Teaching Metaheuristics in Business Schools

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Abstract
In this work we discuss some ideas and opinions related with teaching Metaheuristics in Business Schools. The main purpose of the work is to initiate a discussion and collaboration about this topic, with the final objective to improve the teaching and publicity of the area. The main topics to be discussed are the environment and focus of this teaching. We also present a SWOT analysis which lead us to the conclusion that the area of Metaheuristics only can win with the presentation and discussion of metaheuristics and related topics in Business Schools, since it consists in a excellent Decision Support tools for future potential users.

1. Introduction

Teaching Metaheuristics or related topics, as a successful application of a Metaheuristics for a real problem, in a Business School is without any doubt a challenge to any teacher. The environment, from the students to the other colleagues, has little or no knowledge about the topic, and somehow no interest in knowing about it. For many of the colleagues from other areas, the word Metaheuristics sounds rare or they even do not know the meaning of it. How many times we (the researches and/or professors of the area) had to explain to our colleagues, friends, family what does it mean Metaheuristics? Because of these little knowledge of the area, the teacher that intends to explain this innovative and potentially strongly impacting topic in a Business School, should pay attention to the environment, design carefully the focus of the course and have present the Strengths (S), Weaknesses (W), Opportunities (O) and Threats (T) – SWOT - of the topic. In the following sections we describe our experiences and opinions about the topic that came out of our personal experience and discussions with other colleagues in similar situation. The presentation is organized in three main topics: the environment, the focus, and a SWOT analysis. We would like to emphasize that the main objective of this article is to open a discussion on the topic to be able to improve the teaching in the area and to divulge and publicize the importance of Metaheuristics.

2. The environment

The environment plays an important role in the design, delivery and success of a course where the topic of Metaheuristics or related can be presented. It is not the same to teach Metaheuristics in Engineering Schools or in Business Schools; It is not the same to teach to undergraduates rather than MBA students. Therefore we will start by describing the type of students we usually have in Business Schools. Another important aspect is the relationship with the other professors, as most of them typically do not know what metaheuristics is. The recognition of the area among the colleagues helps to consolidate the area, with respect to the teaching and research. In the following sections we comment our experience and the aspects that did or did not work.

The students

When a teacher plans a class, he / she has always to think about the students of the class, i.e. the public: this aspect is indeed relevant to all courses. In our case, we have three types of students: undergraduates, professional graduate programs (MBA, Masters of Logistics, Masters of Operations Management, etc.) and Ph.D. programs. The focus for each of these three types of students is obviously different, however the large majority of these students, except vary rare exceptions, have in common the following: very basic knowledge of Operations Research and almost no knowledge of algorithms, heuristics and computing. Moreover, the students are not interested in the techniques, but in their application and related results. So, it is hard to spend time describing the metaheuristics or explain the differences between them, as the class should focus on a real application. We cannot also ask the student to implement any heuristics, since they do not know any programming language. Our strategy is to describe several real applications in different companies and industries where metaheuristics have been successful, and in this way make some "publicity" of the area. We mention the metaheuristics technique in the Operations Research course for undergraduates in Economics and Business. But we also mention metaheuristics in the functional area courses, as Operations Management, Logistics, Marketing, etc. at the three different levels. It is on these courses that the students enjoy more since we related the metaheuristics with a very successful application of the respective functional area. For the Ph.D. programs we can go a little further in the topic, but always in connection with a specific area in Business.

The use of real applications is different in the three level, but in any case the presentation and discussion of these ones have been of great interest from the students, and has brought us great satisfaction.

The other professors

One of the most common questions we have from our colleagues in the Business School is: What is metaheuristics? The name sounds rare (and sometimes funny!) for them, in special, when we talk about ant colonies, genetic algorithms or tabu search. The large majority of our colleagues do remember from Operations Research just the Simplex Method (and the corresponding tables). Many of them have never studied heuristics methods at all. Therefore, any time we have the opportunity to discuss the metaheuristics topics with any colleague we try to explain it through an example in his or her area of knowledge. This does not result as an easy task, but, why is it so important that your colleagues recognize the area of metaheuristics? In our opinion, for several reasons: the first one is that in this way the area of research in metaheuristics gets recognition from other professors and this has direct implications in hiring, promotion, in financing your research and also in joint project with them where new applications can be developped. The second one is of course the teaching. This is not of minor importance, since many universities are financed by the teaching, more teaching (and good quality teaching) will lead to more hiring in the area.

In summary, we, professors in Business Schools doing research in metaheuristics (and enjoying this research), should pay a great attention on the environment and get recognition to our area from the students and the other professors. We should learn the lessons from the Operations Research area and the strategy this area got in the 80's, where the area was in a way driven away from applications, and focusing mainly in

theoretical aspects. We do not want to discuss this matter in details, but the reader is refereed to a list of article in ORMS Today. In their edition of August 2003 (http://lionhrtpub.com/orms/orms-8-03/tocfr.html) there is an interesting article from Dr. ManMohsn Sodhi saying "Consider, for example, the corps of business consultants who are a "product" of business schools. Their goal as consultants and therefore as MBA students is not to invent a new algorithm to solve the quadratic assignment problem, but to model a situation in a certain way to allow a standard solution method to solve this model in a spreadsheet environment". Another article in the same line of opinions just came out in the edition of February 2004 with the title "'Better' campaign doesn't go far enough" and subtitle "Promotion is fine, but the profession needs to build a better OR/MS product with more emphasis on "operations" and "management"". We will allow ourselves to apply these ideas to the area of metaheuristics. Just remember, the main objective of the courses in Business Schools where metaheuristics are discussed: the goal is not to make the students becoming experts in these metaheuristics techniques, but to give them the capability of identifying where these techniques can be applied, to lead projects of applications of metaheuristics and recognize the advantages and disadvantages of the metaheuristics. In a way, we intend to motivate the students to "consume" metaheuristics in their professional future.

3. The focus

Knowing the environment, we will discuss now the focus of the courses where metaheuristics are discussed. As mentioned, in general we discuss metaheuristics in the following courses: Operations Research, Operations Management, Logistics or other management courses. And we always relate the metaheuristics with some application in these management areas. We will present next the objectives, some topics and methodology used in the courses.

The objectives

The main objective while presenting the metaheuristics in the courses in a Business School is, as mentioned before, to give the students the capability of identifying where these techniques can be applied, to lead projects of applications of metaheuristics and recognize the advantages and disadvantages of the metaheuristics. The problems in the firms are each day more and more complex and of large scale, while, on the other side, these problems require a very fast solution in order to cope with the market requirements. To be able to respond to the actual challenging businesses issues, the firms need sophisticated decision support systems based on powerful mathematical models and solution techniques, together with advances in information and communication technologies. There is no question that metaheuristics can play an important role in helping to solve these large and complex problems in a fast development and implementation time. Therefore, this is the main message that we want to pass through to the business students.

Topics

We present in the courses two different topics related with metaheuristics and business applications: Application of metaheuristics to commercial Business Information Systems (BIS) by software providers and consulting companies, and we also discuss the specific developed applications to a particular company.

In the first topic, we discuss the use of metaheuristics in BIS, Enterprise Resource Planning (ERP) and Decision Support Systems (DSS). Until recently these softwares only focused on the data base aspects in order to make available the data to the firms; however it is now somewhat widely recognized that it is necessary to go a little further and to incorporate to the system analysis capabilities to enable them to obtain better information and knowledge. Next, we mention some (not all) of the BIS providers that have already incorporate metaheuristics to their systems:

- Carmen Systems (www.carmensystems.com).
- DECISIONEERING (www.decisioneering.com).
- ESRI (www.esri.com).
- GEOCOM (www.geocomtms.com).
- ILOG (www.ilog.com).
- i2 Technologies (www.i2.com).
- MANUGISTICS (www.manugistics.com).
- SAP (www.sap.com).

The following topic is about specific applications in a particular firm or industry. The discussion of these applications is in general more interesting for the students since usually the professors have more resources to use in the class. We consider several examples in different industries, from pharmaceutical, airline transportation to telecommunication and also from different management areas as from logistics, transport to production and finance. At this point we would like to draw the attention of all professors working in the area to the importance of considering applications published on some related journals;, the ones that we use in class come mostly from INTERFACES (http://www.interfaces.smeal.psu.edu/), and some of them are:

- Proctor assignment at Carleton University – Carleton University [3].
- Managing Dairy Routing at Central Lechera Asturiana [1].
- Generate Bid lines at Federal Express – FEDEX [2].
- Service Design at Santa Fe Railway – [5].
- Vehicle routing at SEARS [6].

We also wish to mention the advantages of using metaheuristics to solve large and complex problems that can be found in companies. The metaheuristics have many of the desirable features to make them the chosen technique to solve these business problems: they are in general simple, easy to implement, robust, and highly effective. Sometimes, even the simplest implementation can be very successful. The advantages of the metaheuristics are related with the following four attributes: accuracy, speed, simplicity and flexibility [4]. These ideas are discussed with the students, where we incentive their participation.

The methodology

The topics are presented in class through powerpoint presentations followed by case discussions on a specific real application. At the undergraduate level, the cases are very simple and we focus on a simple decision problem. At the following level the students have to read the complete article and search for more information in Internet or related published articles.

The discussion of the cases is around some of all of the following questions:

1. Describe the industry or company business strategy.
2. Describe the specific problem of this company presented in the case.
3. Describe the methodology and approach followed by the company. Why they follow this methodology? Are there other alternatives that could be used?
4. Comment on the advantages and disadvantages of using metaheuristics.
5. Comment on the implementation issues and the difficulties, if any, that the users and managers could find when implementing the considered technique.
6. Describe the overall benefits of the application.
7. Describe other problems, industries or situations where the same methodology could be applied.

There could exist other questions related specifically with the case, but in general these seven questions are always discussed. Also, in some situations, we have asked the students to find and describe a problem where he or she thinks that a metaheuristics could be applied with success. The course is quite dynamic and the students enjoy participating and we have had very good feedback from these course. We would like to refer to the reader the article "*Course in Action*" in ORMS Today August 2003 where they describe what "To do" and "Not to do" in courses in Operations Research. The same ideas can be applied to courses where metaheuristics are presented. Next we will describe some of these ideas, that adds up to the ones in the mentioned article:

TO DO:
- Dynamic classes with student's participation.
- Discuss how metaheuristics can help to make decisions and solve large and complex business problems.
- Present topics, cases and ideas that the students can use in their professional life, and make them more effective in their jobs.
- Comment on the basic ideas of metaheuristics and show them where they can find more information.

NOT TO DO:
- Describe the metaheuristics in detail providing and deeply discussing the related pseudo-code.
- Introduce too many mathematical formulas.
- Just lecturing.
- Present techniques or metaheuristics about which you do not know any real application.

4. SWOT Analysis
In this section, we will discuss our opinions in the Strengths, Weaknesses, Opportunities and Threats of teaching metaheuristics in programs within a Business School. These opinions are based on our experience and on the discussion with several colleagues in similar situations.

Weaknesses:
- Most of the professors have a background in Engineering or Operations Research, and little real life experience in businesses.
- Ther are few publications of real life applications in metaheuristics, and few incentives to publish them from the research community.

Threats:

- Scepticism and distrust from the students, and sometimes from the colleagues and the responsible for the courses and programs.
- See the metaheuristics area as a very technical area, without many applications in businesses.

Strengths:

- Successful applications in several industries and several business areas, from Finance to Operations Management and Logistics all over the world.
- Great potential to be applied to the large and complex problems in today's businesses.

Opportunities:

- Opportunities to new applications.
- Better information systems implemented in the firms as for example ERPs.
- More recognition from the companies of the need of Decision Support Systems based on optimization techniques.
- Global markets and pressure from these markets leading to large and complex decision problems.
- Recognition of the area of Metaheuristics, from colleagues, researchers in general and also from the Businesses.

As we can see, there are a lot of opportunities that motivate us to keep talking and discussing metaheuristics in Business Schools. From the weaknesses, we would like to recommend to the leaders of the area, the editors of related journals and to directors of departments to incentive and promote the researchers doing applications in this area. It would be a good strategy to promote the area to have more publications and divulgation of real life applications of metaheuristics. The publications can also have a format of case study and be published in forums like: INFORMS: INFORM-ED (education.forum.informs.org//), INFORMS Case and Teaching Materials (www.informs.org/Pubs/Cases/), e-optimization community (e-optimization.com/), or IFORS: Education Resources (www.umsl.edu/~sauter/ifors/index.html). Also, the EU/ME the European chapter on metaheuristics (www.euro-online.org/eume/) or the just created web HEUR - Portal Web (http://heur.uv.es/) could play an important role in the divulgation of these applications.

5. Conclusions

This article presents some ideas and opinions about teaching metaheuristics in Business Schools. The main objective of the article is to initiate a collaboration and discussion on this topic to be able to improve the teaching and promotion of the area of Metaheuristics. We discussed the teaching environment, both with respect to students and other professors. We also introduced the focus of the courses, including the objectives, the topics and the methodology, and finally we presented a SWOT analysis. From this analysis, we can conclude that the area of metaheuristics can only gain in being taught in Business Schools, since this creates good opportunities to promote the area and make it more visible outside the research community in Metaheuristics. Moreover, the metaheuristics can play an important role in solving difficult and complex business problems and this is certainly an opportunity that we do not want to

miss. To help these promotion and teaching of metaheuristics in Business Schools a better communication and collaboration among the professors in similar situations is crucial, as the publication and divulgation of more real application of metaheuristics.

6. References

[1] Adenso-Diáz B., M. González, E. García, *A Hierarchical approach to managing dairy routing*, Interfaces 28:2, pp.21-31. 1998.

[2] Campbell K.W., Durfee R.B. and Hines G.S., *FedEX Generates Bid Lines using Simulated Annealing*, Interfaces 27:2, pp.1-16. 1997.

[3] Chinneck J.W., Awad R.M., *Proctor Assignment at Carleton University*, Interfaces 28:2, pp.58-71. 1998.

[4] Cordeau J.F., Gendreau M., Laporte G., Potvin J.Y., and Semed F., *A guide to vehicle routing heuristics*, JORS, 53, pp.512-522. 2002.

[5] Gorman M.F., *Santa Fe Railway Uses an Operating-Plan Model to improve its Service Design*, Interfaces 28:4, pp.1-12. 1999.

[6] Weigel D., Cao B., *Applying GIS and OR Techniques to solve Sears Technician-Dispatching and Home-Delivery Problems*, Interfaces 29:1, pp.112-130. 1999.