Machine learning with scikit-learn

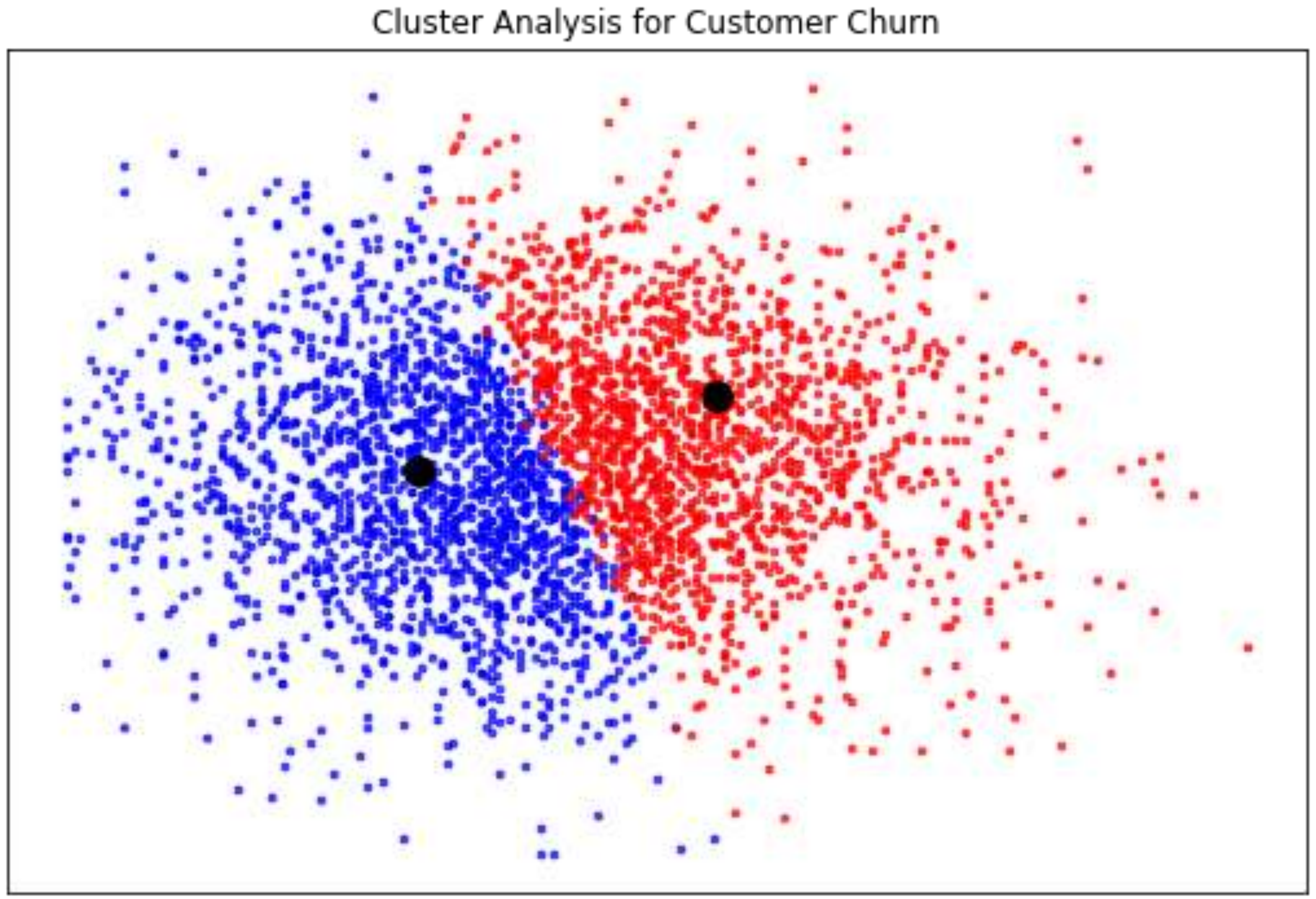
SUPERVISED LEARNING WITH SCIKIT-LEARN

What is machine learning?

- Machine learning is the process whereby:
  - Computers are given the ability to learn to make decisions from data
  - without being explicitly programmed!

Unsupervised learning

- Uncovering hidden patterns from unlabeled data
- Example:
  - Grouping customers into distinct categories (Clustering)



Supervised learning

- The predicted values are known
- Aim: Predict the target values of unseen data, given the features

	Features					Target variable
	points_per_game	assists_per_game	rebounds_per_game	steals_per_game	blocks_per_game	position
0	26.9	6.6	4.5	1.1	0.4	Point Guard
1	13	1.7	4	0.4	1.3	Center
2	17.6	2.3	7.9	1.00	0.8	Power Forward
3	22.6	4.5	4.4	1.2	0.4	Shooting Guard

Types of supervised learning

- Classification: Target variable consists of categories

- Regression: Target variable is continuous

Naming conventions

- Feature = predictor variable = independent variable
- Target variable = dependent variable = response variable

	Features					Target variable
	points_per_game	assists_per_game	rebounds_per_game	steals_per_game	blocks_per_game	position
0	26.9	6.6	4.5	1.1	0.4	Point Guard
1	13	1.7	4	0.4	1.3	Center
2	17.6	2.3	7.9	1.00	0.8	Power Forward
3	22.6	4.5	4.4	1.2	0.4	Shooting Guard

Before you use supervised learning

- Requirements:
  - No missing values
  - Data in numeric format
  - Data stored in pandas DataFrame or NumPy array

- Perform Exploratory Data Analysis (EDA) first

scikit-learn syntax

```
from sklearn.module import Model
model = Model()
model.fit(X, y)
predictions = model.predict(X_new)
print(predictions)
```

```
array([0, 0, 0, 0, 1, 0])
```

The classification challenge

SUPERVISED LEARNING WITH SCIKIT-LEARN

Classifying labels of unseen data

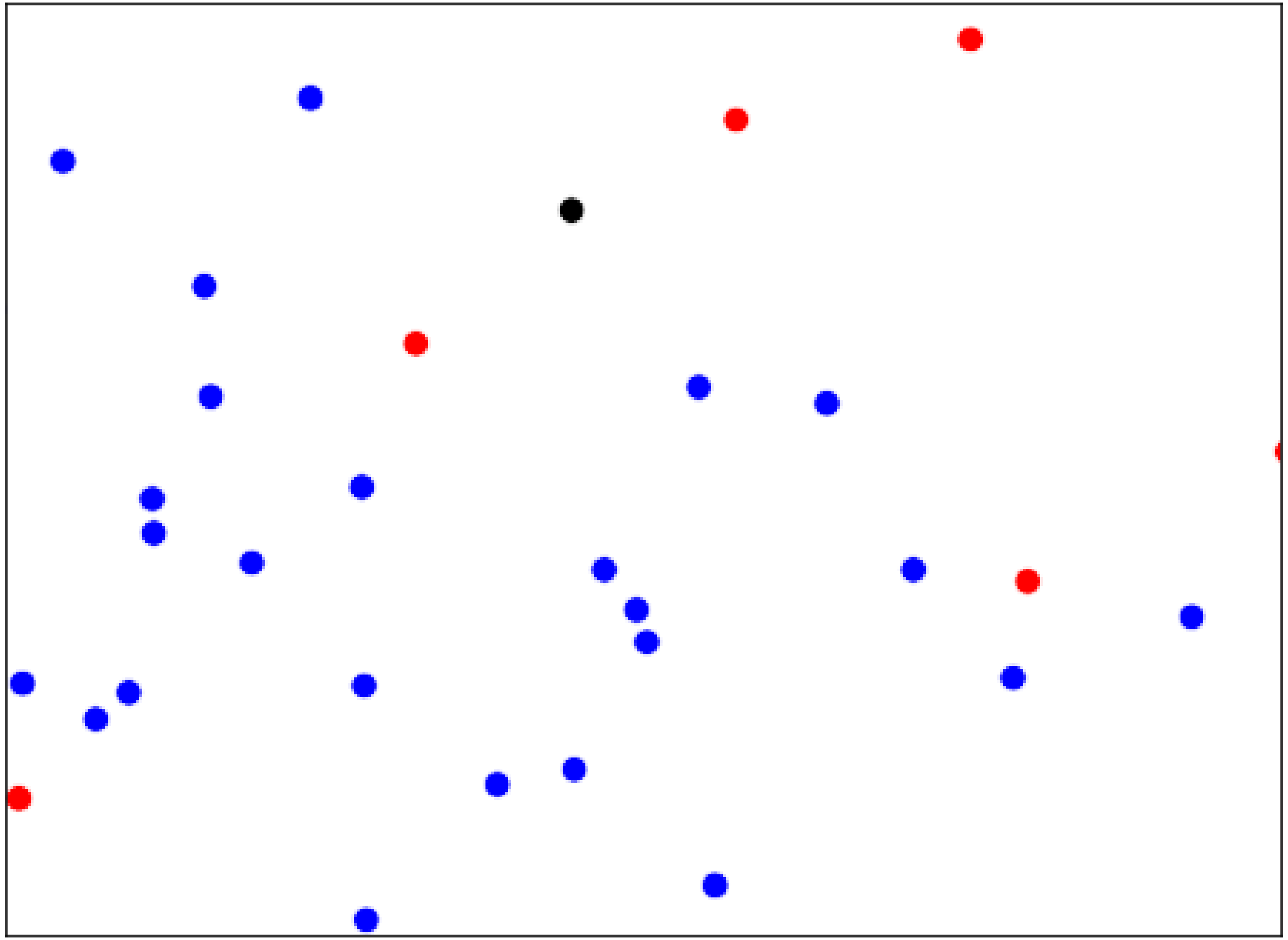
1. Build a model
2. Model learns from the labeled data we pass to it
3. Pass unlabeled data to the model as input
4. Model predicts the labels of the unseen data

- Labeled data = training data

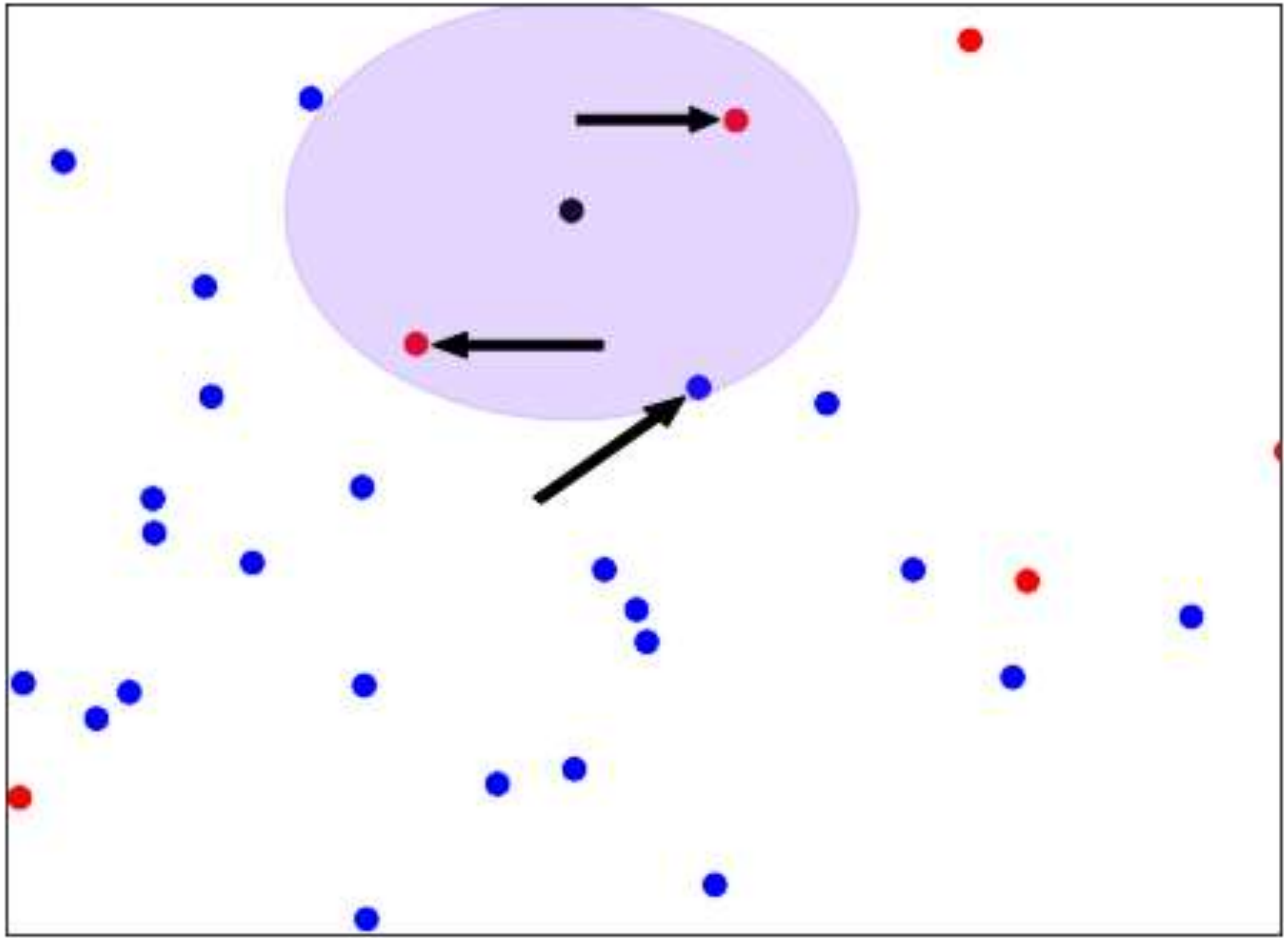
k-Nearest Neighbors

- Predict the label of a data point by
  - Looking at the `k` closest labeled data points
  - Taking a majority vote

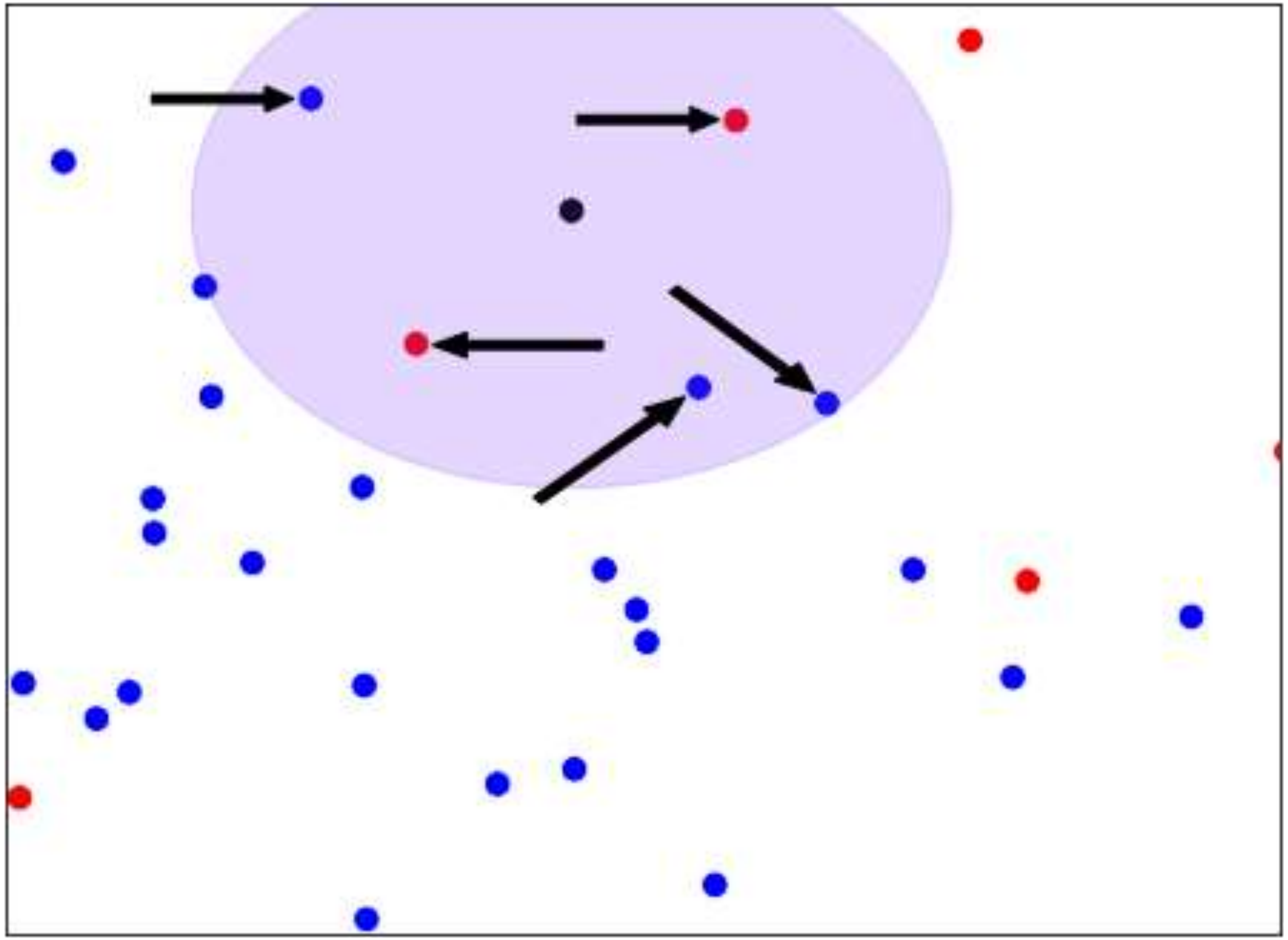
k-Nearest Neighbors



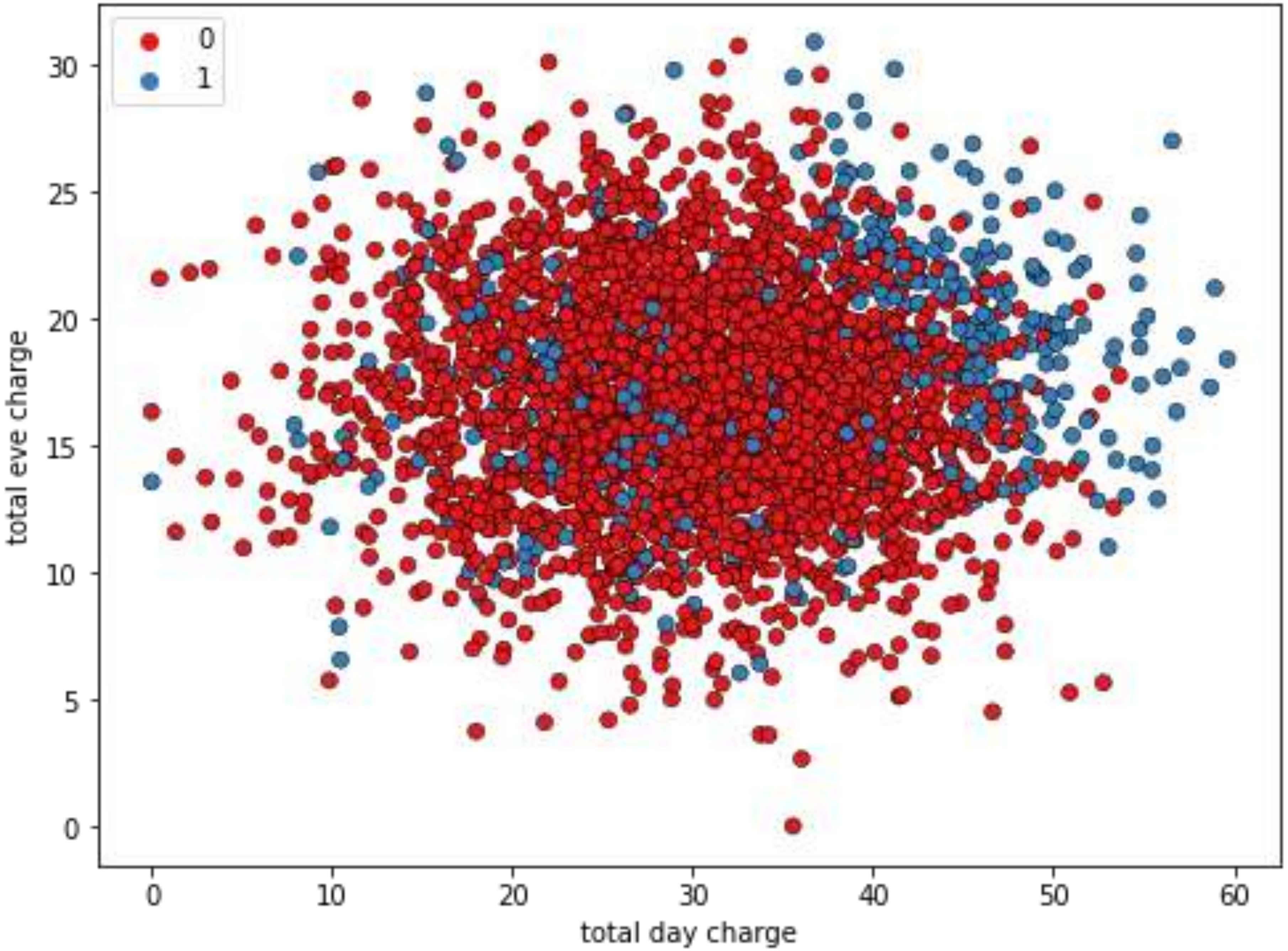
k-Nearest Neighbors



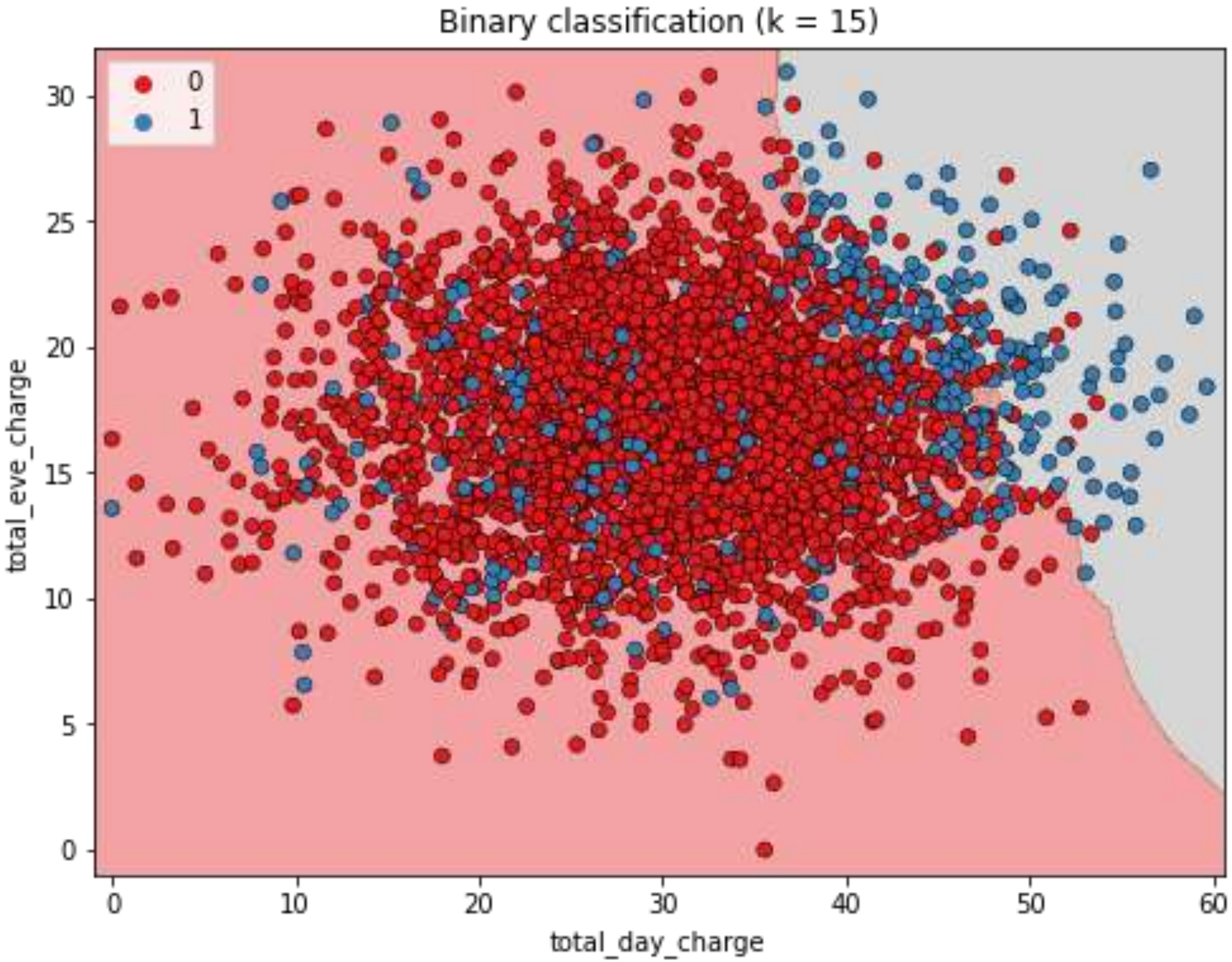
k-Nearest Neighbors



KNN Intuition



KNN Intuition



Using scikit-learn to fit a classifier

```python
from sklearn.neighbors import KNeighborsClassifier
X = churn_df[["total_day_charge", "total_eve_charge"]].values
y = churn_df["churn"].values
print(X.shape, y.shape)
```

```
(3333, 2), (3333,)
```

```python
knn = KNeighborsClassifier(n_neighbors=15)
knn.fit(X, y)
```

Predicting on unlabeled data

```
X_new = np.array([[56.8, 17.5],
                  [24.4, 24.1],
                  [50.1, 10.9]])
print(X_new.shape)
```

```
(3, 2)
```

```
predictions = knn.predict(X_new)
print('Predictions: {}'.format(predictions))
```

```
Predictions: [1 0 0]
```

Measuring model performance

SUPERVISED LEARNING WITH SCIKIT-LEARN

Measuring model performance

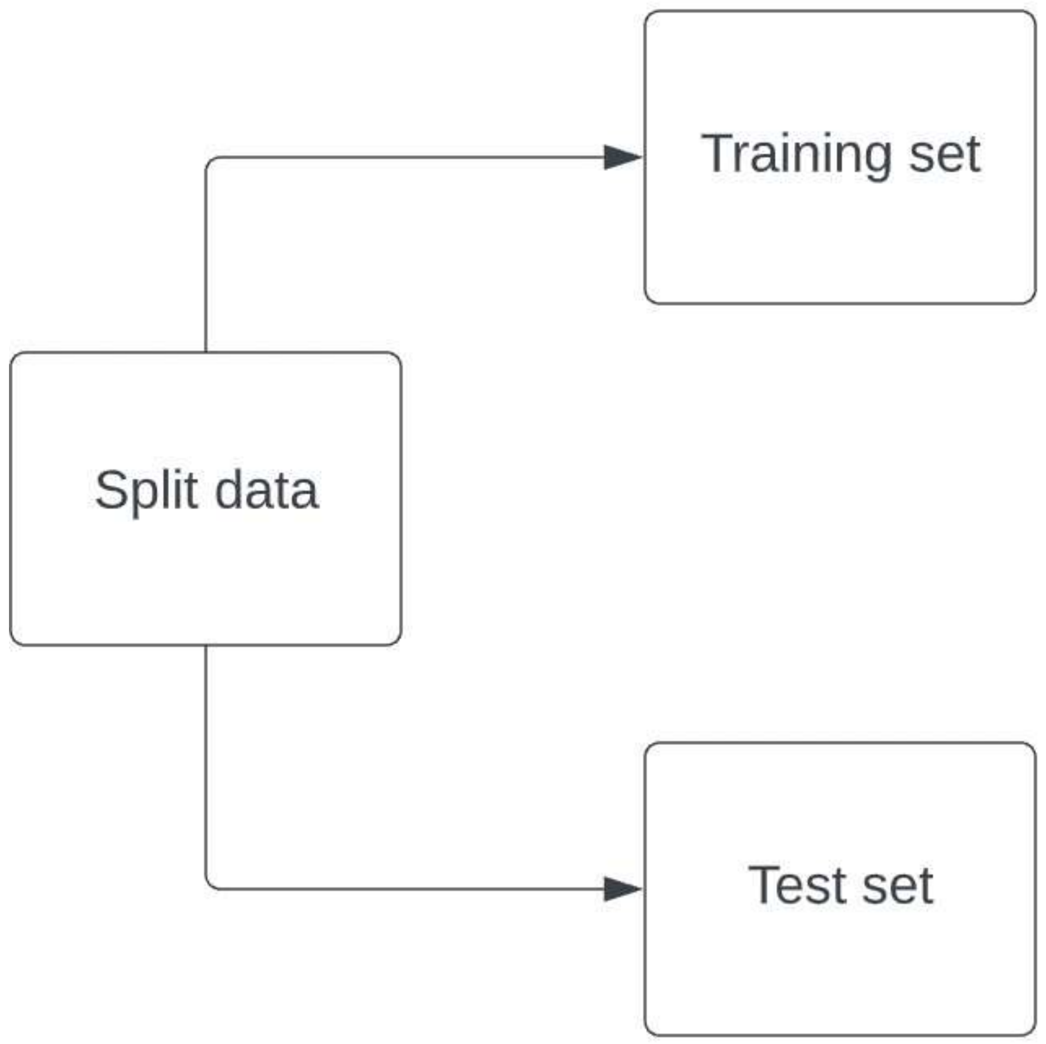
- In classification, accuracy is a commonly used metric
- Accuracy:

$$\frac{correct\ predictions}{total\ observations}$$

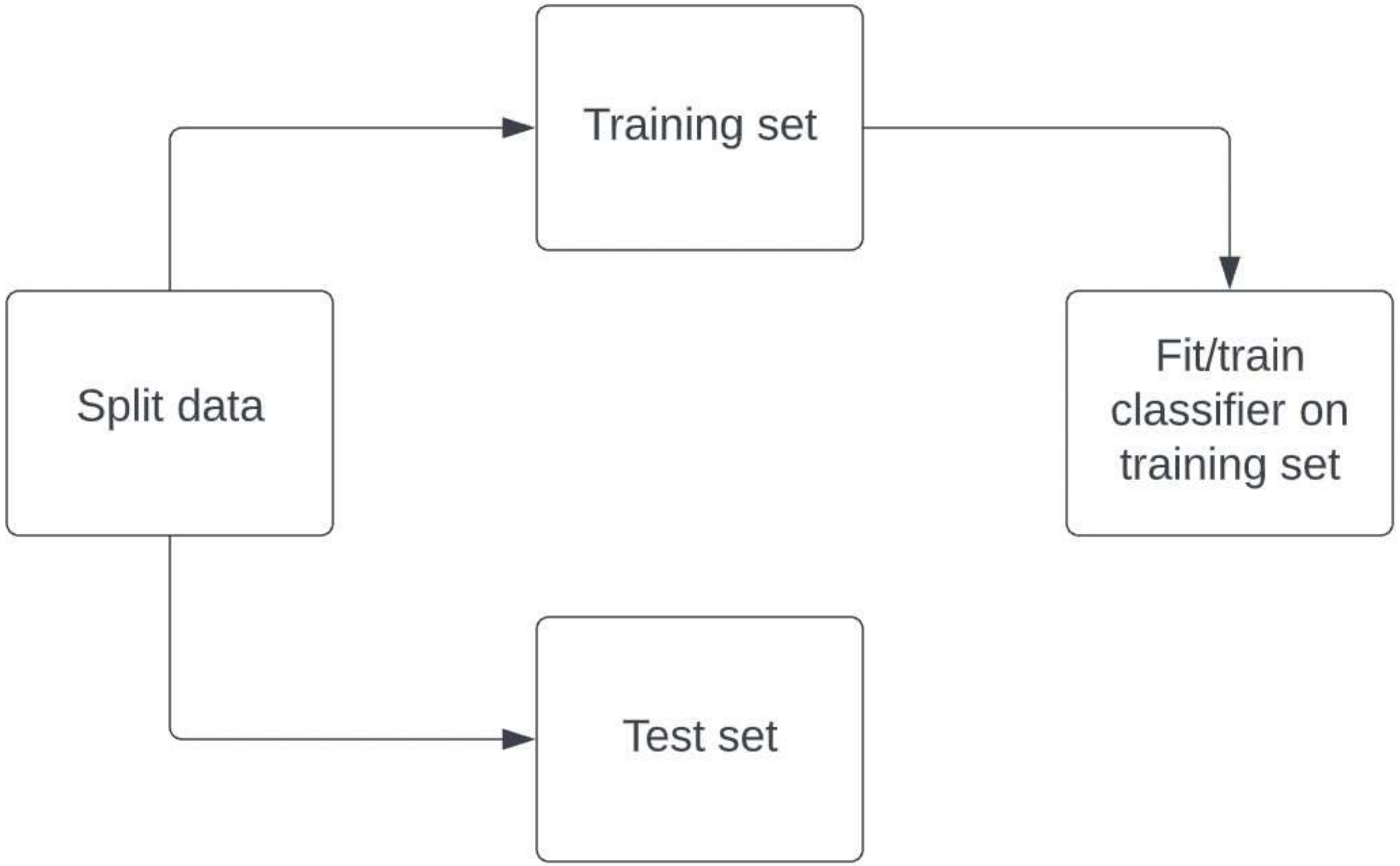
Measuring model performance

- How do we measure accuracy?
- Could compute accuracy on the data used to fit the classifier
- NOT indicative of ability to generalize

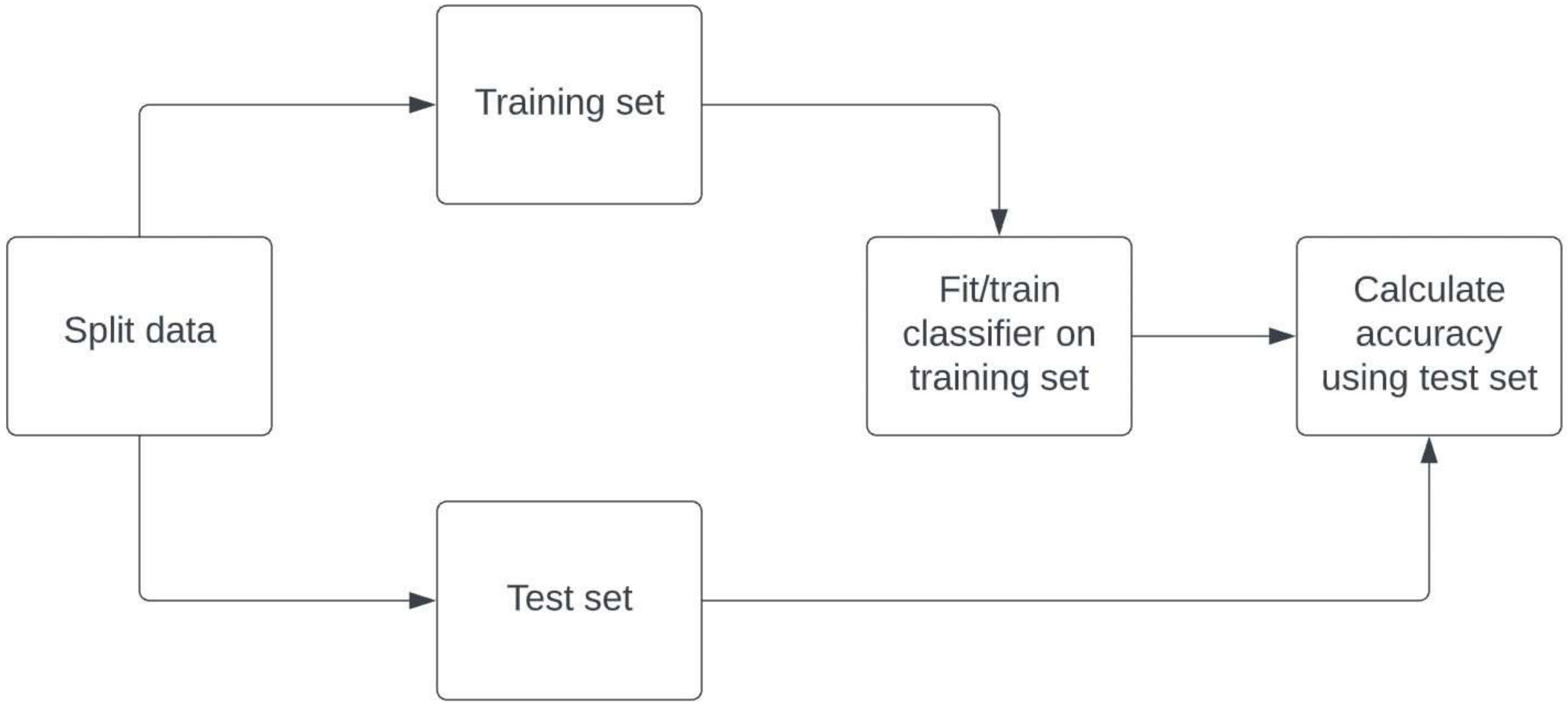
Computing accuracy



Computing accuracy



Computing accuracy



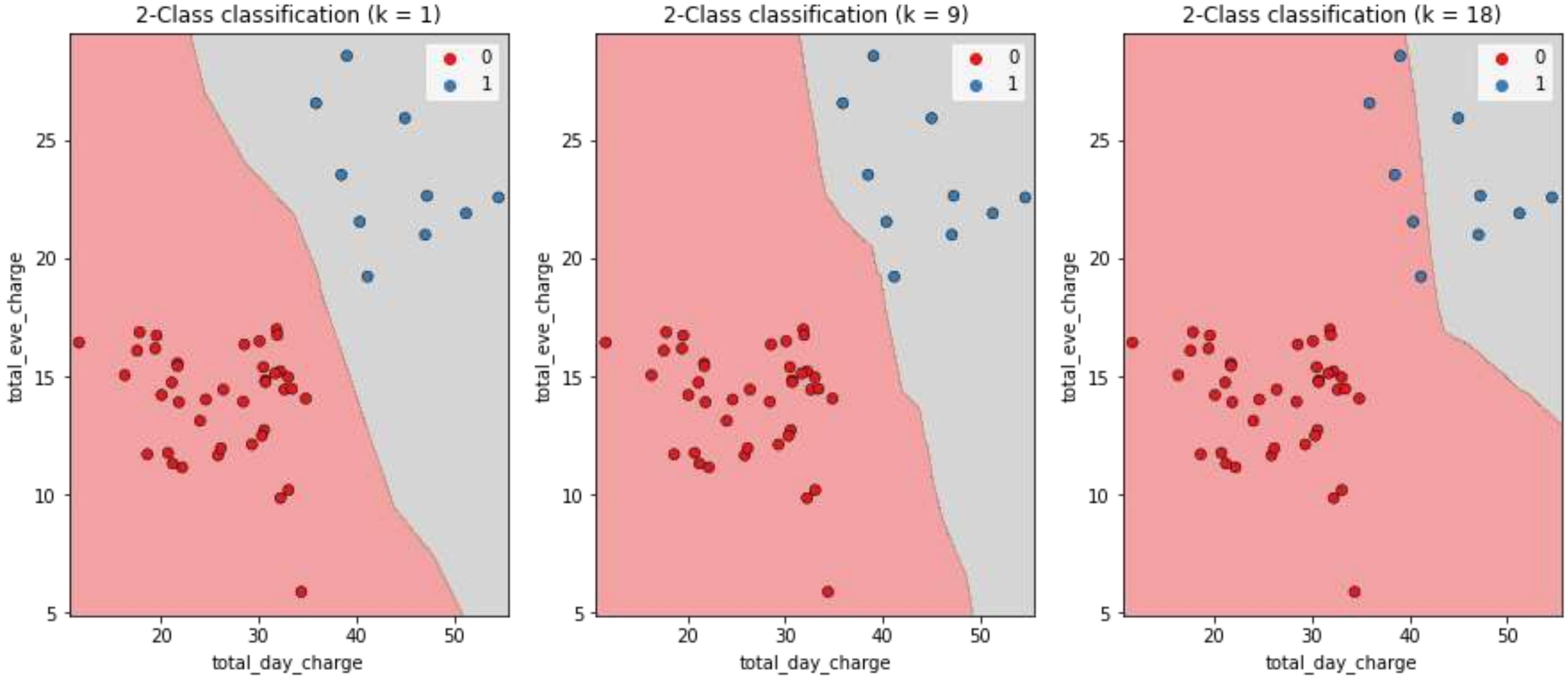
Train/test split

```python
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3,
                                                     random_state=21, stratify=y)
knn = KNeighborsClassifier(n_neighbors=6)
knn.fit(X_train, y_train)
print(knn.score(X_test, y_test))
```

```
0.8800599700149925
```

Model complexity

- Larger k = less complex model = can cause underfitting
- Smaller k = more complex model = can lead to overfitting



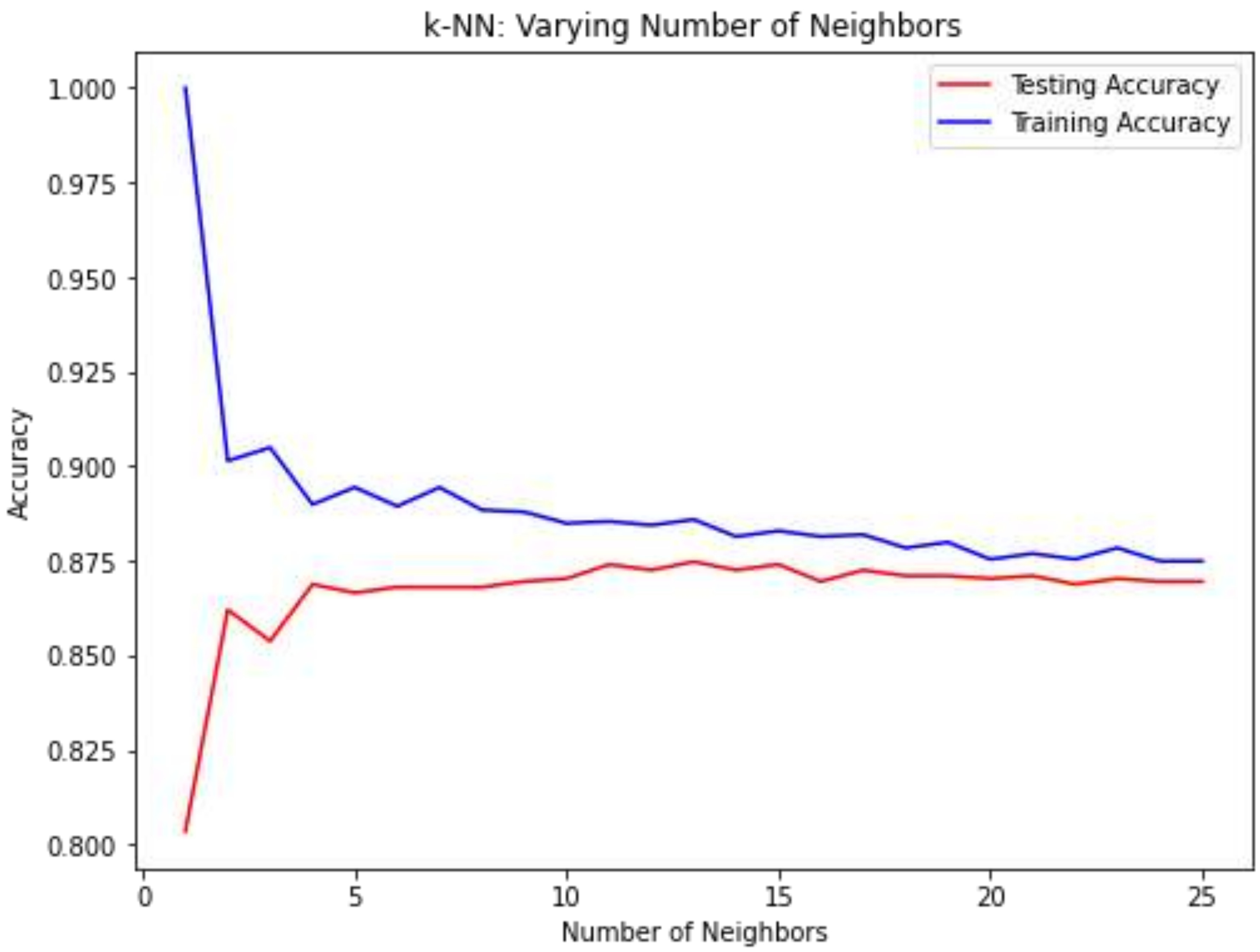
Model complexity and over/underfitting

```
train_accuracies = {}
test_accuracies = {}
neighbors = np.arange(1, 26)
for neighbor in neighbors:
    knn = KNeighborsClassifier(n_neighbors=neighbor)
    knn.fit(X_train, y_train)
    train_accuracies[neighbor] = knn.score(X_train, y_train)
    test_accuracies[neighbor] = knn.score(X_test, y_test)
```

Plotting our results

```
plt.figure(figsize=(8, 6))
plt.title("KNN: Varying Number of Neighbors")
plt.plot(neighbors, train_accuracies.values(), label="Training Accuracy")
plt.plot(neighbors, test_accuracies.values(), label="Testing Accuracy")
plt.legend()
plt.xlabel("Number of Neighbors")
plt.ylabel("Accuracy")
plt.show()
```

Model complexity curve



Model complexity curve