# Develop k-Nearest Neighbors in Python From Scratch

by **Jason Brownlee** on February 24, 2020 in **Code Algorithms From Scratch** 415



In this tutorial you are going to learn about the **k-Nearest Neighbors algorithm** including how it works and how to implement it from scratch in Python (*without libraries*).

A simple but powerful approach for making predictions is to use the most similar historical examples to the new data. This is the principle behind the k-Nearest Neighbors algorithm.

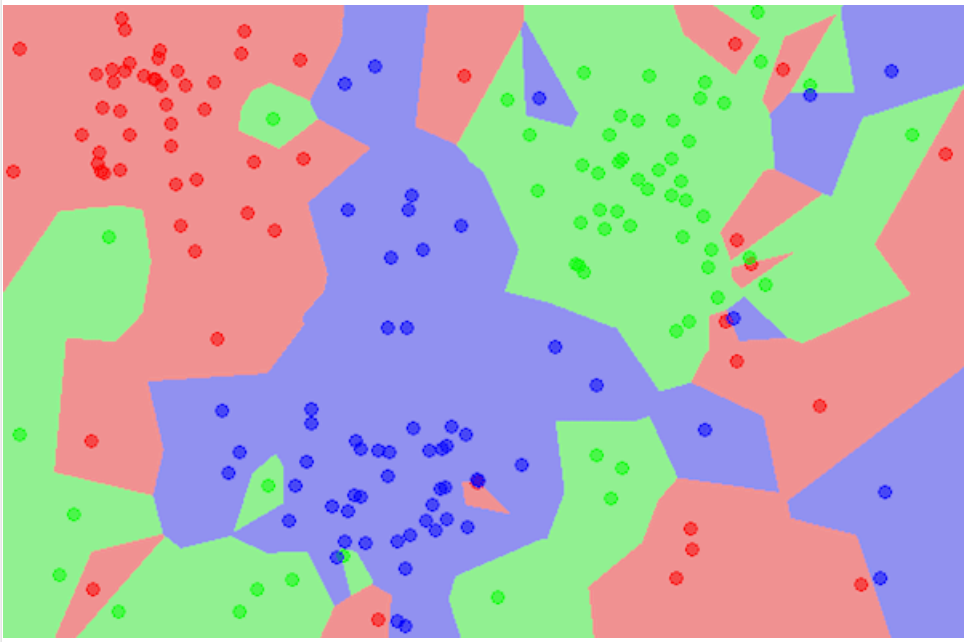
After completing this tutorial you will know:

- How to code the k-Nearest Neighbors algorithm step-by-step.
- How to evaluate k-Nearest Neighbors on a real dataset.
- How to use k-Nearest Neighbors to make a prediction for new data.

**Kick-start your project** with my new book Machine Learning Algorithms From Scratch, including *step-by-step tutorials* and the *Python source code* files for all examples.

Let's get started.

- **Updated Sep/2014**: Original version of the tutorial.
- **Updated Oct/2019**: Complete rewritten from the ground up.



Develop k-Nearest Neighbors in Python From Scratch
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# Tutorial Overview

This section will provide a brief background on the k-Nearest Neighbors algorithm that we will implement in this tutorial and the Abalone dataset to which we will apply it.

## k-Nearest Neighbors

The k-Nearest Neighbors algorithm or KNN for short is a very simple technique.

The entire training dataset is stored. When a prediction is required, the k-most similar records to a new record from the training dataset are then located. From these neighbors, a summarized prediction is made.

Similarity between records can be measured many different ways. A problem or data-specific method can be used. Generally, with tabular data, a good starting point is the Euclidean distance.

Once the neighbors are discovered, the summary prediction can be made by returning the most common outcome or taking the average. As such, KNN can be used for classification or regression problems.

There is no model to speak of other than holding the entire training dataset. Because no work is done until a prediction is required, KNN is often referred to as a lazy learning method.

## Iris Flower Species Dataset

In this tutorial we will use the Iris Flower Species Dataset.

The Iris Flower Dataset involves predicting the flower species given measurements of iris flowers.

It is a multiclass classification problem. The number of observations for each class is balanced. There are 150 observations with 4 input variables and 1 output variable. The variable names are as follows:

- Sepal length in cm.
- Sepal width in cm.
- Petal length in cm.

- Petal width in cm.
- Class

A sample of the first 5 rows is listed below.

```
5.1,3.5,1.4,0.2,Iris-setosa
4.9,3.0,1.4,0.2,Iris-setosa
4.7,3.2,1.3,0.2,Iris-setosa
4.6,3.1,1.5,0.2,Iris-setosa
5.0,3.6,1.4,0.2,Iris-setosa
...
```

The baseline performance on the problem is approximately 33%.

Download the dataset and save it into your current working directory with the filename "*iris.csv*".

- Download Dataset (iris.csv)
- More Information on Dataset (iris.names)

# k-Nearest Neighbors (in 3 easy steps)

First we will develop each piece of the algorithm in this section, then we will tie all of the elements together into a working implementation applied to a real dataset in the next section.

This k-Nearest Neighbors tutorial is broken down into 3 parts:

- **Step 1**: Calculate Euclidean Distance.
- **Step 2**: Get Nearest Neighbors.
- **Step 3**: Make Predictions.

These steps will teach you the fundamentals of implementing and applying the k-Nearest Neighbors algorithm for classification and regression predictive modeling problems.

**Note**: This tutorial assumes that you are using Python 3. If you need help installing Python, see this tutorial:

- How to Setup Your Python Environment for Machine Learning

I believe the code in this tutorial will also work with Python 2.7 without any changes.

## Step 1: Calculate Euclidean Distance

The first step is to calculate the distance between two rows in a dataset.

Rows of data are mostly made up of numbers and an easy way to calculate the distance between two rows or vectors of numbers is to draw a straight line. This makes sense in 2D or 3D and scales nicely to higher dimensions.

We can calculate the straight line distance between two vectors using the Euclidean distance measure. It is calculated as the square root of the sum of the squared differences between the two vectors.

- Euclidean Distance = sqrt(sum i to N (x1_i – x2_i)^2)

Where *x1* is the first row of data, *x2* is the second row of data and *i* is the index to a specific column as we sum across all columns.

With Euclidean distance, the smaller the value, the more similar two records will be. A value of 0 means that there is no difference between two records.

Below is a function named *euclidean_distance()* that implements this in Python.

```
# calculate the Euclidean distance between two vectors
def euclidean_distance(row1, row2):
    distance = 0.0
    for i in range(len(row1)-1):
        distance += (row1[i] - row2[i])**2
    return sqrt(distance)
```

You can see that the function assumes that the last column in each row is an output value which is ignored from the distance calculation.

We can test this distance function with a small contrived classification dataset. We will use this dataset a few times as we construct the elements needed for the KNN algorithm.

```
X1                  X2                  Y
2.7810836           2.550537003         0
1.465489372     2.362125076         0
3.396561688     4.400293529         0
1.38807019      1.850220317         0
3.06407232      3.005305973         0
7.627531214     2.759262235         1
5.332441248     2.088626775         1
6.922596716     1.77106367          1
8.675418651     -0.242068655        1
7.673756466     3.508563011         1
```

Below is a plot of the dataset using different colors to show the different classes for each point.

Scatter Plot of the Small Contrived Dataset for Testing the KNN Algorithm

Putting this all together, we can write a small example to test our distance function by printing the distance between the first row and all other rows. We would expect the distance between the first row and itself to be 0, a good thing to look out for.

The full example is listed below.

```
# Example of calculating Euclidean distance
from math import sqrt

# calculate the Euclidean distance between two vectors
def euclidean_distance(row1, row2):
```

```
    distance = 0.0
    for i in range(len(row1)-1):
        distance += (row1[i] - row2[i])**2
    return sqrt(distance)

# Test distance function
dataset = [[2.7810836,2.550537003,0],
    [1.465489372,2.362125076,0],
    [3.396561688,4.400293529,0],
    [1.38807019,1.850220317,0],
    [3.06407232,3.005305973,0],
    [7.627531214,2.759262235,1],
    [5.332441248,2.088626775,1],
    [6.922596716,1.77106367,1],
    [8.675418651,-0.242068655,1],
    [7.673756466,3.508563011,1]]
row0 = dataset[0]
for row in dataset:
    distance = euclidean_distance(row0, row)
    print(distance)
```

Running this example prints the distances between the first row and every row in the dataset, including itself.

```
0.0
1.3290173915275787
1.9494646655653247
1.5591439385540549
0.5356280721938492
4.850940186986411
2.592833759950511
4.214227042632867
6.522409988228337
4.985585382449795
```

Now it is time to use the distance calculation to locate neighbors within a dataset.

## Step 2: Get Nearest Neighbors

Neighbors for a new piece of data in the dataset are the *k* closest instances, as defined by our distance measure.

To locate the neighbors for a new piece of data within a dataset we must first calculate the distance between each record in the dataset to the new piece of data. We can do this using our distance function prepared above.

Once distances are calculated, we must sort all of the records in the training dataset by their distance to the new data. We can then select the top *k* to return as the most similar neighbors.

We can do this by keeping track of the distance for each record in the dataset as a tuple, sort the list of tuples by the distance (in descending order) and then retrieve the neighbors.

Below is a function named *get_neighbors()* that implements this.

```
# Locate the most similar neighbors
def get_neighbors(train, test_row, num_neighbors):
    distances = list()
    for train_row in train:
        dist = euclidean_distance(test_row, train_row)
        distances.append((train_row, dist))
    distances.sort(key=lambda tup: tup[1])
    neighbors = list()
    for i in range(num_neighbors):
        neighbors.append(distances[i][0])
    return neighbors
```

You can see that the *euclidean_distance()* function developed in the previous step is used to calculate the distance between each *train_row* and the new *test_row*.

The list of *train_row* and distance tuples is sorted where a custom key is used ensuring that the second item in the tuple (*tup[1]*) is used in the sorting operation.

Finally, a list of the *num_neighbors* most similar neighbors to *test_row* is returned.

We can test this function with the small contrived dataset prepared in the previous section.

The complete example is listed below.

```
# Example of getting neighbors for an instance
from math import sqrt

# calculate the Euclidean distance between two vectors
def euclidean_distance(row1, row2):
    distance = 0.0
    for i in range(len(row1)-1):
        distance += (row1[i] - row2[i])**2
    return sqrt(distance)

# Locate the most similar neighbors
def get_neighbors(train, test_row, num_neighbors):
    distances = list()
    for train_row in train:
        dist = euclidean_distance(test_row, train_row)
        distances.append((train_row, dist))
    distances.sort(key=lambda tup: tup[1])
    neighbors = list()
    for i in range(num_neighbors):
        neighbors.append(distances[i][0])
    return neighbors

# Test distance function
dataset = [[2.7810836,2.550537003,0],
    [1.465489372,2.362125076,0],
    [3.396561688,4.400293529,0],
    [1.38807019,1.850220317,0],
    [3.06407232,3.005305973,0],
    [7.627531214,2.759262235,1],
    [5.332441248,2.088626775,1],
    [6.922596716,1.77106367,1],
    [8.675418651,-0.242068655,1],
    [7.673756466,3.508563011,1]]
neighbors = get_neighbors(dataset, dataset[0], 3)
for neighbor in neighbors:
    print(neighbor)
```

Running this example prints the 3 most similar records in the dataset to the first record, in order of similarity.

As expected, the first record is the most similar to itself and is at the top of the list.

```
[2.7810836, 2.550537003, 0]
[3.06407232, 3.005305973, 0]
[1.465489372, 2.362125076, 0]
```

Now that we know how to get neighbors from the dataset, we can use them to make predictions.

## Step 3: Make Predictions

The most similar neighbors collected from the training dataset can be used to make predictions.

In the case of classification, we can return the most represented class among the neighbors.

We can achieve this by performing the *max()* function on the list of output values from the neighbors. Given a list of class values observed in the neighbors, the *max()* function takes a set of unique class values and calls the count on the list of class values for each class value in the set.

Below is the function named *predict_classification()* that implements this.

```
# Make a classification prediction with neighbors
def predict_classification(train, test_row, num_neighbors):
    neighbors = get_neighbors(train, test_row, num_neighbors)
    output_values = [row[-1] for row in neighbors]
    prediction = max(set(output_values), key=output_values.count)
```

```
    return prediction
```

We can test this function on the above contrived dataset.

Below is a complete example.

```
# Example of making predictions
from math import sqrt

# calculate the Euclidean distance between two vectors
def euclidean_distance(row1, row2):
    distance = 0.0
    for i in range(len(row1)-1):
        distance += (row1[i] - row2[i])**2
    return sqrt(distance)

# Locate the most similar neighbors
def get_neighbors(train, test_row, num_neighbors):
    distances = list()
    for train_row in train:
        dist = euclidean_distance(test_row, train_row)
        distances.append((train_row, dist))
    distances.sort(key=lambda tup: tup[1])
    neighbors = list()
    for i in range(num_neighbors):
        neighbors.append(distances[i][0])
    return neighbors

# Make a classification prediction with neighbors
def predict_classification(train, test_row, num_neighbors):
    neighbors = get_neighbors(train, test_row, num_neighbors)
    output_values = [row[-1] for row in neighbors]
    prediction = max(set(output_values), key=output_values.count)
    return prediction

# Test distance function
dataset = [[2.7810836,2.550537003,0],
    [1.465489372,2.362125076,0],
    [3.396561688,4.400293529,0],
    [1.38807019,1.850220317,0],
    [3.06407232,3.005305973,0],
    [7.627531214,2.759262235,1],
    [5.332441248,2.088626775,1],
    [6.922596716,1.77106367,1],
    [8.675418651,-0.242068655,1],
    [7.673756466,3.508563011,1]]
prediction = predict_classification(dataset, dataset[0], 3)
print('Expected %d, Got %d.' % (dataset[0][-1], prediction))
```

Running this example prints the expected classification of 0 and the actual classification predicted from the 3 most similar neighbors in the dataset.

```
Expected 0, Got 0.
```

We can imagine how the *predict_classification()* function can be changed to calculate the mean value of the outcome values.

We now have all of the pieces to make predictions with KNN. Let's apply it to a real dataset.

## Iris Flower Species Case Study

This section applies the KNN algorithm to the Iris flowers dataset.

The first step is to load the dataset and convert the loaded data to numbers that we can use with the mean and standard deviation calculations. For this we will use the helper function *load_csv()* to load the file, *str_column_to_float()* to convert string numbers to floats and *str_column_to_int()* to convert the class column to integer values.

We will evaluate the algorithm using k-fold cross-validation with 5 folds. This means that 150/5=30 records will be in each fold. We will use the helper functions *evaluate_algorithm()* to evaluate the algorithm with cross-validation and *accuracy_metric()* to calculate the accuracy of predictions.

A new function named *k_nearest_neighbors()* was developed to manage the application of the KNN algorithm, first learning the statistics from a training dataset and using them to make predictions for a test dataset.

If you would like more help with the data loading functions used below, see the tutorial:

- How to Load Machine Learning Data From Scratch In Python

If you would like more help with the way the model is evaluated using cross validation, see the tutorial:

- How to Implement Resampling Methods From Scratch In Python

The complete example is listed below.

```
# k-nearest neighbors on the Iris Flowers Dataset
from random import seed
from random import randrange
from csv import reader
from math import sqrt

# Load a CSV file
def load_csv(filename):
    dataset = list()
    with open(filename, 'r') as file:
        csv_reader = reader(file)
        for row in csv_reader:
            if not row:
                continue
            dataset.append(row)
    return dataset

# Convert string column to float
def str_column_to_float(dataset, column):
    for row in dataset:
        row[column] = float(row[column].strip())

# Convert string column to integer
def str_column_to_int(dataset, column):
    class_values = [row[column] for row in dataset]
    unique = set(class_values)
    lookup = dict()
    for i, value in enumerate(unique):
        lookup[value] = i
    for row in dataset:
        row[column] = lookup[row[column]]
    return lookup

# Find the min and max values for each column
def dataset_minmax(dataset):
    minmax = list()
    for i in range(len(dataset[0])):
        col_values = [row[i] for row in dataset]
        value_min = min(col_values)
        value_max = max(col_values)
        minmax.append([value_min, value_max])
    return minmax

# Rescale dataset columns to the range 0-1
def normalize_dataset(dataset, minmax):
    for row in dataset:
        for i in range(len(row)):
            row[i] = (row[i] - minmax[i][0]) / (minmax[i][1] - minmax[i][0])

# Split a dataset into k folds
def cross_validation_split(dataset, n_folds):
    dataset_split = list()
    dataset_copy = list(dataset)
    fold_size = int(len(dataset) / n_folds)
    for _ in range(n_folds):
        fold = list()
        while len(fold) < fold_size:
            index = randrange(len(dataset_copy))
            fold.append(dataset_copy.pop(index))
        dataset_split.append(fold)
    return dataset_split

# Calculate accuracy percentage
```

```
def accuracy_metric(actual, predicted):
    correct = 0
    for i in range(len(actual)):
        if actual[i] == predicted[i]:
            correct += 1
    return correct / float(len(actual)) * 100.0

# Evaluate an algorithm using a cross validation split
def evaluate_algorithm(dataset, algorithm, n_folds, *args):
    folds = cross_validation_split(dataset, n_folds)
    scores = list()
    for fold in folds:
        train_set = list(folds)
        train_set.remove(fold)
        train_set = sum(train_set, [])
        test_set = list()
        for row in fold:
            row_copy = list(row)
            test_set.append(row_copy)
            row_copy[-1] = None
        predicted = algorithm(train_set, test_set, *args)
        actual = [row[-1] for row in fold]
        accuracy = accuracy_metric(actual, predicted)
        scores.append(accuracy)
    return scores

# Calculate the Euclidean distance between two vectors
def euclidean_distance(row1, row2):
    distance = 0.0
    for i in range(len(row1)-1):
        distance += (row1[i] - row2[i])**2
    return sqrt(distance)

# Locate the most similar neighbors
def get_neighbors(train, test_row, num_neighbors):
    distances = list()
    for train_row in train:
        dist = euclidean_distance(test_row, train_row)
        distances.append((train_row, dist))
    distances.sort(key=lambda tup: tup[1])
    neighbors = list()
    for i in range(num_neighbors):
        neighbors.append(distances[i][0])
    return neighbors

# Make a prediction with neighbors
def predict_classification(train, test_row, num_neighbors):
    neighbors = get_neighbors(train, test_row, num_neighbors)
    output_values = [row[-1] for row in neighbors]
    prediction = max(set(output_values), key=output_values.count)
    return prediction

# kNN Algorithm
def k_nearest_neighbors(train, test, num_neighbors):
    predictions = list()
    for row in test:
        output = predict_classification(train, row, num_neighbors)
        predictions.append(output)
    return(predictions)

# Test the kNN on the Iris Flowers dataset
seed(1)
filename = 'iris.csv'
dataset = load_csv(filename)
for i in range(len(dataset[0])-1):
    str_column_to_float(dataset, i)
# convert class column to integers
str_column_to_int(dataset, len(dataset[0])-1)
# evaluate algorithm
n_folds = 5
num_neighbors = 5
scores = evaluate_algorithm(dataset, k_nearest_neighbors, n_folds, num_neighbors)
print('Scores: %s' % scores)
print('Mean Accuracy: %.3f%%' % (sum(scores)/float(len(scores))))
```

Running the example prints the mean classification accuracy scores on each cross-validation fold as well as the mean accuracy score.

We can see that the mean accuracy of about 96.6% is dramatically better than the baseline accuracy of 33%.

```
Scores: [96.66666666666667, 96.66666666666667, 100.0, 90.0, 100.0]
Mean Accuracy: 96.667%
```

We can use the training dataset to make predictions for new observations (rows of data).

This involves making a call to the *predict_classification()* function with a row representing our new observation to predict the class label.

```
...
# predict the label
label = predict_classification(dataset, row, num_neighbors)
```

We also might like to know the class label (string) for a prediction.

We can update the *str_column_to_int()* function to print the mapping of string class names to integers so we can interpret the prediction made by the model.

```
# Convert string column to integer
def str_column_to_int(dataset, column):
    class_values = [row[column] for row in dataset]
    unique = set(class_values)
    lookup = dict()
    for i, value in enumerate(unique):
        lookup[value] = i
        print('[%s] => %d' % (value, i))
    for row in dataset:
        row[column] = lookup[row[column]]
    return lookup
```

Tying this together, a complete example of using KNN with the entire dataset and making a single prediction for a new observation is listed below.

```
# Make Predictions with k-nearest neighbors on the Iris Flowers Dataset
from csv import reader
from math import sqrt

# Load a CSV file
def load_csv(filename):
    dataset = list()
    with open(filename, 'r') as file:
        csv_reader = reader(file)
        for row in csv_reader:
            if not row:
                continue
            dataset.append(row)
    return dataset

# Convert string column to float
def str_column_to_float(dataset, column):
    for row in dataset:
        row[column] = float(row[column].strip())

# Convert string column to integer
def str_column_to_int(dataset, column):
    class_values = [row[column] for row in dataset]
    unique = set(class_values)
    lookup = dict()
    for i, value in enumerate(unique):
        lookup[value] = i
        print('[%s] => %d' % (value, i))
    for row in dataset:
        row[column] = lookup[row[column]]
    return lookup

# Find the min and max values for each column
def dataset_minmax(dataset):
    minmax = list()
    for i in range(len(dataset[0])):
        col_values = [row[i] for row in dataset]
        value_min = min(col_values)
        value_max = max(col_values)
        minmax.append([value_min, value_max])
    return minmax

# Rescale dataset columns to the range 0-1
```

```
def normalize_dataset(dataset, minmax):
    for row in dataset:
        for i in range(len(row)):
            row[i] = (row[i] - minmax[i][0]) / (minmax[i][1] - minmax[i][0])

# Calculate the Euclidean distance between two vectors
def euclidean_distance(row1, row2):
    distance = 0.0
    for i in range(len(row1)-1):
        distance += (row1[i] - row2[i])**2
    return sqrt(distance)

# Locate the most similar neighbors
def get_neighbors(train, test_row, num_neighbors):
    distances = list()
    for train_row in train:
        dist = euclidean_distance(test_row, train_row)
        distances.append((train_row, dist))
    distances.sort(key=lambda tup: tup[1])
    neighbors = list()
    for i in range(num_neighbors):
        neighbors.append(distances[i][0])
    return neighbors

# Make a prediction with neighbors
def predict_classification(train, test_row, num_neighbors):
    neighbors = get_neighbors(train, test_row, num_neighbors)
    output_values = [row[-1] for row in neighbors]
    prediction = max(set(output_values), key=output_values.count)
    return prediction

# Make a prediction with KNN on Iris Dataset
filename = 'iris.csv'
dataset = load_csv(filename)
for i in range(len(dataset[0])-1):
    str_column_to_float(dataset, i)
# convert class column to integers
str_column_to_int(dataset, len(dataset[0])-1)
# define model parameter
num_neighbors = 5
# define a new record
row = [5.7,2.9,4.2,1.3]
# predict the label
label = predict_classification(dataset, row, num_neighbors)
print('Data=%s, Predicted: %s' % (row, label))
```

Running the data first summarizes the mapping of class labels to integers and then fits the model on the entire dataset.

Then a new observation is defined (in this case I took a row from the dataset), and a predicted label is calculated.

In this case our observation is predicted as belonging to class 1 which we know is "*Iris-setosa*".

```
[Iris-virginica] => 0
[Iris-setosa] => 1
[Iris-versicolor] => 2
Data=[4.5, 2.3, 1.3, 0.3], Predicted: 1
```

## Tutorial Extensions

This section lists extensions to the tutorial you may wish to consider to investigate.

- **Tune KNN**. Try larger and larger *k* values to see if you can improve the performance of the algorithm on the Iris dataset.
- **Regression**. Adapt the example and apply it to a regression predictive modeling problem (e.g. predict a numerical value)
- **More Distance Measures**. Implement other distance measures that you can use to find similar historical data, such as Hamming distance, Manhattan distance and Minkowski distance.
- **Data Preparation**. Distance measures are strongly affected by the scale of the input data. Experiment with standardization and other data preparation methods in order to improve results.

- **More Problems**. As always, experiment with the technique on more and different classification and regression problems.

## Further Reading

- Section 3.5 Comparison of Linear Regression with K-Nearest Neighbors, page 104, An Introduction to Statistical Learning, 2014.
- Section 18.8. Nonparametric Models, page 737, Artificial Intelligence: A Modern Approach, 2010.
- Section 13.5 K-Nearest Neighbors, page 350 Applied Predictive Modeling, 2013
- Section 4.7, Instance-based learning, page 128, Data Mining: Practical Machine Learning Tools and Techniques, 2nd edition, 2005.

## Summary

In this tutorial you discovered how to implement the k-Nearest Neighbors algorithm from scratch with Python.

Specifically, you learned:

- How to code the k-Nearest Neighbors algorithm step-by-step.
- How to evaluate k-Nearest Neighbors on a real dataset.
- How to use k-Nearest Neighbors to make a prediction for new data.

### Next Step

Take action!

1. Follow the tutorial and implement KNN from scratch.
2. Adapt the example to another dataset.
3. Follow the extensions and improve upon the implementation.

Leave a comment and share your experiences.

## More On This Topic



K-Nearest Neighbors for Machine Learning



K-Nearest Neighbors Classification Using OpenCV



Nearest Shrunken Centroids With Python



Radius Neighbors Classifier Algorithm With Python



How to Develop a Naive Bayes Classifier from Scratch…



How to Develop a Deep Learning Photo Caption…

### About Jason Brownlee

Jason Brownlee, PhD is a machine learning specialist who teaches developers how to get results with modern machine learning methods via hands-on tutorials.

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## 415 Responses to *Develop k-Nearest Neighbors in Python From Scratch*

**Damian Mingle** September 12, 2014 at 10:22 pm #

REPLY

Jason –

I appreciate your step-by-step approach. Your explanation makes this material accessible for a wide audience.

Keep up the great contributions.

**jasonb** September 13, 2014 at 7:48 am #

REPLY

Thanks Damian!

**jessie** October 10, 2018 at 9:56 pm #

REPLY

How to use knn to imputate missing value???

**Jason Brownlee** October 11, 2018 at 7:55 am #

REPLY

Train a model to predict the column that contains the missing data, not including the missing data.

Then use the trained model to predict missing values.

**Mohammed** December 7, 2018 at 2:51 pm #

I'm new to Machine learning Can you please let me know How can i train a model based on the above user defined KNN and get use the trained model for further prediction.

Is it possible to integrate Jaccard algorithm with KNN?

Thanks.

**Jason Brownlee** December 8, 2018 at 6:58 am #

I recommend using sklearn, you can start here:
https://machinelearningmastery.com/start-here/#python

**babar ali shah** February 25, 2020 at 4:48 am #

REPLY

where can i get the definition of these below predefined functions (actual backend code)??

GaussianNB()

LinearSVC(random_state=0)

KNeighborsClassifier(n_neighbors=3)

please help!!

**Jason Brownlee** February 25, 2020 at 7:50 am #

REPLY

Yes, you can see the sklearn github project that has all the code:
https://github.com/scikit-learn/scikit-learn

**Amresh Kumar** March 11, 2018 at 7:41 pm #

REPLY

A few changes for python 3

1.

print ‘Train set: ‘ + repr(len(trainingSet))
print ‘Test set: ‘ + repr(len(testSet))

print needs to be used with brackets

print (“Train set:” + repr(len(trainingSet)))
print (“Test set:”+ repr(len(testSet)))

2. iteritems() changed to items()

sortedVotes = sorted(classVotes.iteritems(), key=operator.itemgetter(1), reverse=True)

should be:

sortedVotes = sorted(classVotes.items(), key=operator.itemgetter(1), reverse=True)

**Jason Brownlee** March 12, 2018 at 6:28 am #

REPLY

Thanks for sharing.

**Sourav Datta** June 5, 2021 at 5:29 pm #

REPLY

can u provide me psedocode for nearest neighbor using ball tree algo?

**Jason Brownlee** June 6, 2021 at 5:45 am #

Thanks for the suggestion, perhaps in the future.

**Wickie** October 7, 2018 at 4:18 pm #

REPLY

1. I got the error message “TypeError: unsupported operand type(s) for -: ‘str’ and ‘str'”

Change
distance += pow(((instance1[x]) – (instance2[x])), 2)
to
distance += pow((float(instance1[x]) – float(instance2[x])), 2)

**Jason Brownlee** October 8, 2018 at 9:22 am #

REPLY

Thanks. Yes, the example assumes Python 2.7.

**jonah** December 17, 2018 at 2:24 pm #

REPLY

invalid character in identifier error and i cant add any line of code. it gives inconsistent use of tabs error but i don’t.

**Jason Brownlee** December 18, 2018 at 6:00 am #

I have some ideas that might help:
https://machinelearningmastery.com/faq/single-faq/why-does-the-code-in-the-tutorial-not-work-for-me

**Kurla Day** November 14, 2021 at 6:38 pm #

REPLY

thanks for sharing this information sir…

**Pete Fry** September 13, 2014 at 6:56 am #

REPLY

A very interesting and clear article. I haven't tried it out yet but will over the weekend.
Thanks.

**jasonb** September 13, 2014 at 7:48 am #

REPLY

Thanks Pete, let me know how you go.

**Alan** September 13, 2014 at 3:40 pm #

REPLY

Hey Jason, I've ploughed through multiple books and tutorials but your explanation helped me to finally understand what I was doing.

Looking forward to more of your tutorials.

**jasonb** September 13, 2014 at 5:04 pm #

REPLY

Thanks Alan!

**Vadim** September 15, 2014 at 8:16 pm #

REPLY

Hey Jason!
Thank you for awesome article!
Clear and straight forward explanation. I finaly understood the background under kNN.

p.s.
There's some code errors in the article.
1) in getResponse it should be "return sortedVote[0]" instead sortedVotes[0][0]
2) in getAccuracy it should be "testSet[x][-1] IN predictions[x]" instead of IS.

**jasonb** September 16, 2014 at 8:04 am #

REPLY

Thanks Vadim!

I think the code is right, but perhaps I misunderstood your comments.

If you change getResponse to return sortedVote[0] you will get the class and the count. We don't want this, we just want the class.

In getAccuracy, I am interested in an equality between the class strings (is), not a set operation (in).

Does that make sense?

**Upadhyay** May 20, 2019 at 9:10 pm #

REPLY

Hi,
First of all thanks for the informative tutorial.
I would like to impement regression using KNN. I have a data set with 4 attributes and 5th attribute that i want to predict.
Do i just create a function to take average of neighbours[x][-1] or should i implement it in some other way.
Thanks in advance.

**Jason Brownlee** May 21, 2019 at 6:36 am #

REPLY

Yes, that is an excellent start.

**Mario** September 19, 2014 at 12:29 am #

REPLY

Thank you very much for this example!

**jasonb** September 19, 2014 at 5:33 am #

REPLY

You're welcome Mario.

**PVA** September 25, 2014 at 4:27 pm #

REPLY

Thank you for the post on kNN implementation..

Any pointers on normalization will be greatly appreciated ?

What if the set of features includes fields like name, age, DOB, ID ? What are good algorithms to normalize such features ?

**jasonb** September 26, 2014 at 5:48 am #

REPLY

Hey PVA, great question.

Notmalization is just the rescaling of numerical attributes between 0-1. Tools like scikit-learn can do it for you if you like, here's a recipe: https://machinelearningmastery.com/rescaling-data-for-machine-learning-in-python-with-scikit-learn/

You can compute distances between strings using methods like edit distance, learn more here: http://en.wikipedia.org/wiki/Edit_distance

DOB – well the distance between two dates could be in days, hours or whatever makes sense in your domain.

ID might just be useful as some kind of indirect marker of "when the entry was added to the database" if you don't have a "record create time".

I hope this helps.

**Olawale Ahmed Alamu** August 28, 2021 at 1:21 am #

REPLY

Thank you for this great tutorial.

Please, is there a way we can save the model as a pkl file or something?

**Adrian Tam** August 28, 2021 at 4:08 am #

REPLY

pkl is a pickle format (usually), which you use Python's pickle module to save and load. Please refer to Python documentation for some examples. It is native to Python but may not be compatible across machines/versions. Therefore, we avoid using it for machine learning models for the fear that it is not helpful to use it to share your model with other. In Tensorflow, for example, HDF5 format is used instead.

**Landry** September 26, 2014 at 4:46 am #

REPLY

A million thanks !

I've had so many starting points for my ML journey, but few have been this clear.

Merci !

**jasonb** September 26, 2014 at 5:44 am #

REPLY

Glad to here it Landry!

**kumaran** November 7, 2014 at 7:37 pm #

REPLY

Hi,
when i run the code it shows

ValueError: could not convert string to float: 'sepallength'

what should i do to run the program.

please help me out as soon as early….

thanks in advance…

**jasonb** November 8, 2014 at 2:50 pm #

REPLY

Hi kumaran,

I believe the example code still works just fine. If I copy-paste the code from the tutorial into a new file called knn.py and download iris.data into the same directory, the example runs fine for me using Python 2.7.

Did you modify the example in some way perhaps?

**Ankit** March 14, 2018 at 3:06 am #

REPLY

it is because the first line in your code may contain info about each columns,

convert
for x in range(len(dataset)-1):
to
for x in range(1,len(dataset)-1):

it will skip the first line and start reading the data from 2nd line

REPLY

**Ankit** March 14, 2018 at 3:17 am #

use

for x in range(1,len(dataset)):

if you skipped the last line also

REPLY

**kumaran** November 11, 2014 at 3:51 pm #

Hi jabson ,
Thanks for your reply..

I am using Anaconda IDE 3.4 .
yes it works well for the iris dataset If i try to put some other dataset it shows value error because those datasets contains strings along with the integers..
example forestfire datasets.

X Y month day FFMC DMC DC ISI temp RH wind rain area
7 5 mar fri 86.2 26.2 94.3 5.1 8.2 51 6.7 0 0
7 4 oct tue 90.6 35.4 669.1 6.7 18 33 0.9 0 0
7 4 oct sat 90.6 43.7 686.9 6.7 14.6 33 1.3 0 0
8 6 mar fri 91.7 33.3 77.5 9 8.3 97 4 0.2 0
8 6 mar sun 89.3 51.3 102.2 9.6 11.4 99 1.8 0 0

Is it possible to classify these datasets also with your code??
please provide me if some other classifer code example in python…

REPLY

**Hari** February 4, 2017 at 12:54 am #

HI KUMARAN
did you get the solution for the problem mentioned in your comment. I am also facing the same problem. Please help me or provide me the solution if you have..

REPLY

**sanksh** November 30, 2014 at 9:09 am #

Excellent article on knn. It made the concepts so clear.

REPLY

**Jason Brownlee** November 30, 2014 at 11:14 am #

Thanks sanksh!

REPLY

**rvaquerizo** December 5, 2014 at 3:18 am #

I like how it is explained, simply and clear. Great job.

REPLY

**Jason Brownlee** December 5, 2014 at 7:46 am #

Thanks!

REPLY

**Lakshminarasu Chenduri** December 31, 2014 at 7:00 pm #

Great article Jason !! Crisp and Clear.

REPLY

**Raju Neve** January 16, 2015 at 4:31 am #

Nice artical Jason. I am a software engineer new to ML. Your step by step approach made learning easy and fun. Though Python was new to me, it became very easy since I could run small small snippet instead of try to understand the entire program in once.
Appreciate your hardwork. Keep it up.

REPLY

**Jason Brownlee** January 16, 2015 at 7:42 am #

Thanks Raju.

REPLY

**ZHANG CHI** January 29, 2015 at 2:33 pm #

It's really fantastic for me. I can't find a better one

REPLY

**ZHANG CHI** January 29, 2015 at 7:34 pm #

I also face the same problem with Kumaran. After checking, I think the problem "can't convert string into float" is that the first row is "sepal_length" and so on. Python can't convert it since it's totally string. So just delete it or change the code a little.

REPLY

**RK** March 1, 2015 at 2:28 pm #

Hi,

Many thanks for this details article. Any clue for the extension Ideas?

Thanks,
RK

REPLY

**Andy** March 17, 2015 at 9:29 am #

Hi – I was wondering how we can have the data fed into the system without randomly shuffling as I am trying to make a prediction on the final line of data?

Do we remove:

if random.random() < split

and replace with something like:

if len(trainingSet)/len(dataset) < split
# if < 0.67 then append to the training set, otherwise append to test set

The reason I ask is that I know what data I want to predict and with this it seems that it could use the data I want to predict within the training set due to the random selection process.

**Gerry** May 26, 2015 at 2:22 pm #

REPLY

I also have the same dilemma as you, I performed trial and error, right now I cant seem to make things right which code be omitted to create a prediction.

I am not a software engineer nor I have a background in computer science. I am pretty new to data science and ML as well, I just started learning Python and R but the experience is GREAT!

Thanks so much for this Jason!

**Brian** April 9, 2015 at 11:00 am #

REPLY

This article was absolutely gorgeous. As a computational physicist grad student who has taken an interest in machine learning this was the perfect level to skim, get my hands dirty and have some fun.

Thank you so much for the article on this. I'm excited to see the rest of your site.

**Clinton** May 22, 2015 at 12:09 am #

REPLY

Thanks for the article!

**Vitali** July 3, 2015 at 7:26 pm #

REPLY

I wished to write my own knn python program, and that was really helpful !

Thanks a lot for sharing this.

One thing you didn't mention though is how you chose k=3.

To get a feeling of how sensitive is the accuracy % to k, i wrote a "screening" function that iterates over k on the training set using leave-one-out cross validation accuracy % as a ranking.

Would you have any other suggestions ?

**Pacu Ignis** July 27, 2015 at 9:50 pm #

REPLY

This is really really helpful. Thanks man !!

**Mark** September 4, 2015 at 9:17 pm #

REPLY

An incredibly useful tutorial, Jason. Thank you for this.

Please could you show me how you would modify your code to work with a data set which comprises strings (i.e. text) and not numerical values?

I'm really keen to try this algorithm on text data but can't seem to find a decent article on line.

Your help is much appreciated.

Mark

**Max Buck** October 3, 2015 at 7:38 am #

REPLY

Nice tutorial! Very helpful in explaining KNN — python is so much easier to understand than the mathematical operations. One thing though — the way the range function works for Python is that the final element is not included.

In loadDataset() you have

```
for x in range(len(dataset)-1):
```

This should simply be:

```
for x in range(len(dataset)):
```

otherwise the last row of data is omitted!

**Ashley** January 28, 2017 at 7:39 am #

REPLY

this gets an index out of range..

**Azi** November 5, 2015 at 9:26 am #

REPLY

Thank you so much

**mulkan** November 7, 2015 at 1:56 pm #

REPLY

great
thank very much

**Gleb** November 17, 2015 at 1:11 am #

REPLY

That's great! I've tried so many books and articles to start learning ML. Your article is the first clear one! Thank you a lot! Please, keep teaching us!)

**Jason Brownlee** November 17, 2015 at 7:53 am #

REPLY

Thanks Gleb!

**Jakob** November 29, 2015 at 3:25 pm #

REPLY

Hi Jason,

Thanks for this amazing introduction! I have two questions that relate to my study on this.

First is, how is optimization implemented in this code?

Second is, what is the strength of the induction this algorithm is making as explained above, will this is be a useful induction for a thinking machine?

Thank you so much!

REPLY

**erlik** December 1, 2015 at 4:31 am #

HI jason;

it is great tutorial it help me alot thanks for great effort but i have queastion what if i want to split the data in to randomly 100 training set and 50 test set and i want to generate in separate file with there values instead of printing total numbers? becaouse i want to test them in hugin

thank you so much!

REPLY

**İdil** December 3, 2015 at 8:36 am #

Hi Jason,

It is a really great tutorial. Your article is so clear, but I have a problem.
When I run code, I see the right classification.
> predicted='Iris-virginica', actual='Iris-virginica'
> predicted='Iris-virginica', actual='Iris-virginica'
> predicted='Iris-virginica', actual='Iris-virginica'
> predicted='Iris-virginica', actual='Iris-virginica'
…
However, accuracy is 0%. I run accuracy test but there is no problem with code.
How can I fix the accuracy? Where do I make mistake?

Thanks for reply and your helps.

REPLY

**jxprat** January 14, 2016 at 12:11 am #

Hi, I solved this doing this:

Originaly, on the step 5, in the function getAccuracy you have:
…
for x in range(len(testSet)):
if testSet[x][-1] is predictions[x]:
correct += 1
…

The key here is in the IF statement:

if testSet[x][-1] is predictions[x]:

Change "IS" to "==" so the getAccuracy now is:
…
for x in range(len(testSet)):
if testSet[x][-1] == predictions[x]:
correct += 1
…

That solve the problem and works ok!!

REPLY

**Renjith Madhavan** December 9, 2015 at 7:26 am #

I think setting the value of K plays an important role in the accuracy of the prediction. How to determine the best value of ‘K’ . Please suggest some best practices ?

**Sagar kumar** February 9, 2016 at 5:33 am #

REPLY

Dear, How to do it for muticlass classifcation with data in excelsheet: images of digits(not handwritten) and label of that image in corresponding next column of excel ??

Your this tutorial is totally on numeric data, just gave me the idea with images.

**Jack** February 24, 2016 at 8:59 am #

REPLY

Very clear explanation and step by step working make this very understandable. I am not sure why the list sortedVotes within the function getResponse is reversed, I thought getResponse is meant to return the most common key in the dictionary classVotes. If you reverse the list, doesn’t this return the least common key in the dictionary?

**kamal** March 9, 2016 at 3:07 pm #

REPLY

I do not know how to take the k nearest neighbour for 3 classes for ties vote for example [1,1,2,2,0]. Since for two classes, with k=odd values, we do find the maximum vote for the two classes but ties happens if we choose three classes.

Thanks in advance

**I.T.Cheema** March 11, 2016 at 11:31 pm #

REPLY

hi
thanks for this great effort buddy
i have some basic questions:
1: i opened “iris.data’ file and it is simply in html window. how to download?
2: if do a copy paste technique from html page. where to copy paste?

**Jason Brownlee** March 12, 2016 at 8:41 am #

REPLY

You can use File->Save as in your browser to save the file or copy the text and paste it int a new file and save it as the file “iris.data” expected by the tutorial.

I hope that helps.

Jason.

**Hrishikesh Kulkarni** March 21, 2016 at 5:00 pm #

REPLY

This is a really simple but thorough explaination. Thanks for the efforts.
Could you suggest me how to draw a scatter plot for the 3 classes. It will be really great if you could upload the code. Thanks in advance!

**Mohammed Farhan** April 22, 2016 at 1:34 am #

REPLY

What if we want to classify text into categories using KNN,
e.g a given paragraph of text defines {Politics,Sports,Technology}

I'm Working on a project to Classify RSS Feeds

**Lyazzat** May 19, 2016 at 1:41 pm #

REPLY

How to download the file without using library csv at the first stage?

---

**Avinash** June 8, 2016 at 7:00 pm #

REPLY

Nice explanation Jason.. Really appreciate your work..

---

**Jason Brownlee** June 14, 2016 at 8:21 am #

REPLY

Thanks Avinash.

**Agnes** July 10, 2016 at 1:08 am #

REPLY

Hi! Really comprehensive tutorial, i loved it!
What will you do if some features are more important than others to determine the right class ?

---

**Jason Brownlee** July 10, 2016 at 6:35 am #

REPLY

Thanks Agnes.

Often it is a good idea to perform feature selection before building your model:
https://machinelearningmastery.com/an-introduction-to-feature-selection/

---

**Dev** July 10, 2016 at 10:48 am #

REPLY

Hello,
I get this error message.
Train set: 78
Test set: 21
_____

TypeError Traceback (most recent call last)
in ()
72 print('Accuracy: ' + repr(accuracy) + '%')
73
—> 74 main()

in main()
65 k = 3
66 for x in range(len(testSet)):
—> 67 neighbors = getNeighbors(trainingSet, testSet[x], k)
68 result = getResponse(neighbors)
69 predictions.append(result)

in getNeighbors(trainingSet, testInstance, k)
27 length = len(testInstance)-1
28 for x in range(len(trainingSet)):
—> 29 dist = euclideanDistance(testInstance, trainingSet[x], length)
30 distances.append((trainingSet[x], dist))
31 distances.sort(key=operator.itemgetter(1))

in euclideanDistance(instance1, instance2, length)
20 distance = 0
21 for x in range(length):
—> 22 distance += pow(float(instance1[x] – instance2[x]), 2)
23 return math.sqrt(distance)
24

TypeError: unsupported operand type(s) for -: ‘str’ and ‘str’

Can you please help.

Thank you

**Jason Brownlee** July 10, 2016 at 2:21 pm #

REPLY

It is not clear, it might be a copy-paste error from the post?

**Dev** July 11, 2016 at 12:40 am #

REPLY

Thank you for your answer,

as if i can’t do the subtraction here is the error message

TypeError: unsupported operand type(s) for -: ‘str’ and ‘str’
and i copy/past the code directly from the tutorial

**temi Noah** July 14, 2016 at 12:10 am #

REPLY

am so happy to be able to extend my gratitude to you.Have searched for good books to explain machine learning(KNN) but those i came across was not as clear and simple as this brilliant and awesome step by step explanation.Indeed you are a distinguished teacher

**Jason Brownlee** July 14, 2016 at 5:48 am #

REPLY

Thanks.

**tejas zarekar** July 24, 2016 at 8:12 pm #

REPLY

hi Jason, i really want to get into Machine learning. I want to make a big project for my final year of computer engg. which i am currently in. People are really enervating that way by saying that its too far fetched for a bachelor. I want to prove them wrong. I don’t have much time (6 months from today). I really want to make something useful. Can you send me some links that can help me settle on a project with machine learning? PLZ … TYSM

**naveen** August 19, 2016 at 3:38 pm #

REPLY

```
import numpy as np
from sklearn import preprocessing, cross_validation, neighbors
import pandas as pd
df= np.genfromtxt('/home/reverse/Desktop/acs.txt', delimiter=',')
X= np.array(df[:,1])
y= np.array(df[:,0])
X_train, X_test, y_train, y_test = cross_validation.train_test_split(X,y,test_size=0.2)
clf = neighbors.KNeighborsClassifier()
clf.fit(X_train, y_train)
```

ValueError: Found arrays with inconsistent numbers of samples: [ 1 483]

Then I tried to reshape using this code: df.reshape((483,1))

Again i am getting this error "ValueError: total size of new array must be unchanged"

Advance thanks ….

---

**Carolina** October 16, 2016 at 5:48 am #

REPLY

Hi Jason,

great tutorial, very easy to follow. Thanks!

One question though. You wrote:

"Additionally, we want to control which fields to include in the distance calculation. Specifically, we only want to include the first 4 attributes. One approach is to limit the euclidean distance to a fixed length, ignoring the final dimension."

Can you explain in more detail what you mean here? Why is the final dimension ignored when we want to include all 4 attributes?

Thanks a lot,
Caroline

---

**Jason Brownlee** October 17, 2016 at 10:25 am #

REPLY

The gist of the paragraph is that we only want to calculate distance on input variables and exclude the output variable.

The reason is when we have new data, we will not have the output variable, only input variables. Our job will be to find the k most similar instances to the new data and discover the output variable to predict.

In the specific case, the iris dataset has 4 input variables and the 5th is the class. We only want to calculate distance using the first 4 variables.

I hope that makes things clearer.

---

**Pranav Gundewar** October 17, 2016 at 7:09 pm #

REPLY

Hi Jason! The steps u showed are great. Do you any article regarding the same in matlab.
Thank you.

---

**Jason Brownlee** October 18, 2016 at 5:53 am #

REPLY

Thanks Pranav,

Sorry I don't have Matlab examples at this stage.

**Sara** October 18, 2016 at 7:16 pm #

REPLY

Best algorithm tutorial I have ever seen! Thanks a lot!

**Jason Brownlee** October 19, 2016 at 9:18 am #

REPLY

Thanks Sara, I'm glad to hear that.

**Nivedita** November 13, 2016 at 9:47 am #

REPLY

Detailed explanation given and I am able to understand the algorithm/code well! Trying to implement the same with my own data set (.csv file).

loadDataset('knn_test.csv', split, trainingSet, testSet)

Able to execute and get the output for small dataset (with 4-5 rows and columns in the csv file).

When I try the same code for a bigger data set with 24 columns (inputs) and 12,000 rows (samples) in the csv file, I get the following error:

TypeError: unsupported operand type(s) for -: 'str' and 'str'

The following lines are indicated in the error message:
distance += pow((instance1[x] – instance2[x]), 2)
dist = euclideanDistance(testInstance, trainingSet[x], length)
neighbors = getNeighbors(trainingSet, testSet[x], k)
main()

Any help or suggestion is appreciated. Thank in advance.

**Jason Brownlee** November 14, 2016 at 7:34 am #

REPLY

Thanks Nivedita.

Perhaps the loaded data needs to be converted from strings into numeric values?

**Nivedita** November 15, 2016 at 4:00 am #

REPLY

Thank you for the reply Jason. There are no strings / no-numeric values in the data set. It is a csv file with 24 columns(inputs) and 12,083 rows(samples).

Any other advice?

Help is appreciated.

**Jason Brownlee** November 15, 2016 at 7:58 am #

REPLY

Understood Nivedita, but confirm that the loaded data is stored in memory as numeric values. Print your arrays to screen and/or use type(value) on specific values in each column.

**Vedhavyas** November 13, 2016 at 11:51 pm #

REPLY

Implemented this in Golang.
Check it out at – https://github.com/vedhavyas/machine-learning/tree/master/knn

Any feedback is much appreciated.
Also planning to implement as many algorithms as possible in Golang

---

**Jason Brownlee** November 14, 2016 at 7:43 am #

REPLY

Well done Vedhavyas.

---

**Baris** November 20, 2016 at 11:02 pm #

REPLY

Thanks for your great effort and implementation but I think that you need to add normalization step before the eucledian distance calculation.

---

**Jason Brownlee** November 22, 2016 at 6:48 am #

REPLY

Great suggestion, thanks Baris.

In this case, all input variables have the same scale. But, I agree, normalization is an important step when the scales of the input variables different – and often even when they don't.

---

**Sisay** November 22, 2016 at 2:38 am #

REPLY

Great article! It would be even fuller if you add some comments in the code; previewing the data and its structure; and a step on normalization although this dataset does not require one.

---

**Jason Brownlee** November 22, 2016 at 7:06 am #

REPLY

Great suggestion, thanks Sisay.

---

**fery** November 24, 2016 at 2:09 pm #

REPLY

hello, i"ve some error like this:

Traceback (most recent call last):
File "C:/Users/FFA/PycharmProjects/Knn/first.py", line 80, in
main()
File "C:/Users/FFA/PycharmProjects/Knn/first.py", line 65, in main
loadDataset('iris.data', split, trainingSet, testSet)
File "C:/Users/FFA/PycharmProjects/Knn/first.py", line 10, in loadDataset
dataset = list(lines)
_csv.Error: iterator should return strings, not bytes (did you open the file in text mode?)

what's wrong ? how to solve the error ?

**Jason Brownlee** November 25, 2016 at 9:31 am #

REPLY

Change this line:

```
1 with open(filename, 'rb') as csvfile:
```

to this:

```
1 with open(filename, 'r') as csvfile:
```

See if that makes a difference.

**Osman** November 24, 2017 at 1:44 am #

REPLY

i have the same problème, i changed previous line but it didn't work anyway !!

**_ary** November 28, 2016 at 1:02 am #

REPLY

how do i can plot result data set calssifier using matplotlib, thanks

**Jason Brownlee** November 28, 2016 at 8:45 am #

REPLY

Great question, sorry I don't have an example at hand.

I would suggest using a simple 2d dataset and use a scatterplot.

**Rayan** November 29, 2016 at 12:25 pm #

REPLY

hello,
iris.data site link is unreachable. Could you reupload to other site please ? Thank you

**Jason Brownlee** November 30, 2016 at 7:50 am #

REPLY

Sorry, the UCI Machine Learning Repository that hosts the datasets appears to be down at the moment.

There is a back-up for the website with all the datasets here:
http://mlr.cs.umass.edu/ml/

**Gabriela** November 29, 2016 at 9:08 pm #

REPLY

One of the best articles I have ever read! Everything is so perfectly explained … One BIG THANK YOU!!!

**Jason Brownlee** November 30, 2016 at 7:55 am #

REPLY

I'm so glad to hear that Gabriela.

**Abdallah yaghi** December 16, 2016 at 2:50 am # REPLY

Great tutorial, worked very well with python3 had to change the iteritems in the getResponse method to .items()
line 63 & 64:
print (“Train set: ” + repr(len(trainingSet)))
print (“Test set: ” + repr(len(testSet)))

generally great tutorial , Thank you 🙂

**Jason Brownlee** December 16, 2016 at 5:49 am # REPLY

Thanks Abdallah.

**Aditya** January 14, 2017 at 5:24 pm # REPLY

Hi,

first of all, Thanks for this great informative tutorial.

secondly, as compared to your accuracy of ~98%, i am getting an accuracy of around ~65% for every value of k. Can you tell me if this is fine and if not what general mistake i might be doing?

Thanks 🙂

**Jason Brownlee** January 15, 2017 at 5:27 am # REPLY

Sorry to hear that.

Perhaps a different version of Python (3 instead of 2.7?), or perhaps a copy-paste error?

**JingLee** January 19, 2017 at 5:43 am # REPLY

Hi, Jason, this article is awesome, it really gave me clear insight of KNN, and it’s so readable. just want to thank you for your incredible work. Awesome!!

**Jason Brownlee** January 19, 2017 at 7:38 am # REPLY

I’m glad you found it useful!

**Meaz** February 7, 2017 at 1:09 am # REPLY

Hi,
Thanks for your article.. ?
I have something to ask you..
Is the accuracy of coding indicates the accuracy of the classification of both groups ? What if want to see the accuracy of classification of true positives ? How to coding ?
Thanks before

**Jason Brownlee** February 7, 2017 at 10:19 am #

REPLY

Yes Meaz, accuracy is on the whole problem or both groups.

You can change it to report on the accuracy of one group or another, I do not have an off the cuff snippet of code for you though.

**Neeraj** February 9, 2017 at 12:29 am #

REPLY

Super Article!
After reading tones of articles in which by second paragraph I am lost, this article is like explaining Pythagoras theorem to someone who landed on Algebra!

Please keep doing this Jason

**Jason Brownlee** February 9, 2017 at 7:25 am #

REPLY

I'm glad to hear it Neeraj.

**Afees** February 25, 2017 at 8:44 am #

REPLY

This is a great tutorial, keep it up. I am trying to use KNN to generate epsilon for my DBSCAN algorithm. My data set is a time series. It only has one feature which is sub-sequenced into different time windows. I am wondering if there is a link where I can get a clear cut explanation like this for such a problem.Do you think KNN can predict epsilon since each of my row has a unique ID not setosa etc in the iris data set.

**Jason Brownlee** February 26, 2017 at 5:27 am #

REPLY

I don't know Afees, i would recommend try it and see.

**Ahmad** March 7, 2017 at 12:46 am #

REPLY

Hi Jason

I am working on a similar solution in R but i am facing problems during training of knn

**Jason Brownlee** March 7, 2017 at 9:36 am #

REPLY

What problem are you seeing Ahmad?

**koray** March 7, 2017 at 10:20 am #

REPLY

Thank you very much, it really helped me to understand the concept of knn.
But when i run this clock i get an error, and i couldn't solve it. Could you please help

```
import csv
import random
```

```
def loadDataset(filename, split, trainingSet=[] , testSet=[]):
with open(filename, ‘rb’) as csvfile:
lines = csv.reader(csvfile)
dataset = list(lines)
for x in range(len(dataset)):
for y in range(4):
dataset[x][y] = float(dataset[x][y])
if random.random() < split:
trainingSet.append(dataset[x])
else:
testSet.append(dataset[x])

trainingSet=[]
testSet=[]
loadDataset('iris.data', 0.66, trainingSet, testSet)
print 'Train: ' + repr(len(trainingSet))
print 'Test: ' + repr(len(testSet))

IndexError Traceback (most recent call last)
in ()
15 trainingSet=[]
16 testSet=[]
—> 17 loadDataset(‘/home/emre/SWE546_DataMining/iris’, 0.66, trainingSet, testSet)
18 print ‘Train: ‘ + repr(len(trainingSet))
19 print ‘Test: ‘ + repr(len(testSet))

in loadDataset(filename, split, trainingSet, testSet)
7 for x in range(len(dataset)):
8 for y in range(4):
—-> 9 dataset[x][y] = float(dataset[x][y])
10 if random.random() < split:
11 trainingSet.append(dataset[x])

IndexError: list index out of range
```

**koray** March 7, 2017 at 10:37 am #

REPLY

solved it thanks

**Jason Brownlee** March 8, 2017 at 9:39 am #

REPLY

Glad to hear it.

**Carol** July 11, 2017 at 11:20 am #

REPLY

How did you solve it?

**Ruben** March 12, 2017 at 1:04 am #

REPLY

Hi jason,
I am getting error of syntax in return math.sqrt(distance) and also in undefined variables in main()

**Jason Brownlee** March 12, 2017 at 8:28 am #

REPLY

Sorry to hear that, what errors exactly?

**Hardik Patil** March 14, 2017 at 10:17 pm #

REPLY

How should I take testSet from user as input and then print my prediction as output?

**Boris** March 18, 2017 at 10:34 am #

REPLY

AWESOME POST! I cant describe how much this has helped me understand the algorithm so I can write my own C# version. Thank you so much!

**Jason Brownlee** March 19, 2017 at 6:06 am #

REPLY

I'm glad to here!

**Mark Stevens** March 23, 2017 at 10:26 pm #

REPLY

Hello,

I have encountered a problem where I need to detect and recognize an object ( in my case a logo ) in an image. My images are some kind of scanned documents that contains mostly text, signatutes and logos. I am interested in localizing the logo and recognizing which logo is it.
My problem seems easier than most object recognition problems since the logo always comes in the same angle only the scale and position that changes. Any help on how to proceed is welcome as I'm out of options right now.

Thanks

**Jason Brownlee** March 24, 2017 at 7:55 am #

REPLY

Sound great Mark.

I expect CNNs to do well on this problem and some computer vision methods may help further.

**Thomas** March 26, 2017 at 3:18 am #

REPLY

Hi Jason, I have folowed through your tutorial and now I am trying to change it to run one of my own files instead of the iris dataset. I keep getting the error:

lines = csv.reader(csvfile)
NameError: name 'csv' is not defined

All i have done is change lines 62-64 from:

loadDataset('iris.data', split, trainingSet, testSet)
print 'Train set: ' + repr(len(trainingSet))
print 'Test set: ' + repr(len(testSet))

To:

loadDataset('fvectors.csv', split, trainingSet, testSet)
print( 'Train set: ' + repr(len(trainingSet)))
print( 'Test set: ' + repr(len(testSet)))

I have also tried to it with fvectors instead of fvectors.csv but that doesnt work either. DO you have any idea what is going wrong?

**Jason Brownlee** March 26, 2017 at 6:15 am #

REPLY

It looks like your python environment might not be installed correctly.

Consider trying this tutorial:
https://machinelearningmastery.com/setup-python-environment-machine-learning-deep-learning-anaconda/

**Thomas** March 27, 2017 at 1:44 am #

REPLY

Hi Jason, id missed an import, a silly mistake. But now i get this error:

_csv.Error: iterator should return strings, not bytes (did you open the file in text mode?)

Any ideas?

**Thomas** March 27, 2017 at 1:48 am #

REPLY

I got that fixed by changing

with open('fvectors.csv', 'rb') as csvfile:

to

with open('fvectors.csv', 'rt') as csvfile:

but now i get this error.

dataset[x][y] = float(dataset[x][y])
ValueError: could not convert string to float:

**Thomas** March 27, 2017 at 2:07 am #

It appears to not like my headers or labels for the data but are the labels not essential for the predicted vs actual part of the code

**Jason Brownlee** March 27, 2017 at 7:57 am #

Nice.

Double check you have the correct data file.

**rich** March 30, 2018 at 2:25 am #

Hello, Thomas, I have the same issue. I changed 'rb' to 'rt'. I get the error 'dataset[x][y] = float(dataset[x][y])

ValueError: could not convert string to float: ‘sepal_length’, apparently it is caused by the the header, how did you fix it?

REPLY

**Jason Brownlee** March 27, 2017 at 7:57 am #

Consider opening the file in ASCII format open(filename, ‘rt’). This might work better in Python 3.

REPLY

**Nalini** March 29, 2017 at 4:19 am #

Hi Jason

thanks a lot for such a wonderful tutorial for KNN.
when i run this code i found the error as

distance += pow((instance1[x] – instance2[x]), 2)
TypeError: unsupported operand type(s) for -: ‘str’ and ‘str’

can u help me f or clearing this error
Thank u

REPLY

**Akhilesh Joshi** November 23, 2017 at 4:20 am #

distance += pow((float(instance1[x]) – float(instance2[x])), 2)

REPLY

**subrina** April 14, 2017 at 5:20 am #

Hi, i have some zipcode point (Tzip) with lat/long. but these points may/maynot fall inside real zip polygon (truezip). i want to do a k nearest neighbor to see the k neighbors of a Tzip point has which majority zipcode. i mean if 3 neighbors of Tzip 77339 says 77339,77339,77152.. then majority voting will determine the class as 77339. i want Tzip and truezip as nominal variable. can i try your code for that? i am very novice at python…thanks in advance.

tweetzip, lat, long, truezip
77339, 73730.689, -990323 77339
77339, 73730.699, -990341 77339
77339, 73735.6, -990351 77152

REPLY

**Jason Brownlee** April 14, 2017 at 8:56 am #

Perhaps, you may need to tweak it for your example.

Consider using KNN from sklearn, much less code would be required:
https://machinelearningmastery.com/spot-check-classification-machine-learning-algorithms-python-scikit-learn/

REPLY

**subrina** April 24, 2017 at 5:49 am #

Thanks for your reply. i tried to use sklearn as you suggeested. But as for line ‘kfold=model_selection.KFold(n_splits=10,random_state=seed)’ it showed an error ‘seed is not defined’.

Also i think (not sure if i am right) it also take all the variable as numeric..but i want to calculate nearest neighbor distance using 2 numeric variable (lat/long) and get result along each row.

what should i do?

**Aditya** April 14, 2017 at 4:30 pm #

REPLY

def getNeighbors(trainingSet, testInstance, k):
distances = []
length = len(testInstance)-1
for x in range(len(trainingSet)):
dist = euclideanDistance(testInstance, trainingSet[x], length)
distances.append((trainingSet[x], dist))
distances.sort(key=operator.itemgetter(1))
neighbors = []
for x in range(k):
neighbors.append(distances[x][0])
return neighbors

in this fuction either “length = len(testInstance)-1” -1 shouldn’t be there or the
testInstance = [5, 5, 5] should include a character item at its last index??

Am I correct?

**Jason Brownlee** April 15, 2017 at 9:33 am #

REPLY

Yes, I believe so.

**Aditya** April 17, 2017 at 11:46 am #

REPLY

Thanks

**keerti** April 22, 2017 at 12:12 am #

REPLY

plz anyone has dataset related to human behaviour please please share me

**Jason Brownlee** April 22, 2017 at 9:28 am #

REPLY

Consider searching kaggle and the uci machine learning repository.

**gary** April 22, 2017 at 10:43 pm #

REPLY

Hello, can you tell me at getResponce what exactly are you doing line by line?Cause I do this in Java and cant figure out what exactly I have to do.
thanks

**Lubna** April 24, 2017 at 2:37 am #

REPLY

Hi,
I am trying to run your code in Anaconda Python ——Spyder….

I have landed in errors

(1) AttributeError: ‘dict’ object has no attribute ‘iteritems’

(2) filename = ‘iris.data.csv’
with open(filename, ‘rb’) as csvfile:
Initially while loading and opening the data file , it showed an error like

Error: iterator should return strings, not bytes (did you open the file in text mode?)

when i changed rb to rt , it works….i don’t whether it will create problem later…

Please response ASAP

Thanks

**Jason Brownlee** April 24, 2017 at 5:36 am # REPLY

The first error may be caused because the example was developed for Python 2.7 and you are using Python 3. I hope to update the examples for Python 3 in the future.

Yes, In Python 3, change to ‘rt’ top open as a text file.

**Ivan** May 31, 2017 at 4:55 am # REPLY

Hi, for python 3
just replace this line(47):
sortedVotes = sorted(classVotes.iteritems(), key=operator.itemgetter(1), reverse=True)
with this line:
sortedVotes = sorted(classVotes.items(), key=operator.itemgetter(1), reverse=True)

it is in def getResponse(neighbors) function

**Jason Brownlee** June 2, 2017 at 12:42 pm # REPLY

Thanks Ivan.

**VV** April 26, 2017 at 2:29 am # REPLY

I didn’t find anything about performance in this article. Is it so that the performance is really bad?
let’s say we have a training set of 100,000 entries, and test set of 1000. Then the euclidean distance should be calculated 10e8 times? Any workaround for this ?

**Jason Brownlee** April 26, 2017 at 6:24 am # REPLY

Yes, you can use more efficient distance measures (e.g. drop the sqrt) or use efficient data structures to track distances (e.g. kd-trees/balls)

**Vipin GS** June 4, 2017 at 3:37 am # REPLY

Nice !! Thank you 🙂

If you are using Python 3,

Use

1.#instead of rb
with open(filename, ‘r’) as csvfile:

2. #instead of iteritems.
sortedVotes = sorted(classVotes.items(), key=operator.itemgetter(1), reverse=True)

**Jason Brownlee** June 4, 2017 at 7:54 am #

REPLY

Thanks Vipin!

**Mayukh Sarkar** June 27, 2017 at 9:32 pm #

REPLY

Hello Jason,

Nice Article. I understand a lot about the KNN under the hood. But one thing though. In scikit learn we use KNN from training to predict in 2 step.

Step 1: Fitting the classifier
Step 2: Predicting

In Fitting section we didn’t pass the test data. Only train data is passed and hence we can see where it is training and where it is testing. With respect to your other blog on Naive Bayes implementation, the part which was calculating mean and std can be considered as fitting/training part while the part which was using Gaussian Normal Distribtuion can be considered as testing/prediction part.

However in this implementation I can not see that distinction. Can you please tell me which part should be considered as training and which part is testing. The reason I am asking this question is because it is always imporatant to correalte with scikit-learn flow so that we get a better idea.

**Jason Brownlee** June 28, 2017 at 6:23 am #

REPLY

Great question.

There is no training in knn as there is no model. The dataset is the model.

**Mayukh Sarkar** June 28, 2017 at 5:15 pm #

REPLY

Thanks for the reply…Is it the same for even scikit learn ? What exactly happens when we fit the model for KNN in Scikit Learn then?

**Jason Brownlee** June 29, 2017 at 6:31 am #

REPLY

Yes it is the same.

Nothing I expect. Perhaps store the dataset in an efficient structure for searching (e.g. kdtree).

**Mayukh Sarkar** July 5, 2017 at 5:37 pm #

Thanks..That’s seems interesting..BTW..I really like your approach..Apart from your e-books what materials (video/books) you think I may need to excel in deep learning and NLP. I want to switch my career as

a NLP engineer.

**Jason Brownlee** July 6, 2017 at 10:24 am #

Practice on a lot of problems and develop real and usable skills.

**Mayukh Sarkar** July 6, 2017 at 4:18 pm #

Where do you think I can get best problems that would create real and usable skills? Kaggle?? or somewhere else?

**Jason Brownlee** July 9, 2017 at 10:25 am #

See this post:
https://machinelearningmastery.com/get-started-with-kaggle/

**Ron** July 10, 2017 at 10:55 am # REPLY

Great post. Why aren't you normalizing the data?

**Jason Brownlee** July 11, 2017 at 10:26 am # REPLY

Great question. Because all features in the iris data have the same units.

**Golam Sarwar** July 13, 2017 at 4:10 pm # REPLY

HI Jason,

In one of your e-book 'machine_learning_mastery_with_python' Chapter – 11 (Spot-Check Classification Algorithms), you have explained KNN by using scikit learn KNeighborsClassifier class. I would like to know the difference between the detailed one what you've explained here and the KNeighborsClassifier class. It might be a very basic question for ML practitioner as I'm very new in ML and trying to understand the purposes of different approaches.

Thanks
Golam Sarwar

**Jason Brownlee** July 13, 2017 at 5:01 pm # REPLY

The tutorial here is to help understand how the kNN method works.

To use it in practice, I would strongly encourage you to use the implementation in a library like sklearn.

The main reasons are to avoid bugs and for performance. Learn more here:
https://machinelearningmastery.com/dont-implement-machine-learning-algorithms/

**Golam Sarwar** July 13, 2017 at 5:16 pm # REPLY

Thanks…..

**Ahmed rebai** August 21, 2017 at 8:08 pm #

REPLY

nice explication and great tutorial , i hope that you have other blogs about other classification algorithms like this thanks …. Jason

**Jason Brownlee** August 22, 2017 at 6:38 am #

REPLY

Thanks.

I do, use the blog search.

**SS** September 3, 2017 at 11:23 pm #

REPLY

Hi Jason,

Nice explanation !!

Can you please show us the implementation of the same (KNN) algorithm in Java also ?

**Jason Brownlee** September 4, 2017 at 4:34 am #

REPLY

Thanks for the suggestion, perhaps in the future.

**Chard** September 7, 2017 at 12:51 pm #

REPLY

Thanks Jason

**Jason Brownlee** September 7, 2017 at 12:59 pm #

REPLY

You're welcome.

**Barrys** September 26, 2017 at 7:16 am #

REPLY

Hi Jason,

Is it normal to get different accuracy, FP, TP, FN, TN on every different try? I am using same data.

**Jason Brownlee** September 26, 2017 at 3:00 pm #

REPLY

Yes, see this post for an explanation of why to expect this in machine learning:
https://machinelearningmastery.com/randomness-in-machine-learning/

**barrys** September 29, 2017 at 10:23 am #

REPLY

Thanks Jason. you can add below explanation to the post to make it more clear:

I've discovered that the different accuracy is caused by the below line in the loadDataset function:

if random.random() randomized.csv

**Barrys** September 26, 2017 at 7:19 am #

REPLY

Hi,

I am using that function instead of getAccuracy. It gives TP, TN, FP, FN.

```
def getPerformance(testSet, predictions):
tp = 0
tn = 0
fp = 0
fn = 0
for x in range(len(testSet)):
if testSet[x][-1] == predictions[x]:
if predictions[x] == "yes":
tp += 1
else:
tn += 1
else:
if predictions[x] == "yes":
fp += 1
else:
fn += 1
performance = [ ((tp/float(len(testSet))) * 100.0), ((tn/float(len(testSet))) * 100.0), ((fp/float(len(testSet))) * 100.0),
((fn/float(len(testSet))) * 100.0) ]

return performance
```

**larry guidarelli** December 30, 2017 at 4:44 am #

REPLY

HI Barrys,

What is the following line of code checking for –> if predictions[x] == 'yes'

Seems as if it always is false….

```
if predictions[x] == "yes":
tp += 1
else:
tn += 1
```

**Swati Gupta** October 9, 2017 at 1:42 pm #

REPLY

This is the best tutorial entry I have seen on any blog post about any topic. It is very easy to follow. The code is correct and not outdated. I love the way everything is structured. It kind of follows the TDD approach where it first builds on the production code step by step, testing each step on the way. Kudos to you for the great work! This is indeed helpful.

**Jason Brownlee** October 9, 2017 at 4:47 pm #

REPLY

Thanks!

**Hanane** October 25, 2017 at 5:59 am #

REPLY

i have a probleme in reading from the dataset can you tell me wher is the problem?

import pandas as pd

import numpy as np from sklearn import preprocessing, neighbors from sklearn.model_selection import train_test_split import pandas as pd

df = np.read_txt('C:\Users\sms\Downloads\NSLKDD-Dataset-master\NSLKDD-Dataset-master\KDDTrain22Percent.arff') df.replace('?' , -99999, inplace=True) df.drop(['class'], 1, inplace=True)

x = np.array(df.drop(['class'],1)) y = np.array(df['class'])

x_train, x_test, y_train, y_test = train_test_split(x,y,test_size=0.2)

clf = neighbors.KNieghborsClassifier() clf.fit(x_train, y_train)

accuracy = clf.score(x_test, y_test) print(accuracy)

**Jason Brownlee** October 25, 2017 at 6:54 am #

REPLY

What is the problem?

**SHEKINA** November 16, 2017 at 3:03 am #

REPLY

plz upload python code for feature selection using metaheuristic firefly algorithm

**Jason Brownlee** November 16, 2017 at 10:31 am #

REPLY

Thanks for the suggestion.

**Akhilesh Joshi** November 23, 2017 at 4:43 am #

REPLY

```
#python 3 implementation

import random
import csv

split = 0.66

with open('iris-data.txt') as csvfile:
    lines = csv.reader(csvfile)
    dataset = list(lines)

random.shuffle(dataset)

div = int(split * len(dataset))
train = dataset [:div]
test = dataset [div:]


import math
```

```
# square root of the sum of the squared differences between the two arrays of numbers
def euclideanDistance(instance1, instance2, length):
    distance = 0
    for x in range(length):
        #print(instance1[x])
        distance += pow((float(instance1[x]) - float(instance2[x])), 2)
    return math.sqrt(distance)



import operator
#distances = []
def getNeighbors(trainingSet, testInstance, k):
    distances = []
    length = len(testInstance)-1
    for x in range(len(trainingSet)):
        dist = euclideanDistance(testInstance, trainingSet[x], length)
        distances.append((trainingSet[x], dist))
    distances.sort(key=operator.itemgetter(1))
    neighbors = []
    for x in range(k):
        neighbors.append(distances[x][0])
    return neighbors


classVotes = {}
def getResponse(neighbors):
    #classVotes = {}
    for x in range(len(neighbors)):
        response = neighbors[x][-1]
        if response in classVotes:
            classVotes[response] += 1
        else:
            classVotes[response] = 1
    sortedVotes = sorted(classVotes.items(), key=operator.itemgetter(1), reverse=True)
    return sortedVotes[0][0]


def getAccuracy(testSet, predictions):
    correct = 0
    for x in range(len(testSet)):
        #print(predictions[x])
        if testSet[x][-1] == predictions[x]:
            correct += 1
    return (correct/float(len(testSet))) * 100.0

predictions=[]

k = 3

for x in range(len(test)):
    #print(len(test[x]))
    neighbors = getNeighbors(train, test[x], k)
    #print("N",neighbors)
    result = getResponse(neighbors)
    #print("R",result)
    predictions.append(result)
    #print(predictions)
    print('> predicted=' + repr(result) + ', actual=' + repr(test[x][-1]))

accuracy = getAccuracy(test, predictions)
print('Accuracy: ' + repr(accuracy) + '%')
```

**Jason Brownlee** November 23, 2017 at 10:39 am #

REPLY

Nice, I added some pre tags for you.

**Binayak** October 11, 2019 at 7:40 pm #

REPLY

Prediction accuracy seems to be very disappointing when I implemented your code? Where did I make mistake?
> predicted='Iris-versicolor', actual='Iris-setosa'
Accuracy: 35.294117647058826%
# python 3 implementation

```
import random
import csv

split = 0.66

with open('iris-data.txt') as csvfile:
lines = csv.reader(csvfile)
dataset = list(lines)

random.shuffle(dataset)
print(len(dataset))
div = int(split * len(dataset))
train = dataset[:div] # spliting 150 * .66 = 99
print("This is number of train data " + str(len(train)))
test = dataset[div:] # test data = 150-99 = 51
print("This is number of test data " + str(len(test)))

import math

# square root of the sum of the squared differences between the two arrays of numbers
def euclideanDistance(instance1, instance2, length):
distance = 0
for x in range(length):
# print(instance1[x])
distance += pow((float(instance1[x]) – float(instance2[x])), 2)
return math.sqrt(distance)

import operator

# distances = []
def getNeighbors(trainingSet, testInstance, k):
distances = []
length = len(testInstance) – 1
for x in range(len(trainingSet)):
dist = euclideanDistance(testInstance, trainingSet[x], length)
distances.append((trainingSet[x], dist))
distances.sort(key=operator.itemgetter(1))
neighbors = []
for x in range(k):
neighbors.append(distances[x][0])
return neighbors

classVotes = {}

def getResponse(neighbors):
# classVotes = {}
for x in range(len(neighbors)):
response = neighbors[x][-1]
if response in classVotes:
classVotes[response] += 1
else:
classVotes[response] = 1
sortedVotes = sorted(classVotes.items(), key=operator.itemgetter(1), reverse=True)
return sortedVotes[0][0]

def getAccuracy(testSet, predictions):
correct = 0
for x in range(len(testSet)):
# print(predictions[x])
if testSet[x][-1] == predictions[x]:
correct += 1
return (correct / float(len(testSet))) * 100.0

predictions = []
```

```
k = 3

for x in range(len(test)):
# print(len(test[x]))
neighbors = getNeighbors(train, test[x], k)
# print("N",neighbors)
result = getResponse(neighbors)
# print("R",result)
predictions.append(result)
# print(predictions)
print('> predicted=' + repr(result) + ', actual=' + repr(test[x][-1]))

accuracy = getAccuracy(test, predictions)
print('Accuracy: ' + repr(accuracy) + '%')
```

**Leonardo** November 24, 2017 at 2:56 am # REPLY

How can can I return no response for an unbiased random response?
I'm using this code to classify random images as letters. I have a dataset of letters for it.
For example, I have a random image that is not a letter but when I use this code to classify I get a letter in response. How can I tell that this image is not a letter? According to my dataset. Should I modify the code to check the result I get in "sortedVotes[0][1]"?

Thank you.

**Jason Brownlee** November 24, 2017 at 9:50 am # REPLY

Perhaps you can include "non-letters" in the training dataset also?

**Leonardo** November 26, 2017 at 1:35 am # REPLY

But what if I don't have this type of data?

Thank you.

**Jason Brownlee** November 26, 2017 at 7:32 am # REPLY

You may have to invent or contrive it to get the results you are seeking.

**Aditya** December 1, 2017 at 7:29 pm # REPLY

Hi, I want this in java language, can you help me out with this?

**Jason Brownlee** December 2, 2017 at 8:53 am # REPLY

You could port it to Java.

**Chan** December 19, 2017 at 11:44 pm # REPLY

Hi, How can i plot the output of the labelled data?

REPLY

**Jason Brownlee** December 20, 2017 at 5:44 am #

What type of plot would you like?

REPLY

**PS Narayanan** January 2, 2018 at 5:26 pm #

Please do Rotation forest (with LDA and PCA) in python.

REPLY

**Jason Brownlee** January 3, 2018 at 5:30 am #

Thanks for the suggestion.

REPLY

**Vinay** January 11, 2018 at 1:45 am #

Great explanation thinking of where to start ML but this tutorial cleared my doubt and I feeling now I have been confident and can apply this algorithm to any problem thanks to you

REPLY

**Jason Brownlee** January 11, 2018 at 5:51 am #

I'm glad to hear that.

REPLY

**yuvaraj** January 24, 2018 at 3:04 pm #

HI Jason , I seem to be getting the below error. can you please confirm whats that I need to change. quite new to python

```
import csv
import random
def loadDataset(filename, split, trainingSet=[] , testSet=[]):
with open(filename, 'rt') as csvfile:
lines = csv.reader(csvfile)
dataset = list(lines)
for x in range(len(dataset)-1):
for y in range(4):
dataset[x][y] = float(dataset[x][y])
if random.random() < split:
trainingSet.append(dataset[x])
else:
testSet.append(dataset[x])

trainingSet=[]
testSet=[]
loadDataset('iris.data',0.66, trainingSet, testSet)
print ('Train: ' + repr(len(trainingSet)))
print ('Test: ' + repr(len(testSet)))
Traceback (most recent call last):
```

File "", line 17, in
loadDataset('iris.data',0.66, trainingSet, testSet)

File "", line 9, in loadDataset
dataset[x][y] = float(dataset[x][y])

ValueError: could not convert string to float: '5.1,3.5,1.4,0.2,Iris-setosa'

**Nazneen** February 4, 2018 at 4:28 am #

REPLY

@ yuvaraj I just tried your code out (with the correct indentations) and it works perfectly for me with the given data set..

for x in range(len(dataset)-1):
for y in range(4):
dataset[x][y] = float(dataset[x][y])

These lines intend to convert dataset[x][0] dataset[x][1] dataset[x][2] dataset[x][3] from type str to type float so that they can be used for calculating the euclidean distance. You cannot convert 'Iris-setosa' to type float.

**Hugues Laliberte** February 7, 2018 at 4:17 pm #

REPLY

Hi Jason,

i'm running your code above on my dataset, it has 40'000 lines, 10 features and 1 binary class.

It takes much more time to run it (i have actually not let it finish yet, after 5-10 minutes…) compared to your 6 models code here:
https://machinelearningmastery.com/machine-learning-in-python-step-by-step/

This last code runs much much faster on the same dataset, it takes just a few seconds on a Macbook pro.

Is this normal ? Or maybe something i'm doing wrong…

**Hugues Laliberte** February 7, 2018 at 10:51 pm #

REPLY

I let it run today and it took about an hour, accuracy 0.96. why is the other code so much faster ? It does not run on all the data ?

**Jason Brownlee** February 8, 2018 at 8:27 am #

REPLY

It might be a hardware or environment issue?

**Hugues Laliberte** February 8, 2018 at 5:11 pm #

REPLY

Not sure. But you confirm the code on this page runs on all the data, not just a subset, especially the KNN code ?
https://machinelearningmastery.com/machine-learning-in-python-step-by-step/
It runs so fast.

thanks for all this work really, i've learned a lot.

**Jason Brownlee** February 8, 2018 at 8:23 am #

REPLY

You could try running the code on less data.

**Abien Fred Agarap** February 19, 2018 at 3:45 am #

REPLY

Hi, Dr. Brownlee

Perhaps instead of using `is`, let's use the == operator since `is` asks for identity, and not equality. I've stumbled upon this error myself when trying out your tutorial. Nice work btw. Thank you!

**Jason Brownlee** February 19, 2018 at 9:09 am #

REPLY

Thanks.

**Alessandro Pedrini** March 5, 2018 at 5:44 pm #

REPLY

Thank you so much Jason. one of the best tutorial about the KNN !!
One thing..in the GetResponse function the command .iteritems() doesn't existi anymore in Python3…instead is .items()
Thank you again

**Jason Brownlee** March 6, 2018 at 6:09 am #

REPLY

Thanks for the note.

**Nandini** March 12, 2018 at 11:40 pm #

REPLY

I have trained my data using knn,with neighbours no : 3, i have calculate distane for predicted data.i got smaller and larger values as distance.

How to calculate acceptance distance for knn, how to calculate the maximum limit for distance in knn.

Please suggest any procedure to calculate maximum limit for distance in knn

**Jason Brownlee** March 13, 2018 at 6:29 am #

REPLY

Perhaps estimate these values using a test dataset.

**nandini** March 13, 2018 at 3:32 pm #

REPLY

i got very huge values a distance but it's predicted as nearest neighbors,that is reason i wish to find the maximum acceptance distance in knn .

is there any procedure available for calculate maximum acceptance distance in knn.

**Jason Brownlee** March 14, 2018 at 6:16 am #

REPLY

There may be, I'm not across it. Perhaps check papers on google scholar.

**Nandini** March 15, 2018 at 8:30 pm #

Distance in KNN ,Please tell me what are factors will effects on distance value.

**Jason Brownlee** March 16, 2018 at 6:17 am #

The vales of observations.

**Nielglen** March 28, 2018 at 4:15 am #

REPLY

How does one plot this data to return an image similar to the one at the beginning?

**Jason Brownlee** March 28, 2018 at 6:30 am #

REPLY

Good question, sorry I don't have an example at this stage.

**Hong** March 28, 2018 at 3:33 pm #

REPLY

I savor, result in I discovered just what I was having a look for.
You've ended my four day lengthy hunt! God Bless
you man. Have a nice day. Bye

**Jason Brownlee** March 29, 2018 at 6:29 am #

REPLY

Thanks, I'm glad it helped.

**rich** March 31, 2018 at 2:15 am #

REPLY

Hello, Jason, I so like to purchase your book "Code Algorithms From Scratch in Python", but I have one question, in the book, are the code all update to python 3? Even in you posts, so many codes are still in python 2, I already learned python3 and I am learning ML, a total newbie, I want to focus on ML, no debug the python 2 code to python 3. I found it very frustrating and annoying that when the code give me error because the discrepancies in python 2 and python 3, could you also please update your post with python 3? Thanks

**Jason Brownlee** March 31, 2018 at 6:38 am #

REPLY

Not yet, all code are Python 2.7 at this stage.

**mawar** April 14, 2018 at 11:01 am #

REPLY

hai. may i know how your csv looks alike?

**Jason Brownlee** April 15, 2018 at 6:17 am #

REPLY

It is here:
https://archive.ics.uci.edu/ml/machine-learning-databases/iris/iris.data

**Muzi** May 4, 2018 at 7:13 am #

REPLY

Thanks Jason for another great tutorial. One thing i'd to know is , how would you go about plotting a 3d image of the first 3 attributes of the training dataset against the test sample set with labels for a more visual introspective of how the results look like. thanks

**Jason Brownlee** May 4, 2018 at 7:50 am #

REPLY

A Voronoi tessellation is popular fo visualizing knn in 2d:
https://en.wikipedia.org/wiki/Voronoi_diagram

**coco** October 20, 2021 at 1:05 pm #

REPLY

can we do it with LVQ ?

**sachal** May 17, 2018 at 6:56 pm #

REPLY

can we apply this to a dataset having more than two class

**Jason Brownlee** May 18, 2018 at 6:22 am #

REPLY

Sure.

**Koray Tugay** June 1, 2018 at 1:14 pm #

REPLY

Here is my take for the same algorithm, a bit more object-oriented.. Maybe more readable to people familiar with Java or Java-like languages:
https://github.com/koraytugay/notebook/blob/master/programming_challenges/src/python/iris_flower_knn/App.py

**Jason Brownlee** June 1, 2018 at 2:47 pm #

REPLY

Nice work!

**Sam** July 1, 2018 at 3:07 pm #

REPLY

Hi, great tutorial so far. I'm a newbie to Python, and am stuck on the following error in the getNeighbours function:

File "", line 8
distances.sort(key=operator.itemgetter(1))
^
SyntaxError: invalid syntax

I'm using Python 3, but have tried a few alternatives and still can't make it work. Can anyone help?

**Jason Brownlee** July 2, 2018 at 6:20 am #

REPLY

The tutorial assumes Python 2.7.

The code must be updated for Python 3.

**saksham Gupta** August 3, 2018 at 5:57 am #

REPLY

Thanks Mr. jason,
i really thank you from the depth of my heart for providing such an easy and simple implementation of this algo with appropriate meaning and need of each function

really once again thank you

I have also done your 14-day course of machine learning which also really helped me a lot….

Hope to learn more from u like this …

Thank You

**Jason Brownlee** August 3, 2018 at 6:07 am #

REPLY

I'm happy to hear that.

**Anestis Tziamtzis** August 11, 2018 at 1:05 am #

REPLY

I have some questions:

If I want to create an algorithm without an actual train set does this algorithm classify as an instance base algorithm?

Also is KNN the algorithm of choice for such problem?

As an example we can consider the IRIS dataset, but imagine you add new data on a daily basis.

Thanks a lot for your time.

**Jason Brownlee** August 11, 2018 at 6:12 am #

REPLY

You must have labelled data in order to prepare a supervised learning model.

**Anestis Tziamtzis** August 11, 2018 at 5:40 pm #

REPLY

So, if I have we a data set like the example dataframe below, could we have such case?

Age . Income . Savings . House Loan Occupation . Credit Risk .Cat (0-2)
23 . 25000 . 3600 . No Private Sector 1
33 . 37000 . 12000 . Yes IT 1
37 . 34500 . 15000 . Yes IT 1
45 . 54000 . 60000 . Yes . Academic 0
26 . 26000 . 4000 . Yes . Private Sector 2

Here the label is the Credit Risk. Assume that something like this arrives “fresh” every day, is KNN a good way to classify the data? Or we can apply another algorithm too?

My only worry is accuracy and overfitting issues, since you won’t have any test data. Also KNN is a very simple algorithm, Finally, assuming the data comes from the same source is it safe to assume that they will not have any bias?

**Jason Brownlee** August 12, 2018 at 6:31 am # REPLY

I would recommend using a framework like sklearn to investigate your dataset.

You can get started here:
https://machinelearningmastery.com/start-here/#python

**Rajavee** August 28, 2018 at 11:35 pm # REPLY

what it actually give the output in Iris dataset? I mean which accuracy is calculated?

**Jason Brownlee** August 29, 2018 at 8:12 am # REPLY

Sorry, I don’t follow your question. Perhaps you can provide more context or rephrase your question?

**Rajavee** August 31, 2018 at 2:02 am # REPLY

Can i predict more than one parameters from this algorithm. Here in iris data-set types of flowers and is accuracy is calculated. if i added one more parameter for example color then both flower type and color can be predict and it’s accuracy at a same time?

**Jason Brownlee** August 31, 2018 at 8:15 am # REPLY

Neural nets can, sklearn models generally cannot predict more than one variable.

**Ra** October 4, 2018 at 11:32 pm #

Thank you so much. Your way of explanation is to the point and conceptual.

**Jason Brownlee** October 5, 2018 at 5:37 am #

Thanks.

**Rajavee** October 4, 2018 at 11:33 pm #

thanks. your way of explanation is to the pint and conceptual.

**Rajavee** October 4, 2018 at 11:35 pm #

Point*

**SM** September 18, 2018 at 9:37 pm # REPLY

Hi Jason, excellent blog. Love all your posts. Thank you very much. However, I had one question on sklearn's nearest neighbors. I am very confused what "indices" actually mean.

This is from sklearn website. "For the simple task of finding the nearest neighbors between two sets of data, the unsupervised algorithms within sklearn.neighbors can be used".

```
>>> from sklearn.neighbors import NearestNeighbors
>>> import numpy as np
>>> X = np.array([[-1, -1], [-2, -1], [-3, -2], [1, 1], [2, 1], [3, 2]])
>>> nbrs = NearestNeighbors(n_neighbors=2, algorithm='ball_tree').fit(X)
>>> distances, indices = nbrs.kneighbors(X)
>>> indices
array([[0, 1],
[1, 0],
[2, 1],
[3, 4],
[4, 3],
[5, 4]]…)
>>> distances
array([[ 0. , 1. ],
[ 0. , 1. ],
[ 0. , 1.41421356],
[ 0. , 1. ],
[ 0. , 1. ],
[ 0. , 1.41421356]])
```

I implemented this on iris data set and this is what I get. Again, how do I interpret 1,2, and 3 below? Thank you very much.

```
# instantiate learning model (k = 3)
knn = KNeighborsClassifier(n_neighbors=3)

# fitting the model
knn.fit(X_train, y_train)

# predict the response
pred = knn.predict(X_test)

distances, indices = knn.kneighbors(X)

print(indices[1:3])… Q1

[[84 82 35]
[58 18 50]]

print(distances[1:3])..Q2
```

[[0. 0.17320508 0.17320508]
[0. 0.14142136 0.24494897]]

print(y_train[indices][10:12])…Q3

[[0. 0. 0.]
[0. 0. 0.]]

**Jason Brownlee** September 19, 2018 at 6:19 am #

REPLY

Probability the index into the saved training data.

**Mike** September 21, 2018 at 8:12 pm #

REPLY

I was very excited to study your materials but unfortunately the codes don't work in Python 3.7.
For example the very first code bit on this page.

**Jason Brownlee** September 22, 2018 at 6:28 am #

REPLY

Yes, the code was written a long time ago for Py2.7.

**Kiran** October 19, 2018 at 2:48 pm #

REPLY

I Jason ,new to machine learning,your article is really simple and easy to understand,i have a very basic question, (silly one),
Which is the unknown object that is being predicted

**Jason Brownlee** October 19, 2018 at 2:51 pm #

REPLY

Once we fit the model we can use the model to make a prediction on new data.

In this example, the model takes measurements of a flower and predicts the species of iris flower.

**ken stonecipher** October 24, 2018 at 11:08 am #

REPLY

Jason, why do I not find your online example in the downloaded Machine Learning Algorthms from Scratch with Python.

I only see KNN implemented with abalone example. Do I have outdate versions of this ebook?

**Jason Brownlee** October 24, 2018 at 2:44 pm #

REPLY

I provide a fuller example of knn in the book (better design and support for py2 and py3).

**Raj** October 27, 2018 at 9:46 am #

REPLY

Hi Jason,

Thank you so much for the explanation.

I run the code and the accuracy shows 0.0%

**Jason Brownlee** October 28, 2018 at 6:04 am #

REPLY

Perhaps try knn provided by sklearn?

**Bimsara** November 13, 2018 at 9:07 pm #

REPLY

This is my very first approach of Machine Learning. This is a well described article which made me a fan of ML. I did according to your article and got result. Thank you for this article.

It would be a great help if you could you tell me the next article for me to do since this is my very first day of machine learning.

**Jason Brownlee** November 14, 2018 at 7:28 am #

REPLY

Thanks, here are some similar tutorials:
https://machinelearningmastery.com/start-here/#code_algorithms

**Francis** January 2, 2019 at 11:28 pm #

REPLY

Hello,

Kindly amend the code to load the CSV file from URL using numpy and pandas for python 3 users.

thanks

**Jason Brownlee** January 3, 2019 at 6:13 am #

REPLY

Thanks for the suggestion.

**Kaushlender Kumar** January 12, 2019 at 3:33 pm #

REPLY

how I can estimated conditional probability of the predicted class

**Jason Brownlee** January 13, 2019 at 5:39 am #

REPLY

I recommend using sklearn's implementation and calling predict_proba():
https://scikit-learn.org/stable/modules/generated/sklearn.neighbors.KNeighborsClassifier.html

**fred li** February 6, 2019 at 11:51 pm #

REPLY

HI
great tutorial!

but i have trouble understanding the line if response in classVotes
can you please explain ?

**Jason Brownlee** February 7, 2019 at 6:38 am #

REPLY

Sure, which part exactly?

**Simranjit Kaur** February 15, 2019 at 5:08 am #

REPLY

Hi Jason, can you pls give a rough estimate of how long does it take to create a good project in ML?

**Jason Brownlee** February 15, 2019 at 8:16 am #

REPLY

It depends on the project and on the developer/s involved.

It could be one hour, it could be one year.

This process will really speed things up:
https://machinelearningmastery.com/start-here/#process

**Lydia** February 19, 2019 at 2:30 am #

REPLY

Hi thanks for the post. One question is: do you think we should put predictions=[] in the for loop? the predictions list should be cleared after each loop

**nassimahi** February 23, 2019 at 9:06 am #

REPLY

this gots
Traceback (most recent call last):
File “C:\Users\micro\AppData\Local\Programs\Python\Python36-32\distnce1.py”, line 10, in
for x in range(len(dataset)-1):
NameError: name ‘dataset’ is not defined

**Jason Brownlee** February 24, 2019 at 9:02 am #

REPLY

You might have skipped some lines of code from the tutorial.

**Psy** March 2, 2019 at 2:15 pm #

REPLY

I am getting the following error :

iterator should return strings, not bytes (did you open the file in text mode?)

I have saved the data as ‘irisdataset.txt’ in notepad
Please help

**Jason Brownlee** March 3, 2019 at 7:58 am #

REPLY

The file was opened in binary model, perhaps try changing it to text mode?

**Psy** March 4, 2019 at 9:00 am #

REPLY

Thanks Jason . I changed it to text and its working now. But for any value of k, I am getting 100% accuracy

**Jason Brownlee** March 4, 2019 at 2:16 pm #

REPLY

Perhaps there was a typo when you copied the code?

**Ana** March 25, 2019 at 11:26 pm #

REPLY

Hi Jason…
could you help me!
I need this code but it does not work at all :((((
and I'm using python 3.7 with autism dataset and the data has a missing value
what should I do

please anyone can help me !!!
and thank you.

**Jason Brownlee** March 26, 2019 at 8:08 am #

REPLY

I have an updated version for Python 3 in my book:
https://machinelearningmastery.com/machine-learning-algorithms-from-scratch/

**Parag** April 27, 2019 at 4:22 am #

REPLY

How to fix this error ? Mr Jason

```
import csv
import random
import math
import operator

def loadDataset(Part1_Train, split, trainingSet=[] , testSet=[]):
with open('Part1_Train.csv', 'r') as csvfile:
lines = csv.reader(csvfile)
dataset = list(lines)
for x in range(len(dataset)-1):
for y in range(4):
dataset[x][y] = float(dataset[x][y])
if random.random() predicted=' + repr(result) + ', actual=' + repr(testSet[x][-1]))
accuracy = getAccuracy(testSet, predictions)
print('Accuracy: ' + repr(accuracy) + '%')

main()
```

```
————————————————————————————————————————————————————————————
ValueError Traceback (most recent call last)
in ()
72 print('Accuracy: ' + repr(accuracy) + '%')
73
—> 74 main()

in main()
58 testSet=[]
59 split = 0.67
—> 60 loadDataset('Part1_Train.csv', split, trainingSet, testSet)
61 print ('Train set: ' + repr(len(trainingSet)))
62 print ('Test set: ' + repr(len(testSet)))

in loadDataset(Part1_Train, split, trainingSet, testSet)
10 for x in range(len(dataset)-1):
11 for y in range(4):
—> 12 dataset[x][y] = float(dataset[x][y])
13 if random.random() < split:
14 trainingSet.append(dataset[x])

ValueError: could not convert string to float: '5.1,3.5,1.4,0.2,A'
```

**Jason Brownlee** April 27, 2019 at 6:36 am #

REPLY

I have some suggestions here:
https://machinelearningmastery.com/faq/single-faq/why-does-the-code-in-the-tutorial-not-work-for-me

**Feroz** April 28, 2019 at 6:28 pm #

REPLY

```
# -*- coding: utf-8 -*-
"""
Created on Sun Apr 28 00:14:28 2019

@author: Feroz
"""

import csv
import random
import math
import operator
from matplotlib import pyplot
def loadDataset(filename, split, trainingSet=[] , testSet=[]):
with open(filename, 'r') as csvfile:
lines = csv.reader(csvfile)
dataset = list(lines)
for x in range(len(dataset)-1):
for y in range(4):
dataset[x][y] = float(dataset[x][y])
if random.random() predicted=' + repr(result) + ', actual=' + repr(testSet[x][-1]))
accuracy = getAccuracy(testSet, predictions)
print('Accuracy: ' + str(accuracy) + '%')

main()
```

Here is OUTPUT:

```
runfile('C:/Users/Feroz/Desktop/Project/untitled0.py', wdir='C:/Users/Feroz/Desktop/Project')
Train set: 103
```

```
Test set: 47
> predicted='Iris-setosa', actual='Iris-setosa'
> predicted='Iris-setosa', actual='Iris-setosa'
> predicted='Iris-setosa', actual='Iris-setosa'
> predicted='Iris-setosa', actual='Iris-setosa'
> predicted='Iris-setosa', actual='Iris-setosa'
> predicted='Iris-setosa', actual='Iris-setosa'
> predicted='Iris-setosa', actual='Iris-setosa'
> predicted='Iris-setosa', actual='Iris-setosa'
> predicted='Iris-setosa', actual='Iris-setosa'
> predicted='Iris-setosa', actual='Iris-setosa'
> predicted='Iris-setosa', actual='Iris-setosa'
> predicted='Iris-setosa', actual='Iris-setosa'
> predicted='Iris-setosa', actual='Iris-setosa'
> predicted='Iris-setosa', actual='Iris-setosa'
> predicted='Iris-setosa', actual='Iris-setosa'
> predicted='Iris-setosa', actual='Iris-setosa'
> predicted='Iris-setosa', actual='Iris-setosa'
> predicted='Iris-versicolor', actual='Iris-versicolor'
> predicted='Iris-versicolor', actual='Iris-versicolor'
> predicted='Iris-versicolor', actual='Iris-versicolor'
> predicted='Iris-versicolor', actual='Iris-versicolor'
> predicted='Iris-versicolor', actual='Iris-versicolor'
> predicted='Iris-versicolor', actual='Iris-versicolor'
> predicted='Iris-versicolor', actual='Iris-versicolor'
> predicted='Iris-versicolor', actual='Iris-versicolor'
> predicted='Iris-versicolor', actual='Iris-versicolor'
> predicted='Iris-versicolor', actual='Iris-versicolor'
> predicted='Iris-versicolor', actual='Iris-versicolor'
> predicted='Iris-versicolor', actual='Iris-versicolor'
> predicted='Iris-virginica', actual='Iris-virginica'
> predicted='Iris-virginica', actual='Iris-virginica'
> predicted='Iris-virginica', actual='Iris-virginica'
> predicted='Iris-virginica', actual='Iris-virginica'
> predicted='Iris-virginica', actual='Iris-virginica'
> predicted='Iris-virginica', actual='Iris-virginica'
> predicted='Iris-virginica', actual='Iris-virginica'
> predicted='Iris-virginica', actual='Iris-virginica'
> predicted='Iris-virginica', actual='Iris-virginica'
> predicted='Iris-versicolor', actual='Iris-virginica'
> predicted='Iris-virginica', actual='Iris-virginica'
> predicted='Iris-virginica', actual='Iris-virginica'
> predicted='Iris-virginica', actual='Iris-virginica'
> predicted='Iris-virginica', actual='Iris-virginica'
> predicted='Iris-virginica', actual='Iris-virginica'
> predicted='Iris-virginica', actual='Iris-virginica'
Accuracy: 0.0%
```

Thanks for creating such a nice tutorial. I run your code and it works perfectly fine but why it gives accuracy 0.0% I'm not getting this. Thanks

---

**Jason Brownlee** April 29, 2019 at 8:19 am #

REPLY

Nice work.

I have some suggestions here:
https://machinelearningmastery.com/faq/single-faq/why-does-the-code-in-the-tutorial-not-work-for-me

**ESTHER** May 24, 2019 at 8:34 pm #

REPLY

Good job Jason.
I am new to Python.
After running the first code:

import csv
with open('iris.data', 'rb') as csvfile:
lines = csv.reader(csvfile)
for row in lines:
print ', '.join(row)

I get an error message:

File "C:\Users\AKINSOWONOMOYELE\Anaconda3\lib\site-packages\spyder_kernels\customize\spydercustomize.py", line 110, in execfile
exec(compile(f.read(), filename, 'exec'), namespace)

File "C:/Users/AKINSOWONOMOYELE/.spyder-py3/temp.py", line 5
print ', '.join(row)
^
SyntaxError: invalid syntax

How do I handle this?

**Jason Brownlee** May 25, 2019 at 7:47 am #

REPLY

I have some suggestions here:
https://machinelearningmastery.com/faq/single-faq/why-does-the-code-in-the-tutorial-not-work-for-me

**Tracy** July 23, 2019 at 4:57 am #

REPLY

Hello Jason,

```
1 if random.random() < split:
2                 trainingSet.append(dataset[x])
3             else:
4                 testSet.append(dataset[x])
```

How come the random return value can split the dataset into training set and test set?
I don't understand the logic, can you help me ?

**Jason Brownlee** July 23, 2019 at 8:14 am #

REPLY

It returns a number between 0 and 1, and we check if it is below our ratio to decide what list to add the example to.

**Anu** July 31, 2019 at 1:46 am #

REPLY

Traceback (most recent call last):
File "C:/Users/DELL/Desktop/project/python/pro2.py", line 70, in

neighbors = getNeighbors(train, test[x], k)
File “C:/Users/DELL/Desktop/project/python/pro2.py”, line 34, in getNeighbors
dist = euclideanDistance(testInstance, trainingSet[x], length)
File “C:/Users/DELL/Desktop/project/python/pro2.py”, line 23, in euclideanDistance
distance += pow((float(instance1[x]) – float(instance2[x])), 2)
IndexError: list index out of range

what is this error

REPLY

**Jason Brownlee** July 31, 2019 at 6:54 am #

That the list index is out of range.

REPLY

**sandipan sarkar** August 2, 2019 at 4:15 am #

HELLO JASON.

i HAVE FINISHED THE ARTICLE WITH ALL THE 250+ REVIEWS.bUT STILL HAVE DOUBTS WHEN APPLYING KNN IN MY ANALYSIS.wHAT TO DO????PLEASE PROVIDE SUGGESTIONS.THANKS
BEST REGARDS
SANDIPAN SARKAR

REPLY

**Jason Brownlee** August 2, 2019 at 6:56 am #

This example is for learning purposes only, not for projects.

For actual problems, I recommend using sklearn:
https://machinelearningmastery.com/spot-check-classification-machine-learning-algorithms-python-scikit-learn/

REPLY

**Ali Naqvi** August 5, 2019 at 7:32 pm #

How can we predict by giving new data sets like

sepal-length sepal-width petal-length petal-width Class
5.1 3.5 1.4 0.2 ?

and let our model to predict

REPLY

**Jason Brownlee** August 6, 2019 at 6:33 am #

I recommend using a scikit-learn implementation, this example is just for learning.

See this post:
https://machinelearningmastery.com/make-predictions-scikit-learn/

REPLY

**Rohit Sharma** September 1, 2019 at 8:30 am #

Hi, I am in my learning phase, I have a project in hand where I am getting many sensor data from an IoT device on a webserver every minute. I am doing web scraping initially and then the data is stored in CSV format. now all the data including the time date stamp is in string format.

my question is I want to apply Knn for the prediction of the next data set if it contains any anomaly or not so what should be my approach for pre-processing. As in the last, I have to check real-time data for any anomaly present in it.

Thanks

REPLY

**Jason Brownlee** September 2, 2019 at 5:25 am #

If it is data from IoT, it might be a time series. Perhaps you can model it as a time series classification (anomaly or not).

The tutorials here might give you some ideas:
https://machinelearningmastery.com/start-here/#deep_learning_time_series

REPLY

**Kenny** September 9, 2019 at 11:47 am #

please how can i input my query into my knn algorithm for classification, don't know how to code it

REPLY

**Jason Brownlee** September 9, 2019 at 1:56 pm #

Perhaps you can use the scikit-learn implementation here:
https://scikit-learn.org/stable/modules/generated/sklearn.neighbors.KNeighborsClassifier.html

REPLY

**kailash** September 13, 2019 at 2:50 am #

Hey…..I used this code: I have to do this for pima indians data set

```
import random
import csv

split = 0.66

with open('C:\Users\HP\Desktop\diabetes.csv') as csvfile:
lines = csv.reader(csvfile)
dataset = list(lines)

random.shuffle(dataset)

div = int(split * len(dataset))
train = dataset [:div]
test = dataset [div:]

import math
# square root of the sum of the squared differences between the two arrays of numbers
def euclideanDistance(instance1, instance2, length):
distance = 0
for x in range(length):
#print(instance1[x])
distance += pow((float(instance1[x]) – float(instance2[x])), 2)
return math.sqrt(distance)

import operator
#distances = []
def getNeighbors(trainingSet, testInstance, k):
distances = []
length = len(testInstance)-1
for x in range(len(trainingSet)):
dist = euclideanDistance(testInstance, trainingSet[x], length)
```

```
distances.append((trainingSet[x], dist))
distances.sort(key=operator.itemgetter(1))
neighbors = []
for x in range(k):
neighbors.append(distances[x][0])
return neighbors

classVotes = {}
def getResponse(neighbors):
#classVotes = {}
for x in range(len(neighbors)):
response = neighbors[x][-1]
if response in classVotes:
classVotes[response] += 1
else:
classVotes[response] = 1
sortedVotes = sorted(classVotes.items(), key=operator.itemgetter(1), reverse=True)
return sortedVotes[0][0]

def getAccuracy(testSet, predictions):
correct = 0
for x in range(len(testSet)):
#print(predictions[x])
if testSet[x][-1] == predictions[x]:
correct += 1
return (correct/float(len(testSet))) * 100.0

predictions=[]

k = 3

for x in range(len(test)):
#print(len(test[x]))
neighbors = getNeighbors(train, test[x], k)
#print("N",neighbors)
result = getResponse(neighbors)
#print("R",result)
predictions.append(result)
#print(predictions)
print('> predicted=' + repr(result) + ', actual=' + repr(test[x][-1]))

accuracy = getAccuracy(test, predictions)
print('Accuracy: ' + repr(accuracy) + '%')
```

error:

File "C:/Users/HP/.spyder-py3/ir.py", line 23, in euclideanDistance
distance += pow((float(instance1[x]) – float(instance2[x])), 2)

ValueError: could not convert string to float: 'Pregnancies'

---

**Jason Brownlee** September 13, 2019 at 5:44 am #

REPLY

This is a common question that I answer here:
https://machinelearningmastery.com/faq/single-faq/can-you-read-review-or-debug-my-code

---

**Ray** October 25, 2019 at 1:38 pm #

REPLY

Did u use statistical methods or Baysian theory to speed up the convergence when doing parameter matching? Have u applied to pharmacy industry?

REPLY

**Jason Brownlee** October 25, 2019 at 1:48 pm #

I use both, really depends on the project.

A grid search can take you a long way too!

REPLY

**Markus** October 29, 2019 at 5:51 pm #

Hi

By the code of this blog post, when you calculate the K nearest neighbors, you consider the node itself as one of those nodes, correct?

REPLY

**Jason Brownlee** October 30, 2019 at 5:59 am #

No, typically we evaluate a model on data not used to train it.

Here, we use cross validation which separates data into train and test sets many times, examples in the test set are not in the train set.

REPLY

**ashutosh karna** December 20, 2019 at 10:33 am #

Hi Jason,
could you also please help with a blog on other instance-based reduction techniques, like IB2 and IB3, in python?

REPLY

**Jason Brownlee** December 20, 2019 at 1:07 pm #

Thanks for the suggestion!

You mean like condensed NN and edited NN? Yes, I have a tutorial on these topics written and scheduled.

REPLY

**Jack** September 22, 2020 at 7:32 am #

Hi Jason,

Thanks for sharing. Do you have the link of your condensed NN and edited NN algorithm? Would love to see how you implement those.

REPLY

**Jason Brownlee** September 22, 2020 at 7:45 am #

You can use the blog search box.

This might be a good place to start:
https://machinelearningmastery.com/undersampling-algorithms-for-imbalanced-classification/

**Ori Tzadok** January 13, 2020 at 5:10 am #

REPLY

Hello Jason
I think there is something that should be fixed, in the function 'cross_validation_split'.
Consider the division of 'len(dataset) / n_folds'. In cases where the remainder of the division is large, the result may miss some of the data.

For example, given the following code:

```
from random import randrange

# Split a dataset into k folds
def cross_validation_split(dataset, n_folds):
    dataset_split = list()
    dataset_copy = list(dataset)
    fold_size = int(len(dataset) / n_folds)
    for _ in range(n_folds):
        fold = list()
        while len(fold) < fold_size:
            index = randrange(len(dataset_copy))
            fold.append(dataset_copy.pop(index))
        dataset_split.append(fold)
    print("missing data:", dataset_copy) # Added line
    return dataset_split

lst = [1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20]
print(cross_validation_split(lst, 7))
```

then the output is:

```
missing data: [1, 10, 11, 15, 16, 20]
[[13, 14], [2, 4], [19, 6], [8, 18], [5, 3], [9, 12], [7, 17]]
```

This may also be critical when talking about very large datasets.

Thanks anyway,
Ori

**Jason Brownlee** January 13, 2020 at 8:32 am #

REPLY

Thanks for sharing Ori!

**Rakib** January 16, 2020 at 6:33 am #

REPLY

How can i found one comment or review is Invcentivized / biased using this KNN approach??will you tell me ?
Advance thanks.

**Jason Brownlee** January 16, 2020 at 1:30 pm #

REPLY

Perhaps you can model the problem as text classification:
https://machinelearningmastery.com/best-practices-document-classification-deep-learning/

**Thb DL** January 21, 2020 at 3:36 am #

REPLY

Hello ! Great article thank you very much ! Your website helps a lot !

I have a question related to your post :

I am currently working on multiparametric voxel classification. In other words, I have several aligned and registered parametric images and want to form cluster of voxels according to their values in each parametric image.

I focus on medical images. The analysis is done in order to characterize and predict the treatment response of patient to their therapy.

I have a lot of types of images at one time for each patient (CT scanner images, molecular images, MRI, etc.).

To see if I can detect remarkable trends, I first want to simply clusterise the voxels with multi-dimensional k-means, hierarchical based approaches and/or PCA.

I know that it is very important to preprocess the data before applying unsupervised clustering. Based on what I have read, it doesn't seem to be a hard rule on which to choose between NORMALIZING (between 0 and 1) or STANDARDIZING (mean = 0 and std = 1) the data. It seems to depend on data and contexts.

Since my image have very different scales, do you think I should NORMALIZE or STANDARDIZE the value of the voxels in each parametric image ?

Thank you very much for your help.

Cheers !

**Jason Brownlee** January 21, 2020 at 7:20 am # REPLY

You're welcome.

Perhaps try each approach and compare to raw data and use the method that results in the most skillful model.

**Thb DL** January 22, 2020 at 1:33 am # REPLY

Thank you ! So according to you also, there no "hard rule". It confirm a bit what I have read…

This is what I will try but in unsupervised, it is dificult to no which result is the best as we do not have ground truth…

Anyway, thank you very much for your disponibility !

**Thb DL** January 22, 2020 at 1:35 am # REPLY

difficult to KNOW* which

(sorry I am french)

**Nejood** February 5, 2020 at 9:31 am # REPLY

How are you Dr.
How I can use KNN based in recommender systems in requirements traceability to trace the requirements.
Requirements traceability is the ability to trace requirements from the beginning until the end of the project.
Its a part of requirement management.
I need python code to implement that

**Jason Brownlee** February 5, 2020 at 1:40 pm # REPLY

Perhaps start by defining your problem:
https://machinelearningmastery.com/how-to-define-your-machine-learning-problem/

Then perhaps use this process to work through it systematically:
https://machinelearningmastery.com/start-here/#process

**wancong zhang** February 24, 2020 at 5:23 am #

REPLY

Your code line “dist = euclidean_distance(test_row, train_row)” is wrong.

You should switch the order of the arguments.

Look at the for_loop in the implementation of euclidean_distance to see why

**Jason Brownlee** February 24, 2020 at 7:45 am #

REPLY

The code is correct, both classes have an extra element at the end of their list for the class.

You’re right for standalone predictions though, where no such element would be present.

**Mani** March 16, 2020 at 7:21 pm #

REPLY

Hello Dr. Jason Brownlee,

I am working on a PoC for a customer. Let me explain the requirement.

I am given an excel sheet with following columns:

Server_SNo,
Owner,
Hosting Dept,
Bus owner,
Applications hosted,
Functionality,
comments

Except the Server_SNo, other columns may or may not have data.

For some records there is no data except Server_SNo which is the first column.

One business owner can own more than 1 Server.
So, out of 4000 records, about 50% of data contain a direct mapping for a server with the owner. Remaining 50% of data have a combination of other columns (Owner, Hosting Dept, Bus owner, Applications hosted, Functionality and comments)

Here is my problem, I need to find the owner for the given Server_Sno for 50% of data which have a combination of other columns (Owner, Hosting Dept, Bus owner, Applications hosted, Functionality and comments).

Is this an NLP problem? Am I going in the right direction using Python and NLTK for NLP?

Any insights are appreciated.

**Jason Brownlee** March 17, 2020 at 8:12 am #

REPLY

There is probably a fixed number of “owners”. It could be a classification task with some text inputs. A bag of words model would help as a first step to encode each of the variables.

**baua** March 18, 2020 at 11:23 am #

REPLY

Hello
I tried to convert the code to java
and i do it but i get different results

```
/*
* To change this license header, choose License Headers in Project Properties.
* To change this template file, choose Tools | Templates
* and open the template in the editor.
*/
package iris;

import java.io.BufferedReader;
import java.io.File;
import java.io.FileReader;
import java.io.IOException;
import java.util.ArrayList;
import java.util.Arrays;
import java.util.List;
import knntradition.KNNTradition;
import static knntradition.KNNTradition.Max;
import static knntradition.KNNTradition.Sort2DList;
import static knntradition.KNNTradition.euclidean_distance;
import static knntradition.KNNTradition.get_neighbors;

/**
*
* @author Mustapha M. Baua
*/
public class iris {
public KNNTradition knn = new KNNTradition();
public static void main(String[] args)
{
/* # Test the kNN on the Iris Flowers dataset
seed(1)
filename = 'iris.csv'
dataset = load_csv(filename)
for i in range(len(dataset[0])-1):
str_column_to_float(dataset, i)
*/
List<List> DataSetList = LoadDataSet();
System.out.println("Lines in DataSetList "+ DataSetList.size());
System.out.println("");
/*# convert class column to integers
str_column_to_int(dataset, len(dataset[0])-1)
*/
List<List> lookup = lookup(DataSetList, DataSetList.get(0).size()-1);
DataSetList = str_column_to_int(DataSetList, DataSetList.get(0).size()-1);
//System.out.println("lookup "+lookup);
DataSetList = normalize_dataset(DataSetList, dataset_minmax(DataSetList));
//System.out.println(DataSetList.get(0));
//System.out.println(DataSetList.get(51));
//System.out.println(DataSetList.get(101));

/*
# evaluate algorithm
n_folds = 5
num_neighbors = 5
scores = evaluate_algorithm(dataset, k_nearest_neighbors, n_folds, num_neighbors)
print('Scores: %s' % scores)
print('Mean Accuracy: %.3f%%' % (sum(scores)/float(len(scores)))) */
int n_folds = 5;
```

```
int num_neighbors = 5;
// public static List<List<List>> k_nearest_neighbors(List<List> train, List<List> test,int num_neighbors)
List kNearestNeighbors = k_nearest_neighbors(DataSetList, DataSetList, num_neighbors);
List scores = evaluate_algorithm(DataSetList, kNearestNeighbors,n_folds, num_neighbors);
System.out.println("Scores are ");
System.out.println("scores size is "+scores.size()+" "+scores);
System.out.println("Mean Accuracy: "+ sum(scores)/scores.size());
}
public static double sum(List list)
{
double sum = 0;
for(int k = 0 ; k<list.size();k++)
{
sum += Double.valueOf(list.get(k));
}
return sum;
}
public static List LoadDataSet()
{
List<List> DataSetList = new ArrayList();
try{
File file = new File("E:\iris.txt");
FileReader Reader = new FileReader(file);
BufferedReader lineReader = new BufferedReader(Reader);
String lineText;
System.out.println("Attempting to read from file in: "+file.getCanonicalPath());
while ((lineText = lineReader.readLine()) != null)
{
String[] Elements = lineText.split(",");
//System.out.println(lineText);
List singleList = new ArrayList() ;
singleList.addAll(Arrays.asList(Elements));
DataSetList.add(singleList);
}
System.out.println("End of Reading File");
}catch (IOException e)
{
System.out.println(e.getMessage());
}
return DataSetList;
}
/* # Convert string column to integer
def str_column_to_int(dataset, column):
class_values = [row[column] for row in dataset]
unique = set(class_values)
lookup = dict()
for i, value in enumerate(unique):
lookup[value] = i
for row in dataset:
row[column] = lookup[row[column]]
return lookup */
public static List<List> str_column_to_int(List<List> ds, int column)
{
List class_values =new ArrayList();
List unique = new ArrayList();
List<List> lookup = lookup(ds,column);
for(int i = 0;i<ds.size();i++)
class_values.add(ds.get(i).get(column));
```

```
for(int i = 0;i<ds.size();i++)
{
String Count = ChFreq(unique, String.valueOf(class_values.get(i)));
if (Count!=null && "0".equals(Count))
unique.add(class_values.get(i));
}
for(int k = 0;k<ds.size();k++)
{
List TempRow = ds.get(k);
for(int h = 0 ;h < lookup.size();h++)
{
if(lookup.get(h).get(1).equals(ds.get(k).get(column)))
{
TempRow.set(column,lookup.get(h).get(0));
ds.set(k, TempRow);
}
}
}
return ds;
}
public static List<List> lookup(List<List> ds, int column)
{
List<List> lookup =new ArrayList();
List class_values =new ArrayList();
List unique = new ArrayList();
for(int i = 0;i<ds.size();i++)
class_values.add(ds.get(i).get(column));
for(int i = 0;i<ds.size();i++)
{
String Count = ChFreq(unique, String.valueOf(class_values.get(i)));
if (Count!=null && "0".equals(Count))
unique.add(class_values.get(i));
}
for(int k = 0;k<unique.size();k++)
{
List TwoItems = new ArrayList();
TwoItems.add(String.valueOf(k));
TwoItems.add(unique.get(k));
lookup.add(TwoItems);
}
return lookup;
}
/* # kNN Algorithm
def k_nearest_neighbors(train, test, num_neighbors):
predictions = list()
for row in test:
output = predict_classification(train, row, num_neighbors)
predictions.append(output)
return(predictions) */
public static List k_nearest_neighbors(List<List> train, List<List> test,int num_neighbors)
{
List predictions = new ArrayList();
for(int k = 0 ; k<test.size();k++)
{
predictions.add(predict_classification(train, test.get(k), num_neighbors));
}
return predictions;
```

```
}
/* # Make a prediction with neighbors
def predict_classification(train, test_row, num_neighbors):
neighbors = get_neighbors(train, test_row, num_neighbors)
output_values = [row[-1] for row in neighbors]
prediction = max(set(output_values), key=output_values.count)
return prediction */
public static String predict_classification(List<List> train, List test_row, long num_neighbors)
{
//System.out.println("predict_classification train set ");
//System.out.println("train size "+train.size()+" "+train);
List<List> neighbors = get_neighbors(train, test_row, num_neighbors);
List OutputValues = new ArrayList();
String prediction= null;
//System.out.println(neighbors);
//output_values = [row[-1] for row in neighbors]
if(neighbors!=null)
{
for(int i=0;i<neighbors.size();i++)
OutputValues.add(neighbors.get(i).get(neighbors.get(i).size()-2));
//System.out.println("outputvalues "+OutputValues);
prediction = Max(OutputValues);
}
return prediction;
}
// Locate the most similar neighbors
public static List<List> get_neighbors(List<List> train, List test_row,long num_neighbors)
{
List<List> Distances = new ArrayList();
List<List> neighbors = new ArrayList();
double dist;
for(int i=0;i<train.size();i++)
{
List singleList = new ArrayList();
for(int k =0;k<train.get(i).size();k++)
singleList.add(train.get(i).get(k));
dist = euclidean_distance(test_row, train.get(i));
singleList.add(String.valueOf(dist));
Distances.add(singleList);
}
Distances = Sort2DList(Distances);
for(int i=0;i<num_neighbors;i++)
neighbors.add(Distances.get(i));
//System.out.println("neighbors are "+neighbors.size()+" "+ neighbors);
return neighbors;
}
public static List<List> Sort2DList(List<List> list)
{
List maxRow = new ArrayList();
for (int i=0;i<list.size()-1;i++)
{
for(int j=i+1;jDouble.parseDouble(list.get(j).get(list.get(j).size()-1)))
{
maxRow = list.get(i);
list.set(i, list.get(j));
list.set(j, maxRow);
}
}
```

```
}
return list;
}
/* # Evaluate an algorithm using a cross validation split
def evaluate_algorithm(dataset, algorithm, n_folds, *args):
folds = cross_validation_split(dataset, n_folds)
scores = list()
for fold in folds:
train_set = list(folds)
train_set.remove(fold)
train_set = sum(train_set, [])
test_set = list()
for row in fold:
row_copy = list(row)
test_set.append(row_copy)
row_copy[-1] = None
predicted = algorithm(train_set, test_set, *args)
actual = [row[-1] for row in fold]
accuracy = accuracy_metric(actual, predicted)
scores.append(accuracy)
return scores */
public static List evaluate_algorithm(List<List> dataset,List neighbors, int n_folds, int num_neighbors)
{
List<List<List>> folds = cross_validation_split(dataset,n_folds);
List scores = new ArrayList();
for(int i = 0;i <n_folds;i++)
{
List<List<List>> train_set=new ArrayList(folds);
List<List> test_set = folds.get(i);
List<List<List>> train_set_copy = new ArrayList(train_set);
train_set_copy.remove(test_set);
//train_set = sum(train_set, [])
//System.out.println(" i = "+ i +" "+ folds.size());
List predicted = new ArrayList();
//if(!(train_set.get(i).equals(test_set)))
//{
for(int j = 0 ;j<train_set_copy.size();j++)
{
predicted = k_nearest_neighbors(train_set_copy.get(j), test_set, num_neighbors);
}
//}
//System.out.println("predicted size is "+predicted.size()+" "+predicted);
List<List> fold = folds.get(i);
List actual = new ArrayList();
for(int j = 0; j < fold.size();j++)
{
actual.add(fold.get(j).get(fold.get(j).size()-1));
}
//System.out.println("actual size "+actual.size()+" "+actual);
double accuracy = accuracy_metric(actual,predicted);
scores.add(String.valueOf(accuracy));
}
return scores;
}
/* # Split a dataset into k folds
def cross_validation_split(dataset, n_folds):
dataset_split = list()
dataset_copy = list(dataset)
```

```
fold_size = int(len(dataset) / n_folds)
for _ in range(n_folds):
fold = list()
while len(fold) < fold_size:
index = randrange(len(dataset_copy))
fold.append(dataset_copy.pop(index))
dataset_split.append(fold)
return dataset_split */
public static List<List<List>> cross_validation_split(List<List> dataset, int n_folds)
{
List<List<List>> dataset_split = new ArrayList();
List<List> dataset_copy = dataset;
int fold_size = dataset.size()/n_folds;
for(int k = 0; k< n_folds; k++)
{
List<List> fold = new ArrayList();
while(fold.size()< fold_size)
{
int index = (int) (Math.random()*dataset_copy.size()-1)+0;
fold.add(dataset_copy.get(index));
}
dataset_split.add(fold);
}
return dataset_split;
}
/* # Convert string column to float
def str_column_to_float(dataset, column):
for row in dataset:
row[column] = float(row[column].strip())
*/
public static String ChFreq(List list, String word)
{
int counter = 0;
if(list!=null)
{
for(int i =0 ;i <list.size();i++)
{
if(list.get(i) == null ? word == null : list.get(i).equals(word))
counter++;
}
}else
{
return null;
}
return String.valueOf(counter);
}
/* # Find the min and max values for each column
def dataset_minmax(dataset):
minmax = list()
for i in range(len(dataset[0])):
col_values = [row[i] for row in dataset]
value_min = min(col_values)
value_max = max(col_values)
minmax.append([value_min, value_max])
return minmax */
public static List<List> dataset_minmax(List<List> dataset)
{
List<List> minmax = new ArrayList();
```

```
for(int k = 0 ;k < dataset.get(0).size();k ++)
{
List col = GetColumn(dataset,k);
List tempminmax = new ArrayList();
tempminmax.add(Min(col));
tempminmax.add(Max(col));
minmax.add(tempminmax);
}
return minmax;
}
public static List GetColumn(List<List> ds, int col)
{
List column =new ArrayList();
for(int i = 0;i<ds.size();i++)
column.add((ds.get(i).get(col)));
return column;
}
public static String Max(List list)
{
String max = list.get(0);
for(int i=0;i<list.size();i++)
if(Double.valueOf(max)<Double.valueOf(list.get(i)))
max = list.get(i);
return max;
}
public static String Min(List list)
{
String min = list.get(0);
for(int i=0;iDouble.valueOf(list.get(i)))
min = list.get(i);
return min;
}
/* # Rescale dataset columns to the range 0-1
def normalize_dataset(dataset, minmax):
for row in dataset:
for i in range(len(row)):
row[i] = (row[i] – minmax[i][0]) / (minmax[i][1] – minmax[i][0]) */
public static List<List> normalize_dataset(List<List> dataset, List<List> minmax)
{
for(int i = 0; i< dataset.size();i++)
{
List row = dataset.get(i);
for(int j = 0; j<row.size();j++)
{
row.set(j,String.valueOf( (Double.parseDouble(row.get(j)) – Double.parseDouble(minmax.get(j).get(0))) /
(Double.parseDouble(minmax.get(j).get(1)) – Double.parseDouble(minmax.get(j).get(0)))));
}
dataset.set(i, row);
}
//System.out.println("normalized dataset "+ dataset);
return dataset;
}
/* # Calculate accuracy percentage
def accuracy_metric(actual, predicted):
correct = 0
for i in range(len(actual)):
if actual[i] == predicted[i]:
correct += 1
```

```
return correct / float(len(actual)) * 100.0 */
public static double accuracy_metric(List actual, List predicted)
{
int correct =0;
for(int k = 0;k < actual.size();k++)
{
//for(int h = 0 ;h< predicted.size();h++)
//{
if( actual.get(k).equals(predicted.get(k)))
{
correct +=1;
}
//}
}
//System.out.println("correct "+ correct);
return correct / (actual.size() * 100.0);
}
}
```

**Jason Brownlee** March 18, 2020 at 11:25 am #

REPLY

Well done!

**baua** March 18, 2020 at 10:38 pm #

REPLY

Hello ..
but i get different results … is it okay . . because i want to improve the algorithm

**Jason Brownlee** March 19, 2020 at 6:26 am #

REPLY

Yes, different results across languages is to be expected.

**baua** March 20, 2020 at 9:05 pm #

thanks … i treate the problem by multiply the result with 10000
but what do you mean by this step pleaze
train_set = sum(train_set, []) ??

**Jason Brownlee** March 21, 2020 at 8:22 am #

Good question. It looks like it does nothing.

**baua** March 20, 2020 at 9:48 pm #

now i solve the problem of results i get exactly correct results
its a problem data type between int and doulble

when i improve the algorithm i will send it to you
thanks

**Jason Brownlee** March 21, 2020 at 8:22 am #

Well done!

REPLY

**Binu** April 16, 2023 at 5:36 pm #

Hi Sir,
Thanks for sharing this. Where do I get the below java packages
import knntradition.KNNTradition;
import static knntradition.KNNTradition.Max;
import static knntradition.KNNTradition.Sort2DList;
import static knntradition.KNNTradition.euclidean_distance;
import static knntradition.KNNTradition.get_neighbors;

REPLY

**farid** March 20, 2020 at 3:29 am #

i copy your sourcecode
but i got error : “name ‘k_nearest_neighbors’ is not defined”

help please 😕

REPLY

**Jason Brownlee** March 20, 2020 at 8:47 am #

It sounds like you skipped some code, try copy-pasting the example at the end of the tutorial.

REPLY

**farid** March 20, 2020 at 2:57 pm #

still same,the error position in evaluate_algorithm cannot read k_nearest_neighbors

REPLY

**Mike Mawira** March 21, 2020 at 11:27 am #

Hello, Jason.

I would like to find the nearest neighbors of a given row in a dataset. It works well by outputting the dataset itself, however I would like it to print out the Label, for example: iris-setosa, Iris-virginica or Iris-versicolor when dealing with the iris dataset. Just like the way a recommender syatem finds out similarities. How do I go about that?

REPLY

**Jason Brownlee** March 22, 2020 at 6:49 am #

Each class is assigned an integer called integer encoding as par of data preparation. Keep track of this mapping of classes to integers. Then when you gather the k nearest neighbors – calculate the mode of the integer values and map it back to the string class name.

**baua** March 25, 2020 at 12:37 pm #

REPLY

hello Jason i improve the algorithm and also i take care with this method i found many records repeated because of using Random method so i change the code to be the following

```
public List<List<List>> cross_validation_split(List<List> dataset, int n_folds)
{
List<List<List>> dataset_split = new ArrayList();
List<List> dataset_copy = dataset;
int fold_size = dataset.size()/n_folds;
int index = 0;
for(int k = 0; k< n_folds; k++)
{
List<List> fold = new ArrayList();
while(fold.size()< fold_size)
{
// deleted line int index = (int) (Math.random()*dataset_copy.size()-1)+0;
fold.add(dataset_copy.get(index));
index++;
}
//System.out.println("fold # "+ k+ " "+fold);
dataset_split.add(fold);
}
return dataset_split;
}
```

---

**Jason Brownlee** March 26, 2020 at 7:49 am #

REPLY

Sorry, I don't have the capacity to debug your java code.

---

**Ali Akbar** April 9, 2020 at 4:30 am #

REPLY

Dear Jason Brownlee!
The code segments are not arranged i.e. the last combined complete code missing some important code segments while the first than the last has.

---

**Jason Brownlee** April 9, 2020 at 8:08 am #

REPLY

The complete code example at the end contains everything needed.

---

**Grzegorz Kępisty** April 20, 2020 at 3:58 pm #

REPLY

Good lecture Jason and many discussions induced!

I have in mind 2 more extensions to be possibly implemented in case of KNN:
1) Weights of KNN dependent on the distance from predicted point (e.g. inverse of the distance).
2) NN search algorithm improvement/acceleration/paralelization (probably helpful for big datasets).

Regards!

**Jason Brownlee** April 21, 2020 at 5:45 am #

REPLY

Thanks.

Great extension ideas!

**zoiks** May 5, 2020 at 5:43 pm #

REPLY

Hi Jason,

First I want to say thank you for your great work and explanations that you did helping us understand this new IT topic.
Now I wanna ask you a thing: I have copy paste the second bunch of code where the program output the predicted value and after I have runned it I have this output:
[Iris-versicolor] => 0
[Iris-virginica] => 1
[Iris-setosa] => 2
Data=[4.5, 2.3, 1.3, 0.3], Predicted: 2

which is different from yours:
[Iris-virginica] => 0
[Iris-setosa] => 1
[Iris-versicolor] => 2
Data=[4.5, 2.3, 1.3, 0.3], Predicted: 1

Can you please explain me why in my run the setosa is clasified as 2 and in your is classified as 1, also the others are different

Many thanks,
zoiks

**Jason Brownlee** May 6, 2020 at 6:22 am #

REPLY

Yes, you can expected differences in the results given the stochastic nature of the algorithm:
https://machinelearningmastery.com/faq/single-faq/why-do-i-get-different-results-each-time-i-run-the-code

**zoiks** May 6, 2020 at 4:16 pm #

REPLY

thanks for your answer 🙂

**Jason Brownlee** May 7, 2020 at 6:40 am #

REPLY

You're welcome.

**Quang Huy Chu** May 18, 2020 at 9:26 pm #

REPLY

Another good post of you Jason, It really helps me in studying Machine Learning by constructing algorithm from scratch.

Thank you very much.

**Jason Brownlee** May 19, 2020 at 6:03 am #

REPLY

Thanks.

**Zara** May 20, 2020 at 7:03 am #

REPLY

I need to solve a simple KNN code for my course. Can you please send me your email so I can send you the file ? I have to submit today 😕

**Jason Brownlee** May 20, 2020 at 1:32 pm #

REPLY

I don't have the capacity to review your code/data:
https://machinelearningmastery.com/faq/single-faq/can-you-read-review-or-debug-my-code

**GAMZE** June 2, 2020 at 1:29 am #

REPLY

Dear Jason,

I need to calculate the distance between each row and its 25 neighbors and store them as columns fir my project. how can I do, I have tried the following codes but it does not work.

```
distances =list()
for i in range(600):
row0 = dataset[i]
for row in dataset:
dist = euclidean_distance(row0, row)
distances.append((row, dist))
distances.sort(key=lambda tup: tup[1])
```

**GAMZE** June 2, 2020 at 1:33 am #

REPLY

thank in advance

**Jason Brownlee** June 2, 2020 at 6:19 am #

REPLY

Perhaps this will help:
https://machinelearningmastery.com/distance-measures-for-machine-learning/

**mahi** June 26, 2020 at 5:38 pm #

REPLY

why cant i convert string columns into float ?
ValueError: could not convert string to float: 'Id'
I'm facing
same code copy pasted

**Jason Brownlee** June 27, 2020 at 5:29 am #

REPLY

If the string contains a float, you can.

If the string contains characters, you will have to encode them such as an ordinal encode, one hot encode for labels or bag of words for free text.

**Shenghuan** July 24, 2020 at 7:32 am #

REPLY

Hi Jason,

Your tutorial is always so helpful. I just have a question here. When we implement the cross_validation_split, the randrange() was used to generate a single random value to locate the row of dataset. Will this random value repeated? If so, will some rows appears several times in some folds and some rows never used?

**Jason Brownlee** July 24, 2020 at 7:48 am #

REPLY

The indexes selected for each fold are removed to ensure they cannot be reselected, see the call to pop().

**Shenghuan** July 24, 2020 at 9:10 am #

REPLY

Yes, thank you very much!

**Jason Brownlee** July 24, 2020 at 10:37 am #

REPLY

You're welcome.

**Shenghuan** July 24, 2020 at 8:02 am #

REPLY

Hi Jason,

Sorry another quesion.
Can I ask what's the purpose of the step

'rain_set = sum(train_set, []) '

Thank you very much.

**David john** August 1, 2020 at 7:34 am #

REPLY

Hello great tutorial, you explained the concept well.Please the problem I am trying to solve is for blood classification, where a user desires to search for a particular blood group and the system automatically detects that and displays the result alongside suggestions of other blood groups the user can collect blood from …Please is this possible using KNN

**Jason Brownlee** August 1, 2020 at 1:28 pm #

REPLY

Thanks.

It might be possible, perhaps develop a prototype to explore the idea.

**Kenny Lamachine** December 10, 2020 at 1:23 am #

REPLY

Hi Jason,
Thank you very much for putting this together, it has helped me implement one from scratch with my targets(class) and data sperated into two seperate lists.

I am trying to implement Nested cross validation using your code, but I can't seem to figure out how to go about it. Can you please provide some insight and code on how to do that by expanding on your evaluate_algorithm function? Also what is the purpose of line 78 in the evaluate_algorithm function and what does do?

I am new to machine learning.

**Jason Brownlee** December 10, 2020 at 6:28 am #

REPLY

You're welcome.

Perhaps this will give you some ideas:
https://machinelearningmastery.com/nested-cross-validation-for-machine-learning-with-python/

**Kenny Lamachine** January 5, 2021 at 1:15 pm #

REPLY

Thanks again Jason.

**Nava** December 24, 2020 at 5:03 am #

REPLY

Hi Jason,
Thank you very much for this. I ran this part
def evaluate_algorithm(X, algorithm, K, k):
folds = CrossValidationSplit(X, K)
traindata=folds
scores = list()
for fold in folds:
traindata.remove(fold)
traindata = sum(traindata, [])
testdata = list()
for row in fold:
r = list(row)
testdata.append(r)
r[-1] = None
predicted = algorithm(traindata, testdata, k)
actual = [row[-1] for row in fold]
accuracy = accuracy_metric(actual, predicted)
scores.append(accuracy)
return scores, traindata, testdata, actual
and get an error, can you help me please?

**Nava** December 24, 2020 at 5:04 am #

REPLY

ValueError: The truth value of an array with more than one element is ambiguous. Use a.any() or a.all()

**Jason Brownlee** December 24, 2020 at 5:39 am #

REPLY

These tips will help:
https://machinelearningmastery.com/faq/single-faq/why-does-the-code-in-the-tutorial-not-work-for-me

**Jimmy** January 8, 2021 at 4:59 pm #

REPLY

Hi Team,

I was going through the pseudo-code of K-NN. The first step involved calculating the euclidean distance.

1
2
3
4
5
6
7

X1 X2 Y
2.7810836 2.550537003 0
1.465489372 2.362125076 0
3.396561688 4.400293529 0
1.38807019 1.850220317 0
3.06407232 3.005305973 0
7.627531214 2.759262235 1

In the above data, we are given X1 and X2. And while calculating euclidean distance they are calculating euclidean distance between x1 and x2 but I believe x1 and x2 are two features of a point. And why are we calculating the distance between x1 and x2 these are the two features not two points. Also the plot shown above conveys the same.

Request you to please clarify

**Jason Brownlee** January 9, 2021 at 6:39 am #

REPLY

Yes, the same idea scales up to any number of features.

**Nitish** January 16, 2021 at 7:22 pm #

REPLY

Hello Jason,

Was just going through your code, could you explain why did you use range(len(row1)-1) in your euclidean distance code rather than range(len(row1)).

The final values of Euclidean distance over the test set you had provided above are different
for me since you haven't included the last column from your list.

I am still learning ML and need to understand why the column containing the integer values has been left out while computing the distance in your implementation?

# Test distance function
dataset = [[2.7810836,2.550537003,0],
[1.465489372,2.362125076,0],
[3.396561688,4.400293529,0],
[1.38807019,1.850220317,0],
[3.06407232,3.005305973,0],
[7.627531214,2.759262235,1],

[5.332441248,2.088626775,1],
[6.922596716,1.77106367,1],
[8.675418651,-0.242068655,1],
[7.673756466,3.508563011,1]]

I came across this while I was trying to create a vectorized implementation of your euclidean distance function which is as follows:

My Vectorized Implementation:

```
def eucledian dist(vec1,vec2):
“””
Calculates the eucledian distance between two vectors/points.

Parameters
———-
vec1 : array_like
Data point values for a 1st vector/point

vec2 : array_like
Data point values for a 2nd vector/point

Returns
——-
dist : float
The eucledian distance between 2 vectors.

Instructions
———
Calculate the eucledian distance between two vectors/points

“””
dist=0.0
print(“Difference of vectors:”,vec2-vec1)
print(“Sqaure of Difference:”,np.square(vec2-vec1))
print(“Sum of Sqaure of Difference:”,np.sum(np.square(vec2-vec1)))
print(“Sqrt of Sum of Sqaure of Difference:”,np.sqrt(np.sum(np.square(vec2-vec1))))
print(‘————————————————————————————‘)
dist = np.sqrt(np.sum(np.square(vec2-vec1)))

return dist
```

———————————————————————————————————

Function Call:

```
# Retaining Precesion in numpy
np.set_printoptions(precision=17)

dataset_np = np.asarray(dataset)

for i in dataset_np:
eucledian dist(dataset_np[0],i)
```

———————————————————————————————————

Output:

```
Difference if vectors: [0. 0. 0.]
Sqaure of Difference: [0. 0. 0.]
Sum of Sqaure of Difference: 0.0
Sqrt of Sum of Sqaure of Difference: 0.0
```

————————————————————————————

```
Difference if vectors: [-1.3155942280000001 -0.1884119270000002 0. ]
Sqaure of Difference: [1.7307881727469163 0.0354990542358534 0. ]
Sum of Sqaure of Difference: 1.7662872269827696
Sqrt of Sum of Sqaure of Difference: 1.3290173915275787
```

————————————————————————————

Difference if vectors: [0.6154780879999997 1.8497565259999997 0. ]
Sqaure of Difference: [0.37881327680813537 3.4215992054795876 0. ]
Sum of Sqaure of Difference: 3.800412482287723
Sqrt of Sum of Sqaure of Difference: 1.9494646655653247
————————————————————————————

Difference if vectors: [-1.39301341 -0.7003166860000001 0. ]
Sqaure of Difference: [1.9404863604398281 0.4904434606900227 0. ]
Sum of Sqaure of Difference: 2.4309298211298507
Sqrt of Sum of Sqaure of Difference: 1.5591439385540549
————————————————————————————

Difference if vectors: [0.2829887200000001 0.45476896999999994 0. ]
Sqaure of Difference: [0.08008261564723845 0.20681481607486085 0. ]
Sum of Sqaure of Difference: 0.2868974317220993
Sqrt of Sum of Sqaure of Difference: 0.5356280721938492
————————————————————————————

Difference if vectors: [4.846447614000001 0.20872523199999993 1. ]
Sqaure of Difference: [23.488054475246297 0.04356622247345379 1. ]
Sum of Sqaure of Difference: 24.531620697719752
Sqrt of Sum of Sqaure of Difference: 4.952940611164215
————————————————————————————

Difference if vectors: [ 2.551357648 -0.46191022800000026 1. ]
Sqaure of Difference: [6.509425848008093 0.21336105873101222 1. ]
Sum of Sqaure of Difference: 7.722786906739105
Sqrt of Sum of Sqaure of Difference: 2.7789902674782985
————————————————————————————

Difference if vectors: [ 4.1415131160000005 -0.7794733330000001 1. ]
Sqaure of Difference: [17.152130890000034 0.607578676858129 1. ]
Sum of Sqaure of Difference: 18.759709566858163
Sqrt of Sum of Sqaure of Difference: 4.3312480380207
————————————————————————————

Difference if vectors: [ 5.894335050999999 -2.7926056580000003 1. ]
Sqaure of Difference: [34.74318569344716 7.798646361093614 1. ]
Sum of Sqaure of Difference: 43.54183205454078
Sqrt of Sum of Sqaure of Difference: 6.59862349695304
————————————————————————————

Difference if vectors: [4.892672866 0.958026008 1. ]
Sqaure of Difference: [23.938247773692652 0.9178138320044161 1. ]
Sum of Sqaure of Difference: 25.856061605697068
Sqrt of Sum of Sqaure of Difference: 5.084885603993178
————————————————————————————

**Nitish** January 16, 2021 at 7:26 pm #

REPLY

Are taking your last column as a response variable in the test data below

dataset = [[2.7810836,2.550537003,0],
[1.465489372,2.362125076,0],
[3.396561688,4.400293529,0],
[1.38807019,1.850220317,0],
[3.06407232,3.005305973,0],
[7.627531214,2.759262235,1],
[5.332441248,2.088626775,1],
[6.922596716,1.77106367,1],
[8.675418651,-0.242068655,1],
[7.673756466,3.508563011,1]]

**Jason Brownlee** January 17, 2021 at 6:04 am #

REPLY

We exclude the last value in the vector/row as it is the class label.

**Nitish** January 17, 2021 at 2:41 pm #

REPLY

Thanks for the quick reply!

**ivan** February 2, 2021 at 6:50 pm #

REPLY

can you help me to make KNN with cosine similarity ??

**Jason Brownlee** February 3, 2021 at 6:15 am #

REPLY

Sorry, I don't have an example.

Perhaps start with the above example and implement your cosine distance metric instead of euclidean.

**Ted** March 28, 2021 at 5:06 pm #

REPLY

Much appreciate, Jason! Just cited you in my graduate work.

**Jason Brownlee** March 29, 2021 at 6:16 am #

REPLY

Thanks Ted!

**Brij Bhushan** April 3, 2021 at 12:30 am #

REPLY

Hey Jason,
Great article! So well written -This is very helpful article for everyone. I wish to read more article from you! Thanks for sharing this valuable information!

**Jason Brownlee** April 3, 2021 at 5:34 am #

REPLY

Thanks!

**sattamatka** April 28, 2021 at 8:00 am #

REPLY

This was really an interesting topic and I kinda agree with what you have mentioned here!

**Jason Brownlee** April 29, 2021 at 6:20 am #

REPLY

Thanks!

**Maya** May 14, 2021 at 12:12 am #

REPLY

i'm fairly new to python and this really helped me understand!! But i'm unsure on how to do plotting … i"d like to show : the num of k vs accuracy

**Jason Brownlee** May 14, 2021 at 6:26 am #

REPLY

Sorry, I don't have tutorials on the basics of plotting.

Perhaps check the matplotlib API.

**Satta Matka** June 2, 2021 at 11:36 pm #

REPLY

I no vulnerability regarding every single piece of it. It is a stunning site and better than anything typical give. I need to appreciative. Magnificent work! All of you complete an impossible blog, and have some unprecedented substance. Continue doing shocking.

**Jason Brownlee** June 3, 2021 at 5:36 am #

REPLY

Thanks.

**Satta Guessing** October 7, 2021 at 4:28 pm #

REPLY

I am a beginner in Python, this article is very helpful for me. Thanks for sharing this content and looking more such interesting topics.

**Adrian Tam** October 12, 2021 at 12:18 am #

REPLY

Thanks. Glad you enjoyed it.

**riri** October 24, 2021 at 7:30 am #

REPLY

hi
ihave question ?
can I visulize voroni for the list data set after classificaion ?

I want to make Voronoi diagram for vectors(list ) of the dataset with knn classifier
is that possible?

**Adrian Tam** October 27, 2021 at 1:57 am #

REPLY

No example here yet but you can check out a handy function from SciPy that can help you do the plot:
https://docs.scipy.org/doc/scipy/reference/generated/scipy.spatial.voronoi_plot_2d.html

**nclex prep** January 16, 2022 at 12:29 am #

REPLY

I have browsed most of your posts. This post is probably where I got the most useful information for my research

**James Carmichael** January 17, 2022 at 7:29 am #

REPLY

Thank you for the feedback Nclex!

**더원 홀덤** January 22, 2022 at 6:43 am #

REPLY

Really nice and interesting post. I was looking for this kind of information and enjoyed reading this one.

**James Carmichael** January 22, 2022 at 10:01 am #

REPLY

Thank you for the feedback!

**Yusuf Rehman** May 1, 2022 at 6:01 am #

REPLY

Hey, I am having an error that says ” could not convert string to float: ‘sepallength’ “.
Any idea on why is it not working and tips on fixing it?

**James Carmichael** May 2, 2022 at 9:24 am #

REPLY

Hi Yusuf…The following may be of interest to you:

https://itsmycode.com/python-valueerror-could-not-convert-string-to-float/

**Hoi Yu Ng** May 15, 2022 at 8:00 am #

REPLY

Can you show us how to write a function for Manhattan distance?

**James Carmichael** May 15, 2022 at 10:53 am #

REPLY

Hi Hoi Yu Ng…The following may be of interest:

https://machinelearningmastery.com/distance-measures-for-machine-learning/

**Hoi Yu Ng** May 16, 2022 at 3:15 am #

REPLY

That's a lot. I have read it.

**Shein Return Label** May 20, 2022 at 8:17 pm #

REPLY

Really helpful article all about the python from scratch! You really have a great stuff on this topic! Thanks for the valuable information…

**James Carmichael** May 20, 2022 at 10:59 pm #

REPLY

Great feedback Shein!

**satta matka** March 23, 2023 at 6:25 pm #

REPLY

Thanks for your post. I've been thinking about writing a very comparable post over the last couple of weeks, I'll probably keep it short and sweet and link to this instead if thats cool. Thanks.

**James Carmichael** March 24, 2023 at 6:09 am #

REPLY

Thank you for your feedback satta!

**hokiwin** December 26, 2023 at 12:09 pm #

REPLY

Yooo thanks for the tutorial man, really love it. god bless your knowledge

**James Carmichael** December 27, 2023 at 11:31 am #

REPLY

Thank you hokiwin for your kind words and support! We greatly appreciate it!

**ALAA** January 22, 2024 at 11:45 pm #

REPLY

Hello Dr.Jason

Thanks a lot for all your effort , I tried to reimplement the whole experiment over Iris dataset , however I got Error "list index out of range"

```
for i in range(len(actual)):
—> 67 if actual[i] == predicted[i]:
68 correct += 1
69 return correct / float(len(actual)) * 100.0
```

IndexError: list index out of range

I tried to fix the error like that:

```
for i in range(min(len(actual),len(predicted))):
if actual[i] == predicted[i]:
correct += 1
```

return correct / float(len(actual)) * 100.0
I got :

Scores: [3.3333333333333335]
Mean Accuracy: 3.333%

I didn't get the same results as you 96%. Your help and effort is much appreciated If you could help me discover the issue.

Alaa
PhD student

**James Carmichael** January 23, 2024 at 9:18 am #

REPLY

Hi Alaa…Did you copy and paste the code or type it in? Also, have you tried your code within Google Colab and within your local Python environemnt?

**ALAA** January 25, 2024 at 6:06 pm #

REPLY

Hi Dr.James, I sent two replies but they didn't appear on the site. I already typed the code and applied on the Google Colab, but I got the same problem. Any other advice or suggestions will be much appreciated.

ALAA

**aakash** January 27, 2024 at 6:15 pm #

REPLY

Excellent article. Thanks for sharing.

**James Carmichael** January 28, 2024 at 2:29 am #

REPLY

Thank you your feedback! We appreciate it!

## Leave a Reply

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I'm *Jason Brownlee* PhD
and I **help developers** get results with **machine learning**.
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