Verification and Validation in Cyber Physical Systems

LS XXII – Chair for Software Engineering
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Who we are …

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Verification and Validation in CPSs

Cyber-Physical Systems

Challenges

- Trial and error testing (which is the state of the practice) does not provide sufficient rigor in error detection
- Formal methods provide a desired level of expressiveness but are neither intuitive nor scalable
- Existing simulation tools are limited in their capabilities to jointly model physical and cyber components
- Requirements engineering does not yet provide satisfactory techniques, often neglected → GIGO
- Fast online detection and localization of faults and intrusions

X. Zheng and C. Julien, "**Verification and Validation in Cyber Physical Systems: Research Challenges and a Way Forward**,"*2015*

Goal

- Understanding
  - The concept of CPSs
  - Problems in V&V of CPSs and solutions
  - Challenges and the way forward

- Exposure to scientific method
  - Critically reading, understanding, summarizing, explaining and presenting existing scientific work

Tasks Overview

- Mainly independent working
  - Read and understand different concepts
  - Look for papers/material beyond the initial suggestion
    - E.g. online libraries, TUM library
    - **No** Wikipedia
    - **No** blogs, forums etc.
  - Reproduce your understanding in form of a written term paper
  - Present your understanding in front of an audience

- Guidance from the lecturer whenever required

Rules

- Compliance with the prescribed deadlines
- Compliance with the writing formats
- Presence in all meetings
- Participation in the final presentations in one or two block-seminar
- Usage of Moodle and SVN repository

Rules

Grading

- Intermediate submission
- Term paper (50% of the grades)
- Presentation (50% of the grades)

Intermediate Submission

- Optional help offer from us (strongly recommended!)
- Ca. 2-3 pages
- Table of content
  - Detailed with subsections
- Extended abstract
  - Introduction
  - Problem statement and goals
  - A short description/summery of the content of each subsection
  - Clear sketch of own contribution/critical assessment
- Bibliography

Term paper

- Max 15 pages including appendix, LNCS format
- Independent work
- No Plagiarism!
  - Blatant copy-paste, summarizing some else's ideas/results without reference etc. will result in immediate expulsion from the course.
- Discussion of own contribution
- Complete bibliography
- Appendix, if needed

Content

- Don’t deviate from the allotted topic
- Logical and contradiction-free reasoning
- Argue with sources properly cited
- If you find any contradiction in the papers you read, point them out, don’t hide them

Content

- Bibliography
  - Must be referenced in the text
  - Must have consistent numbering
  - No Wikipedia, blogs, forums as sources

- Recommended: BibTeX

Content

- Tables and Pictures
  - Sources must be properly cited
  - Must not be blurry
  - Large enough to be clearly read in print
  - Must be referenced in the text
  - Must have consistent numbering
  - Useful caption
    - Tables have caption above, pictures have captions below

Possible Structure

- Title page
- Introduction
- Related work
- Topic content
- Results
- Conclusion and discussion
- Bibliography
- Appendix

Presentation

- Ca. 30 minutes of talk
  - Clear, easily understandable presentation of the term paper content
- Ca. 10 minutes of discussion at the end
  - Be prepared for questions on your topic
  - Ask questions on the presented topic

Finding Literature

- Moodle Page
- TUM Library
  - Informatik
  - Others
- Search engines
  - Springer (http://www.springerlink.com/)
  - ACM (http://dl.acm.org)
  - IEEE (http://ieeexplore.ieee.org/Xplore/guesthome.jsp)
- Meta search engines
  - Scopus (www.scopus.com)
  - Google Scholar (www.scholar.google.com)

Registration

- TUM Online Matching System
  - *http://docmatching.in.tum.de/*
  - More details from info point

Registration

- Choose 3 topics from the list
- Mail to golagha@in.tum.de
- Order of preference: 1 highest, 3 lowest

- Get a topic by email

Deadlines

- Intermediate Submission
- Term paper submission
- Submission of the presentation slides

- Individual appointment for feedback
- Final seminar-day

- To be announced in **Moodle**

Topics Overview

Topics Overview

Formal modeling and verification

1. The algorithmic analysis of hybrid systems
2. Automatic abstraction for verification of cyber-physical systems
3. Systematic Model-Based Testing of Embedded Automotive Software

Topics Overview

Test case generation/selection

4. Empirically studying the role of selection operators during search-based test suite prioritization
5. Search-based automated testing of continuous controllers
6. Test Case Generation by OCL Mutation and Constraint Solving
7. Test case selection strategies based on Boolean specifications
8. AUSTIN: An open source tool for search based software testing of C programs

Topics Overview

Fault localization and diagnosis

9. Detection of Faults and Intrusions in Cyber-Physical Systems from Physical Correlations
10. Fault localization in embedded control system software
11. Modeling and Mitigation of Faults in Cyber-physical Systems with Binary Sensors
12. Optimization of a knowledge-based system by a meta-heuristic approach for the automotive diagnosis
13. A hybrid-logic approach towards fault detection in complex cyber-physical systems

Topics Overview

Fault tolerance and injection

14. Integrated cyber-physical fault injection for reliability analysis of the smart grid

15. Adaptive fault-tolerance for cyber-physical systems

Topics Overview

You May also write to us if you would like to do your own topic on

verification and validation in cyber physical systems.