

Machine Learning: Introduction to Linear Regression, Logistic Regression, and Neural Networks

Chapter 2 Python Demos

Python Demos

Section	Title	Description
2.1	NumPy Demo	This section has a demo of the principal numpy functions to be used in the course.
2.2	Matplotlib Demo Basic	This section has a demo of the basic matplotlib plotting functions.
2.3	Matplotlib Demo Heatmap	This section has a demo of how to create a scatter plot and heatmap used to visualize machine learning data and results for classification.
2.4	Pandas Demo	This section has a demo of how to use the basic pandas commands to read data from file and perform basic manipulations.
2.5	unittest Demo	This section has a demo of how to set up unit tests.
2.6	sklearn Demo	This section has a demo of how to convert messages into a “feature matrix”

2.1 NumPy Demo

NumPy Demo

NumPy (Numpy/numpy/np) is a Python package for scientific computing

- Key object is multi-dimensional numpy array
- numpy functions manipulate these arrays
 - Can perform standard matrix and vector operations
 - Can perform operations on entire array without explicit looping
- Course codes use numpy array as fundamental building block
- See following site for details: <https://numpy.org/>

Key Numpy Commands and Functions

Operation	numpy functions
Array creation	numpy.array()
Array indexing	
Component-wise operations: addition, multiplication, scalar multiplication	+, *, * with scalar
Functions	numpy.exp(), numpy.absolute(), numpy.square()
Concatenation, shaping, removal, addition of axes	numpy.concatenate(), numpy.reshape(), numpy.squeeze(), numpy.expand_dims()
Sum entries of array	numpy.sum()
Array of zeros, array of ones	numpy.zeros(), numpy.ones()
Array of random numbers: setting seed, from uniform distribution, from normal distribution	numpy.random.seed(), numpy.random.rand(), numpy.random.randn()

Numpy Demo

- [IntroML/Examples/Chapter2/NumpyDemo.ipynb](#)
 - Jupyter Notebook showing key numpy functions to be used in this course

2.2 Matplotlib Basic Demo

Matplotlib Basic Demo

Matplotlib is a Python package for plotting

- See following site for details: <https://matplotlib.org>
- This section has a demo of the basic plotting commands

Matplotlib Basics: Commands and Functions

Operation	matplotlib functions
Plotting	plot
Multiple plots and adding legends	subplot(), legend()

Matplotlib Heatmap Demo

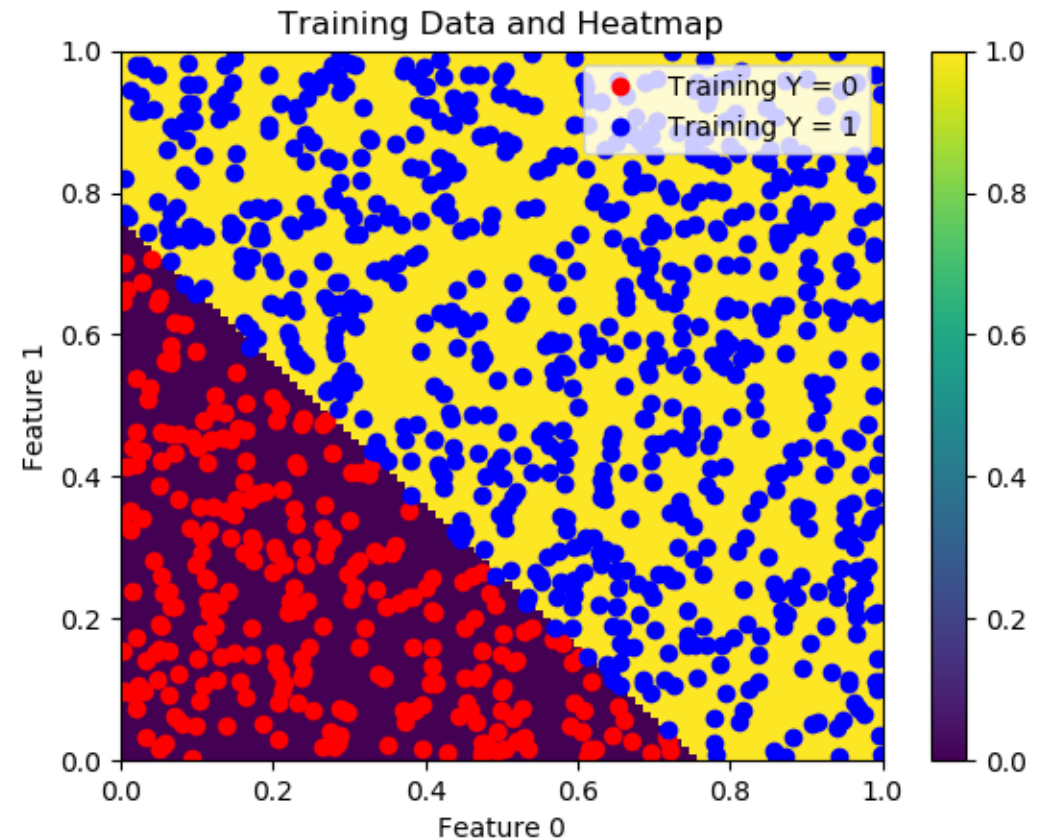
- `IntroML/Examples/Chapter2/MatplotlibBasicsDemo.ipynb`
 - Jupyter Notebook showing basic matplotlib plotting functions

2.3 Matplotlib Heatmap Demo

Matplotlib Heatmap

- Goal: produce plot showing “training data” and Machine Learning prediction
- Training data: red and blue points
- Predicted Results: results predicted by model (purple is predicted 0 and yellow is predicted 1)

Throughout this course we will produce plots like this to visualize effectiveness of machine learning process



Plotting Training Data

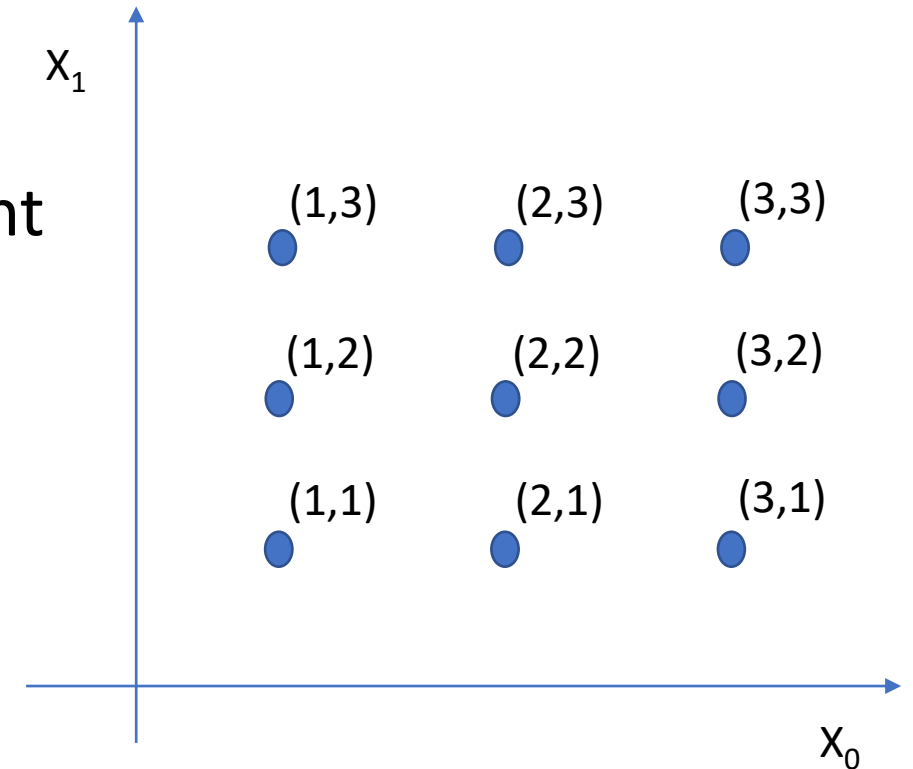
Generate training data: points in (X_0, X_1) plane and labels (0 or 1)

1. Identify indexes for label = 0 – plot corresponding points red
2. Identify indexes for label = 1 – plot corresponding points blue

Plotting Heatmap of Results

Assume that training algorithm has been performed with training data

1. Create grid of points similar to that on right
2. Points: (1,1), (2,1), (3,1), (1,2), (2,2), (3,2), (1,3), (2,3), (3,3)
3. Feature Matrix:
$$X = \begin{bmatrix} 1 & 2 & 3 & 1 & 2 & 3 & 1 & 2 & 3 \\ 1 & 1 & 1 & 2 & 2 & 2 & 3 & 3 & 3 \end{bmatrix}$$
4. Apply prediction algorithm with feature matrix representing grid of points to produce 0 or 1 label for each point
5. Use pcolormesh function in matplotlib.pyplot applied to grid and labels to generate heatmap



Matplotlib Heatmap Demo

- `IntroML/Examples/Chapter2/MatplotlibHeatmapDemo.ipynb`
 - Jupyter Notebook showing how to produce plot of training data and heatmap

2.4 Pandas Demo

Pandas Demo

Pandas is a Python package containing data structures and analysis tools

- Key structure is data frame
- See following site for details: <https://pandas.pydata.org/>

Key Pandas Commands and Functions

Operation	pandas functions
Read data from csv file and put into data frame	<code>pandas.read_csv</code>
List items in data frame	<code>pandas.head()</code> , <code>pandas.tail()</code>
Extract column from data frame and remove column from data frame	<code>pandas.drop()</code>
Extract values from data frame	<code>values</code>

Pandas Demo

- `IntroML/Examples/Chapter2/PandasDemo.ipynb`
 - Jupyter Notebook demo showing key matplotlib functions used in course

2.5 unittest Demo

unittest Demo

unittest is a package that is part of the Python release

- Package allows set up of unit tests
- See following site for details:

<https://docs.python.org/3/library/unittest.html>

Unit Test Functionality

```
In [1]: import unittest

class Test(unittest.TestCase):
    def test1(self):
        x = 7
        y = 8
        z1 = (x+y)*(x+y)
        z2 = x*x + 2*x*y + y*y
        error = abs(z1-z2)
        self.assertLessEqual(error, 1e-7)

if __name__ == "__main__":
    #this is command in python when running in command window
    #unittest.main()
    # this is command in the jupyter notebook
    unittest.main(argv=['first-arg-is-ignored'], exit=False)
```

.

Ran 1 test in 0.016s

OK

- Use functionality in unittest package
- Documentation at <https://docs.python.org/3.7/index.html>
- Create a class derived from unittest.TestCase
- Individual unit tests are set up as methods of the class
- Test should have “assert” command which determines pass or fail
- Use unittest.main to run tests
- Will get OK if test passes

unittest Demo

- IntroML/Examples/Chapter2/unittestDemo.ipynb
 - Jupyter Notebook demo showing how to set up a unittest