MACHINE LEARNING

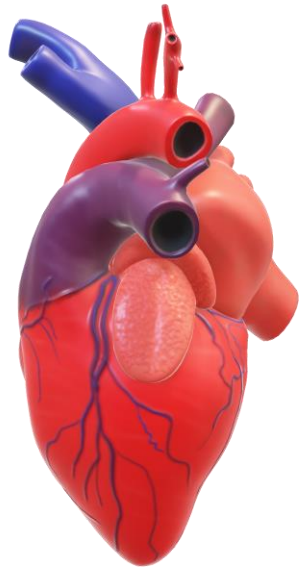
With Heart Disease Dataset

ผู้จัดทำ

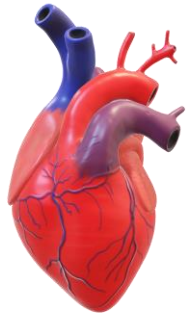
ชื่อ	นาย ศิวกร ภาสว่าง
เลขประจำตัว	6410451423
หมู่เรียนที่	200

Outline

- Heart Dataset
- Preprocessing
- Support Vector Machine Algorithm
- Performance
- Model Selection



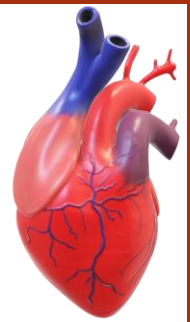
Heart Disease Dataset



- Age
- Sex
- Chest Pain Type
- Resting blood Pressure
- Serum cholesterol in mg/dl
- Fasting blood sugar > 120 mg/dl
- Resting Electrocardiographic results
- Maximum heart rate achieved
- Exercise induced angina
- Old peak = ST depression indued by exercise relative to rest
- The slop of the peak exercise ST segment
- Number of major vessel (0-3) colored by fluoroscopy
- Thalassemia : thal (0 = normal; 1 = fixed defect; 2=reversable defect)
- Target

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1025 entries, 0 to 1024
Data columns (total 14 columns):
 #   Column    Non-Null Count  Dtype
---  ------    --------------  -----
 0   age       1025 non-null   int64
 1   sex       1025 non-null   int64
 2   cp        1025 non-null   int64
 3   trestbps  1025 non-null   int64
 4   chol      1025 non-null   int64
 5   fbs       1025 non-null   int64
 6   restecg   1025 non-null   int64
 7   thalach   1025 non-null   int64
 8   exang     1025 non-null   int64
 9   oldpeak   1025 non-null   float64
 10  slope     1025 non-null   int64
 11  ca        1025 non-null   int64
 12  thal      1025 non-null   int64
 13  target    1025 non-null   int64
dtypes: float64(1), int64(13)
memory usage: 112.2 KB
```

Preprocessing

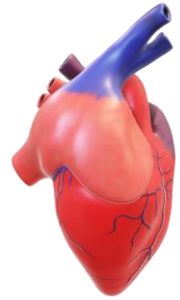


Change value of target from 0 to -1

```
1  dataframe["target"] = dataframe["target"].replace(0, -1)
2  dataframe.sample(5)
```

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal	target
469	67	1	0	160	286	0	0	108	1	1.5	1	3	2	-1
37	59	1	0	138	271	0	0	182	0	0.0	2	0	2	1
202	52	1	3	152	298	1	1	178	0	1.2	1	0	3	1
809	54	0	2	110	214	0	1	158	0	1.6	1	0	2	1
656	57	0	1	130	236	0	0	174	0	0.0	1	1	2	-1

Preprocessing



Split to Training data and Test data by no sklearn library

- Test_size = 0.25

(training = 75 %, test = 25 %)

- Random_state = 40

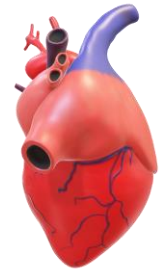
(default : np.random.randint(100))

```python
def train_test_split(features, labels, test_size = 0.25, random_state = np.random.randint(100)):
    train_size = int(np.round((1 - test_size) * features.shape[0]))
    np.random.seed(random_state)
    new_features = np.random.permutation(features)
    np.random.seed(random_state)
    new_labels = np.random.permutation(labels)

    features_train = new_features[:train_size]
    labels_train = new_labels[:train_size]
    features_test = new_features[train_size:]
    labels_test = new_labels[train_size:]

    return features_train, features_test, labels_train, labels_test
```

Support Vector Machine Algorithm



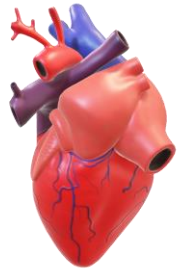
Setup

- **Features** : $\vec{x} = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_d \\ 1 \end{bmatrix}$
- **Weight** : $\vec{w} = \begin{bmatrix} \vec{w} \\ b \end{bmatrix} = \begin{bmatrix} 0 \\ \vdots \\ 0 \end{bmatrix}$

- **Formula of hyperplane** :

$$\vec{w}^T \vec{x} = \begin{bmatrix} \vec{w} \\ b \end{bmatrix}^T \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_d \\ 1 \end{bmatrix} = \vec{w}^T \vec{x} + b = \mathrm{y}$$

Support Vector Machine Algorithm



- With Soft Margin
- Formula of update weight :

$$cost = \gamma w^T w + \ slack_i \ ; \ slack_i \begin{cases} 1 - y_i(w^T x_i) & if \ y_i(w^T x_i) < 1 \\ 0 & otherwise \end{cases}$$

$$\frac{d}{dw} cost = \gamma w + slack_i \ ; \ slack_i \begin{cases} -y_i x_i & if \ y_i(w^T x_i) < 1 \\ 0 & otherwise \end{cases}$$

$$step = -learningRate \ * \frac{d}{dw} cost$$

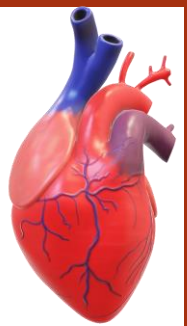
$$w_{t+1} = w_t + step$$

Source Code of update weight

```python
def computeWeight(self, weight, feature_train, labels_train, n_record):
        new_weight = weight
        for i in range(n_record):
            check = labels_train[i] * (np.inner(new_weight, feature_train[i]))
            if check < 1:
                cost = self.gamma * new_weight - np.inner(labels_train[i], feature_train[i])
                step = (-1) * self.learning_rate * cost
                new_weight += step
            else:
                cost = self.gamma * new_weight
                step = (-1) * self.learning_rate * cost
                new_weight += step

        return new_weight
```

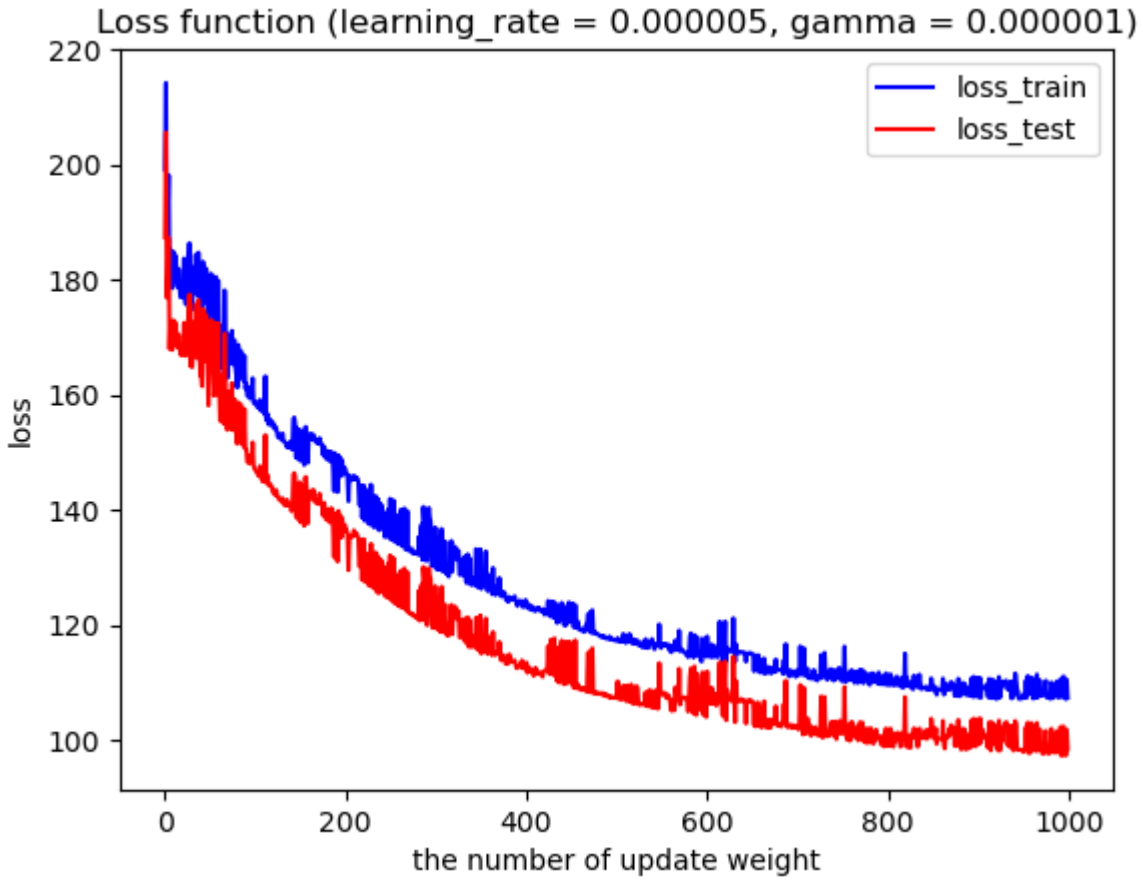
Early Stopping



```
for i in range(1000):
            self.weight = self.computeWeight(self.weight, self.features, self.labels,
self.n_record) # compute to get weight's value

            self.array_weight = np.append(self.array_weight, [self.weight], axis=0)
```

Result After Learning



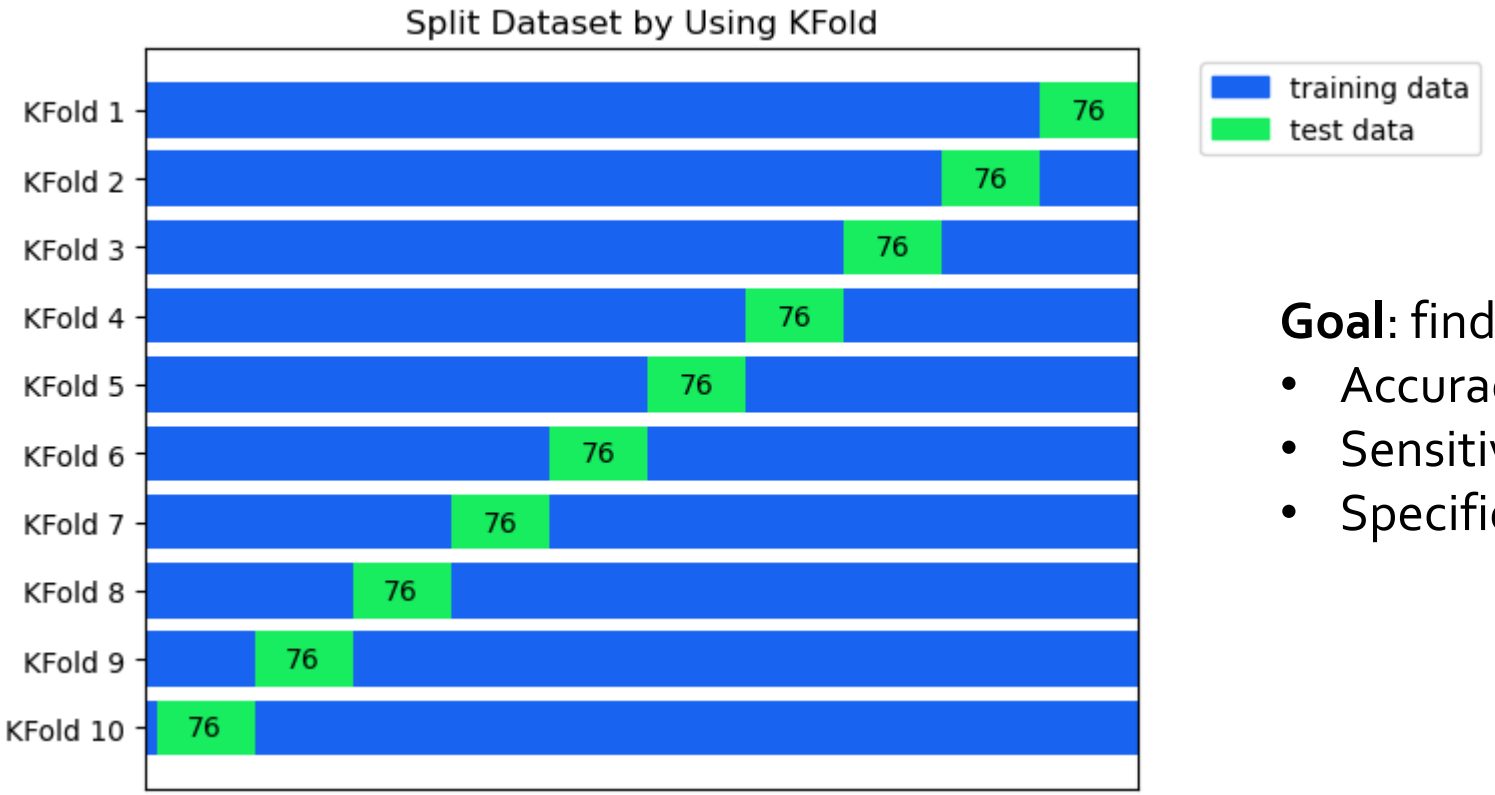
Performance	Training Dataset	Test Dataset
Accuracy	0.8362	0.8516
Sensitivity	0.8022	0.7881
Specificity	1.0	1.0

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

$$Sensitivity = \frac{TP}{TP + FP}$$

$$Specificity = \frac{TN}{TN + FP}$$

Model Selection by Using K-Fold



Goal: find mean and max value score

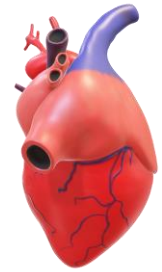
- Accuracy
- Sensitivity
- Specificity

Result by Using K-Fold

`learning rate=0.000005, gamma=0.000001`

Performance	Training Dataset	Validation (Test) Dataset
Mean of Accuracy	0.8278	0.8342
Mean of Sensitivity	0.8056	0.8106
Mean of Specificity	1.0	1.0
Max of Accuracy	0.8427	0.9211
Max of Sensitivity	0.8490	0.9302
Max of Specificity	1.0	1.0

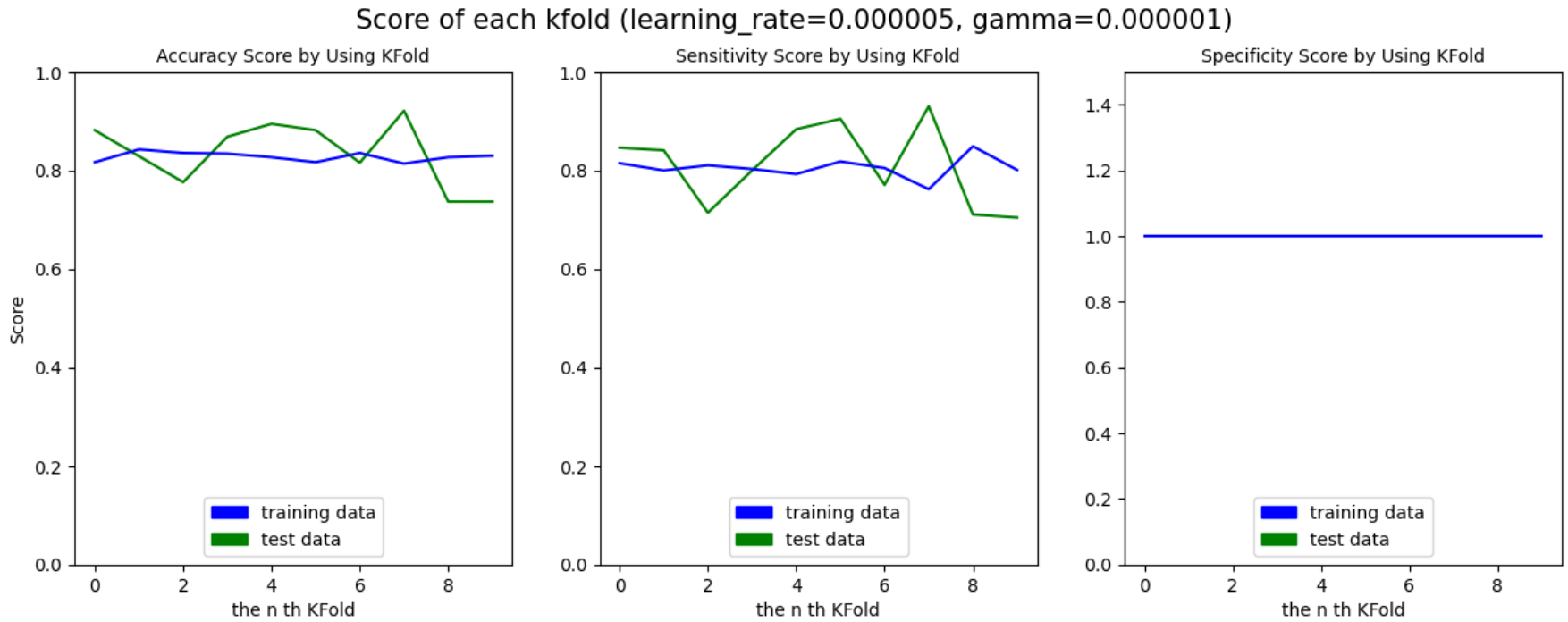
Result by Using K-Fold



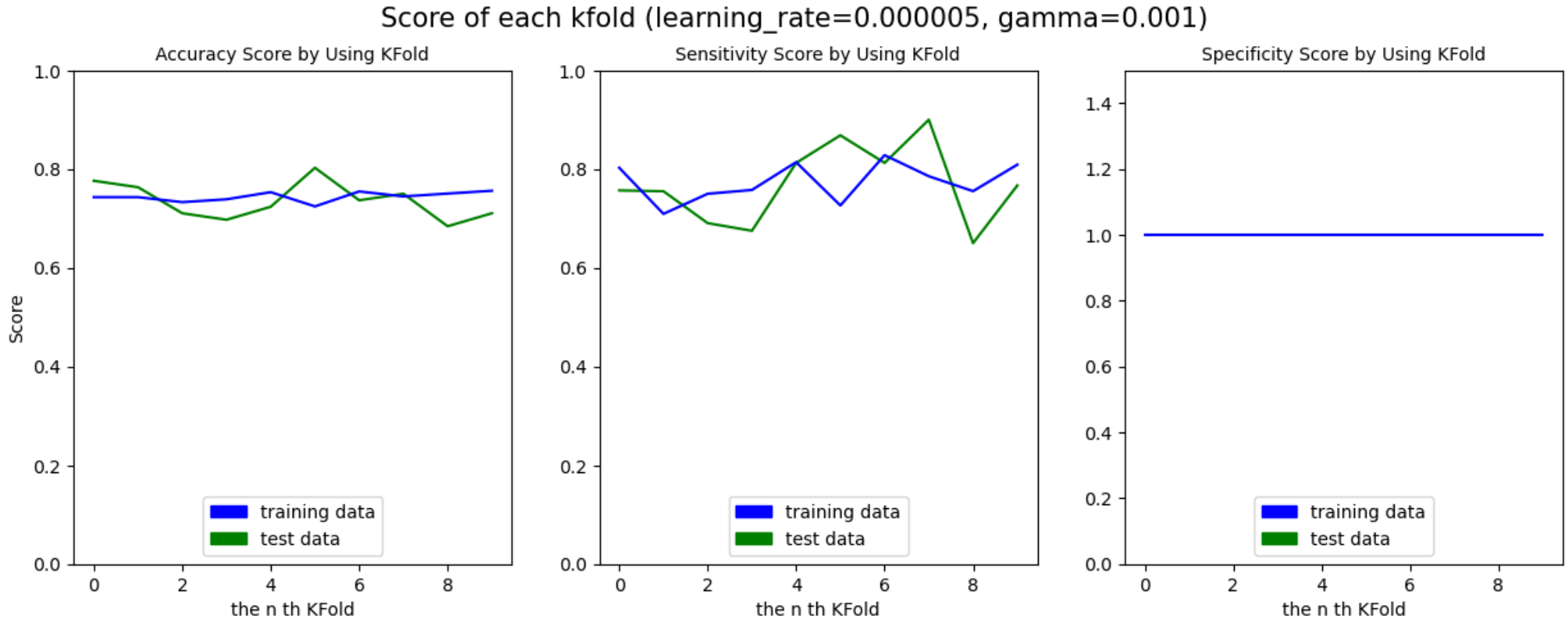
```
learning rate=0.000005, gamma=0.001
```

Performance	Training Dataset	Validation (Test) Dataset
Mean of Accuracy	0.7441	0.355
Mean of Sensitivity	0.7738	0.7688
Mean of Specificity	1.0	1.0
Max of Accuracy	0.7561	0.8026
Max of Sensitivity	0.8282	0.9
Max of Specificity	1.0	1.0

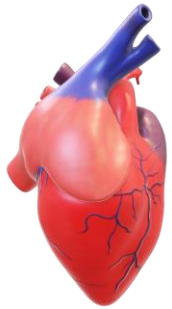
Result by Using K-Fold



Result by Using K-Fold



Summary



การใช้ SVM with soft margin ที่มี learning rate = 0.000005 และ gamma = 0.000001 มีประสิทธิภาพที่ดีกว่าการใช้ SVM with soft margin ที่มี learning rate = 0.000005 และ gamma = 0.001 โดยการทดลองนี้ใช้ K-fold ในการเลือกโมเดล และวัดประสิทธิภาพโดยใช้ความถูกต้อง ความไวและความจำเพาะ

Source Code : https://github.com/OatKID/MLProject

Thank You