CS 520/620
Advanced Software Engineering
Fall 2016

October 06, 2016
Today

- Overview of class project topics
- Overview of the scientific method
- Paper discussion
  
  
  - Open discussion
    - Why do we need statistical tests?
    - Why is it particularly important for randomized algorithms?
    - What’s wrong with the current state of the art?
    - Significance and effect size
    - Parametric vs. non-parametric statistics
    - Internal, external, and construct validity
Class projects: overview

Logistics
- 4 students per project group
- 2 presentations (early feedback and final presentation)
  - Informal 10-15min + questions

High-level topics
- UI Design
- Static analysis
- Empirical studies
- Development of features for two real-world projects:
  - Major: mutation analysis framework
Class projects: UI Design (multiple groups)

**Goal:** Visualization of program mutations and mutation analysis results (e.g., standalone, IDE plug-in, html, ...)

```java
package search;

/**
 * A binary search implementation.
 */
public class BinarySearch implements ISortedArraySearch {
    // public: ............................................................................

    public BinarySearch () {}

    public int find (final int[] data, final int key) {
        int low = 0, high = data.length - 1;
        while (low <= high) {
            final int i = (low + high) >> 1;
            final int v = data[i];
            if (v == key) return i; // this line does not get covered unless there is a match
            else if (v < key) low = i + 1;
            else // v > key
                high = i - 1;
        }
        return -1;
    }

    } // end of class
```
Class projects: UI Design (multiple groups)

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                low = i + 1;
            else // v > key
                high = i - 1;
        }
        return -1;
    }
    // end of class

    // -----------------------------------------------
```
Class projects: Static analysis

**Goal:** Implement a data-flow analysis (e.g., in Soot), in particular a dependency analysis.
Class projects: Empirical studies (multiple groups)

Goal for project 1: Repeat a published experiment

Goal for project 2: Perform statistical analyses, in particular cross validation, on a given data set
Class projects: Development (multiple groups)

Goal for Major:
- Develop a mutation analyzer (standalone, Ant plug-in, Maven plug-in, IDE plug-in)

Goals for Defects4J:
- Develop a bug-mining infrastructure
- Develop a semi-automated review system for patches
The scientific method

Question
The scientific method

Question ➔ Observations
The scientific method

Question → Observations → Hypothesis → Predictions
The scientific method

- Question
- Observations
- Hypothesis
- Experiment
- Predictions
The scientific method

1. Question
2. Observations
3. Hypothesis
4. Experiment
5. Predictions
The scientific method

- Question
- Observations
- Hypothesis
- Experiment
- Predictions

Falsifiable
The scientific method

- Question
- Observations
- Hypothesis
- Experiment
- Predictions
- Data collection and analysis!
- Repeatable
The scientific method

Question → Observations → Hypothesis

Experiment ← Predictions

When do we stop and what are the next steps?
The scientific method: common mistakes

1. Question
2. Data collection
3. Observations
4. Hypothesis
5. Data Analysis
6. Predictions

Diagram:
- Question → Data collection → Observations → Hypothesis → Predictions → Data Analysis
- Question is connected to Data collection by a question mark symbol.

Key points for common mistakes in the scientific method:
- Poorly defined question
- Insufficient data collection
- Bias in observations
- Unfounded hypothesis
- Inadequate data analysis
- Overreaching predictions
The scientific method: common mistakes

If you torture the data long enough, it will confess.
(Ronald Harry Coase)
Paper discussion


- Significance and effect size
- Parametric vs. non-parametric statistics
- Internal, external, and construct validity
- Open discussion:
  - Why do we need statistical tests?
  - Why is this important for randomized algorithms?
  - What’s wrong with the current state of the art?