

# hw04

July 25, 2023

## 1 Metadata

Course: DS 5100  
Module: 04 Functions HW  
Title: Fighting Forest Fires with Functions  
Author: R.C. Alvarado (adapted)  
Date: 7 July 2023

## 2 Student Info

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- Net ID: ddj6tu
- URL of this file in GitHub: <https://github.com/slipr19/DS5100-ddj6tu/tree/main/lessons/M04>

## 3 Instructions

In your **private course repo on Rivanna**, write a Jupyter notebook running Python that performs the numbered tasks below.

For each task, create one or more code cells to perform the task.

Save your notebook in the M04 directory as `hw04.ipynb`.

Add and commit these files to your repo.

Then push your commits to your repo on GitHub.

Be sure to fill out the **Student Info** block above.

To submit your homework, save the notebook as a PDF and upload it to GradeScope, following the instructions.

**TOTAL POINTS: 14**

## 4 Overview

In this homework, you will work with the [Forest Fires Data Set from UCI](#).

There is a local copy of these data as a CSV file in the HW directory for this module in the course repo.

You will create a group of related functions to process these data.

This notebook will set the table for you by importing and structuring the data first.

## 5 Setting Up

First, we read in our local copy of the dataset and save it as a list of lines.

```
[1]: data_file = open('uci_mldb_forestfires.csv', 'r').readlines()
```

Then, we inspect first ten lines, replacing commas with tabs for readability.

```
[2]: for row in data_file[:10]:  
      row = row.replace(',', '\t')  
      print(row, end='')
```

| 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  | 0.0   |     |      |       |       |      |      |    |
| 7    | 4    | oct   | tue | 90.6 | 35.4  | 669.1 | 6.7  | 18.0 | 33 |
| 0.9  | 0.0  | 0.0   |     |      |       |       |      |      |    |
| 7    | 4    | oct   | sat | 90.6 | 43.7  | 686.9 | 6.7  | 14.6 | 33 |
| 1.3  | 0.0  | 0.0   |     |      |       |       |      |      |    |
| 8    | 6    | mar   | fri | 91.7 | 33.3  | 77.5  | 9.0  | 8.3  | 97 |
| 4.0  | 0.2  | 0.0   |     |      |       |       |      |      |    |
| 8    | 6    | mar   | sun | 89.3 | 51.3  | 102.2 | 9.6  | 11.4 | 99 |
| 1.8  | 0.0  | 0.0   |     |      |       |       |      |      |    |
| 8    | 6    | aug   | sun | 92.3 | 85.3  | 488.0 | 14.7 | 22.2 | 29 |
| 5.4  | 0.0  | 0.0   |     |      |       |       |      |      |    |
| 8    | 6    | aug   | mon | 92.3 | 88.9  | 495.6 | 8.5  | 24.1 | 27 |
| 3.1  | 0.0  | 0.0   |     |      |       |       |      |      |    |
| 8    | 6    | aug   | mon | 91.5 | 145.4 | 608.2 | 10.7 | 8.0  | 86 |
| 2.2  | 0.0  | 0.0   |     |      |       |       |      |      |    |
| 8    | 6    | sep   | tue | 91.0 | 129.5 | 692.6 | 7.0  | 13.1 | 63 |
| 5.4  | 0.0  | 0.0   |     |      |       |       |      |      |    |

### 5.1 Convert CSV into Dataframe-like Data Structure

We use a helper function to convert the data into the form of a dataframe-like dictionary.

That is, we convert a list of rows into a dictionary of columns, each cast to the appropriate data type.

Later, we will use Pandas and R dataframes to do this work.

First, we define the data types by inspecting the data and creating a dictionary of lambda functions to do our casting.

```
[3]: dtypes = ['i', 'i', 's', 's', 'f', 'f', 'f', 'f', 'f', 'i', 'f', 'f', 'f']
      # dtypes = list("iissffffffiff") # We could have done it this way, too

      caster = {
          'i': lambda x: int(x),
          's': lambda x: str(x),
          'f': lambda x: float(x)
      }
```

Next, we grab the column names from the first row or list.

Note that `.strip()` is a string function that removes extra whitespace from before and after a string.

```
[4]: cols = data_file[0].strip().split(',')
```

Finally, we iterate through the list of rows and flip them into a dictionary of columns.

The key of each dictionary element is the columns name, and the value is a list of values with a common data type.

```
[5]: # Get the rows, but not the first, and convert them into lists
      rows = [line.strip().split(',') for line in data_file[1:]]

      # Initialize the dataframe by defining a dictionary of lists, with each column
      # name as a key
      firedata = {col:[] for col in cols}

      # Iterate through the rows and convert them to columns
      for row in rows:
          for j, col in enumerate(row):
              firedata[cols[j]].append(caster[dtypes[j]](col))
```

Test to see if it worked ...

```
[6]: firedata['Y'][:5]
```

```
[6]: [5, 4, 4, 6, 6]
```

## 6 Working with spatial coordinates X, Y

For the first tasks, we grab the first two columns of our table, which define the spatial coordinates within the Monteshino park map.

```
[7]: X, Y = firedata['X'], firedata['Y']
```

```
[8]: X[:10], Y[:10]
```

```
[8]: ([7, 7, 7, 8, 8, 8, 8, 8, 8, 7], [5, 4, 4, 6, 6, 6, 6, 6, 6, 5])
```

## 6.1 Task 1

(2 points)

Write a function called `coord_builder()` with these requirements:

- Takes two lists, X and Y, as inputs. X and Y must be of equal length.
- Returns a list of tuples [(x1,y1), (x2,y2), ..., (xn,yn)] where (xi,yi) are the ordered pairs from X and Y.
- Uses the `zip()` function to create the returned list.
- Use a list comprehension to actually build the returned list.
- Contains a docstring with short description of the function.

```
[28]: def coord_builder(X,Y):  
    '''  
    This is the "docstring" of coord_builder.  
  
    PURPOSE: Given two lists, create a list of the tuples of the  
    members of the two lists.  
  
    INPUTS  
    X    list  
    Y    list  
  
    OUTPUT  
    list of tuples  
    '''  
    if(len(X) != len(Y)):  
        print("Error: These lists are not the same length!")  
    else:  
        zipxy = zip(X,Y)  
        [print(tuple(z)) for z in zipxy]
```

## 6.2 Task 2

(1 PT)

Call your `coord_builder()` function, passing in X and Y.

Then print the first ten tuples.

```
[30]: X10 = X[:10]  
Y10 = Y[:10]  
coord_builder(X10, Y10)
```

```
(7, 5)  
(7, 4)  
(7, 4)  
(8, 6)  
(8, 6)
```

```
(8, 6)
(8, 6)
(8, 6)
(8, 6)
(7, 5)
```

## 7 Working with AREA

Next, we work the area column of our data.

```
[47]: area = firedata['area']
```

```
[32]: area[-10:]
```

```
[32]: [0.0, 0.0, 2.17, 0.43, 0.0, 6.44, 54.29, 11.16, 0.0, 0.0]
```

### 7.1 Task 3

(1 PT)

Write code to print the minimum area and maximum area in a tuple (`min_value`, `max_value`).

Save `min_value` and `max_value` as floats.

```
[34]: def min_max(area):
      min_value = float(min(area))
      max_value = float(max(area))
      print(f"The minimum is {min_value}. The maximum is {max_value}.")
```

### 7.2 Task 4

(2 PTS)

Write a lambda function that applies the following function to  $x$ :

$$\log_{10}(1 + x)$$

Return the rounded value to 2 decimals.

Assign the function to the variable `mylog10`.

Then call the lambda function on `area` and print the last 10 values.

Hints: \* Use the `log10` function from Python's [math module](#). You'll need to import it. \* Use a list comprehension to make the lambda function a one-liner. \* To get the last members of a list, used negative offset slicing. See [the Python documentation on lists](#) for a refresher on slicing.

```
[38]: import math
```

```
[43]: mylog10 = lambda x: round(math.log10(1+x), 2)
```

```
[51]:
```

```
[51]: <function __main__.<lambda>(x)>
```

```
[53]: [round(math.log10(1+x), 2) for x in area[-10:]]
```

```
[53]: [0.0, 0.0, 0.5, 0.16, 0.0, 0.87, 1.74, 1.08, 0.0, 0.0]
```

## 8 Working with MONTH

The month column contains months of the year in abbreviated form — jan to dec.

```
[57]: month = firedata['month']
```

```
[19]: month[:10]
```

```
[19]: ['mar', 'oct', 'oct', 'mar', 'mar', 'aug', 'aug', 'aug', 'sep', 'sep']
```

### 8.1 Task 5

(1 PT)

Create a function called `get_uniques()` that extracts the unique values from a list. \* Do not use `set()` but instead use a **dictionary comprehension** to capture the unique names. \* Hint: They keys in a dictionary are unique. \* Hint: You do not need to count how many times a name appears in the source list.

Then function should optionally return the list as sorted in ascending order.

Then apply it to the `month` column of our data with sorting turned on.

Then print the unique months.

```
[92]: def get_uniques(ulist):  
        uniquelist = []  
        [uniquelist.append(x) for x in ulist if not x in uniquelist]  
        return(uniquelist)
```

```
[93]: get_uniques(month)
```

```
[93]: ['mar',  
        'oct',  
        'aug',  
        'sep',  
        'apr',  
        'jun',  
        'jul',  
        'feb',  
        'jan',  
        'dec',  
        'may',  
        'nov']
```

## 8.2 Task 6

(1 PT)

Write a lambda function called `get_month_for_letter` that uses a list comprehension to select all months starting with a given letter from the list of unique month names you just created.

The function should assume that the list of unique month names exists in the global context.

The returned list should contain uppercase strings.

Run and print the result with `a` as the parameter.

```
[106]: def get_month_for_letter(months, letter):  
        return [x.upper() for x in months if x[:1] == letter]
```

## 9 Working with DMC

DMC - DMC index from the FWI system: 1.1 to 291.3

```
[109]: dmc = firedata['DMC']
```

```
[110]: dmc[:10]
```

```
[110]: [26.2, 35.4, 43.7, 33.3, 51.3, 85.3, 88.9, 145.4, 129.5, 88.0]
```

### 9.1 Task 7

(2 PTS)

Write a function called `bandpass_filter()` with these requirements:

- Takes three inputs:
  - A list of numbers `num_list`.
  - An integer serving as a lower bound `lower_bound`.
  - An integer serving as an upper bound `upper_bound`.
- Returns a new array containing only the values from the original array which are greater than `lower_bound` and less than `upper_bound`.

```
[111]: def bandpass_filter(num_list, lower_bound, upper_bound):  
        return [x for x in num_list if x > lower_bound and x < upper_bound]
```

### 9.2 Task 8

(1 PT)

Call `bandpass_filter()` passing `dmc` as the list, with `lower_bound=25` and `upper_bound=35`.

Then print the result.

```
[115]: bandpass_filter(list(dmc), 25, 35)
```

```
[115]: [26.2,
        33.3,
        32.8,
        27.9,
        27.4,
        25.7,
        33.3,
        33.3,
        30.7,
        33.3,
        25.7,
        25.7,
        25.7,
        32.8,
        27.2,
        27.8,
        26.4,
        25.4,
        25.4,
        25.4,
        25.4,
        26.7,
        25.4,
        27.5,
        28.0,
        25.4]
```

## 10 Working with FFMC

FFMC - FFMC index from the FWI system: 18.7 to 96.20

```
[116]: ffmc = firedata['FFMC']
```

```
[117]: ffmc[:10]
```

```
[117]: [86.2, 90.6, 90.6, 91.7, 89.3, 92.3, 92.3, 91.5, 91.0, 92.5]
```

### 10.1 Task 9

(2 PTS)

Write a lambda function `get_mean` that computes the mean  $\mu$  of a list of numbers. \* The mean is just the sum of a list of numeric values divided by the length of that list.

Write another lambda function `get_ssd` that computes the squared deviation of a number. \* The function takes two arguments, a number from a given list and the mean of the numbers in that list. \* The function is meant to be used in a for-loop that iterates through a list. \* The squared deviation of a list element  $x_i$  is  $(x_i - \mu)^2$ .



Then write `get_sum_sq_err()` with these requirements: \* Takes a numeric list as input. \* Computes the mean  $\mu$  of the list using `get_mean`. \* Computes the sum of squared deviations for the list using a list comprehension that applies `get_ssd`. \* Returns the sum of squared deviations.

```
[134]: get_mean = lambda x: sum(x)/len(x)
get_ssd = lambda x, y: (x - y)**2
def get_sum_sq_err(numlist):
    mean = get_mean(numlist)
    return [get_ssd(x, mean) for x in numlist]
```

## 10.2 Task 10

(1 PT)

Call `sum_sq_err()` passing `ffmc` as the list and print the result.

```
[136]: get_sum_sq_err(ffmc)
```

```
[136]: [19.7551878678114,
0.0019963784517678914,
0.0019963784517678914,
1.113698506111859,
1.8081665912171285,
2.7400814848355264,
2.7400814848355264,
0.7315708465372919,
0.12625169760088936,
3.442209144410097,
3.442209144410097,
4.645400633771926,
736.8336985060987,
0.06518786781361177,
5.086464463559245,
7.050719782708326,
1.113698506111859,
33.001358080576715,
2.0871027614298323,
18.876251697598732,
0.12625169760088936,
1.3347623358991267,
13.361358080581125,
0.19774105930264288,
8.152847442282901,
0.5705070167500199,
3.0811453146228365,
0.06518786781361177,
7.591783612495653,
8.152847442282901,
```

13.361358080581125,  
4.180719782706181,  
4.180719782706181,  
1.113698506111859,  
1.3347623358991267,  
0.11880488908992785,  
0.0019963784517678914,  
0.4156133997280844,  
0.0019963784517678914,  
6.475400633769784,  
124.20391127206364,  
0.19774105930264288,  
17.266677229517526,  
3.442209144410097,  
0.29667722951537107,  
13.361358080581125,  
0.06518786781361177,  
12.640294250793886,  
11.865826165684211,  
9.270081484833387,  
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2.117953825260958,  
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3.0811453146228365,  
3.0811453146228365,  
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1.113698506111859,  
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16.359443186960593,

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5.086464463559245,  
5.086464463559245,  
5.086464463559245,  
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6.475400633769784,  
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1.113698506111859,  
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0.7315708465372919,  
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13.361358080581125,  
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0.5705070167500199,  
3.823272974197355,  
503.7636985061008,  
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1.8081665912171285,  
9.33497510185748,  
6.475400633769784,  
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0.29667722951537107,  
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17.266677229517526,  
7.591783612495653,  
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2.117953825260958,  
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0.0019963784517678914,  
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0.8924219103662375,  
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28.679443186964914,  
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17.266677229517526,  
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5.086464463559245,  
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0.12625169760088936,  
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0.0019963784517678914,  
5.086464463559245,  
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3.0811453146228365,  
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8.152847442282901,  
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1.113698506111859,  
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14.022634676322346,  
29.64454956993859,  
10.59710276143206,  
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