

in3050_2022_w6

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1 IN3050/IN4050 2021: Week 06 Perceptron

1.0.1 Introduction

The goal of this week is to get familiar with the perceptron classifier. We will first consider some “paper-and-pencil” exercises to familiarize ourselves with the algorithm, before we consider an implementation.

1.1 Part 1: Paper and Pencil

1.1.1 Exercise I

You want to predict if movies will be profitable based on their screenplays. You hire two critics A and B to read a script you have and rate it on a scale of 1 to 6. The critics are not perfect; here are five data points including the critics’ scores and the performance of the movie:

Movie #	Alice	Bob	Profitable?
1	1	1	no
2	4	3	yes
3	3	5	yes
4	5	6	yes
5	2	3	no

Is the data linearly separable? Plot the data on a sheet of paper; label profitable movies with + and non-profitable movies with x and determine if the data are linearly separable.

1.1.2 Exercise II

Now you decide to use a perceptron to classify your data. Suppose you directly use the scores given above as features, together with a bias feature. That is $f_0 = 1$, $f_1 =$ score given by A and $f_2 =$ score given by B.

Run one pass through the data with the perceptron algorithm, filling out the table below. Go through the data points in order, e.g., using data point 0 at step 1. For each of the 5 steps write the current state of the weights, the score, and whether the prediction is correct.

Step	Weights	Score	Correct prediction?
1	(-1, 0, 0)	$-1*1 + 0*1 + 0 * 1 = -1$	yes
2			
3			
4			
5			

1.1.3 Exercise III

Have weights been learned that separate the data?

1.1.4 Exercise IV

More generally, irrespective of the training data, you want to know if your features are powerful enough to allow you to handle a range of scenarios. Which of the following scenarios can a perceptron using the features above indeed perfectly classify movies which are profitable according to the given rules:

1. Your reviewers are awesome: if the total of their scores is more than 8, then the movie will definitely be profitable, and otherwise it won't be.
2. Your reviewers are art critics. Your movie will be profitable if and only if each reviewer gives either a score of 3 or a score of 4.
3. Your reviewers have weird but different tastes. Your movie will be profitable if and only if both reviewers agree.

1.2 Part 2: Implementing the Perceptron Classifier

1.2.1 Exercise V

We will use the same framework as for the *k*NN-classifier. You should implement the two methods `fit` and `predict`. You don't need a `__init__` method. You may include other methods if you find it convenient.

The main part of the perceptron classifier is the `fit` method that trains the perceptron. `eta` is the learning rate One `epoch` is a run through all the training data. We have set the default to one epoch, but you might need more. Remember to add the bias to the data.

```
[3]: class PyClassifier():
      """Common methods to all python classifiers --- if any

      Nothing here yet"""
```

```
[4]: class PyPerClassifier(PyClassifier):
      """Simple perceptron python classifier"""

      def fit(self, X_train, y_train, eta=1, epochs=1):
          """Train the self.weights on the training data with learning
          rate eta, running epochs many epochs"""

      def predict(self, x):
          """Predict the value for the item x"""
```

1.3 Dataset

We will train and test the classifier on the same sythetic dataset as we used for the k NN last week.

```
[7]: from sklearn.datasets import make_blobs
X_np, y_np = make_blobs(n_samples=200, centers=[[0,0],[1,2]],
                        n_features=2, random_state=2019)
X1 = [(X_np[i,0], X_np[i,1]) for i in range(X_np.shape[0])]
y1 = [y_np[i] for i in range(X_np.shape[0])]
```

```
[8]: X_np, y_np = make_blobs(n_samples=200, centers=[[0,0],[1,2]],
                        n_features=2, random_state=2020)
X2 = [(X_np[i,0], X_np[i,1]) for i in range(X_np.shape[0])]
y2 = [y_np[i] for i in range(X_np.shape[0])]
```

1.3.1 Exercise VI

Train `PyPerClassifier` on `X1`, `y1` and test on `X2`, `y2` as with the k NN-classifier. Try various numbers of epochs and see whether it makes a difference.

Is `X2`, `y2` linearly separable?

1.3.2 Exercise VII: Termination and Weights

- Extend the `PyPerClassifier()` with a method such that we can inspect the weights after training is completed.
- Modify the `fit`-method of the classifier such that training halts when there are no more updates, and it is possible to inspect how many epochs it took.
- Run this on the five points film critics dataset. How many epochs does it take to reach completion?
- What are the final weights? Can you plot the decision border that corresponds to these weights together with the data set?