Workshop 6

COMP90051 Machine Learning

Semester 2, 2020

Learning Outcomes

By the end of this workshop you should be able to:

1. appreciate the functionality provided in neural network libraries
2. define and fit models in Keras
3. explain the architecture of a basic convolutional neural network

How is data represented in neural nets?

- Primary data structure is the tensor—a fancy name for a multi-dimensional array
- Can be used to represent trainable weights, hyperparameters, data flowing through the network, etc.
- E.g. an image can be represented as a 3d-tensor: 2 dimensions for horizontal/vertical pixels + 1 dimension for the RGB channels

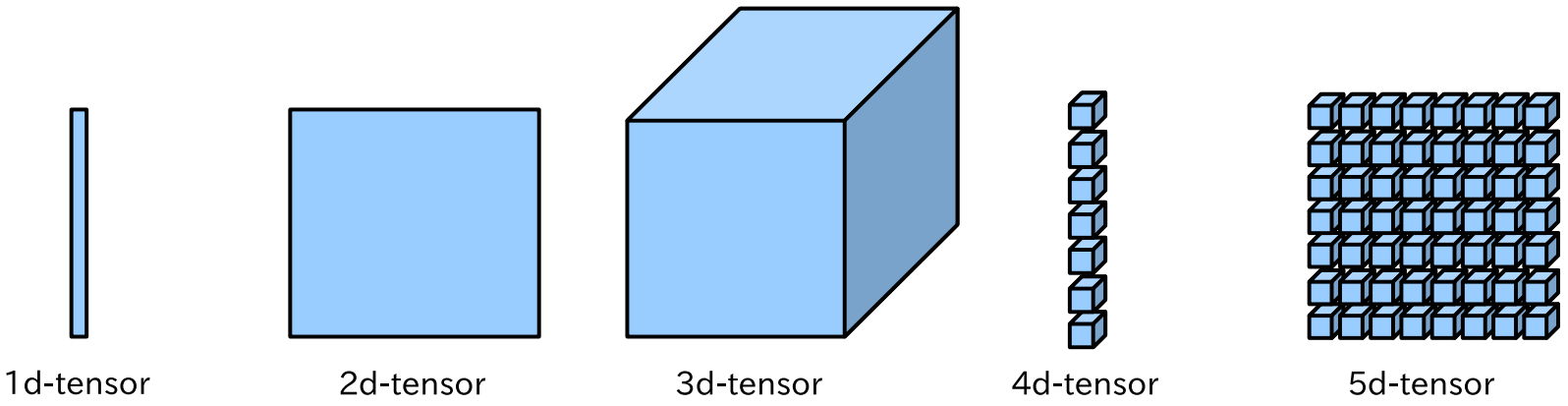


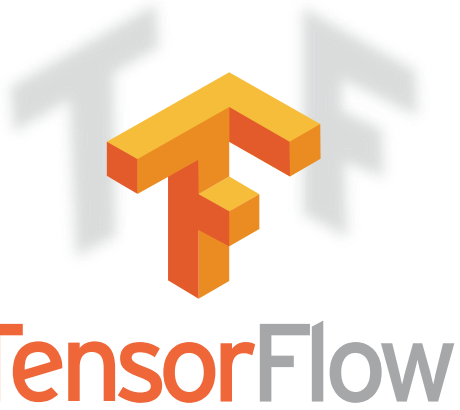
Image source: Tatsuya Yokota (2012). *Tensor Analysis for EEG data.*

Essential functionality for neural nets

- NumPy can manipulate tensors, but is it enough?
- No, we can do better
- A good framework for neural nets should:
  - support optimised tensor operations
  - support automatic differentiation—we don't want to implement backpropagation manually
  - include high-level abstractions—e.g. common layer types, loss functions, optimisers
  - run on GPUs and distributed systems

Popular frameworks for neural nets

- Dominant frameworks are TensorFlow (Google) and PyTorch (Facebook AI Research)
- Both are written in C++/CUDA and provide Python APIs
- With the release of TensorFlow 2.0, both frameworks support an imperative programming style—i.e. they work like NumPy



Keras: a simple API for neural nets

- In workshops we'll mainly use the Keras API in TensorFlow
- It abstracts away low-level details, making it easier to focus on building models
- Keras was formerly an independent project, but it's now been absorbed into TensorFlow
- Easy to extend Keras if needed using lower-level TensorFlow

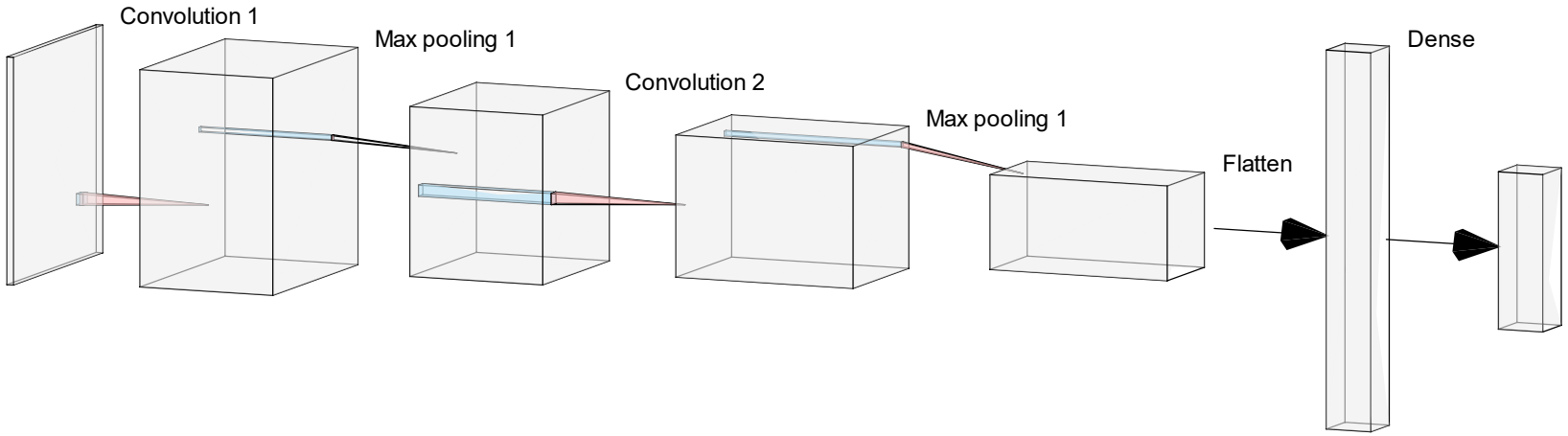
Note: we're assuming you've already installed TensorFlow 2.3.0 on your system (see guide on Canvas)

Resources

- Keras developer guides: https://keras.io/guides/
- TensorFlow tutorials: https://www.tensorflow.org/tutorials
- Books:
  - Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow by Aurélien Géron (2019)
  - Deep Learning with Python by François Chollet (2020)

Convolutional neural nets

- Local connectivity pattern between adjacent layers
- Shared weights—filters are replicated across the spatial dimensions of the input
- Pooling reduces the spatial extent deeper into the network



We'll implement this architecture for handwritten digit recognition

Worksheet 6