

Lesson Title	Intro to MNIST
Sequence	4 of 6
Duration	<ul style="list-style-type: none"> • 45 minute class to set up environment, run code, and reflect
Materials	<ul style="list-style-type: none"> • Python IDE
Objectives	Students will examine the existing MNIST script and make connections between the output probabilities and the applications of handwriting recognition they encounter in other arenas of life.
Standards	Indiana <ul style="list-style-type: none"> • CSII-6.1 Describe the function of a computing artifact • CSII-6.2 Identify the purposes of a computing artifact ITEEA <ul style="list-style-type: none"> • 3 Students will develop an understanding of the relationship among technologies and the connections between technology and other fields of study.

Lesson Notes:

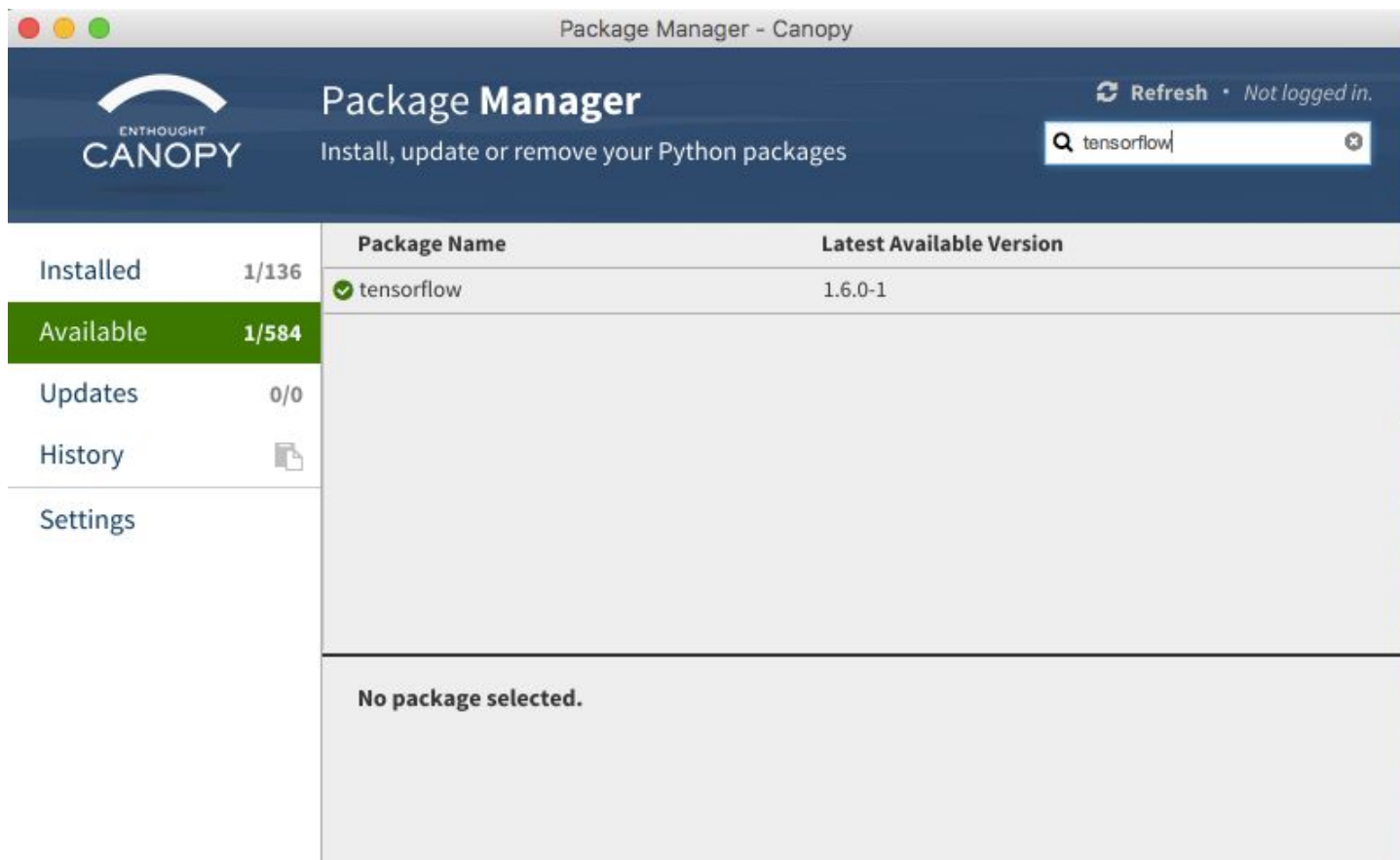
This is designed to introduce students to the MNIST digit classification network. For students to run the MNIST python code, they will first need to establish a TensorFlow environment. After they have downloaded the TensorFlow package, they will run the provided MNIST script. Students will be asked to examine the output data and make observations regarding the resulting probabilities. They will also be asked to reflect on how this type of digit classification maps to the technology they have explored with apps like Photomath.

Assessment: This task will be assessed for thorough responses, clear communication, and timeliness.

Part I: Establish the Environment

Before you can run any of the MNIST script, you need to establish a TensorFlow environment.

1. Open Canopy.
2. Navigate to the Tools Menu and select Package Manager.
3. In the Package Manager window, choose the available tab on the left sidebar. Use the search tool to locate the TensorFlow package. Choose install.



4. When you open a new editor window in canopy, you will be able to import the TensorFlow module like you would with random, matplotlib, or others you have encountered in this course.

Part II: Download the MNIST package

1. Download this zip file and unzip the contents. I would recommend moving the file to your desktop so it will be easy to identify errors when you establish your working directory.
2. Change your working directory to the location where you placed the python file.

The screenshot shows a Canopy IDE window with a Python script editor and an interactive console. The script editor at the top contains a license header for TensorFlow. The console below shows the execution of the script, including directory changes and deprecation warnings.

```
1 # Copyright 2015 The TensorFlow Authors. All Rights Reserved.
2
3 #
4
5 # Licensed under the Apache License, Version 2.0 (the "License");
6 # you may not use this file except in compliance with the License.
7 # You may obtain a copy of the License at
8
9 # http://www.apache.org/licenses/LICENSE-2.0
10
11 # Unless required by applicable law or agreed to in writing, software
12 # distributed under the License is distributed on an "AS IS" BASIS,
13 # WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
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```

Python

Welcome to Canopy's interactive data-analysis environment!
Type '?' for more information.
Python 2.7.11 | 64-bit | (default, Jun 11 2016, 03:41:56)
Type "copyright", "credits" or "license" for more information.

IPython 4.1.2 -- An enhanced Interactive Python.
? -> Introduction and overview of IPython's features.
%quickref -> Quick reference.
help -> Python's own help system.
object? -> Details about 'object', use 'object??' for extra details.

In [1]: %cd "/Users/lmoore/Desktop"
/Users/lmoore/Desktop









In [2]: %run "/Users/lmoore/Desktop/MNIST.py"
WARNING:tensorflow:From /Users/lmoore/Desktop/MNIST.py:125: read_data_sets (from tensorflow.contrib.learn.python.learn.datasets.mnist) is deprecated and will be removed in a future version.
Instructions for updating:
Please use alternatives such as official/mnist/dataset.py from tensorflow/models.
WARNING:tensorflow:From /Users/lmoore/Library/Enthought/Canopy_64bit/User/lib/python2.7/site-packages/tensorflow/contrib/learn/python/learn/datasets/mnist.py:260: maybe_download (from tensorflow.contrib.learn.python.learn.datasets.base) is deprecated and will be removed in a future version.
Instructions for updating:
Please write your own downloading logic.
WARNING:tensorflow:From /Users/lmoore/Library/Enthought/Canopy_64bit/User/lib/python2.7/site-packages/tensorflow/contrib/learn/python/learn/datasets/base.py:252: wrangled_fn (from

Cursor pos 182 : 44 Python 7 ~/Desktop/MNIST.py

3. Try to run the python script. If it runs successfully, you should receive an output similar to the one below.

```
MNIST.py
1 # Copyright 2015 The TensorFlow Authors. All Rights Reserved.
2
3 #
4
5 # Licensed under the Apache License, Version 2.0 (the "License");
6 # you may not use this file except in compliance with the License.
7 # You may obtain a copy of the License at
8
9 # http://www.apache.org/licenses/LICENSE-2.0
10
11 #
12
13 # Unless required by applicable law or agreed to in writing, software
14 # distributed under the License is distributed on an "AS IS" BASIS,
15 # WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
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```

The accuracy of the network is 0.918500

Label: 7	Label: 2	Label: 0	Label: 4	Label: 1	Label: 0	Label: 0	Label: 0
							
Label: 7 Pred: 7 Probability: 0: 0.00001 1: 0.00000 2: 0.00482 3: 0.00209 4: 0.00004 5: 0.00001 6: 0.00000 7: 0.98801 8: 0.00008 9: 0.00494	Label: 2 Pred: 2 Probability: 0: 0.00000 1: 0.00000 2: 0.99712 3: 0.00000 4: 0.00000 5: 0.00000 6: 0.00276 7: 0.00000 8: 0.00012 9: 0.00000	Label: 0 Pred: 0 Probability: 0: 0.99927 1: 0.00000 2: 0.00047 3: 0.00000 4: 0.00000 5: 0.00004 6: 0.00006 7: 0.00004 8: 0.00011 9: 0.00000	Label: 4 Pred: 4 Probability: 0: 0.01130 1: 0.00005 2: 0.01025 3: 0.00195 4: 0.71012 5: 0.08118 6: 0.03142 7: 0.01090 8: 0.07280 9: 0.07003	Label: 1 Pred: 1 Probability: 0: 0.00001 1: 0.94152 2: 0.00596 3: 0.01280 4: 0.00000 5: 0.00227 6: 0.00023 7: 0.00214 8: 0.03148 9: 0.00360	Label: 0 Pred: 0 Probability: 0: 0.99866 1: 0.00000 2: 0.00089 3: 0.00000 4: 0.00000 5: 0.00014 6: 0.00000 7: 0.00000 8: 0.00030 9: 0.00000	Label: 0 Pred: 0 Probability: 0: 0.98532 1: 0.00000 2: 0.00014 3: 0.00003 4: 0.00000 5: 0.01441 6: 0.00004 7: 0.00000 8: 0.00007 9: 0.00000	Label: 0 Pred: 0 Probability: 0: 0.98532 1: 0.00000 2: 0.00014 3: 0.00003 4: 0.00000 5: 0.01441 6: 0.00004 7: 0.00000 8: 0.00007 9: 0.00000

The matrix multiplication time is 0.000726

The time for testing is 0.000604

The time for training is 0.000896

Cursor pos 182 : 44 Python ~/Desktop/MNIST.py

Part III: Reflection

Looking at your results from the MNIST script, consider the following questions.

1. What information is included in the output? What does this communicate?
2. Were all of the digits correctly classified? If not, which ones were incorrectly classified?
3. Look more closely at the probabilities that are displayed. Pick one of the digits that was correctly classified, but had a lower probability. Do you see how the computer could misinterpret that image?
4. Look at your own handwriting. How does it map to the digits displayed in the output?
5. How might this technology of image classification connect to applications like Photomath?