

# Master's Thesis

## How to do linear algebra with Transformers?

In this master's thesis, the student will investigate which iterative algorithms can be implemented by neural networks, specifically Transformer-like architectures (1). This is of great interest to AI as these abilities shed light on what and how neural networks compute.

It has been shown that Transformers can solve complex linear algebra problems such as matrix inversion (2). Nevertheless, the exact mechanics of implementation in the neural network are unknown.

### Aims of the project

- In this thesis, the goal is to provide explicit neural network resp. Transformer weights in order to implement, for instance, a truncated Neumann series to iteratively compute an approximate to the desired matrix inverse.
- Based on these constructions, the student should then aim to empirically study if and when optimisation of Transformers finds (or does not) the identified construction, proving its relevance in practice.

**Prerequisites: Linear algebra and Python programming**

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More information about writing a thesis in our group and a grading scheme can be found [here](#).

## References

- Ashish Vaswani, Noam Shazeer, Niki Parmar, Jakob Uszkoreit, Llion Jones, Aidan N. Gomez, Lukasz Kaiser, and Illia Polosukhin. *Attention Is All You Need*, 2017.
- Francois Charton. *Linear algebra with transformers*, 2022.