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CS 410 Tech Review

TensorFlow and PyTorch

"AI is one of the most important things humanity is working on" (Sundar Pichai). As technology advances, the importance of artificial intelligence and machine learning has only increased since some of the newer technology requires some degree of intelligence. Computer vision is used to navigate self-driving cars, natural language processing is used to determine the sentiments of text, and much more. Helping to facilitate these advancements, machine learning has become more accessible. Of the available open source machine learning frameworks, TensorFlow and PyTorch are the most popular. Both offer a wide variety of machine learning and neural network models that can be used by beginners and experts.

TensorFlow was first developed by the Google Brain team as an internal research tool. It was released to the public in November 2015 (TensorFlow, n.d). Later in October 2019, Google took user feedback into consideration and TensorFlow 2.0 was released (TensorFlow, n.d.). The new version was aimed to be more user-friendly, however, the new features were not all backwards compatible with code written for the original framework (Abdullahi, 2022). At that time, another competitor, PyTorch, was on the rise. While TensorFlow had a head start providing open-source machine learning, Pytorch entered the field one year later in September 2016 (PyTorch, n.d.). PyTorch was developed by Meta's artificial intelligence team. Its framework aimed to make it easy to go from prototyping to deployment (Abdullahi, 2022). This flexibility led to Pytorch being popular in academic and research areas. Furthermore, instead of rewriting code for Tensor 2.0, some developers chose to give PyTorch a try. Pytorch was thus given a

window of opportunity. Despite the changes, TensorFlow remains particularly popular for machine learning in industrial production.

One of the main differences between the two frameworks is the construction of their computational graphs. TensorFlow pre-defines its graphs at the beginning of training and then computations are executed after all graphs are defined (Abdullahi, 2022). This can be beneficial in performance for large models. But, it also means that training models are more rigid and cannot be changed while training (Abdullahi, 2022). On the other hand, PyTorch constructs graphs as operations are executed (Abdullahi, 2022). This leads to less complex graphs because unnecessary data does not get included in intermediate nodes. However, there may be performance issues (Abdullahi, 2022).

TensorFlow and PyTorch also have different approaches to features. PyTorch has primarily lower level APIs which gives developers additional options to customize and optimize array expressions (Abdullahi, 2022). TensorFlow offers both high and low level APIs (Abdullahi, 2022). The higher level APIs are great for ease-of-use while the lower level APIs provide more control. Having both provides options for different users and workflow types. For debugging code, PyTorch can use Python debugging tools such as PyCharm Debugger and pdb because it uses immediate execution (Abdullahi, 2022). TensorFlow requires the user to write code in your graph or to use TensorFlow debugger (Abdullahi, 2022). Finally, TensorFlow has TensorBoard, which users can use to visualize and help debug training models. PyTorch does not have its own visualization tool, but it can use TensorBoard (Abdullahi, 2022).

TensorFlow and PyTorch are both good options for building machine learning models. While TensorFlow has a wider range of features, PyTorch can be easier to get up and running faster. Generally, PyTorch is great for individual research because of its flexibility and ease of use. In contrast, TensorFlow excels in production due to its ability to scale for larger models.

References

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