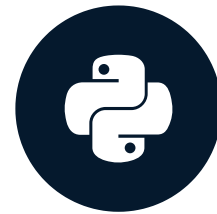


Introduction to ensemble methods

ENSEMBLE METHODS IN PYTHON



Román de las Heras
Data Scientist, Appodeal

Choosing the best model

Classifier	Accuracy
Decision Tree	75%
Logistic Regression	72%
K-Nearest Neighbors	74%

Surveys



Classifier	Accuracy
Decision Tree	75%
Logistic Regression	72%
K-Nearest Neighbors	74%



Ensemble
Methods

Classifier	Accuracy
Combined Model	79%

Prerequisite knowledge

- Supervised Learning with scikit-learn
- Machine Learning with Tree-Based Models in Python
- Linear Classifiers in Python



Technologies



- scikit-learn
- numpy
- pandas
- seaborn



```
from sklearn.ensemble import MetaEstimator
# Base estimators
est1 = Model1()
est2 = Model2()
estN = ModelN()
# Meta estimator
est_combined = MetaEstimator(
    estimators=[est1, est2, ..., estN],
    # Additional parameters
)
# Train and test
est_combined.fit(X_train, y_train)

pred = est_combined.predict(X_test)
```

Learners, ensemble!

ENSEMBLE METHODS IN PYTHON

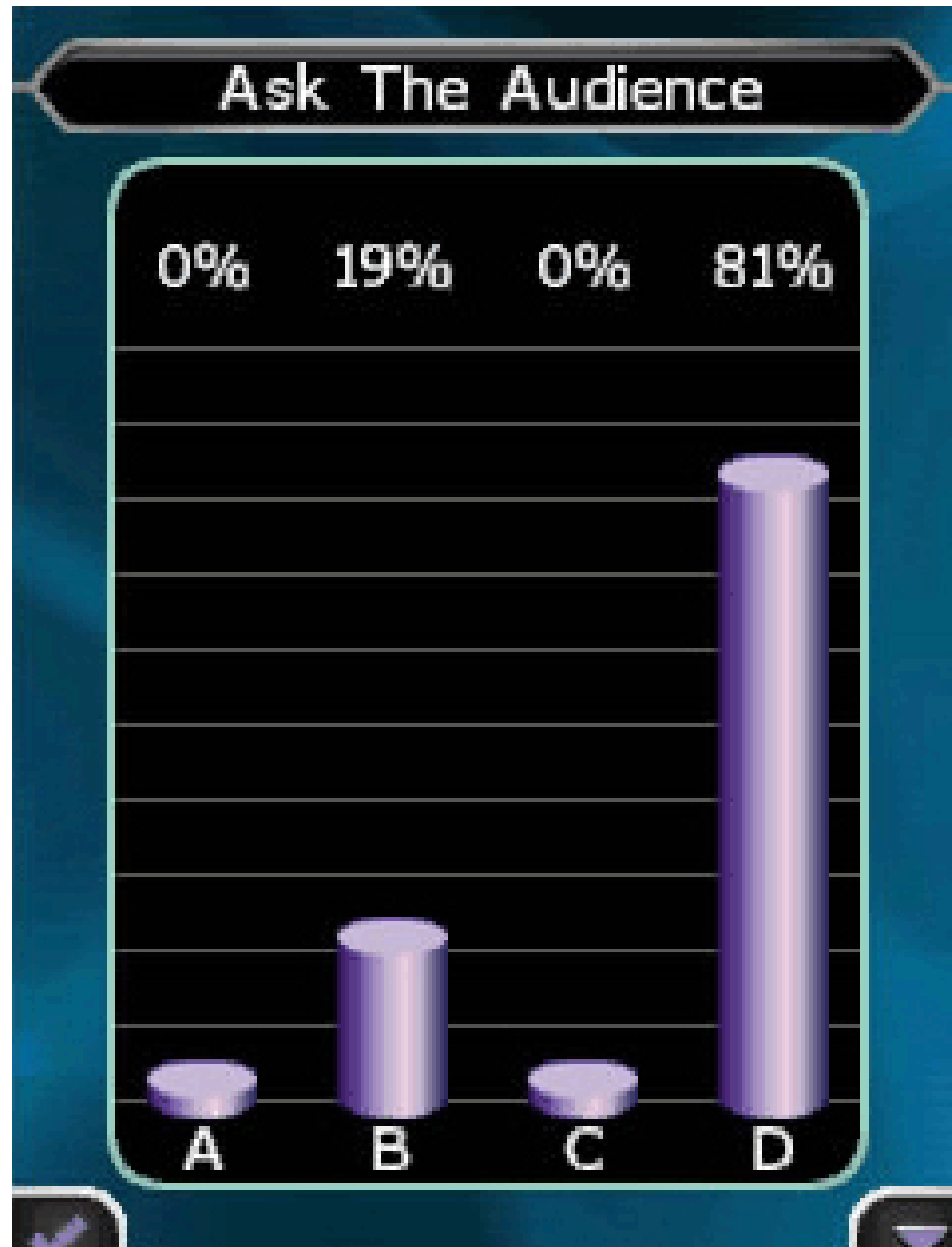
Voting

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Ask the audience



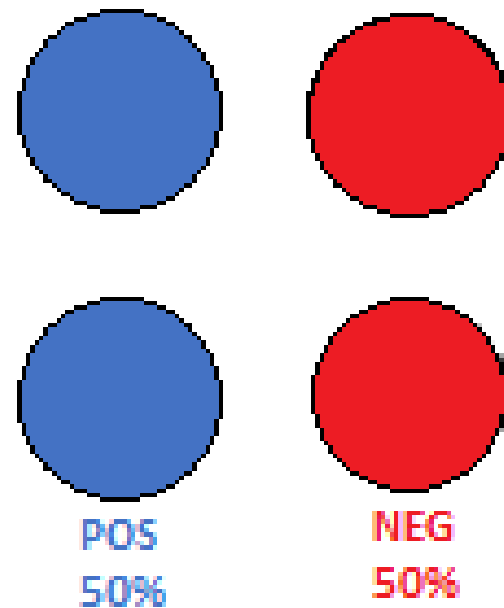
Wisdom of the crowd

- Collective intelligence
- Large group of individuals \geq Single expert
- Problem solving
- Decision making
- Innovation
- Prediction

Majority voting

Properties

- Classification problems
- Majority Voting: Mode
- Odd number of classifiers (3+)



Wise Crowd Characteristics:

- Diverse: different algorithms or datasets
- Independent and uncorrelated
- Use individual knowledge
- Aggregate individual predictions

Voting ensemble using scikit-learn

```
from sklearn.ensemble import VotingClassifier
clf_voting = VotingClassifier(
    estimators=[
        ('label1', clf_1),
        ('label2', clf_2),
        ('labelN', clf_N)])
```

Evaluate the performance

```
# Get the accuracy score
acc = accuracy_score(y_test, y_pred)
print("Accuracy: {:.3f}".format(acc))
```

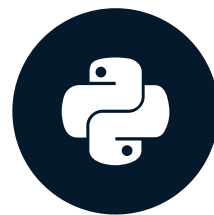
Accuracy: 0.938

```
# Create the individual models
clf_knn = KNeighborsClassifier(5)
clf_dt = DecisionTreeClassifier()
clf_lr = LogisticRegression()
# Create voting classifier
clf_voting = VotingClassifier(
    estimators=[
        ('knn', clf_knn),
        ('dt', clf_dt),
        ('lr', clf_lr)])
# Fit it to the training set and predict
clf_voting.fit(X_train, y_train)
y_pred = clf_voting.predict(X_test)
```

Let's give it a try!
ENSEMBLE METHODS IN PYTHON

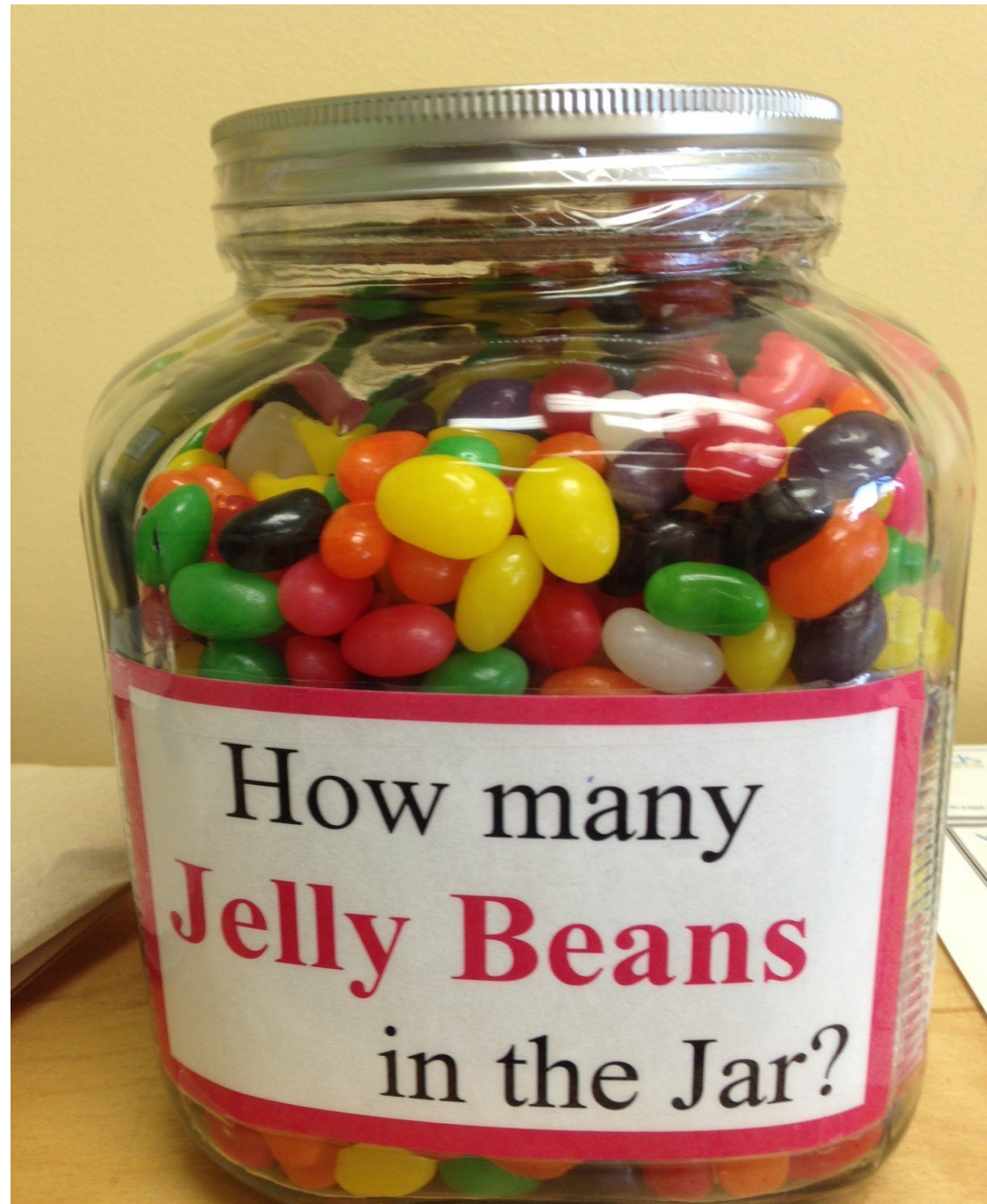
Averaging

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Counting Jelly Beans



How to provide a good estimate?

- Guessing (random number)
- Volume approximation
- Many more approaches

Actual Value \sim mean(estimates)

Averaging (Soft Voting)

Properties

- Classification & Regression problems
- Soft Voting: Mean
 - **Regression:** mean of predicted values
 - **Classification:** mean of predicted probabilities
- Need at least 2 estimators

Averaging ensemble with scikit-learn

Averaging Classifier

```
from sklearn.ensemble import VotingClassifier
clf_voting = VotingClassifier(

    estimators=[
        ('label1', clf_1),
        ('label2', clf_2),
        ...
        ('labelN', clf_N)],

    voting='soft',

    weights=[w_1, w_2, ..., w_N]
)
```

Averaging Regressor

```
from sklearn.ensemble import VotingRegressor
reg_voting = VotingRegressor(

    estimators=[
        ('label1', reg_1),
        ('label2', reg_2),
        ...
        ('labelN', reg_N)],

    weights=[w_1, w_2, ..., w_N]
)
```

scikit-learn example

```
# Instantiate the individual models
```

```
clf_knn = KNeighborsClassifier(5)
```

```
clf_dt = DecisionTreeClassifier()
```

```
clf_lr = LogisticRegression()
```

```
# Create an averaging classifier
```

```
clf_voting = VotingClassifier(
```

```
    estimators=[
```

```
        ('knn', clf_knn),
```

```
        ('dt', clf_dt),
```

```
        ('lr', clf_lr)],
```

```
    voting='soft',
```

```
    weights=[1, 2, 1]
```

```
)
```


Game of Thrones deaths

Target:

- Predict whether a character is alive or not

Features:

- Age
- Gender
- Books of appearance
- Popularity
- Whether relatives are alive or not



Time to practice!

ENSEMBLE METHODS IN PYTHON