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Job Scheduling and Human Resource Management in Service Centers

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Abstract

The main project objective is to develop modules for the automatic planning of tasks and human resources management for a Service Center Management Tool. These modules will generate action plans for Service Centers based on metaheuristic techniques of optimization.

Keywords: Service Center Management, automatic planning, human resources management, project scheduling

1 Project goals

Description of the objectives of the project

Companies must offer a series of services for their clients. These services may be planned, or unplanned, and related, or not, with the company's principal activity. They are usually managed by a Service Center (SC) and offered to clients by a Call Center. The task of a SC is to identify the occurrence of certain events and activate the mechanisms and resources necessary to resolve these events – in accordance with established management procedures.

Tools have been developed to automate and rationalize the daily activity of SC's. These tools can be termed Service Center Management Tools (SCMT). We are aware of proposed SCMT's that can automate most of the operations of a SC – those related with the management of the Call Center, communications, security, clients, knowledge, inventories, and so on. However, there are two important areas that remain uncovered, automatic task scheduling and automatic management of human resources. SCMT's often have modules with names similar to those above. However, these modules usually present information and do not prepare plans.

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The service quality level agreed for each client, project, and event, is a fundamental aspect of the operation of an SC. These quality levels generally establish maximum time periods for the beginning and end of tasks – with penalties for delays. Another fundamental aspect is that a given event sparks a process in the system (workflow).

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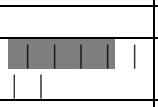
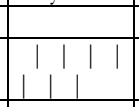
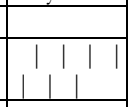
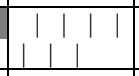
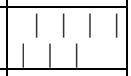
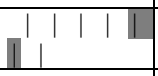
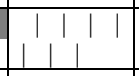
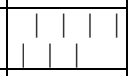
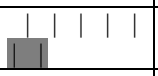
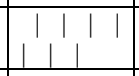
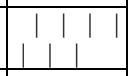
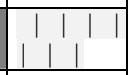
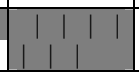
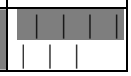
Resources

- 5 researches
- 1 technician
- Computers and software
- Cooperation with Selling Soluciones, S. L.

Cronograph

The project cronograph is shown below.

Activities/tasks	Responsible institution	People involved	First year	Second year	Tirad year
Work meetings	Universitat de València	Valls Lino, Pérez, Quintanilla Company engineers			
Memo writing	Universitat de València	Pérez, Quintanilla Post researcher 1, Post researcher 2			
Statistical analysis of datebase	Universitat de València	Pérez, Quintanilla Ballestín			
Solution robustness	Universitat de València	Valls			
Mathematical model Construction	Universitat de València	Pérez, Quintanilla			
Development of Efficient algorithms	Universitat de València	Pérez, Quintanilla Post researcher 1, Post researcher 2			

Development of real time Algorithms	Universitat de València	Pérez, Quintanilla			
Software specification	Universitat de València	Lino Ballestín,Pérez, Quintanilla Technician Company engineers			
Development of plug and play modules		Lino Technician Ballestín,Pérez, Quintanilla			
Evaluation in real environment		Lino Technician Ballestín,Pérez, Quintanilla Company engineers			

2 Measuring level of success

a.- Análisis of a specific SCMT for preparation of original proposal

Selling Soluciones, S. L. was our reference point for basing our research on real market requirements. In meetings with company engineers we have analysed the functions and gaps in the planning of the company product - eMas. The most important criticism is that eMas manages independent events – despite studies that show that these events are not independent. So, the next step in the development of SCMT's is to see them as system event managers. This viewpoint enables us to give SCMT's planning tools that help decision-making.

As a result of this analysis, we have designed a planning system whose uselfulness and viability is supported by company engineers. The planning system is based on three project management mathematical models. The concept of an event has been extended, new requirements have been added to the database, mathematical models have been specified and module functions have been defined.

b.- Bibliographic revision

We have researched two memos that compile, analyse and comment on the literature available regarding task planning with the characteristics of our models. Special emphasis has been made on the problems related to homogeneous and heterogeneous human resource management problems.

c.- *Development of highly efficient algorithms for resolving these models*

The planning system has been based on three project scheduling models – none of which have been previously studied in detail. Our methodology has been to develop simple models that incorporated same of the important characteristics and then integrate the developed models. Each model represents a research line.

The first line deals with the management of specialized human resources in project management. We have defined a model that incorporates due dates, availability dates, delay penalties, heterogeneous human resources, and assignment of the most suitable people for each given task. For the first time in the literature, we have developed genetic and scatter-search algorithms for this problem. We have also developed a problem test generator that eliminates bias detected in previous studies.

Another line of work has been the development of highly efficient metaheuristic algorithms for the resource constraint project scheduling problem (RCPSP). The methods developed for the RCPSP will be applied to the real-time resolution of the more complex models that make up the proposed planning system. Within this line of work, we have devised a Hybrid Genetic Algorithm (HGA) for the Resource Constrained Project Scheduling Problem (RCPSP). HGA introduces several changes in the GA paradigm: a crossover operator specific for the RCPSP; a local improvement operator that is applied to all generated schedules; and a two-phase strategy by which the second phase re-starts the evolution from a neighbour's population of the best schedule found in the first phase. The computational results show that HGA is a fast and high quality algorithm that outperforms all state-of-the-art algorithms.

A third line of work is as follows. A fundamental assumption in the majority of the project scheduling models is that activities in progress are non-preemptable. However pre-emption is a fundamental characteristic of one of our models. Very little effort has been made in uncovering the potential benefits of discrete activity preemption, and the papers dealing with this issue have reached the conclusion that it has little effect on project length when constant resource availability levels are defined. On the contrary, our research shows that preemption helps in decreasing the project length with respect to that of the no interruption case. We consider this as the main conclusion of this line of work as it contradicts the validity of previous conclusions and motivate research to further investigate the effects of interruption on project length - not only in the RCPSP but also in more general project scheduling problems. We have also shown how three basic elements of many heuristic algorithms for the RCPSP can be adapted to deal with the preemptive case. We have also proposed a strategy to adapt many RCPSP heuristics to the preemptive case without significantly changing the procedure - apart from the above three adaptations. We have also shown the usefulness of the double justification in the presence of preemption. In a previous work, we have shown that the double justification is a RCPSP technique that can be easily incorporated into a wide range of algorithms for the RCPSP, increasing their solution quality and maintaining at the same time the number of schedules calculated.

Another line of research deals with two related problems: one with due dates and the total tardiness minimization criterion and the other with deadlines and the makespan minimization criterion. We have adapted well-known heuristics (priority rules, sampling procedures and metaheuristics) developed for the RCPSP to solve these problems. We have compared the performance of the new versions on test instances generated by our own generator. This can

generate instances with loose, medium, and tight due dates. We have also adapted the technique of the double justification to deal with due dates and deadlines and shown its profitability.

A fundamental assumption in the above models is that the duration of activities is known before their execution. However, in an SMCT the activity durations are stochastic. So, we have considered another line of research. Very little effort has been made in developing heuristics for the RCPSP with stochastic durations, that is, when the duration of activities is given by a distribution of probability. In practice, in stochastic projects, estimations of the averages of the durations of the activities are often used to obtain a solution for the project in a deterministic manner. We wanted to know when it is worth the effort, in heuristic algorithms, to work with stochastic durations instead of deterministic ones. We have shown that on average and depending on the algorithm used, the deterministic approach may be a good way to obtain a good solution, but only if several conditions are met. Firstly, the variability should not be very large. Secondly, the time available for searching for the solution should be short. Finally, the activity list given by the deterministic algorithm must be followed in the appropriate way (with the stochastic Serial SGS). If some of these conditions do not apply, it is advisable to work with the stochastic model, because a better solution will probably be calculated. Depending on the absent condition, the solution of the deterministic algorithm will be better or worse. We have also introduced techniques that seem to be useful for a wide variety of heuristic algorithms for the stochastic problem. With these techniques we have been able to develop a sampling procedure and a genetic algorithm capable of outperforming the few other heuristic algorithms in the literature.

Recently, we have also started to work on the development of an efficient algorithm for the RCPSP with generalized precedence constraints of maximal and minimal types. We have already developed a genetic algorithm - but it is still not competitive with existing algorithms.

d.- Software development

The contracted technician has already completed the following tasks.

- study the project and the related project scheduling skills and techniques

- study the planning system designed for a SMCT

- study the functioning, architecture, and technology used by Selling Soluciones, S. L. for the product eMas.

- design and specify the activities necessary for developing the new pieces of software

- develop a suitable database

- partial development of a graphic interface

- development of some modules that can be easily integrated into SMCT's

- development of associated workflow processes

e.- *Problems found*

The original project requested two postgraduate researches and grants were not subsequently given. This has meant that researcher tasks were reassigned and prioritised. As a result, the task of historically analysing the database has not begun.

The development of the commercial software has progressed more slowly than initially planned. The highly specialised nature of the study has meant that the technician has had to undertake various studies before beginning the task of writing software. This is because he has had to familiarise himself with the project, task planning in a SCMT, the new planning system, the development of workflow applications on commercial platforms, and the product eMas. These studies have had to be combined with more general computing skills in Delphi, C/C++, Lotus Notes, database and so on. Our experience has shown that it was more difficult for a non-specialised technician to handle this task than we had imagine. This has resulted in a two months delay in the development of the modules.

3 Result indicators

Training

- Eva Vicente Abadía. Trabajo Investigación tercer ciclo: *Secuenciación de Proyectos con Plantillas Heterogéneas de Trabajadores.* 2003. Sobresaliente.
- Sylvain Boussier. Estancia de formación reglada en sus estudios en l'IUP Génie Mathématique et Informatique d'Avignon. *Desarrollo de un algoritmo en C para el RCPSP/max.* 2004.
- Agustín Barrios Sarmiento. Proyecto de Tesis Doctoral: *Gestión Automática de Recursos Humanos.* 2004.

Invited presentations

- *Towards a Theory of Peaks for the Resource Constraint Project Scheduling Problem.* Euro / Informs 2003
- *Justification Technique Generalisations.* Euro / Informs 2003

Presentations

- *A new crossover operator for the Resource Constrained Project Scheduling Problem.* Fifth Metaheuristic International Conference, Kyoto, 2003.
- *The Heterogeneous Workforce Project Scheduling Problem.* Ninth International Workshop on Project Management and Scheduling, Nancy, 2004.
- *Due Dates and RCPSP*, Ninth International Workshop on Project Management and Scheduling, Nancy (France), 2004.
- *Project length minimization in preemptive resource-constrained project scheduling*, 20th European Conference on Operational Research: OR and the management of electronic services, Rodas, 2004.
- *Heuristic algorithms for the stochastic RCPSP.* 20th European Conference on Operational Research: OR and the management of electronic services, Rodas, 2004.

TIC2002-02510

Papers submitted to international journals

- *An hybrid genetic algorithm for the RCPSP*. Submitted to European Journal of Operational Research. 2004.
- *When it is worthwhile to work with the stochastic RCPSP*. Submitted to Journal of Scheduling. 2004.
- *Preemption in resource-constrained project scheduling*. Submitted to European Journal of Operational Research. 2004.

Publications in Proceedings

- *The Heterogeneous Workforce Project Scheduling Problem*. Proceedings of the Ninth International Workshop on Project Management and Scheduling, Nancy, 104-108, 2004.
- *Due Dates and RCPSP*, Ninth International Workshop on Project Management and Scheduling, Nancy (France), 114-118, 2004.

Contract signed

- Contract with the company *Francisco Ros Casares, S. A.,* to develop the project *Sistema de planificación en tiempo real para el Centro Multicanal de Soporte. Cost:* 171.583 Euros plus IVA. Duration: 24 months. Signed: March 26, 2004.

Cooperation with other national groups

- We participate in the project *PMSVALNET – Red Valenciana de Project Management and Scheduling*, led by Universidad Politécnica de Valencia and integrated by 6 research groups, and submitted to Sistema Valenciano de Ciencia-tecnología-Empresa (SVCTE) , 2004.

- We participate in the project *RESET – Red sobre Secuenciación de Trabajos*, led by the Universidad de Sevilla and integrated by 16 research groups, and submitted to "*Acciones Complementarias en el marco de algunos Programas Nacionales del Plan Nacional de Investigación Científica, Desarrollo e Innovación Tecnológica 2004-2007",* 2004.

Participation in international projects

- We participate in the project *TRIPLETIME - Transnational Institute for the Promotion of Logistic Efficiency and Transport Integration in the Mediterraneum* led by the university "Libera Università degli Studi Sociali – LUISS Guido Carli" University of Rome, to be presented before October 30, 2004, as part of European Program INTERREG III B – MEDOCCReferences