What is Software Engineering?

Martin Kellogg

Reading quiz: SE + research

Q1: **TRUE** or **FALSE**: the author argues that major results in fields like software engineering gain credibility over time as successive papers provide incremental improvement of the result and progressively stronger credibility.

Q2: When and where is this class' final exam? (Give the date, start time, and room. Hint: it is in one of the two rooms that class is held in, so you just need to unambiguously specify which.)

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Monday, December 16th at 11:30am, in GITC 1100.

Announcements

- Exam review session will be on **Friday evening**
  - 5-6:30pm on Zoom; I will post the link on Discord
  - bring questions; ends early if there are no more questions
- Extra OH Friday morning 9-10:30 (but no regular OH on Thursday)
- Course evaluations close tonight
  - please fill it out! I do read them…
  - I'll give you ~15-20 minutes at the end of class today (hopefully)
- Final demo attendance is mandatory
  - all demos are in my office (GITC 4314)
  - time slots will be strictly enforced

What is Software Engineering?

Today's agenda:

- **What is research? How is it similar/different from SE generally?**
- Your relationship to researchers, as a developer
- What sort of problems does SE research solve

What is research?

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    - in those field, anyone doing something new is doing “research”

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    - or explore what computers we can **physically build** (arch)

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We'll come back to this stuff later in the lecture in a bit more detail, with some examples.

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Not just PhD students: as an **undergraduate** you can get involved in research too (I did!)

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However, developers rarely **publish** their research, which is important if you want it to be a part of the **total sum of human knowledge**.

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Another misconception: in the US, you usually **do not** need a master's degree to start a PhD program!

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  - it might be more affordable than you think!

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    - industrial researcher
      - e.g., static analysis designer, ML architecture developer, etc.

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  - it takes a **long time**
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  - it's **mentally taxing**
    - you're working on only one thing for 4-6 years!
    - rates of mental health problems among PhD students are much higher than the general population

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to find out about a professor's work, google "their name NJIT" and read their website

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- at NJIT, research professors all have “professor” in the title
- teaching professors are “lecturers”

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    - at this stage, you know enough to be useful, but you'll be around long enough that you can ramp up on a project

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  - Many developers are also working in fast-changing **domains** within CS
    - e.g., if you're working on ML, you'll want to keep up with the latest ML research

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  - if you're at a "big tech" company, you definitely do; other places, it's a maybe
- Especially if you're working on something **cutting edge** and you're considering trying to keep up with the latest research yourself, finding an industrial researcher in your company is a good idea
  - they can keep up with the research so you don't have to!

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- Keep up with research areas you’re particularly interested in directly, by reading (or, more likely, **skimming**) papers
  - more advice on this next

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Exception: papers published by **industrial research labs** (e.g., Google Research, MSR) are almost always written in a style closer to what developers are trained to read. These are often the ones you want to focus on as a developer, anyway!

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  - so SE research is particularly important to developers!

What's Hot in Software Engineering Research

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- If you **want to know more** about any of this, come by my office hours or make an appointment with me - I love to talk about this stuff!

What's Hot: Using LLMs in SE

Applications of LLM and Other AI Technologies

- Liuqing Chen, Yunnong Chen, Shuhong Xiao, Yaxuan Song, Lingyun Sun, Yankun Zhen, Tingting Zhou, Yanfang Chang:
  EGFE: End-to-end Grouping of Fragmented Elements in UI Designs with Multimodal Learning. 11:1-11:12
- Cuiying Gao, Gaozhun Huang, Heng Li, Bang Wu, Yueming Wu, Wei Yuan:
  A Comprehensive Study of Learning-based Android Malware Detectors under Challenging Environments. 12:1-12:13
- Antonio Mastropaolo, Fiorella Zampetti, Gabriele Bavota, Massimiliano Di Penta:
  Toward Automatically Completing GitHub Workflows. 13:1-13:12
- Junjielong Xu, Ziang Cui, Yuan Zhao, Xu Zhang, Shilin He, Pinjia He, Liqun Li, Yu Kang, Qingwei Lin, Yingnong Dang, Saravan Rajmohan, Dongmei Zhang:
  UniLog: Automatic Logging via LLM and In-Context Learning. 14:1-14:12
- Yutong Wang, Cindy Rubio-González:
  Predicting Performance and Accuracy of Mixed-Precision Programs for Precision Tuning. 15:1-15:13
- Benjamin Steenhoek, Hongyang Gao, Wei Le:
  Dataflow Analysis-Inspired Deep Learning for Efficient Vulnerability Detection. 16:1-16:13
- Aidan Z. H. Yang, Claire Le Goues, Ruben Martins, Vincent J. Hellendoorn:
  Large Language Models for Test-Free Fault Localization. 17:1-17:12

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EGFE: End-to-end Grouping of Fragmented Elements in UI Designs with Multimodal Learning. 11:1-11:12

DNN and Language Models for Code

Binhang Qi, Hailong Sun, Hongyu Zhang, Ruobing Zhao, Xiang Gao:
Modularizing while Training: A New Paradigm for Modularizing DNN Models. 31:1-31:12

Lipeng Ma, Weidong Yang, Bo Xu, Sihang Jiang, Ben Fei, Jiaqing Liang, Mingjie Zhou, Yanghua Xiao:
KnowLog: Knowledge Enhanced Pre-trained Language Model for Log Understanding. 32:1-32:13

Changan Niu, Chuanyi Li, Vincent Ng, David Lo, Bin Luo:
FAIR: Flow Type-Aware Pre-Training of Compiler Intermediate Representations. 33:1-33:12

Qi Guo, Junming Cao, Xiaofei Xie, Shangqing Liu, Xiaohong Li, Bihuan Chen, Xin Peng:
Exploring the Potential of ChatGPT in Automated Code Refinement: An Empirical Study. 34:1-34:13

Boxi Yu, Jiayi Yao, Qiuai Fu, Zhiqing Zhong, Haotian Xie, Yaoliang Wu, Yuchi Ma, Pinjia He:
Deep Learning or Classical Machine Learning? An Empirical Study on Log-Based Anomaly Detection. 35:1-35:13

Yangruibo Ding, Benjamin Steenhoek, Kexin Pei, Gail E. Kaiser, Wei Le, Baishakhi Ray:
TRACED: Execution-aware Pre-training for Source Code. 36:1-36:12

Hao Yu, Bo Shen, Dezhi Ran, Jiaxin Zhang, Qi Zhang, Yuchi Ma, Guangtai Liang, Ying Li, Qianxiang Wang, Tao Xie:
CoderEval: A Benchmark of Pragmatic Code Generation with Generative Pre-trained Models. 37:1-37:12

Shibbir Ahmed, Hongyang Gao, Hridesh Rajan:
Inferring Data Preconditions from Deep Learning Models for Trustworthy Prediction in Deployment. 38:1-38:13

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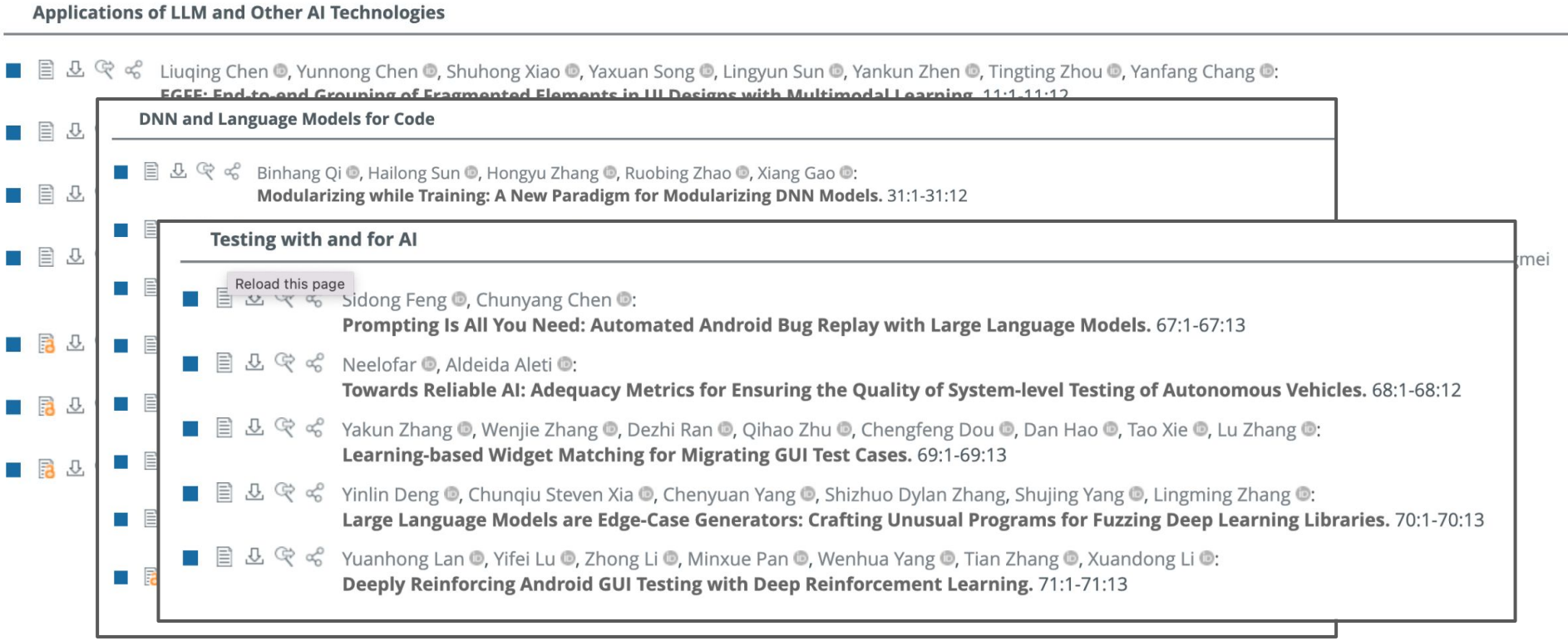
What's Hot: Using LLMs in SE



What's Hot: Using LLMs in SE

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Applications of LLM and Other AI Technologies

Liuqing Chen, Yunnong Chen, Shuhong Xiao, Yaxuan Song, Lingyun Sun, Yankun Zhen, Tingting Zhou, Yanfang Chang:
EGFE: End-to-end Grouping of Fragmented Elements in UI Designs with Multimodal Learning. 11:1-11:12

DNN and Language Models for Code

Binhang Qi, Hailong Sun, Hongyu Zhang, Ruobing Zhao, Xiang Gao:
Modularizing while Training: A New Paradigm for Modularizing DNN Models. 31:1-31:12

Testing with and for AI

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Sidong Feng, Chunyang Chen:
Prompting Is All You Need: Automated Android Bug Replay with Large Language Models. 67:1-67:13

Neelofar, Aldeida Aleti:
Towards Reliable AI: Adequacy Metrics for Ensuring the Quality of System-level Testing of Autonomous Vehicles. 68:1-68:12

Yakun Zhang, Wenjie Zhang, Dezhi Ran, Qihao Zhu, Chengfeng Dou, Dan Hao, Tao Xie, Lu Zhang:
Learning-based Widget Matching for Migrating GUI Test Cases. 69:1-69:13

Yinlin Deng, Chunqiu Steven Xia, Chenyuan Yang, Shizhuo Dylan Zhang, Shujing Yang, Lingming Zhang:
Large Language Models are Edge-Case Generators: Crafting Unusual Programs for Fuzzing Deep Learning Libraries. 70:1-70:13

Yuanhong Lan, Yifei Lu, Zhong Li, Minxue Pan, Wenhua Yang, Tian Zhang, Xuandong Li:
Deeply Reinforcing Android GUI Testing with Deep Reinforcement Learning. 71:1-71:13

Advice: Large Language Models (LLMs) in SE

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    - great for generating boilerplate, tests, etc.

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Possible future workflow:

1. LLMs generate code
2. deductive verification tools check for correctness
3. SDE reviews final code

What's Hot: Automated Program Repair

AI&SE Program Repair

- Julian Aron Prenner, Romain Robbes:
  Out of Context: How important is Local Context in Neural Program Repair? 83:1-83:13
- Hadeel Eladawy, Claire Le Goues, Yuriy Brun:
  Automated Program Repair, What Is It Good For? Not Absolutely Nothing! 84:1-84:13
- Wenzhang Yang, Linhai Song, Yinxing Xue:
  Rust-lancet: Automated Ownership-Rule-Violation Fixing with Behavior Preservation. 85:1-85:13
- Fairuz Nawer Meem, Justin Smith, Brittany Johnson:
  Exploring Experiences with Automated Program Repair in Practice. 86:1-86:11
- Yiu Wai Chow, Luca Di Grazia, Michael Pradel:
  PyTy: Repairing Static Type Errors in Python. 87:1-87:13
- Xin Zhou, Kisub Kim, Bowen Xu, DongGyun Han, David Lo:
  Out of Sight, Out of Mind: Better Automatic Vulnerability Repair by Broadening Input Ranges and Sources. 88:1-88:13
- Changhua Luo, Wei Meng, Shuai Wang:
  Strengthening Supply Chain Security with Fine-grained Safe Patch Identification. 89:1-89:12
- Shaoheng Cao, Minxue Pan, Yu Pei, Wenhua Yang, Tian Zhang, Linzhang Wang, Xuandong Li:
  Comprehensive Semantic Repair of Obsolete GUI Test Scripts for Mobile Applications. 90:1-90:13
- Zunchen Huang, Chao Wang:
  Constraint Based Program Repair for Persistent Memory Bugs. 91:1-91:12

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- Basic ***automated program repair*** (APR) idea:
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- Basic ***automated program repair*** (APR) idea:
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  - make some change so that the test passes
- Modern APR revival is based on **promise of LLMs**
- But we've been here before…
  - back in 2012, we had APR systems claiming ~50% repair rate
  - this was mostly hype + bad measurements
    - ask me for more details…
  - maybe this time will be different?

What's Hot: Fuzzing

Fuzzing and Symbolic Execution

Yue Sun, Guowei Yang, Shichao Lv, Zhi Li, Limin Sun:
Concrete Constraint Guided Symbolic Execution. 122:1-122:12

Luiz Carvalho, Renzo Degiovanni, Maxime Cordy, Nazareno Aguirre, Yves Le Traon, Mike Papadakis:
SpecBCFuzz: Fuzzing LTL Solvers with Boundary Conditions. 123:1-123:13

Zhiwu Xu, Bohao Wu, Cheng Wen, Bin Zhang, Shengchao Qin, Mengda He:
RPG: Rust Library Fuzzing with Pool-based Fuzz Target Generation and Generic Support. 124:1-124:13

Xindi Zhang, Bohan Li, Shaowei Cai:
Deep Combination of CDCL(T) and Local Search for Satisfiability Modulo Non-Linear Integer Arithmetic Theory. 125:1-125:13

Chunqiu Steven Xia, Matteo Paltenghi, Jia Le Tian, Michael Pradel, Lingming Zhang:
Fuzz4All: Universal Fuzzing with Large Language Models. 126:1-126:13

Shuohan Wu, Zihao Li, Luyi Yan, Weimin Chen, Muhui Jiang, Chenxu Wang, Xiapu Luo, Hao Zhou:
Are We There Yet? Unraveling the State-of-the-Art Smart Contract Fuzzers. 127:1-127:13

Shuo Yang, Jiachi Chen, Mingyuan Huang, Zibin Zheng, Yuan Huang:
Uncover the Premeditated Attacks: Detecting Exploitable Reentrancy Vulnerabilities by Identifying Attacker Contracts. 128:1-128:12

Katherine Hough, Jonathan Bell:
Crossover in Parametric Fuzzing. 129:1-129:12

Shengcheng Yu, Chunrong Fang, Mingzhe Du, Yuchen Ling, Zhenyu Chen, Zhendong Su:
Practical Non-Intrusive GUI Exploration Testing with Visual-based Robotic Arms. 130:1-130:13

Xuwei Liu, Wei You, Yapeng Ye, Zhuo Zhang, Jianjun Huang, Xiangyu Zhang:
FuzzInMem: Fuzzing Programs via In-memory Structures. 131:1-131:13

Danushka Liyanage, Seongmin Lee, Chakkrit Tantithamthavorn, Marcel Böhme:
Extrapolating Coverage Rate in Greybox Fuzzing. 132:1-132:12

What's Hot: Fuzzing

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Fuzzing and Vulnerability Detection

Junda He, Zhou Yang, Jieke Shi, Chengran Yang, Kisub Kim, Bowen Xu, Xin Zhou, David Lo:
Curiosity-Driven Testing for Sequential Decision-Making Process. 165:1-165:14

Yuqiang Sun, Daoyuan Wu, Yue Xue, Han Liu, Haijun Wang, Zhengzi Xu, Xiaofei Xie, Yang Liu:
GPTScan: Detecting Logic Vulnerabilities in Smart Contracts by Combining GPT with Program Analysis. 166:1-166:13

Qi Zhan, Xing Hu, Zhiyang Li, Xin Xia, David Lo, Shanping Li:
PS3: Precise Patch Presence Test based on Semantic Symbolic Signature. 167:1-167:12

Zhijie Zhong, Zibin Zheng, Hong-Ning Dai, Qing Xue, Junjia Chen, Yuhong Nan:
PrettySmart: Detecting Permission Re-delegation Vulnerability for Token Behaviors in Smart Contracts. 168:1-168:12

Huanting Wang, Zhanyong Tang, Shin Hwei Tan, Jie Wang, Yuzhe Liu, Hejun Fang, Chunwei Xia, Zheng Wang:
Combining Structured Static Code Information and Dynamic Symbolic Traces for Software Vulnerability Prediction. 169:1-169:13

Feng Luo, Ruijie Luo, Ting Chen, Ao Qiao, Zheyuan He, Shuwei Song, Yu Jiang, Sixing Li:
SCVHunter: Smart Contract Vulnerability Detection Based on Heterogeneous Graph Attention Network. 170:1-170:13

Xun Deng, Sidi Mohamed Beillahi, Cyrus Minwalla, Han Du, Andreas G. Veneris, Fan Long:
Safeguarding DeFi Smart Contracts against Oracle Deviations. 171:1-171:12

Wrapup

- If you remember one thing from this class:
  - software engineering is all about trade-offs!
- I hope you enjoyed CS 490 this semester
- Remaining class time: course evaluations
  - I do read them!
  - find it at canvas.njit.edu or blue.njit.edu/blue