



UNIVERSITY of
ROCHESTER

Teaching Innovations

Teaching **Deep Learning** to MBAs using **Tensorflow**

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MBA Core Teaching

- An MBA Core class is typically about:
 - A basic skill set (acct, stat, communications...)
 - OR, a functional area (fin, mkt, econ...)

IS/IT Core Teaching Questions to Talk About

- **What new cases, experiential learning, and topics have you added recently?**
- **What tools should we teach in the core (Excel, Access, SQL, Tableau, Plotly, Google Analytics, R, VBA)?**
 - **Are they to be done in class, or lab. or online tutorials, or in some other way?**
- **What is the role of “AI/Deep Learning” in the IS core class?**

AI/Deep Learning Teaching I

- Students must understand how emerging technologies may shape businesses of the future
- The pioneers of the driverless car movement — such as Google and Tesla — are mapping the MBAs a future in which artificial intelligence and robotics will likely impact the entire job market and global economy.
- Such disruptive technologies are now an “essential” part of the b-school landscape
- Despite their Major Structural limitations, at times they are being (over) sold as “**The Magic Power**”
 - Hence we need a ‘**Buyer Beware**’


AI/Deep Learning Teaching II

- **What I'm trying to teach students is:**
 - *“What can these technologies deliver? And what are the challenges and opportunities for a company that does AI?”*
- **Beyond a ‘Black Box’:**
 - My students must understand how these technologies work on a basic level but, more importantly, how they may shape businesses of the future
- **The Challenge:**
 - Most AI technologies have a ‘high barrier to entry’
 - Require Tech Set, Complex background, Programming Skills, Powerful M/C, Vast Data set → Yet, at the Core, we are short in Time, and most of the above...

AI/Deep Learning Machinery Teaching III

- **Didactic Objectives:**
 - **Get a Hands-On Experience in Deep Learning (Classification)**
 - (Develop Awareness, and Basic Intuition)
 - Understand: → Neural Networks Constructs, Hidden Layers
 - Recognize the key **tradeoffs** involving:
 - Learning Rate
 - Regularization
 - Activation, Features
 - Impact of Data Noise
 - Accuracy (Loss) Measures
 - Computational Challenges
 - Ratio of training to Test Data

Comparison of Deep Learning Tools

	Languages	Tutorials and training materials	CNN modeling capability	RNN modeling capability	Architecture: easy-to-use and modular front end	Speed	Multiple GPU support	Keras compatible
Theano	Python, C++	++	++	++	+	++	+	+
Tensor-Flow	Python	+++	+++	++	+++	++	++	+
Torch	Lua, Python (new)	+	+++	++	++	+++	++	
Caffe	C++	+	++		+	+	+	
MXNet	R, Python, Julia, Scala	++	++	+	++	++	+++	
Neon	Python	+	++	+	+	++	+	
CNTK	C++	+	+	+++	+	++	+	

Introduction to **tensorflow-playground**

- Web App developed as Open Source in d3.js
- Has web based examples to learn from interactively
- Helps students learn about NN:
 - No Math
 - No Programming
 - Built in data sets for experimentaion
 - Can create a NN on their Web Browser and run it



Epoch
000,000

Learning rate
0.03

Activation
Tanh

Regularization
None

Regularization rate
0

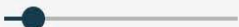
Problem type
Classification

DATA

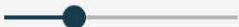
Which dataset do you want to use?



Ratio of training to test data: 20%



Noise: 15



Batch size: 10



REGENERATE

FEATURES

Which properties do you want to feed in?

- X_1
- X_2
- X_1^2
- X_2^2
- $X_1 X_2$
- $\sin(X_1)$
- $\sin(X_2)$

+ - 3 HIDDEN LAYERS

+ -

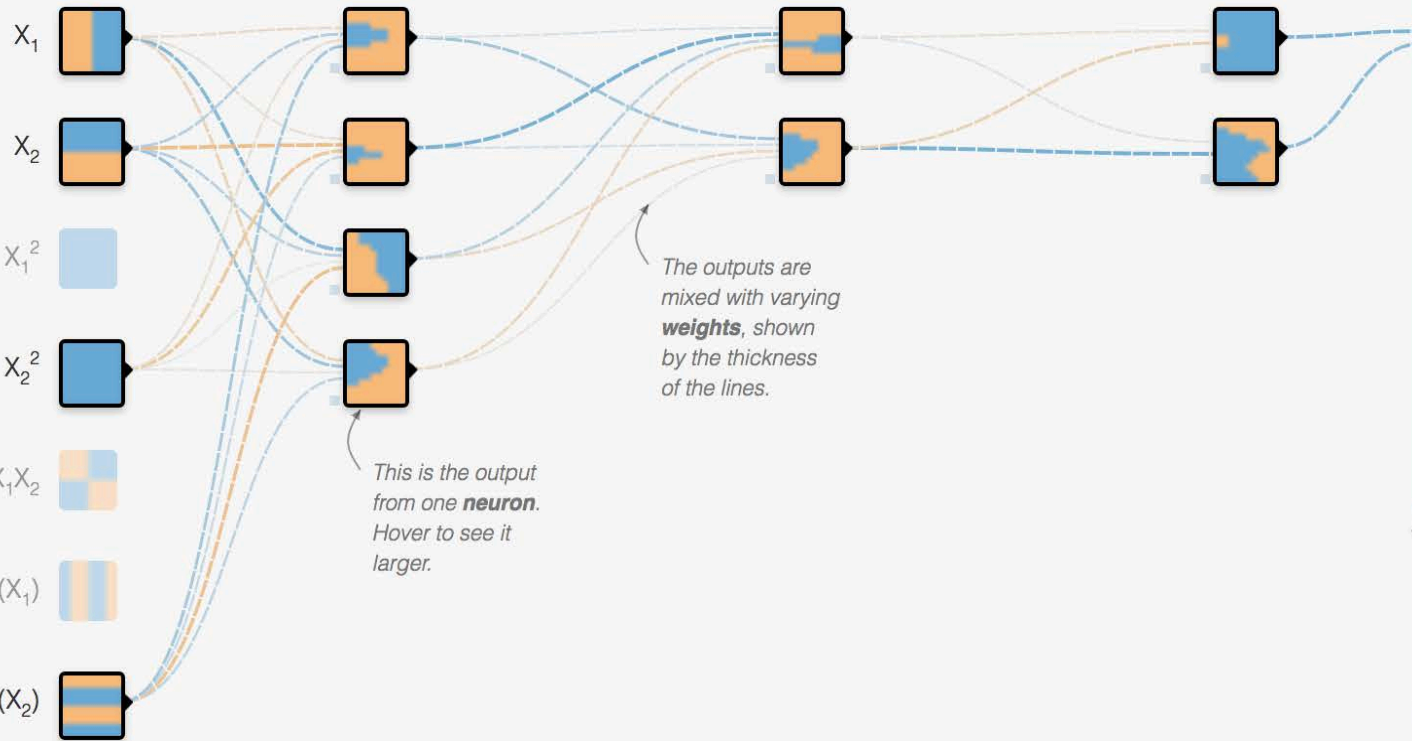
4 neurons

+ -

2 neurons

+ -

2 neurons

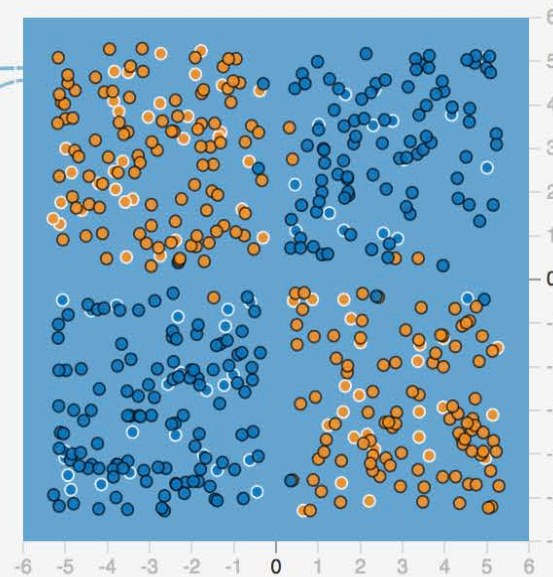


The outputs are mixed with varying **weights**, shown by the thickness of the lines.

This is the output from one **neuron**. Hover to see it larger.

OUTPUT

Test loss 0.511
Training loss 0.550



Colors shows data, neuron and weight values.

- Show test data
- Discretize output

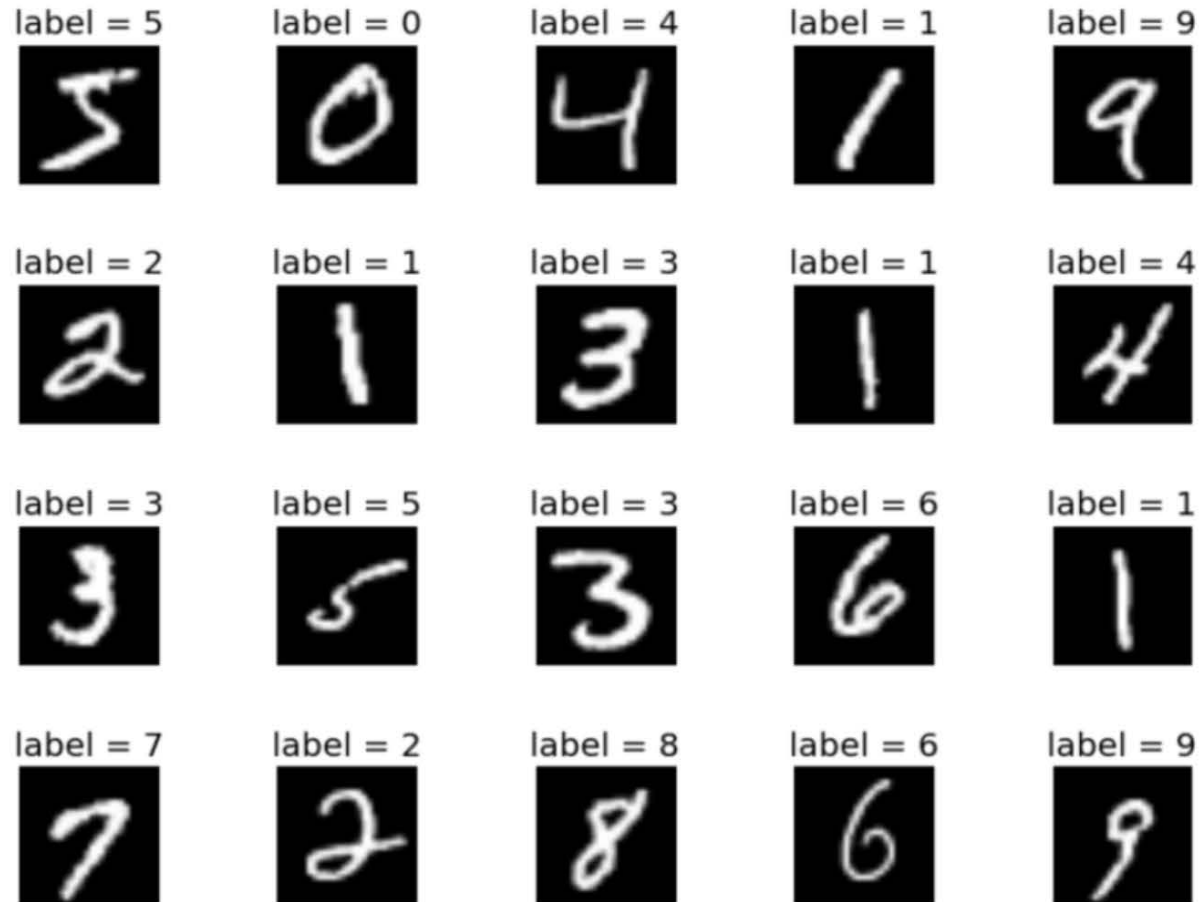
AI/Deep Learning **Hands-On** Teaching I

- **Selected Google's Tensorflow**
 - **Open Source, Popular**
 - <https://playground.tensorflow.org/>
- **Demo**
 - **Hwk #1 based on**
 - playground.tensorflow.org
 - **Hwk #2 based on**
 - Classification of 50,000 handwritten digits data set
 - Install TensorFlow (Windows, Linux and Mac OS)

Objective

Hwk #2

You are given a dataset with 50,000 images of handwritten digits. The range of each digit is from 0-9. The task is to predict a label (which is the correct number) for each handwritten image. The next figure illustrates the input and output of the neural network we are about to build. This “classification” is a common task in machine learning. You choose your prediction from a limited number of options, which in this case, is 0-9.



Part of the Students' Output: “Modifying code by adding layers [30, 10, 10, 30]”

In [23]:

```
##### change the hidden_units parameter. Currently, its value is [30,10],
##### meaning there are 30 hidden units in the first Layer and 10 in the second (also the last Layer)
##### Changing it to a vector of longer length, for example, [30,10,10] means you have are building
##### a deeper network with 3 Layers. Feel free to try different numbers.
dnn_clf = tf.contrib.learn.DNNClassifier(hidden_units=[30,10,10,30],
                                       n_classes=10,
                                       feature_columns=feature_cols) # create a Deep Neural Network classifier
dnn_clf = tf.contrib.learn.SKCompat(dnn_clf)# adds a few SK-learn functionalities to the tf classifier
##### Tune parameters in the below function #####
dnn_clf.fit(X_train, y_train, batch_size=500, steps=400,) # train the model
from sklearn.metrics import accuracy_score
y_pred = dnn_clf.predict(X_test)
accuracy_score(y_test, y_pred['classes']) # report accuracy

INFO:tensorflow:Using default config.
WARNING:tensorflow:Using temporary folder as model directory: C:\Users\Public\Documents\Wondershare\CreatorTemp\tmp7czeu409
INFO:tensorflow:Using config: {'_evaluation_master': '', '_is_chief': True, '_task_id': 0, '_save_checkpoints_secs': 600, '_session_config': None, '_log_step_count_steps': 100, '_save_summary_steps': 100, '_tf_config': gpu_options {
  per_process_gpu_memory_fraction: 1
}
, '_num_worker_replicas': 0, '_train_distribute': None, '_model_dir': 'C:\\Users\\Public\\Documents\\Wondershare\\CreatorTemp\\tmp7czeu409', '_master': '', '_keep_checkpoint_max': 5, '_task_type': None, '_environment': 'local', '_cluster_spec': <tensorflow.python.training.server_lib.ClusterSpec object at 0x0000026DF4F48C50>, '_save_checkpoints_steps': None, '_num_ps_replicas': 0, '_tf_random_seed': None, '_keep_checkpoint_every_n_hours': 10000}
INFO:tensorflow:Create CheckpointSaverHook.
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
INFO:tensorflow:Saving checkpoints for 1 into C:\Users\Public\Documents\Wondershare\CreatorTemp\tmp7czeu409\model.ckpt.
INFO:tensorflow:step = 1, loss = 50.366352
INFO:tensorflow:global_step/sec: 164.309
INFO:tensorflow:step = 101, loss = 1.7844528 (0.618 sec)
INFO:tensorflow:global_step/sec: 181.809
INFO:tensorflow:step = 201, loss = 1.6078864 (0.560 sec)
INFO:tensorflow:global_step/sec: 173.717
INFO:tensorflow:step = 301, loss = 1.4975865 (0.566 sec)
INFO:tensorflow:Saving checkpoints for 400 into C:\Users\Public\Documents\Wondershare\CreatorTemp\tmp7czeu409\model.ckpt.
INFO:tensorflow:Loss for final step: 1.4342444.
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Restoring parameters from C:\Users\Public\Documents\Wondershare\CreatorTemp\tmp7czeu409\model.ckpt-400
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
```

Out[23]: 0.4519

AI/Deep Learning **Hands-On** Teaching II

- **Conclusions:**
 - **Students all mastered fast our Hwk #1**
 - They went 'above and beyond'; Very Engaging, Amazingly Easy
 - **Students needed more help with our Hwk #2**
 - Gave them a deeper empirical understanding of AI/Deep Learning
- **They have gained new insights concerning the **Power & Limitations** of AI/Deep Learning (Science, Art)**
 - It is feasible, enjoyable, and worth doing
 - I do need to reflect on doing a bit more/better next time

Many Thanks

- Please contact me for:
 - Didactic Material, Tech Support, etc'
- Avi

Future Managers will need different skills.... To handle and interpret all kinds of unstructured data and [for] managing teams of people and smart machines harmoniously

