

Future of Software Engineering@ICSE 2023

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Abstract—Artificial Intelligence (AI) is revolutionizing various industries, creating new challenges and opportunities for software engineering research. To explore the future of software engineering in this new AI era, a special track was held at the 45th International Conference on Software Engineering (ICSE 2023). Twelve leading researchers and industry practitioners were invited to present and discuss range of directions in future software engineering. This future of software engineering track (FoSE@ICSE 2023) had three sessions which were run as part of the main ICSE programme. After the conference, a post-proceedings was organized which features papers from several invited speakers.

I. INTRODUCTION

In the past decade, software engineering has evolved rapidly with the (re-)emergence of Artificial Intelligence (AI). AI techniques have been used to support various software engineering tasks (AI4SE), improving software quality and accelerating productivity. Recently, Large Language Models (LLMs) (e.g., GPT-3) achieved remarkable performance in (e.g.) code generation [5], testing [3], code review [5], and program repair [8]. The increasing number of AI systems also raises new challenges to software engineering (SE4AI), e.g., how to test and verify AI systems, manage technical debt, and improve the privacy and security of AI systems. There are still many open questions of how future software engineering research should evolve in the era of AI.

To discuss the road ahead of software engineering (SE), a special track was held at the 45th International Conference on Software Engineering from May 14–20, 2023 in Melbourne, Australia. This future of the software engineering track (FoSE@ICSE 2023) featured presentations and discussions from 12 leading researchers and industry practitioners on the key directions in future software engineering. FoSE@ICSE 2023 covers a wide range of topics including AI and SE, Technical Debt, Testing, Security, Productivity, Human-centric SE, Tools and Environment, and SE for Quantum Computing.

II. FoSE SESSIONS

Three FoSE sessions were run as part of the main ICSE 2023 program. Each session had four presentations (10 minutes each) and a Q&A panel discussion (50 minutes).

A. AI & SE and Debt session

In this session, David Lo (Singapore Management University), Thomas Zimmermann (Microsoft Research), Mark Harman (Meta Platforms, Inc. and University College London),

and Paris Ageriou (University of Groningen) discussed the challenges and future directions of AI4SE and SE4AI.

In his talk on “AI and ML: The Software Engineers of the Future”, Zimmermann first gave an overview on the current and potential future roles of AI/ML in software engineering. He then presented several use cases which demonstrates how these technologies are already impacting the software industry. His talk was ended with an overview of the exciting opportunities and potential pitfalls of AI/ML in software engineering.

Lo presented his vision for trustworthy and synergistic AI4SE. Harman discussed the future of Generative Artificial Intelligence for Software Engineering. Finally, Ageriou envisioned a future for Technical Debt in software engineering. We will discuss their contribution in details in Section III.

B. Testing, Security and Productivity session

This session featured talks on the future of software testing, security, and productivity in the era of LLM from Aldeida Aleti (Monash University), Laurie Williams (North Carolina State University), Gail Murphy (University of British Columbia), and Lionel Briand (University of Ottawa and University of Luxembourg).

In her talk entitled “The Future of Software Security: Beyond the Security Silo to All of Us”, Williams explored some major software engineering venues, and identified a number of trends in software security research. On this basis, she presented a range of key opportunities for exciting research in software security research for software engineering researchers.

Murphy presented “Enabling Flow in Software Development”. In her talk, she first discussed some major problems that organizations constantly face in delivering software applications successfully. She then identified the challenges for combining advances in different areas of software development into a coherent solution to address those problems.

Briand presented “How is the rapid progress in Artificial Intelligence affecting the future of Software Engineering?”. His talk highlighted the impact of AI on many software engineering areas such as requirements elicitation, automated testing and run-time verification. He also discussed the implications of those changes for the SE community, leading to a number of future research avenues in software engineering.

Aleti presented an vision for the future of software testing, which we will discuss in details in Section III.

C. Human and Tools, Ethics, and Quantum session

This sessions featured Miryung Kim (University of California at Los Angeles), Tim Menzies (North Carolina State University), Krysta Svore (Microsoft Research), and Myra Cohen (Iowa State University), who explored the future of heterogeneous computing, ethics, and quantum computing in software engineering.

In his “Got ethics?” talk, Menzies emphasized the ubiquitous of software in the modern era and the important role of software engineers in observing and influencing the world. He argued that AI-powered tool support (e.g., GitHub co-pilot) has provided significant assistance for software engineers to develop software. He then envisioned a future where software engineers will spend more time on exploring the ethical effects of software on the world and societies, and less time on, internally, how to achieve those effects.

Svore presented “The path to quantum at scale”. In her talk, she discussed the current challenges of scaling quantum computers to practical software engineering settings. She argued that quantum at scale requires three foundational elements: industrial scale quantum machines, cloud infrastructures, and an ecosystem of innovators. She then presented Azure Quantum, Microsoft’s platform for software engineer researchers and practitioners to innovate, explore and prepare for tomorrow’s scaled quantum compute.

In her talk “The Software Revolution of Obfuscation”, Cohen envisioned a future where everyone is a programmer and programming is everywhere. She then argued the need for new software engineering methods to empower a new generation of domain experts and end-user-developers for that future. She presented several examples of such new methods, including non-intrusive techniques for explainability and interpretability, easy-to-deploy validation techniques, and methods for facilitating the creation and inclusion of meta-data, documentation and first class configurability.

Kim discussed a number of future software engineering directions for Big Data and hardware heterogeneity. We will discuss her contribution in details in Section III.

III. FOSE POST-PROCEEDINGS

We invited all FoSE special session speakers to submit a full paper based on their talk after ICSE 2023. We received five papers, which are published in this post-proceedings. Here, we briefly highlight their key contributions and refer the readers to the papers for further details.

- In her paper entitled “Software Testing of Generative AI Systems: Challenges and Opportunities” [1], Aleti explored the challenges posed by generative AI systems (GenAI) and discussed potential opportunities for future research in the field of testing. Aleti described several specific characteristics of GenAI systems. She then discussed a number of approaches for Oracle learning and for assessing the adequacy of test suites for GenAI systems.
- In their paper entitled “Technical debt management: The road ahead for successful software delivery”, Avgeriou

et al. highlighted that technical debts raise a clear risk, especially for large and complex systems, and might bankrupt them in the future. They revisited the state of the art in managing Technical Debt, identified challenges, and discussed promising future directions [2].

- Fan et al.’s paper “Large language models for software engineering: Survey and open problems”, which is based on Harman’s talk, reviewed the profound impact of Generative Artificial Intelligence on many areas of software engineering research and provided suggestions for future research on hybrid technologies that incorporate Generative AI into software engineering workflows [4].
- In her paper “Software engineering for data intensive scalable computing and heterogeneous computing”, Kim summarized the challenges in developing heterogeneous applications and discussed the new techniques of refactoring, testing, and debugging tools for big data analytics and heterogeneous application development [6].
- In his paper “Trustworthy and synergistic artificial intelligence for software engineering: Vision and roadmaps”, Lo focused on the vision of future AI4SE, especially, how AI4SE can realize trustworthy and synergistic AI-powered bots that can work well with one another and software engineers [7]. Lo presented two strategic roadmaps of AI4SE, i.e., realizing trustworthy AI4SE and synergistic AI4SE.

IV. CONCLUSIONS

The discussions at FoSE@ICSE 2023 were centered around the emergence of LLMs and their impact on the future of software engineering. The consensus was that LLMs can help in various software engineering tasks, e.g., code generation, testing and verification, and requirement elicitation. Our research community should embrace the changes. To transition LLM4SE bots from intelligent tools to workmates, the trustworthiness and synergy of bots should be taken into consideration. LLMs raise many new challenges to software engineering, and new techniques are required to test LLMs, manage technical debts and AI software supply chains, and improve the security and privacy of LLMs. In addition, we should also pay attention to the new ethics issues in the era of LLMs. Furthermore, the development process might be changed substantially due to the impact of LLMs, and it is important to investigate how developers work with various LLM-based tools, and how to improve and measure developer productivity. In addition, to develop LLMs efficiently, more tools (e.g., refactoring, testing, and debugging) for heterogeneous computing should be investigated.

We hope that you enjoy these Future of Software Engineering papers and they are helpful for charting key future research and practice directions.

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