Q4

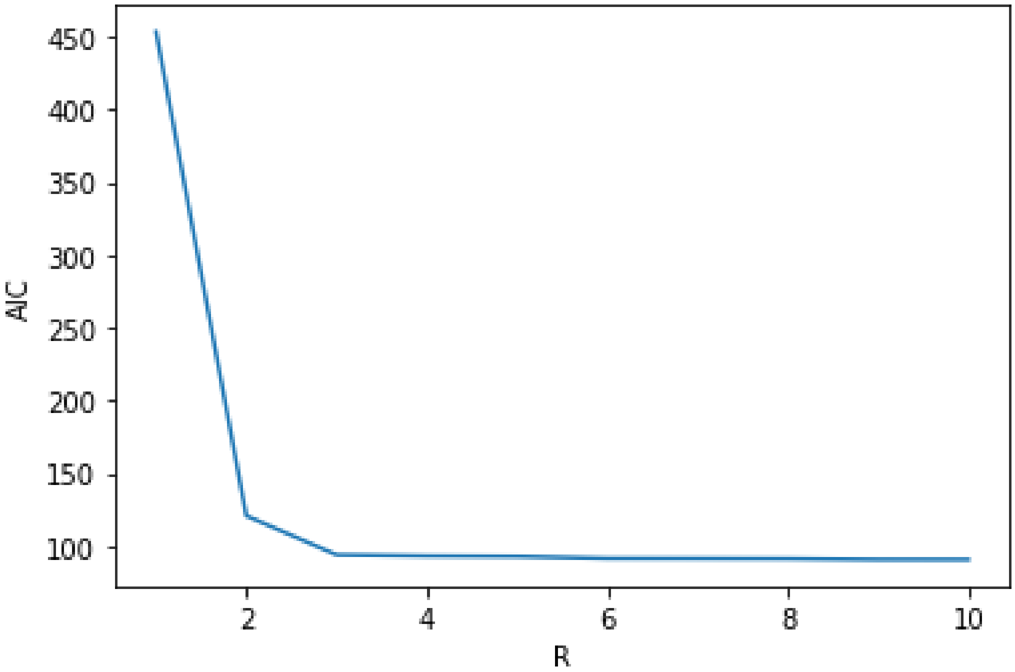
June 17, 2020

```
In [1]: import glob
        from itertools import combinations

        import numpy as np
        import matplotlib.pyplot as plt
        import matplotlib.image as mpimg
        import tensorly
        from tensorly.decomposition import parafac as cp
        from scipy.io import loadmat
        import tensorly as tl
        %matplotlib inline
```

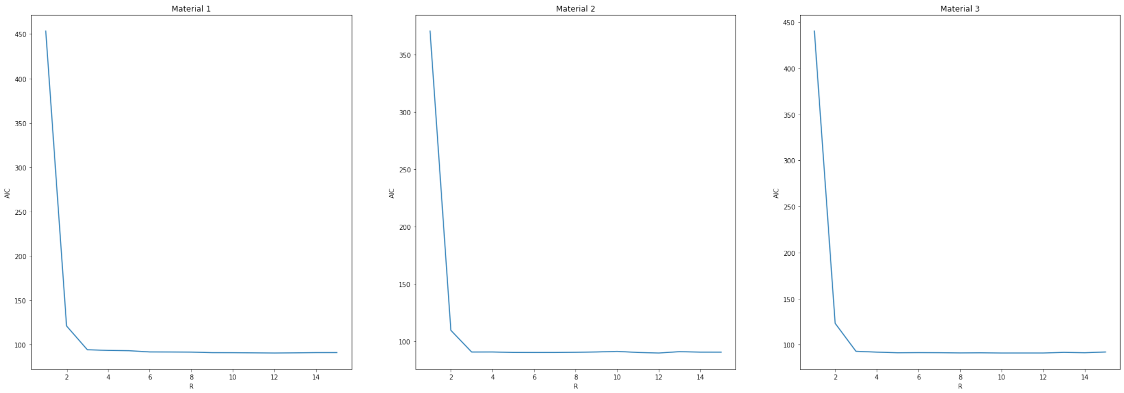
```
In [2]: mat = loadmat('heatT.mat')
        t1 = mat["T1"][0][0][0]
        t2 = mat["T2"][0][0][0]
        t3 = mat["T3"][0][0][0]
```

```
In [3]: max_rank = np.min([np.multiply(*x) for x in combinations(t1.shape, 2)])
```

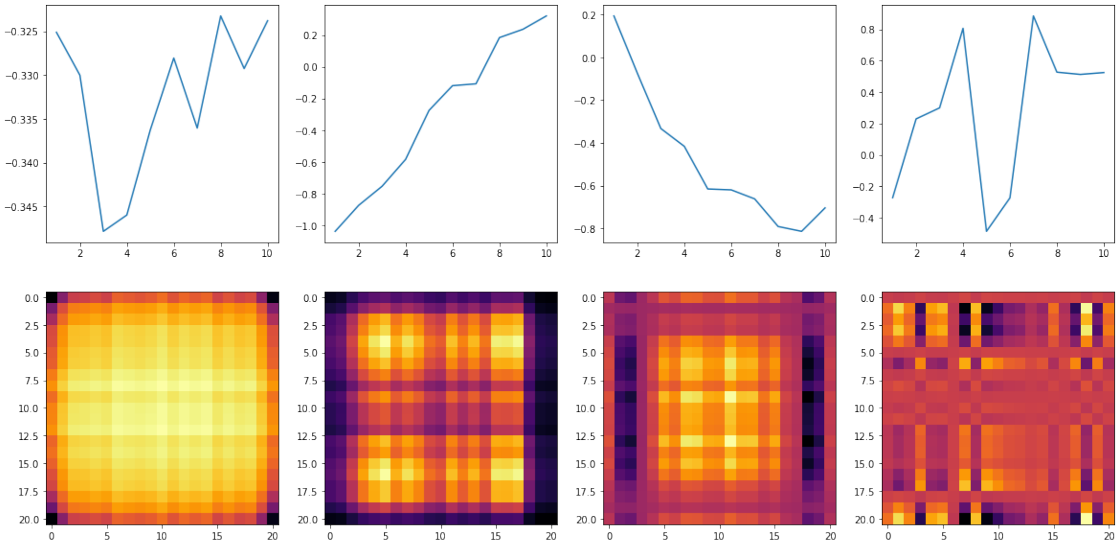
```
In [4]: aic = []
        for k in range(1,11):
            kt,e = cp(t1,k)
            reconstructed = tensorly.kruskal_to_tensor((kt,e))
            err = ((t1-reconstructed)**2).sum()
            aic.append(2*err + 2*k)

        plt.plot(np.arange(1,11),aic)
        plt.xlabel('R')
        plt.ylabel('AIC')
        plt.show()
```



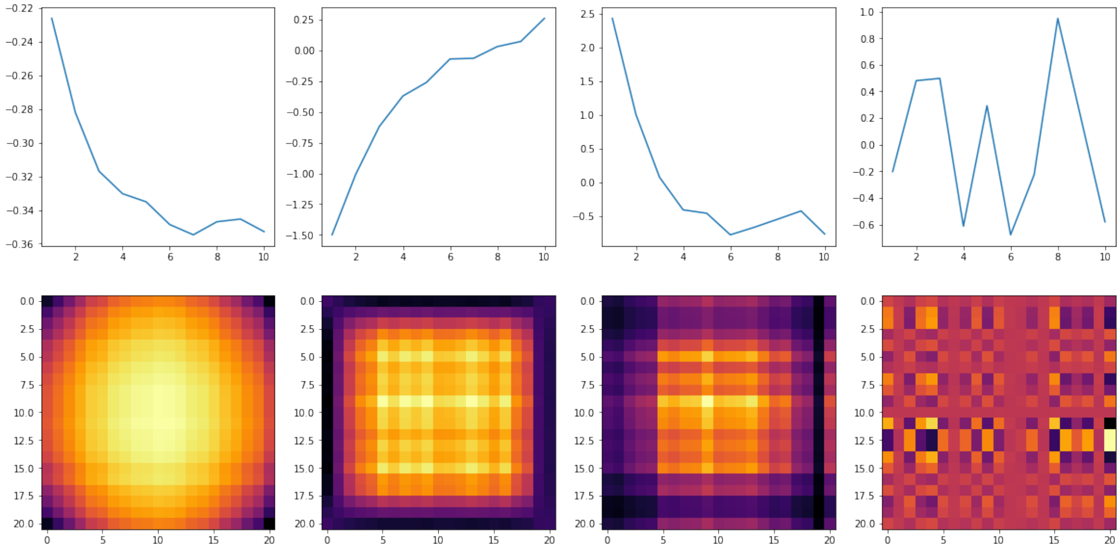
```
In [5]: fig, ax = plt.subplots(1, 3, figsize=(30,10))
        images = []
        min_aic = []
        max_rank = 16
        for i,t in enumerate([t1,t2,t3]):
            aic = []
            for k in range(1,max_rank):
                wf = cp(t,k)
                reconstructed = tensorly.kruskal_to_tensor(wf)
                err = ((t-reconstructed)**2).sum()
                aic.append(2*err + 2*k)
            min_aic.append(np.argmin(aic)+1)
            ax[i].plot(np.arange(1,max_rank),aic)
            ax[i].set(xlabel='R', ylabel='AIC')
            ax[i].set_title(f'Material {i+1}')
```



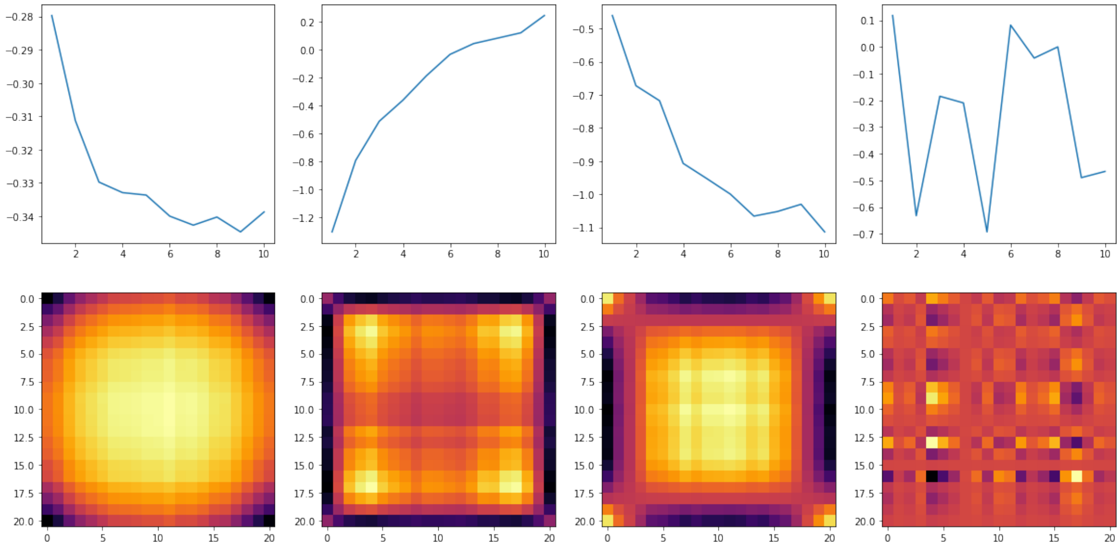
```
In [6]: # rank with min aic
        min_aic

Out[6]: [12, 12, 10]

In [7]: # material 1
        wf = cp(t1,min_aic[0])

        fig, ax = plt.subplots(2, 4, figsize=(20,10))
        a,b,c = wf[1]
        for i in range(4):
            ax[0,i].plot(np.arange(1,11),c[:,i])
            A = a[:,i]
            B = b[:,i]
            XY = np.outer(A,B)
            ax[1,i].imshow(XY,cmap='inferno')
```



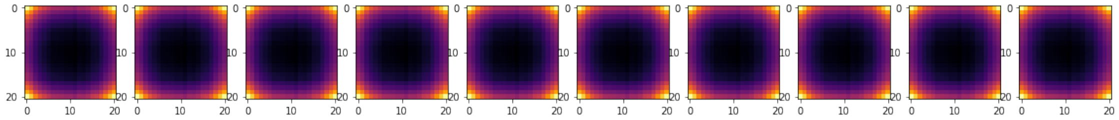
```
In [8]: # material 2
        wf = cp(t2,min_aic[1])

        fig, ax = plt.subplots(2, 4, figsize=(20,10))
        a,b,c = wf[1]
        for i in range(4):
            ax[0,i].plot(np.arange(1,11),c[:,i])
            A = a[:,i]
            B = b[:,i]
            XY = np.outer(A,B)
            ax[1,i].imshow(XY,cmap='inferno')
```



```
In [9]: # material 3
        wf = cp(t3,min_aic[2])

        fig, ax = plt.subplots(2, 4, figsize=(20,10))
        a,b,c = wf[1]
        for i in range(4):
            A = a[:,i]
            B = b[:,i]
            C = c[:,i]

            ax[0,i].plot(np.arange(1,11),C)
            XY = np.outer(A,B)
            ax[1,i].imshow(XY,cmap='inferno')
```



```
In [14]: # just for fun
         fig, ax = plt.subplots(1, 10, figsize=(20,10))
         a,b,c = wf[1]
         A = a[:,0]
         B = b[:,0]
         C = c[:,0]
         XY = np.outer(A,B)
         for i in range(10):
             t = XY*C[i]
             ax[i].imshow(t,cmap='inferno')
```


0
10
20
0
10
20