TEXAS TECH UNIVERSITY
DEPARTMENT OF COMPUTER SCIENCE
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CS 5374 – SOFTWARE VERIFICATION AND VALIDATION

Spring 2026

Course Description

This course reviews the software validation and verification (V & V) techniques. The students taking this course will learn about validation, or known as testing, and formal verification. From validation or testing perspective, students will learn basic and advanced topics in software testing including test case generation, adequacy criteria, model-based and graph-based testing, fault localization, and fault-based testing. Various validation techniques including the black and white box test case generation techniques will be discussed. From formal verification point of view, students will learn about logic-based approaches to mathematically prove the correctness of programs such as model checking and static analysis. Prepositional logic and model checking as the primary tools for verifying the correctness of programs will be presented along with their practical implications. Topics (tentative) covered by this course include:

- Basic vocabulary of software quality and testing
- Validation and testing including black and white box testing
- Functional versus structural testing
- Adequacy criteria and graph coverage
- State-based specifications and model-based testing based on FSM
- Testing Object-Oriented programs
- Security testing
- Fault localization
- Mutation testing
- Model Checking and verification
- AI/ML based approaches to software testing
- LLM Evaluation and Debugging

The course also covers new materials in AI/LLM/RL debugging and evaluation. The main objective is to learn cutting edge practices in evaluation AI-powered applications along with evaluation of foundation models such as LLM through debugging, testing, and tracing.

Prerequisites

- Knowledge of programming languages.
- Knowledge of software engineering practices.

Instructor

- Name: Akbar S. Namin
- Office: 306G
- Office Hours:

Tuesdays.2:00 –4:00

- Email: akbar.namin@ttu.edu

Textbook and Lecture Notes

The course will be based on lecture notes (to be made available through the Blackboard system) . Some sections of the following textbooks will be used in teaching:

- Introduction to Software Testing, Paul Ammann and Jeff Offutt
  https://cs.gmu.edu/~offutt/softwaretest/

- Software Testing and Analysis, Process, Principles, and Techniques, Mauro Pezze and Michael Young
  http://ix.cs.uoregon.edu/~michal/book/

- Logic in Computer Science, Modeling and Reasoning about Systems, Michael Huth and Mark Ryan
  The first two textbooks have online slides that will be used through this course. Some other online and free slides developed by some other researchers will be used for model checking and verification purposes.

- Scientific papers published in (1) International Symposium on Software Testing and Analysis (ISSTA), (2) International Conference on Software Testing (ICST), and Journal of Software Testing, Verification, and Reliability (STVR).

Some other sources for hands-on experiences and framework for AI/LLM/RL evaluation and debugging:

- An Introduction to Debugging And Testing LLMs in LangSmith:
  https://www.datacamp.com/tutorial/introduction-to-langsmith
- https://github.com/langchain-ai/langsmith-cookbook
- https://github.com/langchain-ai/intro-to-langsmith
- https://docs.langchain.com/langsmith/evaluation-quickstart
- https://cobusgreyling.medium.com/langsmith-by-langchain-ce1742d44f24
- https://github.com/langchain-ai/langsmith-sdk/blob/main/js/README.md

Team-based Projects

You need to be part of a team and work on a team-based project related to software testing and program analysis.

Student Evaluation

On-campus Students will be graded based on assignments, exams, and the project (tentative).

The total mark is out of 100 marks

- Project (2 submissions, each 9%): 18% (to be submitted in the end of each month along with a 15 – 20 minutes presentation by each group, one in the mid-semester, one in the end of semester)
- Individual Assignments (3 submissions, each 9%): 27% (submission deadlines to be announced)
- Pop-up quizzes and Class participations (~5 pop up quizzes, each 2% Adjusted based on the exact number of quizzes): 10%
- Mid Term examination: 15%
- Final written examination: 30%

Off-campus Students will be graded based on assignments, exams, and the project (tentative).

- Project (2 submissions, each 10%): 20%. The project for off-campus students is solo. (To be submitted in the mid and also in the end of semester, along with a 15 – 20 minutes video by each student)
- Individual Assignments (3 submissions, each 10%): 30% (submission deadlines to be announced)
- Mid-term and Final written examination – online
  - Mid Term examination: 20%
  - Final written examination: 30%

Students with Disabilities

Any student who because of a disability may require special arrangements in order to meet course require- ments should contact the instructor as soon as possible to make any necessary accommodations. Student should present appropriate verification from Student Disability Services during the instructors office hours. Please note: instructors are not allowed to provide classroom accommodations to a student until appropriate verification for Student Disability Services has been provided. For additional information, please contact Student Disability Services in West hall or call 806-742-2405.

Ethical Conduct

Although discussion about ideas and problems is one of the major learning methods, students must write their own assignments and essays. When taking ideas or sentences from another author, students must acknowledge their debt by citation. Plagiarism is the most serious academic offence and there will be zero- tolerance for academic dishonesty. Scholastic dishonesty includes, but is not limited to, cheating, plagiarism, collusion, and falsifying academic record. For a detailed list of offenses, refer to Texas Tech University online resource for students, found in Part IX, pp. 21-30, available on line at:

http://www.depts.ttu.edu/studentaffairs/publications/2008 2009 Handbook and Code.pdf

All assignments are individual works. You may discuss approaches to problems among yourselves; however, the actual details of the work (assignment coding, answers to concept questions, etc.) must be an individual effort. The standard departmental penalty for assignments that are judged to be the result of academic dishonesty is, for the student's first offence, a mark of zero for the assignment, and possible consequences, possibly suspension from the university.

Learning Outcomes

The following are the expected learning outcomes of the course:

- Masters of Science Degree:
  (1) Communicate effectively orally and in writing (LO 1) (2) Engage in life-long learning and self-critique (LO 2)
  (3) Function independently on self-directed projects or research where appropriate (LO 4)
- Doctor of Philosophy Degree:

(1) Graduates are expected to communicate effectively orally and in writing (LO 1)
(2) Engage in life-long learning and self-critique (LO 2).
(3) Function in a multi-disciplinary, and culturally diverse environment with cross-functional teams (LO 3)

(Tentative Schedule)

Week	Topics	Note
1	Introduction to V & V	
2	Adequacy criterion	
3	**Student presentation**	
4	Black box testing	
5	White box testing	
6	Model-based testing	
7	**Student presentation**	
8	Graph-based testing	
9	Fault-based testing & Fault localization	
10	Security testing	
11	Formal verification	
12	Verification	
13	Model checking	
14	**Student presentation**	
15	LangSmith + Hands-on Experience	
16	AI/LLM/RL Evaluation	

17	More	