THESIS REVIEWER'S REPORT

I. IDENTIFICATION DATA

Thesis title:	**Learning-Based Solution to Routing Problems**
Author's name:	**Petra Fridrichová**
Type of thesis :	master
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Cybernetics
Thesis reviewer:	Robert Pěnička
Reviewer's department:	Department of Cybernetics

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment	challenging

How demanding was the assigned project?

I consider the assignment to be quite challenging.

Fulfilment of assignment	fulfilled

How well does the thesis fulfil the assigned task? Have the primary goals been achieved? Which assigned tasks have been incompletely covered, and which parts of the thesis are overextended? Justify your answer.

To my best knowledge the assignment has been fulfilled.

Methodology	correct

Comment on the correctness of the approach and/or the solution methods.

The methodology is quite complex as it combines a lot of techniques such as encoder-decoder neural network, nearest neighbor search, Growing Self-Organizing Array, and Variable Neighborhood Search. Nevertheless, the performance of the final method is convincing about its correctness.

Technical level	B - very good.

Is the thesis technically sound? How well did the student employ expertise in the field of his/her field of study? Does the student explain clearly what he/she has done?

In general, the thesis is technically sound and a lot of algorithms relevant to the student's study field is either directly used in the proposed method, or tested as competitive approach.

Yet, I miss crucial information regarding the important and only learning part of the thesis (which inspired the thesis name) about the encoder-decoder network. For example, how many layers with how many neurons, what activation function is used, and how is the network trained? Moreover, practical information is missing such as how a fixed-size network is used on differently sized instances. While the encoder-decoder part is based on cited existing work, inclusion of such information seems important to understand the methodology in a self-contained format.

In the beginning of the thesis, we can read that heuristics are beneficial solvers mostly due to their computational time. However, the thesis does not compare in the main text the computational times of the methods nor discuss them in the text. This is very strange because based on the appendix tables the computational times of the proposed method are very competitive to other methods while being also interesting when comparing GSOA and greedy feasible solution creators.

Formal and language level, scope of thesis	A - excellent.

Are formalisms and notations used properly? Is the thesis organized in a logical way? Is the thesis sufficiently extensive? Is the thesis well-presented? Is the language clear and understandable? Is the English satisfactory?

In overall the thesis is nicely organized and very-well readable with only few mistakes. However, please notice the written but otherwise non-existing variable k in the optimization problem (3.1) you are trying to solve.

Selection of sources, citation correctness	B - very good.
Does the thesis make adequate reference to earlier work on the topic? Was the selection of sources adequate? Is the student's original work clearly distinguished from earlier work in the field? Do the bibliographic citations meet the standards?	
In general, the thesis nicely overviews existing methods for solving the studied problem including exact algorithms, heuristics and learning-based methods. Yet, I miss more citations of existing literature in the Background chapter 4 that servers to introduce the employed methods to the reader. For example, the 4.1 "Encoder-Decoder Architecture" and its subsection "Embedding as a Feature Vector" does not cite any works that either use these techniques or introduced them.	

III. OVERALL EVALUATION, QUESTIONS FOR THE PRESENTATION AND DEFENSE OF THE THESIS, SUGGESTED GRADE

In overall I consider the thesis to be very interesting and inspiring in employing learning-based approaches in combinatorial optimization routing problems. However, there are several aspects of the work that I consider to be slightly missing as described above. Most importantly the missing comparison of computational time of the methods and its discussion in the main text, missing details about the learned encoder part of the method, and missing references in the Background chapter.

Nevertheless, the thesis is nicely written and certainly has its merit in showing the potential of combining learning-based and heuristic approaches for the studied Travelling Salesman Problem. Therefore, the grade that I award for the thesis is **B - very good.**

Questions:
1. What are the parameters of the used encoder network? How is the network used for differently large TSP instances?
2. Why do you use the learned embedding from the encoder with follow-up nearest neighbor search instead of the TSP solution that would be given by the encoder-decoder as shown in Fig.4.1. It would be interesting if in such a case the full NN generalizes better than half of the network with subsequent nearest neighbor search.

Date: **1.6.2023**   Signature: