RANDOM FOREST

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Application of Random Forest

Remote Sensing

Used in ETM devices to acquire images of the earth's surface.

Accuracy is higher and training time is less

Object Detection

Multiclass object detection is done using Random Forest algorithms

Provides better detection in complicated environments

Kinect

Random Forest is used in a game console called Kinect

Tracks body movements and recreates it in the game

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Application of Random Forest

User performs a step

Kinect registers the movement

Marks the user based on accuracy

Application of Random Forest

User performs a step

Kinect registers the movement

Marks the user based on accuracy

Training set to identify body parts

Random forest classifier learns

Identifies the body parts while dancing

Score game avatar based on accuracy

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What's in it for you?

- **What is Machine Learning?**
- Applications of Random Forest
- What is Classification?
- Why Random Forest?
- What is Random Forest?
- Random Forest and Decision Tree
- Comparing Random Forest and Regression
- Use Case – Iris Flower Analysis

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Types of Machine Learning
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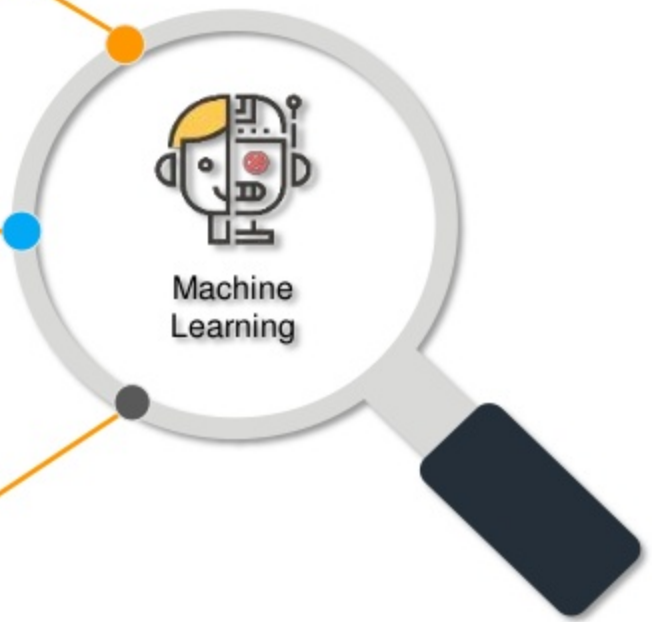
Types of Machine Learning

Supervised Learning

Unsupervised Learning

Reinforcement Learning



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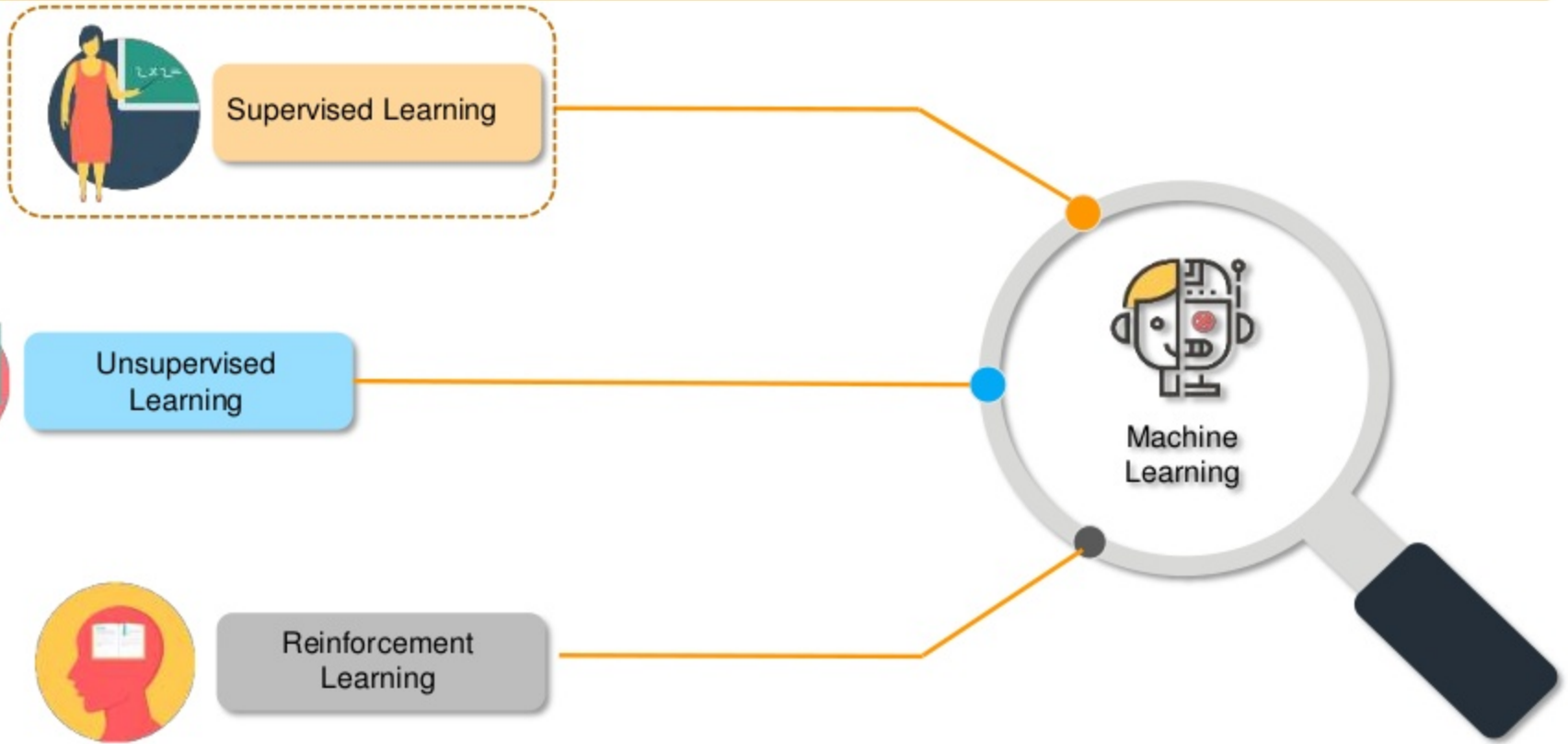
Types of Machine Learning



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Types of Supervised Learning

Supervised Learning

Unsupervised Learning

Reinforcement Learning

Machine Learning

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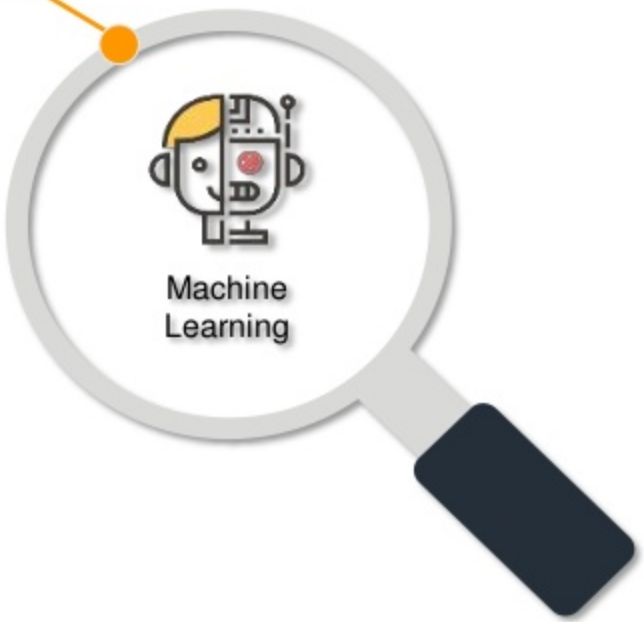
Types of Supervised Learning

Supervised Learning

Classification

Regression



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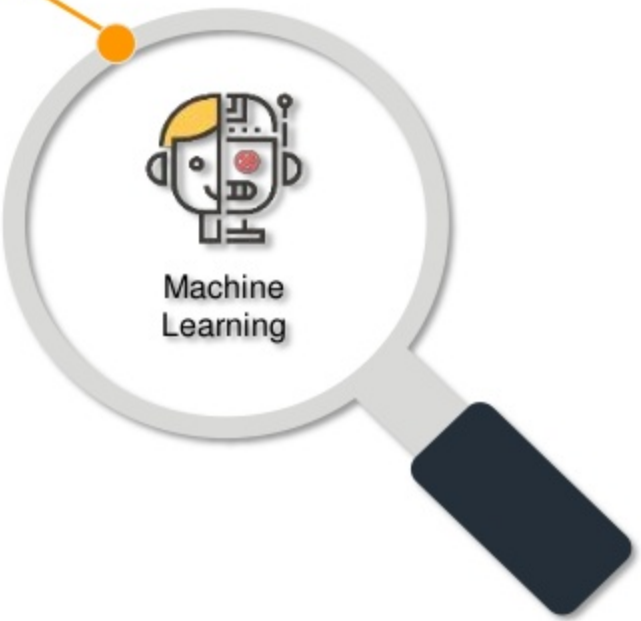
What is Classification?

Supervised Learning

Classification

Regression



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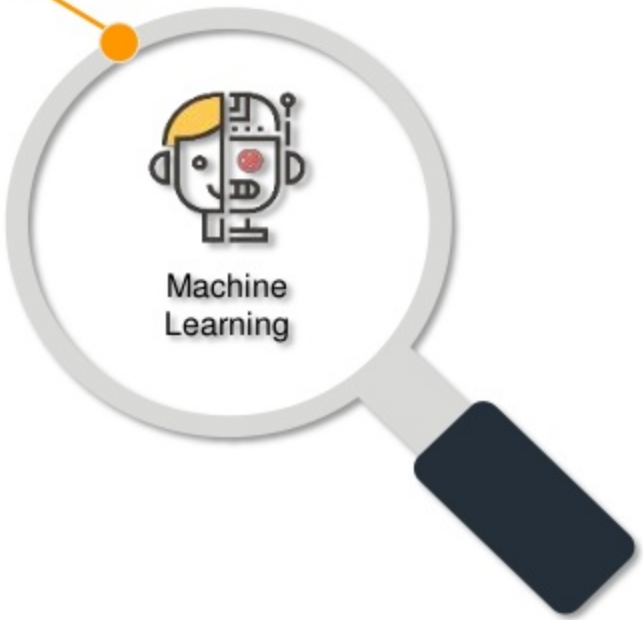
What is Classification?

Supervised Learning

Classification

Classification is a kind of problem wherein the outputs are categorical in nature like 'Yes' or 'No', 'True' or 'False', '0' or '1'



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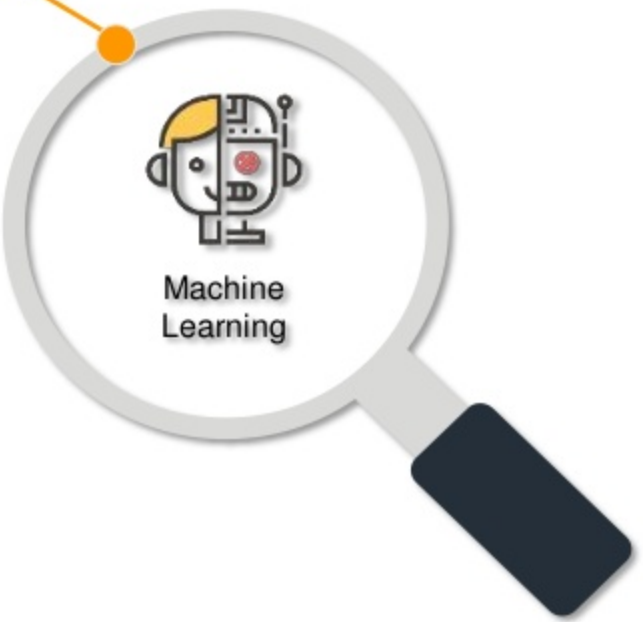
Solutions under Classification

Supervised Learning

Classification



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Solutions under Classification

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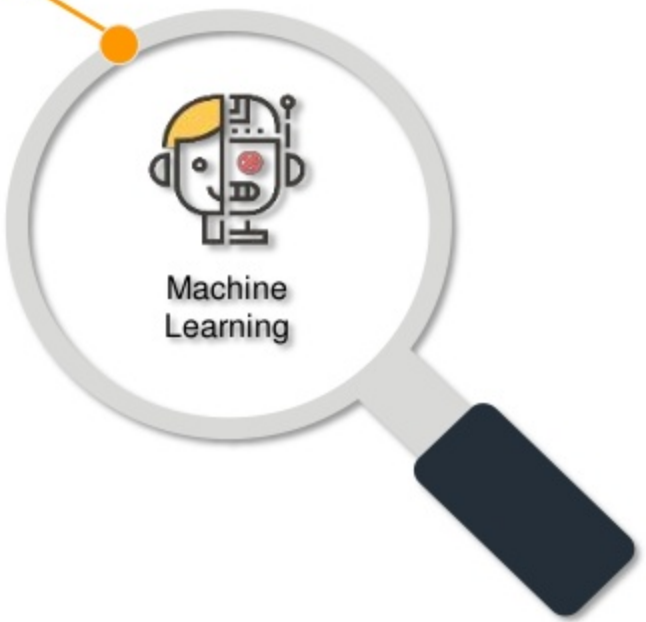
KNN

Classification



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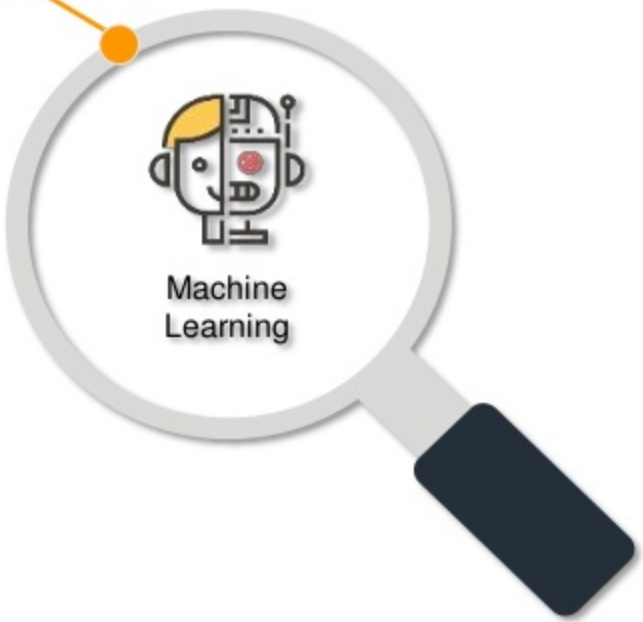
Solutions under Classification

Supervised Learning

KNN

Naïve Bayes

Classification



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Solutions under Classification

Supervised Learning

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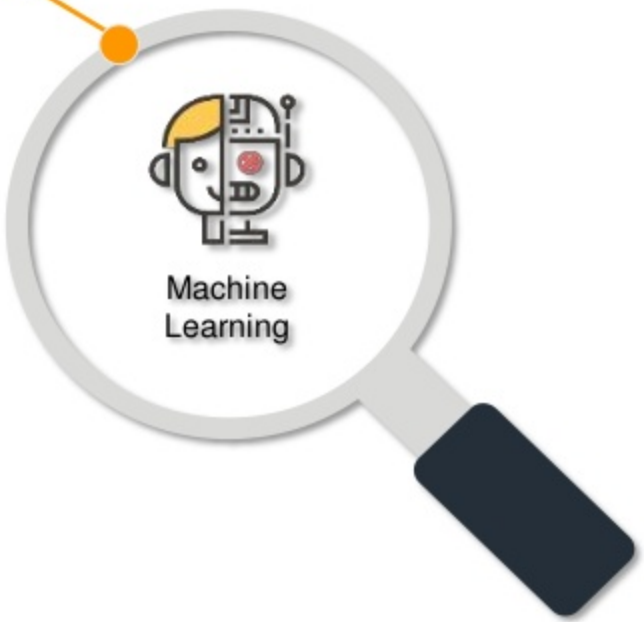
KNN

Naïve Bayes

Decision Tree



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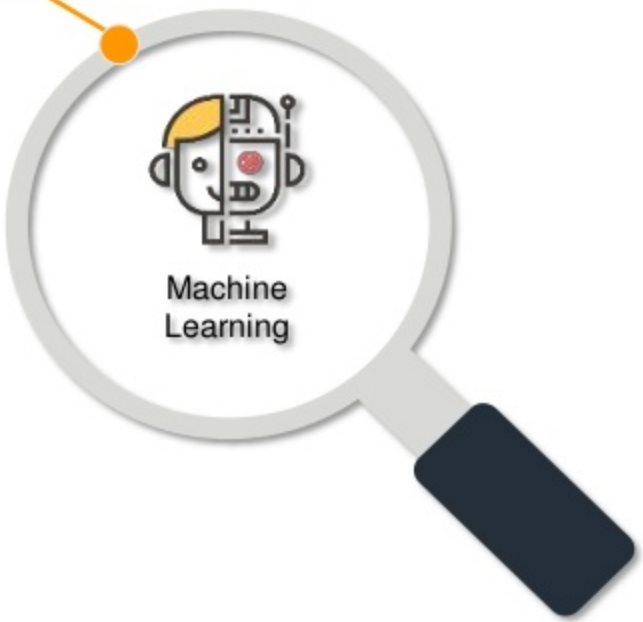
Solutions under Classification

Supervised Learning

Classification

- KNN
- Naïve Bayes
- Decision Tree
- Random Forest



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Solutions under Classification

Supervised Learning

Classification

KNN

Naïve Bayes

Decision Tree

Random Forest

Machine Learning

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Why Random Forest?
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Why Random Forest?

No overfitting

Use of multiple trees reduce the risk of overfitting

Training time is less

High accuracy

Runs efficiently on large database

For large data, it produces highly accurate predictions

Estimates missing data

Random Forest can maintain accuracy when a large proportion of data is missing

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What is Random Forest?
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Random forest or Random Decision Forest is a method that operates by constructing multiple Decision Trees during training phase.
The Decision of the majority of the trees is chosen by the random forest as the final decision

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Decision Tree 1

Output 1

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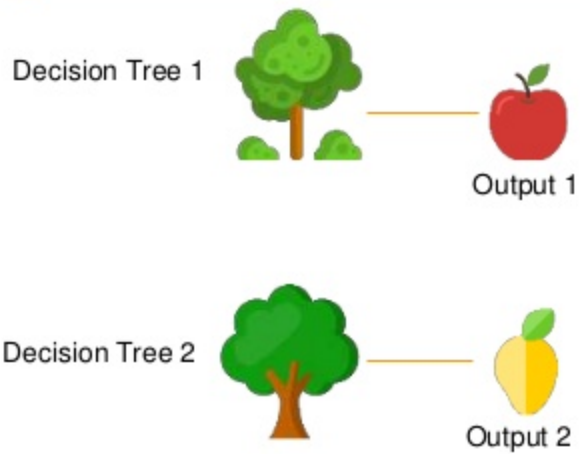

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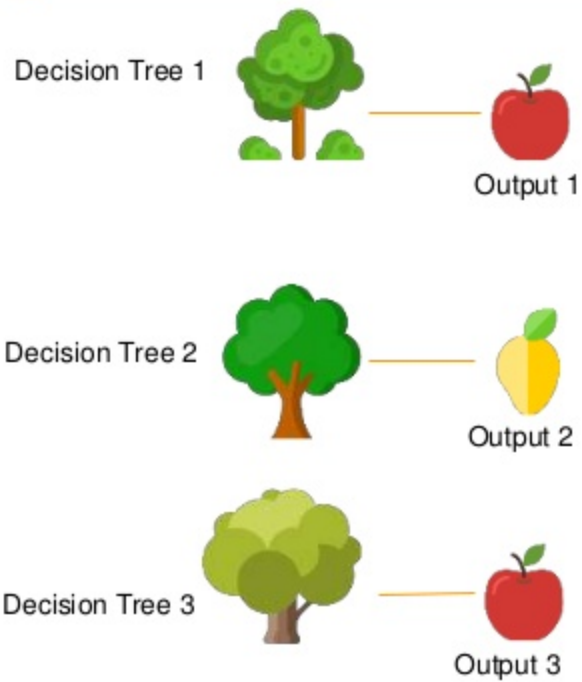

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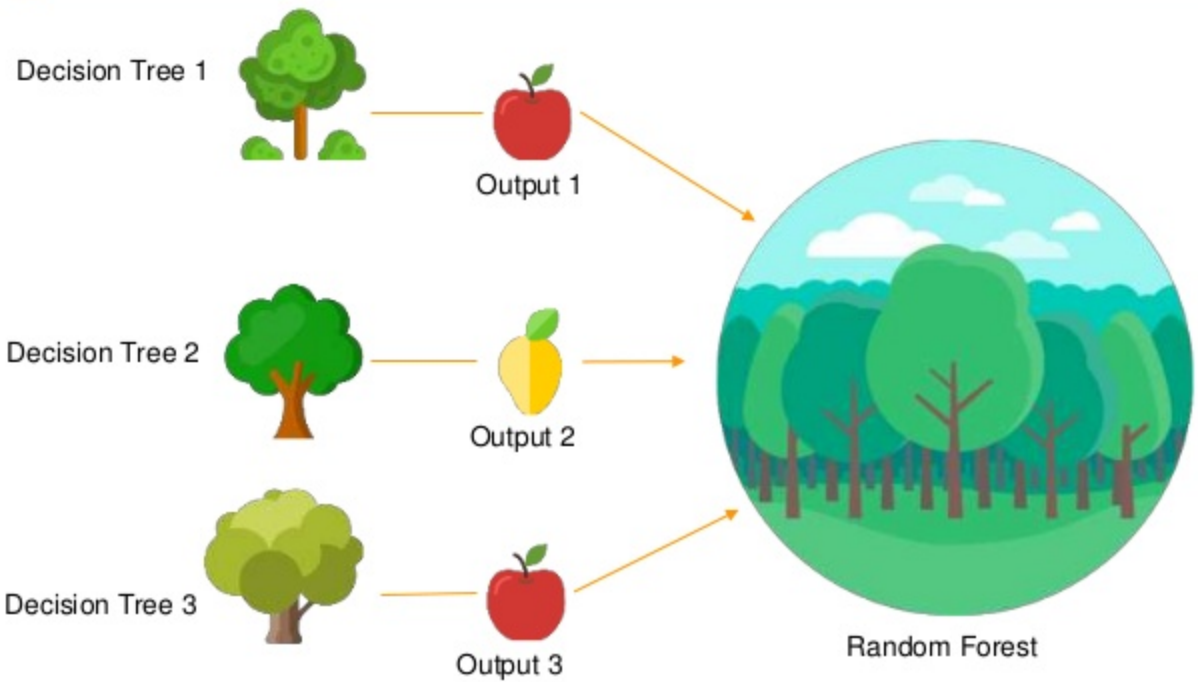

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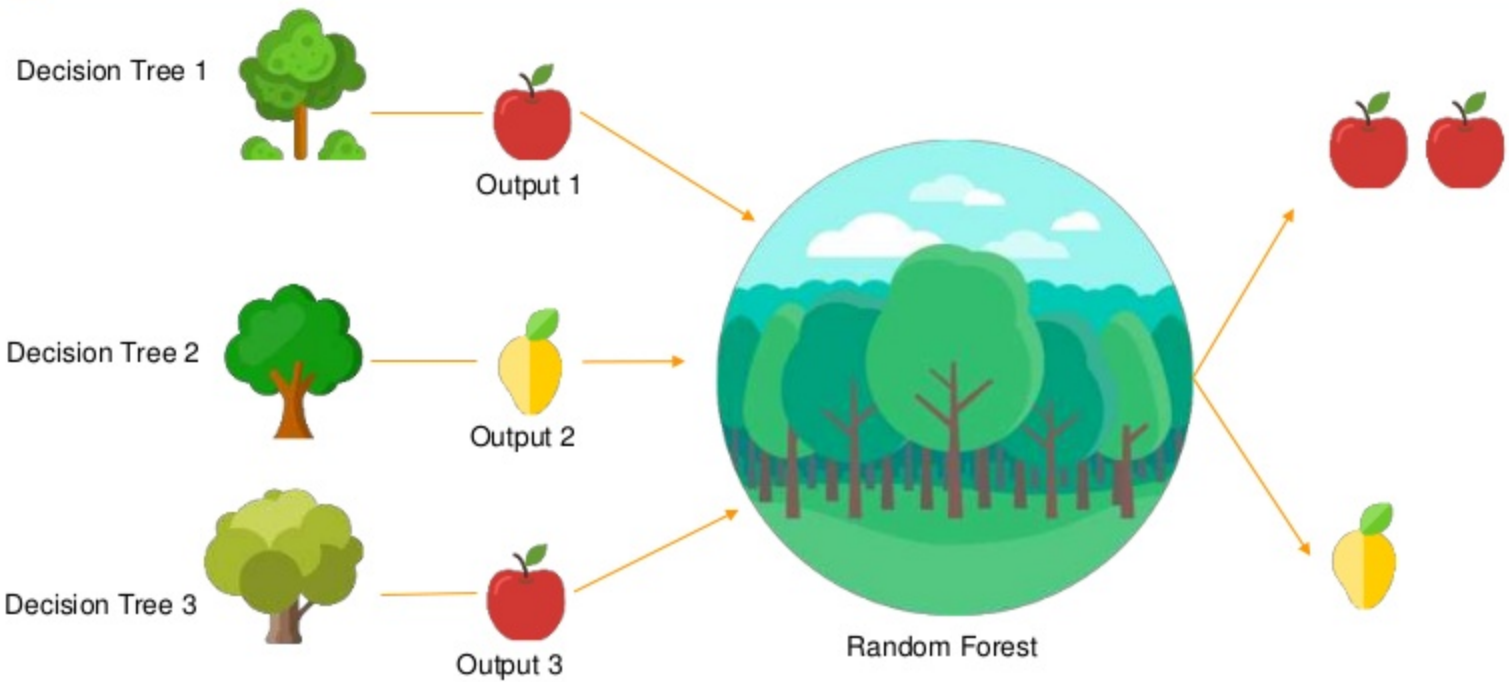

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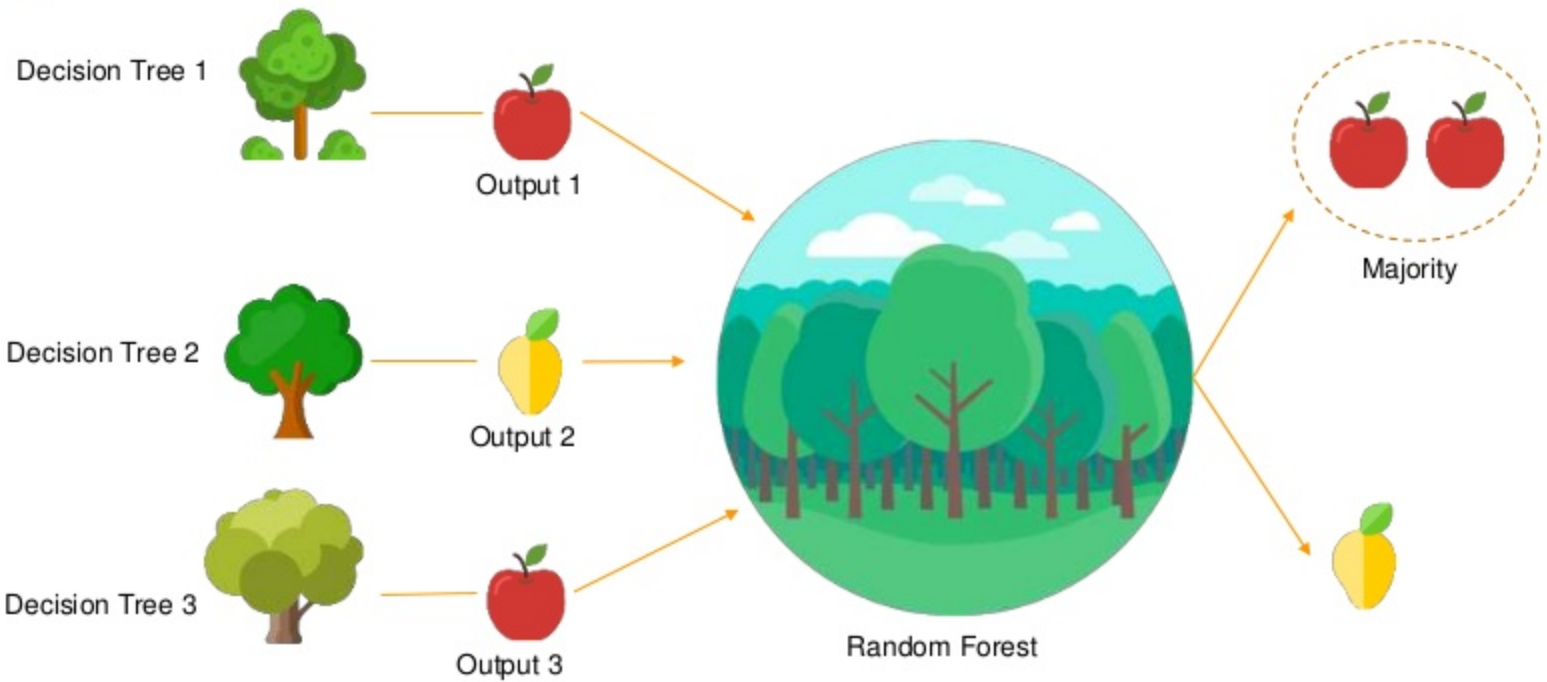

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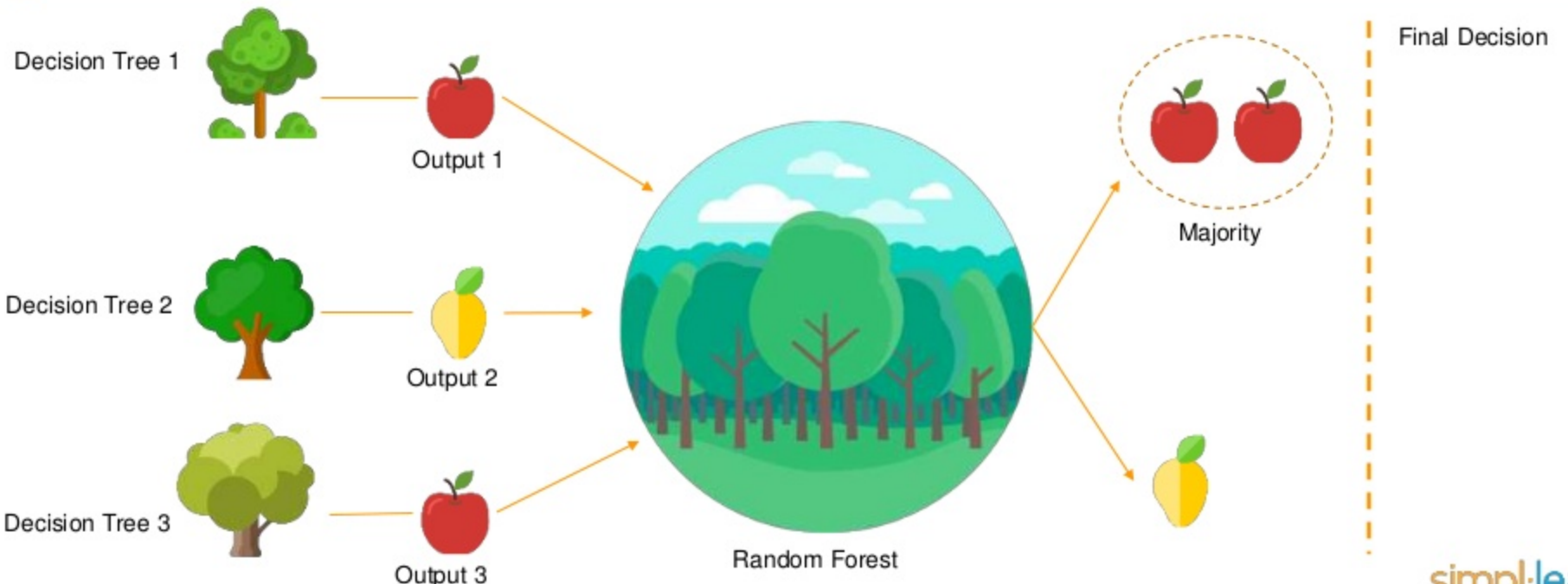

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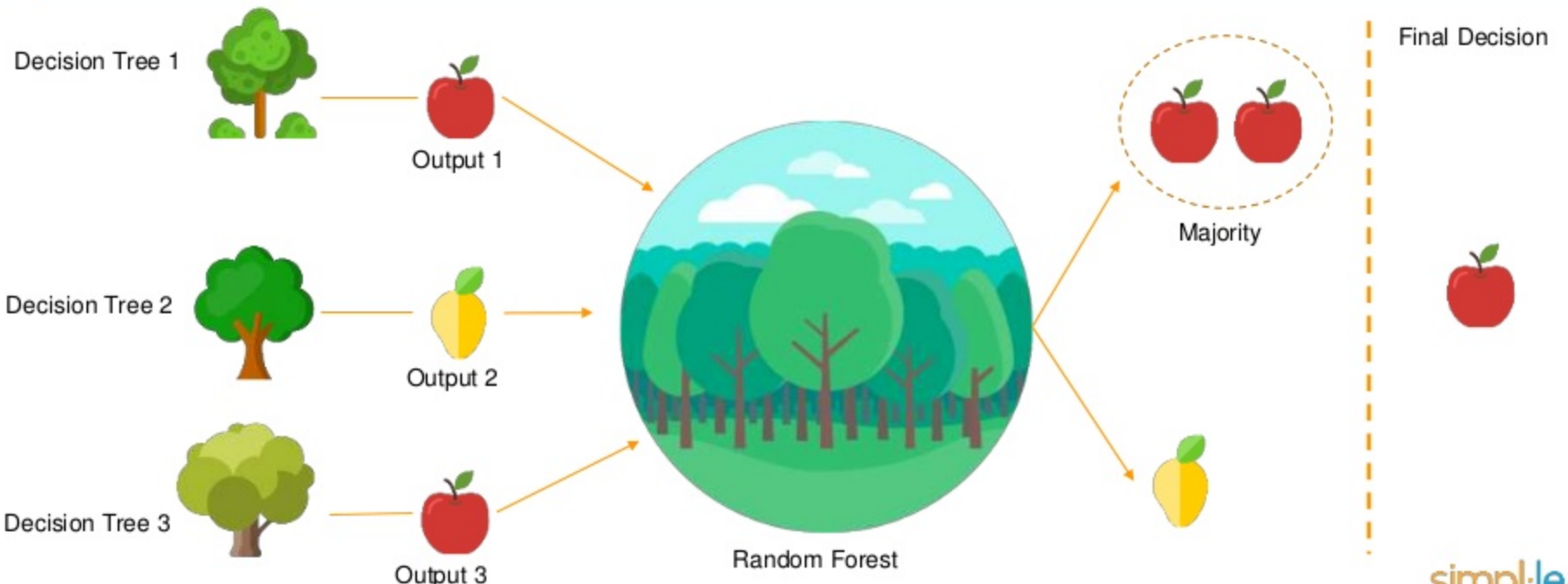

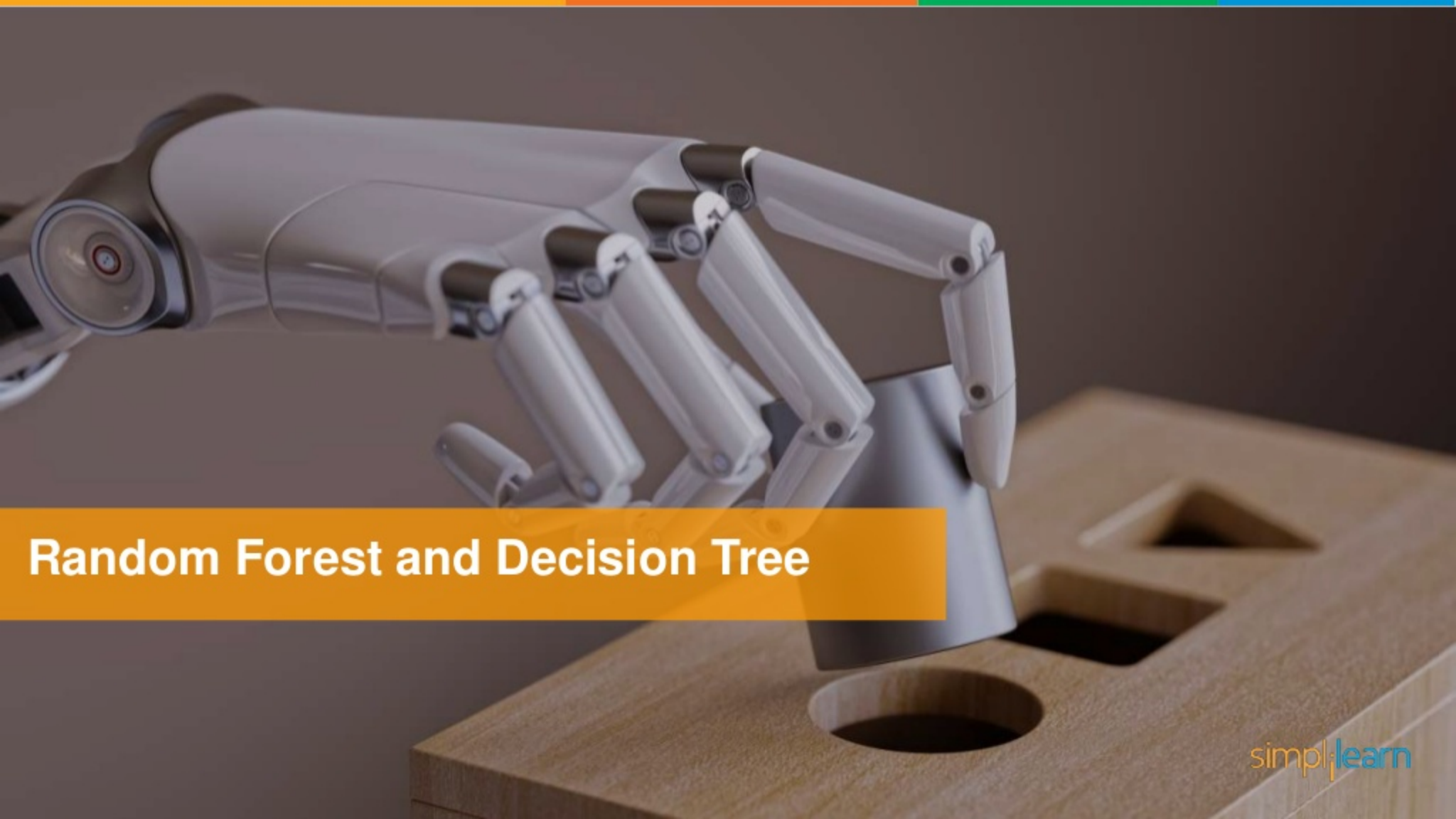
Random Forest and Decision Tree
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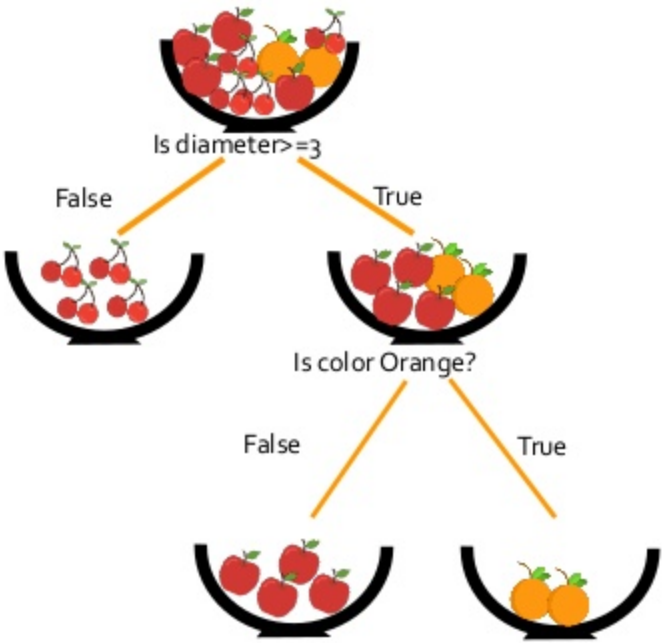
Decision Tree

Decision Tree is a tree shaped diagram used to determine a course of action. Each branch of the tree represents a possible decision, occurrence or reaction



Decision Tree- Important Terms

Entropy

Entropy is the measure of randomness or unpredictability in the dataset

Information gain

Leaf Node

Decision Node

Root Node

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Decision Tree - Important Terms

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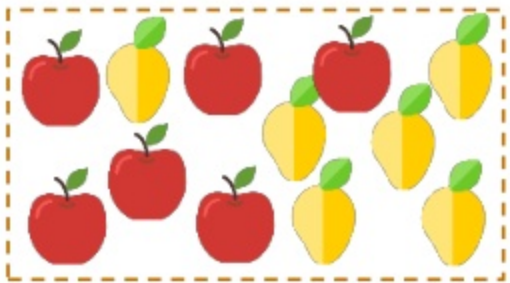

High entropy

E1

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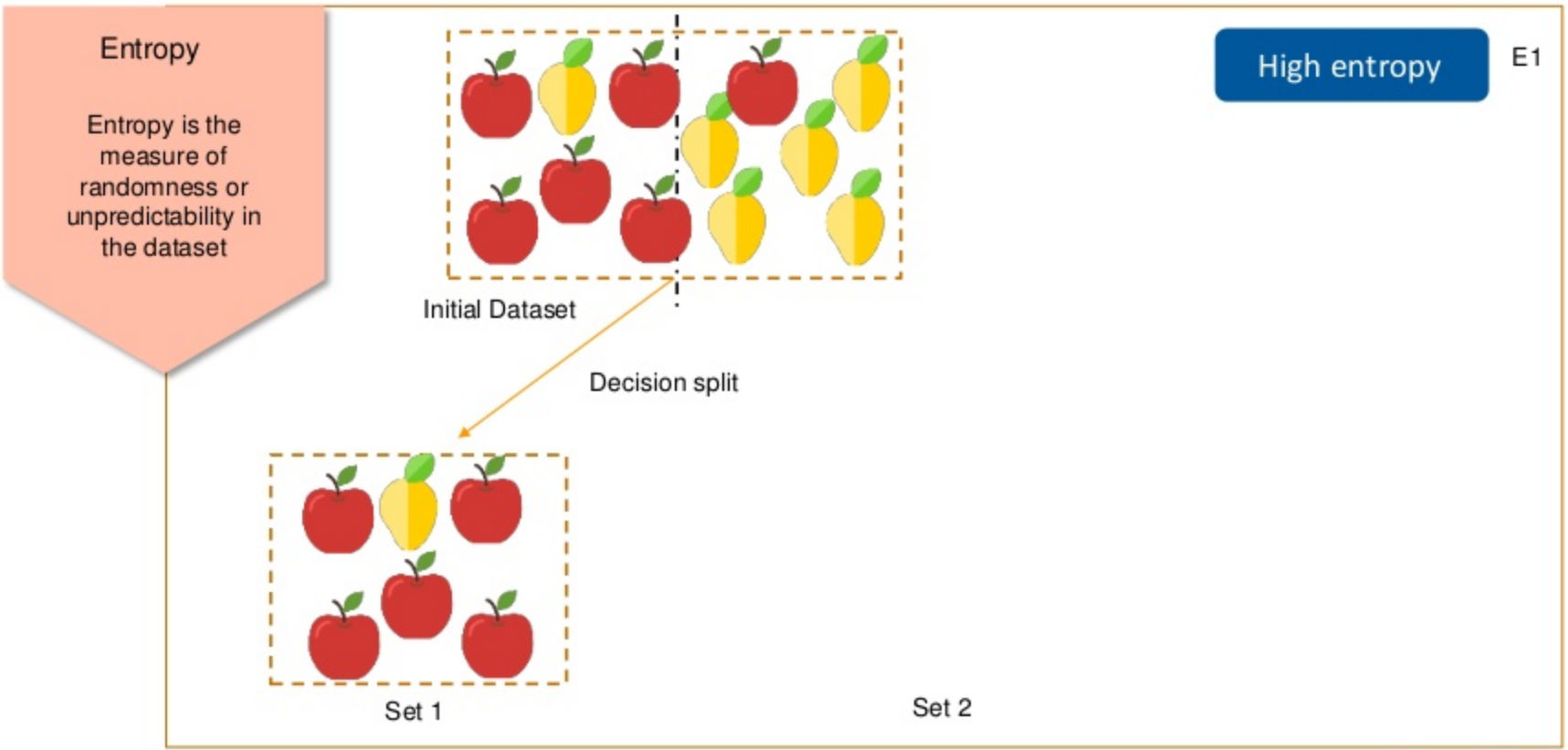
Decision Tree - Important Terms



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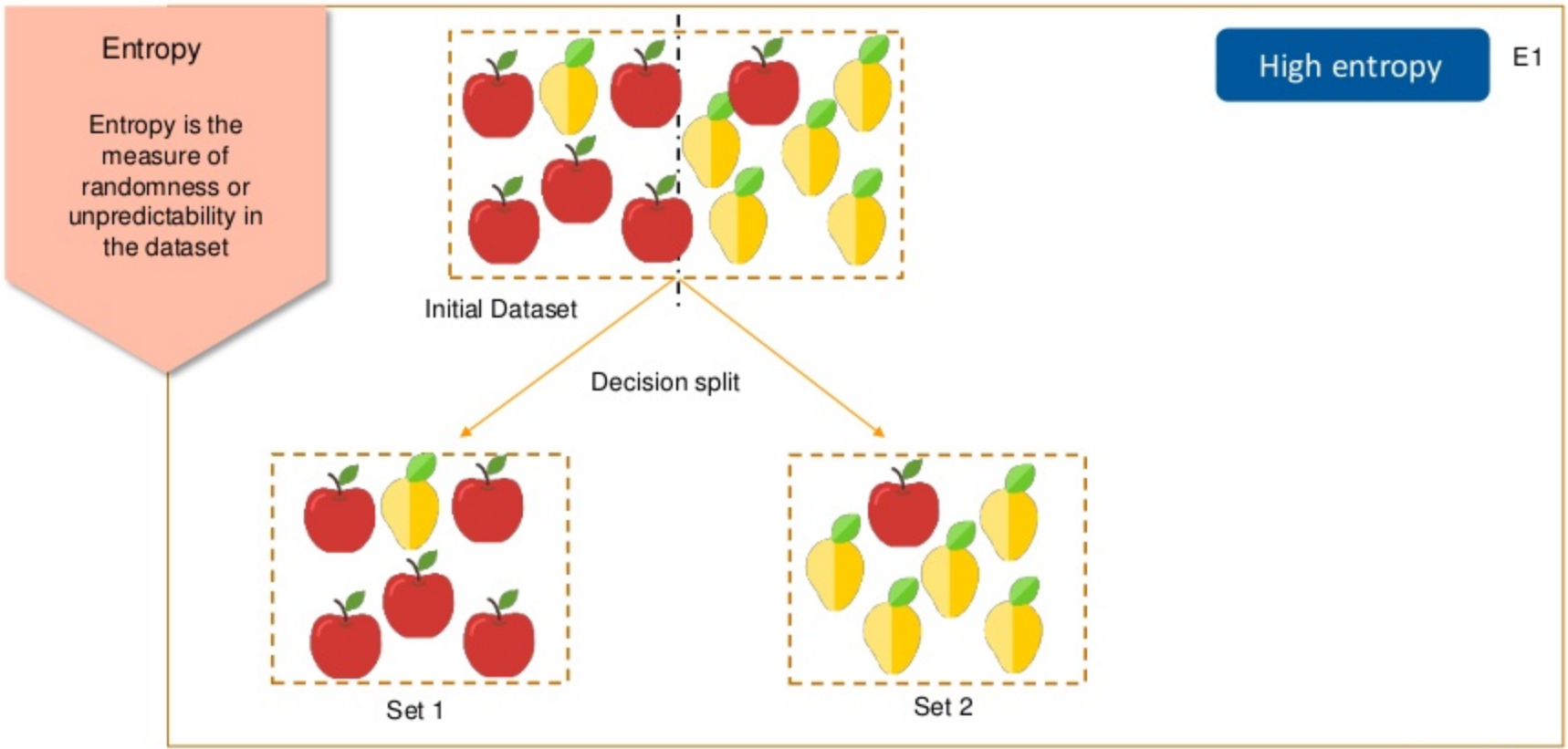

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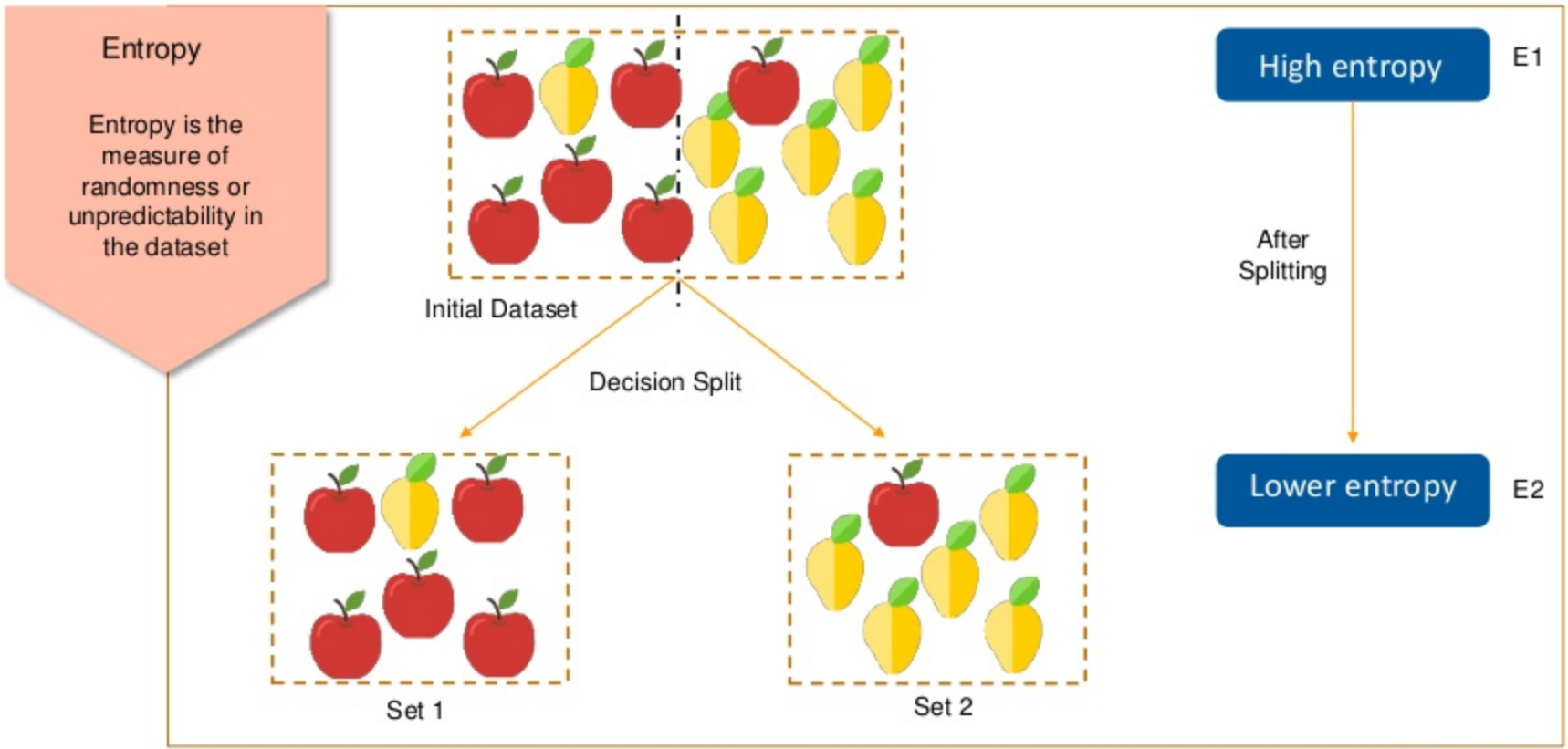

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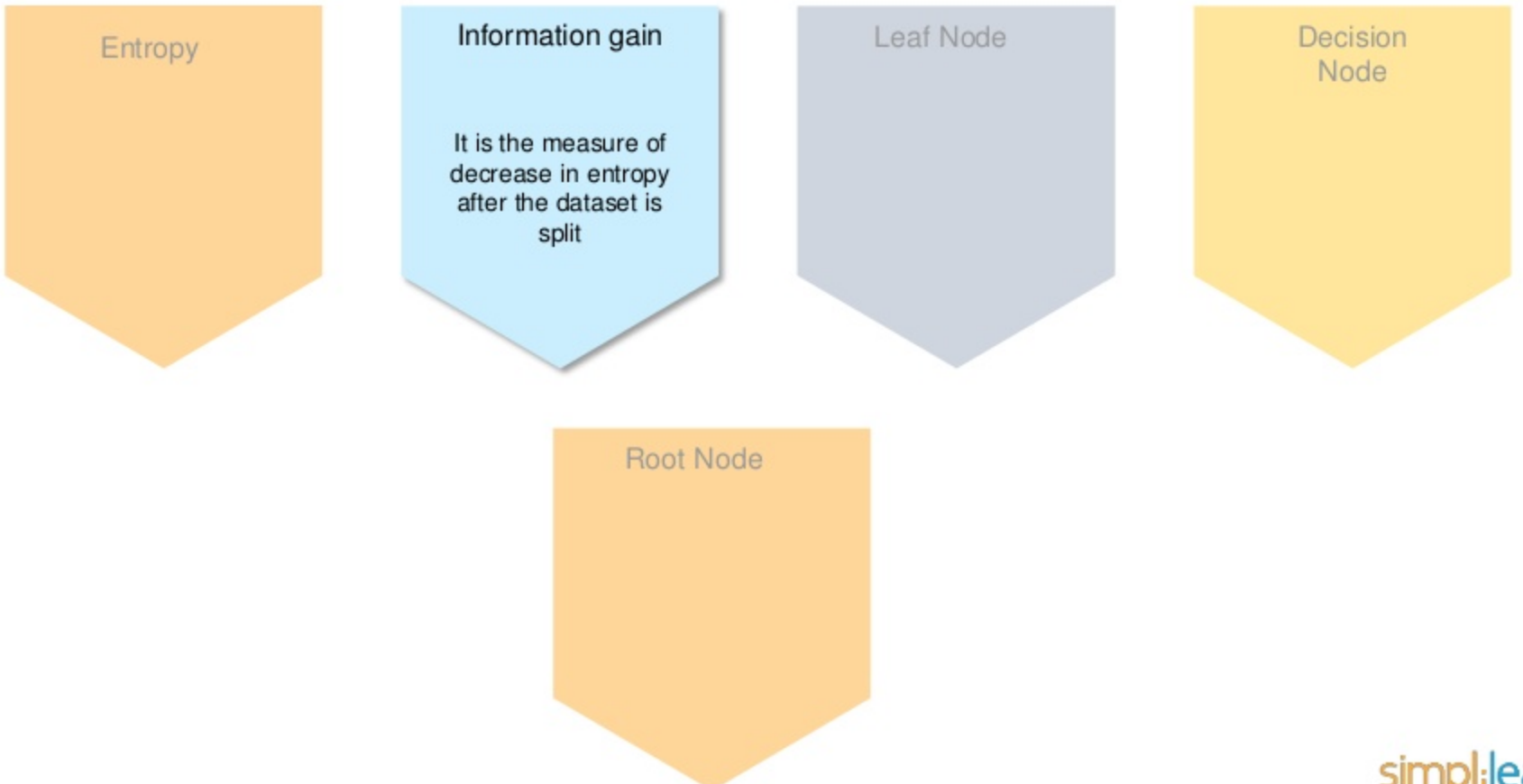

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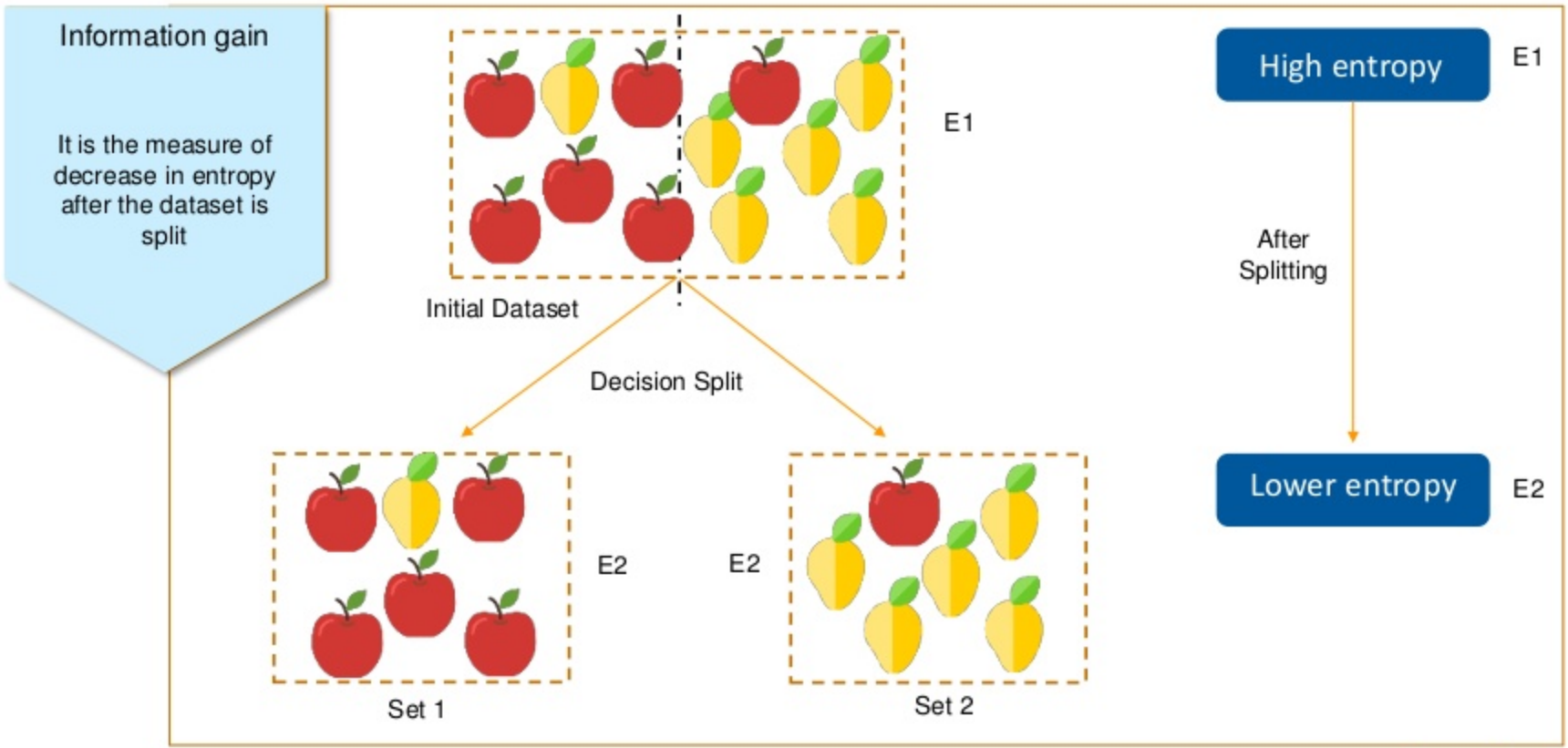

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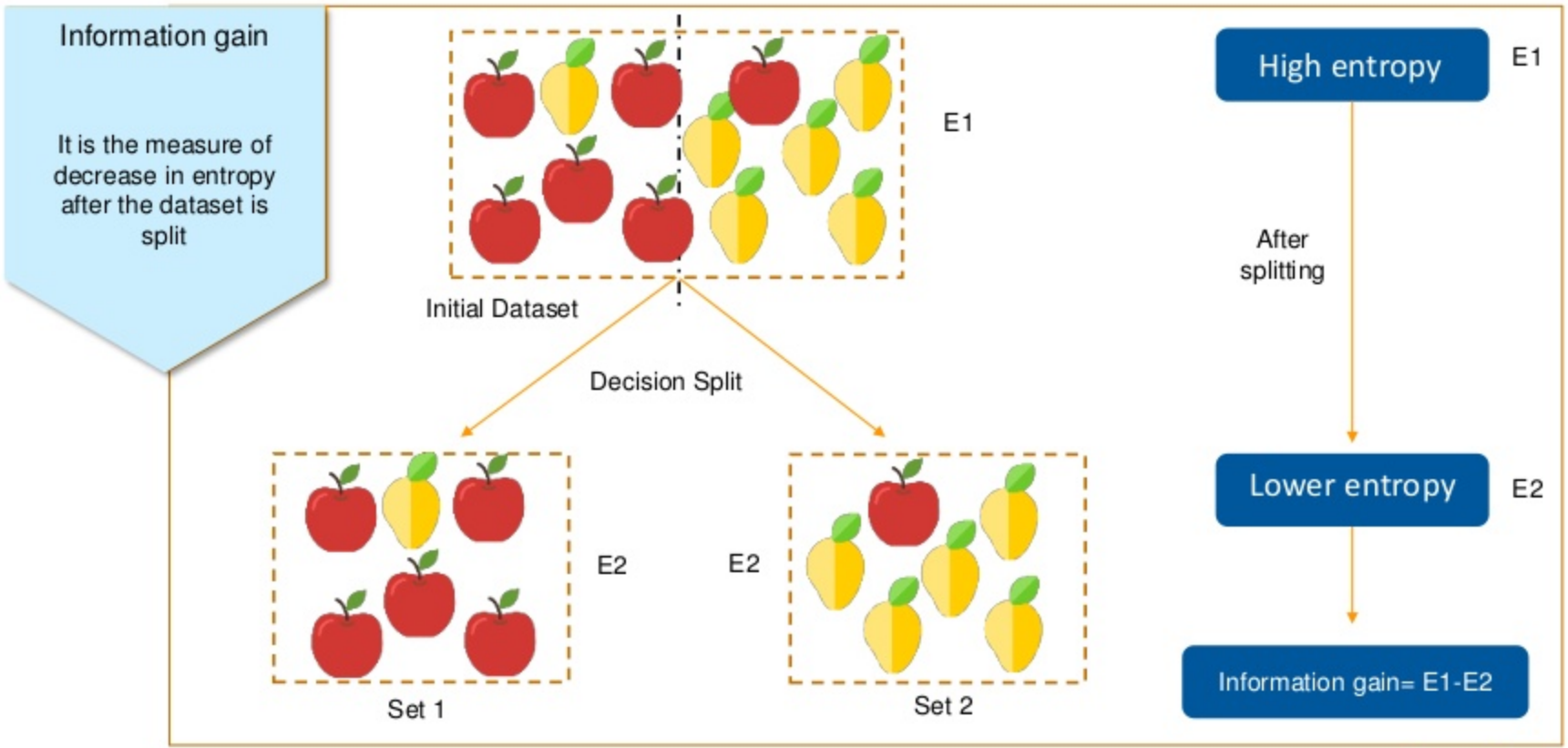

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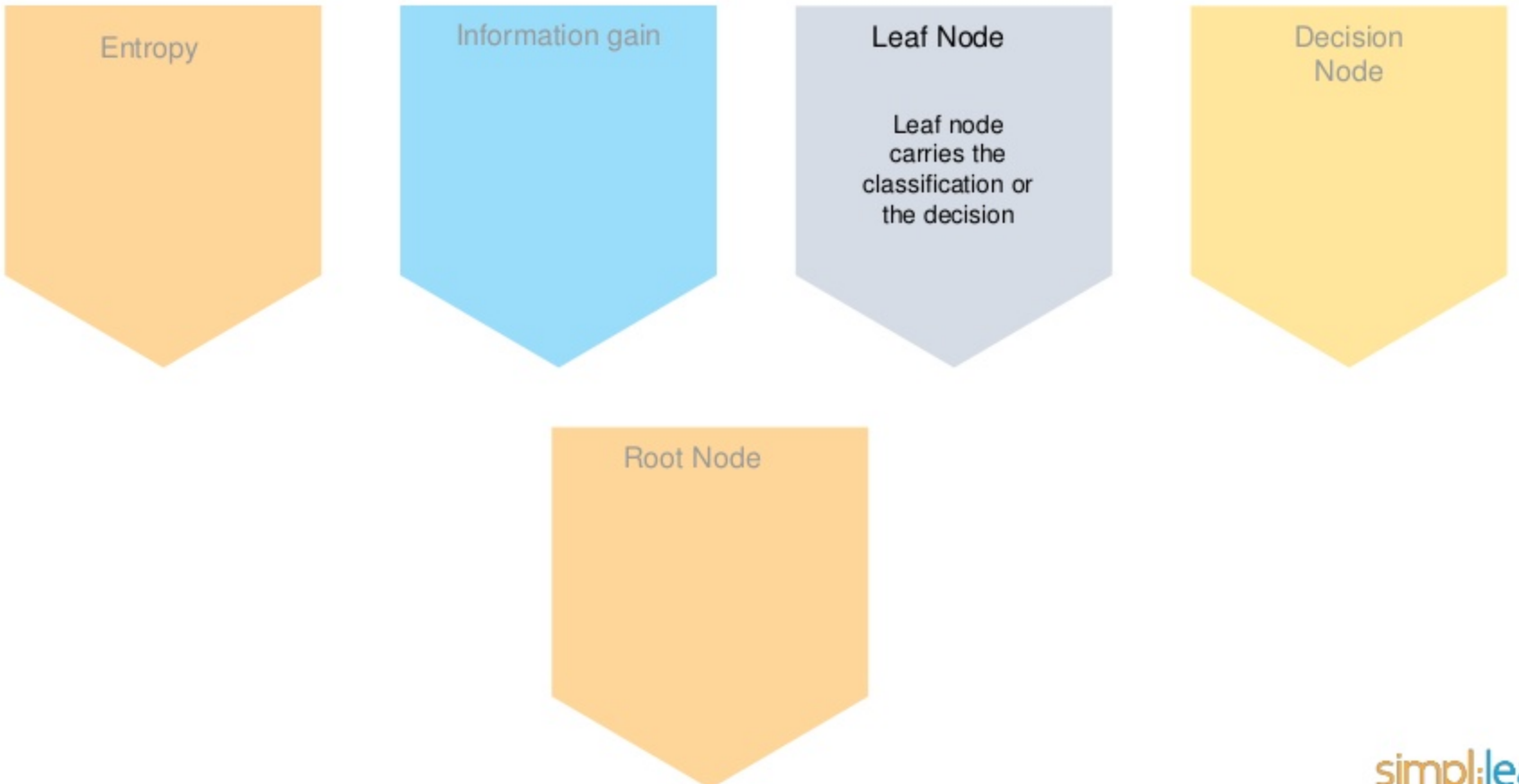
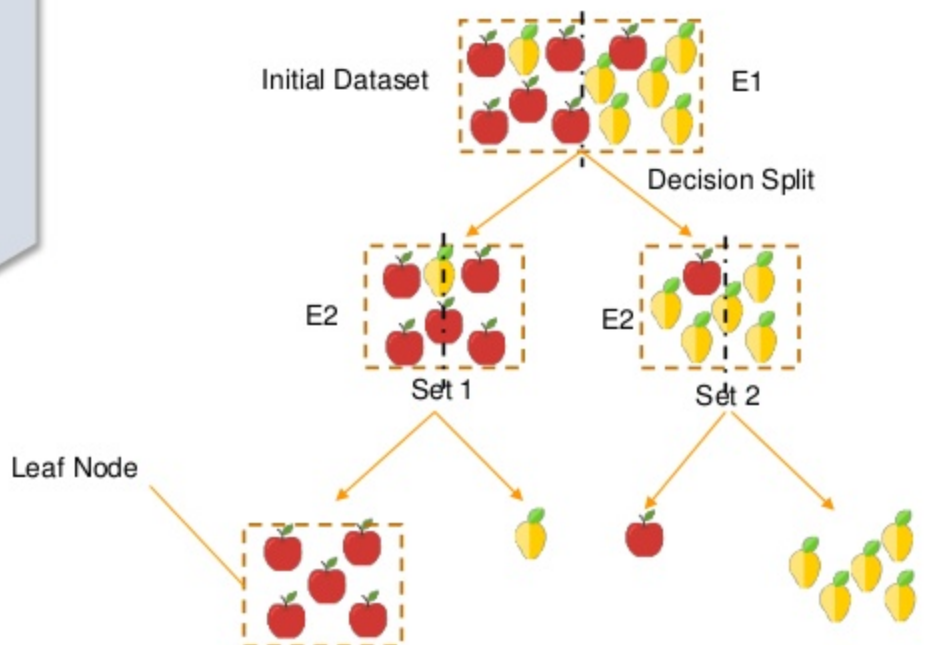


Decision Tree - Important Terms

Leaf Node

Leaf node carries the classification or the decision



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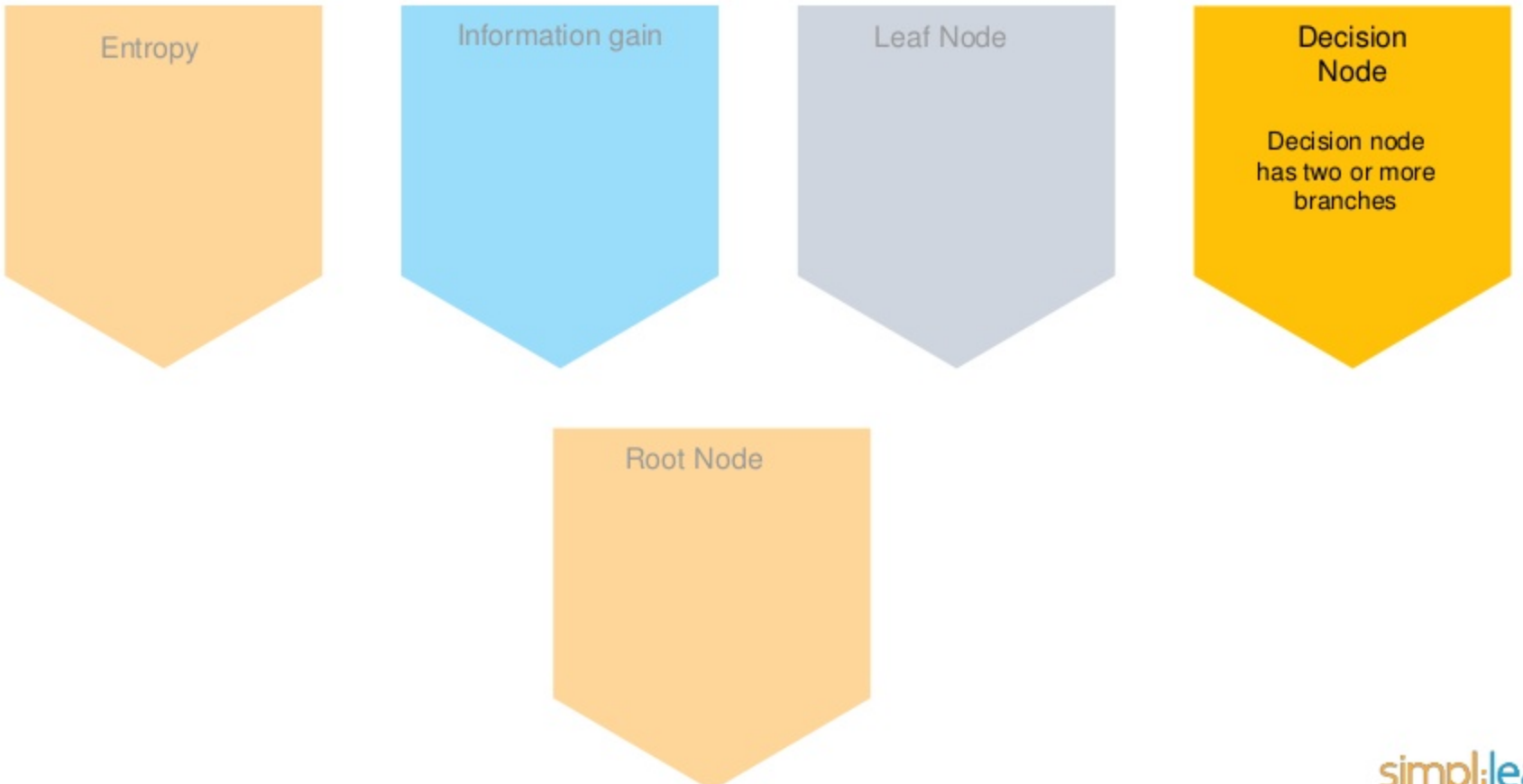
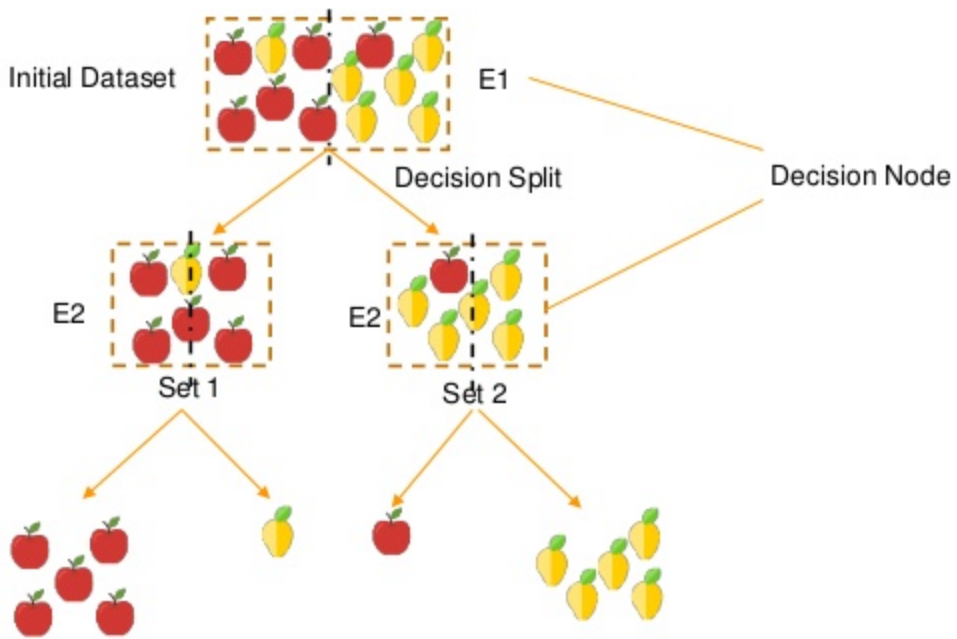
Decision Tree - Important Terms



Decision Tree - Important Terms

Decision Node

Decision node has two or more branches



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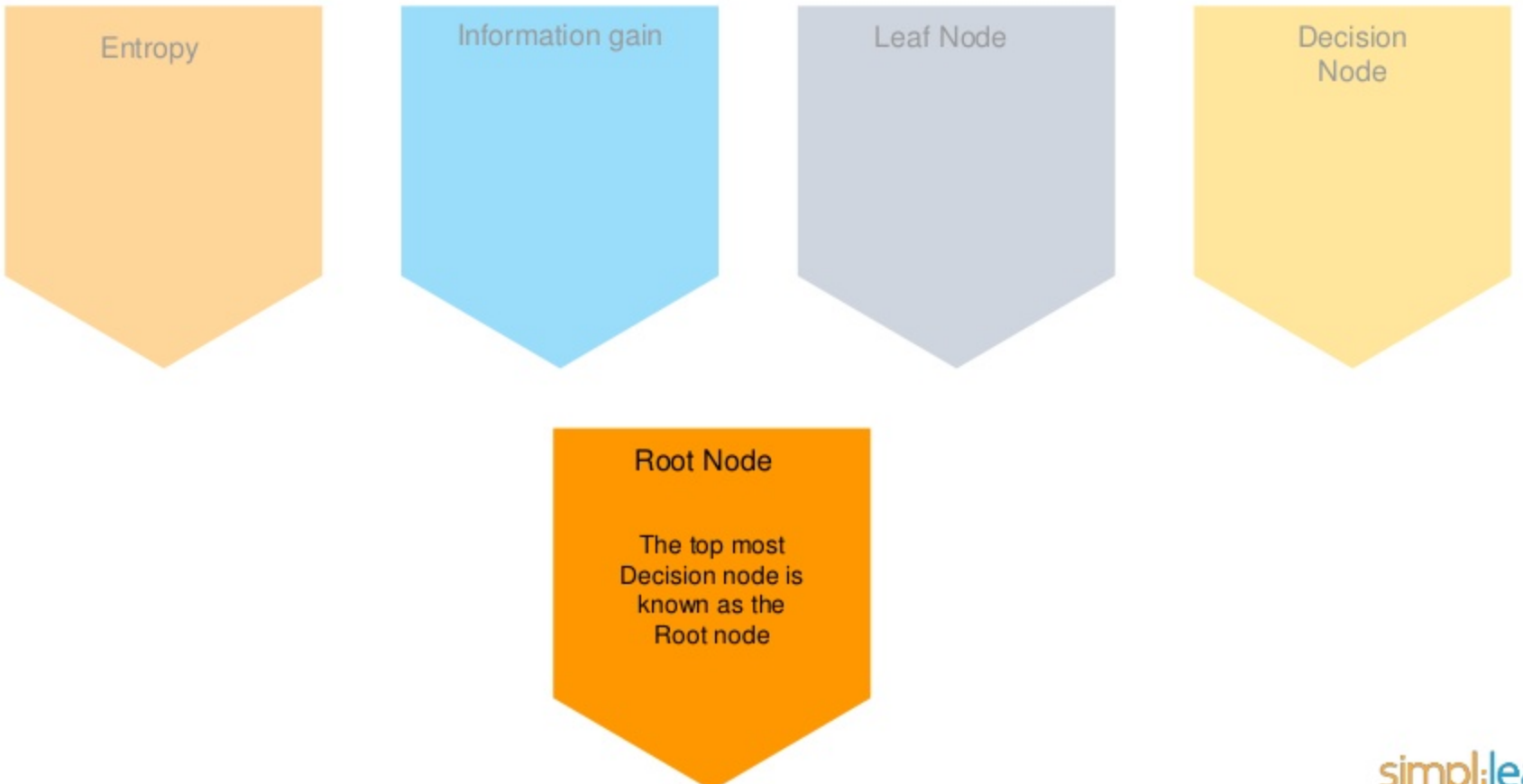
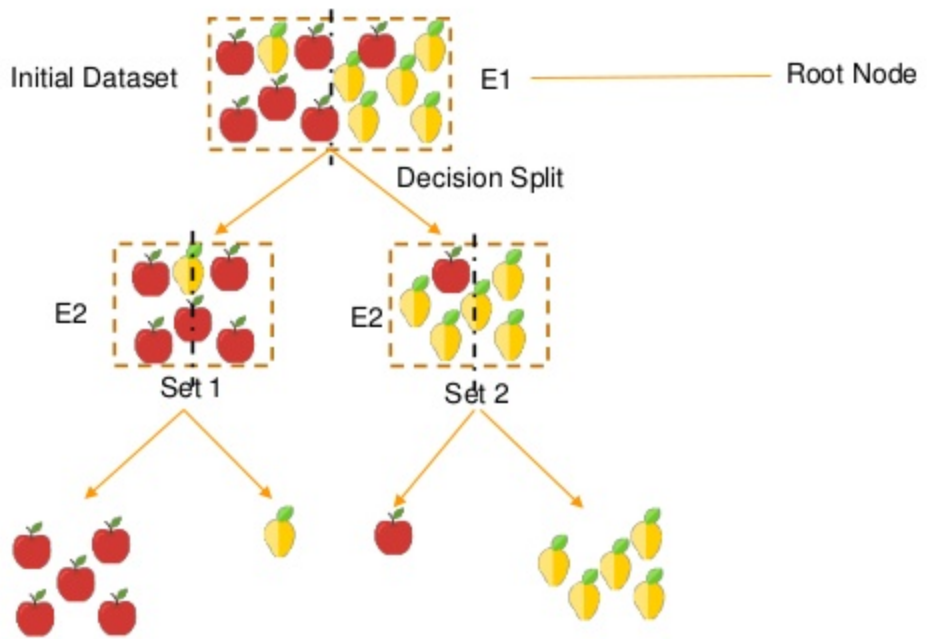


Decision Tree - Important Terms

Root Node

The top most Decision node is known as the Root node



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How does a Decision Tree work?
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How does a Decision Tree work?

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Problem statement

To classify the different types of fruits in the bowl based on different features

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The dataset(bowl) is looking quite messy and the entropy is high in this case

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The dataset(bowl) is looking quite messy and the entropy is high in this case

Training Dataset

Color	Diameter	Label
Red	3	Apple
Yellow	3	Lemon
Purple	1	Grapes
Red	3	Apple
Yellow	3	Lemon
Purple	1	Grapes

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How does a Decision Tree work?

How to split the data

We have to frame the conditions that split the data in such a way that the information gain is the highest

How does a Decision Tree work?

How to split the data

We have to frame the conditions that split the data in such a way that the information gain is the highest

Note

Gain is the measure of decrease in entropy after splitting

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How does a Decision Tree work?

Now we will try to choose a condition that gives us the highest gain

How does a Decision Tree work?

Now we will try to choose a condition that gives us the highest gain

We will do that by splitting the data using each condition and checking the gain that we get out them.

How does a Decision Tree work?

The condition that gives us the highest gain will be used to make the first split

We will do that by splitting the data using each condition and checking the gain that we get out them.

How does a Decision Tree work?

Conditions

Color== purple?

Diameter=3

Color==Yellow?

Color== Red?

Diameter=1

Training Dataset

Color	Diameter	Label
Red	3	Apple
Yellow	3	Lemon
purple	1	Grapes
Red	3	Apple
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How does a Decision Tree work?

Conditions

Color== purple?

Diameter=3

Color==Yellow?

Color== Red?

Diameter=1

Let's say this condition gives us the maximum gain

Training Dataset

Color	Diameter	Label
Red	3	Apple
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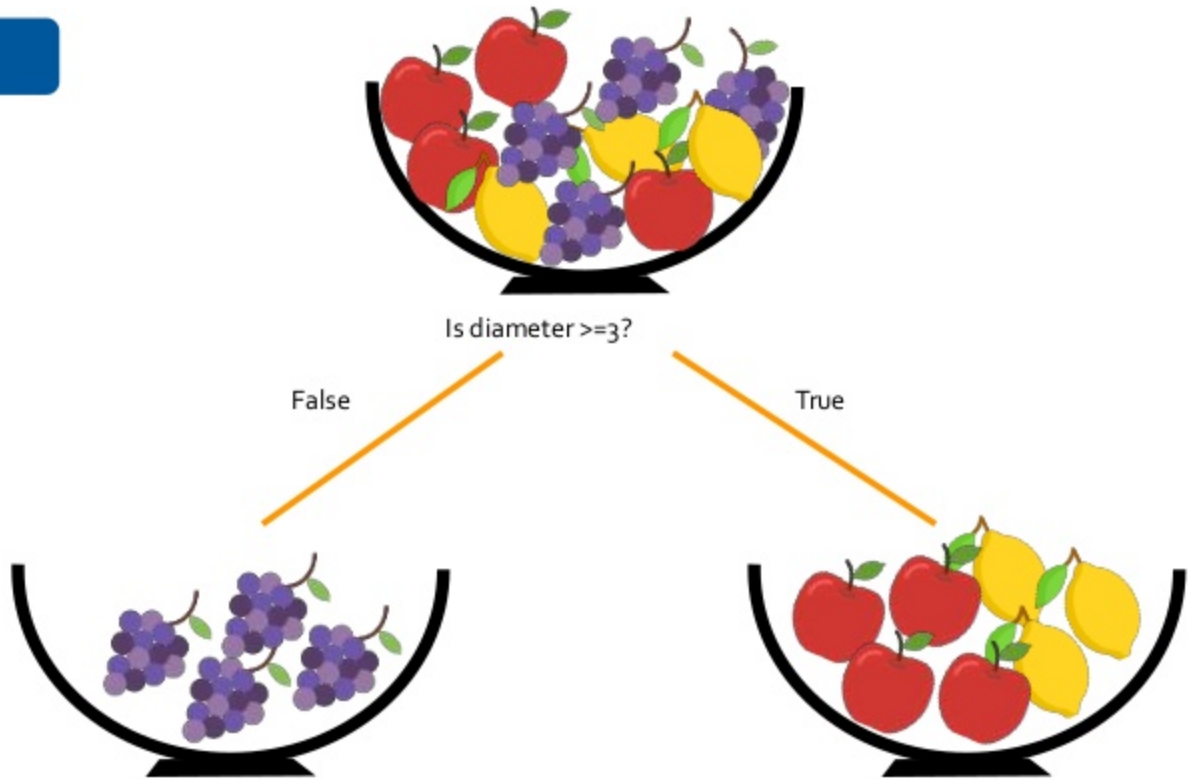
How does a Decision Tree work?

We split the data



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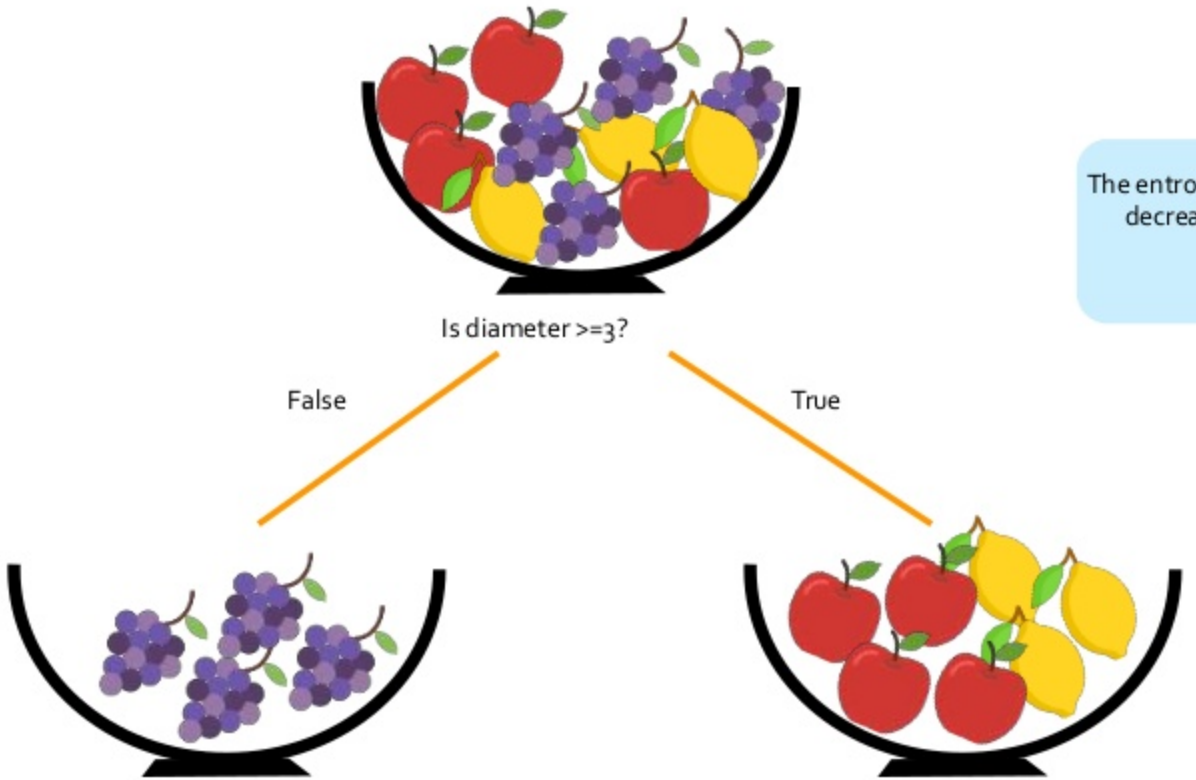
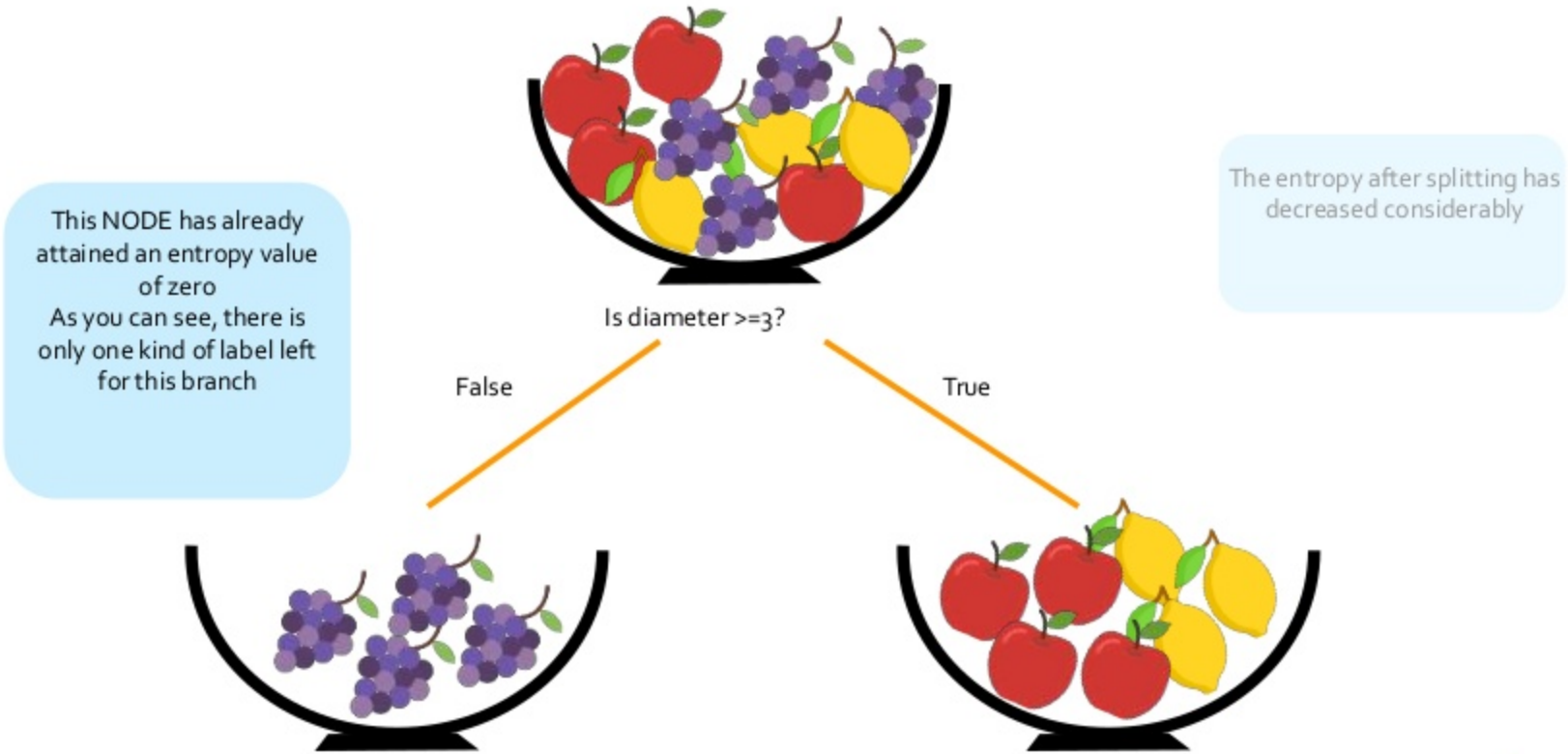


The entropy after splitting has decreased considerably

How does a Decision Tree work?



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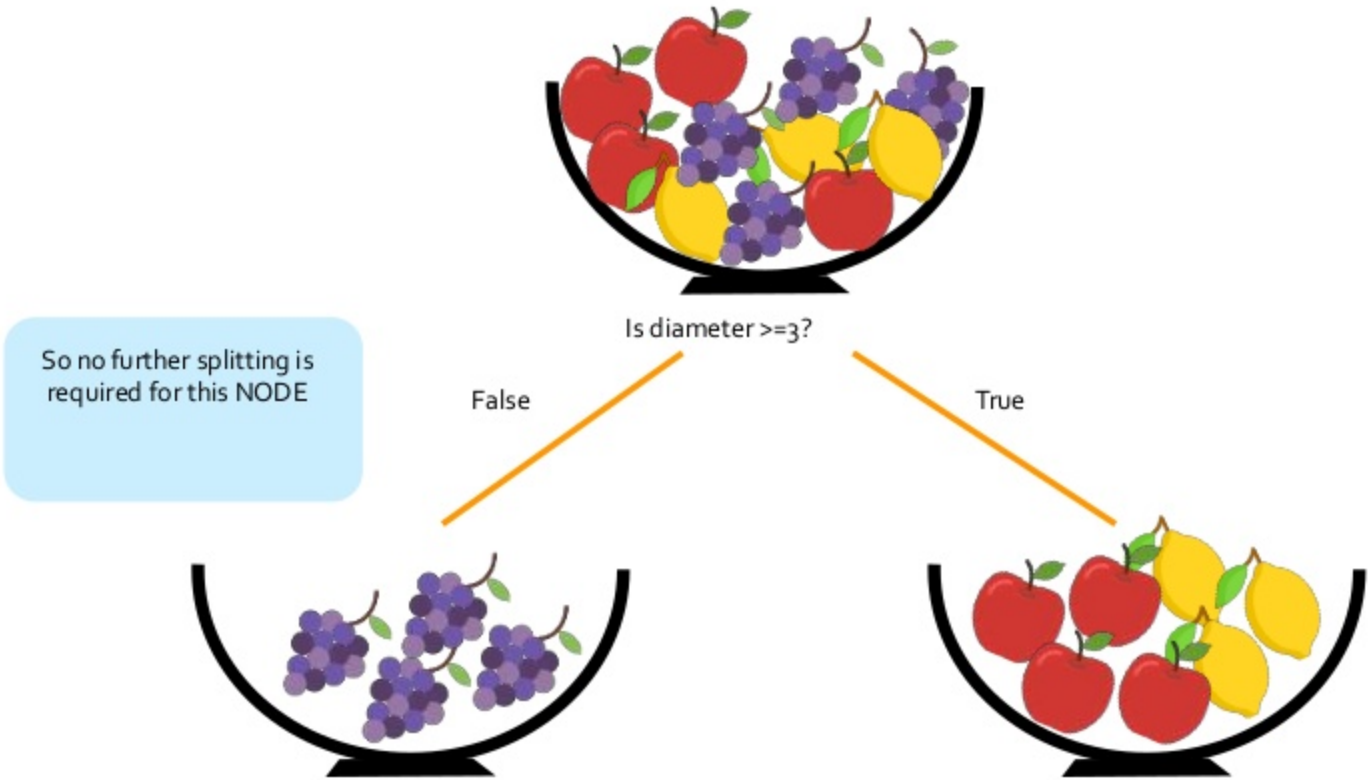

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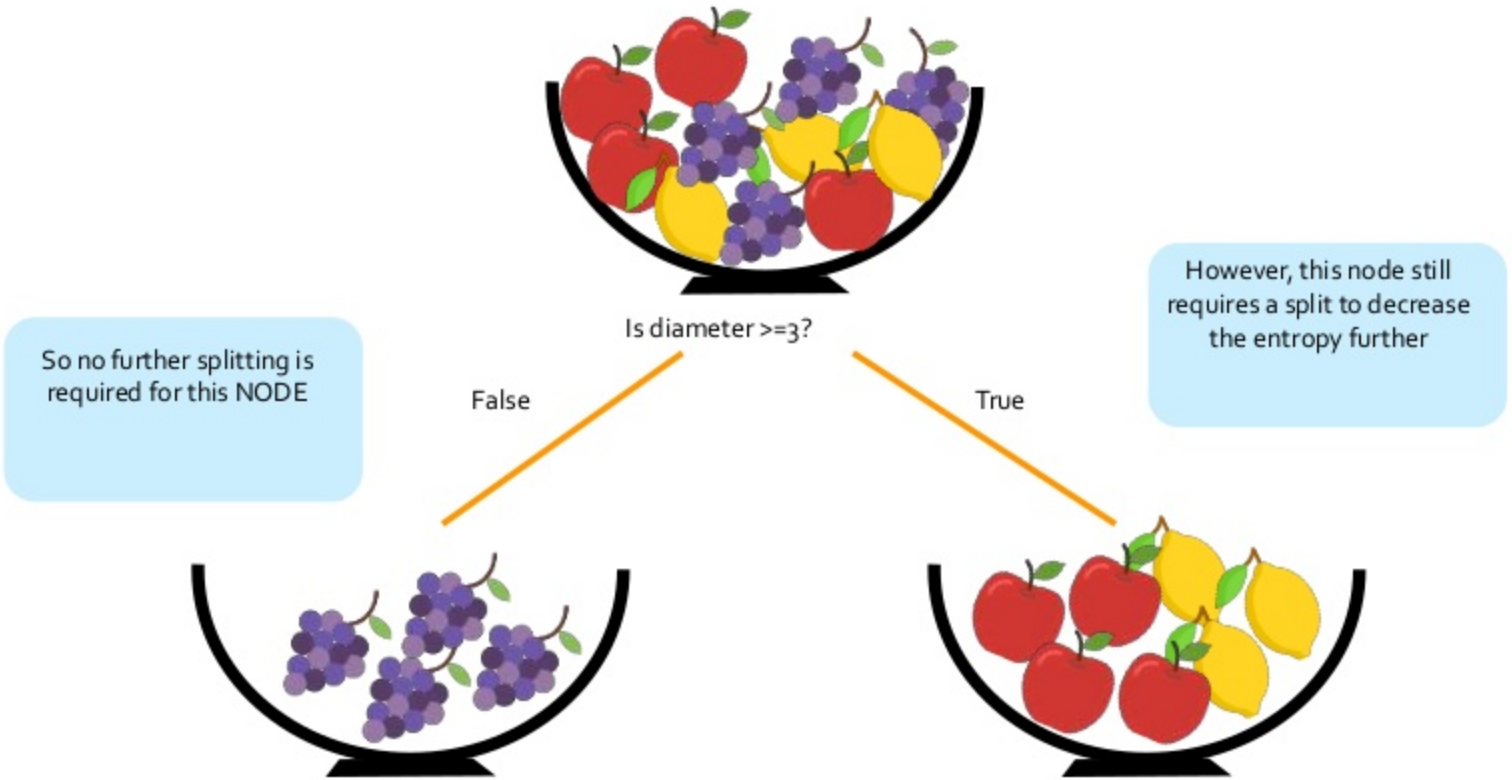

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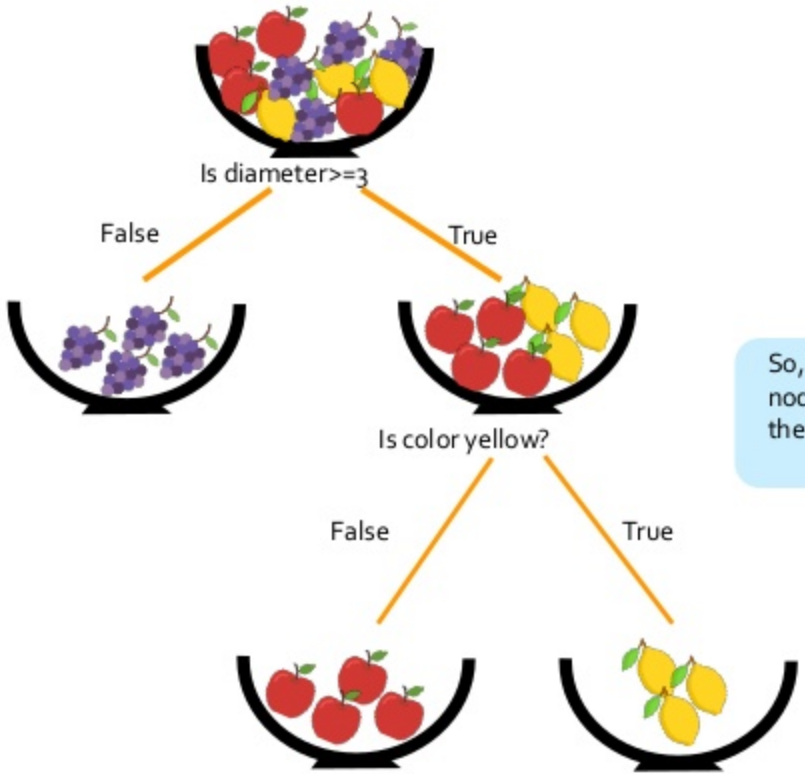
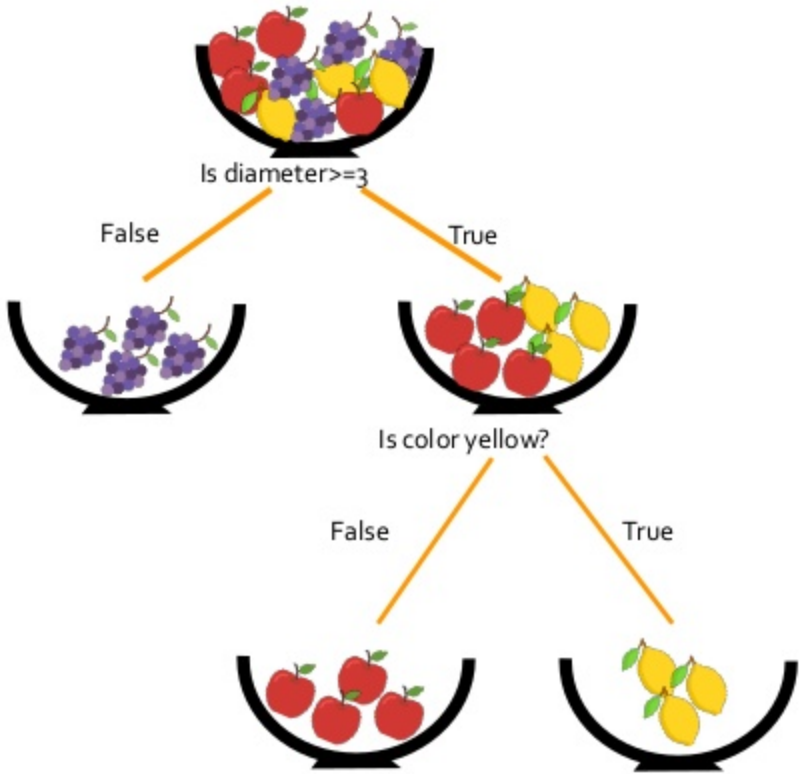


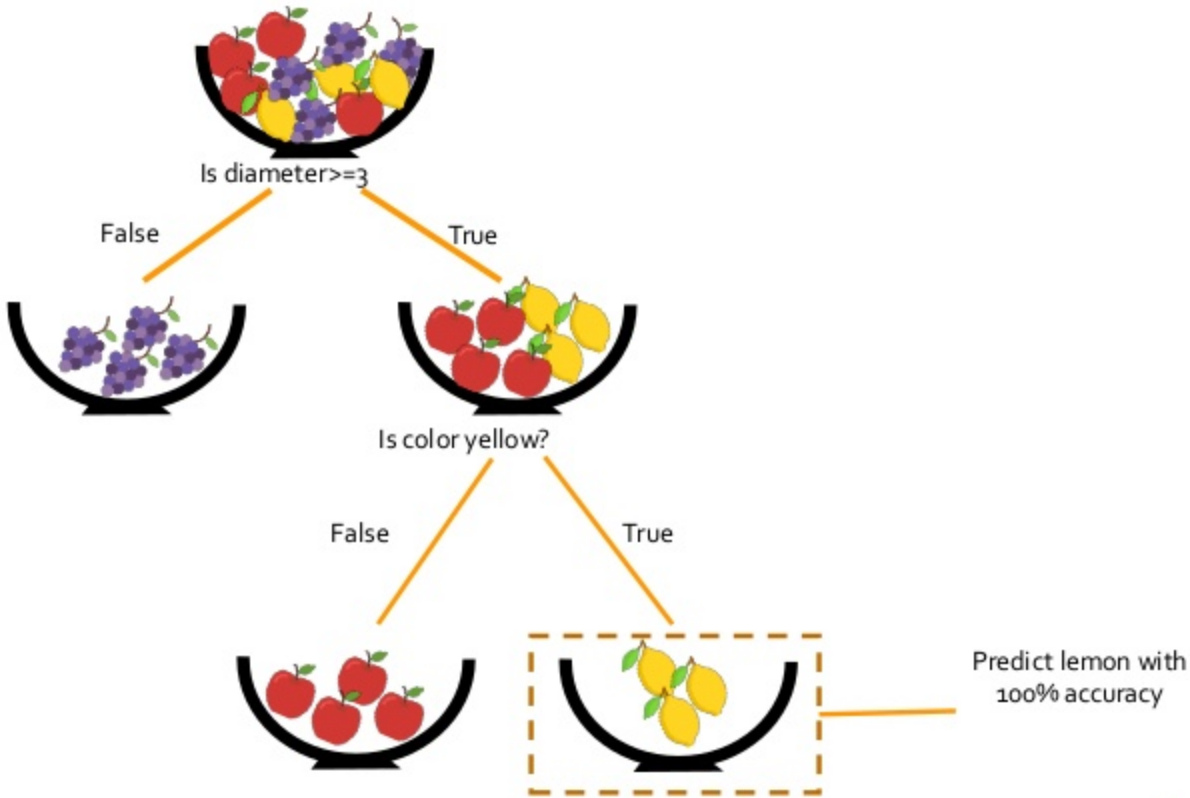
So, we split the right node further based on the color

How does a Decision Tree work?



So the entropy in this case is now zero

How does a Decision Tree work?



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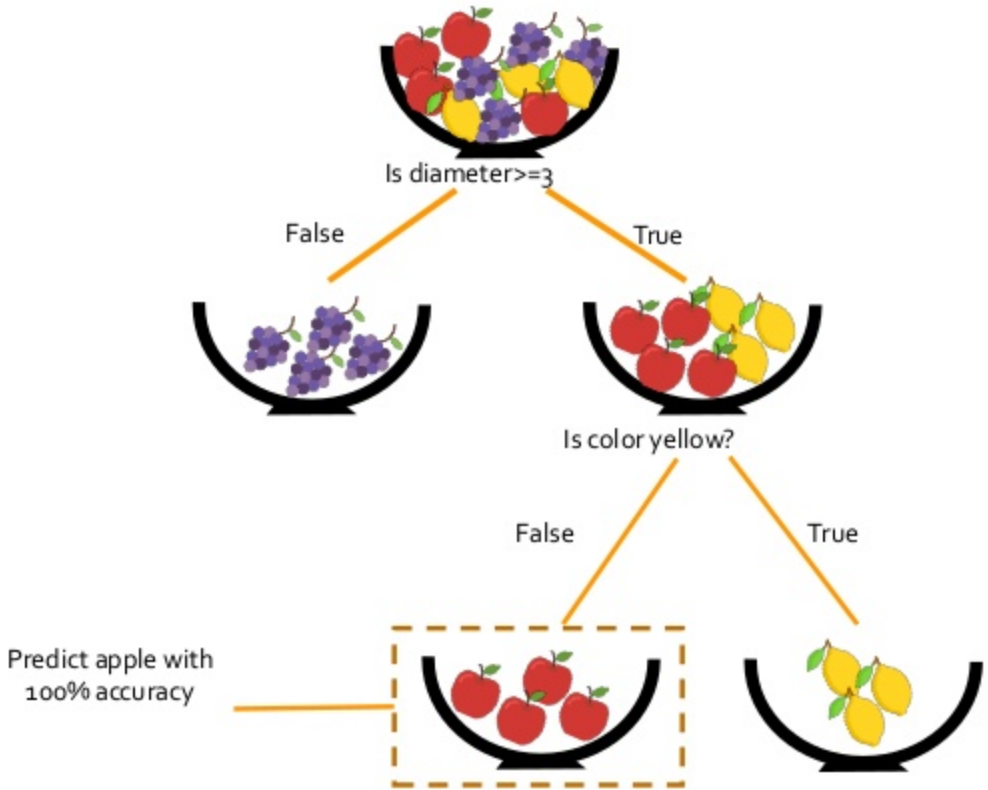

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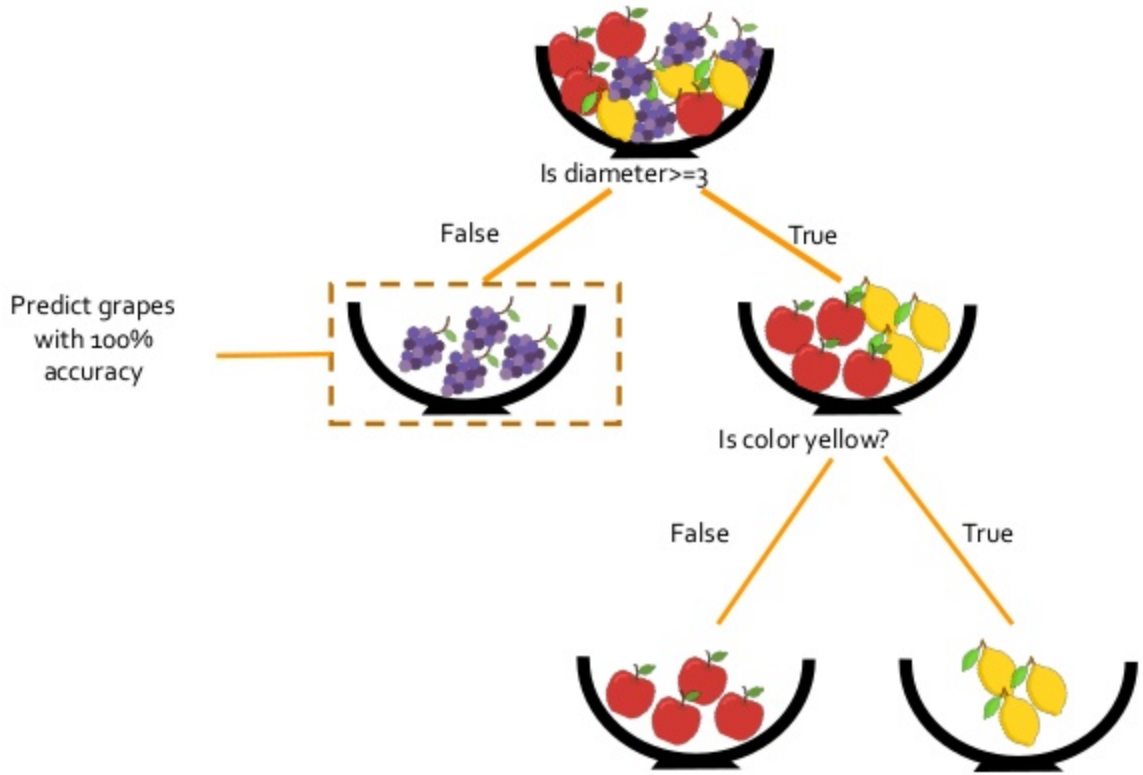

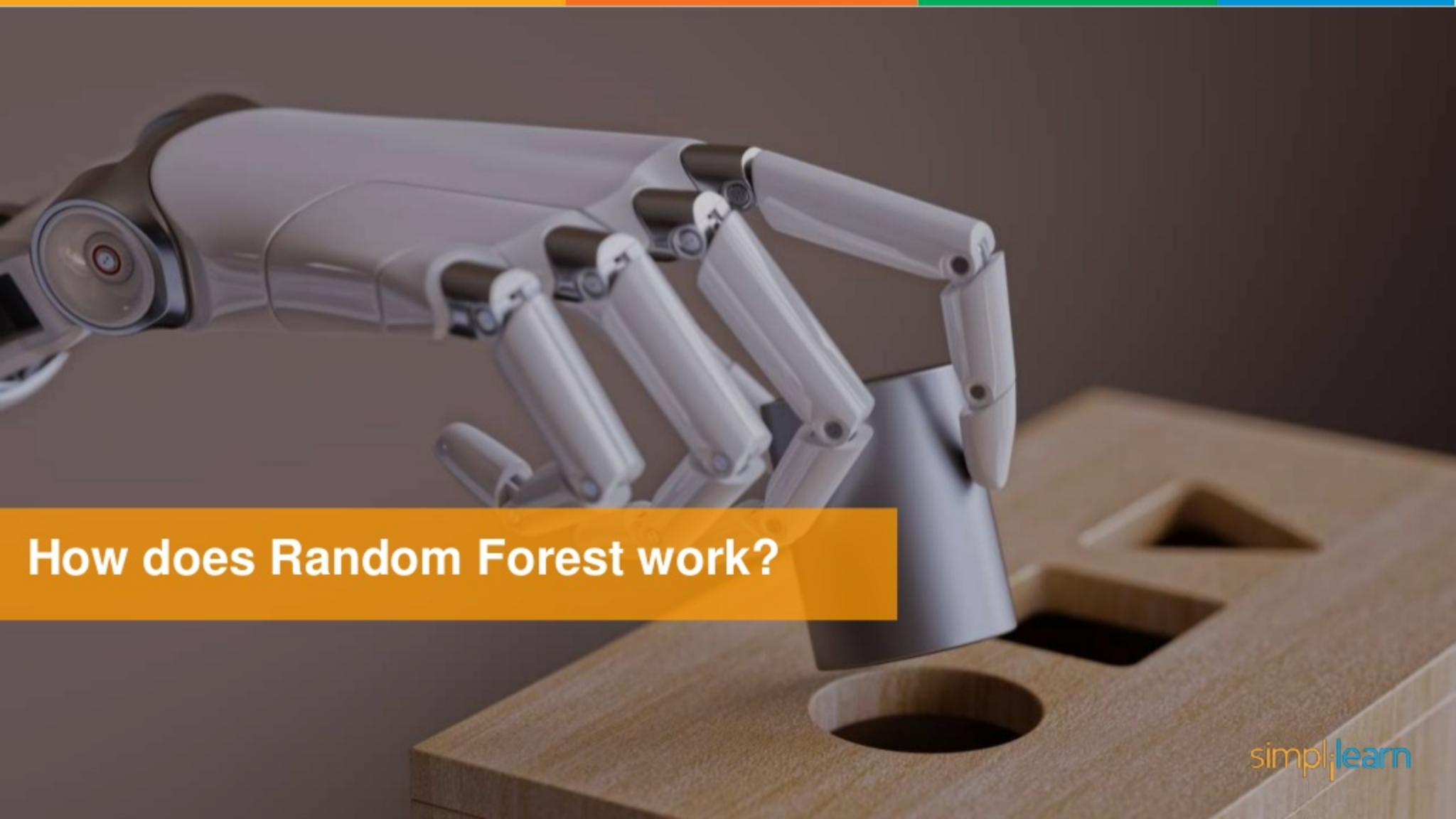
How does Random Forest work?
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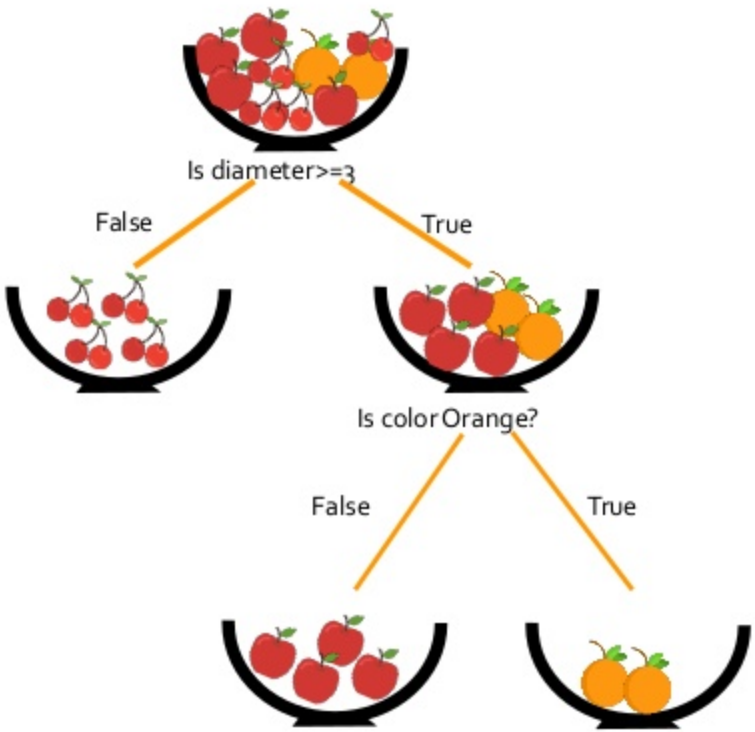
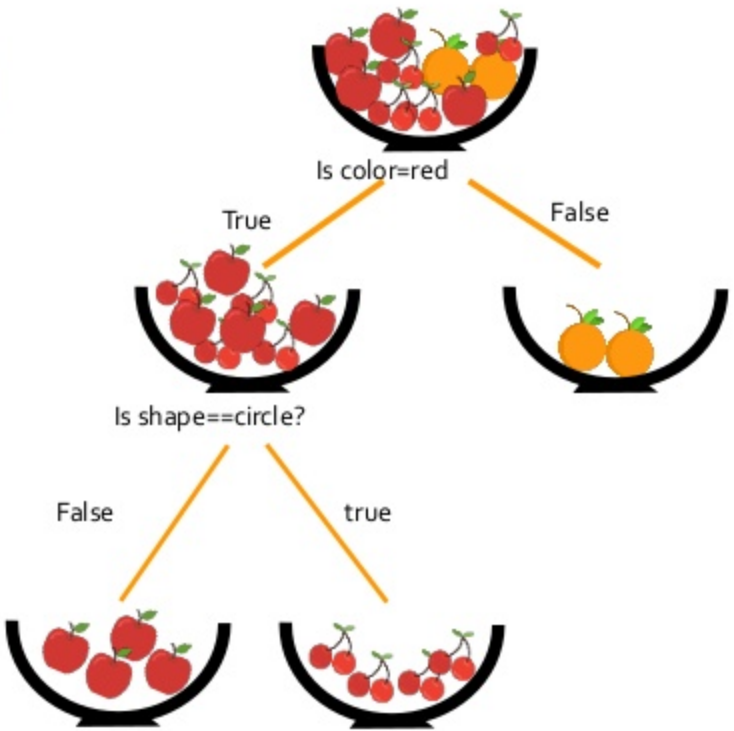
How does a Random Forest work?

Let this be Tree 1



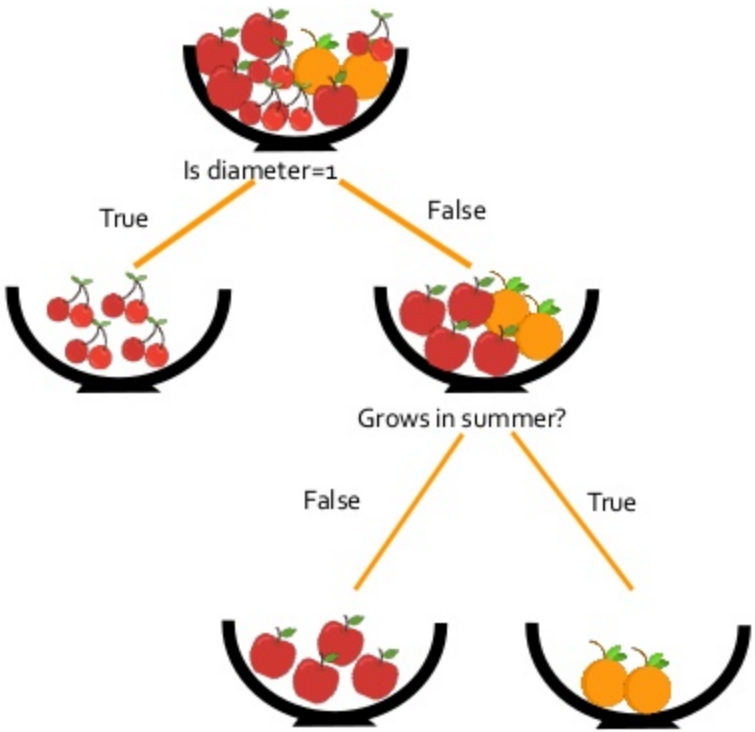
How does a Random Forest work?

Let this be Tree 2

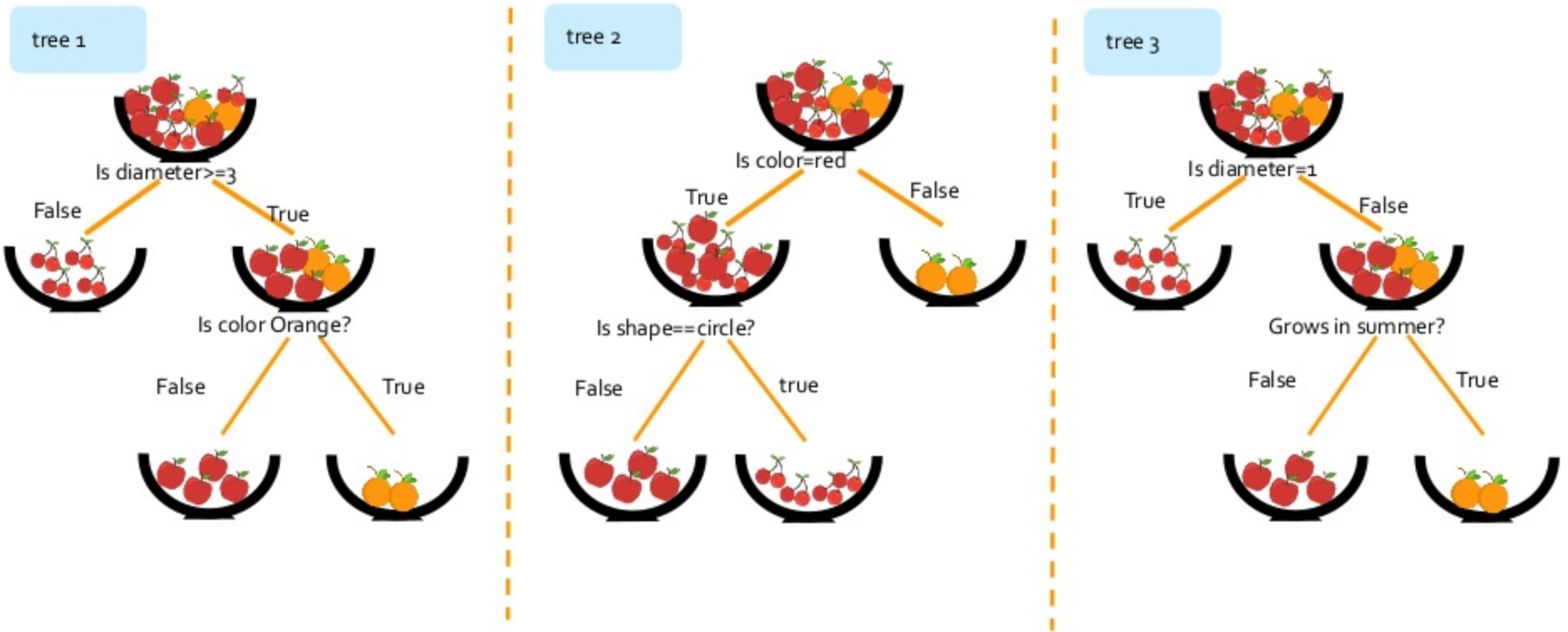


How does a Random Forest work?

Let this be Tree 3



How does a Random Forest work?



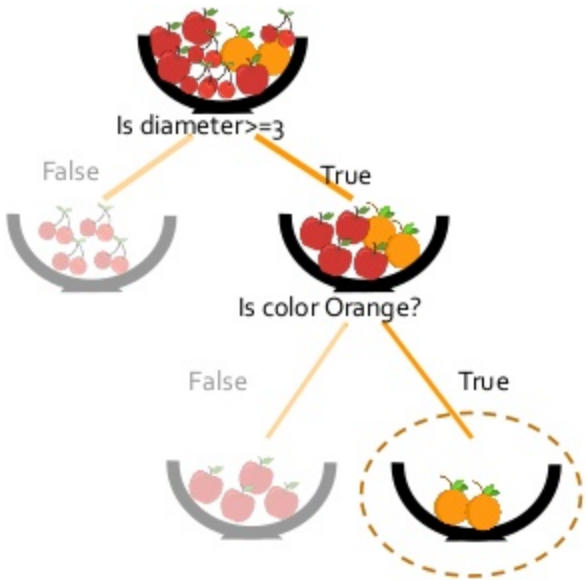
How does a Random Forest work?

Now Lets try to classify this fruit

How does a Random Forest work?

Tree 1 classifies it as an orange

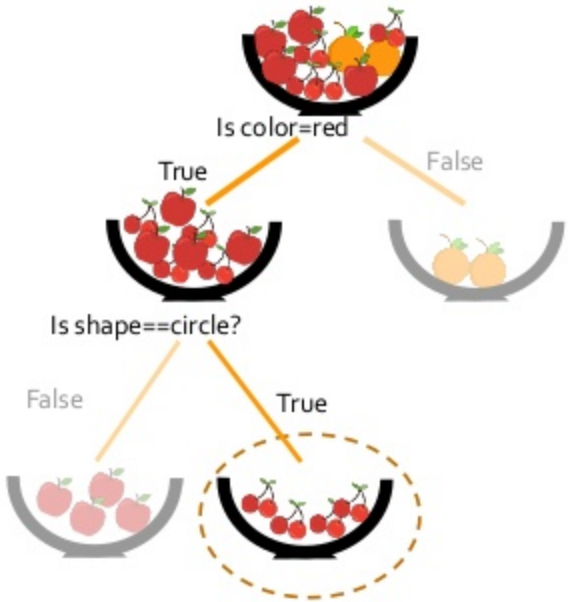
Diameter = 3
Colour = orange
Grows in summer = yes
SHAPE = CIRCLE



How does a Random Forest work?

Tree 2 classifies it as cherries

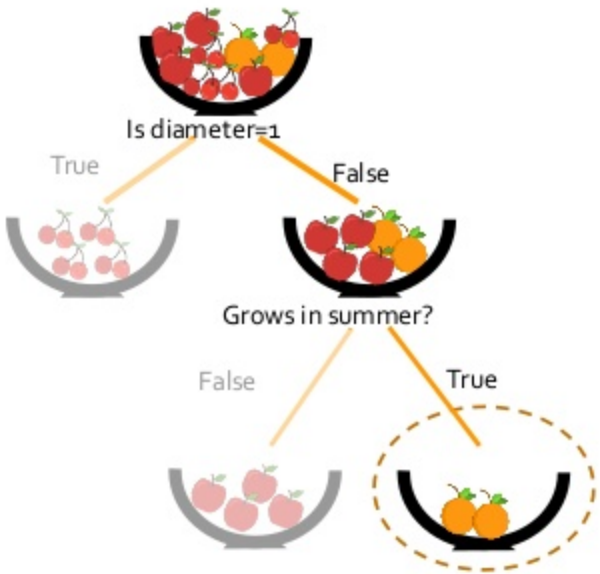
Diameter = 3
Colour = orange
Grows in summer = yes
SHAPE = CIRCLE



How does a Random Forest work?

Tree 3 classifies it as orange

Diameter = 3
Colour = orange
Grows in summer = yes
SHAPE = CIRCLE



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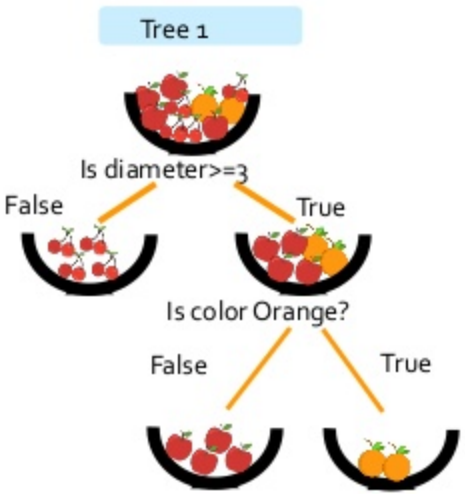
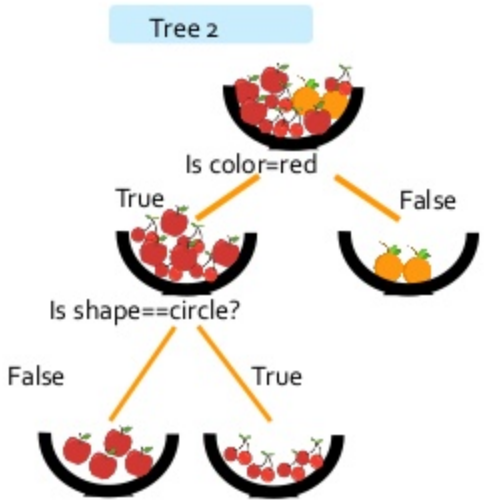
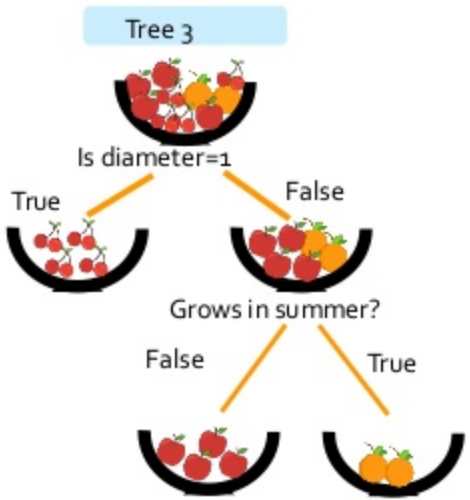
How does a Random Forest work?







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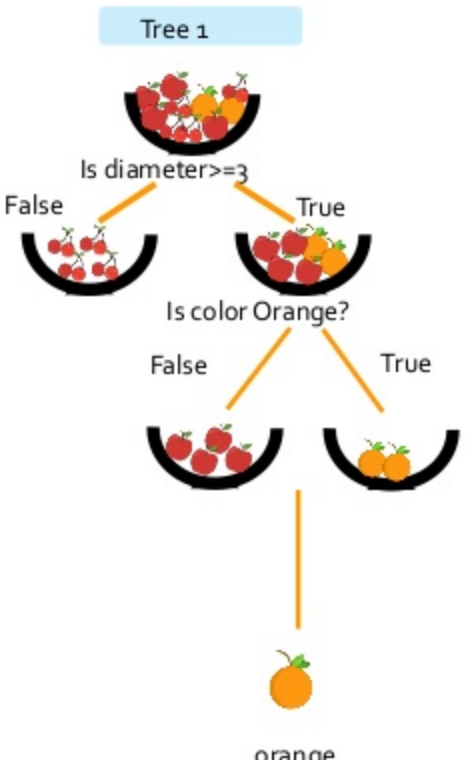
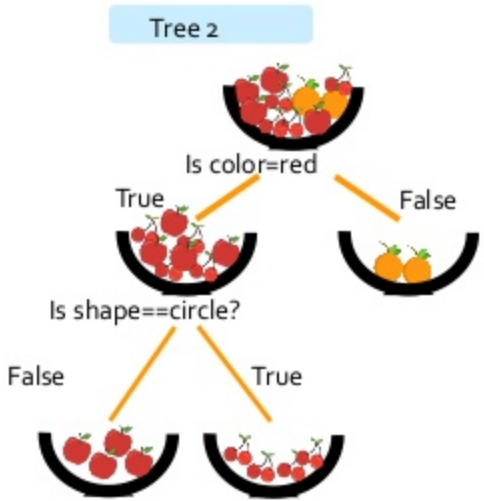
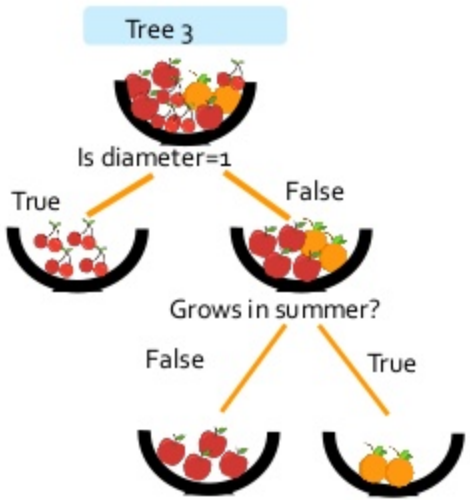
How does a Random Forest work?







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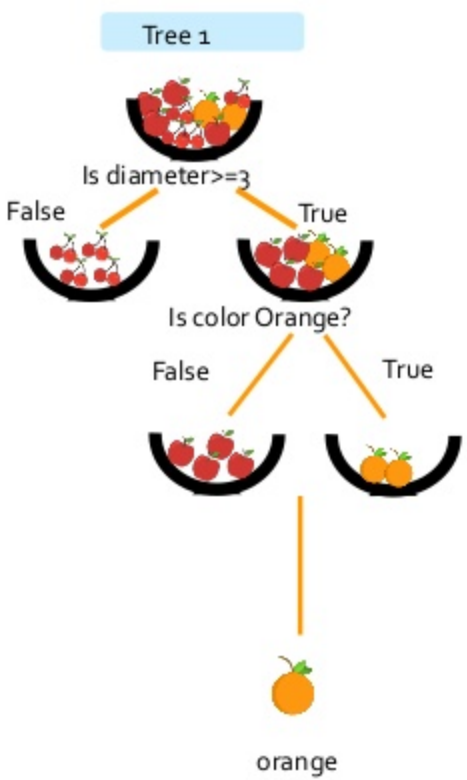

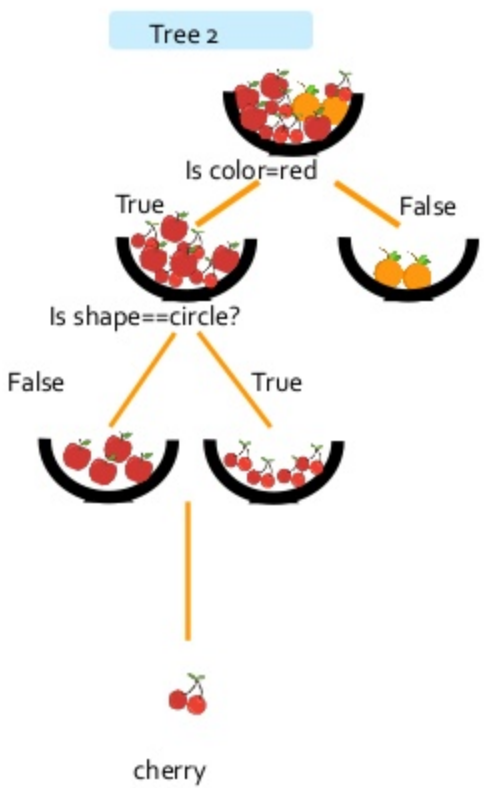

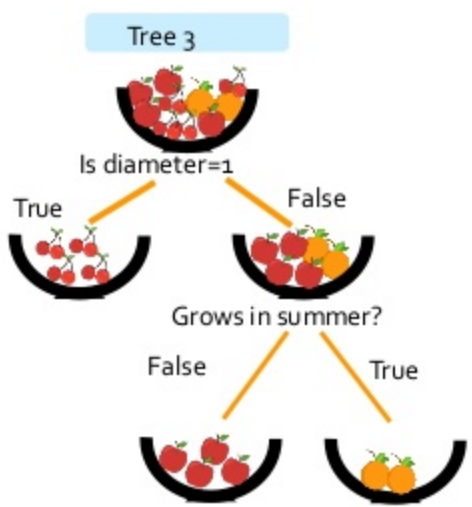

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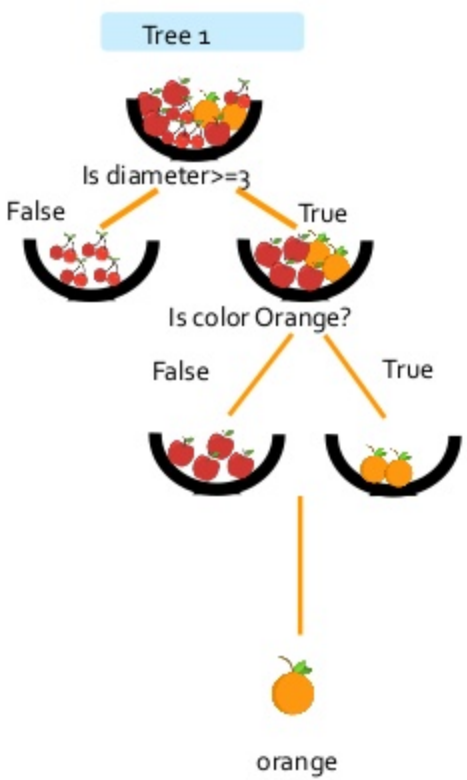

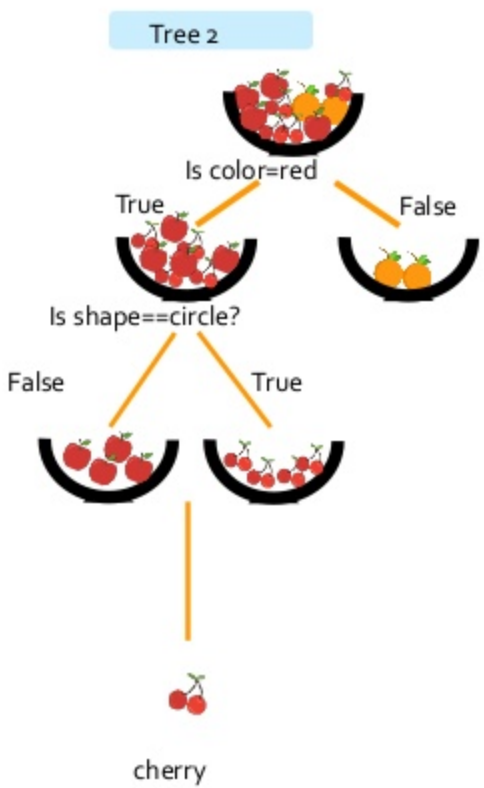

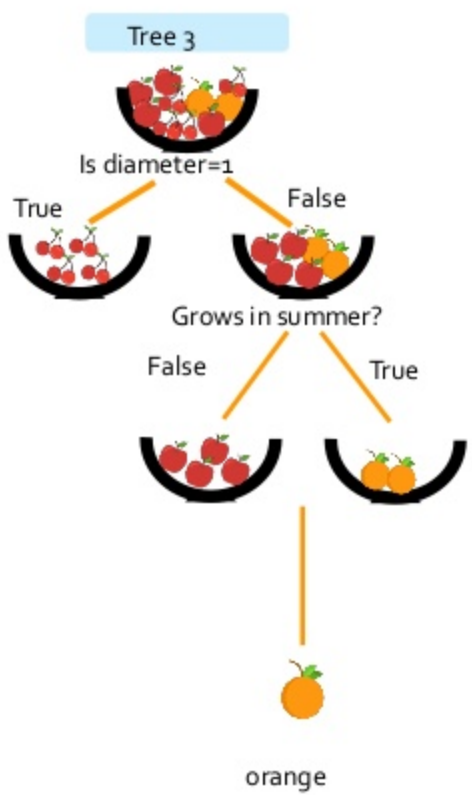

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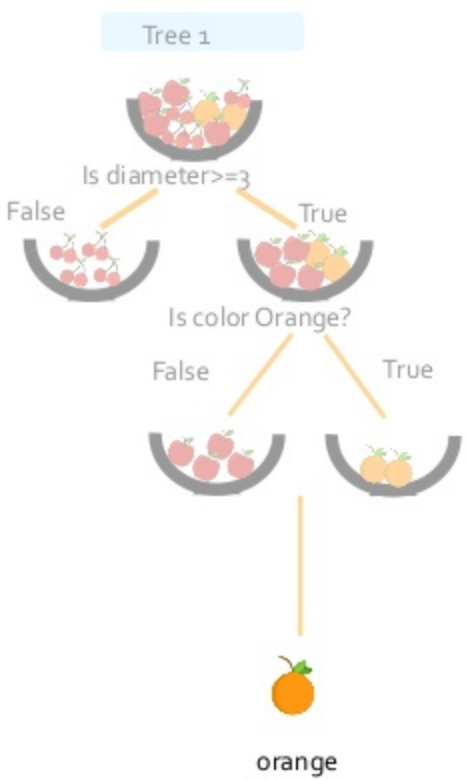
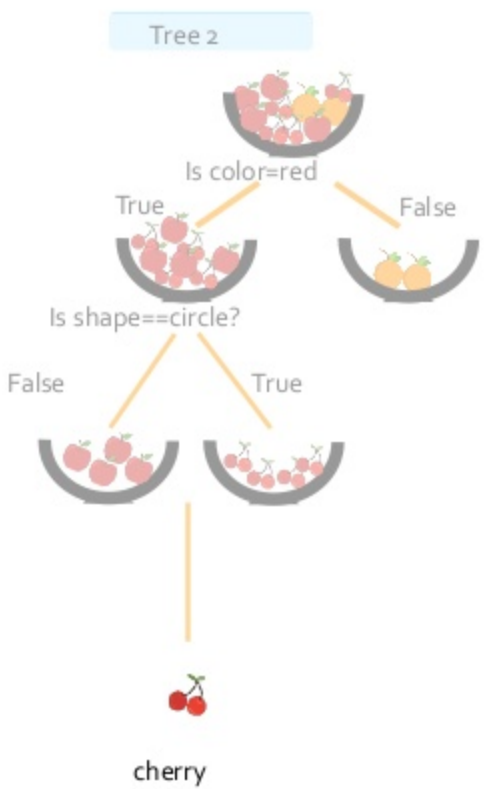
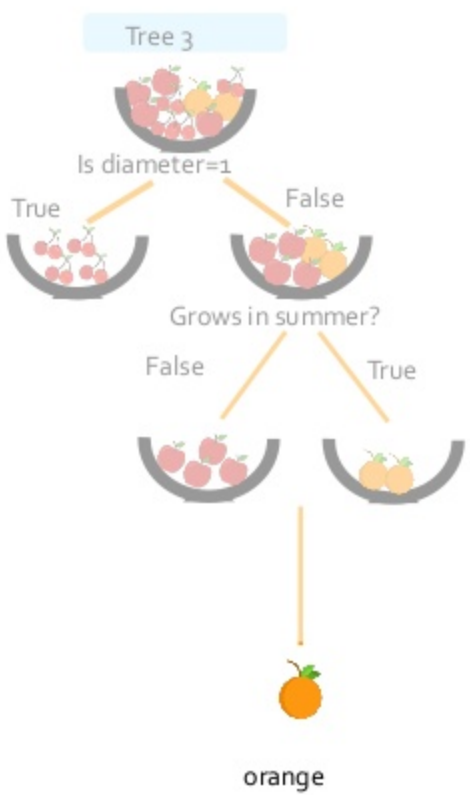
How does a Random Forest work?



orange



cherry



orange

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How does a Random Forest work?

How does a Random Forest work?

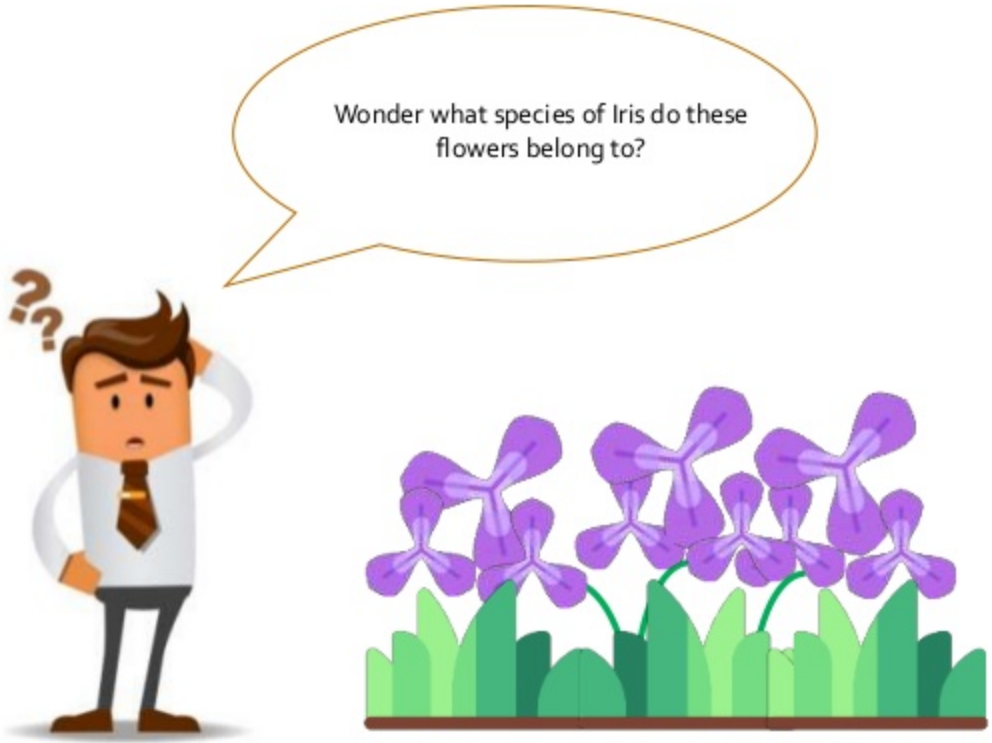
So the fruit is classified as an orange

How does a Random Forest work?

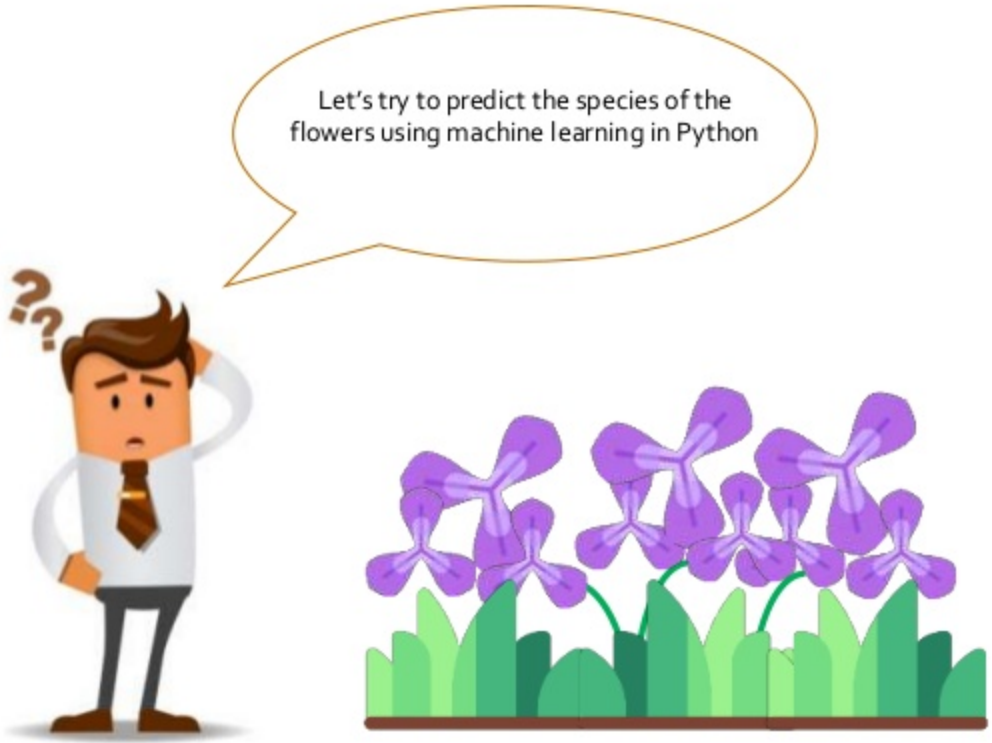
So the fruit is classified as an orange

Use Case – Iris Flower Analysis

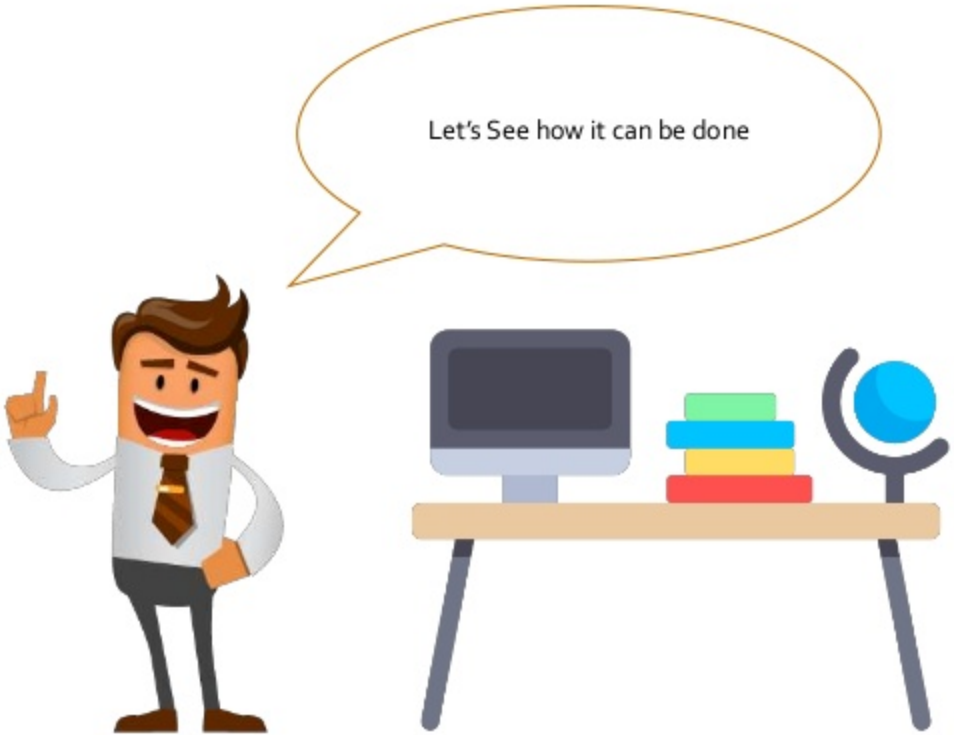
Use Case - Problem Statement



Use Case - Problem Statement



Use Case - Implementation



Use Case - Implementation

```
# Loading the library with the iris dataset
from sklearn.datasets import load_iris

# Loading scikit's random forest classifier library
from sklearn.ensemble import RandomForestClassifier

# Loading pandas
import pandas as pd

# Loading numpy
import numpy as np

# Setting random seed
np.random.seed(0)
```

Use Case - Implementation

```
# Creating an object called iris with the iris data
iris = load_iris()

# Creating a dataframe with the four feature variables
df = pd.DataFrame(iris.data, columns=iris.feature_names)

# Viewing the top 5 rows
df.head()
```

Out[2]:

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)
0	5.1	3.5	1.4	0.2
1	4.9	3.0	1.4	0.2
2	4.7	3.2	1.3	0.2
3	4.6	3.1	1.5	0.2
4	5.0	3.6	1.4	0.2

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Use Case - Implementation

```
# Adding a new column for the species name
df['species'] = pd.Categorical.from_codes(iris.target,
iris.target_names)

# Viewing the top 5 rows
df.head()
```

Out[3]:

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)	species
0	5.1	3.5	1.4	0.2	setosa
1	4.9	3.0	1.4	0.2	setosa
2	4.7	3.2	1.3	0.2	setosa
3	4.6	3.1	1.5	0.2	setosa
4	5.0	3.6	1.4	0.2	setosa

Use Case - Implementation

```
# Creating Test and Train Data
df['is_train'] = np.random.uniform(0, 1, len(df)) <= .75

# View the top 5 rows
df.head()
```

Out[4]:

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)	species	is_train
0	5.1	3.5	1.4	0.2	setosa	True
1	4.9	3.0	1.4	0.2	setosa	True
2	4.7	3.2	1.3	0.2	setosa	True
3	4.6	3.1	1.5	0.2	setosa	True
4	5.0	3.6	1.4	0.2	setosa	True

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Use Case - Implementation

```
# Creating dataframes with test rows and training rows
train, test = df[df['is_train']==True], df[df['is_train']==False]

# Show the number of observations for the test and training dataframes
print('Number of observations in the training data:', len(train))
print('Number of observations in the test data:',len(test))
```

```
Number of observations in the training data: 118
Number of observations in the test data: 32
```

Use Case - Implementation

```
# Create a list of the feature column's names
features = df.columns[:4]

# View features
features
```

```
Out[7]: Index(['sepal length (cm)', 'sepal width (cm)', 'petal length (cm)',
               'petal width (cm)'],
              dtype='object')
```

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Use Case - Implementation

```
# Converting each species name into digits
y = pd.factorize(train['species'])[0]

# Viewing target
y
```

```
Out[8]: array([0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
               0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1,
               1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
               1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
               2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
               2, 2, 2], dtype=int64)
```

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Use Case - Implementation

```
# Creating a random forest Classifier.
clf = RandomForestClassifier(n_jobs=2, random_state=0)

# Training the classifier
clf.fit(train[features], y)
```

```
Out[9]: RandomForestClassifier(bootstrap=True, class_weight=None, criterion='gini',
                               max_depth=None, max_features='auto', max_leaf_nodes=None,
                               min_impurity_decrease=0.0, min_impurity_split=None,
                               min_samples_leaf=1, min_samples_split=2,
                               min_weight_fraction_leaf=0.0, n_estimators=10, n_jobs=2,
                               oob_score=False, random_state=0, verbose=0, warm_start=False)
```

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Use Case - Implementation

```
# Applying the trained Classifier to the test
clf.predict(test[features])
```

```
Out[10]: array([0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 2, 2, 1, 1, 2, 2, 2,
                2, 2, 2, 2, 2, 2, 2, 2, 2], dtype=int64)
```

Use Case - Implementation

```
# Viewing the predicted probabilities of the first 10
observations
clf.predict_proba(test[features])[0:10]
```

```
Out[11]: array([[ 1. ,  0. ,  0. ],
                [ 1. ,  0. ,  0. ],
                [ 1. ,  0. ,  0. ],
                [ 1. ,  0. ,  0. ],
                [ 1. ,  0. ,  0. ],
                [ 1. ,  0. ,  0. ],
                [ 1. ,  0. ,  0. ],
                [ 0.9,  0.1,  0. ],
                [ 1. ,  0. ,  0. ],
                [ 1. ,  0. ,  0. ]])
```

Use Case - Implementation

```
# mapping names for the plants for each predicted plant class
preds = iris.target_names[clf.predict(test[features])]



# View the PREDICTED species for the first five
observations
preds[0:5]
```

```
Out[13]: array(['setosa', 'setosa', 'setosa', 'setosa', 'setosa'],
               dtype='<U10')
```

Use Case - Implementation

```
# Viewing the ACTUAL species for the first five observations
test['species'].head()
```

```
Out[14]: 7     setosa
         8     setosa
         10    setosa
         13    setosa
         17    setosa
         Name: species, dtype: category
         Categories (3, object): [setosa, versicolor, virginica]
```

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Use Case - Implementation

```
# Creating confusion matrix
pd.crosstab(test['species'], preds, rownames=['Actual Species'],
colnames=['Predicted Species'])
```

Out[15]:

Actual Species \ Predicted Species	setosa	versicolor	virginica
setosa	13	0	0
versicolor	0	5	2
virginica	0	0	12

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Use Case - Implementation

Out[15]:

Predicted Species	setosa	versicolor	virginica
Actual Species			
setosa	13	0	0
versicolor	0	5	2
virginica	0	0	12

Total number of predictions = 32

Use Case - Implementation

Out[15]:

Predicted Species	setosa	versicolor	virginica
Actual Species			
setosa	13	0	0
versicolor	0	5	2
virginica	0	0	12

Number of accurate predictions = 30

Use Case - Implementation

Out[15]:

Predicted Species	setosa	versicolor	virginica
Actual Species			
setosa	13	0	0
versicolor	0	5	2
virginica	0	0	12

Number of inaccurate predictions = 2

Use Case - Implementation

Out[15]:

Predicted Species	setosa	versicolor	virginica
Actual Species			
setosa	13	0	0
versicolor	0	5	2
virginica	0	0	12

Model Accuracy

$$\frac{30}{32} \times 100 = 93$$

Use Case - Implementation

Out[15]:

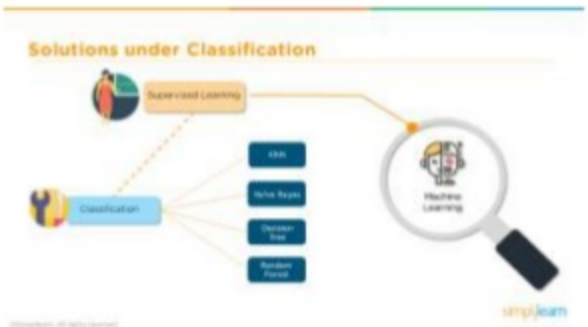
Predicted Species	setosa	versicolor	virginica
Actual Species			
setosa	13	0	0
versicolor	0	5	2
virginica	0	0	12

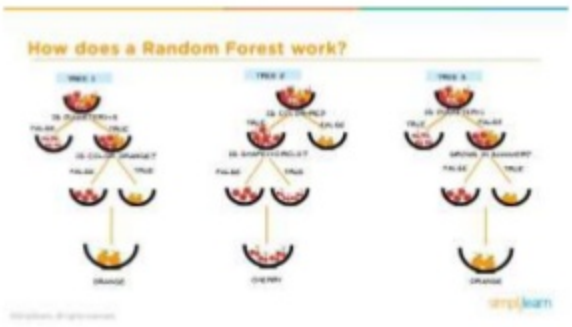
Model Accuracy

$$\frac{30}{32} \text{ X } 100 = 93$$

So the model accuracy is 93%

Key takeaways





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THANK YOU
For more information, visit
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