

Class 1: Predictive Analytics and Predictive Maintenance



Agenda

- What Is Predictive Analytics?
- Predictive Analytics Examples?
- What is Predictive Maintenance?
- Predictive Maintenance Examples
- Exploring Colaboratory
- Lab Project: Data Collection with a Raspberry Pi

What is Predictive Analytics ?



Predictive Analytics (PA):

“ Is the use of data, statistical algorithms and machine learning techniques to identify the likelihood of future outcomes based on historical data”.



Source:

https://www.sas.com/en_us/insights/analytics/predictive-analytics.html

What is Predictive Analytics ? . . .



PA Goals:

The objective of PA to make an assessment of what will happen in the future based on previous or current knowledge and experiences.

What is Predictive Analytics ?



1930s–40s

Dawn of Computer Age

1940s:

Turing and Good conduct groundbreaking work with “weights of evidence” to decode German messages in WWII

1940:

Kerrison Predictor automates targeting of anti-aircraft weapons against enemy planes

1944:

Manhattan Project team runs computer simulations to predict behavior of nuclear chain reactions

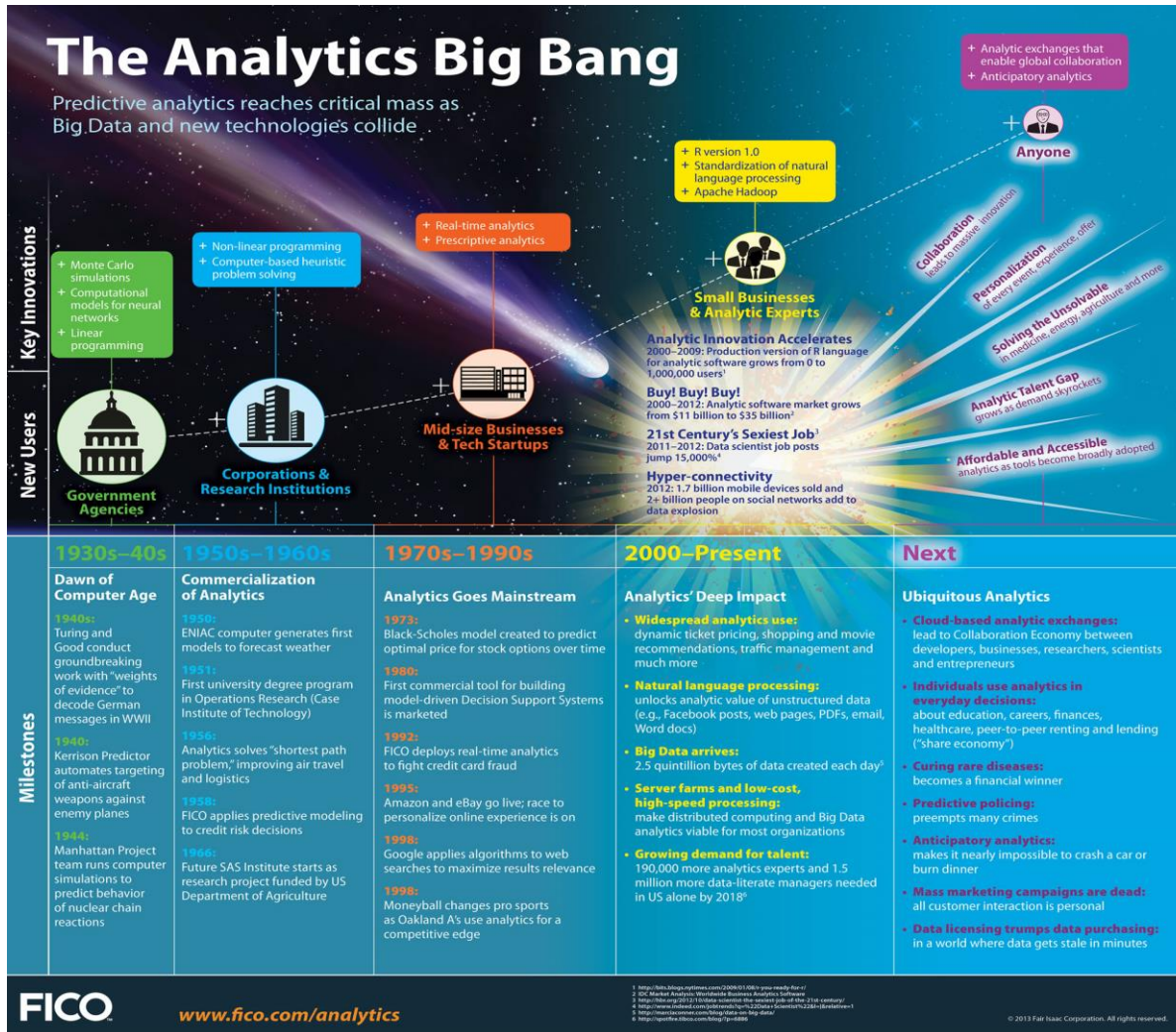
PA History

Question 1



What is the objective of Predictive Analytics?

What is Predictive Analytics ?



PA Evolution

What is Predictive Analytics ?



PA Present to the Future

2000–Present	Next
<p>Analytics' Deep Impact</p> <ul style="list-style-type: none">• Widespread analytics use: dynamic ticket pricing, shopping and movie recommendations, traffic management and much more• Natural language processing: unlocks analytic value of unstructured data (e.g., Facebook posts, web pages, PDFs, email, Word docs)• Big Data arrives: 2.5 quintillion bytes of data created each day⁵• Server farms and low-cost, high-speed processing: make distributed computing and Big Data analytics viable for most organizations• Growing demand for talent: 190,000 more analytics experts and 1.5 million more data-literate managers needed in US alone by 2018⁶	<p>Ubiquitous Analytics</p> <ul style="list-style-type: none">• Cloud-based analytic exchanges: lead to Collaboration Economy between developers, businesses, researchers, scientists and entrepreneurs• Individuals use analytics in everyday decisions: about education, careers, finances, healthcare, peer-to-peer renting and lending (“share economy”)• Curing rare diseases: becomes a financial winner• Predictive policing: preempts many crimes• Anticipatory analytics: makes it nearly impossible to crash a car or burn dinner• Mass marketing campaigns are dead: all customer interaction is personal• Data licensing trumps data purchasing: in a world where data gets stale in minutes

What is Predictive Analytics ? . . .



What is Predictive Analytics ? . . .



Reasons for (PA):

- Organizations use PA to increase bottom line and provide a competitive advantage.
- Easier to use software tools
- Growing volumes of data types and interest in applying to products and services.
- The economic conditions making the markets extremely competitive.

What is Predictive Analytics ? . . .



Reasons for (PA):

- Faster, cheaper computers
- Easier to use software tools
- Growing volumes of data types and interest in applying to products and services.
- The economic conditions making the markets extremely competitive.

Predictive Analytics Examples

Example: Health Care

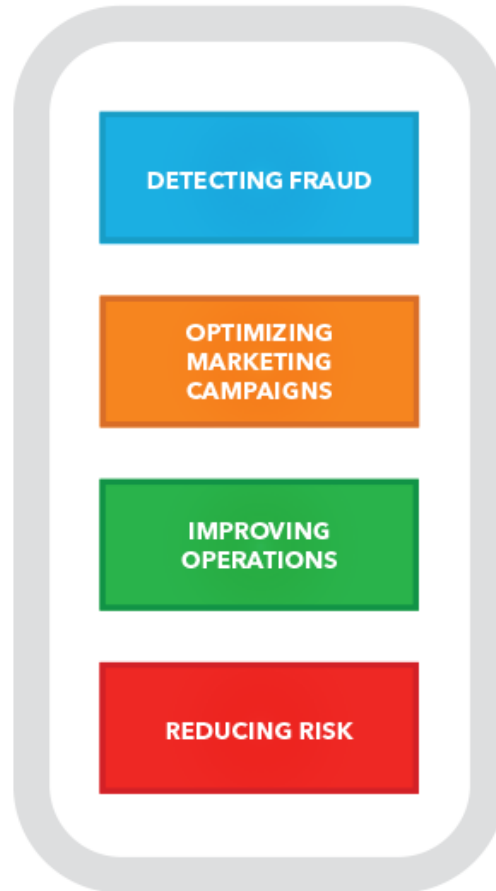


Question 2



List two reasons for using Predictive Analytics.

Predictive Analytics Application Examples. . .



Source:

https://www.sas.com/en_us/insights/analytics/predictive-analytics.html

Predictive Analytics Application Examples. . .



Detecting Fraud:

Pattern detection of criminal behavior can be predicted using multiple analytics.

Optimizing marketing campaigns:

Customer responses or purchases as well as promote cross-sell opportunities

Improving Operations:

Companies use predictive models to forecast inventory and manage resources

Predictive Analytics Application Examples. . .



Reducing risk:

Determining the likelihood of mitigating disruption events in an organization.

What is Predictive Maintenance?



Predictive Maintenance:

- a. The monitoring of wear conditions and equipment characteristics against a predetermined tolerance to predict possible malfunctions or failures.
- b. Equipment operation data is gathered and analyzed to show trends in performance and component characteristics.

Source:

Rockis, G.J., & Mazur, G.A. (2014). *Electrical motor controls for integrated systems*, 5th ed. Orland Park, IL. American Technical Publishers.

What is Predictive Maintenance?

Predictive Maintenance Applications



VISUAL AND AUDITORY INSPECTION



VIBRATION ANALYSIS



UE Systems, Inc.

INFRARED THERMOMETER



Fluke Corporation

Source:

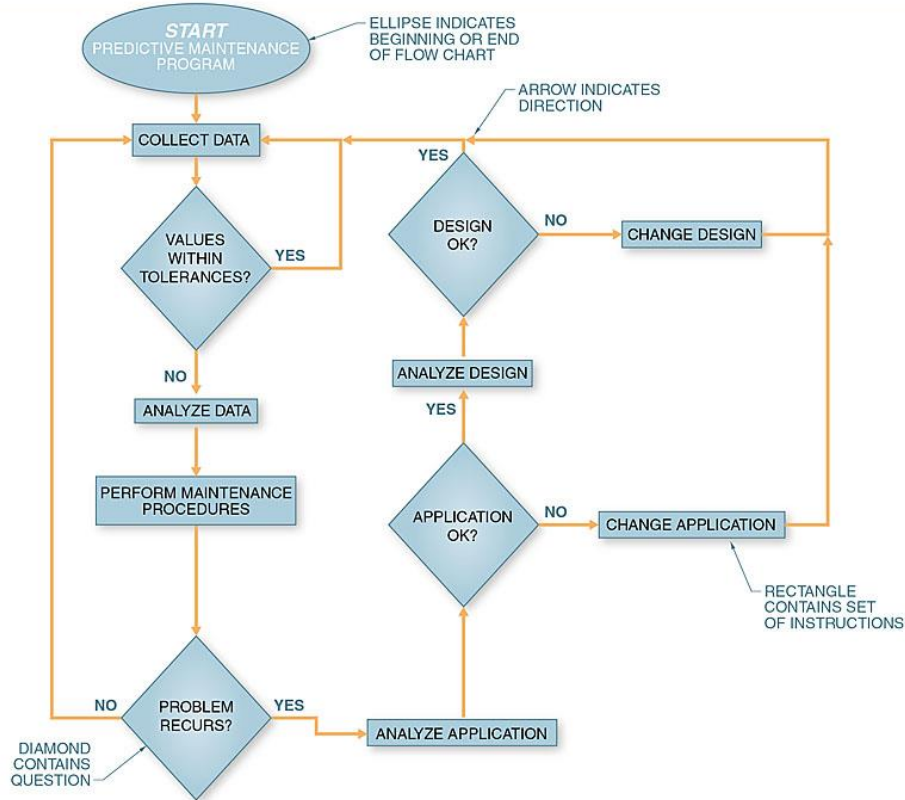
Rockis, G.J., & Mazur, G.A. (2014). *Electrical motor controls for integrated systems*, 5th ed. Orland Park, IL. American Technical Publishers.

What is Predictive Maintenance?



Predictive Maintenance

PREDICTIVE MAINTENANCE FLOW CHART



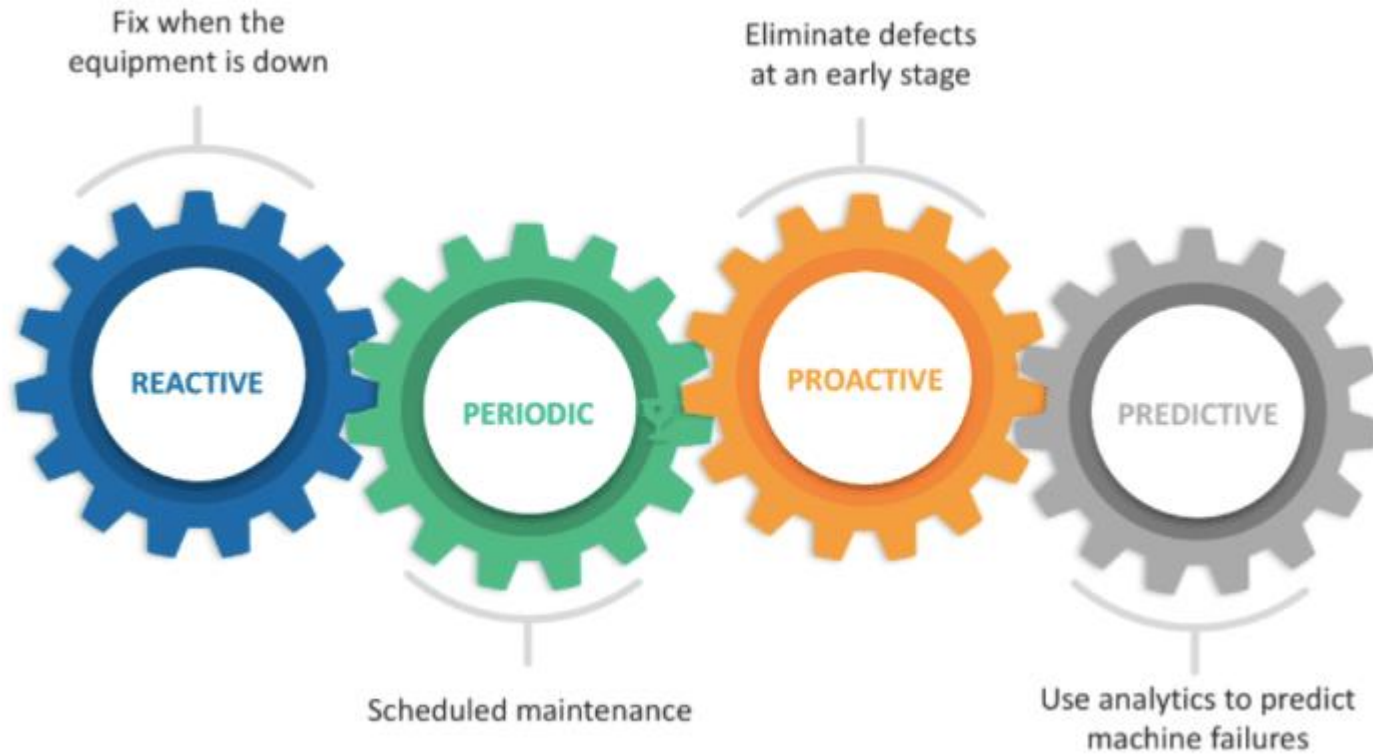
Source:

Rockis, G.J., & Mazur, G.A. (2014). Electrical motor controls for integrated systems, 5th ed. Orland Park, IL. American Technical Publishers.

What is Predictive Maintenance?



Preventative Maintenance vs Predictive Maintenance



Question 3



What are the benefits of Predictive Maintenance?

Exploring Colaboratory



What is Colaboratory?

Colaboratory is a Google research project created to help disseminate machine learning education and research. It's a Jupyter notebook environment that requires no setup to use and runs entirely in the cloud. ... **Colaboratory** is free to use.

url website address:

<https://research.google.com/colaboratory/>

Exploring Colaboratory. . .

The screenshot shows the Google Colaboratory web interface. At the top, there's a navigation bar with 'Hello, Colaboratory', a star icon, and 'COMMENT' and 'SHARE' buttons. Below that is a menu with 'File', 'Edit', 'View', 'Insert', 'Runtime', 'Tools', and 'Help'. The main area is divided into sections. The first section is 'Welcome to Colaboratory!'. The second section is 'TensorFlow execution', which includes a text description, a mathematical equation showing the addition of two 2x3 matrices, a code cell with TensorFlow and NumPy code, and its output: an array of two 2x3 matrices. The third section is 'Visualization', which includes a text description, a code cell with matplotlib code, and a scatter plot with a linear regression line. The plot shows 20 data points and a green line of best fit.

co Hello, Colaboratory ☆

File Edit View Insert Runtime Tools Help

CODE TEXT CELL CELL

CONNECTED EDITING

Welcome to Colaboratory!

TensorFlow execution

Colaboratory allows you to execute TensorFlow code in your browser with a single click. The example below adds two matrices.

$$\begin{bmatrix} 1. & 1. & 1. \\ 1. & 1. & 1. \end{bmatrix} + \begin{bmatrix} 1. & 2. & 3. \\ 4. & 5. & 6. \end{bmatrix} = \begin{bmatrix} 2. & 3. & 4. \\ 5. & 6. & 7. \end{bmatrix}$$

```
[ ] import tensorflow as tf
import numpy as np

with tf.Session():
    input1 = tf.constant(1.0, shape=[2, 3])
    input2 = tf.constant(np.reshape(np.arange(1.0, 7.0, dtype=np.float32), (2, 3)))
    output = tf.add(input1, input2)
    result = output.eval()

result
```

```
array([[ 2.,  3.,  4.],
       [ 5.,  6.,  7.]], dtype=float32)
```

Visualization

Colaboratory includes widely used libraries like [matplotlib](#), simplifying visualization.

```
[ ] import matplotlib.pyplot as plt
import numpy as np

x = np.arange(20)
y = [x_i + np.random.randn(1) for x_i in x]
a, b = np.polyfit(x, y, 1)
_ = plt.plot(x, y, 'o', np.arange(20), a*np.arange(20)+b, '-')
```

Exploring Colaboratory. . .



Colaboratory

Frequently Asked Questions

What is Colaboratory?

Colaboratory is a research tool for machine learning education and research. It's a Jupyter notebook environment that requires no setup to use.

What browsers are supported?

Colaboratory works with most major browsers, and is most thoroughly tested with desktop versions of [Chrome](#) and [Firefox](#).

Is it free to use?

Yes. Colaboratory is a research project that is free to use.

What is the difference between Jupyter and Colaboratory?

[Jupyter](#) is the open source project on which Colaboratory is based. Colaboratory allows you to use and share Jupyter notebooks with others without having to download, install, or run anything on your own computer other than a browser.

How is this related to colaboratory.jupyter.org?

In 2014 we worked with the Jupyter development team to release an early version of the tool. Since then Colaboratory has continued to evolve, guided by internal usage.

Where are my notebooks stored, and can I share them?

All Colaboratory notebooks are stored in [Google Drive](#). Colaboratory notebooks can be shared just as you would with Google Docs or Sheets. Simply click the Share button at the top right of any Colaboratory notebook, or follow these [Google Drive file sharing instructions](#).

If I share my notebook, what will be shared?

If you choose to share a notebook, the full contents of your notebook (text, code, and output) will be shared. You can omit code cell output from being saved or shared by selecting **Edit > Notebook settings > Omit code cell output when saving this notebook**. The virtual machine you're using, including any custom files and libraries that you've setup, will not be shared. So it's a good idea to include cells which install and load any custom [libraries](#) or [files](#) that your notebook needs.

Source:

<https://research.google.com/colaboratory/faq.html>

Exploring Colaboratory. . .



Programming in Colaboratory Python Example:

A screenshot of a Colaboratory notebook interface. The notebook title is "BasicMath_Calculators.ipynb". The menu bar includes "File", "Edit", "View", "Insert", "Runtime", "Tools", and "Help". Below the menu bar are buttons for "CODE", "TEXT", "CELL", and "CELL". The code cell contains the following Python code:

```
mass_kg = int(input("What is your mass in kilograms?" ))
mass_stone = mass_kg * 2.2 / 14
print("You weigh", mass_stone, "stone.")
```

The output cell shows the result of running the code with the input "10":

```
What is your mass in kilograms?10
('You weigh', 1.5714285714285714, 'stone.')
```


Question 4



True or False: Colaboratory is a Google X project.

Data Collection with a Raspberry Pi



Lab Project Objectives:

- a. Learn how to create Common Separated Values file.
- b. Learn how to code a read/write file application using Colaboratory.
- c. Learn how code a read/write file application using Python.

Data Collection with a Raspberry Pi . . .



You will need a :



Data Collection with a Raspberry Pi. . .



Colaboratory Python Code File (read/write:)

```
[33] import csv

csvData = [['SN', 'Name', 'City'], ['1', 'Michael', 'New Jersey'], ['2', 'Jack', 'California'], ['3', 'Donald', 'Detroit']]

with open('names.csv.txt', 'w') as csvFile:
    writer = csv.writer(csvFile)
    writer.writerows(csvData)

csvFile.close()
```

```
▶ import csv

with open('names.csv.txt', 'r') as csvFile:
    reader = csv.reader(csvFile)
    for row in reader:
        print(row)

csvFile.close()
```

```
↳ ['SN', 'Name', 'City']
   ['1', 'Michael', 'New Jersey']
   ['2', 'Jack', 'California']
   ['3', 'Donald', 'Detroit']
```

Data Collection with a Raspberry Pi. . .



**A Common Separated Value (csv)
file can be created in:**

	A	B	C	D
1	SN	Name	City	
2	1	Michael	New Jersey	
3	2	Jack	California	
4	3	Donald	Texas	

spreadsheet

```
SN Name City
1 Michael New Jersey
2 Jack California
3 Donald Texas
```

notepad

Question 5



Besides using a Mac or Windows machine, what other computer platform can the Colaboratory environment run on?

Data Collection with a Raspberry Pi. . .



Steps for reading and writing data into a csv.txt file.

1. Code read_csv.py
2. Code write_csv.py
3. Run (execute) read_csv.py
4. Run (execute) write_csv.py
5. Open person.csv.txt
6. Review file of data contents

Data Collection with a Raspberry Pi. . .



Coding a read file application in Python

```
read_csv.py - /home/pi/read_csv.py (3.5.3)
File Edit Format Run Options Window Help
import csv

with open('person.csv.txt', 'r') as csvFile:
    reader = csv.reader(csvFile)
    for row in reader:
        print(row)

csvFile.close()
|
```

Data Collection with a Raspberry Pi. . .



Coding a write file application in Python.

File Edit Format Run Options Window Help

```
import csv

csvData = [['Name of Person', 'Age'], ['Peter', '22'], ['Jasmine', '21'], ['Sam', '24'], ['Don', '32']]

with open('person.csv.txt', 'w') as csvFile:
    writer = csv.writer(csvFile)
    writer.writerows(csvData)

csvFile.close()
```

Question 6



How many steps are required for the reading and writing data into a csv.txt file?

Data Collection with a Raspberry Pi. . .



Running (execute) read file application in Python: Console Results

```
Python 3.5.3 Shell
File Edit Shell Debug Options Window Help
Python 3.5.3 (default, Jan 19 2017, 14:11:04)
[GCC 6.3.0 20170124] on linux
Type "copyright", "credits" or "license()" for more information.
>>>
===== RESTART: /home/pi/write_csv.py =====
>>>
===== RESTART: /home/pi/read_csv.py =====
['Name of Person', 'Age']
['Peter', '22']
['Jasmine', '21']
['Sam', '24']
['Don', '32']
>>> |
```

Data Collection with a Raspberry Pi. . .



Running (execute) write file application in Python: Console Results

```
Python 3.5.3 Shell
File Edit Shell Debug Options Window Help
Python 3.5.3 (default, Jan 19 2017, 14:11:04)
[GCC 6.3.0 20170124] on linux
Type "copyright", "credits" or "license()" for more information.
>>>
===== RESTART: /home/pi/write_csv.py =====
>>> |
```


Data Collection with a Raspberry Pi. . .



Contents of person.csv.txt

```
/home/pi/person.csv.txt - pi@192.168.7.76 - Editor - WinSCP  
Name of Person, Age  
Peter, 22  
Jasmine, 21  
Sam, 24  
Don, 32
```