

REPORT OF SUPERVISOR OF BACHELOR THESIS

Title: Deep learning for the solution of differential equations

Author: Matěj Vais

SUMMARY OF THE WORK

This thesis compares solving differential equations using physics informed neural networks (PINN) with a more classical numerical method (the finite element method). It first summaries both the PINN and finite element methods, and performs numerical solution of a linear, nonlinear, and singularly perturbed differential equation using these methods.

OVERALL EVALUATION OF THE WORK

Thesis topic. The topic is suitable for a thesis, and has been successfully completed.

Author's contribution. The author has summarised the existing methods and has performed numerical experiments to compare them.

Mathematical level. The mathematical content is sufficient and fairly good, but has some short comings. There are several notation errors, such as in the title for Figure 1.1 the second use of \mathbf{W}^1 and \mathbf{b}^1 should be \mathbf{W}^2 and \mathbf{b}^2 . Similarly, some definitions are missing; for example, what is \mathcal{P}_1 ? Furthermore, while the description of the PINN included is fairly good, it misses some details which would make it harder to understand for anybody without knowledge of neural networks. As such, a more detail description of neural networks would have been useful.

The numerical results for the problems are fairly interesting. However, some more details in a few areas would be useful. For example, more detail on what happens with the singularly perturbed problem for PINN would be good; for example, how does it fail as $\epsilon \rightarrow 0$ and why?

Sources. The references which are present are generally good, but a few additional references for some statements would have been useful.

Formal preparation. The structure of the thesis and the general level of language is good, although with a few typographical or spelling errors. Additionally there are several mistakes which give an impression of a slightly rushed write without proper proof-reading (such as repeated words; for example *the*).

CONCLUSION

I recommend this thesis as a bachelor thesis

Scott Congreve, Ph.D.
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