## ARTIFICIAL INTELLIGENCE TOOLS FOR ACADEMIC MANAGEMENT: ASSIGNING STUDENTS TO ACADEMIC SUPERVISORS

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### Abstract

In the last few years, there has been a broad range of research focusing on how learning should take place both in the classroom and outside the classroom. Even though academic dissertations are a vital step in the academic life of both students, as they get to employ all their knowledge and skills in an original project, there has been limited research on this topic. In this paper we explore the topic of allocating students to supervisors, a time-consuming and complex task faced by many academic departments across the world. Firstly, we discuss the advantages and disadvantages of employing different allocation strategies from the point of view of students and supervisors. Then, we describe an artificial intelligence tool that overcomes many of the limitations of the strategies described in the article, and that solves the problem of allocating students to supervisors. The tool is capable of allocating students to supervisors by considering the preferences of both students and supervisors with regards to research topics, the maximum supervision quota of supervisors, and the workload balance of supervisors.

Keywords: Apps for education, New projects and innovation, Academic management.

## **1 INTRODUCTION**

Every year, students in Higher Education face the challenge of carrying out a long-term project that encompasses a wide breadth of the skills and competences developed during their respective degrees. These projects usually come in the form of undergraduate, master, or PhD. dissertations. While there is a wide range of strategies, tools, and methodologies that have been studied with the purpose of conducting good in-class and module/course experiences [1, 2], there is, comparatively, very little effort on the matter of conducting the experience and guidance of students with respect to their individual dissertations [3]. Yet, we believe that this is an important event in every student's academic life, as it usually entails their degrees' completion and an opportunity to exhibit their accomplishments.

Generally, the responsibility of assigning students to academic supervisors lies on the shoulders of decision makers in academic management (i.e., department heads, coordinators, etc.). Albeit it may initially seem straightforward, decision makers face an intricate problem influenced by a variety of criteria such as the number of students to allocate, the number of supervisors from where to choose, both students' and supervisors' preferences on research topics, work load constraints by academic staff, and even the department's social climate. As a result, the decision on how students should be allocated to supervisors is arduous, time consuming, and, quite often, stressful.

This decision has almost countless possibilities and, making an optimal decision on the matter, may be unfeasible for human decision makers Despite this problem, Artificial Intelligence has proved to be a helpful tool in supporting decision making in a variety of complex domains such as emergency response [4], analytics [5], health [6], sports [7], or even education [8, 9, 10]. Its ability to manage complex decision problems (i.e., involving many variables), provide time effective responses, and learn from experience has put artificial intelligence to the forefront of today's ICT solutions. We believe that the problem of assigning students to supervisors is a complex one, and it would benefit from the support of Artificial Intelligence tools.

In this paper, we present an artificial intelligence tool that aims to support members in academic management in the decision of allocating students to supervisors for their academic dissertations. On the one hand, the tool takes into consideration the preferences of both students and supervisors on research topics to ensure that students are advised by supervisors with experience on their desired research topic, and that supervisors feel comfortable advising and guiding students throughout their dissertations. On the other hand, the tool also takes into consideration the different workload levels of individual supervisors (i.e., the maximum number of students that each supervisor may be able to supervise). In order to foster a good work climate, the tool also ensures that all supervisors have a similar workload in the final allocation. We have implemented some pilot experiences, with positive perspectives, to test its feasibility as a decision support tool for members in academic management.

## 2 STRATEGIES FOR ALLOCATING STUDENTS TO SUPERVISORS

When one faces the task of allocating students for their undergraduate, master, or PhD dissertations (or even summer internship projects), there are multiple alternatives that one may follow. In most institutions, there is a single individual that is responsible for the management of the allocation of students to their respective dissertation projects or supervisors. The general strategy followed by the manager to carry out this decision can be analyzed on different dimensions. In the next lines, we analyze and discuss some of the most relevant dimensions related to the decision of allocating students to dissertations.

- **Distributed vs. Centralized:** If the decision is to be made entirely by supervisors and students, we say that we have a distributed decision, as involved individuals make their own decisions. This approach may have the disadvantage of some students ending up without a dissertation or supervisor, a fatal and unfair consequence for the satisfaction of students with their dissertation project. In addition to this, some supervisors may end up with an excessive workload due to their popularity, and some other supervisors may not be able to supervise any student. Considering that supervising students is a good starting point for starting new research projects, exploring new research areas, or learning on new topics, a distributed decision making process may hinder the research work of some staff members in comparison to those staff members that are the most popular. A centralized decision is one that is entirely carried out by individual in charge of the allocation process, considering the inputs of both students and staff members. A centralized decision may overcome all the previous problems. Nevertheless, the decision faced by this individual is complex, large, and it may involve too many criteria to handle without any external support. In many schools, departments, and faculties the decision is at some point in the spectrum between fully distributed and fully centralized. That is, some individual arrangements between students and supervisors may be allowed, but the academic manager still faces a complex and large decision-making problem.
- **Preference elicitation on items:** This dimension affects centralized decisions, as a purely random allocation may be highly unsatisfactory for both students and supervisors. When making a decision that involves several stakeholders, one should aim to approximately know the preferences of all the stakeholders. This knowledge facilitates making a decision that may satisfy all the parties. The preferences of students and supervisors may be expressed in different terms: individual-based preferences, project-based preferences, and topic-based preferences.
  - Individual-based preferences [11, 12, 13] force students to rank supervisors, and supervisors to rank students. We argue that this preference elicitation method may be biased by the academic merit of specific students and the popularity of specific staff members. In the former case, students with highest academic merits may be more popular among supervisors and end up being preferred by most supervisors. We argue that making decisions purely based on academic merit is against the spirit of modern learning institutions, whose aim should be to promote the learning of all students, providing them with equal opportunities. The latter suffers from the same problems for staff members than those mentioned for distributed decisions. In addition to this, one should also consider that many students and staff members may not be known by their counterparts.

- Project-based preferences [11, 14, 15] consists of staff members proposing a catalogue of projects, and students ranking their preferences over those projects. The expression of students' preferences in terms of projects avoids creating disadvantage for supervisors that are unknown by students, as, supposedly students choose projects based on the project topics. It may also avoid unfair allocations by merit. Despite this, there is some inherent disadvantage for this approach, as usually supervisors need to propose a project catalogue that includes a wide range of choices. Usually, a range of projects that is larger than the number of students. Proposing a set of projects may be a time-consuming process for staff members, with many of the projects ending up unassigned due to the lack of interest from students.
- Topic-based preferences [16] involve students and staff members expressing their preferences in terms of dissertation topics or research (sub)areas. For instance, students and supervisors may provide a list of research topics in which they are interested. Then, the matching is purely based on common research interests of the students and his/her allocated supervisor. This allocation strategy avoids unfair allocation of students based on merit and the issue of (un)popular students/supervisors. On top of that, this method does not require staff members to invest significant time to provide a broad range of projects, as they can negotiate the projects with their allocated students based on the common interests of both.
- Single/Multi-objective decision: Another dimension to be considered for the allocation process is whether to consider multiple objectives. Some proposals [14, 15] only consider the objective of satisfying students' preferences, ignoring staff members' preferences. While student satisfaction is important for every academic institution, one should not forget the other side of the coin: staff members. In fact, one could argue that unhappy workers may affect the quality of the teaching and supervision process. One way to overcome this problem is considering several objectives when allocating students to supervisors. In fact, we propose that at least two objectives should be considered, one being the satisfaction of students with the allocation process, and the other being supervisors' satisfaction with the same process. From this point, other considerations may be included such as the distribution of students across different departments.
- Supervision constraints: Another dimension consists of whether the allocation considers supervision constraints. In the real world, not every single allocation is possible. Normally, there are realistic constraints that preclude some allocations from being possible. One of these constraints may be realistic workload. Staff members can only supervise a limited number of students, as they have other arrangements and teaching commitments. Another constraint that may be considered is the maximum number of students that may work on the same dissertation topic/project. Some other constraints may include personal incompatibilities or conflicts between specific students and supervisors.

In our perspective, an adequate allocation process should be centralized, multi-objective, consider constraints, and be based on unbiased preferences such as topic-based preferences and project-based preferences.

### 3 AN ARTIFICIAL INTELLIGENCE TOOL FOR ASSIGNING STUDENTS TO SUPERVISORS

We have developed a student-supervisor allocation tool based on an Artificial Intelligence algorithm that allows to find high quality allocations even for large student cohorts (e.g., 400 students). It is based on a genetic algorithm that finds solutions that are near optimal. The tool is freely available for download<sup>1</sup>. It aims to overcome most of the aforementioned problems. In order to do that, the tool has the following characteristics:

• It is a centralized decision-making tool whereby the user provides through the software all the data needed to solve the problem. Due to this fact, we avoid the case of students not being assigned a supervisor.

<sup>&</sup>lt;sup>1</sup> The tool is currently available for download at https://github.com/rithinch/pareto-optimal-student-supervisor-allocation

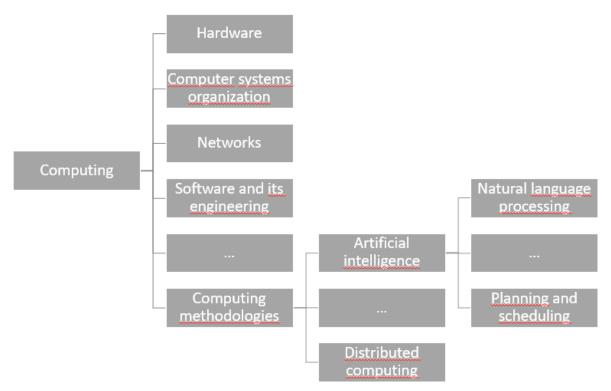


Figure 1. An example of a hierarchy of research topics

- The tool takes into consideration the fact that supervisors may only supervise a limited number of students, and the fact that they may have different teaching commitments. Thus, we provide the ability for the user to individually specify, for each staff member, the maximum number of students to be supervised. The allocation provided by the algorithm never produces allocations that exceed the maximum supervision quota of each supervisor.
- The students' and supervisors' preferences are provided by means of a ranked list of five keywords, from the most preferred topic to the least preferred topic. The keywords are part of a hierarchy of topics that represents the body of knowledge in a discipline. An example of this kind of organization can be found in Figure 1. We chose this representation as it is easy to obtain or construct one for any discipline, and it provides extra and valuable information to the artificial intelligence algorithm. We may use the information encoded in the hierarchy to improve allocations. For instance, if a student has expressed its preference to work on *Natural Language Processing* dissertation and there is no supervisor with such a keyword, it may be possible to find supervisors that have provided the more general keywords of *Artificial Intelligence* and *Computing Methodologies*. These supervisors, even though they may not be experts in the topic they may have knowledgeable experience in the broader field to supervise dissertations in the student's choice of topic. As of now, the tool includes the ACM classification taxonomy for computing topics and the PhySH classification scheme for physics. However, users can provide their own taxonomies in a file, making the tool applicable to almost any discipline.
- The software provides allocations by taking into consideration both the students' and supervisors'
  preferences. The valuation of the quality of the matching of a student to a specific supervisor is
  calculated taking into consideration the keywords provided by each of them, the position of those
  keywords in the hierarchy, and the position of the keywords in the ranked list of preferences. The
  more similar the ranked lists, the higher quality for the matching. One of the objectives aims to
  maximize the average quality of the allocation from the students' perspective. The other objective
  aims to maximize the average quality of the allocation from the point of view of supervisors.
- The software also strives to find an allocation in which supervisors have a similar level of supervision workload. This avoids some supervisors being overutilized while other supervisors being underutilized.
- The tool provides a range of prospective solutions to the decision maker, with different priorities for the students' and supervisors' objectives. This allows decision makers to trade-off between

different levels of quality for each objective, as well as choosing the solutions that best matches his/her preferences.

• The data is provided to the tool in a friendly Excel spreadsheet format, so that users can prepare their data in comfortable and familiar way. The output of the tool is also an Excel spreadsheet that allows easy interpretation of the results. Examples of these files, with synthetic data, can be observed in Figure 2.

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Student ID	Student Name	Keyword 1		Keyword 2		Keyword 3		Keyword 4		Keyword 5
5640317	Deanna Pittard	Network algorithms		Network protocols		Models of computation		Hardware validation		Computer systems or
8285751	Camie Junious	Information theory		Dependable and fault-tolerant system	ns and networks	Concurrent computing methodo	logies	Computer graphics		Parallel computing m
6932519	Twila Starkes	Computing / technology p	policy	General and reference		Cryptography		Network components		Software notations a
5230783	Wilhelmina Dismukes Security in hardware		Operations research		Network security		Mathematical analysis		Concurrent computin	
1139444	Ellamae Allgood Hardware		Electronic design automation		Document management and text processing		Professional topics		Randomness, geome	
8478490	Nelly Buell Logic		Network performance evaluation		Arts and humanities		Hardware test		Computational comp	
8201201	Shante Brass Continuous mathematics			Security services		Information retrieval		Network protocols		Emerging technologi
2625849	Kate Franceschi Printed circuit boards		Network architectures			Randomness, geometry and discrete structures		Information storage systems		Software creation an
3881668	Tiffani Ebert	Software and application	security	Continuous mathematics		Intrusion/anomaly detection and malware mitigation		Emerging technologies		Computational comp
3730005	Donte Luebbers	Design and analysis of alg		Machine learning		Continuous mathematics		Document management and text processing		Architectures
5708348	Derick Stuber	Arts and humanities		Mathematics of computing		Architectures		Electronic design automation		Software and applica
3556004	Venita Marksberry	Enterprise computing		Randomness, geometry and discrete	tructures	Network properties		Network security		Logic
4981375	Loan Chevere	Hardware		Robustness		Models of computation		Arts and humanities		Semantics and reaso
6453992	Teresa Worthen	Software and its engineer	ring	Human-centered computing		Education		Systems security		Document managem
4135264	Tien Pomerleau	Information retrieval		Theory and algorithms for application	domains	Visualization		Human computer interaction ()	101	Emerging technologi
9282954	Cherilyn Frigo	Collaborative and social or	omputing	Information theory		Integrated circuits		Mathematical analysis		Document managem
4724075	Matthew Beery	Theory of computation	- the same	information retrieval		Integrated circuits		Robustness		Security services
7701687	Rosa Manner	Models of computation		Professional topics		Network types		Network protocols		Database and storage
2348495	Glady Hoos	Human computer interact	tion (MCII)	Computer systems organization		Data management systems		Security and privacy		Systems security
4523338	Ernestine Paulsen	Theory and algorithms for				Education		Probability and statistics		Software and its eng
4750845	Boyd Harm	Information theory	apprication domain	Hardware test		Computer forensics		Social and professional topics		Logic
9862378	Ernie Sloat	Information theory		Formal languages and automata theor	hr.	Security services		ACM Computing Classification	Curtan	Computing methodo
2913396	Marion Lacey		ed discrete steadur	e Ubiquitous and mobile computing	*	Network algorithms		Machine learning	ayacens	Hardware validation
3452245	Ernie Sloat	Software and application		Network architectures		Life and medical sciences		Concurrent computing method	alaalaa	Network services
5567213	Tiffani Ebert	Visualization	second	Security in hardware		Network protocols		Accessibility	orogres	Interaction design
3307223	B	C		D		F		F		G
Supervisor ID	Supervisor Name	Quota	Keyword 1	0	Keyword 2	E	Keyword 3	F	Keyword 4	0
aab9775	Boris Lovell	Quota	Keyword 1							
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Figure 2. Examples of the spreadsheets provided to the tool for students (top) and supervisors (bottom)

The tool provides a simple graphical interface that aims to be intuitive and easy to use by everyone. In the main window, one can select an input spreadsheet file for the students' data, an input spreadsheet file for supervisors' data, and the filename where the results should be output. The artificial intelligence algorithm has been configured with optimal parameters, so that the user can just focus on creating his/her allocations. Figure 3 shows the main window of the application.

Al Tool For S	tudent - Supervisor Allocation	_		×	
File Options	Help				
	Student File =			Browse	
	Select Supervisors File			Browse	
Select Where to Save the Results					
	Start Genetic Algorithm				

Figure 3. The main window of the tool

The tool has been employed with success at Coventry University (United Kingdom) to allocate a cohort of more than 300 students to approximately 50 supervisors. The feedback gathered from the academic in charge of the allocation was positive, highlighting its ability to significantly reduce the time employed to allocate students to supervisors. In addition to this, the tool is currently being tested at other UK and Spanish institutions.

The Artificial Intelligence algorithm has proved to provide near optimal results in minutes even for large and complex decision problems [16]. In fact, the tool can obtain solutions that have 88.63% of the best quality achievable for the best solution for students, and 93.83% of the best quality achievable for the best solution for supervisors. These results have been obtained on an average of 247 seconds (4 minutes).

## 4 CONCLUSIONS AND FUTURE WORK

In this paper, we have presented a new tool, powered by Artificial Intelligence, that supports academics in the process of allocating students to supervisors for their respective undergraduate, master, and PhD dissertations. This tool falls into the category of a centralized decision-making tool that is guided by the preferences of students and supervisors on research topics rather than specific projects or students/supervisors. In addition, the tool takes into consideration multiple objectives in the form of the students' preferences with regards to research topics, and the supervisors' preference with regards to research topics. The tool also includes several tools to produce realistic allocations such as the maximum supervision quota of each supervisor, or the need to produce a balanced allocation that avoids some supervisors being overutilized and other supervisors being underutilized.

As mentioned, there is limited research with regards to student supervision compared to other teaching activities. This means that there is still plenty of room to improve and produce tools that help in the process of allocating and supervising students. For instance, in this article we have employed research topics extracted from a hierarchy of topics to represent the preferences of students and supervisors. This preference elicitation process could be enriched with information from the latest articles published by the supervisors, descriptions from the subjects taught by supervisors, or abstracts from previously supervised dissertations. In addition to this, another potential area of exploration is studying the impact of psychological profiles in the evolving relationship between students and supervisors.

## REFERENCES

- [1] R. R. Schmeck, Learning strategies and learning styles, Springer Science, 2013.
- [2] J. Biggs and C. Tang, Teaching for Quality Learning at University, McGraw Hill, 2011.
- [3] M. Woolhouse, "Supervising dissertation projects: Expectations of supervisors and students," *Innovations in Education and Teaching Internationa,* vol. 39, no. 2, pp. 137-144, 2002.
- [4] S. Potter, "Critical reasoning: Al for emergency response," *Applied Intelligence,* vol. 37, no. 3, pp. 337-256, 2012.
- [5] F. Y. Wang, "A big-data perspective on AI: Newton, Mertin, and analytics intelligence," *IEEE Intelligent Systems*, vol. 27, no. 5, pp. 2-4, 2012.
- [6] J. Huang, N. R. Jennings and J. Fox, "Agent-based approach to health care management," *Applied Artificial Intelligence*, vol. 9, no. 4, pp. 401-420, 1995.
- [7] J. M. Alberola and A. Garcia-Fornes, "Using a case-based reasoning approach for trading in sports betting markets," *Applied Intelligence,* vol. 38, no. 3, pp. 465-477, 2012.
- [8] J. M. Alberola, E. Del Val, V. Sanchez-Anguix, A. Palomares and M. D. Teruel, "An artificial intelligence tool for heterogeneous team formation in the classroom," *Knowledge-Based Systems*, vol. 101, pp. 1-14, 2016.
- [9] E. Del Val, J. M. Alberola, V. Sanchez-Anguix, A. Palomares and M. D. Teruel, "A team formation tool for educational environments," in *Trends in Practical Applications of Heterogeneous Multi-Agent Systems. The PAAMS Collection*, Springer, 2014, pp. 173-181.

- [10] R. Luckin, W. Holmes, M. Griffiths and L. B. Forcier, Intelligence Unleashed: An argument for AI in Education, Pearson, 2016.
- [11] D. J. Abraham, R. W. Irving and D. F. Manlove, "Two algorithms for the student-project allocation problem," *Journal of Discrete Algorithms,* vol. 5, no. 1, pp. 73-90, 2007.
- [12] D. Srinivasan and L. Rachmawati, "Efficient fuzzy evolutionary algorithm-based approach for solving the student project allocation problem," *IEEE Transactions on Education*, vol. 51, no. 4, pp. 439-447, 2008.
- [13] L. Pan, S. Chu, G. Han and J. Z. Huang, "Multi-criteria student project allocation: A case study of goal programming formulation with dss implementation," in 8th International Symposium on Operations Research and Its Applications, Zhangjiajie, 2009.
- [14] A. A. Anwar and A. Bahaj, "Student project allocaton using integer programming," *IEEE Transactions on Education*, vol. 46, no. 3, pp. 359-367, 2003.
- [15] P. R. Harper, V. de Senna, I. T. Vieira and A. K. Shahani, "A genetic algorithm for the project assignment problem," *Computers & Operations Research,* vol. 32, no. 5, pp. 1255-1265, 2005.
- [16] V. Sanchez-Anguix, R. Chalumuri, R. Aydoğan and V. Julian, "A near Pareto optimal approach to student–supervisor allocation with two sided preferences and workload balance," *Applied Soft Computing*, vol. 76, pp. 1-15, 2019.