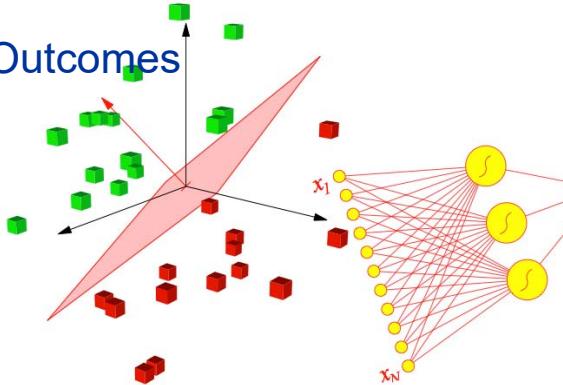


1

## Outline

- My Introduction
- Applications of Machine Learning
- What's this course all about?
- Course Outline and Learning Outcomes

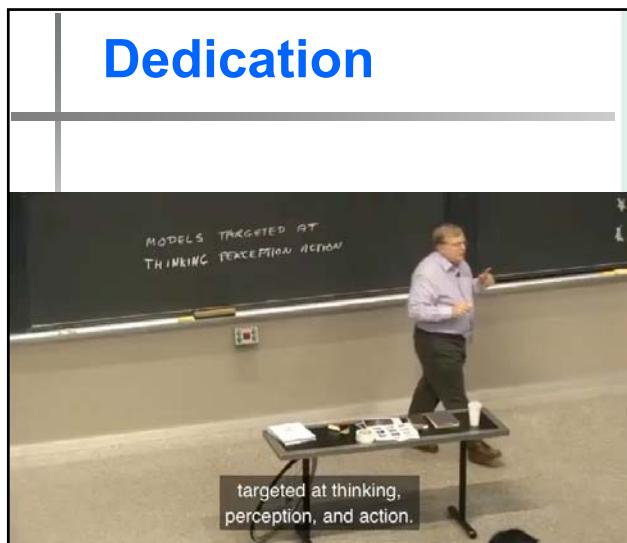


Dr. Ali Hassan, DC&SE, College of E&ME, NUST

2

2

## Dedication



A man in a purple shirt and green pants stands at a chalkboard in a lecture hall. The chalkboard has "MODELS TARGETED AT THINKING PERCEPTION ACTION" written on it. A small table in front of him holds a coffee cup, a book, and some papers. A caption box at the bottom left of the image says "targeted at thinking, perception, and action."

July 22 '19

**Professor Patrick Winston,  
former director of MIT's Artificial  
Intelligence Laboratory, dies at  
76**



Dr. Ali Hassan, DC&SE, College of E&ME, NUST

3



Three men are sitting at a long wooden table in a lecture hall. The man on the left is wearing a light blue shirt and has his hand near his face. The man in the middle is wearing a plaid shirt. The man on the right is wearing a light blue shirt and glasses, leaning over the table. In the background, there are red chairs and a logo for "Fazl-e-Awan Digital Media".

Dr. Ali Hassan, DC&SE, College of E&ME, NUST

4

## My Introduction

- Did PhD in 2012 from University of Southampton
  - Area of research: Application of Machine Learning on Emotion Recognition from Speech



Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME, NUST

5

5

### TEAM

Dr. Ali Hassan  
Email: alihassan@eme.nust.edu.pkDr. Farhan Hussain  
Email: farhan.hussain@eme.nust.edu.pkDr. Muhammad Yasin  
Email: mu.yasin@eme.nust.edu.pkDr. Muhammad Salman  
Email: m.salm@eme.nust.edu.pkDr. Kiran Khurshid  
Email: kiran.khurshid@eme.nust.edu.pk<https://sites.google.com/view/wiselabeme/team>

Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME, NUST

6

6

## Current Research Areas

- EEG Signals
- Heart Sound Classification
- Fusion of different heart modalities
- Biometrics
- Gait Analysis
- IOTs
- Embedded IOTs



## CURRENT RESEARCH PROJECTS

- Use of EEG for rehabilitation of stroke patients in collaboration with
  - New Zealand Centre for Chiropractic Research
  - Auckland University of Technology, NZ
  - University of Aalborg, Denmark
- Detection of chronic pain development Using Fluoroscopy images with
  - School of Health Sciences, University of Aalborg, Denmark



## CURRENT RESEARCH PROJECTS

- CAD system for lesion and ulcer detection in Gastroenterology in collaboration with
  - Local Hospital in Pakistan
  - Centre for Advance Research and Engineering, Pakistan
  - APICTA Award 2013
- Detecting Melanoma in Dermoscopy Images in collaboration with
  - Vision Group, University of Porto, Portugal.



## CURRENT RESEARCH PROJECTS

- Gait biomechanics for Rehab
  - New Zealand Centre for Chiropractic Research
  - Railway Hospital Riphah University
- TechsaC@re Pakistan / Malaysia
  - LLM based Skin Care Analysis
  - RADScans



## TDF Recent Projects

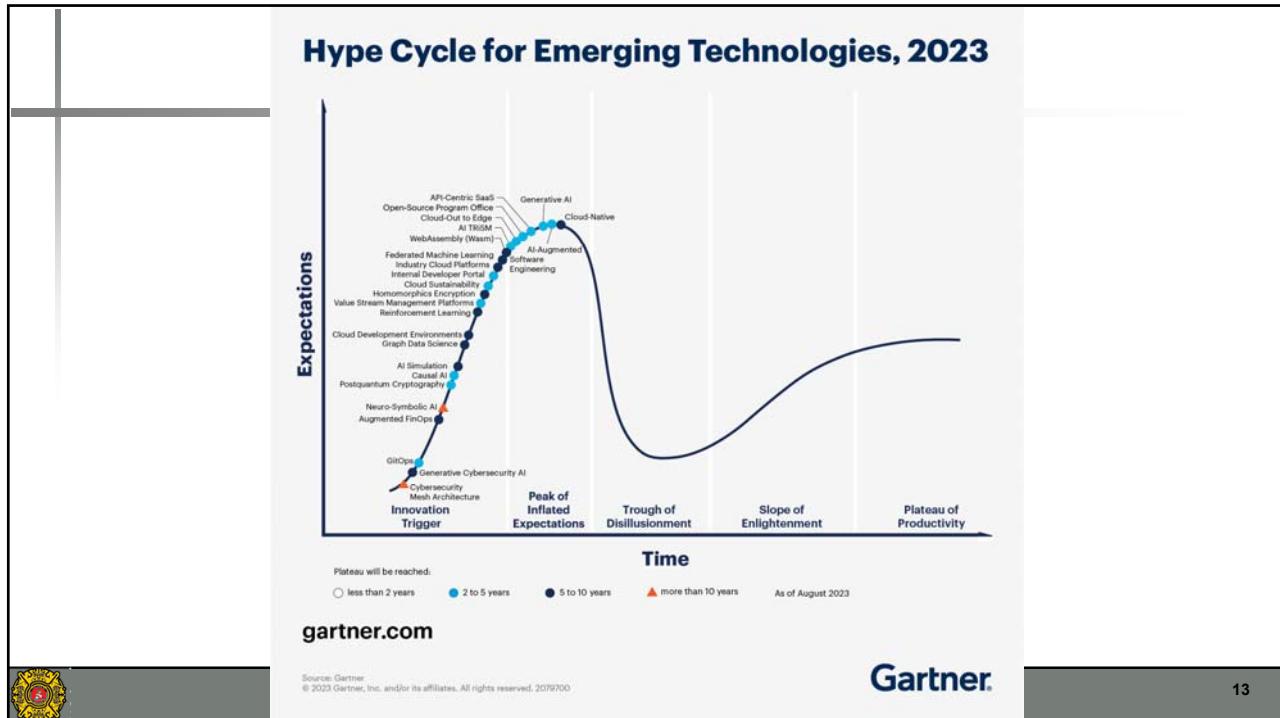
- Use of IOTs in Industry 4.0
  - Mesh Network for IOTs
- Use of EEG for UX quantization
- Smart Gloves for Hansa Leather Industry
- Gait Biometrics Lab using Standard Cameras
- Digital Pakistan Lab



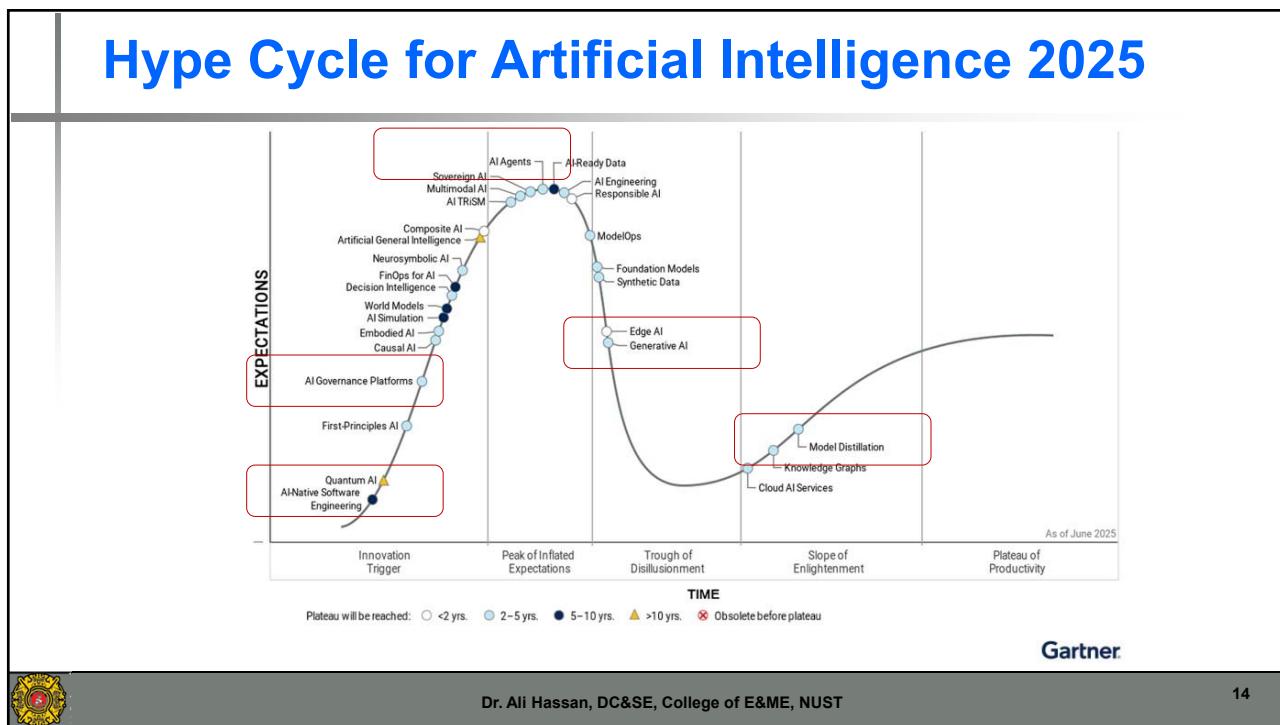
ML/AI

## POTENTIAL IMPACT ON GLOBAL GDP





13



14

## Assignment 1(a)

- Short note on AI on the Gartner Hype Cycle of 2025
  - Do google searches/ chat GPT but then write in your own words, what you understand of these technologies
  - Each technology shall be explained in 200-400 words

10:24

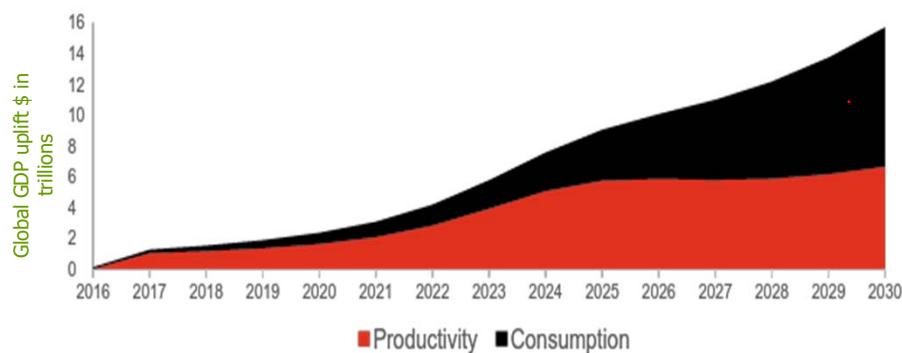
Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME, NUST

15

15

## Potential of ML/AI

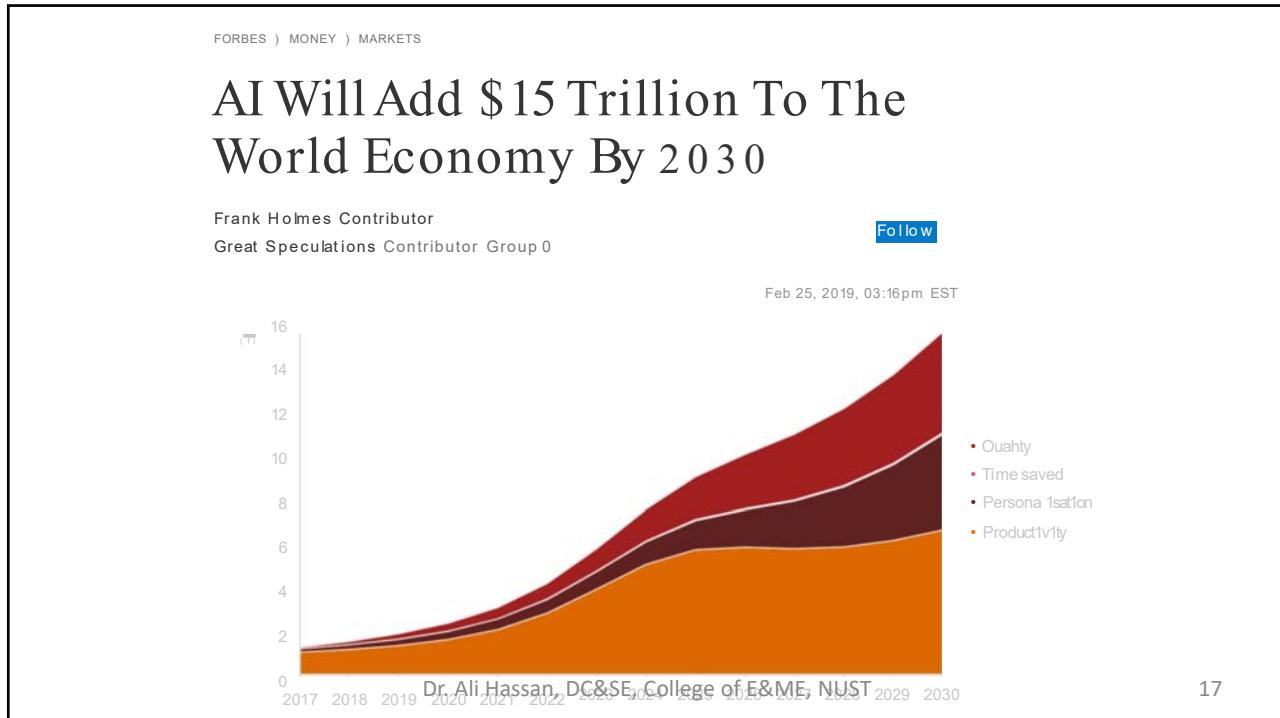
\$15.7 T Global GDP Impact of ML/AI through 2030



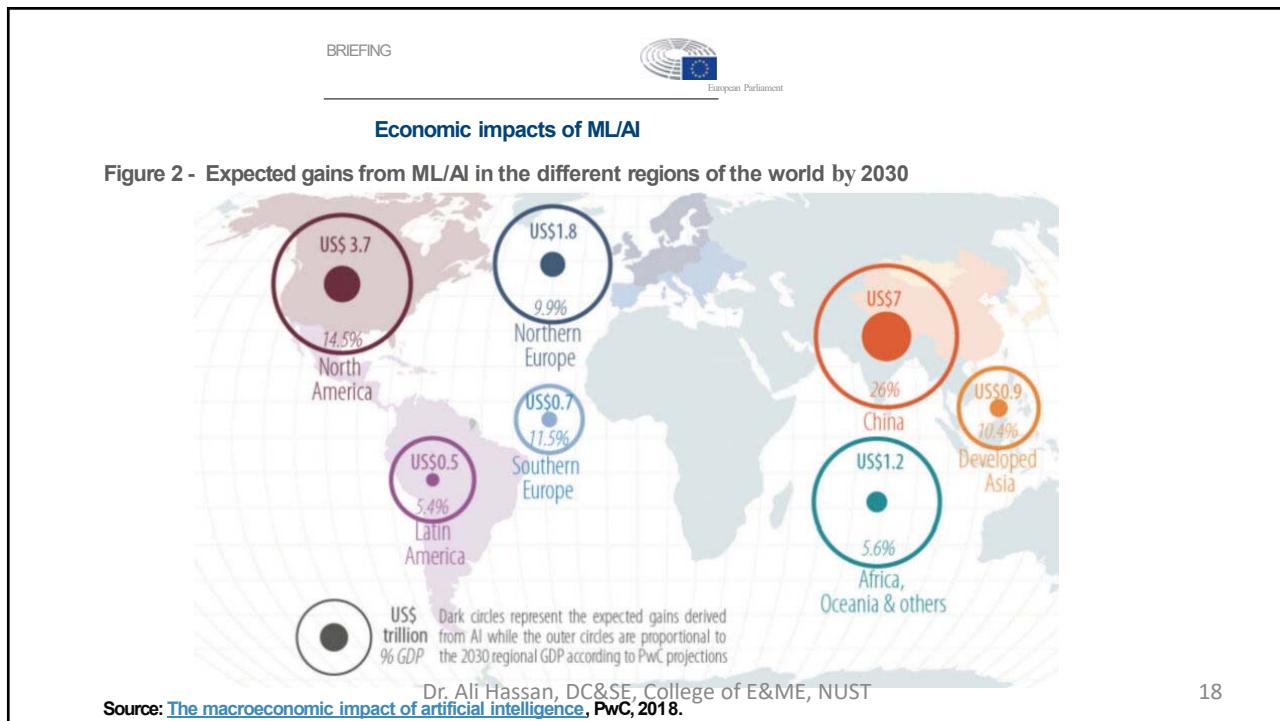
Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME, NUST

16

16



17



18



19



20

## How to Use ML to Solve Riddle from Our

- A Farmer wants to bring a Lion, a Goat, and Grass across the river. The boat is tiny and can only carry one passenger at a time.
  - If he leaves the Lion and the goat alone together, the Lion will eat the goat.
  - If he leaves the goat and the Grass alone together, the goat will eat the Grass.
- How can he bring all three safely across the river?

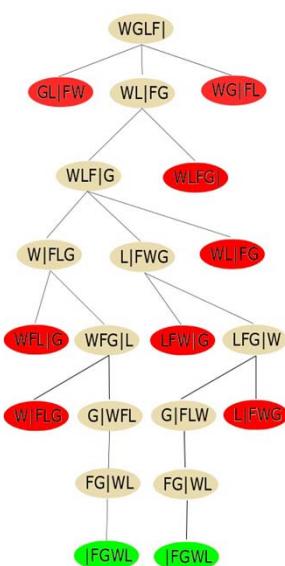


Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME, NUST

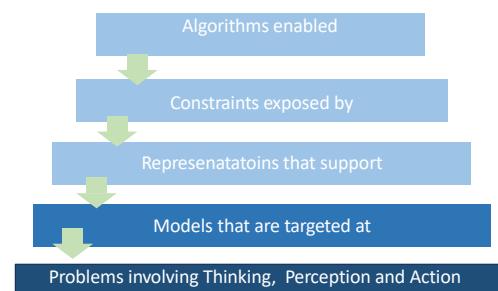
21

21

## ML Solving a Riddle?



| : left side and right side of the river  
 W: Grass  
 G: Goat  
 L: Lion  
 F: Farmer

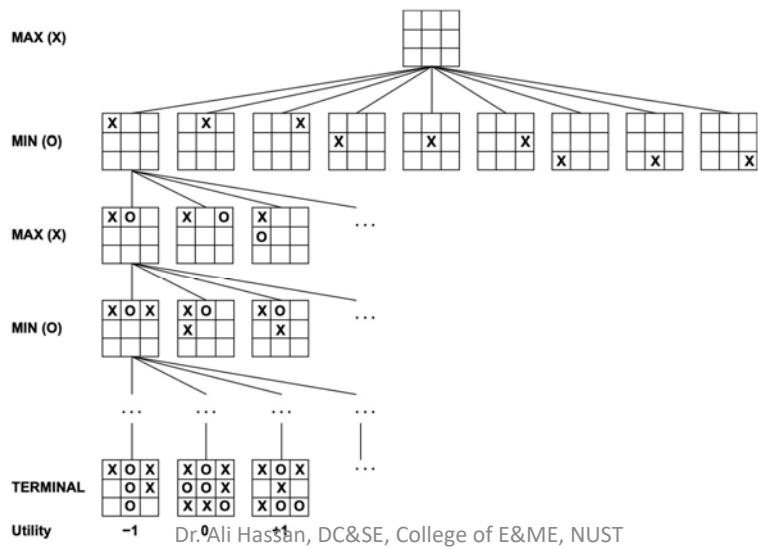


Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME, NUST

22

22

## Another Game from our Childhood



23

23

## IBM's Deep Blue Beat World Champion



May 11, 1997, an IBM computer called IBM® Deep Blue® beat the world chess champion after a six-game match: **two wins for IBM, one for the champion and three draws.**

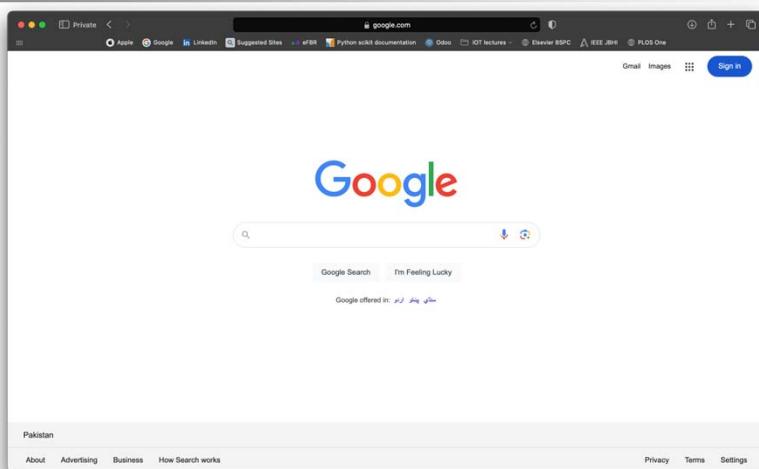
24

24

## Learning From Data

- This course is about learning “rules” from data
- Applications can’t program by hand.
- This is the **new AI**
- Has huge commercial applications

the field of study that gives  
computers the ability to learn without  
being explicitly programmed



Google News

Top stories >

- D DAWN.com 5.7 magnitude earthquake felt in Punjab: PDMA 42 minutes ago • By Imran Gabol
- D DAWN.com 5.7 magnitude earthquake felt in Punjab: PMD 42 minutes ago • By Iman Gabol
- PTV News Earthquake of magnitude 5.8 strikes Pakistan, tremors felt in Delhi, neighbouring areas 52 minutes ago
- Metro Earthquake Today: Tremors felt in Pakistan, Afghanistan 53 minutes ago
- D DAWN.com We need to revive Jinnah's vision 5 hours ago • By Asquib Rajar
- D DAWN.com President Zardari calls on nation to uphold Quaid's legacy 6 hours ago
- PTV News Governor, CM Sindh Visit Quaid's Mausoleum: Nation goes to Follow The Teachings Of Quaid-e-Azam 53 minutes ago
- Geo News President, PM urge nation to embrace Quaid's Vision' for stronger Pakistan 53 minutes ago

Local news >

- D DAWN.com Three Dead After Consuming Toxic Alcohol in Islamabad 2 days ago
- PTV News Cases filed against PTI leadership over Islamabad rally violations 2 days ago
- Geo News Brighter Kashmir: Busting Pakistan's Incredulous Kashmir Narrative 2 days ago • By Nilesh Kumar

Picks for you

Sign in for personalised stories in your briefing and news feed

Sign in

27

Google News

Pakistan

Home For you Following

- D DAWN.com US pledges \$5 million to support Pakistan's renewable energy push by 2030 2 hours ago
- PTV News Recharge Pakistan Project Launched: Pakistan Grappling With Severe Climate Crisis: Romaina 22 hours ago
- PTV News Tackling floods, climate change: Pakistan launches landmark recharge project 13 hours ago • By Muhammad Waseem Bhatti
- D DAWN.com PTI leaders seek transit bail from Peshawar High Court over Islamabad rally cases 1 hour ago
- Business Recorder ATCO grants bail to PTI men Yesterday
- ARY NEWS Fearing arrest: PTI's Zartaj Gul seeks transit bail from PHC 2 hours ago
- N The Nation Jinnah House attack: Court extends interim bail of Omar Ayub 7 days ago

SAMAA TV

28

Google News

Your briefing  
Monday, 9 September

**Top stories >**

- Huge rally calls for release of Pakistan's former PM Khan** (DAWN.com) - Supporters clash with cops at PTI rally as leaders demand Imran's release 16 hours ago • By Shakeel Qamar
- Punjab launches polio drive in 15 dists, targeting 13.9m children** (DAWN.com) - Positive sewage samples, fake finger marking pose challenge to polio eradication in KP 8 hours ago • By Ashfaq Yusufzai
- PTI Goons Attack Police; Naqvi Takes Notice Of Stone-Pelting At Police** (PTV's Official Web Portal) - PTI workers clash with police after Islamabad rally exceeds time bar 3 hours ago
- MPS Preview: SBP to slash policy rate by 150bps** (The Nation) - MPS Preview: SBP to slash policy rate by 150bps 3 hours ago • By Abdul Rahman
- Repairing financial coverage flaws** (DAWN.com) - Repairing financial coverage flaws 8 hours ago • By Afshan Subohi

**Picks for you**

- The e-bike 'revolution'** (DAWN.com)
- MPS Preview: SBP to slash policy rate by 150bps** (The Nation)
- Repairing financial coverage flaws** (DAWN.com)

Rawalpindi 34°C More on weather.com

Dr. Ali Hassan, DC&SE, College of E&ME, NUST

29

29

Home For you Following Pakistan World Local Business Technology Entertainment Sports Science

An intriguing televised address

7 hours ago • By anjum ibrahim

**Week-long special anti-polio vaccination drive underway** (Radio Pakistan) - Positive sewage samples, fake finger marking pose challenge to polio eradication in KP 3 hours ago

**New Poll Suggests Harris's Support Has Stalled After a Euphoric August** (The New York Times) - Trump and Harris Neck and Neck After Summer Upheaval, Tim Finds Yesterday • By Ruth Igielnik and Jonathan Weisman

**PM Shehbaz launches nationwide anti-polio drive amid uptick in cases** (CBS News) - Harris v. Trump CBS News poll finds Pennsylvania, Michigan, V tight ahead of debate 10 hours ago • By Fred Backus, Anthony Salvanto and Kabir Khan

**News about polio**

**Top news**

- Week-long special anti-polio vaccination drive underway** (Radio Pakistan) - Positive sewage samples, fake finger marking pose challenge to polio eradication in KP 3 hours ago
- Anti-Polio Drive: Polio Drive Begins In 115 Districts Across The Country** (PTV's Official Web Portal) - Anti-Polio Drive: Polio Drive Begins In 115 Districts Across The Country 2 hours ago
- Polio immunisation drive to start in Hyderabad from today** (The Nation) - Polio immunisation drive to start in Hyderabad from today 6 hours ago
- PM Shehbaz launches nationwide anti-polio drive amid uptick in cases** (CBS News) - Harris v. Trump CBS News poll finds Pennsylvania, Michigan, V tight ahead of debate 10 hours ago
- Polio immunisation drive to start in Hyderabad from today** (The Nation) - Polio immunisation drive to start in Hyderabad from today 16 hours ago

**All coverage**

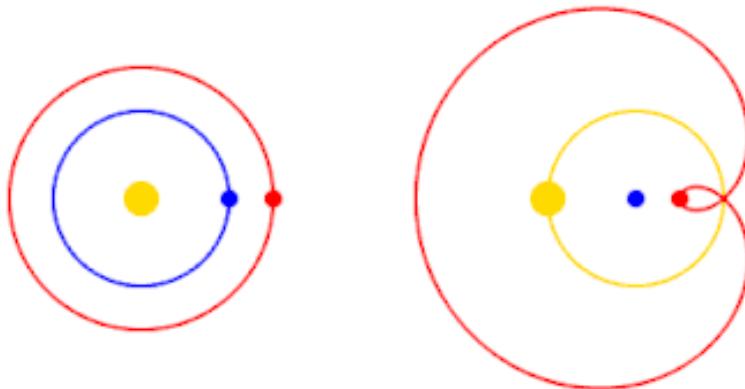
- Polio immunisation drive to start in Hyderabad from today** (The Nation)
- 'Collective efforts to eradicate polio will certainly bear fruit,' PM kicks off anti-polio drive** (Pakistan Today)

Dr. Ali Hassan, DC&SE, College of E&ME, NUST

30

30

## Ptolemaic and Copernican models of the solar system



See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/234083377>

### Modeling the History of Astronomy: Ptolemy, Copernicus and Tycho

Article in *Astronomy Education Review* · January 2013 DOI: 10.3847/AER2013001 · Source: arXiv

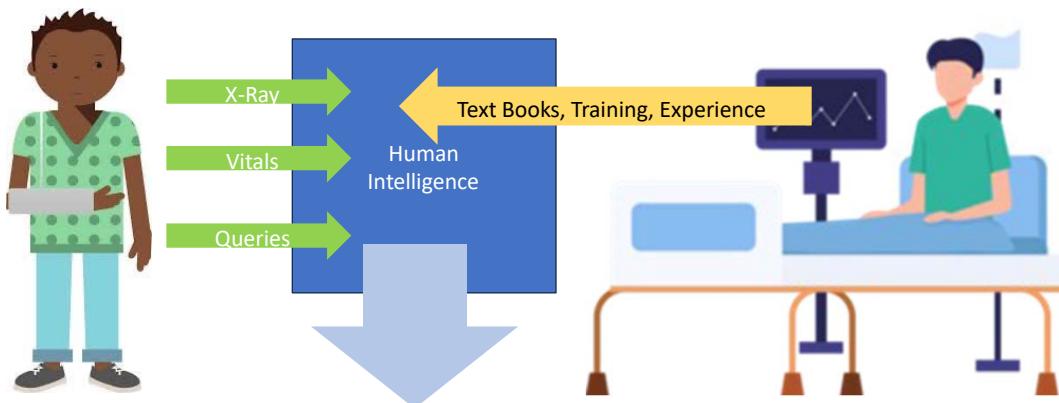


Dr. Ali Hassan, DC&SE, College of E&ME, NUST

31

31

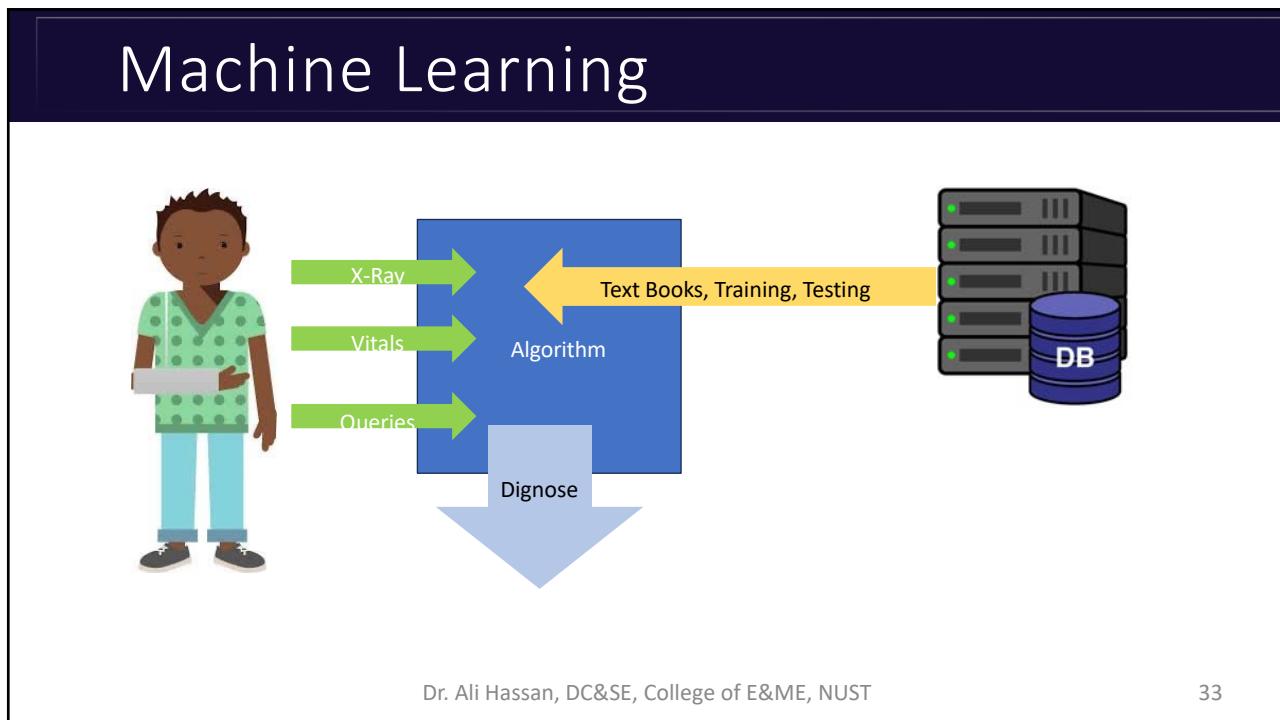
## Human Intelligence



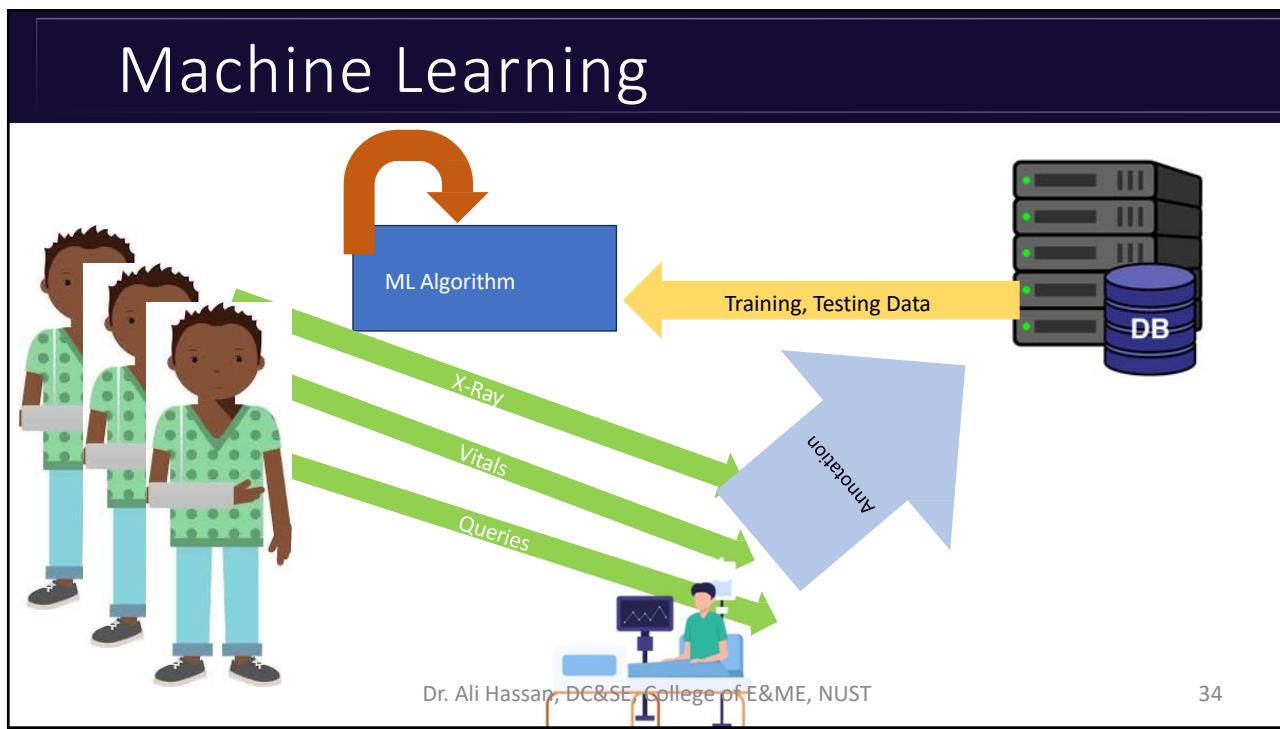
Dr. Ali Hassan, DC&SE, College of E&ME, NUST

32

32

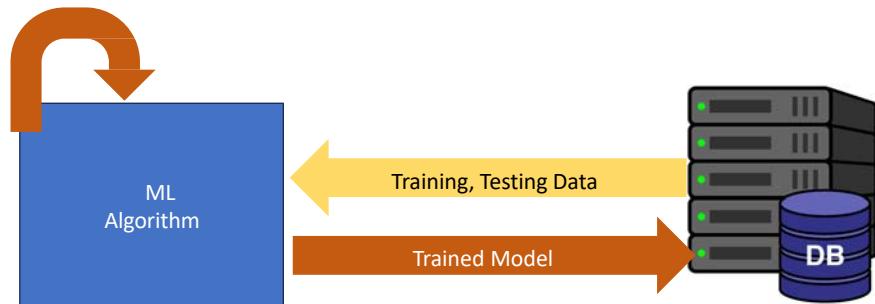


33



34

## Machine Learning Training

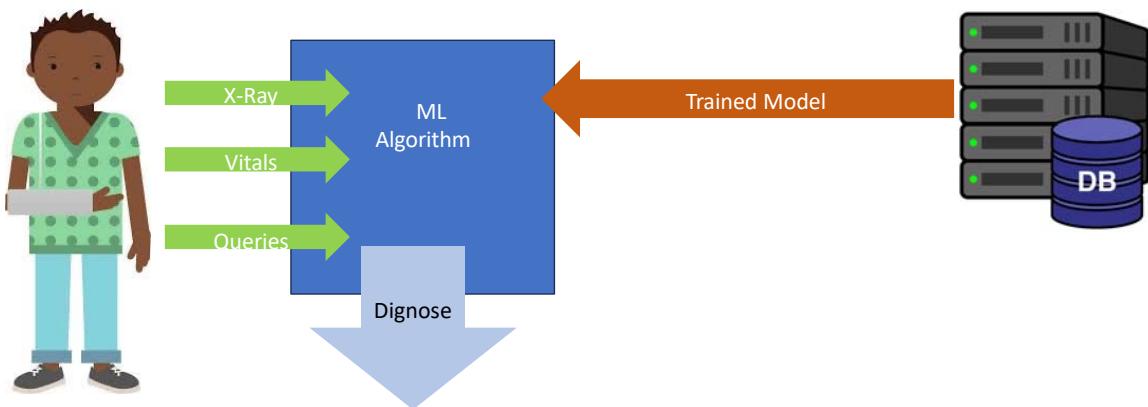


Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME, NUST

35

35

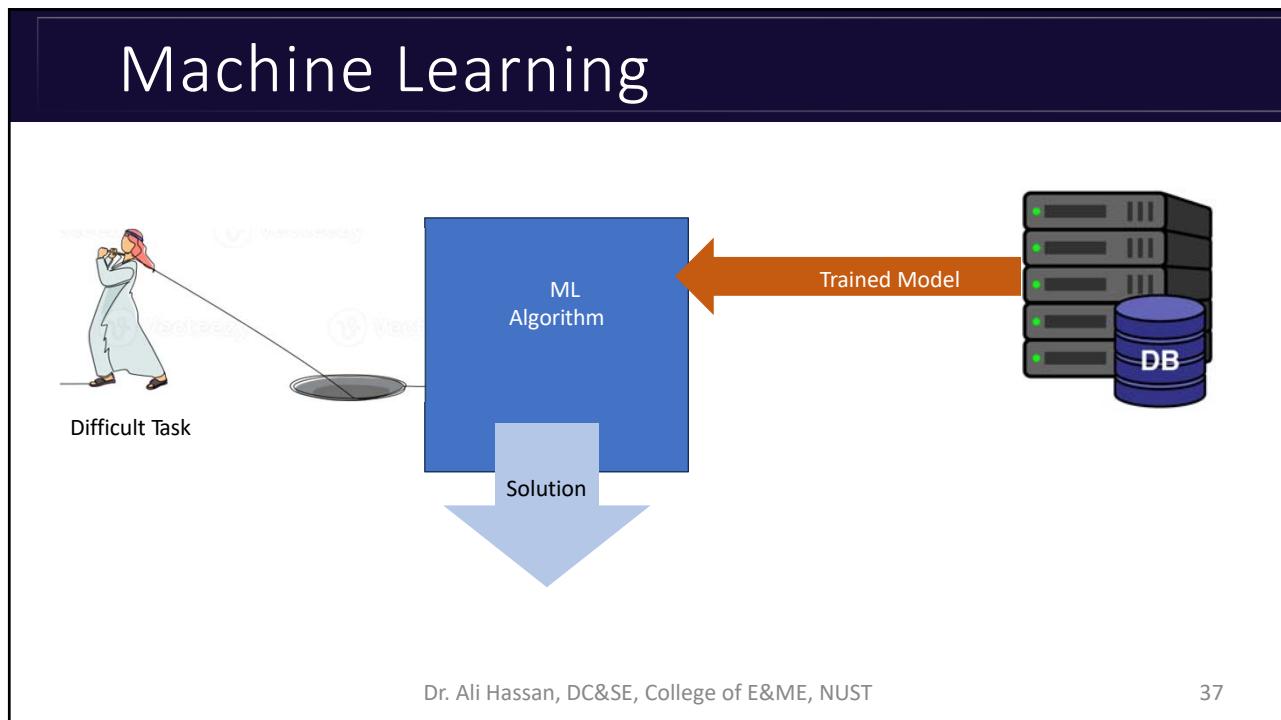
## Machine Learning -- Testing



Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME, NUST

36

36



37

## Arthur Samuel

- Arthur Samuel (1959). Field of study that gives computers the ability to learn without being explicitly programmed.

38

## Diff b/w Machine learning and Data Mining

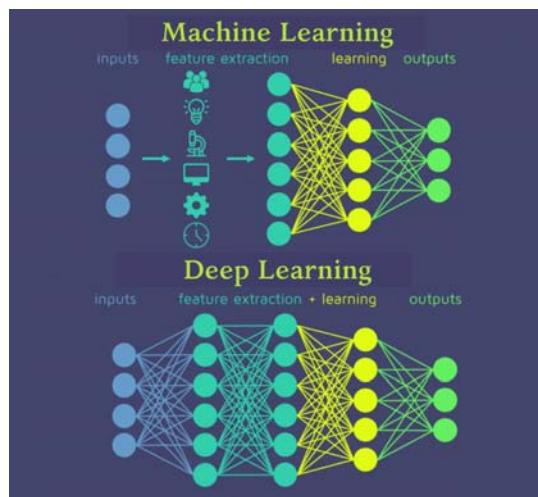
- Machine learning and data mining often employ the same methods and overlap significantly
- ML focuses on prediction, based on known properties learned from the training data
- Data mining focuses on the discovery of (previously) unknown properties in the data



A Venn diagram consisting of three nested circles. The outermost circle is dark grey and contains the text "Artificial Intelligence". The middle circle is light blue and contains the text "Machine Learning". The innermost circle is light blue and contains the text "Deep Learning".



## Machine vs Deep Learning



Historically  
AI Mostly Solves  
Classification Problems

## Classification with Two Classes: Good from Bad

The diagram illustrates a classification process for emails. Three types of messages (spam, good, spam) are fed into a 'CLASSIFIER'. The classifier outputs messages to either an 'INBOX' (containing good messages) or a 'SPAM FOLDER' (containing spam messages). To the right, a scatter plot shows data points for 'Class A' (blue dots) and 'Class B' (green triangles), separated by a diagonal line.

Dr. Ali Hassan, DC&SE, College of E&ME, NUST

43

43

## Covid Positive – Covid Negative

**DeepCOVID-XR: An Artificial Intelligence Algorithm to Detect COVID-19 on Chest Radiographs Trained and Tested on a Large U.S. Clinical Data Set**

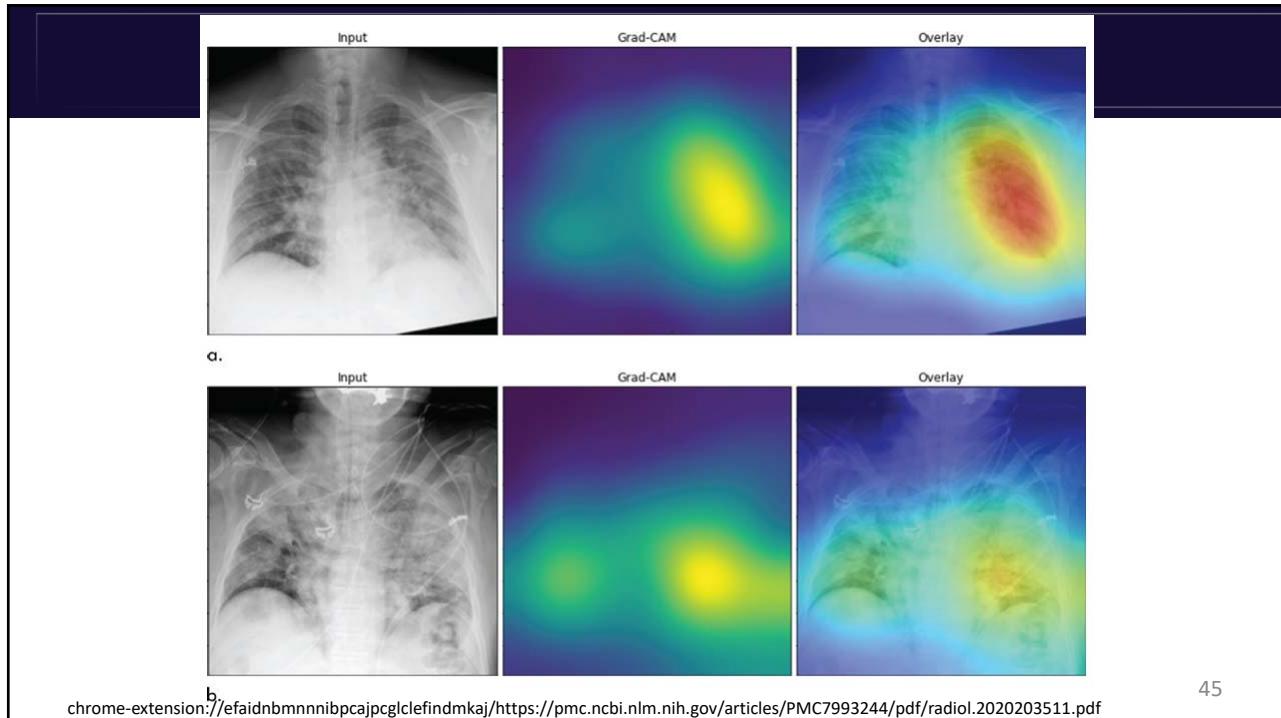
Ramsey M. Wehbe, MD•Jiayue Sheng, BS•Shinjan Dutta, BS•Siyuan Chai•Amil David•Semih Barutcu, MS•Yunan Wu, MS•Donald R. Cantrrell, MD, PhD•Nicholas Xiao, MD•Bradley D. Allen, MD, MS•Gregory A. MacNealy, MD•Hatice Savas, MD•Rishi Agrawal, MD•Nishant Parekh, MD•Aggelos K. Katsaggelos, PhD

Radiology Volume 299, Issue 1 April 2021 Pages 1-246

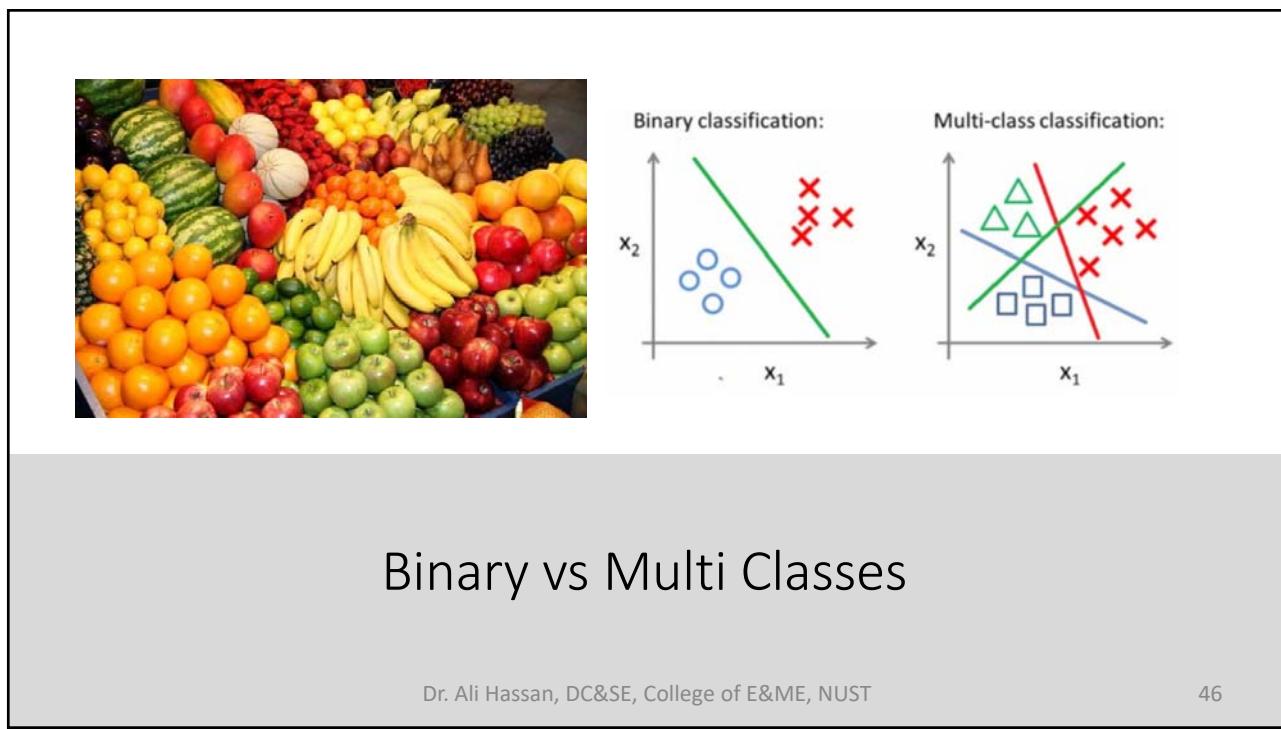
Dr. Ali Hassan, DC&SE, College of E&ME, NUST

44

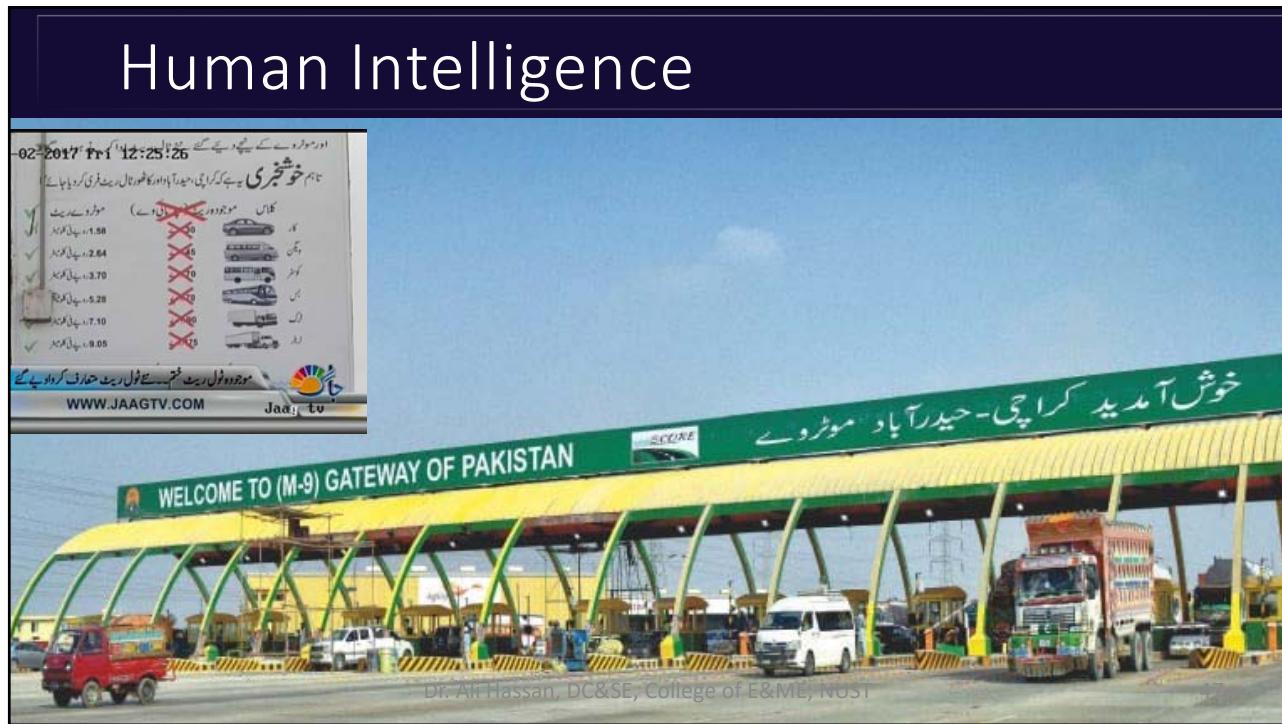
44



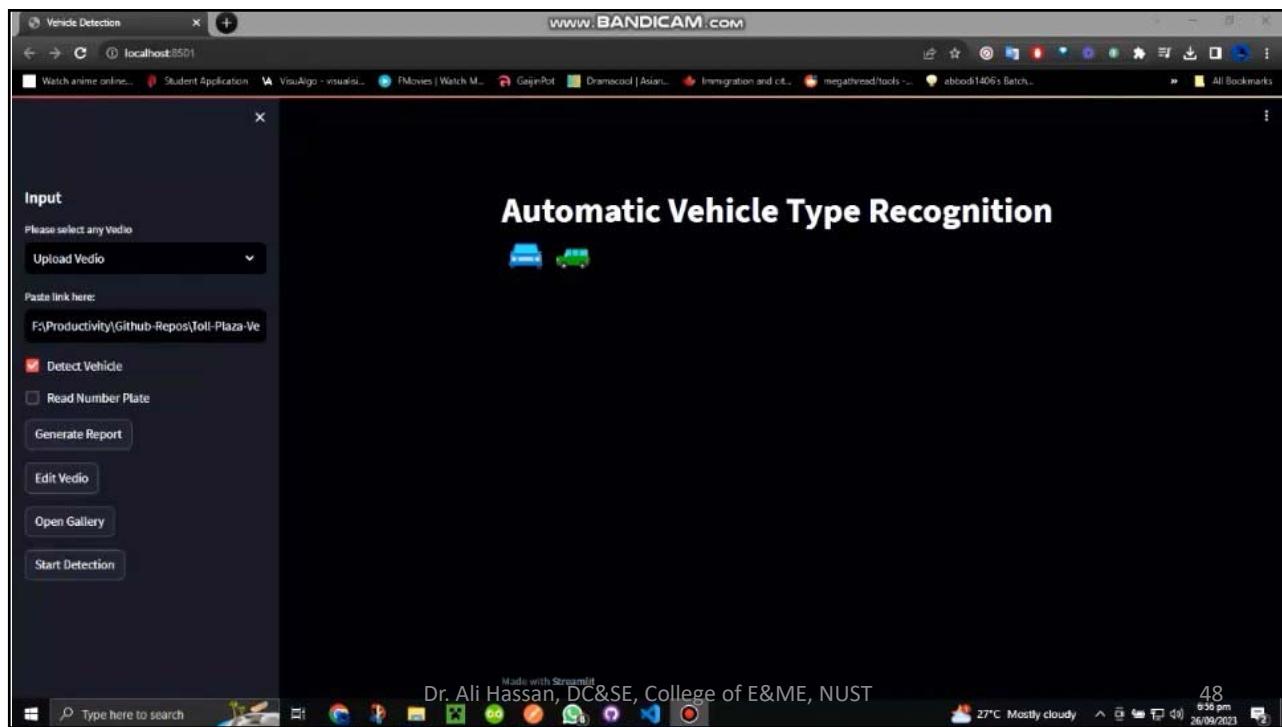
45



46



47



48

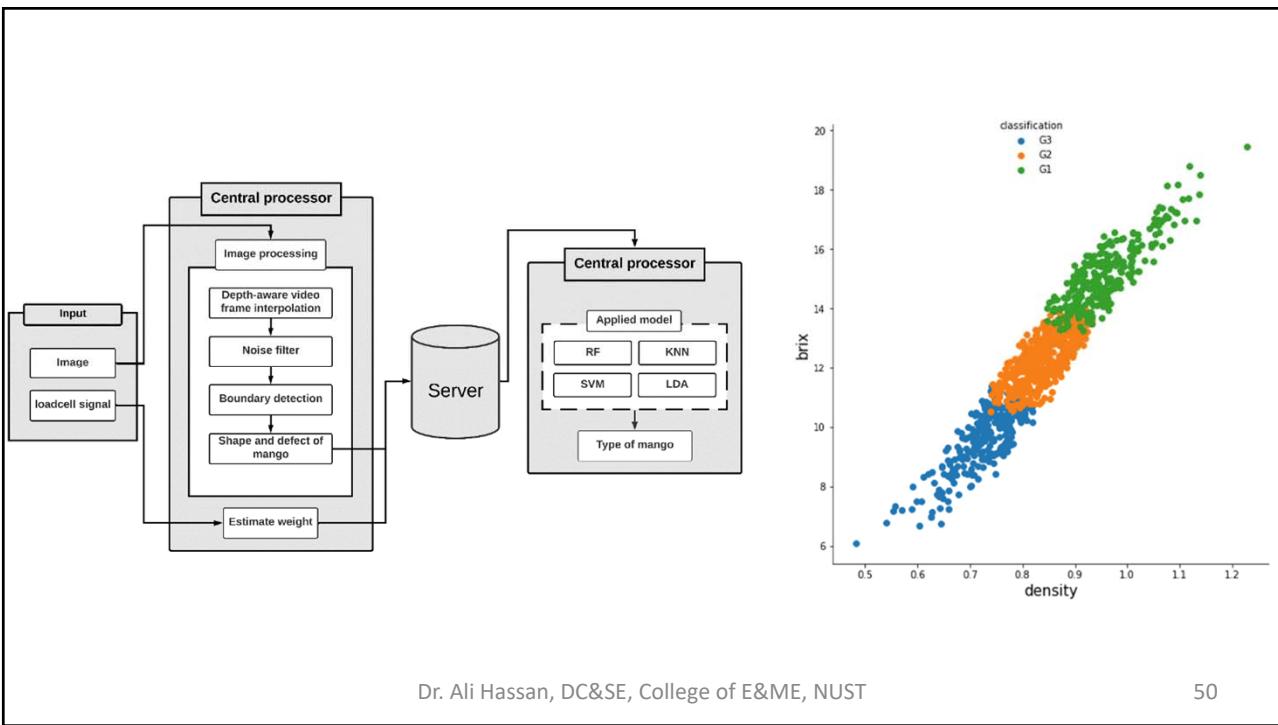
# Human Intelligence



Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME, NUST

49

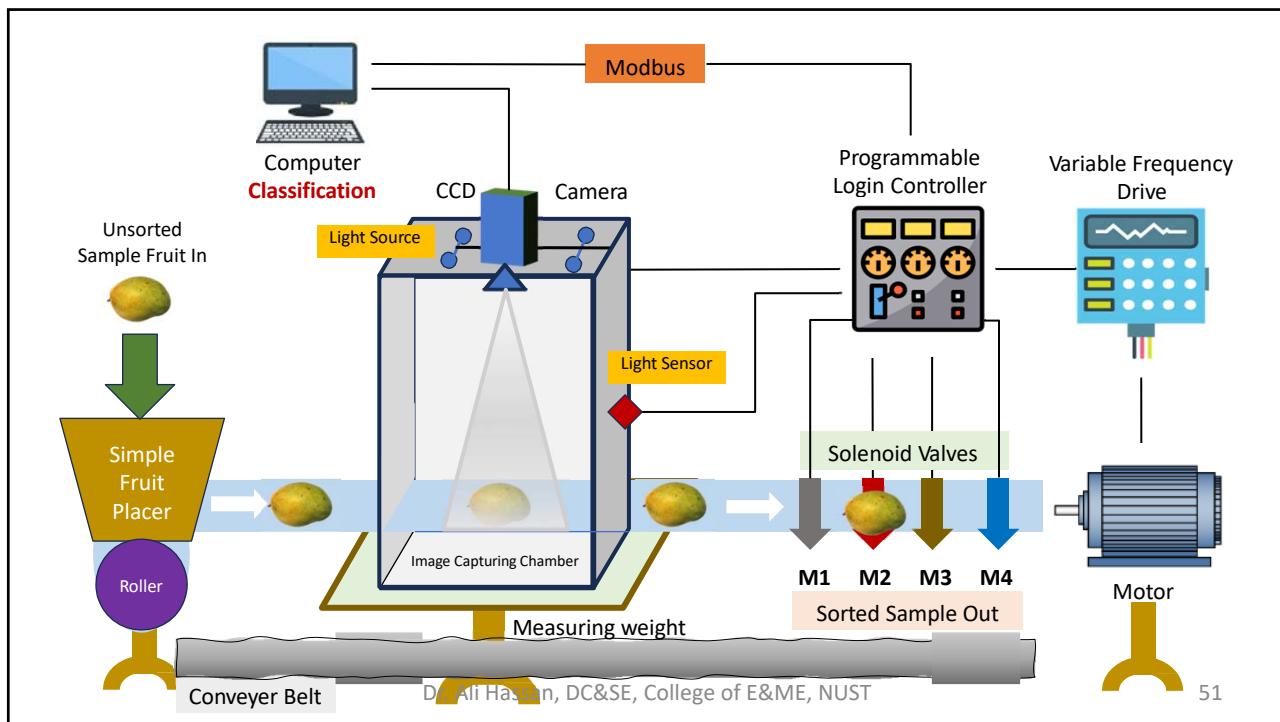
49



Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME, NUST

50

50



51



## Classification, Regression and Generative AI Artificial Intelligence

Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME, NUST

52

## Regression / Forecasting

US DOLLAR TO PAKISTANI RUPEE (USD/PKR) 5-YEAR FOREX CHART



Post performance is not a reliable indicator. Dr. Ali Hassan, DC&SE, College of E&ME, NUST

Source: TradingView

53

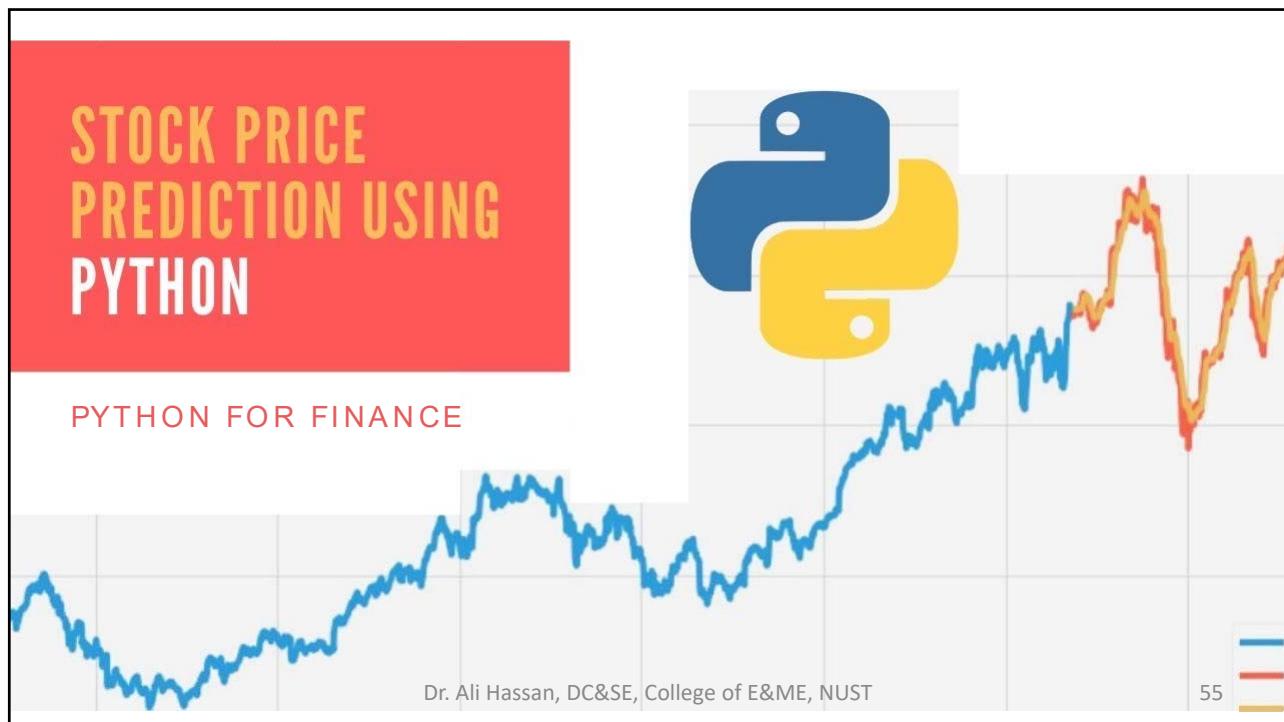
53

PROJECTED SCORE = 733

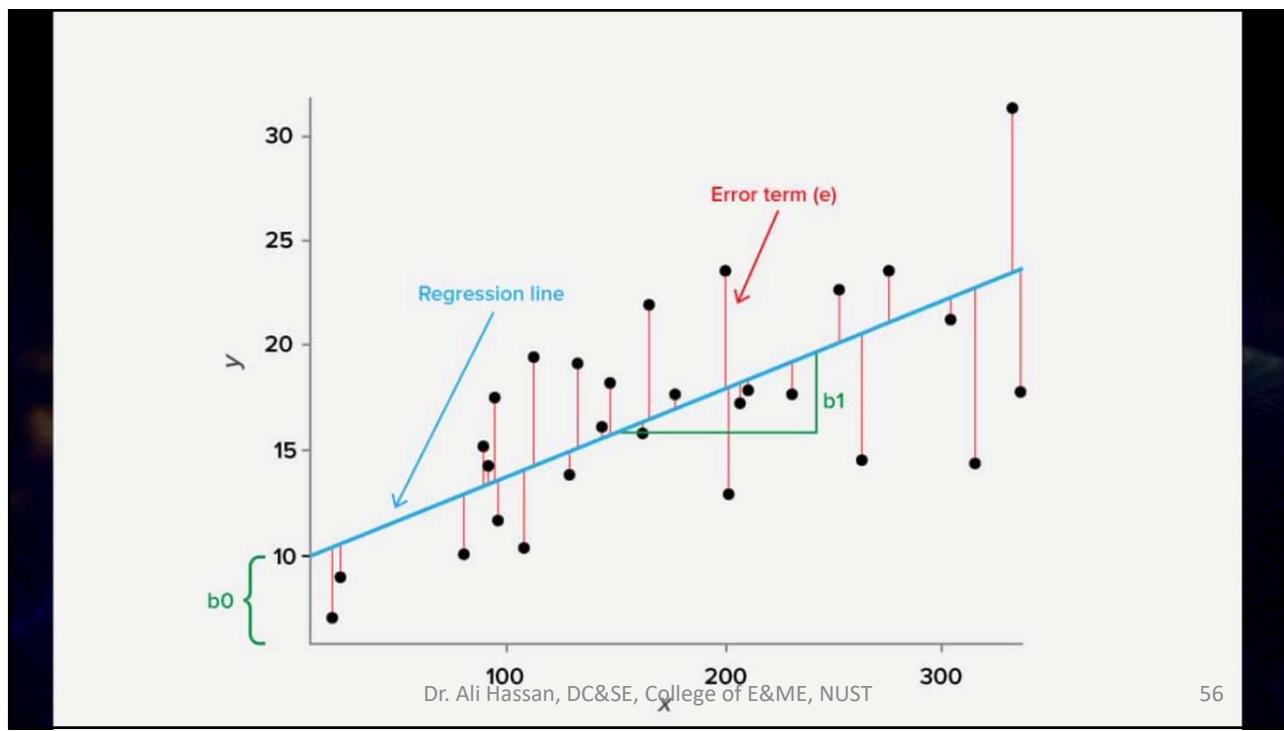


54

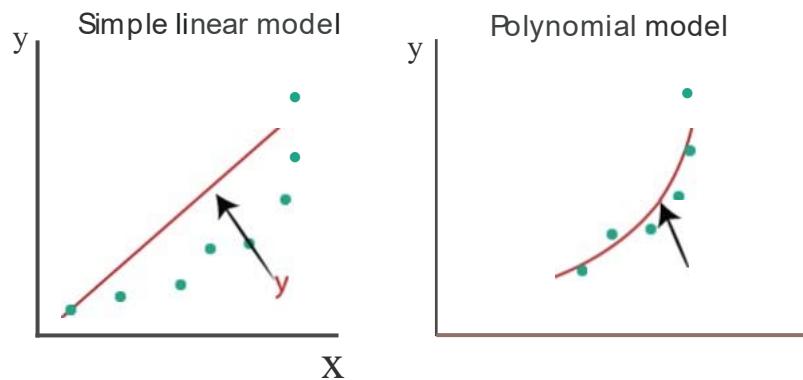
54



55



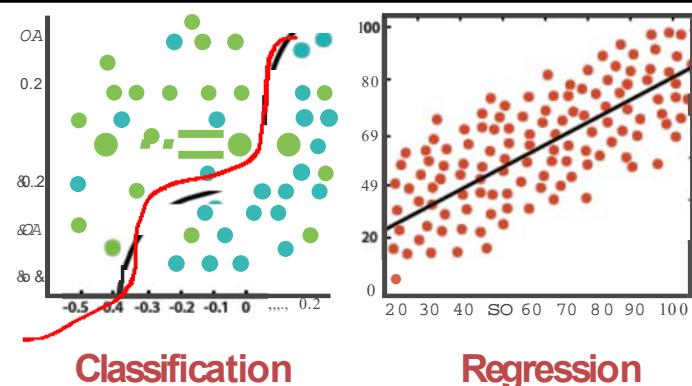
56



Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME, NUST

57

57

**Classification****Regression****Classification**

Will it be hot or cold tomorrow?



Fahrenheit

**Regression**

What will be the temperature tomorrow?

84°

Fahrenheit

Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME, NUST

58

58



# Classification, Regression and **Generative AI**

## **Artificial Intelligence**

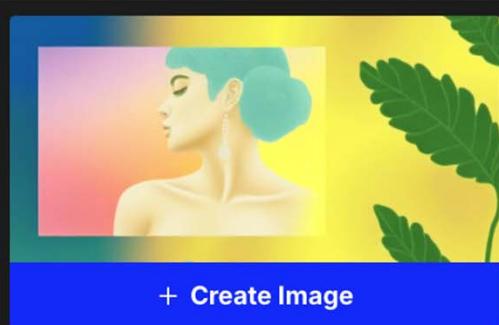
Dr. Ali Hassan, DC&SE, College of E&ME, NUST

59

59

Hi Ali Hassan! Ready to get creative?

🎨 [Change Facial Expression](#) and [Flux](#) are now available.



### Quick starts



Choose a style

Start with a style you like



Explore models

See 100+ Fine-tuned models



Train Model

Customize your creativity

60

60



61



62

# Who do you know in all these pictures?

None is real !!!

Dr. Ali Hassan, DC&SE, College of E&ME, NUST

63

63

<https://thispersondoesnotexist.com/>

## New AI Generates Freakishly Realistic People Who Don't Actually Exist

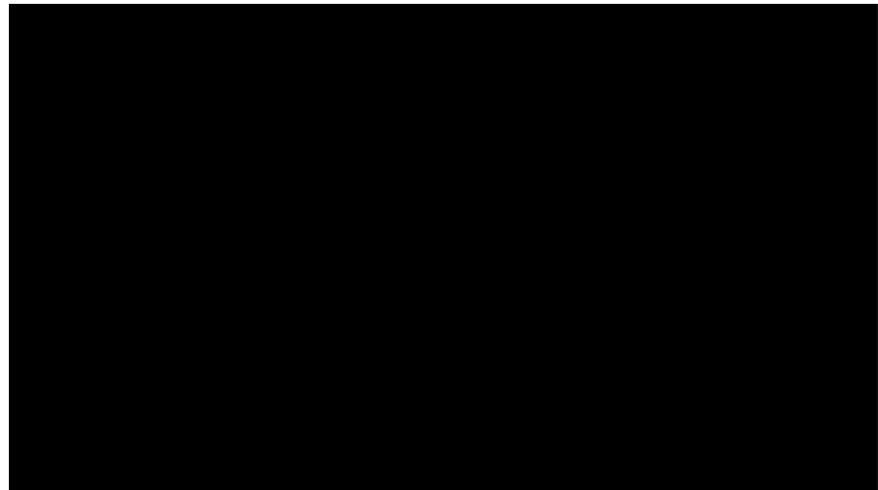
Inspired by a GAN (generative adversarial network)  
StyleGAN2 (2019) - Karras et al. / NVIDIA  
Don't panic. Learn how it works! [1] [2] [3]  
Help this AI continue to dream! Contact me  
Code for training your own [original] [simple]  
Art • Cats • Horses • Chem  
Photo

Dr. Ali Hassan, DC&SE, College of E&ME, NUST

64

64

## Deepfake: We're entering an era in which anyone can make anyone say anything



Dr. Ali Hassan, DC&SE, College of E&ME, NUST

65

65

## Deep Fakes



Dr. Ali Hassan, DC&SE, College of E&ME, NUST

66

66

## CruiseDeepFake



Dr. Ali Hassan, DC&SE, College of E&ME, NUST

67

67

## De-Age the Face



 <https://www.youtube.com/watch?v=Ddx5B-84ebo>

Dr. Ali Hassan, DC&SE, College of E&ME, NUST

68

68

## Replace the Face



<https://www.youtube.com/watch?v=RTjgkhMugVw>

Dr. Ali Hassan, DC&SE, College of E&ME, NUST

69

69

## Deep Face Lab



Dr. Ali Hassan, DC&SE, College of E&ME, NUST

70

70



71

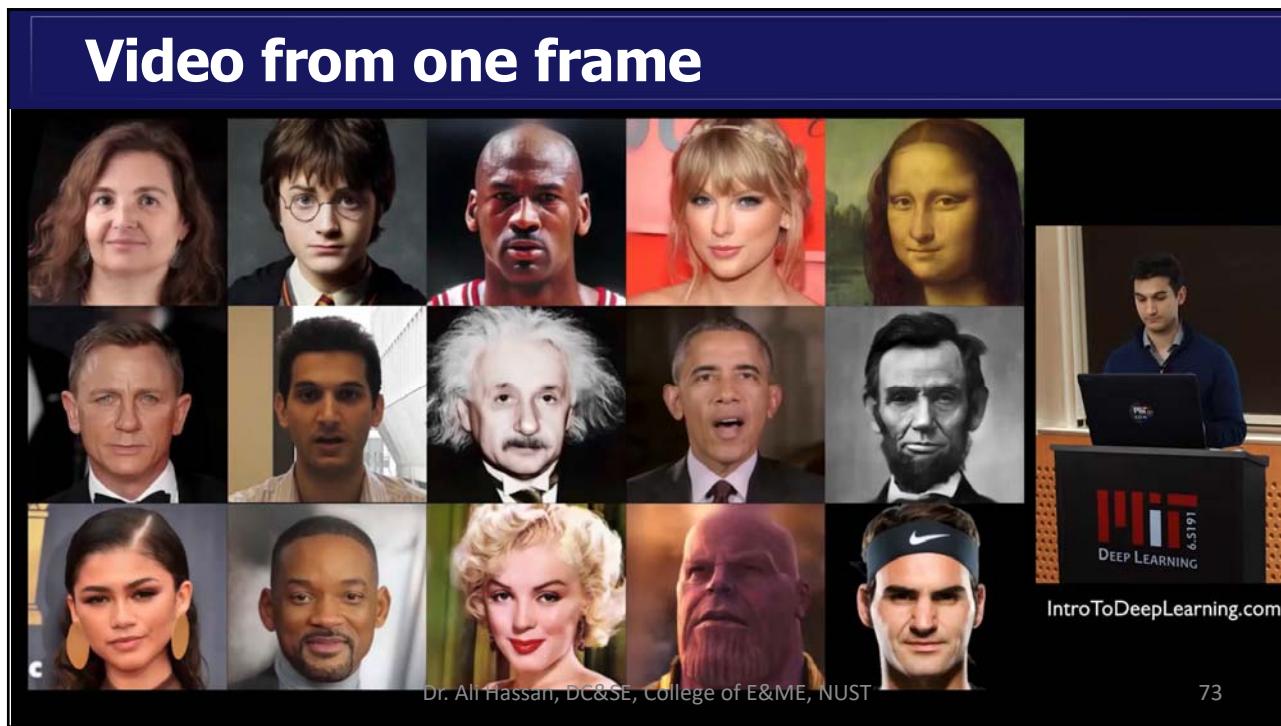
## Deep Fakes

Done through Generative Adversarial Networks

Dr. Ali Hassan, DC&SE, College of E&ME, NUST

72

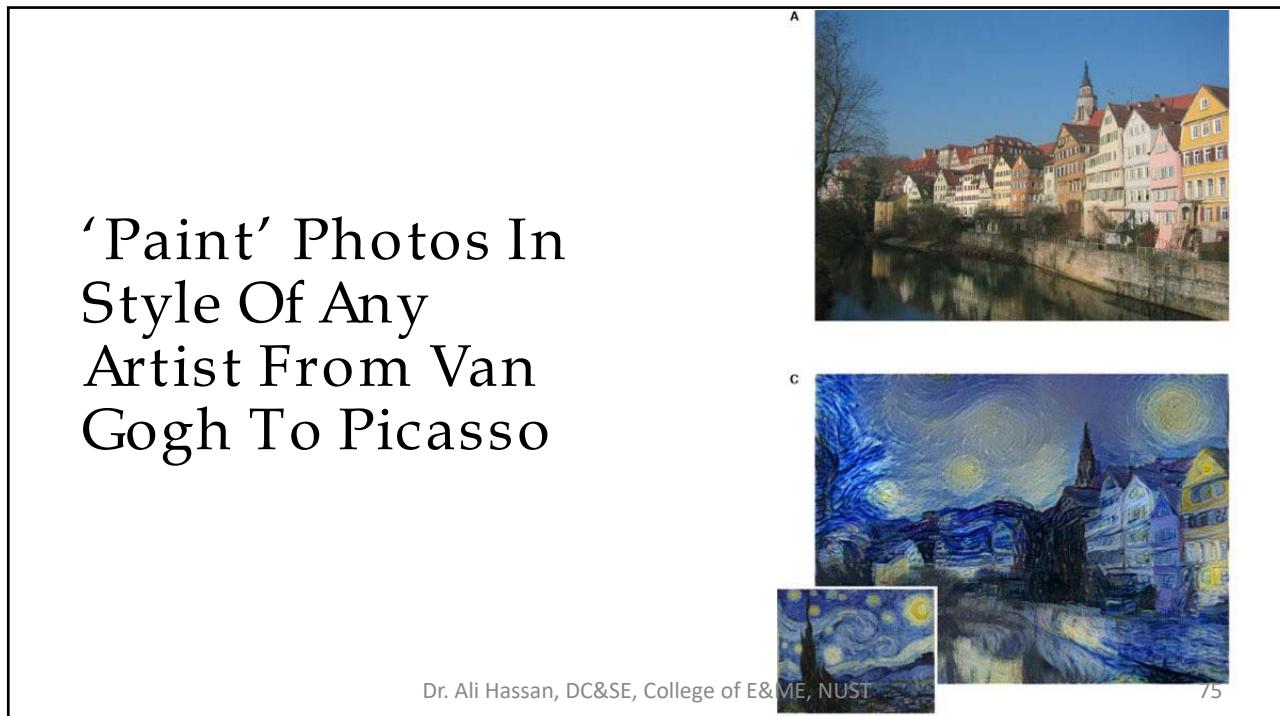
72



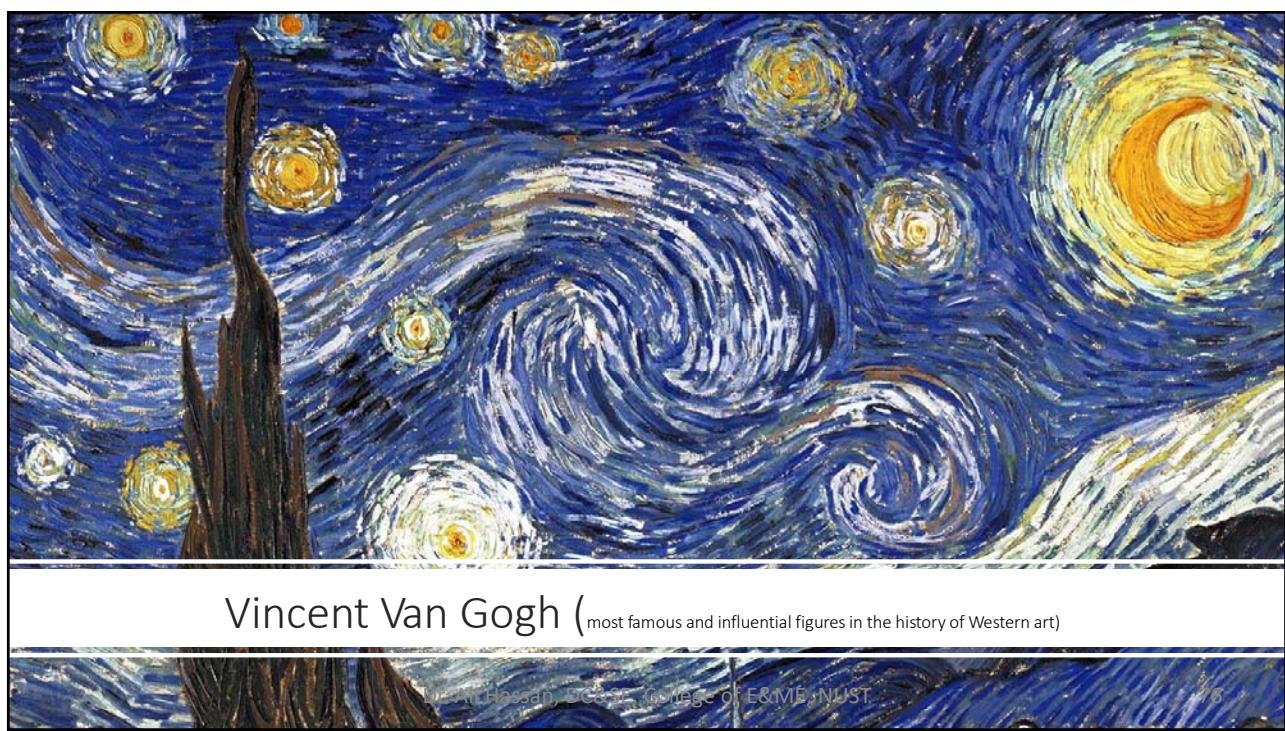
73



74



75



76

New York City skyline in the style of Van Gogh



Dr. Ali Hassan, DC&SE, College of E&ME, NUST

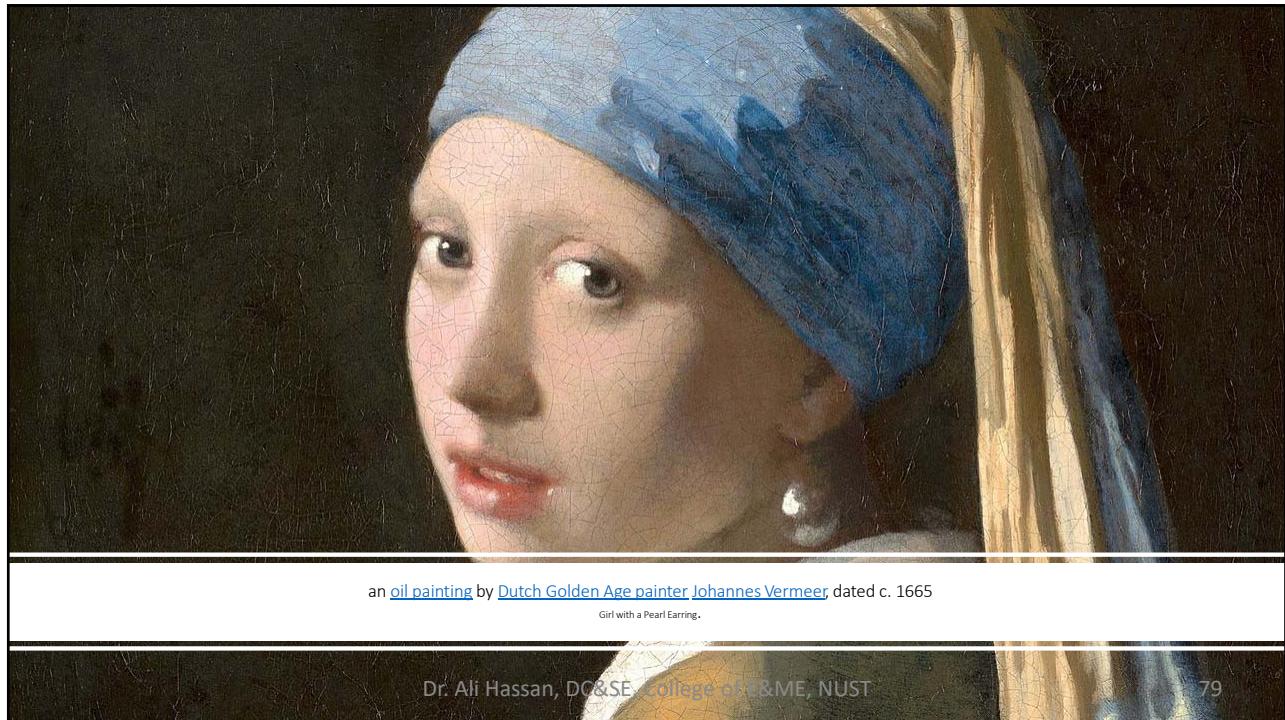
77



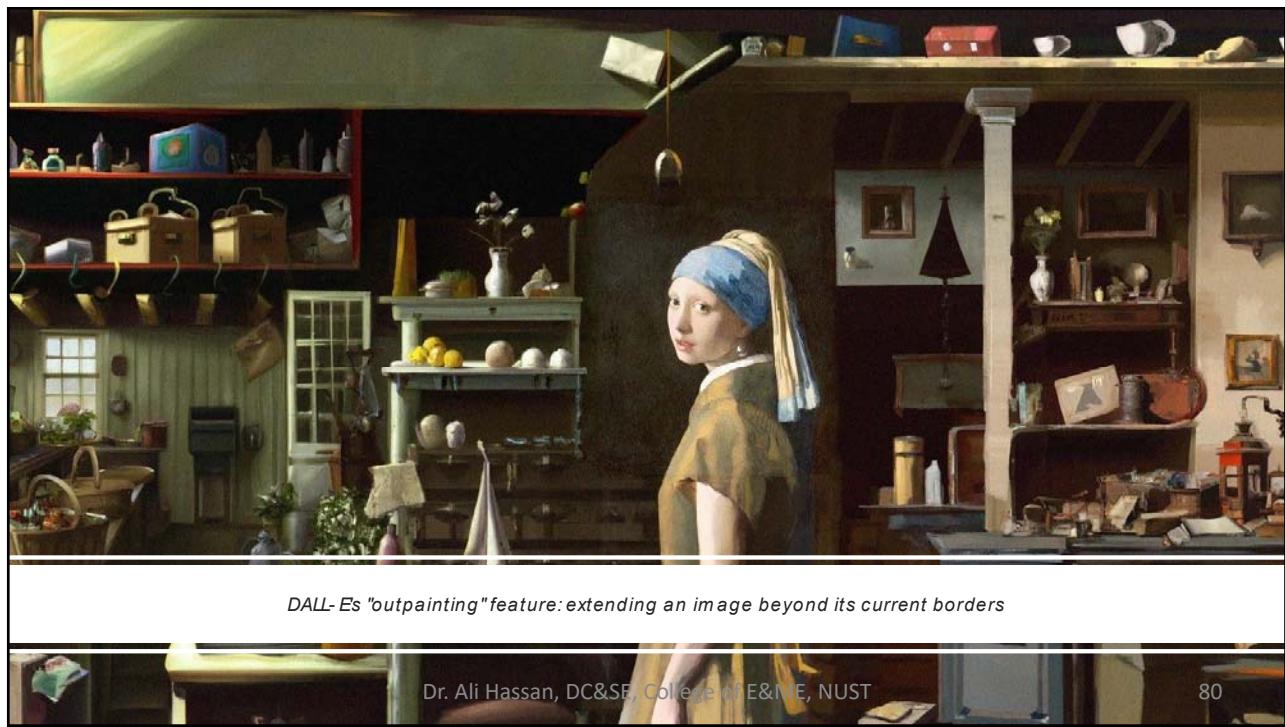
Dr. Ali Hassan, DC&SE, College of E&ME, NUST

78

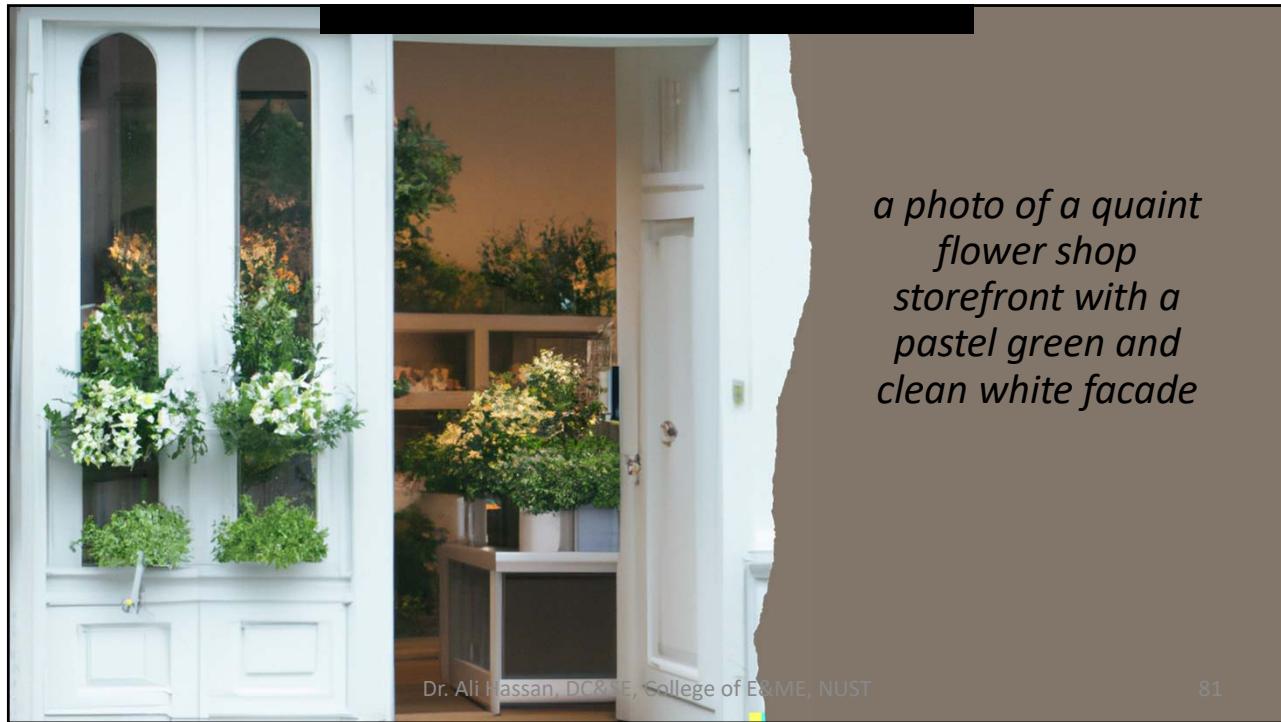
78



79



80



81

# Text to Image

raining by von gogh painting

Enter a negative prompt

Generate image

Dr. Ali Hassan, DC&SE, College of E&ME, NUST

82

82

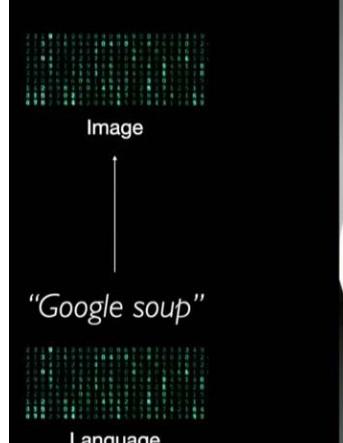


we wrote google soup, and the image shown on the right is generated



AI knows that soup is usually hot, so it must melt the Google symbol. Another thing that it did is to take the yellow part of Google's symbol and make it similar to corn, which is also yellow.

“Google soup”



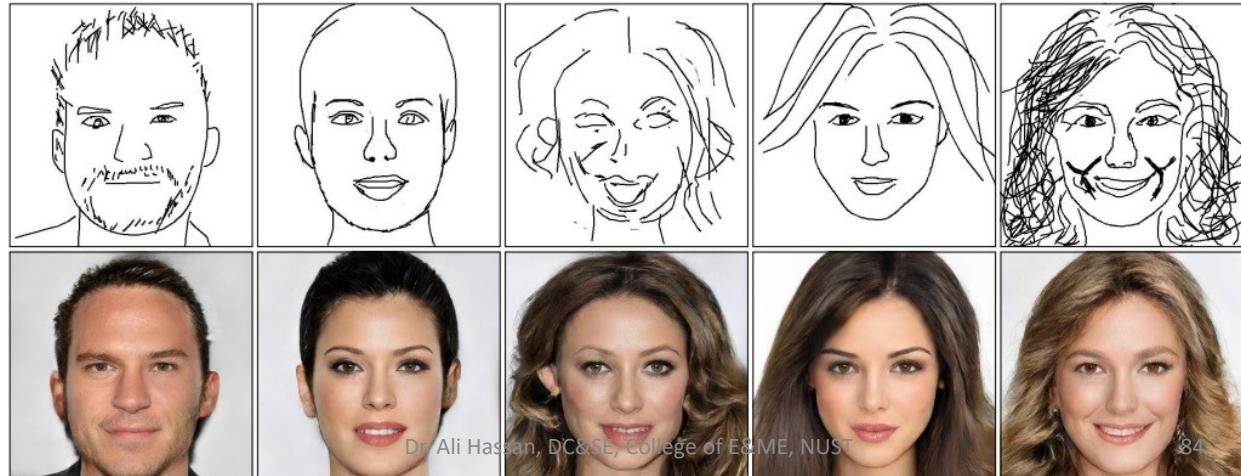
Dr. Ali Hassan, DC&SE, College of E&ME, NUST

83

83

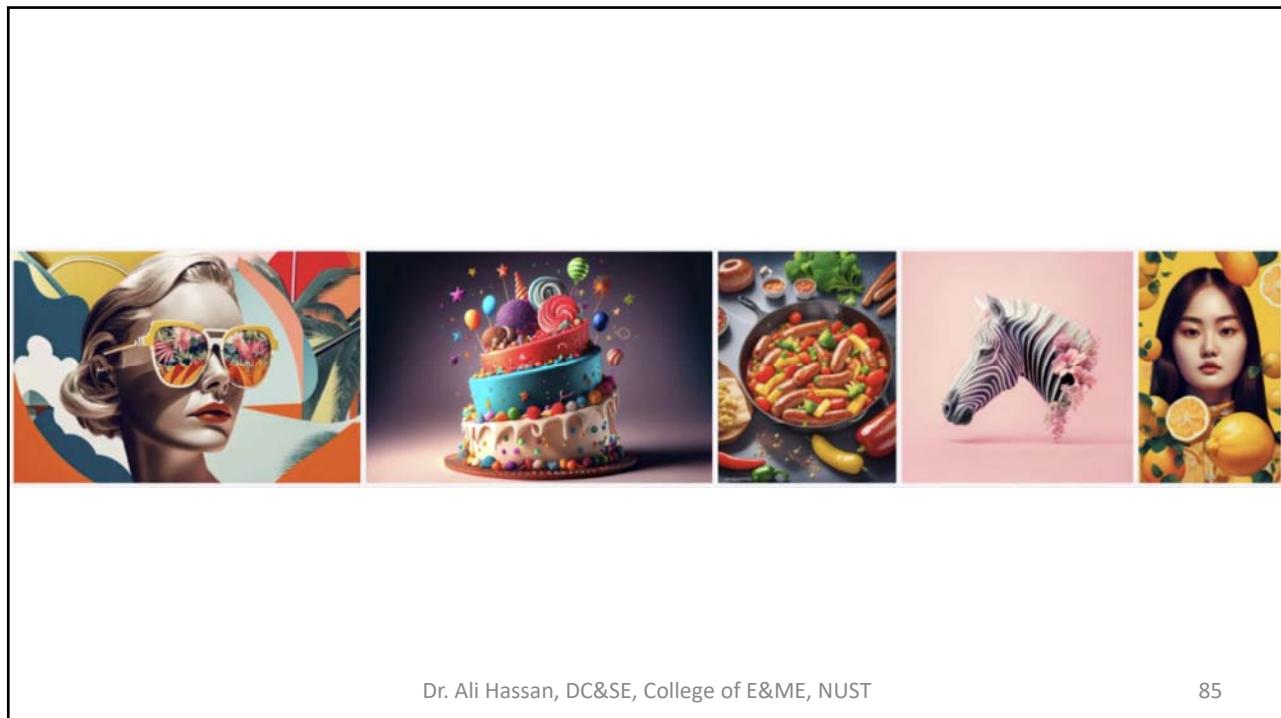
## Sketches-to-realistic images.

[DeepFaceDrawing: Deep Generation of Face Images from Sketches.](#)



Dr. Ali Hassan, DC&SE, College of E&ME, NUST

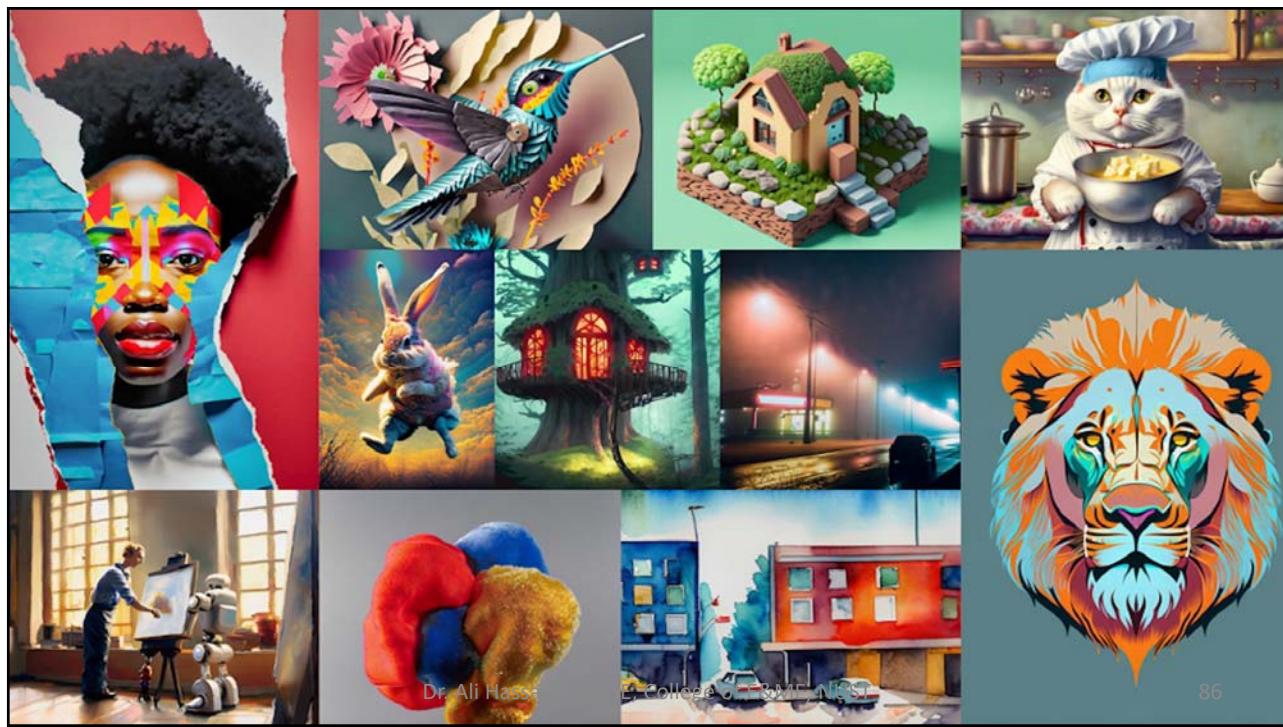
84



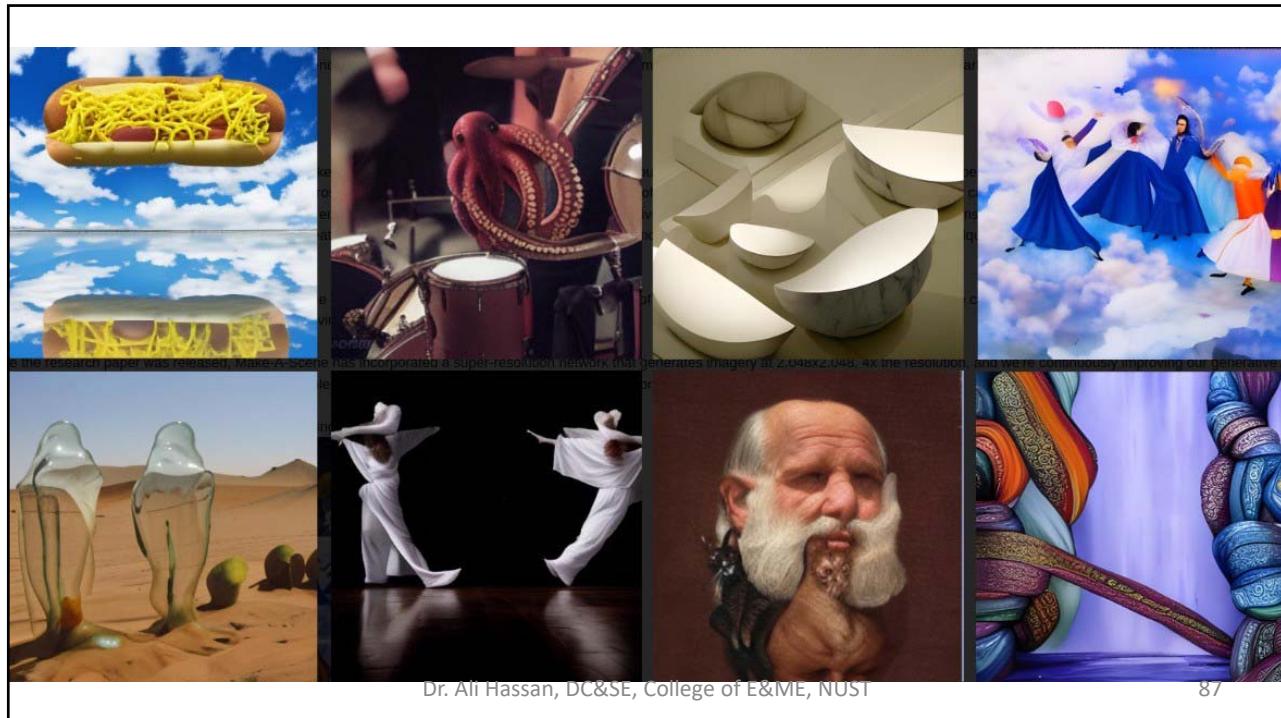
Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME, NUST

85

85

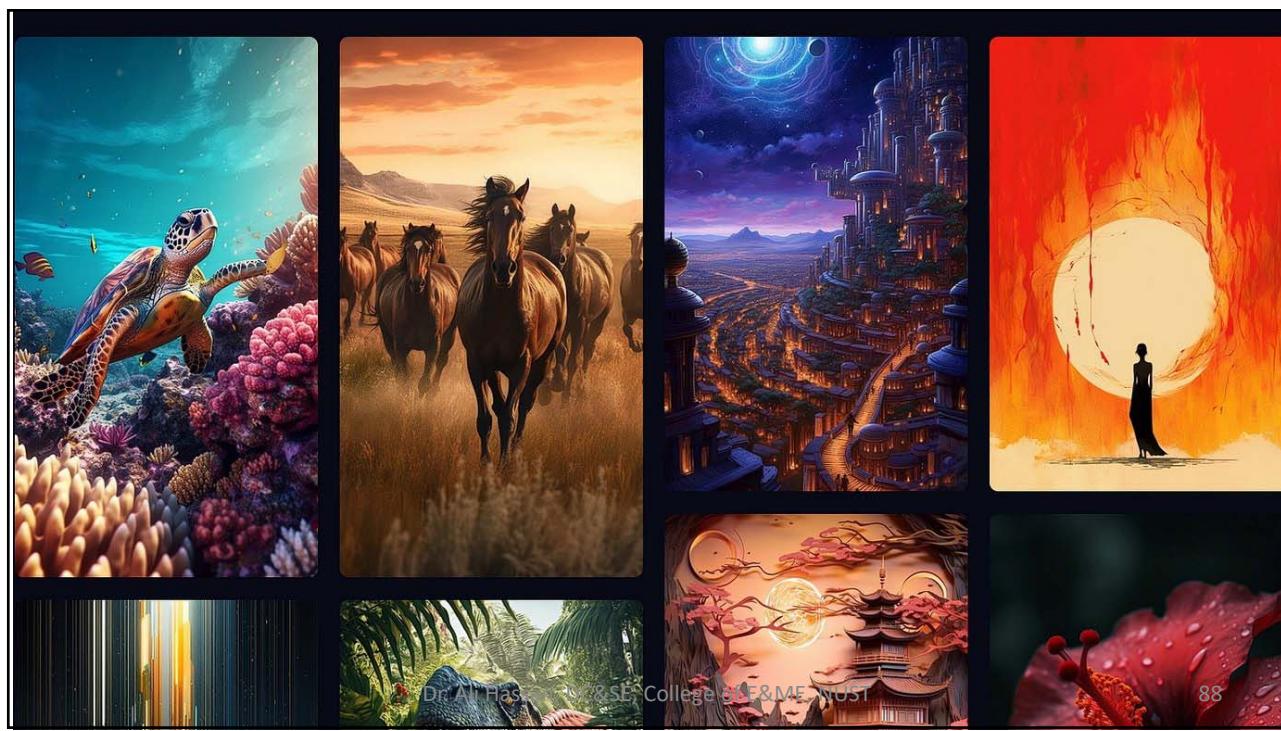


86



Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME, NUST

87

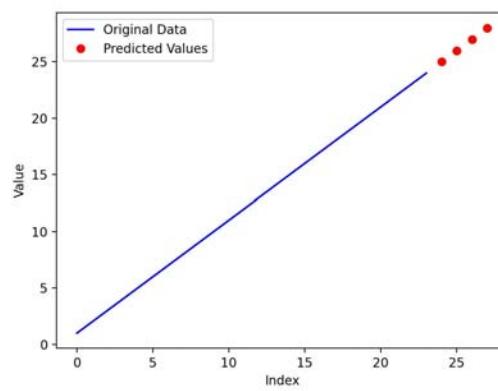


Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME, NUST

88

# Code Generation

```
FromChatGPT > ...
1 import numpy as np
2 import matplotlib.pyplot as plt
3 from sklearn.linear_model import LinearRegression
4
5 # Array with 24 values
6 data = np.array([1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24])
7
8 # Splitting the data into features (X) and target variable (y)
9 X = data[:-4] # Use all values except the last four as features
10 y = data[4:] # Use all values except the first four as target variable
11
12 # Reshape the data to 2D array for sklearn
13 X = X.reshape(-1, 1)
14 y = y.reshape(-1, 1)
15
16 # Create and train the linear regression model
17 model = LinearRegression()
18 model.fit(X, y)
19
20 # Predict the next four values
21 next_values = []
22 for i in range(1, 5):
23     next_value = model.predict([[data[-i]]])
24     next_values.append(next_value[0][0])
25
26 # Reverse the order of predicted values
27 next_values = next_values[::-1]
28
29 # Concatenate original and predicted values
30 all_values = np.concatenate((data, np.array(next_values)))
31
32 # Create x-axis values for the plot
33 x = np.arange(len(all_values))
34
35 # Plot original and predicted values
36 plt.plot(x[len(data):], data, 'b-', label='Original Data')
37 plt.plot(x[len(data):], all_values[len(data):], 'r.', label='Predicted Values')
38 plt.xlabel('Index')
39 plt.ylabel('Value')
40 plt.legend()
41 plt.show()
```



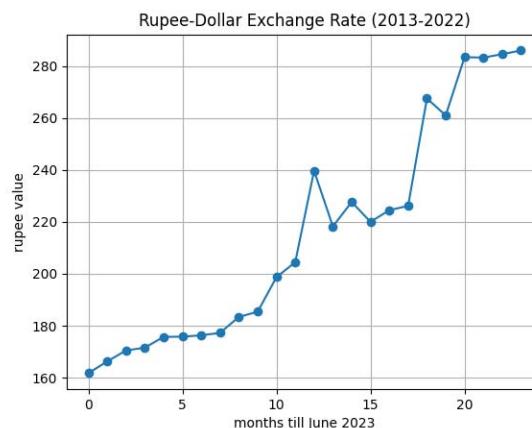
Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME, NUST

89

89

# Generated Code with Relevant Data

```
predictDollarValue > ...
1 import numpy as np
2 import matplotlib.pyplot as plt
3 from sklearn.linear_model import LinearRegression
4
5 # Array with 24 values
6 data = np.array([
7     286.000,
8     284.550,
9     283.250,
10    283.410,
11    261.000,
12    267.500,
13    226.150,
14    224.500,
15    220.000,
16    227.650,
17    218.250,
18    239.660,
19    264.500,
20    198.700,
21    185.400,
22    183.400,
23    177.250,
24    176.320,
25    175.000,
26    175.720,
27    171.550,
28    170.500,
29    166.250,
30    161.750])
31
32 data = np.flip(data)
33
34 # Plotting the data
35
36 # Splitting the data into features (X) and target variable (y)
37 X = data[:-1] # Use all values except the last one as features
38 y = data[1:] # Use all values except the first one as target variable
```

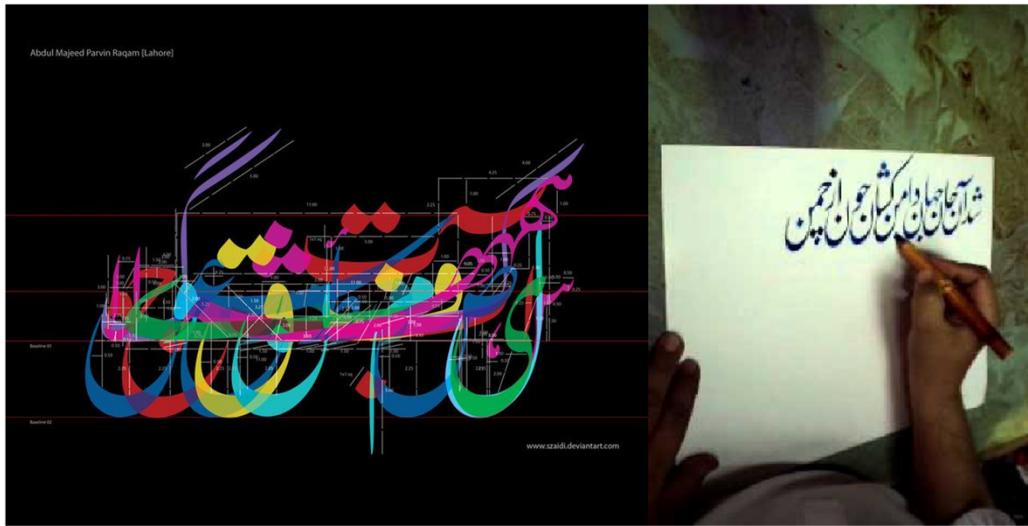


Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME, NUST

90

90

# Many Professions will Become Obsolete



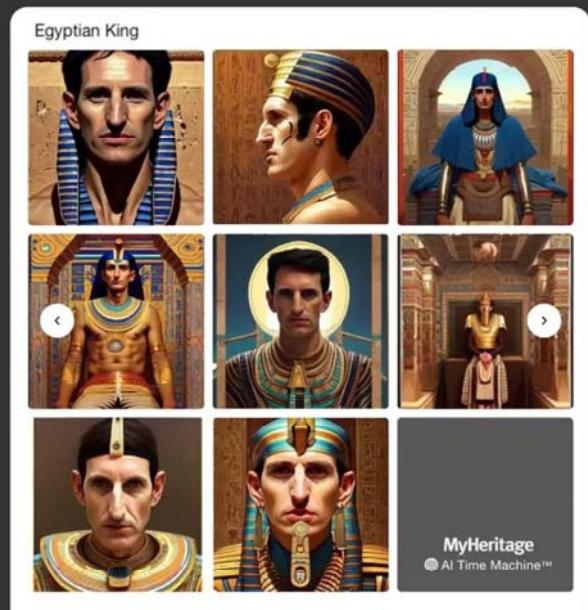
Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME, NUST

91

91

With generative AI tools, you can easily be an astronaut, a 19th-century lord or lady, a medieval knight, or an Egyptian pharaoh!

- [Google Bard AI](#)
- [Bing AI](#)
- [Chinchilla](#)
- [Notion AI](#)
- [Google Apprentice Bard](#)
- [Chai](#)
- [NovelAI](#)
- [Caktus AI](#)
- [AI Dungeon](#)
- [YouChat](#)
- [Neeva AI](#)
- [Fake name generators](#)



Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME

[Download](#)
 [Share](#)

92

92

## Assignment 1 (b)

- Be creative and generate an image using any text to image Generative AI tool
- Submit the image and also share it on whatsapp group (only your best image please). Let us find out who generates the most creative image
- Name the tool and the text prompt you used for image generation.

<https://labs.openai.com/>

<https://gencraft.com/generate>

Dr. Ali Hassan, DC&SE, College of E&ME, NUST

93

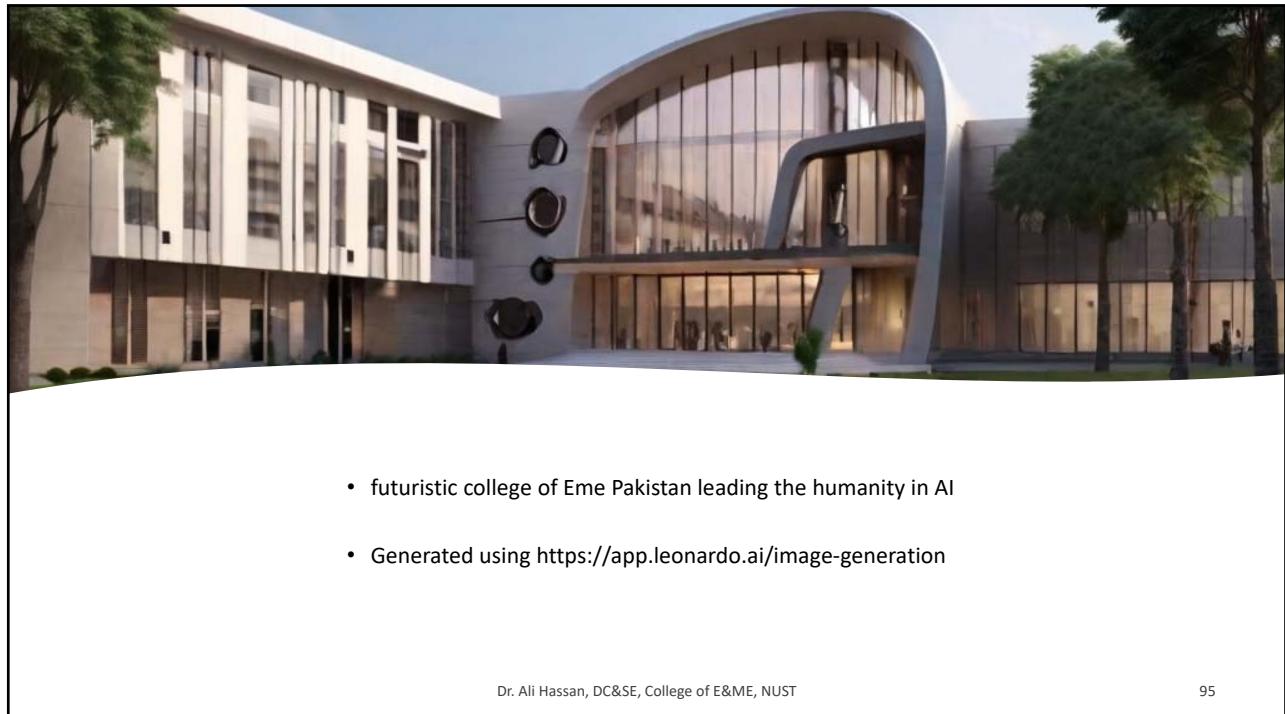
93



Dr. Ali Hassan, DC&SE, College of E&ME, NUST

94

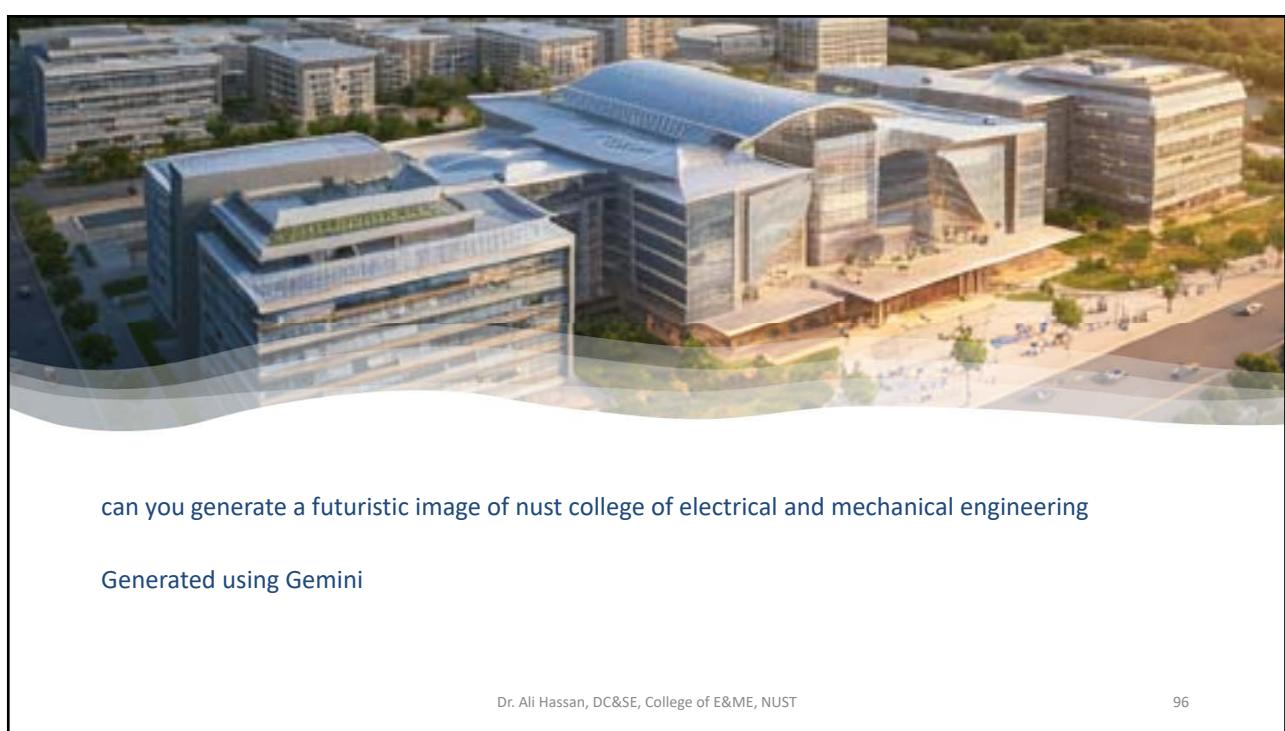
94



- futuristic college of Eme Pakistan leading the humanity in AI
- Generated using <https://app.leonardo.ai/image-generation>

Dr. Ali Hassan, DC&SE, College of E&ME, NUST

95



can you generate a futuristic image of nust college of electrical and mechanical engineering

Generated using Gemini

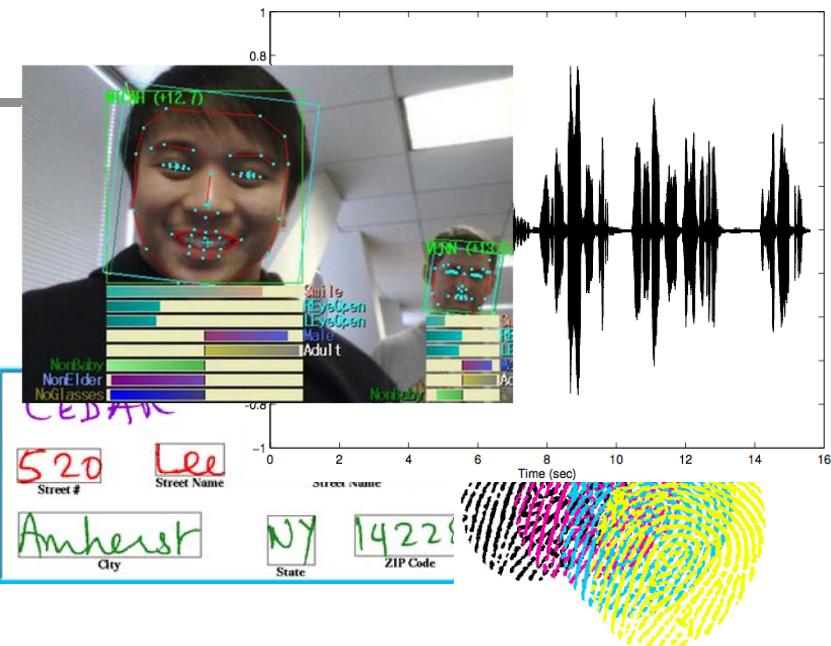
Dr. Ali Hassan, DC&SE, College of E&ME, NUST

96

96

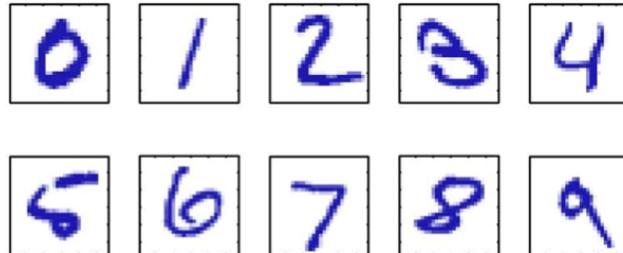
## What we want to do

- Algorithms that can improve their performance using **training data**
- Typically the algorithm has a (large) number of parameters whose values are learnt from the data
- Can be applied in situations where it is very challenging (**=impossible**) to define rules by hand, e.g.:
  - Facedetection
  - Speechrecognition
  - Stockprediction



## Handwritten Address Interpretation System

- One of first commercial and widely used ML systems (for zip codes & checks)



- Images are 28x28 pixels
- Represent input image as a vector
- Learn a classifier  $f(x)$  such that

$$x \in \Re^{784}$$

$$f : x \rightarrow \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$$



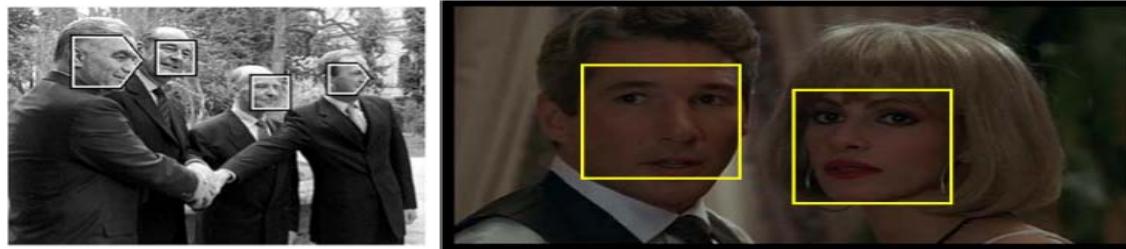
## How to Proceed

- Collect some training samples for each digits
- Start learning and classifying
- Systems can achieve errors of 0.4%

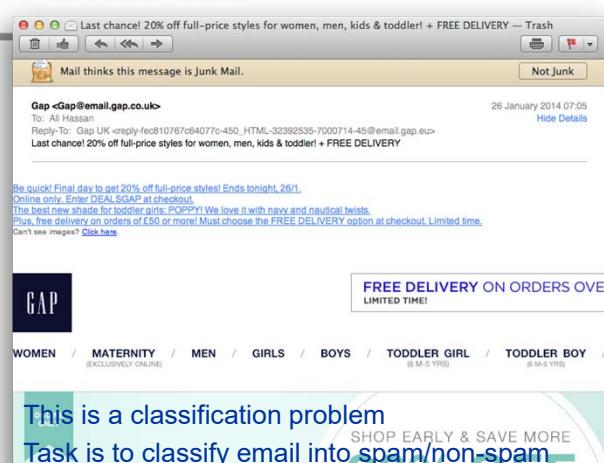
0 0 0 1 1 1 1 1 1 2  
2 2 2 2 2 2 3 3 3 3  
3 4 4 4 4 4 5 5 5 5  
6 6 7 7 7 7 8 8 8 8  
8 8 9 9 9 9 9 9 9 9



## Example 2: Face Detection



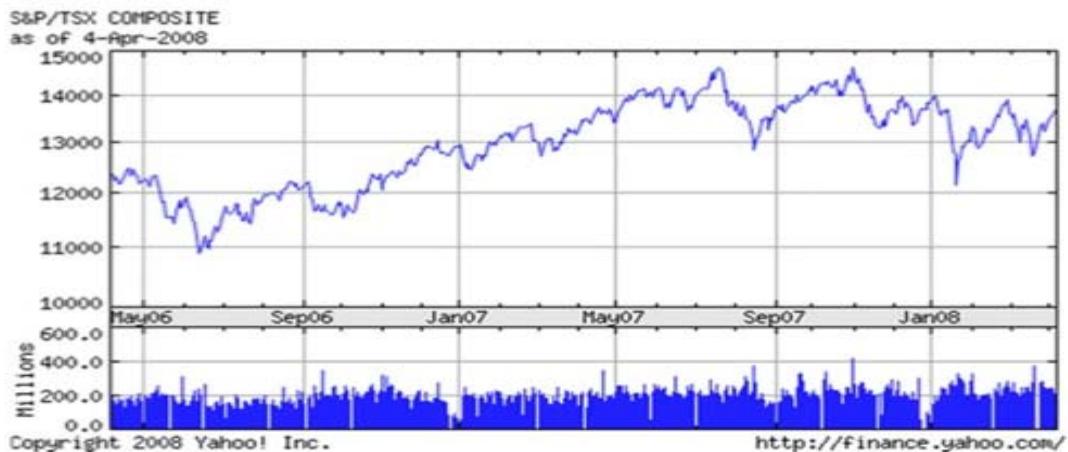
## Spam Detection



- This is a classification problem
- Task is to classify email into spam/non-spam
- Data  $x_i$  is word count, e.g., outperform, “you may be surprised to be contacted” ...
- Requires a learning system as “enemy” keeps innovating



## Stock Price Predictions



Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME, NUST

103

103

## Language Translation

Web Images Maps News Shopping Mail more ▾

Google Translate BETA

Translate text or webpage

Enter text or a webpage URL.

French > English swap

Translation: French → English

Under the new proposals, what is the cost of collection of fees?

[Suggest a better translation](#)

[Google Home - About Google Translate](#)

©2009 Google



Dr. Ali Hassan, DC&amp;SE, College of E&amp;ME, NUST

104

104

## Recommender Systems

**Frequently Bought Together**

Customers buy this book with [Pattern Recognition and Machine Learning \(Information Science and Statistics\) \(Information Science and Statistics\)](#) by Christopher M. Bishop

Price For Both: £104.95

[Add both to Basket](#)

**Customers Who Bought This Item Also Bought**

Page 1

<a href="#">Pattern Recognition and Machine Learning (Information Science and Statistics) by Christopher M. Bishop</a> ★★★★★ (4) £48.96	<a href="#">MACHINE LEARNING (McGraw-Hill International Edition) by Tom M. Mitchell</a> ★★★★★ (3) £42.74	<a href="#">Pattern Classification, Second Edition by Richard O. Duda</a> ★★★★★ (1) £78.38	<a href="#">Data Mining: Practical Machine Learning Tools and Techniques by Ian H. Witten</a> ★★★★★ (1) £37.04
<a href="#">Show related items</a>	<a href="#">Show related items</a>	<a href="#">Show related items</a>	<a href="#">Show related items</a>



## Applications

- Medical diagnosis
- Reading postcodes
- Autonomous vehicles
- Data mining
- Fraud detection
- Bioinformatics
- Text analysis
- Speech recognition
- Biometrics
- Fault detection
- Character recognition
- Cancer screening
- Financial modelling



## Pattern Recognition: Overview

- Function  $F$

$$f : X \rightarrow Y$$

Learning

find  $f' \in F$   
s.t  $y_i \approx f'(x_i)$

Prediction

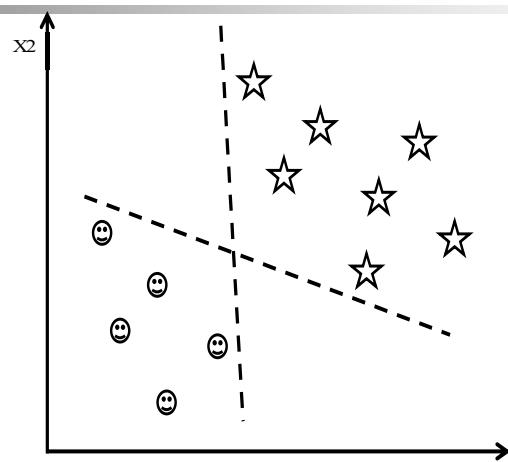
$$y = f'(x)$$

### Training Data

$$\{(x_i, y_i) \in X, Y\}$$

### New Data

$$x$$



## Common Techniques

- Linear Regressions
- Nearest-Neighbour Classifier
- Support Vector Machine (SVM)
- Perceptron
- Multi-Layer Perceptron (MLP)
- Radial-Basis Functions (RBF)
- Bayesian Inference
- K-Means Clustering
- Principle Component Analysis (PCA)



## More Common Techniques

- Decision Trees: ID3/C4.5/CART
- Bayesian Optimal Classifiers
- Belief Networks
- Monte-Carlo Techniques (MCMC)
- Hidden Markov Models (HMM)
- Graphical Models
- Reinforcement Learning



## Yet More Techniques

- Self-Organized Maps (Kohonen networks)
- Hopfield Models
- Gaussian Processes
- Maximum Entropy
- Q-learning
- Recurrent networks
- Kalman filters



## And more ...

- Boltzmann Machine
- Helmholtz Machine
- Independent Component Analysis
- Kernel PCA
- Fisher Discriminant Analysis
- Neocognitron
- Genetic Programming
- Competitive Network



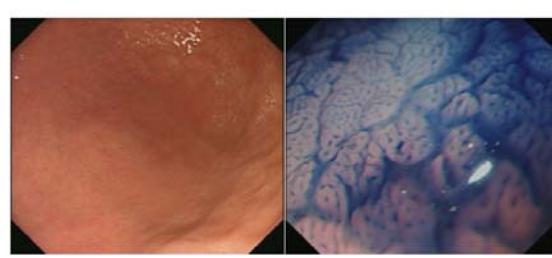
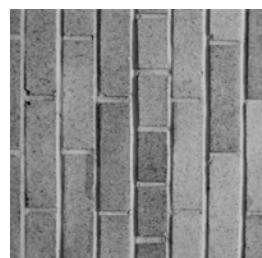
## Aim of the Course

- I am not going to teach a long list of techniques
- Concentrate on a few representative techniques
- Provide a theoretical framework for understanding different techniques
  - Maths—linear algebra, optimization, probability
  - Learning theory
- Practical experience (Python)



## Example 1

- Texture and Gastroenterology

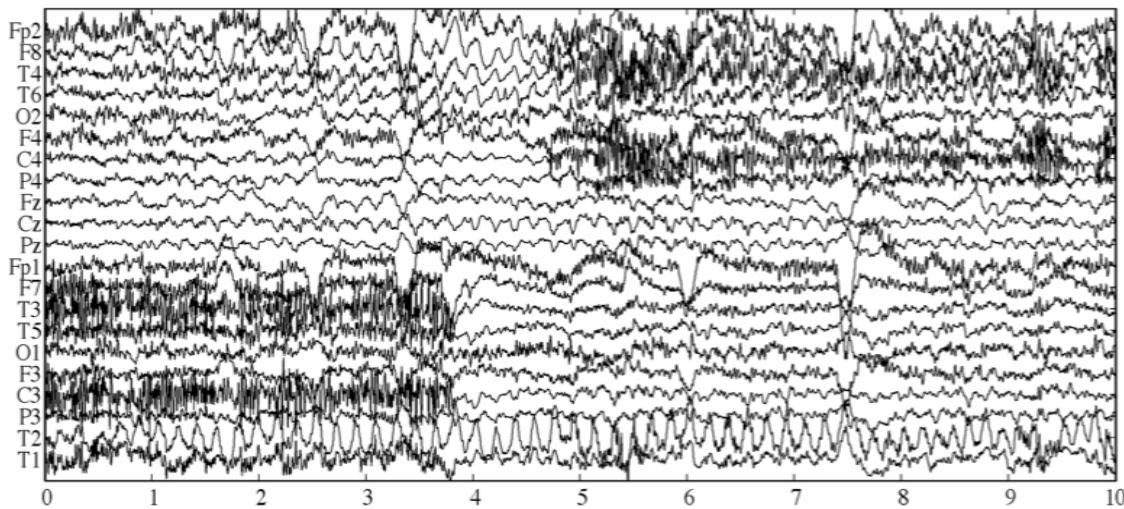


## Example 2

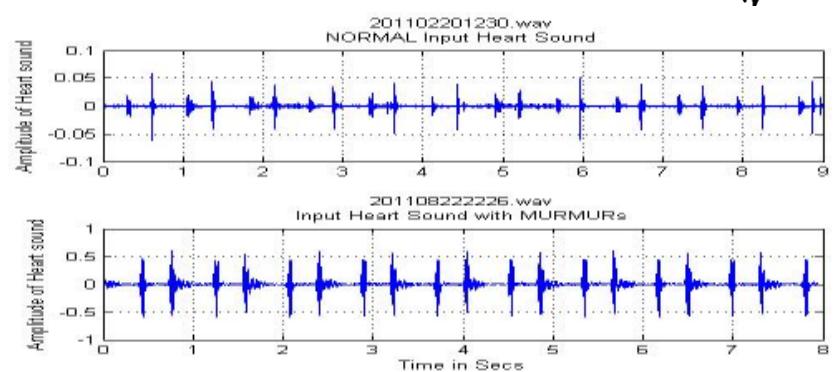
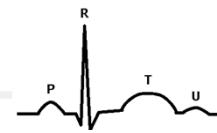
- Source Separation Problem
  - Usually done via two sources and uses Doppler effect
  - Also known as BSS or ICA
- Can be directly applied to ECG or Heart Sounds



## EEG: Source Separation



## Heart Sound Classification



- Issues:

- How to classify first peak
- How to detect murmurs



## Course Names

Machine  
Learning

Neural  
Networks

Learning from  
Data

Statistical  
Pattern  
Recognition

Computational  
Intelligence

Intelligent  
Systems

Data Mining



## Prerequisites for this Course

- Knowledge of Digital Image Processing
- Working Knowledge of **Python**
- Mathematical knowledge
  - Linear Algebra
    - Derivatives, integration
    - Eigen values, eigen vectors
    - Matrix manipulations
  - Statistical Mathematics
    - Mean, variance, covariance, correlations
  - Probability Theory

■ Pdf, cdf, correlations, covariance

Dr. Ali Hassan, DC&SE, College of E&ME, NUST

119

119

Tinker With a Neural Network Right Here in Your Browser.  
Don't Worry, You Can't Break It. We Promise.

Epoch  
000,271      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: 50%

Noise: 0

Batch size: 10

REGENERATE

FEATURES

Which properties do you want to feed in?



$X_1$

$X_2$

$X_1^2$

$X_2^2$

$X_1 X_2$

$\sin(X_1)$

2 HIDDEN LAYERS

+ -



4 neurons

+ -



2 neurons

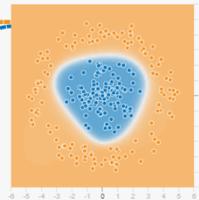
The outputs are mixed with varying weights, shown by the thickness of the lines.

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

OUTPUT

Test loss 0.004

Training loss 0.003

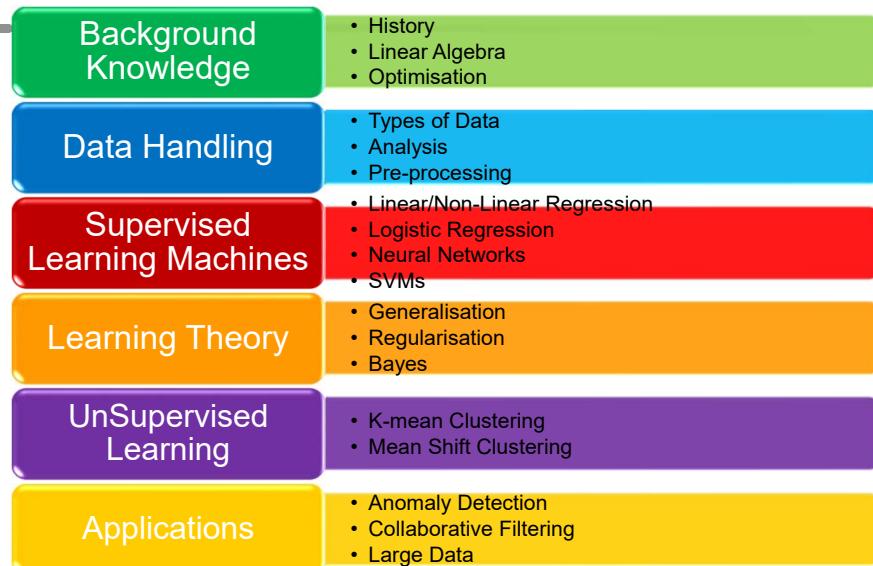


Dr. Ali Hassan, DC&SE, College of E&ME, NUST

120

120

## Course Outline



## Books

- *Machine Learning: A Probabilistic Perspective* by Kevin Murphy (online version available)
- Hands-on Machine Learning with SciKit-Learn, Keras and TensorFlow by Aurelien Geron
- Reference Books
  - Google
  - Pattern Recognition and Machine Learning by Christopher Bishop
  - Pattern Classification (2<sup>nd</sup> Edition) by Richard Duda, Peter Hart and David Stork (online version available)



## Grading Distribution

- Mid Term 1x 30%
- Final Term 1x 40%
- Quizzes 4x 10%
- Assignments 4x 10%
- Term Project 1x 10%



## House Keeping Policies

- Class on
  - Thursday 18:00 – 21:00
  - CRC-16 Try to be on time
- You have to maintain > 75% attendance
- Quizzes – unannounced
- Assignments – No late submissions, **LMS**
- Best way to contact: [alihassan@cheme.nust.edu.pk](mailto:alihassan@cheme.nust.edu.pk)
- Lecture Slides/Notes: **NUST LMS**



## Software



Visual Studio Code



## Contact Details

- Dr Ali Hassan
  - [alihassan@ceme.nust.edu.pk](mailto:alihassan@ceme.nust.edu.pk)



## What do you need to do?

- REGISTER on Qalam within first ONE/TWO weeks



## LMS Code

■ Code: 426708913



## Acknowledgements for material used in creating these slides

- Duda Hart Stork lecture slides
- Andrew Ng Standford



## Good Material

- Machine Learning by Andrew Ng on Coursera
- You tube channel
  - <https://youtu.be/qeHZOdmJvFU?list=PLZ9qNFMHZ-A4rycrgOYma6zxF4BZGGPW>
- Neural Network Class by Hugo Larochelle
  - <https://youtu.be/SGZ6BttHMPw>
- Dr Shoab Lectures
  - <https://youtu.be/FW4eKlvuGnY?si=tA4O1J3nLdWIPHOt>



## Refresher on Maths

- To know the rules of differentiation check out [Khan Academy's Differential Calculus classes](#).
- To know what are matrices and how to perform operations (transpose, arithmetic, dot product) on matrices, check out [Khan Academy's Linear Algebra playlist](#).



**THANK YOU !!**

