K – Nearest Neighbors

Classification Algorithm

Predicts category or class labels for data points

A type of supervised machine learning algorithm

Learns from labeled training data for predictions

Outputs discrete values like "yes" or "no"

Common in spam filters, disease detection, etc.

Key task: classify into predefined categories

Types of Classification Algorithms

Logistic Regression – simple, interpretable, linear boundaries

Decision Trees – splits data into rule-based branches

Random Forest – multiple decision trees combined

Support Vector Machine (SVM) – separates with optimal margin

K-Nearest Neighbors (KNN) – based on closest data points

Naive Bayes – based on Bayes' Theorem assumptions

Binary vs Multiclass Classification

- **Binary**: Two possible classes (e.g., spam or not)
- **Multiclass**: More than two output classes
- Binary is simpler, often a yes/no scenario
- Multiclass includes scenarios like classifying animal types
- One-vs-All technique used in multiclass models
- Algorithms can be adapted for both types

Real-World Use Case Example

Email Spam Detection: spam or not spam

Medical Diagnosis: disease present or absent

Sentiment Analysis: positive, neutral, or negative

Loan Approval: approved or rejected

Image Recognition: identify cats, dogs, etc.

Customer Churn Prediction: stay or leave

Key Benefits of Classification Algorithms

- Automate decision-making tasks efficiently
- Can handle large amounts of data
- Improve with more training data
- Adaptable to various domains and industries
- Useful for real-time predictions and alerts
- Enhance accuracy with proper tuning and features

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?

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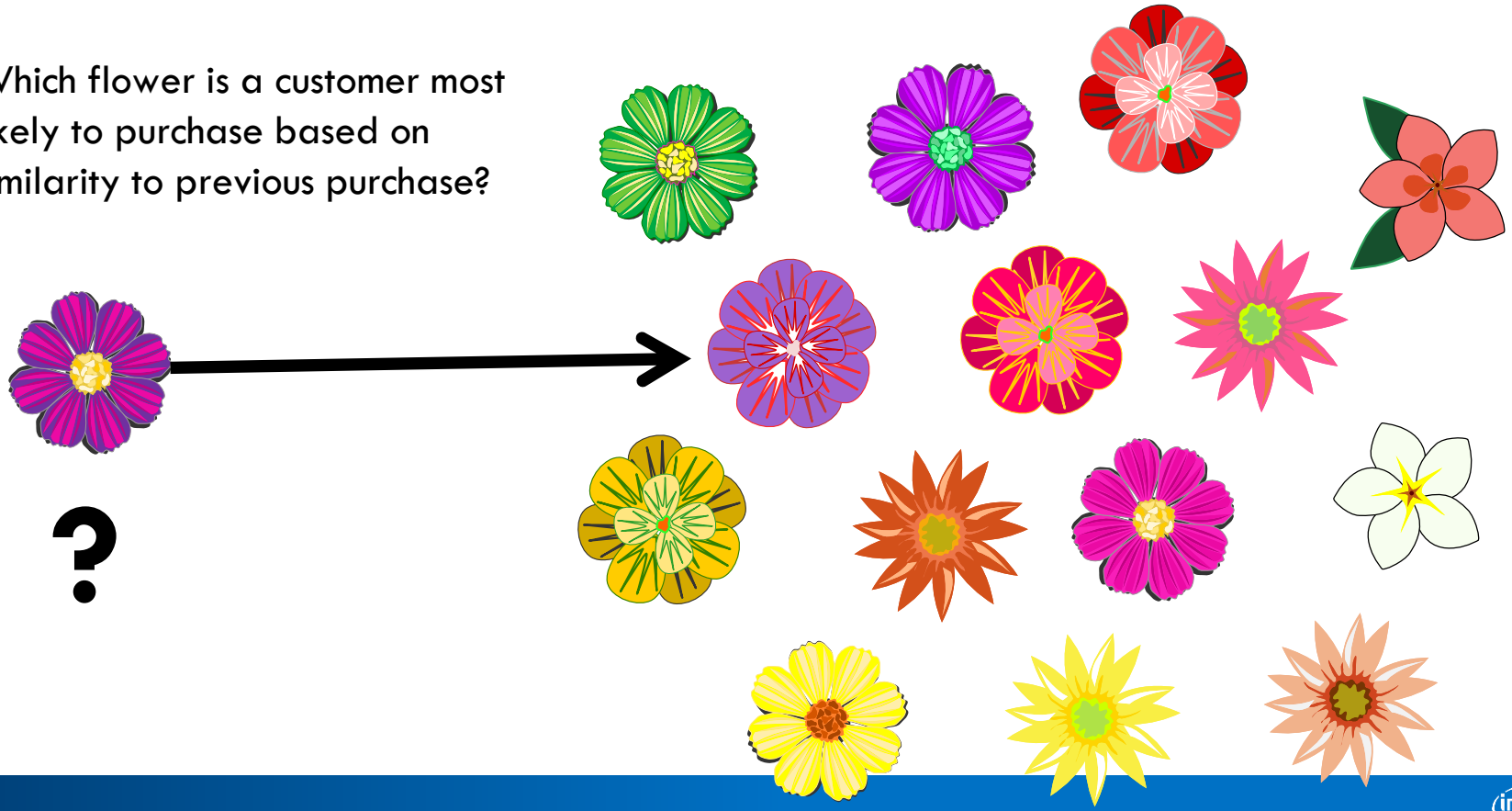

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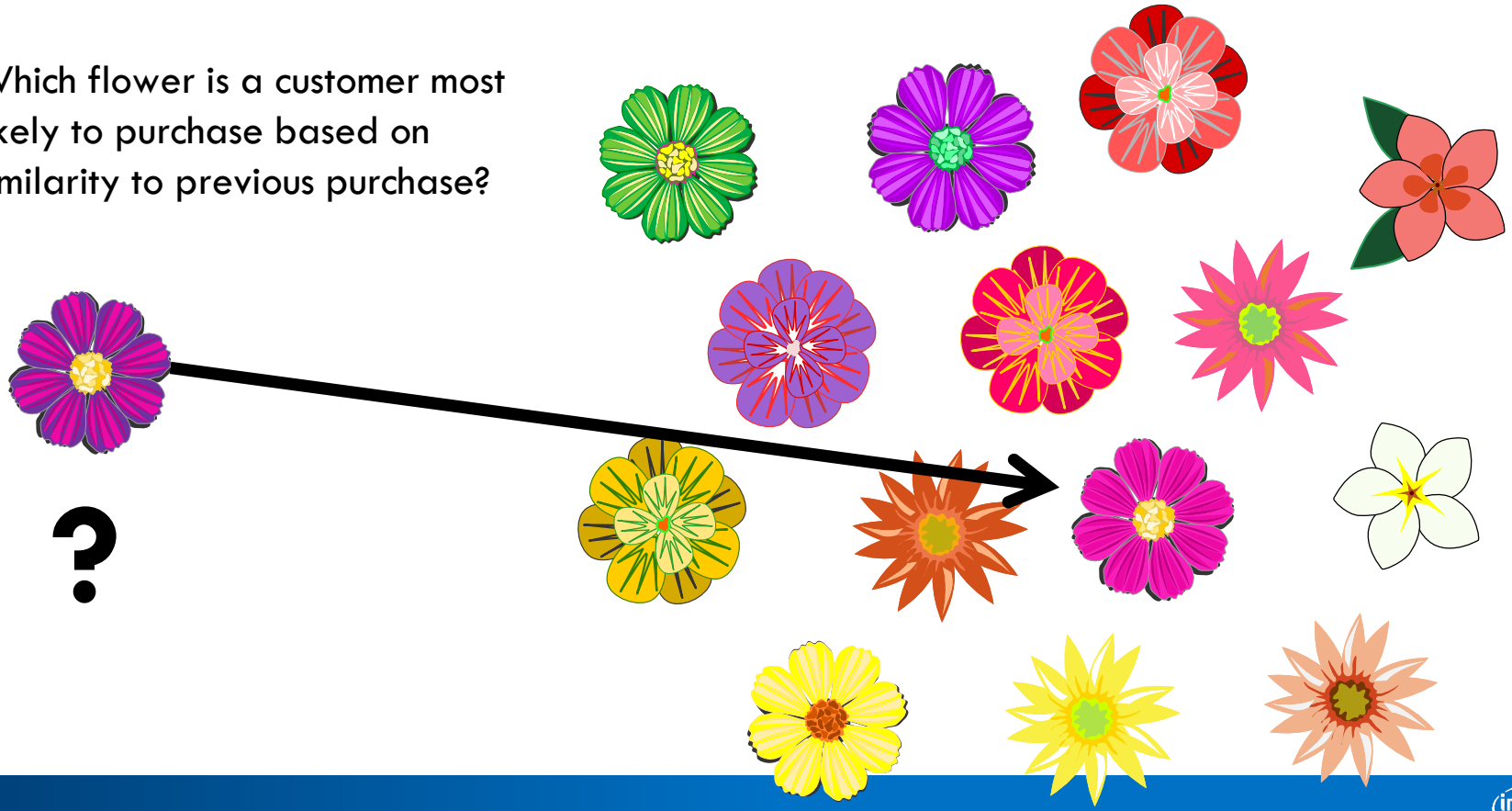

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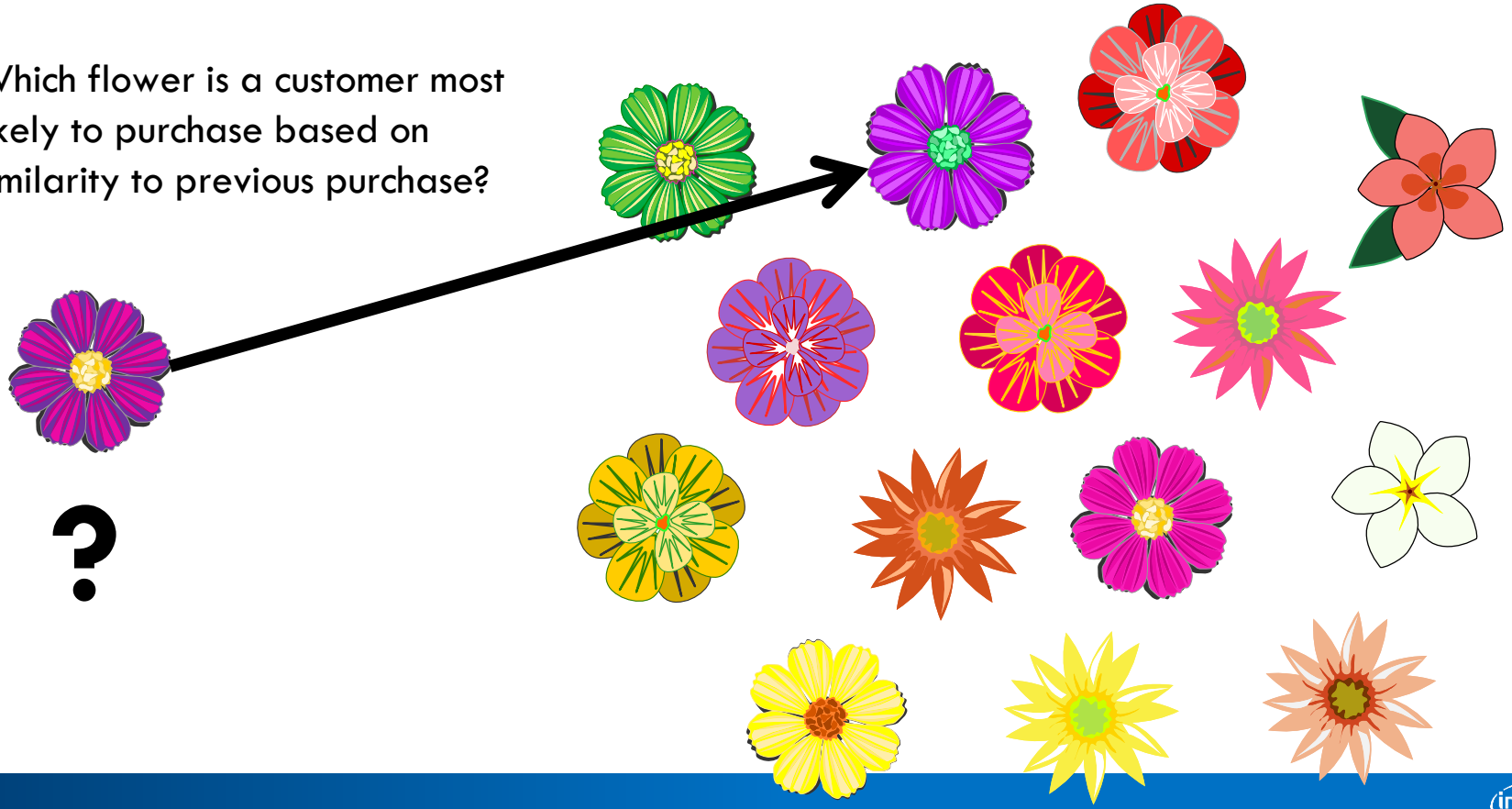

What is Needed for Classification?

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- Model data with:
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  - Labels that are known
- Method to measure similarity

KNN Classification

- A simple, non-parametric classification algorithm
- Classifies based on nearest training data points
- No model training phase — lazy learner
- Stores all training data for comparison
- Works for classification and regression tasks

How KNN Works

Choose a value for **K** (number of neighbors)

Calculate distance to all training points

Common distance: Euclidean distance formula

Select **K** nearest neighbors to test data

Count votes from neighbors' class labels

Assign most common label as prediction

Pros and Cons of KNN

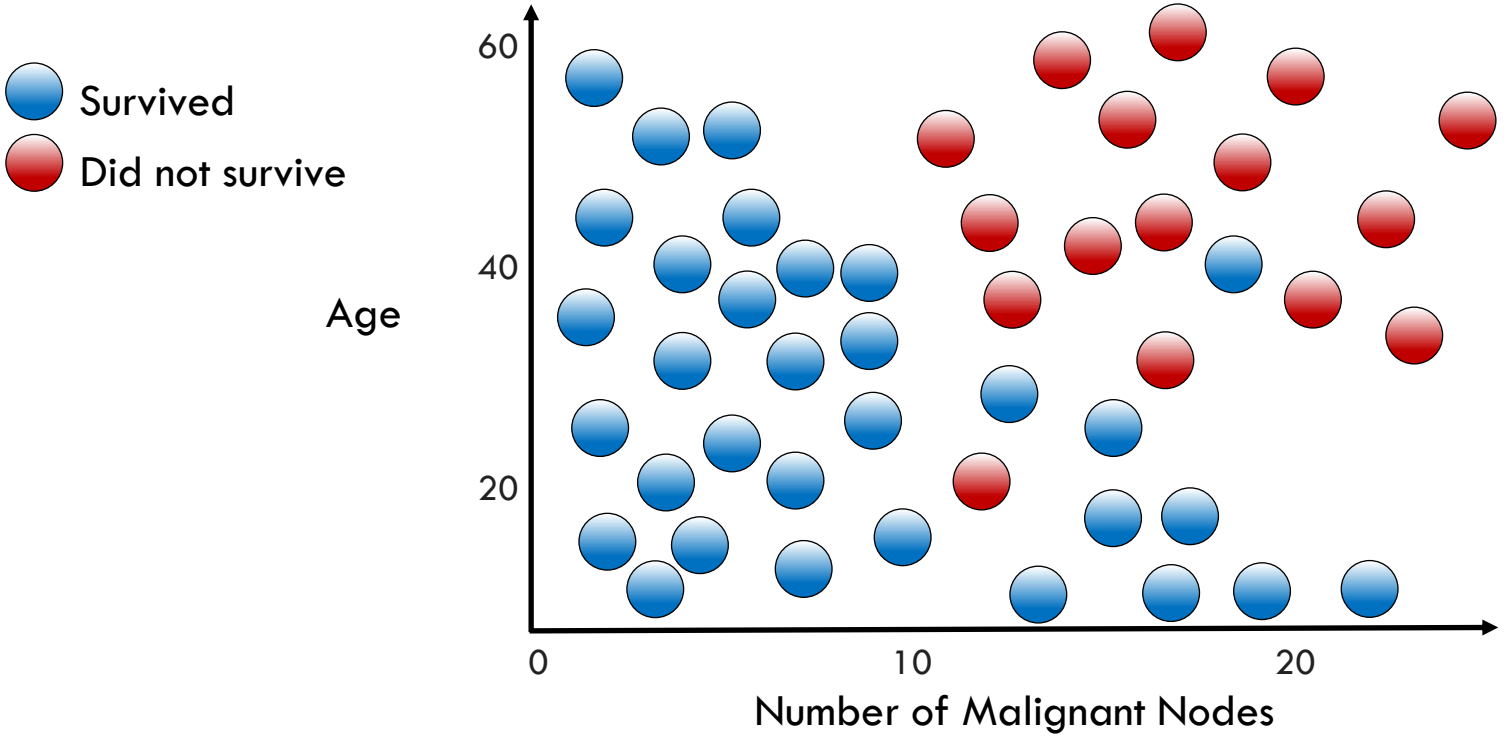
Pros

- Simple and easy to understand
- No training time required
- Adapts well to new data

Cons

- Slow with large datasets
- Sensitive to irrelevant features
- Struggles with high-dimensional data

K Nearest Neighbors Classification



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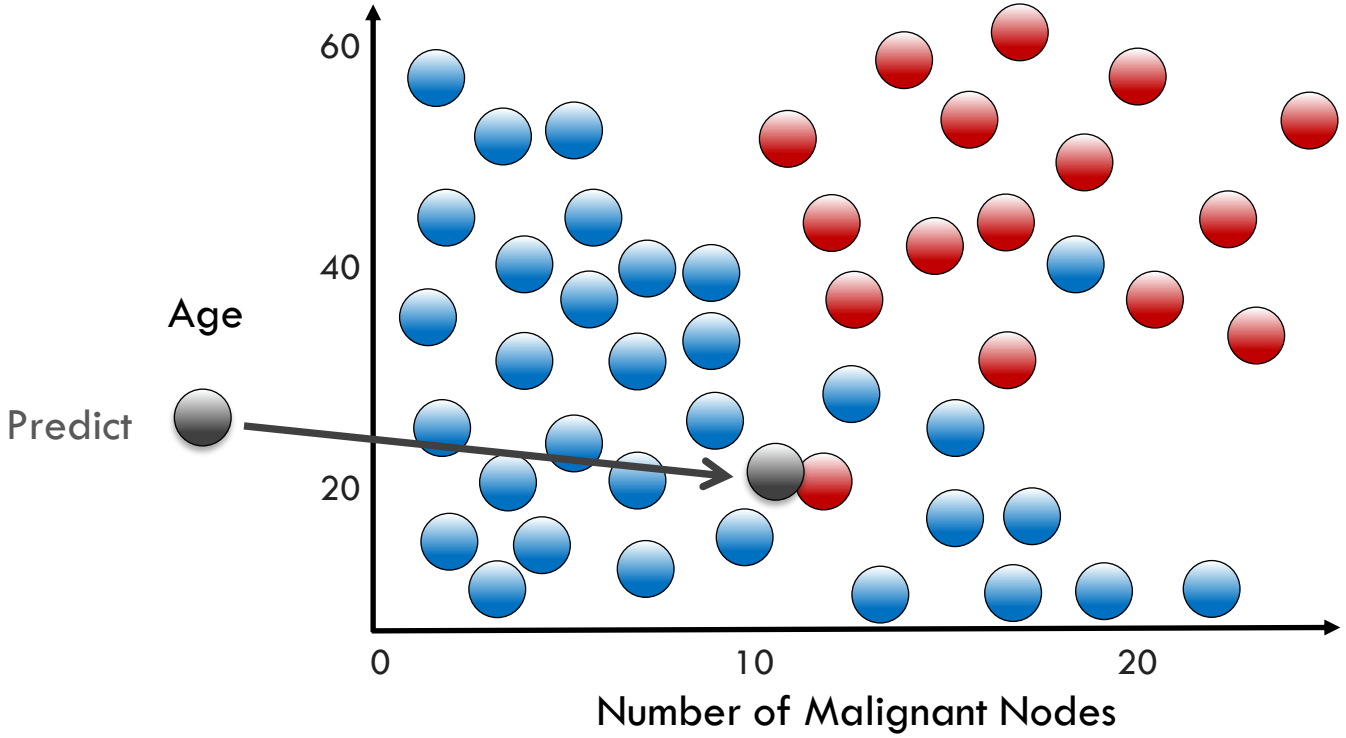

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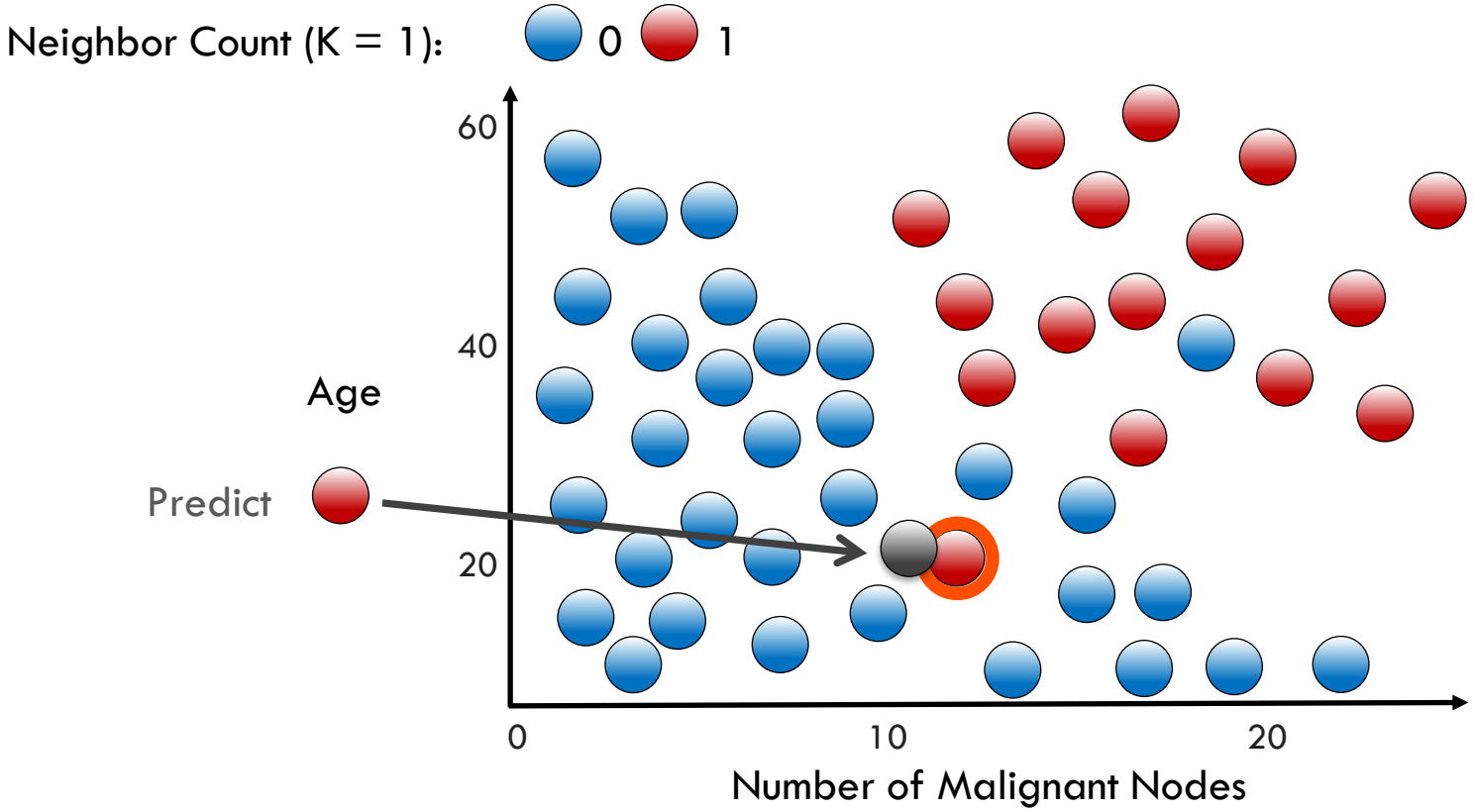

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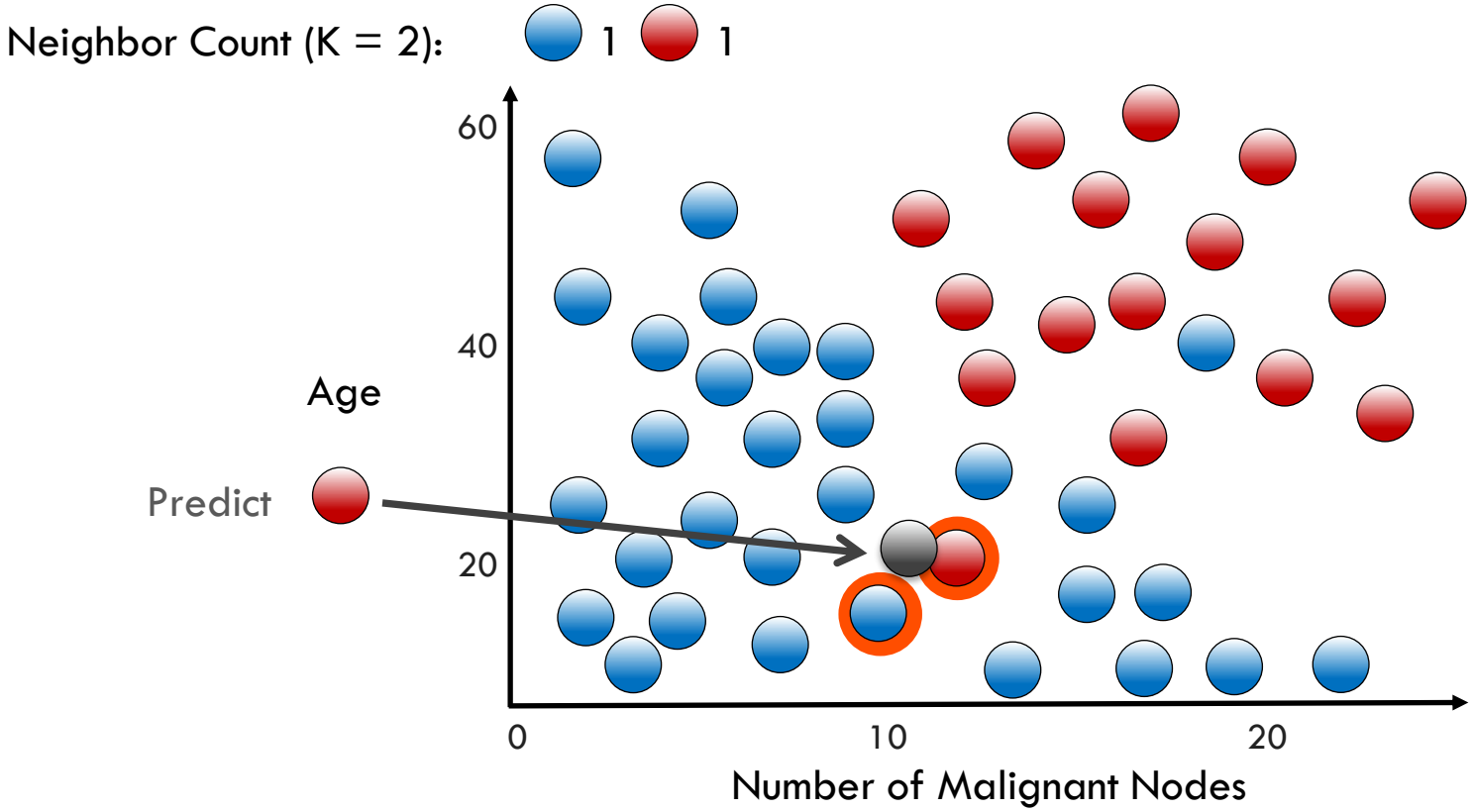

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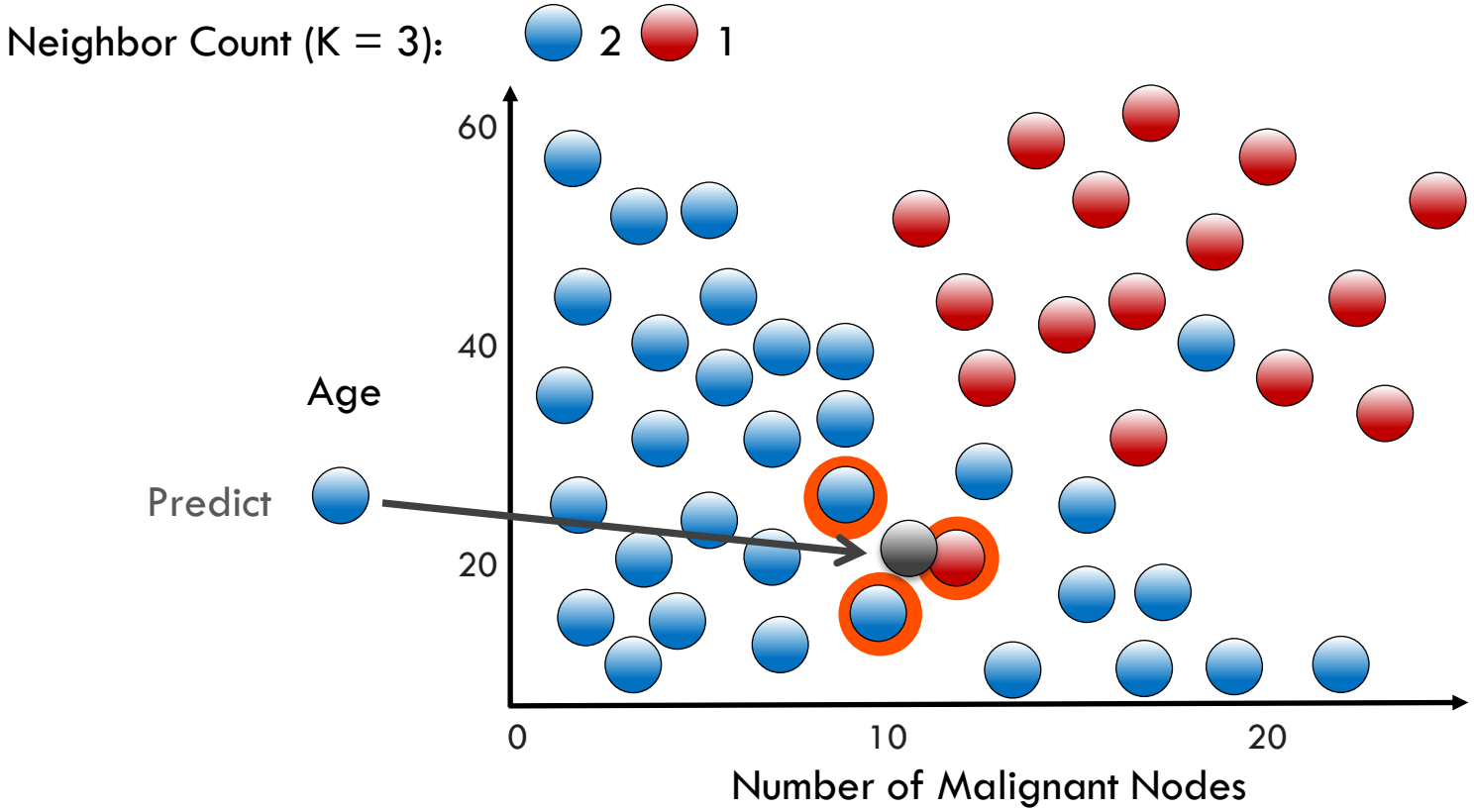

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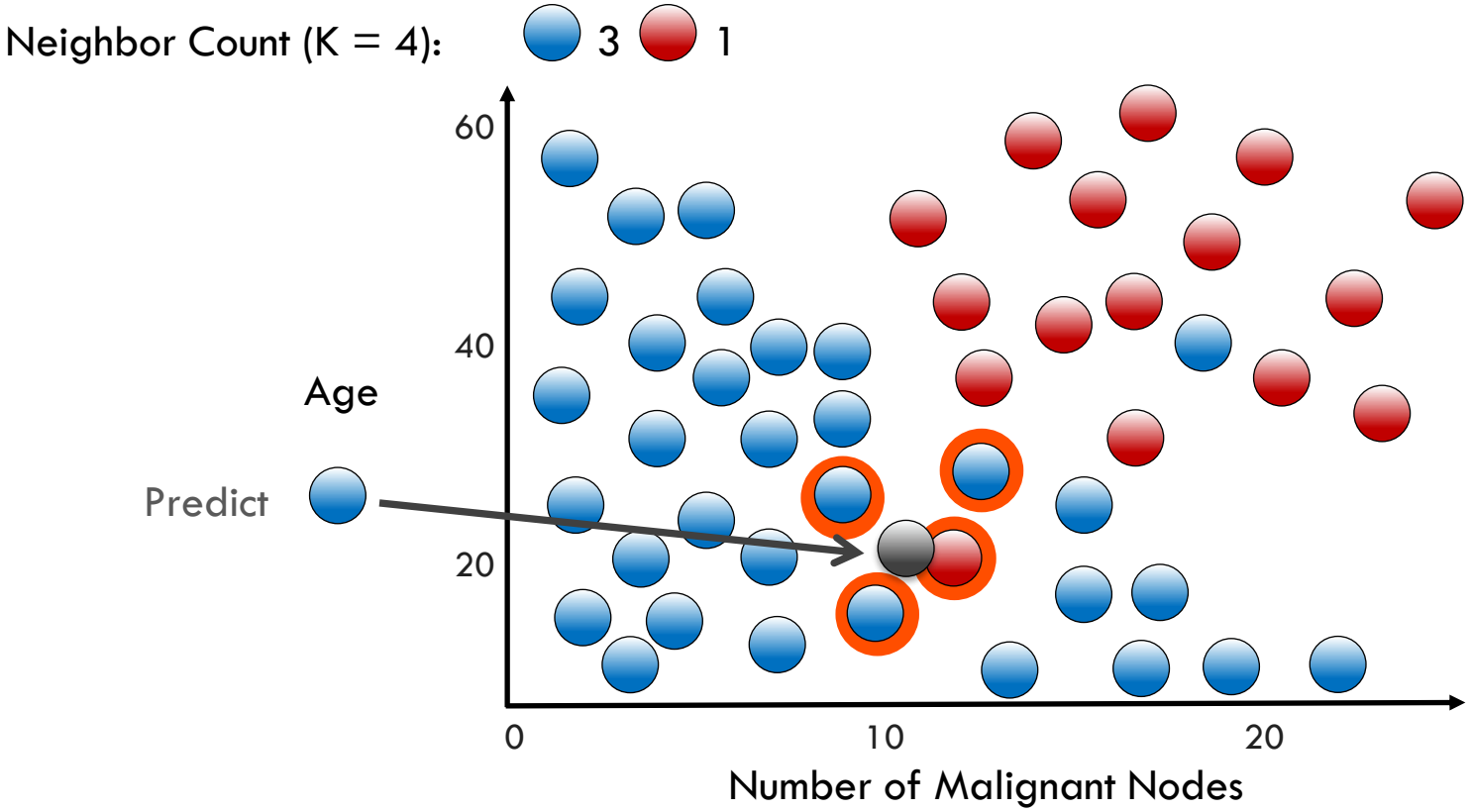

What is Needed to Select a KNN Model?

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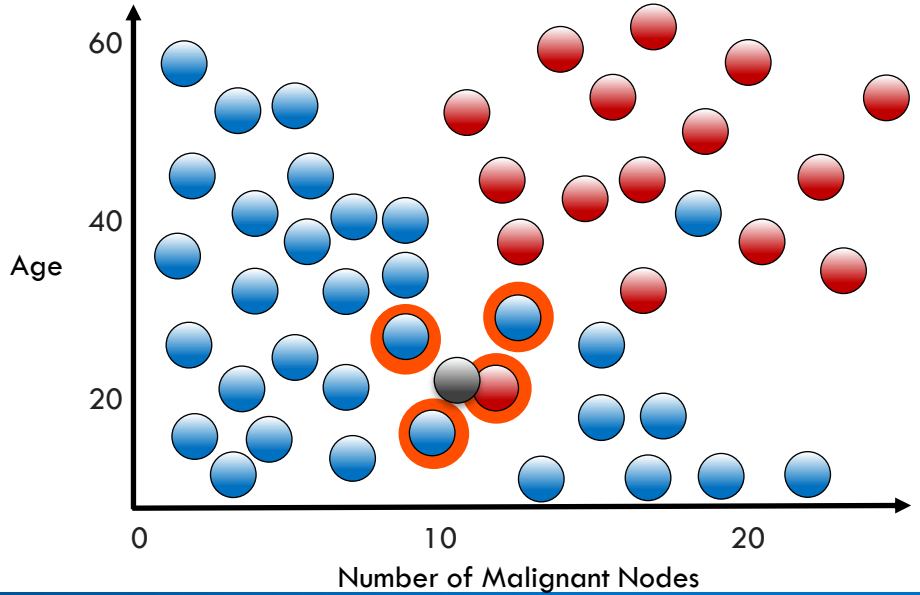
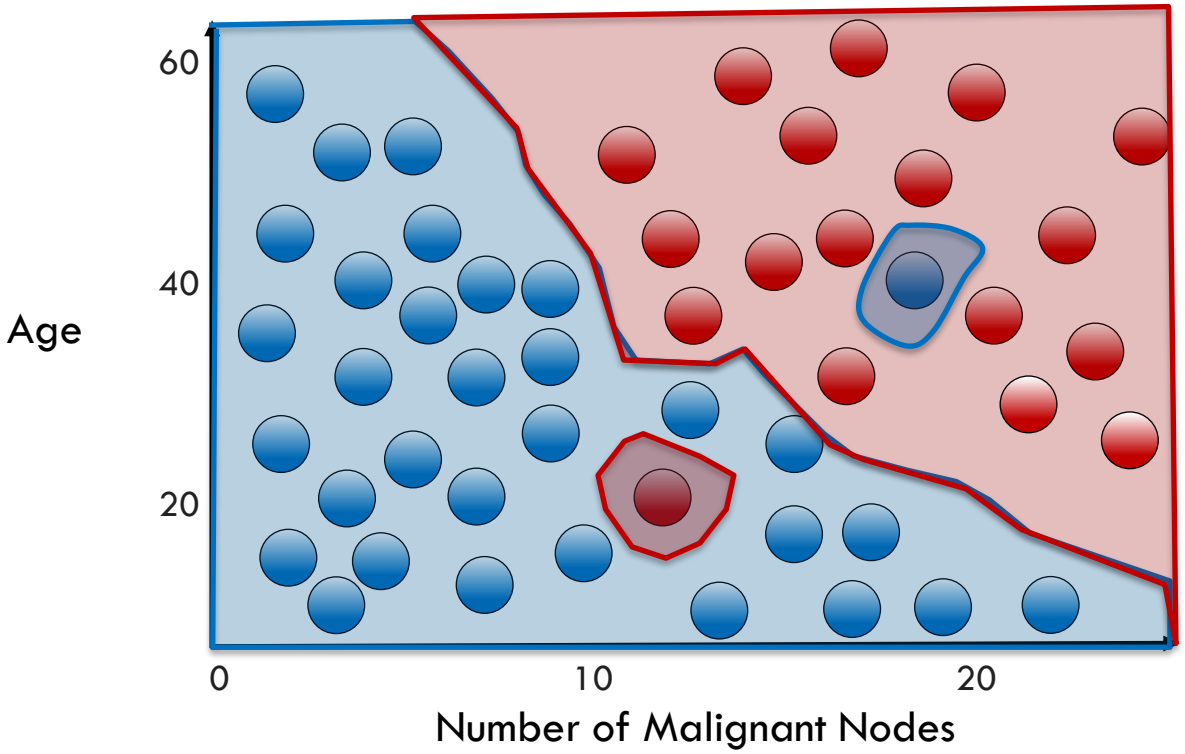
- Correct value for 'K'
- How to measure closeness of neighbors?



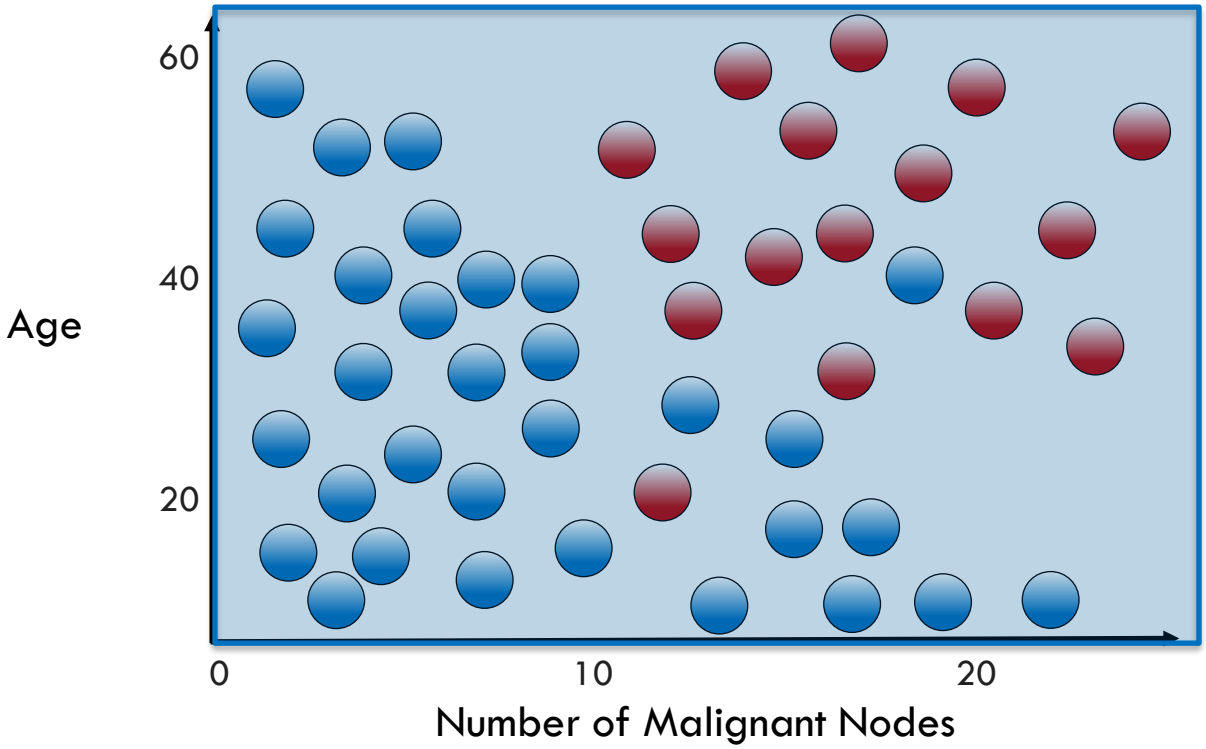
K Nearest Neighbors Decision Boundary

K = 1

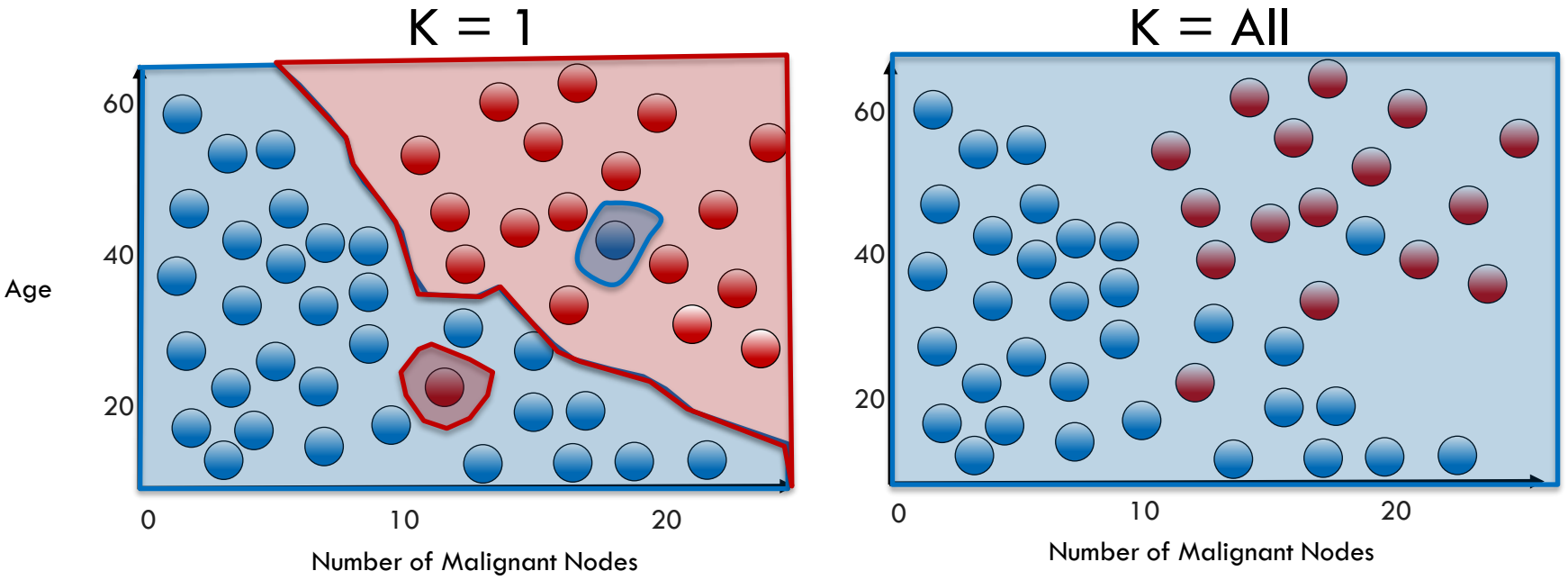


K Nearest Neighbors Decision Boundary

K = All



Value of 'K' Affects Decision Boundary



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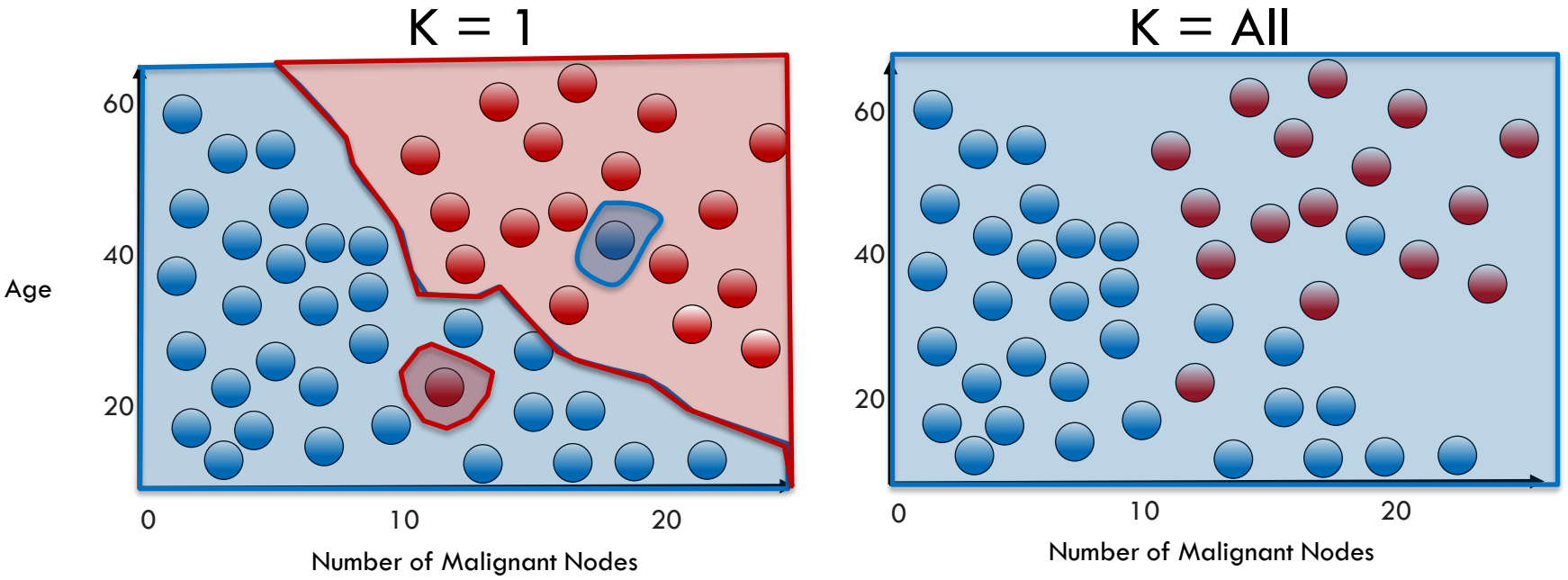
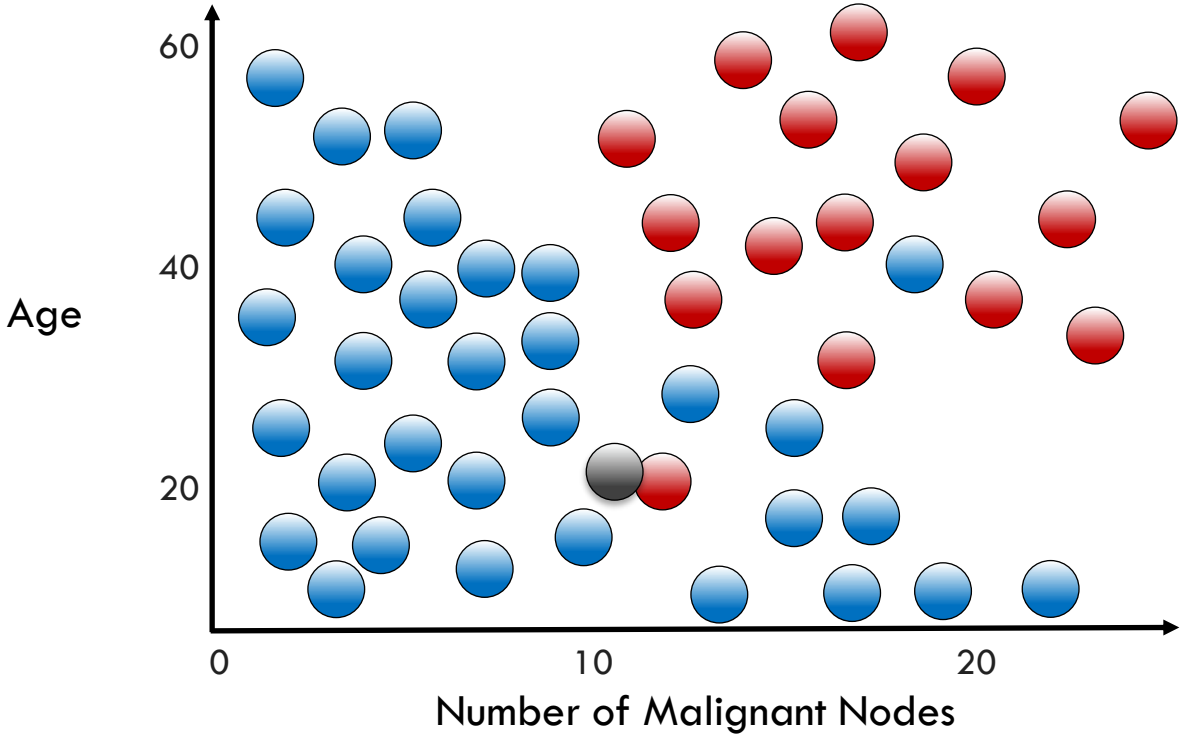


Methods for determining 'K' will be discussed in next lesson

Measurement of Distance in KNN



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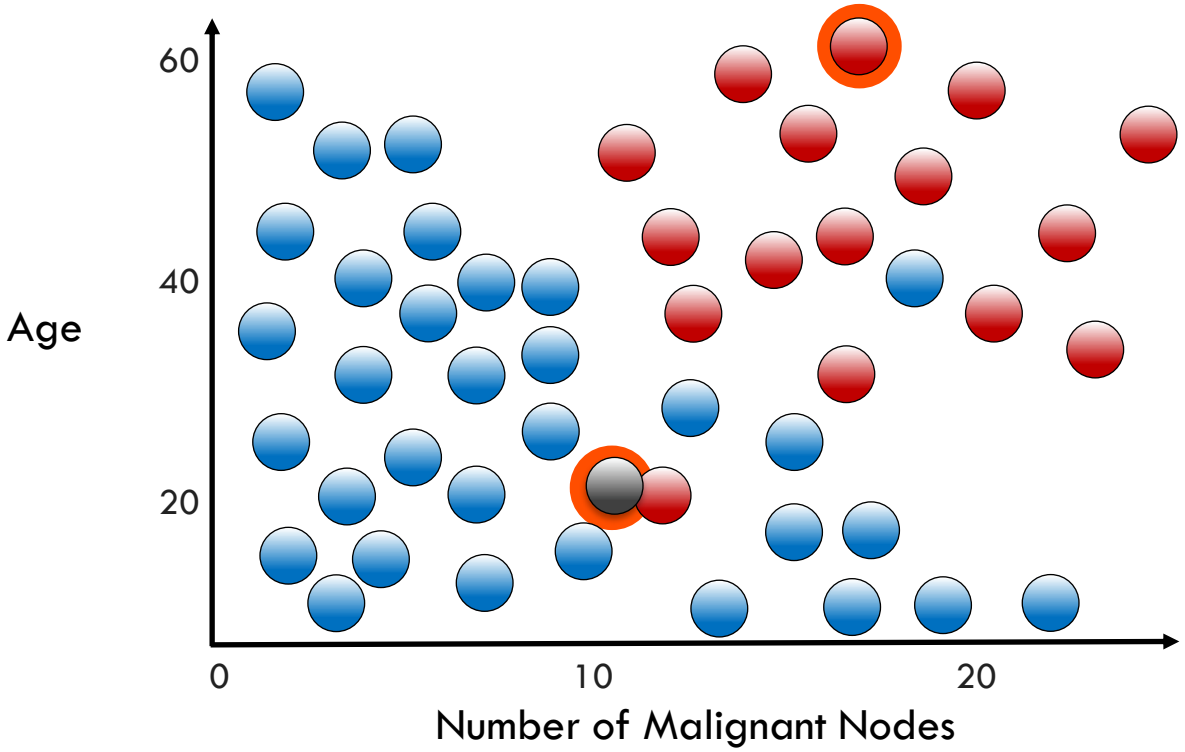
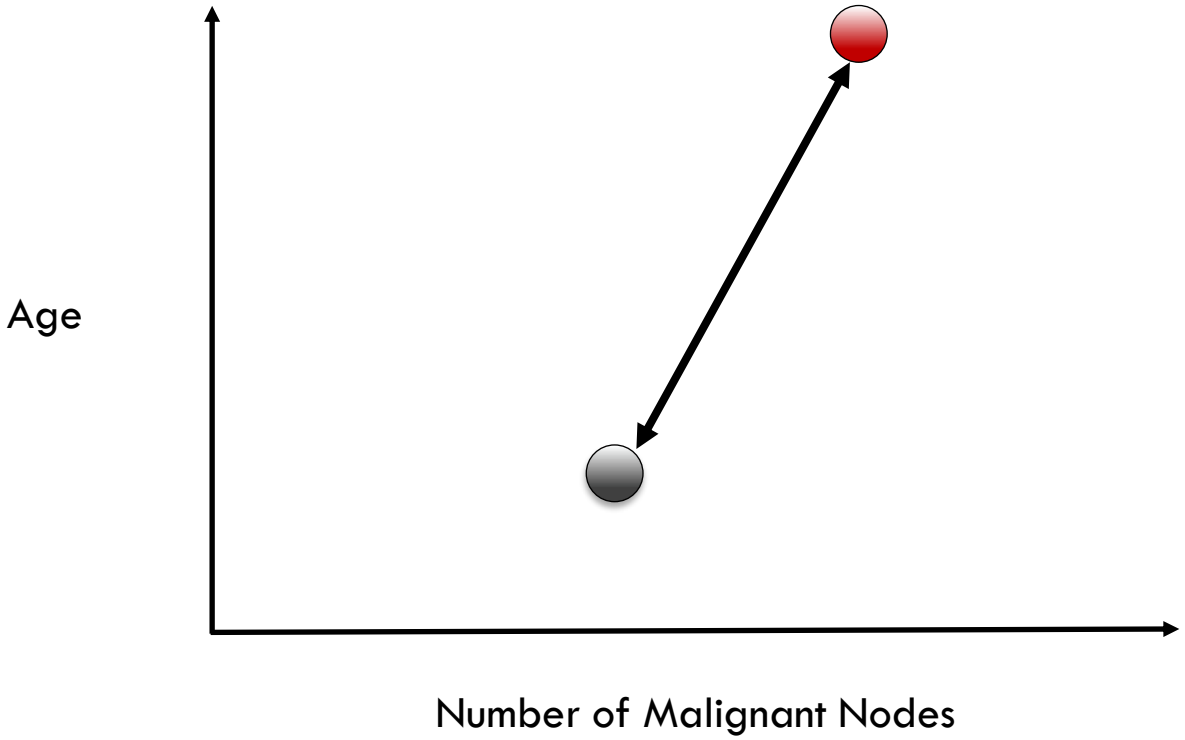
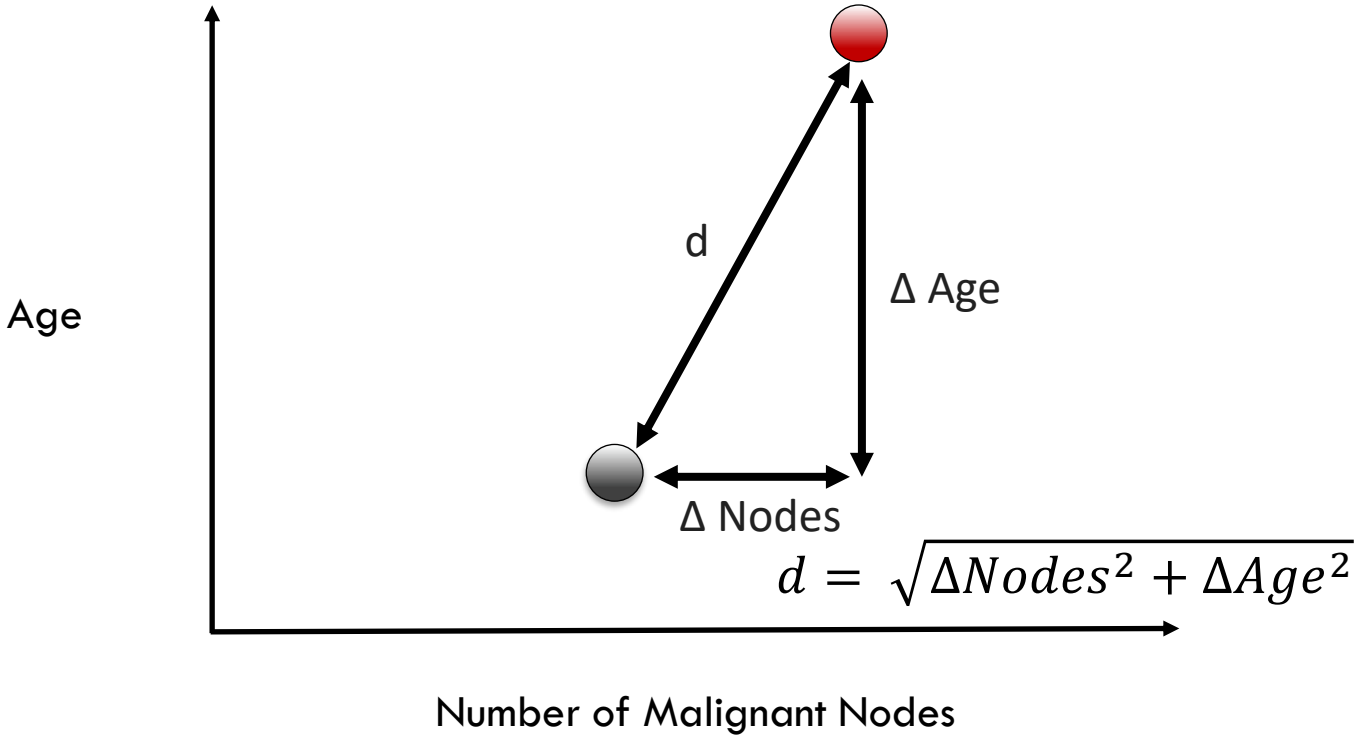


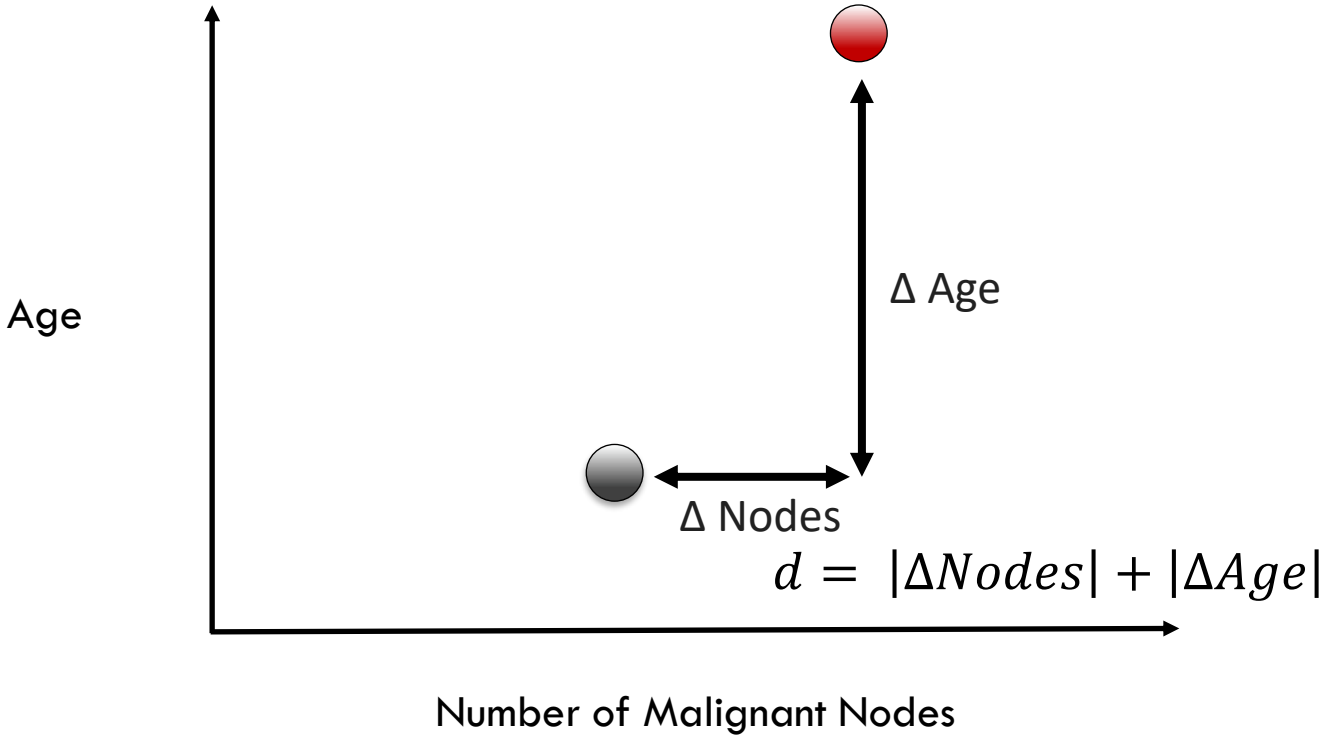
Euclidean Distance



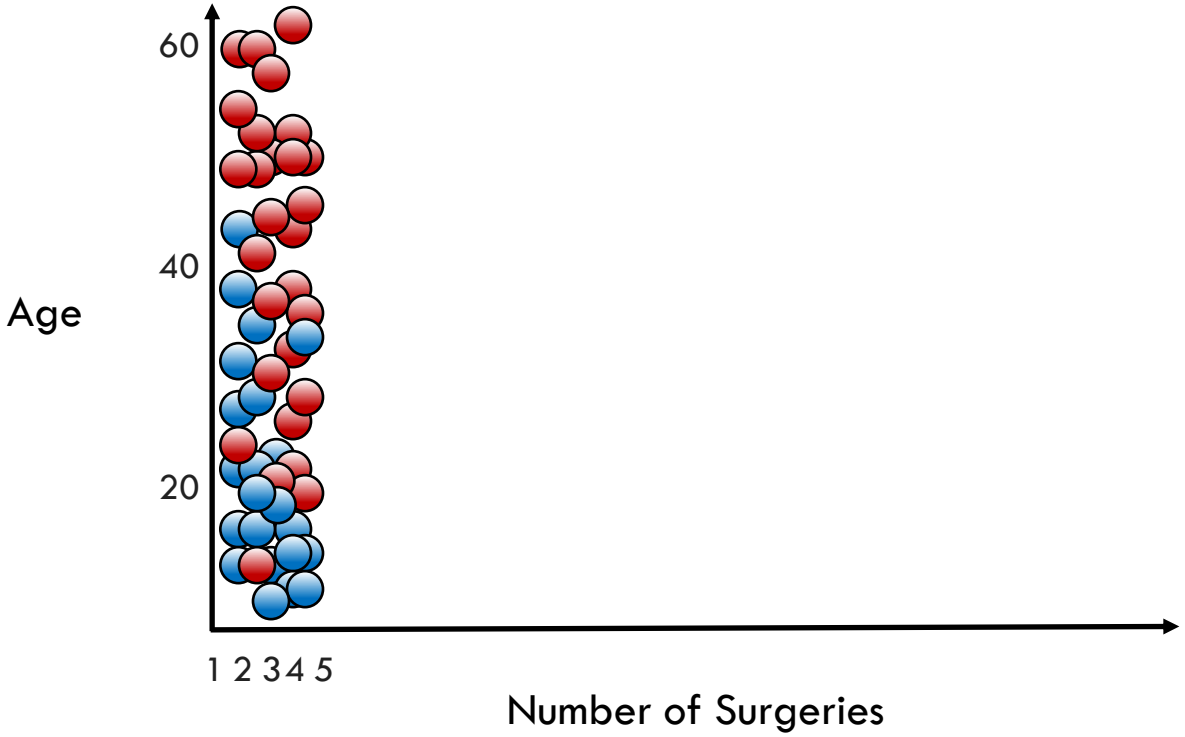
Euclidean Distance (L2 Distance)



Manhattan Distance (L1 or City Block Distance)



Scale is Important for Distance Measurement



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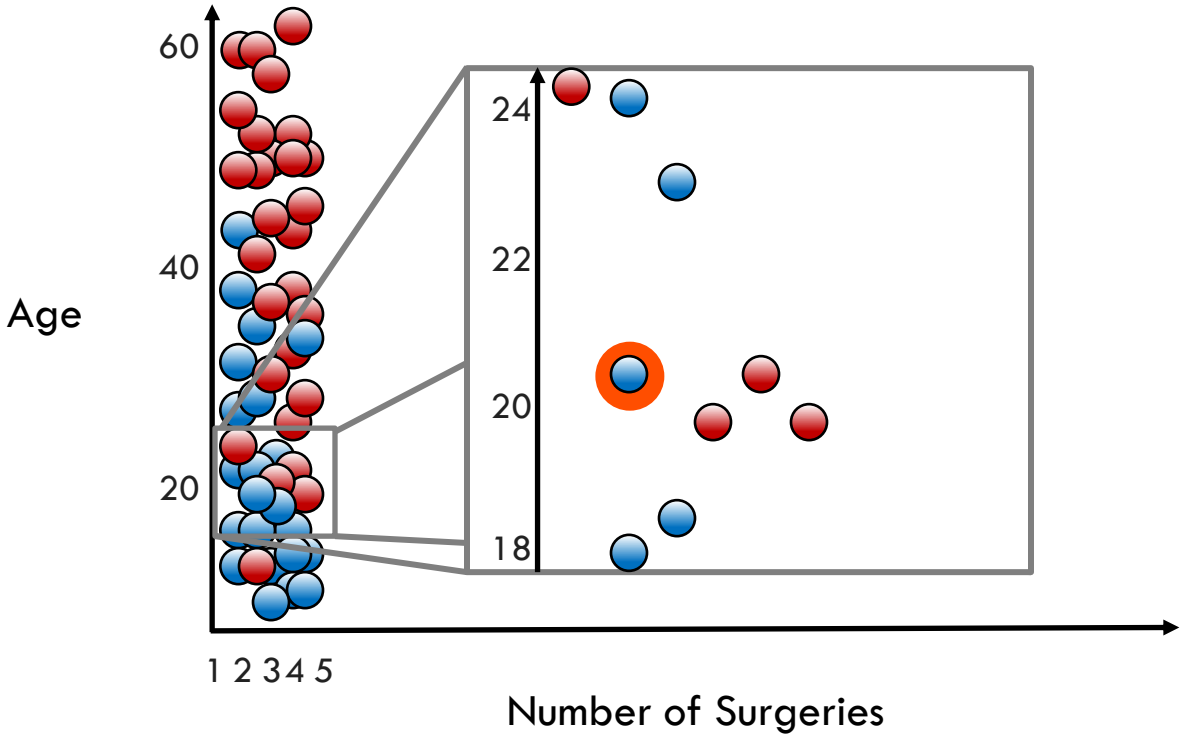

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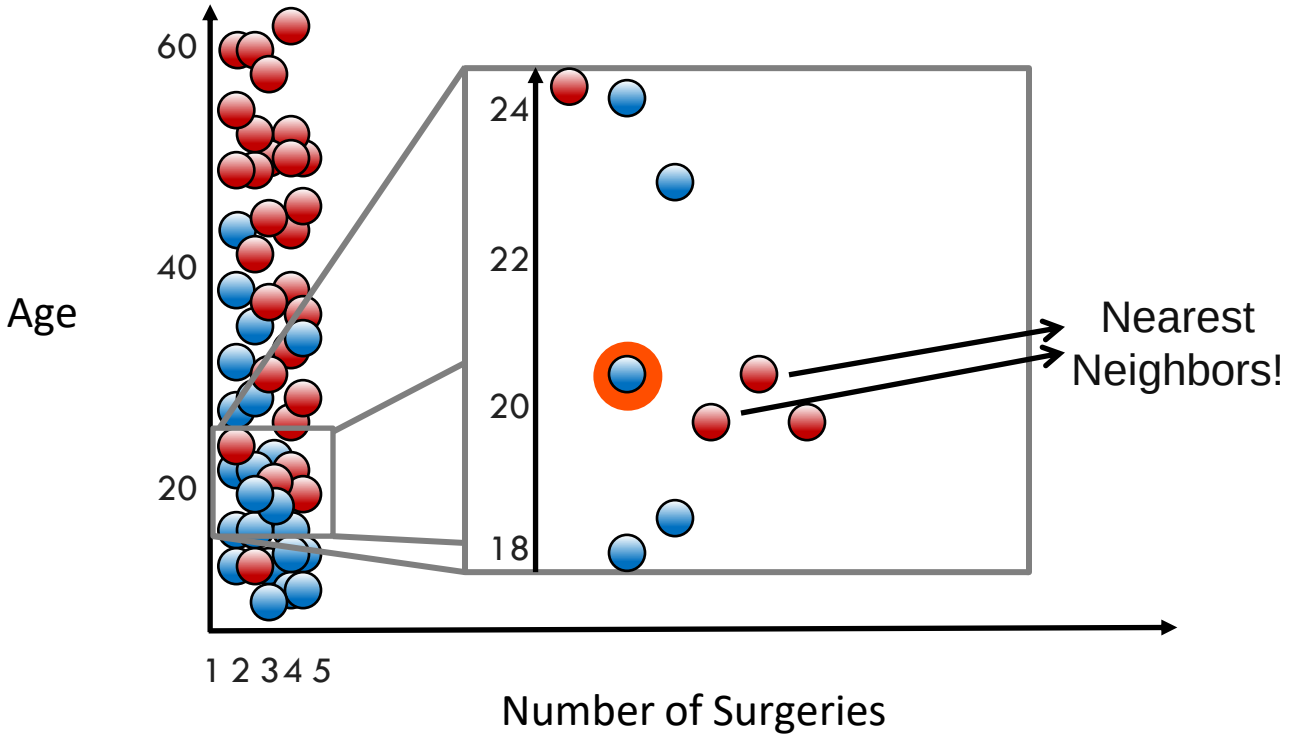

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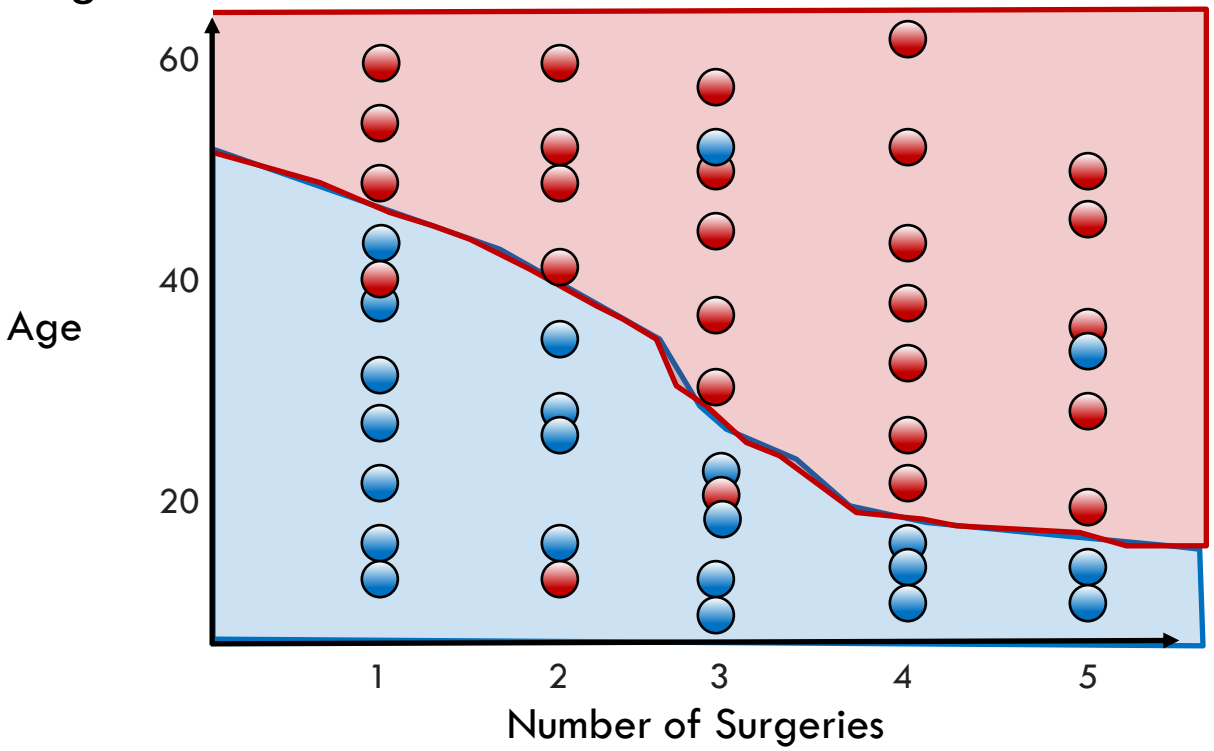
"Feature Scaling"



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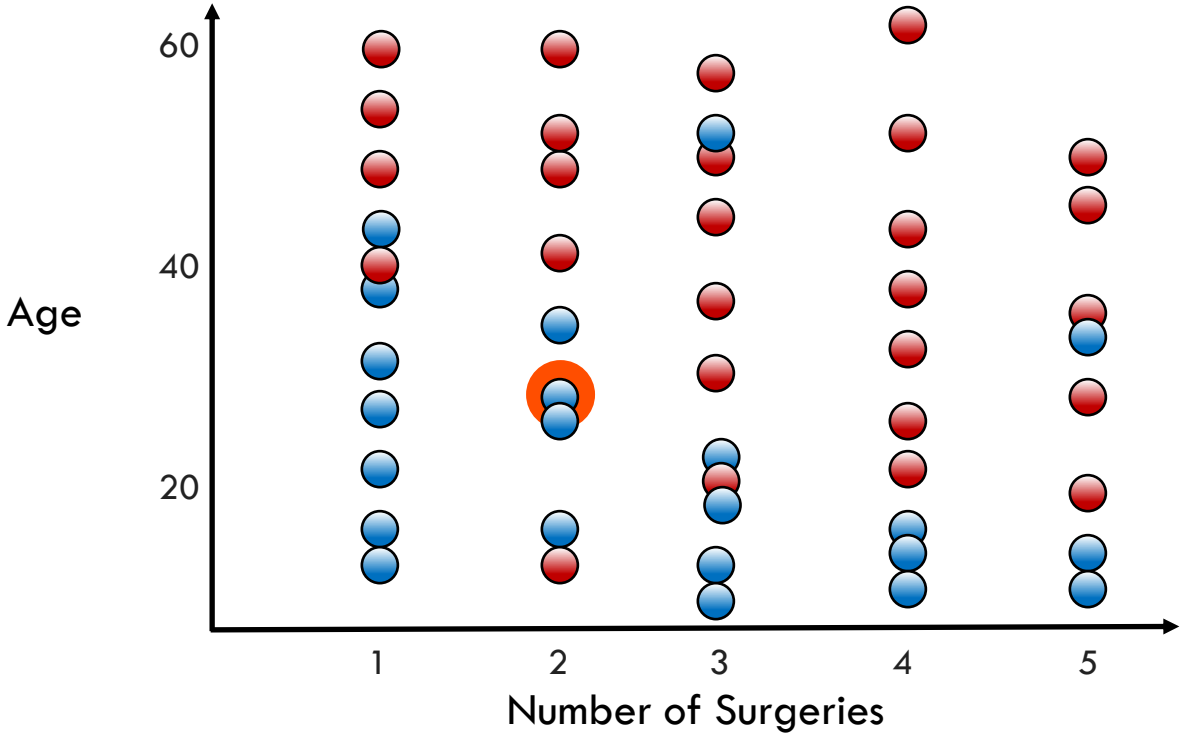

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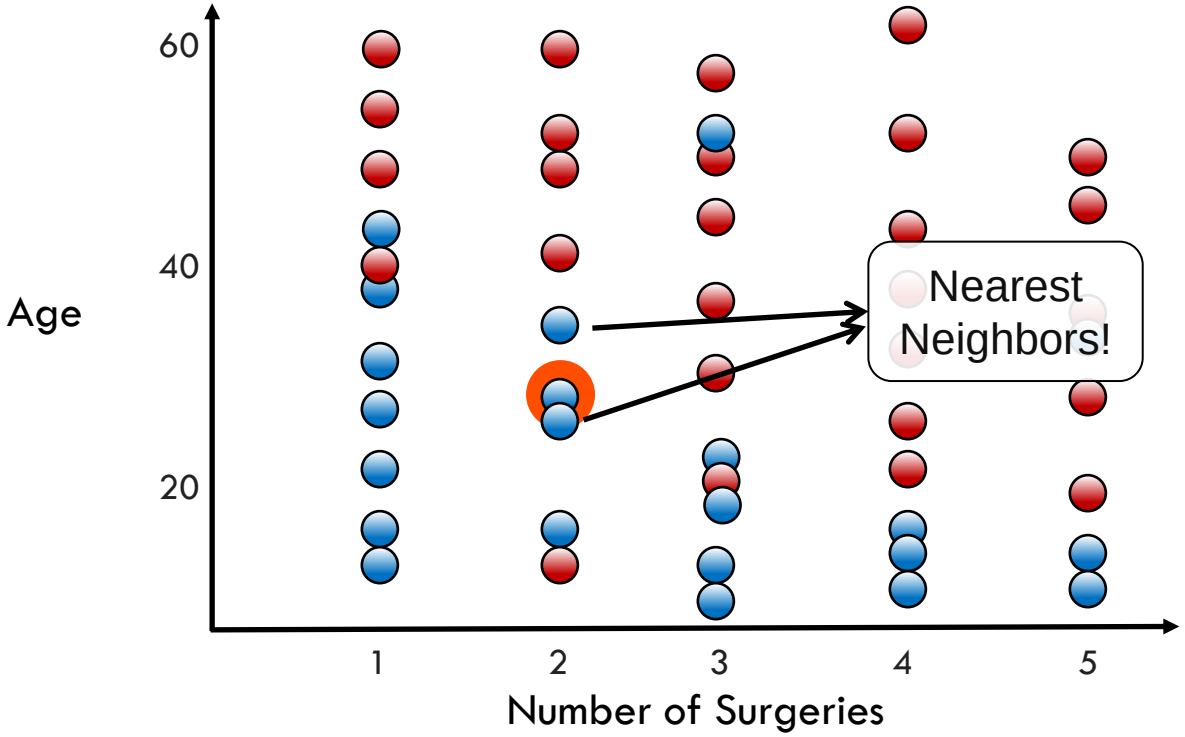

Comparison of Feature Scaling Methods

- **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

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Import the class containing the scaling method

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Other scaling methods exist: MinMaxScaler, MaxAbsScaler.

Multiclass KNN Decision Boundary

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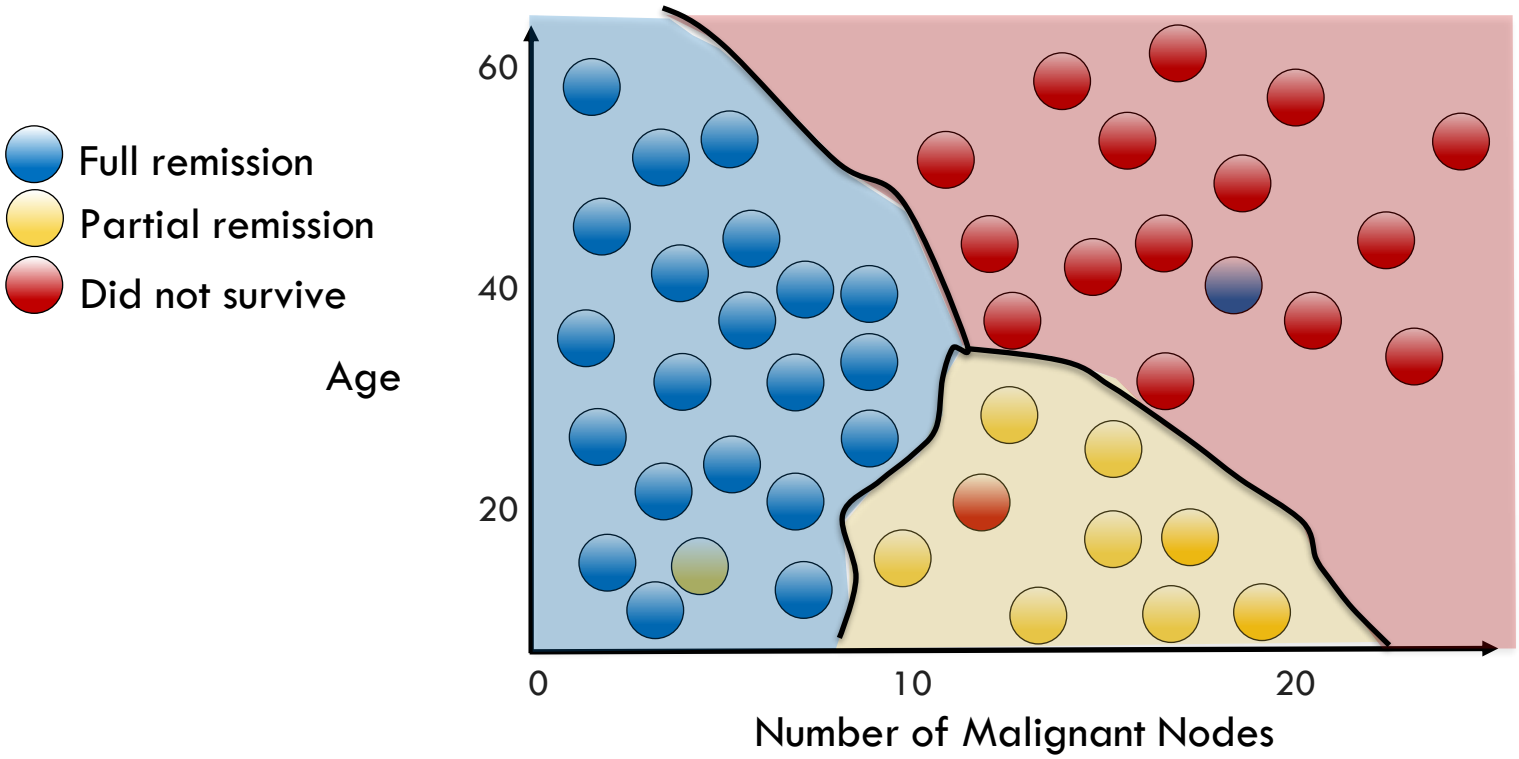
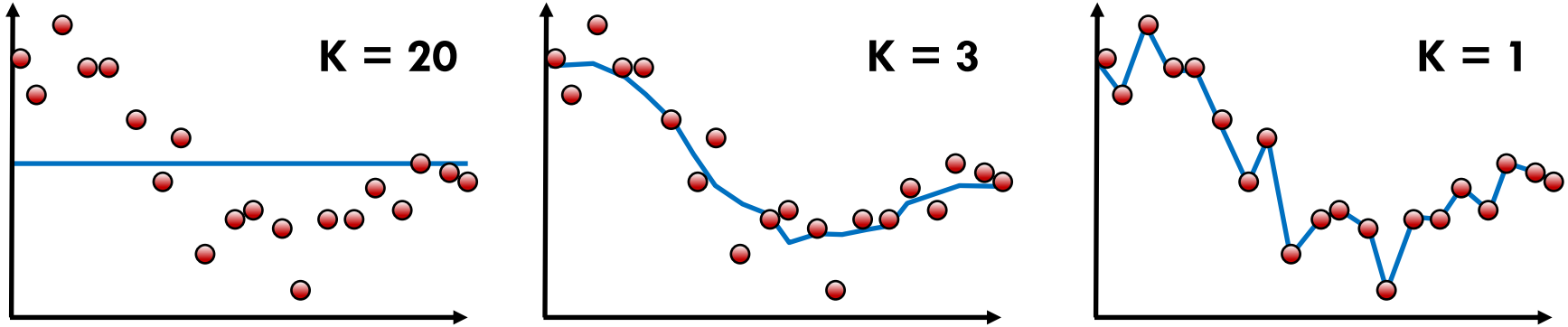


Regression with KNN



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

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

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Regression can be done with KNeighborsRegressor.

Additional Resources for KNN

Effective k-nearest neighbor models for data classification enhancement

https://journalofbigdata.springeropen.com/articles/10.1186/s40537-025-01137-2#citeas

Enhancing K-nearest neighbor algorithm: a comprehensive review and performance analysis of modifications

https://journalofbigdata.springeropen.com/articles/10.1186/s40537-024-00973-y

KNeighborsClassifier

https://scikit-learn.org/stable/modules/generated/sklearn.neighbors.KNeighborsClassifier.html

THANK YOU

- Source compiled from intel ai academy