Deep Learning with Tensorflow in practice

Démarrage à 9h05
Conférence ENREGISTREE

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Rouen

2022

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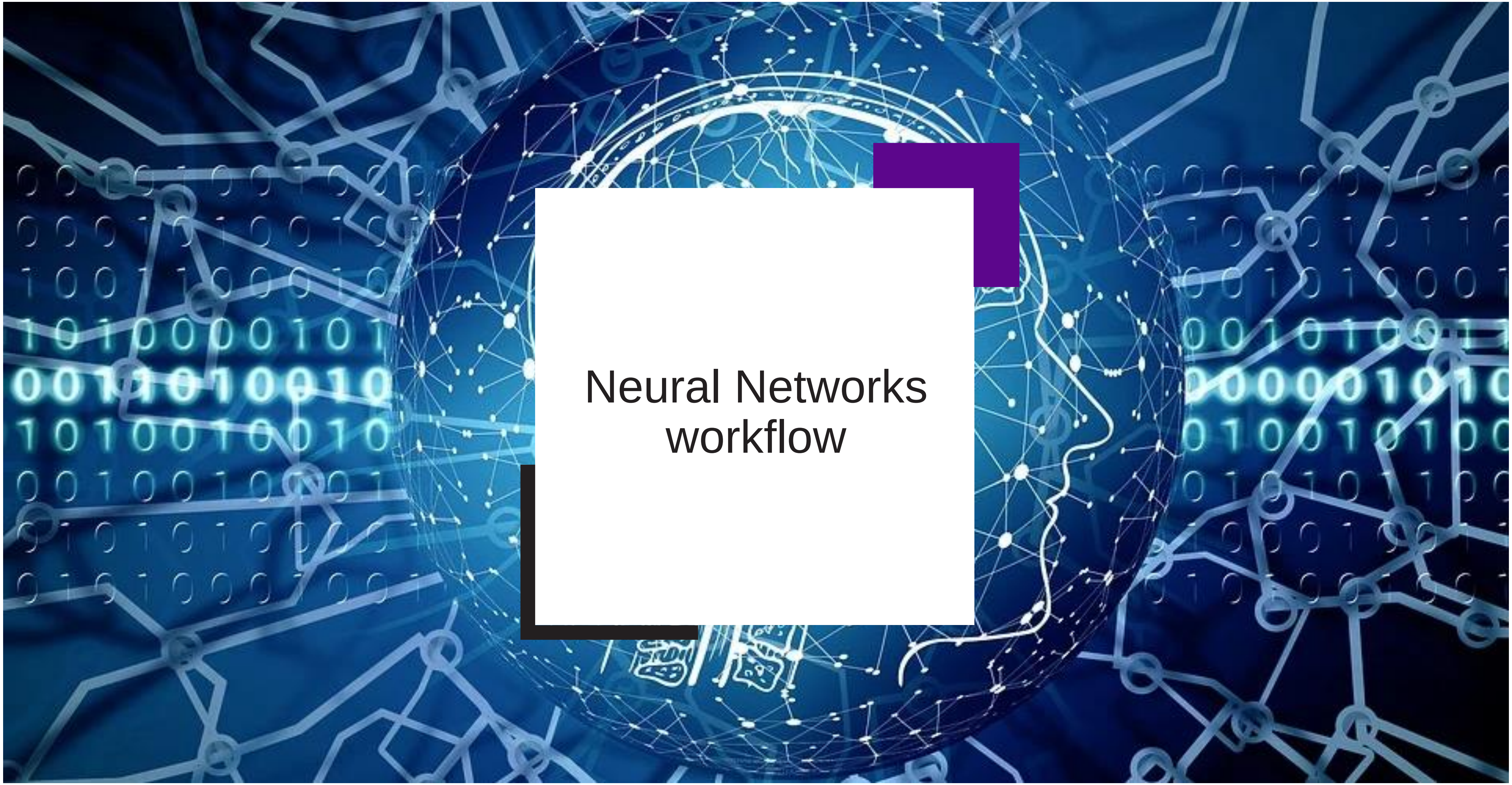
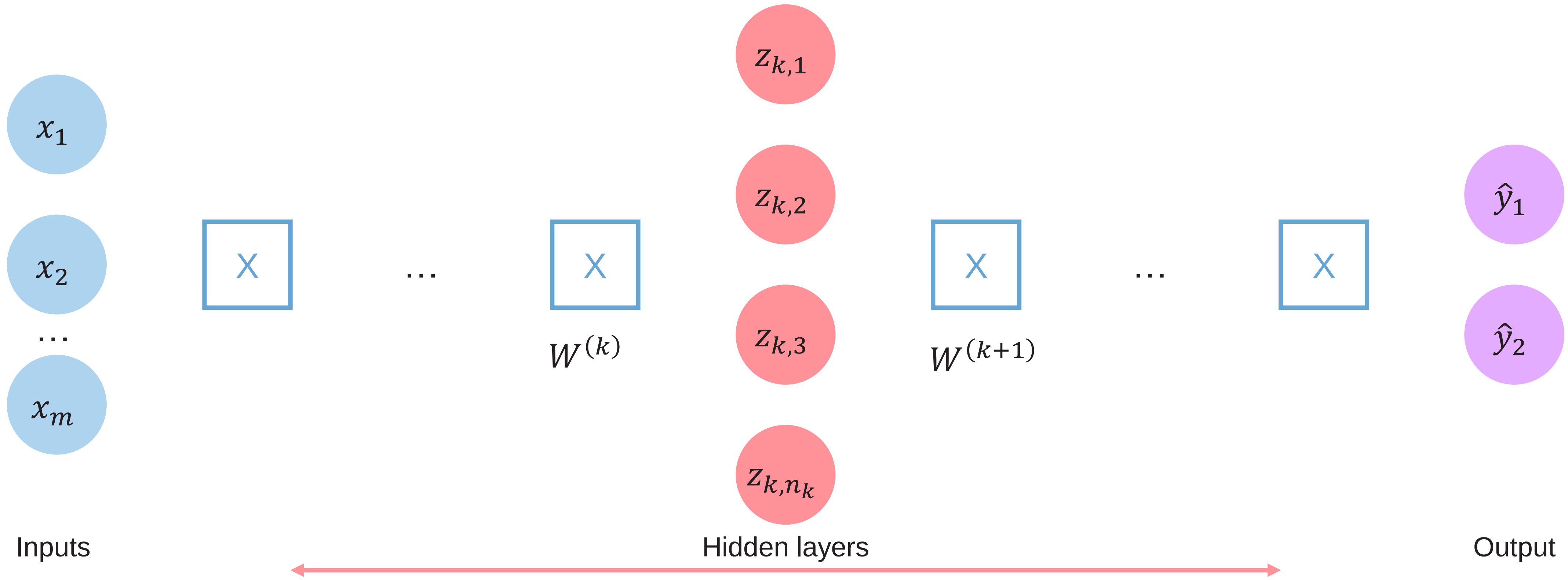
Outline

1. **Neural Networks workflow**
2. **Deep Learning Metrics**
3. **Conclusion**



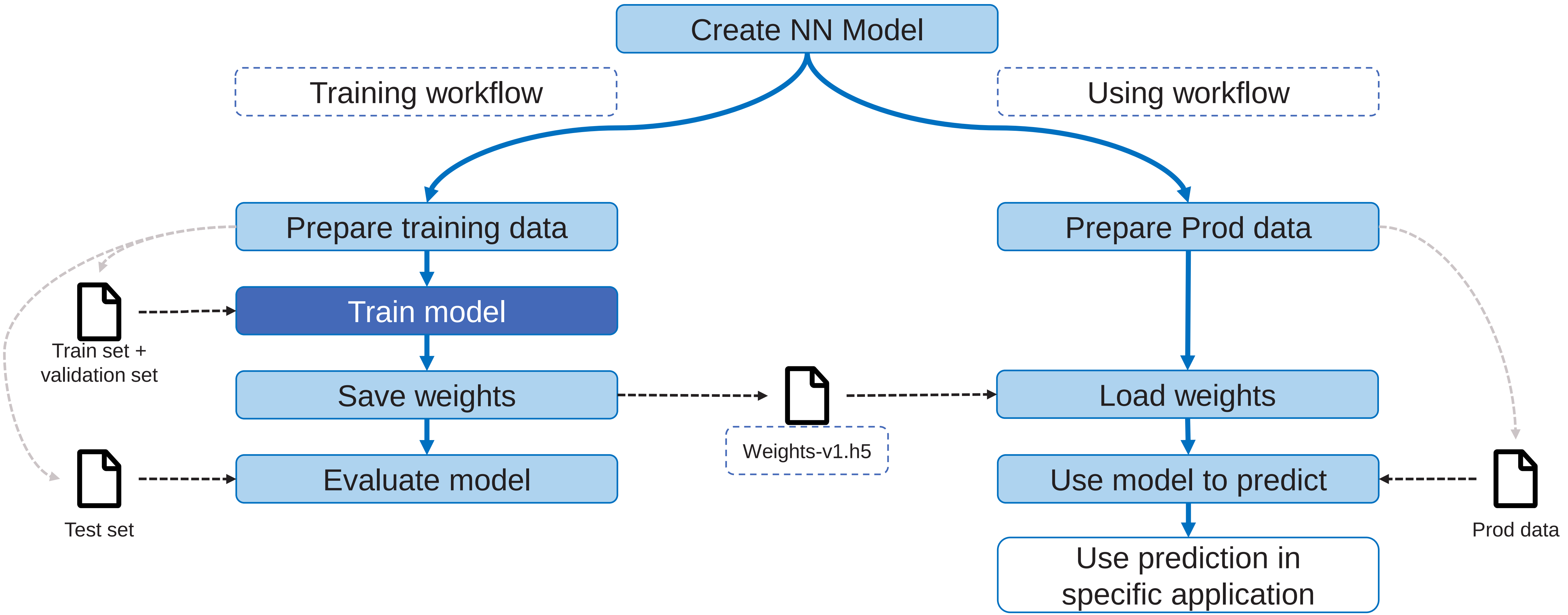
Neural Networks workflow

Deep Neural Network

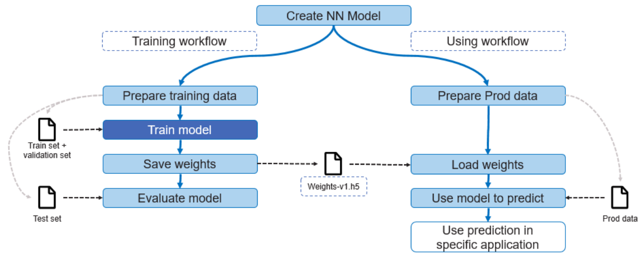


$$z_{k,i} = w_{0,i}^{(k)} + \sum_{j=1}^{d_1} g(z_{k-1,j}) w_{j,i}^{(k)}$$

Neural networks workflow



Neural networks workflow



How to **train** a neural network?

1. Prepare your training data in several sets *(training validation, test)*
2. Create your model
   - Define NN
   - Set the Loss function
     Depends on the problematic to solve
   - Set the optimizer
   - Set the metrics
   - and compile
3. Train the neural network on the training set and please wait…
4. Save the NN weights
5. Evaluate on the test set

How to **use** a neural network?

1. Prepare your data to use
2. Create the exactly same model
   - Define NN
   - Set the Loss function
     Depends on the problematic to solve
   - Set the optimizer
   - Set the metrics
   - and compile
3. Load the NN weights
4. *(classification only) transform into probability model*
5. Predict on the data given

Neural networks workflow

How to train a neural network?

1. Prepare your data in several sets *(training validation, test)*
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   - Define NN
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   - and compile
3. Train the neural network on the training set and please wait…
4. Save the NN weights*
5. Evaluate on the test set

*Save the NN weights during training
https://www.tensorflow.org/tutorials/keras/save_and_load#checkpoint_callback_usage

How to train a neural network?

1. Prepare your data in several sets *(training set, validation set, test set)*

[18]:
```
mnist = tf.keras.datasets.mnist

(x_train, y_train), (x_test, y_test) = mnist.load_data()
x_train, x_test = x_train / 255.0, x_test / 255.0
```

2. Create your model
   - Define NN
   - Set the Loss function *(It depends on the problematic to solve)*
   - Set the metrics for evaluation
   - and compile

[16]:
```
def create_model(summary=False, loss_fn_to_use =
                 tf.keras.losses.SparseCategoricalCrossentropy(from_logits=True)):
    model = tf.keras.models.Sequential([
      tf.keras.layers.Flatten(input_shape=(28, 28)),
      tf.keras.layers.Dense(128, activation='relu'),
      tf.keras.layers.Dropout(0.2),
      tf.keras.layers.Dense(10)
    ])
    if summary:
        model.summary()
    # Set loss function to use with the model
    loss_fn = loss_fn_to_use

    # and compile
    model.compile(optimizer='adam', loss=loss_fn, metrics=['accuracy',
                                                  tf.metrics.SparseCategoricalAccuracy()])
    return model
```

3. Train the neural network on the training set …*and please wait*
   it is possible to save the NN weights during training see https://www.tensorflow.org/tutorials/keras/save_and_load#checkpoint_callback_usage
4. Save the Neural Network weights
5. Evaluate on the test set

[17]:
```
# Create your model
model = create_model(summary=True)
# Training from a few minutes to days
model.fit(x_train, y_train, epochs=5) # *you can save NN weights during training

# Save weights after training
model.save_weights('./mnist_model_0.98.h5')

# evaluate training on test set
model.evaluate(x_test,  y_test, verbose=2)
```

Neural networks workflow

How to use a neural network?

1. Prepare your data to use
2. Create the exactly same model
   - Define NN
   - Set the Loss function
     Depends on the problematic to solve
   - Set the metrics
   - and compile
3. Load the NN weights
4. *(classification only) transform into probability model*
5. Predict on the data given

How to use a neural network?

1. prepare your data

```
[29]: mnist = tf.keras.datasets.mnist

      (x_train, y_train), (x_test, y_test) = mnist.load_data()
      x_train, x_test = x_train / 255.0, x_test / 255.0
```

2. Create your model
   - Define NN
   - Set the Loss function *(It depends on the problematic to solve)*
   - Set the metrics for evaluation
   - and compile
3. Load the NN weights

```
[ ]: model = create_model(summary=False)

     model.load_weights('./mnist_model_0.98.h5')
     # evaluate to check the model is well loaded
     model.evaluate(x_test,  y_test, verbose=2)
```

4. (classification only) transform into probability model
5. Predict on the data given

```
[ ]: # probability model
     probability_model = tf.keras.Sequential([model, tf.keras.layers.Softmax()])
```

```
[44]: # Prepare the data given
      im_to_test = x_test[0]
      # only when testing on 1 unique sample
      im_to_test = np.expand_dims(im_to_test, axis=0)

      # NOT UNDERSTANDABLE approach
      model_output = model.predict(im_to_test)
      model_output_class = np.argmax(model_output)
      print(model_output)
      print(model_output_class)

      # UNDERSTANDABLE approach
      prob_model_output = probability_model.predict(im_to_test)
      prob_model_output_class = np.argmax(prob_model_output)
      print(prob_model_output)
      print(prob_model_output_class)

[[ -6.098753  -13.523815   -4.2792406   1.8365132 -20.36935    -3.3478541
  -22.223114   13.569721   -5.958574   -1.6038301]]
7
[[2.8713529e-09 1.7116818e-12 1.7712962e-08 8.0228556e-06 1.8215655e-15
  4.4955883e-08 2.8534189e-16 9.9999166e-01 3.3034322e-09 2.5716190e-07]]
7
```

One hot Encoding label for classification

One-hot encoding is a way to represent label for classification

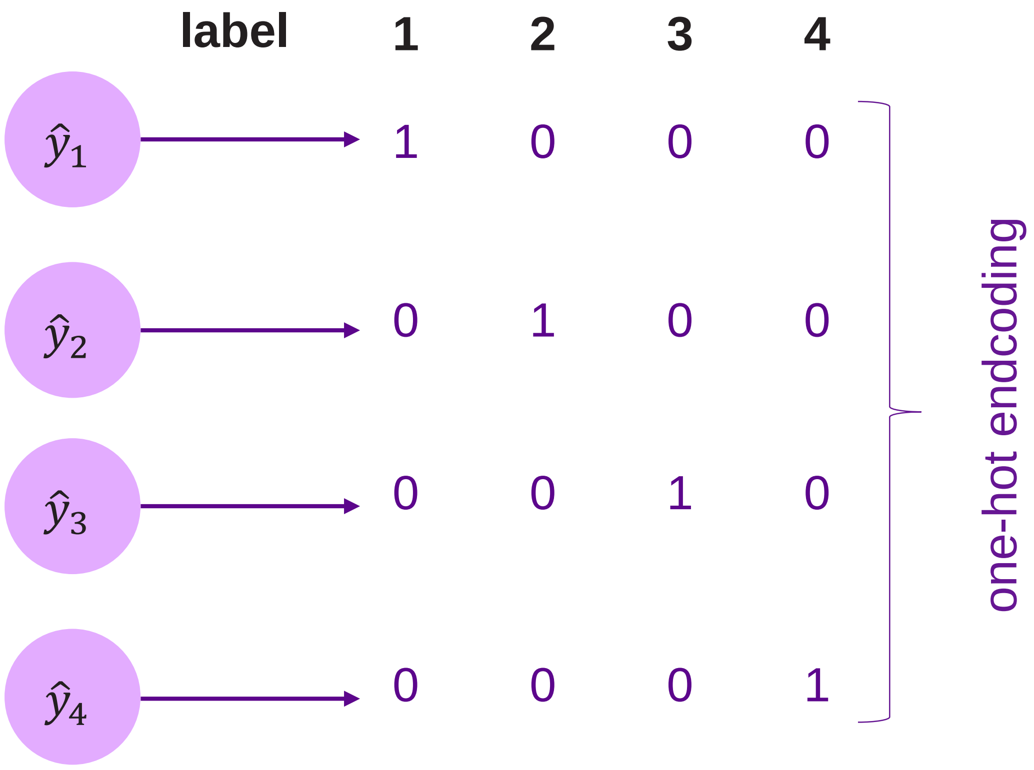
In tensorflow, when you use:

- **CategoricalCrossEntropy**: the label must be encoded in one-hot representation

  y_true = [1,2,3,4,4,2,1, …]

- **SparseCategoricalCrossEntropy**: the label must be in integer and it is <u>automatically</u> converted into on-hot encoding

  y_true = [[1,0,0,0],
  [0,1,0,0],
  [0,0,1,0],
  [0,0,1,0],
  [0,0,0,1],
  [0,1,0,0],
  [1,0,0,0]]

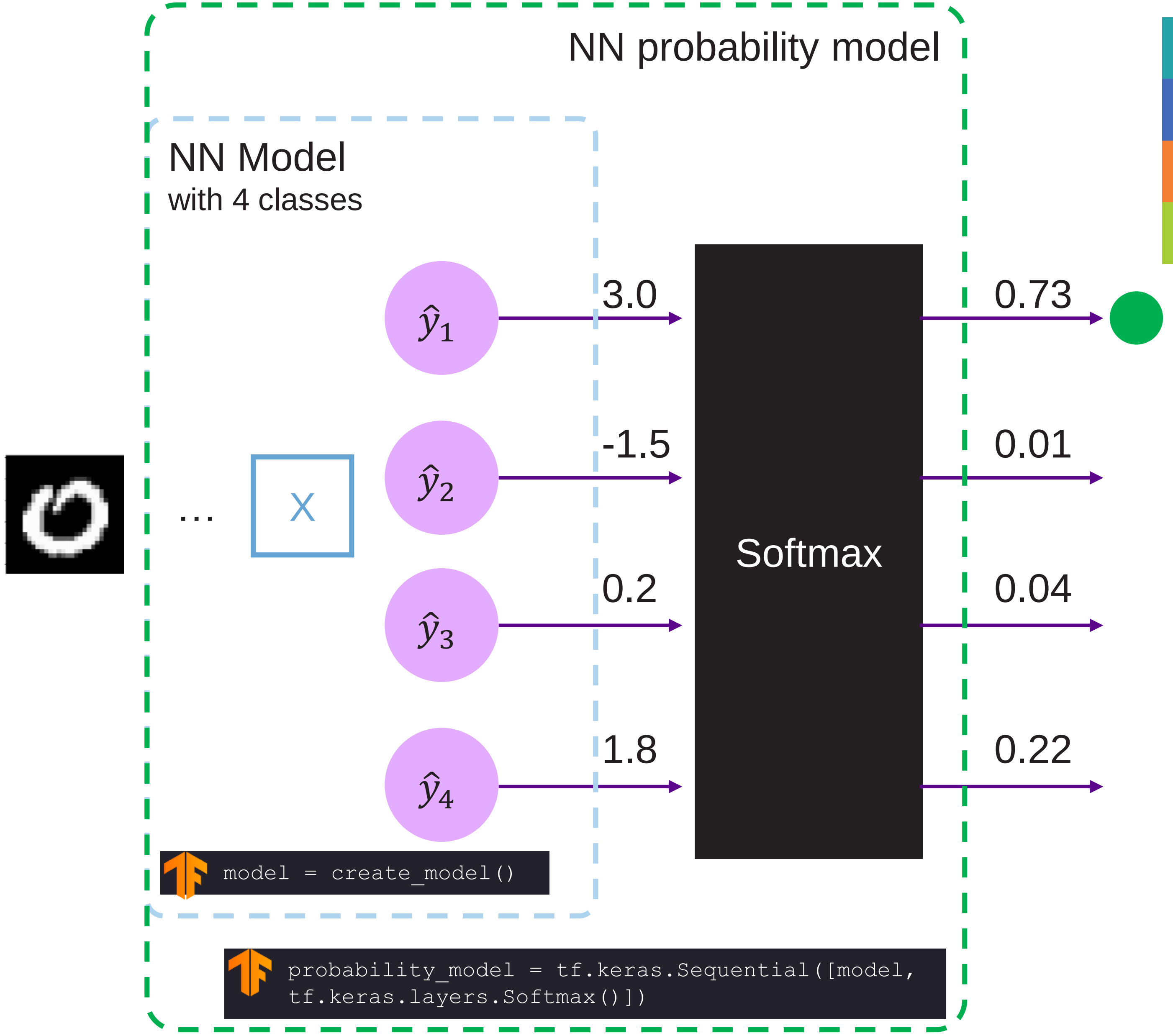


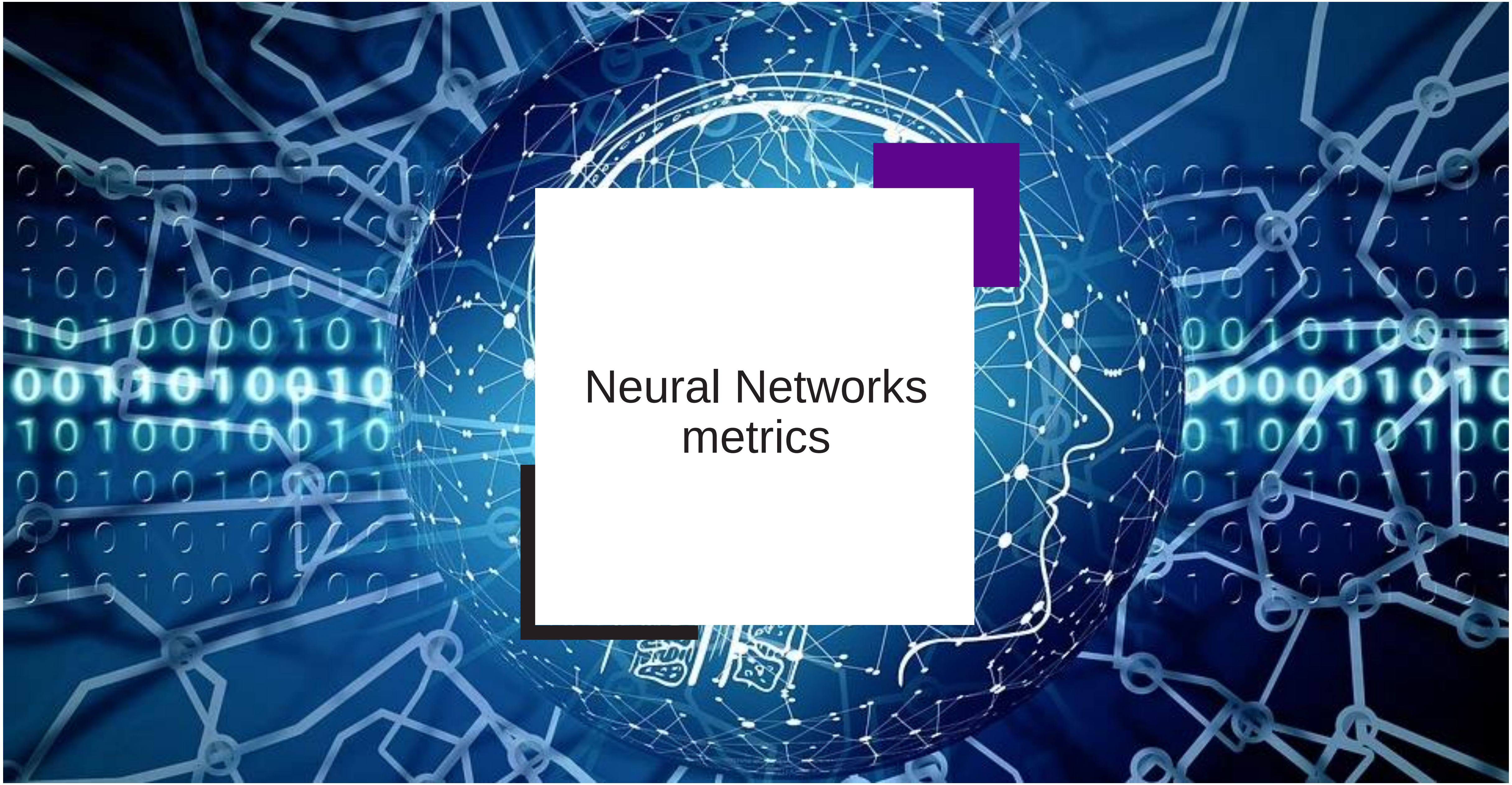
What is a softmax layer?

It transforms a vector of value into a vector of probability value.

For a Neural network with K classes, it is.

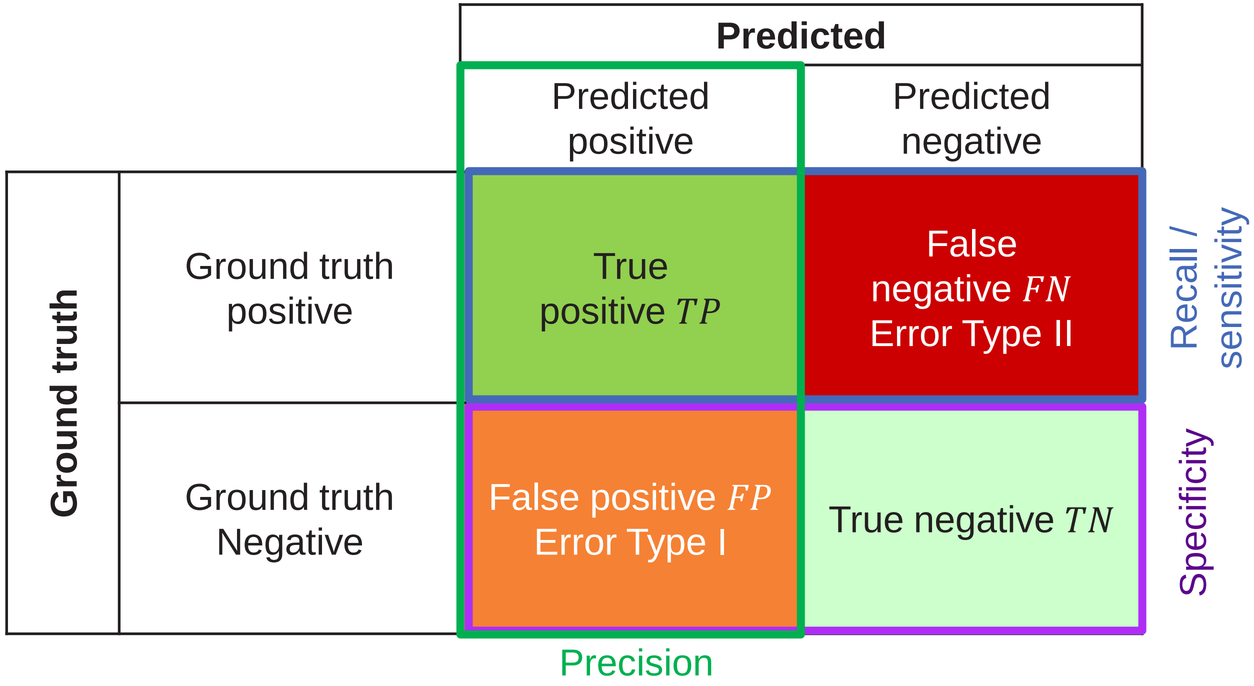
$$\boldsymbol{softmax}(\boldsymbol{z})_i = \frac{e^{z_i}}{\sum_{j=1}^{K} e^{z_j}}, for\ i = 1 \ldots K$$





Neural Networks metrics

Binary classification metrics



$$Accuracy = \frac{TP+TN}{ALL}$$

$$precision = \frac{TP}{Pred\ positive} = \frac{TP}{TP+FP}$$

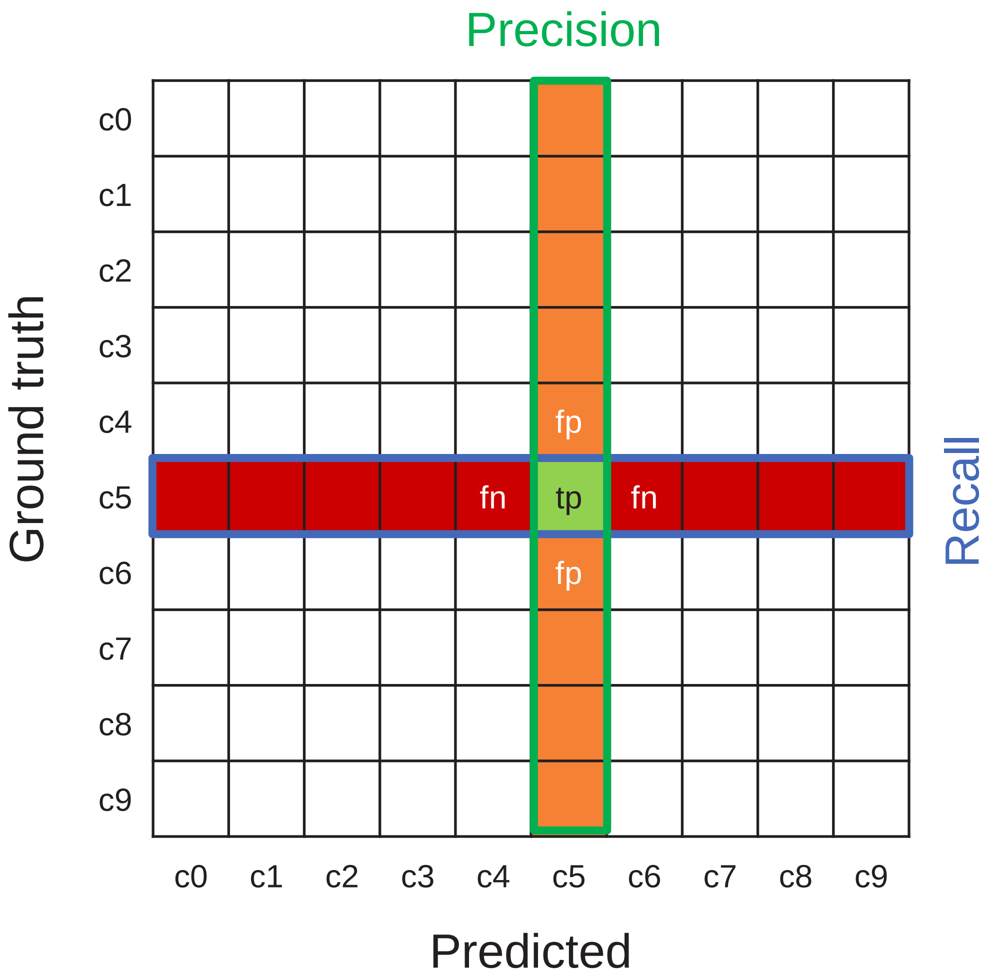
$$TPR = recall = sensitivity = \frac{TP}{GT\ positive} = \frac{TP}{TP+FN}$$

$$specificity = \frac{TN}{GT\ negative} = \frac{TN}{FP+TN}$$

$$FPR = \frac{FP}{GT\ negative} = \frac{FP}{FP+TN}$$

$$F1_{score} = \frac{2 \cdot precision \cdot recall}{precision+recall}$$

Multi classes classification metrics – Confusion matrix



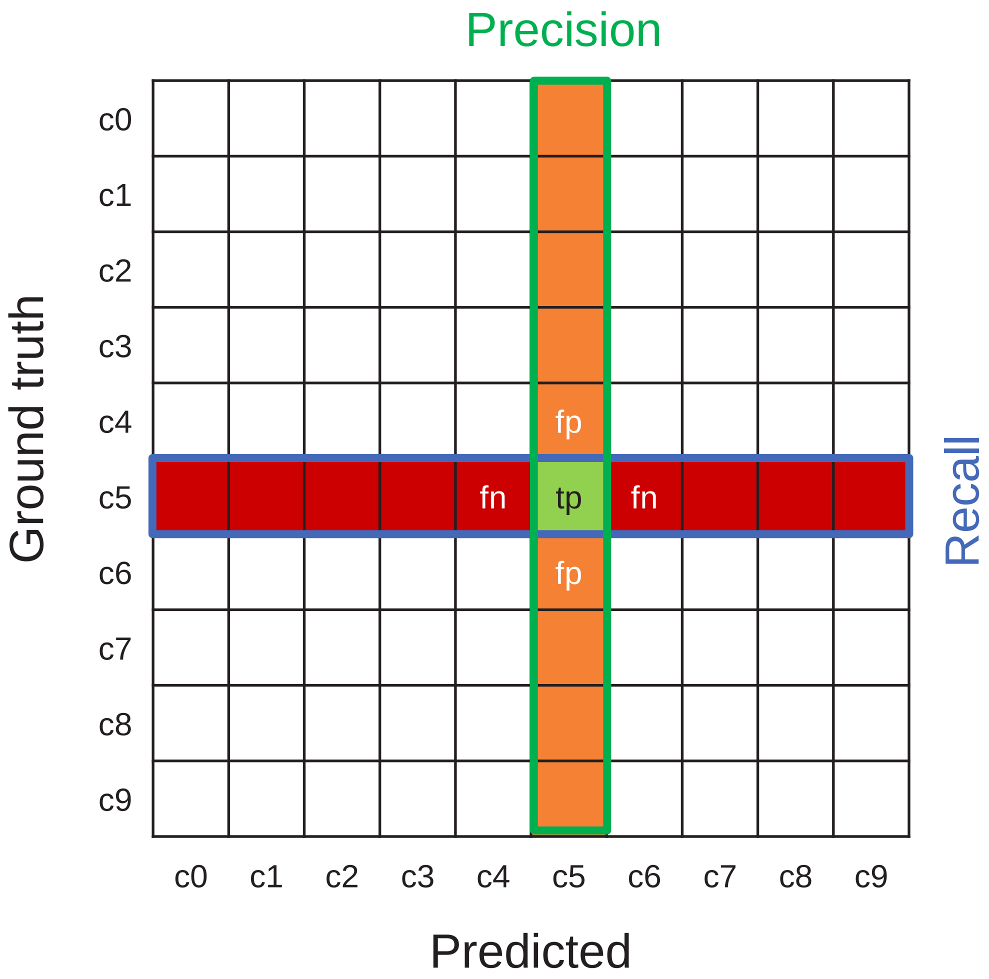
True positive, false positive and false negative on confusion matrix on **c5** class

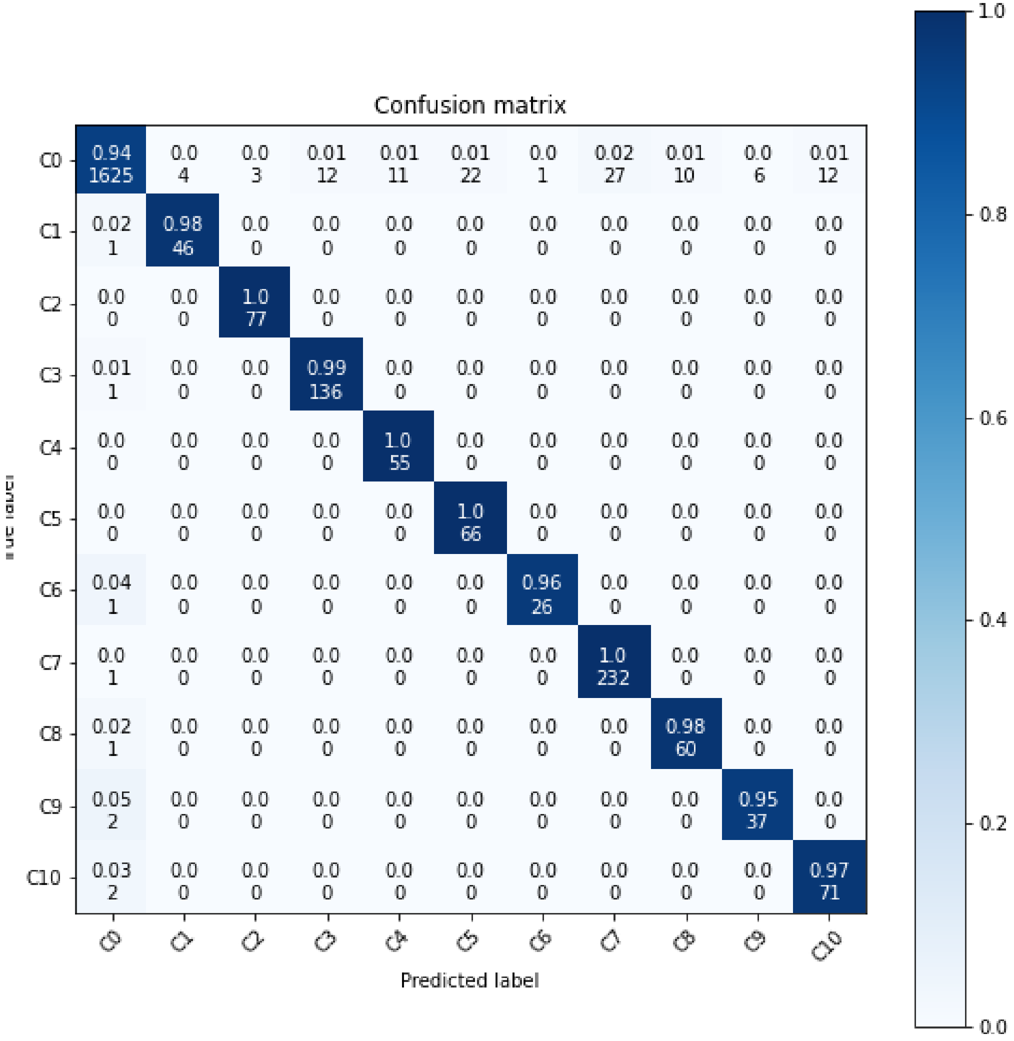
tp: true positive
fn: false negative

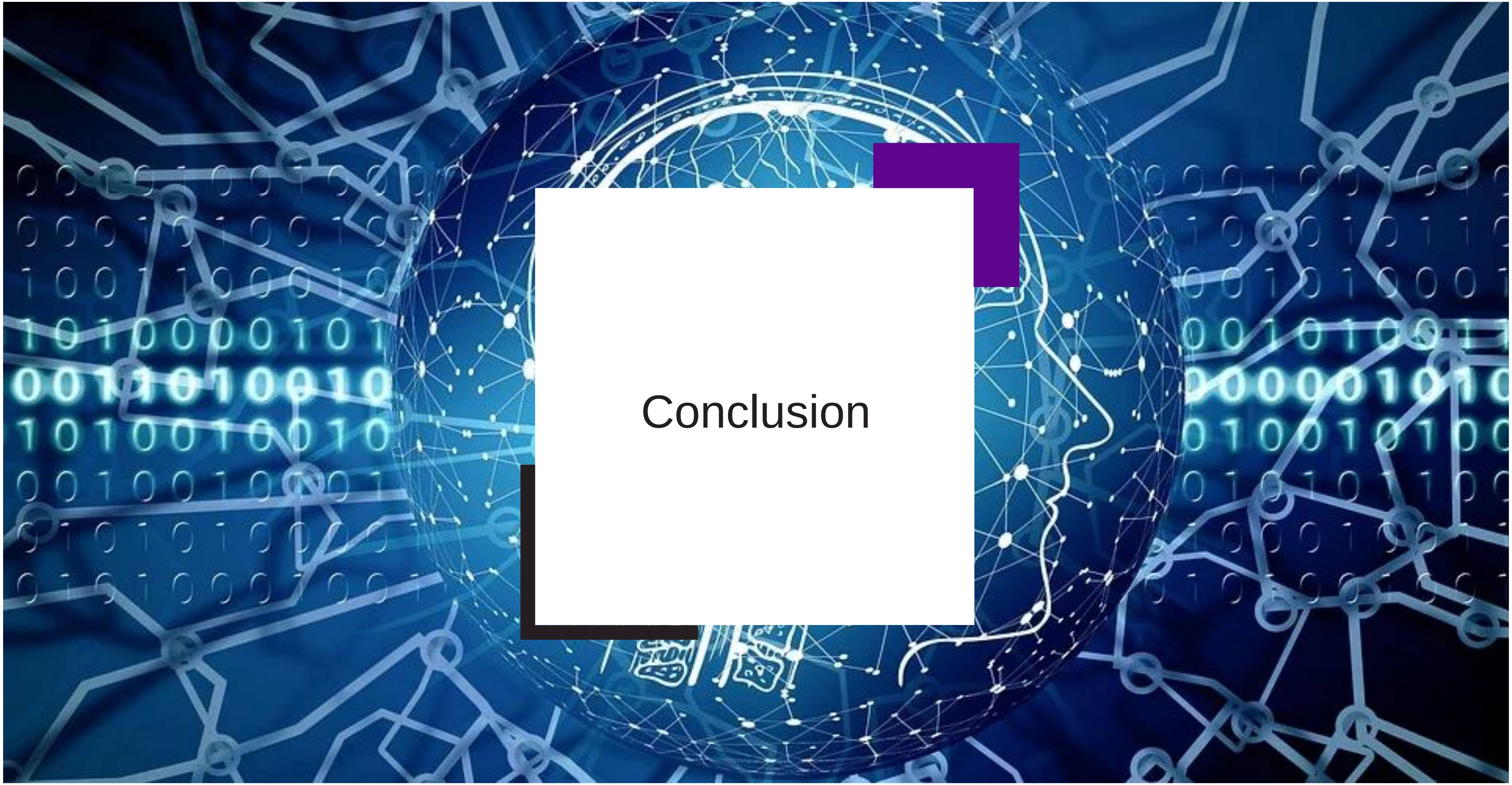
fp: false positive
tn: true negative

True negative is not computable with this representation.

Neural Networks evaluation on classification task with confusion matrix representation





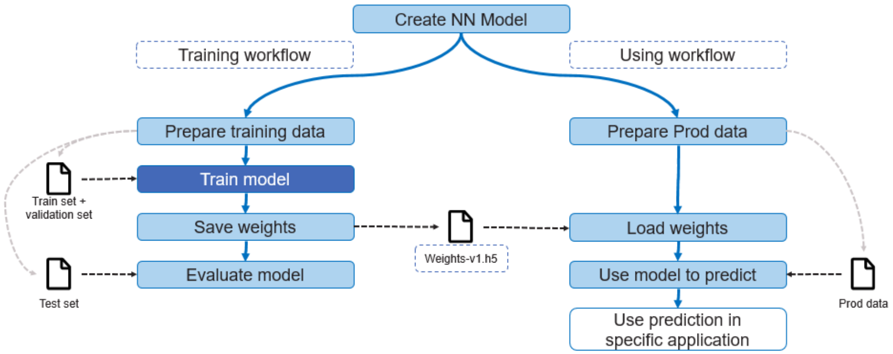


Conclusion

Conclusion

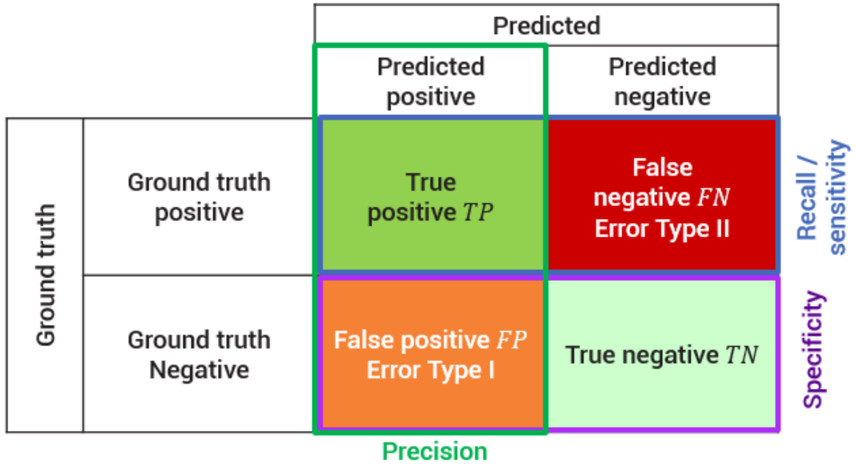
Neural Networks creation workflow

- **Prepare** your data
- **Create** your model
- **Train** the neural network
- **Save** the NN weights
- **Evaluate** on the test set



Evaluating Neural Networks

- Accuracy
- Precision
- Recall = sensitivity
- Specificity
- F1 score



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