Scientific Report

First name / Family name	Efi Papatheocharous
Nationality	Cypriot
Name of the *Host Organisation*	SICS
First Name / family name of the *Scientific Coordinator*	Jakob Axelsson
Period of the fellowship	05/01/2013 to 06/01/2014

I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

*During the fellowship my scientific activity related to (a) conducting **primary research** in the areas of software engineering (in particular software cost estimation, process improvement and project management in agile software development processes), software ecosystems and Systems-of-Systems, and human factors in software engineering, (b) applying to **raise funding** (via proposals submitted to the European Commission (EC), Cyprus Research Promotion Foundation (RPF), Swedish Governmental Agency for Innovation Systems (Vinnova) and other agencies), and, (c) **disseminating and exploiting research work results**, where activities aimed in expanding and maintaining my existing collaborative networks, and this was achieved by publishing scientific articles, taking part in exhibitions, conferences and workshops and also conducting REP visits to research institutes.*

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

Title	**Evidence of Agile Adoption in Software Organizations: An Empirical Survey**
Author(s)	Papatheocharous Efi and Andreou S. Andreas
Abstract	This paper aims at empirically investigating the levels of agile adoption by software development organizations in comparison with the type of practices followed, the business sectors and the countries of origin, as well as revealing the geographical organization and distribution of teams both within agile and traditional development environments. Through a dedicated survey conducted, the paper also discovers, analyzes and presents the business strategies, levels of expertise, benefits and concerns of agile adoption within the various participating organizations. The results obtained indicate that agile methods seem to offer opportunities for improved products in terms of quality and suggest a number of critical factors that affect the software process and the adoption of agile methods in general
Reference	Papatheocharous, E. and Andreou, S. A., "Evidence of Agile Adoption in Software Organizations: An Empirical Survey", Proceedings of the EuroSPI 2013, Dundalk, June 25-28, 2013, pp. 237-246.
Status	Published

Title	**Product Development and Open Innovation in Ecosystems of Federated Embedded Systems (EcoFES)**
Author(s)	Papatheocharous Efi, Jakob Axelsson and Jesper Andersson
Abstract	The project concerns future product development in embedded systems, i.e., electronics and software in physical products, and aims to study how an ecosystem around the products and its actors for open innovation and customization could be developed and evolved.
Reference	-
Status	Poster presented, not published

Title	**Issues and Challenges in Ecosystems for Federated Embedded Systems**
Author(s)	Papatheocharous Efi, Jakob Axelsson and Jesper Andersson
Abstract	This paper discusses how Systems of Systems (SoS) can be constructed by linking together embedded computers in constituent systems to create complex but more flexible and adaptable systems. The approach of software system development is called Federated Embedded Systems (FES) and their revolved ecosystem of players is presented, aiming to ensure quality in engineering SoS. Ecosystems for Federated Embedded Systems (EcoFES) comprise a new area of research that scales component-based software development for embedded software into new dimensions. The proposed ecosystem dimension introduces an open, flexible and adaptable SoS architecture for improving the process of FES development. In the paper, we identify some architectural challenges and discuss the implications of scaling from a closed ecosystem to an open one, providing open

	collaboration and innovation in the context of FES.
Reference	Papatheocharous, E., Axelsson, J. and Andersson, J., "Issues and Challenges in Ecosystems for Federated Embedded Systems", Proceedings of the First International Workshop on Software Engineering for Systems-of-Systems (SESoS 2013), Montpellier, July 2, 2013, pp. 21-24, New York, NY, USA: ACM. DOI:10.1145/2489850.2489854.
Status	Published

Title	**Fuzzy Cognitive Maps as Decision Support Tools for Investigating Critical Agile Adoption Factors**
Author(s)	Papatheocharous Efi, Nyfjord Jaana and Papageorgiou Elpiniki
Abstract	A lot of discussion on how to efficiently adopt, scale or improve processes by using agile to a larger extent in enterprises and what kind of implications enterprises face on their path towards enterprise agility exists in nowadays. This paper describes how Fuzzy Cognitive Maps (FCM) can be used as Computational Intelligence (CI) tools for Decision Support (DS) in reducing the risks of the implications in this adaptation or transformation process. Particularly, FCM are used in understanding the effect of a set of critical Agile Adoption Factors (AAF) proposed in literature in the success of adopting agile. A set of preliminary experiments have been conducted to show that AAF can be evaluated with the use of FCM and their effect on adoption success is validated in three specific contexts. The results show that a critical implication is corporate bureaucracy and some enablers are the project teams' personal traits, such as collaborative attitude and readiness to change, as well as, the customers' level of commitment. The proposed FCM model provides an insight on the usefulness of the method for assessing agile transformation success.
Reference	Papatheocharous, E., Nyfjord, J. and Papageorgiou, E., "Fuzzy Cognitive Maps as Decision Support Tools for Investigating Critical Agile Adoption Factors", Proceedings of the Lean Enterprise Software and Systems Conference (LESS), Galway, Ireland, December 1-4, 2013, Springer-Verlag Berlin Heidelberg, 2013, Fitzgerald B. et al. (Eds.): LESS2013, LNBIP 167, pp. 180–193.
Status	Published

Title	**Characteristics of Software Ecosystems for Federated Embedded Systems: A Case Study**
Author(s)	Jakob Axelsson, Papatheocharous Efi and Jesper Andersson
Abstract	Context: Traditionally, embedded systems (ES) are tightly linked to physical products, and closed both for communication to the surrounding world and to additions or modifications by third parties. New technical solutions are however emerging that allow addition of plug-in software, as well as external communication for both software installation and data exchange. These mechanisms in combination will allow for the construction of Federated Embedded Systems (FES). Expected benefits of this are the possibility of third party actors developing add-on functionality; a shorter time to market for new functions; and the ability to upgrade existing products in the field. This will however require not only new technical solutions, but also a transformation of the software ecosystems for ES. Objective: This paper aims at providing an initial characterization of the mechanisms that need to be present to make a FES ecosystem successful. This includes identification of the actors, the possible business models, the effects on product development processes, methods and tools, as well as on the product architecture. Method: The research was carried out as an explorative case study based on interviews with 15 senior staff members at 9 companies related to ES that represent different roles in a future ecosystem for FES. The interview data was analyzed and the findings were mapped according to the Business Model Canvas.

	Results: The findings from the study describe the main characteristics of a FES ecosystem, and identify the challenges for future research and practice. Conclusions: The case study indicates that new actors exist in the FES ecosystem compared to a traditional supply chain, and that their roles and relations are affected. The business models include new revenue streams and services, but also create the need for trade-offs between, e.g., openness and dependability in the architecture, as well as new ways of working.
Reference	-
Status	Submitted, conditionally accepted (major revision submitted)

Title	**A Multivariate Statistical Framework for the Analysis of Software Effort Phase Distribution**
Author(s)	Chatzipetrou Panagiota, Papatheocharous Efi, Angelis Lefteris, Andreou S. Andreas
Abstract	One of the most challenging problems in software project management for mitigating the project risks is to effectively decide how to distribute resources among the various project activities. Project success depends on how effectively work effort is allocated among the project phases. Properly distributed effort for a project will ultimately lead to more productive teams satisfying project constraints of quality, budget and schedule, as well as other product requirements. This paper firstly investigates the various forms of effort distribution suggested in the relevant literature, and also compares the effort distributions reported in around 1,500 software projects of the ISBSG R11 repository. Secondly, it obtains useful visual information regarding the correlation of the composition of effort attributed in phases starting from their representation as vectors of proportions and continuing with their subsequent analysis using a number of multivariate statistical methodologies based on Compositional Data Analysis (CoDA). Empirical effort distribution is thus compared to theoretical propositions found in literature and examined with respect to primary project attributes, such as organisation type, language type and size. Among the main findings is the identification of significant workload on specific phases for different types of projects. The proposed framework aims to provide a beneficial set of statistical methods for analysing software project data, towards better allocation of the available resources and formation of a basis for accurate cost estimation.
Reference	-
Status	Submitted, Under review

Title	**Modeling Users on the World Wide Web based on Cognitive Factors, Navigation Behavior and Clustering Techniques**
Author(s)	Belk Marios, Papatheocharous Efi, Germanakos Panagiotis, Samaras George
Abstract	This paper focuses on modeling users' cognitive styles based on a set of Web usage mining techniques on navigation patterns and clickstream data. Main aim is to investigate whether specific clustering techniques can group users of particular cognitive style using measures obtained from psychometric tests and content navigation behavior. Three navigation metrics are proposed and used to find identifiable groups of users that have similar navigation patterns in relation to their cognitive style. The proposed work has been evaluated with two user studies which entail a psychometric-based survey for extracting the users' cognitive styles, combined with a real usage scenario of users navigating in a controlled Web 2.0 environment. A total of 106 participants of age between 17 and 25 participated in the study providing interesting insights with respect to cognitive styles and navigation behavior of users. Studies like the reported one can be useful for assisting adaptive Web 2.0 environments to organize and present information and

	functionalities in an adaptive format to diverse user groups.
Reference	Belk M., Papatheocharous E., Germanakos P., and Samaras G. (2013). "Modeling Users on the World Wide Web based on Cognitive Factors, Navigation Behavior and Clustering Techniques", *Journal of Systems and Software* (JSS), Special Issue on Web 2.0 Engineering: New Practices and Emerging Challenges, Elsevier, Available Online May 7, doi: 10.1016/j.jss.2013.04.029.
Status	Published

Title	**Investigating Empirically Effort Distribution among Development Phases: A Four Stage Progressive Software Effort Estimation Model**
Author(s)	Papatheocharous E., Bibi S., Stamelos I. and Andreou A. S.
Abstract	Software cost estimation is an essential process in project management. The accuracy of the cost estimated can be linked to or considered to depend upon the time of the estimate. Data collection can be also time-aware since data can be accumulated at a phased-based manner. Therefore, different software cost estimation models may be more suitable or accurate in different phases of a project. Along the process of software development, both the levels of confidence and availability of information do not remain constant for extended periods of time. Therefore, the selection and utilization of a single software cost estimation model may not be the best alternative for predicting the costs of every phase of development. In this work we suggest the adjustment of the initial effort estimates during the development life cycle based on available effort data of completed phases of projects. As project evolve and progress in time, the initial estimates are reviewed based on the experience on projects and known information gained. A four stage estimation model is proposed that provides an early, a post planning, a post specifications and a post design estimate. The model's accuracy and efficiency is assessed using industrial data from the ISBSG (R10) dataset.
Reference	-
Status	Prepared, not submitted

Title	**Integrating Human Factors and Semantic Markups in Adaptive Interactive Systems**
Author(s)	Belk Marios, Germanakos Panagiotis, Papatheocharous Efi, Samaras George
Abstract	This paper focuses on incorporating individual differences in cognitive processing and semantic markups in the context of adaptive interactive systems. In particular, a semantic Web-based adaptation framework is proposed that enables Web authors to enrich content and functionality of Web environments with semantic markups, which are further processed and reconstructed by an adaptation mechanism based on cognitive factors of users. Main aim of this work is to investigate the added value of personalizing content and functionality of Web environments based on the unique cognitive characteristics of users. Accordingly, a user study has been conducted that entailed a psychometric-based survey for extracting users' cognitive characteristics, combined with a real usage scenario of an existing commercial Web environment that was enriched with semantic markups and was personalized through different adaptation effects. The initial results obtained provide interesting insights in the design and deployment of adaptive interactive systems based on cognitive factors and semantic markups
Reference	-
Status	Submitted, Under review

Title	**Integrating Non-parametric Models with Linear Components for Producing Software Cost Estimations**
Author(s)	Mittas Nikolaos, Papatheocharous Efi, Angelis Lefteris, Andreou S. Andreas

Abstract	A long lasting endeavor in the area of software project management is minimizing the risks caused by under– or over–estimations of the overall effort required to build new software systems. Deciding which method to use for achieving accurate cost estimations among the many proposed in the relevant literature is a significant issue for project managers. This paper investigates whether it is possible to improve the accuracy of such estimations using a set of popular non-parametric techniques coupled with a linear component thus producing a new set of techniques called semi-parametric models (SPM). The non-parametric models examined in this work include Estimation by Analogy (EbA), Artificial Neural Networks (ANN), Support Vector Machines (SVM) and Locally Weighted Regression (LOESS). A formal statistical comparison is carried out to investigate whether this coupling improves software cost estimations. Our experimentation shows that the use of the SPM models proposed is favored over their non-parametric counterparts, especially in cases where both a linear and non-linear relationship exists between software effort and the related cost drivers. The proposed approach is empirically validated through a statistical framework which uses multiple comparisons to rank and cluster the models examined in non-overlapping groups of significantly different performances.
Reference	-
Status	Prepared, not submitted

Title	**A Personalization Approach of CAPTCHA Challenges based on Cognitive Styles and Artificial Neural Networks**
Author(s)	Belk Marios, Papatheocharous Efi, Germanakos Panagiotis, Samaras George
Abstract	A CAPTCHA challenge is a widely used security mechanism to protect Web applications from malicious software attacks by verifying that the entity interacting with a system is a human being. Given that users' CAPTCHA interactions are primarily cognitive tasks, this work aims to drive the reported research toward the design and development of an adaptive CAPTCHA mechanism for supporting the usability of CAPTCHA interactions through appropriate adaptation effects and user modeling techniques based on users' cognitive styles. The main objective of the paper is two-fold: investigate the relation among users' cognitive styles and CAPTCHA challenges in terms of efficiency, effectiveness and preference, and, further propose and evaluate an implicit user modeling approach based on Artificial Neural Networks for classifying and predicting cognitive styles of users through CAPTCHA-related interaction data. The results can be considered valuable for future deployment of adaptive CAPTCHA mechanisms since it has been initially shown that cognitive styles of users could be a determinant factor for the adaptation of CAPTCHA mechanisms. Results also revealed that Artificial Neural Networks could be used as a suitable user modeling technique for predicting cognitive styles of users based on CAPTCHA interaction data.
Reference	-
Status	Submitted, conditionally accepted (major revision submitted)

Title	**Towards Implicit User Modeling based on Cognitive Styles and Web Interaction Data**
Author(s)	Belk Marios, Papatheocharous Efi, Germanakos Panagiotis, Samaras George
Abstract	This paper proposes an approach for analyzing Web interaction data of users and identifying similarities in their navigation behavior, preference and cognitive style. In particular, user characteristics are obtained through explicit and implicit user modeling techniques which include psychometric tests and a Web-based user navigation tracking tool. Specific metrics are utilized to find groups of users that have similar navigation patterns and

	preferences in relation to their cognitive style. The proposed work has been evaluated with a user study that entails a psychometric-based survey for extracting the users' cognitive styles, combined with a real usage scenario of users navigating in a controlled Web environment. A total of 84 participants of age between 17 and 25 participated in the study providing interesting insights with respect to cognitive styles, preference and navigation behavior of users. Studies like the reported one can be useful in the adaptation process of Web interactive systems, organize and present information and functionalities in an adapted format to diverse user groups.
Reference	-
Status	Submitted, conditionally accepted (major revision submitted)

Title	**Embracing Cognitive Factors and Fuzzy Logic in Adaptive Interactive Systems**
Author(s)	Papatheocharous Efi, Belk Marios, Germanakos Panagiotis, Samaras George
Abstract	The increased demand of services on the Web to satisfy the diverse characteristics of users have resulted in a plethora of applications that aim to provide personalized services based on the heterogeneous needs and preferences of users. With the aim to enhance and support the personalization process of Web applications, an innovative adaptation framework is proposed embracing cognitive factors of users which serve as the user model, and Computational Intelligence techniques that decide on the adaptation effects of Web applications for providing a personalized user experience. The user model is based on a series of psychometric measures which capture particular cognitive factors of users, and the adaptation mechanism includes the utilization of Artificial Neural Networks and Fuzzy Logic for exploiting the benefits of intelligent classification and partial truth in the adaptation process. The proposed method has been evaluated with a user study that has revealed a main effect of cognitive factors of users on the adaptation of Web content and functionality since users were more efficient and effective in completing tasks in the adapted than the non-adapted version of the same environment.
Reference	Papatheocharous E., Belk M., Germanakos P., and Samaras G. (2013). "Embracing Cognitive Factors and Fuzzy Logic in Adaptive Interactive Systems", International Journal of Engineering Intelligent Systems (EIS), Special Issue on Artificial Intelligence Applications and Innovations 2013, CRL Publishing Ltd., Vol. 21(1): 1-18, June 2013.
Status	Published

Title	**A Systematic Mapping Study on Embedded Systems and Open Innovation**
Author(s)	Jesper Andersson, Papatheocharous Efi and Jakob Axelsson,
Abstract	The report investigates future development strategies for embedded systems, i.e., electronics and software in physical products, through a literature study. A systematic mapping study is carried out that describes published research that has been conducted in the field and attempts to classify, structure it and highlight certain characteristics of the field.
Reference	-
Status	Under preparation

Title	**Personalised Continuous Software Engineering**
Author(s)	Papatheocharous Efi, Belk Marios, Nyfjord Jaana, Germanakos Panagiotis and Samaras George
Abstract	This work describes how human factors can influence continuous software engineering. The reasoning begins from the Agile Manifesto promoting individuals and interactions over processes and tools. The organisational need to continuously develop, release and learn from software development

	in rapid cycles requires empowered and self-organised agile teams. However, these teams are formed without necessarily considering the members' individual characteristics towards effective teamwork, from the personality and cognitive perspective. In this realm, this paper proposes a two level approach: first, form teams based on their collective personality traits and second, provide personalised tools and methods based on their individual differences in cognitive processing. The approach is motivated by a study conducted in a business environment focusing on task execution, satisfaction and effectiveness of team members in relation to their personalities and cognitive characteristics. Our preliminary results show that human factors provide a promising basis for increasing the capability of continuous software engineering.
Reference	-
Status	Submitted, Under Review

III – ATTENDED SEMINARS, WORKSHOPS, CONFERENCES

- *SICS Open House Exhibition (Stockholm, SWEDEN)* – March 21, 2013
- *EuroSPI 2013 - European System & Software Process Improvement and Innovation Conference (Dundalk, IRELAND)* – June 25-28, 2013
- *ECOOP/ECSA/ECMFA 2013 Conferences - European Conference on Object-Oriented Programming/ European Conference on Software Architecture/ European Conference on Modelling Foundations and Applications & SESoS Workshop 2013 - International Workshop on Software Engineering for Systems-of-Systems (Montpellier, FRANCE)* – July 1-5, 2013
- *AIAI 2013 – 9th IFIP International Conference on Artificial Intelligence Applications and Innovations Conference (Paphos, CYPRUS)* – September 26-28 2013
- *Co-SUMMIT exhibition (Stockholm, SWEDEN)* – December 4-5, 2013
- *LESS 2013 - Lean Enterprise Software and Systems Conference (Galway, IRELAND)* – December 1-4, 2013

IV – RESEARCH EXCHANGE PROGRAMME (REP)

- *University of Oslo, Department of Informatics (Oslo, Norway)*
  Professor Dag Sjøberg & Magne Jørgensen
  August 13-20, 2013
- *University of Cyprus, Department of Computer Science (Nicosia, Cyprus)*
  Professor George Samaras & Professor Andreas S. Andreou
  July 27-August 08, 2013 & September 22-October 2, 2013

During the visits I refined and enhanced my work in my primary areas of research interest and exchanged ideas on the overarching aims of my current and future research. I had the opportunity to collaborate and discuss with top researchers and scientists in other institutions, based on the research results that I presented during the visits. The visits also led in expanding my collaboration networks, which were then used to advance my research activities, and also offered new opportunities in my future research career prospective. The exchange of research results, ideas and experiences led to fruitful discussions that triggered some of the most recent research publications mentioned above and also led to writing and submitting one funding application proposal.