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Outline: What students are expected to Learn

1. What is AI

2. Background of AI on PC

3. Machine Learning

4. Deep Learning

5. Summary
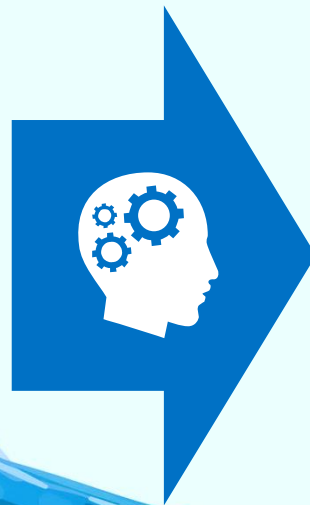
THE DELUGE OF DATA

DAILY BY 2020

AVERAGE INTERNET USER	**1.5 GB**
AUTONOMOUS VEHICLE	**4 TB**
CONNECTED AIRPLANE	**5 TB**
SMART FACTORY	**1 PB**
CLOUD VIDEO PROVIDER	**750 PB**

BUSINESS INSIGHTS

OPERATIONAL INSIGHTS

SECURITY INSIGHTS

Source: Amalgamation of analyst data and Intel analysis.

AI WILL TRANSFORM

CONSUMER	HEALTH	FINANCE	RETAIL	GOVERNMENT	ENERGY	TRANSPORT	INDUSTRIAL	OTHER
Smart Assistants	Enhanced Diagnostics	Algorithmic Trading	Support	Defense	Oil & Gas Exploration	In-Vehicle Experience	Factory Automation	Advertising
Chatbots	Drug Discovery	Fraud Detection	Experience	Data Insights	Smart Grid	Automated Driving	Predictive Maintenance	Education
Search	Patient Care	Research	Marketing	Safety & Security	Operational Improvement	Aerospace	Precision Agriculture	Gaming
Personalization	Research	Personal Finance	Merchandising	Resident Engagement	Conservation	Shipping	Field Automation	Professional & IT Services
Augmented Reality	Sensory Aids	Risk Mitigation	Loyalty	Smarter Cities		Search & Rescue		Telco/Media
Robots			Supply Chain					Sports
			Security					

Source: Intel forecast

THE PATH TO DEEPER INSIGHT

Advanced Analytics

Operational Analytics

Descriptive Analytics

Hindsight
What Happened?

Diagnostic Analytics

Insight
What Happened and Why?

Predictive Analytics

Foresight
What Will Happen, When, and Why

Prescriptive Analytics

Forecast
How Should I Proceed?

Cognitive Analytics

Self-Learning
How Do I Proceed?

AI
IS THE DRIVING FORCE
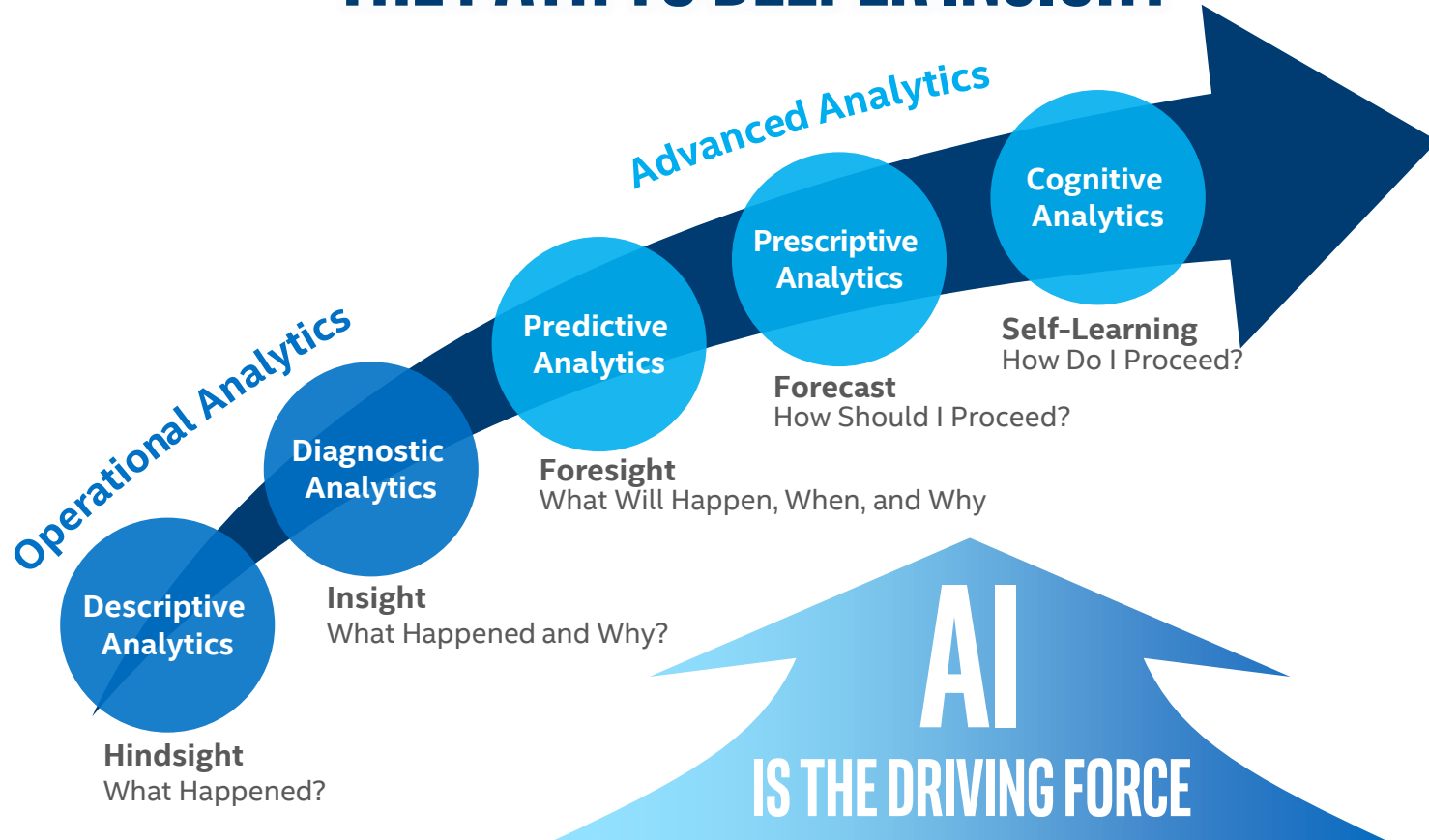
AI ADOPTION IS NASCENT

According to a recent Gartner survey...

46%

of Chief Information Officers (CIOs) have developed plans to implement AI, but **only**

4%

have implemented AI so far.

THE AI LIFECYCLE

1. Define the Challenge

7. Organization
Organization embraces data insights, sponsors properly resourced teams, and prioritizes analytic development work

2. Approach
Team breaks down the defined business problem into workable steps to translate the right data to achieve results

6. Infrastructure
Organization secures hardware and software infrastructure that supports data processing in a timely manner

3. Expertise
A team of management sponsors, data scientists, data engineers, solution architects, and domain experts identifies the right data and works to translate the data to achieve results

5. Source Data
Team understands and obtains the right data that explains the business problem to achieve results

4. Philosophy
Team embraces fail-fast continuous improvement practices to evaluate their success in translating data to achieve results
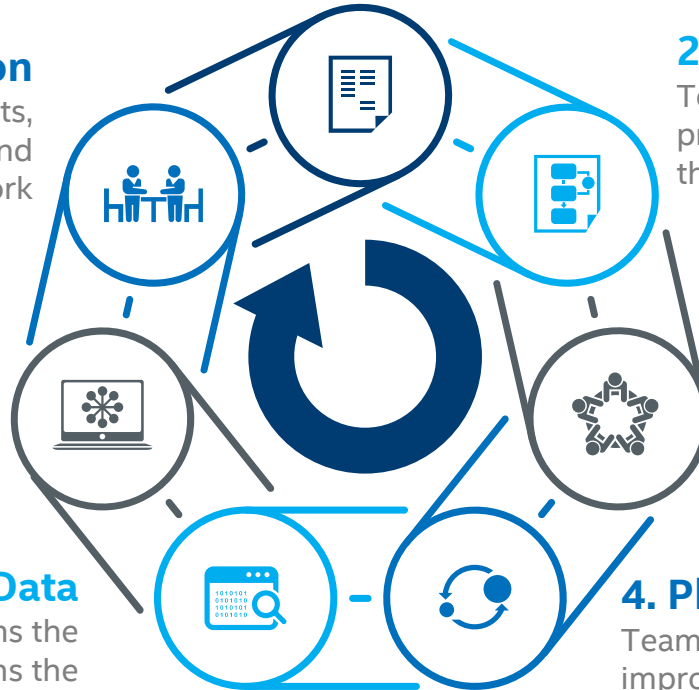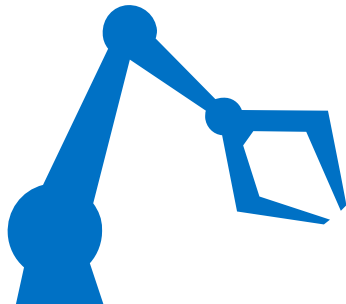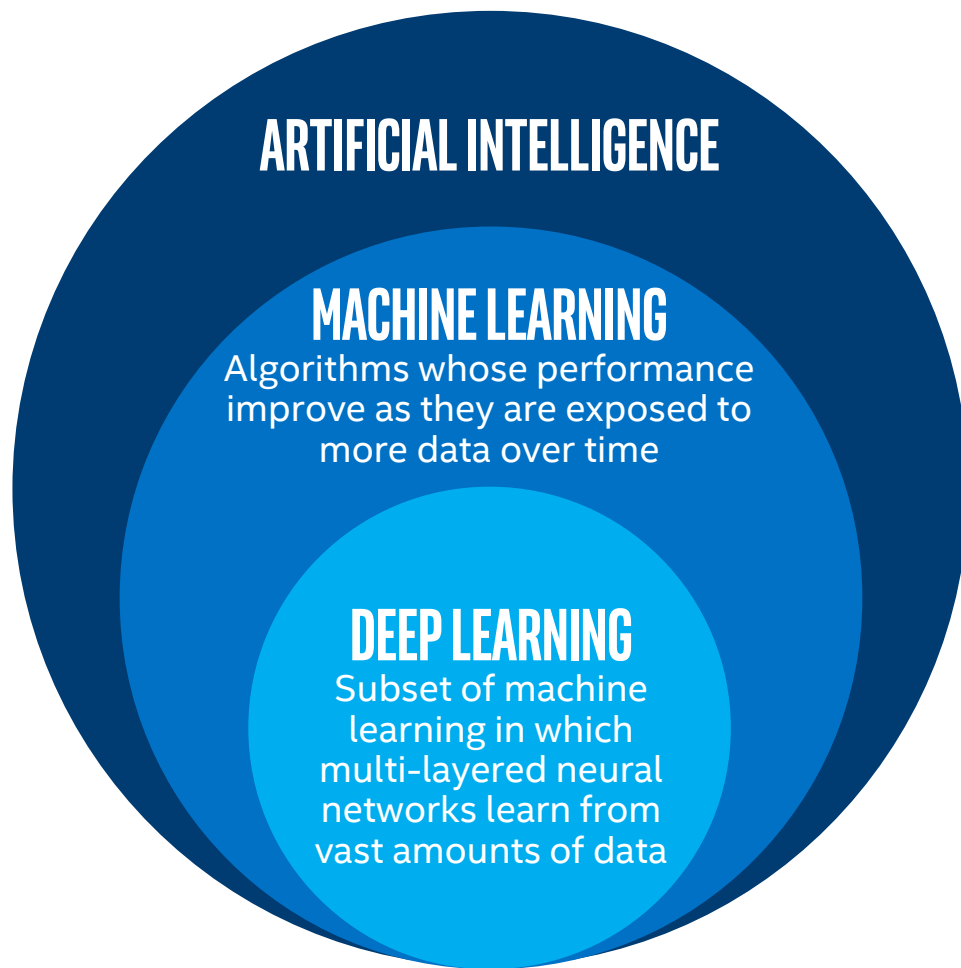
WHICH APPROACH IS RIGHT?

A large **manufacturer** uses data to improve their operations, with each challenge using a different approach to deliver maximum business value at the lowest possible cost

CHALLENGE	BEST APPROACH	APPROACH	ANSWER
How many widgets should we manufacture?	Analyze historical supply/demand	Analytics/ Business Intelligence	10,000
What will our yield be?	Algorithm that correlates many variables to yield	Statistical/ Machine Learning	At current conditions, yield will be at 90% with 10% loss expected
Which widgets have visual defects?	Algorithm that learns to identify defects in images	Deep Learning	Widget 1003, Widget 1094 . . .

LEARN MORE IN THE NEXT SLIDES

ARTIFICIAL INTELLIGENCE

is the ability of machines to learn from experience, without explicit programming, in order to perform cognitive functions associated with the human mind

ARTIFICIAL INTELLIGENCE

MACHINE LEARNING
Algorithms whose performance improve as they are exposed to more data over time

DEEP LEARNING
Subset of machine learning in which multi-layered neural networks learn from vast amounts of data

Artificial Intelligence

- "A branch of computer science dealing with the simulation of intelligent behavior in computers." (Merriam-Webster)

- "A program that can sense, reason, act, and adapt." (Intel)

- "Colloquially, the term 'artificial intelligence' is applied when a machine mimics 'cognitive' functions that humans associate with other human minds, such as 'learning' and 'problem solving'." (Wikipedia)

Background of AI on PC

- AI has increased significantly in the last 5 years with the availability of large data sources, growth in compute engines and modern algorithms development. AI on PC is propelling new technologies into all parts of modern life. Central to this story is that the PCs are now well capable of applying AI technologies to varied usages from computer vision to identification, classification to natural language processing.

- As a data scientist Andrew Ng noted, AI is the next electricity:

   "Just as electricity transformed almost everything 100 years ago, today I actually have a hard time thinking of an industry that I don't think AI will transform in the next several years."

- While AI usage in the cloud continues to grow, there is an inclination to perform AI inference on the PCs driven by the need for lower latency, persistent availability, lower costs and addressing privacy concerns. We are moving to the day that devices from phones to PCs and embedded edge devices all will have AI embedded in them.
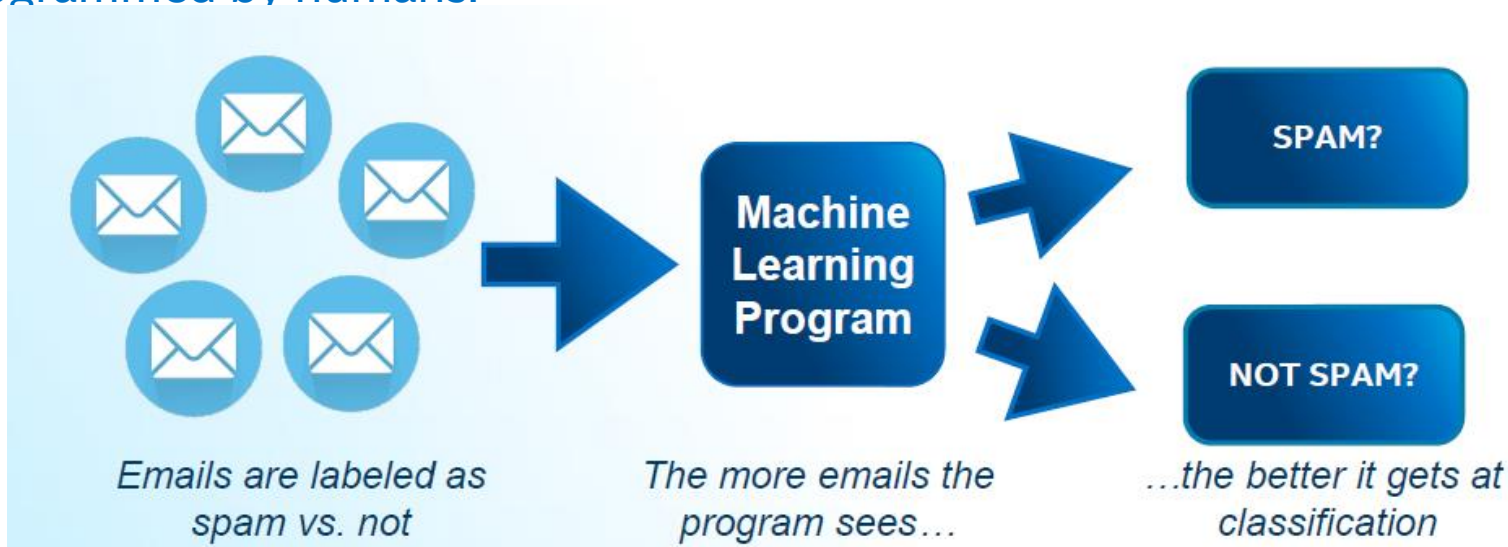
Machine Learning

"The study and construction of programs that are *not explicitly programmed*, but learn patterns as they are exposed to more data over time." (Intel)

ARTIFICIAL INTELLIGENCE
A program that can sense, reason, act, and adapt

MACHINE LEARNING
Algorithms whose performance improve as they are exposed to more data over time
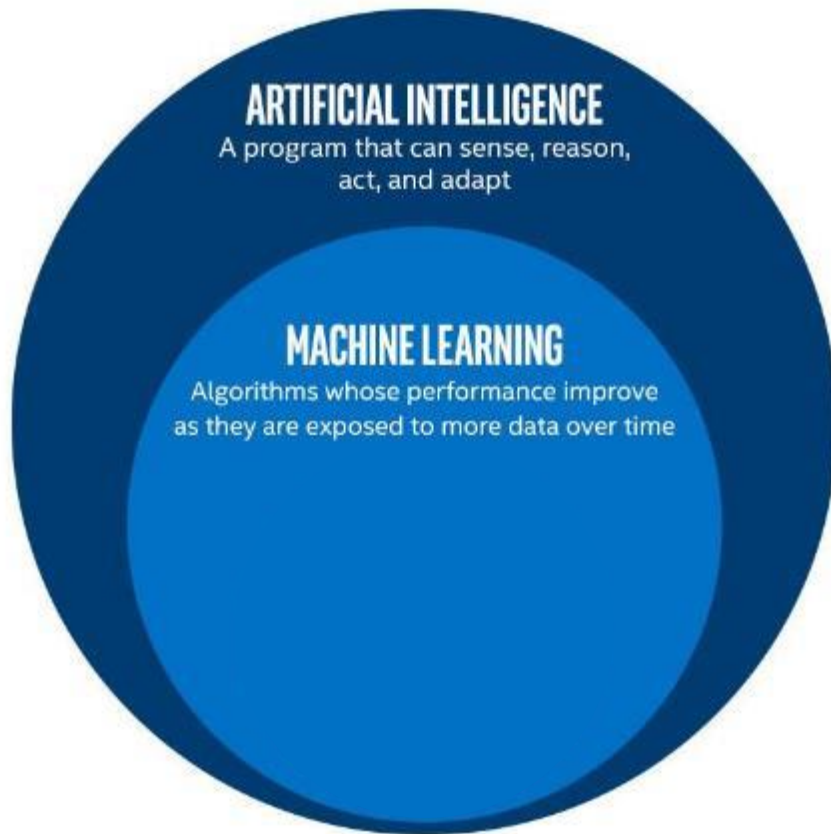
Machine Learning

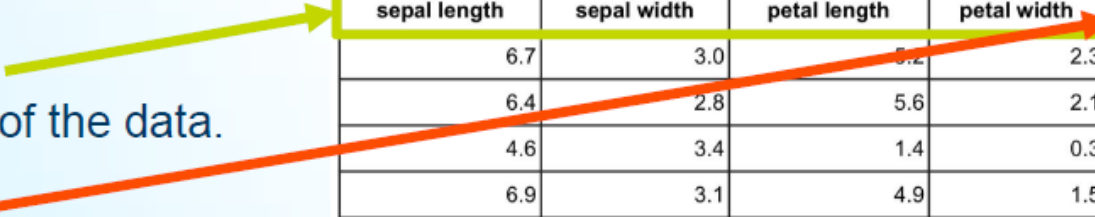These programs learn from repeatedly seeing data, rather than being explicitly programmed by humans.

Emails are labeled as spam vs. not

The more emails the program sees…

…the better it gets at classification

Machine Learning Terminology

This example is learning to classify a species from a set of measurement features.

Features:
Attributes of the data.

Target:
Column to be predicted.

sepal length	sepal width	petal length	petal width	species
6.7	3.0	5.2	2.3	virginica
6.4	2.8	5.6	2.1	virginica
4.6	3.4	1.4	0.3	setosa
6.9	3.1	4.9	1.5	versicolor
4.4	2.9	1.4	0.2	setosa
4.8	3.0	1.4	0.1	setosa
5.9	3.0	5.1	1.8	virginica
5.4	3.9	1.3	0.4	setosa
4.9	3.0	1.4	0.2	setosa
5.4	3.4	1.7	0.2	setosa

Two Main Types of Machine Learning

	Dataset	Goal	Example
Supervised Learning	**Has a target column**	**Make predictions**	**Fraud detection**
Unsupervised Learning	**Does not have a target column**	**Find structure in the data**	**Customer segmentation**

Machine Learning Example – fraud detection

- Suppose you wanted to identify fraudulent credit card transactions.

- You could define features to be:

  - Transaction time

  - Transaction amount

  - Transaction location

  - Category of purchase

- The algorithm could learn what feature combinations suggest unusual activity.

Machine Learning Limitations

- Suppose you wanted to determine if an ima   .
a dog.

- What features would you use?

- This is where Deep Learning can come in.

Dog and cat recognition

Deep Learning

"Machine learning that involves using very complicated models called "deep neural networks"." (Intel)

Models determine best representation of original data; in classic machine learning, humans must do this.

ARTIFICIAL INTELLIGENCE
A program that can sense, reason, act, and adapt

MACHINE LEARNING
Algorithms whose performance improve as they are exposed to more data over time

DEEP LEARNING
Subset of machine learning in which multilayered neural networks learn from vast amounts of data
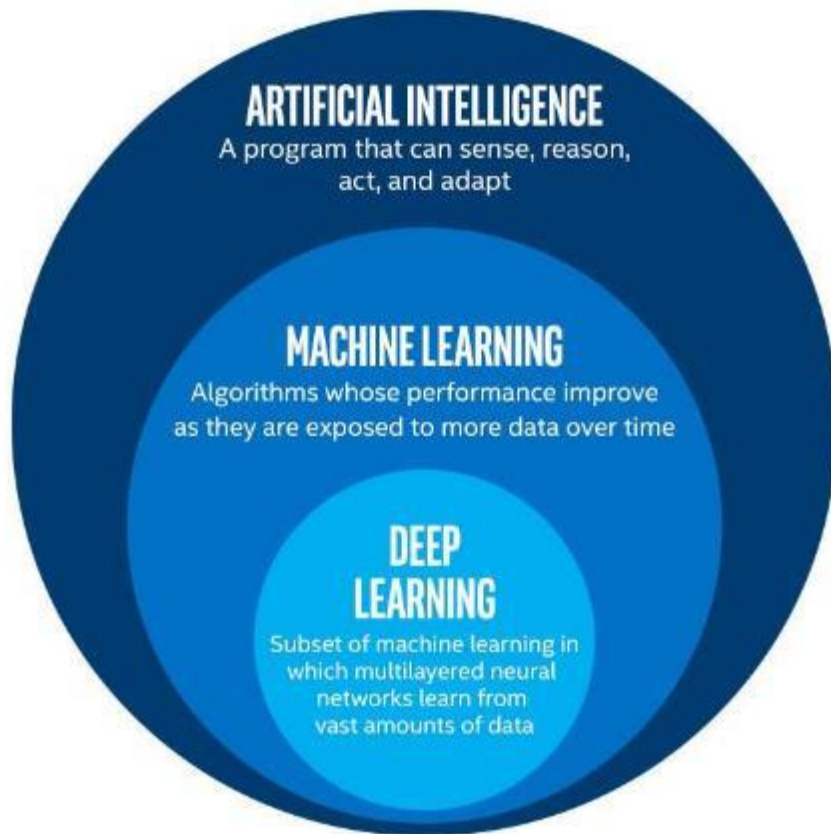
MACHINE VS. DEEP LEARNING

MACHINE LEARNING
How do you engineer the best features?

$N \times N$

$$(f_1, f_2, \ldots, f_K)$$

Roundness of face
Dist between eyes
Nose width
Eye socket depth
Cheek bone structure
Jaw line length
...etc.

CLASSIFIER ALGORITHM

SVM
Random Forest
Naïve Bayes
Decision Trees
Logistic Regression
Ensemble methods

Arjun
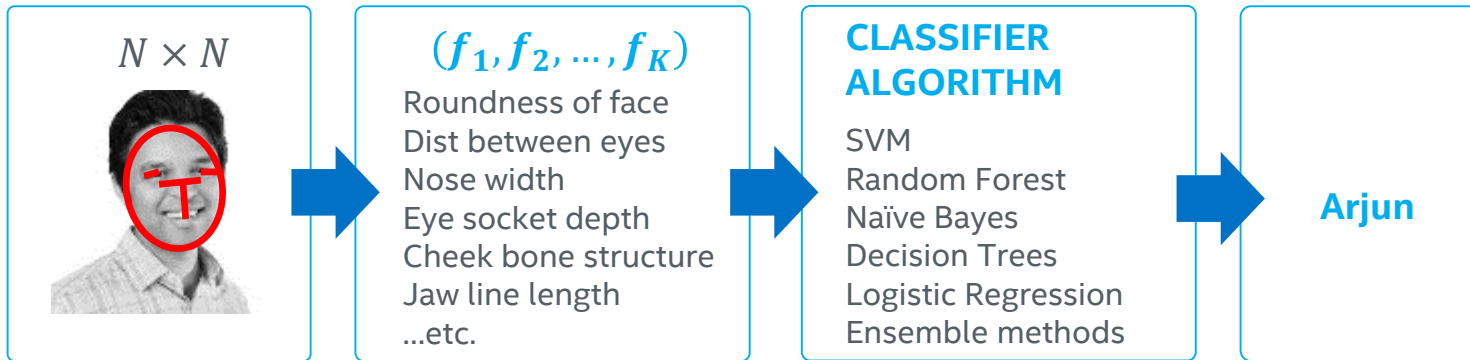
DEEP LEARNING
How do you guide the model to find the best features?
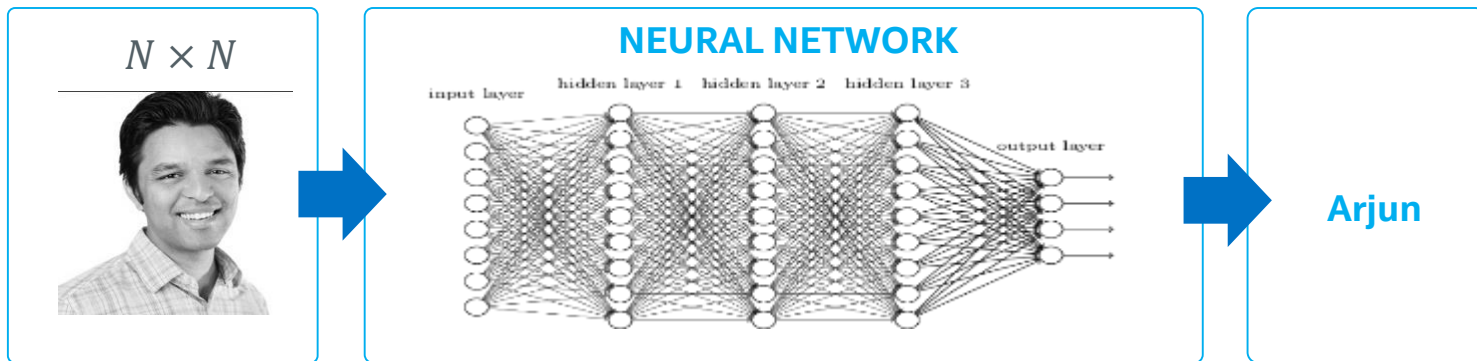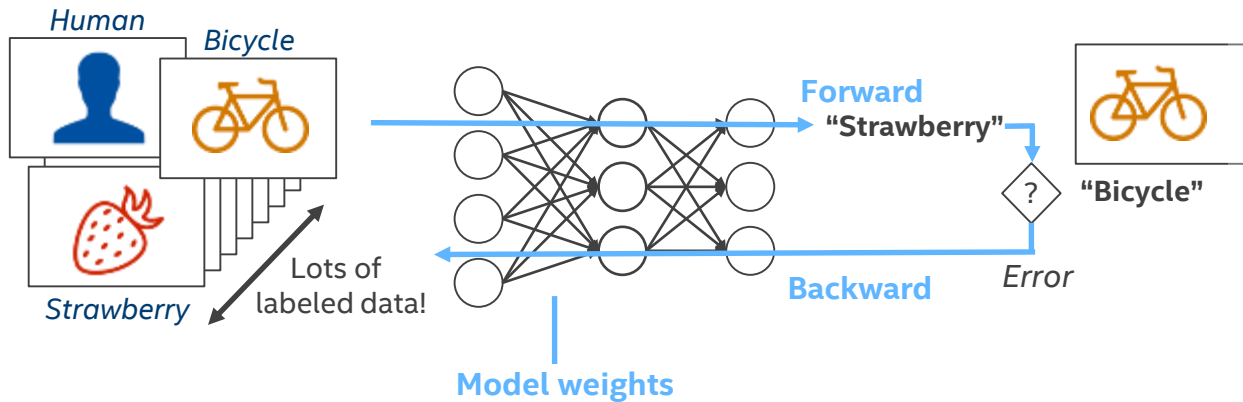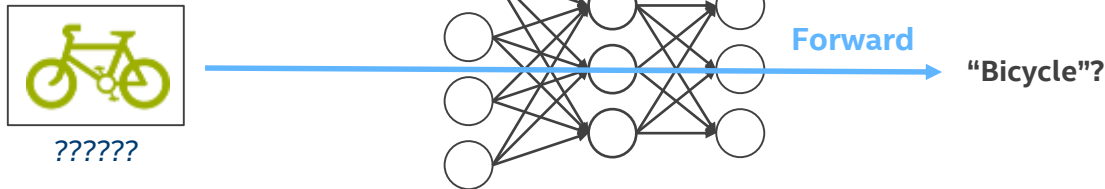
$N \times N$

NEURAL NETWORK

input layer   hidden layer 1   hidden layer 2   hidden layer 3   output layer

Arjun
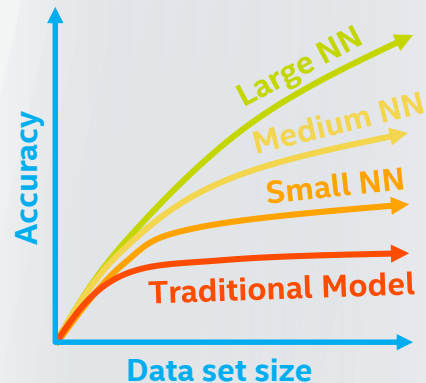
Machines Learn in Two Ways:

Supervised Learning &
Unsupervised Learning

Supervised Learning

We train the model. We feed the model with correct answers. Model Learns and finally predicts.

We feed the model with "ground truth".

Unsupervised Learning

Data is given to the model. Right answers are not provided to the model. The model makes sense of the data given to it.

Can teach you something you were probably not aware of in the given dataset.

Types of Supervised and Unsupervised learning

SUPERVISED

UNSUPERVISED

CLASSIFICATION

REGRESSION

CLUSTERING

RECOMMENDATION

EXAMPLES OF SUPERVISED LEARNING - CLASSIFICATION

Predict a **label** for an entity with a given set of features.

PREDICTION
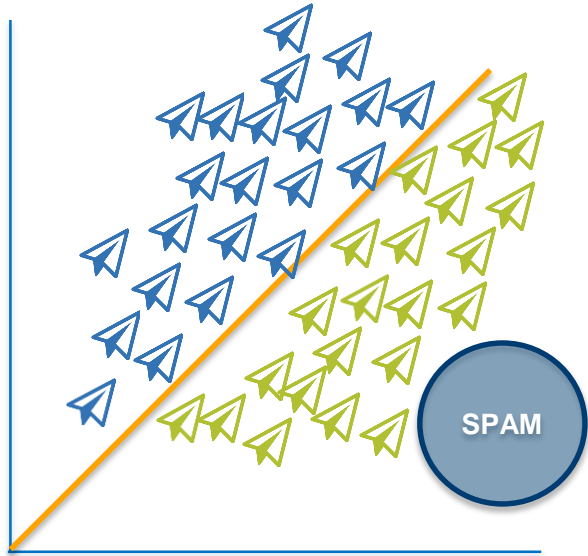
SENTIMENT ANALYSIS
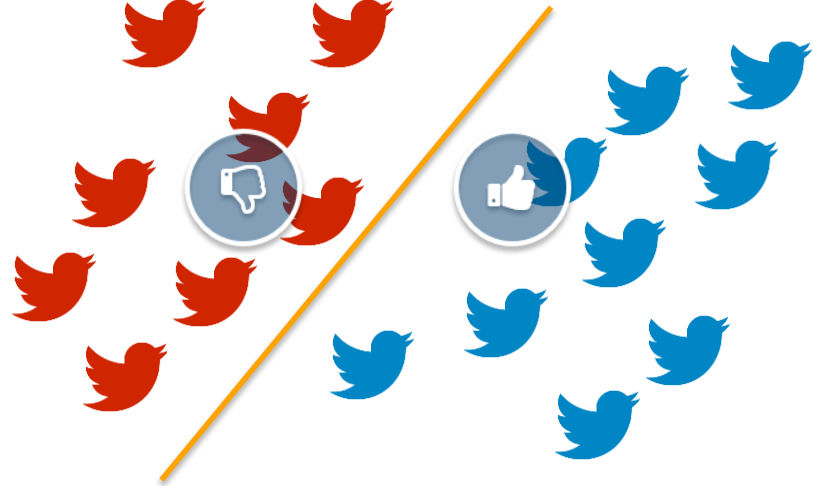
Supervised Learning Overview

Training: Train a model with known data.

Data with answers (features and labels) + Model → **Fit** → Trained Model

Inference: Feed unseen data into trained model to make predictions.

Data without answers (features only) + Trained Model → **Predict** → Predicted Answer

Which Model?

Some considerations when choosing are:

- Time needed for training

- Speed in making predictions

- Amount of data needed

- Type of data

- Problem complexity

- Ability to solve a complex problem

- Tendency to overcomplicate a simple one

Evaluation Metric

Accuracy target

There are many metrics available* to measure performance, such as:

- **Accuracy**: how well predictions match true values.

- **Mean Squared Error**: average square distance between prediction and true value.

$$\min_{\beta_0, \beta_1} \frac{1}{m} \sum_{i=1}^{m} \left(\left(\beta_0 + \beta_1 x_{obs}^{(i)} \right) - y_{obs}^{(i)} \right)^2$$
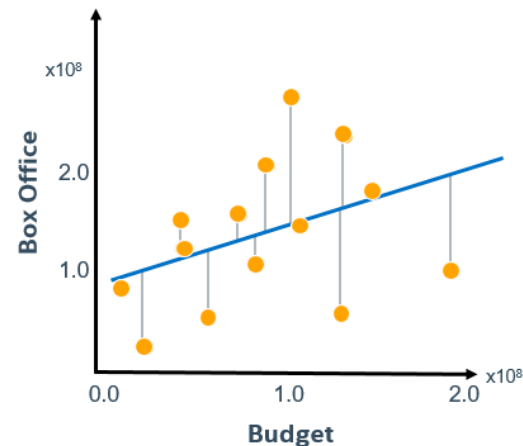
The wrong metric can be misleading or not capture the real problem.

EXAMPLE OF UNSUPERVISED LEARNING - CLUSTERING

Group entities with similar features

MARKET SEGMENTATION
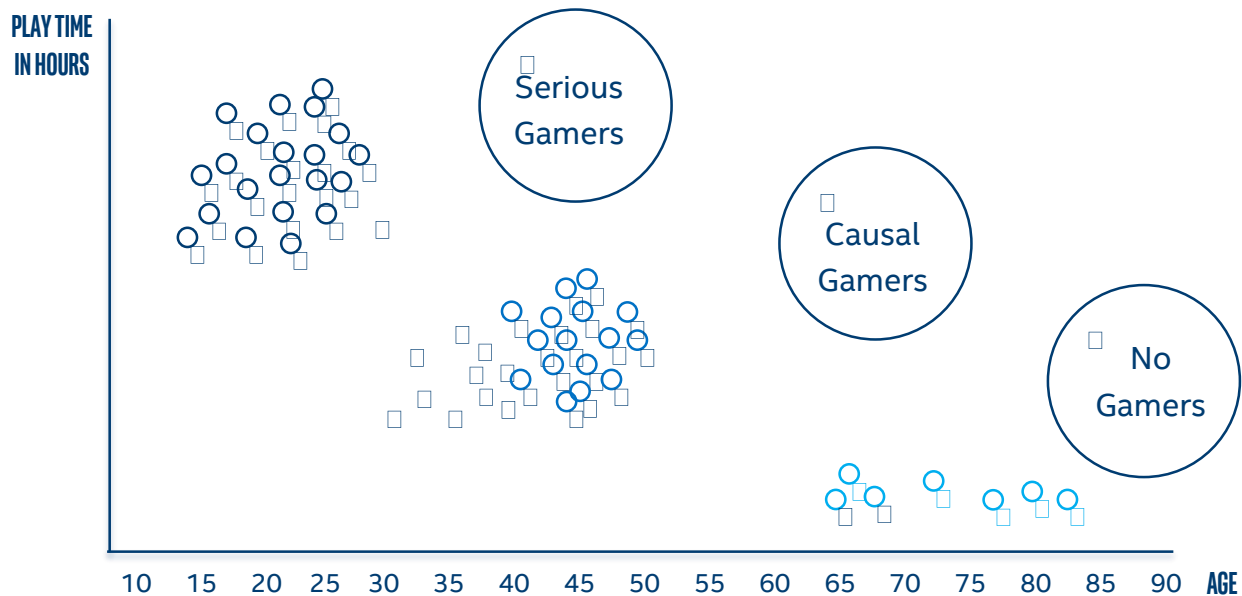
PLAY TIME IN HOURS

Serious Gamers

Causal Gamers

No Gamers

10   15   20   25   30   35   40   45   50   55   60   65   70   75   80   85   90   AGE
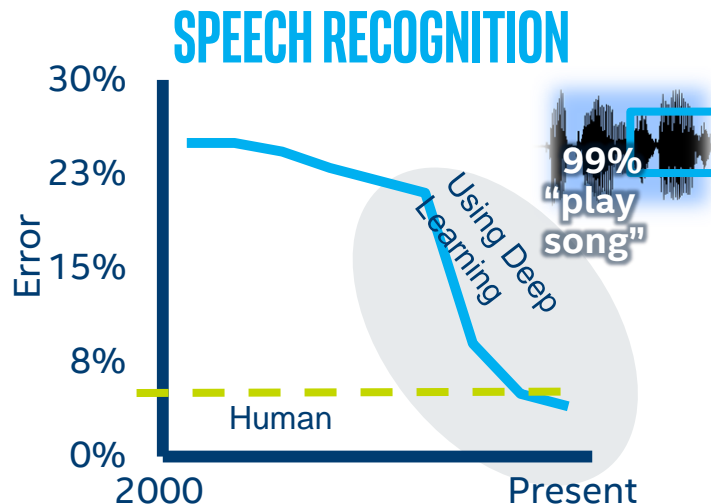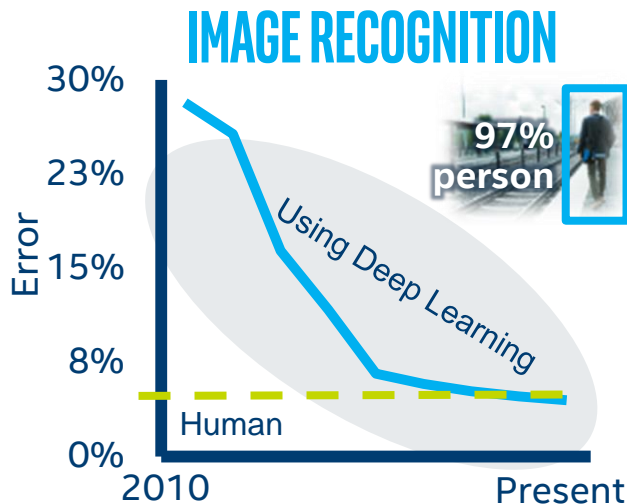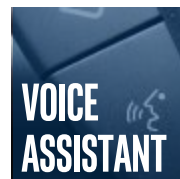
Classification and Detection

Detect and label the image
- Person
- Motor Bike
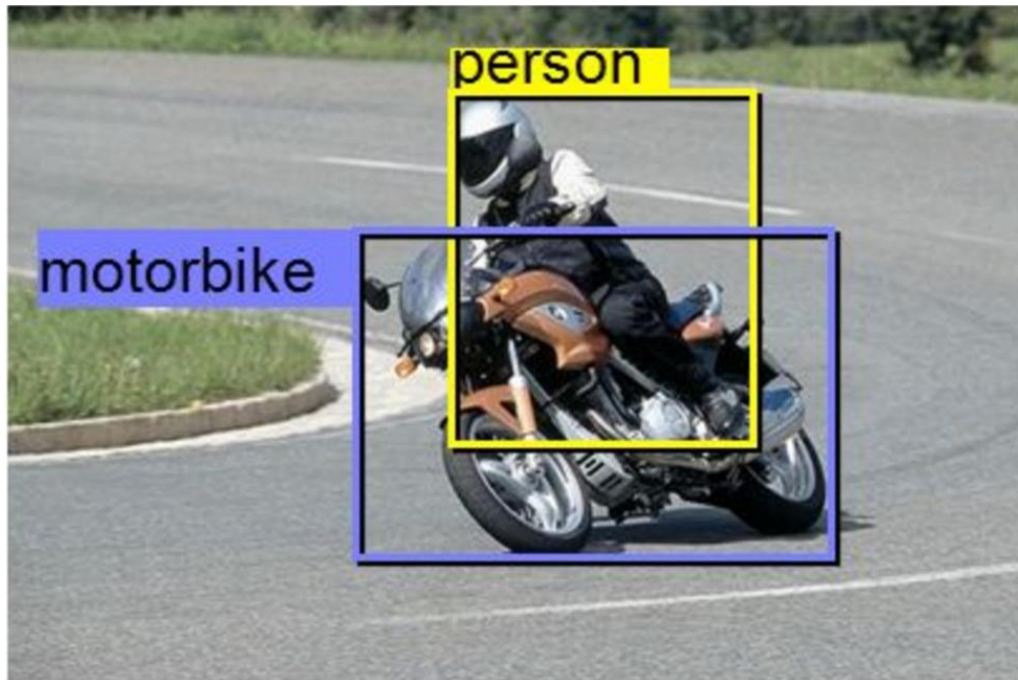
Semantic Segmentation

Label every pixel

https://people.eecs.berkeley.edu/~jhoffman/talks/lsda-baylearn2014.pdf

Natural Language Object Retrieval

a scene with three people   query='*man far right*'   query='*left guy*'   query='*cyclist*'
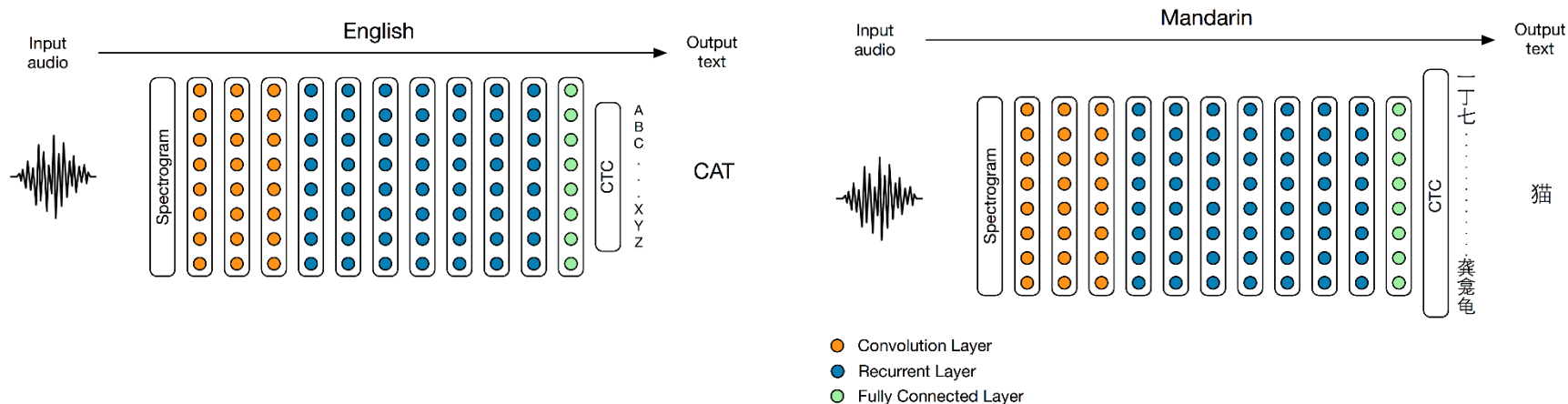
http://arxiv.org/pdf/1511.04164v3.pdf

Speech Recognition and Language Translation

The same architecture is used for English and Mandarin Chinese speech recognition

Fully Connected Network
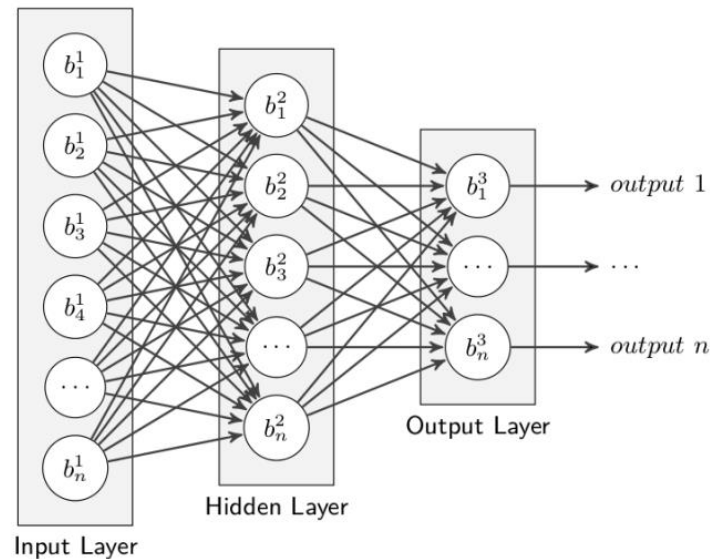
More complicated problems can be solved by connecting multiple neurons together and using more complicated activation functions.

- Organized into layers of neurons.

- Each neuron is connected to every neuron in the previous layer.

- Each layer transforms the output of the previous layer and then passes it on to the next.

- Every connection has a separate weight

Convolutional Neural Network

Convolutional neural networks reduce the required computation and are good for detecting features.

- Each neuron is connected to a small set of nearby neurons in the previous layer

- The same set of weights are used for each neuron

- Ideal for spatial feature recognition, Ex: Image recognition

- Cheaper on resources due to fewer connections

http://svail.github.io/mandarin/
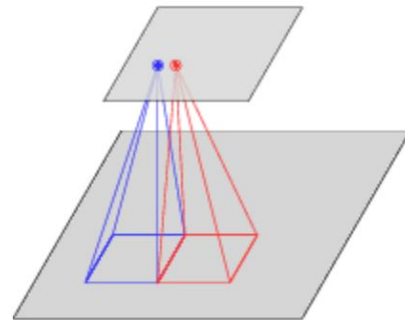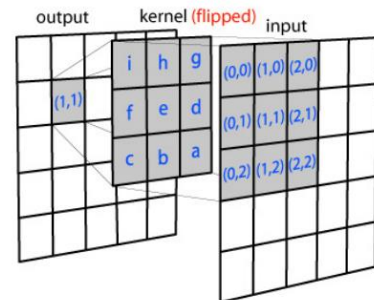
Summary

- AI on PC will impact and transform many segments in society.

- AI on PC capabilities will continue to grow with ever growing increasing amounts of data available for training along with faster computing power, and better algorithms.

- The differences between machine learning and deep learning are:

  - Machine learning requires humans to engineer the features and the algorithms that will learn either in supervised or unsupervised modes.

  - Deep learning where the algorithms represent a variety of connection between computational nodes – the so called neural-networks.

- The differences between training and inference are:

  - Training refers to the process where data is processed by an algorithm to produce a model that is consistent with the features of the given data.

  - Inference refers to the process where a trained model when presented with new data can make predictions.