HW3_Pre-Processing

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1 Homework Assignement 3 - Pre-Processing

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[4]:
```
import numpy as np
import random as rd
import matplotlib.pyplot as plt
```

4. Consider the array above but without the NAs (replaced by some other value) and normalize the array by using:

- min-max normalization
- z-score normalization

This excercise refers to the previous one:

3. Consider the following array `<8,12,4,12,NA,9,7,1,15,NA,12,13,7,NA,23,12,NA,9,8,5,NA,21,13,NA,12` Compare different methods of data imputation and their effect on the mean and standard deviation of the array. Consider the methods:

- replace by a constant value (e.g. -1)
- replace by the most frequent value
- replace by the mean
- replace each NA by a value sampled from the distribution of observed values.

We can compute both normalizations for each of the dat imputation methods mentioned in exercise 3 and compare the results.

The normalizations we are computing are

Min-max normalization

$$x_i' = \frac{x_i - \min_x}{\max_x - \min_x}$$

Z-score normalization (Standardization)

$$x_i' = \frac{x_i - \text{mean}_x}{\text{std}_x}$$

[1]:
```
def min_max_normalization(data):
    data_min  = np.min(data)
    data_max  = np.max(data)
    norm_data = data * 0
```

```
    for i,dp in enumerate(data):
        norm_data[i] = (dp - data_min) / (data_max - data_min)
    return norm_data

def z_score_normalization(data):
    data_mean = np.mean(data)
    data_std  = np.std(data)
    norm_data = data * 0
    for i,dp in enumerate(data):
        norm_data[i] = (dp - data_mean) / data_std
    return norm_data
```

We can get the different arrays considered with

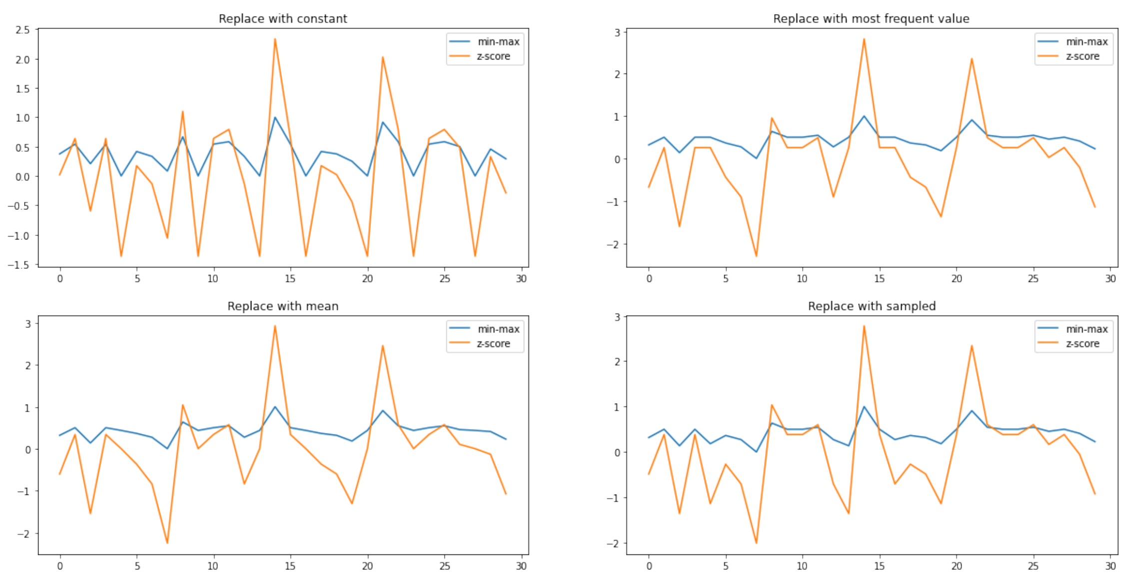
[6]:
```
data = np.array([8,12,4,12,np.nan,9,7,1,15,np.nan,12,13,7,np.nan,23,12,np.
 ↪nan,9,8,5,np.nan,21,13,np.nan,12,13,11,np.nan,10,6])

nan_indices = np.argwhere(np.isnan(data))
non_nan_ind = np.argwhere(~np.isnan(data))

clean_data = np.array(np.reshape(data[non_nan_ind],(23)),int)

new_data_constant = np.copy(data)
new_data_frequent = np.copy(data)
new_data_mean     = np.copy(data)
new_data_sampled  = np.copy(data)

#Replace by constant value

for i in nan_indices:
    new_data_constant[i] = -1

#Replace by the most frequent value

data_mode = np.bincount(clean_data).argmax()
for i in nan_indices:
    new_data_frequent[i] = data_mode

#Replace by the mean

data_mean = np.mean(clean_data)
for i in nan_indices:
    new_data_mean[i] = data_mean


#Replace by a value sampled from the dstribution
```

```
for i in nan_indices:
    j = rd.randint(0,len(clean_data)-1)
    new_data_sampled[i] = clean_data[j]
```

Then, we can see the new normalized data distributions in different ways. With a plot that for each data imputation method compares both normalizations. Or with a plot that for each normalization compared the different data imputation method.

[8]:

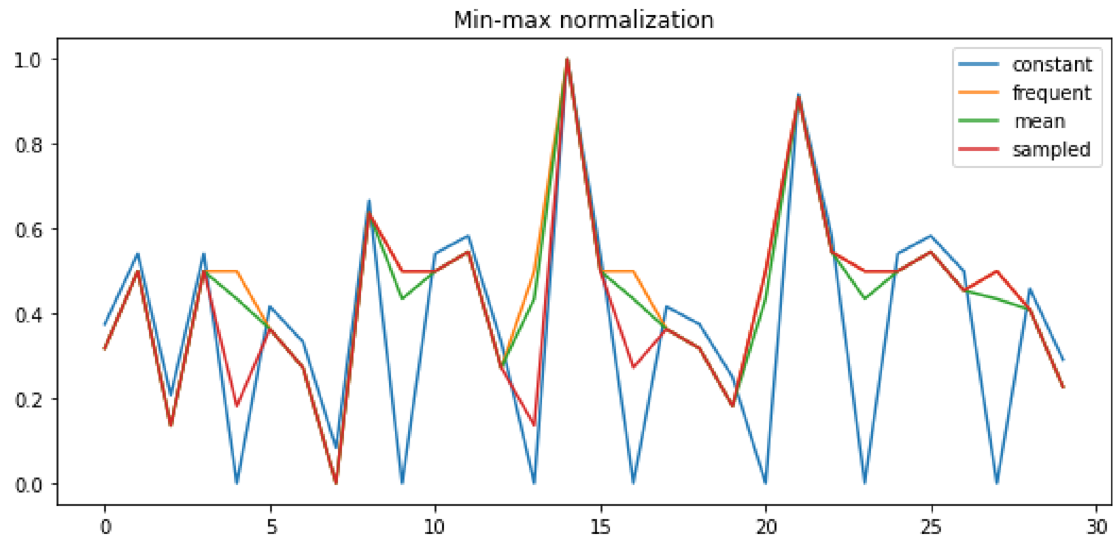
```
#for each data imputation method compare both normalizations
fig,ax = plt.subplots(2,2, figsize=(20,10))
data_types = [new_data_constant,new_data_frequent,new_data_mean,new_data_sampled]
columns = ['Replace with constant','Replace with most frequent value','Replace with mean','Replace with sampled']
cols = [0,0,1,1]
lins = [0,1,0,1]
for i in range(4):
    ax[cols[i],lins[i]].plot(min_max_normalization(data_types[i]),label='min-max')
    ax[cols[i],lins[i]].plot(z_score_normalization(data_types[i]),label='z-score')
    ax[cols[i],lins[i]].legend()
    ax[cols[i],lins[i]].title.set_text(columns[i])
plt.show()
```

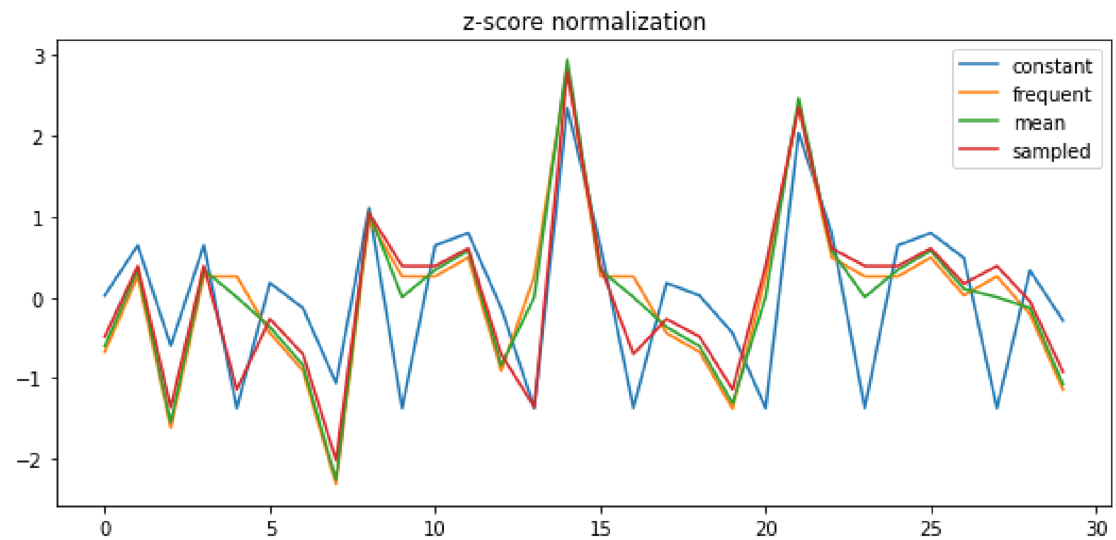


[9]:

```
#for each normalization compare the different data imputation method
fig,(ax1,ax2) = plt.subplots(2,figsize=(10,10))
titles = ['Min-max normalization', 'z-score normalization']
```

```python
funcs = [min_max_normalization,z_score_normalization]
axs = [ax1,ax2]
def plot(f,i,a):
    a.plot(f(new_data_constant),label='constant')
    a.plot(f(new_data_frequent),label='frequent')
    a.plot(f(new_data_mean    ),label='mean')
    a.plot(f(new_data_sampled ),label='sampled')
    a.legend()
    a.title.set_text(titles[i])

for i in range(2):
    plot(funcs[i],i,axs[i])
plt.show()
```





An example of the arrays we got for each normalization for the mean imputation method:

[10]:
```
print('Data')
print(new_data_mean)
print('Min-max')
print(min_max_normalization(new_data_mean))
print('z-score')
print(z_score_normalization(new_data_mean))
```

```
Data
[ 8.         12.          4.         12.         10.56521739  9.
  7.          1.         15.         10.56521739 12.         13.
  7.         10.56521739 23.         12.         10.56521739  9.
  8.          5.         10.56521739 21.         13.         10.56521739
 12.         13.         11.         10.56521739 10.          6.        ]
Min-max
[0.31818182 0.5        0.13636364 0.5        0.43478261 0.36363636
 0.27272727 0.         0.63636364 0.43478261 0.5        0.54545455
 0.27272727 0.43478261 1.         0.5        0.43478261 0.36363636
 0.31818182 0.18181818 0.43478261 0.90909091 0.54545455 0.43478261
 0.5        0.54545455 0.45454545 0.43478261 0.40909091 0.22727273]
z-score
[-0.6037047   0.33766534 -1.54507474  0.33766534  0.         -0.36836219
 -0.83904721 -2.25110228  1.04369287  0.          0.33766534  0.57300785
 -0.83904721  0.          2.92643296  0.33766534  0.         -0.36836219
 -0.6037047  -1.30973223  0.          2.45574794  0.57300785  0.
  0.33766534  0.57300785  0.10232283  0.         -0.13301968 -1.07438972]
```