Automated Optimisation of Modern Software System Properties

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ABSTRACT

Realizing modern software systems poses new challenges to the software engineers: Users of applications running on limited capability devices still demand acceptable performance [2, 5, 13, 15]; users of systems relying on artificial intelligence to take decision (rightly) reclaim a fair treatment [4, 7, 12]; users of social networking systems expect to be protected against malicious behaviours [1]. Moreover, AI-enabled software systems are so energy-greedy that their usage is causing an alarming surge in energy consumption with a significant increase in CO_2 emissions [10].

Equipping software with appealing functionalities and minimising faults, is not enough if the emerging non-functional properties of these systems, such as fairness, safety and sustainability, are not taken into account. Mobile users will stop using an app if it is too slow or uses much bandwidth [5, 13]. Human bias can be transferred to various real-word systems relying on ML: Bias has been found in advertisement, recruitment, admission processes [3, 9, 19], among others, and human rights [16]. A growing number of malicious users use well-intentioned software platforms as a tool to attack the innocent users with whom they share the platform. Examples of such harmful acts are sadly too many to list; they include bullying, harassment, hate speech, misinformation, election interference, scamming and spamming. ChatGTP is an AI model able to answer a variety of questions, compose essays, have philosophical conversations, and even code or fix bugs [18]. However, all these come at a high cost: ChatGPT has been estimated to consume the equivalent of the electricity consumed by 175,000 people in Denmark per month. [1]

In this keynote, I will discuss the necessity to take these properties into account when realizing these type of systems, and the extent to which it is possible to automate their optimization . I will discuss existing solutions mainly based, but not limited to, multi-objective optimisation [5, 6, 8, 10, 14, 17]. In fact, we cannot expect that a software engineer, regardless of their level of expertise, would be able to manually find all opportunities for optimising these non-functional properties [11]. I will review research trends, presenting results from the SOLAR group and others.[2] I will also discuss some directions for future work and open-challenges towards achieving better, fairer, safer and greener software.

[1] https://towardsdatascience.com/chatgpts-electricity-consumption-7873483feac4
[2] https://solar.cs.ucl.ac.uk/

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CCS CONCEPTS

• **Software and its engineering → Software functional properties**; **Extra-functional properties**; **Search-based software engineering**.

KEYWORDS

Software optimisation; functional properties; non-functional properties; search-based software engineering; genetic improvement; green software; green artificial intelligence

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BIO

Federica Sarro is a Professor of Software Engineering in the Department of Computer Science at UCL, where she is the Head of the Software Systems Engineering group and has established the SOLAR team within the CREST centre.

Her expertise lies at the intersection of software engineering, software optimisation, machine learning and evolutionary computation. She has carried out research on Machine Learning for Software Engineering and Software Engineering for Machine Learning with a focus on automatic software testing, repair, optimisation, software fairness, and predictive analytics for project management and quality assurance. She has published over 100 peer-reviewed scholarly articles, and given several invited talks at academic and industrial international events. She has led the international community in the development of predictive modelling for Software Engineering, and led scientific advances in the areas of Search-Based Software Engineering and Empirical Software Engineering.

Professor Sarro has obtained numerous awards and generous funding for her research. She has also worked with several companies including Meta, formerly known as Facebook, Google and Microsoft. In 2021, she was awarded the *Rising Star Award* by the IEEE Technical Community on Software Engineering in recognition of her "*excellence in Software Engineering research with scholarly and real-world impact*".

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