AI

DNN AND ML METRICS

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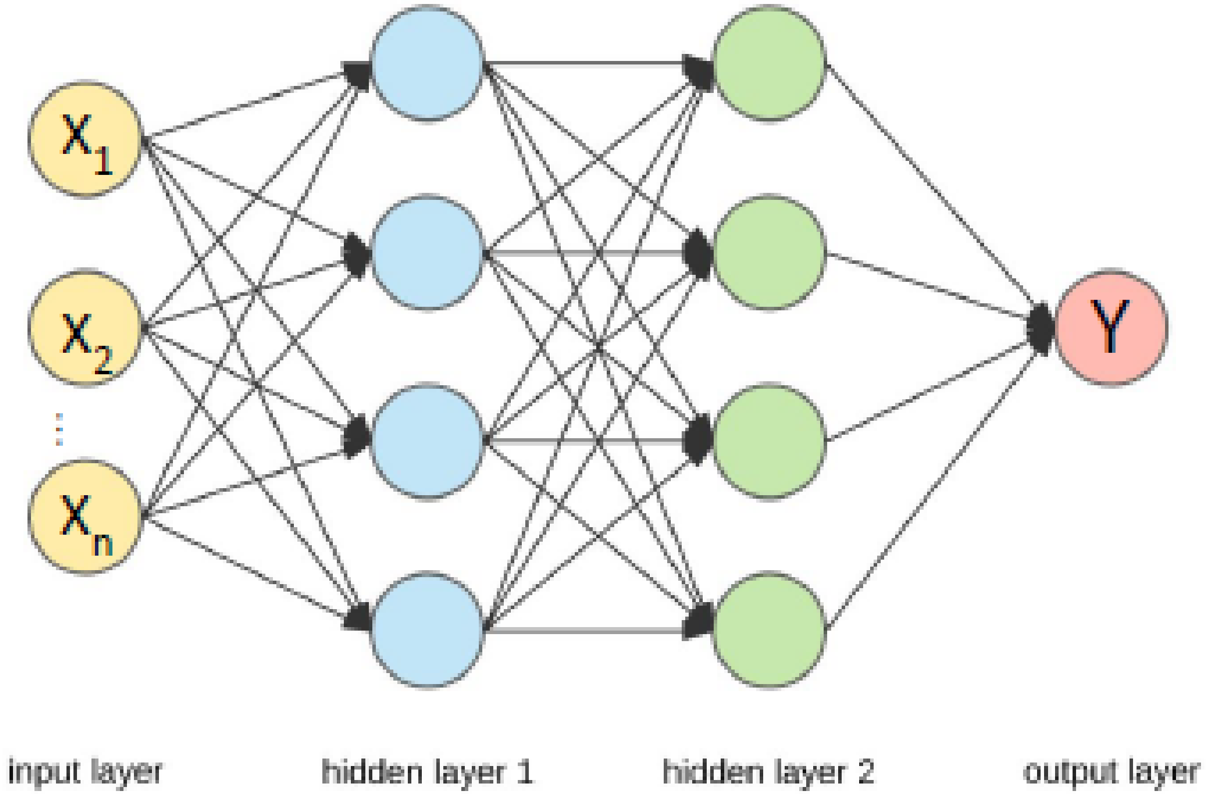
- DNN and ML Metrics

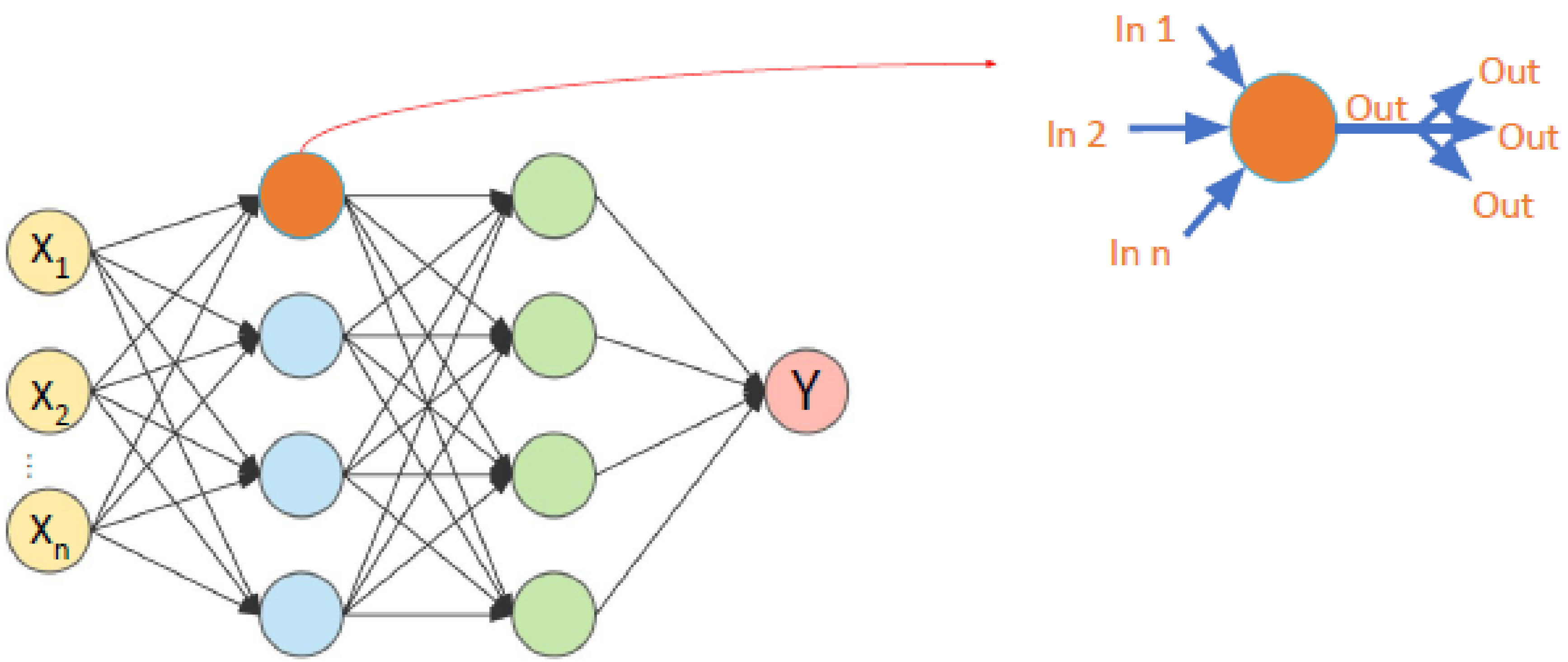
DNN

- Supervised machine learning with DNN



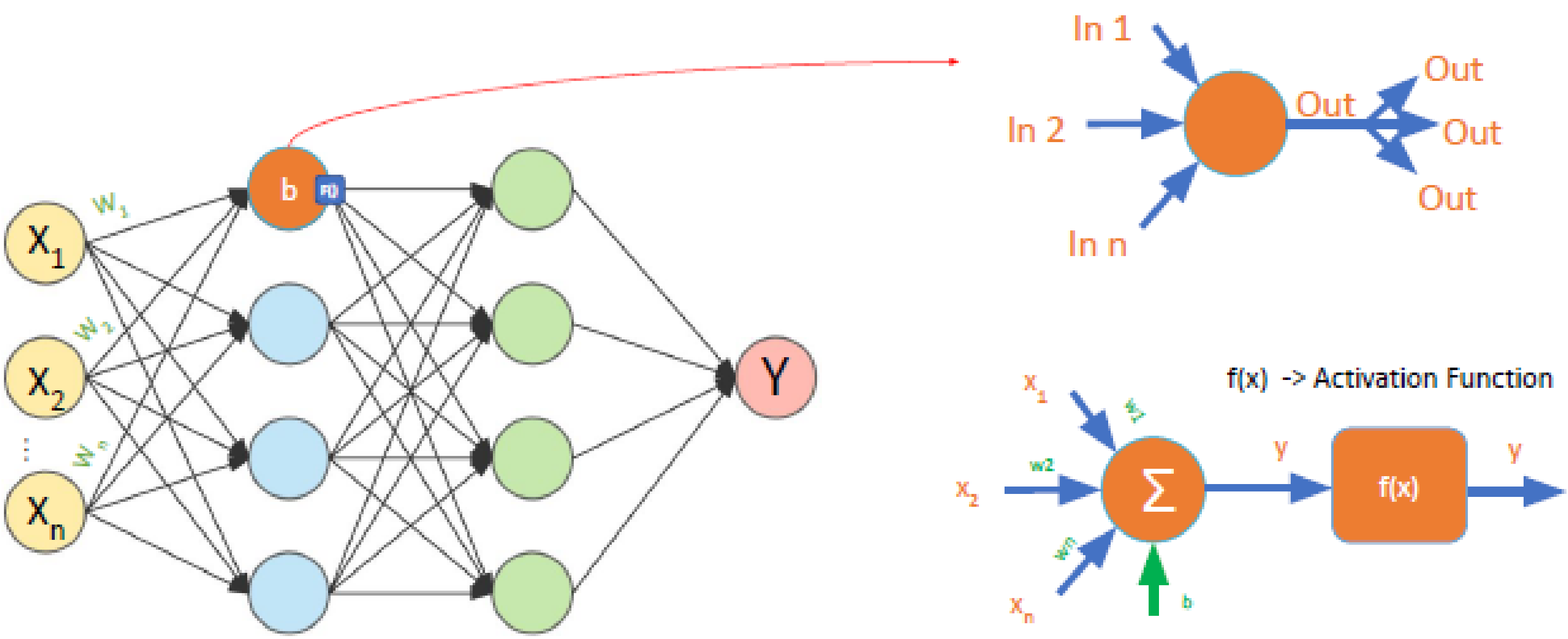
DNN

- Supervised machine learning with DNN



DNN

❖ Supervised machine learning with DNN

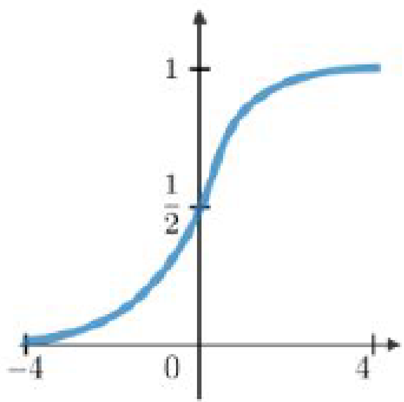


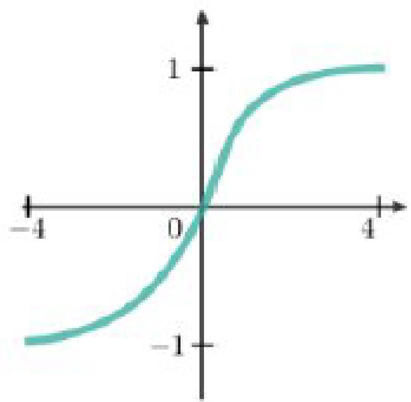
$$y = f(\sum_{i=1}^{n} x_i w_i + b)$$

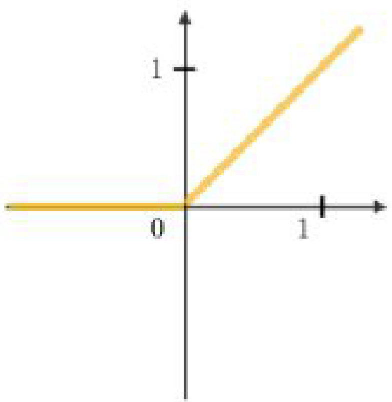
DNN

- Supervised machine learning with DNN
  - Activation Functions

Sigmoid	Tanh	RELU
$g(z) = \dfrac{1}{1+e^{-z}}$	$g(z) = \dfrac{e^{z}-e^{-z}}{e^{z}+e^{-z}}$	$g(z) = \max(0, z)$

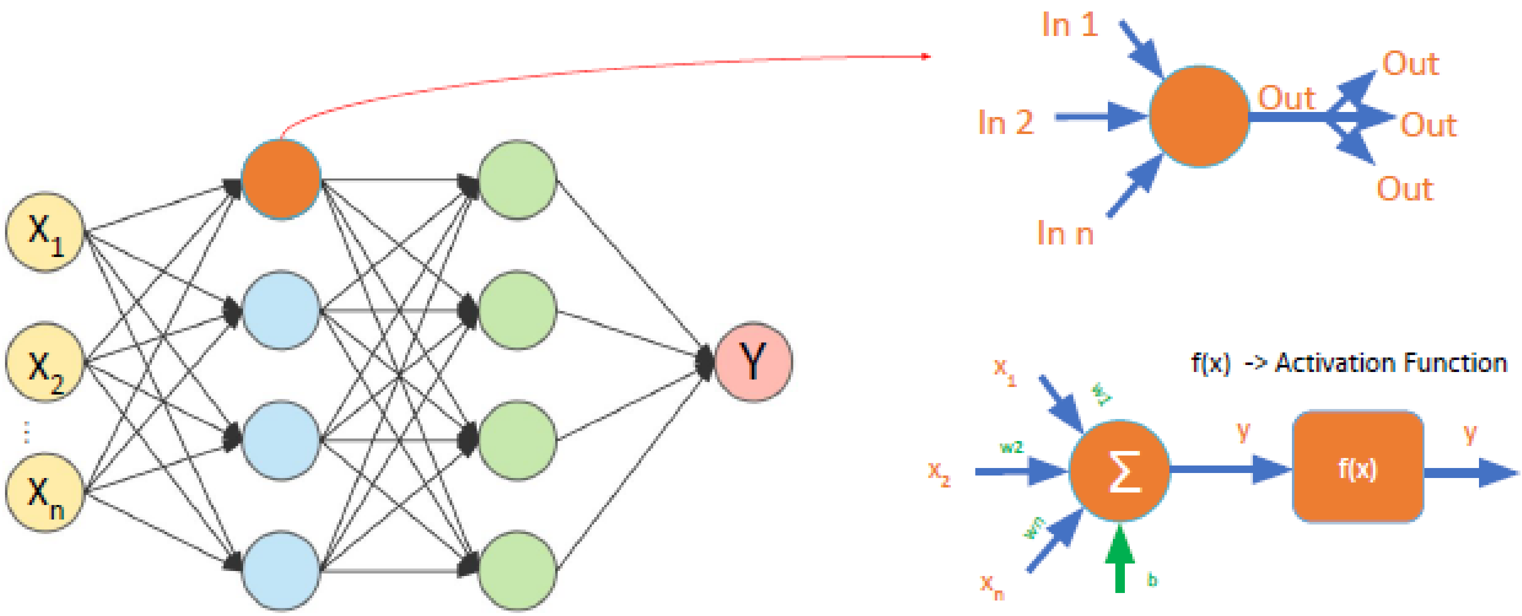






DNN

❖ Supervised machine learning with DNN

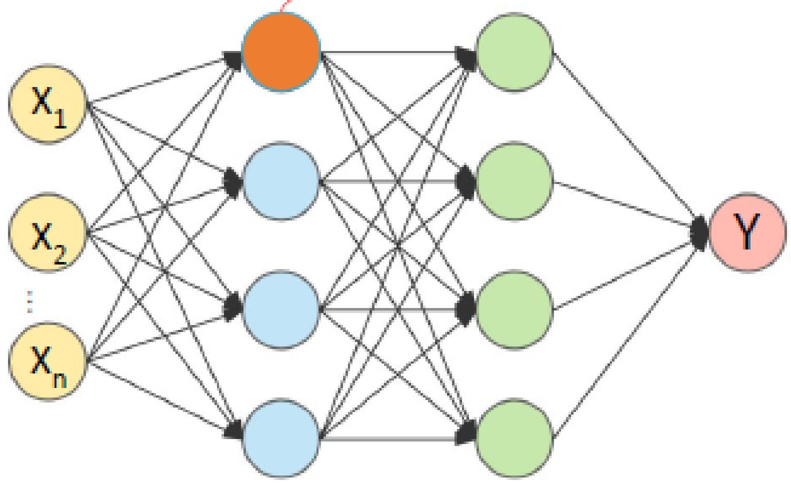


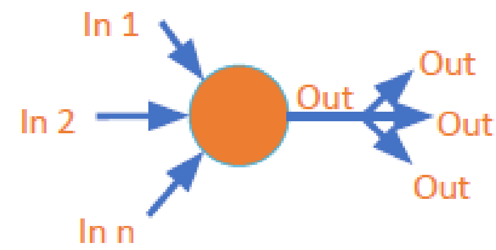
Parameters to be found during training, to reach minimum error

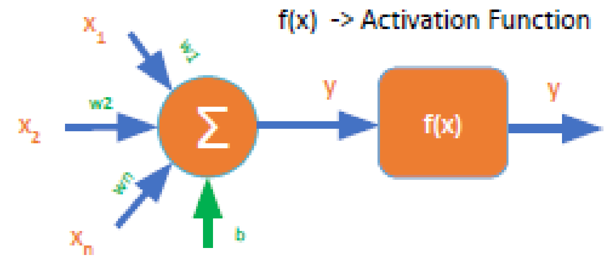
$$y = f(\sum_{i=1}^{n} x_i w_i + b)$$

DNN

- Supervised machine learning with DNN







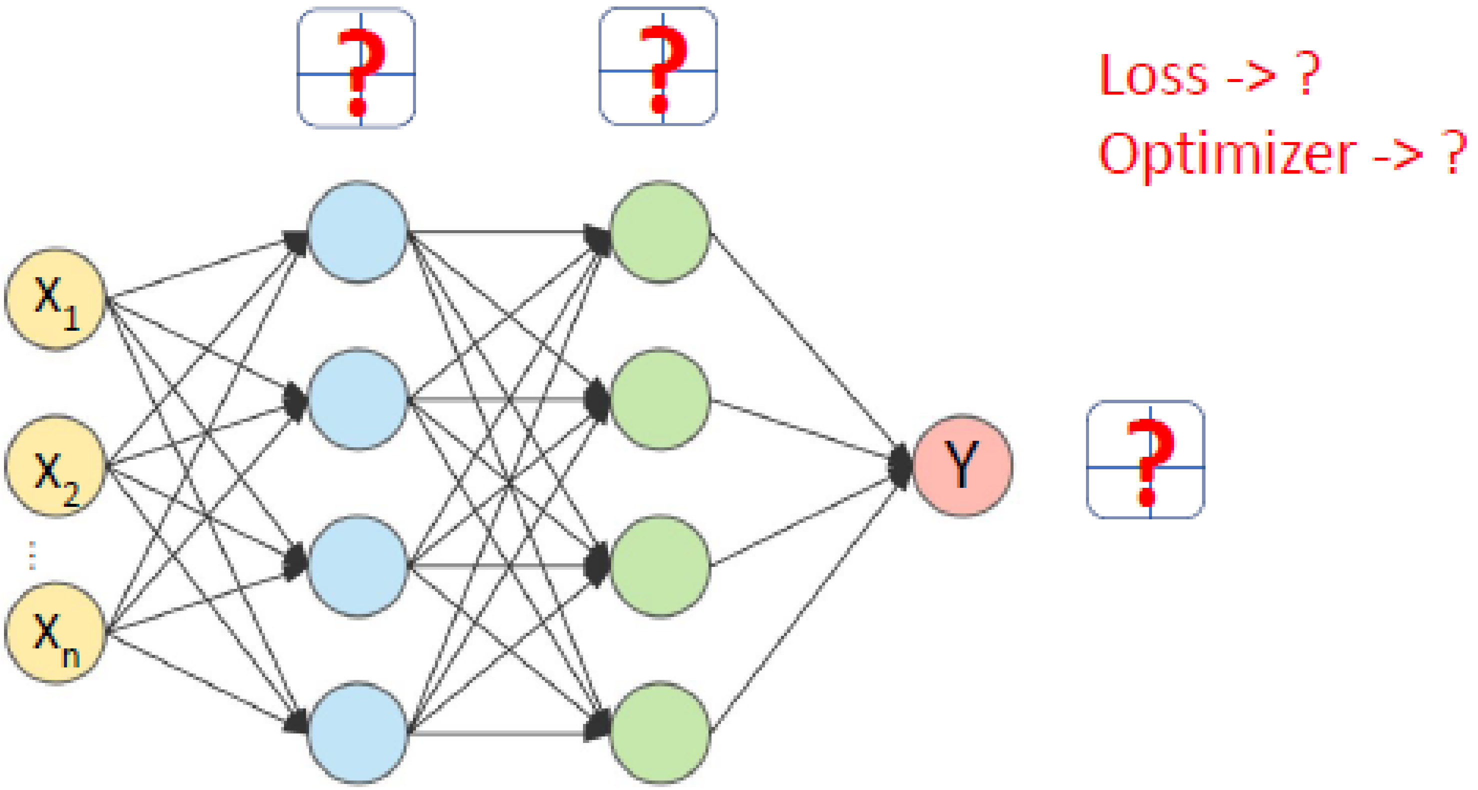
- Error Measurement (Loss)
- Optimization

Parameters to be found during training, to reach minimum error

$$y = f(\sum_{i=1}^{n} x_i w_i + b)$$

DNN

❖ Supervised machine learning with DNN

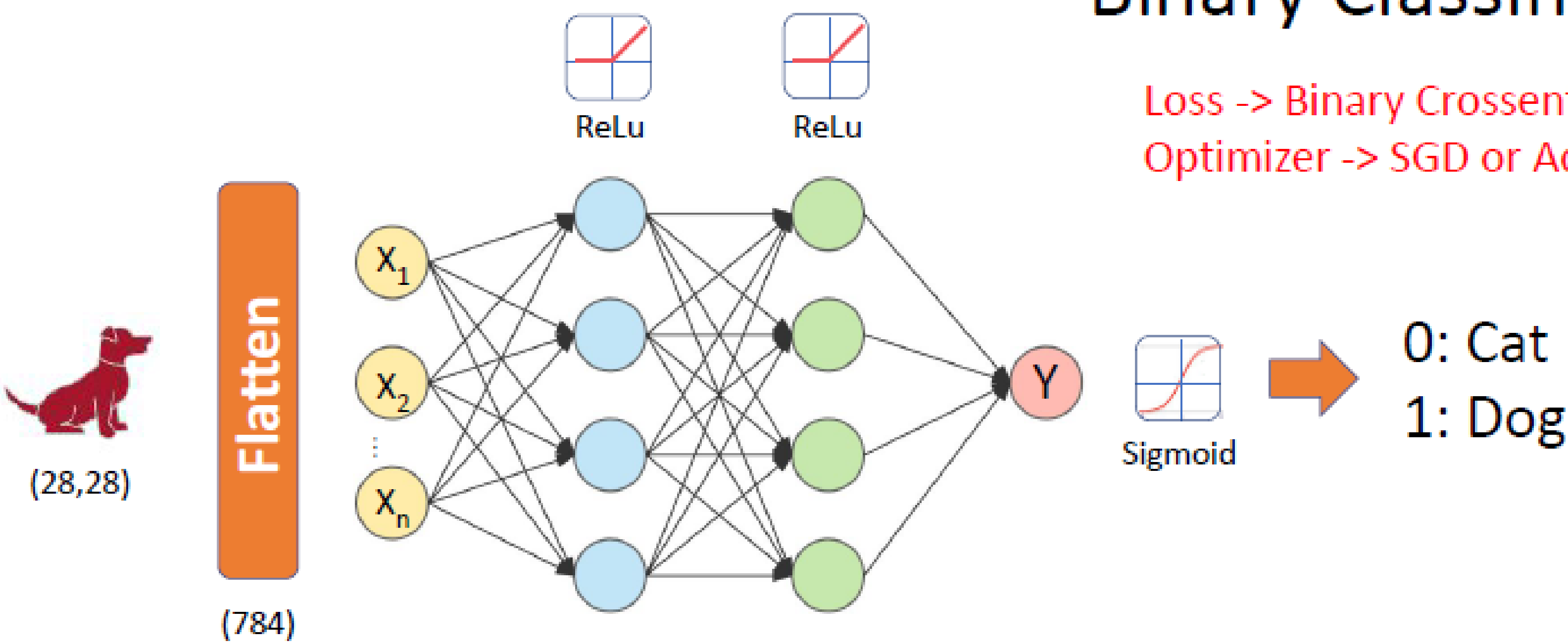


DNN

❖ Supervised machine learning with DNN

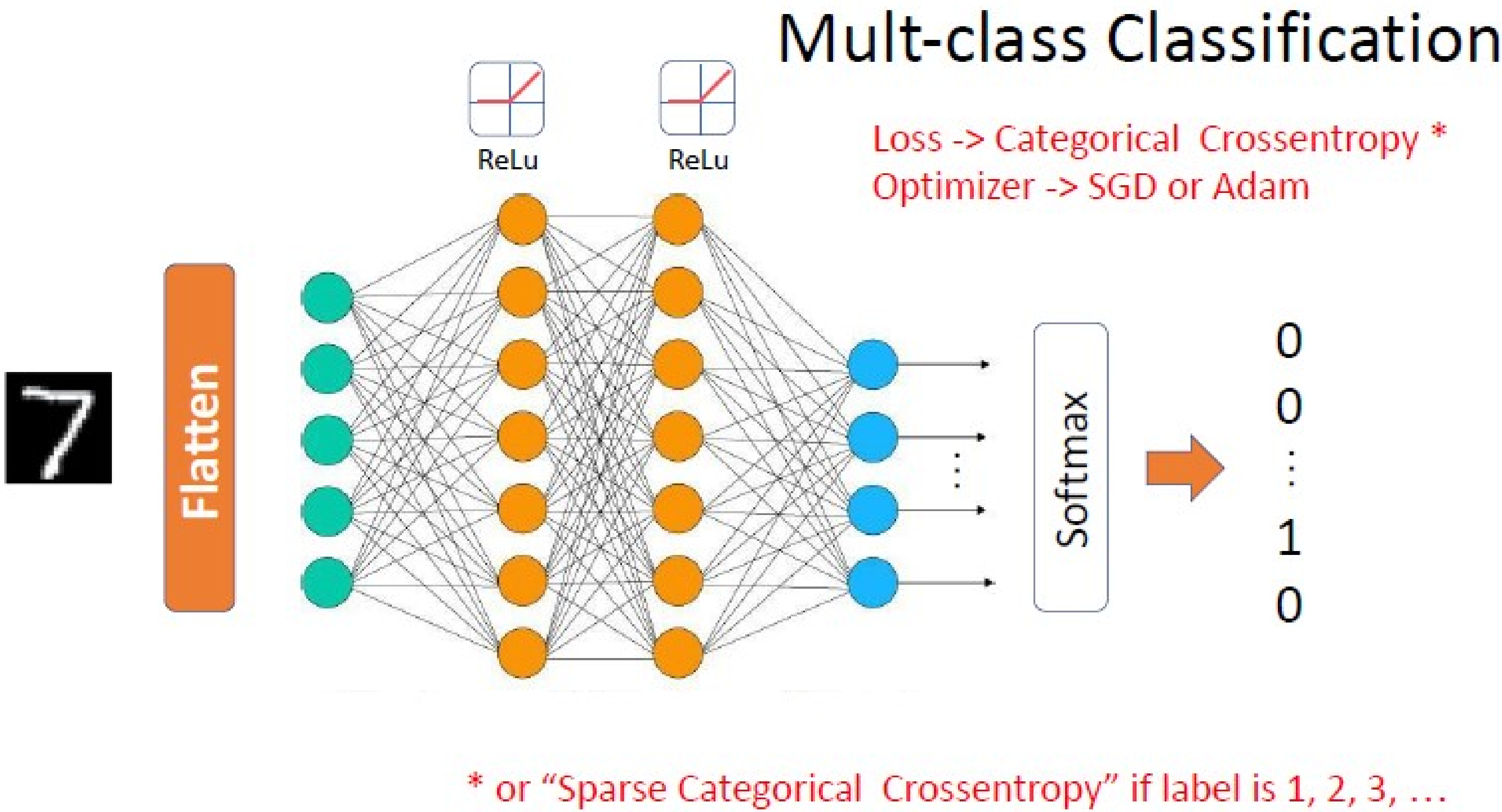
Binary Classification

Loss -> Binary Crossentropy
Optimizer -> SGD or Adam



DNN

❖ Supervised machine learning with DNN



DNN

- Supervised machine learning with DNN
  - Dataset for training and testing

DNN

- Supervised machine learning with DNN
  - Dataset for training and testing

Steps to take

1. Get as many examples of shoes as possible
2. Train using these examples
3. Profit!

DNN

- Supervised machine learning with DNN
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Steps to take

1. Get as many examples of shoes as possible
2. Train using these examples
3. Profit!

```
Training accuracy: .920
Training accuracy: .935
Training accuracy: .947
Training accuracy: .961
Training accuracy: .977
Training accuracy: .995
Training accuracy: 1.00
```

DNN

- Supervised machine learning with DNN
  - Dataset for training and testing

Steps to take

1. ~~Get as many examples of shoes as possible~~
2. ~~Train using these examples~~
3. Profit?

DNN

- Supervised machine learning with DNN
  - Dataset for training and testing

Data

The network 'sees' everything. Has no context for measuring how well it does with data it has never previously been exposed to.

DNN

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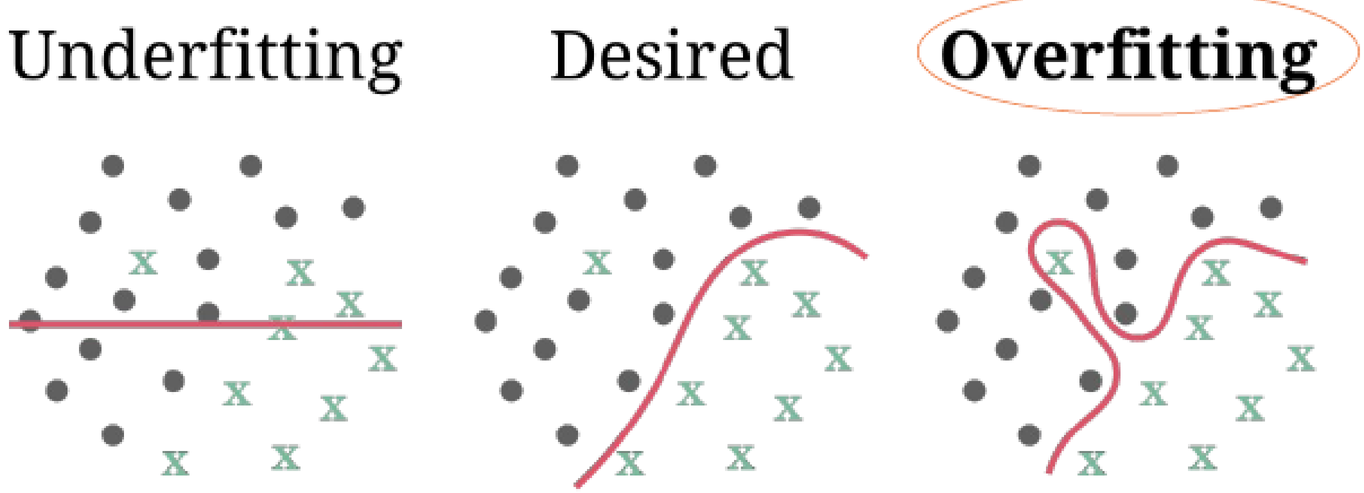


DNN

- Supervised machine learning with DNN
  - Dataset for training and testing

Data	Validation Data

The network 'sees' a subset of your data. You can use the rest to measure its performance against previously unseen data.

DNN

- Supervised machine learning with DNN
  - Dataset for training and testing

Data	Validation Data	Test Data

The network 'sees' a subset of your data. You can use an unseen subset to measure its accuracy while training (validation), and then another subset to measure its accuracy after it's finished training (test).

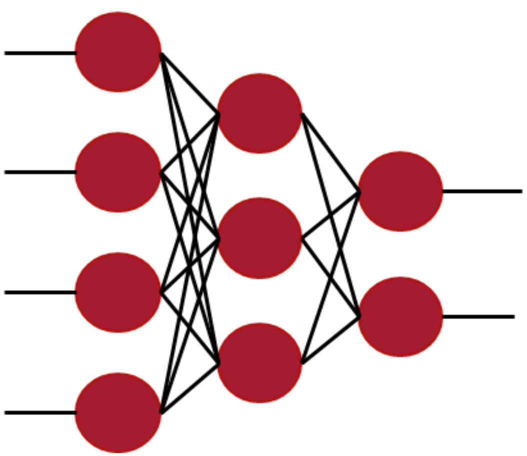
Validation Data: Is used to evaluate the current training epoch

Test Data: Is used to evaluate the final model after training

DNN

- Supervised machine learning with DNN
  - Dataset for training and testing

Data	Validation Data	Test Data
Accuracy: 0.999	Accuracy: 0.920	Accuracy: 0.800



DNN

- Supervised machine learning with DNN
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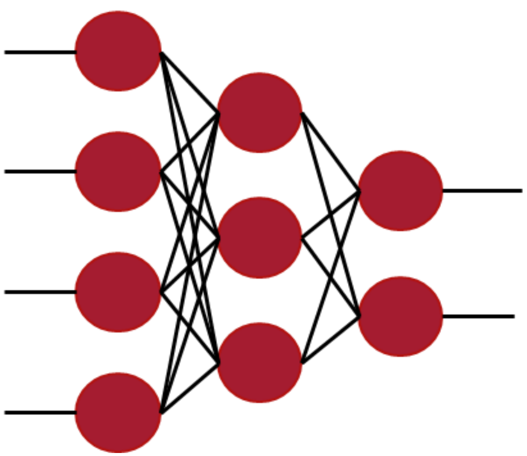

DNN

- Supervised machine learning with DNN
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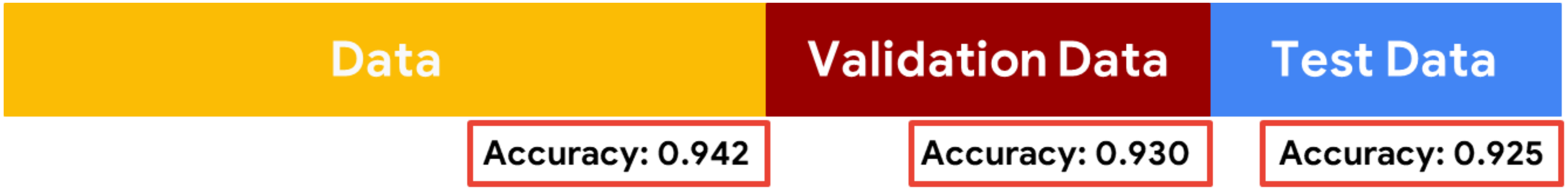
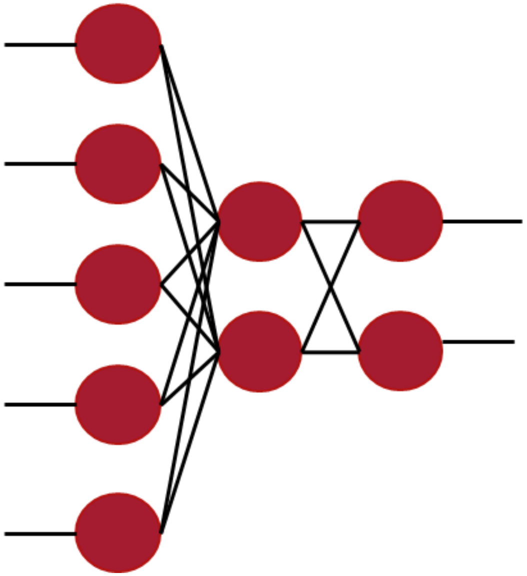




DNN

- Supervised machine learning with DNN
  - Dataset for training and testing

Digits Classification: validation and test dataset

Code Time!

TF_MNIST_Classification_v2.ipynb

DNN

- Supervised machine learning with DNN
  - Dataset for training and testing

```
data = tf.keras.datasets.mnist

(tt_images, tt_labels), (test_images, test_labels) = data.load_data()
```

```
print(tt_images.shape)
print(tt_labels.shape)
```

```
(60000, 28, 28)
(60000,)
```

```
print(test_images.shape)
print(test_labels.shape)
```

```
(10000, 28, 28)
(10000,)
```

DNN

- Supervised machine learning with DNN
  - Dataset for training and testing

```
val_images = tt_images[:10000]
val_labels = tt_labels[:10000]
```

```
train_images = tt_images[10000:]
train_labels = tt_labels[10000:]
```

Split tt data in:
- train (50,000) and,
- validation (10,000)

```
print(train_images.shape)
print(train_labels.shape)
```

```
(50000, 28, 28)
(50000,)
```

```
print(val_images.shape)
print(val_labels.shape)
```

```
(10000, 28, 28)
(10000,)
```

DNN

- Supervised machine learning with DNN
  - Dataset for training and testing

```
history = model.fit(
        train_images,
        train_labels,
        epochs=20,
        validation_data=(val_images, val_labels)
        )
```

You could leave the training data with all samples, and alternatively use:

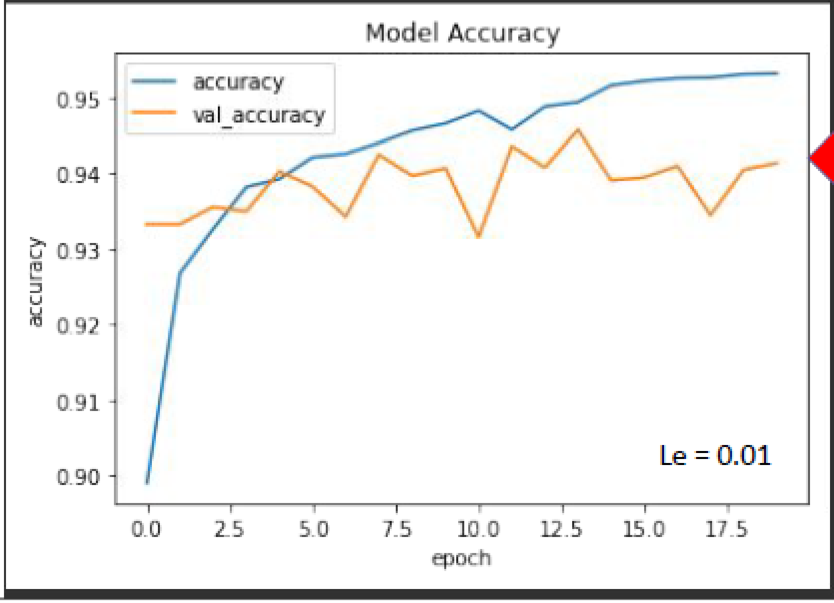
- *validation_split=0.1* instead of *validation_data=(val_images, val_labels)*.

In this case, TF will split the validation data by itself.

DNN

- Supervised machine learning with DNN
  - Dataset for training and testing

```
plt.plot(history.history['accuracy'], label='accuracy')
plt.plot(history.history['val_accuracy'], label='val_accuracy')
plt.title('Model Accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(loc='upper left')
plt.show()
```



If validation accuracy seems "instable", could be that Learning Rate is high (try to reduce it).

DNN

- Supervised machine learning with DNN
  - Dataset for training and testing

```
plt.plot(history.history['accuracy'], label='accuracy')
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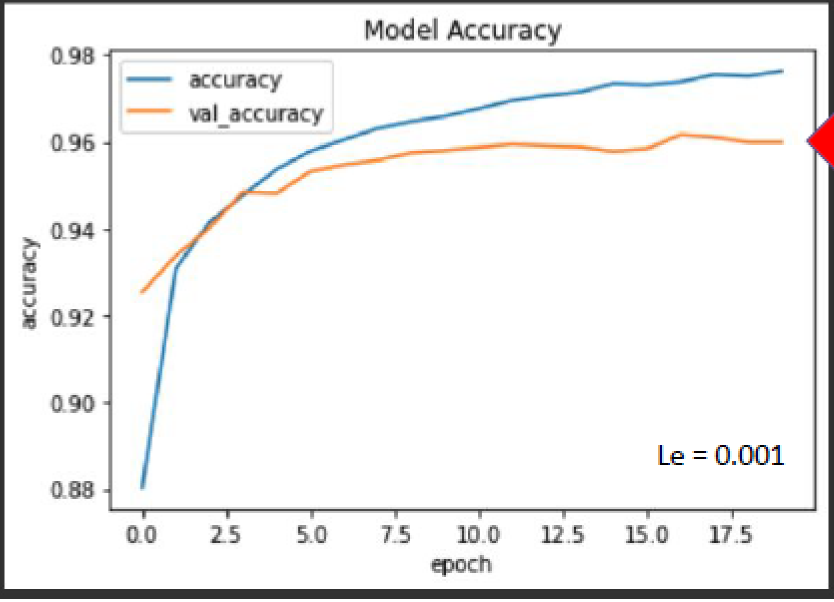


If validation accuracy goes down (or became stable) , even if train accuracy goes up, means that probably the model is overfitting. In this case the training (epochs) should terminate.

DNN

- Supervised machine learning with DNN
  - Dataset for training and testing

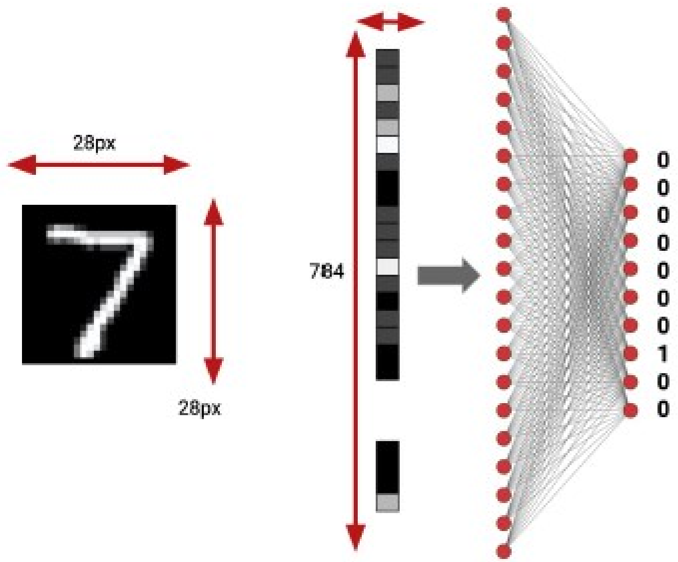
```
model.evaluate(test_images, test_labels)
```

```
313/313 [==============================] - 1s 2ms/step - loss: 0.1495 - accuracy: 0.9569
```

DNN

- Supervised machine learning with DNN
  - Dataset for training and testing

Data	Validation Data	Test Data
Accuracy: 0.976	Accuracy: 0.963	Accuracy: 0.957



DNN

- Supervised machine learning with DNN
  - Dataset for training and testing
    - Training Data
      - Used to train model parameters
    - Validation Data
      - Used to determine what model hyperparameters to adjust (and re-training)
    - Test Data
      - Used to get model final performance metric

MODEL PERFORMANCE METRICS

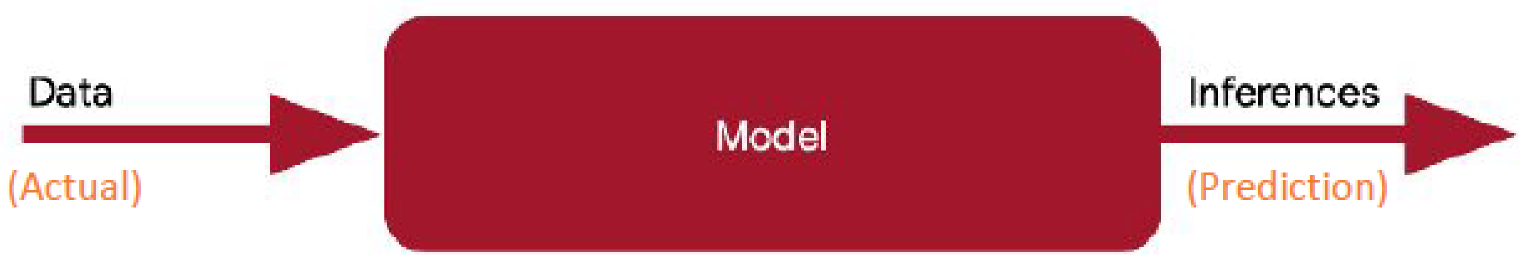
- Classification model performance metrics

Class = [1]

actual = [1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0]

prediction = [0, 0, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1]

Class = [0]



MODEL PERFORMANCE METRICS

- Classification model performance metrics

Class = [1]

actual = [1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0]

prediction = [0, 0, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1]

Class = [0]

Model Performance (Confusion Matrix)

		predicted condition	
	12 pictures, 8 of cats and 4 of dogs	Cat [1]	Dog [0]
true condition	Cat [1]	6	2
	Dog [0]	1	3

MODEL PERFORMANCE METRICS

❖ Classification model performance metrics

Class = [1]

actual = [1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0]

prediction = [0, 0, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1]

Class = [0]

Model Performance (Confusion Matrix)

		predicted condition	
	12 pictures, 8 of cats and 4 of dogs	Cat [1]	Dog [0]
true condition	Cat [1]	True Positive (TP) 6	False Negative (FN) (type II error) 2
	Dog [0]	False Positive (FP) (Type I error) 1	True Negative (TN) 3

MODEL PERFORMANCE METRICS

❖ Classification model performance metrics

Model Performance (Confusion Matrix)

		predicted condition	
	total population (P + N)	prediction positive (PP)	prediction negative (PN)
true condition	condition positive (P)	**True Positive (TP)**	**False Negative (FN)** (type II error)
	condition negative (N)	**False Positive (FP)** (Type I error)	**True Negative (TN)**

MODEL PERFORMANCE METRICS

❖ Classification model performance metrics

Type I error (false positive) **Type II error (false negative)**

MODEL PERFORMANCE METRICS

❖ Classification model performance metrics

Precision

vs.

Accuracy

In a set of measurements:

- **Accuracy** is closeness of the measurements to a specific value
- **Precision** is the closeness of the measurements to each other.

High Precision, High Accuracy

Low Precision, High Accuracy

High Precision, Low Accuracy

Low Precision, Low Accuracy

MODEL PERFORMANCE METRICS

❖ Classification model performance metrics

Accuracy , Precision and Recall

$$\text{Accuracy} = \frac{TP + TN}{(P + N)} = \frac{TP + TN}{(TP + TN + FP + FN)} = \frac{6 + 3}{(6 + 3 + 1 + 2)} = \frac{9}{12} = 0.75$$

$$\text{Precision} = \frac{TP}{(TP + FP)} = \frac{6}{(6 + 1)} = \frac{6}{7} = 0.86 \qquad \frac{\text{Total Positive}}{\text{Total Predict Positive}}$$

$$\text{Recall} = \frac{TP}{(TP + FN)} = \frac{6}{(6 + 2)} = \frac{6}{8} = 0.75 \qquad \frac{\text{Total Positive}}{\text{Total Actual Positive}}$$

(or Sensitivity)

MODEL PERFORMANCE METRICS

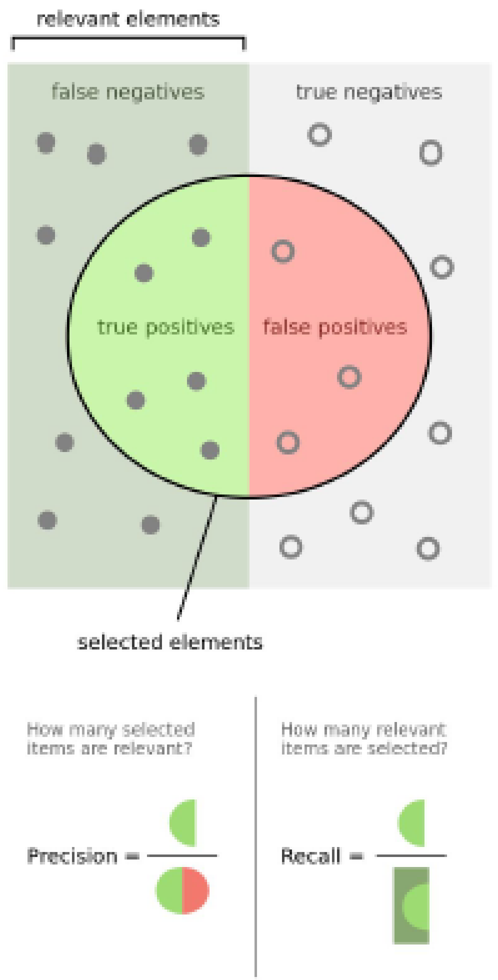
❖ Classification model performance metrics

F1-Score

$$F1 = 2 \times \frac{(Precision * Recall)}{(Precision + Recall)}$$

$$F1 = 2 \times \frac{(0.86 * 0.75)}{(0.86 + 0.75)} = 2 \times \frac{0.65}{1.61} = 0.80$$

The F1-score is a way of combining the precision and recall of the model



MODEL PERFORMANCE METRICS

❖ Classification model performance metrics

Classification Report

Code Time!

Classification_Report.ipynb

MODEL PERFORMANCE METRICS

❖ Classification model performance metrics

```
from sklearn.metrics import classification_report
```

```
actual = [1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0]
prediction = [0, 0, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1]
```

```
target_names = ['Dogs', 'Cats']
```

```
print(classification_report(actual, prediction, target_names=target_names))
```

```
              precision    recall  f1-score   support

        Dogs       0.60      0.75      0.67         4
        Cats       0.86      0.75      0.80         8

    accuracy                           0.75        12
   macro avg       0.73      0.75      0.73        12
weighted avg       0.77      0.75      0.76        12
```