Classification of Diploma Thesis – opponent

Author of classification: Ing. Marek Běhálek, Ph.D.
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Opponents: Ing. Marek Běhálek, Ph.D.
Title: Branch and Bound Approach for Scheduling Problem
Thesis version: 1
Student: Bc. Pavel Ivánek

1. Meeting the requirements of the thesis assignment.
   The main idea of this master thesis is to use the Branch and Bound algorithm to solve bounds for various types of the flow-shop problem. This idea was realized, although some parts of the thesis assignment were not addressed. For example, NEH algorithm was not used. The work was of an average difficulty.

2. Thesis technicality evaluation.
   From the technical point of view, the text is acceptable. It is divided into expected chapters, which clearly follow each other. I would expect more space given to the author’s original contribution, while first 25 pages describe known techniques and only 15 remaining pages describe mostly the author’s original work.

3. Results evaluation of the thesis.
   In the work, the Branch and Bound algorithm was used for 4 variants of the flow-shop problem. Flow-shop is NP-hard problem. The size of the searched space is at minimum n!, where n is the number of jobs. So, even small instances are very computationally demanding. The crucial part of the solution is a function that computes lower bounds. If it is well defined, it allows cutting some branches and thus it reduces the size of the problem. For 3 problems, lower bound functions from the referenced papers are used. There is no explanation, why these functions were chosen. For the simple flow-shop, probably new lower bound function was invented by the author. This lower bound is very poorly described (Section 4.1.1). The text is not concise with the presented formal definition. Also, very important is a strategy that is used to explore the solutions space. The author uses a slightly modified depth first search.

   Mentioned approach was implemented in C++, but it is in fact very simple. I would expect that the author will try different variants for lower bound functions or he will be tuning-up the performance of this initial solution. Or at least provide some additional information about the computed results. No other extensions (like mentioned NEH algorithm) were implemented.

   Implemented algorithms were used to compute bounds for the extended Taillard set. During the testing, a very strict time limit was used. An instance was allowed to run only several seconds. So the obtained results are inconclusive. For example (if I read the results correctly), just one solution (from 1000 factorial solutions) was generated for the largest instance of the permutation flow-shop.

   Finally, the quality of the text of the master thesis itself is low. There are various inconsistencies or errors. For example, the example from section 2.3 is very hard to read. Due date is informally defined as a time when the job can be completed at the latest. Following this definition, there is no valid schedule for jobs from Table 1. Moreover, the lower bound function defined in this section is clearly wrong (following the described calculations and considering two jobs J1(10, 3) and J2(3,3) as unscheduled, we get the lower bound 7+10 = 17, while the tardiness for the sequence J2 J1 is 10, so the computed value is not the lower bound). Moreover, the lower bound computed as an example is not the same as the lower bound in the corresponding node in the following figure.

4. Evaluation of the new findings contribution.
   For the experiments, extended Taillard benchmark data set was used. For new instances from this set no bounds were known before.

5. Utilization and selection of information sources.
   Used information sources are selected wisely and are well chosen considering the solved problem.
They are referenced in the text. It can be distinguished what is the author’s work and which part are taken from other sources. The text contains some formal definitions that are taken from referenced sources. In this case, I would expect a more precise reference. For example on page 21, there is Theorem 3.1 from [6]. But [6] contains many theorems and I was unable to find the referenced theorem. If it is just an observation based on [6], then while it is a theorem, it needs to be proven.

6. **Question for the defense of the thesis.**

7. **Summary evaluation.**

   The main idea of the master thesis was to use the Branch and Bound algorithm to compute bounds for new large instances from the extended Tillard set. Some variants of this algorithm were implemented for selected types of the flow-shop problem. But this implementation represents something like an initial solution and if we want to obtain some meaningful bounds especially for large instances, it still requires a lot of work. So at the end we have a relatively simple solution (several hundred non-repeating code lines), performed experiments with weak results and a poorly written text with many inconsistencies. It is hard to judge the amount of time that was invested by the author to create his master thesis, but I believe that it was low, for sure it is lower than was necessary. So I cannot rate the work as acceptable for the master thesis.

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**Overall classification:** insufficient

Ostrava, 31.05.2015

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