Course 592

Data Science with Python

Exercise Manual

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# Exercise 2.1: Array Creation

The aim of this exercise is to gain some experience of working with NumPy arrays.

1. Start IPython.
2. Define an ndarray containing the integer numbers 0 to 9.
3. Print the type of the array to the console.
4. Print the following properties of the array (they are accessible in the same way as ntype):
   1. ndim
   2. shape
   3. size
   4. itemsize
5. Define a 3 x 3 NumPy array containing all 1’s and display it to the console.
6. Print the four properties of Step 4 on the array defined in Step 5.

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# Exercise 2.2: Array Basic Operations

The aim of this exercise is to gain some experience of working with basic operations on NumPy arrays.

1. Define a 3 x 3 array with the integers 1 through 9 named array1.
2. Define a second 3 x 3 array with the number 2 in each cell named array2.
3. Now, perform the following operations using the two arrays:
   1. array1+array2
   2. array1-array2
   3. array1/array2
   4. array1\*5
4. Print elements 4 to 6 of array 1 using a slice operation.
5. Create a new single-dimensioned array named array3 with the numbers 0 through 19 in it.
6. Take a slice of elements 5 to 15 of array 3 and assign the slice to a variable named aslice and print the variable.
7. Modify the contents of the first and last elements of the slice by writing the value 99 into these elements.
8. Print the contents of the slice aslice and the array array3. Are the contents what you expect of both arrays?

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# Exercise 3.1: Pandas Series

The aim of this exercise is to gain some experience of working with the NumPy Series data structure.

1. Define a Series object holding the values 1 to 10.
2. Display the data values of the Series object defined in Step 1.
3. Display the index values of the Series object defined in Step 1.
4. Define a new Series object holding the values 1 to 10, with the corresponding index values set ‘a’ through to ‘j’.
5. Display the data values and index of the Series object of Step 4.
6. Access the third and fifth elements of the Series object using their index.
7. Define the following dictionary: {'Dublin': 200000, 'Athlone': 15000, 'Galway': 700000}.
8. Define the following array: ['Dublin', 'Athlone', 'Waterford'].
9. Now, construct a Series object using the dictionary in Step 7 and the index in Step 8.
10. Display the Series object defined in Step 9.
11. Use the Series notnull() and isnull() methods to display which elements are not null and null, respectively, for the Series object defined in Step 9.

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# Exercise 3.2: Pandas DataFrame

The aim of this exercise is to gain some experience of working with NumPy DataFrame data structure.

1. Use the following dictionary to create a DataFrame:
   1. {'team':['Leicester', 'Manchester City', 'Arsenal'], player':['Vardy', 'Aguero', 'Sanchez'],'goals':[24,22,19]}
2. Display the above DataFrame to the console.
3. What values are assigned for the index and columns?

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1. Use the dictionary from Step 1 and create a second DataFrame with index values 'one', 'two', 'three', respectively, and columns team, player, goals, played. Display the DataFrame to the console.

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# Exercise 3.3: Working with DataFrame and Series

The aim of this exercise is to gain some more experience of working with NumPy Series and DataFrame data structures.

1. Define and display a Series object with the following data: [1.1,2.2,3.3,4.4] and index=['d','b','c','a'].
2. Reindex the data with the index index=['a','b','c','d','e','f'] and display the Series object. Are there any missing values? \_\_\_\_\_\_\_\_\_\_\_\_\_\_  
   If so, reindex again and zero-fill the missing values.
3. Display only those values in the series that have a data value >2.
4. Define a 3 x 3 DataFrame with columns A, B, C and index a, b, c. You choose the integer values of the data for each cell. Display the DataFrame.
5. Reindex the DataFrame of Step 3 with the index a, b, c, d, e. Display the DataFrame. Is it as you expect? What order are the rows?

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1. For your DataFrame, display the data but only include those rows whose data in Column B is >2.
2. Define a 4 x 4 DataFrame of integer numbers. Define a 3 x 3 DataFrame of integer numbers. Add the two DataFrame’s together. What is the result?

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1. Repeat Step 7, but in a way that any missing values in the result are zero-filled.
2. Define the following DataFrame: DataFrame(np.random.randn(4,4)).
3. Now, define a Python Lambda function of the following form: f = lambda x: x.max() - x.min().
4. Apply the function in Step 7 to each row in the DataFrame defined in Step 9.
5. Repeat Step 11, but for each column.
6. Sort the DataFrame in Step 7 firstly by column index, then repeat by row index.
7. On the DataFrame defined in Step 7, apply the following functions:
   1. describe()
   2. sum() – do this for each axis

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# Exercise 4.1: Combining and Merging Data Sets

The aim of this exercise is to gain some more experience of joining and merging Series and DataFrame data structures.

1. Define two data structures as follows:
   1. DataFrame({'key': ['b','b','a','c','a','a','b'], 'data1': range(7)})
   2. DataFrame({'key': ['a','b','d'], 'data2': range(3)})
2. Now, merge the two DataFrames and display the results. Are they as you expected? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. On the two DataFrames of Step 1, perform the following joins:
   1. Left
   2. Right
   3. Outer
4. Define two data structures as follows:
   1. DataFrame({'key': [0,1,0,0,1,2], 'value': range(6)})
   2. DataFrame({'value': [2,4]})
5. Merge the above DataFrames on the following:
   1. Left key with right index
   2. Left index with right key
   3. Left and right indexes
6. Define the following three data structures:
   1. Series([0,1], index=['a','b'])
   2. Series([3,4,5], index=['c','d','e'])
   3. Series([6,7,8], index=['f','g','h'])
7. Now, concatenate the three Series objects defined in Step 6 and display the result.
8. In the result of Step 7, it is not known which Series the pieces in the result originated from. Re-run the concatenate, but in a way that shows the origin of the pieces of data in the result.
9. Use the following: np.arange(6) as the basis to define a 2 x 3 DataFrame. Perform the following operations on the DataFrame and confirm the results are as you expect:
   1. Stack
   2. Unstack

# Exercise 4.2: Transforming Data

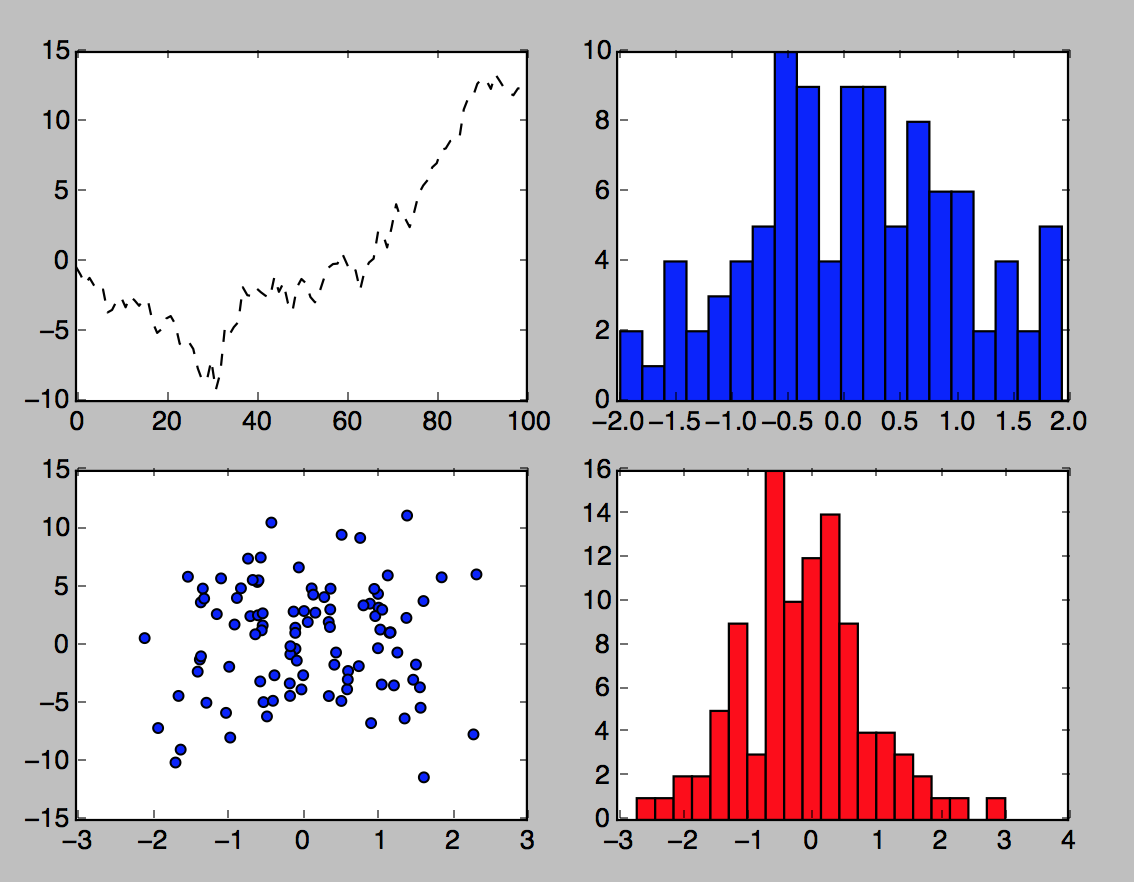
The aim of this exercise is to gain some experience of transforming DataFrame data structures.

1. Define a data structure of the following form:
   1. DataFrame({'c1' : ['a']\*2 + ['b']\*3, 'c2' : [10,10,11,12,12]})
2. For the DataFrame in Step 1, perform the following:
   1. Display it to the console.
   2. Print the indexes and whether the values at each index are duplicates or not.
   3. Print the DataFrame with duplicates removed.
3. Repeat Step 2b above, but the duplicates should only consider column c1.
4. Define a data structure of the following form:
   1. DataFrame({'player': ['sanchez','vardy','costa','lukaku'], 'goals' : [19,24,18,22]})
5. Now, transform the data in Step 5 by adding an extra column named team which represents the team each player belongs to. The data values are:
   1. sanchez Arsenal
   2. vardy Leicester
   3. costa Chelsea
   4. lukaku Everton
6. Define the following data structure:
   1. customer\_ages = [21,65,43,44,71,64,27,20,28,24,55,33,29]
7. The data above represents the ages of customers who have purchased goods from our e-commerce site. Bin these data into the following categories and display the number of people in each category:
   1. Young Adult 25-40
   2. Senior 60-100
   3. Middle Age 40-60
   4. Student 18-25

# Exercise 5.1: Working with Matplotlib

The aim of this exercise is to gain some experience of plotting data using matplotlib.

1. Your task is to plot a chart similar to the following:



1. The data for the above can be generated as follows:
   1. For the plot: randn(x).cumsum()
   2. For the histogram: randn(x), bins=y
   3. For the scatter plot: randn(x), randn(x)-y\*randn(100)
2. Plot the result of the cumulative sum of 2000 random numbers. The chart should have a title, x axis ticks set at 1, 500, 1000, 1500, and 2000 intervals, and x and y labels.
3. Define the following DataFrame:
   1. DataFrame({'A': np.random.randn(1000) + 1,'B': np.random.randn(1000), 'C': np.random.randn(1000)-1})
4. Plot the DataFrame from Step 4 as a histogram.
5. For the DataFrame of Step 4, plot a scatter plot for the following:
   1. Column A vs. Column B
   2. Column B vs. Column C
6. Add labels and a title to the plots in Step 6.