Comparison between TensorFlow by Google and PyTorch by Facebook in NLP, and a Sneak Peek at Keras

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Natural language processing can trace its origins to the 1950s and the famous Turing test is a key component of what we consider to be “intelligence”. Yet, before the implementation of neural networks and deep learning, there were very limited success with NLP using symbolic and statistical models. There are numerous challenges to NLP and neural networks is the way to achieve state-of-the-art results in language modelling, parsing, and much more.

As a student in data sciences and particularly text information systems, the best tool for NLP using neural networks is a fascinating topic. Currently, there are two front runners in terms popularity, TensorFlow by Google and PyTorch by Facebook. Both libraries are open-sources machine learning libraries on the Python programming language, yet there are factors that differentiate TensorFlow and PyTorch for a potential user. It is crucial for a new student in the field to pick the right tool for the job.

There are much to be said about the differences between TensorFlow and PyTorch in terms of ease of use, support, scalability, style, and security. But there are many reviews and articles online discussing these details, I have included some of the best ones I read in the references, and I have attached a table to show some of the differences. However, NLP is the focus of the discussion here, so this review will prioritize what is important to a new student who is picking a library to start their first study project into NLP.

The learning curve with TensorFlow is another major strike, the lack of online resources for beginners and the incomprehensible API make it incredibly difficult for new users to learn. The only great resource I have found is this Coursera course taught by Laurence Moroney from deeplearning.ai. https://www.coursera.org/learn/natural-

language-processing-tensorflow which have been invaluable to understand NLP with TensorFlow. On the other hand, there is quite a comprehensive tutorial library on pytorch.org. *Deep Learning for NLP with PyTorch*② and NLP From Scratch series③ are particularly helpful to a new user.

State-of-the-art NLP using neural networks use Recurrent Neural Networks (RNN). PyTorch offers multi-layer classes with nn.RNN, nn.GRU and nn.LSTM. Objects of these classes can represent deep bidirectional recurrent neural networks. And cell-level classes with nn.RNNCell, nn.GRUCell and nn.LSTMCell. Objects of these classes can represent only a single cell that can handle one timestep of the input data.① TensorFlow uses the tf.nn.rnn_cell module for RNN functionality, and there are cell level classes and MultiRNNCell class within tf.nn.rnn module to provide the same functionalities as PyTorch. One of the common complaints with TensorFlow is its API, and Keras makes TensorFlow more usable. Keras also provide recurrent layers in the library with sequential and functional APIs for building a NN model.

Another important factor for a student is the outlook of the future in NLP, some people believe Transformers will become the dominate NLP architecture, replacing RNN.④ TensorFlow, with TensorFlow 2.0 already has a stable release for Transformer architecture. PyTorch also has released many pre-trained transformer models at Huggingface's https://github.com/huggingface/transformers.

A major difference between TensorFlow and PyTorch is that TensorFlow utilize static computational graphs where PyTorch utilize dynamic computational graphs. Static graphs work well with fixed-size networks where dynamic graphs works well for dynamic

graphs. In NLP, or more broadly in neural networks, variable length input is extremely useful, and as such, dynamic computational graphs give PyTorch a huge advantage.

Even though with the TensorFlow 2.0 release and the full integration of Keras. The API and tools are still less pythonic than PyTorch, which means a higher learning curve than PyTorch. Coupled with the fact that the inherent advantage of the computation graphs employed by the two frameworks, it is no wonder that PyTorch has been gaining in popularity since 2017. The number of research papers using PyTorch has exceeded that of TensorFlow in 2019[5], and that trend seems to continue. As a student seeking to build a NLP research project efficiently, I would pick PyTorch. But if I am looking to build a commercial NLP project, TensorFlow is still the top choice due to support, scalability, and high-level API.

	TensorFlow	**PyTorch**
Developed by	Google	Facebook
Graphs	Static graphs	Dynamic graphs
Distinguish Feature	Support for CUDA	TensorBoard
Learning curve	Steep learning curve	Easy to learn
Level of API	Provides both high and low level APIs	Provides only Low level APIs
Architecture	Complicated and may not be very helpful for the beginners	Complex and readability is less
Ease of Use	Provides a reduced size model with high accuracy as the number of lines of code is lesser as compared to PyTorch	Need to write more number of lines of code and is not as simple as TensorFlow
Debugging	Debugging is difficult. Requires the TensorFlow debugger tool.	Better debugging capabilities. Dynamic computational process.
Community	Large	Comparatively small
Deployment	Supportive	Comparatively less supportive

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