Benchmarking and Comparison of Software Project Human Resource Allocation Optimization Approaches

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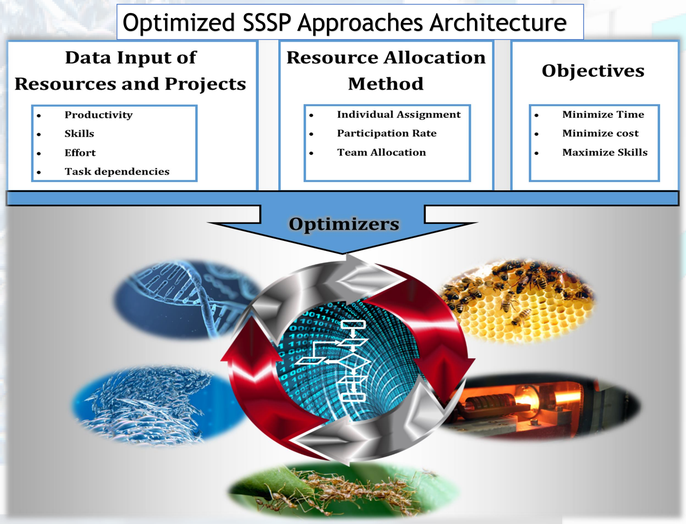
Problem Statement:

Successful resource allocation by Staffing and Scheduling the Software Projects (SSSP) is tremendously challenging as variety of variables need to be considered, such as task dependencies and complexity, resources availability and competencies, and project time [1-4].

- Different optimization techniques specifically meta-heuristics have been used by diversity of SSSP approaches in various incarnations [3, 5, 6].
- These approaches tend to vary in the parameters they consider which means their accuracy, performance and applicability can vastly differ, making it difficult to select the most suitable approach for the problem.



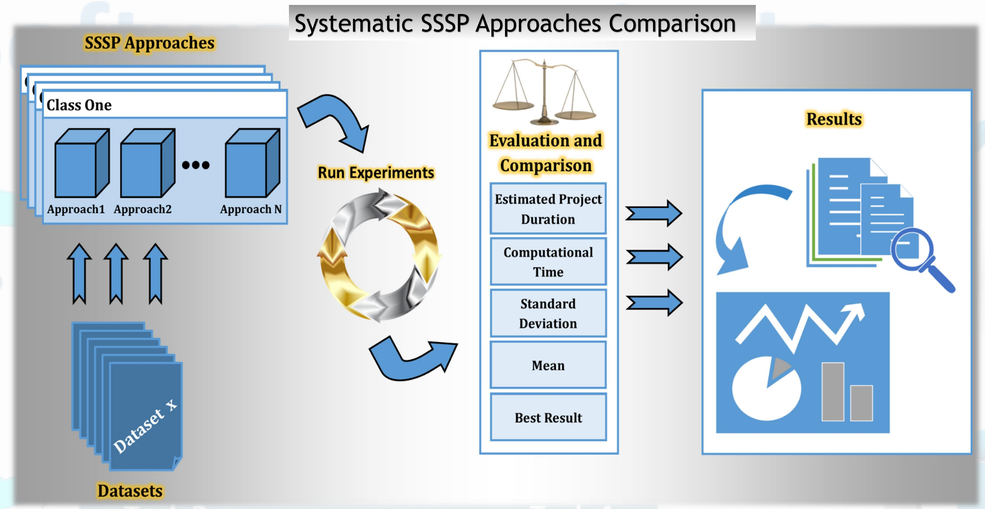
- only two studies [3, 4] were published that compare SSSP approaches but neither of these studies performs an empirical evaluation of SSSP approaches using a unified basis and dataset.
- These studies has compared the approaches by extracting the text that describing the problem and solution of the approaches.
- The fundamental reason for this lack of comparative material lies in the absence of a systematic evaluation method that uses a validation dataset to benchmark SSSP approaches.

Proposed Approach for a Systematic SSSP Comparison:

The proposed approach for performance comparison of SSSP approaches combined with an evaluation dataset and a suite of evaluation criteria consists of:

1. Benchmark Dataset:

The first artefact for the systematic evaluation of SSSP approaches is a flexible and configurable benchmark dataset. The dataset used in this project can be found on: http://seg.cmp.uea.ac.uk/projects/resource-optimisation/files/dataset.zip. Or scan the following QR code



2. SSSP Classes:

The proposed grouping to SSSP approaches according to the inputs and constraints required by each are:

Class One. Inputs of estimated effort , and the number and productivity of human resources.
Class Two. Inputs of estimated effort, dependencies between project tasks, and number and productivity of human resources.
Class Three. Inputs of estimated effort, skills required, and number and productivity of human resources
Class Four. Inputs of estimated effort, dependencies between project tasks, skills required, and the number and productivity of human resources.
Class Five. Inputs of the same nature of class one however the number of tasks and resources represents complex and big software project size.

3. Comparison Metric and Overall Scoring Model:

- **Estimated Project Time (EPT).**
- **Computational Time (CT).**
- **Standard Deviation (STDEV).**
- **Arithmetic average (Mean).**
- **Best Results - Minimal EPT.**

The overall **Scoring Model** consisting of two formulas. The Accuracy (1) and CT (2) performance of an SSSP approach using the following equations:

(1) ***Optimality of solution = [1-[(V-min)/(max-min)]] x 100***

(2) ***CTime Score = [Vct / Max (Class)]***

Application to Set of SSSP Approaches:

Five SSSP approaches are used in this study that are belongs to two different classes -as can be seen in the following table-. These approaches use meta-heuristics such as Genetic Algorithm (GA) and Simulated annealing (SA) to find near optimal solutions.

Class	One	Two	Three	Four	Five
Approach					
[10]	X				
[11]	X				
[7]	X		X		X
[5]		X			
[6]		X		X	

Expected Contribution:

- provide a validation dataset that has both resources and detailed project information for a range of SSSP challenges.
- Provide a systematic process and a set of performance measures that can compare SSSP approaches in various categories and supporting a range of optimisation criteria.
- Evaluation of the performance of a set of SSSP approaches against well-defined performance measures that researchers can use to compare their own approaches to.
- A comparison of computational approaches and current industry standards.

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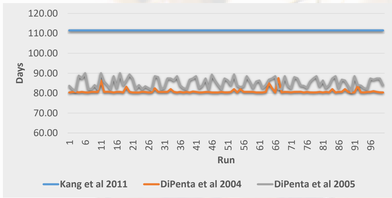
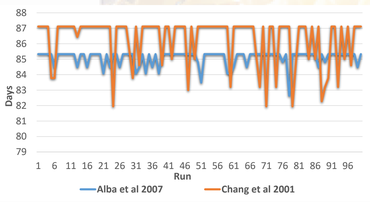
Analysis Results:

The results of **class one Dataset evaluation** using three SSP approaches presented in the following figure and table. The figure shows in graphical representation the data and the behaviour over multiple runs.



Approach	Computation Time		Accuracy of Solution		
	Mean	STDEV	Mean	STDEV	Best Solution
[7]	127.90	2.82	111.5	0	111.5
[10]	285.91	2.57	80.83	1.139	80.33
[11]	109.65	0.19	85.13	2.61	80.6

The results of **Class Two Dataset evaluation** using two SSP approaches presented in the following figure and table.



Approach	Computation Time		Accuracy of Solution		
	Mean	STDEV	Mean	STDEV	Minimal EPT
[5]	41.88	0.17	86.29	1.52	81.95
[6]	134.99	1.91	85.1	0.49	82.64

The results of the comparison between these SSSP approaches are listed in the following table

Class	Approach	Optimality of Result	CT Score
Class One	[7]	96.5%	0.45
	[10]	99.9%	1
	[11]	99.46%	0.3835
Class Two	[5]	99.37%	0.312
	[6]	99.54	1

Research Agenda:

- Refinement of the benchmark dataset.
- Extend the set of implemented and evaluation SSSP approaches.
- Examine a mechanism that allows us to easily bridge the gap between SSSP approaches.
- Evaluate the SSSP benchmarking process suitability and relevance by means of empirical evaluation with industrial partners.

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