Adaptive Business Intelligence (ABI)

A – Programmatic Component

1. Theme and motivation

Business organizations are increasingly using decision-making processes that are based on data. **Business Intelligence (BI)** is an umbrella term that includes methodologies, architectures, tools, applications and technologies to enhance managerial decision making [1][2]. The goal of BI is to access data from multiple sources and process these data into useful knowledge to support decision making. In 2007, a new trend emerged in the marketplace called **Adaptive Business Intelligence (ABI)** [3]. ABI systems extend the traditional BI model by encompassing two additional modules: **forecasting** [2, 4] and **optimization** [5], 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.

The topics covered by ABI (data mining and data science, forecasting, modern optimization and adaptive systems) have a large research community, with several prestigious international scientific journals (e.g., Decision Support Systems, Machine Learning, Journal of Heuristics, Applied Soft Computing) and conferences (e.g., ACM KDD, IEEE IJCNN, ACM GECCO) available. There are also several international PhD programs that include ABI topics, such as:

- Carnegie Mellon University (CMU), USA (http://www.cmu.edu/):
  - **Ph.D. Program in Computer Science** (artificial intelligence, machine learning);
- Stanford University, USA (http://www.stanford.edu/):
  - **Ph.D. in Computer Science** (artificial intelligence, machine learning, databases, optimization)
- Berkeley University of California, USA (http://berkeley.edu/):
  - **Ph.D. in Computer Science** (artificial intelligence, machine learning, database management systems).

The proposed ABI unit had already **eleven** previous **MAP-I editions**, including:

- 2020-21: 6 students, at University of Porto;
- 2019-20: 3 students, at University of Minho;
- 2018-19: 4 students, at University of Aveiro;
- 2017-18: 9 students, at University of Porto;

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 - **85**% (highly agree).

Two ABI **projects** (element B) of the 2014/15 edition resulted in **papers** published in the KDBI track of the EPIA international conference (Springer LNCS, indexed at Scopus and ISI): http://epia2015.dei.uc.pt/kdbi/. One of these papers [6] won the **best EPIA 2015 paper award**. Also, the ABI teachers published **international books**

covering several ABI topics, namely: Business Intelligence and Data Analytics [1, 2]; and Optimization [5].

2 Objectives and Learning Outcomes

- To learn ABI concepts: BI, 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: 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 and deep learning, support vector machine, random forests, hierarchical and relational clustering, inductive logic programming), application of optimization techniques in ABI (e.g., simulated annealing, 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: Prediction and optimization tools (e.g., R [5], Python [6], WEKA/MOA/Rapidminer).

4 Teaching Methodologies 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 [7]).
3 - Case-based learning.
4 - Project based learning.

Evaluation will include two elements:

A - review of ABI research article(s) (30%, individual essay); and
B - an ABI project that describes the application of ABI tools to real-world datasets (70%, group project of 2 to 3 students).

ABI course can be offered either in a b-learning or in e-learning mode due to restrictions on classroom teaching.

5 Bibliography

Cited references:

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[5] P. Cortez. Modern Optimization with R. Springer, 2nd edition, https://www.springer.com/gp/book/9783030728182

[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, LNCS 9273, pp. 535-546, September, 2015.

[7] D. Johnson, R. Johnson and K. Smith, Active Learning: Cooperation in the College Classroom, 2nd edition, Edina, Interaction Book Company, 1998.

Additional references:

[8] S. Luke, S. Essentials of metaheuristics (second edition). George Mason University. Free access: http://cs.gmu.edu/~sean/book/metaheuristics/, 2015.

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B Lecture Team

1. Summary

The lecture team includes the four members. **Manuel Filipe Santos** and **Paulo Cortez** belong to the Intelligent Data Systems (IDS) - http://algoritmi.uminho.pt/research-teams/ids, research group of the ALGORITMI R&D Centre, 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** and **João Mendes Moreira** are from the Laboratory of Artificial Intelligence and Decision Support (LIAAD) R&D centre, http://www.liaad.up.pt/, of INESC-TEC and Faculty of Engineering University of Porto (FEUP). R. Camacho researches in Inductive Logic Programming and Data Mining and J. Moreira researches in Machine Learning, Applied Data Mining and Intelligent Transport Systems.

2. Coordinator

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