

Agenda

- 1 What is AI, ML, DL & DS – Terminology Know How
- 2 Machine Learning Overview
- 3 Life Cycle of a Typical ML Model
- 4 AI Adaptability in Semiconductors
- 5 Top Trends in Semiconductors
- 6 Why AI makes sense in Semiconductors
- 7 Semiconductor Ideal Expectations from AI
- 8 AI Technology Verticals to meet The Expectations
- 9 Digital Image Processing – CNN Architecture

What is AI, ML, DL and DS

Artificial Intelligence (AI)

Programs with the ability to learn and reason like humans

Machine Learning (ML)

Algorithms with the ability to learn without being explicitly programmed

Deep Learning (DL)

Subset of ML in which artificial neural networks adopt and learn from vast amount of data

Data Science (DS)

DS is a field of study which combines Statistics and Math.

Programming skills – Python / R
And most importantly Domain expertise to extract meaningful insights from data

Statistics

Domain
Knowledge

Programming
Skills

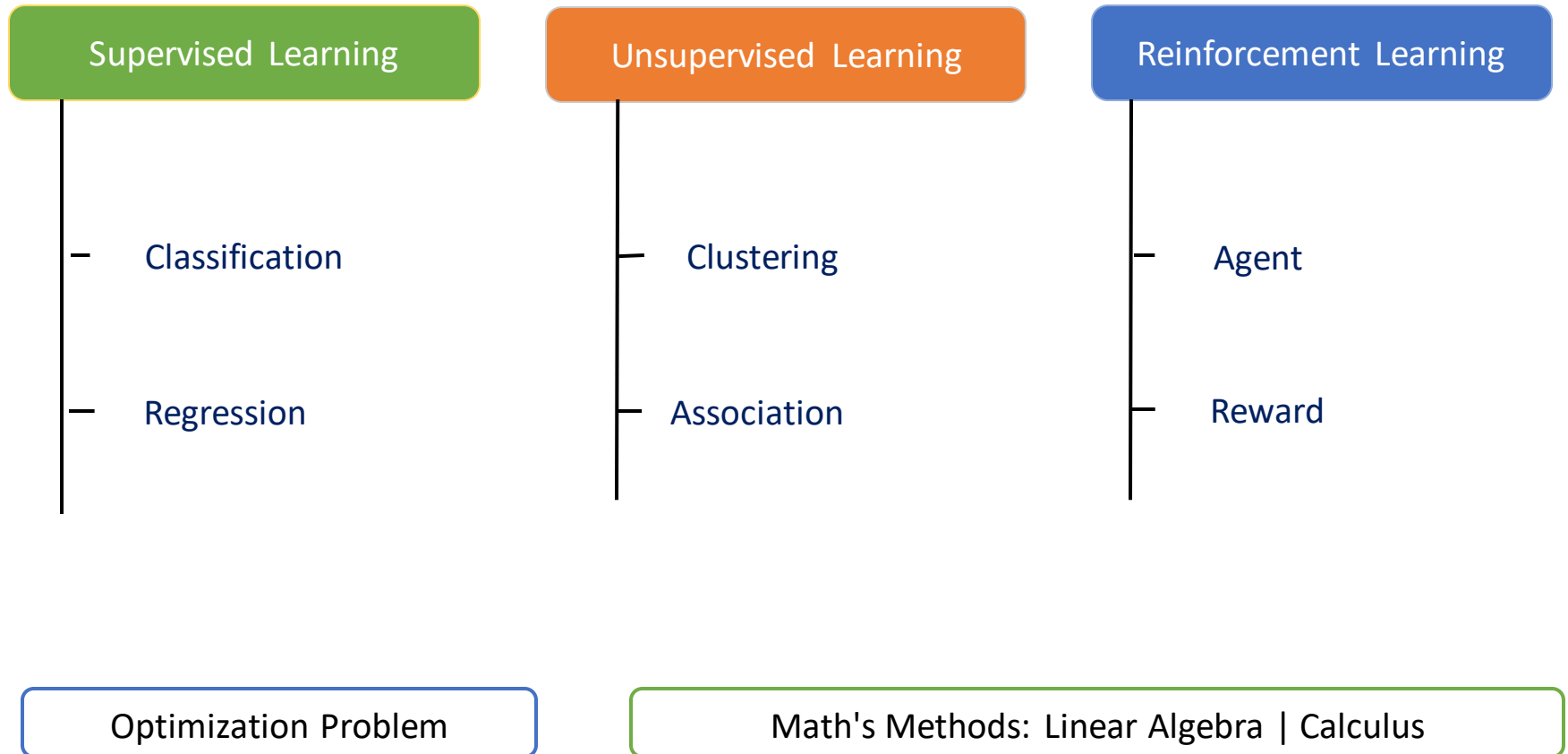
~80%

~80% of World's
Data generated in
last 10 Years

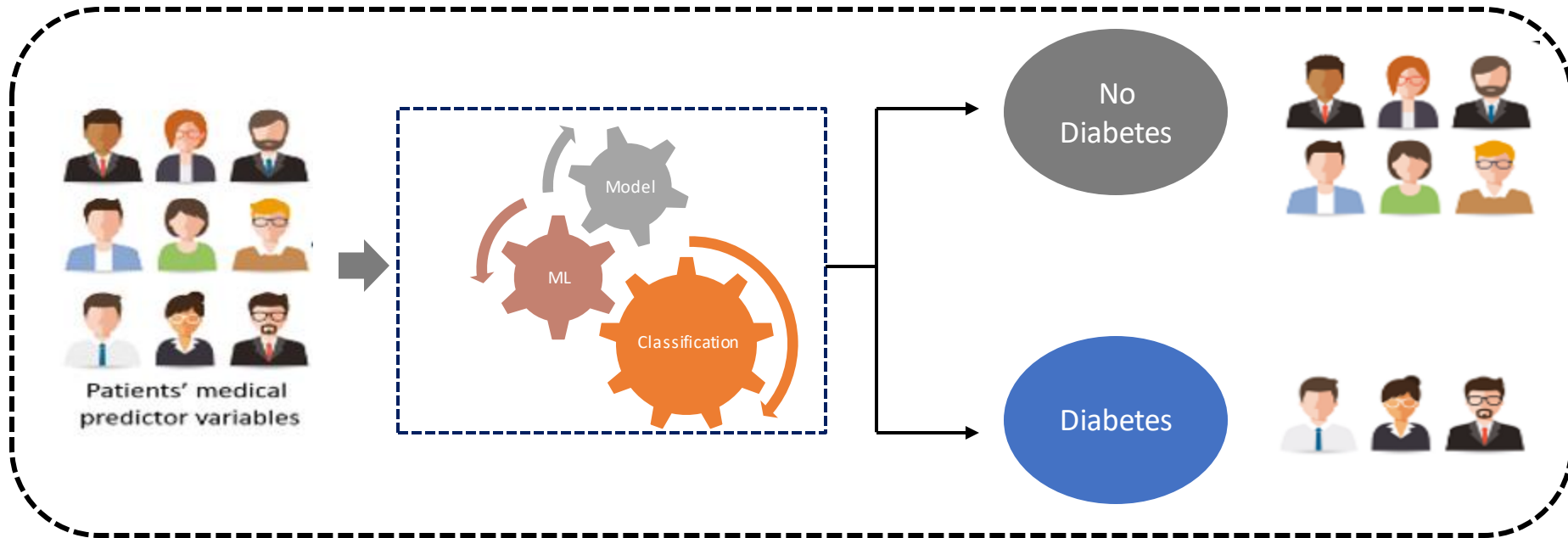
~80% of Resources
improvement in last
10 Years

Data Science
integrates all the
above AI, ML & DL to
extracts insight from
data (EDA) and make
predictions from large
datasets (Predictive
Analysis)

What is AI, ML, DL and DS



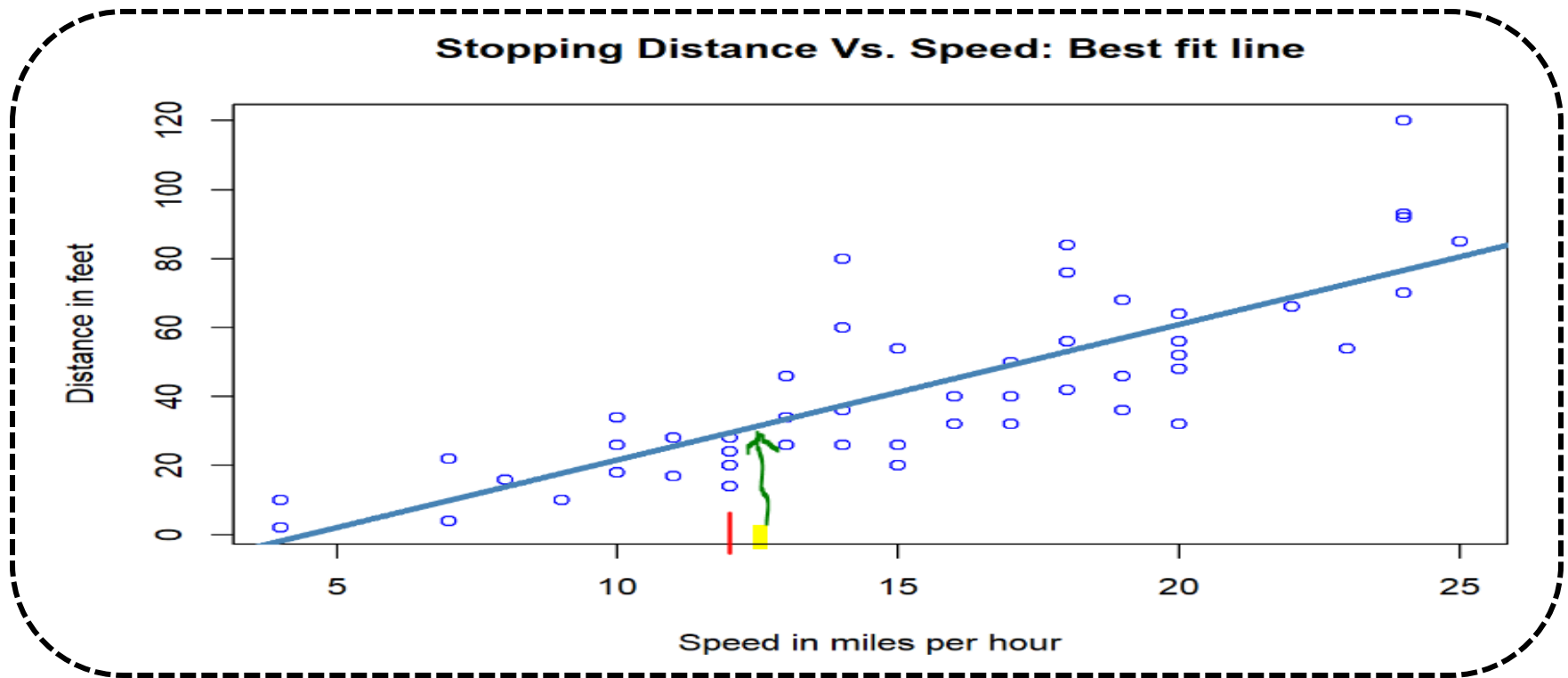
Supervised Learning – Classification



Important Algorithms for Classification

1. Logistic Regression
2. Naïve Bayes' Classifier
3. K-Nearest Neighbors – KNN
4. Decision Tree
5. Ensemble Methods: Bagging & Boosting
6. Random Forest
7. Support Vector Machine
8.

Supervised Learning – Regression



Important Algorithms for Regression

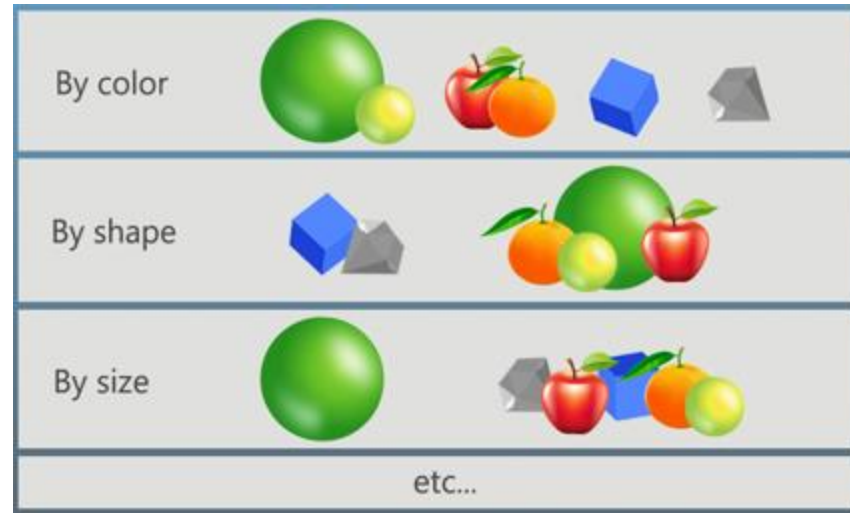
1. Linear Regression
2. Multiple Linear Regression
3. Decision Trees
4. Random Forests
5.

Unsupervised Learning – Clustering

Pre Clustering



Post Clustering



Clustering

- Find elements (rows, tuples) which are similar.
- Finding “areas” in space where data is concentrated
- WYSIWYG : What You Select Is What You Get

Important Algorithms:

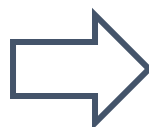
- K-Means
- Fuzzy C-means
- Expectation Maximization
- Hierarchical Clustering
-

Applications

- Recommendation engines
- Market segmentation
- Social network analysis
- Search result grouping
- Image segmentation
- Anomaly detection

Unsupervised Learning – Association

<i>TID</i>	<i>Items</i>
1	Bread, Milk
2	Bread, Diaper, Beer, Eggs
3	Milk, Diaper, Beer, Coke
4	Bread, Milk, Diaper, Beer
5	Bread, Milk, Diaper, Coke



	Beer	Bread	Milk	Diaper	Eggs	Coke
T_1	0	1	1	0	0	0
T_2	1	1	0	1	1	0
T_3	1	0	1	1	0	1
T_4	1	1	1	1	0	0
T_5	0	1	1	1	0	1

What does the value of one feature tell us about the value of another feature?

People who buy diapers are likely to buy baby powder
If (people buy diaper), then (they buy baby powder)

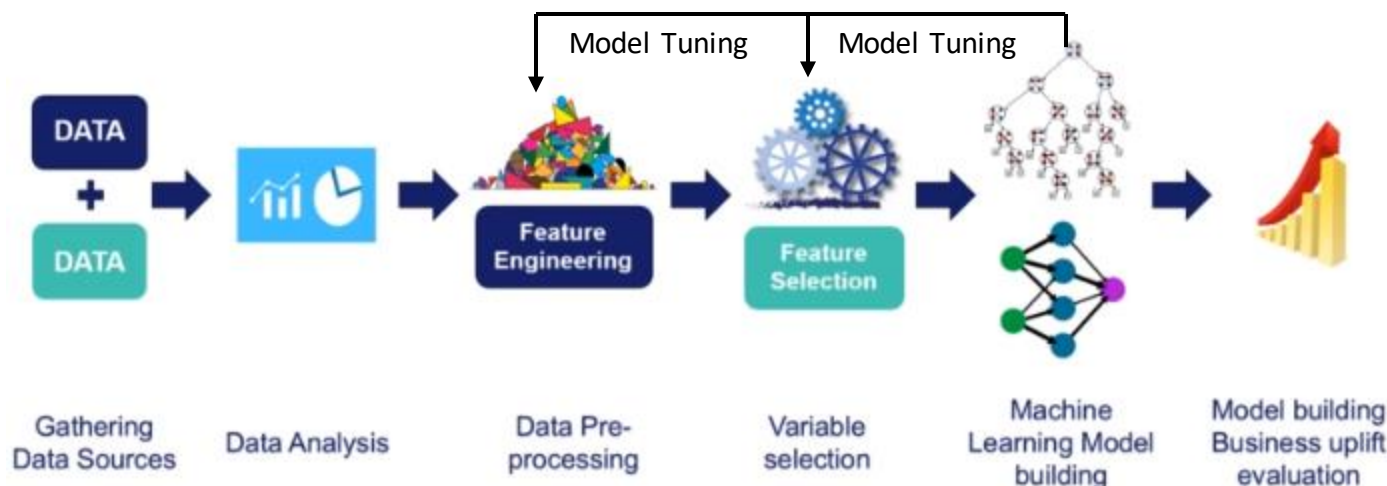
Association rules

- Are statements about relations among features (attributes) : across elements (tuples)
- Use a transaction-item set data model

Association Rules beyond Market Basket Analysis

- People who visit webpage X are likely visit webpage Y.
- Nodes which run a web server are likely to run Linux.
- People who have age-group [30,40] & income [>\$100k] are likely to own home

Machine Learning Model Flow



Gathering Data

- Collecting the data is first and an essential step towards any data science and Machine Learning project.
- It can be from business units or from public datasets for building ML models.

Data Analysis

Answer questions such as:

- what variables are available?
- how are they related?
- what is the characteristics of those variables? (numerical or categorical?)
- missing values? outliers?

Data Pre-processing (Feature Engineering)

Our goal here is to make the data ready for building ML models! To this end, many things can be done but not limited to such as

- Filling missing values in the data
- Dealing with (e.g., removing) outliers
- Transforming categorical values

Variable Selection (Feature Selection)

- Select a subset of features out of all features which is critical to ML model performance.
- Many feature could just be noise so removing them is important for overfitting and complexity reduction etc.

ML Model Building

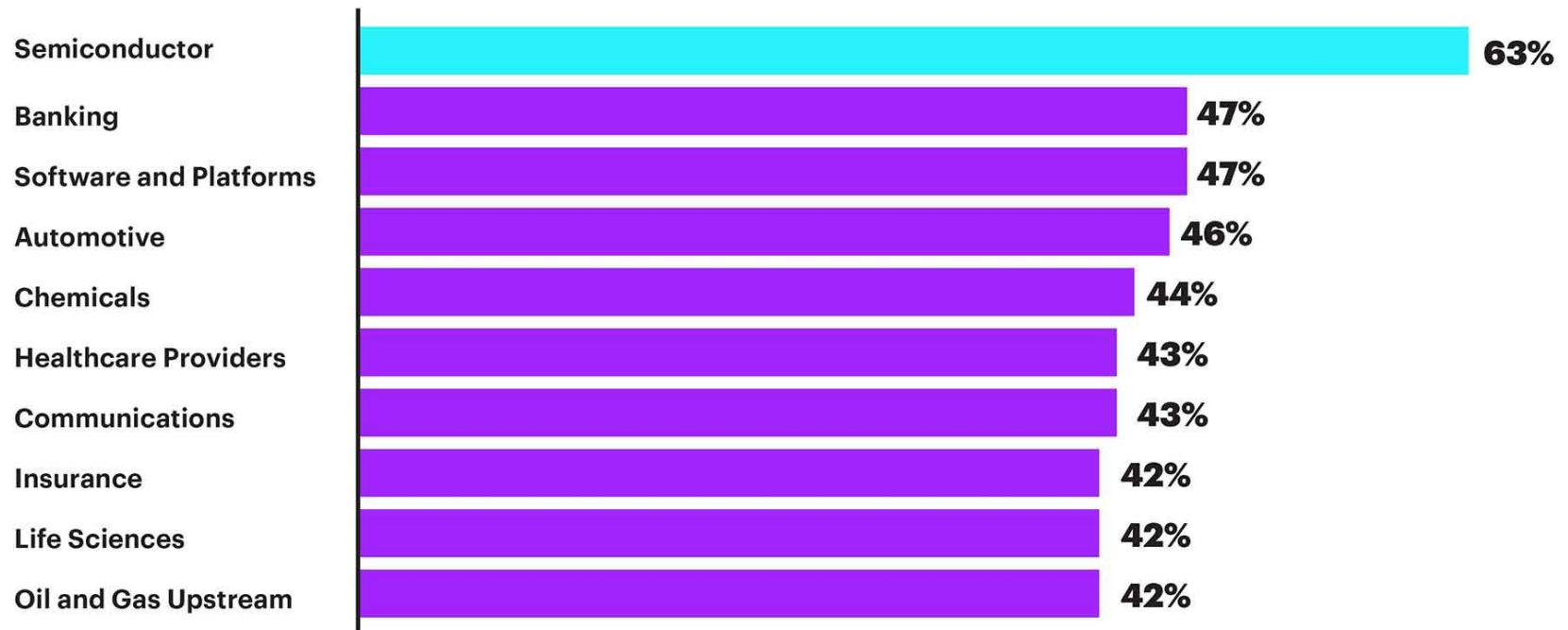
Select the ML Model family for training which suited to best of our need:

- Linear Regression
- Logistic Regression
- KNN
- DT
- RF
- Ensembles
-

AI Adaptability in Semiconductors | Market Research

Two-thirds of semiconductor executives expect AI to have the greatest impact on their business over the next three years

Top 10 Sectors



N=6,672 Business and IT Executives

Source: Accenture Technology Vision 2019

Semiconductor Industry Leads in Artificial Intelligence Adaption, Accenture Report Finds

<https://newsroom.accenture.com/industries/electronics-high-tech/semiconductor-industry-leads-in-artificial-intelligence-adoption-accenture-report-finds.htm>

Market Opinion

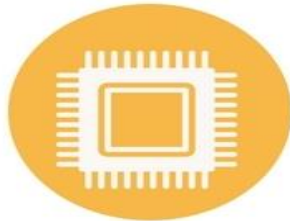
“AI will be a major growth driver for the semiconductor industry in light of high manufacturing costs and the growing complexity of chip development,”

“To capture this opportunity, chipmakers should leverage AI technologies and partnerships to increase efficiency across their operations.”

---Syed Alam, Managing Director at Accenture, leads its Semiconductor practice globally.

Top Trends in Semiconductor Industry

Top Trends in Semiconductor Industry to watch out for this year



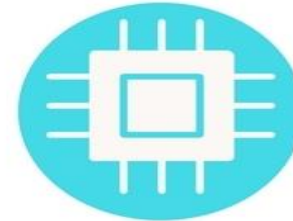
TREND 1

**RISE OF ARTIFICIAL
INTELLIGENCE**



TREND 2

**GOING SMALLER BUT
STRONGER**

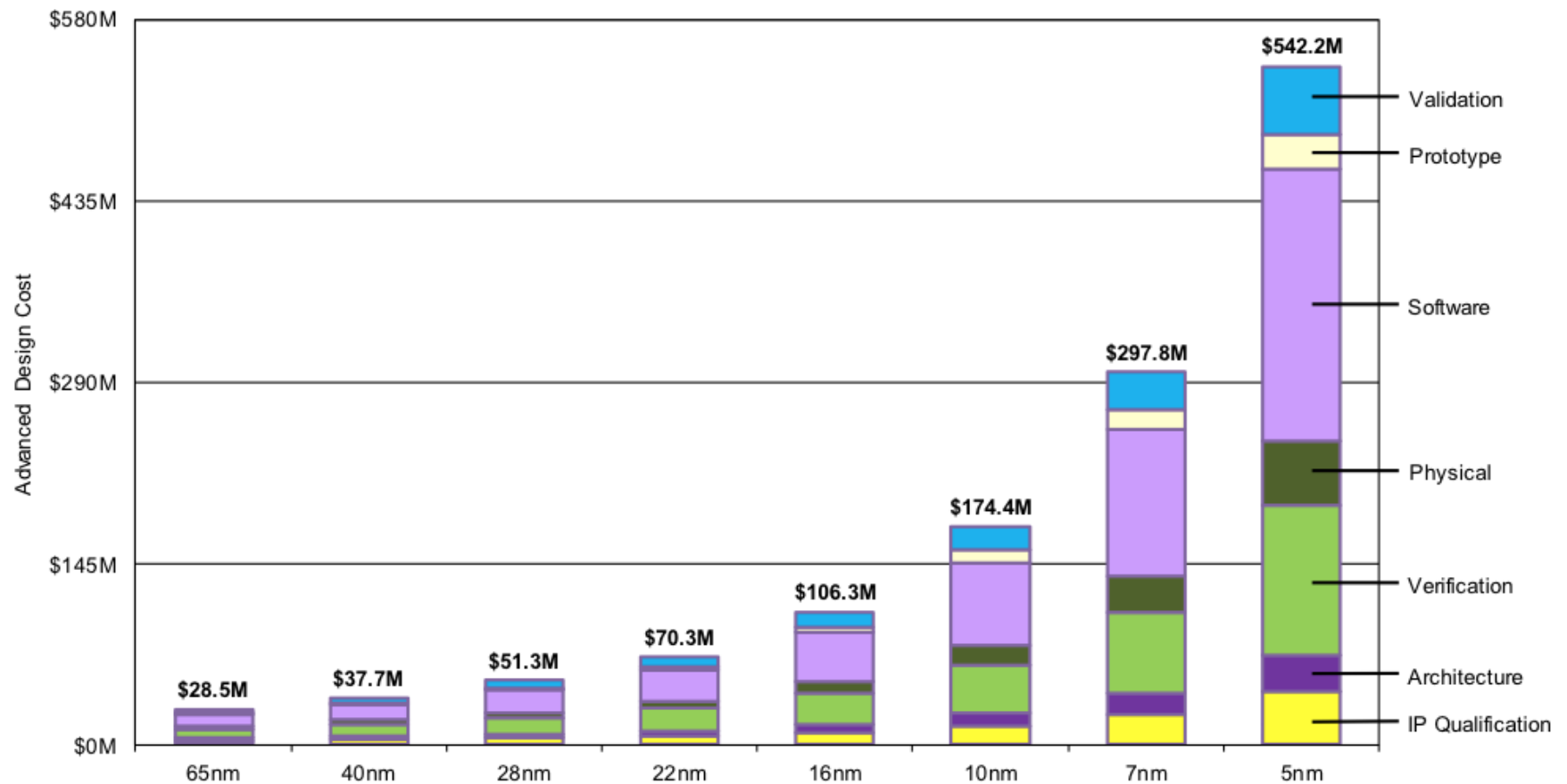


TREND 3

**USING ANALYTICS TO OPTIMIZE
SEMICONDUCTOR PROCESSES**



Why AI make sense in Semiconductors



As you can see there is one clear conclusion - **the design and manufacturing of advanced node (10 nm and below) are HUGE and increasing exponentially.**

<https://www.quora.com/How-much-does-it-cost-to-design-and-fabricate-an-integrated-circuit>

Semiconductor Ideal Expectations from AI



No repeated iterations

Tools should not return unexpected results

Achieve predictability from the user's point of view

Use old design data to improve new designs

Focus on reducing design time , design efforts

What is the solution?

Machine Learning will be a key piece of this . . .

AI Technology Verticals used in Semiconductors

Natural Language Processing

Text Processing Technique to process raw and unstructured text to generate information.

Ex.

1. Q & A Bot
2. Sentiment Analysis
3. Feedback Rating System
4. Document Retrieval

Important Libraries: NLTK, spaCy.

Computer Vision

Computer Vision or CV is a digital Image Processing Technique where we apply different Neural Network Architecture to process image and classify them.

Ex.

1. Wafer Defect Classification
2. Congestion Prediction
3. Image to Image Generation

Etc...

Neural Net: CNN

Machine Learning

ML has wide range of application which fall in predictive modelling as well as time series forecasting.

Ex.

1. Anomalies Detection
2. Predicting upcoming market trends
3. Stock price forecasting

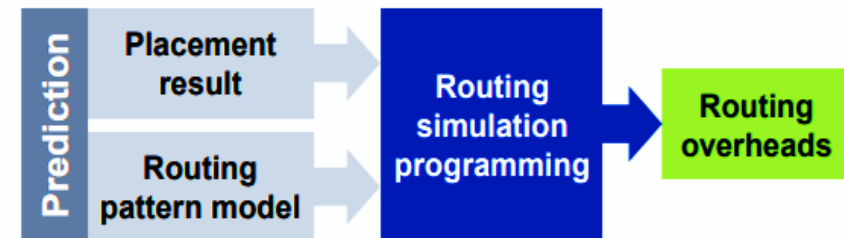
Etc...

Types: Classification & Regression

Use-case 1 (Congestion Prediction)

Eliminate human and fixed model subjective bias with statistical important features

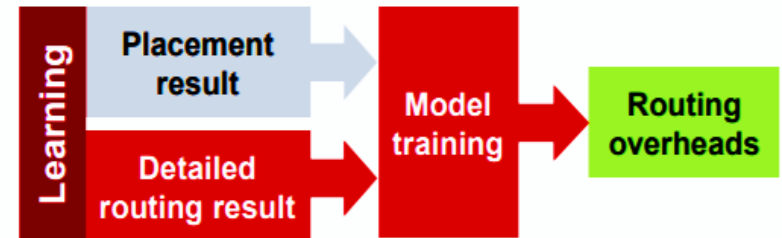
Traditional EDA Approach



Easy to be biased and no guaranteed quality

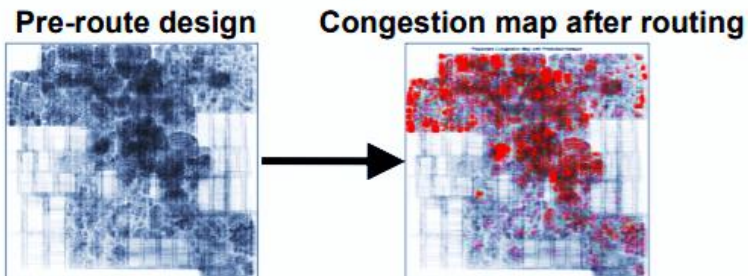
Only heuristics are possible

Machine Learning Approach



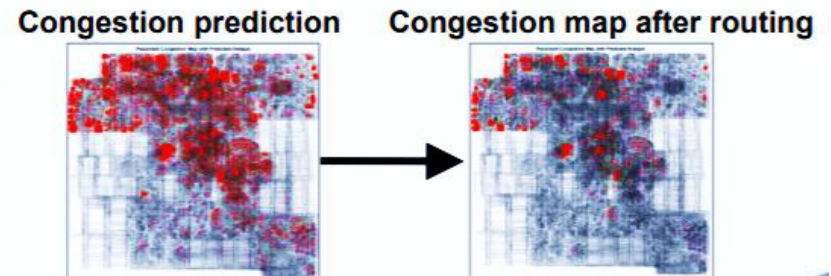
Leverage widely used deep learning packages

Traditional (EDA) flow



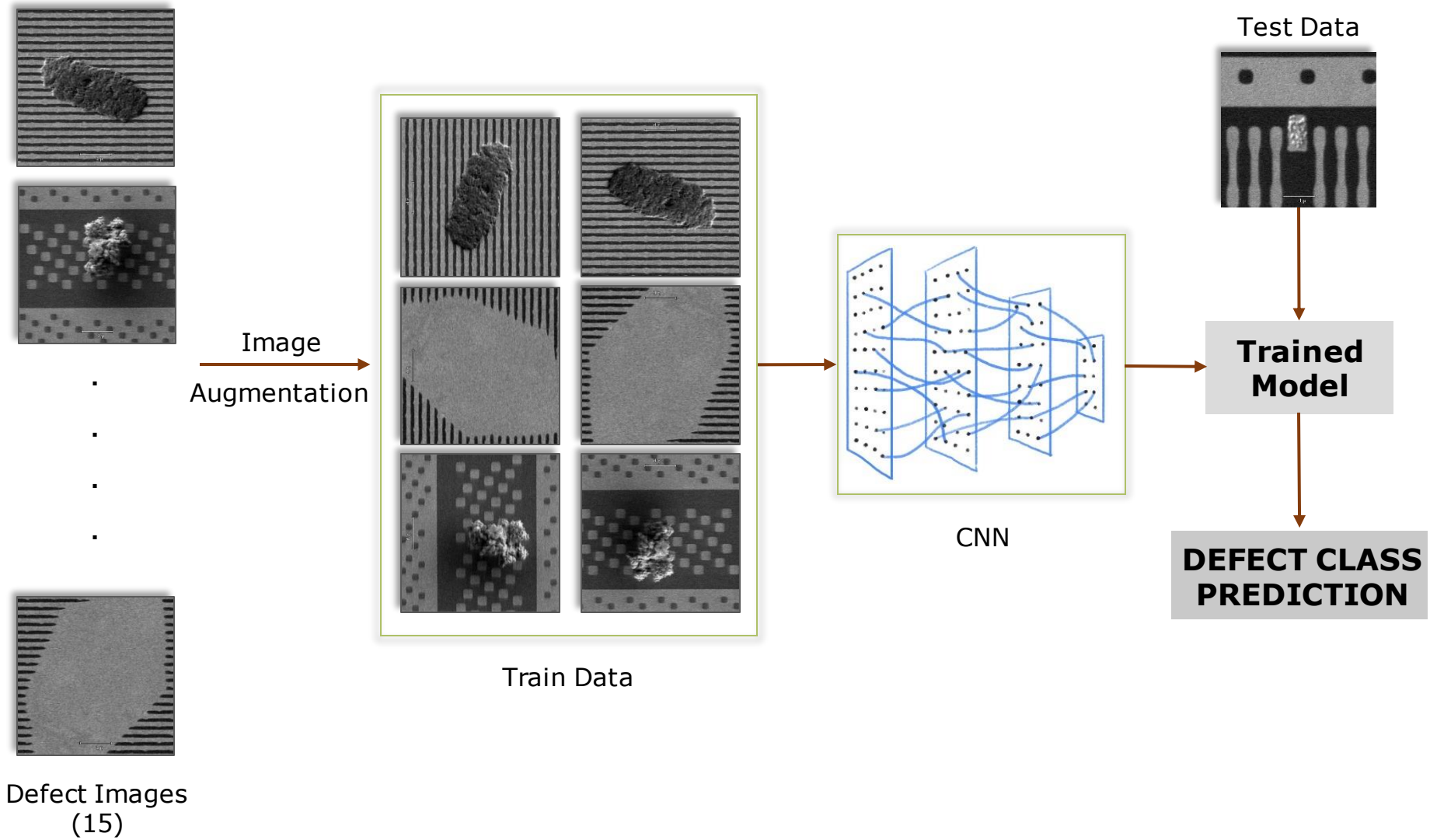
Only know routing results after running routing

Flow enables by Machine Learning

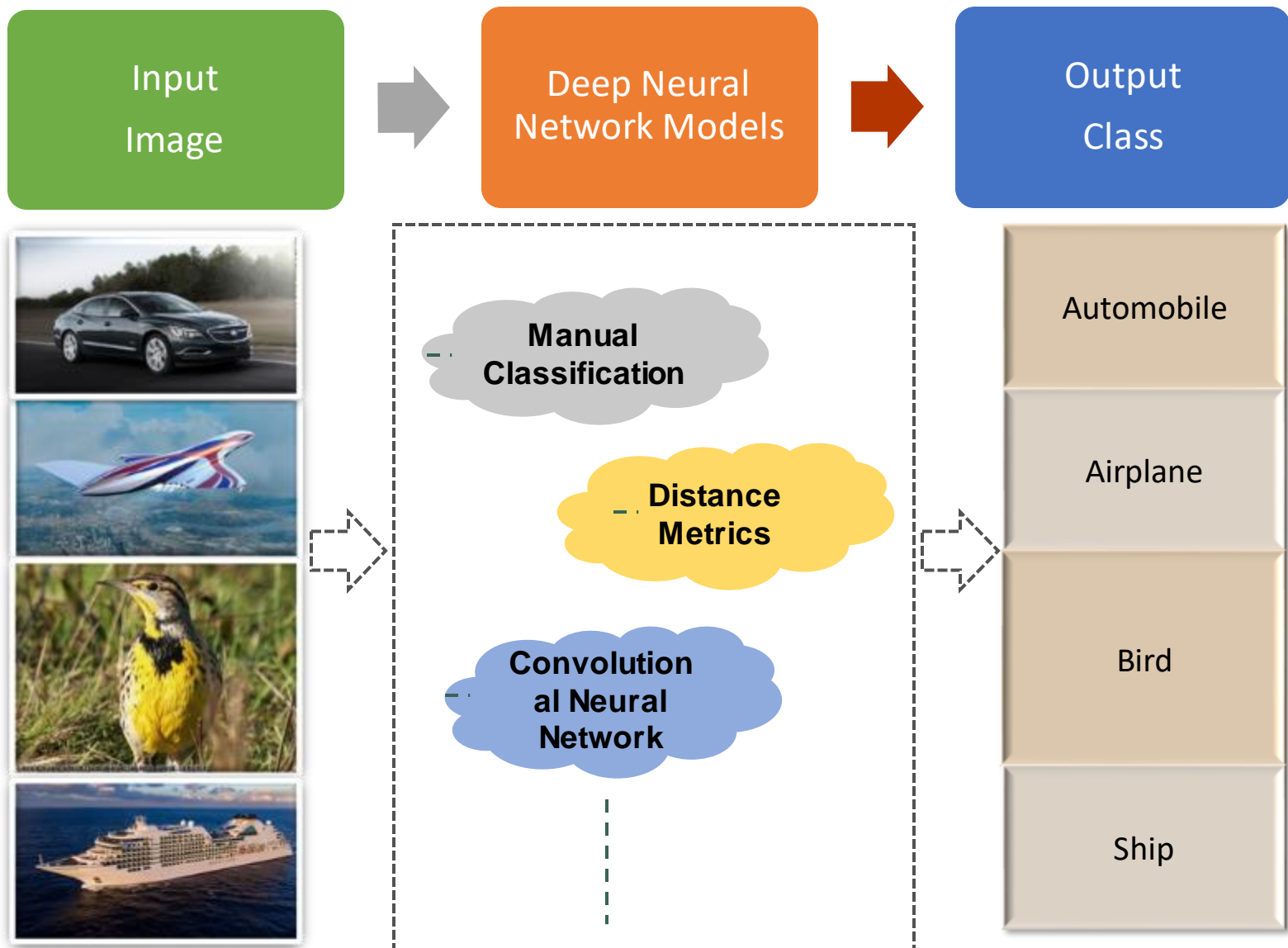


Able to predict routing behavior and improve congestion with new recipes to achieve 40Mhz

Use-case 2 (Wafer Defect Classification)

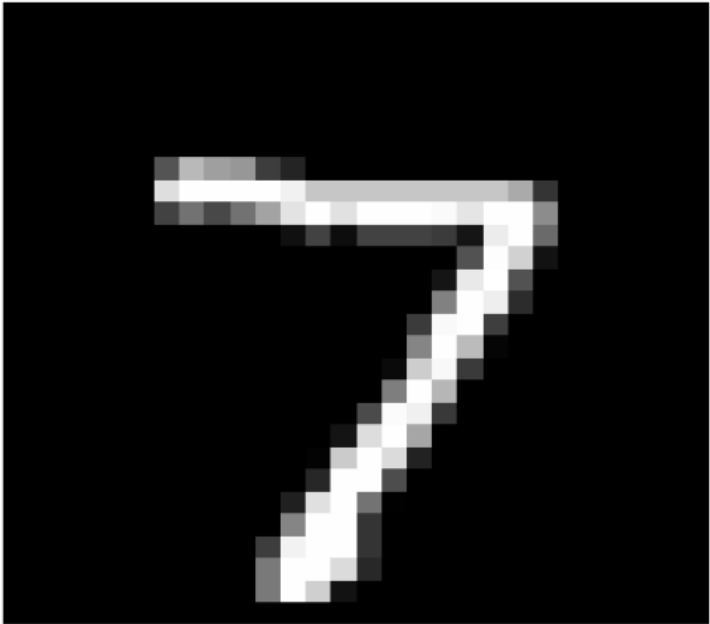


Introduction to Image Classification



How Images are Represented

28 x 28 image



28 columns

28 rows

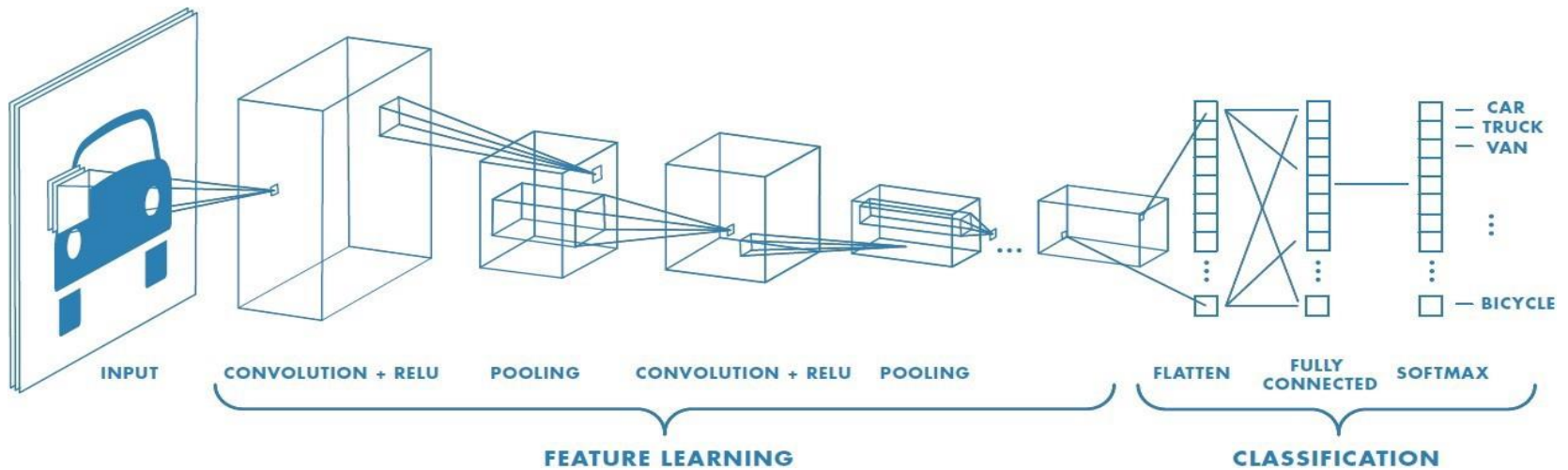
	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20	V21	V22	V23	V24	V25	V26	V27	V28
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	84	185	159	151	60	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	222	254	254	254	241	198	198	198	198	198	198	198	198	170	52	0	0	0	0	0	0
11	0	0	0	0	0	0	0	67	114	72	114	163	227	254	225	254	254	254	250	229	254	254	140	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	17	66	14	67	67	67	59	21	236	254	106	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	83	253	209	18	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	233	255	83	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	129	254	238	44	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59	249	254	62	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	133	254	187	5	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	205	248	58	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	126	254	182	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	75	251	240	57	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	19	221	254	166	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	3	203	254	219	35	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	38	254	254	77	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	31	224	254	115	1	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	133	254	254	52	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	61	242	254	254	52	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	121	254	254	219	40	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	121	254	207	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Pixel Value (brightness) range : 0 - 255

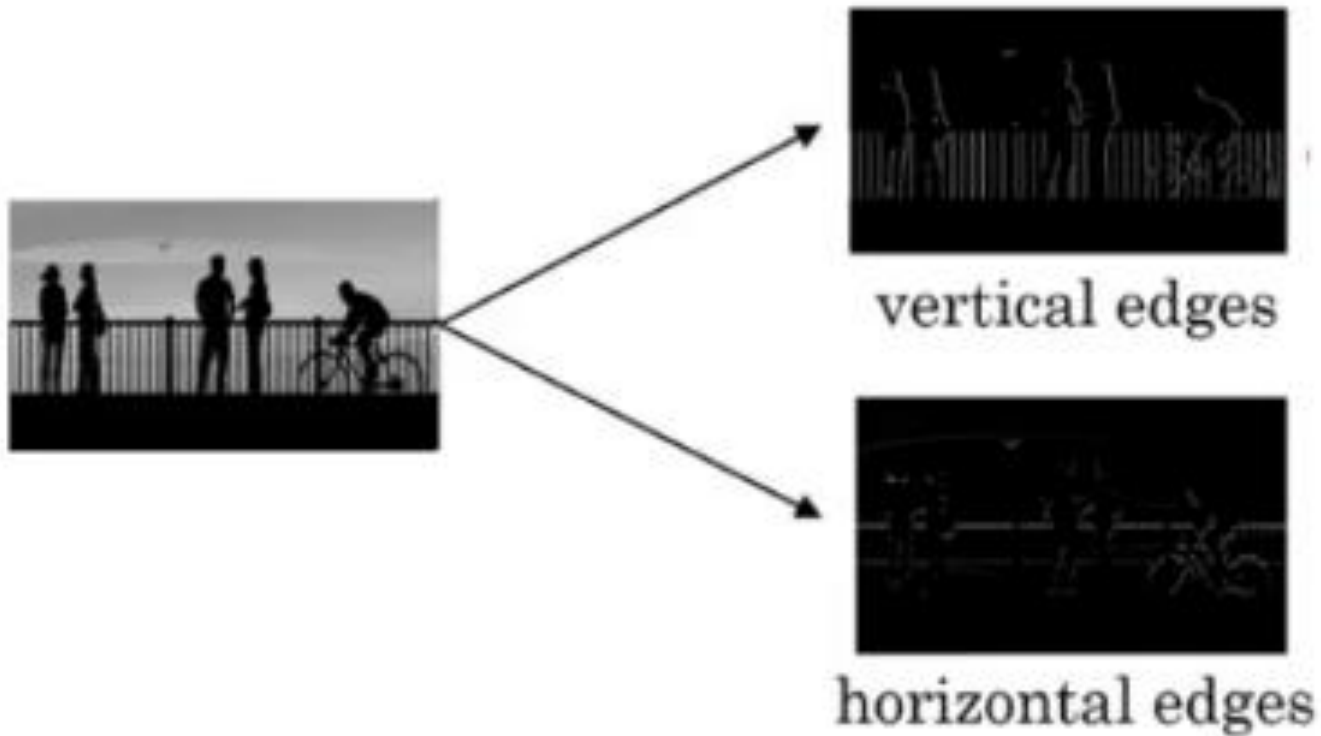
Major Challenges in Image Processing

- Size of the input data.
- Suppose an image is of the size $68 \times 68 \times 3$. The input feature dimension then becomes 12,288.
- This will be even bigger if we have larger images (say, of size $720 \times 720 \times 3$).
- Now, if we pass such a big input to a neural network, the number of parameters will swell up to a HUGE number (depending on the number of hidden layers and hidden units).
- This will result in more computational and memory requirements – not something to be handled easily.
- Convolutional Neural Network solves all these challenges in a step by step Approach.

Architecture of Convolutional Neural Network – CNN



1. Convolution Layer - Edge Detection



1. Convolution Layer - Edge Detection

1	1	1	0	0
0	1	1	1	0
0	0	1	1	1
0	0	1	1	0
0	1	1	0	0

Image

1	0	1
0	1	0
1	0	1

Filter

1. Convolution Layer - Edge Detection

1 _{x1}	1 _{x0}	1 _{x1}	0	0
0 _{x0}	1 _{x1}	1 _{x0}	1	0
0 _{x1}	0 _{x0}	1 _{x1}	1	1
0	0	1	1	0
0	1	1	0	0

4		

1	1 _{x1}	1 _{x0}	0 _{x1}	0
0	1 _{x0}	1 _{x1}	1 _{x0}	0
0	0 _{x1}	1 _{x0}	1 _{x1}	1
0	0	1	1	0
0	1	1	0	0

4	3	

1	1	1 _{x1}	0 _{x0}	0 _{x1}
0	1	1 _{x0}	1 _{x1}	0 _{x0}
0	0	1 _{x1}	1 _{x0}	1 _{x1}
0	0	1	1	0
0	1	1	0	0

4	3	4

1	1	1	0	0
0 _{x1}	1 _{x0}	1 _{x1}	1	0
0 _{x0}	0 _{x1}	1 _{x0}	1	1
0 _{x1}	0 _{x0}	1 _{x1}	1	0
0	1	1	0	0

4	3	4
2		

.....

1	1	1	0	0
0	1	1	1	0
0	0	1 _{x1}	1 _{x0}	1 _{x1}
0	0	1 _{x0}	1 _{x1}	0 _{x0}
0	1	1 _{x1}	0 _{x0}	0 _{x1}

4	3	4
2	4	3
2	3	4

Image

Convolved Features

What Weight Matrix or Filter does?

- The weight matrix behaves like a filter in an image extracting particular information from the original image matrix.
- One weight combination might be extracting edges, while another one might extract a particular color, while another one might just blur the unwanted noise.
- When we have multiple convolutional layers, the initial layer extracts more generic features, while as the network gets deeper, the features extracted by the weight matrices are more and more complex and more suited to the problem at hand.

Importance of Padding in Convolution Layer

- Every time we apply a convolutional operation, the size of the image shrinks
- Pixels present in the corner of the image are used only a few number of times during convolution as compared to the central pixels.
- Hence, we do not focus too much on the corners since that can lead to information loss
- To overcome these issues, we can pad the image with an additional border, i.e., we add one pixel all around the edges.
- This is where padding comes to the fore

Strided Convolutions

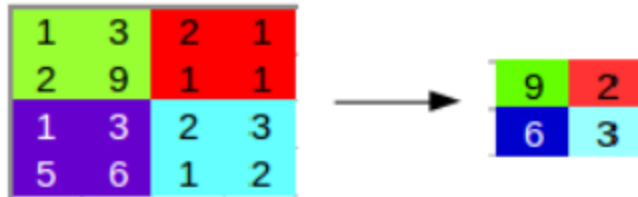
- Stride is nothing but the steps that filter takes while convoluting over the image matrix.
- For example if stride is 2 then filter will jump two steps while convoluting.
- Stride helps to reduce the size of the image, a particularly useful feature.

1 _{x1}	1 _{x0}	1 _{x1}	0	0
0 _{x0}	1 _{x1}	1 _{x0}	1	0
0 _{x1}	0 _{x0}	1 _{x1}	1	1
0	0	1	1	0
0	1	1	0	0

1	1	1 _{x1}	0 _{x0}	0 _{x1}
0	1	1 _{x0}	1 _{x1}	0 _{x0}
0	0	1 _{x1}	1 _{x0}	1 _{x1}
0	0	1	1	0
0	1	1	0	0

2. Pooling Layers

- Pooling is another method to reduce the size of the image and hence speed up the computation.
- Consider a 4 X 4 matrix as shown below:
- Applying max pooling on this matrix will result in a 2 X 2 output:



- For every consecutive 2 X 2 block, we take the max number.
- Here, we have applied a filter of size 2 and a stride of 2.
- Another method could be the average pooling instead of Max pooling.
- These all are the hyper parameters which we set to fine tune the model.

Formula to calculate the feature size

Input: $n \times n \times n_c$

Filter: $f \times f \times n_c$

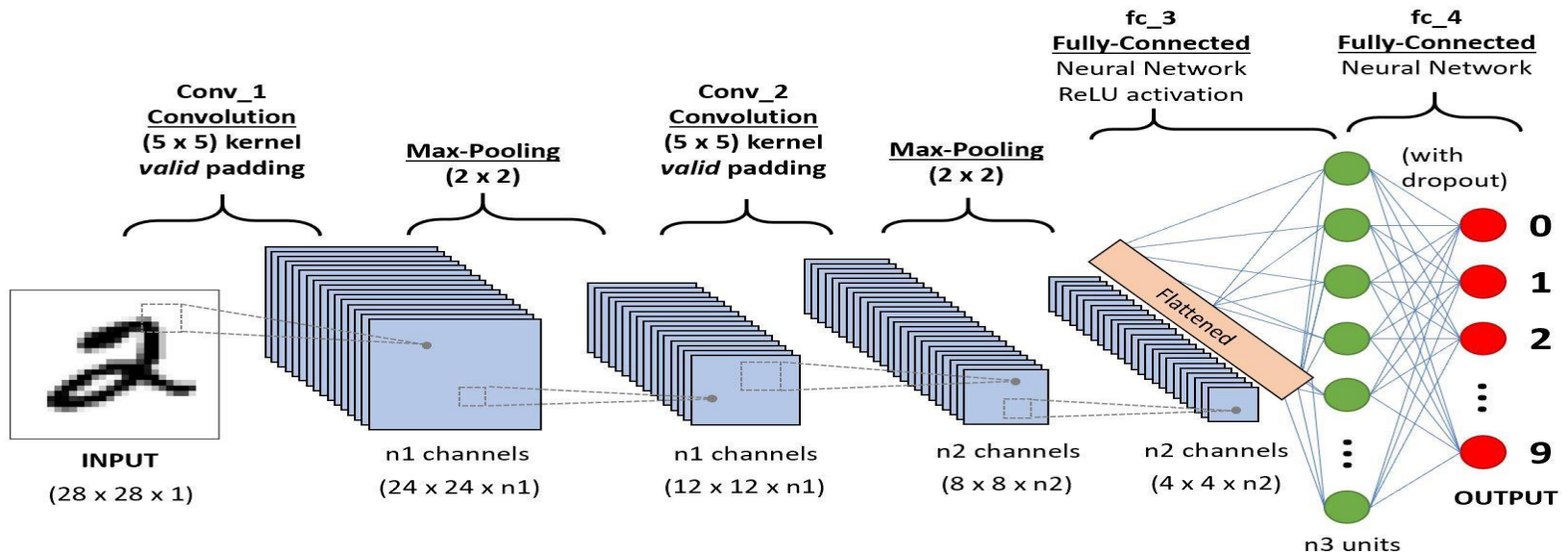
Padding: p

Stride: s

Output: $[(n+2p-f)/s+1] \times [(n+2p-f)/s+1] \times n_c'$

Here, n_c is the number of channels in the input and filter, while n_c' is the number of filters.

3. The Output layer



Future of Semiconductors with AI

<https://venturebeat.com/2020/04/23/google-claims-its-ai-can-design-computer-chips-in-under-6-hours/>

Contact Details

Website: <https://ashutoshtripathi.com>

Data Science, Machine Learning & Artificial Intelligence

HOME STATISTICS FOR DS & ML FREE MOCK INTERVIEWS MACHINE LEARNING DBMS ABOUT

```
1] # ADD A NEW RULE TO THE PIPELINE
2 def set_custom_sentence_end_points(doc):
3     for token in doc[:-1]:
4         if token.text == ';':
5             doc[token.i+1].is_sent_start = True
6     return doc
7
8 nlp.add_pipe(set_custom_sentence_end_points, before='parse')
9
10 nlp.pipe_names
11] ['tagger', 'set_custom_sentence_end_points', 'parser', 'ner']
```

HOW TO PERFORM SENTENCE SEGMENTATION OR SENTENCE TOKENIZATION USING SPACY | NLP SERIES | PART 5

Ashutosh Tripathi

Sentence Segmentation or Sentence Tokenization is the process of identifying

Sebastian Thrun started working on self-driving cars at Google in 2007, \ outside of the company took him seriously."
nlp.docx, style="ent", jupyter=True
[PERSON] Thrun started working on self-driving cars at [ORG] Google in [DATE] 2007, few people outside of the
Over the last quarter Apple sold nearly 20 thousand iPods for a profit of \$6 million. " y contrast, Sony sold only 7 thousand Walkman music players."
nlp.docx, style="ent", jupyter=True
quarter DATE Apple ORG sold nearly 20 thousand CARDINAL iPods PRODUCT for a profit of \$6 million M
sold only 7 thousand CARDINAL Walkman music players.

NAMED ENTITY RECOGNITION NER USING SPACY | NLP | PART 4

Ashutosh Tripathi

Named Entity Recognition NER works by locating and identifying the named entities present in unstructured text into the standard categories such as person names, locations,

Website: <https://enetwork.ai>

OUR SERVICES

Mock Interviews



If you are an aspiring data scientist or an experienced professional who is trying to make his career in Data Science, then this platform is for you. In Mock Interviews, we focus on high-quality interactive interview sessions. You have the option to schedule two kinds of Mock Interviews with us.

1. Generic (AI, ML or DS) Interview to prepare on all

Guided Mentorship



We help you to quickstart your Data Science and Machine Learning journey. We help you by:

- Preparing a learning roadmap.
- Providing the best resources available online.
- Best training institutes suited for your need.
- Industry projects know-how.

Study Material



If you are struggling to find good resources on data science and machine learning then we can help you here.

We have planned a step by step learning process which starts from understanding the concepts of Statistics for Data Science goes till Advanced Artificial Intelligence.

LinkedIn: <https://www.linkedin.com/in/ashutoshtripathi1/>

Instagram: https://www.instagram.com/ashutosh_ai/

Thank You