https://www.youtube.com/embed/io87SbDOKqM?start=60&end=97&version=3

https://www.youtube.com/embed/RBnIbqW6ZhM?start=15&end=75&version=3

ML Key Terminology and living with ambiguity…

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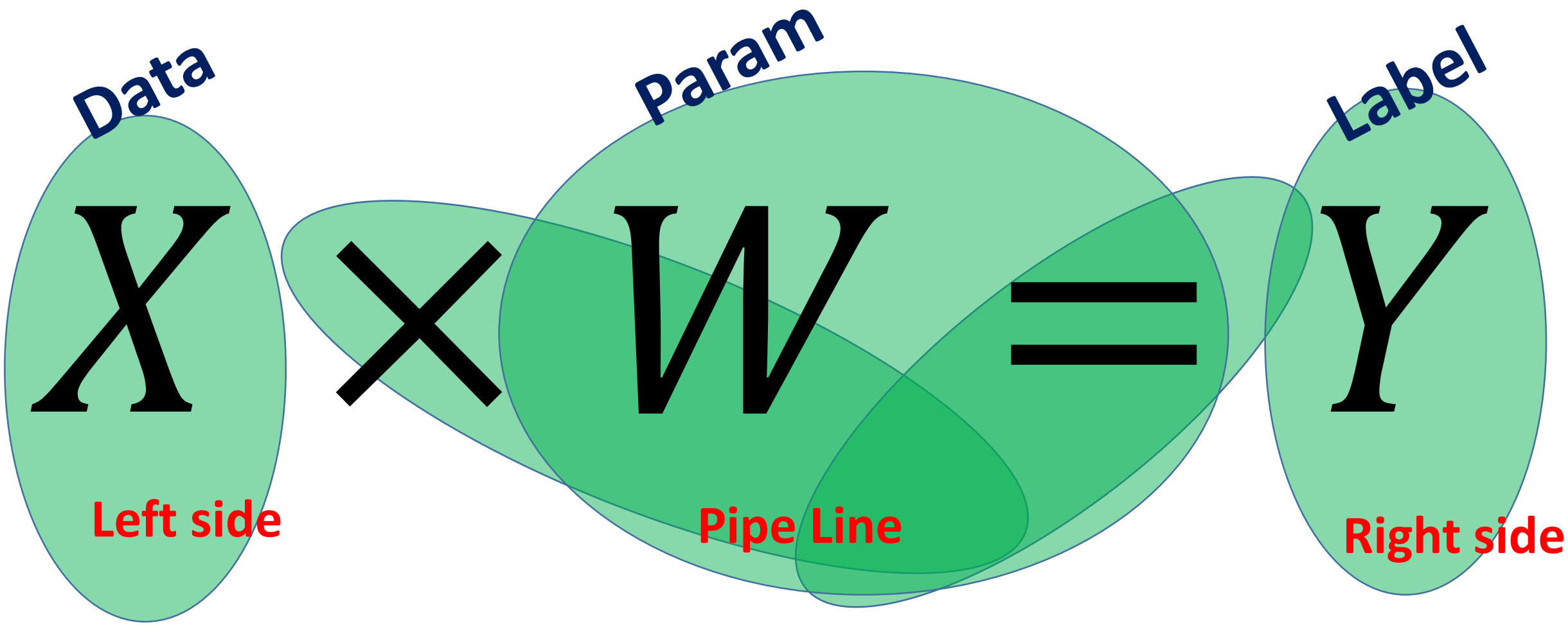
In this lecture you will learn about 21 key phrases and known ambiguities to live with in Machine Learning World

1) key phrases… “Data, Label, Parameter”



$N \times k$ *matrix*

$k \times 1$ *vector*

$N \times 1$ *vector*

$$X \times w = y$$

2) key phrase… “Data”

X is called **Data**

$$X_{N \times k}$$

Dimensionality of a data point

Number of ***data points***

Attributes,
Features,
Dimensions,
Properties,
Columns

$$X = \begin{bmatrix} x_0^T \\ \cdots \\ \cdots \\ x_i^T \\ \cdots \\ x_N^T \end{bmatrix}$$

Single Data Point

$$x_i$$

It's a column vector

k dimensional point

Each row corresponds to…
transpose of a data point

By default assumed to be (k x 1) matrix

3) key phrase… “Targets,

…Labels, Actuals, **Ground** truth”

target vector

$$y = \begin{bmatrix} y_1 \\ \dots \\ y_i \\ \dots \\ y_N \end{bmatrix}$$

pronounced as…
“target i” or “label i”

N× 1 *vector*

4) key phrase… "Supervised"

- Given x_i and y_i pairs of points
- NOTE: (in case of problems we have seen so far…)
- x_i is a k-dimensional vector
- y_i is a scalar

We will see trivial extension to the case when y_i can be a vector as well

5) key phrase… “Data Set”

Pair of points

in

$$D = \{(x_i, y_i)\}_{i \in [1..N]}$$

Set of Points

Pronounced as…

“x i y i” with i over 1 to N

For each point i

1 to N

6) key phrase… "Model"

f(x) is a scalar i.e. 1x1

Linear Model

$$f(x) = x^T w$$

x^T is (1 x k) vector

w is (kx1) vector

This function invocation is called PREDICTION for a given data point

$$f(x) = x \cdot w$$

DOT PRODUCT FORM

7) key phrase… "Prediction"

"prediction for i^{th} point"

$$y_i' = f(x_i) = x_i \cdot w$$

pronounce as "y prime i"

$$y' = \begin{bmatrix} y'_1 \\ y'_2 \\ \dots \\ y'_i \\ \dots \\ y'_N \end{bmatrix} = \begin{bmatrix} f(x_1) \\ f(x_2) \\ \dots \\ f(x_i) \\ \dots \\ f(x_N) \end{bmatrix} = \begin{bmatrix} x_1 \cdot w \\ x_2 \cdot w \\ \dots \\ x_i \cdot w \\ \dots \\ x_N \cdot w \end{bmatrix}$$

8) key phrase… "Loss function"

$$L(w) = \left|\left|y - y'\right|\right|^2$$

$$L(w) = \sum_{i=1}^{i=N} (y_i - x_i \cdot w)^2$$

Actual value

Predicted value

$$L(y_i, f(x_i)) = (f(x_i) - y_i)^2$$

Squared Loss Function

9) key phrase… "Gradient of Loss function"

$$L(w) = \sum_{i=1}^{i=N} (y_i - x_i \cdot w)^2$$

$$\nabla L = \frac{\partial L}{\partial w} = 2\, X^T (Xw - y)$$

its only, a notational convenience…

differentiating with respect to w

Squared Loss Function

For example,

$$L(W) = (XW - Y)^T (XW - Y)$$

Multi Variate - Loss Function (or simply just *Loss Function*)

For example,

$$L(w) = (Xw - y)^T (Xw - y)$$

$w_{K\times 1}$ is K dimensional vector

Popular two - Regression Loss Functions

$$L(w) = (Xw - y)^T (Xw - y)$$

Squared Error

$$= ||Xw - y||_2 = \sum_{i=1}^{i=N} (y_i - x_i \cdot w)^2$$

L2- Norm

$$L(w) = ||Xw - y||_1 = \sum_{i=1}^{i=N} |y_i - x_i \cdot w|$$

Absolute Error

L1- Norm

Popular… Regression Loss Functions

$$L(w) = \frac{1}{N}\sum_{i=1}^{i=N}(y_i - x_i \cdot w)^2$$

Mean Squared Error (MSE)

$$L(w) = \frac{1}{N}\sum_{i=1}^{i=N}|y_i - x_i \cdot w|$$

Mean Absolute Error (MAE)

Popular… Regression Loss Functions

***Root** Mean Squared Error (RMSE)*

$$L(w) = \sqrt{\frac{1}{N}\sum_{i=1}^{i=N}(y_i - x_i \cdot w)^2}$$

10) key phrase… "BUILDING A MODEL"

- Determining a w such that $L(w)$ is minimized

  Symbolically denoted as,

$$w^* = \underset{w}{\operatorname{argmin}}\, L(w)$$

- NOTE: $\min_{w} L(w)$ is different from $\underset{w}{\operatorname{argmin}}\, L(w)$
- $\min_{w} L(w)$ means **minimum value** of Loss function across various values of w
- $\underset{w}{\operatorname{argmin}}\, L(w)$means **minimizing vector** w for a given Loss function

11) key phrase… “Training/Learning/Fitting a model”

- “Building a model” on a given data set

12) key phrase… “model deployment”

- “Building a model” and using it “to predict” on “new data points”

13) key phrase… "model evaluation"

$$L(w) = \sum_{i=1}^{i=N} (y_i - w \cdot x_i)^2$$

this is an implicit form.. "data set" is assumed to have been given

explicitly compute loss function value on a given "data set"

data set

$$L(w, D) = \sum_{(x,y) \in D} (y - x \cdot w)^2$$

point in a data set

each point in a data set is a tuple

14) key phrase… “model performance”

- **Loss** function value in “model evaluation” being **low**

15) key phrase… “model maintenance”

- “model performance” being high over several months or weeks
- IF “model performance” is LOW
- THEN
  - Identify suitable “new data set”
  - re-“Train model”
  - re-”Evaluate model”
  - re-”Deploy model”
- ELSE
  - continue using

16) key phrase… “production model”

- A “deployed model” already being used in a real world setting

17) key phrase… “Training and Testing”

- We need to mimic or simulate real world scenario

- A “production model” always “sees new data”

- With a “given data set”, we need to mimic this scenario

- Create “train set” to build “temporarily a production model”
- Create “test set” to do “model evaluation” on “new data”

18) key phrase… “Training Set”

- A “data set” “of points” reserved for “training a model”

19) key phrase… “Test Set”

- A “data set” “of points” reserved for “model evaluation”

20) key phrase… “Training/Emperical Error”

- “model performance” on “training set”
- Loss function value on “training set”

21) key phrase… “Test/Generalization Error”

- “model performance” on “test set”
- Loss function value on “test set”