I. IDENTIFICATION DATA

Thesis name:	**Meta-heuristics for routing problems**
Author's name:	**Jan Mikula**
Type of thesis :	bachelor
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Control Engineering
Thesis reviewer:	Dr. Juan José Miranda Bront
Reviewer's department:	School of Business, Universidad Torcuato Di Tella / CONICET (Argentina)

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment   **challenging**

Evaluation of thesis difficulty of assignment.

The objectives of the thesis aim at improving recent methods already published in the operations research literature and to evaluate its application within autonomous mobile robotics. This represents a major challenge regarding a bachelor thesis, given that advances particular knowledge in both areas (optimization and robotics) are required to carry out the project and, furthermore, the aim is to obtain improved results compared to the literature. Therefore, in my opinion the thesis represents an excellent assignment.

Satisfaction of assignment   **fulfilled**

Assess that handed thesis meets assignment. Present points of assignment that fell short or were extended. Try to assess importance, impact or cause of each shortcoming.

The assignment proposed is, in my opinion, fulfilled. A previous metaheuristic approach for the Graph Search Problem (GSP) is improved for the context of application considered in the thesis, improving the both the quality of the solutions found and the computing times. On the other hand, an experimental environment for the Serach Problem in a Known Environment is considered, building upon the previous results. Thus, the thesis covers the development of a tailored metaheuristic for the GSP and its corresponding evaluation within the context of application proposed.

Method of conception   **correct**

Assess that student has chosen correct approach or solution methods.

The GSP is correctly approached by developing a Variable Neighborhood Search (VNS) approach, a well known metaheuristic framework which has shown to provide an excellent performance on a wide variety of optimization problems. The tailored metaheuristic is built correctly, analyzing the impact of each of its component in terms of quality, algorithmic complexity and its potential impact when incorporated within the framework. Finally, the approach is correctly evaluated on benchmark instances from the related literature to assess for its effectivenes. Regarding the context of application, a wide variety of techniques widely used within the robotic community are applied, emphasizing on their application in the particular context and discussing different alternatives that capture the particular characteristics of the problem. Overall, in my opinion from a methodological perspective the approach is correct.

Technical level   **A - excellent.**

Assess level of thesis specialty, use of knowledge gained by study and by expert literature, use of sources and data gained by experience.

The thesis builds upon a wide variety of advanced computational techniques, in particular, some of the very advanced in the context of optimization, operations research and computer science. The developments consider recent and solid methods and related scientific literature, as well as diverse comptutaional tools which are combined to tackle the two problems proposed (the optimization problem and its corresponding application).

Formal and language level, scope of thesis

A - excellent.

Assess correctness of usage of formal notation. Assess typographical and language arrangement of thesis.
The thesis is correctly written, with a correct formal notation level combined with the necessary explanations to give the necessary intuitions when required.

Selection of sources, citation correctness

A - excellent.

Present your opinion to student's activity when obtaining and using study materials for thesis creation. Characterize selection of sources. Assess that student used all relevant sources. Verify that all used elements are correctly distinguished from own results and thoughts. Assess that citation ethics has not been breached and that all bibliographic citations are complete and in accordance with citation convention and standards.
The literature regarding the optimization methods is correctly cited, including updated references to realted problems and techniques. The student correctly identifies the contributions in each cases, and clearly establishes how they are incorporated and/or extended within the thesis. To the best of my knowledge, all relevant citations related to the problems covered are covered by the bibliography considered.

Additional commentary and evaluation

Present your opinion to achieved primary goals of thesis, e.g. level of theoretical results, level and functionality of technical or software conception, publication performance, experimental dexterity etc.
Overall, I believe the both the student and his advisor conducted a nice work, setting clear objectives and achieving them satisfctorily through solid methodology. The problem under study is very interesting both from a practical perspective as well as regarding the theoretical and algorithmic challenges it includes. The developments proposed within the thesis, including advanced optimization techniques, require a detailed knowledge about the methods, which are later evaluated in an experimental setting. Overall, I believe the results in this thesis could result in one more publications and leave open several research lines to be extended in the future.

III. OVERALL EVALUATION, QUESTIONS FOR DEFENSE, CLASSIFICATION SUGGESTION

Summarize thesis aspects that swayed your final evaluation. Please present apt questions which student should answer during defense.

The thesis covers a very interesting, difficult and challenging problem by combining advance optimization methods applied to mobile robotics. The objectives of the project are very clear and the solution approach combines state of the art ideas with particular characteristics of the problem. Furthemore, the thesis represents a good contribution by improving previous results in the scientific literature.

I have a some simple questions which can be addressed during the defense:

1. Can you give an explanation (or at least an intuition) why bVNS-v2 improves the results obtained by the previous GRASP-based approaches? What do you think is the most important characteristic that would justify the difference in the computing times for these set of instances?

2. How did you defined the configurations for both bVNS versions, mainly regarding the configurations for the neighborhoods structures (M and N) and the number of iterations?

3. The LK-operator is shown to obtain good quality solutions, but it is more demanding in terms of computing times than other neighborhoods. Have you considered including it within the VNS approach in

some fashion? If not, do you think it may be help to improve the results obtained so far (eventually by modifying it conveniently).

Overall, I would like to congratulate both Jan Mikula as well as his advisor for the job done. Nice work! I evaluate handed thesis with classification grade A - excellent.

Date: **01/06/2018**

Signature: Dr. Juan José Miranda-Bront.