Scientific Report

First name / Family name	Hui Han
Nationality	China
Name of the *Host Organisation*	Fraunhofer IESE
First Name / family name of the *Scientific Coordinator*	Julien Siebert
Period of the fellowship	01/04/2021 to 31/03/2022

I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

For the first half year (April to September), I worked for the two research topics from Dr. Julien Siebert: A review of data science challenges for SMEs and Data science canvas. For the first topic "a review of data science challenges for SMEs", I collect the relevant papers, and read papers to find the challenges for each paper. Then I classify the data science challenges into six groups: technological factors, organizational factors and environmental factors (based on the technological-organizational-environmental (TOE) model), as well as three dimensions of data, human resources and financial issues as additional challenges specially for SMEs adopting of data science. I wrote down my work as one part (Section 3) of the paper "A Systematic Literature Review of Data Science for SMEs: Challenges and Solutions". For the second topic "Data science canvas", I read papers to check whether these papers are relevant to the research topic. Then I find the content for each canvas, and classify them based on the content.

For the second half year (October to March), I propose two research topics from my side: A review of TinyML (Tiny Machine learning) and TinyML for AI security. Tiny machine learning (TinyML) is a fast-growing field of machine learning (ML) technologies and applications that include algorithms, hardware (dedicated integrated circuits), and software that are capable of performing on-device sensor (vision, audio, inertial measurement unit, biomedical, etc.) data analytics, doing so at extremely low power, typically in the order of

milliwatts, hence enabling a variety of always-on machine learning use cases on battery-powered devices. It enables the possibility of keeping data mainly on edge devices and there being processed and running machine learning (ML) tasks directly in the device. Therefore, TinyML paradigm is frequently supposed to preserve AI security. TinyML will play an essential character in our daily interactions with ML in the near future. The two research topics were published by Fourth International Conference on AI in information and communication (ICAIIC 2022) and ERCIM News respectively.

Except above mentioned science activities, I collaborated with Prof. Silvana Trimi from University of Nebraska – Lincoln (USA) on research articles "data science platform for improving SME collaboration through Industry 4.0 technologies", and "Cloud Computing-based Higher Education Platforms during the COVID-19 Pandemic". These two papers were published in Technological Forecasting and Social Change and 13th International Conference on E-Education, E-Business, E-Management and E-Learning (IC4E 2022) respectively.

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

Towards a data science platform for improving SME collaboration through Industry 4.0 technologies
Hui Han and Silvana Trimi (2022). Towards a data science platform for improving SME collaboration through Industry 4.0 technologies. Technological Forecasting and Social Change, 174, 1-13. DOI: https://doi.org/10.1016/j.techfore.2021.121242
Abstract

Industry 4.0 (I4.0) is about realizing digital transformation by linking machines to plants, fleets, and humans through sensors and control elements in order to create smart networks, smart factories, smart manufacturing, and smart value chains. By leveraging I4.0 technologies, a small and medium enterprise (SME) can increase its organizational agility, adaptability, and resilience to cope with today's competitive environment by becoming a valuable and innovative partner in the power dynamics with its large buyer counterparts. However, SMEs face technology, trust, and big data challenges when they adopt I4.0 technologies. This study provides new solutions for SMEs to overcome these three challenges in implementing I4.0. Specifically, the paper proposes the following: (1) a roadmap for the application of I4.0 technologies to enhance the collaboration capabilities of SMEs; (2) a structure for I4.0 standardization to develop and sustain trust among partners; and (3) an improved data science platform for systematizing big data to extract critical information for collaboration solutions for SMEs. Additionally, the solutions are evaluated based on an application case of a Greek SME, demonstrating their potentials for practical implementation.

Cloud computing-based higher education platforms during the COVID-19 pandemic
Hui Han and Silvana Trimi (2022). Cloud computing-based higher education platforms during the COVID-19 pandemic. In 13th International Conference on E-Education, E-Business, E-Management and E-Learning (IC4E 2022, ACM conference), DOI: https://doi.org/10.1145/3514262.3514307.
Abstract

Cloud computing has become the infrastructure that supports people's daily activities, business operations, and education delivery around the world. Cloud computing-based education platforms have been widely applied to assist online teaching during the COVID-19 pandemic. This paper examines the impact and importance of cloud computing in remote learning and education. This study conducted multiple-case analyses of 22 online platforms of higher education in Chinese universities during the epidemic. A comparative analysis of the 22 platforms revealed that they applied different cloud computing models and tools based on their unique requirements and needs. The study results provide strategic insights to higher education institutions regarding effective approaches to applying cloud computing-based platforms for remote education, especially during crisis situations.

TinyML: A Systematic Review and Synthesis of Existing Research

Hui Han and Julien Siebert (2022). TinyML: A Systematic Review and Synthesis of Existing Researc. In Fourth International Conference on AI in information and communication (ICAIIC 2022), 269-274. ISBN: 978-1-6654-5818-4/22/

Abstract

Tiny Machine Learning (TinyML), a rapidly evolving edge computing concept that links embedded systems (hardware and software) and machine learning, with the purpose of realizing ultra-low-power and low-cost and efficiency and privacy, brings machine learning inference to battery-powered intelligent devices. In this study, we conduct a systematic review of TinyML research by synthesizing 47 papers from academic and grey publication since 2019 (the early TinyML publication starts from 2019). Relevant TinyML literature is analyzed from five aspects: hardware, framework, datasets, use cases, and algorithms/model. This systematic review will serve as a roadmap for understanding the literature within the new emerging field of TinyML.

Standardisation for Security Applications and Technologies

Hui Han (2021). Standardisation for Security Applications and Technologies. ERCIM News, 126, 42-43

Abstract

Standardisation can help ensure proper contractual procedures for protecting digital information and systems, guaranteeing security and privacy in the dynamic digital environment. With standardisation, companies can effectively collaborate with their partners, thus strengthening trust among organisations. As a result, various standards have been established for security applications and technologies.

III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

- "Virtual workshop on Visual Communication of Science" on 17. & 18.05.2021 (in English) by Technical University of Kaiserslautern.
- Online-Workshop "Gute wissenschaftliche Praxis" on 23.06.2021 (in Deutsch) by Technical University of Kaiserslautern.
- Online-Seminar "Safety meets security" on 18.11.2021 by Fraunhofer IESE.
- 13th International Conference on E-Education, E-Business, E-Management and E-Learning (IC4E 2022) on Jan 14-17, 2022.

- Fourth International Conference on AI in information and communication (ICAIIC 2022) on Feb 21-24, 2022.

IV – RESEARCH EXCHANGE PROGRAMME (REP)

Research Exchange Program (REP) institute: Centrum Wiskunde & Informatica (CWI), Computer Security Group, Amsterdam, Netherlands
Local scientific coordinators: Prof. Dr. Marten van Dijk and Dr. Chenglu Jin

Due to the ongoing pandemic, many institutes are remote work (home office) currently. Therefore, a virtual research visit was arranged between Jan and Feb 2022. During the virtual visit, the program was carried out through several emails and online meetings. I provided a PowerPoint presentation about my research concerning how TinyML (as a new technique) can solve AI security problems. Prof. Dr. Marten van Dijk discussed with me about the topic of the TinyML with Security, and pointed out several possibilities for future research directions. Dr. Chenglu Jin also presented a PowerPoint to show me their project about PwoP ("Privacy w/o Pollutions"), and answered my many questions in details regarding this project. We will arrange more meetings to discuss deep collaboration in the coming future.