University of Amsterdam

Anton Pannekoek instituut

Basic Linux and Coding for AA (BLAC)
Exercise 5 (week 3)

Author:
Timo Halbesma, 6126561

Supervisor:
Dr. T. Coenen

1 Questions

1. The wettest day was at 19750623 in ROTTERDAM(344). The precipitation amount was 101.4 mm.
   The hottest day was at 19760703 in VOLKEL(375). The temperature was 36.7 degrees Centigrade.

2. Maximum temperature for station 260 in 1968 has the following first ten entries:
   $[[260, 19680101, 23], [260, 19680102, 22], [260, 19680103, 27], [260, 19680104, 29],$
   $[260, 19680105, 84], [260, 19680106, 51], [260, 19680107, 22], [260, 19680108, 35],$
   $[260, 19680109, -35], [260, 19680110, 32]]$

3. I have chosen to plot the Maximum Temperature 'TX' because the question did not specify which of the three temperature entries in the dataset should be used. Changing this is just a matter of changing one parameter in the function call though.

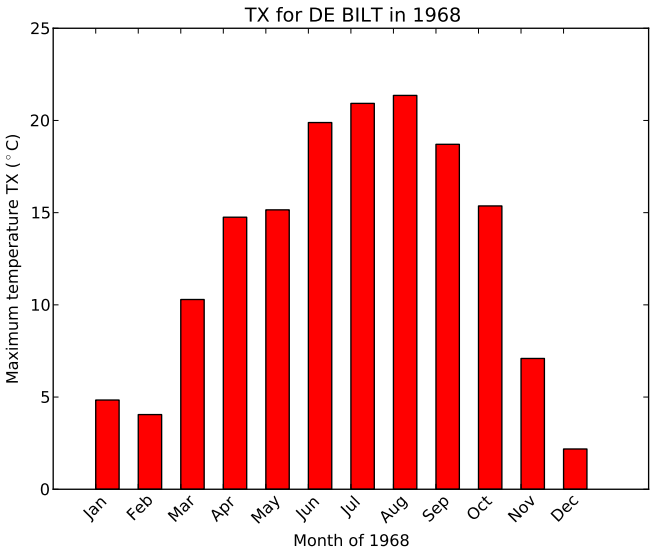

Figure 1: Required plot for third question.

4. From Figure 2 and Figure 3 it is clear that the summers in the station in the West (210, Valkenburg) are significantly hotter than in the East (283, Hupsel) in the period 1991 - 1996. Futhermore the winters in the East (283, Hupsel) are significantly colder than in the West (210, Valkenburg) in the same time period.

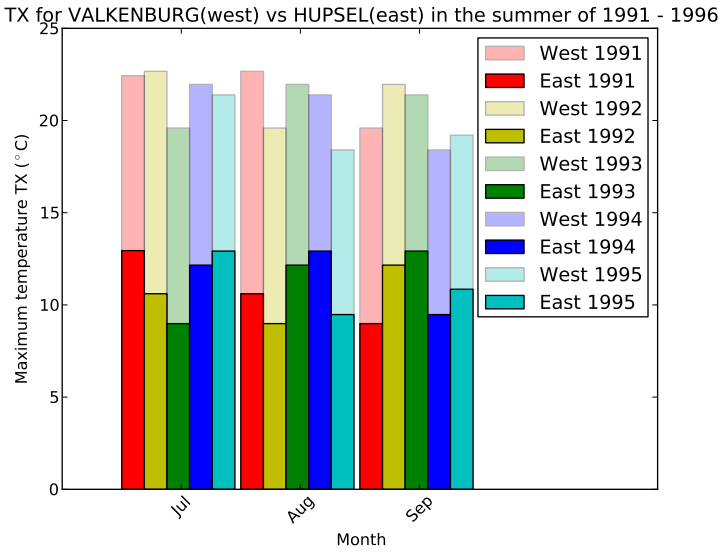

Figure 2: Maximum temperature in the summer for station Valkenburg (210) in the West versus station Hupsel (283) in the East.

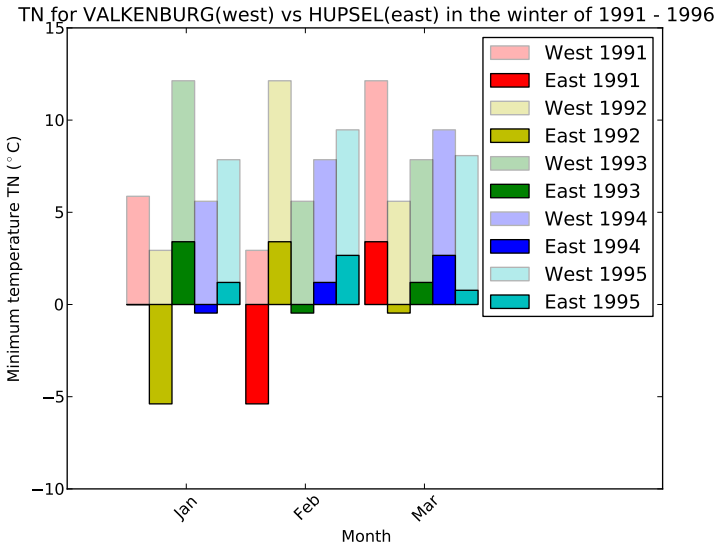

Figure 3: Minimum temperature in the winter for station Valkenburg (210) in the West versus station Hupsel (283) in the East..

6. This homework set has taken quite a lot of time... skipping this one :-(

5.

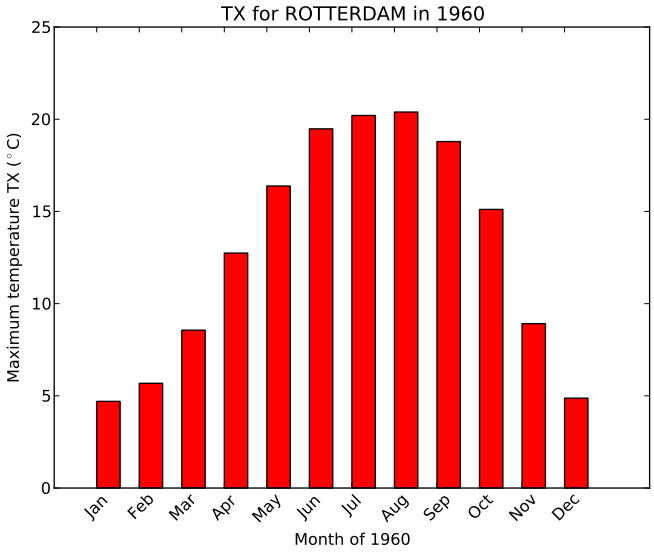

Figure 4: Monthly averaged decade 1960 - 1969 for station Rotterdam (344).

Listing 1: TLRH's solution for the BLAC homework 3 (week 2) . Not that this code has been slightly modified since my last submission.

```
# knmi-1-6126561.py <-- Assignment 2

# Python script for Basic Linux and Coding for AA homework 3 (week 2).
# Usage: python knmi-1-6126561.py
# TLR Halbesma, 6126561, september 9, 2014. Version 1.0; implemented

# NB All functions in this program require the entire dataset as input.
# This behavior could be altered such that main() subsets the dataset and feeds
# it to the functions. I might change this later on for aesthetic reasons.

# Not yet required. However, dr. Coenen did mention we will plot this data.
# import math
# import matplotlib.pyplot as plt

INPUTFILE = './KNMI_20000101.txt'

def read_data(datasetKNMI, endLine): # <-- Assignment 5
    """
    Function to read KNMI dataset obtained from
    http://www.knmi.nl/climatology/daily_data/selection.cgi

    datasetKNMI : list containing the entire dataset including header

    returns a list containing a list of all datapoints per station per date.
    """

    lines = []

    # Assignment 3
    # Skip first 85 lines because that is the header. Very ugly solution :-(
    # NB this breaks down if the header size changed. Be cautious!
    for i in range(85,endLine): # Header: first 85 lines. Read endLine lines.
            myLine = datasetKNMI[i].strip().split(',') # strip to remove '\n'
            cleanLine = []
            for entry in myLine:
                # entry.strip() removes the whitespace around the datapoint.
                # entry.strip() returns False if len(x.strip()) == 0 (missing..)
                if entry.strip():
                    cleanLine.append(int(entry.strip()))
                else:
                    # Assignment 4. Use None for missing data entries.
                    cleanLine.append(None)
            lines.append(cleanLine)
```

```
    return lines

def read_StationID(datasetKNMI): # <-- Assignment 8
    """
    Function to read header from KNMI dataset, in particular the station info.

    datasetKNMI : list containing the entire dataset including header.

    returns a list containing one list for each station.
    """

    allStations = datasetKNMI[3:41]
    allStationsCleaned = list()

    for station in allStations[1:]: # First line contains column info, remove.
        # Remove leading '#', split and unpack first four columns.
        stationID, lon, lat, alt = \
                station.replace(':','').strip('#').split()[:4]
        # The name may contain spaces. Take sublist until last element.
        name = ' '.join(station.strip('#').split()[4:])

        # Create list containing one list for each station.
        # That list contains for each station 5 entries
        # Expliciet typecasts to sensible datatypes. Trivial datatype choices.
        # StationID is a natural number, thus, an integer.
        # longitude, latitude and altitude are rational numbers, thus, floats.
        # The name consists of multiple characters, thus, is saved to string.
        allStationsCleaned.append([int(stationID), float(lon), \
                float(lat), float(alt), str(name)])

    return allStationsCleaned

def read_ColumnDescription(datasetKNMI): # <-- Assignment 9
    """
    Function to read header from KNMI dataset, in particular column descriptions

    datasetKNMI : list containing the entire dataset including header.

    returns a dictionary mapping the column name to its description
    NB dictionaries may be printed in random order.
    """

    columnDescription = datasetKNMI[42:82]
    columnDescriptionCleaned = dict()

    for entry in columnDescription:
        abbreviation = ''.join(entry.strip('#').split('=')[:1]).strip()
        description = ' '.join(entry.strip('#').split('=')[1:])
        columnDescriptionCleaned[abbreviation] = description

    return columnDescriptionCleaned

def read_ColumnHeader(datasetKNMI): # <-- Assignment 10
    """
    Function to read header from KNMI dataset, in particular column header.

    datasetKNMI : list containing the entire dataset including header.

    returns list of column names.
    """

    columnHeader = datasetKNMI[83:84]

    return ''.join(columnHeader).strip('#').strip().replace(' ', '').split(',')

def main():
    # Assignment 1
    f = open(INPUTFILE, 'r')
    datasetKNMI = f.readlines()
    f.close()

    # Assignment 12
    print read_data(datasetKNMI, 500)[0], '\n\n' # Read until line 500.
    print read_StationID(datasetKNMI), '\n\n'
    print read_ColumnDescription(datasetKNMI), '\n\n'
    print read_ColumnHeader(datasetKNMI)
    # NB there is one entry more in the list returned by read_ColumnHeader
    # STN is in the line with column headers but it has no description.

# This codeblock is executed from CLI, but not upon import.
```

```
if __name__ == '__main__': # <-- Assignment 6; was already in my file though.
    main()
```

Listing 2: TLRH's solution for the BLAC homework 4 and 5 (week 2 and 3)

```
# -* coding: utf-8 -*
#!/usr/bin/python
# knmi-6126561.py <-- Step 1

# Python script for Basic Linux and Coding for AA homework 4 (week 2).
# Usage: python knmi-6126561.py
# TLR Halbesma, 6126561, september 12, 2014. Version 1.0; implemented

import math
import matplotlib.pyplot as plt
import numpy as np
from collections import defaultdict
# An instance of defaultdict(dict) enables obtaining values as
# name_of_instance[var1][var2]. e.g. for matrix of month and decade.

# Import methods and variables from homework 3 (week 2).
from knmi_1_6126561 import * # <-- Step 2

# Override INPUTFILE with dataset that does not include 20000101!
# NB this is a slightly different dataset than I used for the prior assignment
INPUTFILE = './KNMI_19991231.txt'

# Make data available troughout all methods.
knmiData = list()
knmiStationIDs = list()
knmiColumnDescription = dict()
knmiColumnHeader = list()

def readDataset(maxLines=None):
    """
    Read the KNMI dataset, save to global variables.

    maxLines : int/None. if None, entire dataset is read.
               else: maxLines is the maximum number of lines to read.

    knmiData: list containing a list with all datapoints.
    knmiStationIDs: list containing stationID's parameters.
    knmiColumnDescription: dict mapping column name to description.
    knmiColumnHeader: list of column names

    See knmi_1_6126561.py for full details.
    """

    f = open(INPUTFILE, 'r')
    datasetKNMI = f.readlines()
    f.close()

    if maxLines is None:
        maxLines = len(datasetKNMI)
    # The header is 85 lines so the program fails if maxLines < 85!
    elif maxLines < 85:
        maxLines = 85

    global knmiData
    global knmiStationIDs
    global knmiColumnDescription
    global knmiColumnHeader

    # Obtain data and entries using last homework3's methods.
    knmiData = read_data(datasetKNMI, maxLines)
    knmiStationIDs = read_StationID(datasetKNMI)
    knmiColumnDescription = read_ColumnDescription(datasetKNMI)
    knmiColumnHeader = read_ColumnHeader(datasetKNMI)

    print "readDataset successful"

def findColumnNumber(myIdentifier):
    """
    Function to obtain the number of a column given a (unique) identifier.
    This functions searches myIdentifier in ColumnDiscription header, finds
    its abbreviation and looks for that abbreviation in the columnHeader.

    myIdentifier : string. e.g. 'Maximum temperature', 'precipitation', etc.
```

```
    returns an integer. Data entry list number for myIdentifier string.
    """

    ColumnAbbreviation = None
    # Loop trough ColumnDescription, find given string in value (description).
    for key,value in knmiColumnDescription.items():
        if myIdentifier in value:
            # Now get the key (abbreviation) and find it in the ColumnHeader.
            ColumnAbbreviation = key
            break
    if ColumnAbbreviation: # Check if ColumnAbbreviation is found.
        return knmiColumnHeader.index(ColumnAbbreviation)
    else:
        return None

def findStationName(myStationID):
    for station in knmiStationIDs:
        if station[0] == myStationID:
            return station[-1]

    return None

def findStationID(myStationName):
    for station in knmiStationIDs:
        if ''.join(station[4:]) == myStationName:
            return station[0]

    return None

def findMax(myDataSet, columnNumber, toReverse): # <-- Step 3
    """
    Find the maximum value in the data set given a columnNumber to sort on.
    Found sorting a matrix on http://xahlee.info/perl-python/sort_list.html

    myDataSet : nested list. Contains the dataset that should be sorted.
    columnNumber : int. Specify which column should be sorted on.
    toReverse : boolean. True => reverse (max -> min); False => (min -> max)

    returns a list containing the entry of the max (or min) in the dataset.
    """

    myDataSet.sort(key=lambda x:x[columnNumber], reverse=toReverse)
    return myDataSet[0]

def seriesOfMinMaxPrecipitation(myDataSet, stationID): # <-- Step 4
    """
    function to REPLACEREPLACE

    myDataSet :
    stationID :

    returns
    """
    # station of choice in 1968
    choice1968 = list()
    precipitationNumber = findColumnNumber('precipitation amount')
    hottestNumber = findColumnNumber('Maximum temperature')
    coldestNumber = findColumnNumber('Minimum temperature')

    for entry in myDataSet:
        # entry[1] is the date YYYYMMDD as integer. So div by 1e5 will
        # result in YYYY. As it is int-int division it is truncated.
        if entry[0] == stationID and entry[1]/10000 == 1968:
            choice1968.append(entry)

    # This part fully depends on the assumptions what to include in the time
    # series. But one can find a time-series of max/min/precipitation
    for entry in choice1968:
        continue
        #entry[precipitationNumber]
        #entry[hottestNumber]
        #entry[coldestNumber]

    # REPLACEREPLACE
    plt.clf()
    plt.plot([x for x in range(len(choice1968))], \
             [y[precipitationNumber]/10.0 for y in choice1968], lw=1)
    plt.xlabel('Number of the day in 1968',fontsize=16)
    plt.ylabel('Precipitation amount in mm')
```

```
    plt.title('precipitation amount for '+str(stationID)+' in 1968.')
    plt.show()

    plt.plot([x for x in range(len(choice1968))], \
             [y[hottestNumber]/10.0 for y in choice1968], lw=1)
    plt.xlabel('Number of the day in 1968',fontsize=16)
    plt.ylabel('Maximum temperature in degrees Centigrade.')
    plt.title('Maximum temperature for '+str(stationID)+' in 1968.')
    plt.show()

    plt.plot([x for x in range(len(choice1968))], \
             [y[coldestNumber]/10.0 for y in choice1968], lw=1)
    plt.xlabel('Number of the day in 1968',fontsize=16)
    plt.ylabel('Minimum temperature in degrees Centigrade.')
    plt.title('Minimum temperature for '+str(stationID)+' in 1968.')
    plt.show()

    #return choice1968

# Step 5
# Compare the summers in De kooy with those in Valkenburg. Calculate
# monthly averages for min, max temperature and the amount of precipitation
# on a 10 yearly basis. Where are the summers warmer, where are they
# wetter?

def plotComparison(valkenburgData, deKooyData, s):
    """
    REPLACEREPLACE
    """

    # http://matplotlib.org/examples/api/barchart_demo.html
    title = {'TX': 'maximum temperature', 'TN':'minimum temperature',\
             'RH': 'daily precipitation'}
    monthNames = ['Jan', 'Feb', 'Mrt', 'Apr', 'Mei', 'Jun', 'Jul', 'Aug',\
             'Sep', 'Okt', 'Nov', 'Dec']
    ind = np.arange(1,13)
    width = 0.35
    fig, ax = plt.subplots()
    rects1 = ax.bar(ind, tuple([valkenburgData.get((s,i, 5))\
             for i in range(1,13)]), width, color='r')
    rects2 = ax.bar(ind+width, tuple([deKooyData.get((s,i, 5))\
             for i in range(1,13)]), width, color='y')

    ax.legend((rects1[0], rects2[0]), ('Valkenburg', 'DeKooy'))
    ax.set_ylabel(s)
    ax.set_title('Plot of '+title[s])
    plt.xticks(range(1,13), monthNames, rotation=45)
    plt.show()
    #plt.close()


def monthlyDecadeAverage(myDataSet, stationID, columnNumber):
    """
    Function to calculate monthly averages per decade.
    NB, this functions requires a dataset from 1950 until (excluding) 2000.
    This is because I use integer indices representing month and decade
    in the range(1,13) for month, and range(5,10) for decade.

    myDataSet : list containing the entire dataset including header
    stationID : int. ID number of Station the averages should be obtained for.
    columnNumber : int. Number of column the averages should be obtained for.

    returns a dictionary. The keys are 4-tuples (stationID, columnNumber,
        month, decade). The values are the averages as a float.
    """

    decadeAverage = dict()
    numberOfEntries = defaultdict(dict)

    # All variables must be zero initialy. Otherwise the first += fails.
    for month in range(1,13):
        for decade in range(5,10):
            numberOfEntries[month][decade] = int()
            decadeAverage[(stationID,columnNumber,month,decade)] = int()

    for entry in myDataSet:
        if entry[0] == stationID:
            # entry[1] is the date YYYYMMDD as integer. So (div by 100)%100
            # will result in MM. As it is int-int division it is truncated.
            month = (entry[1]/100)%100
```

```
            # split decade up in blocks of 10
            # Note that the dataset must not include 2000!!
            decade = (entry[1]/100000)%10

            # Missing data has value None in dataset. NB bool(0) -> False!
            if entry[columnNumber] and entry[columnNumber] is not 0:
                numberOfEntries[month][decade] += 1
                decadeAverage[(stationID,columnNumber,month,decade)] \
                        += entry[columnNumber]

    # Now divide the monthly decade sums over the number of entries.
    for month in range(1,13):
        for decade in range(5, 10):
            if decadeAverage[(stationID, columnNumber,month,decade)] != 0:
                decadeAverage[(stationID,columnNumber,month,decade)]\
                        /= float(numberOfEntries[month][decade])

    return decadeAverage

def compareDeKooyValkenburg(myDataSet):
    precipitationNumber = findColumnNumber('precipitation amount')
    hottestNumber = findColumnNumber('Maximum temperature')
    coldestNumber = findColumnNumber('Minimum temperature')

    deKooy = findStationID('DE KOOY')
    valkenburg = findStationID('VALKENBURG')

    deKooyRHAverage = \
            monthlyDecadeAverage(knmiData, deKooy, precipitationNumber)
    valkenburgRHAverage =\
            monthlyDecadeAverage(knmiData, valkenburg, precipitationNumber)
    deKooyTXAverage = \
            monthlyDecadeAverage(knmiData, deKooy, hottestNumber)
    valkenburgTXAverage =\
            monthlyDecadeAverage(knmiData, valkenburg, hottestNumber)
    deKooyTNAverage = \
            monthlyDecadeAverage(knmiData, deKooy, coldestNumber)
    valkenburgTNAverage =\
            monthlyDecadeAverage(knmiData, valkenburg, coldestNumber)

    for k,v in deKooyRHAverage.items():
        print k,v
    for k,v in  valkenburgRHAverage.items():
        print k,v
    print
    for k,v in deKooyTXAverage.items():
        print k,v
    for k,v in  valkenburgTXAverage.items():
        print k,v
    print
    for k,v in deKooyTNAverage.items():
        print k,v
    for k,v in  valkenburgTNAverage.items():
        print k,v

# Step 6
# Using the monthly averages (averaged over 10 year blocks), is the weather
# getting warmer or wetter?
def warmerOrWetter():
    # To implement this function requires rewriting the very crappy
    # implementation of step 5.
    return None

def main():
    readDataset()

    #precipitationNumber = findColumnNumber('precipitation amount')
    #wettestDay = findMax(knmiData, precipitationNumber,  True)
    #print "The wettest day was at {0} in {1}({2}).".format(\
    #        wettestDay[1],findStationName(wettestDay[0]),wettestDay[0]),
    #print "The precipitation amount was {} mm."\
    #        .format(wettestDay[precipitationNumber]/10.0)


    #hottestNumber = findColumnNumber('Maximum temperature')
    #hottestDay = findMax(knmiData, hottestNumber, True)
    #print "The hottest day was at {0} in {1}({2}).".format(\
    #        hottestDay[1],findStationName(hottestDay[0]),hottestDay[0]),
    #print "The temperature was {} degrees Centigrade."\
    #        .format(hottestDay[hottestNumber]/10.0)
```

```
    #seriesOfMinMaxPrecipitation(knmiData, 260)

    compareDeKooyValkenburg(knmiData)

    #valkenburg, deKooy =compareDeKooyValkenburg(knmiData)
    #print 'valkenburg'
    #for k,v in valkenburg.items():
    #    print k,v
    #print 'deKooy'
    #for k,v in deKooy.items():
    #    print k,v

if __name__ == '__main__':
    main()
```