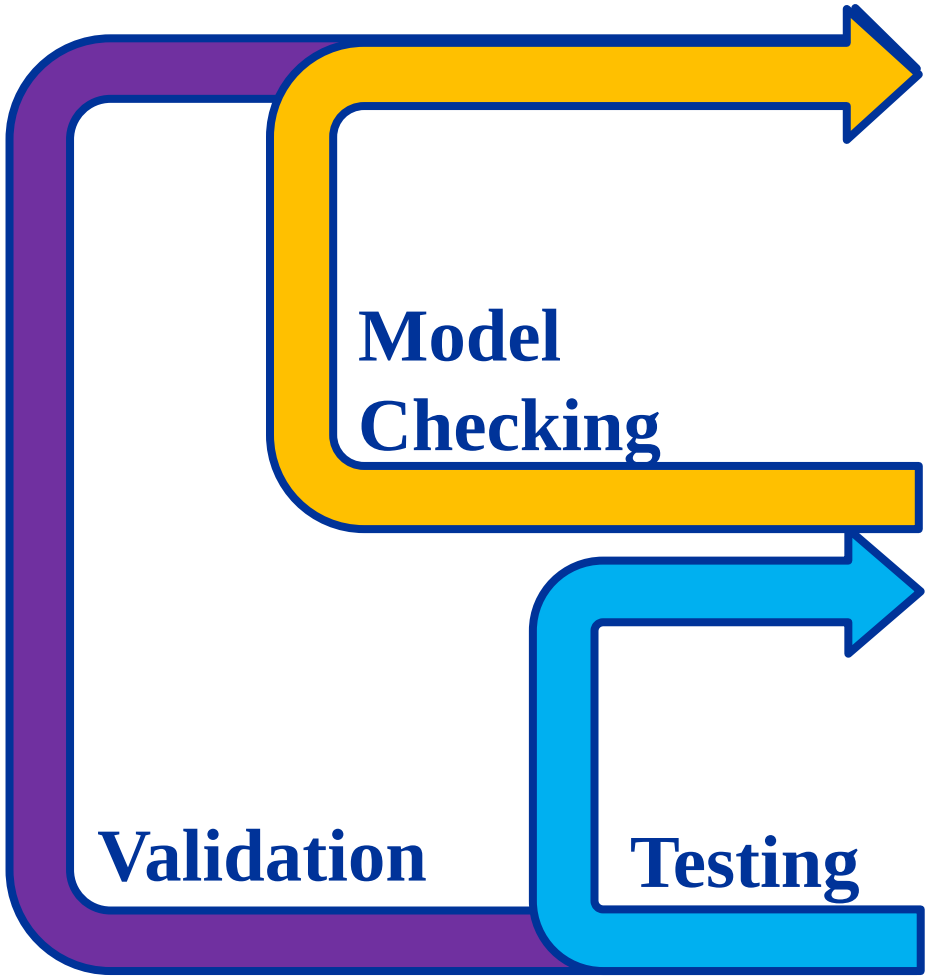
- Develop “validatable” artifacts early





3. Validation

Software Development Process



- Requirements
  - i.e. the vehicle should not crash with any other objects
- Specifications
  - i.e. when the vehicle detects an object on its path, apply brake
- Implementation

3. Validation

What should we validate?

- Efficacy: The system can do its job as designed
- Safety: Under intended use, the system will not harm the user and its surroundings
- Security: Prevent malicious use of the system

Model-based Software Design

- From verified model to verified code
  - Business model (in UML)
  - Analysis model (in UPPAAL)
  - Design model (in UML/Simulink)
  - Code (in Matlab)
- Verify analysis/design model
- Maintain traceability during development

How to convince others that your system is good?

- Rigorousness of the development process
- Rigorousness of the techniques
- Demonstration of effort
- “All or nothing”

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Curriculum

- Software development lifecycle
- Project management
- Capture software requirements using UML
- Strike a balance: risk management
- Early bug-finding using model checking
- Maintain traceability in model-based software design
- Software testing

Grading

- Homework: 4*5%
- Midterm: 20%
- Final Project: 60%

Project Logistics

- 3 students per team (1,2,3)
- 3 mini projects (a,b,c)
- Each project has 3 stages
  - Requirement (R)
  - Development (D)
  - Validation (V)
- Student 1: a.R+b.D+c.V
- Student 2: b.R+c.D+a.V
- Student 3: c.R+a.D+b.V

Checkpoints and Progression

- Team meeting every week
  - Report on what has been done and plan for next week
  - Part of the demonstration of "effort"

- 3 Customer Consultations
  - Chance to demonstrate initial results and ask for feedback
  - Please take them seriously!

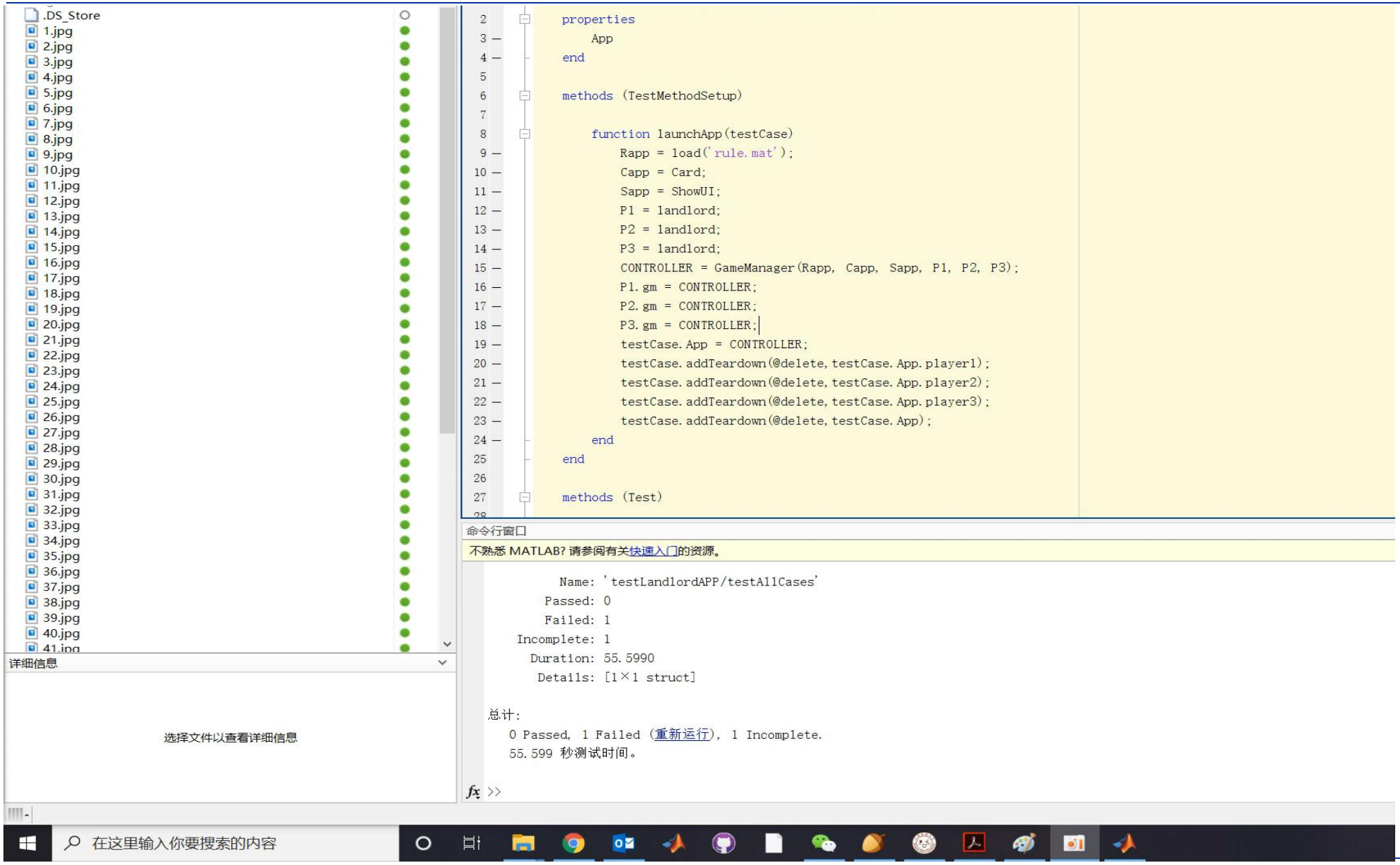
Project Grading

- Overall Product (70%+10%)
  - Functional requirements (40%)
  - Non-functional requirements (15%)
  - Validation (15%)
  - Extra Credits (10%)
- Documentation (30%)
  - Requirement (10%)
  - Development (10%)
  - Validation (10%)

Grading Example

Project 1			Project 2			Project 3		
Overall Product		55	Overall Product		60	Overall Product		65
Documentation	Requirement	8	Documentation	Requirement	5	Documentation	Requirement	6
	Development	7		Development	4		Development	3
	Validation	5		Validation	9		Validation	7

	Score
Student 1 (1R2D3V)	(55+60+65)/3+8+4+7=79%
Student 2 (2R3D1V)	(55+60+65)/3+5+3+5=73%
Student 3 (3R1D2V)	(55+60+65)/3+6+7+9=82%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详细信息
选择文件以查看详细信息
properties
App
end
methods (TestMethodSetup)
function launchApp(testCase)
Rapp = load('rule.mat');
Capp = Card;
Sapp = ShowUI;
P1 = landlord;
P2 = landlord;
P3 = landlord;
CONTROLLER = GameManager(Rapp, Capp, Sapp, P1, P2, P3);
P1.gm = CONTROLLER;
P2.gm = CONTROLLER;
P3.gm = CONTROLLER;
testCase.App = CONTROLLER;
testCase.addTeardown(@delete,testCase.App.player1);
testCase.addTeardown(@delete,testCase.App.player2);
testCase.addTeardown(@delete,testCase.App.player3);
testCase.addTeardown(@delete,testCase.App);
end
end
methods (Test)
命令行窗口
不熟悉 MATLAB? 请参阅有关快速入门的资源。
Name: 'testLandlordAPP/testAllCases'
Passed: 0
Failed: 1
Incomplete: 1
Duration: 55.5990
Details: [1×1 struct]
总计:
0 Passed, 1 Failed (重新运行), 1 Incomplete.
55.599 秒测试时间。
>>
在这里输入你要搜索的内容

Working as a team

- Team up with someone you trust
- You are responsible for some task doesn't mean you "only" need to complete the task
- "Make other's job easier"
- "The Black Sheep" will get severe penalties

You may complain about…

- "The requirements are too vague!"
  - It's not a bug, it's a feature!
- "I did my part, why do I get penalized for what others didn't do?"
  - Because you are on the same team, that's why.
- Please do not ask
  - "Can we get/lose points if we implement/not implement a feature?"

Logistics

- Slides are released 1 day before each lecture on blackboard
- Recordings of lectures will be posted on BB after the class
- Important announcements are sent via emails
- Forum available on Piazza (piazza.com/shanghaitech.edu.cn/spring2021/cs132)
  - Ask questions regarding implementations, not ideas

Academic Ethics

- Homework should be done alone
- Do not share code/documents among teams
- Feel free to reuse code segments within the team
- Do not use code/documents from other sources (previous years' or online)
- Violators will receive severe penalties