



ABCDE



Scientific Report

First name / Family name

DALIA KRIKSCIUNIENE

Nationality

Lithuanian

Name of the *Host Organisation*

Masaryk University Faculty of
Informatics and Institute of Computer
Science (CRCIM)

First Name / family name
of the *Scientific Coordinator*

TOMÁŠ PITNER

Period of the fellowship

01/04/2012 to 31/03/2013

Rsearch fellow :

Assoc.prof.PhD. Dalia Krikščiūnienė

Supervisor:

Assoc. prof. RNDr. Phd. Tomáš Pitner

Member of CERIT Strategic Board

Head of Lasaris lab

Masaryk University, Brno, Czech



I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

The planned research is oriented to application of artificial intelligence, computational methods for business data analysis in domains of enterprise customer and marketing data analysis, anomaly detection in financial markets, and facility management systems.

Computational intelligence models for enterprise customer and marketing data analysis

The problem of the research is targeted to application of computational intelligence models and approaches for exploring the customer-related information in order to substantiate the enterprise financial results. The concept of dynamic customer portrait is introduced for creating analytical model. The suggested model explores the most influential variable sets for identifying customer clusters and basis for their membership. The computational methods of neural network, sensitivity analysis and self-organized maps for unsupervised classification were applied and verified by the experimental research.

The research tasks in this area were discussed and shared with my supervisor Tomáš Pitner, who serves as member of the board of CERIT (Center for Education, Research and Innovation in ICT in Brno) and is in charge of industrial partnership of Masaryk University.

During my ERCIM fellowship I continued this area of research. The outcomes were the joint Thomson ISI listed publications (journal and conference proceedings) and also the talk at the scientific kolokvium of Masaryk university, and the tutorial at the scientific conference Hybrid Intelligent Systems (HIS).

The topic was found to be suitable to offer as a elective study module for the SSME “Service Science, Management, and Engineering“, which is the master study program run by Faculty of Informatics. Among the other exclusive properties of the program is the guaranteed one semester internship in a real service-oriented business company, e.g. IBM. I had an opportunity to communicate to Ing. Leonard Wallezký, Ph.D. Coordinator of SSME program. He explained of the innovativeness of the study program and the need for interdisciplinary knowledge to be provided for the students, according to the demand for T-professionals expressed by the business companies.

I was invited to prepare the interdisciplinary study module “PV250 Marketing Information Systems” (in English) and taught it during autumn semester of 2012. Ten students were enrolled for this course. The possibility to teach this study module in future as a visiting professor was discussed with prof. Vaclav Matyas.

Publications for this topic:

1. Krikščiūnienė, Dalia; Pitner, Tomas; Sakalauskas, Virgilijus. Tracking customer portrait by unsupervised classification techniques // Transformations in business and economics / Vilnius University. Kaunas Faculty of Humanities, Brno University of Technology. Faculty of Business and Management, University of Latvia. Faculty of Management and Economics. Vilnius : Vilniaus universiteto leidykla. ISSN 1648-4460. 2012, vol. 11, no. 3, p. 167-189. [Science Citation Index Expanded (Web of Science).; Social Sciences Citation Index (Thomson ISI) [Impact factor 2010 (1.67)]]
2. Krikščiūnienė, Dalia and Sandra Strigūnaitė. Fuzzy Expert System for Virtual Team Collaboration and Work Evaluation. In Business Information Systems Workshops BIS 2012 International Workshops and Future Internet Symposium, Vilnius, Lithuania, May 21-23, 2012 Revised Papers. Berlin: Springer Berlin Heidelberg, 2012. p. 37-43, 7 pp. series LNBIP Vol. 127.



Seminar and colloquium talks presented:

3. KRIKSCIUNIENE, Dalia. Application of neural networks for the sensitivity analysis of customer loyalty. 2012. Informatics Colloquium of Faculty of Informatics at Masaryk University, April 3, 2012.
<http://www.fi.muni.cz/research/colloquium/2012-sa.xhtml#Krikščiūniene>
Colloquium talk
4. Dalia KRIKSCIUNIENE. Application of computational intelligence methods and knowledge based technologies for business. April 17, 2012. *The seminars' talk in the framework of the advanced course of PV226: Seminar LaSaRIS "New topics in the lab and relevant topics not covered by specific subjects"*.
5. KRIKSCIUNIENE, Dalia. Analytical methods for tracking customer portrait: intelligent interpretation of CRM philosophy. In 12th International Conference on Hybrid Intelligent Systems (HIS). Pune, India, Dec. 4, 2012. *Tutorial talk*

Study module: "PV250 Marketing Information Systems"

Course objectives:

The module is aimed to provide advanced interdisciplinary knowledge and augmented skills for creating enterprise information systems able to support marketing management processes and to provide information, which could meet the needs of marketing management specialists. The teaching module introduces creation principles and variety of concepts used for building marketing information systems (MkIS). The course provides knowledge of the functional components and structure of MkIS, develops ability to distinguish and apply methods of marketing management, including marketing planning, modelling and customer relationship management domains. The students get acquainted and acquire practical skills of marketing analytics by using intelligent computational tools, cloud-based applications, functional modules of the integrated systems, market games, and applied software for marketing decision-making, planning and control. The module also aims to deepen scientific writing skills and apply methods of virtual team learning for fulfilment of assignments in MkIS area.

<https://is.muni.cz/auth/course/fi/autumn2012/PV250?lang=en>

Participation in research consulting

I had extensive communication with the Phd students about their research progress. I had a talk presented at research seminar for the PHD and master students of the Faculty of Informatics, as a part of their study program.

I had meetings with doctoral candidates Daniel Tovarňák and Jiří Kolář who presented their topics, problems and objectives, and also made discussion about the computational methods, business process and information system modelling techniques to be applied for their research works.

I had an opportunity to be the consultant and reviewer for Jiří Kolář who was preparing book chapter and the article according to the thesis topic "A Framework for Business Process Management in Small and Medium Enterprises".

I currently act as thesis supervisor for master student Jakub Bareš, who is preparing thesis "Business intelligence solutions for enterprise performance management".

Application of computational intelligence for anomaly detection in financial markets and facility management systems

Detection of anomalies, exploring analytic indicators and sensitivity of domain models are related to two domain areas:

- Financial markets
- Facility management, surveillance and monitoring systems, where experimental



data provided by Masaryk university, Bohunice campus.

Although the business domains are of different origin, the computational analytics based on exploring anomalous behaviour and application of long – term performance analysis methods are highly compatible.

In both areas numerous statistical, econometrical and intelligent methods are researched in the scientific works and industrial applications for finding repeating patterns and approximated distribution rules of data series. However lack of regularities and rather chaotic nature of real data hinders performance of the forecasting methods based on finding regular behaviour and defining distributions of data streams. It limits their application to analytics of historical data repositories and reveals high unreliability of the models applied to real data streams.

The research outcomes in the area of financial markets are a continuation of my previous research. Here I explore application of computational analysis methods for detecting behaviour anomalies in financial data series. The methods and the principles of anomaly detection are analysed from the theoretical perspective and evaluated for their ability to serve for analysis and forecasting in the domain of financial markets, affected by changes of investor activeness due to different calendar effects, impacts of various media announcements and news, fluctuations of financial markets, including crises and bubbles. The results of currently published research cover several methods for detecting behaviour anomalies including information efficiency evaluation methods (Shannon's entropy, Hurst exponent), impacts explored by the methods of interrupted time series, and evaluation of performance of binary clustering algorithms.

The research results are evaluated by discussing the potential power of explored methods for detection behaviour anomalies in the expanding research area of Big Data.

The outcomes include publications on the ISI listed conference proceedings and also the talks at the seminars held at scientific kolokvium of Faculty of Informatics at Masaryk University and during the research exchange visits to SBA research group in Vienna and Business information research group at University of Zurich.

Application of computational intelligence methods and anomaly detection models in the area of **facility management** is rather novel topic. It addresses the problem of intelligent monitoring of facility management data flows collected from heterogeneous sources, including low-level data of sensors and probes, geographical indicators, scheduling and personal identification systems.

The domain area of facility management is a new one for me, however the need for application of computational methods was opportunity for me to join the research team.

The research topic was carried out jointly with Assoc. prof. Tomas Pitner and Adam Kučera his Phd. Student of FI PST Computer Systems and Technologies. Adam Kučera is preparing his thesis in the area of facility management and also works at the institute of Computer Science. He provided with the sensor network data for possible application of computational analytics in the area of anomaly detection and also description of business use cases in this area. The joint article was prepared and submitted to the scientific conference, where the initial results of the research are presented. In this article we suggest the framework of analytical model, based on deriving descriptors which could sentinel the level of thermal comfort of working environments. We aim to facilitate process of extracting essential characteristics of facility management for detecting dependencies and observing anomalies. The performance of the model was tested by experimental analysis of facility management of the university campus; it included exploring how various environment variables affect temperature in lecture rooms, equipped by the air conditioning devices.



The anomaly detection with the help of computational analysis was also explored by contacting Jan Vykopal, researcher of the CSIRT-MU Group - Security Department - Communication Infrastructure Division - Institute of Computer Science. He is also a Phd candidate working in the area of network security. The cooperation broadened my comprehension of processing and analytics in the area of large data real-time flows and necessity of special methodologies for anomaly detection in this area.

Publications for this topic:

1. Krikščiūnienė, Dalia; Tamašauskas, Darius; Sakalauskas, Virgilijus. Evaluation framework of hierarchical clustering methods for binary data // Hybrid Intelligent Systems (HIS) : the 12 international conference : proceedings, Pune, India, 4th-7th December, 2012 IEEE, 2012. ISBN 9781467351157. p. 421-426. [0,333].;
2. Krikščiūnienė, Dalia; Sakalauskas, Virgilijus. Evaluation the day-of-the-week effect using long range dependence measures // Intelligent Systems Design and Applications (ISDA) : the 12 international conference : proceedings, Kochi, India, 27th-29th, 2012 IEEE, 2012. ISBN 9781467351188. p. 143-148

Seminar and colloquium talks presented:

3. PITNER, Tomáš and Dalia KRIKSCIUNIENE. Integrated Surveillance and Monitoring Systems (Integrated Surveillance and Monitoring Systems). In CSSim 2012, Brno, September 3, 2012. *Keynote talk*
4. KRIKSCIUNIENE, Dalia. Anomaly detection methods and applications. 2013. Informatics Colloquium of Faculty of Informatics at Masaryk University, March 12, 2013. <http://www.fi.muni.cz/research/colloquium/2013-sa.xhtml#kriksciuniene> *Colloquium talk*

Submitted research article:

5. Dalia KRIKSCIUNIENE, Tomas PITNER, Adam KUCERA and Virgilijus SAKALAUŠKAS. Sensor Network Analytics for Intelligent Facility Management. Special session of Intelligent Data Analysis with Applications in Information Retrieval and Machine Learning (IDAIR) at the International conference KES IIMSS 2013 (Expected notification March 25, 2013)

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

• **Published article in ISI listed journal**

1. Krikščiūnienė, Dalia; Pitner, Tomas; Sakalauskas, Virgilijus. Tracking customer portrait by unsupervised classification techniques // Transformations in business and economics / Vilnius University. Kaunas Faculty of Humanities, Brno University of Technology. Faculty of Business and Management, University of Latvia. Faculty of Management and Economics. Vilnius : Vilniaus universiteto leidykla. ISSN 1648-4460. 2012, vol. 11, no. 3, p. 167-189. [Science Citation Index Expanded (Web of Science).; Social Sciences Citation Index (Thomson ISI) [Impact factor 2010 (1.67)]

• **Published articles in conference proceedings:**

2. Krikščiūnienė, Dalia and Sandra Strigūnaitė. Fuzzy Expert System for Virtual Team Collaboration and Work Evaluation. In Business Information Systems Workshops BIS 2012 International Workshops and Future Internet Symposium, Vilnius, Lithuania, May 21-23, 2012 Revised Papers. Berlin: Springer Berlin Heidelberg, 2012. p. 37-43, 7 pp. series LNBIP Vol. 127.
3. Krikščiūnienė, Dalia; Tamašauskas, Darius; Sakalauskas, Virgilijus. Evaluation framework of hierarchical clustering methods for binary data // Hybrid Intelligent Systems (HIS) : the 12 international conference : proceedings, Pune, India, 4th-



- 7th December, 2012 IEEE, 2012. ISBN 9781467351157. p. 421-426. [0,333].;
4. Krikščiūnienė, Dalia; Sakalauskas, Virgilijus. Evaluation the day-of-the-week effect using long range dependence measures // Intelligent Systems Design and Applications (ISDA) : the 12 international conference : proceedings, Kochi, India, 27th-29th, 2012 IEEE, 2012. ISBN 9781467351188. p. 143-148

III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

- **The talks presented at the seminars:**
 1. KRIKSCIUNIENE, Dalia. Application of neural networks for the sensitivity analysis of customer loyalty. 2012. Informatics Colloquium of Faculty of Informatics at Masaryk University, April 3, 2012. <http://www.fi.muni.cz/research/colloquium/2012-sa.xhtml#Krikščiūnienė> *Colloquium talk*
 2. PITNER, Tomáš and Dalia KRIKSCIUNIENE. Integrated Surveillance and Monitoring Systems (Integrated Surveillance and Monitoring Systems). In CSSim 2012, Brno, September 3, 2012. *Keynote talk*
 3. Dalia KRIKSCIUNIENE. Application of computational intelligence methods and knowledge based technologies for business. April 17, 2012. *The seminars' talk in the framework of the advanced course of PV226: Seminar LaSArIS "New topics in the lab and relevant topics not covered by specific subjects"*.
 4. KRIKSCIUNIENE, Dalia. Analytical methods for tracking customer portrait: intelligent interpretation of CRM philosophy. In 12th International Conference on Hybrid Intelligent Systems (HIS). Pune, India, Dec. 4, 2012. *Tutorial talk*
 5. KRIKSCIUNIENE, Dalia. Anomaly detection methods and applications for Big Data problems. At SBA research group, Vienna, Austria, Feb.1, 2013. http://iee.ict.tuwien.ac.at/index.php?option=com_eventlist&Itemid=55&did=299&func=details *Colloquium talk*
 6. KRIKSCIUNIENE, Dalia. Computational intelligence for anomaly detection in financial data series. At University of Zurich, Department of Informatics – Business Intelligence Research Group. March 7, 2013. *Seminar talk*
 7. KRIKSCIUNIENE, Dalia. Anomaly detection methods and applications. 2013. Informatics Colloquium of Faculty of Informatics at Masaryk University, March 12, 2013. <http://www.fi.muni.cz/research/colloquium/2013-sa.xhtml#kriksciuniene> *Colloquium talk*
- **The conferences and workshops organized and attended:**
 8. Conference co-chair : BIS2012, 15th International Conference on Business Information Systems, Vilnius, Lithuania 21-23 May, 2012
 9. Workshop co-chair AKTB 2012, 4th Workshop on Applications of Knowledge-Based Technologies in Business in conjunction with 15th International Conference on Business Information Systems (BIS 2012)Vilnius, Lithuania, 21-23 May, 2012
 10. Workshop co-chair ISDA2012, 12th International Conference on Intelligent Systems Design and Applications (ISDA)
 11. Workshop co-chair HIS2012, 12th International Conference on Hybrid Intelligent Systems (HIS). Pune, India, Dec. 4, 2012
- **The conferences and seminars attended:**
 12. 3rd International Conference on Computer Modelling and Simulation, Brno, Czech Republic, 3 - 5 September, 2012 (CSSim 2012) Brno, Czech



13. Prof. Melius Weideman, A successful website = Visibility + Usability: www.muni.cz?
Faculty of Informatics and Design, Cape Peninsula University of Technology, Cape Town, South Africa, Feb. 19, 2013, Brno, Czech
14. IBM Forum 2012, October 11, 2012, LITEXPO exhibition and conference centre, Vilnius, Lithuania
15. ERCIM meetings and ERCIM symposium, ABCDE Seminar II 24 to 26 October 2012, Sophia Antipolis, INRIA, France

IV – RESEARCH EXCHANGE PROGRAMME (REP)

During ABCDE fellowship I visited two research institutions for research exchange programme: SBA Research group (Vienna, Austria, ERCIM member AARIT) and University of Zurich. (Switzerland) (ERCIM member SIRA):

1. SBA Research group (Vienna, Austria, ERCIM member AARIT) Research director of and Associate Professor (Privatdozent) Edgar Weippl, eweippl@sba-research.org Dates of REP stay: Jan.28-Feb.03, 2013

During the visit I was introduced to the activities of SBA Research and particularly with the work of prof. Edgar Weippl and other four main research teams. I was especially interested in their project works where the security component was successfully implemented in the areas of various business domains: patient data, digital preservation of business processes. The common interest points of integrating the security components and aspects into the research areas of anomaly detection and customer data analytics were outlined. The further cooperation in the forms of project involvement were envisioned. The visit broadened research scope, international contacts and participation in scientific community. During the research exchange visit I made a seminar talk about my research topic about anomaly detection methods and their performance due to increasing scale of data streams, which are related to the network security area of the SBA research group (Vienna, Austria). The title of the seminar talk: “Anomaly detection methods and applications for Big Data problems”.

2. Department of Informatics, Business Intelligence Research Group (ERCIM member SIRA), University of Zurich. (Switzerland) Prof. Dr. Daning Hu, Assistant Professor Head of Research Group, hdaning@ifi.uzh.ch, stay March 4-10, 2013

During the visit I got introduced to the work of Business Intelligence Research Group, supervised by Prof. Dr. Daning Hu at University of Zurich. (Switzerland). The research areas lie in the intersection of network science and business intelligence applied in the domain of financial institutions. The approach for introducing transactional information and social network information for analysis of financial data stream was new and compatible to my research interests in the area financial data analytics.

The research exchange possibilities and perspective of joint participation in scientific events by preparing experimental research were discussed. The perspective of business partner involvement for sharing financial databases for analytics was outlined.

During the visit I made a seminar talk about my research topics “Computational intelligence for anomaly detection in financial data series”. The members of Business Intelligence Research Group, Database technology and Economics of Informatics of the Faculty of Informatics of University of Zurich took part in the discussion.