CS 320

Introduction to Software Engineering
Spring 2017

January 30, 2017

Recap: software development process

Activities and steps

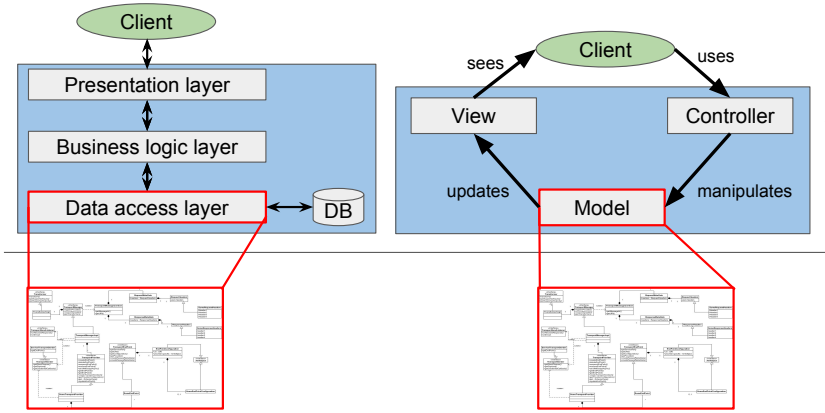
- **Requirements engineering**
- **Design and architecture**
- Implementation
- Verification and Validation
- Deployment and Maintenance

Recap: requirements engineering

The process of eliciting, analyzing, documenting, and maintaining requirements.

- **Types of requirements:**
  Functional requirements, Non-functional requirements, Additional constraints.
- **Common mistakes and challenges:**
  Implementation details instead of requirements, unclear scope, changing/evolving requirements.
- **Possible strategies for eliciting requirements:**
  Interviews, observations, use cases, user stories, prototyping

Recap: software architecture vs. design



Architecture: What is developed?

Design: How are the components developed?

Architecture and design

- Lower complexity: separation of concerns, well defined interfaces
- Simplifies communication, effort estimation, and progress monitoring

Today

- More on activities and steps in a systematic software development process.
- Project pitches for possible class projects.

Software development process

Activities and steps

- Requirements engineering
- Design and architecture
- Implementation
- Verification and Validation
- Deployment and Maintenance

Back to the fridge

Activities and steps

- Requirements engineering
- Design and architecture
- Implementation
- **Verification and Validation**
- Deployment and Maintenance

Verification vs. validation

Verification (did we build it right)

- Does the software meet its specification
- Usually an internal process
- E.g., formal verification and software testing

Validation (did we build the right thing?)

- Does the specification reflect the client's needs?
- Usually an internal and external process
- E.g., acceptance testing

Verification: static vs. dynamic analysis

Static analysis

- Reason about the program without executing it

Dynamic analysis

- Execute the program and observe its behavior

Verification: static vs. dynamic analysis

Static analysis

- Reason about the program without executing it
  - Code/design reviews
  - Type checking of a compiler
  - Rule/pattern-based analysis
  - Formal verification

Dynamic analysis

- Execute the program and observe its behavior
  - Software testing
  - Profiling

Static analysis: example

Rule/pattern-based analysis

```
double avg(double[] nums) {
  int n = nums.length;
  double sum = 0;

  int i = 0;
  while (i<n)
    sum = sum + nums[i];
    i = i + 1;

  double avg = sum / n;

  return avg;
}
```

Static analysis: example

Rule/pattern-based analysis

```
double avg(double[] nums) {
  int n = nums.length;
  double sum = 0;

  int i = 0;
  while (i<n)
    sum = sum + nums[i];
    i = i + 1;

  double avg = sum / n;

  return avg;
}
```

```
double avg(double[] nums) {
  int n = nums.length;
  double sum = 0;

  int i = 0;
  while (i<n) {
    sum = sum + nums[i];
    i = i + 1;
  }
  double avg = sum / n;

  return avg;
}
```

Dynamic analysis: example

Software testing

```
double avg(double[] nums) {
  int n = nums.length;
  double sum = 0;

  int i = 0;
  while (i<n)
    sum = sum + nums[i];
    i = i + 1;

  double avg = sum / n;

  return avg;
}
```

A test for the avg function:

```
@Test(timeout=1000)
public void testAvg() {
  double nums =
      new double[]{1.0, 2.0, 3.0});
  double actual = Math.avg(nums);
  double expected = 2.0;
  assertEquals(expected,actual,EPS);
}
```

Summary: verification vs. validation

Verification (did we build it right)

- Does the software meet its specification
- **Static analysis**
  - Reason about the program without executing it
- **Dynamic analysis**
  - Execute the program and observe its behavior

Validation (did we build the right thing?)

- Does the specification reflect the client's needs?