Developing a novel algorithm for solving the resource-levelling problem or resource-constrained project scheduling

1 Background

The Capability Systems Centre (CSC) is exploring the possibility of collaboration with researchers with expertise in operation research and in particular project management approaches to enhance project and program success addressing issues such as project schedule and cost estimates and, in particular, resource-levelling problems. We are particularly interested in developing new algorithms to enhance schedule and cost estimation and management approaches: for instance, by addressing resource levelling problem. CSC calls for EOIs from interested researchers with the suitable background and expertise to tackle the following work package.

2 Work package overview

A research direction in the CSC is to enhance project/program success by developing advanced tools and techniques addressing issues related to project scheduling, budgeting, and risk. In order to achieve the project success, appropriate and efficient 'project control' tools and techniques should be developed to track project progress. Such innovative tools should consider a variety of uncertainties and changes. The purpose of this work package is to: (a) develop an effective algorithm for addressing the resource-levelling problem in projects, and (b) test applicability and utility of the proposed technique in the applications areas that CSC is interested in.

2.1 Scope

Obtaining a feasible and minimal schedule to minimise the resource usage variations during project execution is pivotal in project scheduling to safeguard effective use of scares resources (Li et al., 2017), which requires optimising both time and resources. These project scheduling challenges are formulated as either: a 'resource-constrained project scheduling problem' (Brucker et al., 1999) that is a 'problem of scarce resources', which minimises the project completion time under the given resource availability; or a 'resource levelling problem' that is a 'problem of scarce time', which optimises resource usage under the project completion time constraint (Möhring 1984; Faghihi et al. 2016).

Since the resource-levelling problem is NP-hard (Neumann WT AL., 2003), addressing scheduling issues in a real-world large/complex project requires continuing improvement of the efficiency and effectiveness of its solution methods (Li et al., 2017).

2.2 Focus

As stated by Li et al. (2017), the available methods for the deterministic resource-levelling problem (considering mainly the 'finish-to-start' relationship between activities) include integer programming (Easa 1989; Hariga and El-Sayegh 2011), dynamic programming (Bandelloni, Tucci, and Rinaldi 1994), problem-specific branch-and-bound procedures (Ahuja 1976), and branch-price-and-cut algorithm (Coughlan, Lübbecke, and Schulz 2015). These approaches attempt to find optimal solutions and are limited in dealing with small instances, so various heuristic and metaheuristic approaches have been proposed to manage large-scale applications, including: genetic algorithms (GA) (Chan, Chua, and Kannan 1996; Leu, Yang, and Huang 2000; El-Rayes and Jun 2009; Ponz-Tienda et al. 2013; Li et al., 2017), path-relinking algorithm (Ranjbar 2013); and a hybrid ant colony – GA (Kyriklidis et al. 2014), to name a few.

In this study, we aim to extend the existing approaches by developing a new algorithm for resource levelling and/or resource-constrained project scheduling problems to address scheduling challenges in complex projects.

2.3 Milestones and Deliverables

Milestone #	Milestone description	Date
1	Initial workshop to establish working arrangements, further define the problem and to clarify any questions or issues.	Within two weeks of commencement of agreement.
2	Literature review and analysis of past studies on 'resource levelling problem' and 'resource-constrained project scheduling problem'. The analysis should categorised the existing approaches and point to any limitations in the employed research designs, and their implications for future research.	
3	Propose a new novel effective algorithm for resource levelling and/or resource-constrained project scheduling problems.	
Deliverable 1: Joint paper with CSC staff covering Milestones 1-3 to be submitted to relevant conference or a journal (TBD)		
5	Develop and use a series of case study vignettes to validate and illustrate the application of the proposed algorithm in practice. This step should result in implementation and technical considerations involved in real large-scale projects.	
Deliverable: Joint paper with CSC staff covering Milestones 1-4 to be submitted to relevant journal (TBD)		

3 References

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4 Requirements

Please provide:

- A brief CV describing your research background.
- A focused statement of your suitability for undertaking the work detailed above.
- A detailed description outlining how you would undertake the research described above.
- A brief project plan attaching dates and an outline budget to the milestones outlined above.

5 Submissions

Submissions must be lodged via email, as a PDF file, to: capabilitysystems@adfa.edu.au.

Inquiries may be directed to: Associate Professor Mike Ryan, Director, Capability Systems Centre, capabilitysystems@adfa.edu.au.