Referee Report: Mixed Integer Programming Based Merge Search for Open Pit Block Scheduling

Paper #COR-D-19-00552

Summary: The authors present a new heuristic designed to solve open-pit mine scheduling problems in the form of the so-called *resource-constrained production scheduling problem* more quickly; they accompany their new methodology with a set of compelling results taken from instances of `MineLib`, an on-line library.

Assessment: The paper makes an argument for an improved heuristic designed to solve a particular type of mine scheduling problems. However, it is not publishable in its current form for the following reasons: (i) the problem for which the authors construct their heuristic is not well described; (ii) the literature review is severely muddled and relevant papers have been omitted; (iii) the methodology is disorganized; and (iv) the numerical results are not well presented. Furthermore, the paper must be thoroughly proofread. I elaborate on these issues below.

Page numbers are those given by the authors. Line $-x$ means x lines before the bottom of the page.

Problem Definition

The problem is not well described. The authors use vague words such as "challenging," "efficient" and "best" several times each in the abstract, as well as "significant" (three times in the first six lines of the paper), for example. The abstract omits any quantitative results, and at the bottom of p. 1, a "large number of variables and constraints" is mentioned without any precise information.

Literature Review

- The authors cite Hochbaum and Chen (2000) twice, as if there were two such papers; both citations are incorrectly formatted. But, more importantly, they claim that this work addresses a scheduling problem. It does not. It addresses a specialized maximum flow algorithm for the ultimate pit limit problem (a design problem that does not contain scheduling decisions). This must be fixed and the entire literature review must be rechecked for accuracy.

- In general, the literature review is disorganized. The order in which the papers are described is unsystematic; for example, the common thread among the papers listed in the first full paragraph on p. 2 is unclear. And, the authors' contribution in the context of these papers is not stated. Furthermore, the structure of the RCPSP (the authors use PCPSP, but I am not sure how common this is) is not clearly explained (p. 2) before it is discussed. For example, the authors say that Bley et al. (2010) tighten "the" formulation (p. 3), but what is the formulation?

- The authors are missing many potentially relevant papers. Below is a list I encourage the authors to look through (in addition to performing a more exhaustive search themselves):

  ⋆ Samavati et al. (2017b)

- ⋆ Samavati et al. (2017a)
- ⋆ Morales et al. (2015)
- ⋆ Jélvez and Morales (2017)
- ⋆ Jélvez et al. (2019b)
- ⋆ Jélvez et al. (2019a)
- ⋆ Samavati et al. (2018)
- ⋆ Reus et al. (2018)
- ⋆ Liu and Kozan (2016)
- ⋆ Aras et al. (2019)
- ⋆ Mousavi et al. (2016)
- ⋆ Vossen et al. (2016)
- ⋆ Kenny et al. (2019)

Methodology

- What is the purpose of Figure 1 and the corresponding example?
- At the beginning of §2.2, "solving various aspects of the problem" is not clear (in part, because *the* problem is not clear).
- The authors should state their assumptions more explicitly. For example, their rendition of the model does not consider stockpiling.
- Details such as the number of time periods an instance contains (p. 4) belong in the numerical results section instead and should correspond to the specifics of the problem instances present in `MineLib`.
- Explain the merge search better:
  - ⋆ Does it depend heavily on the version of the RCPSP used in this paper?
  - ⋆ How is an initial feasible solution obtained and how is feasibility maintained throughout the algorithm?
  - ⋆ What is the intuition behind the procedure?
  - ⋆ What is a "large" neighborhood (in Algorithm 1)?
- It is not clear how the various algorithms of §4 fit together.
- The preprocessing in §4.1 is not new and a reference should be given for it. Similarly, the rounding heuristic in §4.3.1 looks a lot like TopoSort from Chicoisne et al. (2012).

Numerical Results

- Table 3 needs to be rescaled to eliminate all the exponential notation. Furthermore, the correct mathematical notation should not contain an E anywhere in it. For example, do not express 10^7 as $E + 07$.
- p. 16: $UB*$ is strange notation and I would use a real superscript if simply UB cannot be used (as in LB^* on p. 17).
- Figure 6-13 seem a bit tedious. And what is the purpose of showing results from both P-MS and MS? Either make a compelling case or summarize and reduce the number of results shown.

Exposition

- Avoid footnotes.
- Choose either American or British spelling (depending on the convention of the journal) and be consistent.
- Do not use colloquial phrases such as "max flow."
- Fix typos, e.g., "the a block" (p. 4, line -3); "an be broken" (p. 12, point 3).
- The only "slashed" word in English is and/or.
- p. 12, line 4: Changes to the costs can get lost??
- p. 22, line 14: It is not necessary to use etc. with e.g., as e.g. already denotes a partial list of examples.
- Various figure captions: All runs across what?

These are just examples and the entire paper must be proofread to eliminate the poor exposition still present.

References

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