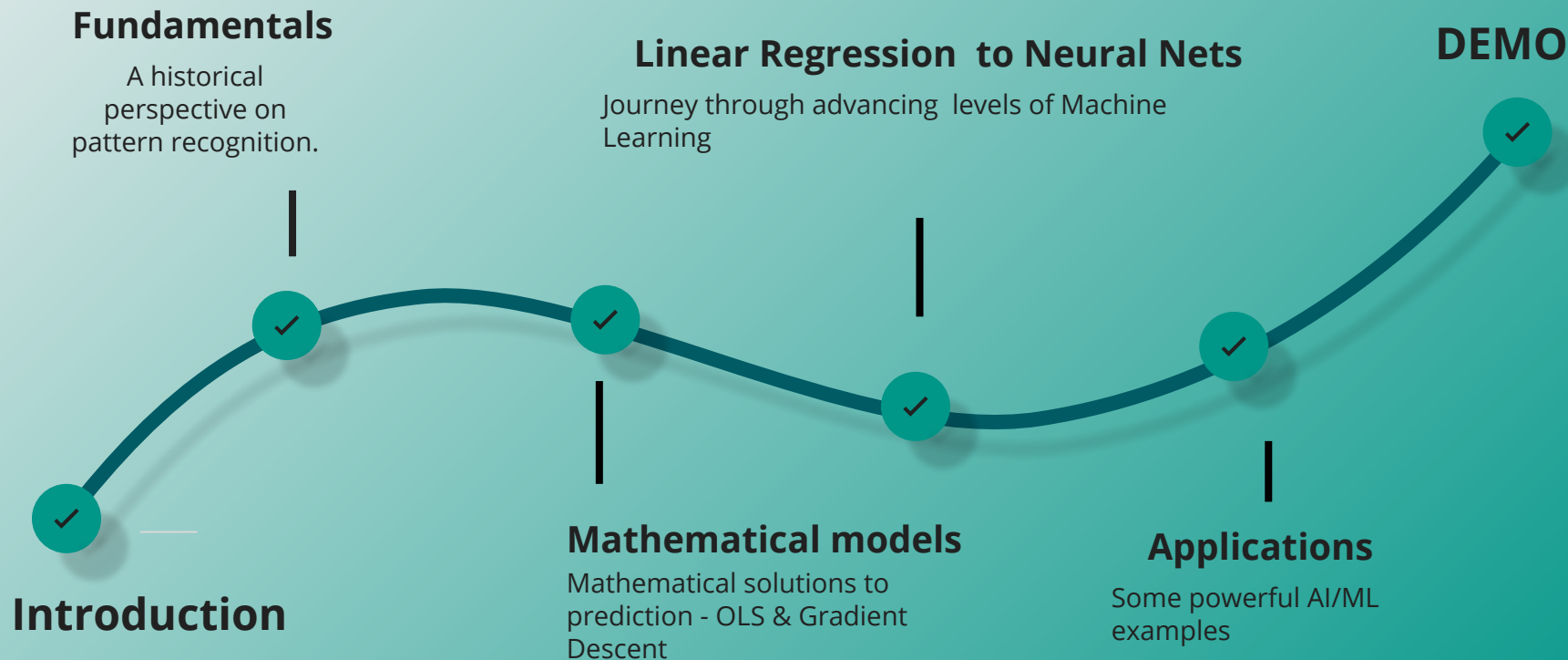


# Machine Learning and Artificial Intelligence (ML/AI)

Core Principles and Applications

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Software Development Manager, AWS/Amazon

# Agenda



# The Fundamentals

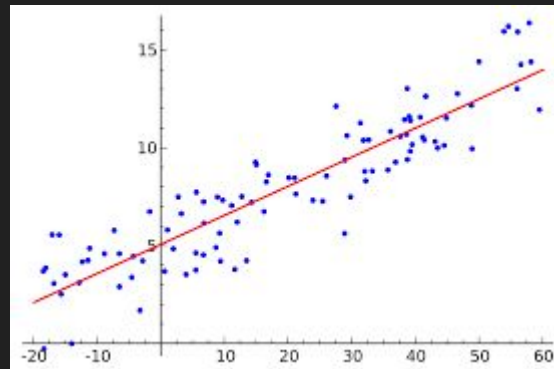
# Predictions

- As humans, we make numerous predictions on a daily basis
- Our ability to make these predictions allow us to be functional and productive
- Historical learnings and experiences allow us to identify and recognize patterns, which in turn allow us to make predictions



# Traditional approaches to Prediction

- For a long time, Linear Regression (OLS) has been the primary tool for prediction.
- It typically involves finding a line of best fit using the method of least squares
- This method suffers from several problems
  - It breaks down when multiple independent variables exist
  - It is computationally intractable as the number of independent variables increase or as the data points increase resulting in sampling smaller sets of data and parameters.
  - Valid solutions do not always exist in all cases.



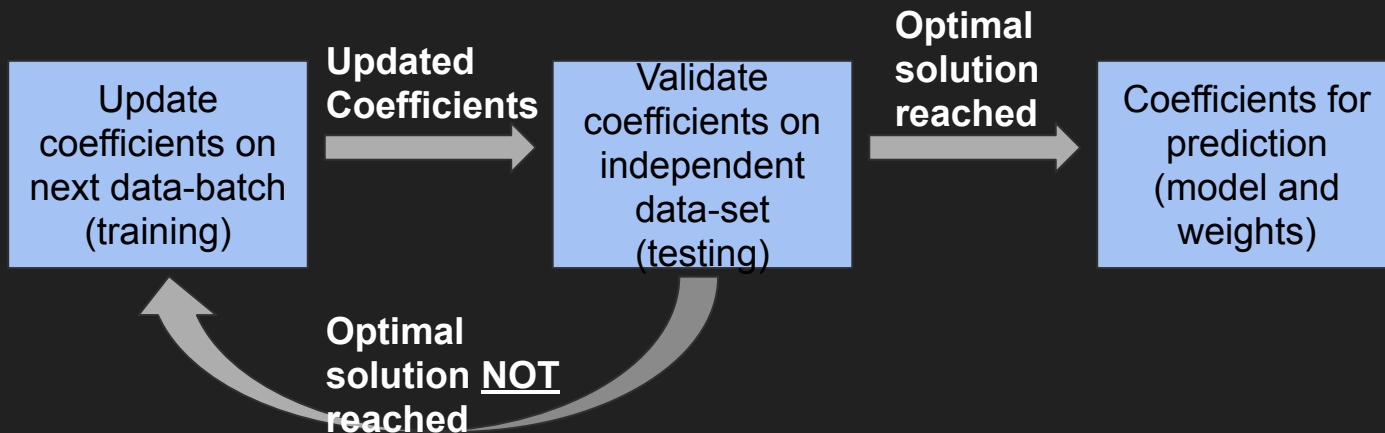
Source:

[https://en.wikipedia.org/wiki/Linear\\_regression](https://en.wikipedia.org/wiki/Linear_regression)

# Mathematical Models

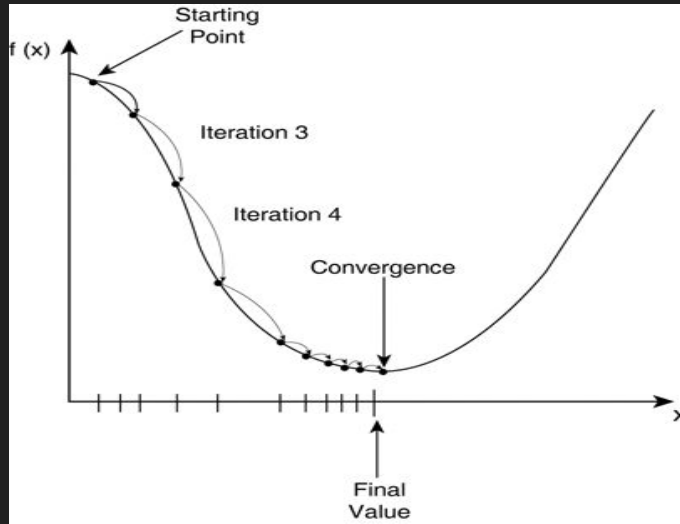
# The Machine Learning Approach

- The machine learning approach to prediction is based on incremental problem solving
- Rather than attempt to solve for all the unknown coefficients with all known data, we strive to close in on the most optimal solution in an incremental manner



# Visualizing Convergence and Validation

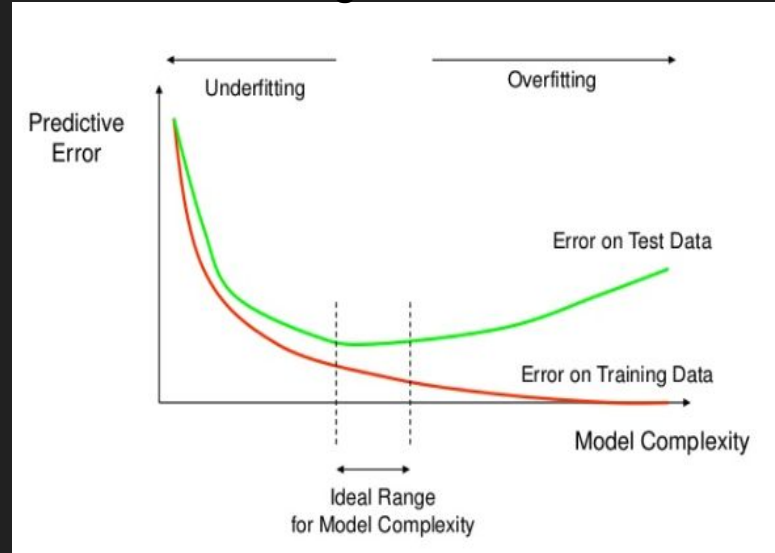
## Cost Functions and Gradients



Source:

<https://towardsdatascience.com/machine-learning-fundamentals-via-linear-regression-41a5d11f5220>

## Training and Validation



Source:

<https://stats.stackexchange.com/questions/292283/general-question-regarding-over-fitting-vs-complexity-of-models>



# Linear Regression to Neural Nets

# Linear Regression Algorithm

- Linear Regression algorithms generate a model that makes predictions for continuous output values
- This is similar to the types of predictions made by traditional mathematical models based on Ordinary Least Squares (OLS), although the algorithm uses the machine learning approach.
- Uses of Linear Regression



House Prices



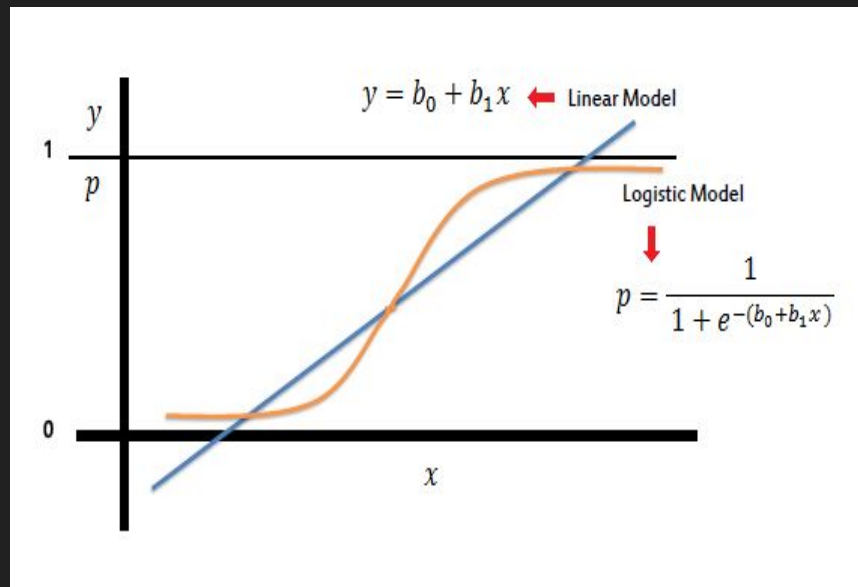
Stock Prices



Product Prices

# Logistic Regression

- Logistic Regression is a modification to the Linear Regression algorithm that allows for the prediction of categorical values
- Example:
  - Single Class Classification: True or False
  - Multiple Class Classification: Dog, Cat, Lion etc



**Source:**

[https://www.saedsayad.com/logistic\\_regression.htm](https://www.saedsayad.com/logistic_regression.htm)

# On to simple neural networks

- Neural Networks attempt to model the behavior of the human nervous system

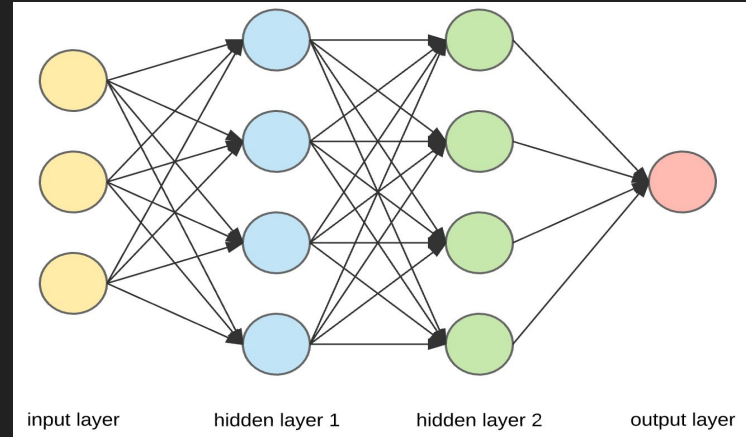
**The Human Brain**



Source:

[https://www.123rf.com/photo\\_90941320\\_stock-illustration-human-brain-and-neuron-cells-on-abstract-blue-background-3d-illustration.html](https://www.123rf.com/photo_90941320_stock-illustration-human-brain-and-neuron-cells-on-abstract-blue-background-3d-illustration.html)

**A Neural Network**

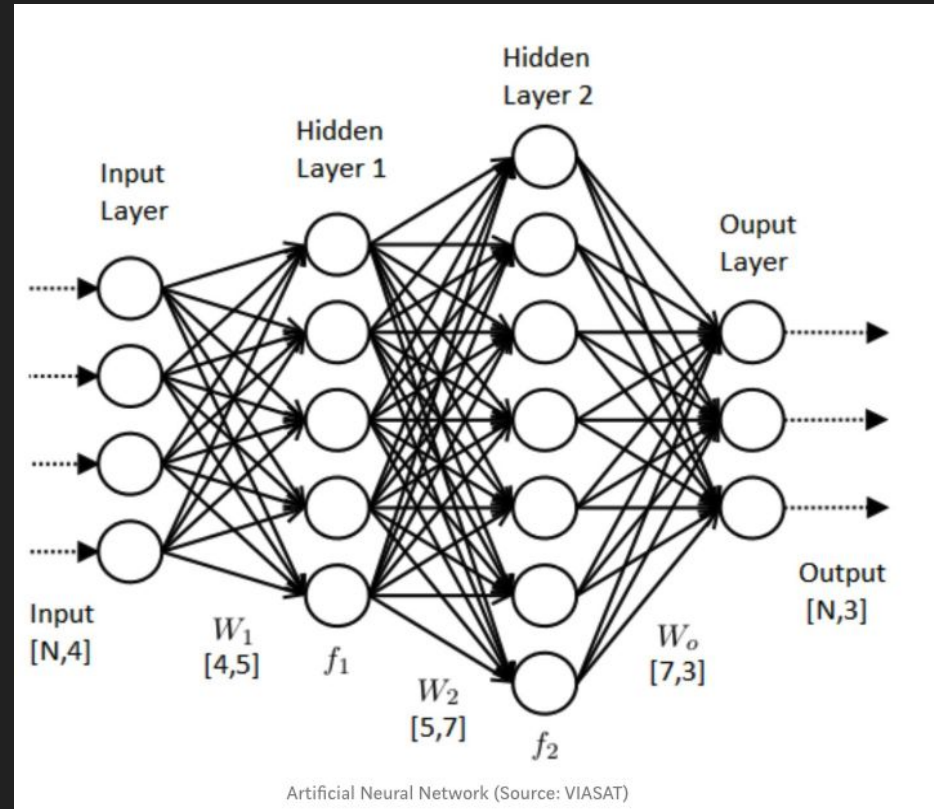


Source:

<https://towardsdatascience.com/applied-deep-learning-part-1-artificial-neural-networks-d7834f67a4f6>

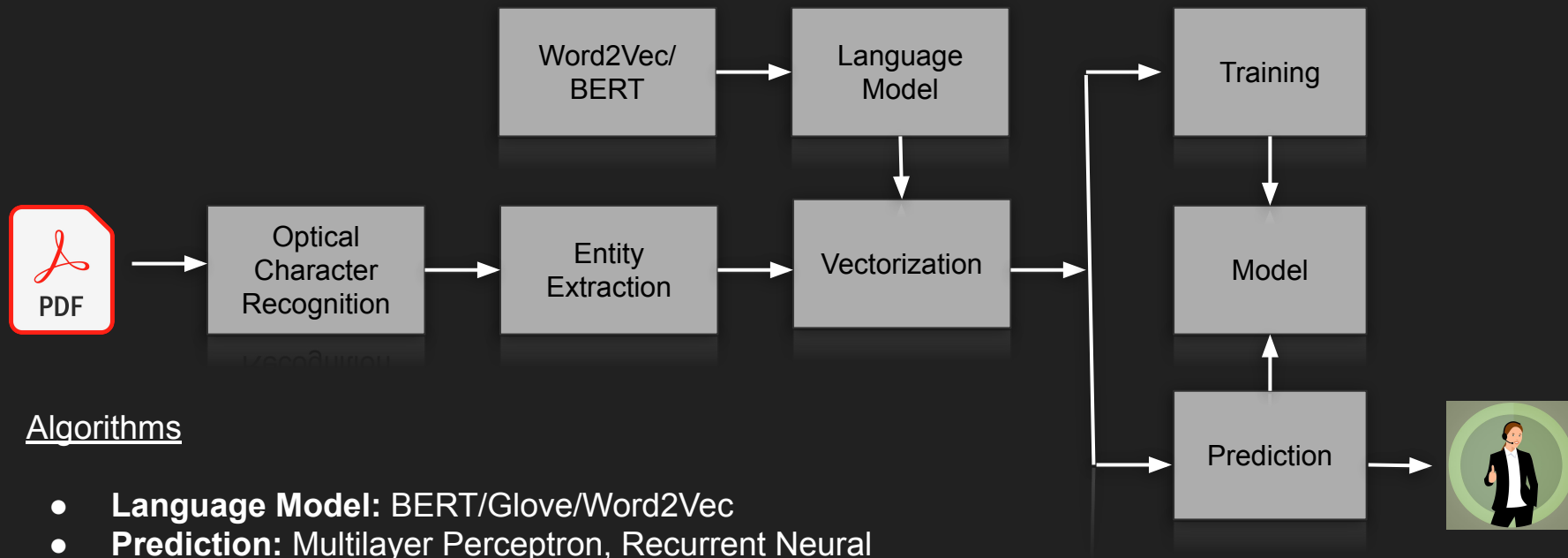
# Neural Network as an aggregation of Logistic Regression blocks

- Each block is Logistic Regression block
- Intermediate blocks are called hidden units
- Multiple layers make this a **deep net**
- Fewer layers form a **shallow net**
- Together, the blocks can learn complex patterns
  - [https://en.wikipedia.org/wiki/Universal\\_approximation\\_theorem](https://en.wikipedia.org/wiki/Universal_approximation_theorem)



# ML/AI Applications

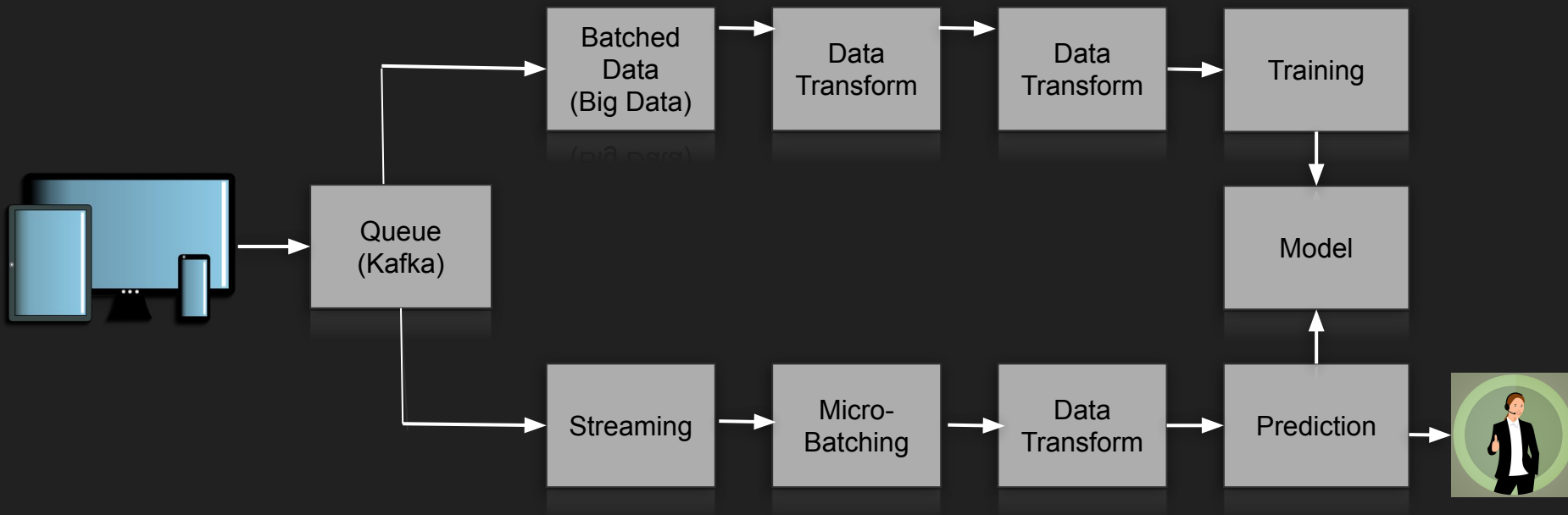
# Document Intelligence



## Algorithms

- **Language Model:** BERT/Glove/Word2Vec
- **Prediction:** Multilayer Perceptron, Recurrent Neural Nets, Sequence to Sequence networks

# Fault Prediction



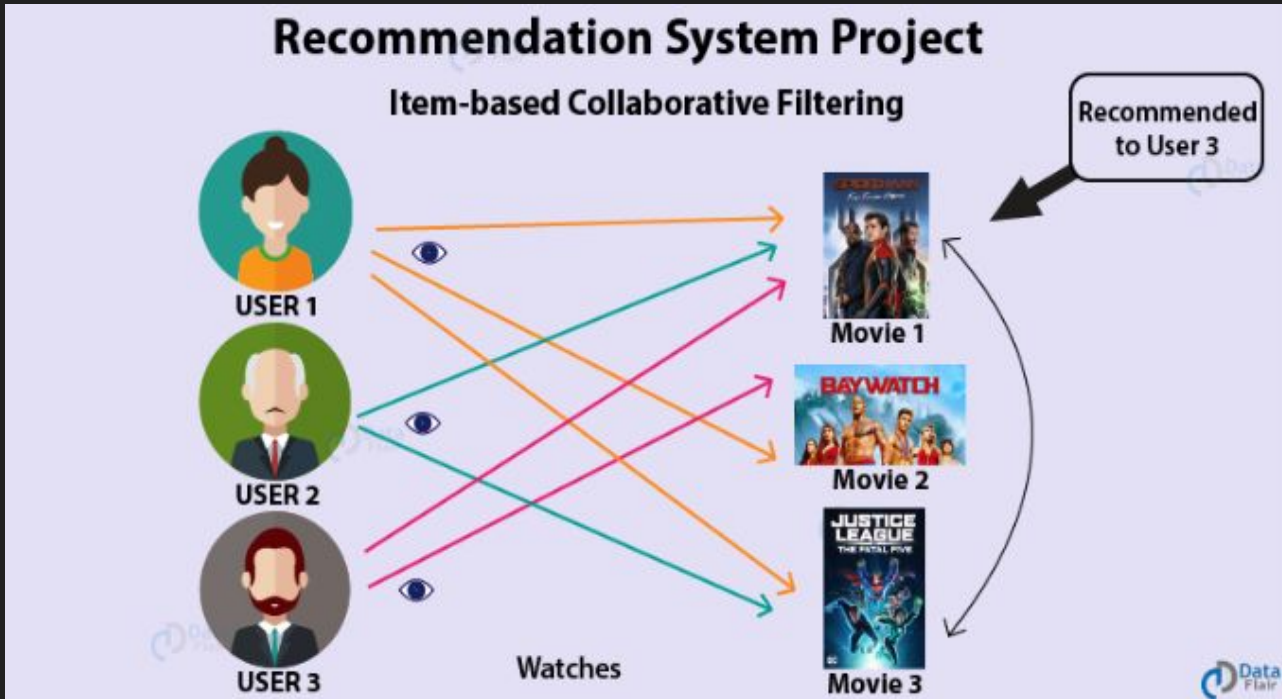
## Algorithms

- **Prediction:** Distributed Random Forest, Logistic Regression, SVM, Neural Nets



# Recommendations Systems













- Movie Recommendations















Source: <https://data-flair.training/blogs/data-science-r-movie-recommendation/>

# Recommendations

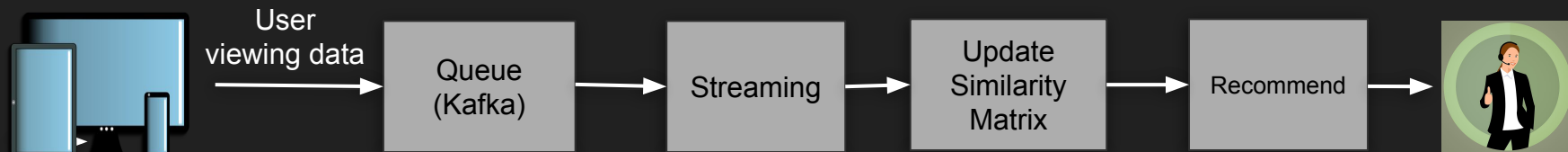
## - Item-Item & User-User Similarity

						
	4	3			5	
	5		4		4	
	4		5	3	4	
		3				5
		4				4
			2	4		5

						
	1.00	0.75	0.63	0.22	0.30	0.00
	0.75	1.00	0.91	0.00	0.00	0.16
	0.63	0.91	1.00	0.00	0.00	0.40
	0.22	0.00	0.00	1.00	0.97	0.64
	0.30	0.00	0.00	0.97	1.00	0.53
	0.00	0.16	0.40	0.64	0.53	1.00

Source: <https://buildingrecommenders.wordpress.com/2015/11/18/overview-of-recommender-algorithms-part-2/>

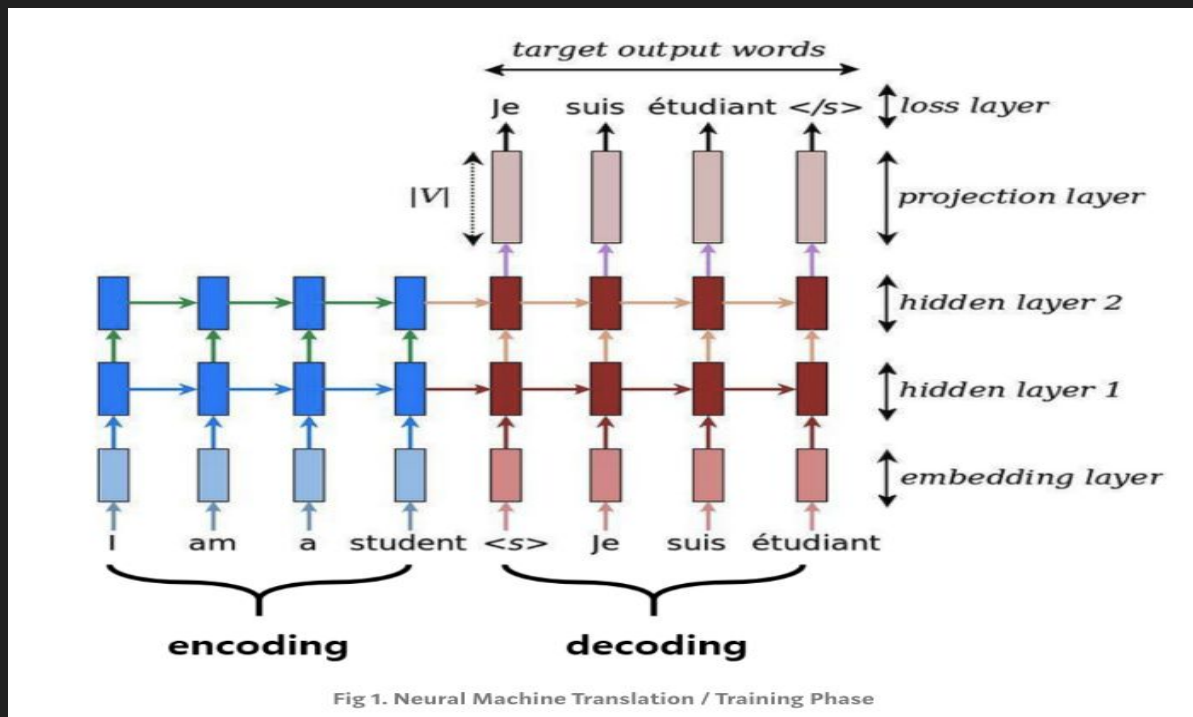
# Recommendation Systems Pipeline



## Algorithms

- Collaborative Filtering, Cosine Similarity

# Machine Translation Algorithm

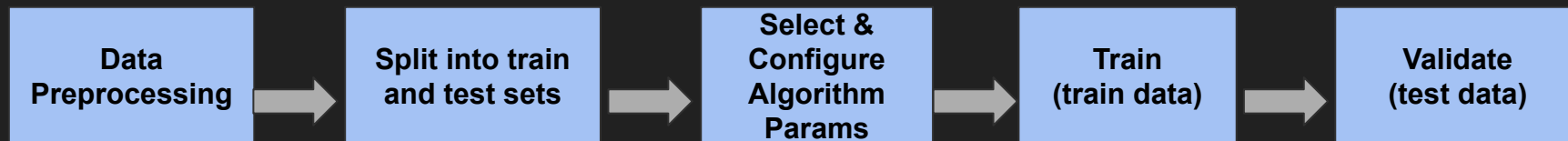


Source: <https://towardsdatascience.com/seq2seq-model-in-tensorflow-ec0c557e560f>

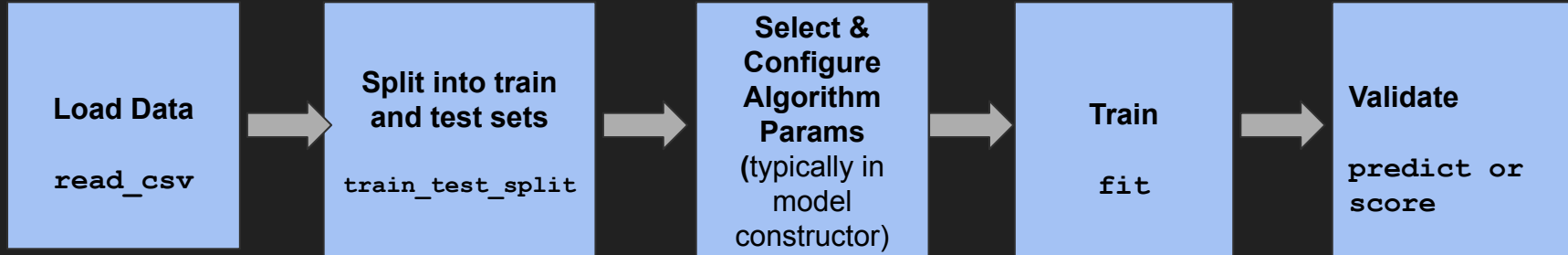
Demo

# Typical Machine Learning Pipeline

## Conceptual Flow



## Equivalent methods in sklearn/pandas



## **If the training does not yield an optimal solution**

1. Get additional data
2. Use a different machine learning algorithm
3. Fine tune machine learning algorithm parameters

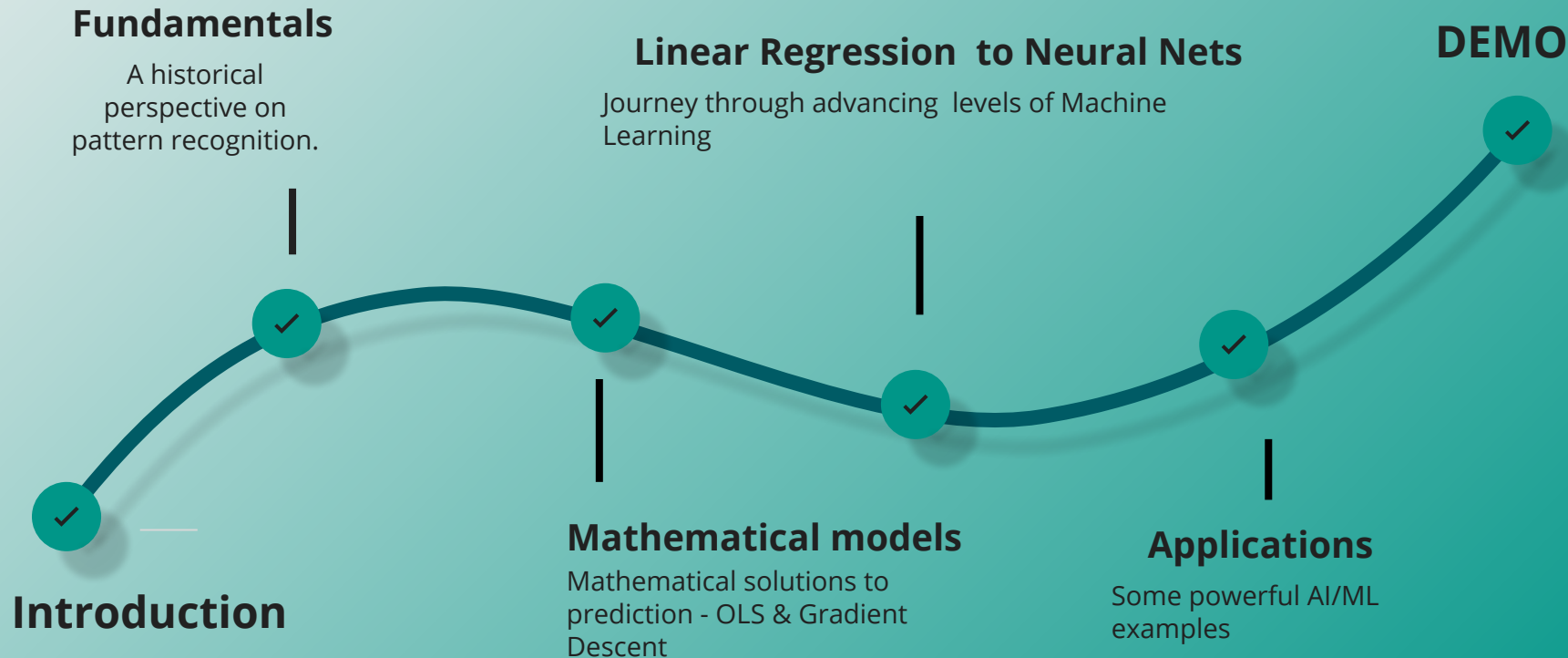
# About this demo

- Data obtained from US census bureau based on the 1994 census
- Prediction task is to determine whether a person makes over 50k USD/year
- <https://archive.ics.uci.edu/ml/machine-learning-databases/adult/adult.data>
- Total data points - 32,561
- Predictors
  - a. Age, workclass, education, education-num, Marital-status, occupation, relationship, race, sex, capital-gain, capital-loss: hours-per-week, native-country
- Predicted value, also known as the response value
  - a. <50k
  - b. >=50k

Demo using Sklearn



# Wrap-Up



Questions?

# Thanks!

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**Twitter handle:** @sanjayd\_