FACULTY
OF INFORMATION
TECHNOLOGY
CTU IN PRAGUE

Review report of a final thesis

Reviewer:	Mgr. Alexander Kovalenko, Ph.D.
Student:	Bc. František Koutenský
Thesis title:	Improving neural cellular automata by incorporating physical dynamics
Branch / specialization:	Computer Science
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Evaluation criteria

1. Fulfillment of the assignment

▸ [1] **assignment fulfilled**
[2] assignment fulfilled with minor objections
[3] assignment fulfilled with major objections
[4] assignment not fulfilled

2. Main written part

90 / 100 (A)

The Final Thesis (FT) is well-written and technically sound. The literature review is thorough, providing essential information to acquaint the reader with the topic.
Upon review, no significant language or typographical issues were found. Relevant references are appropriately quoted and cited. All quotations are clearly differentiated from the findings presented in the FT. Only open-source software was utilized for the FT.
Minor remarks:
- Sometimes acronyms are used along with full names. The standard practice for acronyms is to use the full name initially followed by the acronym in parentheses. Thereafter, only the acronym should be used throughout the text.
- Some figures are not very informative or need better description (eg. Figure 2.6), Additionally, both Figure 2.7 and Figure 2.10 share fundamentally the same caption, making it challenging to discern their distinct content.
- The "Current Work" section appears somewhat fragmented. For instance, to grasp the "Constrained vs. Unconstrained" principle, readers must refer to the "Learning Differential Operators" segment in the literature review and infer its relation to the physical constraints imposed on the model. Elaborating on these constraints within the practical section would enhance clarity.
- Similarly, for the "unknown" vs. "known" configurations, it would enhance FT clarity if the student provided explanations for these configurations at the beginning of each section.
- Some rather important implementations are not well-argumented (i.e. the choice of the

loss function multipliers)
- Using "we" in FT appears out of place since it's an individual project, impersonally written text using passive voice would be more appropriate.

3. Non-written part, attachments 98/100 (A)

The attached source code is well-structured, and even with the lack of documentation and comments, it remains readable. The results are readily reproducible.

4. Evaluation of results, publication outputs and awards 99/100 (A)

The topic of PINCA is extremely intriguing and holds vast potential in numerous fields.

The overall evaluation 95/100 (A)

A solid first-stage fundamental research work with the potential to expand into various fields way beyond leopard patterns.

Questions for the defense

My biggest concern is the loss function:
- Given the goals and domain, do you consider pixel-wise image comparison MSE (with additional components) to be the most appropriate measure of successful training?
- Would you subjectively evaluate the result as a failure if the output would be a "leopard pattern" but with larger/smaller dots even though MSE-based loss might classify it as such?
- How the multipliers in the loss function were obtained?
- Are these multipliers architecture dependent?
- What are the ratios between the three components of the loss function, and which is the dominant one?
- How the loss computed on the constrained filters was obtained?
- Since filter loss (constraints) adds to the total loss, what is the reason that in Figure 2.7 constrained model has a lower loss than the unconstrained one?
Regarding the governing equations:
- As for my understanding the equations were extracted from the learned convolutional filters, do you think that the anisotropy that is uncommon in traditional Turing reaction-diffusion models may be inherited from the learned kernels that can exhibit anisotropic properties, especially given the dataset and the training method? Do you view this anisotropy as intrinsic to the reaction-diffusion model or more as a byproduct of the NCA?

Instructions

Fulfillment of the assignment

Assess whether the submitted FT defines the objectives sufficiently and in line with the assignment; whether the objectives are formulated correctly and fulfilled sufficiently. In the comment, specify the points of the assignment that have not been met, assess the severity, impact, and, if appropriate, also the cause of the deficiencies. If the assignment differs substantially from the standards for the FT or if the student has developed the FT beyond the assignment, describe the way it got reflected on the quality of the assignment's fulfilment and the way it affected your final evaluation.

Main written part

Evaluate whether the extent of the FT is adequate to its content and scope: are all the parts of the FT contentful and necessary? Next, consider whether the submitted FT is actually correct – are there factual errors or inaccuracies?

Evaluate the logical structure of the FT, the thematic flow between chapters and whether the text is comprehensible to the reader. Assess whether the formal notations in the FT are used correctly. Assess the typographic and language aspects of the FT, follow the Dean's Directive No. 52/2021, Art. 3.

Evaluate whether the relevant sources are properly used, quoted and cited. Verify that all quotes are properly distinguished from the results achieved in the FT, thus, that the citation ethics has not been violated and that the citations are complete and in accordance with citation practices and standards. Finally, evaluate whether the software and other copyrighted works have been used in accordance with their license terms.

Non-written part, attachments

Depending on the nature of the FT, comment on the non-written part of the thesis. For example: SW work – the overall quality of the program. Is the technology used (from the development to deployment) suitable and adequate? HW – functional sample. Evaluate the technology and tools used. Research and experimental work – repeatability of the experiment.

Evaluation of results, publication outputs and awards

Depending on the nature of the thesis, estimate whether the thesis results could be deployed in practice; alternatively, evaluate whether the results of the FT extend the already published/known results or whether they bring in completely new findings.

The overall evaluation

Summarize which of the aspects of the FT affected your grading process the most. The overall grade does not need to be an arithmetic mean (or other value) calculated from the evaluation in the previous criteria. Generally, a well-fulfilled assignment is assessed by grade A.