Software Systems Verification and Validation

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Software Systems Verification and Validation

"Tell me and I forget, teach me and I may remember, involve me and I learn."

(Benjamin Franklin)

Outline

- Verification and Validation
- Software development life cycle Model
  - V-Model
  - Extended V-Model [CB03]
- Quality
  - Quality control vs. Quality Assurance
  - Quality definitions
- What is a bug?
  - First bug
  - Terms for software failures
  - Software error (or bug)
  - When? Why? Cost?
  - Famous Software bugs

Verification and Validation (SEI and NASA) [NTO5],[PYO8]

Software Engineering Institute

- **Verification**
  - assures the product is developed according to requirements, specifications and standards.
  - building the product correctly.
  - Are we building the product right?
- **Validation**
  - assures that the product will be usable on the market.
  - building the correct product.
  - Are we building the right product?

NASA - Software Assurance Guidebook and Standard [NAS]

- Verification and Validation
  - the process that assures that the software product:
    - every step in the product development is resulting in a correct (sub)product = **verification**.
    - will satisfy the requirement (functional and others) = **validation**.

Verification and Validation - comparison

Verification	Validation
• evaluates if the product of a given development phase satisfies the requirements of that phase; • reviews products to ensure their quality (consistency, completeness, correctness); • static and dynamic analysis techniques.	• helps us at confirming that a product meets its intended use. • is performed toward the end of the system development to determine if the entire system meets the customer's needs and expectations; • is performed on the entire system by actually running the system in its real environment and using a variety of tests.

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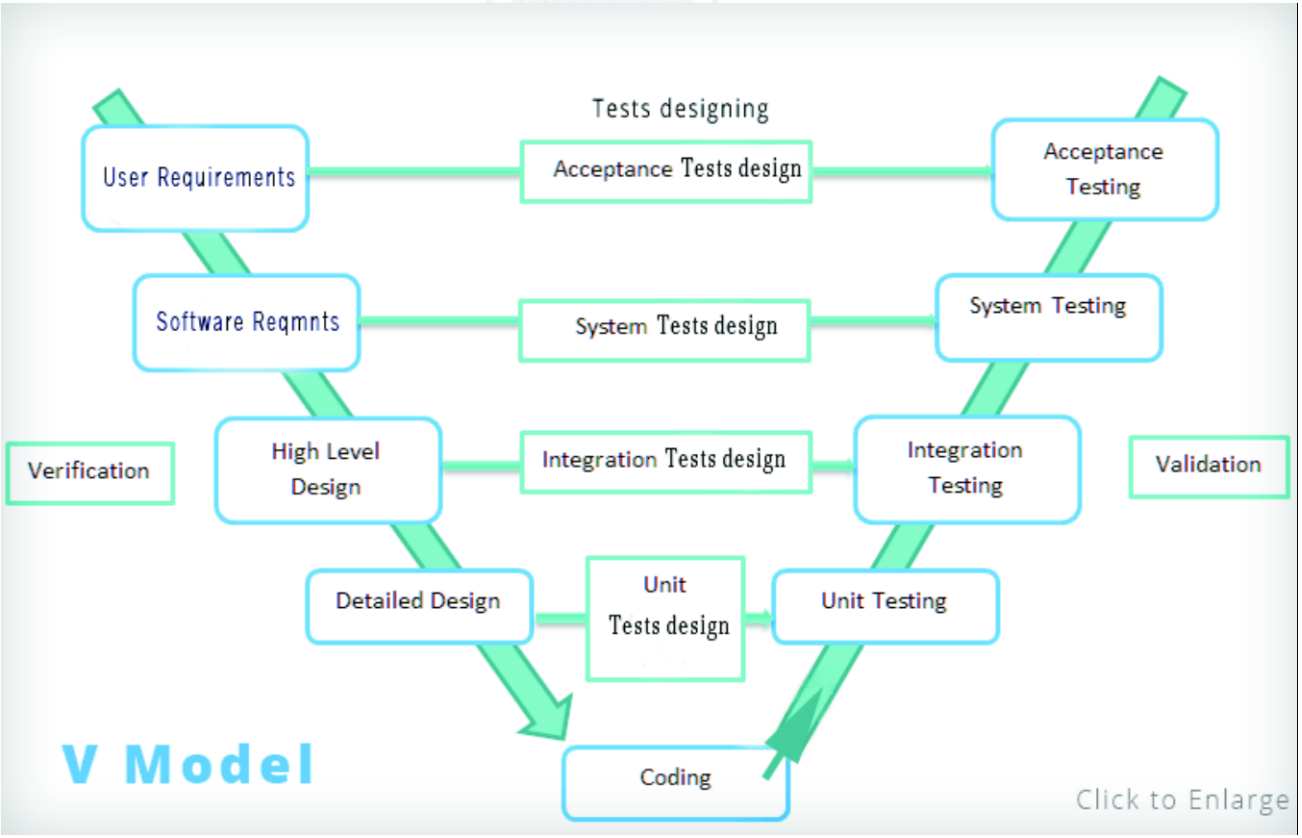
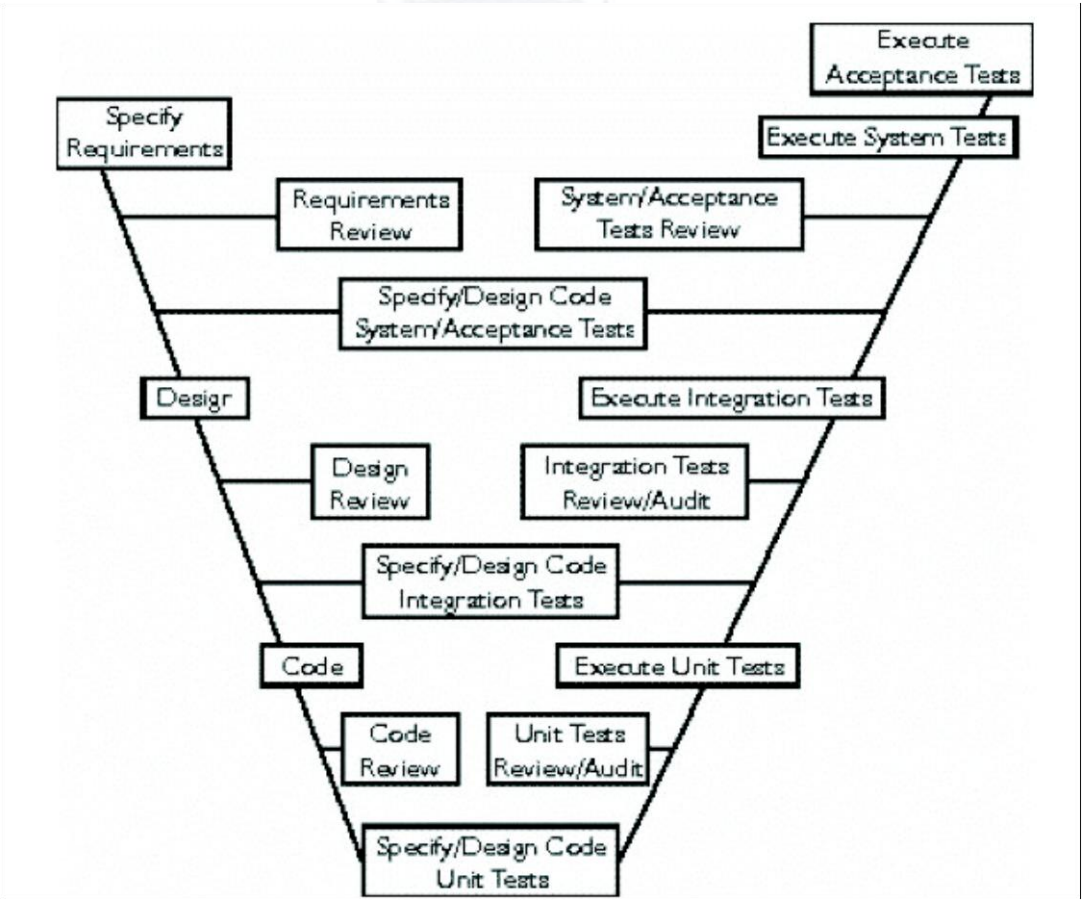
Software development life cycle Model

- V-Model



Software development life cycle Model

- Extended V-Model



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Quality control vs. Quality Assurance

Quality control	Quality Assurance
• QC = Quality of products • How do you control the quality of the work you have done? • Goal: detect problems in the work products	• QA = Quality of processes • How do you assure the quality of the work you are going to do? • Goal: Ensure adherence to processes, standards and plans

Quality definitions [BBST]

"Quality is conformance"

"Software quality: Conformance to explicitly stated functional and performance requirements, explicitly documented development standards, and implicit characteristics that are expected of all professionally developed software." [Pre00]

"Quality is free." by Phil Crosby [Cro80]

conformance with requirements, i.e. conformance to the user's actual requirements which may or may not be written down in a specification.

Quality - conformance to the needs and not to documents.

"Quality - fitness for use." by Joseph Juran [JJ98]

satisfiers - anything that makes you like the application

dissatisfiers - anything that makes you like the application less.

Quality – according to who? (Program manager, Programmer, Tech writer, Tester)

"Quality - is value to some person." by Jerry Weinberg [Wei92]

quality is subjective - what's valuable for you may not be so valuable for me.

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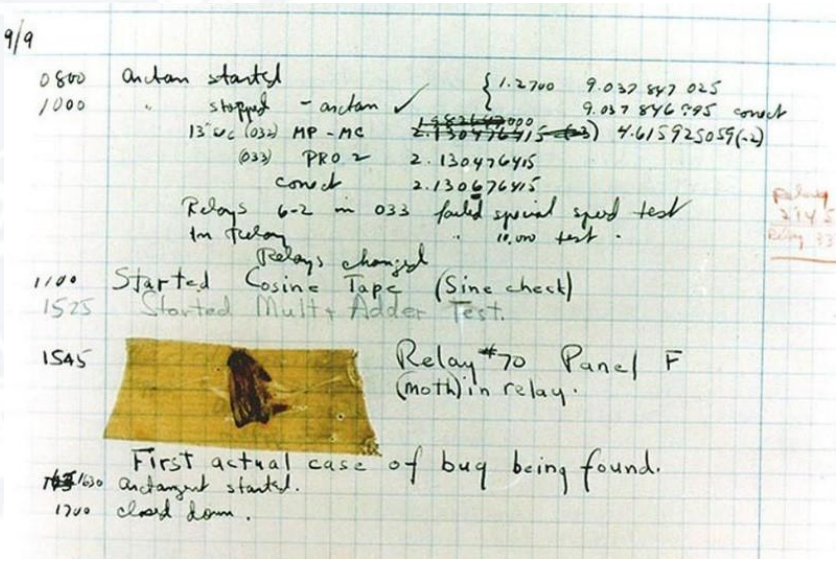
What is a bug?

- First bug
  - Grace Hopper - About first software bug: (2'10")
    https://www.youtube.com/watch?v=lQS0hDqpVLE
  - 1947 - Harvard University - Mark II

- The first computer bug was born!



Well, okay, it died!

Terms for software failures [Pat05]

- **Failure**
  - A failure is said to occur whenever the external behavior of a system does not conform to that prescribed in the system specification.
- **Error**
  - An error is a state of the system. In the absence of any corrective action by the system, an error state could lead to a failure which would not be attributed to any event subsequent to the error.
- **Fault**
  - A fault is the adjudged cause of an error.
- Process of failure manifestation - represented as a behavior chain:

  fault → error → failure.

Software error (or bug)

- A bug is an aspect of the product that causes an unnecessary or unreasonable reduction in the quality of the product.
  - design weaknesses, documentation error, usability annoyances

Remark. Some aspects of a product do limit its quality but are not bugs!

- A bug is anything about the product that threatens its value.

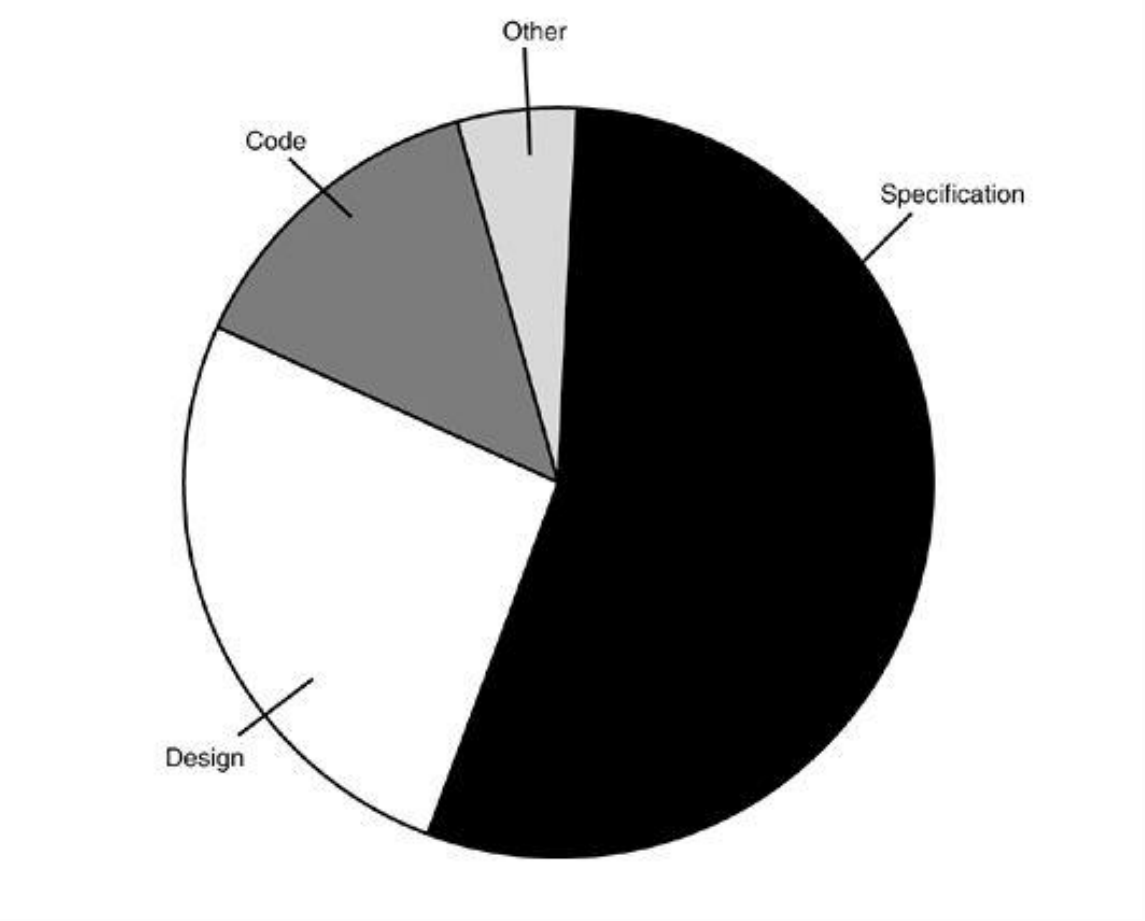
[James Bach, Michal Bolton] [BBST]

- In this course, all software problems will be called bugs.

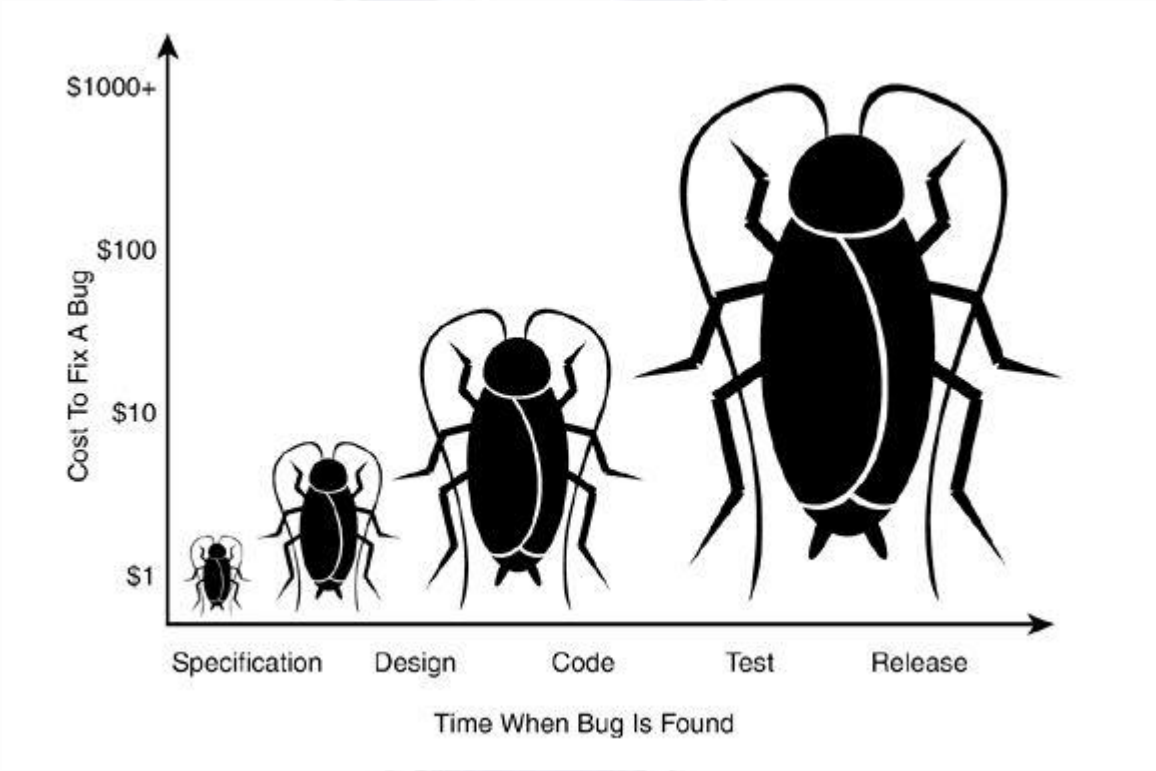
When a software bug occurs?

- A software bug occurs when one or more of the following rules is true [Pat05]:
  - The software doesn't do something that the product specification says it should do.
  - The software does something that the product specification says it shouldn't do.
  - The software does something that the product specification doesn't mention.
  - The software doesn't do something that the product specification doesn't mention but should.
  - The software is difficult to understand, hard to use, slow, or in the software tester's eyes will be viewed by the end user as just plain not right.

Why do bugs occur? [Pat05]



The cost of bugs [Pat05]



Famous Software bugs

- **Mariner 1 rochet – 1962 - diverted from its intended flight path shortly after launch.**
  - **Cause**: A programmer incorrectly transcribed a handwritten formula into computer code.
  - **Cost**: $ 18.5 million
- **World War III – almost – 1983 - The Soviet early warning system falsely indicated the United States had launched five ballistic missiles.**
  - **Cause**: A bug in the Soviet software failed to filter out false missile detections caused by sunlight reflecting off cloud-tops.
  - **Cost**: Nearly all of humanity
- **Therac-25 radiation therapy machine – 1985 - Canada Therac-25 radiation therapy machine malfunctioned and delivered lethal radiation doses to patients.**
  - **Cause**: Because of a subtle bug called a race condition, a technician could accidentally configure Therac-25 so the electron beam would fire in high-power mode without the proper patient shielding.
  - **Cost**: Three people dead, three people critically injured
- **Pentium Fails Long Division – 1993 - Intel highly-promoted Pentium chip occasionally made mistakes when dividing floating-point numbers within a specific range.**
  - **Cause**: The divider in the Pentium floating point unit had a flawed division table, missing about five of a thousand entries and resulting in these rounding errors.
  - **Cost**: $475 million, corporate credibility.
- **Disney's Lion King – 1995 - The Disney company released its first multimedia cd-rom game for children, The Lion King Animated Storybook. Several parents couldn't get the software to work.**
  - **Cause**: Disney failed to test the software on a broad representation of the many different PC models available on the market.
  - **Cost**: cd-rom replacements, corporate credibility.
- **Mars Climate Crasher – 1998 - After a 286-day journey from Earth, the Mars Climate Orbiter fired its engines to push into orbit around Mars. The engines fired, but the spacecraft fell too far into the planet atmosphere, likely causing it to crash on Mars.**
  - **Cause**: The software that controlled the Orbiter thrusters used imperial units (pounds of force), rather than metric units (Newtons) as specified by NASA.
  - **Cost**: $125 million.
- **Cancer Treatment -2000 - Radiation therapy software by Multidata Systems International miscalculated the proper dosage, exposing patients to harmful and in some cases fatal levels of radiation.**
  - **Cause**: The software calculated radiation dosage based on the order in which data was entered, sometimes delivering a double dose of radiation.
  - **Cost**: Eight people dead, 20 critically injured.

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Next Lecture (Still today!)

Inspection

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