Scientific Report

First name / Family name	Ali Sedaghatbaf
Nationality	Iran
Name of the *Host Organisation*	RISE Research Institutes of Sweden
First Name / family name of the *Scientific Coordinator*	Mehrdad Saadatmand
Period of the fellowship	01/10/2020 to 01/10/2021

I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

During my fellowship, I worked in the division of digital platform at RISE Research Institutes of Sweden. I got involved in a European research project called IVVES (https://ivves.eu/). The purpose of this project is devising techniques and developing tools for the verification and validation of evolving industrial systems. Rapid and continuous changes and embedding Artificial Intelligence services are the key features of the systems targeted by this project. This project includes several use cases provided by its industrial partners. I had the chance to work on two of these use cases. One use case was provided by F-Secure corporation in Finland. The use case was about concept drift in data stream mining. In this use case, we were interested to cluster a stream of data received from a security monitoring system. However, the existing clustering algorithm was offline and extra manual effort was needed to handle changes in data and the impact of those changes on the quality of the obtained clusters. As a solution, we proposed and implemented an online clustering algorithm which took advantage of a change detector to detect and overcome three common forms of concept drift.

The second use case was provided by ABB Robotics, and it was about testing the performance of a robot control software, which is an evolving system and has a large input space. Usually, a few input values are responsible for most of the performance issues in software system. However, finding those values efficiently and with minimal test effort is challenging. As a solution for efficient input space exploration, we proposed an active deep learning algorithm. Our experiments on a benchmark web application show that our solution has a better performance compared to some state-of-the-art solutions. In addition to the above use cases, I had the chance to work with another ERCIM fellow on a deep learning solution for anomaly detection under concept drift. That work is still in progress. Furthermore, I collaborated with some researchers at Antwerp university (in Belgium) on a solution for fault injection testing. The algorithm that we proposed relies on generative adversarial networks for effective fault space exploration. Our initial experiments on an adaptive cruise control system indicate that our algorithm can identify critical faults more effectively compared to random sampling.

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

1. Sedaghatbaf A., et al., "Automated performance testing based on active deep learning", 2nd ACM/IEEE International Conference on Automation of Software Test (in press).
2. Sedaghatbaf A., et al., "A drift-aware algorithm for host profiling", 19th Australian Data Mining Conference (under review).
3. Moradi M., Sedaghatbaf A., et al., "Fault injection testing using generative adversarial networks", Design, Automation and test in Europe Conference (under review).
4. Sinaei S., Sedaghatbaf A., et al., "A deep learning algorithm for anomaly detection under concept drift", (under preparation).

III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

1. Presented a paper at 2nd ACM/IEEE International Conference on Automation of Software Test.
2. Attended the 4th International Workshop on Testing Extra-Functional Properties and Quality Characteristics of Software Systems.
3. Attended the annual software centre reporting workshop.
4. Attended IEEE International Conference on Omni-layer Intelligent Systems.

IV – RESEARCH EXCHANGE PROGRAMME (REP)

For the research exchange program, I visited the department of engineering complex software systems at Simula in Norway for one week in September 2021. During this visit, I had a lecture on exploratory testing using active deep learning presenting a summary of my recent work and got very useful feedbacks from the researchers at Simula. One of the

interesting points discussed after this presentation was about dealing with uncertainty in labeling data for training neural networks. We had also interesting discussions about the following topics during this visit:

- performance testing with dynamic thresholds where the thresholds for performance metrics (e.g. response time) get updated intelligently based on the knowledge learned during the testing process (with Christoph Laaber <laaber@simula.no>),
- analyzing the robustness of elevator systems against passenger uncertainty using statistical tests (with Liping Han <liping@simula.no>),
- mode collapse in generative adversarial networks which leads to a degradation in their performance, and anomaly detection in digital twins using deep learning algorithms (with Qinghua Xu <qinghua@simula.no>), and
- quantum software engineering (with Hagen Echzell <hagen@simula.no>)