

## I. IDENTIFICATION DATA

<b>Thesis title:</b>	Input-Output Representations for Supervised Clustering Methods
<b>Author's name:</b>	Jakub Monhart
<b>Type of thesis :</b>	bachelor
<b>Faculty/Institute:</b>	Faculty of Electrical Engineering (FEE)
<b>Department:</b>	Control Engineering
<b>Thesis reviewer:</b>	Gustav Šír
<b>Reviewer's department:</b>	Computer Science

## II. EVALUATION OF INDIVIDUAL CRITERIA

<b>Assignment</b>	<b>challenging</b>
<i>How demanding was the assigned project?</i>	
The thesis explores a number of advanced neural methods (although it is limited merely to their evaluation).	

<b>Fulfilment of assignment</b>	<b>fulfilled with minor objections</b>
<i>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.</i>	
The thesis seems fixed to the single (numeric matrix) representation approach (specified in the beginning) instead of exploring the possible variety, but that's fine with me – it explores a variety of models operating upon it instead.	

<b>Methodology</b>	<b>correct</b>
<i>Comment on the correctness of the approach and/or the solution methods.</i>	
The student experiments with a number of state-of-the-art methods, which is highly commendable for a bachelor. In some aspects this actually seems a bit overstretched to me, as I would find it more appropriate to compare with some simple baselines first (see comments), but the approach is correctly aligned with the assignment.	

<b>Technical level</b>	<b>A - excellent.</b>
<i>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?</i>	
Sound and clear. The approach is well structured and documented in a professional manner.	

<b>Formal and language level, scope of thesis</b>	<b>A - excellent.</b>
<i>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?</i>	
Very nice, comprehensible and generally pleasant to read. I appreciate the notation, even though it's not flawless. The typography is great, too. English level is excellent.	

<b>Selection of sources, citation correctness</b>	<b>A - excellent.</b>
<i>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?</i>	
The thesis is fully based on existing works, but it is denoted appropriately beforehand, in agreement with the assignment.	

<b>Additional commentary and evaluation (optional)</b>
<i>Comment on the overall quality of the thesis, its novelty and its impact on the field, its strengths and weaknesses, the utility of the solution that is presented, the theoretical/formal level, the student's skillfulness, etc.</i>
See below

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

*Summarize your opinion on the thesis and explain your final grading. Pose questions that should be answered during the presentation and defense of the student's work.*

This is a very nice thesis discussing a number of advanced neural architectures beyond the common fixed-size tensor representations. I commend the student highly for having to study their principles, and for their presentation in the respective background chapter. The implementation and experimental parts seem appropriate for a Bachelor thesis. I'm not completely persuaded by the selected approach to the task, but it seems completely in agreement with the assignment.

*Some minor comments:*

In the text, you put a lot of emphasis on the elements' (cluster) "context" importance in the neural model processing part, which is why you discard the simpler (neural) models and the respective representations at the very beginning. But then you use spectral clustering which considers the elements jointly, too, by operating globally on the similarity matrix (graph/manifold). The artificial tasks you introduce (nested circles and gaussians) are then commonly used for demonstration of spectral clustering – i.e. I'm quite sure it would be able to solve these on its own, i.e. without any similarity metric pre-learning (with an appropriate kernel, e.g. RBF for the gaussians and 3-NN for the circles). I therefore very much miss this natural baseline in the work, as it is not clear to me what is the added value of the neural models here, if any.

Also, the choice of the 2<sup>nd</sup> step clustering and its parameters will significantly influence the models, which is not accounted for here – this should be studied before approaching the task end-to-end, as proposed at the end.

Here, given that you have the labels, the task seems closer to the "collective classification" setting, and Graph Neural Network architectures could be an appropriate choice (although they would be quite similar to the Transformers actually). Or, instead of being fancy with the latest deep learning proposals, you could just try good old Kohonen maps (for the 1<sup>st</sup> projection part of elements based on their context).

Also, regarding the actual last task of (semantic) clustering of textual blocks within documents - I would suggest to perform a more thorough review of the literature, there is also a local company "Rossum" doing just that.

*Ad-hoc:*

- Math notation:
  - "We trade the mathematical correctness of our notation.." you could have just used  $\mathcal{X}$  for the set notation, and leave  $X$  for the matrix, as usual
  - $y \in [1, \dots, kX]^{nX}$  – that's a bit cumbersome definition of a vector of labels – the labels are chosen from a set  $\{1..kx\}$  and only then you create a vector of length  $nX$  with these...
- equation 2.1 – this doesn't seem like a definition of an equivariant fcn to me (more like an element-wise expansion of a vector fcn...you should have taken it from [12] as is)
- Training complexity  $O(nx)$  – but that's just a single step, not training complexity

typos: informationx, similiary, propably

The grade that I award for the thesis is **A - excellent**.

Date: **31.5.2021**

Signature: