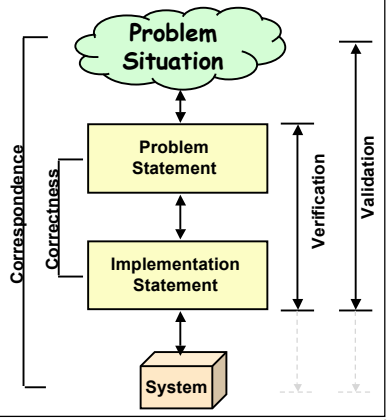
Lecture 2: What are Requirements?

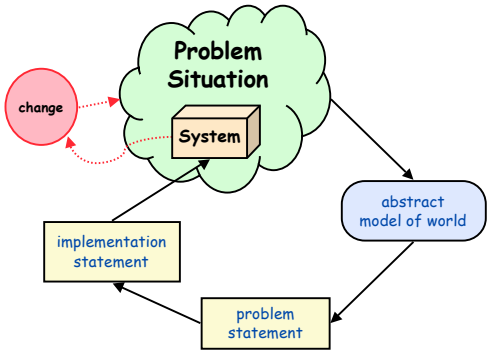
- Two basic principles of requirements engineering:
  - Separate the problem from the solution
  - Problems and solutions intertwine with one another
- Describing problems:
  - Application Domains vs. Machine Domains
  - Verification vs. Validation
- Systems Engineering
  - Systems vs. software

Separate the problem from the solution

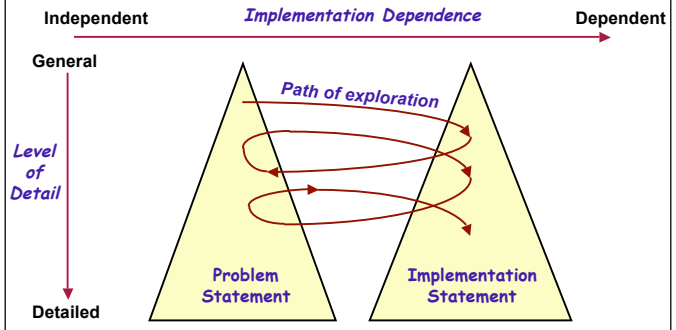
- A separate problem description is useful:
  - Most obvious problem might not the right one to solve
  - Problem statement can be discussed with stakeholders
  - Problem statement can be used to evaluate design choices
  - Problem statement is a source of good test cases
- Still need to check:
  - Solution correctly solves the stated problem
  - Problem statement corresponds to the needs of the stakeholders



But design changes the world…



Intertwining of problems and solutions

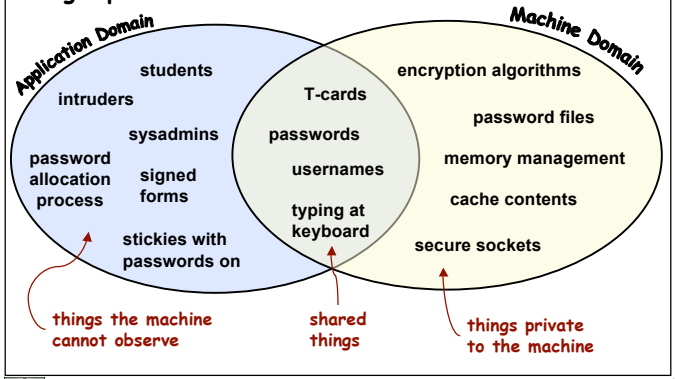


Some observations about RE

- RE is not necessarily a sequential process:
  - Don't have to write the problem statement before the solution statement
    - (Re-)writing a problem statement can be useful at any stage of development
  - RE activities continue throughout the development process
- The problem statement will be imperfect
  - RE models are approximations of the world
    - will contain inaccuracies and inconsistencies
    - will omit some information.
    - analysis should reduce the risk that these will cause serious problems…
- Perfecting a specification may not be cost-effective
  - Requirements analysis has a cost
  - For different projects, the cost-benefit balance will be different
- Problem statement should never be treated as fixed
  - Change is inevitable, and therefore must be planned for
  - There should be a way of incorporating changes periodically

A problem to describe…

- E.g. "prevent unauthorized access to CSG machines"



What are requirements?

- Domain Properties:
  - things in the application domain that are true whether or not we ever build the proposed system
- Requirements:
  - things in the application domain that we wish to be made true by delivering the proposed system
    - Many of which will involve phenomena the machine has no access to
- A Specification:
  - is a description of the behaviours that the program must have in order to meet the requirements
    - Can only be written in terms of shared phenomena!

Fitness for purpose?

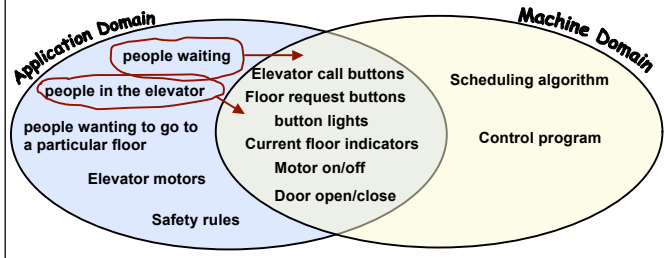
- Two correctness (verification) criteria:
  - The Program running on a particular Computer satisfies the Specification
  - The Specification, in the context of the given domain properties, satisfies the requirements
- Two completeness (validation) criteria:
  - We discovered all the important requirements
  - We discovered all the relevant domain properties
- Example:
  - Requirement R:
    - "Reverse thrust shall only be enabled when the aircraft is moving on the runway"
  - Domain Properties D:
    - Wheel pulses on if and only if wheels turning
    - Wheels turning if and only if moving on runway
  - Specification S:
    - Reverse thrust enabled if and only if wheel pulses on
  - Verification: S, D $\models$ R

Another Example

- Requirement R:
  - "The database shall only be accessible by authorized personnel"
- Domain Properties D:
  - Authorized personnel have passwords
  - Passwords are never shared with non-authorized personnel
- Specification S:
  - Access to the database shall only be granted after the user types an authorized password
- S + D entail R
  - But what if the domain assumptions are wrong?

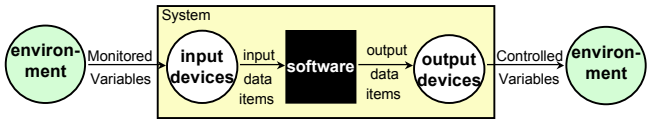
But we can also move the boundaries…

- E.g. Elevator control system:



- We can shift things around:
  - E.g. Add some sensors to detect when people are waiting
  - This changes the nature of the problem to be solved

Systems vs. Software Engineering



IN (Properties of the **input device**)

SOFT (properties of the **software**)

OUT (properties of the **output device**)

REQ (the requirements - relationships between monitored and controlled variables that the **system** is required to establish or maintain)
NAT (natural relationships between monitored and controlled variables that are part of the domain)

Summary

- Requirements Engineering is about describing problems
  - It is useful to separate the problem from the solution
    - Even though this cannot be achieved entirely
  - Problems evolve continuously:
    - Delivering a solution changes the problem
    - Describing the problem changes the problem
- Key distinctions:
  - Application Domains vs. Machine Domains
  - Verification vs. Validation
  - Systems Engineering vs. Software Engineering