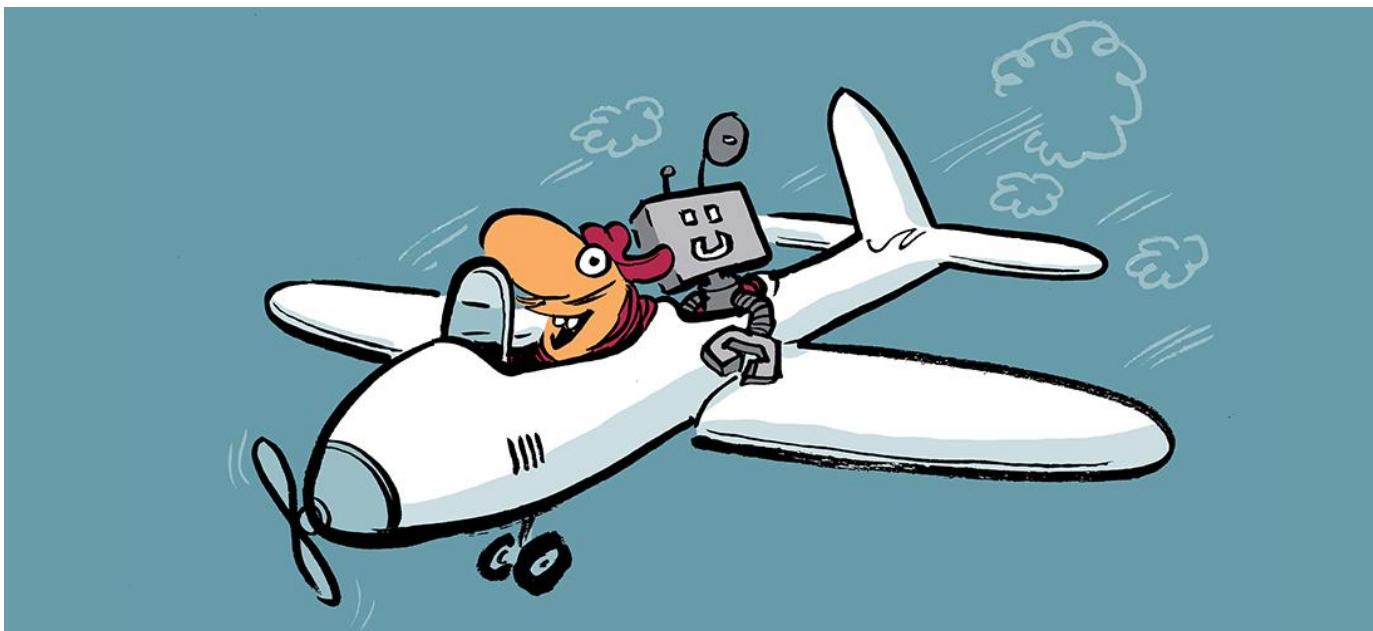


CSC 591 & 791 - Welcome to GAI4SE!

Generative AI for Software Engineering



About each other

Instructor

- Bowen Xu
 - Office: Engineering Building II (EB2), Room 3261
 - Homepage: <https://www.bowenxu.me>
 - Email: bxu22@ncsu.edu
 - Research Focus:
 - Software Engineering
 - Data Mining
 - Machine Learning
 - Program Analysis



I am looking for graduate students to work with!



Bowen Xu

Assistant Professor

Research Interests:

- Generative AI for Coding
 - AI Security for SE
 - Software Text Analytics
 - Bug and Vulnerability Analysis

Improve Developers' Productivity

Improve Software Quality



PAPER Software Q&A Data Interpretation and AI-Bots



Sentiment Analysis



Code Search



Code Completion



Adversarial Attack



Model Compression



Awarded



Nominated



Highly Cited



Recommended to Extend to Journal



It's your turn for self-introduction :)



About this course

What is Generative AI for SE?

A (breakthrough) technology

A (vital) domain



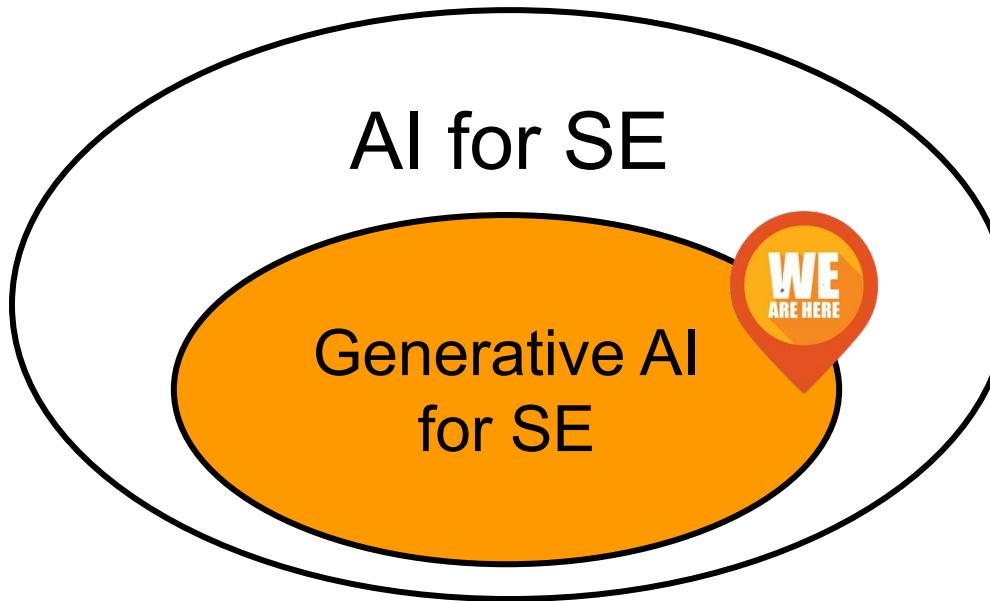
- Software governs our day-to-day activities
- Software is a multi-billion dollars business



What is Generative AI for SE?

A breakthrough technology

A vital domain (to human life)



Why Generative AI for Software Engineering?



COMMUNICATIONS
OF THE
ACM

CACM.AC.M.ORG



The End of Programming

Why Generative AI for Software Engineering?

- Various software artifacts exists
 - These artifacts are of various forms
 - Stored in various locations
 - Learning from these artifacts could improve software development process



Course Information

- Time slot: MoWe 3:00PM - 4:15PM
- Classroom: 01226 Engineering Building 2
- Course webpage:
- Research Paper Resources:

Course Objectives

- Upon completion of the course, students will be able to:
 - **Familiar with** unique properties of SE data and tasks
 - **Understand** the core concepts and technology of generative AI
 - **Apply** generative AI for SE tasks
 - **Analyze** the challenges of generative AI for SE
 - **Evaluate** existing generative AI tools on SE tasks
 - **Build** a generative AI-related solution for SE task

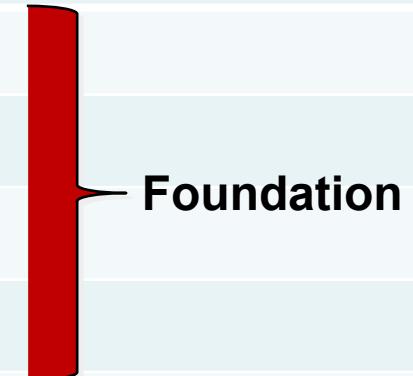


Course Design

- This is a graduate level class
- Stresses discovery over textbook knowledge
 - Will focus on identifying the key points and ignoring the irrelevant or secondary details
 - This is **NOT** a machine learning course
- Covering the latest technology
- SE Application oriented

Course Outline (1)

Week	Materials
1	Introduction
2	Code Distribution
3	Code Representation and Embedding
4	Code Synthesis and Generation
5	Large Language Model of Code
6	Class Project Identification (Consultation, no class)
7 & 8	Recent Trends (Flipped Class) + Mid-term Exam (closed-book)



Course Outline (2)

Week	Materials
9	Attack and Defense to Language Model of Code
10	Human Aspect of AI-assisted Software Development
11	Neural Code Model Compression
12	Prompt Engineering for SE
13 & 14	Class Project Solution Presentation
15	Class Project Submission (no class)

Advanced
Topics

Group Projects

- Team of 3-4 people
 - Inform the instructor by end of Week 1 (**Sun, 27 August, 23:59**)
- Create your own team
- Need to work together
- “Freeloaders” would be penalized

Group Projects: Final Deliverables

- Report
 - ACM Conference Style
 - Around 10 pages
- Code
- Dataset (if any)
- Documentation
 - Readme files
 - Some comments on source code
 - Rationale: Research should be replicable

Grading

- Attendance and Participation: 20%
- Mid-term Exam: 30%
- Group Project: 50%
 - Proposal Presentation: 10% (Week 7 & 8)
 - Solution Presentation: 20% (Week 13 & 14)
 - Artifact Evaluation: 20% (Week 15)

Participation Rubric

- **Outstanding Performance (90-100)**
 - “If you weren’t in this class, the quality of class discussions and learning would be significantly diminished”
- **Good Performance (60-80)**
 - “If you weren’t in this class, the quality of class discussions and learning would be somewhat diminished”
- **Average Performance (30-50)**
 - “If you weren’t in this class, the quality of class discussions and learning would not be necessarily diminished”
- **Poor Performance (0-20) (nobody should be here!!)**
 - “If you weren’t in this class, the quality of class discussions and learning would either be unchanged or perhaps, improved”

Group Projects: Tips (I)

- Start work early
- Have regular meetings
- Prepare for meetings
- Brainstorm for ideas
- Divide and conquer tasks

Group Projects: Tips (II)

- Clear tasks responsibility
- Leverage your unique skills
- Work on multiple iterations
 - Start with the simplest solution that works
 - Improve the simplest solution further
- Create documentations along the way

Group Projects: Selections

- Propose your own project.
 - Must be related to Generative AI for SE
 - Instructor decides if a project is appropriate
 - Grading is based on relative quality of a project wrt. other projects
- Please send a short description via email
 - Describes: Problem, Motivation, Relevance
 - Latest by the **Feb 11 (End of Week 6; 23:59)**
 - First come first serve
 - No duplicate/very similar project
 - Notification of acceptance: **Feb 13 (Thu of Week 6)**

Academic Honesty

- **Acceptable**

- Talk with other students about general course content, requirements and technology issues

- **NOT Acceptable**

- Offer or ask for substantial material assistance to or from other students (or teams) in completing individual (or team) graded assignment

- **Consequence**

- Fail the course
 - Disciplinary action at the school or university level
 - Damage your reputation among your peers and the faculty



Class #1: Introduction

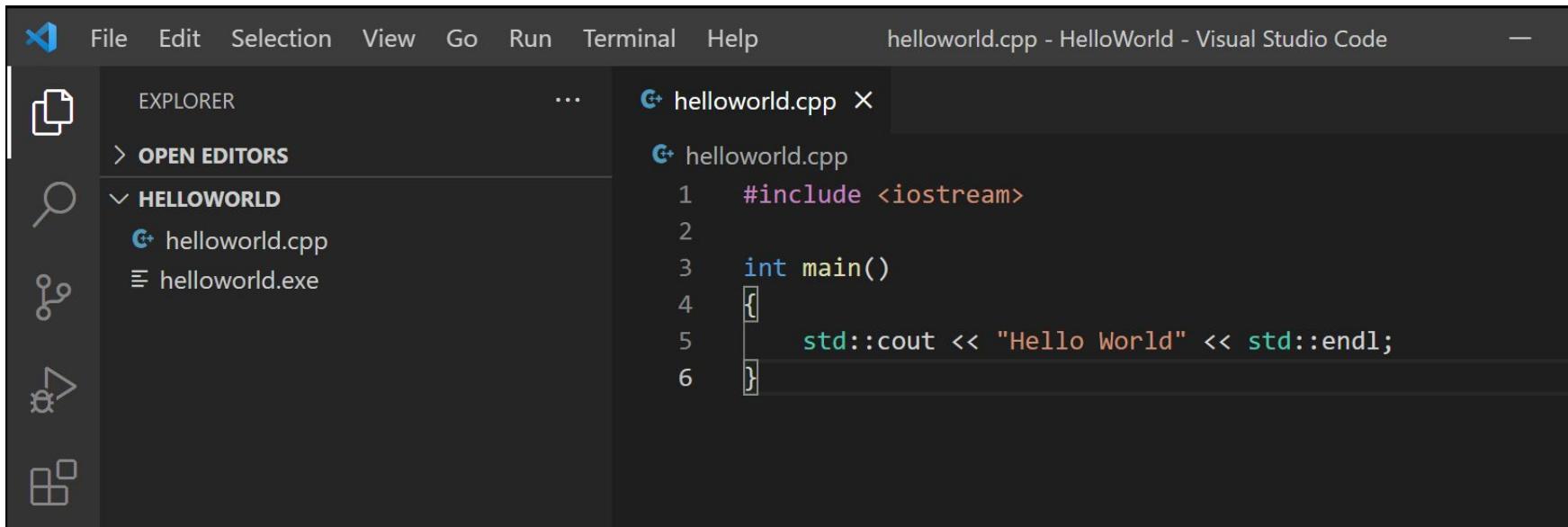
Outline

1. Introduction to software artifacts 
2. Introduction to SE problems
3. Play with ChatGPT for SE tasks

Part I: Software Artifacts

- Source Code
- Execution Trace
- Development History
- Bug Reports
- Developer Activities
- Software Forums
- Software Microblogs
- Other Artifacts

Artifact: Source Code



A screenshot of the Visual Studio Code interface. The title bar shows "helloworld.cpp - HelloWorld - Visual Studio Code". The left sidebar has icons for File Explorer, Search, Problems, and others. The main area shows the file "helloworld.cpp" with the following code:

```
#include <iostream>
int main()
{
    std::cout << "Hello World" << std::endl;
```

Artifact: Source Code

- Where to **find** source code?
 - Google code: <http://code.google.com/> (archive)
 - Github: <https://github.com/>
 - Many other places online
- How to **analyze** source code?
 - Analyze -> automatically parse and understand
 - Program analysis tools

Artifact: Source Code

- Various languages
- Various kinds of systems
- Various scale: small, medium, large
- Various complexities
 - Cyclomatic Complexity
- Various programming styles

Artifact: Execution Trace

- Information collected when a program is run
- What kind of information is collected?
 - Sequences of methods that are executed
 - State of various variables at various times
 - State of various invariants at various times
 - Which components are loaded at various times

Artifact: Execution Traces

```
nu.fw.jeti.backend.JabberHandler&14716637|nu.fw.jeti.backend.Jabber&12532667|nu.fw.jeti.  
nu.fw.jeti.backend.JabberHandler&14716637|nu.fw.jeti.backend.Jabber&12532667|nu.fw.jeti.  
nu.fw.jeti.backend.JabberHandler&14716637|nu.fw.jeti.backend.Jabber&12532667|nu.fw.jeti.  
nu.fw.jeti.backend.JabberHandler&14716637|nu.fw.jeti.backend.Jabber&12532667|nu.fw.jeti.  
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nu.fw.jeti.backend.JabberHandler&12532667|nu.fw.jeti.plugins.drawing.shapes.PictureChat&1507654  
nu.fw.jeti.backend.JabberHandler&14716637|nu.fw.jeti.backend.Jabber&12532667|nu.fw.jeti.  
nu.fw.jeti.backend.Jabber&12532667|nu.fw.jeti.plugins.drawing.shapes.PictureChat&1507654  
nu.fw.jeti.plugins.drawing.shapes.PictureChat$1&16548518|nu.fw.jeti.plugins.drawing.shap  
nu.fw.jeti.plugins.drawing.shapes.PictureHistory&23493887|nu.fw.jeti.plugins.drawing.sha  
nu.fw.jeti.plugins.drawing.shapes.PictureHistory&23493887|nu.fw.jeti.plugins.drawing.ui.  
nu.fw.jeti.plugins.drawing.ui.HistoryPanel&5049504|nu.fw.jeti.plugins.drawing.shapes.act  
nu.fw.jeti.plugins.drawing.shapes.PictureHistory&23493887|nu.fw.jeti.plugins.drawing.shap  
nu.fw.jeti.plugins.drawing.shapes.PictureChat$1&16548518|nu.fw.jeti.plugins.drawing.shap  
nu.fw.jeti.plugins.drawing.shapes.PictureChat$1&7798629|nu.fw.jeti.plugins.drawing.shape  
nu.fw.jeti.plugins.drawing.shapes.PictureHistory&23493887|nu.fw.jeti.plugins.drawing.shap  
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nu.fw.jeti.plugins.drawing.ui.HistoryPanel&5049504|nu.fw.jeti.plugins.drawing.shapes.act  
nu.fw.jeti.plugins.drawing.ui.HistoryPanel&5049504|nu.fw.jeti.plugins.drawing.shapes.act  
nu.fw.jeti.plugins.drawing.ui.HistoryPanel&5049504|nu.fw.jeti.plugins.drawing.shapes.act  
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nu.fw.jeti.plugins.drawing.ui.HistoryPanel&5049504|nu.fw.jeti.plugins.drawing.shapes.act
```

Caller | Callee | Method Signature

Artifact: Execution Trace

```
decl-version 2.0
var-comparability none

ppt org.apache.ftpserver.gui.ServerFrame.getDefaultRootPath():::ENTER
ppt-type enter
parent parent org.apache.ftpserver.gui.ServerFrame:::CLASS 1
variable org.apache.ftpserver.gui.ServerFrame.serialVersionUID
    var-kind variable
    dec-type long
    rep-type int
    constant 8399655106217258507
    flags nomod
    comparability 22
parent org.apache.ftpserver.gui.ServerFrame:::CLASS 1
variable org.apache.ftpserver.gui.ServerFrame.BASE_PAGE
    var-kind variable
    dec-type java.lang.String
    rep-type hashCode
    flags nomod
    comparability 22
parent org.apache.ftpserver.gui.ServerFrame:::CLASS 1
variable org.apache.ftpserver.gui.ServerFrame.BASE_PAGE.toString()
    var-kind function toString()
    enclosing-var org.apache.ftpserver.gui.ServerFrame.BASE_PAGE
    dec-type java.lang.String
    rep-type java.lang.String
    flags nomod synthetic to_string
    comparability 22
parent org.apache.ftpserver.gui.ServerFrame:::CLASS 1
variable org.apache.ftpserver.gui.ServerFrame.HOME_PAGE
    var-kind variable
    dec-type java.lang.String
    rep-type hashCode
    flags nomod
    comparability 22
```

Chicory Trace. Variable values at method entries and exits

Artifact: Execution Trace

- How to collect?
 - Insert instrumentation code
 - Execute program
 - Instrumentation code writes a log file
- What tools are available to collect traces?
 - Daikon Chicory: <https://plse.cs.washington.edu/daikon/>
 - PIN:
<http://software.intel.com/en-us/articles/pin-a-dynamic-binary-instrumentation-tool>
 - Valgrind: <http://valgrind.org/>

Artifact: Development History

- What code is
 - Added
 - Deleted
 - Edited
- When
- By Whom
- For What Reason

Artifact: Development History

Commits

branch	date	commit message	author	status	diff	hash	copy
main	Jul 6, 2023	Refactor FXIOS-6524 [v117] Update mobile icons to new style pt2/1 (#1...	thatswinnie committed 1 hour ago ✓	Verified		30834c6	
		Refactor FXIOS-5536 [v117] text field table view cell theming (#15268) ...	lmarceau committed 1 hour ago ✘	Verified		5372531	
		Add FXIOS-6865 [v117] Add empty component library in BrowserKit (#15340) ...	lmarceau committed 2 hours ago ✓	Verified		dc11242	
		Bugfix FXIOS-6887 [v116.1] background save tabs (#15345) ...	OrlaM committed 2 hours ago ✘	Verified		4d21463	
		Add FXIOS-6894 [v117] Create sample application that will be used for... ...	lmarceau committed 3 hours ago ✘	Verified		43d8d13	
		Bugfix MTE-1234 [v117] Remove pocket sponsored stories (#15365) ...	clarmso committed 7 hours ago ✘	Verified		1d6f95f	
		Bugfix FXIOS-6876 [v116] - Missing use saved card option for credit... ...	nbhasin2 committed 14 hours ago ✘	Verified		8574354	
		Bugfix FXIOS-6898 [v116] Fix initial credit card telemetry (#15353)	lmarceau committed 19 hours ago ✘	Verified		b40d43f	

Artifact: Development History

Commit

✗ Bugfix FXIOS-6898 [v116] Fix initial credit card telemetry (#15353)

[Browse files](#)

main (#15353)

 lmarceau committed 19 hours ago Verified

1 parent 7025707 commit b40d43f

Showing 1 changed file with 4 additions and 4 deletions.

[Split](#) [Unified](#)

```
v ⌂ 8 Client/Frontend/Browser/ViewController.swift □
  @@ -1861,8 +1861,8 @@ class ViewController: UIViewController, SearchBarLocationProvider, Themea
1861 1861      // Default value is true for autofill credit card input
1862 1862      let autofillStatus = UserDefaults.value(forKey: key) as? Bool ?? true
1863 1863      TelemetryWrapper.recordEvent(
1864 1864      + category: .action,
1865 1865      - method: .tap,
1864 1864      + category: .information,
1865 1865      + method: .settings,
1866 1866      object: .creditCardAutofillEnabled,
1867 1867      extras: [
1868 1868          TelemetryWrapper.ExtraKey.isCreditCardAutofillEnabled.rawValue: autofillStatus
  @@ -1874,8 +1874,8 @@ class ViewController: UIViewController, SearchBarLocationProvider, Themea
1874 1874      guard hasSync else { return }
1875 1875      let syncStatus = self.profile.syncManager.checkCreditCardEngineEnablement()
1876 1876      TelemetryWrapper.recordEvent(
1877 1877      - category: .action,
1878 1878      - method: .tap,
1877 1877      + category: .information,
1878 1878      + method: .settings,
1879 1879      object: .creditCardSyncEnabled,
1880 1880      extras: [
1881 1881          TelemetryWrapper.ExtraKey.isCreditCardSyncEnabled.rawValue: syncStatus
  ...
```

Artifact: Development History

- Useful for distributed software development
 - Various people updating different parts of code
- Easy to backtrack changes
- Easier to find out answer to the question:
 - My code works yesterday but not today. Why?
- Easier to quantify contributions of team members

Artifact: Development History

- Various tools
 - CVS – Version per file
 - SVN – Version per snapshot
 - Git - Distributed
- Slightly different ways to manage content

Artifact: Code Reviews



open source project

Branch

Search for status:open

Subject	Status	Owner	Project	Branch
▶ QEMU1 changes to make AndroidEmu usable in QEMU2		Yurii Zubrytskyi	platform/external/qemu	emu-master-dev
test comment - do not merge		Bruce J Beare	platform/build	master
MIPS32: int java.lang.*.numberOfLeadingZeros		Chris Larsen	platform/art	master
Add sconsole to system/extras.		Elliott Hughes	platform/system/extras	master
adb/base: fix adb push of Unicode filenames on Win32		Spencer Low	platform/system/core	master
Fix GNU/POSIX basename headers.		Josh Gao	platform/bionic	master

Artifact: Code Reviews

Change 179541 - Needs Code-Review

QEMU1 changes to make AndroidEmu usable in QEMU2

Cleaning up the qemu1 build and AndroidEmu to make it easily accessible from Qemu2:

- build has to define paths starting from the root
- AndroidEmu should not include anything from outside world
- Don't define some functions when building for Qemu2 temporary workaround, until we decide which implementation wins

Change-Id: [I819e990a9514233aa5e028093cfdaad9cce5774c](#)

Artifact: Code Reviews

History	Expand All
Yurii Zubrytskyi	Uploaded patch set 1.
Yurii Zubrytskyi	Patch Set 1: Code-Review+1
Vince Harron	
Patch Set 1: Code-Review+1	
(1 comment)	
android/looper-qemu.cpp	
Line 19:	nit: other places in the code, each namespace gets its own line
Yurii Zubrytskyi	Uploaded patch set 2.
Yurii Zubrytskyi	
Patch Set 1:	
(1 comment)	
android/looper-qemu.cpp	
Line 19:	fixed
Yurii Zubrytskyi	Patch Set 2: Code-Review+1 Verified+1 Ping :)

Artifact: Code Reviews

Android Open Source Project CHANGES ▾ DOCUMENTATION ▾ BROWSE ▾ 

Merged as [fa349f6](#)  | [179541](#): QEMU1 changes to make AndroidEmu usable in QEMU2

Updated	Nov 07, 2015
Owner	 Yuriy Zubrytskyi
Uploader	 David Turner
Committer	 David 'Digit' Turner
Assignee	
Reviewers	 David Turner  Bo Hu  Vince Harron  Prathmesh Prabhu
CC	
Repo	platform/external/qemu
Branch	emu-master-dev
Parent	ec26683 

QEMU1 changes to make AndroidEmu usable in QEMU2

Cleaning up the qemu1 build and AndroidEmu easily accessible from Qemu2:

- build has to define paths starting from world
- AndroidEmu should not include anything from temporary workaround, until we decide what wins

Change-ID: [I819e990a9514233aa5e028093cfdaa](#)

Artifact: Bug Reports

The screenshot shows a web browser displaying the Eclipse Bugzilla interface. The title bar reads "eclipse BUGS". The main content area shows a bug report titled "Bugzilla – Bug 214050" with the description "Cannot update clipse". Below the title, there is a search bar and navigation links for Home, New, Search, Find, Reports, Requests, Help, and Copyright Agent. A link to "Bug List: (1 of 1)" is also present. The bug report details are as follows:

<u>Title</u>
Bug 214050 - Cannot update clipse
<u>Status:</u> NEW
<u>Product:</u> Platform
<u>Component:</u> Update (deprecated - use RT>Equinox>p2)
<u>Version:</u> 3.3.1
<u>Platform:</u> PC Windows XP
<u>Importance:</u> P3 normal (vote)

Bug List: (1 of 1) [First](#) [Last](#) [Prev](#) [Next](#) [Show last search results](#)

[Bug 214050 - Cannot update clipse](#)

Title

Status: NEW

Product: Platform

Component: Update (deprecated - use RT>Equinox>p2)

Version: 3.3.1

Platform: PC Windows XP

Importance: P3 normal ([vote](#))

Artifact: Bug Reports

Yair Eshel 2008-01-01 07:55:49 EST

Build ID: M20071023-1652

Steps To Reproduce:

- 1.Update eclipse 3.3.1.1 from the help menu
- 2.Mark with V Eclipse RCP Patch 1 for 3.3.1.1 3.3.1.1_v20071204_3311, on <http://ftp.osuosl.org/pub/eclipse/eclipse/updates/3.3/site.xml>
- 3.Next until error

Detailed
Description

More information:

Update operation has failed

Error retrieving

"plugins/com.ibm.icu36.data.update_3.6.1.v20071204_2007j.jar". [Server HTTP response code: "403 Forbidden" for URL:

<http://ftp.osuosl.org/pub/eclipse/eclipse/updates/3.3/plugins/com.ibm>

Server returned HTTP response code: "403 Forbidden" for URL:

<http://ftp.osuosl.org/pub/eclipse/eclipse/updates/3.3/plugins/com.ibm>

Running on winxp

Artifact: Bug Reports

- People report errors and issues that they encounter in the field
- These errors include:
 - Description of the bugs
 - Steps to reproduce the bugs
 - Severity level
 - Parts of the system affected by the bug
 - Failure traces

Artifact: Bug Reports

- Various kinds of bug repositories
 - BugZilla: <http://www.bugzilla.org/>
 - Example site: <https://bugzilla.mozilla.org/>
 - JIRA: <http://www.atlassian.com/software/jira/>
 - Example site: <https://issues.apache.org/jira/browse/WW22>



Artifact: Developer Activities

- Developers form a social network
 - Developers work on various projects
 - Projects have various types, programming languages and developers
 - Developers *follow updates from* various other developers and projects
- A *heterogeneous* social network is formed

Artifact: Developer Activities

GitHub



GitHub, Inc. (/ˈgɪθəb/[a]) is a platform and cloud-based service for **software development** and **version control** using **Git**, allowing developers to store and manage their code. It provides the **distributed version control** of Git plus **access control**, **bug tracking**, **software feature** requests, **task management**, **continuous integration**, and **wikis** for every project.^[6] Headquartered in **California**, it has been a subsidiary of **Microsoft** since 2018.^[7]

It is commonly used to host open source software development projects.^[8] As of January 2023, GitHub reported having over 100 million developers^[9] and more than 372 million repositories,^[10] including at least 28 million public repositories.^[11] It is the largest source code host as of June 2023.



Artifact: Developer Activities

**Keith Mitchell**

kemitche

Currently @reddit. Previously @VREALITY
@lyft @Blizzard @oracle

@reddit

Seattle

[Overview](#)[Repositories 23](#)[Projects 0](#)[Stars 23](#)[Followers 37](#)[Following 4](#)**Pinned**[reddit](#)

Forked from reddit-archive/reddit

the code that powers reddit.com



Python

[praw](#)

Forked from praw-dev/praw

PRAW, an acronym for "Python Reddit API Wrapper", is a python package that allows for simple access to reddit's API.



Python

[pynamodb/PynamoDB](#)

A pythonic interface to Amazon's DynamoDB



Python



1.1k



282

[l2cs](#)

Archived

DEPRECATED - Python library to rewrite Lucene syntax search queries to Amazon CloudSearch syntax



Python



8



5

667 contributions in the last year

2019

Artifact: Developer Activities

reddit

Overview Repositories 109 Packages People 18

Pinned

IndicatorFastScroll Public

Android library providing a simple UI control for scrolling through RecyclerViews

Kotlin 689 stars 50 forks

baseplate.py Public

reddit's python service framework

Python 514 stars 171 forks

baseplate.go Public

Reddit's Service Framework in Go

Go 86 stars 70 forks

mcsauna Public

Track hottest memcached keys by regex in a graphite-friendly format.

Go 61 stars 10 forks

rpan-studio Public

RPAN Studio

C 269 stars 62 forks

People



Artifact: Software Forums

- Developers ask and answer questions
- About various topics
- In various threads, some of which are very long
- Stored in various sites
 - StackOverflow: <http://stackoverflow.com/>
 - StackExchange: <https://stackexchange.com/sites>
 - Reddit, Programming: <https://www.reddit.com/r/programming/>
 - Quora: <https://www.quora.com/>

Artifact: Software Forums

Questions tagged [java]

[Ask Question](#)

Java (not to be confused with JavaScript, JScript or JS) is a general-purpose, platform-independent, statically typed, object-oriented programming language designed to be used in conjunction with the Java Virtual Machine (JVM). "Java platform" is the name for a computing system that has installed tools for developing and running Java programs. Use this tag for questions referring to the Java programming language or Java platform tools.

[Learn more...](#) [Top users](#) [Synonyms \(10\)](#) [java jobs](#)

1,621,412 questions

Newest Active Bountied 24 Unanswered More ▾ Filter

0
votes

How to mock a POST request with json data using Mockito

I have the following unit test package mobi.grocerymonkey.groceryapp; import static com.google.common.truth.Truth.assertThat; import static org.mockito.Mockito.when; import static org.mockito....

0
answers

[java](#) [json](#) [servlets](#) [junit](#) [mockito](#)

6 views



kristian nissen

2,329 ● 4 ● 32 ● 58



Saransh

1

0
votes

How to use guava API in bluej?

I have put the .jar file in the userlib folder but when I write import com.google.common.graph; , it shows "package system does not exist". Am I missing something?

0
answers

[java](#) [guava](#) [bluej](#)

4 views



Artifact: Software Forums

How to mock a POST request with json data using Mockito

Asked today Viewed 6 times

I have the following unit test

0

```
package mobi.grocerymonkey.groceryapp;

import static com.google.common.truth.Truth.assertThat;
import static org.mockito.Mockito.when;
import static org.mockito.Mockito.mock;

import com.google.appengine.tools.development.testing.LocalServiceTestHelper;

import org.junit.After;
import org.junit.Before;
import org.junit.Test;
import org.junit.runner.RunWith;
import org.junit.runners.JUnit4;
import org.mockito.Mock;
import org.mockito.MockitoAnnotations;
```

java

json

servlets

junit

mockito

asked 8 mins ago



kristian nissen

2,329 ● 4 ● 32 ● 58

Artifact: Software Microblogs



Greg Brockman ✅ @gdb · Jul 4

Temporarily disabling ChatGPT's "Browse" beta functionality, team is working to bring it back soon:

...

OpenAI ✨ @OpenAI · Jul 4

We've learned that ChatGPT's "Browse" beta can occasionally display content in ways we don't want, e.g. if a user specifically asks for a URL's full text, it may inadvertently fulfill this request. We are disabling Browse while we fix this—want to do right by content owners.

28

31

202

86.7K



Mike Taylor ✅ @hammer_mt · 8h

Browse model being unavailable has severely killed my usage of ChatGPT.

...

5



3

696



What else in your mind? Share with ur classmates!



Part II: SE/PL Tasks

Assume you accept an offer and will join a company as a software developer...



Program Summarization

Welcome my new colleague!
Please try to **be familiar with our current codebase** asap.



```
import sqlite3

conn = sqlite3.connect("employees.db")
results = conn.execute("SELECT * FROM employees_info").fetchall()
conn.close()

for row in results:
    print(f"ID: {row[0]}, Name: {row[1]}, Salary: {row[2]}")
```



This code connects to the "employees.db" database, executes the query, fetches all results, prints the data, and then closes the connection.

Program Optimization

Good job! Recently we are facing efficiency issue. Can you help to **optimize the existing code?**



sum of an arithmetic sequence

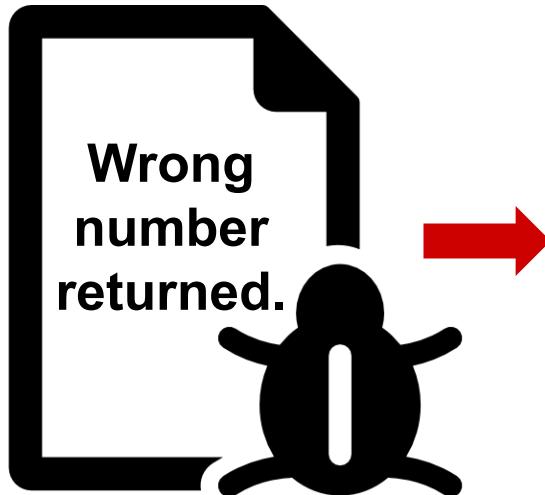
```
def sum_even_numbers(n):  
    total = 0  
    for i in range(1, n + 1):  
        if i % 2 == 0:  
            total += i  
    return total
```

↓

```
def sum_even_numbers(n):  
    if n % 2 == 0:  
        return n // 2 * (n + 1)  
    else:  
        return (n + 1) // 2 * n
```

Bug/Vulnerability Localization

You receive a bug report. Please **localize the root cause** asap.



```
def find_largest_number(numbers):  
    if len(numbers) == 0:  
        return None  
  
    largest_number = numbers[0]  
    for num in numbers:  
        if num > largest_number:  
            largest_number = num  
  
    return largest_number
```

Program Repair

It's really a great news you manage to localize the bug. Please **fix the bug** asap.



if num < largest_number:



if num > largest_number:

```
def find_largest_number(numbers):
    if len(numbers) == 0:
        return None

    largest_number = numbers[0]
    for num in numbers:
        if num > largest_number:
            largest_number = num

    return largest_number
```

A graphic element consisting of a yellow wrench and a red heart-shaped bolt, overlaid on the original faulty code where the condition 'num > largest_number' is crossed out with a large red X.

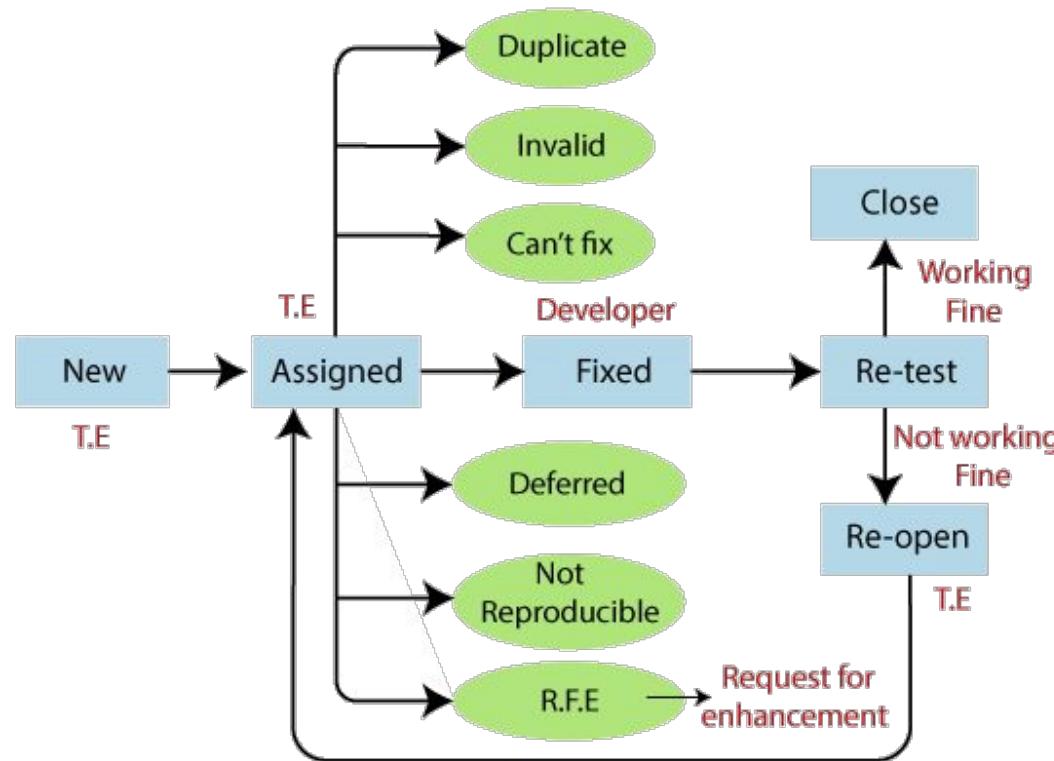
What else in your mind? Share with ur classmates!



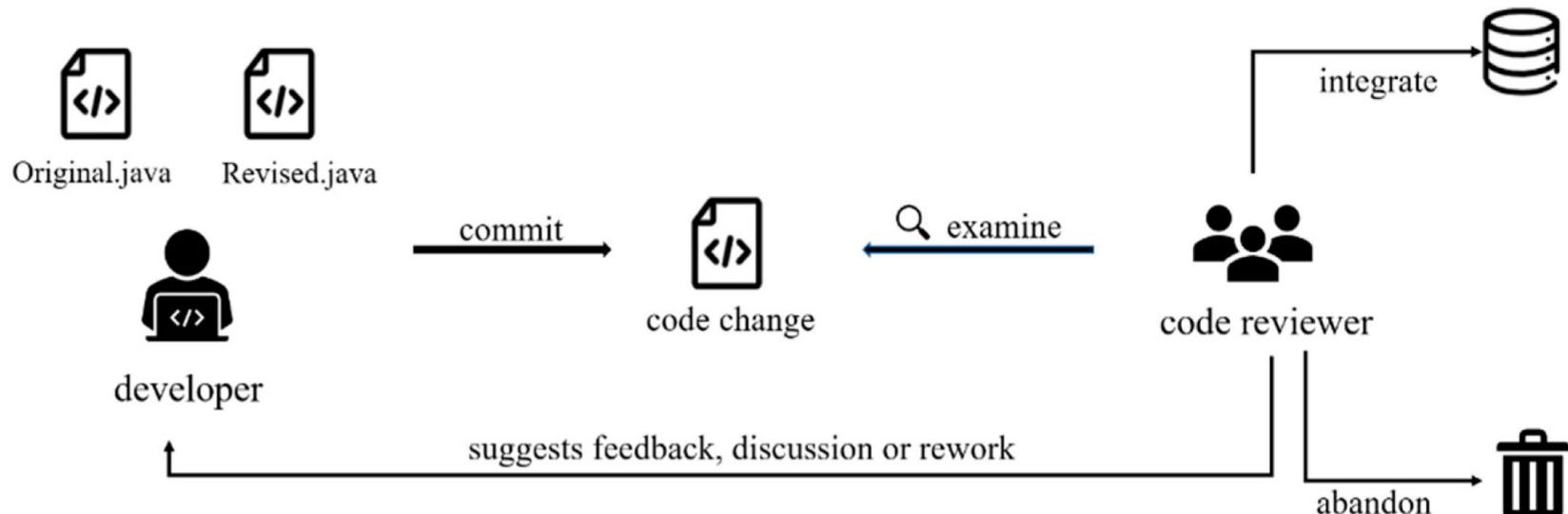
Part III: Workflows in SE Lifecycle



Process of Bug Fixing



Process of Code Review



Conclusion & Acknowledgement

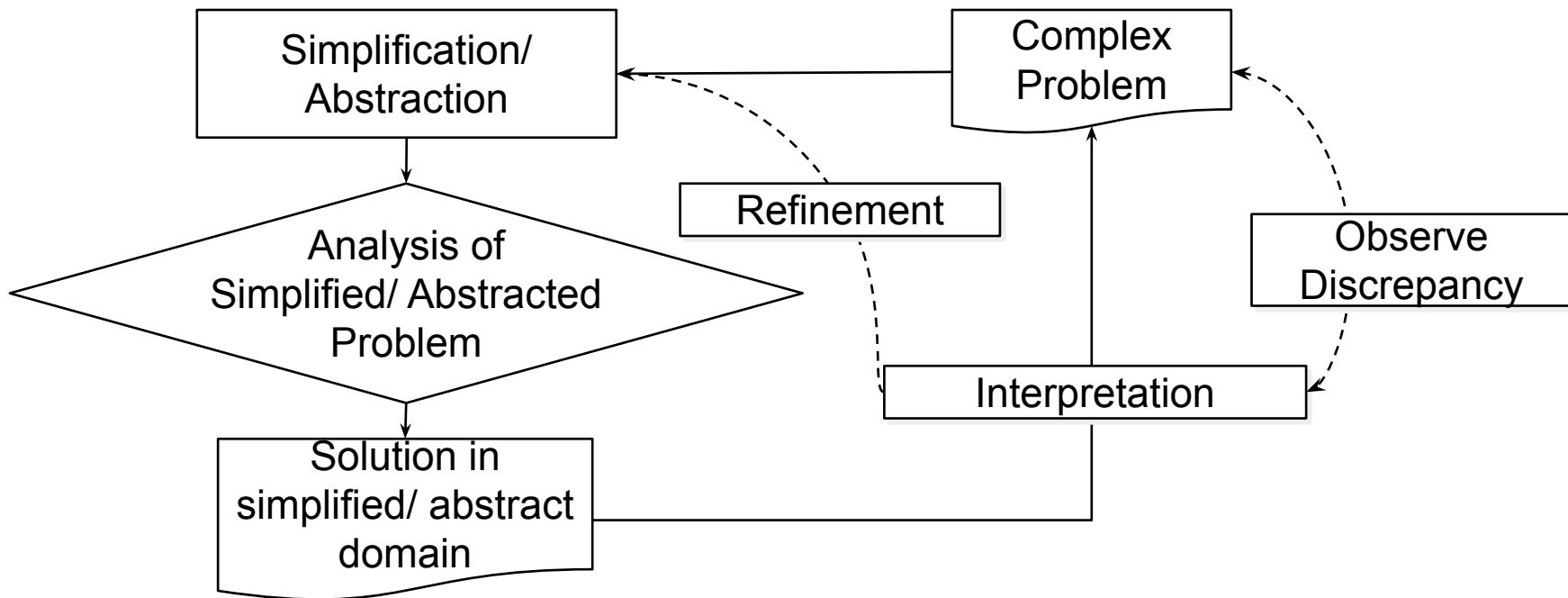
- Part I: Software Artifacts
- Part II: Overview of SE Problems
- Part III: Workflows in SE Lifecycle
- Some material are taken from:
 - David Lo's slides
 - Various papers referenced in the slides
- Some diagrams are taken from various sites indicated in the slide notes.

Extra Part: (Traditional) SE Techniques

- Program Modeling & Analysis
- Data Mining
 - Classification
 - Clustering
 - Pattern Mining
- Information Retrieval
- Natural Language Processing
- Meta-Heuristics

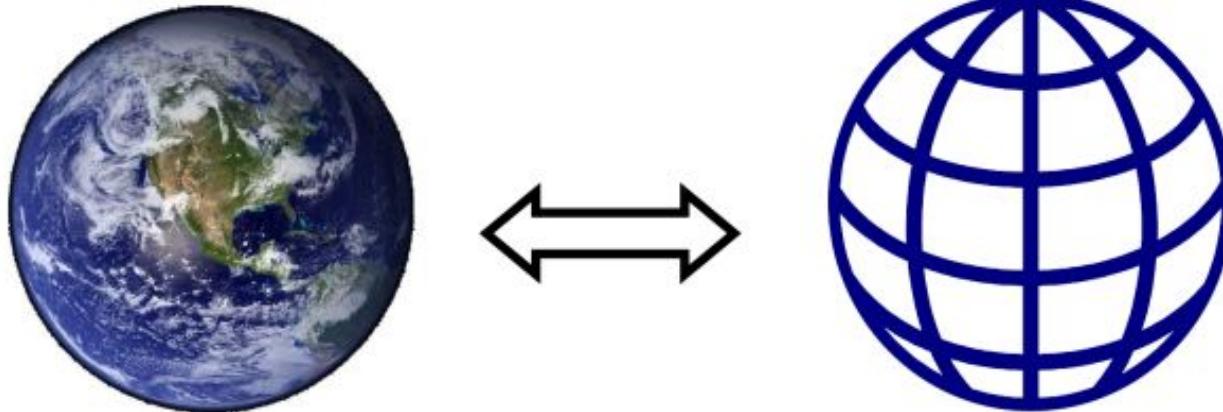
Program Modeling & Analysis

- Model/simplify/abstract program states



Partial Analysis

- Model/ignore some parts of a program



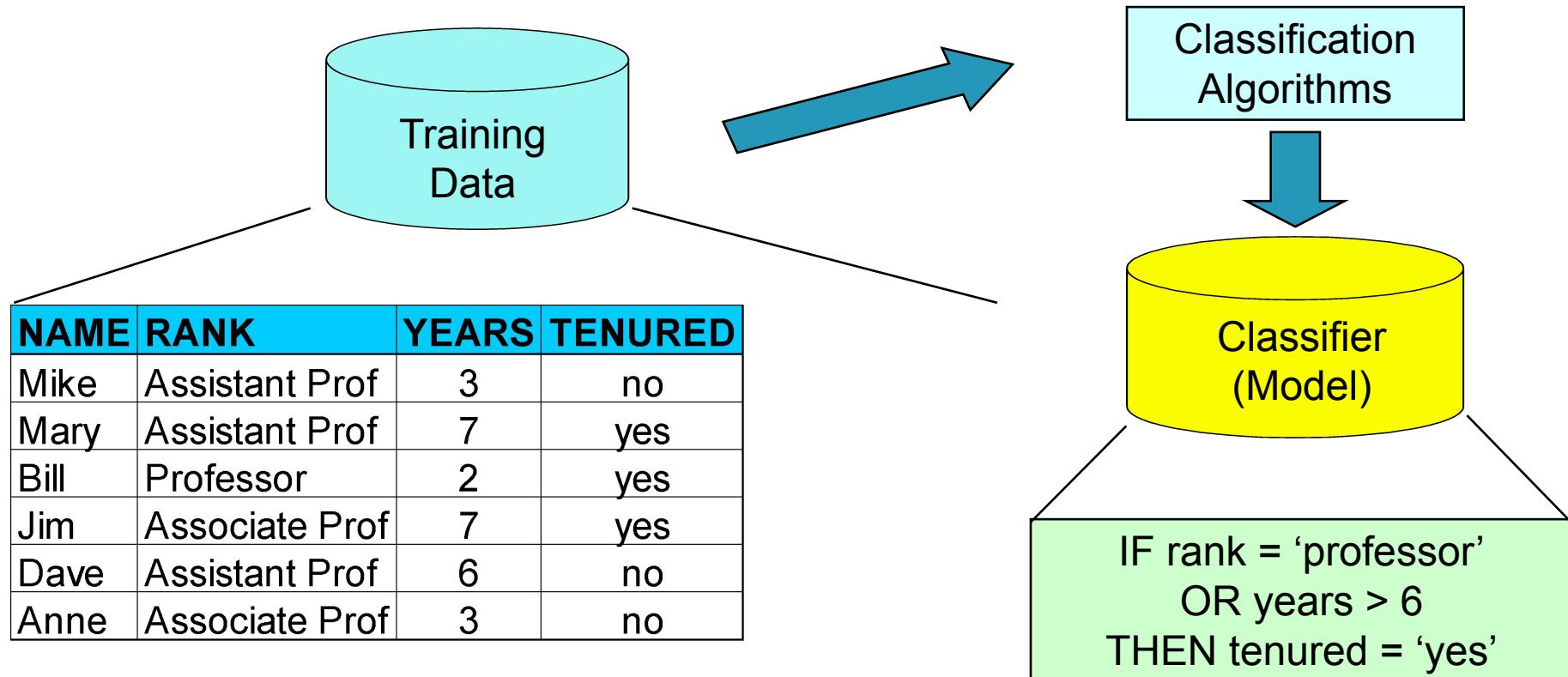
Static Analysis vs. Dynamic Analysis

- Need to run the program under analysis or not
 - Yes vs. No

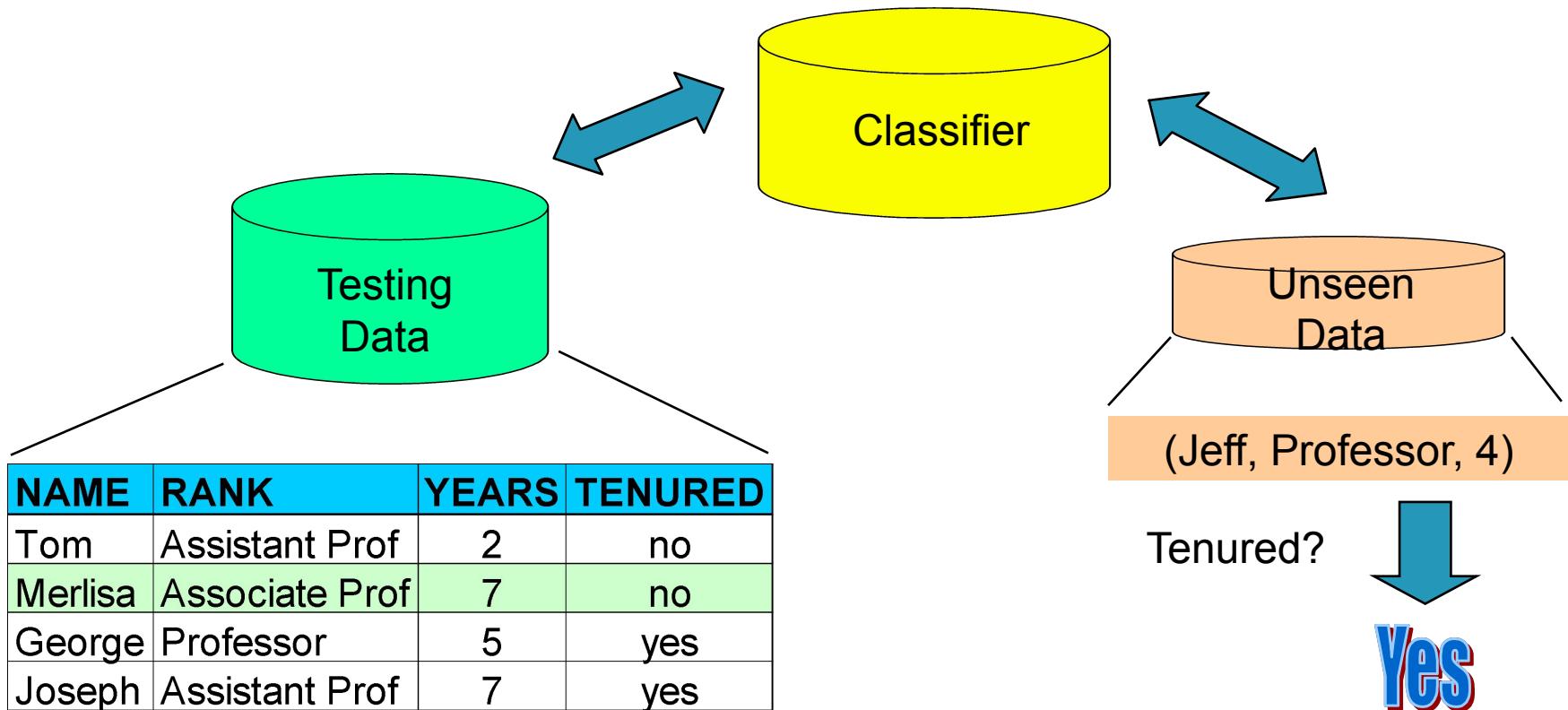
Classification: Definition

- Simple:
 - Assign data to some predefined categories
- Textbook:
 - Construct of a model based on the training set and the values (class labels) in a classifying attribute, which is then used in classifying new data

Classification: Example (I)



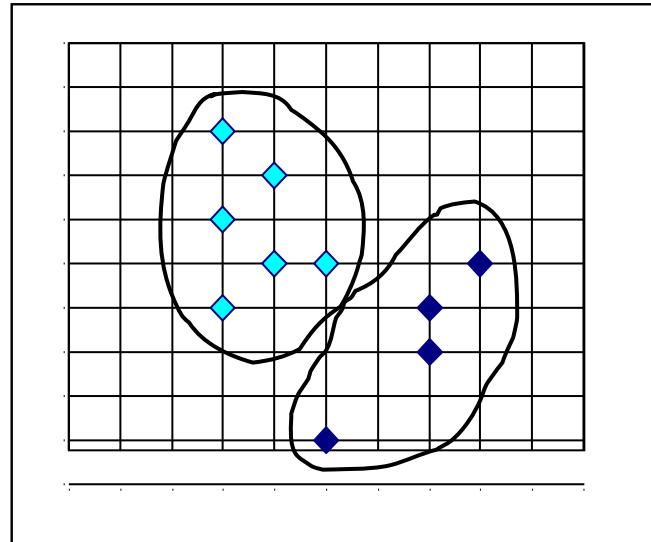
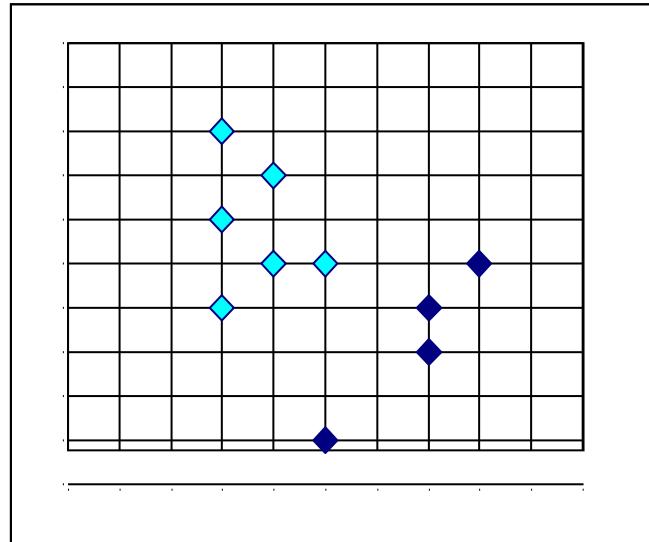
Classification: Example (II)



Clustering: Definition

- Finding similarities between data
 - according to data characteristics
 - grouping similar data objects into clusters
- Cluster: a collection of data objects
 - Similar to one another within the same cluster
 - Dissimilar to the objects in other clusters

Clustering: Example



Pattern Mining: Definition

- Motivation:
 - Finding inherent regularities in data
- Frequent pattern:
 - a pattern (a set of items, subsequences, substructures, etc.) that occurs frequently in a data set

Pattern Mining: Example

- Itemset: a set of items
 - E.g., $\text{acm}=\{\text{a, c, m}\}$
- Support of itemsets
 - $\text{Sup}(\text{acm})=3$
- Given $\text{min_sup} = 3$, **acm** is a frequent pattern
- Frequent pattern mining: find all frequent patterns in a database

Transaction database TDB

TID	Items bought
100	f, a, c , d, g, I, m , p
200	a , b, c , f, l, m , o
300	b, f, h, j, o
400	b, c, k, s, p
500	a , f, c , e, l, p, m , n

Information Retrieval: Definition

- Simple:
 - Searching for information from a large (typically textual) data given a (typically textual) query
- Textbook:
 - Activity of obtaining information resources relevant to an information need from a collection of information resources

Information Retrieval: Example

- Given all Shakespeare's plays, find all plays that contain the word Brutus AND Caesar and NOT Calpurnia.

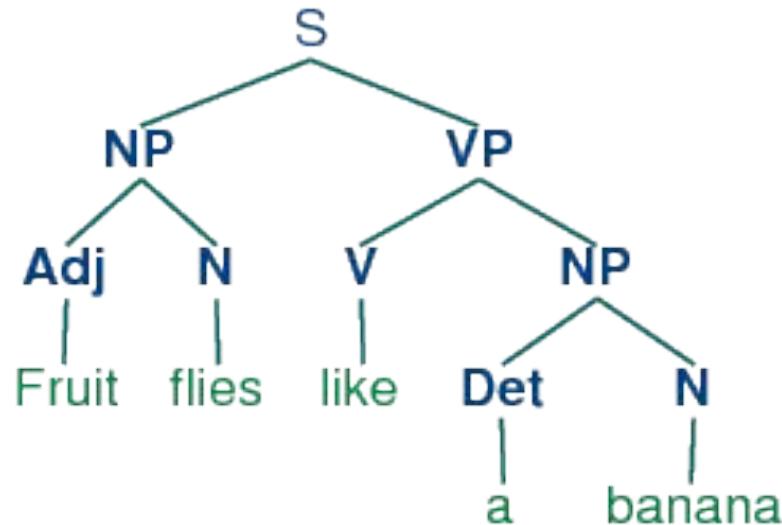
	Antony and Cleopatra	Julius Caesar	The Tempest	Hamlet	Othello	Macbeth	...
Antony	1	1	0	0	0	1	
Brutus	1	1	0	1	0	0	
Caesar	1	1	0	1	1	1	
Calpurnia	0	1	0	0	0	0	
Cleopatra	1	0	0	0	0	0	
mercy	1	0	1	1	1	1	
worser	1	0	1	1	1	0	
...							

Term-Document Incidence Matrix

Natural Language Processing

- Simple:
 - Automated means to parse, make sense, and understand human language
- Textbook:
 - A field of computer science, artificial intelligence, and linguistics concerned with the interactions between computers and human (natural) languages

Natural Language Processing: Example



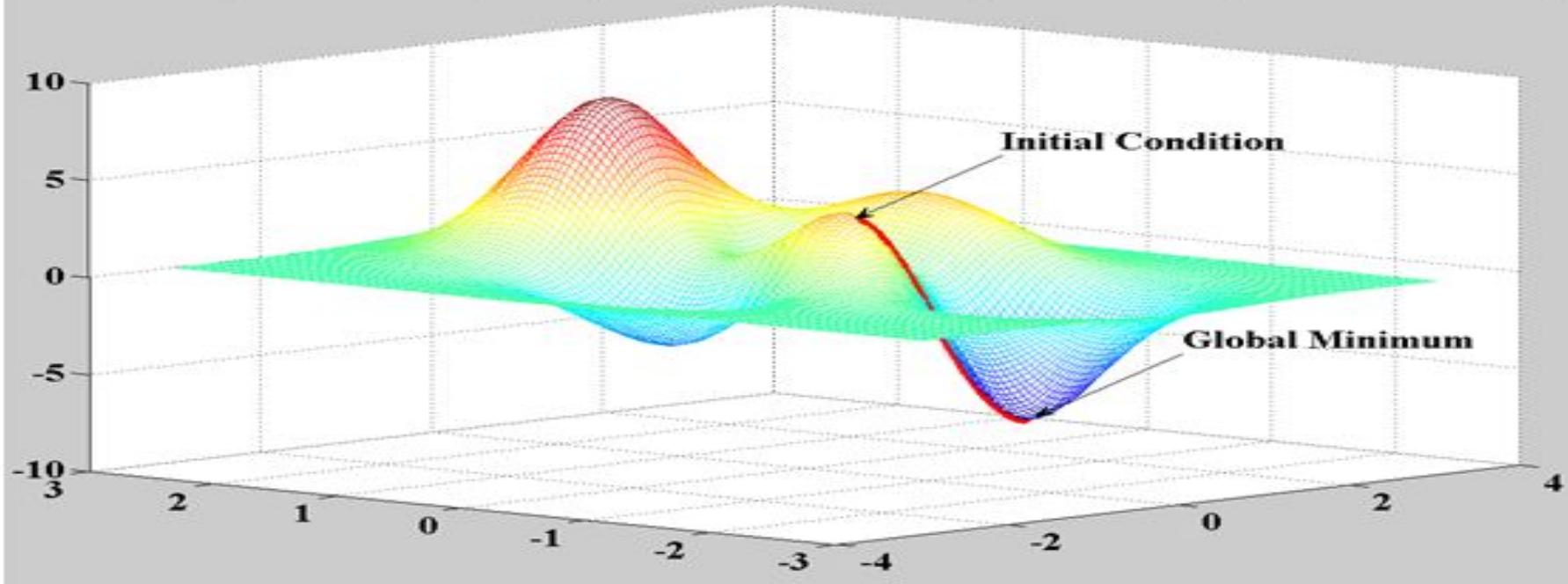
Parts-of-Speech (POS) Tagging

Metaheuristics: Definition

- Simple:
 - Finding one semi-optimal solution in a search space by smart traversal of the space
- Textbook:
 - Computational method that optimizes a problem by iteratively trying to improve a candidate solution with regard to a given measure of quality

Meta-Heuristics: Example

This is the path followed by the optimizer to reach the global minimum [0.22777 -1.6257]



Extra Food for Thoughts

- Reflections and Advice on Life as a Mid-stage Ph.D. Student by Philip Guo:
<http://www.pgbvine.net/PhD-life.htm>
- How to Be a Good Graduate Student by Marie des Jardins:
<http://lamp.cfar.umd.edu/restricted/Misc/GoodStudent/index.html>
- Many advices compiled by Michael Ernst:
<http://homes.cs.washington.edu/~mernst/advice/#grad-students>

Refs

- <https://twitter.com/michaelhilton/status/1646315922947284997?s=20>
<https://github.com/CMU-313/llm-lecture>
- [COS 597G: Understanding Large Language Models](#)