RAMT: Ethical Impact Statement

This research studies the transformer architecture applied to raw audio data for automatic generation of harmonies, using a collection of Bach's previous work. Considering the original transformer model, proposed in [1], memory scales quadratically with sequence length and the main challenge has therefore been investigate adaptations to facilitate for the inherently long sequence in the raw audio domain. Even though the generation of musical harmonies in itself does not raise significant ethical concerns, it is worth discussing some of the potential ethical implication that could arise from proposing transformer systems that enhances current models for long sequences.

Transformer models have set a new quintessential standard within natural language processing (NLP) modelling, with OpenAI's GPT models taking the community by storm. GPT-3 have achieved unpresented performance in various NLP tasks, such as generating articles, news reports and dialog. However, such models have also been subject to particular scrutiny, due to the range of potential ethical implications. People repeatedly reported on the models producing hate-speech, fake news and being biased towards particular races and demographics. In particular, by conducting research into transformer models for longer sequences, our study could potentially contribute to the development of NLP models that could generate "better" fake news and hate-speech [2][3].

Machine learning is also increasingly finding its way into military applications. Various instruments used by the army, rely on sensor data, which draws resemblance to raw audio data, as high **sampling** frequencies can result in very long-sequenced data. As mentioned previously, the vanilla transformer model (and more traditional recurrent networks) struggle to capture dependencies across long sequences of data. Since our study aim to investigate and propose methods to process such time-series data, our findings could potentially be used for various military applications[4], such as forecasting, interpretation of sensor data and various other prediction tasks based on raw sensor data, without having to significantly alter our proposed methods.

Finally, as with most of the research within deep learning, it has become increasingly important to be aware of the adverse effects this field have on the environment. Returning to the GPT-3 model, it was guesstimated that training of this model consumed some 190,000 kWh of energy, roughly the same energy required to drive a car the distance to the moon and back [5]. A slightly more formal research, estimates that the end-to-end training of a transformer (big), with neural architecture search, consume 280,000 $CO_2e\ (kg)$. Compared to the 900 $CO_2e\ (kg)$, estimated for a 1 passenger flight from New York to San Francisco, this is a staggering amount [6]. Even though the accuracy of such estimates are debatable, it is evident that it has become pivotal to start thinking more about the carbon footprint and energy consumption resulting from increased research and use of new AI models.

References:

[1] ASWANI, Ashish, et al. Attention is all you need. In: Advances inneural information processing systems. 2017. p. 5998-6008.

[2] Website: https://www.bbc.com/news/technology-49446729 (Accessed 27.10.21).

[3] Website: https://www.forbes.com/sites/helenleebouygues/2021/07/15/what-happens-when-robots-make-fake-news/?sh=2ecc2f077453 (Accessed 27.10.21).

[4] Website: https://medium.com/@nqabell89/7-key-military-applications-of-machine-learning-9818dfa2ea86 (Accessed 27.10.21).

[5] Website: https://www.theregister.com/2020/11/04/gpt3_carbon_footprint_estimate/ (Accessed 27.10.21).

[6] Strubell, E., Ganesh, A., & McCallum, A. (2019). Energy and policy considerations for deep learning in NLP. *arXiv preprint arXiv:1906.02243*.