# Supervised Learning with Random Forests

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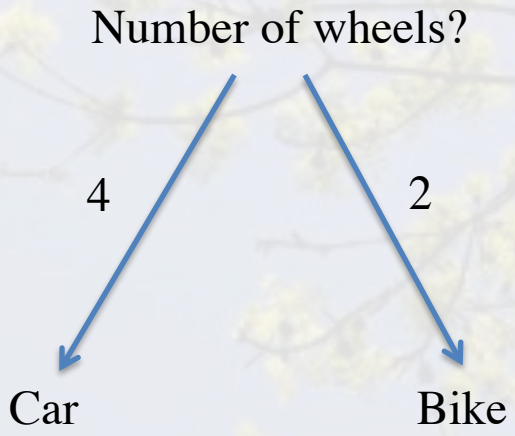
# Classification – what is this thing?

## Decision trees

Classes: Car or Bike

Features: Number of wheels

Question: How many wheels does it have?



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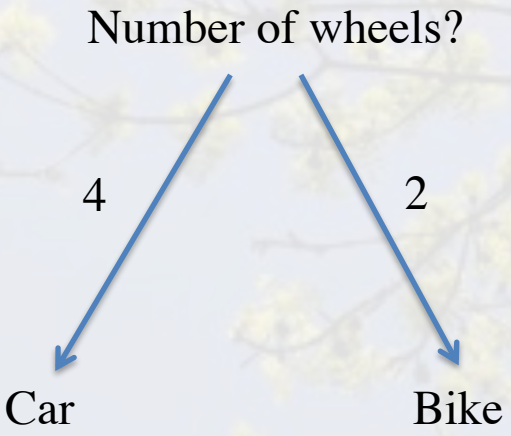
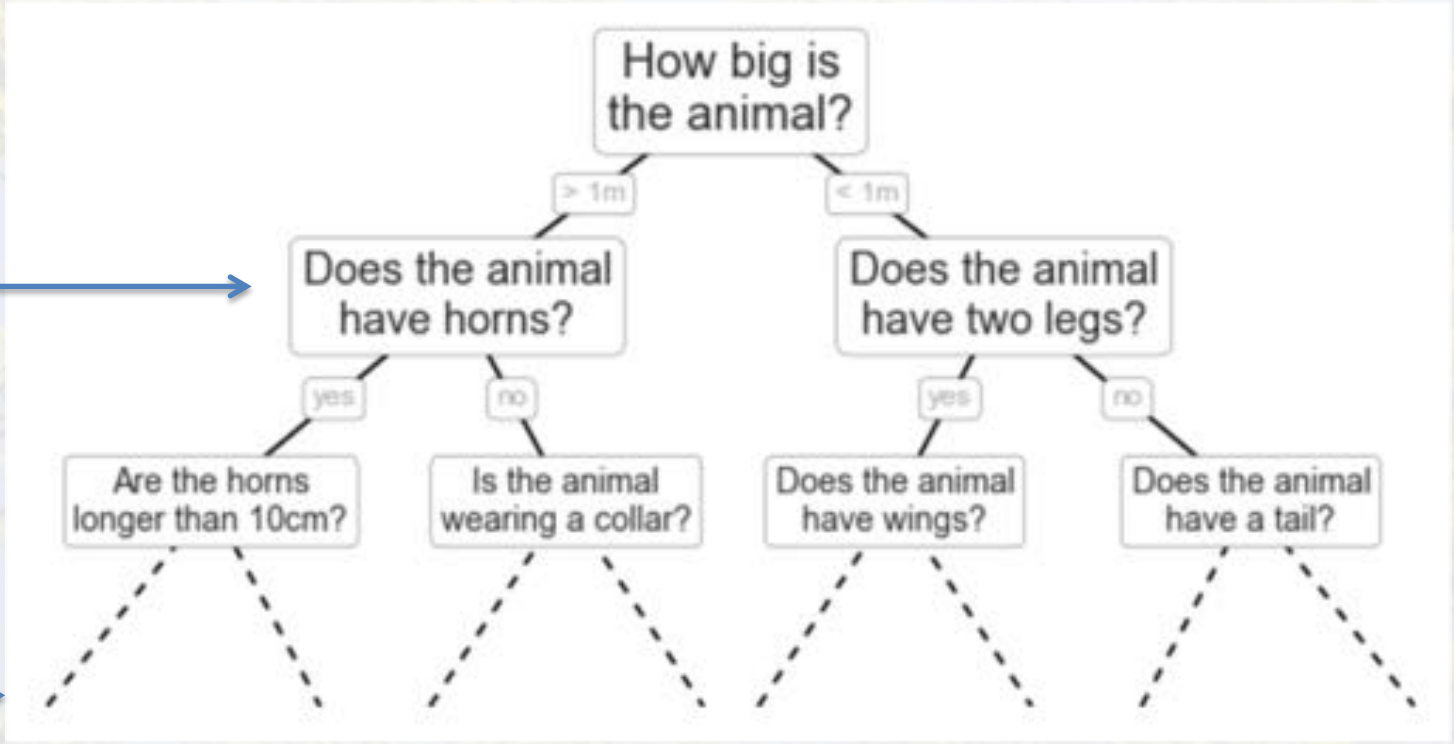



# Classification – what is this thing?

## Decision trees

features




Classes are discrete

Requires training data such that the algorithm can map decisions to known output classes

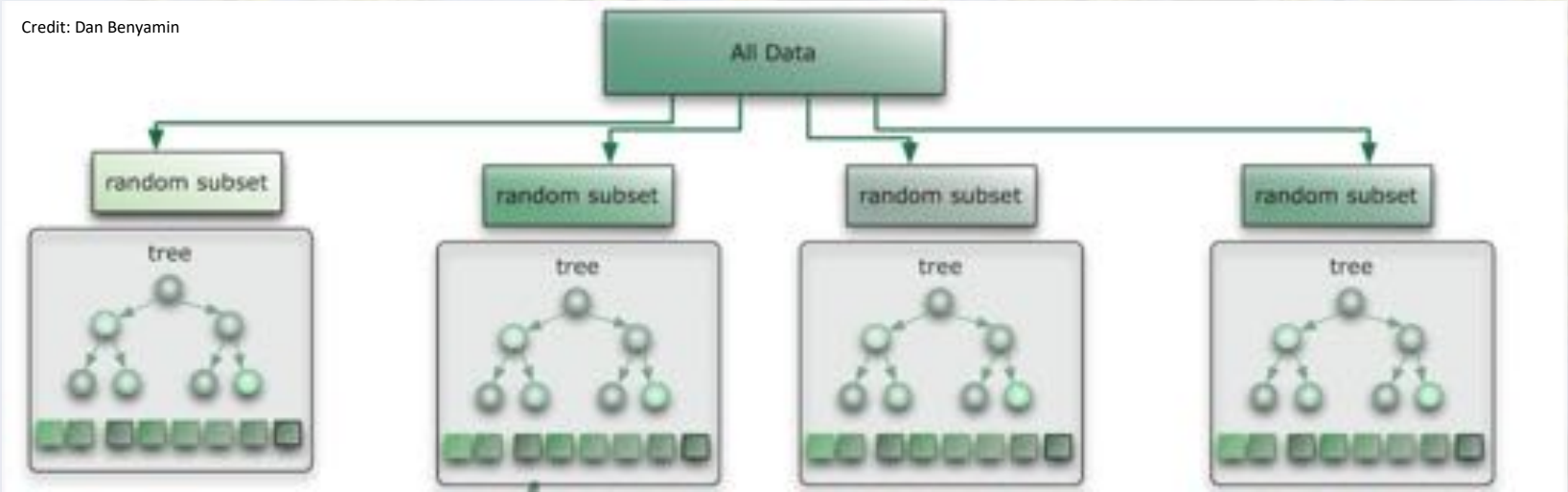
# Random Forests

Combine many decision trees into a single model

- Each decision tree in the forest considers a random subset of features and data (so is a biased estimator)

- They each capture different trends in the data

- At the end take majority vote from all decision trees for the predicted class

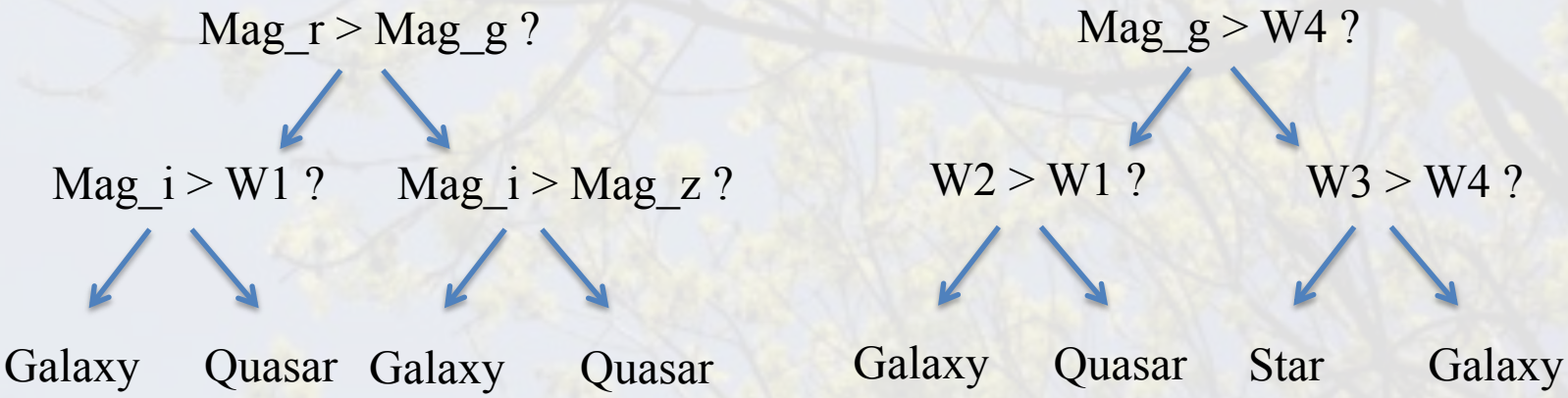





2.5 million sources with photometry points (optical/IR/radio)

| Class | Mag_u | Mag_g | Mag_r | Mag_i | Mag_z | w1 | w2 | w3 | w4 |
|---|---|---|---|---|---|---|---|---|---|
| Star | 21.2 | 19.8 | 19.1 | 18.7 | 18.3 | 14.3 | 14.1 | 10.7 | 8.9 |
| Galaxy | 21 | 17 | 24 | 23.2 | 18.5 | 15.1 | 15.2 | 9 | 8 |
| Quasar | 20.9 | 19.4 | 21.4 | 17.1 | 21.1 | 16.4 | 15.7 | 10.1 | 9.9 |
| … | … | … | … | … | … | … | … | … | … |

Lots of trees working on random subsets of features and samples

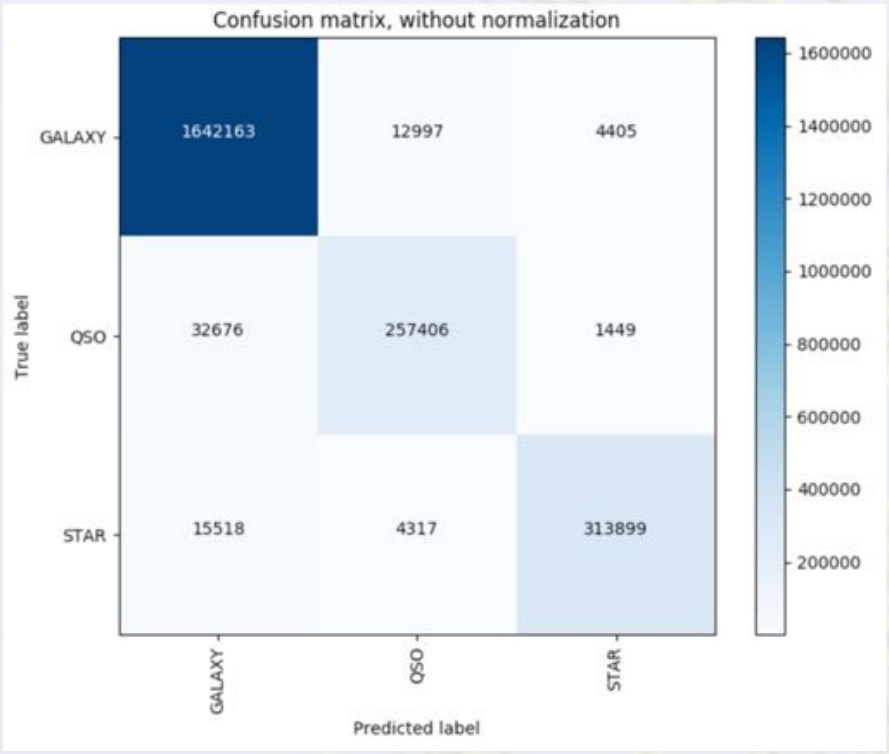


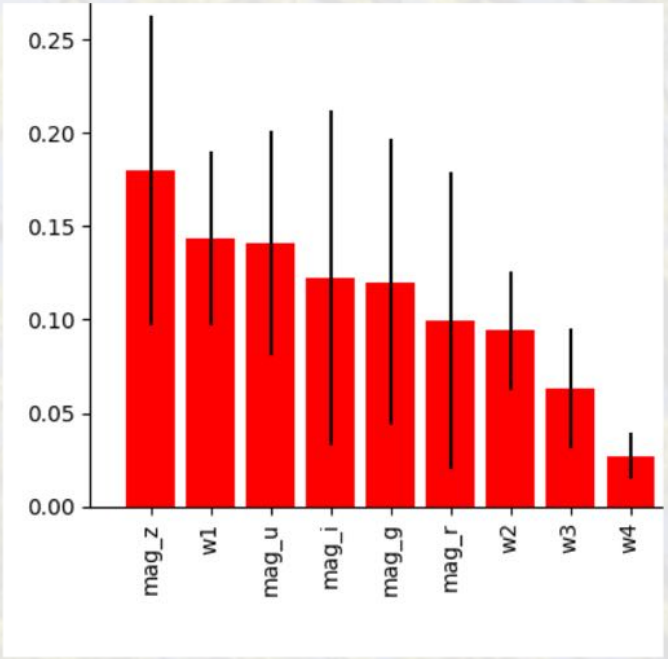

Ensemble of trees decides the most likely class at the end




2.5 million sources with 9 photometry points (optical/IR/radio)
Trained on 250k samples, classifies remaining 2.25 million with 97% accuracy*

**Also 0.97 precision and recall*




More info at: github.com/informationcake/Astro-Machine-Learning

# Python implementation

**Load in libraries from sklearn:**

```
>>> from sklearn.ensemble import RandomForestClassifier
>>> from sklearn.model_selection import train_test_split
>>> from sklearn.metrics import accuracy_score
```

**Load data in:**

```
>>> all_features = [[mag_u, mag_g, …], [mag_u, mag_g, …], …]  #photometry data
>>> all_classes = [Galaxy,Star, …] #class labels
```

**split your data set up into two parts, one for training, one for testing:**

```
>>> features_train, features_test, classes_train, classes_test = train_test_split(all_features, all_classes, test_size=0.5)
```

**Initialise classifier (n_estimators is number of trees):**

```
>>> forest = RandomForestClassifier(n_estimators=100)
```

**fit to the train data:**

```
>>> forest = forest.fit(features_train, classes_train)
```

**Predict classes from your test data**

```
>>> classes_predicted= forest.predict(features_test)
```

**Check accuracy:**

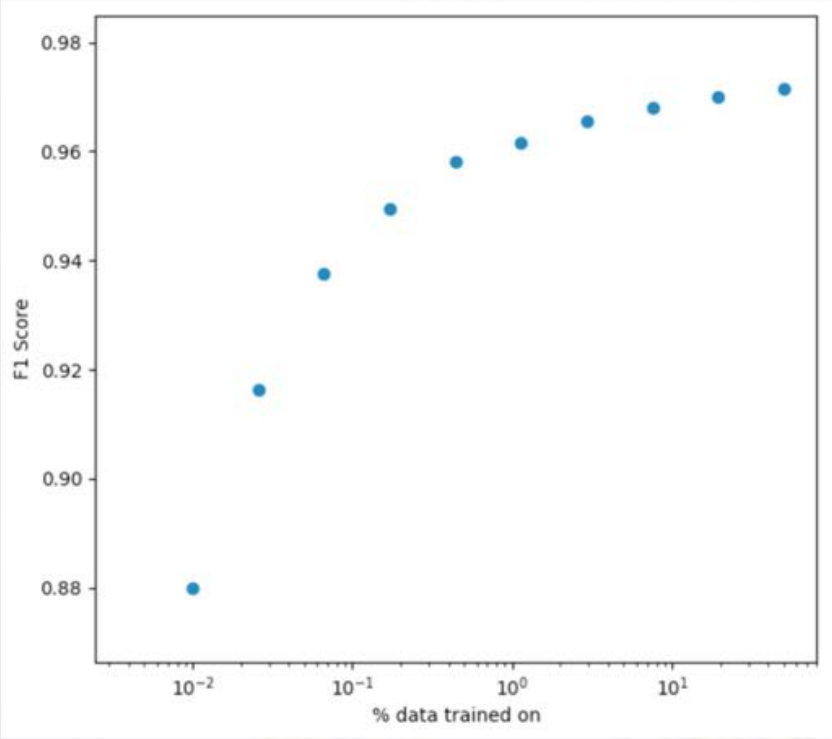
```
>>> accuracy  = accuracy_score(classes_test, classes_predicted)
```

# Tuning hyper parameters

2.5 million sources with 13 photometry points (optical/IR/radio)

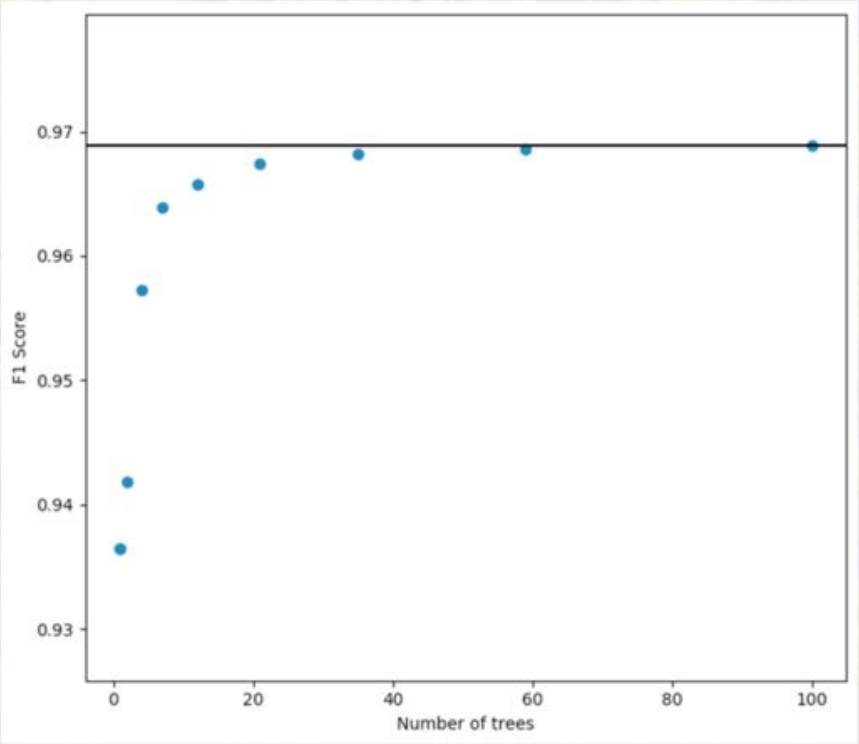
**How much data needed to train on?**

Depends on the complexity of the data and classifications




**Number of trees (estimators)?**

The more features you have the more you'll need




Questions?