CLASSIFICATION

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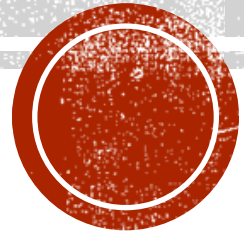

CLASSIFICATION

regression - continuous output

classification - discrete

- Now some different problems:
  - With regression, we assumed we were taking input and producing a quantity: what number (continuous value) do we think *y* will be (close to) for a particular input?
  - Many ML problems have a more limited set of outputs. Often the question is more like: which group is this input (mostly likely) part of?
- These are classification problems.
- Our outputs will be restricted to the possible classes for our problem. i.e. for *n* samples with *K* categories, we predict a vector of *n* values chosen from $C_1, C_2, \ldots, C_k$.
- Our inputs will stay the same: an $n \times m$ matrix of numbers (for *n* samples and *m* features).

CLASSIFICATION

- Some problems that can be seen as classification:
  - Is this email spam? (2 categories)
  - Is this credit card charge fraud? (2 categories)
  - Is this biological sample malignant or benign? (2 categories)
  - What (English) word did the user say into the microphone? (≈470k categories)
  - What date will Easter fall on next year? (<<365 categories) Or is that regression?
  - How many people are in this picture? Who are the people?
  - Given an RGB colour value, what colour word describes it?
  - Given weather observations, can you guess what city are we looking at?

MODELLING

- There are many ways to model classification.
- All do the same basic job:
  1. Train on known data
  2. Make predictions about correct category for other unseen inputs.

```
model = SomeClassifierModel(....)
model.fit(X_train, y_train)
y_predicted = model.predict(X_test)
somehowcompareresults(y_test, y_predicted)
```

- (Often use validation to pick the best form of the Classifier, previously used

```
model = LinearRegression(....)
```

- it all takes the same basic idea in code)

EVALUATING CLASSIFICATION PERFORMANCE

- For evaluating Classification algorithms often people just see how accurate the predictions are on the test set

```
y_pred = model.predict(X_test)
from sklearn.metrics import accuracy_score
accuracy_score(y_test, y_pred)
```

- Will give a score (< 1) which is the fraction of how many predictions were correct.
- This stores the y predictions separately (which may be useful later) but the model has a method itself that can be used if you just want the accuracy score

```
model.score(X_test, y_test)
```

- This one line does the predicting and comparing of predictions in the same step. We will come back to this later, about alternatives.

BINARY CLASSIFICATION

- Definition:
- A Binary classification problem has:
  - Negative Class
  - Positive Class

$$y \in [0, 1] \text{ or } y \in [-1, 1]$$

- We'll consider Multi-class problems later.
- Some models can directly address multi-class (Naive Bayes, *k*-nearest neighbours), while some are inherently binary but can be "extended" (SVM, Logistic Regression)

CATEGORICAL RESPONSE VARIABLE

- Methods used when the response variable ($\hat{y}$) has a distinct number of possible outcomes:
  - a customer buys or does not buy a product,
  - a patient lives or dies,
  - or a candidate accepts or declines a job offer.
- In general, we call the two outcomes of the response variable ”success” and “failure” and represent them by 1 and 0.
  - The mean is then the proportion of 1s.