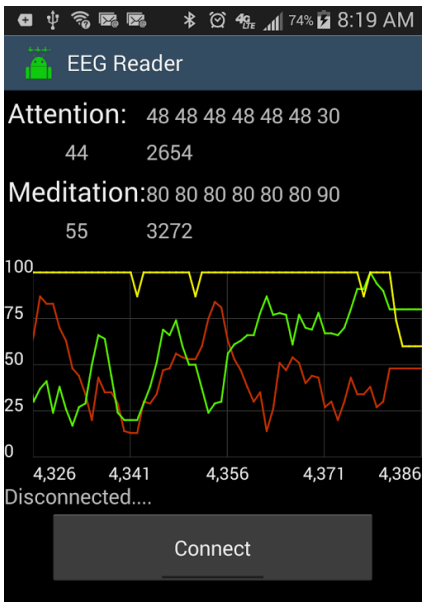
Thesis title: *Detecting Challenging Programming Tasks Using EEG Neurofeedback*

Thesis description:

Many tasks are routinely completed in software engineering, whereas others require considerable effort. The research discipline *program comprehension* concerns the study of how software engineers develop and maintain source code, focusing on the cognitive processes involved. Understanding when and how software engineers experience flow and when they encounter challenging tasks could help design productive work environments [1], and enable adaptive development environments, e.g., dynamically presenting related information and recommending the engineer when to take breaks. Unfortunately, direct measurement of cognitive processes is not straightforward [2].



On the other hand, the price of non-invasive brain-computer interfaces such as electroencephalography (EEG) have drastically dropped in recent years - common consumer devices now offer scalp-recorded EEG with fine temporal resolution. Previous research has successfully used EEG neurofeedback to assess the difficulty of programming tasks. Fritz et al. studied 15 professional programmers in a controlled lab environment, and managed to predict whether a task was easy or difficult using a Neurosky MindBand [3]. They obtained an accuracy of 85% precision and 70% recall.

Neurosky has since then released a device called MindWave (see picture below), providing more comfortable access to EEG measurements. Furthermore, MindWave uses Bluetooth to connect to Android device for convenient data collection and visualization. Several Android apps are available on Google Play, including open source software such as EEG Reader. The possibility to collect EEG measurements on the go has never been easier.

The objective of the thesis project is to replicate the study by Fritz et al. using the Neurosky MindWave. Furthermore, study the robustness of the approach by collecting EEG data from: 1) students in a controlled environment, and 2) software developers in their normal work environments. The latter is enabled by the convenience of using MindWave and a Bluetooth-connected Android device. Apply machine learning to train a classifier that detects challenging programming tasks in real-time.

[1] S. Radevski, et al. Real-time Monitoring of Neural State in Assessing and Improving Software Developers' Productivity, In *Proc. of the 8th Int'l Workshop on Cooperative and Human Aspects of Software Engineering*, pp. 93-96, 2015.

[2] J. Siegmund, et al. Understanding Understanding Source Code with Functional Magnetic Resonance Imaging, In *Proc. of 36th Int'l Conference on Software Engineering*, pp. 378-389, 2014.

[3] T. Fritz, et al. Using Psycho-Physiological Measures to Assess Task Difficulty in Software Development, In *Proc. 36th Int'l Conference on Software Engineering*, pp. 402-413, 2014.

Tasks:

- Study related work on classification of EEG data, i.e., both software engineering tasks and seizure detection etc.
- Adapt EEGReader (or similar open source app) to match the needs of this study
- Design a replication of Fritz et al.'s experiment, incl. replications with students and programmers in the field
- Run experiments, collect data, and analyse the results.
- Compare with original experiment and discuss results as well as practical applications.

Key skills:

- Essential: programming, software engineering
- Preferred: signal processing, time series analysis, machine learning, Android development

Applications should include a brief cover letter, CV, and recent grades. In your application, please provide examples of previous programming experiences or other projects that you consider relevant for the position.

Expected start time: January-March 2017

Location: SICS Swedish ICT AB, Lund

Contact person/s: Dr. Markus Borg (markus.borg@sics.se)

SICS SWEDISH ICT AB
Box 1263
SE-164 29 Kista
ORG NR 556587-0119
WWW.SICS.SE

About SICS:

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The Software and Systems Engineering Laboratory (SSE) has as its research theme "successful development of software-based systems for the digital society". The focus is on providing relevant solutions for software and systems development in a society that becomes increasingly connected and automated, and frequently updated through continuous deployment. Special attention is given to large-scale cyber-physical systems, where traditional embedded systems are evolving into systems-of-systems through connectivity, using technologies from the Internet of Things. Currently, the research activities in the SSE lab focus on four areas: process evolution, system architecture, software ecosystems, and system qualities.

The RISE institutes SP, Swedish ICT and Innventia are merging in order to create a unified institute sector and become a stronger innovation partner for businesses and society. At the end of the 2016 we will change our name to RISE. Read more at www.ri.se/en/about-rise

SICS Swedish ICT AB,
Software and Systems Engineering Lab
Ideon Science Park
Building Beta 2 3v
Scheelevägen 17
SE-223 70 Lund