generate_Matrix_CSV_AlisEdits

April 1, 2021

[1]:
```
import pandas as pd
import seaborn as sn
import matplotlib.pyplot as plt
import numpy as np
import seaborn as sns
```

0.1 Read in Data

[2]:
```
matrix_data = pd.read_csv("PROKKA.matrix.data", names=['Gene Count', 'Phage 1',␣
↪'Phage 2'], sep=",")
```

[3]:
```
unique_genome = matrix_data['Phage 1'].unique().tolist()
```

[4]:
```
len(matrix_data)
```

[4]:
```
36481
```

0.2 Generate A Pairwise Count Matrix

To do so, our strategy is the following:

1. Get all the unique phages
2. We get all the unique values of phages, and the corresponding array of counts
3. Get a pandas series
4. Create a numpy matrix from the obtained series (should be size 190x190)

[5]:
```
phage_list = matrix_data['Phage 1'].unique()
print(f"Number of unique phages: {len(phage_list)}")
```

```
Number of unique phages: 191
```

Now moving on to getting the pairwise counts:

[6]:
```
# you want to get all the unique Phage 1 values, and the corresponding gene␣
↪counts for every other phage, including itself
# here with group by we get, and now we want to get all the values as a list
c_matrix = matrix_data.groupby('Phage 1')['Gene Count'].apply(list)
```

above will result in a pandas series. Now to finally get what we need, we need to turn into an array, but first let's check the type:

```
[7]: type(c_matrix)
```

```
[7]: pandas.core.series.Series
```

```
[8]: # c_matrix.tolist()
     numpy_matrix = np.asarray(c_matrix.tolist())
```

Now let's check out the matrix we got:

```
[9]: print(numpy_matrix)
     print(f"\n Matrix has the shape: {numpy_matrix.shape}")
```

```
[[0 0 0 … 0 0 0]
 [0 0 0 … 0 0 0]
 [0 0 0 … 0 0 0]
 …
 [0 0 0 … 0 0 0]
 [0 0 0 … 0 0 0]
 [0 0 0 … 0 0 0]]

 Matrix has the shape: (191, 191)
```

```
[10]: np.savetxt("prokka_matrix.csv", numpy_matrix, delimiter=",")
```

which is exactly what we wanted!

0.3 Make a Dataframe with the Count Matrix

```
[11]: pairwise_count = pd.DataFrame(data = numpy_matrix)
```

```
[12]: pairwise_count.columns = list(phage_list)
```

```
[13]: pairwise_count.index = list(phage_list)
```

```
[14]: pairwise_count
```

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0.3.1 Example of plotting heatmaps for this dataframe we generated

I think the best way to visualize this data now is to do a heatmap, and pandas provides a very nice way of doing this with the actual numbers in them. Here is how:

[15]:
```
ax = sns.heatmap(uniform_data, linewidth=0.5)
plt.show()
```

```
      ␣
↪---------------------------------------------------------------------------

       NameError                                 Traceback (most recent call␣
↪last)

       <ipython-input-15-4fbd8887ca0c> in <module>
   ----> 1 ax = sns.heatmap(uniform_data, linewidth=0.5)
         2 plt.show()


       NameError: name 'uniform_data' is not defined
```

[16]:
```
pairwise_count.style.background_gradient(cmap='Blues')
```

[16]:
```
<pandas.io.formats.style.Styler at 0x7f8e6767e370>
```

0.4 Optional

0.4.1 Example of getting lower and upper triangular of a matrix

[17]:
```
A = np.array([[2,3,4], [3,45,8], [34,7,0.8], [21,31,41]])

print(f'A : \n {A}')
print(f'A^T is : \n {A.T}')

S = np.matmul(A,A.T)

print(f'Symmetric Matrix 1: \n {S}')
```

```
A :
 [[ 2.   3.   4. ]
 [ 3.  45.   8. ]
 [34.   7.   0.8]
 [21.  31.  41. ]]
A^T is :
 [[ 2.   3.  34.  21. ]
 [ 3.  45.   7.  31. ]
 [ 4.   8.   0.8 41. ]]
Symmetric Matrix 1:
 [[  29.     173.      92.2    299.   ]
 [ 173.    2098.     423.4   1786.   ]
 [  92.2    423.4   1205.64   963.8 ]
 [ 299.    1786.     963.8   3083.   ]]
```

[19]:
```
symmetry = pd.DataFrame(data = S)
```

[20]:
```
symmetry.style.background_gradient(cmap='Blues')
```

[20]:
```
<pandas.io.formats.style.Styler at 0x7f8e66e51b20>
```

Now extract upper and lower tringulars:

[18]:
```
upper = np.triu(S)
upper
```

[18]:
```
array([[  29.  ,  173.  ,   92.2 ,  299.  ],
       [   0.  , 2098.  ,  423.4 , 1786.  ],
       [   0.  ,    0.  , 1205.64,  963.8 ],
       [   0.  ,    0.  ,    0.  , 3083.  ]])
```

[19]:
```
lower = np.tril(S)
lower
```

```
[19]: array([[  29.  ,    0.  ,    0.  ,    0.  ],
             [ 173.  , 2098.  ,    0.  ,    0.  ],
             [  92.2 ,  423.4 , 1205.64,    0.  ],
             [ 299.  , 1786.  ,  963.8 , 3083.  ]])
```