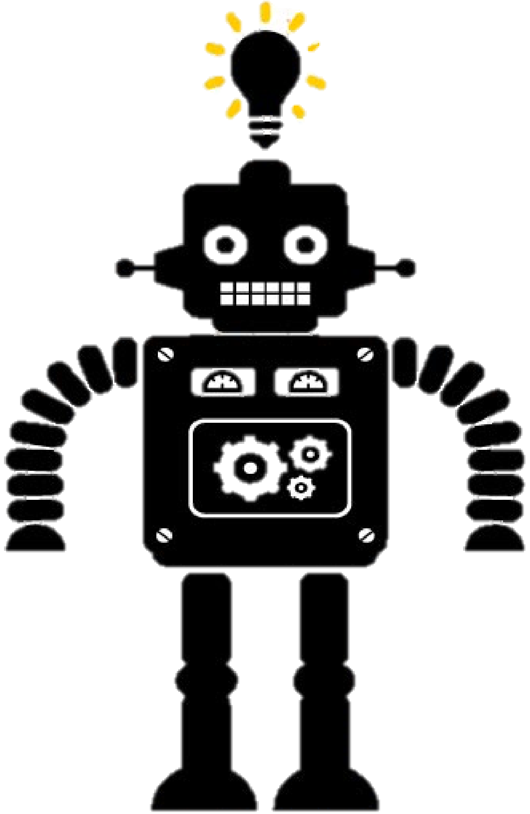
Chapter 2

Introduction to Supervised Learning and K-Nearest Neighbor

Introduction to Supervised Learning

What is Machine Learning?

Machine learning allows computers to learn and infer from data.



Machine Learning in Our Daily Lives

Spam Filtering

Machine Learning in Our Daily Lives

Spam Filtering

Web Search

Machine Learning in Our Daily Lives

Spam Filtering

Web Search

Postal Mail Routing

Machine Learning in Our Daily Lives

Spam Filtering	Web Search	Postal Mail Routing
Fraud Detection	Movie Recommendations	Vehicle Driver Assistance
Web Advertisements	Social Networks	Speech Recognition

Types of Machine Learning

Supervised

data points have known outcome

Types of Machine Learning

Supervised	data points have known outcome
Unsupervised	data points have unknown outcome

Types of Machine Learning

Supervised	data points have known outcome
Unsupervised	data points have unknown outcome

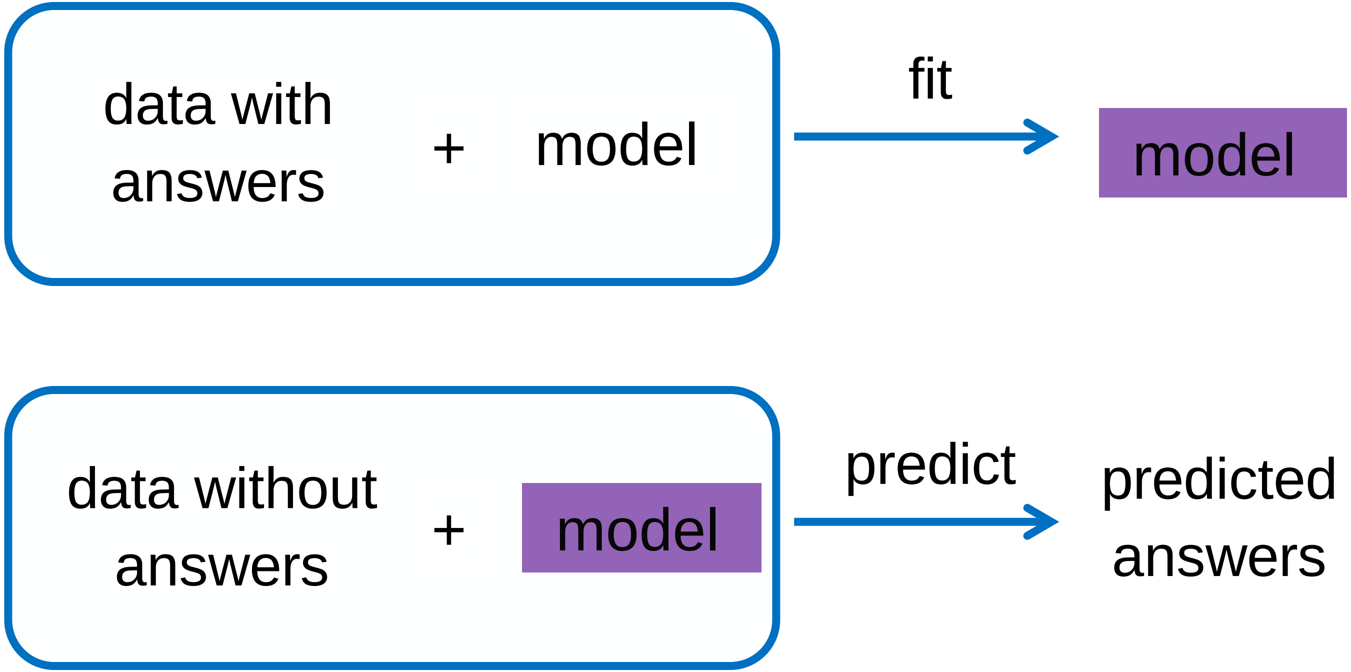
Types of Supervised Learning

Regression outcome is continuous (numerical)

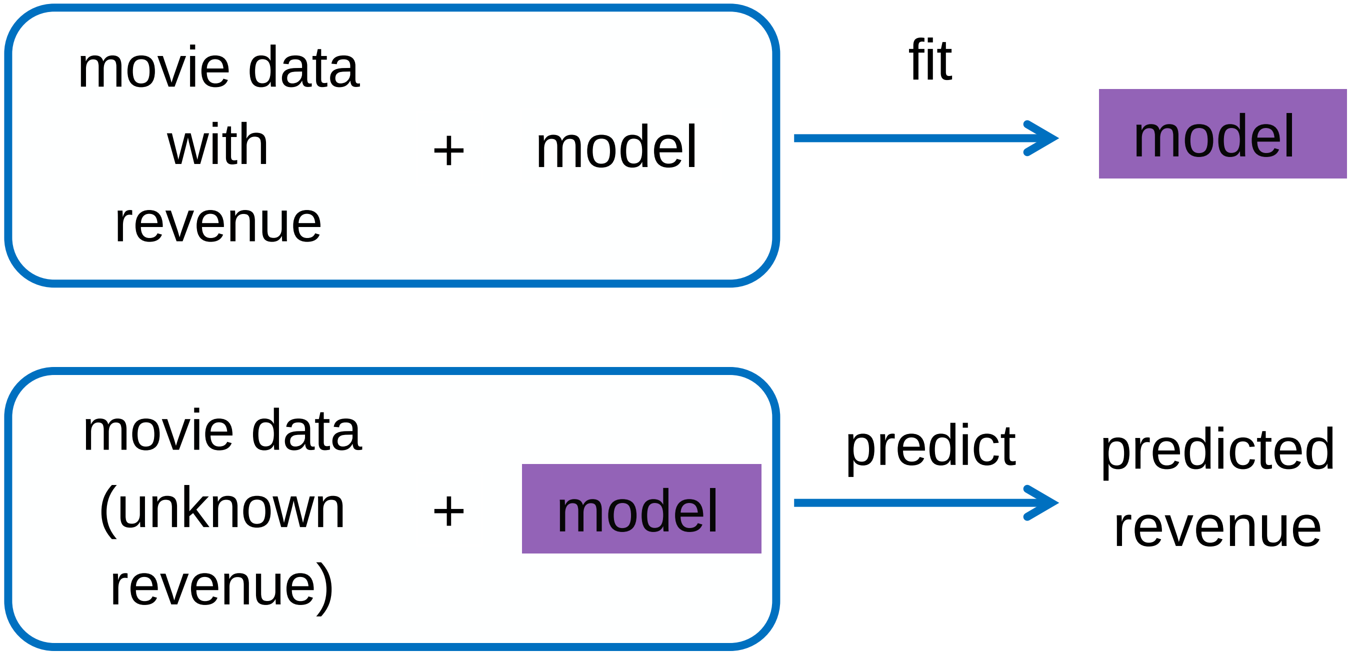
Types of Supervised Learning

Regression	outcome is continuous (numerical)
Classification	outcome is a category

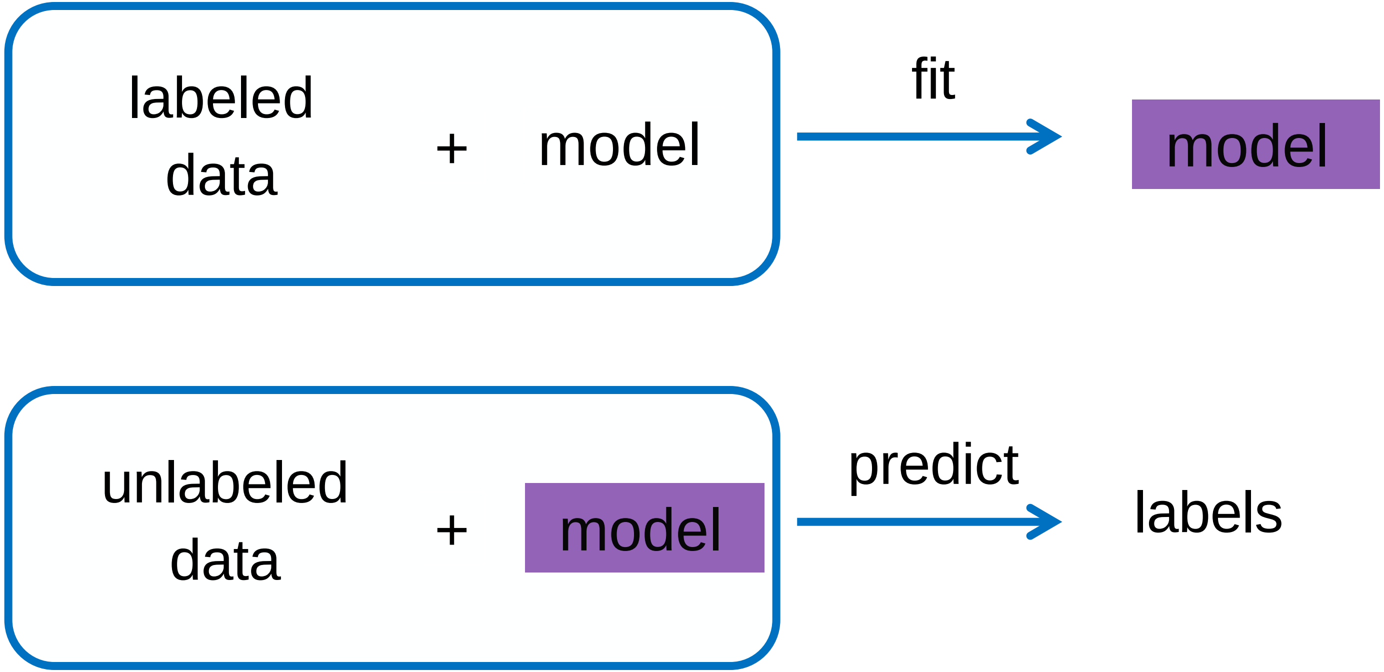
Supervised Learning Overview



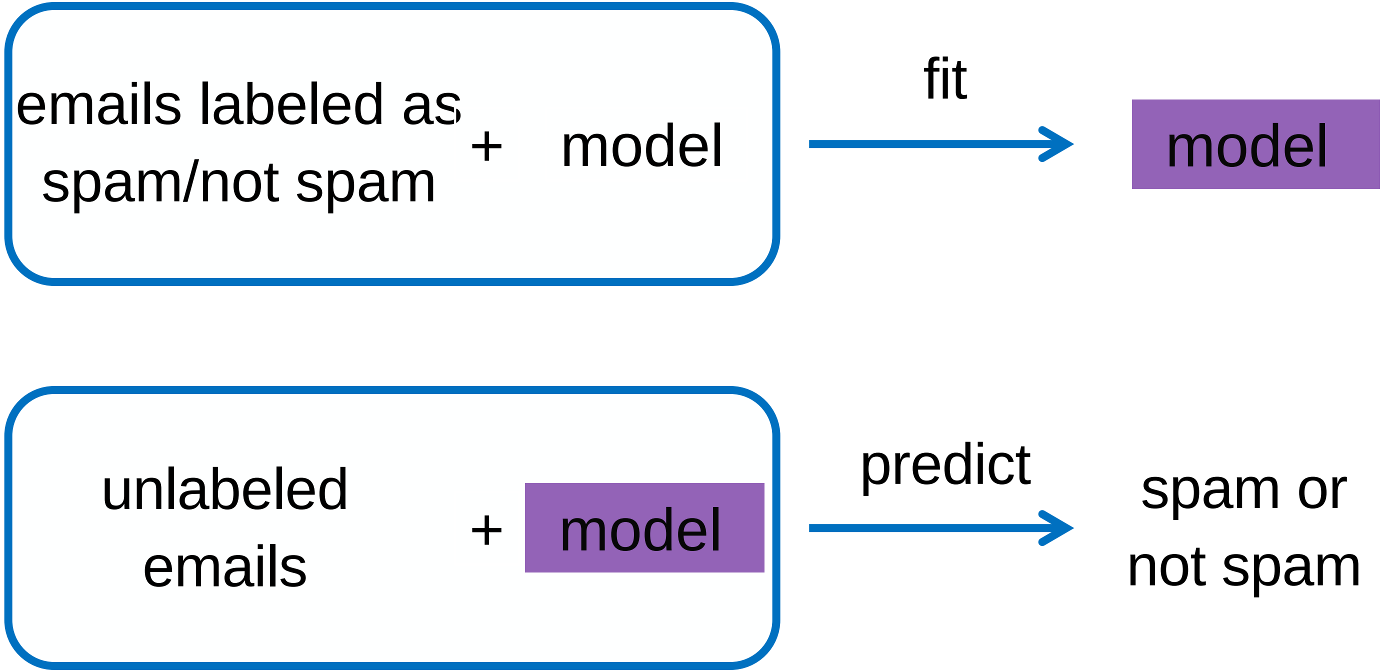
Regression: Numeric Answers



Classification: Categorical Answers



Classification: Categorical Answers



Machine Learning Vocabulary

- **Target:** predicted category or value of the data (column to predict)

Machine Learning Vocabulary

sepal length	sepal width	petal length	petal width	species
6.7	3.0	5.2	2.3	virginica
6.4	2.8	5.6	2.1	virginica
4.6	3.4	1.4	0.3	setosa
6.9	3.1	4.9	1.5	versicolor
4.4	2.9	1.4	0.2	setosa
4.8	3.0	1.4	0.1	setosa
5.9	3.0	5.1	1.8	virginica
5.4	3.9	1.3	0.4	setosa
4.9	3.0	1.4	0.2	setosa
5.4	3.4	1.7	0.2	setosa

Machine Learning Vocabulary

Target

sepal length	sepal width	petal length	petal width	**species**
6.7	3.0	5.2	2.3	virginica
6.4	2.8	5.6	2.1	virginica
4.6	3.4	1.4	0.3	setosa
6.9	3.1	4.9	1.5	versicolor
4.4	2.9	1.4	0.2	setosa
4.8	3.0	1.4	0.1	setosa
5.9	3.0	5.1	1.8	virginica
5.4	3.9	1.3	0.4	setosa
4.9	3.0	1.4	0.2	setosa
5.4	3.4	1.7	0.2	setosa

Machine Learning Vocabulary

- **Target:** predicted category or value of the data (column to predict)
- **Features**: properties of the data used for prediction (non-target columns)

Machine Learning Vocabulary

Features

sepal length	sepal width	petal length	petal width	species
6.7	3.0	5.2	2.3	virginica
6.4	2.8	5.6	2.1	virginica
4.6	3.4	1.4	0.3	setosa
6.9	3.1	4.9	1.5	versicolor
4.4	2.9	1.4	0.2	setosa
4.8	3.0	1.4	0.1	setosa
5.9	3.0	5.1	1.8	virginica
5.4	3.9	1.3	0.4	setosa
4.9	3.0	1.4	0.2	setosa
5.4	3.4	1.7	0.2	setosa

Machine Learning Vocabulary

- **Target:** predicted category or value of the data (column to predict)
- **Features**: properties of the data used for prediction (non-target columns)
- **Example:** a single data point within the data (one row)

Machine Learning Vocabulary

Example

sepal length	sepal width	petal length	petal width	species
6.7	3.0	5.2	2.3	virginica
6.4	2.8	5.6	2.1	virginica
4.6	3.4	1.4	0.3	setosa
6.9	3.1	4.9	1.5	versicolor
4.4	2.9	1.4	0.2	setosa
4.8	3.0	1.4	0.1	setosa
5.9	3.0	5.1	1.8	virginica
5.4	3.9	1.3	0.4	setosa
4.9	3.0	1.4	0.2	setosa
5.4	3.4	1.7	0.2	setosa

Machine Learning Vocabulary

- **Target:** predicted category or value of the data (column to predict)
- **Features**: properties of the data used for prediction (non-target columns)
- **Example:** a single data point within the data (one row)
- **Label:** the target value for a single data point

Machine Learning Vocabulary

Label

sepal length	sepal width	petal length	petal width	species
6.7	3.0	5.2	2.3	virginica
6.4	2.8	5.6	2.1	virginica
4.6	3.4	1.4	0.3	setosa
6.9	3.1	4.9	1.5	versicolor
4.4	2.9	1.4	0.2	setosa
4.8	3.0	1.4	0.1	setosa
5.9	3.0	5.1	1.8	virginica
5.4	3.9	1.3	0.4	setosa
4.9	3.0	1.4	0.2	setosa
5.4	3.4	1.7	0.2	setosa

K-Nearest Neighbors

What is Classification?

A flower shop wants to guess a customer's purchase from similarity to most recent purchase.

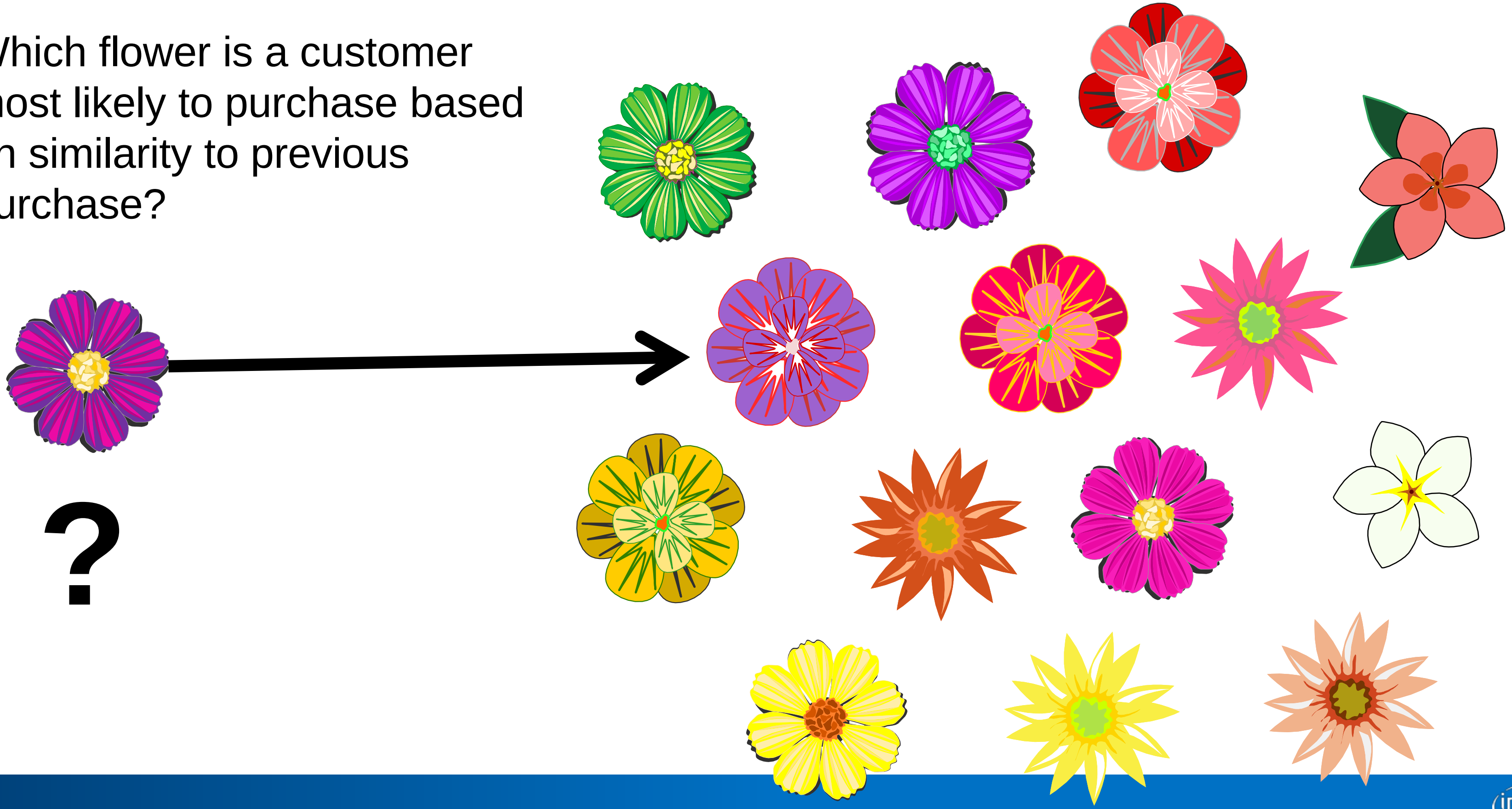
What is Classification?

Which flower is a customer most likely to purchase based on similarity to previous purchase?

?

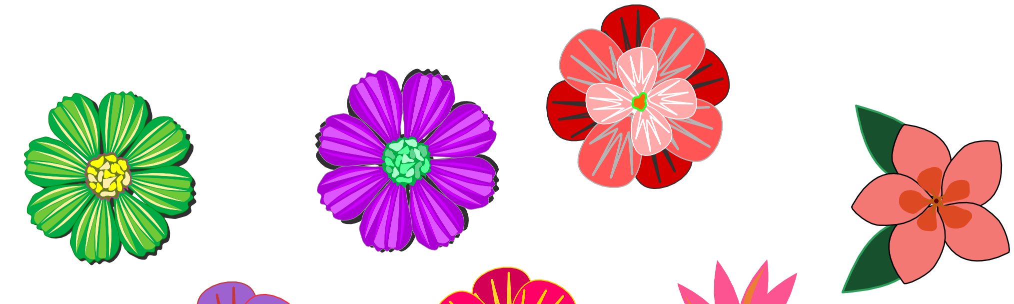
What is Classification?

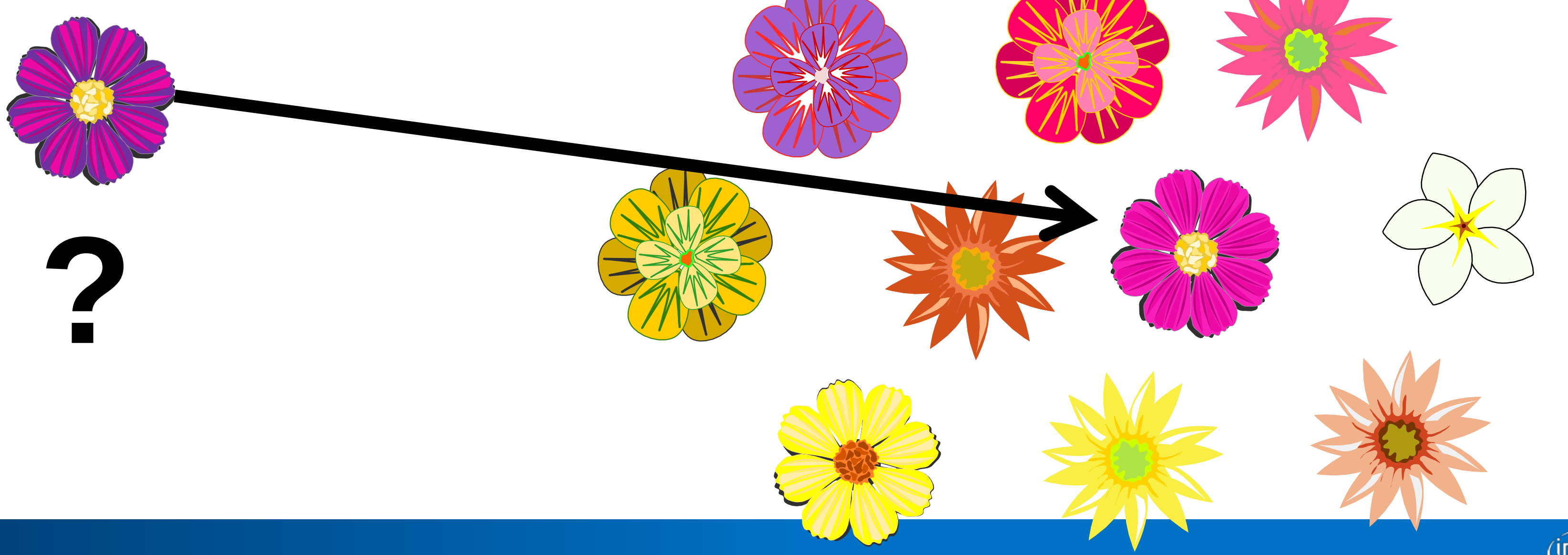
Which flower is a customer most likely to purchase based on similarity to previous purchase?



What is Classification?

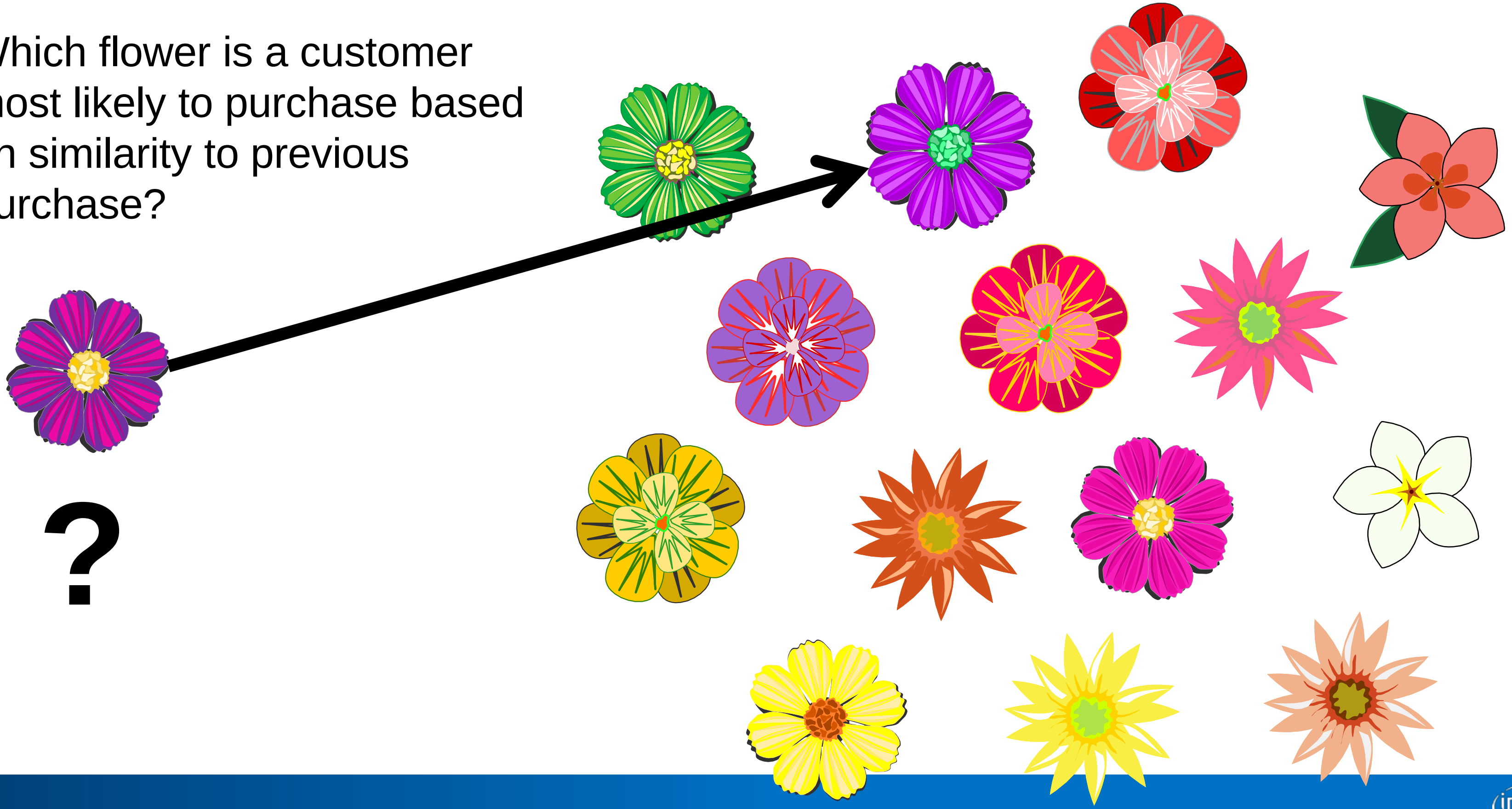
Which flower is a customer most likely to purchase based on similarity to previous purchase?





What is Classification?

Which flower is a customer most likely to purchase based on similarity to previous purchase?



What is Needed for Classification?

- Model data with:
    - Features that can be quantitated

What is Needed for Classification?

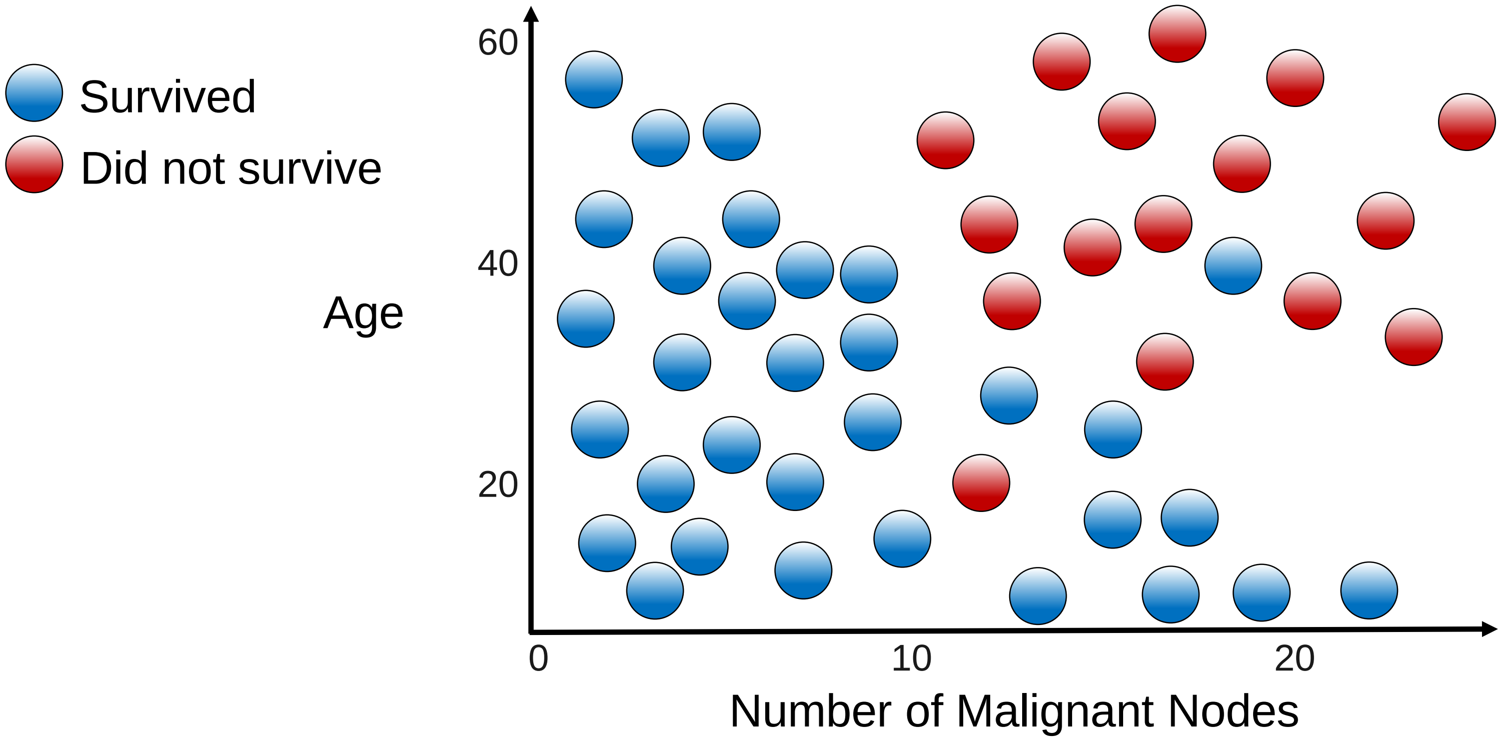
- Model data with:
  - Features that can be quantitated
  - Labels that are known

What is Needed for Classification?

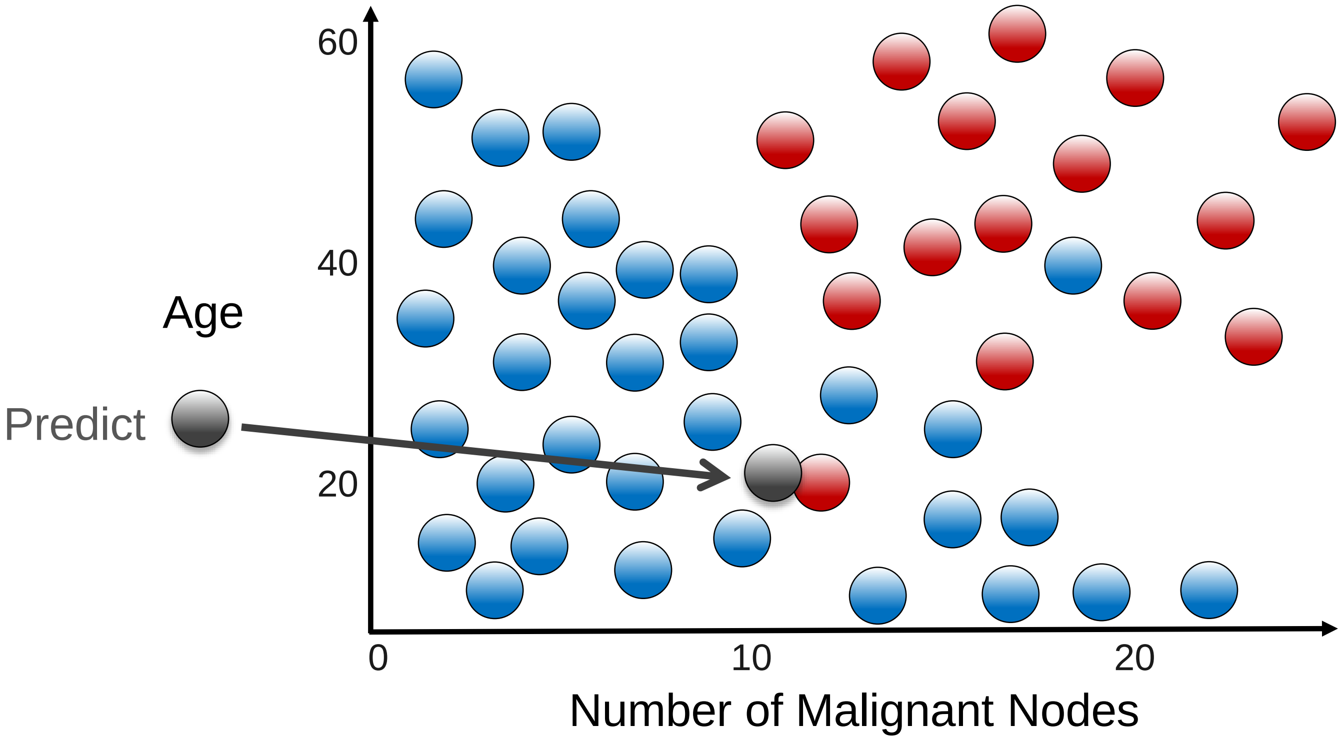
- Model data with:
  - Features that can be quantitated
  - Labels that are known
- Method to measure similarity

K Nearest Neighbors Classification

K Nearest Neighbors Classification

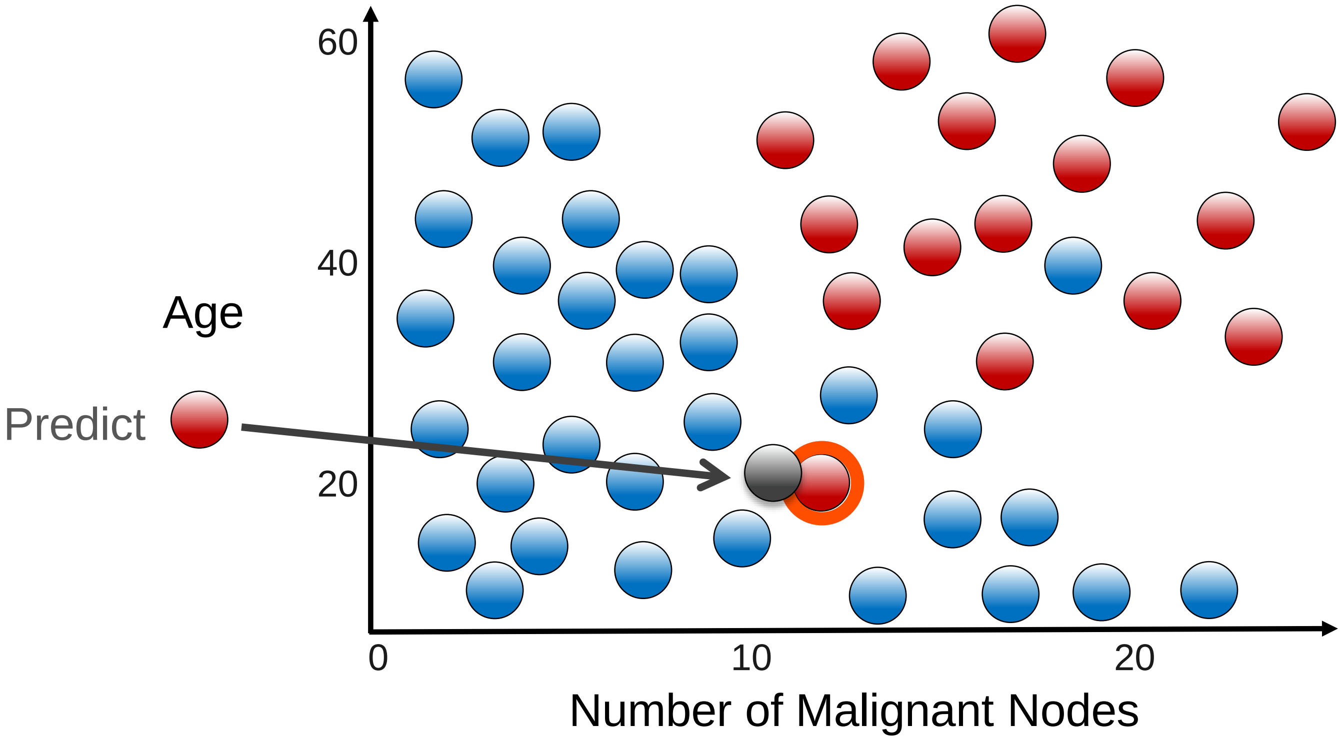


K Nearest Neighbors Classification

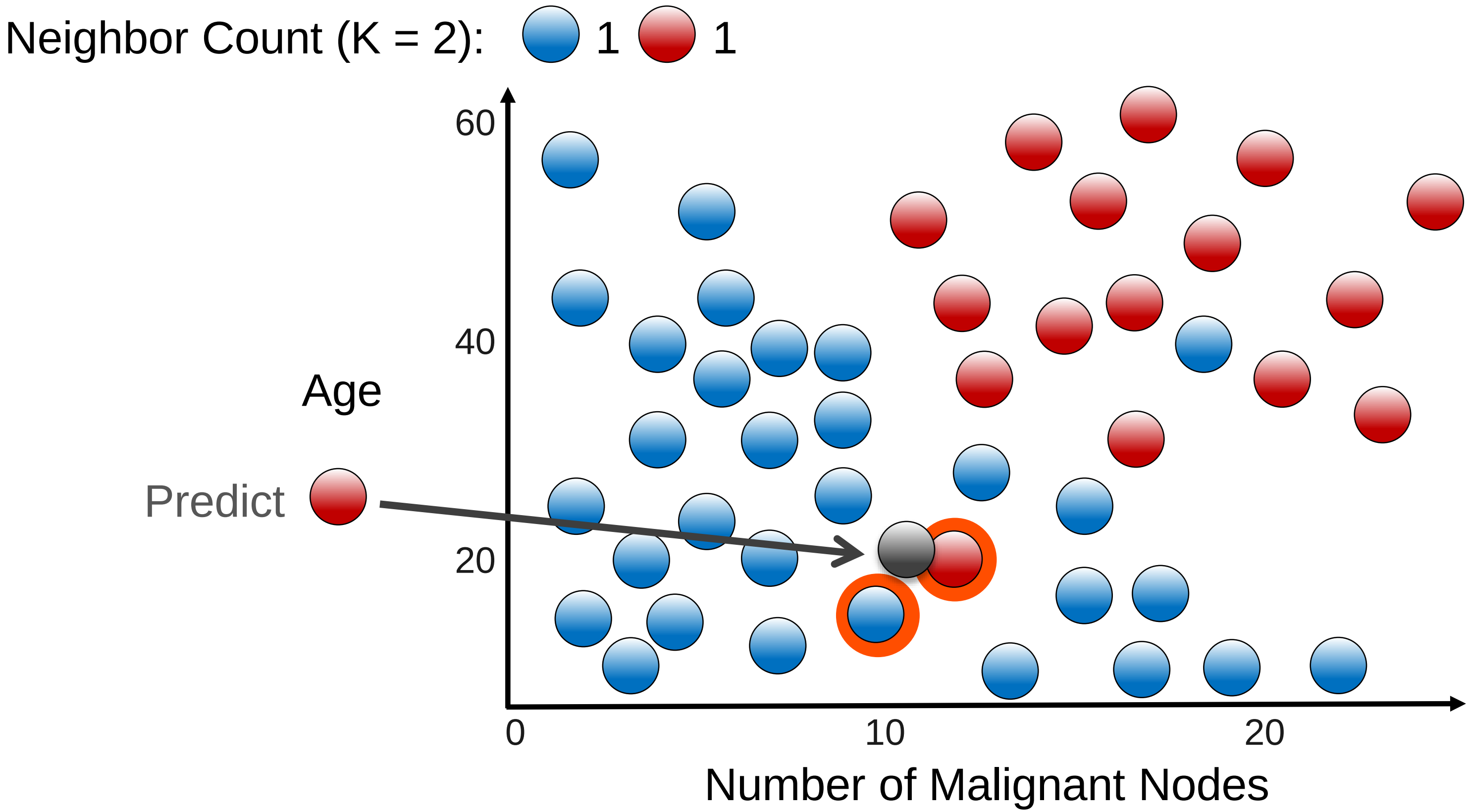


K Nearest Neighbors Classification

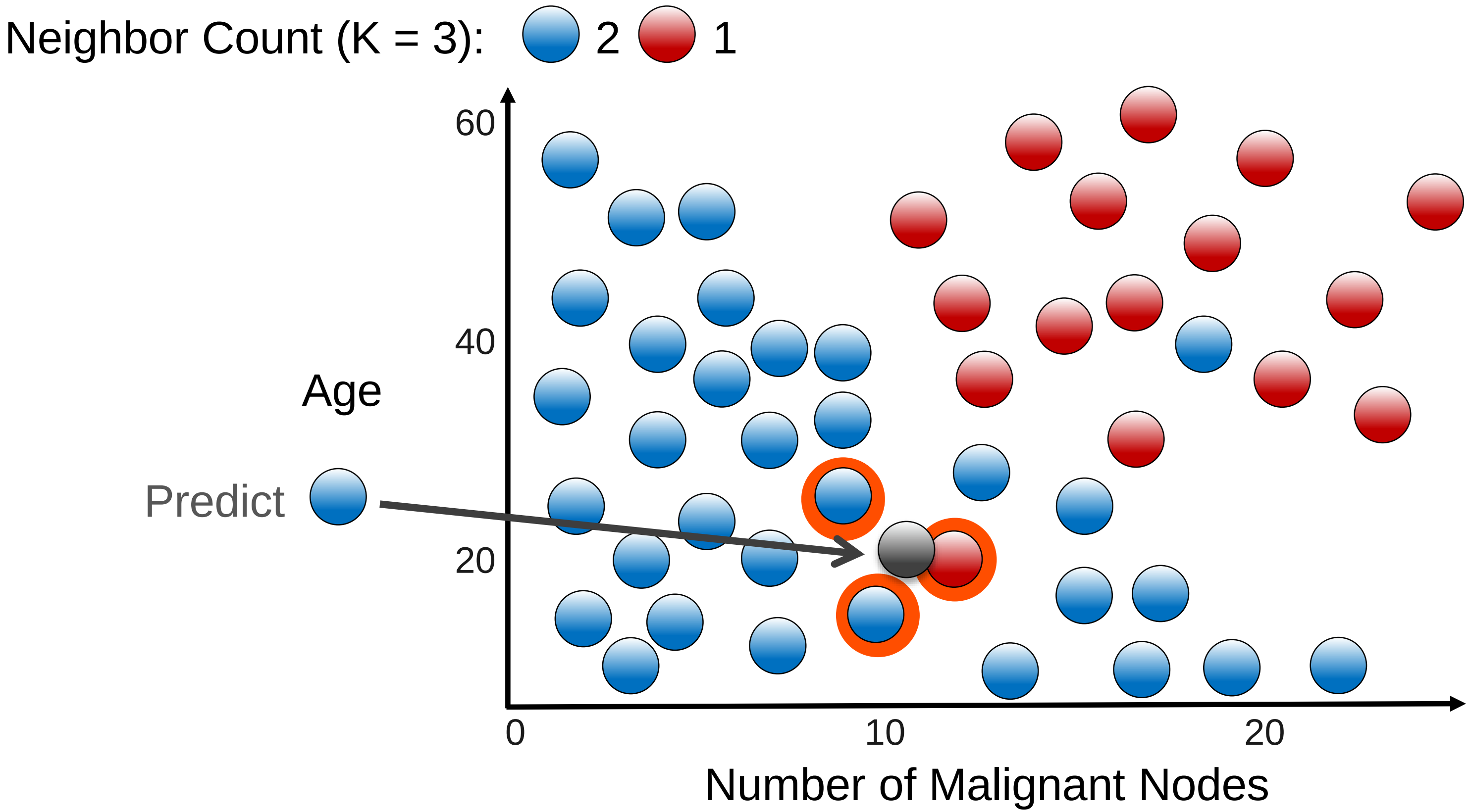
Neighbor Count (K = 1): 0 1



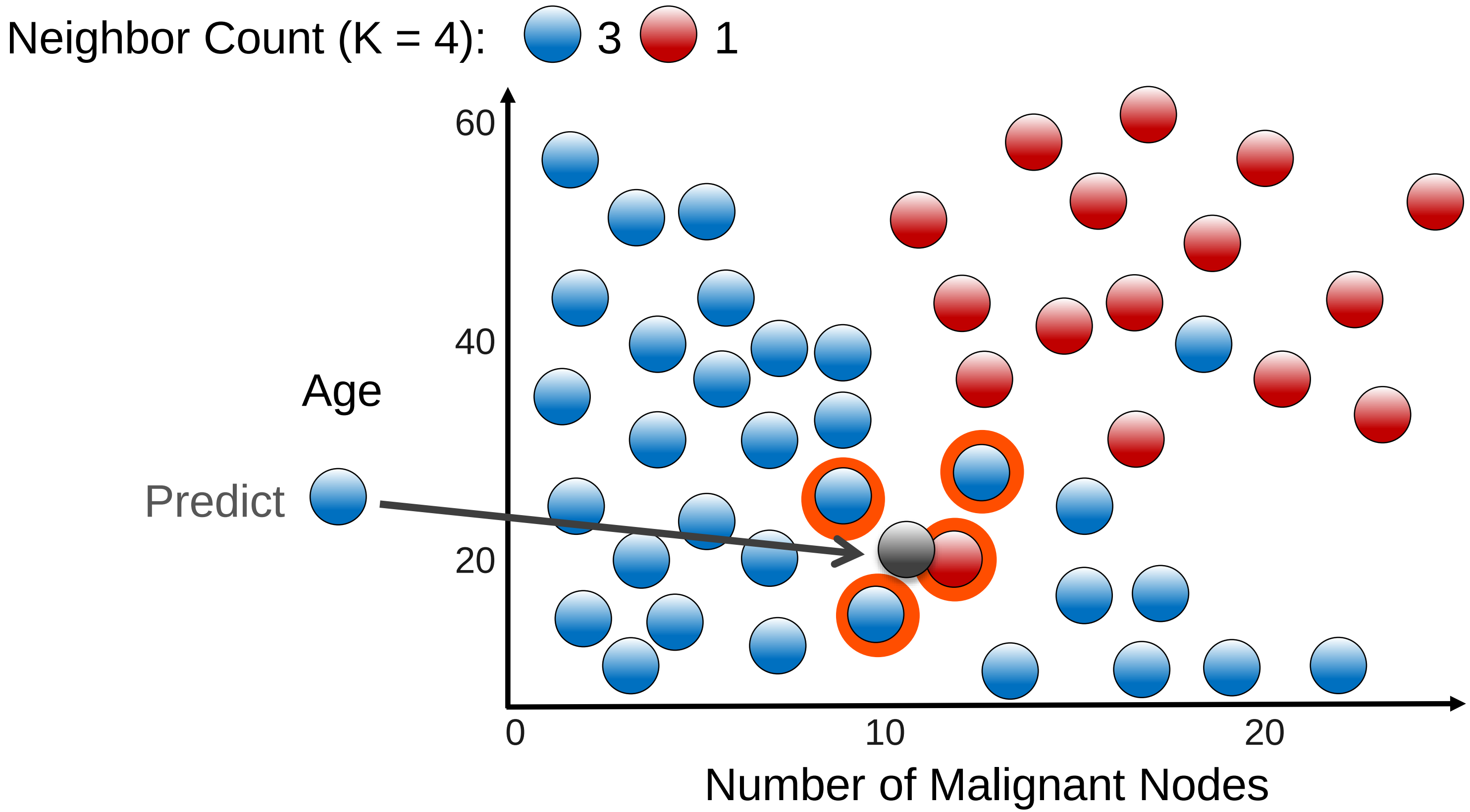
K Nearest Neighbors Classification



K Nearest Neighbors Classification



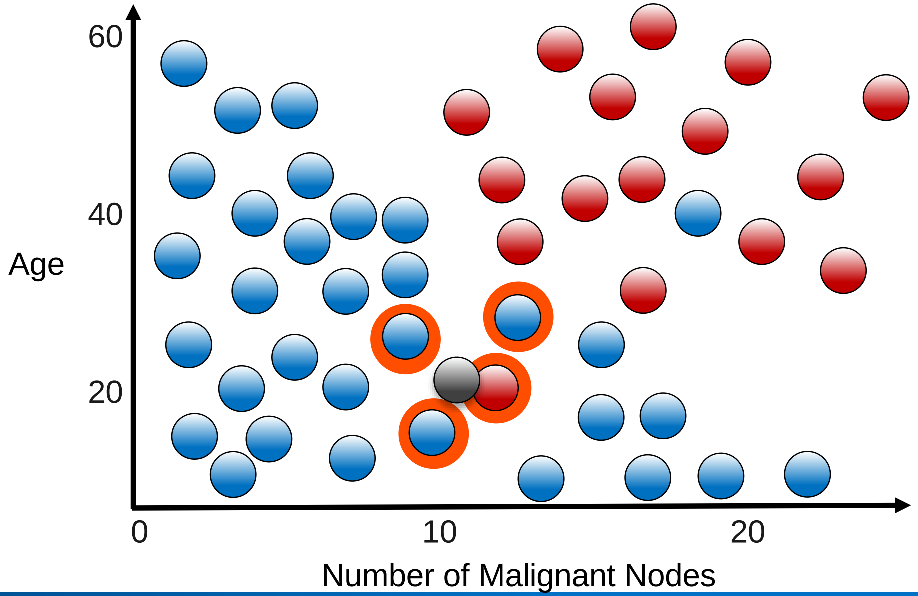
K Nearest Neighbors Classification



What is Needed to Select a KNN Model?

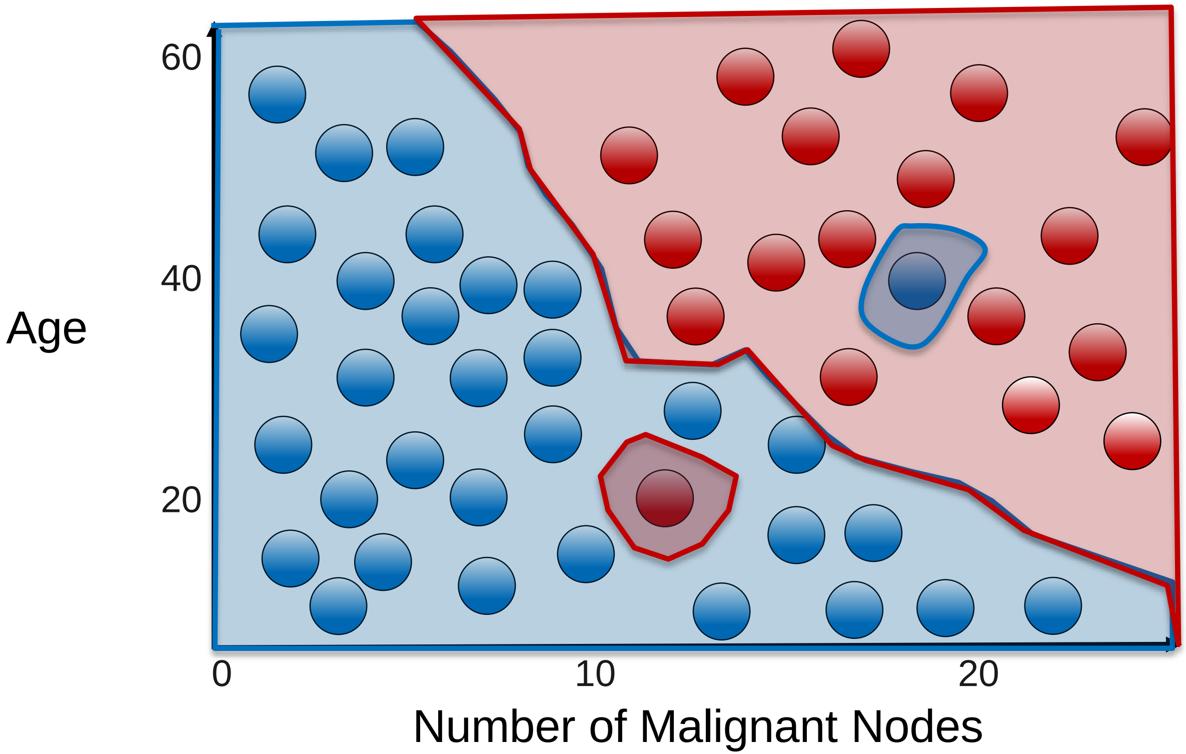
What is Needed to Select a KNN Model?

- Correct value for 'K'
- How to measure closeness of neighbors?



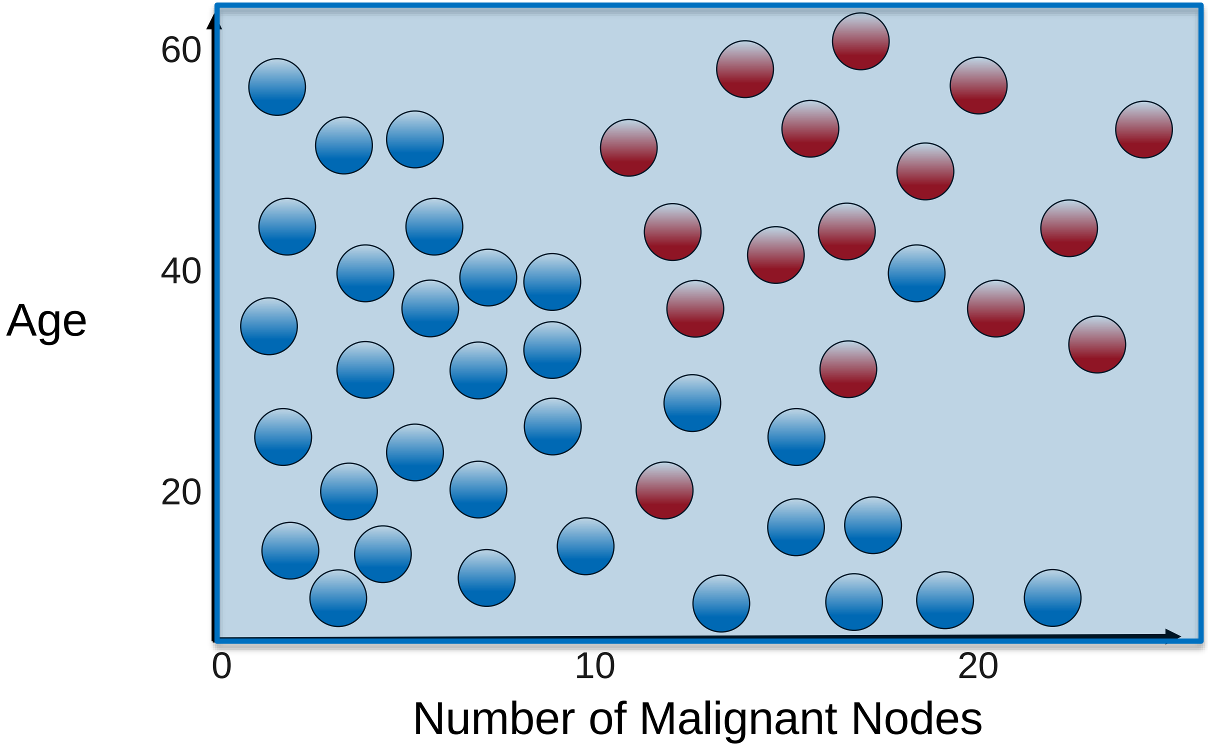
K Nearest Neighbors Decision Boundary

K = 1

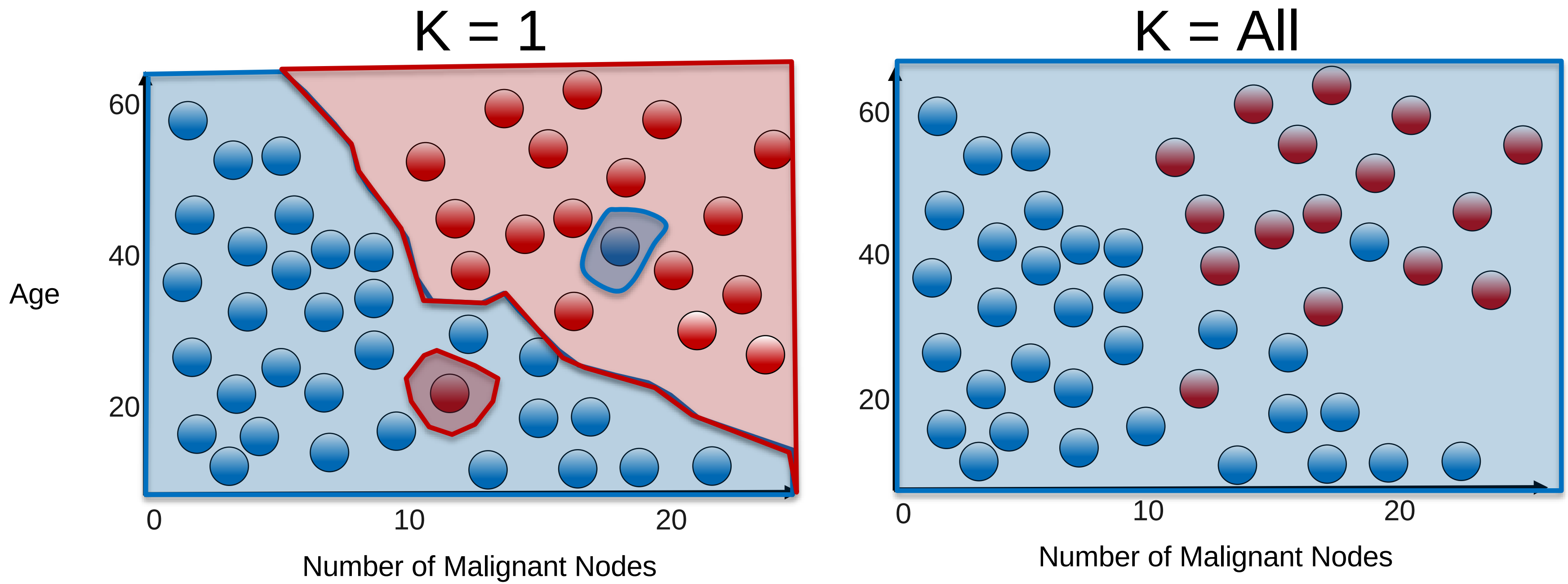


K Nearest Neighbors Decision Boundary

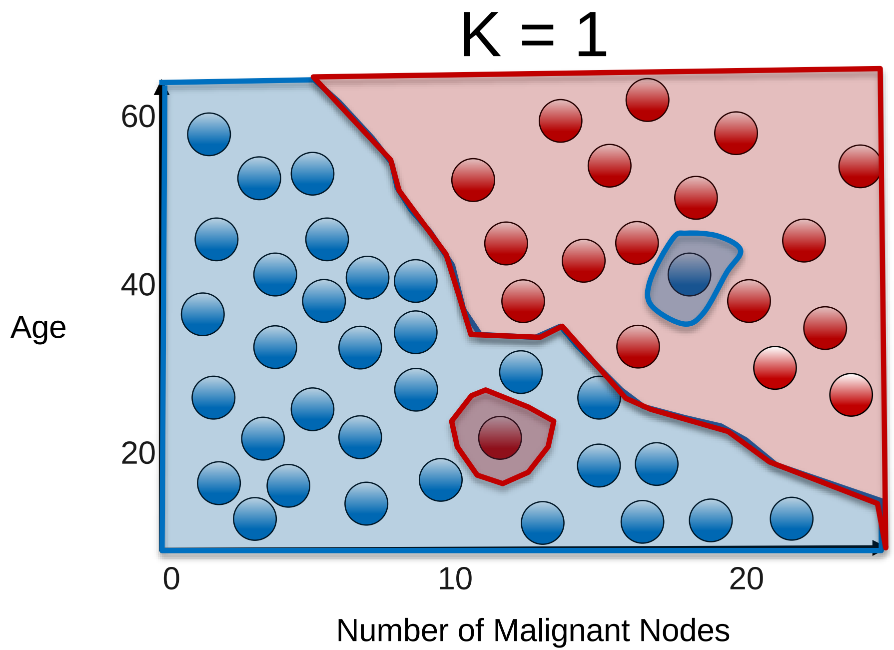
K = All

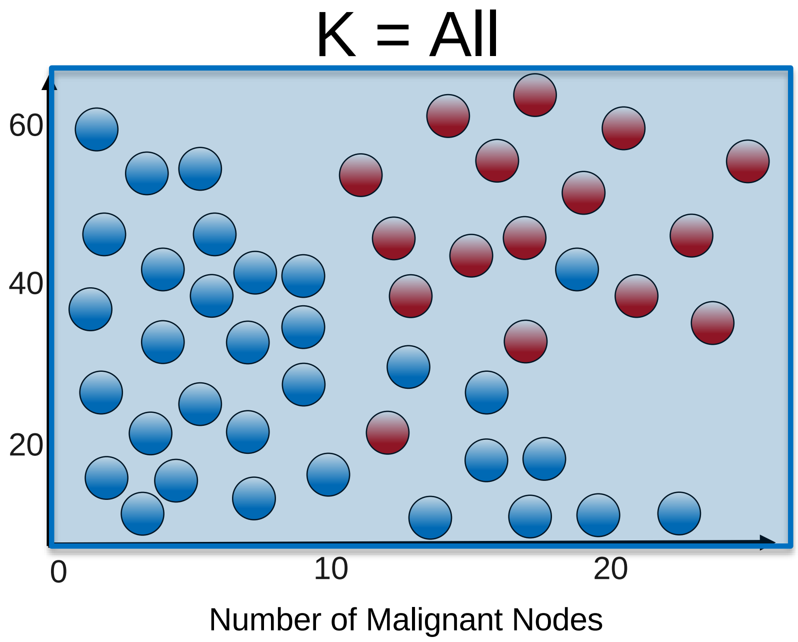


Value of 'K' Affects Decision Boundary



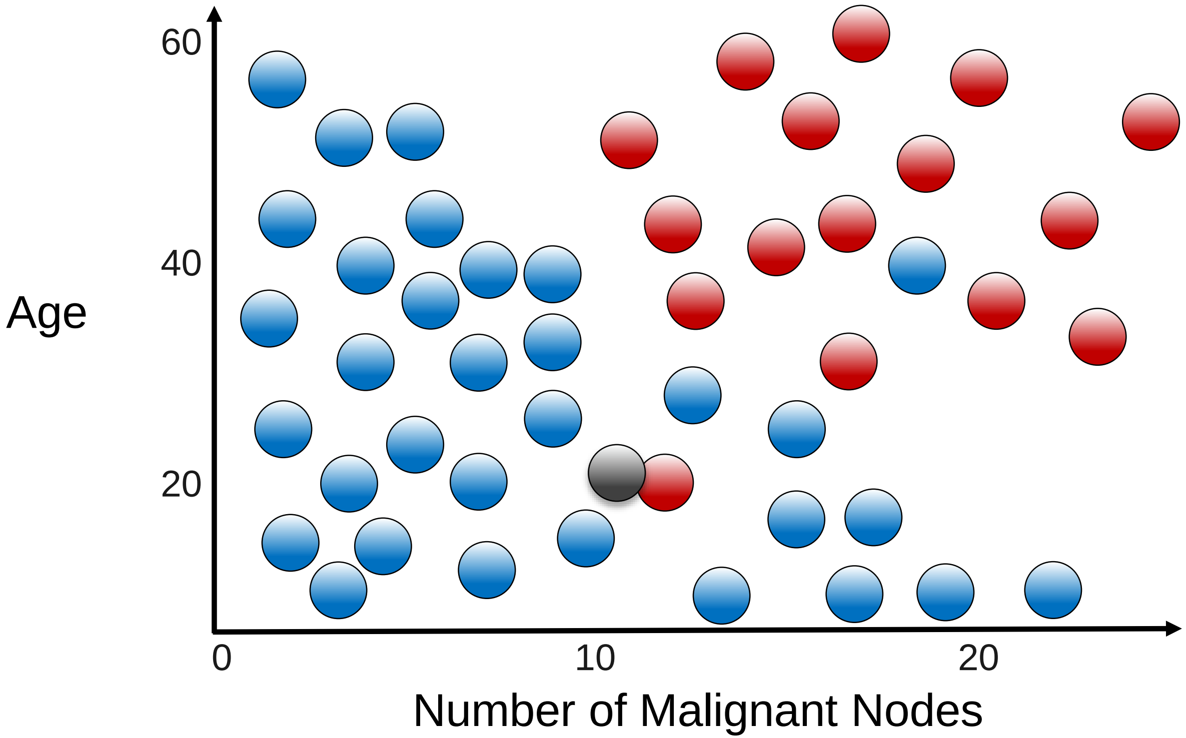
Value of 'K' Affects Decision Boundary



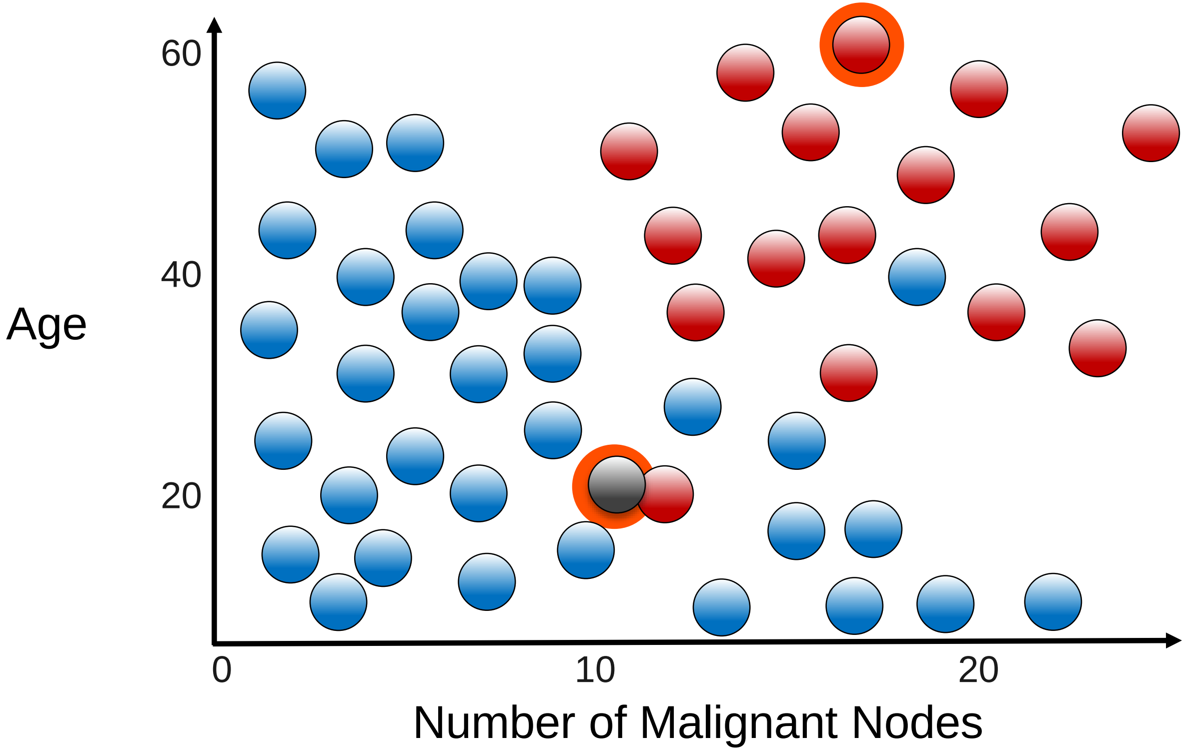


Methods for determining 'K' will be discussed in next lesson

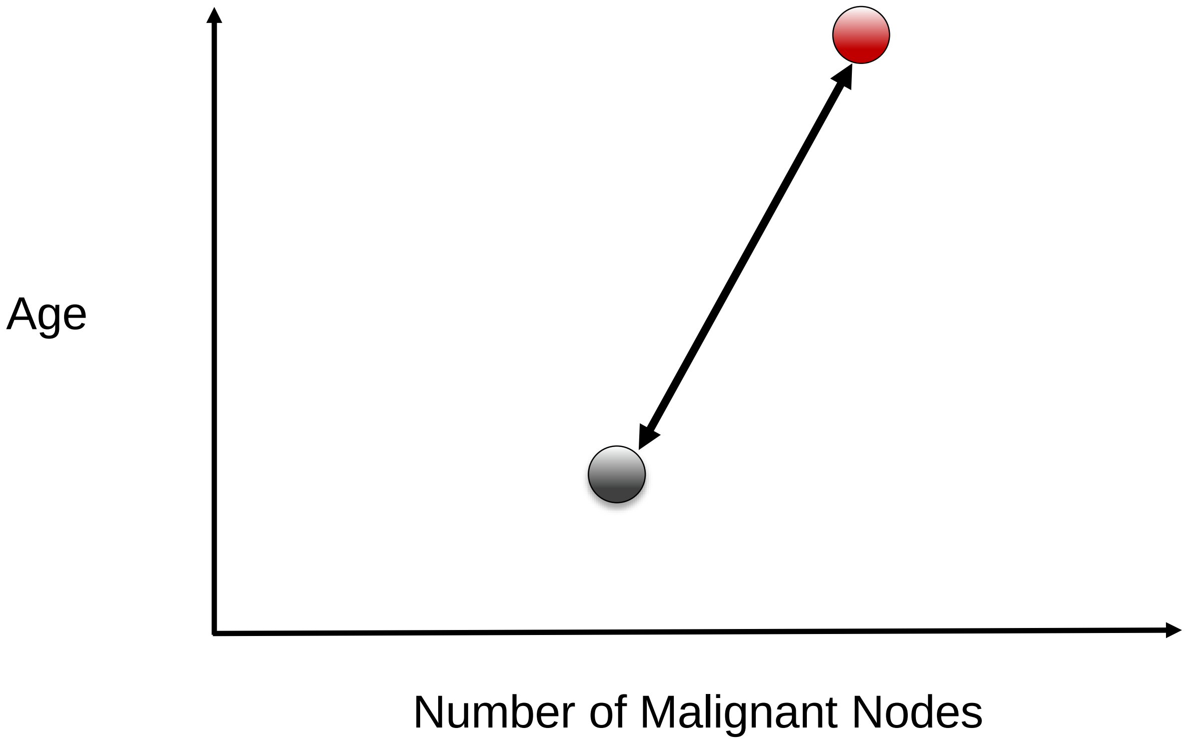
Measurement of Distance in KNN



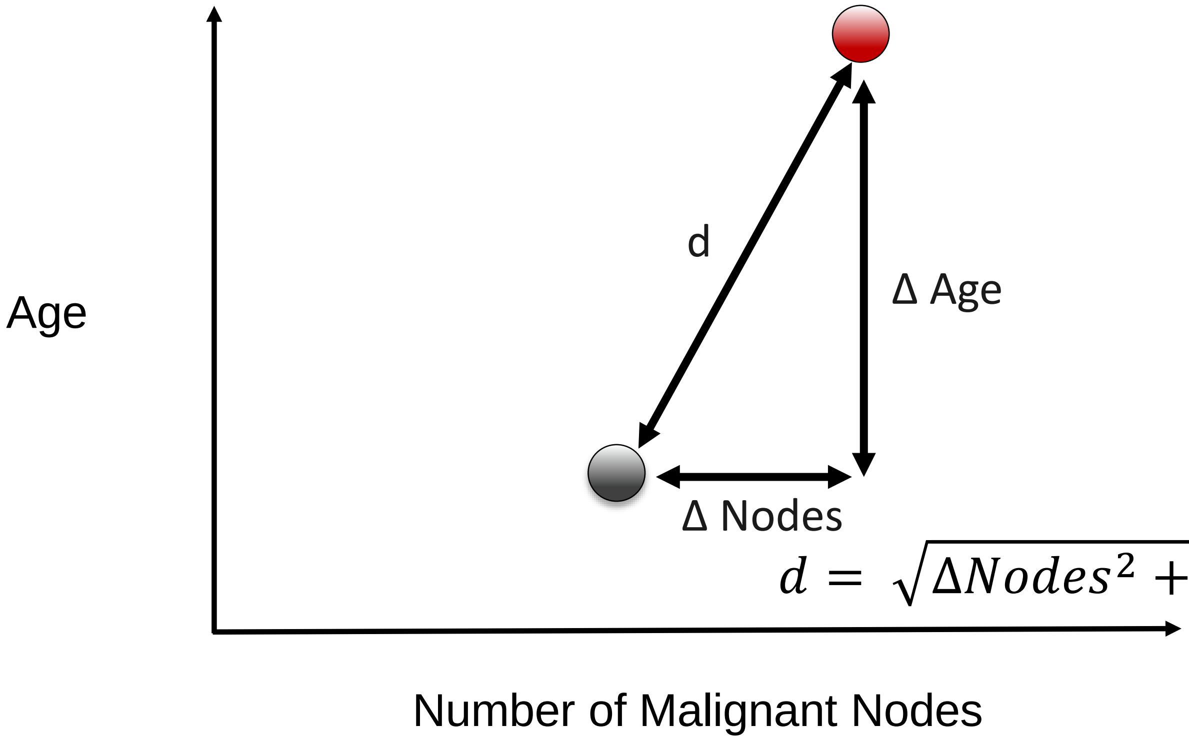
Measurement of Distance in KNN



Euclidean Distance

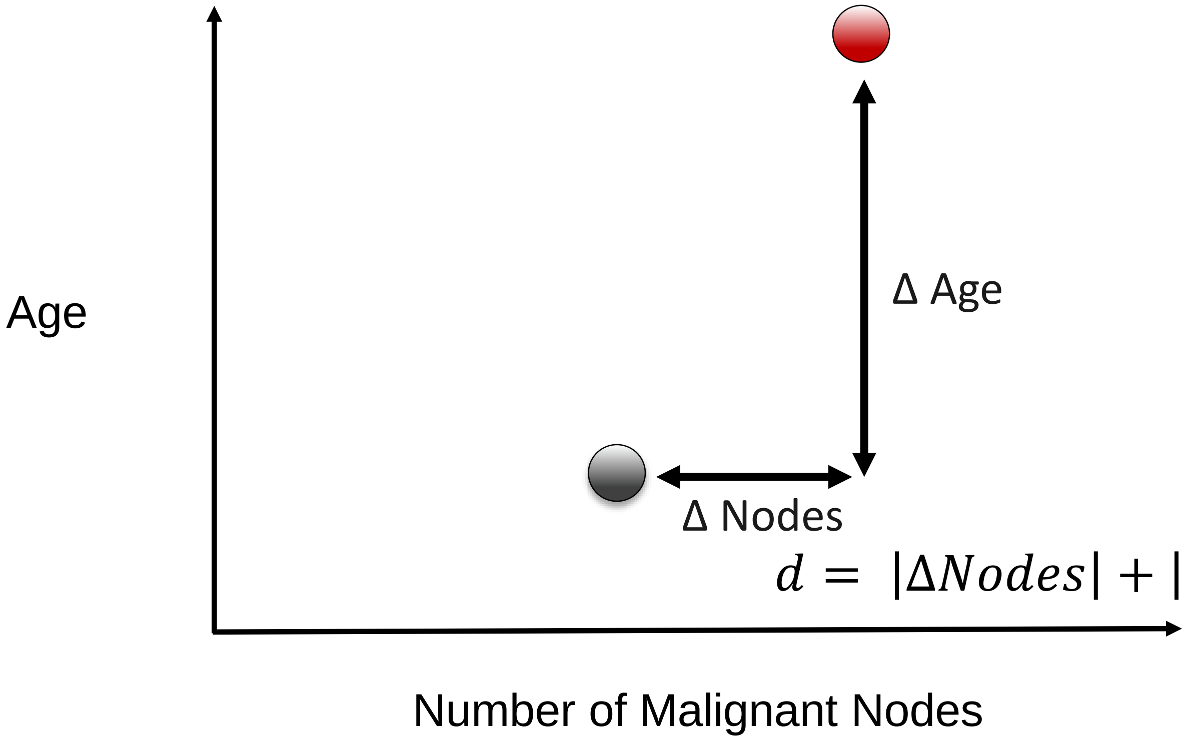


Euclidean Distance (L2 Distance)



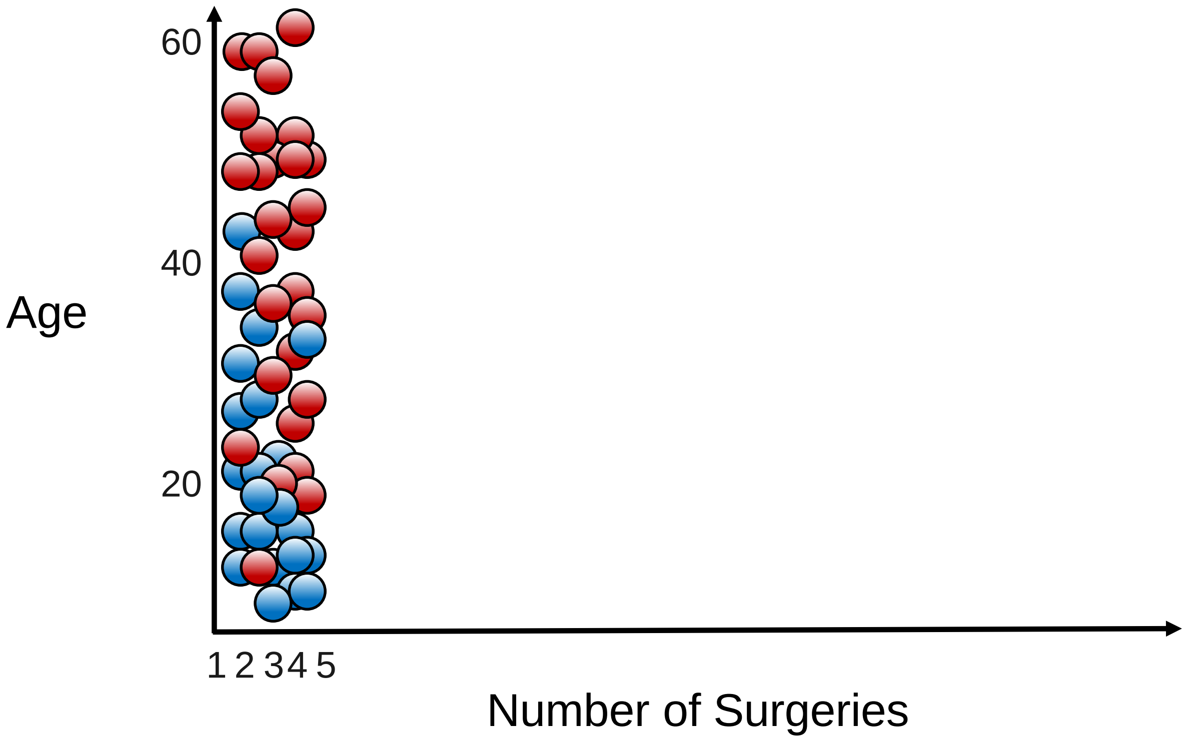
$$d = \sqrt{\Delta Nodes^2 + \Delta Age^2}$$

Manhattan Distance (L1 or City Block Distance)

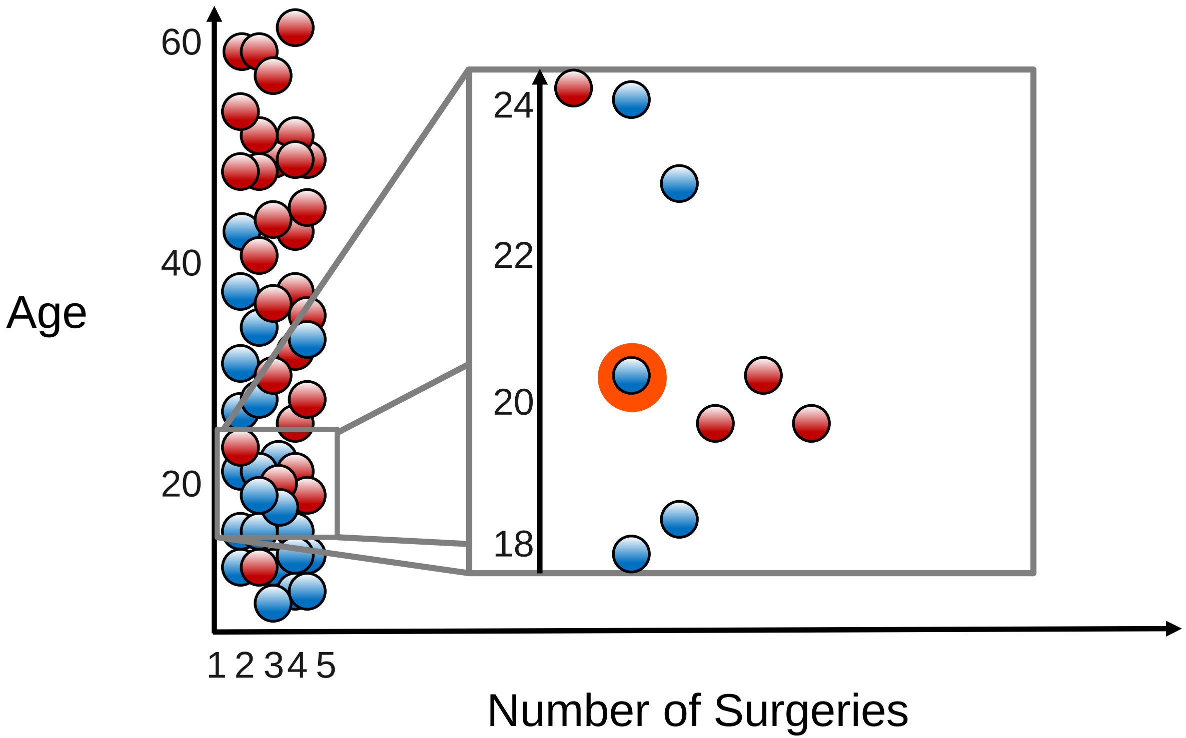


$$d = |\Delta Nodes| + |\Delta Age|$$

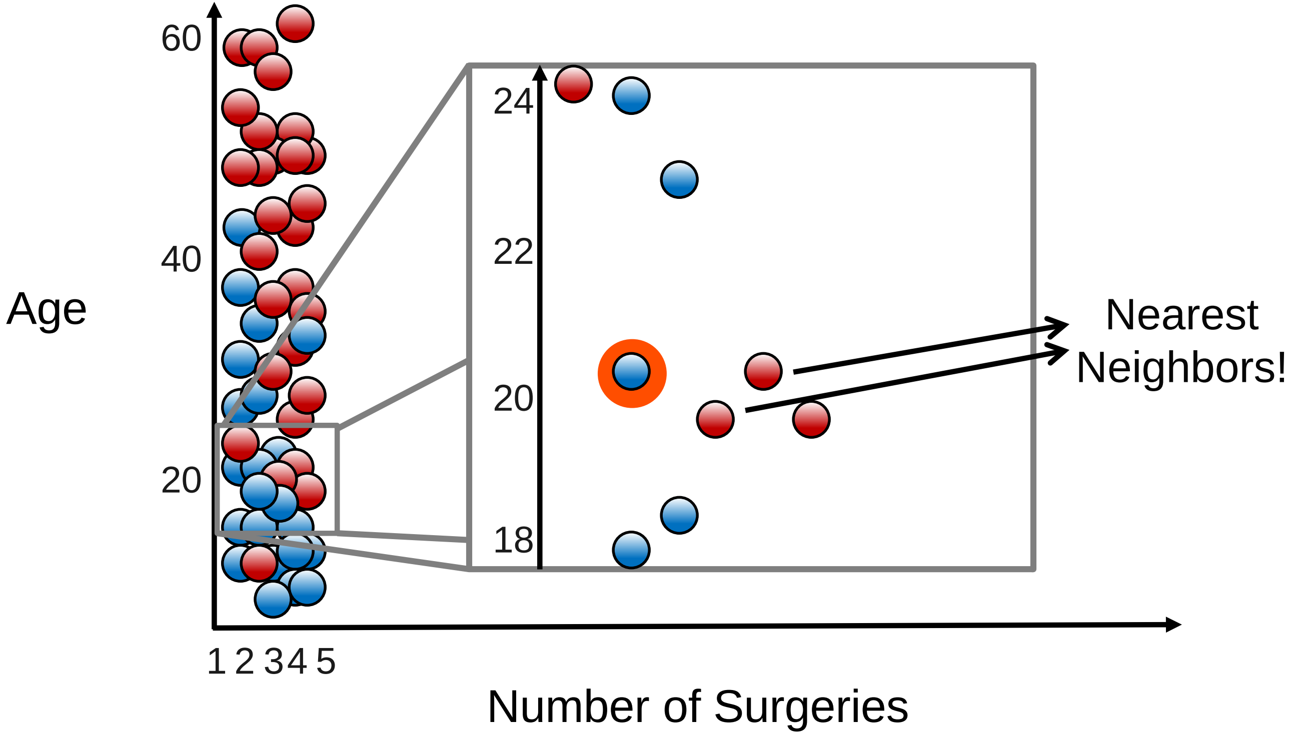
Scale is Important for Distance Measurement



Scale is Important for Distance Measurement

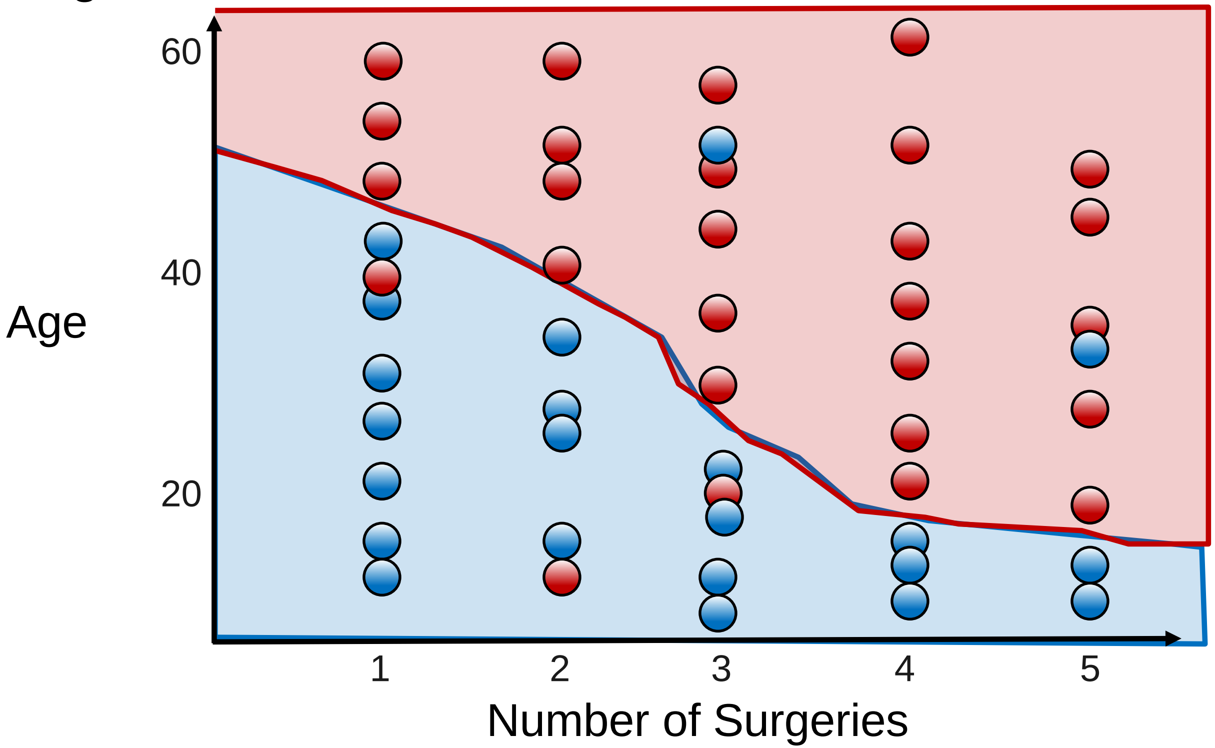


Scale is Important for Distance Measurement



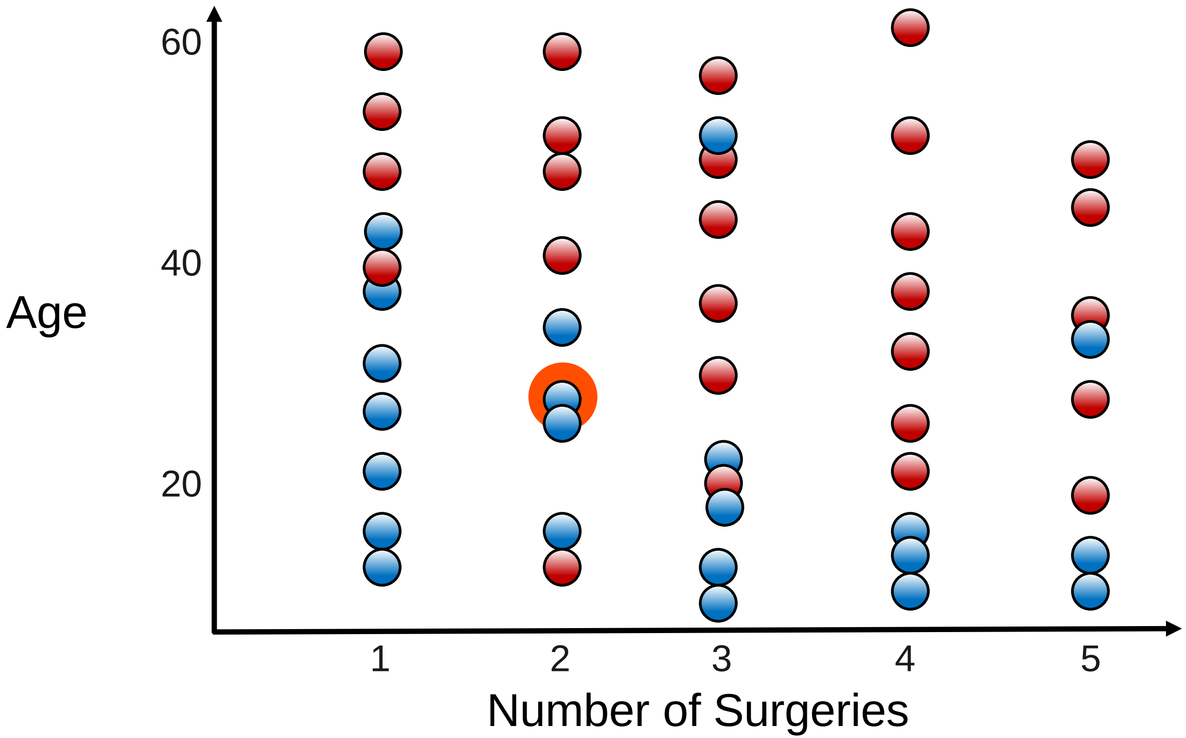
Scale is Important for Distance Measurement

"Feature Scaling"



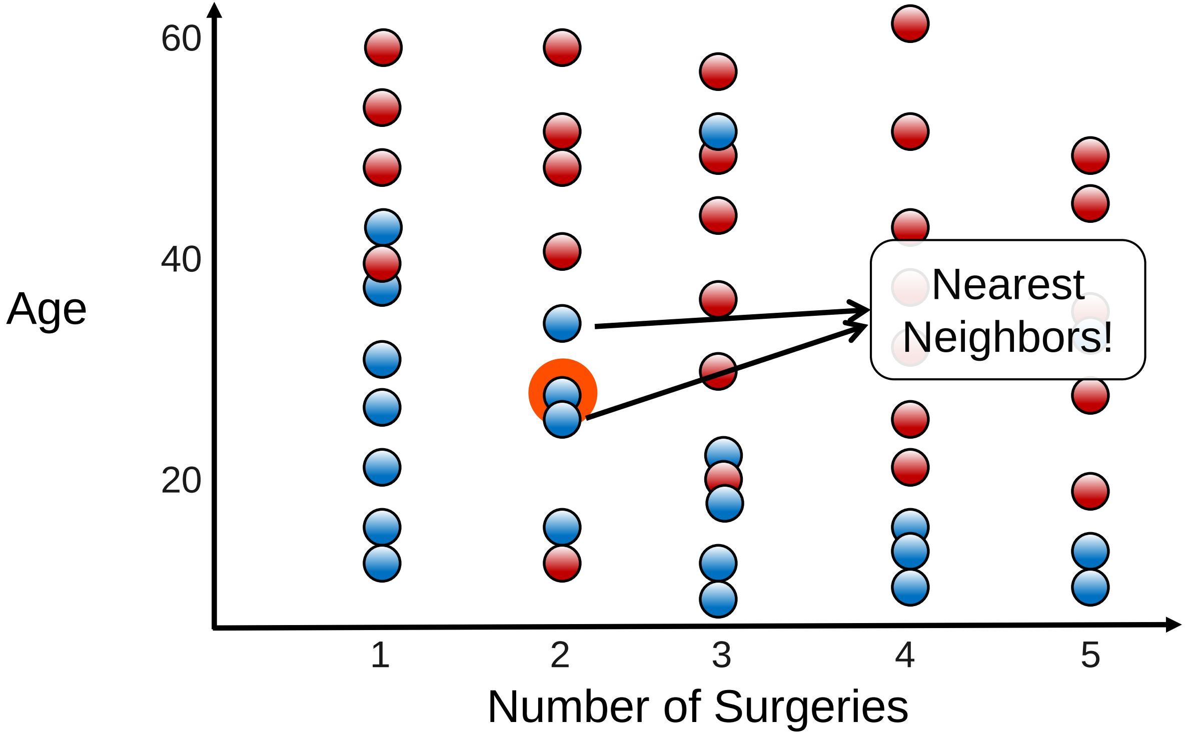
Scale is Important for Distance Measurement

"Feature Scaling"



Scale is Important for Distance Measurement

"Feature Scaling"



Comparison of Feature Scaling Methods

- **Standard Scaler:** mean center data and scale to unit variance
- **Minimum-Maximum Scaler:** scale data to fixed range (usually 0–1)
- **Maximum Absolute Value Scaler:** scale maximum absolute value

Feature Scaling: The Syntax

Import the class containing the scaling method

```
from sklearn.preprocessing import StandardScaler
```

Feature Scaling: The Syntax

Import the class containing the scaling method

```
from sklearn.preprocessing import StandardScaler
```

Create an instance of the class

```
StdSc = StandardScaler()
```

Feature Scaling: The Syntax

Import the class containing the scaling method

```
from sklearn.preprocessing import StandardScaler
```

Create an instance of the class

```
StdSc = StandardScaler()
```

Fit the scaling parameters and then transform the data

```
StdSc = StdSc.fit(X_data)

X_scaled = StdSc.transform(X_data)
```

Feature Scaling: The Syntax

Import the class containing the scaling method

```
from sklearn.preprocessing import StandardScaler
```

Create an instance of the class

```
StdSc = StandardScaler()
```

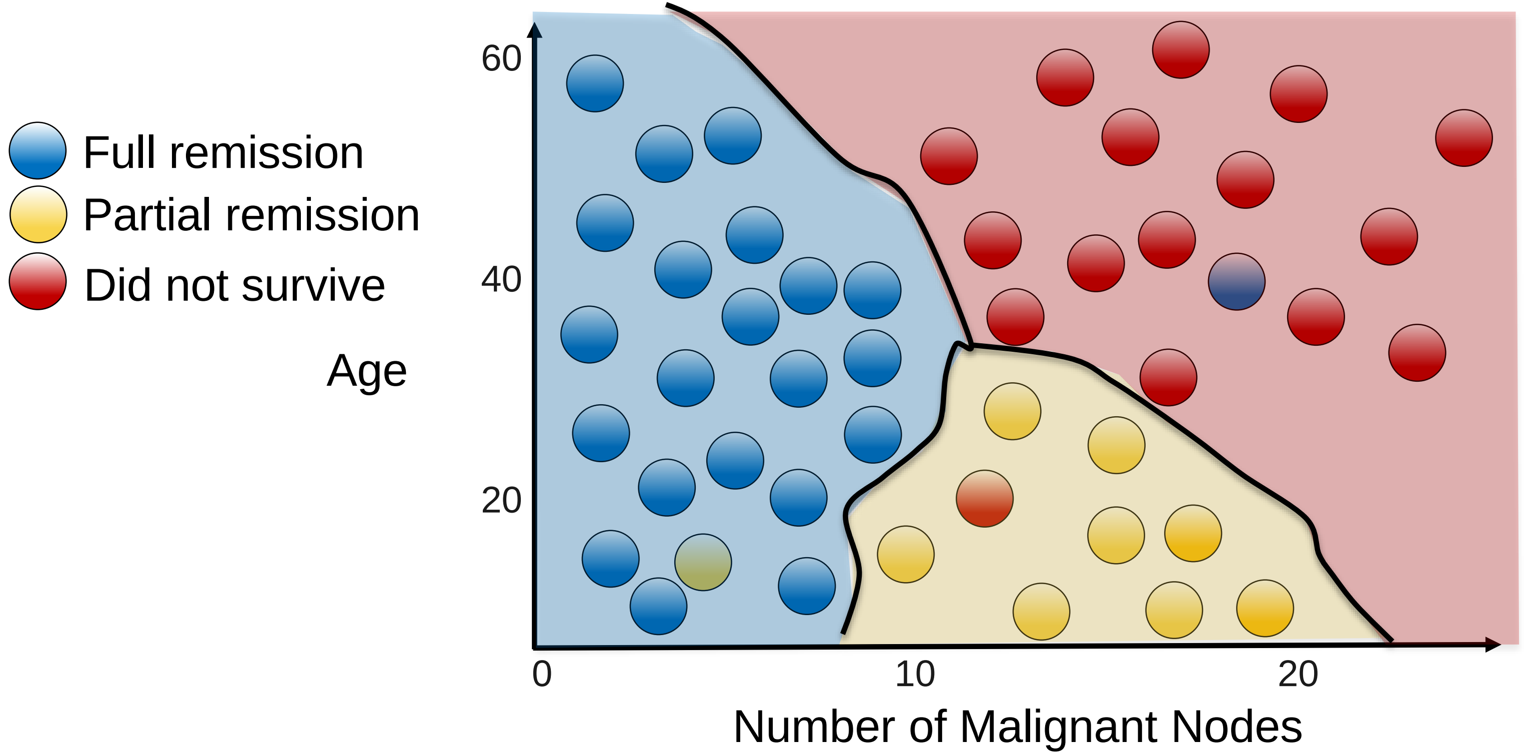
Fit the scaling parameters and then transform the data

```
StdSc = StdSc.fit(X_data)
X_scaled = StdSc.transform(X_data)
```

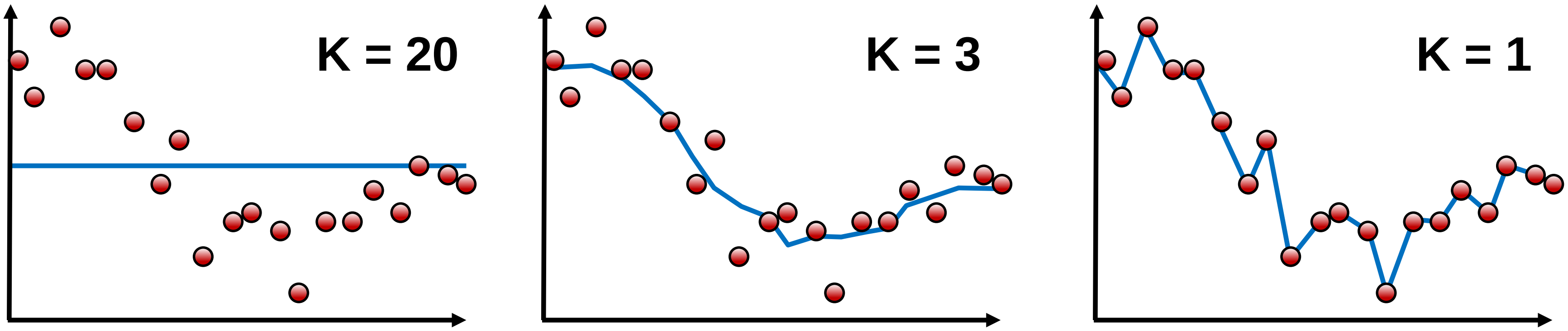
Other scaling methods exist: MinMaxScaler, MaxAbsScaler.

Multiclass KNN Decision Boundary

K = 5



Regression with KNN



Characteristics of a KNN Model

- Fast to create model because it simply stores data
- Slow to predict because many distance calculations
- Can require lots of memory if data set is large

K Nearest Neighbors: The Syntax

Import the class containing the classification method

```
from sklearn.neighbors import KNeighborsClassifier
```

K Nearest Neighbors: The Syntax

Import the class containing the classification method

```
from sklearn.neighbors import KNeighborsClassifier
```

Create an instance of the class

```
KNN = KNeighborsClassifier(n_neighbors=3)
```

K Nearest Neighbors: The Syntax

Import the class containing the classification method

```
from sklearn.neighbors import KNeighborsClassifier
```

Create an instance of the class

```
KNN = KNeighborsClassifier(n_neighbors=3)
```

Fit the instance on the data and then predict the expected value

```
KNN = KNN.fit(X_data, y_data)
y_predict = KNN.predict(X_data)
```

K Nearest Neighbors: The Syntax

Import the class containing the classification method

```
from sklearn.neighbors import KNeighborsClassifier
```

Create an instance of the class

```
KNN = KNeighborsClassifier(n_neighbors=3)
```

Fit the instance on the data and then predict the expected value

```
KNN = KNN.fit(X_data, y_data)
y_predict = KNN.predict(X_data)
```

The fit and predict/transform syntax will show up throughout the course.

K Nearest Neighbors: The Syntax

Import the class containing the classification method

```
from sklearn.neighbors import KNeighborsClassifier
```

Create an instance of the class

```
KNN = KNeighborsClassifier(n_neighbors=3)
```

Fit the instance on the data and then predict the expected value

```
KNN = KNN.fit(X_data, y_data)
y_predict = KNN.predict(X_data)
```

Regression can be done with KNeighborsRegressor.

Legal Notices and Disclaimers