Introduction to the Keras API

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Part 0: Prerrequisites

Before starting to use Keras

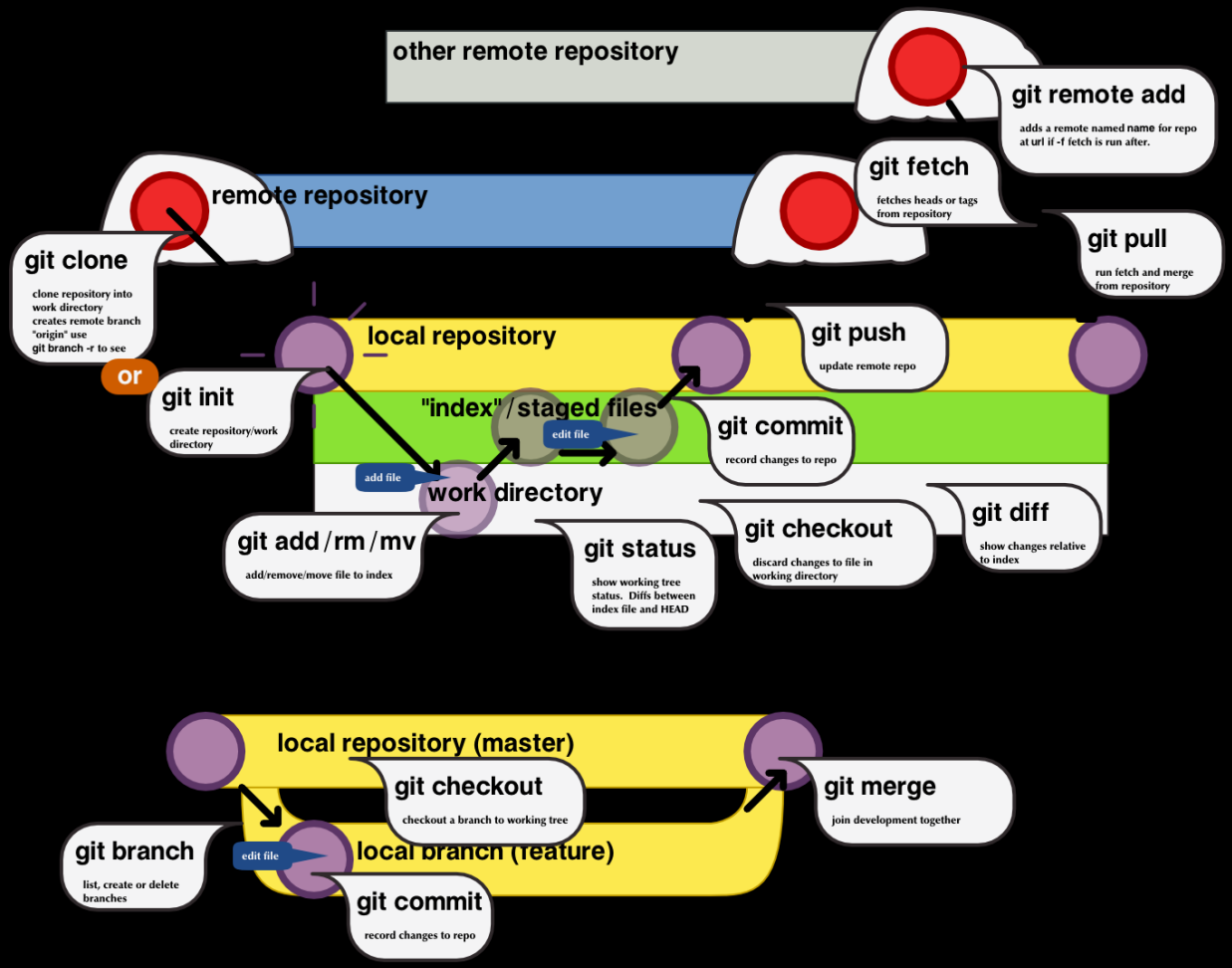
Git

- Version control, and distributed collaboration.
- Mac and Linux should have it pre-installed.
- Windows, download basic tool and client from: https://git-scm.com/downloads
  - Alternative (more complete) clients:
    - Sourcetree: https://www.sourcetreeapp.com/
    - GitHub Desktop: https://desktop.github.com/
- We'll use the command line.

Git

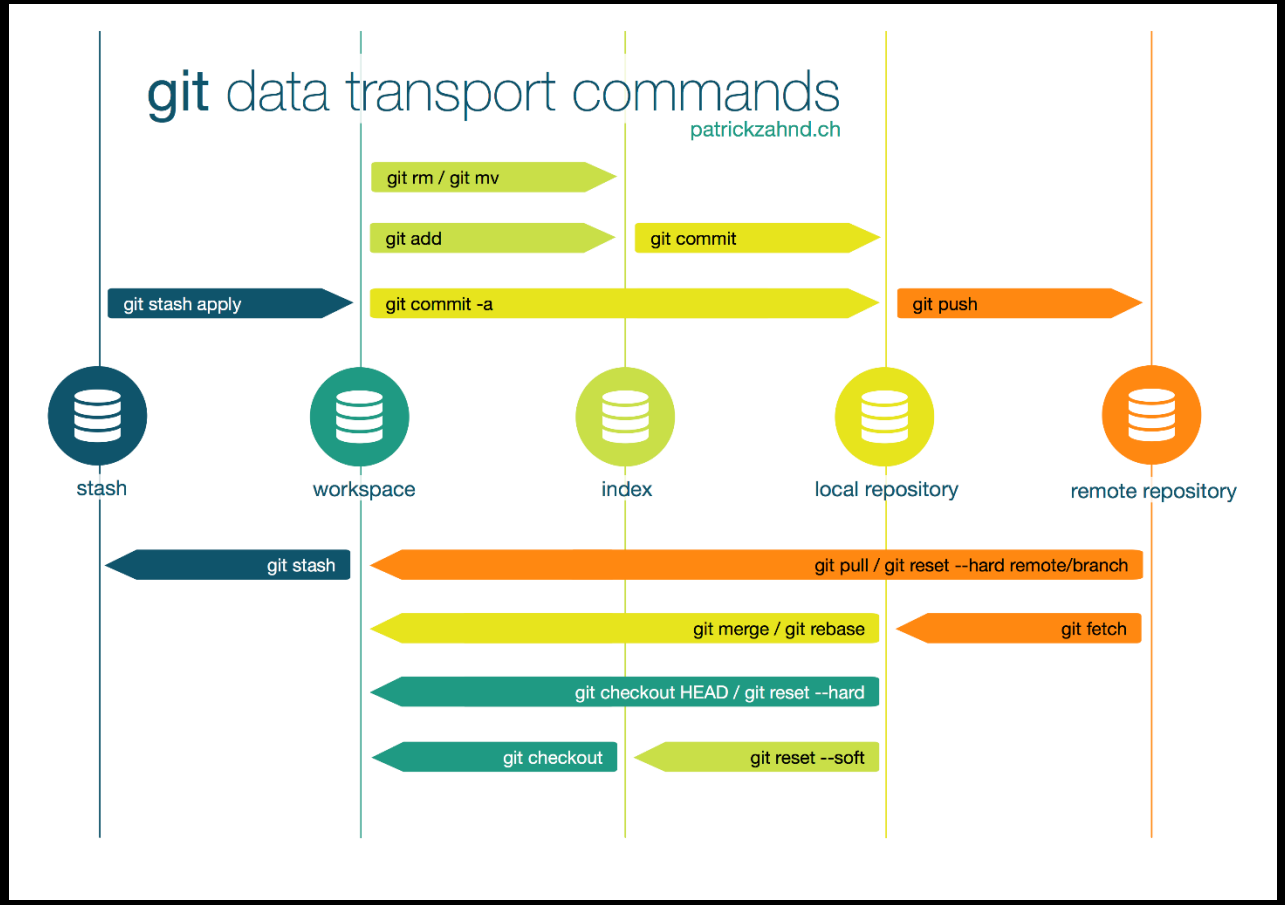
- Open a command prompt window (terminal in Mac/Linux)
- Navigate to a folder of your choosing in your own computer.
  - E.g. “c:\TDS Projects”
- Run command to clone remote repository to your computer.
  - `C:\TDS Projects>git clone https://github.com/Tulsa-Data-Science/Basic-tutorials.git`
- (In the future, when you want to save your updates into your local repository. Don’t do this now):
  - `C:\TDS Projects>git add .`
  - `C:\TDS Projects>git commit -m “My own commit message.”`

Git (Optional)



Source: https://github.com/mattharrison/Git-Supervisual-Cheatsheet/

Git (Optional)



Source: http://www.patrickzahnd.ch/blog.html#gitflow

Git (Optional)

- More info:
  - Cheat sheet: https://ndpsoftware.com/git-cheatsheet.html#loc=stash
  - One-page cheat sheet: https://jan-krueger.net/wordpress/wp-content/uploads/2007/09/git-cheat-sheet.pdf
  - Visual Git Reference: http://marklodato.github.io/visual-git-guide/index-en.html

TensorFlow Installation (Windows)

- (These steps you already installed the Anaconda package manager.)
- Create a self-contained environment
  - `C:\TDS Projects>conda create -n tensorflow pip python=3.5`
- Activate your environment
  - `C:\TDS Projects>activate tensorflow`
- Install TensorFlow
  - `C:\TDS Projects>pip install --ignore-installed --upgrade tensorflow`

TensorFlow Installation (Mac)

- Install pip and virtualenv
  - ~/TDS Projects>sudo easy_install pip
  - ~/TDS Projects>pip install --upgrade virtualenv
- Create a self-contained environment
  - ~/TDS Projects>virtualenv --system-site-packages -p python3 *targetDirectory*
- Activate your environment
  - ~/TDS Projects>cd *targetDirectory*
  - ~/TDS Projects>source ./bin/activate
- Install TensorFlow
  - ~/TDS Projects> easy_install -U pip
  - ~/TDS Projects> pip3 install --upgrade tensorflow

TensorFlow Installation (Linux)

- Install pip and virtualenv
  - ~/TDS Projects>sudo apt-get install python3-pip python3-dev python-virtualenv
- Create a self-contained environment
  - ~/TDS Projects>virtualenv --system-site-packages -p python3 *targetDirectory*
- Activate your environment
  - ~/TDS Projects>cd *targetDirectory*
  - ~/TDS Projects>source *targetDirectory*/bin/activate
- Install TensorFlow
  - ~/TDS Projects> easy_install -U pip
  - ~/TDS Projects> pip3 install --upgrade tensorflow

Keras Installation

- (Optional, but recommended. Install later.)
  - HDF5 and h5py, for saving into disk.
    - `(tensorflow) C:\TDS Projects>conda install h5py`
  - graphviz and pydot, for visualization.
    - `(tensorflow) C:\TDS Projects>conda install -c conda-forge graphviz`
    - `(tensorflow) C:\TDS Projects>conda install -c anaconda pydot`
  - `(tensorflow) C:\TDS Projects>pip install keras`

Let’s test it!

Quick Example.

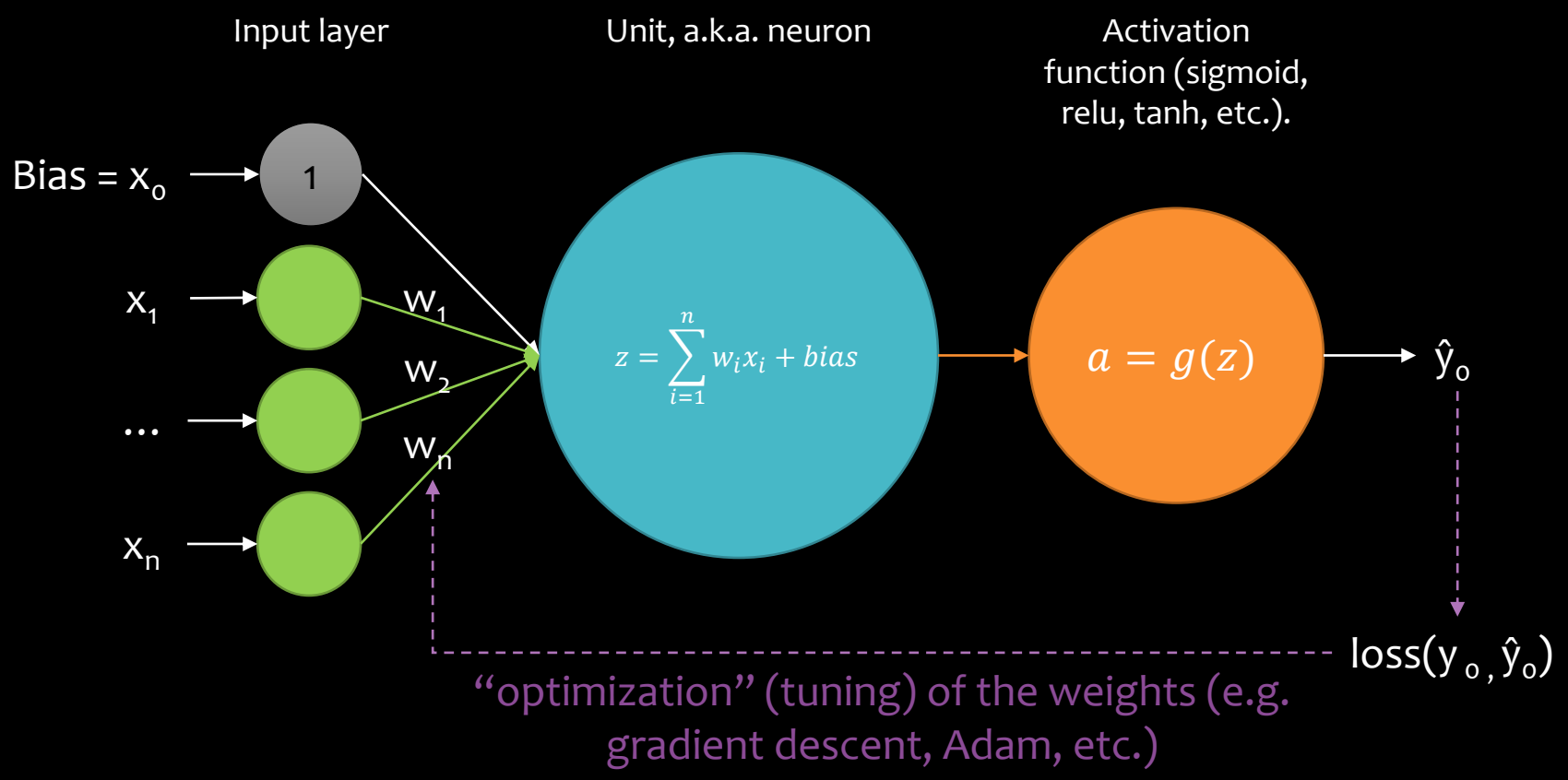
Run example notebook

- Go to the folder created after cloning the repository
- Open the sample notebook
  - `(tensorflow) C:\TDS Projects>jupyter notebook "T00 - Keras Jumpstart.ipynb"`
- Run each cell by selecting it and pressing "Shift + Enter"
  - You can also "run all cells."
    - "Ctrl + A"
    - "Ctrl + Enter"

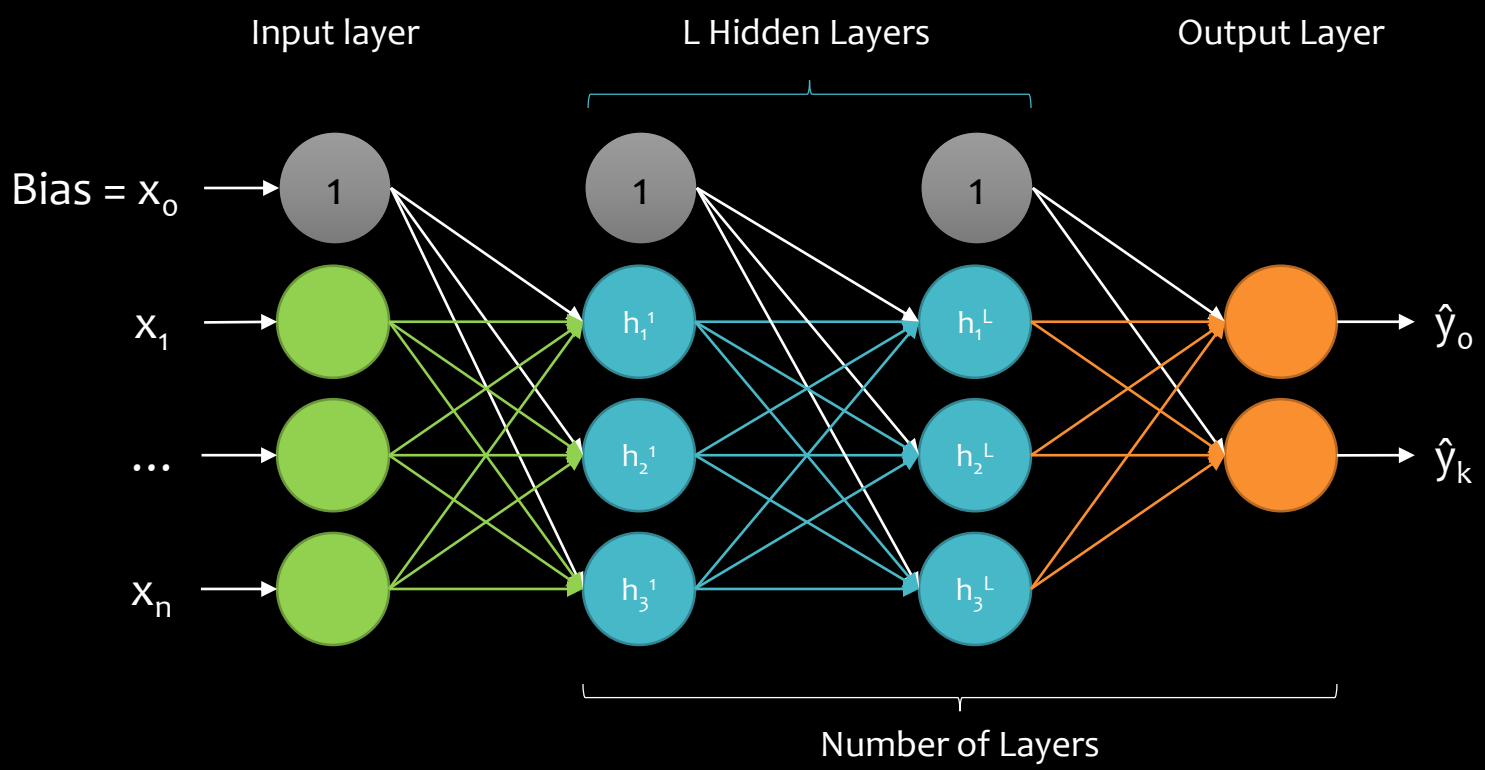
Part 1: Nomenclature

Basic terms in machine learning.

Basic Perceptron



Multiple layers



Vectors, Matrices and Tensors

- Vector:
  - Row Vector of n elements: $\mathbf{v} = [v_1 \quad \cdots \quad v_n]$
  - Column Vector of m elements: $\mathbf{v} = \begin{bmatrix} v_1 \\ \vdots \\ v_m \end{bmatrix}$
- Matrix:
  - Matrix of m x n elements: $\mathrm{M} = \begin{bmatrix} m_{11} & \cdots & m_{1n} \\ \vdots & \ddots & \vdots \\ m_{m1} & \ldots & m_{mn} \end{bmatrix}$
  - Can be thought of as a vector of vectors:
    $$M = [[m_{11} \quad \cdots \quad m_{1n}], \quad \ldots, \quad [m_{m1} \quad \cdots \quad m_{mn}]]$$
- Tensor:
  - General Arrangement of D dimensions, where each element: $t \in R^D$
  - Can be thought of as a vector of vectors of vectors of …

Other terms

- Hyperparameters:
  - Number of layers, type of layer, number of units per layer
  - Activation function
  - Learning rate, optimization method
- Epochs:
  - Number of times the training goes through the complete training data.
- Cross-validation data:
  - Subset of the data, not used for training, but for testing the network.

Part 2: Why Keras?

Keras and its interaction with a “back-end”.

Machine learning is Math

- The naïve approach performs each calculation one by one, within a multitude of loops (for, while, etc.).
- A first step in optimizing these calculations is “vectorizing” the algorithms
  - It means, performing as many of the operations using linear algebra (vectors, matrices, etc.).
    - This is where hardware such as GPUs and TPUs can excel.
  - $\boldsymbol{A} = g(\boldsymbol{Z}) = g(\boldsymbol{WX} + \boldsymbol{bias})$
- As the networks grow in complexity, even vectorization becomes complicated and cumbersome.
  - Libraries have been created to abstract these operations, and perform much of the boilerplate automatically.
  - Enter tools such as TensorFlow, Theano, Caffe, Pytorch, etc.

Machine learning is Math

- After a while, even these tools become cumbersome.
- It is necessary to make another abstraction:
  - Enter **Keras** (https://keras.io/).
    - An API to specify networks descriptively, and by their *hyperparameters*.
    - Uses TensorFlow, Theano or CNTK as its “back-end” (TensorFlow is the default).
    - You can also train the network, test it, and generate predictions.
    - You can still access the network details, if necessary.

Part 3: MNIST example

(Coming up)