

# About the Instructor

**Dr. Muhammad Safyan**

PhD(2018) – Knowledge Graph (Activity Recognition), Machine Learning

**Research Output**

Number of Journal publications -20

Citation=167

Conference Paper=9

Book Chapter=5

Conference attended Out side Country: 1 (Australia)

HEC Grand Challenge Fund: Proposal submitted in the field of security and privacy: Rs: 240 millions

# About the Course

## About the Course

### Machine Learning

Pre-requisite and background

How differ from Data Science, Artificial Intelligence , Deep Learning

### Applications

### Applied Side

# Others

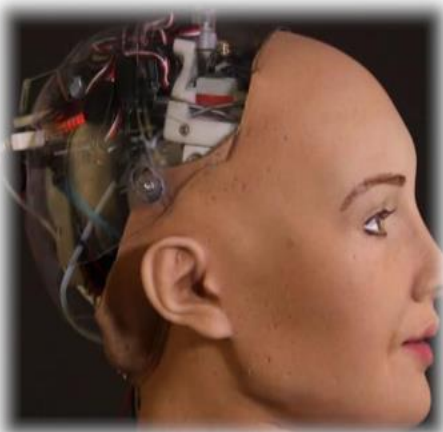
Course Outline

Teaching Method

Assignment

Research Focus

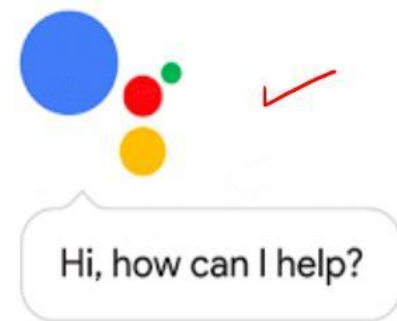
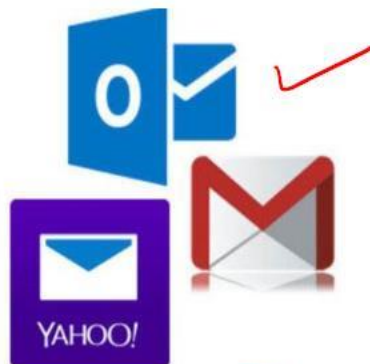
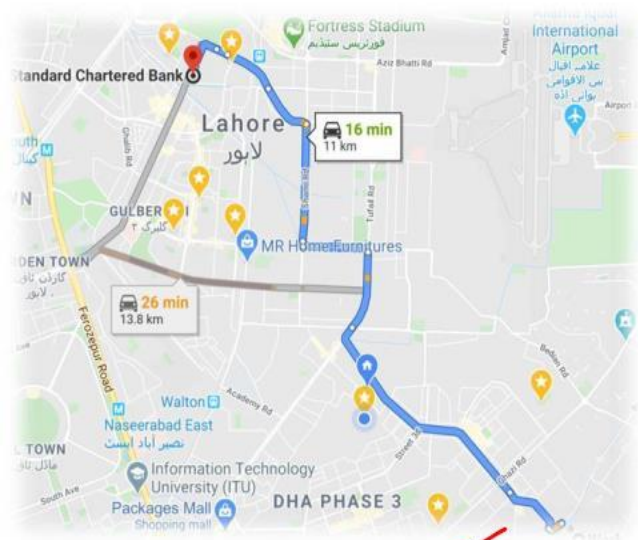
Term Paper discussion



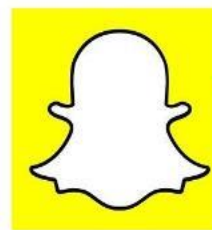


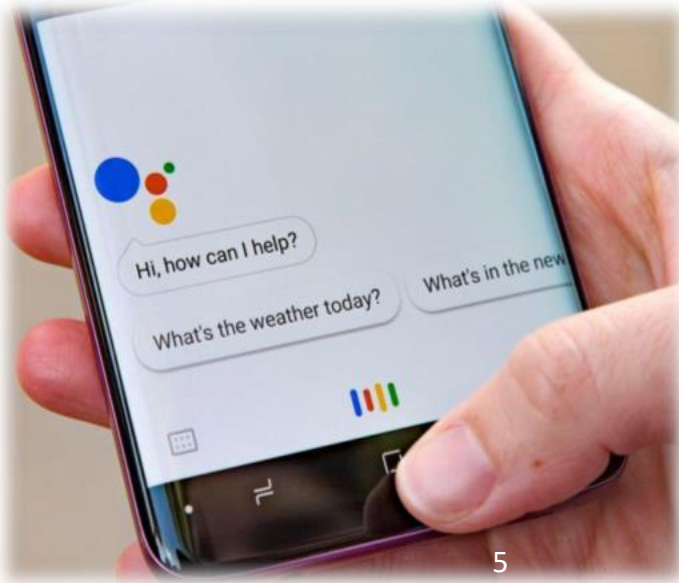


amazon alexa

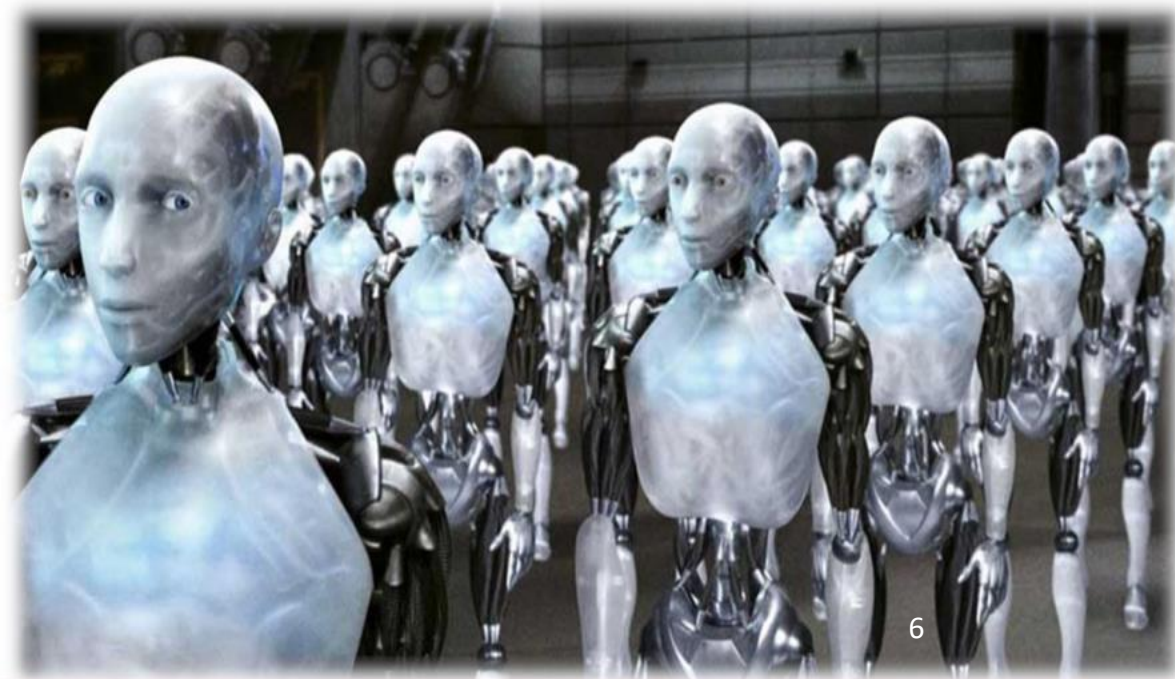
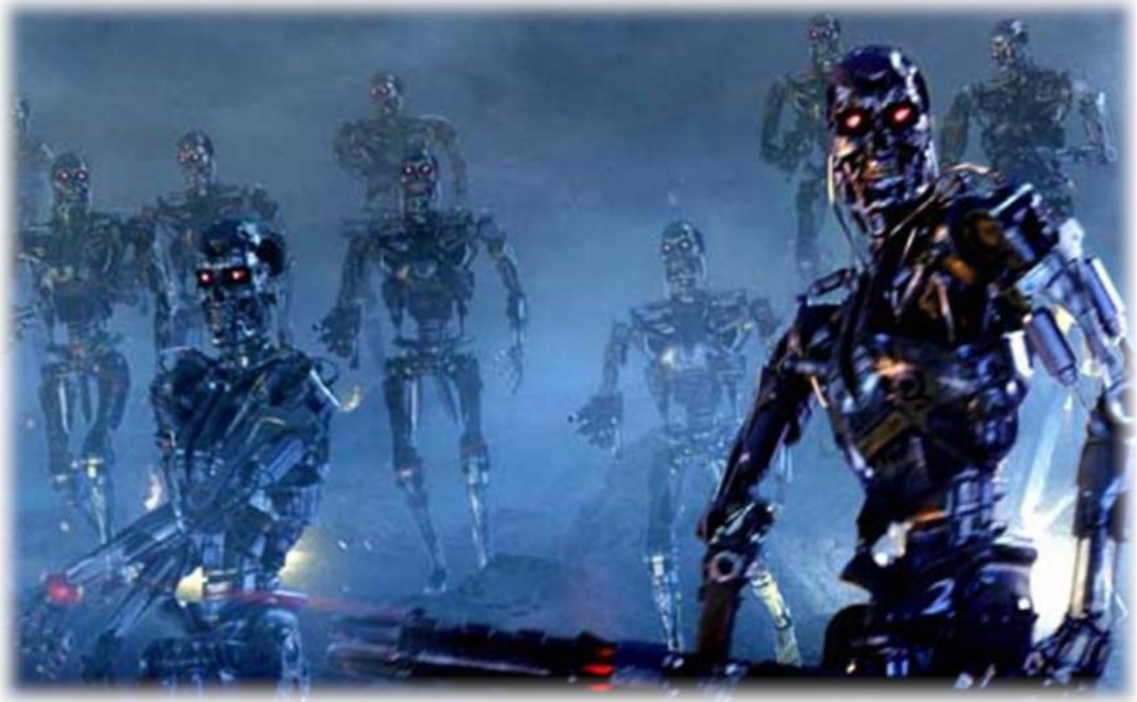


Google Translate

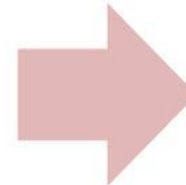
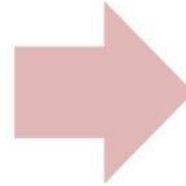








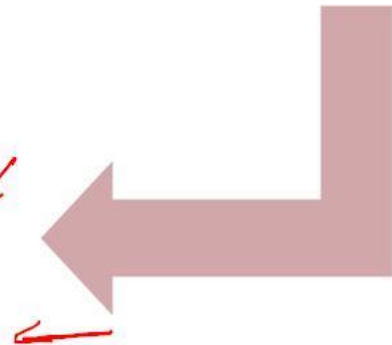
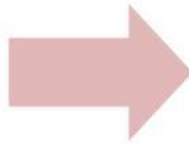




# **What is Machine Learning?**

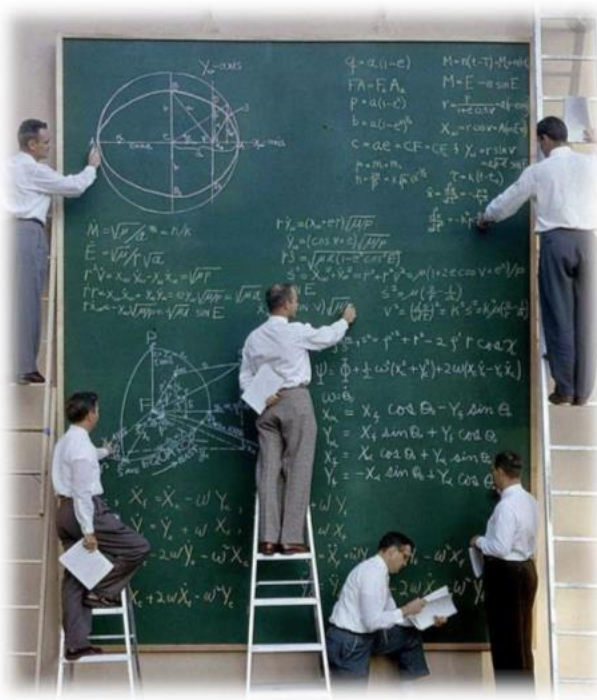
**How does it work?**

# Machines as mechanical helpers

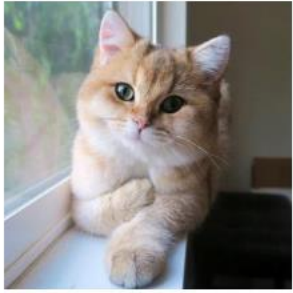




# Machines as Intellectual helpers

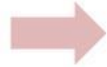


# Machines as Intellectual helpers



→ Cat

Is this a cat or a dog?



→ No

Should I hire this person?





# A Classifier



{cat, dog}



→ cat



{happy, sad, angry,  
surprised, neutral}



→ happy



{empty, full}



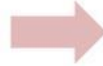
→ empty



# A Classifier



{All words of the language}



Hospital



Return the *best* of {all board positions one black move from current}



Best move

# **How do we train a classifier?**

# How to train your intern?

## How would you train a new intern to conduct job Interviews?

- **Option 1: Teach all the complicated rules**
  - Grades are important
  - University is important
  - Great grades – Good university – All good!
  - Bad grades – Unknown university – Not so good
  - Bad grades – Good university – ?
  - Good grades – unknown university – ?
- Still there would be exceptions
- Murky thresholds and gray areas
- Very hard to instill intuitive and experiential knowledge



# How to train your intern?

## How would you train a new intern to conduct job Interviews?

- **Option 2: Make them sit and watch as a expert conducts interviews**
  - Learning by experience
  - Eventually, patterns start emerging
  - Let the intern get the intuition on their own
- More experience – better learning
- More exposure (balanced cases) – better learning
- Caveat!
  - What if the expert has systematic flaws of judgement aka biases?
    - Conduct sessions with many experts
    - What is they all share biases and stereotypes?
    - Initially, your intern could only be as good as the experts

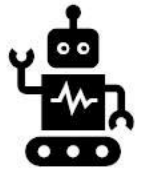
# How to train your machine?

Allowing the machines to learn on their own using prior decisions of experts is known as Machine Learning

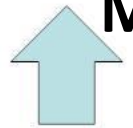
## Supervised

## Unsupervised

- The goal of AI was to make a machine more like a human
  - Give the machine a lot of world knowledge
  - A logical decision-making frame-work
- The Machine Learning framework seeks to make a better machine – not necessarily emulating a human
  - Based on Statistics and Optimization
  - Learn from labelled data
  - More data – more consistent decisions
  - More balanced data – more confident decisions
- Certainty in the real-world is a rare luxury – Uncertainty is the basis of ML that is quantified using probability and statistics



ML



# Applications

## Supervised Learning

Input(x) ↙	Output (y) ↙	Application
Home features	Price	Real Estate
Ad, user info ↙	Click on ad? (0/1)	Online Advertising
Image	Object (1,...,1000)	Photo tagging
Audio	Text transcript	Speech recognition
English	Chinese	Machine translation
Image, Radar info	Position of other cars	Autonomous driving



Google news

Search News

Search the V

[Advanced news](#)

## ■ Top Stories

Deepwater Horizon  
Fed meeting  
Foreign exchange  
market  
Lindsay Lohan  
IBM  
Tom Brady  
Toronto  
International Film  
Festival  
Paris Hilton  
Iran  
Hurricane Igor

## ■ Starred ★

■ San Francisco Bay  
Area  
■ World  
■ U.S.  
■ Business  
■ Sci/Tech

## Top Stories

Christine O'Donnell »

**White House official denies Tea Party-focused ad campaign**

CNN International - Ed Henry - 1 hour ago

Democratic sources say the White House is not considering an ad campaign tying Republicans to the Tea Party. Washington (CNN) -- A top White House official sharply denied a report that claims President Obama's political advisers are weighing a national ...

[Tea Party is misplacing the blame, former President Bill Clinton claims](#)

New York Daily News

[GOP tea party backer defends Christine O'Donnell](#) The Associated Press[Atlanta Journal Constitution](#) - [Politics Daily](#) - [MyFox Washington DC](#) - [Salon](#)[all 726 news articles »](#)

CNN Interna...

**US Stocks Climb After Recession Called Over, Homebuilders Gain**

MarketWatch - Kristina Peterson - 16 minutes ago

NEW YORK (MarketWatch) -- US stocks climbed Monday, gaining speed after a key nonprofit organization officially called the recession over, giving investors a boost of confidence in the gradual economic recovery.

[Longest recession since 1930s ended in June 2009, group says](#)

Los Angeles Times

[Downturn Was Longest in Decades, Panel Confirms](#) New York Times[Wall Street Journal](#) - [AFP](#) - [CNN](#) - [USA Today](#)[all 276 news articles »](#)

MyFox Phila...

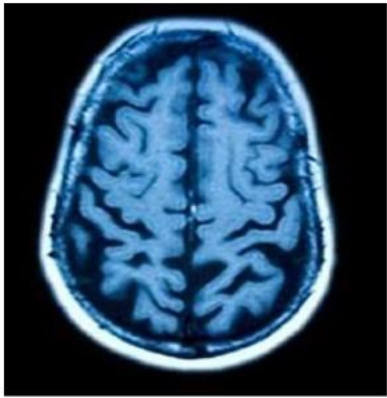
# Traditional Computer Science

Tasks like:

- Play an audio/video file
- Display a text file on screen
- Perform a mathematical operation on two numbers
- Sort an array of numbers using *Insertion Sort*
- Search for a string in a text file



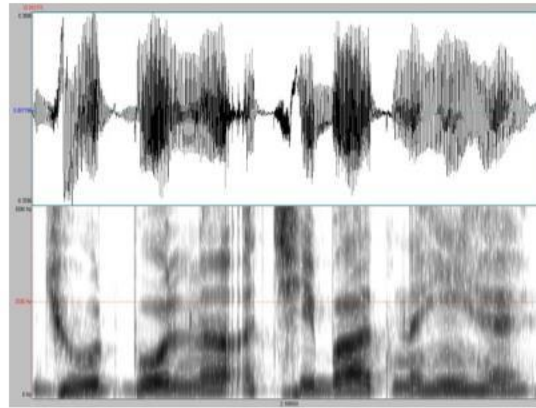
# Machine Learning



**Tumor? y/n**



## Price?



## What was said?

A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P if its performance at tasks in T, as measured by P, improves with experience E. (Tom Mitchell)

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A computer program is said to learn from experience E with respect to some class of tasks

# Summarize text



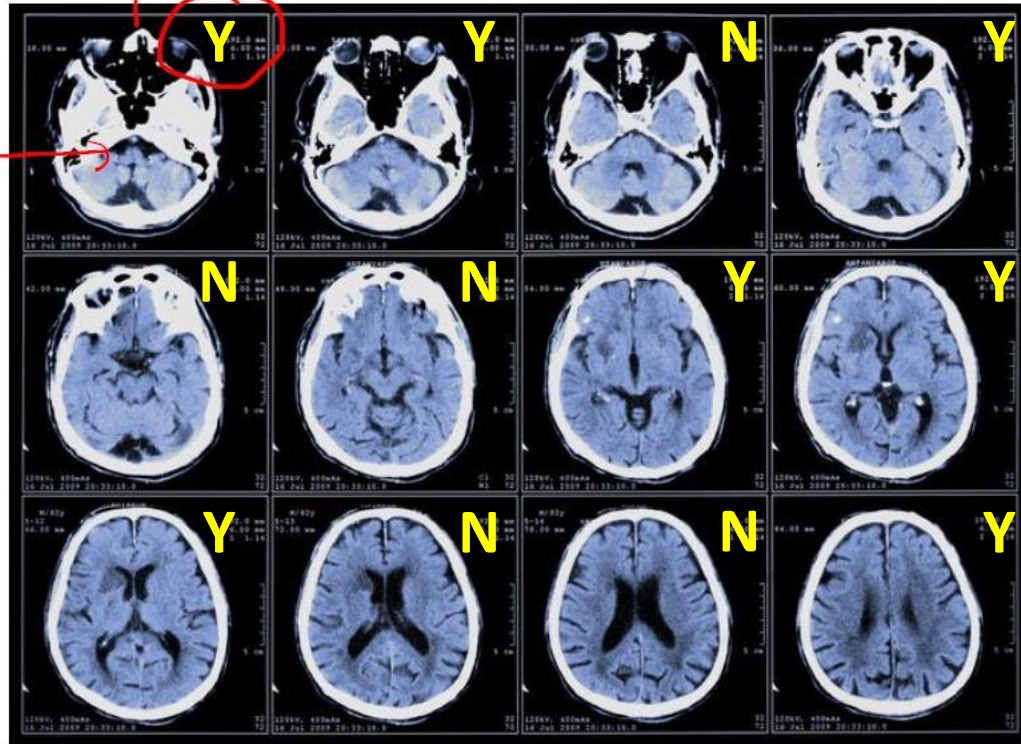
## Output

# Program



# Past data

*Program (function)*



**\$100,000**



**\$140,000**



**\$400,000**



**\$250,000**



**\$190,000**



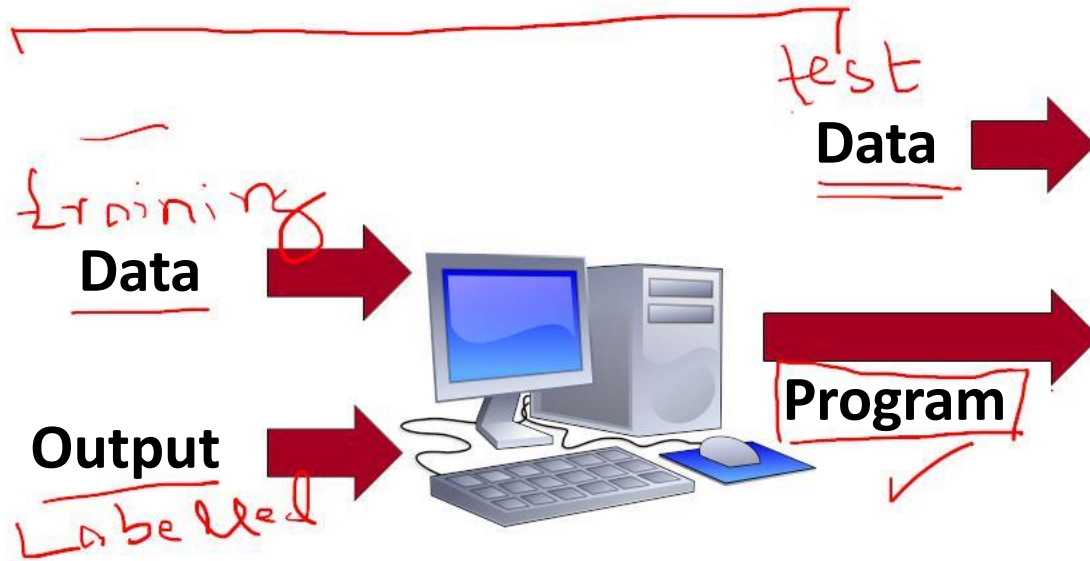
# Traditional CS



# Machine Learning



# Machine Learning



Training

# Traditional CS



Testing

# What is Machine Learning?

**Formally:** A computer program **A** is said to learn from experience **E** with respect to some class of tasks **T** and performance measure **P** if its performance at tasks in **T**, as measured by **P**, improves with experience **E**. (Tom Mitchell, 1997)

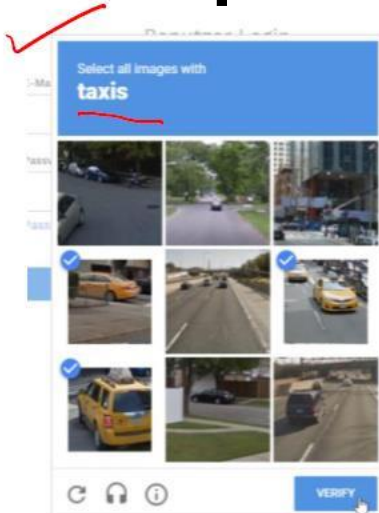
**Informally:** Algorithms that improve on some task with experience.

# Data – Big, Big,...data!

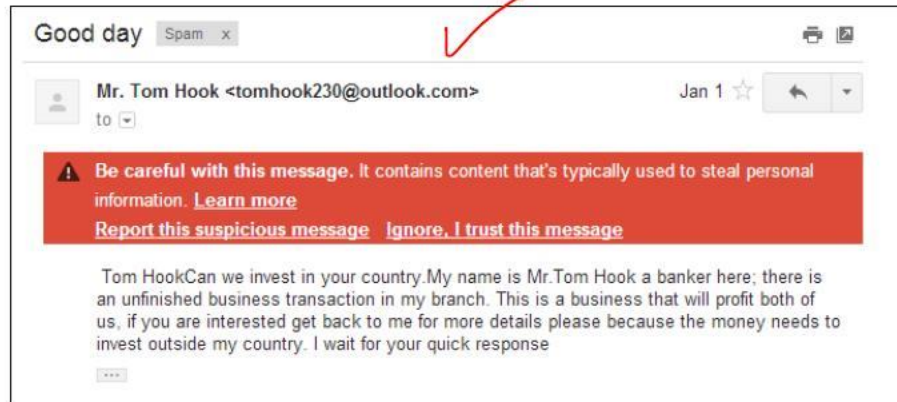
## How do we obtain these massive datasets to train our Machine Learning models?

- From real interactions e.g. call centers
- Expert annotators e.g. hired teams of annotators
- Crowd sourcing

### Recaptcha

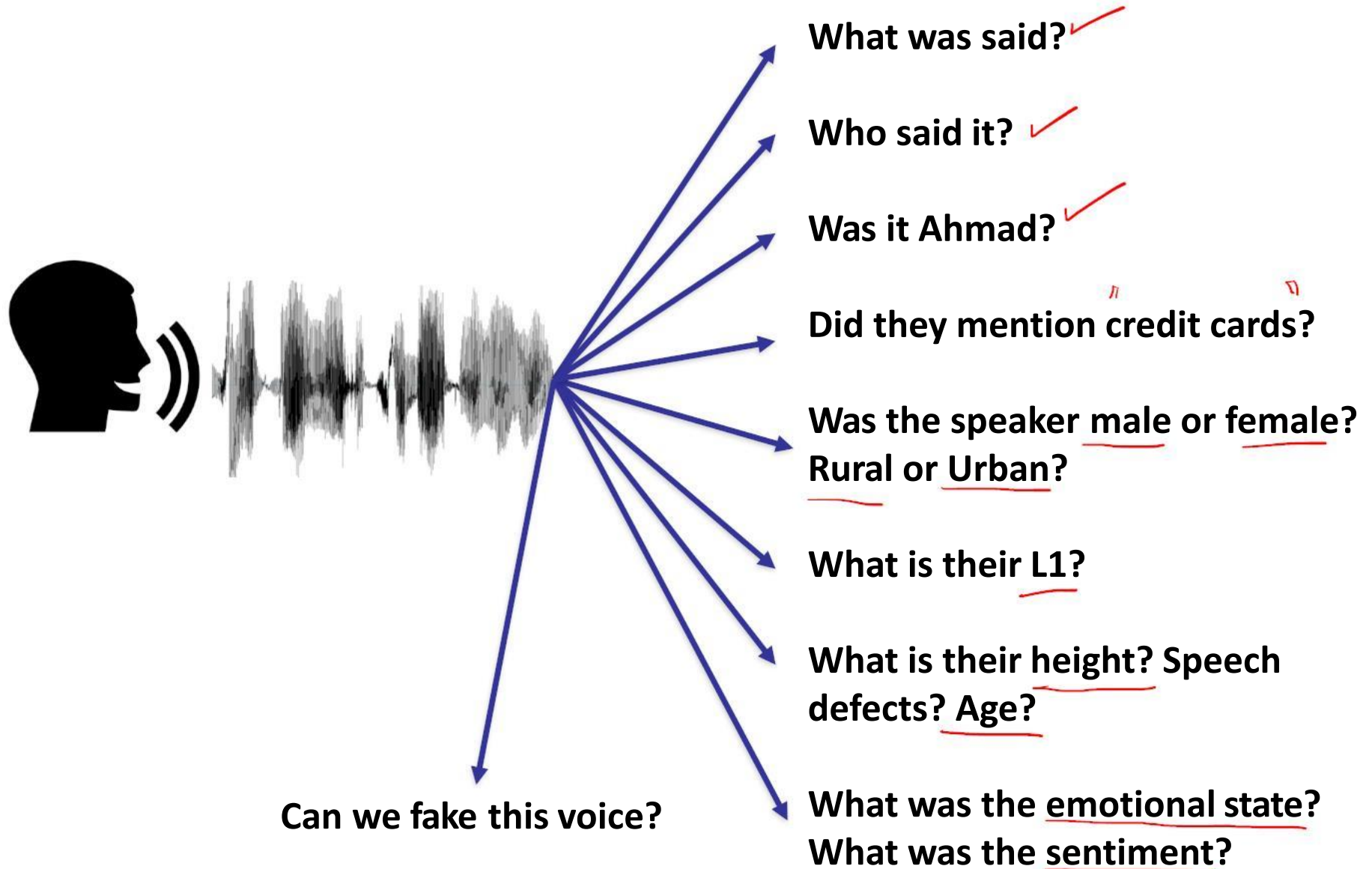


### Tagging

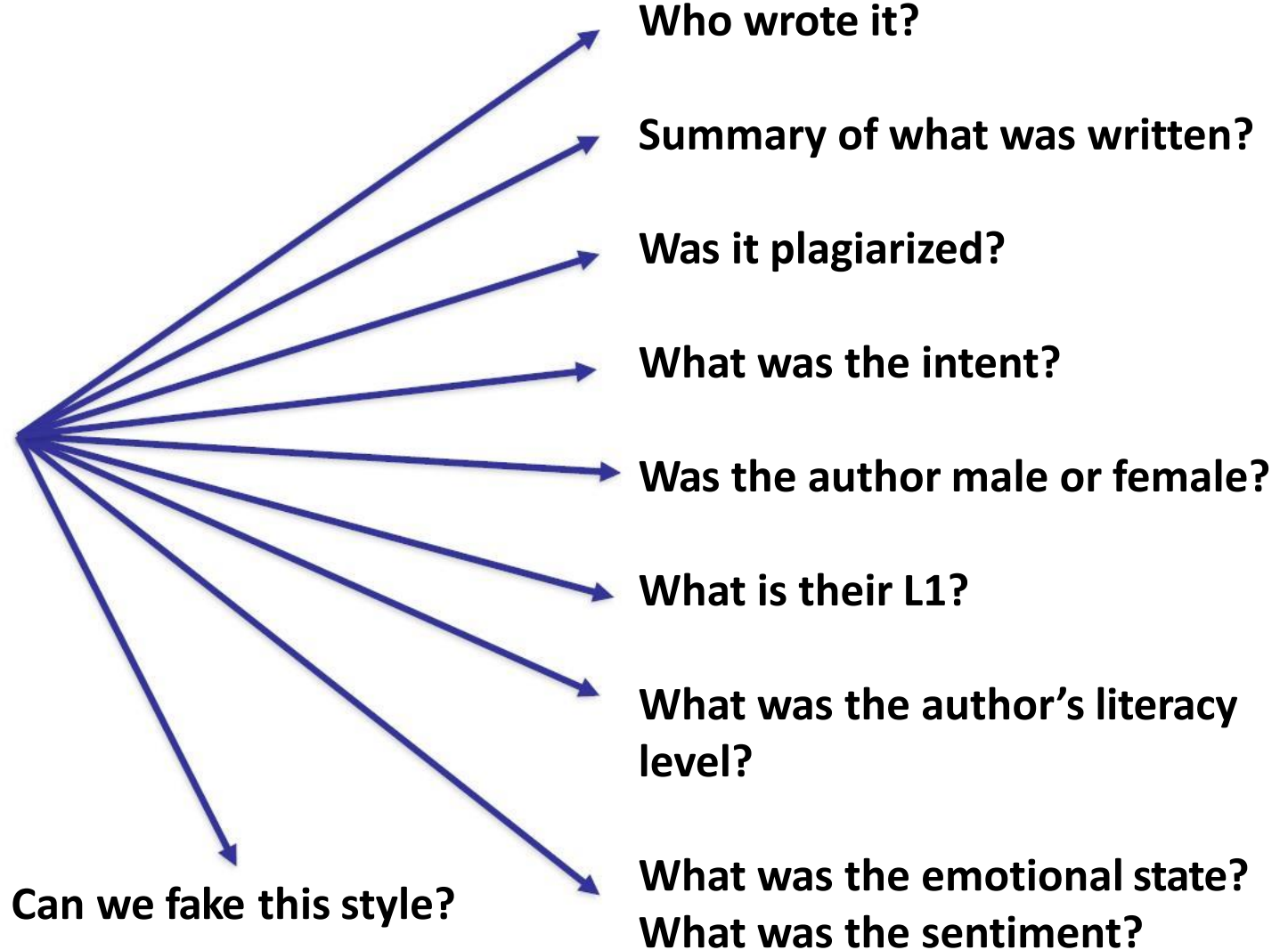




# Speech Technologies



# Text Technologies



# Challenges of ML – Explainability

- A classifier can potentially learn to classify on the basis of features not desirable for humans
  - All dogs wearing a collar in the training data while no cat is wearing it – ML just learns to separate based on collar
  - All horse images have a copyrights notice – ML just learns to recognize horses based on the copyrights notice

**Explainable ML:** The results should be understandable by humans

- As opposed to a black-box system

# Challenges – Fairness in AI

- AI tends to reflect the biases of the society
  - Human taggers who mark a recording as misinformation based on accent or gender
  - Court decisions in country that make a rich person's acquittal more likely
  - Automated standardized testing in the US could yield unfavorable results for certain demographic groups
  - AI plays a deciding role in hiring decisions, with up to 72% of resumes in the US never being viewed by a human
  - Decisions on immigration, bank loans, credit history checks, criminal profiling



# Machine Learning in Low-resource settings

- Problems where large data sets and tools are not available
- Natural Language Processing and Speech problems for languages of developing regions
  - Pakistan has 71 languages
  - We barely have speech recognition capabilities for Urdu

**Why is this important?**

# The Internet

- The internet has transformed the way people participate in the information ecology and digital economy
  - Social media, online discussion forums, crowdsourcing marketplaces
- The Internet empowers people who enjoy access to it
  - Mostly urban, affluent and literate

**So, who is left out?**

# The Offline Ones

- **3.6 billion people worldwide are offline**
  - That is 46.4% of the world population
  - 13.4% of the developed world, **53%** of the developing world and **80.9%** of the Least Developed Countries are offline\*
- **Offline populations**
  - too poor to afford Internet-enabled devices
  - too remote to access the Internet
  - too low-literate to navigate the mostly-text-driven Internet

**References:** McKinsey (2014), WHO, World Bank, Ethnologue, The World Fact book – CIA, GSMA Mobile Economy, weforum.org

\*International Telecommunication Union (ITU). <https://itu.ileon.com/itu/measuring-digital-development/offline-population/> (accessed: Jun 2020)

# Oral and Offline

- **3.6 billion people worldwide are offline**
  - 13.7% of the world population comprises non-literate adults
    - Two-thirds are women
    - More men than women use the Internet. The gap is smaller in developed countries and larger in developing countries, and LDCs.
  - 285 million visually impaired individuals
    - 90% live in low-income settings
  - Not counting: Low-literates, oral cultures, native speakers of unwritten languages (46% of all languages)
- Internet penetration is less than 38% in Pakistan

**References:** McKinsey (2014), WHO, World Bank, Ethnologue, The World Fact book – CIA, GSMA Mobile Economy,  
<https://itu.foleon.com/itu/measuring-digital-development/gender-gap/>  
<https://www.pta.gov.pk/en/telecom-indicators>

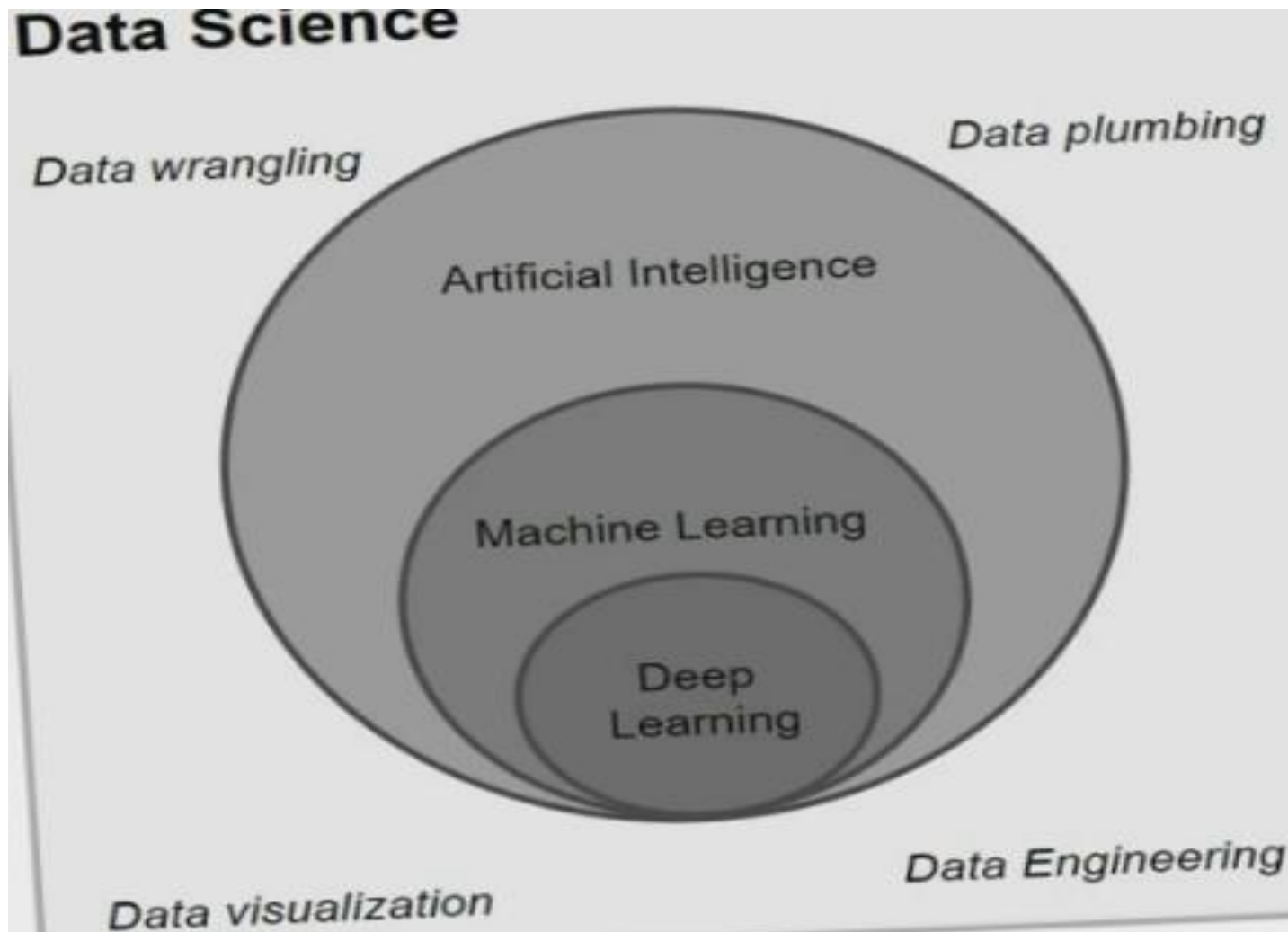




# Lack of access to Information and Connectivity can be a major impediment to Development



# Demystifying DS, AI, ML and DL



## **Artificial Intelligence**

A branch of computer science that deals with providing intelligence to machines artificially; and hence the name. They could be simple rule based systems, knowledge driven databases etc.

## **Machine Learning**

A subfield within AI that deals with making machines intelligent without explicit programming. It is in fact the most successful branch of AI

## **Deep Learning**

A subfield of machine learning that deals with making machine intelligent and are concerned with algorithms inspired by the structure and function of the brain called artificial neural networks.

## **Data Science**

It deals with the entire journey of extracting, cleaning, transforming, visualizing, mining and developing AI/ML products from data.

# Tools for Machine Learning

MatLab

Octave

R

Torch

Python

- Pandas

- Numpy

- Theano

- keras

- Scikit Learn (Academia purpose, not concurrency sport)

- Tensorflow (google product)

- Mahout-Hadoop

- SPARK

- Caffe (Deep Learning, specific)



# Gurus

Geoffrey hinton

Founder of modern machine learning.

Yaan Lecun

Head of Facebook Resarch Lab, Post doc with

Nando De Freitas

Currently in oxford, students are on popular places

Russell Salakhutdinov

student of Geoffery Hinton, Game Changer(Deep Learning)

Andrew NG

# Notation

Variable

Random Variable

Vector