

# Adaptive Business Intelligence (ABI)

## Computing Paradigms (UCPP) or Technologies Curricular Unit (UTC) proposal for the MAP-I PhD Program<sup>1</sup>

### A – Programmatic Component

#### 1. Motivation

Nowadays, business organizations are increasingly moving towards decision-making processes that are based on information. **Business Intelligence (BI)** is an umbrella term that includes methodologies, architectures, tools, applications and technologies to enhance managerial decision making [1]. The goal of BI is to access data from multiple sources and process these data into useful knowledge that can be used to support decision making.

Recently, a new trend emerged in the marketplace called **Adaptive Business Intelligence (ABI)** [2]. Besides extracting knowledge from data, ABI also addresses the decision-making process. BI systems often include elements of databases, data warehouses and data mining [1], while ABI systems encompass two additional modules: **forecasting** [3] and **optimization** [4], in order to enhance adaptability. In effect, **adaptability** is a vital component of any intelligent system and this issue is expected to gain popularity in the next years. The final ABI goal is to use computer systems that can adapt to changes in the environment, solving complex real-world problems with multiple objectives, in order to aid business managers to make better decisions, increasing efficiency, productivity and competitiveness.

Although being a recent field, the topics covered by ABI (i.e., data mining, forecasting, modern optimization and adaptive systems) have a large research community, with several prestigious international scientific journals (e.g., Data Mining Knowledge Discovery, Decision Support Systems, Machine Learning, IEEE Trans. Neural Networks, International Journal of Forecasting, IEEE Trans. Evolutionary Computation, Journal of Heuristics, Applied Soft Computing) and conferences (e.g. ACM KDD, ACM CIKM, ACM ICIS, IEEE ICDM, IEEE IJCNN, IEEE CEC) available. There are also several international examples of Computer Science PhD programs that include ABI topics, such as:

- Carnegie Mellon University (CMU), USA:
  - **Ph.D. Program in Computer Science** (machine learning, optimization);
  - **Ph.D. Program in Information Systems and Management** (business analytics, data mining, machine learning, time series analysis);
  - **Ph.D. Program in Machine Learning** (data mining, database management systems, machine Learning, optimization);
- Stanford University, USA:
  - **Ph.D. in Computer Science** (databases, data mining, machine learning, modern optimization)
- Berkeley University of California, USA:
  - **Ph.D. in Computer Science**, specialization ins Communication, Computation and Statistics (database management systems, data

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<sup>1</sup> The same ABI curricular unit was considered by the MAP-i committee as “Computing Paradigms” (UCPP) in the 2013-2014 and 2014-15 MAP-i editions and “Technologies” (UTC) in the previous editions (e.g., 2013-14).

mining, decision support).

The proposed ABI unit had already **six** previous **MAP-I editions**:

- **2014-15** course edition, 13 students, at University of Porto (<http://mapi.map.edu.pt/node/25>);
- **2013-14** course edition, 11 students, at University of Minho (<http://mapi.map.edu.pt/node/34>);
- **2012-13** course edition, 8 students, at University of Aveiro (<http://mapi.map.edu.pt/node/40>);
- **2011-12** course edition, 10 students, at University of Porto (<http://mapi.map.edu.pt/node/47>);
- **2010-11** course edition, 6 students, at University of Minho (<http://mapi.map.edu.pt/node/56>);
- **2008-09** course edition, 7 students, at University of Porto (<http://mapi.map.edu.pt/node/72>).

The **assessment made by the students** on the previous editions **encourages further editions**. An anonymous questionnaire was launched in the e-learning system and the student's average responses were:

- Question: "This teaching unit is **useful** for the PhD program". Average responses over all ABI editions - **83%** (highly agree).
- Question: "**Positive stimulus** for an active student participation and discussion in class?". Average responses over all ABI editions: **87%** (highly agree).
- Question: "**Positive evaluation** of the teachers global performance in this teaching unit". Average responses over all ABI editions: **86%** (highly agree).

**Two ABI projects** (element B) of the 2014/15 edition resulted in **papers** (e.g., [6]) published in the KDBI track of the EPIA international conference (Springer LNCS, indexed at Scopus and ISI): <http://epia2015.dei.uc.pt/kdbi/>

## 2 Objectives and Learning Outcomes

- To learn about the basic ABI concepts, including: characteristics of complex business problems, BI and ABI, data mining, prediction, modern optimization and adaptability;
- To master the state of the art of ABI methods and models and tools;
- To perform a review essay over an advanced research ABI topic;
- To apply ABI in real-world applications.

## 3 Detailed Program

**1 - Introductory ABI concepts:** characteristics of complex business problems, BI and ABI, data mining, prediction, optimization and adaptability, state of the art.

**2 – Using prediction and optimization to build adaptive systems:** application of data mining models and techniques in ABI (e.g. decision trees, neural networks, support vector machine, learning classifier systems, hierarchical and relational clustering, inductive logic programming), application of optimization techniques in ABI (e.g., heuristic search, hill-climbing, tabu-search, evolutionary computation).

**3 - Conducting ABI projects and case studies:** CRISP-DM, ABI applied to real-world problems (e.g., Finance, Economy, Marketing).

**4 - Exploration of ABI tools:** DM and optimization tools (e.g., R [6], Python, WEKA, SAS Enterprise Miner, Rapidminer, Evolution Machine, SCS-C, Aleph,

Moss), BI tools (e.g., SAS, MS SQL Server).

## 4 Teaching Methodology and Evaluation

Four teaching methodologies will be applied:

- 1 - Lecture exposition of key ABI issues.
- 2 - Active learning (e.g. think-pair-share, in-class teams [5]).
- 3 - Case-based learning.
- 4 - Project based learning.

Evaluation will include two elements:

- A - review of ABI research article(s) (30%); and
- B - an ABI project that describes the application of ABI tools to real-world datasets (70%).

## 5 Bibliography

### Cited references:

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- [2] Z. Michalewicz, M. Schmidt, M. Michalewicz and C. Chiriach, Adaptive Business Intelligence, Springer-Verlag, Leipzig, Germany, 2007.
- [3] S. Makridakis, S. Wellwright and R. Hyndman, Forecasting: Methods and Applications, John Wiley & Sons, New York, USA, 1998.
- [4] P. Cortez. Modern Optimization with R. Springer, 2014, <http://www.springer.com/gp/book/9783319082622>
- [5] D. Johnson, R. Johnson and K. Smith, Active Learning: Cooperation in the College Classroom, 2nd edition, Edina, Interaction Book Company, 1998.

### Additional references:

- [6] K. Fernandes, P. Vinagre and P. Cortez. A Proactive Intelligent Decision Support System for Predicting the Popularity of Online News, In Proceedings of 17th Portuguese Conference on Artificial Intelligence (EPIA 2015), Springer, Coimbra, Portugal, September, 2015.
- [7] S. Luke, S. Essentials of metaheuristics. George Mason University. Free access: <http://cs.gmu.edu/~sean/book/metaheuristics/>, 2009.
- [8] Z. Michalewicz, M. Schmidt, M. Michalewicz and C. Chiriach. Adaptive Business Intelligence: Three Case Studies, In Evolutionary Computation in Dynamic and Uncertain Environments, pp. 179-196, Springer, 2007.
- [9] E. Turban, R. Sharda and D. Delen. Decision Support and Business Intelligence Systems, Prentice Hall, 2011.
- [10] P. Cortez, Data Mining with Neural Networks and Support Vector Machines using the R/rminer Tool, In P. Perner (Ed.), Advances in Data Mining, Proceedings of 10th Industrial Conference on Data Mining, Berlin, Germany, Lecture Notes in Artificial Intelligence 6171, pp. 572-583, Berlin, Germany, July, 2010

## B Lecture Team

### 1. Summary

The lecture team includes the three members of the previous six ABI editions (MAP-I 2008/9, 2010/11, 2011/12, 2012/13, 2013/14 and 2014/15). **Manuel Filipe Santos (M.F. Santos)** and **Paulo Cortez (P. Cortez)** belong to the Intelligent Data Systems (IDS) - <http://algoritmi.uminho.pt/research-teams/ids>, research group of the ALGORITMI R&D Centre (evaluated as “**Very Good**” by FCT), University of Minho. Both research on Adaptive Business Intelligence, Decision Support Systems and Data Mining. M.F. Santos performed his PhD in Distributed Learning Classifier Systems, while P. Cortez performed his PhD in Forecasting, Neural Networks and Evolutionary Optimization. **Rui Camacho (R. Camacho)** is from the Laboratory of Artificial Intelligence and Decision Support (LIAAD R&D centre, <http://www.liaad.up.pt/>, of INESC Tec evaluated as “**Excellent**” by FCT), University of Porto. R. Camacho researches in Inductive Logic Programming and Data Mining. For more details, see the CVs in section B.3.

The team is willing to write didactic texts related to this unit. An example of this is the book “**Modern Optimization with R**” that P. Cortez had recently published with **Springer** (in 2014), see: <http://www.springer.com/gp/book/9783319082622>

### 2. Coordinator

Manuel Filipe Santos (MFS)

### 3. CVs

#### 3.1 Manuel Filipe Santos

**Biography:** Manuel Filipe Santos received his Ph.D. in Computer Science (Artificial Intelligence) from the University of Minho (UMinho), Portugal, in 2000. He is associate professor at the Department of Information Systems, UMinho, teaching undergraduate and graduate classes of Business Intelligence and Decision Support Systems. He is the head of Intelligent Data Systems group ([www.algoritmi.uminho.pt](http://www.algoritmi.uminho.pt)) and coordinator of Healthy and Secure People thematic strand (<http://algoritmi.uminho.pt/ts-healthy>) of the R&D Algoritmi Centre, with the current research interests:

- Business Intelligence and Decision Support Systems;
- Data Mining and Machine Learning (Learning Classifier Systems);
- Grid Data Mining.

#### Relevant publications in the last 5 years:

He is co-author of more than 110 indexed (e.g., ISI, Scopus) publications in international conferences, books and journals (e.g., published by IEEE, Elsevier or Springer). He has more than 1174 google scholar citations and his google scholar h-index is 15 and i10-index is 33. Recently, he co-edited the book Integration of Data Mining in Business Intelligence Systems, IGI, 2014, ISBN13: 9781466664777. His relevant publications in this area, in the last 5 years, are:

- [1] Á. Silva, P. Cortez, M.F. Santos, L. Gomes and J. Neves. Rating organ failure via adverse events using data mining in the intensive care unit. In Artificial Intelligence in Medicine, Elsevier, In Press (ISI impact factor 1.882).
- [2] Sérgio Oliveira, Filipe Portela, Manuel Filipe Santos, José Machado, António Abelha, Álvaro Silva and Fernando Rua. Characterizing Barotrauma Patients in ICU – Clustering Data Mining using ventilator variables . Lecture Notes in

- Artificial Intelligence (LNAI) - EPIA 2015 - Artificial Intelligence in Medicine Track. Springer. (2015). (accepted for publication).
- [3] Sónia Pereira, Filipe Portela, Manuel Filipe Santos, José Machado, António Abelha. Predicting Preterm Birth in Maternity Care by means of Data Mining . Lecture Notes in Artificial Intelligence (LNAI) - EPIA 2015 - Artificial Intelligence in Medicine Track. Springer. (2015). (accepted for publication).
- [4] Rui Teixeira, Filipe Portela, Manuel Filipe Santos, António Abelha and José Machado. Decision Support in E-Government – A Pervasive Business Intelligence Approach - Case study in a local government. Advances in Intelligent Systems and Computing (WorldCist 2015 - Pervasive Information Systems Workshop). Volume 354, 2015, pp 155-166. ISBN: 978-3-319-16527-1. Springer. (2015).
- [5] Filipe Portela, Manuel Filipe Santos, Álvaro Silva, José Machado, António Abelha and Fernando Rua. Pervasive and Intelligent Decision Support in Intensive Medicine – The Complete Picture . Lecture Notes in Computer Science (LNCS) - Information Technology in Bio- and Medical Informatics. Springer. (2014).
- [6] António Abelha , Eliana Pereira, Andreia Brandão, Filipe Portela, Manuel Filipe Santos, José Machado, Jorge Braga. Improving Quality of Services in Maternity Care Triage System. International Journal of E-Health and Medical Communications (IJEHMC) . IGI Global. (2015).
- [7] Filipe Portela, Pedro Gago, Manuel Filipe Santos, José Machado, António Abelha, Álvaro Silva, Fernando Rua. Implementing a Pervasive Real-time Intelligent System for Tracking Critical Events with Intensive Care Patients. IJHISI - International Journal of Healthcare Information Systems and Informatics. IGI Global. (2014).
- [8] João M. C. Gonçalves, Filipe Portela, Manuel F. Santos, Álvaro Silva, José Machado, António Abelha, Fernando Rua. Real-time Predictive Analytics for Sepsis Level and Therapeutic Plans in Intensive Care Medicine. IJHISI - International Journal of Healthcare Information Systems and Informatics. Springer. (2014).
- [9] Á. Silva, P. Cortez, M.F. Santos, L. Gomes and J. Neves. Mortality assessment in intensive care units via adverse events using artificial neural networks. In Artificial Intelligence in Medicine, Elsevier, 36 (3): 223-234, 2006 (ISI impact factor 1.882).
- [10] Tiago Miranda; António G Correia; Manuel F Santos; Luís R Sousa; Paulo Cortez NEW MODELS FOR STRENGTH AND DEFORMABILITY PARAMETERS CALCULATION IN ROCK MASSES USING DATA MINING TECHNIQUES ASCE's International Journal of Geomechanics, 2010 20-30.
- [11] Ana Azevedo, Manuel Santos, A Perspective on Data Mining Integration with Business Intelligence in "Knowledge Discovery Practices and Emerging Applications of Data Mining: Trends and New Domains", IGI Global 2010, ISBN 978-1-60960-069-3.
- [12] Henrique Santos; Manuel Filipe Santos; Wesley Mathew Supervised Learning Classifier System for Grid Data Mining Data Mining: Trends and New Domains, Viena, Intech, 2010, ISBN 978-953-7619-X-X.
- [13] Júlio Duarte, Maria Salazar, Cesar Quintas, Manuel Santos, José Neves, António Abelha and José Machado Data Quality Evaluation of Electronic Health Records in the Hospital Admission Process, IEEE/ACIS 2010 Japan August , 2010 (ISI proceedings).

- [14] Modelling intelligent behaviours in multi-agent based HL7 services, IEEE/ACIS 2010 Japan, August, 2010 (ISI proceedings).
- [15] I. A. Iurgel; R. E. da Silva; M. F. dos Santos Towards virtual actors for acting out stories Edutainment 2010, China, August, 2010 (ISI proceedings).
- [16] Manuel Filipe Santos; Wesley Mathew; Henrique Dinis Santos, Grid Data Mining by means of Learning Classifier Systems and Distributed Model Induction, GECCO 2011, July, Dublin.
- [17] Filipe Portela, Manuel Filipe Santos, Marta Vilas-Boas, A Pervasive Approach to a Real-Time Intelligent Decision Support System in Intensive Medicine, accepted to be published in a book of Communications in Computer and Information Science, Springer-verlag, 2011.

### **Participation in R&D projects in the last 5 years:**

He participated in various R&D projects, being Principal Investigator of 4 projects, namely:

- INTELLITAG - Intelligent tagging systems.
- INTCARE II - Intelligent Decision Support System for Intensive Care, Principal Investigator, Approved for founding by FCT PTDC/EEI-SII/1302/2012, 2013-2014
- GridClass – Learning Classifiers for Grid Data Mining, Principal Investigator, Approved for founding FCT GRID/GRI/81736/2006, 2008-2011
- INTCARE - Intelligent Decision Support System for Intensive Care, Principal Investigator, Approved for founding FCT PTDC/EIA/72819/2006, 2008-2012

### **Supervision of Graduate Students:**

Supervised more than 20 MSc theses and 8 PhD theses. Currently he is supervising 5 PhD students and 1 pos-doc.

### **Other relevant topics of his CV:**

- **Co-organized** the EPIA 2007 – 13th Portuguese Conference on Artificial Intelligence.
- **Reviewer** of several conferences (e.g. AAMAS, EPIA, ICEIS, ICAART, MEDI) and journals (e.g. European Journal of Operational Research, Intelligent Decision Making Support Systems);
- **Co-organizer of** the Ubiquitous Data Mining workshop of ECAI 2012, 2010, Knowledge Discovery and Business Intelligence - KDBI 2009, 2011, 2013 and 2015 and AIM 2015 thematic tracks of EPIA; WISA/CISTI 2011 and Intelligent Systems/ESM 2011.

## **3.2 Paulo Cortez**

### **Biography:**

**Paulo Cortez** (PhD, Habilitation) is **Associate Professor** (with tenure) at the Department of Information Systems, University of Minho. He is also **Coordinator** of the Information Systems and Technologies (IST) research group of ALGORITMI Centre (with 33 PhD researchers). His current research interests are in the fields of: Business Intelligence and Decision Support Systems; Data Mining and Machine Learning; Neural Networks and Evolutionary Computation; and Forecasting.

### Relevant publications in the last 5 years:

He is co-author of more than ninety indexed (e.g., ISI, Scopus) publications in international conferences and journals (e.g., published by IEEE, Elsevier or Springer). He has more than 1915 google scholar citations and his google scholar h-index is 21 (<http://scholar.google.com/citations?hl=en&user=fQ42U-8AAAAAJ>). His relevant publications in the last 5 years are:

- [1] K. Fernandes, P. Vinagre and **P. Cortez**. A Proactive Intelligent Decision Support System for Predicting the Popularity of Online News, In Proceedings of **17th Portuguese Conference on Artificial Intelligence (EPIA 2015)**, Springer, Coimbra, Portugal, September, 2015.
- [2] M. Parente, **P. Cortez**, A.G. Correia. An evolutionary multi-objective optimization system for earthworks. In **Expert Systems with Applications**, Elsevier, 42:6674-6685 (ISI impact factor 1.965)
- [3] S. Moro, **P. Cortez**, P. Rita. Business intelligence in banking: A literature analysis from 2002 to 2013 using Text Mining and latent Dirichlet allocation. In **Expert Systems with Applications**, Elsevier, 42(3):1314-1324 (ISI impact factor 1.965)
- [4] J. Peralta Donate and **P. Cortez**. Evolutionary Optimization of Sparsely Connected and Time-Lagged Neural Networks for Time Series Forecasting. In **Applied Soft Computing**, Elsevier, 23:432-443, October 2014 (ISI impact factor 2.679)
- [5] **P. Cortez** and J. Peralta Donate. Global and Decomposition Evolutionary Support Vector Machine Approaches for Time Series Forecasting. In **Neural Computing and Applications**, 25(5):1053-1062, Springer, (ISI impact factor 1.168)
- [6] S. Moro, **P. Cortez**, P. Rita. A Data-Driven Approach to Predict the Success of Bank Telemarketing. In **Decision Support Systems**, Elsevier, 62:22-31, June 2014 (ISI impact factor 2.201)
- [7] J. Peralta Donate, P. Cortez, G. Sánchez and A. de Miguel. Time series forecasting using a weighted cross-validation evolutionary artificial neural network ensemble. In **Neurocomputing**, Elsevier, 109:27-32, June 2013 (ISI impact factor 1.634).
- [8] M. Stepnicka, **P. Cortez**, J.P. Donate, L. Stepnickova. Forecasting seasonal time series with computational intelligence: on recent methods and the potential of their combinations. In **Expert Systems with Applications**, Elsevier, 40(6):1981-1922, May 2013, ISSN 0957-4174 (ISI impact factor 2.203).
- [9] P. Cortez and M.J. Embrechts. Using Sensitivity Analysis and Visualization Techniques to Open Black Box Data Mining Models. In **Information Sciences**, Elsevier, 225:1-17, March 2013, ISSN 0020-0255 (ISI impact factor 2.833).
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- [11] P. Cortez, M. Rio, M. Rocha and P. Sousa. Multiscale Internet Traffic Forecasting using Neural Networks and Time Series Methods. In **Expert Systems**, Wiley-Blackwell, 29(2):143-155, May 2012 (ISI impact factor 1.231).

- [12] P. Cortez. Data Mining with Multilayer Perceptrons and Support Vector Machines. In D. Holmes and L. Jain (Eds.), **DATA MINING: Foundations and Intelligent Paradigms, Volume 2: Core Topics including Statistical, Time-Series and Bayesian Analysis**, ISRL 24, chapter 2, pp. 9-25, 2012. Springer (ISI).
- [13] C. Lopes, P. Cortez, P. Sousa, M. Rocha and M. Rio. Symbiotic filtering for spam email detection. In *Expert Systems with Applications*, Elsevier, 38(8):9365-9372, August 2011 (ISI impact factor 1.924).
- [14] M. Rocha, P. Sousa, P. Cortez and M. Rio. Quality of Service Constrained Routing Optimization using Evolutionary Computation, In *Applied Soft Computing*, Elsevier, Elsevier, 11(1):356-364, 2011 (ISI impact factor 2.415, Scopus)
- [15] P. Cortez and M. Embrechts. Opening Black Box Data Mining Models Using Sensitivity Analysis. In Proceedings of the 2011 **IEEE Symposium on Computational Intelligence and Data Mining (CIDM)**, pp. 341-348, Paris, France, April, 2011 (ISI, Scopus).

#### **Participation in R&D projects in the last 5 years:**

He participated in 2 R&D projects, namely:

- **INTCARE II - Intelligent Decision Support System for Intensive Care**, Project: PTDC/EEI-SII/1302/2012, July 2013 to June 2015.
- **SIDIC - Integrated System for Detection and Identification of Behaviors and Biometric data**, Project: QREN Co-Promoção N° 21584, Concurso 03/SI/2011, October 2011 to January 2014.

#### **Supervision of Graduate Students in the last 5 years:**

Supervised 1 Postdoc, 2 PhD thesis and 11 MSc thesis. Currently he is supervising 4 PhD students.

#### **Other relevant topics of his CV:**

- **Associate Editor** of the *Expert Systems* (Wiley, ISI, since 2013) and *Neural Processing Letters* (Springer, ISI, since 2008) journals.
- **Reviewer** of several ISI journals: *Information Sciences*, *Data & Knowledge Engineering*, *Artificial Intelligence in Medicine*, *Computer Journal*, *Decision Support Systems*, *Neurocomputing*, *Expert Systems*, *Intelligent Data Analysis* and *Artificial Intelligence Communications*.
- **Program Committee Member** of 66 int. conferences/workshops, such as: IDEAL 2013, IEEE CIDM 2013, ACM WIMS'13, ECAI2010, IEEE IJCNN 2012, IEEE FUZZ 2013, DDDM of IEEE ICDM 2011, IEEE CBMS 2011.
- **Co-organizer** of 22 Workshops, such as: Machine Learning track of IBERAMIA 2012; Knowledge Discovery and Business Intelligence (KDBI EPIA 2015); Ubiquitous Data Mining (UDM-IJCAI 2013; UDM-ECAI 2012).
- **Invited lecturer** in the International Summer School of Neural Networks in Classification, Regression and Data Mining (2010; 2012).
- Acted as **external examiner** of 20 MSc and 6 PhD thesis.
- **Author** of the open source RMiner library, which facilitates the use of Data Mining applications in R (<http://www3.dsi.uminho.pt/pcortez/rminer.html>).
- He is **vice-president** of the Portuguese Association for Artificial Intelligence (APPIA).
- He has a **strong post-graduate teaching experience**, having taught 27 MSc course units and 6 PhD course units in MAP-I Universities, University



### 3.3 Rui Camacho

**Biography:** Rui Camacho received his Ph.D. in Electrical Engineering and Computers from the University of Porto (UP), Portugal, in 2000. He is Associate Professor at the Informatics Engineering Department of the Faculty of Engineering at UP, teaching undergraduate and graduate classes of Machine Learning and Data Mining. He is also researcher at the Laboratory of Artificial Intelligence and Decision Support (LIAAD), with the current research interests:

- Inductive Logic Programming;
- Data Mining and Machine Learning;
- Relational Data Mining;
- Applications of Bioinformatics;
- Applications of Biomedicine.

#### Relevant publications in the last 5 years:

His most significant publications for the field in the last 5 years are:

- [1] Diogo Teixeira, Andeia Cruz, Sandra Braz, Alexandra Moreira, João Relvas e Rui Camacho, "PBS Finder: a tool to assist RNA Binding Proteins studies", 29th Annual ACM Symposium on Applied Computing (SAC 2015), Salamanca, Espanha, Abril 2015, doi:10.1145/2695664.2695865
- [2] Célia Talma Gonçalves, Rui Camacho, Eugénio Oliveira, "Ranking MEDLINE Documents", Journal of the Brazilian Computer Society, volume 20, number 13, 2014, doi:10.1186/1678-4804-20-13
- [3] Tiago Loureiro, Rui Camacho, Jorge Vieira e Nuno A. Fonseca, "Improving the performance of Transposable Elements detection tools", Journal of Integrative Bioinformatics, 10(3):231-242, 2013, doi:10.2390/biecoll-jib-2013-231.
- [4] Rui Camacho, Rita Ferreira, Natacha Rosa, Vânia Guimarães, Nuno A. Fonseca, Vítor Santos Costa, Miguel de Sousa, Alexandre Magalhães, "Predicting the secondary structure of proteins using Machine Learning algorithms", International Journal of Data Mining and Bioinformatics, Vol6, N6, pp 571-584, 2012
- [5] Célia Talma Gonçalves, Rui Camacho, Eugénio Oliveira, "BioTextRetriever: a tool to retrieve relevant papers" International Journal of Knowledge Discovery in Bioinformatics (IJKDB), Editor: Jason T. L. Wang, vol 2, N 3, pp 21-36, July-September 2011, IGI Publishing
- [6] Rui Camacho, Max Pereira, Vítor Santos Costa, Nuno A. Fonseca, Carlos Adriano, Carlos J. V. Simões, Rui M. M. Brito, "A Relational Learning approach to Structure-Activity Relationships in Drug Design Toxicity studies", Journal of Integrative Bioinformatics, 8(3), pp 182-201, September, 2011.
- [7] Miguel M de Sousa, Cristian R Munteanu, Alejandro Pazos, Nuno A Fonseca, Rui Camacho e Alexandre Lopes Magalhães, "Amino Acid Pair- and Triplet-wise Groupings in the Interior of Alpha-Helical Segments in Proteins", Journal of Theoretical Biology, 271(1):136-144, February 2011.
- [8] Nuno A. Fonseca, Vítor Santos Costa, and Rui Camacho, "Conceptual clustering of multi-relational data", Inductive Logic Programming, 21th International Conference, ILP 2011, London, UK, 31 July-3 August, 2011.
- [9] Max Pereira, Nuno A. Fonseca Vítor Santos Costa Rui Camacho, "Interactive Discriminative Mining of Chemical Fragments", in Proceedings of the 19th

International Conference on Inductive Logic Programming, Springer-Verlag, LNAI 6489, pp 59-66, Florence, Italy, 2010.

**Participation in R&D projects in the last 5 years:**

He participated in various R&D projects:

- ICE.Mobilidade ([SI IDT – 13843/2011](#)) projecto QREN;
- IC4Depression (projecto europeu).
- FCT project : ADE - Adverse Drug Effects Detection

Principal Investigator of the project: **ILP-Web-Service: An Inductive Logic Programming based Web service**

**Supervision of Graduate Students:**

Has supervised 15 MSc theses and 6 PhD theses. Currently supervises 2 PhD students and 4 MsC students.

**Other relevant topics of his CV:**

- Will organize VecPar 2016
- Co-organized the ILP 2004 – International Conference on Inductive Logic Programming.
- Co-organized the ECML/PKDD 2005 – European Conference on Machine Learning and the European Conference on Principles and Practice of Knowledge Discovery in Databases.
- Was guest editor of the Machine Learning journal Vol. 64, N. 1/2/3, 2006.
- Belongs to the editorial board of the International Journal of Computational Intelligence in Bioinformatics and Systems Biology (IJCIBSB)
- Made review work for the following international journals: Journal of Computational Intelligence; IEEE journal of Systems Man and Cybernetic (SMC-B); Data & Knowledge Engineering (DKE), journal of Artificial Intelligence Research (JAIR); Machine Learning journal.
- Foi avaliadoe de várias propostas de projecto no departamento de informática da Katholieke Universiteit Leuven, Bélgica.
- É "International Colaborator" do "Núcleo de Apoio à Pesquisa para Aprendizado de Máquina em Análise de Dados" da USP, Brasil.
- Foi examinador externo de um trabalho de doutoramento da University of New South Wales, (Austrália)