Tamkang University
淡江大學

商業智慧實務

Tamkang University

Practices of Business Intelligence

處方性分析：最佳化與模擬

(Prescriptive Analytics: Optimization and Simulation)

1071BI08
MI4 (M2084) (2888)
Wed, 7, 8 (14:10-16:00) (B217)

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http://mail. tku.edu.tw/myday/

2018-11-21

課程大綱 (Syllabus)

週次 (Week)	日期 (Date)	內容(Subject/Topics)
1	2018/09/12	商業智慧實務課程介紹 (Course Orientation for Practices of Business Intelligence)
2	2018/09/19	商業智慧、分析與資料科學 (Business Intelligence, Analytics, and Data Science)
3	2018/09/26	人工智慧、大數據與雲端運算 (ABC: AI, Big Data, and Cloud Computing)
4	2018/10/03	描述性分析I：數據的性質、統計模型與可視化 (Descriptive Analytics I: Nature of Data, Statistical Modeling, and Visualization)
5	2018/10/10	國慶紀念日 (放假一天) (National Day) (Day off)
6	2018/10/17	描述性分析II：商業智慧與資料倉儲 (Descriptive Analytics II: Business Intelligence and Data Warehousing)

課程大綱 (Syllabus)

週次 (Week)　日期 (Date)　內容(Subject/Topics)

7　2018/10/24　預測性分析I：資料探勘流程、方法與演算法
(Predictive Analytics I: Data Mining Process, Methods, and Algorithms)

8　2018/10/31　預測性分析II：文本、網路與社群媒體分析
(Predictive Analytics II: Text, Web, and Social Media Analytics)

9　2018/11/07　期中報告 (Midterm Project Report)

10　2018/11/14　期中考試 (Midterm Exam)

11　2018/11/21　處方性分析：最佳化與模擬
(Prescriptive Analytics: Optimization and Simulation)

12　2018/11/28　社會網絡分析
(Social Network Analysis)

課程大綱 (Syllabus)

週次 (Week)	日期 (Date)	內容(Subject/Topics)
13	2018/12/05	機器學習與深度學習 (Machine Learning and Deep Learning)
14	2018/12/12	自然語言處理 (Natural Language Processing)
15	2018/12/19	AI交談機器人與對話式商務 (AI Chatbots and Conversational Commerce)
16	2018/12/26	商業分析的未來趨勢、隱私與管理考量 (Future Trends, Privacy and Managerial Considerations in Analytics)
17	2019/01/02	期末報告 (Final Project Presentation)
18	2019/01/09	期末考試 (Final Exam)

Business Intelligence (BI)

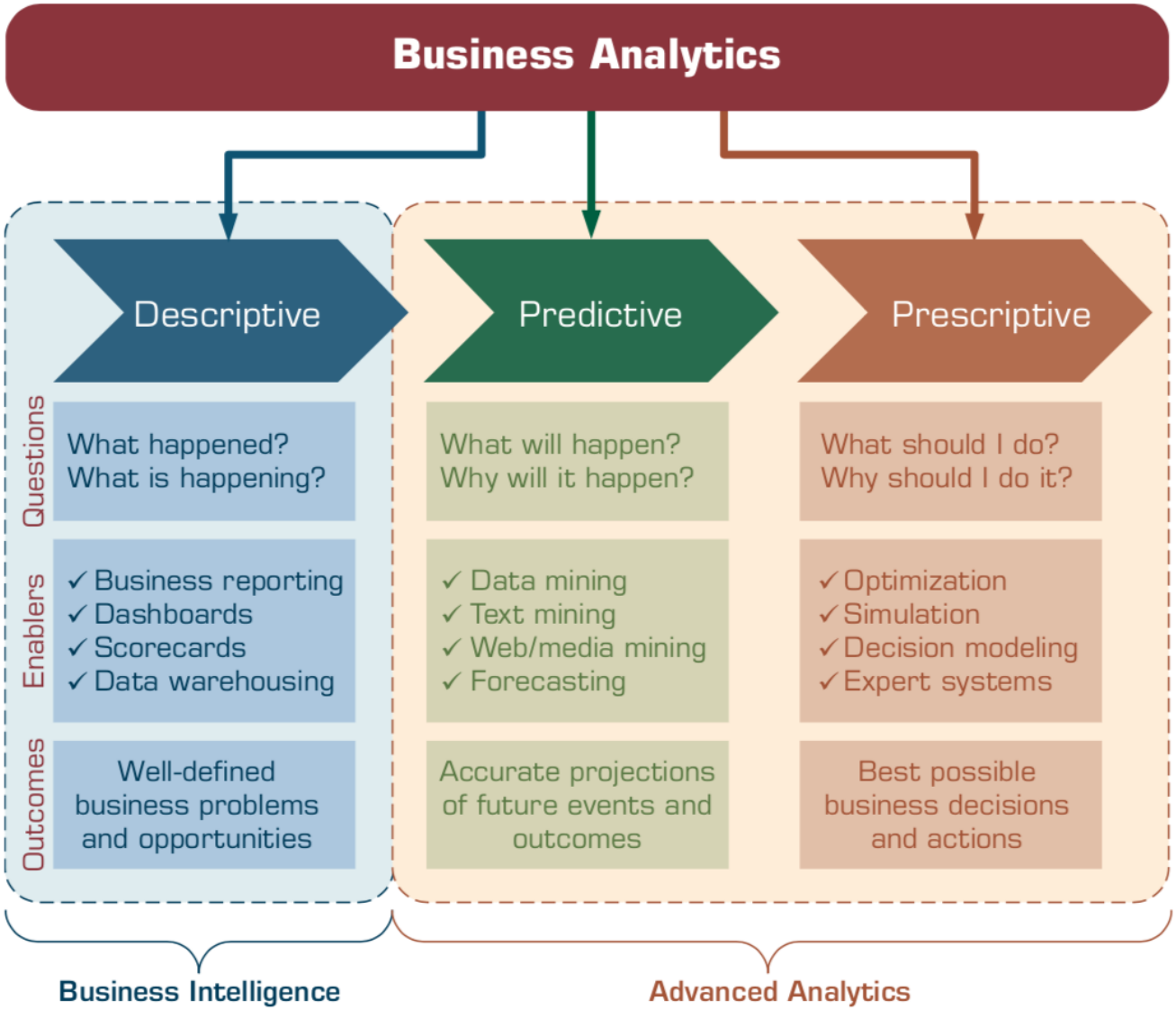
1. Introduction to BI and Data Science
2. Descriptive Analytics
3. Predictive Analytics
4. Prescriptive Analytics
5. Big Data Analytics
6. Future Trends

Prescriptive Analytics: Optimization and Simulation

Outline

- Prescriptive Analytics
- Model-Based Decision Making
- Structure of Mathematical Models for Decision Support
- Certainty, Uncertainty, and Risk
- Mathematical Programming Optimization
- Simulation

Business Analytics and Prescriptive Analytics



Source: Ramesh Sharda, Dursun Delen, and Efraim Turban (2017), Business Intelligence, Analytics, and Data Science: A Managerial Perspective, 4th Edition, Pearson

Prescriptive Analytics Model Examples

- Modeling is a key element for prescriptive analytics.
- Employ a mathematical model to be able to recommend a decision for any realistic problem.
- Building a **probability-based response maximization model** with the budget as a constraint would give us the information we are seeking.

Identification of the Problem and Environmental Analysis

- Environmental scanning and analysis
  - Monitoring, scanning, and interpretation of collected information
- Business intelligence/business analytics (BI/BA) tools can help identify problems by scanning for them.
- Variable Identification
- Forecasting (Predictive Analytics)

Categories of Models

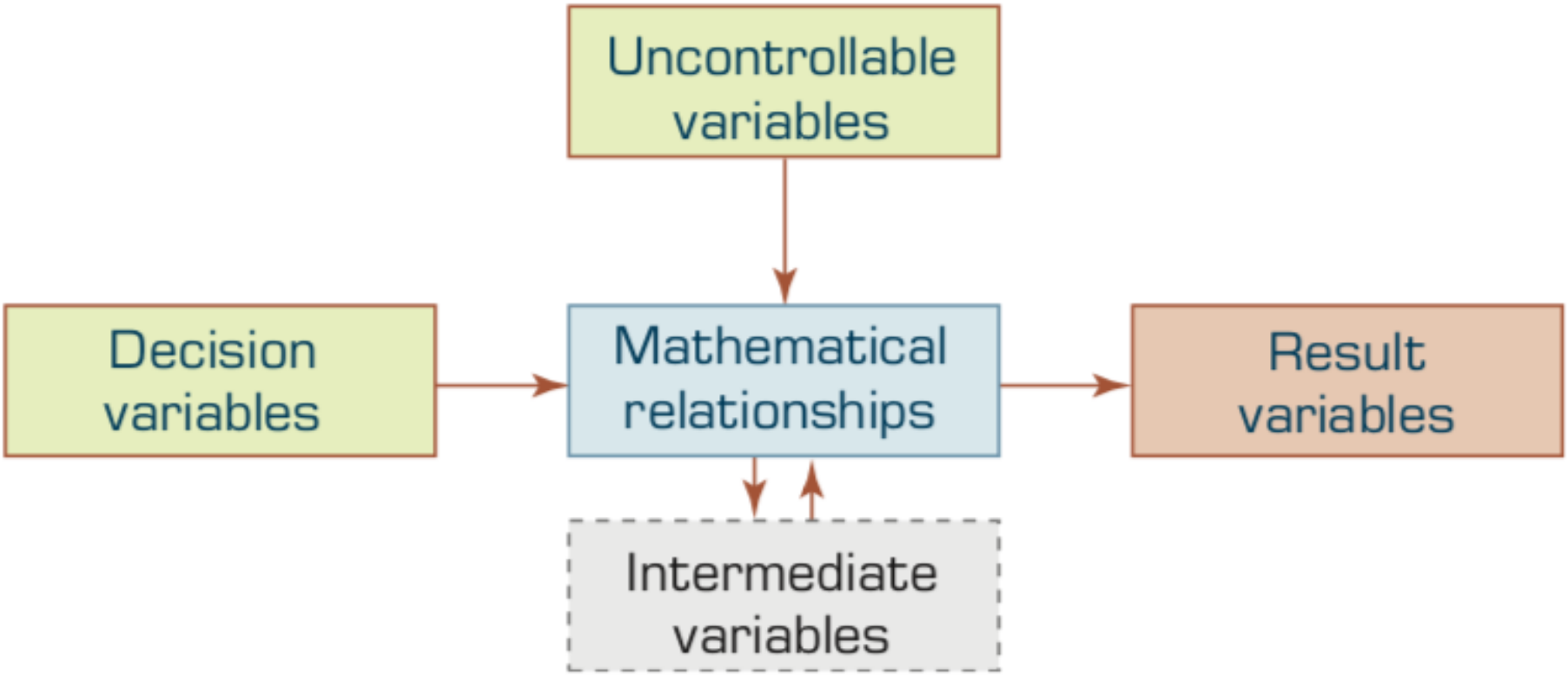
Category	Process and Objective	Representative Techniques
Optimization of problems with few alternatives	Find the best solution from a small number of alternatives	Decision tables, decision trees, analytic hierarchy process
Optimization via algorithm	Find the best solution from a large number of alternatives, using a step-by-step improvement process	Linear and other mathematical programming models, network models
Optimization via an analytic formula	Find the best solution in one step, using a formula	Some inventory models
Simulation	Find a good enough solution or the best among the alternatives checked, using experimentation	Several types of simulation
Heuristics	Find a good enough solution, using rules	Heuristic programming, expert systems
Predictive models	Predict the future for a given scenario	Forecasting models, Markov analysis
Other models	Solve a what-if case, using a formula	Financial modeling, waiting lines

Source: Ramesh Sharda, Dursun Delen, and Efraim Turban (2017), Business Intelligence, Analytics, and Data Science: A Managerial Perspective, 4th Edition, Pearson

Structure of Mathematical Models for Decision Support

- The Components of Decision Support Mathematical Models
- The Structure of Mathematical Models

The General Structure of a Quantitative Model



Source: Ramesh Sharda, Dursun Delen, and Efraim Turban (2017), Business Intelligence, Analytics, and Data Science: A Managerial Perspective, 4th Edition, Pearson

Examples of Components of Models

Area	Decision Variables	Result Variables	Uncontrollable Variables and Parameters
Financial investment	Investment alternatives and amounts	Total profit, risk Rate of return on investment (ROI) Earnings per share Liquidity level	Inflation rate Prime rate Competition
Marketing	Advertising budget Where to advertise	Market share Customer satisfaction	Customer's income Competitor's actions
Manufacturing	What and how much to produce Inventory levels Compensation programs	Total cost Quality level Employee satisfaction	Machine capacity Technology Materials prices
Accounting	Use of computers Audit schedule	Data processing cost Error rate	Computer technology Tax rates Legal requirements
Transportation	Shipments schedule Use of smart cards	Total transport cost Payment float time	Delivery distance Regulations
Services	Staffing levels	Customer satisfaction	Demand for services

Source: Ramesh Sharda, Dursun Delen, and Efraim Turban (2017), Business Intelligence, Analytics, and Data Science: A Managerial Perspective, 4th Edition, Pearson

The Structure of Mathematical Models

A very simple financial model is

$$P = R - C$$

where P = profit, R = revenue, *and* C = cost.

The Structure of Mathematical Models

Financial model (present-value cash flow model)

$$P = F / (1 + i)^n$$

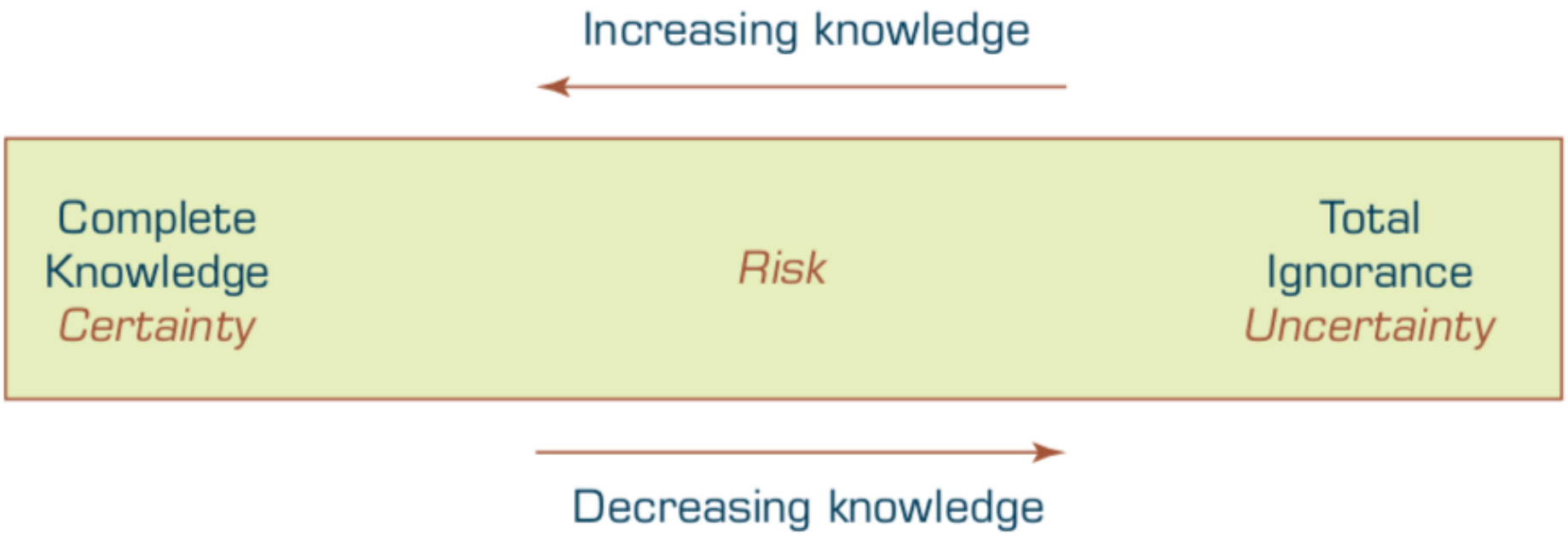
where P = present value, F = a future single payment in dollars, i = interest rate (percentage), and n = number of years.

$$P = 100{,}000 / (1 + 0.1)^5 = 62{,}092$$

Certainty, Uncertainty, and Risk

- Decision Making under Certainty
- Decision Making under Uncertainty
- Decision Making under Risk (Risk Analysis)

The Zones of Decision Making

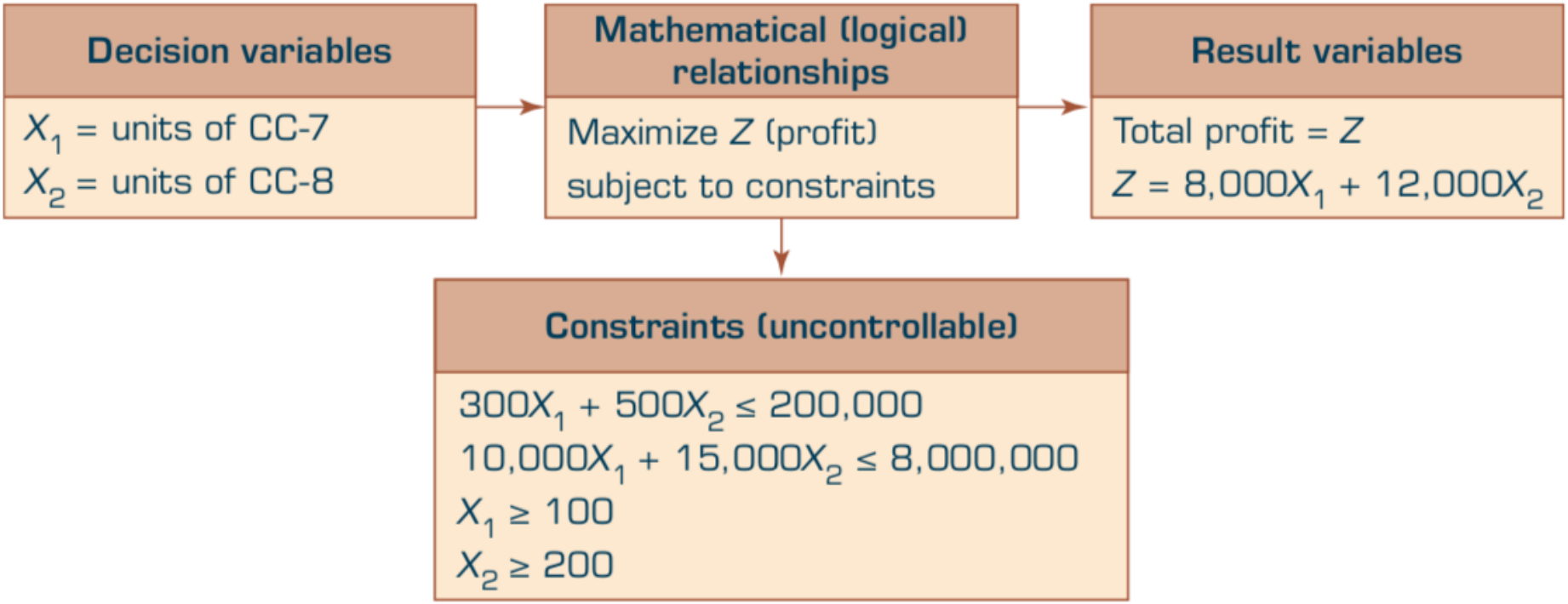


Source: Ramesh Sharda, Dursun Delen, and Efraim Turban (2017), Business Intelligence, Analytics, and Data Science: A Managerial Perspective, 4th Edition, Pearson

Mathematical Programming Optimization

- **Mathematical programming**
  - a family of tools designed to help solve managerial problems in which the decision maker must allocate scarce resources among competing activities to optimize a measurable goal.
- **Linear programming (LP)** is the best-known technique in a family of optimization tools called *mathematical programming*.

Mathematical Model of a Product-Mix Example



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Prescriptive Analytics, Operations research/ Management Science

- Multiple Goals
- Sensitivity Analysis
- What-If Analysis
- Goal Seeking

Decision Analysis with Decision Tables and Decision Trees

- **Decision tables**
  - conveniently organize information and knowledge in a systematic, tabular manner to prepare it for analysis.
- **Decision tree**
  - shows the relationships of the problem graphically and can handle complex situations in a compact form.

Investment Problem Decision Table Model

	State of Nature (Uncontrollable Variables)		
Alternative	Solid Growth (%)	Stagnation (%)	Inflation (%)
Bonds	12.0	6.0	3.0
Stocks	15.0	3.0	–2.0
CDs	6.5	6.5	6.5

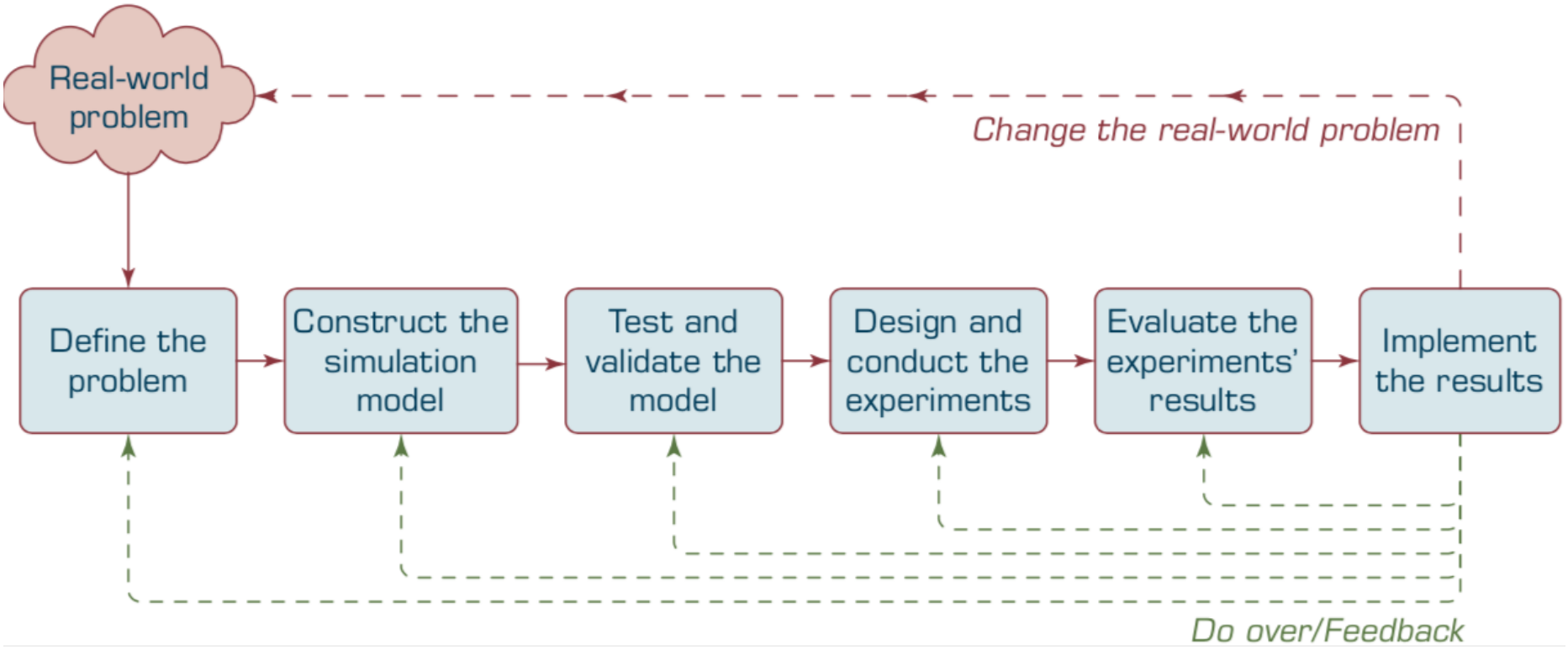
Source: Ramesh Sharda, Dursun Delen, and Efraim Turban (2017), Business Intelligence, Analytics, and Data Science: A Managerial Perspective, 4th Edition, Pearson

Multiple Goals

Alternative	Yield (%)	Safety	Liquidity
Bonds	8.4	High	High
Stocks	8.0	Low	High
CDs	6.5	Very high	High

Source: Ramesh Sharda, Dursun Delen, and Efraim Turban (2017), Business Intelligence, Analytics, and Data Science: A Managerial Perspective, 4th Edition, Pearson

The Process of Simulation



Source: Ramesh Sharda, Dursun Delen, and Efraim Turban (2017), Business Intelligence, Analytics, and Data Science: A Managerial Perspective, 4th Edition, Pearson

Discrete versus Continuous Probability Distributions

Daily Demand	Discrete Probability	Continuous Probability
5	0.10	Daily demand is normally distributed with a mean of 7 and a standard deviation of 1.2
6	0.15	
7	0.30	
8	0.25	
9	0.20	

Source: Ramesh Sharda, Dursun Delen, and Efraim Turban (2017), Business Intelligence, Analytics, and Data Science: A Managerial Perspective, 4th Edition, Pearson

Simulation Types

- Monte Carlo Simulation
- Discrete Event Simulation

Visual Interactive Simulation

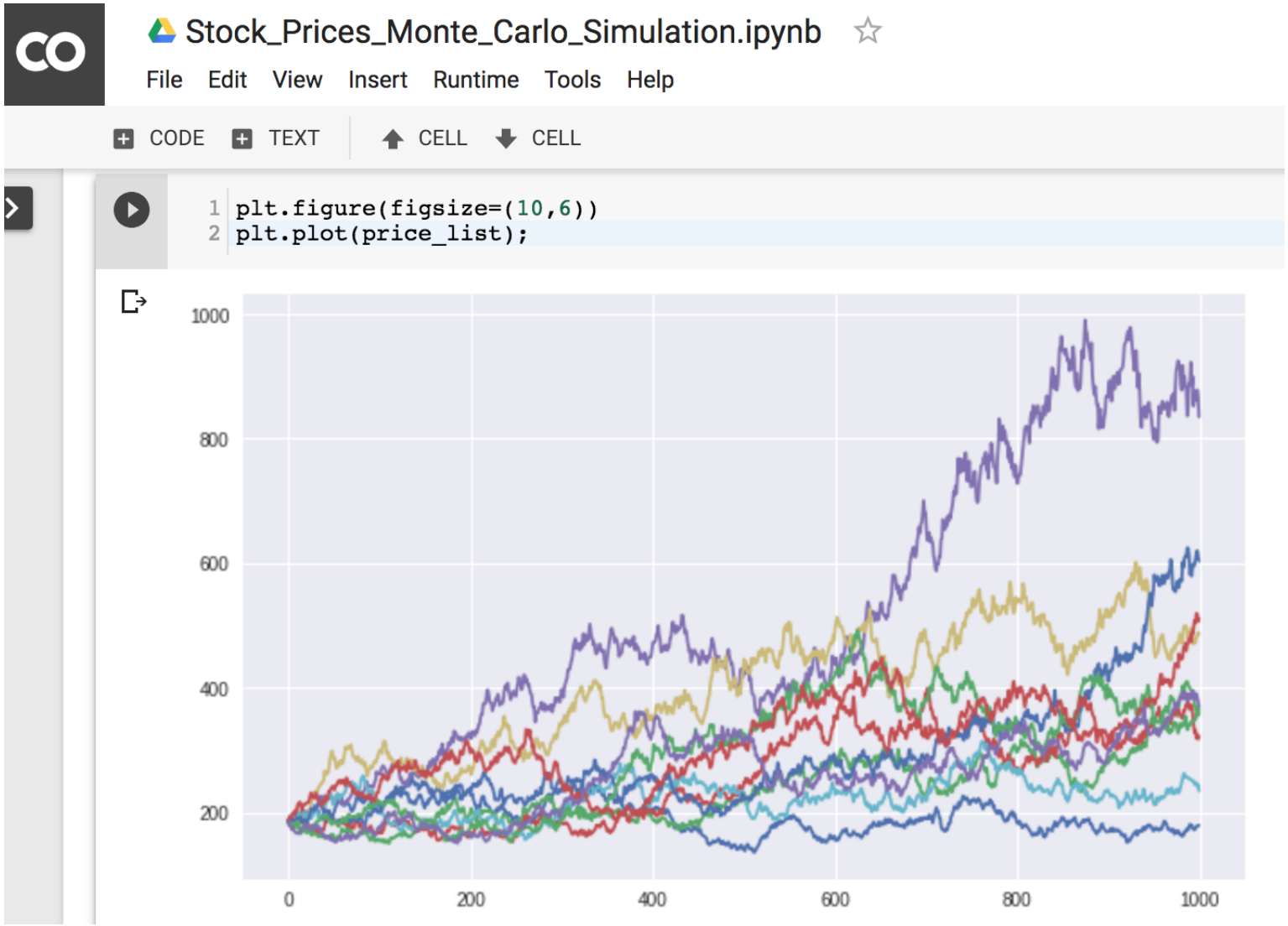
- Conventional Simulation Inadequacies
- Visual Interactive Simulation (VIS)
  - Visual Interactive Modeling (VIM)
- Visual Interactive Models and DSS

Simulation Software

- Analytica
  (Lumina Decision Systems, lumina.com)
- Excel add-ins Crystal Ball
- @RISK (Palisade Corp., palisade. com)
- Arena
- Simio (simio.com)
- ExtendSim (extendsim.com)
- SAS JMP

Monte Carlo Simulation

Monte Carlo Simulation to Forecast Stock Prices

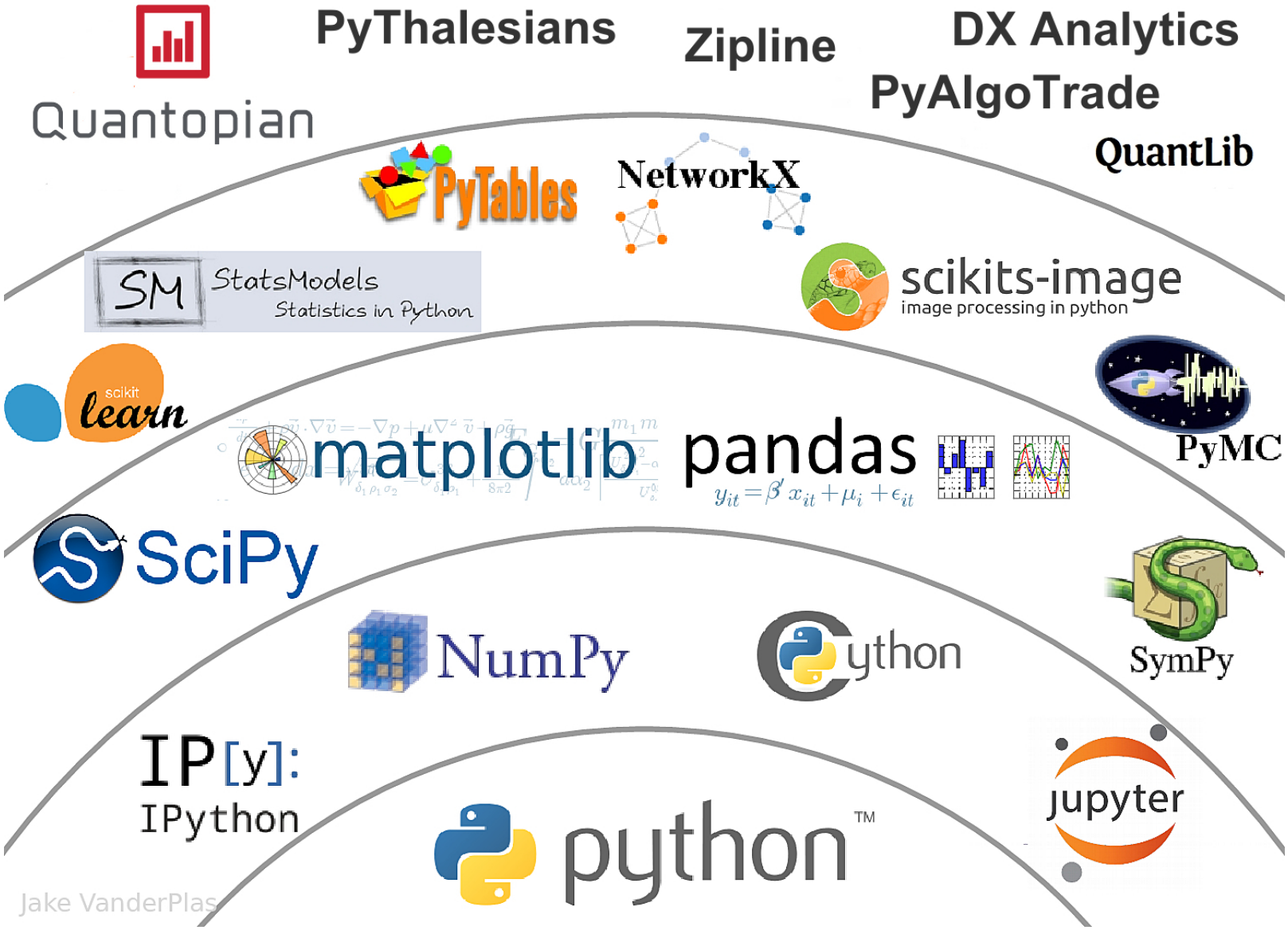


https://colab.research.google.com/drive/1lwXt0TlidwF2jhPPE7tte2TH-JWb9QFk

Python Pandas for Finance

Source: https://mapattack.wordpress.com/2017/02/12/using-python-for-stocks-1/

The Quant Finance PyData Stack



Source: http://nbviewer.jupyter.org/format/slides/github/quantopian/pyfolio/blob/master/pyfolio/examples/overview_slides.ipynb#/5


AAPL
Adj Close
MA05
MA20
MA60
220
200
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160
140
120
100
80
2016-02
2016-06
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Python in Google Colab

https://colab.research.google.com/drive/1FEG6DnGvwfUbeo4zJ1zTunjMqf2RkCrT

python101.ipynb

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COMMENT SHARE A

CODE TEXT CELL CELL CONNECTED EDITING

```
# !pip install pandas_datareader
import pandas as pd
import pandas_datareader.data as web
import matplotlib.pyplot as plt
import seaborn as sns
import datetime as dt
%matplotlib inline

#Read Stock Data from Yahoo Finance
end = dt.datetime.now()
#start = dt.datetime(end.year-2, end.month, end.day)
start = dt.datetime(2016, 1, 1)
df = web.DataReader("AAPL", 'yahoo', start, end)
df.to_csv('AAPL.csv')
df.from_csv('AAPL.csv')
df.tail()

df['Adj Close'].plot(legend=True, figsize=(12, 8), title='AAPL', label='Adj Close')
plt.figure(figsize=(12,9))
top = plt.subplot2grid((12,9), (0, 0), rowspan=10, colspan=9)
bottom = plt.subplot2grid((12,9), (10,0), rowspan=2, colspan=9)
top.plot(df.index, df['Adj Close'], color='blue') #df.index gives the dates
bottom.bar(df.index, df['Volume'])

# set the labels
top.axes.get_xaxis().set_visible(False)
top.set_title('AAPL')
top.set_ylabel('Adj Close')
bottom.set_ylabel('Volume')

plt.figure(figsize=(12,9))
sns.distplot(df['Adj Close'].dropna(), bins=50, color='purple')

# simple moving averages
df['MA05'] = df['Adj Close'].rolling(5).mean() #5 days
df['MA20'] = df['Adj Close'].rolling(20).mean() #20 days
df['MA60'] = df['Adj Close'].rolling(60).mean() #60 days
df2 = pd.DataFrame({'Adj Close': df['Adj Close'],'MA05': df['MA05'],'MA20': df['MA20'], 'MA60': df['MA60']})
df2.plot(figsize=(12, 9), legend=True, title='AAPL')
df2.to_csv('AAPL_MA.csv')
fig = plt.gcf()
fig.set_size_inches(12, 9)
fig.savefig('AAPL_plot.png', dpi=300)
```

! pip install pandas_datareader

```
1 ! pip install pandas_datareader
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```
Collecting pandas_datareader
  Downloading https://files.pythonhosted.org/packages/cc/5c/ea5b6dcfd0f55c5fb1e37fb45335ec01cceca199b8a79339137f5ed269e0/pandas_datarea
    100% |████████████████████████████████| 112kB 2.7MB/s
Collecting lxml (from pandas_datareader)
  Downloading https://files.pythonhosted.org/packages/03/a4/9eea8035fc7c7670e5eab97f34ff2ef0ddd78a491bf96df5accedb0e63f5/lxml-4.2.5-cp3
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Requirement already satisfied: pandas>=0.19.2 in /usr/local/lib/python3.6/dist-packages (from pandas_datareader) (0.22.0)
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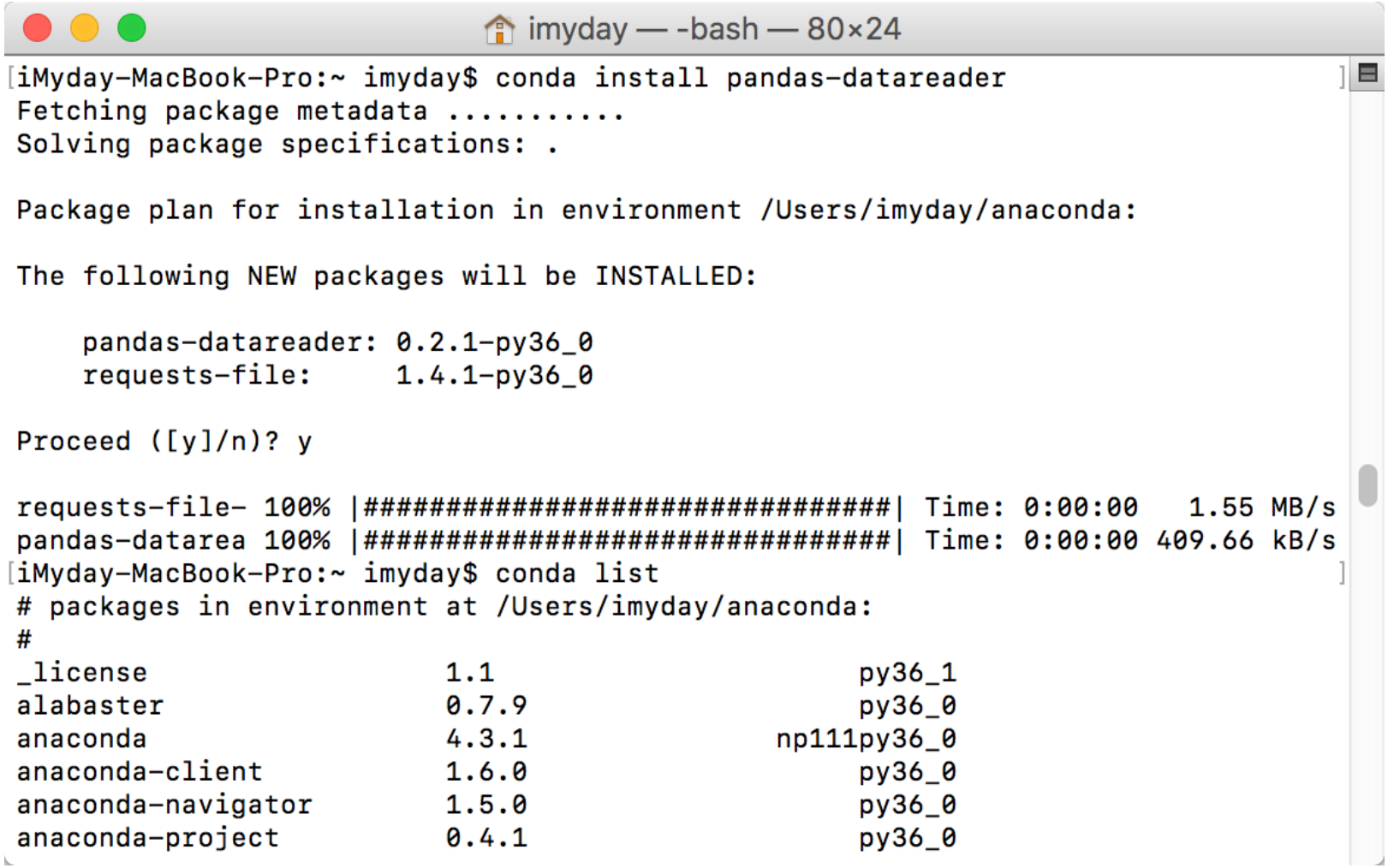
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.6/dist-packages (from python-dateutil>=2->pandas>=0.19.2->pandas_data
Installing collected packages: lxml, pandas-datareader
Successfully installed lxml-4.2.5 pandas-datareader-0.7.0
```

conda install pandas-datareader

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Finance Data from Yahoo Finance

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import datetime as dt
#Read Stock Data from Yahoo Finance
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start = dt.datetime(2016, 1, 1)
df = web.DataReader("AAPL", 'yahoo', start, end)
df.to_csv('AAPL.csv')
df.from_csv('AAPL.csv')
df.tail()
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AAPL
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 # set the labels
top.axes.get_xaxis().set_visible(False)
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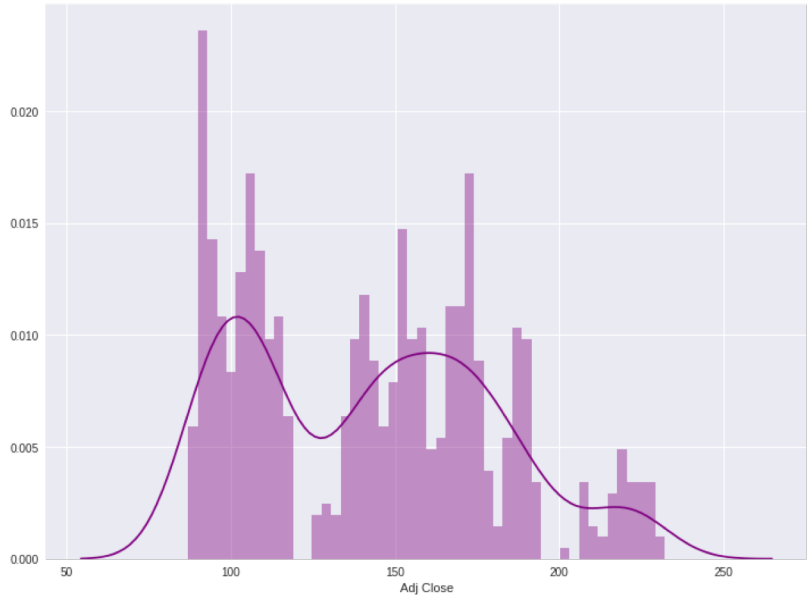

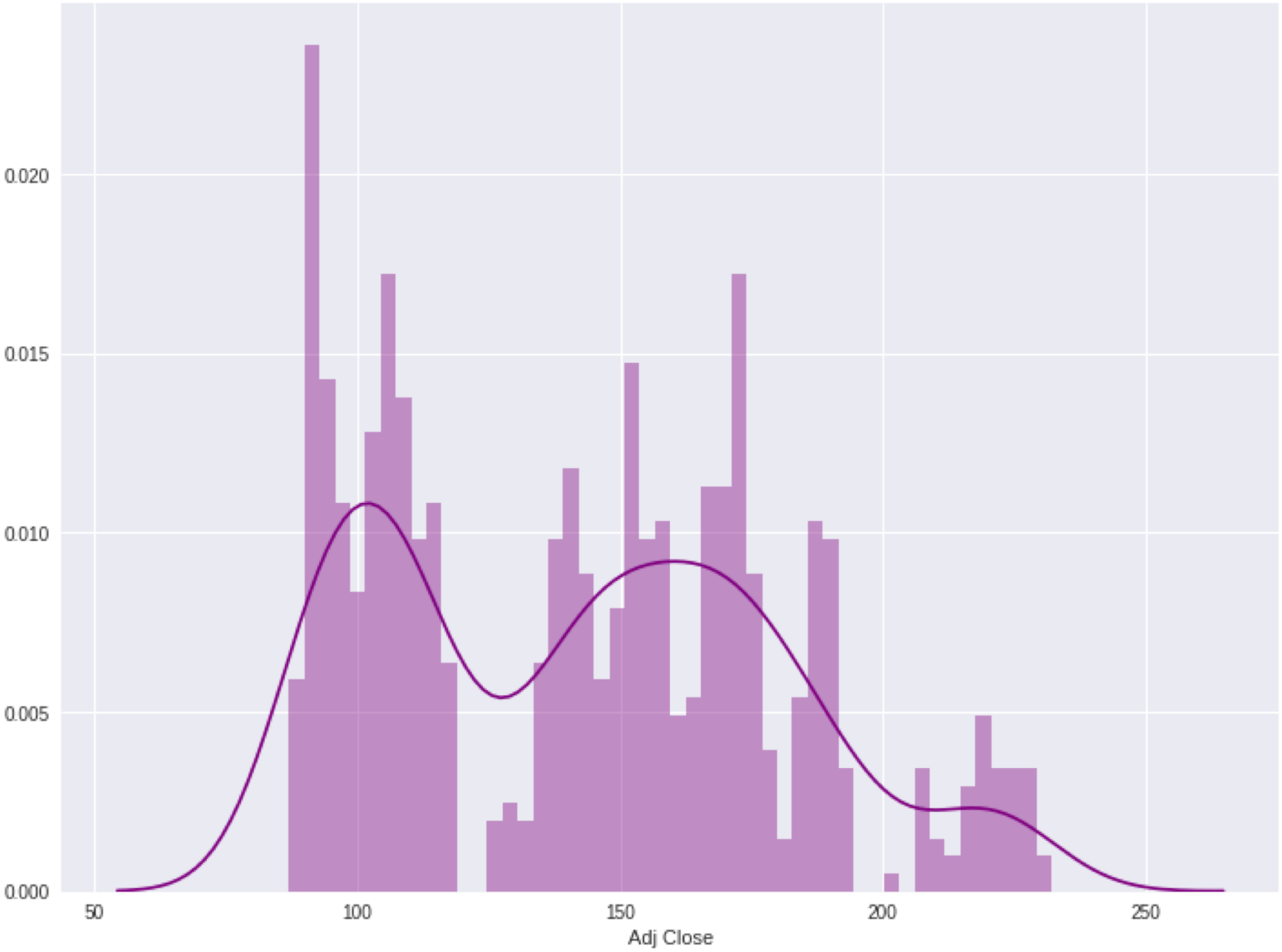
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Adj Close

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top.set_title('AAPL')
top.set_ylabel('Adj Close')
bottom.set_ylabel('Volume')

plt.figure(figsize=(12,9))
sns.distplot(df['Adj Close'].dropna(), bins=50, color='purple')

# simple moving averages
df['MA05'] = df['Adj Close'].rolling(5).mean() #5 days
df['MA20'] = df['Adj Close'].rolling(20).mean() #20 days
df['MA60'] = df['Adj Close'].rolling(60).mean() #60 days
df2 = pd.DataFrame({'Adj Close': df['Adj Close'],'MA05': df['MA05'],'MA20': df['MA20'], 'MA60': df['MA60']})
df2.plot(figsize=(12, 9), legend=True, title='AAPL')
df2.to_csv('AAPL_MA.csv')
fig = plt.gcf()
fig.set_size_inches(12, 9)
fig.savefig('AAPL_plot.png', dpi=300)
plt.show()
```

Finance Data from Quandl

```
# ! pip install quandl
import quandl
# quandl.ApiConfig.api_key = "YOURAPIKEY"
df = quandl.get("WIKI/AAPL", start_date="2016-01-01", end_date="2017-12-31")
df.to_csv('AAPL.csv')
df.from_csv('AAPL.csv')
df.tail()
```

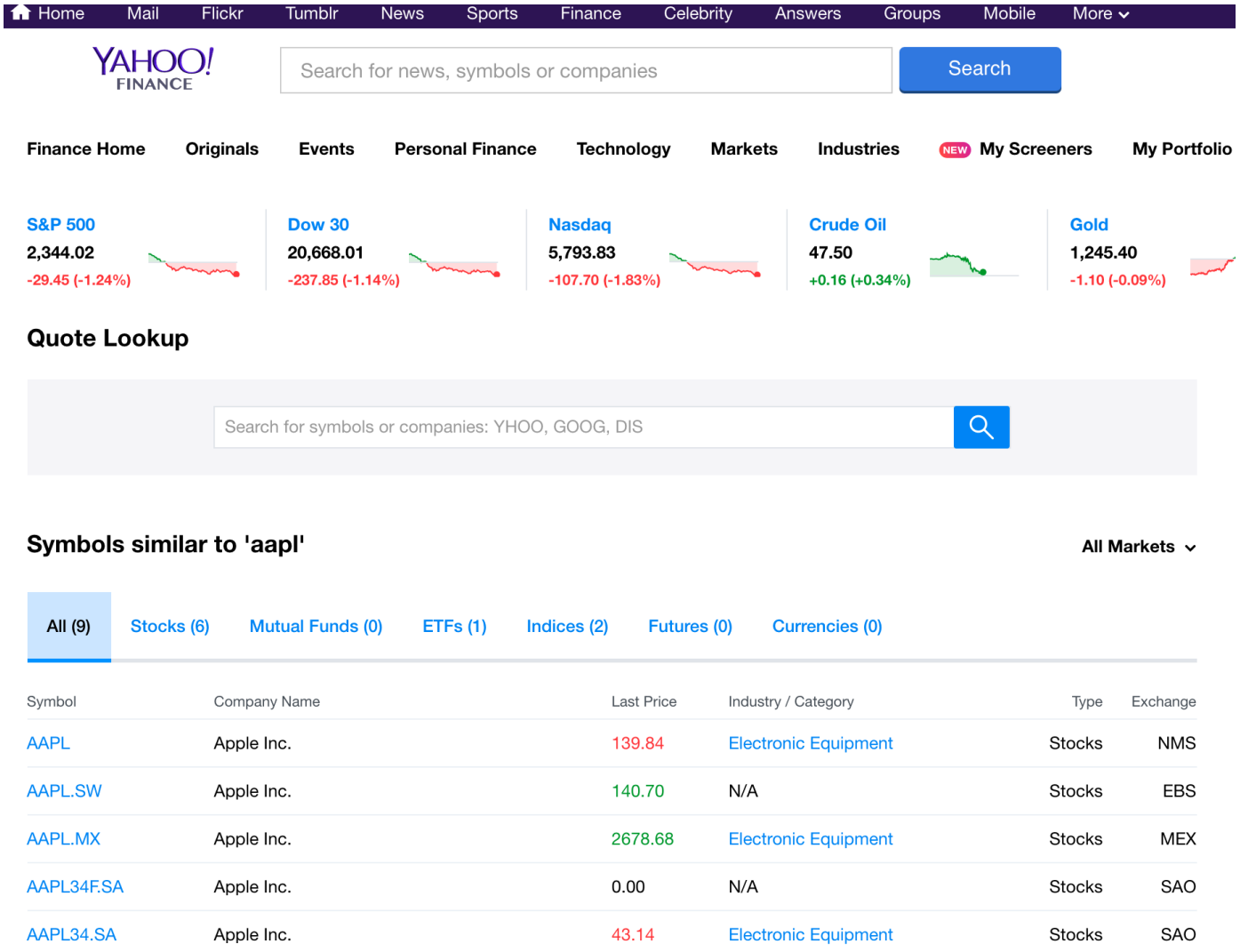
```
1 # ! pip install quandl
2 import quandl
3 # quandl.ApiConfig.api_key = "YOURAPIKEY"
4 df = quandl.get("WIKI/AAPL", start_date="2016-01-01", end_date="2017-12-31")
5 df.to_csv('AAPL.csv')
6 df.from_csv('AAPL.csv')
7 df.tail()
```

```
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:5: FutureWarning: from_csv is deprecated. Please use read_csv(...) instead
  """
```

Date	Open	High	Low	Close	Volume	Ex-Dividend	Split Ratio	Adj. Open	Adj. High	Adj. Low	Adj. Close	Adj. Volume
2017-12-22	174.68	175.424	174.500	175.01	16052615.0	0.0	1.0	174.68	175.424	174.500	175.01	16052615.0
2017-12-26	170.80	171.470	169.679	170.57	32968167.0	0.0	1.0	170.80	171.470	169.679	170.57	32968167.0
2017-12-27	170.10	170.780	169.710	170.60	21672062.0	0.0	1.0	170.10	170.780	169.710	170.60	21672062.0
2017-12-28	171.00	171.850	170.480	171.08	15997739.0	0.0	1.0	171.00	171.850	170.480	171.08	15997739.0
2017-12-29	170.52	170.590	169.220	169.23	25643711.0	0.0	1.0	170.52	170.590	169.220	169.23	25643711.0

Source: https://www.quandl.com/tools/python

Yahoo Finance Symbols: AAPL Apple Inc. (AAPL)



http://finance.yahoo.com/q?s=AAPL

Dow Jones Industrial Average (^DJI)

http://finance.yahoo.com/chart/^DJI

TSEC weighted index (^TWII) - Taiwan

http://finance.yahoo.com/chart/^TWII

Yahoo Finance Charts
TSMC (2330.TW)

http://finance.yahoo.com/chart/2330.TW

```
import pandas as pd
import pandas_datareader.data as web
df = web.DataReader('AAPL', data_source='yahoo',
start='1/1/2010', end='3/21/2017')
df.to_csv('AAPL.csv')
df.tail()
```

```
import pandas as pd
import pandas_datareader.data as web
#df = web.DataReader('AAPL', 'yahoo')
df = web.DataReader('AAPL', data_source='yahoo', start='1/1/2010', end='3/21/2017')
#df = web.DataReader('AAPL', data_source='google', start='1/1/2010', end='3/21/2017')
df.to_csv('AAPL.csv')
df.tail()
```

	Open	High	Low	Close	Volume	Adj Close
Date						
2017-03-15	139.410004	140.750000	139.029999	140.460007	25566800	140.460007
2017-03-16	140.720001	141.020004	140.259995	140.690002	19132500	140.690002
2017-03-17	141.000000	141.000000	139.889999	139.990005	43597400	139.990005
2017-03-20	140.399994	141.500000	140.229996	141.460007	20213100	141.460007
2017-03-21	142.110001	142.800003	139.729996	139.839996	39116800	139.839996

```
df = web.DataReader('GOOG',
data_source='yahoo', start='1/1/1980',
end='3/21/2017')
df.head(10)
```

```
df = web.DataReader('GOOG', data_source='yahoo', start='1/1/1980', end='3/21/2017')
df.head(10)
```

	Open	High	Low	Close	Volume	Adj Close
Date						
2004-08-19	100.000168	104.060182	95.960165	100.340176	44871300	50.119968
2004-08-20	101.010175	109.080187	100.500174	108.310183	22942800	54.100990
2004-08-23	110.750191	113.480193	109.050183	109.400185	18342800	54.645447
2004-08-24	111.240189	111.600192	103.570177	104.870176	15319700	52.382705
2004-08-25	104.960181	108.000187	103.880180	106.000184	9232100	52.947145
2004-08-26	104.950180	107.950188	104.660179	107.910182	7128600	53.901190
2004-08-27	108.100185	108.620186	105.690180	106.150181	6241200	53.022069
2004-08-30	105.280178	105.490184	102.010172	102.010172	5221400	50.954132
2004-08-31	102.300173	103.710180	102.160177	102.370175	4941200	51.133953
2004-09-01	102.700174	102.970180	99.670169	100.250171	9181600	50.075011

df.tail(10)

```
df.tail(10)
```

	Open	High	Low	Close	Volume	Adj Close
Date						
2017-03-08	833.510010	838.150024	831.789978	835.369995	988700	835.369995
2017-03-09	836.000000	842.000000	834.210022	838.679993	1259900	838.679993
2017-03-10	843.280029	844.909973	839.500000	843.250000	1701100	843.250000
2017-03-13	844.000000	848.684998	843.250000	845.539978	1149500	845.539978
2017-03-14	843.640015	847.239990	840.799988	845.619995	779900	845.619995
2017-03-15	847.590027	848.630005	840.770020	847.200012	1379600	847.200012
2017-03-16	849.030029	850.849976	846.130005	848.780029	970400	848.780029
2017-03-17	851.609985	853.400024	847.109985	852.119995	1712300	852.119995
2017-03-20	850.010010	850.219971	845.150024	848.400024	1190300	848.400024
2017-03-21	851.400024	853.500000	829.020020	830.460022	2442900	830.460022

df.count()

```
df.count()
```

```
Open          3169
High          3169
Low           3169
Close         3169
Volume        3169
Adj Close     3169
dtype: int64
```

df.ix['2015-12-31']

```
df.ix['2015-12-31']
```

```
Open          7.695000e+02
High          7.695000e+02
Low           7.583400e+02
Close         7.588800e+02
Volume        1.489600e+06
Adj Close     7.588800e+02
Name: 2015-12-31 00:00:00, dtype: float64
```

```
df.to_csv('2330.TW.Yahoo.Finance.Data.csv')
```

2330.TW.Yahoo.Finance.Data.csv

```
Date,Open,High,Low,Close,Volume,Adj Close
2010-01-01,64.5,64.5,64.5,64.5,0,52.8308
2010-01-04,65.0,65.0,64.0,64.9,39407000,53.1584
2010-01-05,65.0,65.1,63.9,64.5,37138000,52.8308
2010-01-06,64.5,64.9,63.7,64.9,49261000,53.1584
2010-01-07,64.9,65.0,64.2,64.2,42134000,52.5851
2010-01-08,63.5,64.3,63.5,64.0,46076000,52.4213
2010-01-11,64.0,64.9,63.5,64.5,36799000,52.8308
2010-01-12,64.4,64.4,63.3,63.6,49853000,52.0936
2010-01-13,63.0,63.1,62.6,62.8,47976000,51.4384
2010-01-14,63.6,63.6,63.0,63.2,36149000,51.766
2010-01-15,62.9,63.5,62.8,63.5,47852000,52.0117
2010-01-18,62.8,63.1,62.8,62.9,30136000,51.5203
2010-01-19,63.0,63.2,62.0,62.5,47202000,51.1926
2010-01-20,62.9,63.2,62.2,63.0,52281000,51.6022
```

```
import fix_yahoo_finance as yf
data = yf.download("^TWII", start="2017-07-01", end="2017-11-15")
data.to_csv('TWII_201707_201711.csv')
data.tail()
```

```
import fix_yahoo_finance as yf
data = yf.download("^TWII", start="2017-07-01", end="2017-11-15")
data.to_csv('TWII_201707_201711.csv')
data.tail()
```

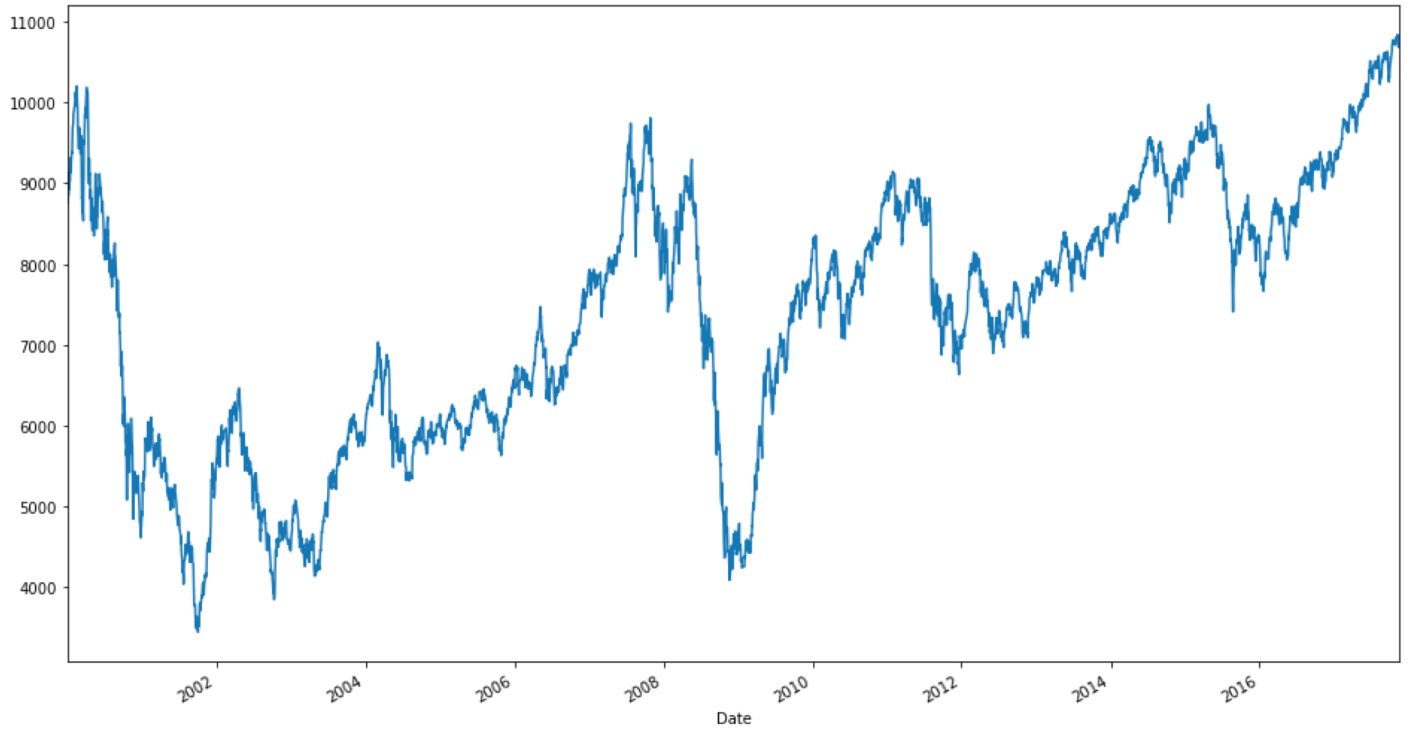
```
[**********************100%**********************]  1 of 1 downloaded
```

	Open	High	Low	Close	Adj Close	Volume
Date						
2017-11-08	10839.440430	10844.740234	10806.009766	10818.990234	10818.990234	2438000
2017-11-09	10802.950195	10831.379883	10721.870117	10743.269531	10743.269531	2917800
2017-11-10	10713.669922	10742.610352	10659.290039	10732.669922	10732.669922	2277000
2017-11-13	10728.219727	10749.389648	10683.919922	10683.919922	10683.919922	2765100
2017-11-14	10716.589844	10735.080078	10654.580078	10687.179688	10687.179688	2596600

df.loc[start:end]

```
df = df.loc['2017-10-01':'2017-11-15']
```

```
import matplotlib.pyplot as plt
%matplotlib inline
import fix_yahoo_finance as yf
df = yf.download("^TWII", start="2000-01-01", end="2017-11-15")
df.to_csv('YF_TWII_2000_2017.csv')
print(df.head())
fig = plt.figure(figsize=(16,9))
df["Adj Close"].plot()
fig.show()
```



candlestick_ohlc

```
import matplotlib.pyplot as plt

from matplotlib.finance
import candlestick_ohlc
```

Source: https://matplotlib.org/examples/pylab_examples/finance_demo.html

```
import matplotlib.pyplot as plt
from matplotlib.finance import candlestick_ohlc
```

Source: https://ntguardian.wordpress.com/2016/09/19/introduction-stock-market-data-python-1/

daily_to_weekly

```
#Convert Daily Data to Weekly Data
def daily_to_weekly(df):
     #dfWeekly = daily_to_weekly(df)
    #df.sort_index(axis=0, level=None, ascending=True, inplace=True)
     Open = df.Open.resample('W-Fri').first() #W #W-MON #W-Fri
     High = df.High.resample('W-Fri').max()
     Low = df.Low.resample('W-Fri').min()
     Close = df.Close.resample('W-Fri').last()
     Volume = df.Volume.resample('W-Fri').sum()
     Adj_Close = df["Adj Close"].resample('W-Fri').last()
    dfWeekly = pd.concat([Open, High, Low, Close, Volume, Adj_Close], axis=1)
    dfWeekly = dfWeekly[pd.notnull(dfWeekly['Adj Close'])]
    return dfWeekly
```

daily_to_monthly

```
#Convert Daily Data to Monthly Data
def daily_to_monthly(df):
    #dfMonthly = daily_to_monthly(df)
    Open = df.Open.resample('M').first()
    High = df.High.resample('M').max()
    Low = df.Low.resample('M').min()
    Close = df.Close.resample('M').last()
    Volume = df.Volume.resample('M').sum()
    Adj_Close = df["Adj Close"].resample('M').last()
   dfMonthly = pd.concat([Open, High, Low, Close, Volume, Adj_Close], axis=1)
    dfMonthly = dfMonthly[pd.notnull(dfMonthly['Adj Close'])]
    return dfMonthly
```

TA-Lib:
Technical Analysis Library

TA-Lib : Technical Analysis Library

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TA-Lib is widely used by trading software developers requiring to perform technical analysis of financial market data.

- Includes 200 indicators such as ADX, MACD, RSI, Stochastic, Bollinger Bands etc... (more info)
- Candlestick pattern recognition
- Open-source API for C/C++, Java, Perl, Python and 100% Managed .NET

Free Open-Source Library

TA-Lib is available under a BSD License allowing it to be integrated in your own open-source or commercial application. (more info)

Commercial Application

TA-Lib is also available as an easy to install Excel Add-Ins. Try it for free!

http://ta-lib.org/

Stochastic Oscillator (KD)

```
#Stochastic oscillator %D
def KDJ(df, n, m1, m2):
    #KDJ(df, 9, 3, 3)
    KDJ_n = n
    KDJ_m1 = m1
    KDJ_m2 = m2

    df['Low_n'] = pd.rolling_min(df['Low'], KDJ_n)
    df['Low_n'].fillna(value=pd.expanding_min(df['Low']), inplace=True)
    df['High_n'] = pd.rolling_max(df['High'], KDJ_n)
    df['High_n'].fillna(value=pd.expanding_max(df['High']), inplace=True)

    df['RSV'] = (df['Close'] - df['Low_n']) / (df['High_n'] - df['Low_n']) * 100

    df['KDJ_K'] = pd.ewma(df['RSV'], KDJ_m1)
    df['KDJ_D'] = pd.ewma(df['KDJ_K'], KDJ_m2)
    df['KDJ_J'] = 3 * df['KDJ_K'] - 2 * df['KDJ_D']
    return df
```

Source: https://www.quantopian.com/posts/technical-analysis-indicators-without-talib-code

Bollinger Bands

```
#Bollinger Bands
def BBANDS20(df, n):
    MA = pd.Series(pd.rolling_mean(df['Close'], n))
    MSD = pd.Series(pd.rolling_std(df['Close'], n))
    b1 = 4 * MSD / MA
    B1 = pd.Series(b1, name = 'BollingerB_' + str(n))
    df = df.join(B1)
    b2 = (df['Close'] - MA + 2 * MSD) / (4 * MSD)
    B2 = pd.Series(b2, name = 'Bollinger%b_' + str(n))
    df = df.join(B2)
    return df
```

Source: https://www.quantopian.com/posts/technical-analysis-indicators-without-talib-code

Bollinger Bands

```
#BB Bollinger Bands BB_20
def BB_20(df):
    df['BB_MA20'] = pd.stats.moments.rolling_mean(df["Adj Close"], 20)
    df['BB_SD20'] = pd.stats.moments.rolling_std(df['Adj Close'],20)
    df['BB_UpperBand'] = df['BB_MA20'] + (df['BB_SD20']*2) # Default 2*SD
    df['BB_LowerBand'] = df['BB_MA20'] - (df['BB_SD20']*2)
    df['BB_PB'] = (df['Adj Close'] - df['BB_LowerBand']) / (df['BB_UpperBand'] -
df['BB_LowerBand'])
    df['BB_BW'] = (df['BB_UpperBand'] - df['BB_LowerBand']) / df['BB_MA20']
    df['BB_UpperBand_1SD'] = df['BB_MA20'] + (df['BB_SD20'])
    df['BB_LowerBand_1SD'] = df['BB_MA20'] - (df['BB_SD20'])
    #BB_PB: Bollinger Band Percent b (PB)
    #BB_BW: Bollinger Band Band Width (BW)
    return df
```

Source: https://www.quantopian.com/posts/technical-analysis-indicators-without-talib-code

AI + VDI

POC

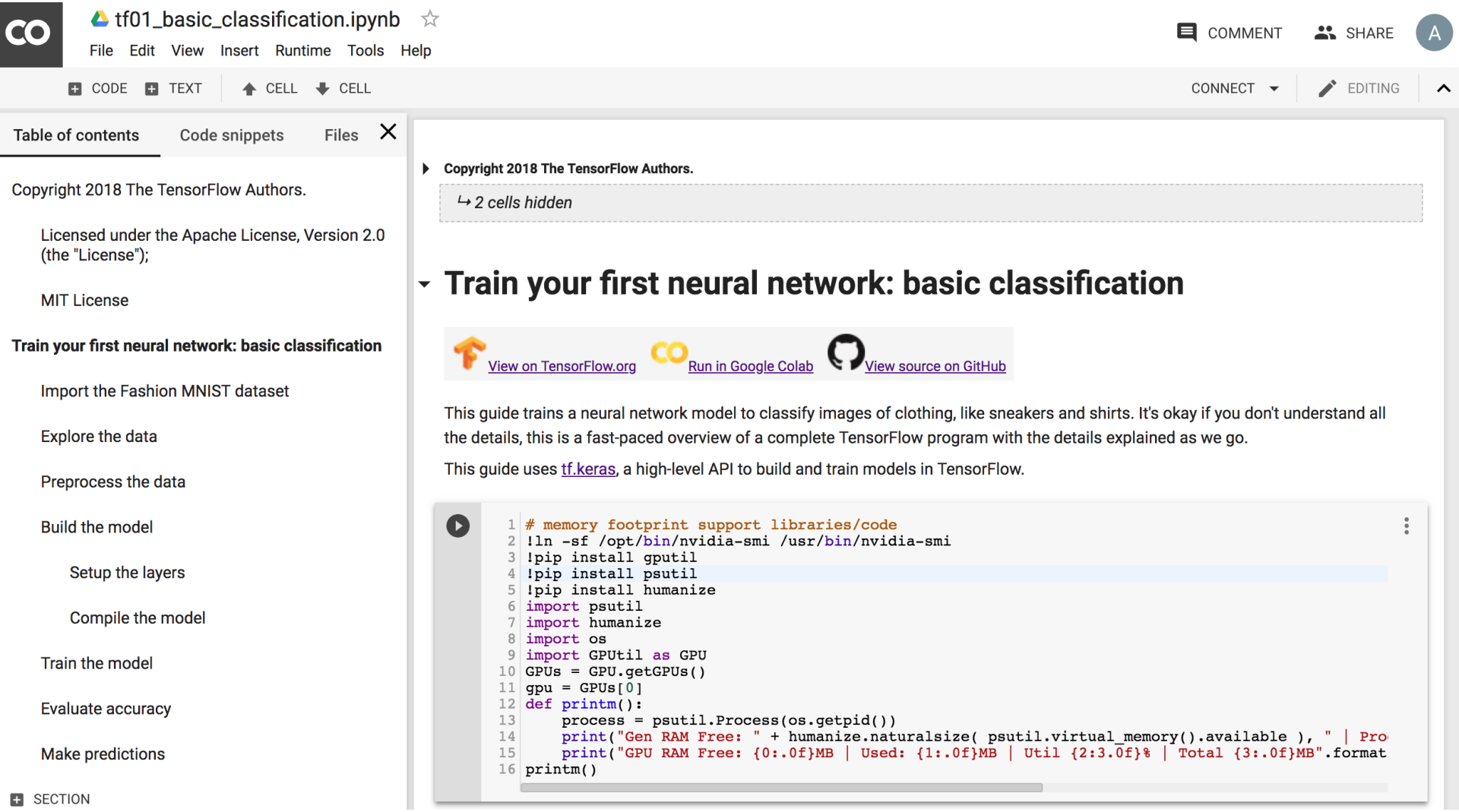
AI + VDI POS
TensorFlow Models

- M1: Basic Classification (Image Classification) (65 Seconds)
  - https://colab.research.google.com/github/tensorflow/docs/blob/master/site/en/tutorials/keras/basic_classification.ipynb
- M2: Basic Text Classification (Text Classification) (46 Seconds)
  - https://colab.research.google.com/github/tensorflow/docs/blob/master/site/en/tutorials/keras/basic_text_classification.ipynb
- M3: Basic Regression (Predict House Prices) (43 Seconds)
  - https://colab.research.google.com/github/tensorflow/docs/blob/master/site/en/tutorials/keras/basic_regression.ipynb
- M4: Pix2Pix Eager (Option) (7-8 Hours)
  - https://colab.research.google.com/github/tensorflow/tensorflow/blob/master/tensorflow/contrib/eager/python/examples/pix2pix/pix2pix_eager.ipynb
- M5. NMT with Attention (Option) (20-30 minutes)
  - https://colab.research.google.com/github/tensorflow/tensorflow/blob/master/tensorflow/contrib/eager/python/examples/nmt_with_attention/nmt_with_attention.ipynb

Basic Classification

Fashion MNIST Image Classification

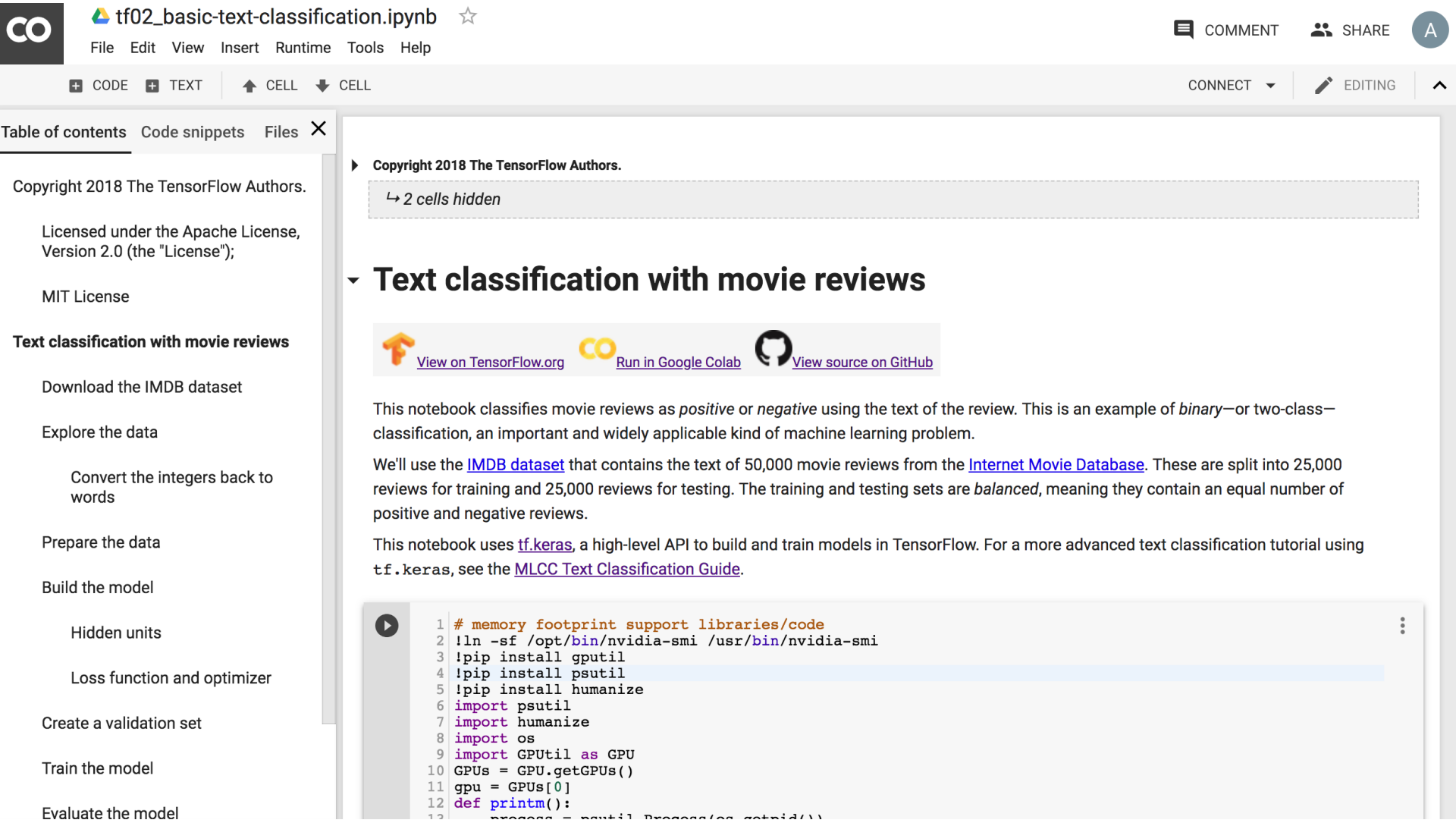
https://colab.research.google.com/drive/19PJOJi1vn1kjcutlzNHjRSLbeVl4kd5z



Source: https://colab.research.google.com/github/tensorflow/docs/blob/master/site/en/tutorials/keras/basic_classification.ipynb

Text Classification
IMDB Movie Reviews

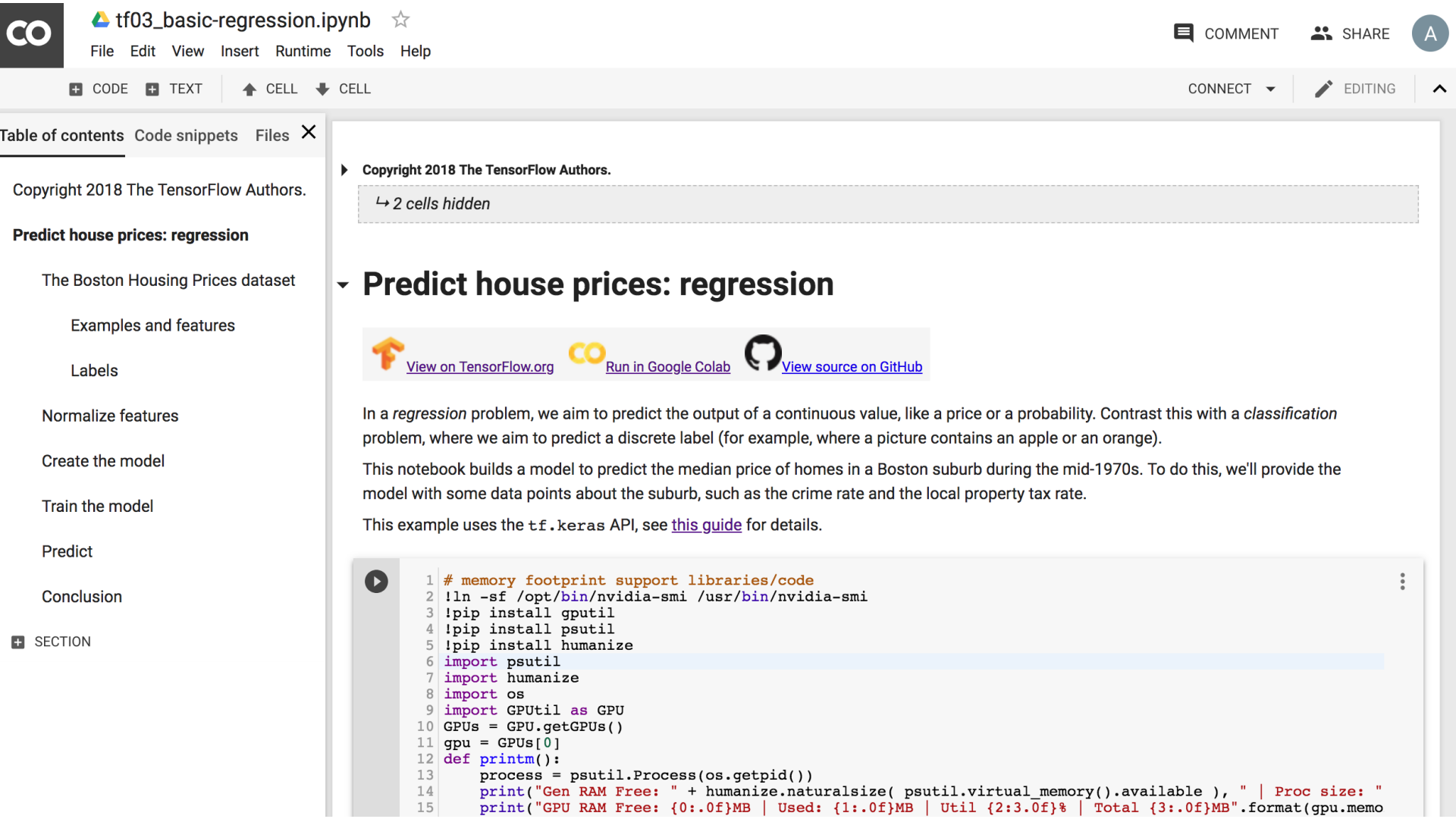
https://colab.research.google.com/drive/1x16h1GhHsLIrLYtPCvCHaoO1W-i_gror



Source: https://colab.research.google.com/github/tensorflow/docs/blob/master/site/en/tutorials/keras/basic_text_classification.ipynb

Basic Regression
Predict House Prices

https://colab.research.google.com/drive/1v4c8ZHTnRtgd2_25K_AURjR6SCVBRdlj



Source: https://colab.research.google.com/github/tensorflow/docs/blob/master/site/en/tutorials/keras/basic_regression.ipynb

AI+VDI POC
ISAC+TKU Test

- AI+VDI POC Folder (3+1 ipynb) (v3.0.20181120)
  - https://drive.google.com/open?id=1qHOemktbEmUz-ot8eFxIKbGwJvXlrjtc
- run3models.ipynb
  - https://colab.research.google.com/drive/1HQ1GrIqQUUPCct7_AVgoMwMrh0UqMm0f
- AI+VDI POC ISAC+TKU Test Report
  - https://docs.google.com/spreadsheets/d/1meMwqn15PSuTk6d5TgendDpdDX6L3OfHM4E0SIkq1Zk/edit?usp=sharing

Summary

- Prescriptive Analytics
- Model-Based Decision Making
- Structure of Mathematical Models for Decision Support
- Certainty, Uncertainty, and Risk
- Mathematical Programming Optimization
- Simulation

References

- Ramesh Sharda, Dursun Delen, and Efraim Turban (2017), Business Intelligence, Analytics, and Data Science: A Managerial Perspective, 4th Edition, Pearson.
- Jake VanderPlas (2016), Python Data Science Handbook: Essential Tools for Working with Data, O'Reilly Media.