LM Assignment-3

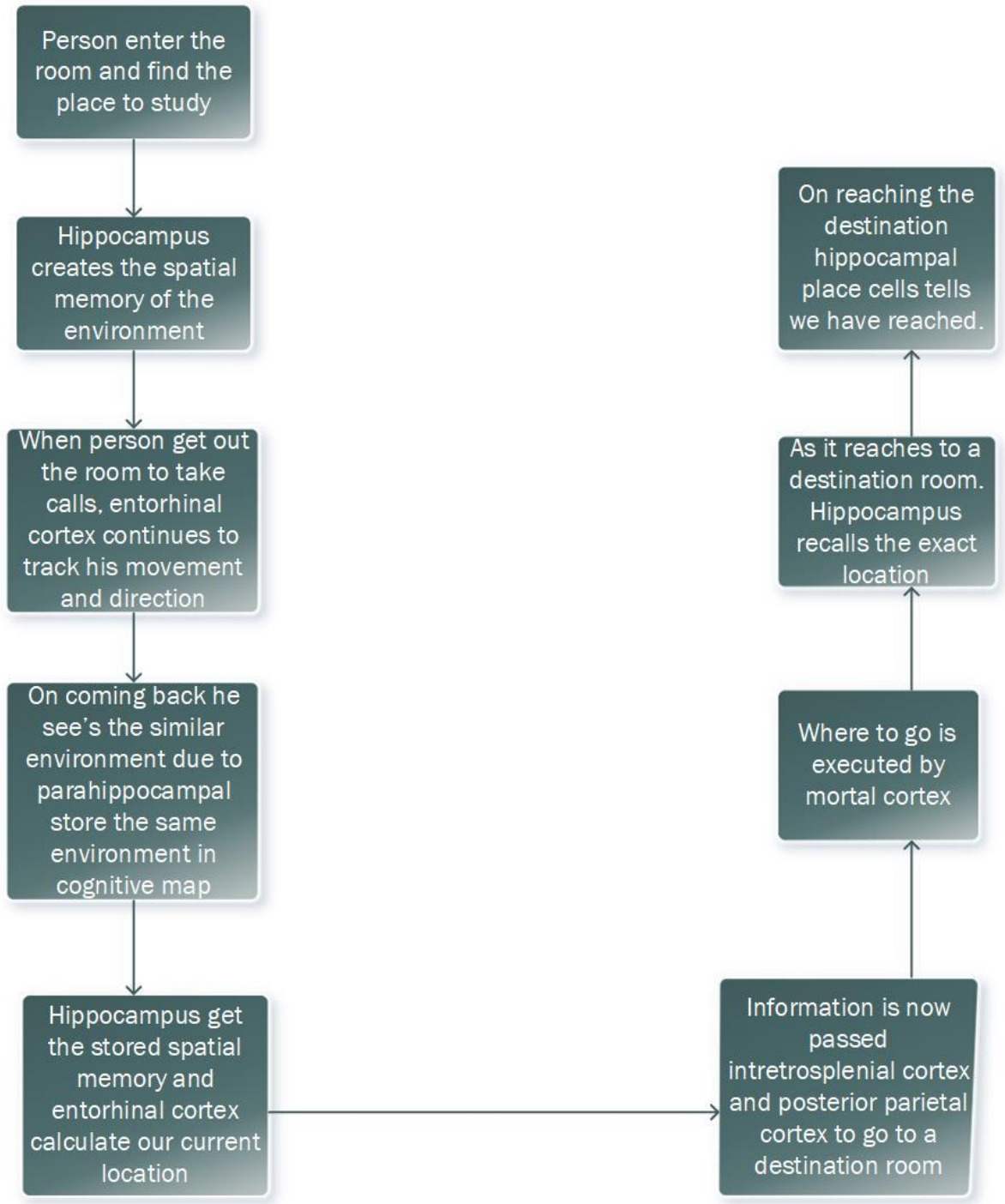
Q2. Please watch the attached video by Prof. Neil Burgess (Institute of Cognitive Neuroscience, University College London) and answer the following questions based on your understanding of thevideo.[All figures/schematics should be properly labelled and should have accompanying captions/legendsto provide all information necessary to interpret the same…]

You are in the library and just found a place in the reading room. You settle down to study when you get a call and must step outside the library to take the call. After finishing the call as you are going back to the reading room your brain helps you navigate to the location in the library that you chose for yourself. Draw a flowchart of the neural algorithm/mechanism that will enable your brain to guide your path in moving to the spatial location that you had found inside the library reading room.

Hint: Use proper flowchart shapes and conventions [https://support.microsoft.com/en-us/office/create-a-basic-flowchart-in-visio-e207d975-4a51-4bfa-a356-eeec314bd276]

Briefly explain the key steps of the above neural mechanism.

Ans:



The steps I did the following:

1. Person enters the library or any room and finds a place to study.
2. When a person enters the room hippocampus encodes the location and spatial cue of any room the person enters. Hippocampus creates the cognitive map of the surroundings, like the chair, is at the position of a person working at this position, etc.
3. When a person has to go outside the room to do anything just for a short period. On coming, he sees the familiar landmarks and environment because parahippocampal place areas recognize the same environment and place as all this is stored in the cognitive map.

4. Hippocampus gets the cognitive memory in which all the information is stored, and the entorhinal cortex calculates the current distance.
5. Information is now passed into the retrosplenial cortex and posterior parietal cortex to go to our destination room.
6. Now in which direction to go is executed by the motor cortex.
7. As the person tends to reach their destination more details in the environment match with memory as the hippocampus recalls the precise location coordinates of the destination we want to reach.
8. On reaching the destination hippocampal cells tell we have reached the location. Now the cognitive map is updated with the latest experience.

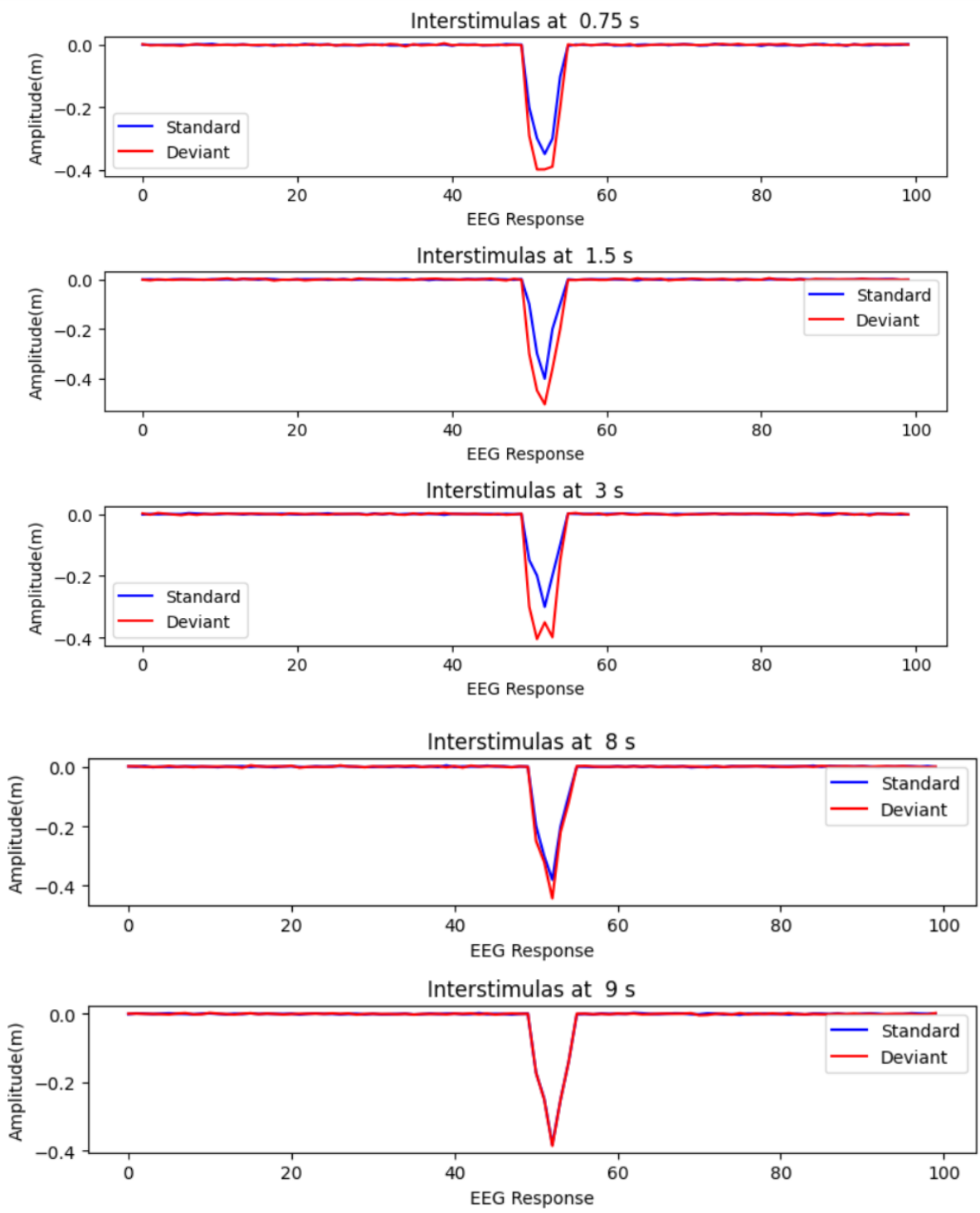
Use the data given in Assignment3-Q2Bdata.xlsx | An experimenter recorded and pre-processed EEG data from 20 participants on an auditory oddball task playing them standard and deviant tones. The interstimulus intervals between the two tones were manipulated at four levels – 0.75 s, 1.5s, 3s, 8s, 9s as the EEG traces evoked by both standard and deviant tones were measured (1000 Hz sampling rate) from the participants' brains. Each sheet of the Excel file has data for both standard tone (beginning from cell 'B3') and deviant tone (beginning from cell 'B25'). For each of the above tone there is a 20 (participants) x 100 (time point) matrix in each sheet. Do the following…

2 Assignment-3 Learning and Memory PSY-306 (Winter 2023)

[All figures/schematics should be properly labelled and should have accompanying captions/legends to provide all information necessary to interpret the same…]

b. Make a figure with five subplots – one for each interstimulus interval. In each subplot, graph the average EEG response (across 20 participants) from both standard and deviant tones in blue and red colours respectively.

Ans:



Code:

```
#!/usr/bin/env python
# coding: utf-8

# In[1]:
```

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt

read1 is 0.75s
read2 is 1.5s
read3 is 3s
read4 is 8s
read5 is 9s
# In[2]:


read1 = pd.read_excel('Assignment3-Q2Bdata.xls',header=None)
read1 = read1.fillna(0)
read1


# In[3]:


read2 = pd.read_excel('Assignment3-Q2Bdata.xls',header=None,sheet_name =1)
read2 = read2.fillna(0)
read2


# In[4]:


read3 = pd.read_excel('Assignment3-Q2Bdata.xls',header=None,sheet_name =2)
read3 = read3.fillna(0)
read3


# In[5]:


read4 = pd.read_excel('Assignment3-Q2Bdata.xls',header=None,sheet_name =3)
read4 = read4.fillna(0)
read4


# In[29]:


read5 = pd.read_excel('Assignment3-Q2Bdata.xls',header=None,sheet_name =4)
read5 = read5.fillna(0)
read5


# In[7]:
```

```
arr1 =[]
for i in range(2,22):
    arr1.append(np.mean(read1.iloc[i,1:101].to_numpy()))
arr1


# In[8]:


stand075 =  read1.iloc[2:22,1:101].to_numpy()
dev075 =  read1.iloc[24:44,1:101].to_numpy()


# In[9]:


arr2=[]
for i in range(24,44):
    arr2.append(np.mean(read1.iloc[i,1:101].to_numpy()))
arr2


# In[32]:


stanMean075 = np.mean(stand075,axis =0)
dev075Mean = np.mean(dev075,axis=0)

stanMean075


# In[11]:


stan15 =  read2.iloc[2:22,1:101].to_numpy()
dev015 =  read2.iloc[24:44,1:101].to_numpy()


# In[12]:


arr3=[]
for i in range(2,22):
    arr3.append(np.mean(read2.iloc[i,1:101].to_numpy()))
arr3


# In[13]:
```

```
arr4=[]
for i in range(24,44):
    arr4.append(np.mean(read2.iloc[i,1:101].to_numpy()))
arr4


# In[14]:


stanMean15 = np.mean(stan15,axis=0)
dev15Mean = np.mean(dev015,axis=0)
stanMean15


# In[15]:


stan3 =  read3.iloc[2:22,1:101].to_numpy()
dev3 =  read3.iloc[24:44,1:101].to_numpy()


# In[16]:


arr5=[]
for i in range(2,22):
    arr5.append(np.mean(read3.iloc[i,1:101].to_numpy()))
arr5


# In[17]:


arr6=[]
for i in range(24,44):
    arr6.append(np.mean(read3.iloc[i,1:101].to_numpy()))
arr6


# In[18]:


stanMean3 = np.mean(stan3,axis=0)
dev3Mean = np.mean(dev3,axis=0)


# In[19]:
```

```
stan8 =  read4.iloc[2:22,1:101].to_numpy()
dev8 =  read4.iloc[24:44,1:101].to_numpy()


# In[20]:


arr7=[]
for i in range(2,22):
    arr7.append(np.mean(read4.iloc[i,1:101].to_numpy()))
arr7


# In[21]:


arr8=[]
for i in range(24,44):
    arr8.append(np.mean(read4.iloc[i,1:101].to_numpy()))
arr8


# In[22]:


stanMean8 = np.mean(stan8,axis=0)
dev8Mean = np.mean(dev8,axis=0)


# In[23]:


stan9 =  read5.iloc[2:22,1:101].to_numpy()
dev9 =  read5.iloc[24:44,1:101].to_numpy()


# In[24]:


arr9=[]
for i in range(2,22):
    arr9.append(np.mean(read5.iloc[i,1:101].to_numpy()))
arr9


# In[25]:


arr10=[]
for i in range(24,44):
```

```
    arr10.append(np.mean(read5.iloc[i,1:101].to_numpy()))
arr10


# In[26]:


stanMean9 = np.mean(stan9,axis=0)
dev9Mean = np.mean(dev9,axis=0)
stanMean9


# In[27]:


dev9Mean


# In[37]:


fig, axs = plt.subplots(nrows=5, ncols=1, figsize=(8, 10))


axs[0].plot(stanMean075, color='blue', label='Standard')
axs[0].plot(dev075Mean, color='red', label='Deviant')
axs[0].set_title('Interstimulas at  0.75 s')
axs[0].set_xlabel("EEG Response")
axs[0].set_ylabel("Amplitude(m)")
axs[0].legend()

axs[1].plot(stanMean15, color='blue', label='Standard')
axs[1].plot(dev15Mean, color='red', label='Deviant')
axs[1].set_title('Interstimulas at  1.5 s')
axs[1].set_xlabel("EEG Response")
axs[1].set_ylabel("Amplitude(m)")
axs[1].legend()

axs[2].plot(stanMean3, color='blue', label='Standard')
axs[2].plot(dev3Mean, color='red', label='Deviant')
axs[2].set_title('Interstimulas at  3 s')
axs[2].set_xlabel("EEG Response")
axs[2].set_ylabel("Amplitude(m)")
axs[2].legend()

axs[3].plot(stanMean8, color='blue', label='Standard')
axs[3].plot(dev8Mean, color='red', label='Deviant')
axs[3].set_title('Interstimulas at  8 s')
axs[3].set_xlabel("EEG Response")
axs[3].set_ylabel("Amplitude(m)")
```

```
axs[3].legend()

axs[4].plot(stanMean9, color='blue', label='Standard')
axs[4].plot(dev9Mean, color='red', label='Deviant')
axs[4].set_title('Interstimulas at  9 s')
axs[4].set_xlabel("EEG Response")
axs[4].set_ylabel("Amplitude(m)")
axs[4].legend()

plt.tight_layout()
plt.show()


# In[ ]:




# In[ ]:
```

ii. Analyze the data from each interstimulus interval statistically and report the time scale of echoic memory. Explain the cognitive science consistent rationale behind the calculation and reported time scale. [4 + 2 points]

Hint: Carefully inspect the correctly created figure above for clues.

Ans

Statistics for 0.75s

```
Standard is 1      0.000466
2       0.000203
3       0.000030
4       0.000165
5       0.000263
          ...
96      0.000712
97     -0.001089
98     -0.000247
99     -0.000316
```

```
100    0.001855
Length: 100, dtype: float64

Standard deviation is 1      0.004189
2      0.007351
3      0.006491
4      0.005524
5      0.006201
         ...
96     0.005129
97     0.006792
98     0.003760
99     0.005594
100    0.005128
Length: 100, dtype: float64

Standard Median is [ 6.48862723e-04 -2.55284451e-03 -4.67303980e-04 -1.
25767074e-03
  9.36803937e-04 -7.22470065e-04  3.77890208e-04  1.69377959e-03
  2.75920758e-03  4.85750753e-03 -6.78659535e-04  3.68366584e-04
  2.65372552e-04  2.26386051e-03 -2.04790661e-03 -3.62511771e-03
 -1.30953055e-03 -6.27648346e-06 -1.28754015e-04 -1.14111626e-03
 -9.56257745e-04  2.20529968e-03  8.60392548e-05  5.69902081e-04
  5.57104989e-04 -2.15174223e-03 -6.54316861e-04 -1.93347291e-03
  1.13209926e-03  3.07677995e-03 -1.02383245e-03 -8.16033558e-04
 -1.91113426e-03 -2.10708542e-03 -4.09052777e-04  9.38677720e-04
  1.84131344e-03  8.65384626e-04 -6.09054851e-04  2.03818518e-03
 -2.50560351e-03  3.62036288e-04 -1.30360773e-04  1.37373691e-03
 -1.88089091e-03 -6.40551229e-04 -2.02030243e-03  2.53497350e-03
  2.36574227e-03  1.52669605e-03 -2.00393914e-01 -2.99694468e-01
 -3.50048548e-01 -3.00916962e-01 -1.01426979e-01 -5.82188772e-03
  1.59646783e-03 -5.74409491e-04 -1.04444941e-03  8.56998434e-04
  2.48862072e-03 -2.14328758e-03 -6.38981613e-04 -1.20539279e-03
  1.98471292e-04 -2.20947399e-05 -9.96381552e-04  1.28539737e-03
 -3.03353158e-03  1.27880612e-03  3.38570703e-03  1.14146351e-03
 -2.30715151e-03 -1.14946628e-03  3.92336481e-03 -9.15388955e-04
  6.27265048e-04 -1.14812493e-03 -6.30768010e-04 -8.61466224e-04
 -4.03943572e-03  2.49118624e-04 -1.45364088e-03 -3.10584128e-04
 -8.13088809e-04 -2.62617129e-03  1.07812535e-03  5.42289539e-04
  3.56505843e-03 -1.52658230e-03  8.70591752e-04 -2.75748827e-03
  1.04677829e-03 -1.66191878e-03 -2.62291230e-03 -1.11219129e-03
 -1.31206973e-05 -8.23486073e-04 -6.82450539e-04  3.68540730e-03]

Standard Mode is ModeResult(mode=array([[-0.00867266, -0.01185216, -0.0
140276 , -0.00880639, -0.01587623,
        -0.01407921, -0.0096296 , -0.00962723, -0.01287317, -0.00664197
,
        -0.01038348, -0.00922571, -0.01285687, -0.00678083, -0.00926923
,
        -0.01273848, -0.00985051, -0.00936979, -0.01457325, -0.00940428
,
        -0.01041604, -0.01018404, -0.01304493, -0.00967123, -0.00711849
,
        -0.00849138, -0.0136615 , -0.00813484, -0.01197907, -0.0101337
,
        -0.01052284, -0.01153143, -0.01515915, -0.0119101 , -0.01117637
,
```

```
        -0.0138574 , -0.00546744, -0.0076093 , -0.01096868, -0.00763356
,
        -0.01054702, -0.00987873, -0.00845794, -0.01616991, -0.01027139
,
        -0.01578245, -0.00723711, -0.00775434, -0.01063927, -0.00903959
,
        -0.21156278, -0.30724784, -0.35820507, -0.31282333, -0.11196207
,
        -0.01563602, -0.00871238, -0.00848899, -0.01337303, -0.01602627
,
        -0.00696727, -0.01035075, -0.01142289, -0.01279682, -0.00862343
,
        -0.01273371, -0.01336404, -0.00979179, -0.00934573, -0.01030932
,
        -0.00857424, -0.0058053 , -0.01031291, -0.01255883, -0.00728089
,
        -0.01122926, -0.00769491, -0.01160519, -0.00974317, -0.0075818
,
        -0.01252739, -0.00744894, -0.02230412, -0.01215323, -0.00915479
,
        -0.01390072, -0.01511313, -0.01065208, -0.01125878, -0.01150438
,
        -0.01069748, -0.01449429, -0.00830299, -0.01073525, -0.00754623
,
        -0.00905239, -0.01741395, -0.00685657, -0.01486036, -0.00549539
]]), count=array([[1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1
, 1, 1, 1, 1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1]]))

Standard Variance 1      0.000017
2       0.000051
3       0.000040
4       0.000029
5       0.000037
          ...
96      0.000025
97      0.000044
98      0.000013
99      0.000030
100     0.000025
Length: 100, dtype: float64

Deviant Mean is 1      0.001949
2     -0.001663
3     -0.000906
4     -0.001683
5     -0.001491
          ...
96     0.001337
97     0.001877
98     0.001387
99     0.002022
```

```
100    0.000662
Length: 100, dtype: float64

Deviant standard deviation is 1      0.007010
2      0.008779
3      0.006465
4      0.007397
5      0.006464
         ...
96     0.007646
97     0.007893
98     0.010483
99     0.006271
100    0.008167
Length: 100, dtype: float64

Deviant Median is [ 7.29920453e-04 -7.42643188e-04 -9.43197137e-04 -6.6
0781088e-04
 -1.19049385e-03 -9.05076957e-04  6.33915469e-04  3.89852941e-03
  8.43834394e-05 -6.65442567e-04  1.63389589e-03 -1.73018380e-03
 -2.94323269e-04  6.04660217e-05 -1.75134532e-03 -1.79409843e-04
  1.16771878e-03 -2.25104236e-03  1.58023524e-03 -2.68987359e-03
  3.32065757e-04  1.83625543e-03  3.47653669e-03 -1.53574105e-03
  1.85022384e-03 -3.89327667e-03 -5.76386799e-04  3.38818108e-03
 -4.20677678e-03 -1.31549513e-03  9.69257101e-04 -6.49745114e-04
  2.41571360e-03  1.86225681e-03 -5.39851924e-03  2.10017647e-03
 -3.40354276e-03 -2.23805046e-03 -9.80918665e-04  3.57526705e-03
 -2.87894817e-04 -5.75049187e-04 -3.15467408e-03 -5.95665696e-04
 -1.32698230e-03 -1.25630138e-03  2.11785853e-03 -7.10737879e-04
 -6.44184400e-04  4.06991239e-04 -2.89392122e-01 -4.00513144e-01
 -3.98869030e-01 -3.89107128e-01 -1.99671639e-01  1.36356786e-03
  1.41645948e-03  3.53858553e-03  9.56727499e-04  8.24149439e-04
  2.90010169e-04 -6.46830949e-04 -1.00834880e-03  1.14305820e-03
 -2.63894636e-03 -2.46110695e-04  1.32499208e-03  2.36859179e-03
  7.97051963e-04 -9.29245658e-04  2.77097459e-03 -4.67734432e-04
 -4.29526954e-04  1.48136726e-04  2.39109078e-03  4.17620129e-03
  1.12312323e-03  3.55137429e-03  4.11361441e-04 -1.26118612e-03
  1.07189910e-03  2.10563458e-03  2.72993011e-03  5.01794122e-03
 -7.21631349e-04 -1.18474046e-03  2.39913812e-04  5.66287422e-04
 -1.40044627e-03 -1.34931547e-03 -1.14196994e-03  1.29178912e-04
  1.64192435e-03  3.16058795e-04  1.99014316e-03 -4.93783678e-04
  2.14307593e-03  2.49762908e-03  3.92001353e-03 -1.30029506e-04]

Deviant Mode is ModeResult(mode=array([[-0.00779238, -0.01536822, -0.01
255822, -0.01367547, -0.01320779,
        -0.02176505, -0.0173377 , -0.01524983, -0.01715184, -0.01200604
,
        -0.01563999, -0.01612651, -0.01231571, -0.01308619, -0.01112876
,
        -0.02168947, -0.01661916, -0.01610823, -0.0111886 , -0.02021409
,
        -0.01403253, -0.0191337 , -0.01110688, -0.01311256, -0.0132824
,
        -0.01475445, -0.01404053, -0.02178416, -0.01881835, -0.01029359
,
        -0.01126012, -0.01430736, -0.00474697, -0.01018689, -0.01424203
,
```

```
        -0.00556362, -0.01584635, -0.01230733, -0.01485815, -0.00987948
,
        -0.01348758, -0.01151147, -0.01495491, -0.0120539 , -0.01304513
,
        -0.01393812, -0.01904528, -0.01840152, -0.00730106, -0.01947736
,
        -0.30740417, -0.40888699, -0.41048225, -0.39839232, -0.20979254
,
        -0.01585884, -0.02303335, -0.01312718, -0.01810655, -0.01470741
,
        -0.01583353, -0.0137251 , -0.01411203, -0.00791633, -0.01920282
,
        -0.01472217, -0.0232753 , -0.0150445 , -0.01106594, -0.01286454
,
        -0.01086707, -0.00789591, -0.02017721, -0.01095991, -0.00994624
,
        -0.01275978, -0.01058719, -0.00988731, -0.01417665, -0.01190143
,
        -0.01606796, -0.01158401, -0.01437738, -0.01136367, -0.01068055
,
        -0.01441238, -0.01349419, -0.01040291, -0.01808362, -0.02160485
,
        -0.02118036, -0.01169208, -0.01860803, -0.01980214, -0.01585953
,
        -0.00654213, -0.00810372, -0.02143194, -0.01064207, -0.01180847
]]), count=array([[1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1
, 1, 1, 1, 1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1]]))

Deviant Variance is 1      0.000047
2      0.000073
3      0.000040
4      0.000052
5      0.000040
         ...
96     0.000056
97     0.000059
98     0.000104
99     0.000037
100    0.000063
Length: 100, dtype: float64
```

Statistics for 1.5s

```
Standard Mean is 1     -0.000255
2      0.000375
3     -0.000643
4     -0.001712
```

```
5      0.000492
         ...
96     0.000125
97     0.001202
98     0.001090
99    -0.001379
100   -0.000963
Length: 100, dtype: float64

Standard deviation is 1      0.004718
2      0.004833
3      0.006402
4      0.005286
5      0.005652
         ...
96     0.005529
97     0.004559
98     0.004881
99     0.004297
100    0.005204
Length: 100, dtype: float64

Standard Median is [ 5.09518065e-04  3.46787716e-04  9.65177978e-05 -1.
10062106e-03
  6.90180621e-04  1.40157678e-04 -4.95449269e-04 -1.29632972e-03
 -3.50210510e-03  2.01279410e-03 -1.61239500e-03  4.73789325e-04
 -9.53742678e-04  2.97654027e-03  2.54020462e-03 -1.41404116e-03
  2.13351489e-03  1.72007319e-03  3.50079706e-04 -1.95894967e-03
 -8.35771618e-05 -6.38890491e-04  7.79571541e-04 -5.95186568e-04
 -8.75593433e-04 -2.99048010e-04  1.65119582e-03 -2.41393146e-03
 -6.26225328e-04  1.04793906e-03  8.62598264e-04 -1.77675478e-03
  8.96937079e-04  6.13364627e-04  1.83249999e-03 -2.53435787e-03
  1.26289815e-03 -3.41066995e-03  9.97227703e-04 -8.33638690e-04
 -1.05899907e-03 -1.32508085e-03  2.08519453e-03 -8.24824943e-04
  1.02310407e-03 -9.92337948e-04  7.77136907e-04  1.11481526e-03
 -1.23973344e-03  9.51028637e-04 -9.97209706e-02 -2.99665862e-01
 -4.00724540e-01 -1.99033846e-01 -9.99411936e-02  1.52406268e-03
 -1.73498172e-03  3.05070673e-04 -1.32334217e-04  5.99856956e-04
  2.79428403e-04  1.06150568e-04 -2.06987329e-03 -2.03249610e-03
 -4.96226130e-03  1.03471564e-03 -9.04404034e-04 -1.04112894e-03
  2.55784908e-04 -7.84868316e-05  2.08814528e-03  3.01835709e-04
 -8.66420568e-04 -5.69794220e-04  7.02086915e-04 -1.30251365e-03
  3.40503824e-04 -3.50100588e-03  7.98396264e-04 -3.10212936e-04
 -3.18854607e-04  2.00385889e-03  1.13739771e-03  3.57202138e-04
  5.43779419e-04  1.79182458e-03  5.80089114e-04 -5.11630251e-04
 -1.05757647e-03  5.87739347e-04 -1.64780435e-03 -1.94052754e-03
 -4.54618023e-04  8.64091656e-05 -8.55023979e-05  1.24509796e-03
  8.65733162e-04  1.77436831e-03 -1.10098685e-03 -5.19169120e-04]

Standard Mode is ModeResult(mode=array([[-0.00942142, -0.00727898, -0.0
1139076, -0.01342321, -0.01066194,
        -0.01020072, -0.00854433, -0.01121355, -0.00843528, -0.01088228
,
        -0.00718575, -0.01119156, -0.0098986 , -0.01594523, -0.00696799
,
        -0.01025691, -0.01041917, -0.00702739, -0.01038928, -0.00954659
,
```

```
        -0.01191991, -0.00777346, -0.01116688, -0.01153348, -0.0101687
,
        -0.01435714, -0.00582485, -0.01016274, -0.01493259, -0.00899792
,
        -0.01046689, -0.00652171, -0.00918112, -0.01283102, -0.0080999
,
        -0.0111564 , -0.01041498, -0.0108155 , -0.01148698, -0.01475735
,
        -0.01552119, -0.01453116, -0.00745881, -0.01061381, -0.00927847
,
        -0.00975901, -0.01151353, -0.01144814, -0.0113059 , -0.01024394
,
        -0.10728343, -0.30709115, -0.41180864, -0.21367009, -0.11005424
,
        -0.01144074, -0.01117104, -0.0118531 , -0.00880543, -0.00703142
,
        -0.00842202, -0.00711161, -0.00955604, -0.01216826, -0.01403511
,
        -0.01067712, -0.01252531, -0.01027379, -0.00633218, -0.01463374
,
        -0.01138395, -0.00728357, -0.01400129, -0.01229213, -0.00847455
,
        -0.01121958, -0.0124253 , -0.01628588, -0.01393667, -0.00997498
,
        -0.01562844, -0.01001397, -0.00710647, -0.01258422, -0.01326654
,
        -0.0094045 , -0.01018503, -0.01174628, -0.01226918, -0.01102829
,
        -0.01098936, -0.01143004, -0.00646289, -0.00769887, -0.00889303
,
        -0.01041146, -0.00857582, -0.00777899, -0.0094716 , -0.01477095
]]), count=array([[1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1
, 1, 1, 1, 1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1]]))

Standard Variance 1      0.000021
2      0.000022
3      0.000039
4      0.000027
5      0.000030
         ...
96     0.000029
97     0.000020
98     0.000023
99     0.000018
100    0.000026
Length: 100, dtype: float64

Deviant Mean is 1     -0.000902
2     -0.003614
3     -0.000149
4     -0.001067
```

```
5     -0.001660
         ...
96     0.000245
97    -0.000541
98     0.000282
99    -0.000828
100   -0.000521
Length: 100, dtype: float64

Deviant standard deviation is 1      0.009127
2      0.007502
3      0.007178
4      0.007661
5      0.007787
         ...
96     0.007063
97     0.006485
98     0.007629
99     0.010174
100    0.010131
Length: 100, dtype: float64

Deviant Median is [-5.02896578e-04 -1.91061843e-03 -8.34723545e-04 -1.7
5723770e-03
 -1.28470043e-03  1.32186877e-03  2.19060210e-04 -2.24044756e-03
 -1.85611095e-03 -1.31945005e-03  2.11739088e-03  3.69056395e-03
 -1.81467380e-04  2.66299341e-03  6.39031240e-04  2.38869114e-03
  1.00853314e-03 -6.20053352e-03 -9.86737524e-04 -1.11698519e-03
 -9.06715435e-04 -3.11928533e-03 -2.35597588e-03  1.44214726e-04
  4.17139378e-04 -6.68107686e-04  1.03588170e-03  2.26474770e-04
  2.84773562e-03 -9.69935451e-04 -1.32752577e-03 -5.82879016e-04
 -1.83688203e-03 -2.51391714e-03 -2.78897262e-03 -1.96500120e-03
 -2.40190894e-04  2.30304508e-03  2.61623513e-03  3.10877246e-03
  8.69848080e-04 -8.09196006e-04  1.69368176e-03 -3.13349079e-03
  1.35120932e-03  3.31426831e-03 -1.42315033e-03 -6.40110188e-03
  1.76607534e-03 -3.30556568e-03 -3.00522127e-01 -4.47989447e-01
 -5.04761592e-01 -3.62369924e-01 -2.01687491e-01 -8.95541087e-04
 -2.66393021e-03  6.91622098e-04  1.05498495e-04 -2.79518223e-03
 -2.23514225e-03  3.90273702e-04  8.63219026e-04 -3.73438891e-04
  5.80471206e-03 -8.57028276e-04 -1.38768673e-03  2.26624670e-03
 -1.79151205e-03 -3.05193340e-03 -1.32778142e-03  4.84822438e-03
  2.78812812e-03  8.72507366e-05 -1.77235916e-04  2.20509971e-03
 -1.94471385e-03 -3.52980446e-04  2.06588565e-04 -1.33263223e-03
  1.01079635e-05  5.33084022e-03  2.90656619e-04 -5.21849292e-04
 -1.87071466e-03  1.62615065e-03 -2.44616250e-03  2.47748963e-03
  2.02595213e-04 -4.80898331e-04  5.47284430e-05  1.75601645e-04
 -5.26963889e-04  3.46819580e-03  1.35232040e-03  7.03794499e-04
 -7.10767981e-04 -6.59839821e-04 -1.64735503e-03  6.40946194e-04]

Deviant Mode is ModeResult(mode=array([[-0.02117183, -0.01913341, -0.01
264688, -0.01957869, -0.01388785,
        -0.01753583, -0.01950424, -0.01418139, -0.01555576, -0.01437816
,
        -0.00908896, -0.01002799, -0.01604614, -0.00755255, -0.01350117
,
        -0.00731475, -0.01776782, -0.02296875, -0.02581413, -0.01677168
,
```

```
        -0.01898428, -0.03397089, -0.01959297, -0.01305159, -0.0091481
,
        -0.02163664, -0.01567888, -0.02639871, -0.01986637, -0.01114151
,
        -0.01482111, -0.02020205, -0.01860593, -0.01272909, -0.01770105
,
        -0.02559964, -0.01861759, -0.00928361, -0.01530491, -0.01282056
,
        -0.02081419, -0.01672939, -0.01319132, -0.01379896, -0.01336406
,
        -0.01445577, -0.01776298, -0.01554782, -0.01143857, -0.01613065
,
        -0.31912112, -0.46313618, -0.52425308, -0.37316325, -0.2072163
,
        -0.0205377 , -0.01545086, -0.01186611, -0.01184816, -0.01382777
,
        -0.01874687, -0.01083893, -0.01754306, -0.0299422 , -0.01534041
,
        -0.01462003, -0.01357887, -0.0140707 , -0.02918164, -0.01695898
,
        -0.01625445, -0.01106499, -0.01370184, -0.02215693, -0.01622062
,
        -0.01373424, -0.02017647, -0.01345324, -0.02403075, -0.01594955
,
        -0.01663759, -0.01384557, -0.01521619, -0.01102418, -0.01060731
,
        -0.0146821 , -0.01232689, -0.00814738, -0.02146398, -0.01437953
,
        -0.01248207, -0.0109248 , -0.01502779, -0.01241559, -0.01455857
,
        -0.01209361, -0.01419529, -0.01666033, -0.01471723, -0.02220787
]]), count=array([[1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1
, 1, 1, 1, 1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1]]))

Deviant Variance is 1      0.000079
2      0.000053
3      0.000049
4      0.000056
5      0.000058
         ...
96     0.000047
97     0.000040
98     0.000055
99     0.000098
100    0.000098
Length: 100, dtype: float64
```

Statistics for 3s

```
Standard Mean is 1     -0.001537
2      0.000089
3     -0.001009
4     -0.000161
5     -0.000193
         ...
96     0.000599
97     0.000540
98    -0.000224
99    -0.001745
100   -0.000880
Length: 100, dtype: float64

Standard deviation is 1      0.004433
2      0.004071
3      0.004835
4      0.005100
5      0.004020
         ...
96     0.003853
97     0.004053
98     0.005232
99     0.004472
100    0.004072
Length: 100, dtype: float64

Standard Median is [-1.43008585e-03 -6.40330984e-04 -5.60312563e-04 -4.
18410422e-04
  3.62379262e-05 -3.76408238e-05  4.54141725e-03  2.51104390e-03
 -1.58267106e-04 -1.68660603e-03 -9.43970544e-05  1.32396592e-04
  7.03961565e-04 -1.74895551e-03  8.60838016e-04 -7.23421404e-04
 -1.34801802e-04 -7.35107624e-05  2.98508476e-04 -1.14949669e-03
 -1.34843306e-03 -1.30399099e-03 -1.25271470e-03  7.42650836e-04
  1.38708342e-03 -6.87844155e-04 -4.76063551e-04 -7.94247378e-04
  1.62771169e-04 -2.53567185e-03  1.00551888e-03 -8.36315603e-05
  1.81632207e-03 -5.18596526e-04  1.17021673e-03 -5.28964233e-04
 -1.82151906e-04  1.53518481e-04  3.52925513e-04 -1.71627784e-03
  3.09162053e-04 -3.62562772e-04 -7.42649881e-04 -1.34050570e-03
 -1.65762441e-04  1.21212276e-04  2.92663879e-04  3.42698931e-04
 -4.01147517e-04  9.98061051e-05 -1.49780573e-01 -1.99979246e-01
 -3.00580433e-01 -1.99239114e-01 -1.00632886e-01  6.45927894e-04
  2.08682130e-03 -3.90338421e-04  6.72644536e-04 -6.79986242e-04
  8.20606114e-04  1.25472991e-04  1.55854384e-03  1.60861729e-03
  7.19849637e-04 -1.94012749e-03  4.91803231e-04 -2.04902751e-03
 -1.05976364e-03  1.55857590e-03 -7.48624516e-04 -1.19899162e-03
  1.49558707e-03  1.29441127e-03  1.71201790e-03  5.36752952e-04
  1.42834453e-03  3.39311664e-04  7.55358248e-04 -1.00427732e-04
  5.67557143e-04  7.26861322e-04  1.52734650e-03  8.91538506e-04
  4.09287717e-04 -6.32620020e-04  4.77715721e-04 -4.08441135e-05
  8.77392003e-04  5.58200792e-04  1.19789921e-03 -1.82172716e-03
 -2.01355668e-04 -1.17408171e-03 -6.97113794e-04  1.59623203e-03
  2.58742568e-04 -7.41634057e-04 -1.18236620e-03 -1.08314004e-03]

Standard Mode is ModeResult(mode=array([[-0.00804027, -0.00526583, -0.0
1071926, -0.00909562, -0.00727217,
        -0.00665885, -0.00829594, -0.00903121, -0.00986606, -0.01177998
,
```

```
        -0.00862254, -0.00595987, -0.00814655, -0.008692  , -0.00442751
,
        -0.00860885, -0.0080773 , -0.00797813, -0.00492155, -0.01006986
,
        -0.01084914, -0.00727063, -0.00838488, -0.00765497, -0.00375391
,
        -0.01119656, -0.00689109, -0.00859558, -0.01180691, -0.00840445
,
        -0.0070565 , -0.01161522, -0.00469002, -0.01134258, -0.00811132
,
        -0.00870971, -0.00548413, -0.00583094, -0.00747356, -0.01034418
,
        -0.00891141, -0.00599295, -0.01014214, -0.00584115, -0.00727801
,
        -0.00965031, -0.01424867, -0.01097321, -0.00945286, -0.00676187
,
        -0.15632024, -0.2044102 , -0.3080361 , -0.20755541, -0.10707893
,
        -0.00494756, -0.00865287, -0.00578082, -0.00891153, -0.01001796
,
        -0.01185891, -0.00853888, -0.00477641, -0.00650899, -0.01225282
,
        -0.00717229, -0.00851499, -0.00583743, -0.01629134, -0.00878963
,
        -0.00811726, -0.0092617 , -0.00768856, -0.00976608, -0.00736914
,
        -0.01406026, -0.0074176 , -0.00588516, -0.01317596, -0.00916547
,
        -0.00949182, -0.006555  , -0.00925762, -0.00884002, -0.01037892
,
        -0.01042473, -0.00841613, -0.01273317, -0.00322788, -0.0052703
,
        -0.00813126, -0.00776151, -0.01225173, -0.01202178, -0.00725907
,
        -0.00745403, -0.00805574, -0.01176632, -0.01083593, -0.00994109
]]), count=array([[1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1
, 1, 1, 1, 1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1]]))

Standard Variance 1      0.000019
2      0.000016
3      0.000022
4      0.000025
5      0.000015
         ...
96     0.000014
97     0.000016
98     0.000026
99     0.000019
100    0.000016
Length: 100, dtype: float64
```

```
Deviant Mean is 1      0.001982
2     -0.002064
3      0.003498
4      0.001035
5     -0.001531
         ...
96     0.000795
97    -0.000272
98    -0.001601
99     0.001430
100   -0.001398
Length: 100, dtype: float64

Deviant standard deviation is 1      0.009460
2      0.006198
3      0.008015
4      0.007151
5      0.008009
         ...
96     0.006972
97     0.006690
98     0.007025
99     0.006200
100    0.009426
Length: 100, dtype: float64

Deviant Median is [-6.21880133e-05 -2.45238299e-03  5.31140967e-03  2.4
3386408e-03
 -1.83791048e-03 -3.77301361e-03 -1.86869518e-03 -2.39544890e-03
 -3.50350469e-04 -7.68171177e-04 -1.01897547e-03  1.56634369e-03
 -1.36652709e-03  3.06954738e-03  2.32757433e-04  1.22024413e-03
 -9.82998487e-04 -1.57236375e-03 -1.00490637e-03  1.34872741e-03
  1.22312256e-03 -1.35451194e-03  1.75980396e-04 -1.40028055e-03
 -2.01623502e-03 -1.25624218e-03 -5.86265319e-04  7.24989104e-04
 -1.26365871e-03 -3.80841553e-03 -8.49802573e-04  7.39791959e-04
  1.94811698e-03 -1.61851172e-03 -2.66970324e-03  2.98467394e-03
 -1.37331538e-03  3.55207339e-03  5.23641033e-04  2.53912292e-03
  1.18325221e-03 -1.00266612e-03 -1.67541898e-03  1.07950095e-03
 -1.96444973e-03 -1.10589959e-03  8.56581476e-04 -2.08514457e-03
 -1.07517748e-03  2.38585423e-04 -2.99976905e-01 -4.04066424e-01
 -3.50104527e-01 -4.00271431e-01 -1.50126309e-01  1.18947755e-03
  3.28944433e-03  1.44479282e-03 -1.43090247e-03  3.02485884e-03
 -4.11828647e-03  2.88383828e-04  3.94094900e-03 -1.05648079e-03
 -3.58762811e-03  1.78103982e-03  1.01616369e-03 -1.01461438e-05
 -1.19105066e-03 -5.17348624e-03 -3.45876282e-04  8.08418514e-05
 -5.86785489e-04  8.18835732e-04  1.42356264e-03  7.14766214e-04
  1.12314701e-03 -7.22688260e-04  4.82364986e-04  2.45934550e-03
 -1.41559991e-03 -5.70974832e-04 -1.39103258e-03 -3.03838429e-04
 -3.51998255e-03  7.65723895e-04  1.09230299e-03  5.33649088e-04
 -2.60250885e-03 -4.18578006e-03  1.06376366e-03  1.89713796e-03
 -1.37681303e-03  6.60296323e-04 -3.04565750e-03  2.30663082e-03
 -3.92799973e-04 -4.07264561e-04 -9.14206058e-04 -1.01611621e-03]

Deviant Mode is ModeResult(mode=array([[-0.01627817, -0.01187356, -0.01
663248, -0.01549933, -0.02009802,
        -0.02051799, -0.01040561, -0.01730681, -0.01066525, -0.01241358
,
```

```
        -0.00699791, -0.01149958, -0.01198404, -0.0133675 , -0.01227977
,
        -0.01081775, -0.01111985, -0.01217486, -0.01939518, -0.0119909
,
        -0.00680773, -0.006273  , -0.00720796, -0.01258134, -0.01116468
,
        -0.01168174, -0.01836487, -0.015235  , -0.00865369, -0.01234481
,
        -0.01060178, -0.02565096, -0.00943521, -0.0179981 , -0.02635955
,
        -0.01725296, -0.02071745, -0.01480981, -0.01203106, -0.00684509
,
        -0.01286116, -0.01202619, -0.01044775, -0.01391436, -0.00942808
,
        -0.01252832, -0.01271576, -0.0266773 , -0.01812856, -0.01106204
,
        -0.30989795, -0.41749583, -0.364063  , -0.41144932, -0.16308512
,
        -0.01381069, -0.00861785, -0.01887407, -0.01220374, -0.01738965
,
        -0.01475259, -0.01569654, -0.01299049, -0.01333595, -0.0158412
,
        -0.01045992, -0.0105224 , -0.01163967, -0.01841879, -0.01539437
,
        -0.01390899, -0.01750431, -0.01168029, -0.01676448, -0.01055186
,
        -0.01126894, -0.01206432, -0.00912341, -0.01394912, -0.02286388
,
        -0.01254156, -0.01338875, -0.02538309, -0.01764992, -0.0168511
,
        -0.01439877, -0.01141686, -0.01888975, -0.02116643, -0.01546212
,
        -0.00928333, -0.01029774, -0.01478492, -0.01199182, -0.01709346
,
        -0.01027775, -0.01307247, -0.01634749, -0.0078971 , -0.02609971
]]), count=array([[1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1
, 1, 1, 1, 1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1]]))

Deviant Variance is 1      0.000085
2      0.000036
3      0.000061
4      0.000049
5      0.000061
         ...
96     0.000046
97     0.000043
98     0.000047
99     0.000037
100    0.000084
Length: 100, dtype: float64
```

Statistics for 8s

```
Standard Mean is 1      0.000638
2     -0.000574
3      0.001730
4     -0.002355
5     -0.000341
         ...
96     0.000945
97     0.000902
98    -0.000993
99     0.001479
100   -0.001369
Length: 100, dtype: float64

Standard deviation is 1      0.005722
2      0.004558
3      0.004885
4      0.004363
5      0.007015
         ...
96     0.007035
97     0.007011
98     0.004664
99     0.005253
100    0.007905
Length: 100, dtype: float64

Standard Median is [-5.15361611e-04 -7.90321049e-04  2.55322421e-03 -3.
98070852e-03
  7.04316227e-04 -3.04186660e-04 -5.65318485e-04 -5.39036029e-04
  4.96916234e-04 -2.11818753e-03 -1.63271012e-03 -7.87617793e-04
  1.51491751e-03 -6.39825680e-04  1.64383923e-03 -4.01246470e-05
  1.87700392e-03 -1.99964489e-03 -2.02528275e-03 -5.02161472e-04
 -1.58532326e-04 -1.29769156e-03 -1.05234889e-03  9.04548705e-05
 -5.84186081e-04  1.61337216e-03  1.11667606e-03  5.52611678e-04
 -1.89180735e-03 -7.81756075e-04 -2.74069451e-03 -5.09438128e-04
 -1.50492635e-03 -2.78583813e-04 -2.08942386e-03 -1.49606500e-04
 -9.01826959e-04 -7.74044539e-04 -1.33547786e-03  4.75402814e-03
 -5.40132505e-04  1.73951512e-03  1.62752359e-03  8.38674795e-04
  2.35396116e-03 -1.24635983e-03  1.67014510e-03 -4.65338868e-04
 -7.28300600e-04 -6.12568269e-04 -1.99425483e-01 -2.99810161e-01
 -3.79005690e-01 -2.01715888e-01 -9.82231835e-02  2.71570685e-04
  7.04635367e-04 -6.26412558e-05 -6.62388059e-04 -3.25140981e-04
  2.49468653e-03 -1.02616451e-04  1.91552995e-03 -1.06377293e-03
 -5.27986978e-04  1.61353694e-04 -5.22491149e-04 -1.69504918e-03
  1.21330647e-03 -3.80768611e-03 -9.56105240e-04 -5.28216507e-04
 -1.87003910e-04 -1.94470459e-03  2.75998304e-03  6.62896147e-04
  9.47433721e-04  1.55691139e-03  1.05078814e-03 -5.32395521e-04
 -1.14238649e-03 -1.27523154e-04  1.69157244e-04 -1.04277390e-04
  2.94443991e-03  2.95143889e-04  2.14321025e-03 -1.81769828e-04
  2.50562898e-03 -7.73710546e-04  2.57458289e-03 -1.03232992e-03
 -1.14340641e-03 -4.76088928e-04 -6.43105855e-04 -8.36041973e-05
  1.58824825e-03 -5.37183052e-04  1.52757020e-04 -3.18762767e-03]

Standard Mode is ModeResult(mode=array([[-0.00687623, -0.00675902, -0.0
1189723, -0.00936931, -0.01346803,
```

```
        -0.01260859, -0.01045984, -0.00940325, -0.00575326, -0.00724622
,
        -0.01233496, -0.01470965, -0.00893688, -0.00668507, -0.01183183
,
        -0.01115244, -0.01002141, -0.00809106, -0.01720792, -0.00885284
,
        -0.01227489, -0.01052176, -0.01194057, -0.00592359, -0.01547221
,
        -0.0114868 , -0.00874179, -0.01153839, -0.01060794, -0.01134721
,
        -0.00891756, -0.00721018, -0.01064512, -0.00695546, -0.01130251
,
        -0.00987384, -0.01557593, -0.00979698, -0.00957865, -0.00754896
,
        -0.01414464, -0.01150266, -0.01052825, -0.00804854, -0.00430307
,
        -0.01202899, -0.01627794, -0.01137864, -0.00577673, -0.00996341
,
        -0.20943992, -0.31028446, -0.38646586, -0.21822572, -0.10769633
,
        -0.01036907, -0.00966113, -0.01001679, -0.01178536, -0.01053261
,
        -0.01039339, -0.01187924, -0.00423854, -0.01604798, -0.00636947
,
        -0.01263914, -0.01201584, -0.00994499, -0.00589355, -0.01076701
,
        -0.01422921, -0.01322211, -0.01537611, -0.01498164, -0.0067371
,
        -0.01261622, -0.00603823, -0.00926536, -0.00688062, -0.01060892
,
        -0.00395645, -0.01630889, -0.00919289, -0.00586685, -0.00962077
,
        -0.01403133, -0.00737419, -0.00834303, -0.01121567, -0.00780032
,
        -0.00931651, -0.01130513, -0.0120453 , -0.00645445, -0.01031915
,
        -0.0101994 , -0.01468843, -0.00992601, -0.00640305, -0.01349152
]]), count=array([[1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1
, 1, 1, 1, 1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1]]))

Standard Variance 1      0.000031
2      0.000020
3      0.000023
4      0.000018
5      0.000047
         ...
96     0.000047
97     0.000047
98     0.000021
99     0.000026
100    0.000059
```

```
Length: 100, dtype: float64

Deviant Mean is 1      0.000702
2      0.000984
3     -0.001184
4     -0.000859
5     -0.001256
         ...
96     0.001394
97    -0.000561
98    -0.000649
99    -0.002215
100   -0.000366
Length: 100, dtype: float64

Deviant standard deviation is 1      0.006542
2      0.007958
3      0.005817
4      0.008356
5      0.006904
         ...
96     0.006264
97     0.006698
98     0.006988
99     0.006929
100    0.006653
Length: 100, dtype: float64

Deviant Median is [ 1.15645283e-03  8.82293650e-04 -1.92599538e-03  8.5
3873871e-05
 -2.35512039e-03  1.64977882e-03 -8.13439854e-04 -1.57407607e-03
 -3.33480258e-03  8.64528592e-04  1.22892048e-04  2.42537150e-04
  3.12687908e-04 -1.98167078e-03 -4.60241730e-03  3.09281583e-03
  1.71924069e-03  1.81075760e-03  1.05820862e-03  7.72095673e-04
  2.67219711e-03 -5.59128207e-03 -1.94808298e-03 -1.97351568e-03
 -7.72424305e-04  4.02133933e-04  5.14626460e-03 -5.20182890e-04
  7.42451340e-04 -3.68596676e-03  1.42577107e-03  1.33178675e-03
  1.37795997e-03  4.91266550e-04  3.18366429e-04  3.45323378e-03
 -5.21797607e-04 -1.15607001e-03  3.08688503e-04 -3.01397570e-03
 -5.70561709e-04 -1.74509467e-03  2.99064251e-03  6.24334513e-04
  1.40481992e-03  2.06951329e-03 -6.24600387e-04 -1.52607163e-03
  1.41244105e-03 -6.39460221e-04 -2.49679959e-01 -3.18606895e-01
 -4.41140597e-01 -2.19674010e-01 -1.21551799e-01  3.33678793e-04
  1.92021382e-03 -1.06376352e-03 -2.42411598e-03 -4.63881065e-04
 -3.48614158e-04  3.78977078e-04  2.83554314e-04 -2.06185102e-03
  1.04945505e-03 -6.98848637e-04  8.94624928e-04 -2.66500859e-04
 -2.36918251e-04  8.69608261e-04 -1.60726640e-04 -2.24522574e-03
  1.11519591e-03 -1.78551764e-03  1.70119878e-03  2.87526059e-03
  2.86629594e-03  8.66209128e-04  2.01636524e-03  8.15794614e-04
  2.06443254e-04 -1.09745226e-03  1.30650052e-04  3.13306311e-03
 -3.98519885e-04  1.64525939e-03  9.73235457e-04  2.51778664e-03
  3.31131563e-03 -2.67711930e-03 -1.35051450e-03 -1.80058903e-03
  1.96728488e-03  2.30279110e-03  5.92808741e-04  1.31201908e-03
 -1.49238341e-03 -2.97563566e-03 -2.59986552e-03 -4.34747068e-04]

Deviant Mode is ModeResult(mode=array([[-0.01006378, -0.01206152, -0.01
241486, -0.01896195, -0.01211461,
```

```
        -0.01619997, -0.01481978, -0.01295129, -0.01052248, -0.01011489
,
        -0.01570198, -0.01273819, -0.01521192, -0.00903421, -0.01476041
,
        -0.0066976 , -0.01255619, -0.01753369, -0.00711575, -0.01263356
,
        -0.01118218, -0.01573776, -0.01007432, -0.00733233, -0.01238559
,
        -0.00827687, -0.00715886, -0.01008334, -0.0155732 , -0.01242141
,
        -0.00931286, -0.01644327, -0.01808811, -0.01614888, -0.00846787
,
        -0.01274678, -0.01647169, -0.01553909, -0.01180329, -0.01146176
,
        -0.00654181, -0.0181629 , -0.01039538, -0.0097302 , -0.01443799
,
        -0.01227672, -0.01253826, -0.0132016 , -0.00621309, -0.01564834
,
        -0.26255238, -0.33966837, -0.45389163, -0.23382269, -0.13508065
,
        -0.01498495, -0.00896593, -0.00576729, -0.00824212, -0.01095272
,
        -0.01216819, -0.01105811, -0.00836345, -0.01197848, -0.01594838
,
        -0.01181509, -0.00855747, -0.01171864, -0.01243433, -0.0106489
,
        -0.01283157, -0.01492551, -0.01111751, -0.01135945, -0.01567803
,
        -0.01365851, -0.01696083, -0.00990107, -0.01168289, -0.01124429
,
        -0.02217773, -0.01098445, -0.01419004, -0.01445723, -0.01091876
,
        -0.01076552, -0.01778425, -0.01506931, -0.01721062, -0.00872611
,
        -0.0114841 , -0.01072313, -0.01605965, -0.00847292, -0.00935087
,
        -0.01276353, -0.01128708, -0.01136584, -0.0138286 , -0.0140237
]]), count=array([[1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1
, 1, 1, 1, 1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1]]))

Deviant Variance is 1      0.000041
2      0.000060
3      0.000032
4      0.000066
5      0.000045
         ...
96     0.000037
97     0.000043
98     0.000046
99     0.000046
100    0.000042
```

```
Length: 100, dtype: float64
```

Statistics for 9s

```
Standard Mean is 1     -0.000544
2      0.001727
3      0.000951
4     -0.000345
5      0.000926
         ...
96    -0.000547
97     0.002092
98     0.001034
99     0.000300
100    0.001482
Length: 100, dtype: float64

Standard deviation is 1      0.006079
2      0.003991
3      0.006192
4      0.005485
5      0.005678
         ...
96     0.004791
97     0.007097
98     0.004885
99     0.005675
100    0.003632
Length: 100, dtype: float64

Standard Median is [ 9.66361482e-06  1.87049277e-03  9.13342931e-04 -6.
96656851e-06
  2.51280552e-03  1.97734288e-03  1.06755343e-03  2.89741813e-04
  1.84472063e-05  1.18251511e-03  3.10665586e-04 -3.35169449e-04
 -1.08470016e-03  3.79435421e-04 -4.74201114e-04  3.06733609e-03
  1.47380387e-03  8.46014708e-04  6.92560679e-04  1.98770149e-03
  1.18548267e-03 -2.25560975e-03 -7.64353425e-04  1.47080380e-03
 -4.56330112e-05  9.99147903e-05 -1.68302814e-03  1.07816538e-03
  1.96556590e-04 -1.97643448e-03  3.00905406e-04 -2.78876244e-04
 -2.39377203e-06 -1.76672946e-03  2.07667158e-03 -1.56715642e-03
 -2.98282670e-04  2.87083612e-04 -8.98520296e-04 -1.38007630e-03
 -8.38190366e-05 -7.63864943e-04  4.24952377e-04  1.58148389e-03
  1.72466972e-04  1.14849344e-03 -1.46987828e-03 -2.06274619e-03
 -2.95850750e-04 -7.93633891e-04 -1.72058296e-01 -2.46922584e-01
 -3.82271603e-01 -2.52040450e-01 -1.40120935e-01 -1.21135999e-03
  6.66181567e-04 -1.49122808e-03  9.47936309e-04 -1.91307983e-04
  9.89018531e-04  1.73249460e-03  2.83598710e-03  2.75902964e-03
  5.13427633e-04 -1.78584218e-04  1.28115978e-03  2.58708767e-03
  1.79370637e-03  8.64140680e-04 -2.08378162e-03  3.08120208e-03
  1.35248583e-03 -1.01525032e-03 -6.89739120e-04 -2.42102138e-03
 -4.87270322e-05 -1.16813251e-03  1.59895168e-04 -5.79678647e-04
 -8.31543589e-04 -1.07790694e-03  9.57518635e-04 -1.31134292e-03
  1.60009456e-03  2.44541928e-03 -1.91550384e-03  1.95722039e-03
 -2.07230517e-03 -1.46300147e-03  2.12807899e-03  2.18830710e-03
  7.22960044e-04 -5.76693717e-04  2.46779887e-04 -2.02945834e-04
  2.47378933e-03  1.32578298e-03  1.44883219e-03  1.44176308e-03]
```

```
Standard Mode is ModeResult(mode=array([[-0.01368237, -0.00615507, -0.0
1240774, -0.01073733, -0.01349379,
        -0.00928043, -0.01037618, -0.00694393, -0.01186363, -0.01117581
,
        -0.00619891, -0.00845706, -0.01184908, -0.00621405, -0.01028269
,
        -0.00780273, -0.01272972, -0.01026589, -0.00660874, -0.01360109
,
        -0.01552942, -0.0116491 , -0.00649062, -0.00500805, -0.01164742
,
        -0.00837064, -0.0129426 , -0.00958128, -0.01072446, -0.01005199
,
        -0.00876671, -0.01140026, -0.0121486 , -0.00766456, -0.0125192
,
        -0.00963281, -0.00889198, -0.00542857, -0.00891425, -0.00674563
,
        -0.00778999, -0.01322956, -0.01343663, -0.00497646, -0.01026284
,
        -0.0078458 , -0.01053298, -0.01134662, -0.01444965, -0.01107531
,
        -0.18234815, -0.2642637 , -0.39079469, -0.26129198, -0.1470726
,
        -0.0136895 , -0.0099404 , -0.00856581, -0.00810516, -0.00688832
,
        -0.00942778, -0.0144681 , -0.0081828 , -0.00746101, -0.00927934
,
        -0.01141872, -0.01306765, -0.00630584, -0.01257022, -0.01034142
,
        -0.01315808, -0.01479527, -0.01121328, -0.01073361, -0.01498296
,
        -0.01213196, -0.00899742, -0.00997215, -0.01142937, -0.00995632
,
        -0.00912125, -0.01710765, -0.01574149, -0.01568063, -0.00575193
,
        -0.01239738, -0.01170789, -0.0061641 , -0.01165951, -0.01266136
,
        -0.01376226, -0.00655041, -0.00726045, -0.01260652, -0.01471046
,
        -0.01566129, -0.0078921 , -0.00590172, -0.01123356, -0.00656635
]]), count=array([[1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1
, 1, 1, 1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1]]))

Standard Variance 1      0.000035
2      0.000015
3      0.000036
4      0.000029
5      0.000031
         ...
96     0.000022
97     0.000048
98     0.000023
```

```
99     0.000031
100    0.000013
Length: 100, dtype: float64

Deviant Mean is 1      0.000719
2      0.001113
3      0.000291
4     -0.000009
5     -0.000548
         ...
96    -0.000163
97     0.000125
98    -0.002087
99    -0.001407
100    0.002463
Length: 100, dtype: float64

Deviant standard deviation is 1      0.004761
2      0.004942
3      0.007061
4      0.005083
5      0.004738
         ...
96     0.005339
97     0.004727
98     0.005438
99     0.006134
100    0.005345
Length: 100, dtype: float64

Deviant Median is [ 1.56119403e-03  9.81432277e-04  2.24927566e-03 -9.5
4973903e-05
 -1.54741373e-03 -2.30924801e-03  1.15204578e-03  2.70610301e-03
 -7.75217986e-04 -1.44184782e-03  5.10636131e-03  2.43564291e-03
 -1.91664696e-03 -1.46775684e-03  4.52404655e-04  9.52878548e-04
  6.78492494e-06  1.27413530e-03  5.50906085e-04 -2.23648406e-03
 -3.48561021e-04 -6.36034273e-04  1.24279669e-03  1.08176909e-03
  2.43980465e-04  2.98481978e-03 -9.91717140e-04  1.20600257e-03
 -1.39537181e-03 -2.14704784e-03  4.54848707e-04  3.16738461e-04
  4.85782793e-04 -1.96066239e-03  6.01942147e-04 -2.12628357e-03
 -7.39301678e-04 -6.11094985e-04  5.14413118e-04 -4.20868952e-03
  1.34354089e-03 -9.00344586e-04  1.10519461e-03 -1.78123397e-03
  2.53105027e-03 -1.64236639e-03  5.04269692e-04  2.20321469e-03
 -7.14112456e-04  1.49548524e-03 -1.72785939e-01 -2.49587722e-01
 -3.85930241e-01 -2.54453932e-01 -1.41022009e-01  1.61616580e-03
 -6.99153369e-05 -1.33075160e-03 -4.44859667e-04 -1.78031170e-03
  2.36463166e-03  9.66612390e-05 -1.68602780e-04 -5.38621555e-04
 -1.70098648e-04  6.86323165e-05  2.73503628e-03  8.28254975e-05
 -1.60043354e-04  2.00499548e-03 -2.31556609e-03 -2.66801257e-03
  1.71834877e-05  5.97421337e-04 -2.45241723e-03  2.21920893e-03
 -1.51043373e-03  2.03901122e-03 -1.50319101e-03  3.19134518e-03
 -4.44234524e-04  1.39352370e-03 -6.42364022e-04 -2.72974999e-03
  3.86544836e-04 -1.11007240e-03  8.03071344e-04  1.28019953e-03
  3.73341738e-04  3.25565067e-04  1.57473515e-04  2.09228527e-05
 -2.98186631e-03 -4.58067217e-04  6.10781766e-04  5.38545718e-04
 -1.03059172e-03 -1.03336340e-03  1.73673156e-05  3.27819484e-03]
```

```
Deviant Mode is ModeResult(mode=array([[-0.00712369, -0.00831379, -0.01
327678, -0.01020993, -0.00921385,
        -0.01162079, -0.00804278, -0.00570725, -0.01211673, -0.01033018
,
        -0.01044239, -0.01014024, -0.0094917 , -0.01283603, -0.00985613
,
        -0.00916255, -0.01267242, -0.0102775 , -0.01119502, -0.01151742
,
        -0.0082327 , -0.008844  , -0.01423419, -0.00748468, -0.01037017
,
        -0.01137472, -0.00592301, -0.0132573 , -0.01369066, -0.0095302
,
        -0.01011233, -0.01001808, -0.01147503, -0.0138995 , -0.00797746
,
        -0.01064516, -0.01126689, -0.01037201, -0.01327624, -0.0112185
,
        -0.00975674, -0.00778762, -0.00800101, -0.01375641, -0.01445132
,
        -0.01329586, -0.01208805, -0.00720517, -0.00917676, -0.01483118
,
        -0.18063891, -0.25757212, -0.39754748, -0.26116165, -0.15205845
,
        -0.01105123, -0.0129155 , -0.01012693, -0.01004071, -0.00907808
,
        -0.01077414, -0.01172972, -0.00907744, -0.01304882, -0.00899686
,
        -0.00624411, -0.0105371 , -0.01171217, -0.00991376, -0.00695451
,
        -0.01508758, -0.01199558, -0.010911  , -0.01188366, -0.0103954
,
        -0.00743058, -0.0092836 , -0.01056674, -0.00891346, -0.00857838
,
        -0.0102607 , -0.00392685, -0.01180041, -0.0078033 , -0.01071125
,
        -0.00976113, -0.014918  , -0.00928219, -0.00845869, -0.00812641
,
        -0.0103104 , -0.00777288, -0.00750604, -0.0099402 , -0.0126051
,
        -0.01376635, -0.01020543, -0.01423974, -0.01506783, -0.00666636
]]), count=array([[1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1
, 1, 1, 1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1,
        1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1]]))

Deviant Variance is 1      0.000022
2      0.000023
3      0.000047
4      0.000025
5      0.000021
         ...
96     0.000027
97     0.000021
98     0.000028
```

```
99     0.000036
100    0.000027
Length: 100, dtype: float64
```

Now for the time scale of echoic memory

For 0.75 sec

```
Participant 1: 0.02
Participant 2: 0.02
Participant 3: 0.02
Participant 4: 0.02
Participant 5: 0.02
Participant 6: 0.02
Participant 7: 0.02
Participant 8: 0.02
Participant 9: 0.02
Participant 10: 0.02
Participant 11: 0.02
Participant 12: 0.02
Participant 13: 0.02
Participant 14: 0.02
Participant 15: 0.02
Participant 16: 0.02
Participant 17: 0.02
Participant 18: 0.02
Participant 19: 0.02
Participant 20: 0.02
```

For 1.5 sec

```
Participant 1: 0.01
Participant 2: 0.02
Participant 3: 0.02
Participant 4: 0.02
Participant 5: 0.02
Participant 6: 0.02
Participant 7: 0.01
Participant 8: 0.02
Participant 9: 0.02
Participant 10: 0.01
Participant 11: 0.01
Participant 12: 0.02
Participant 13: 0.02
Participant 14: 0.02
Participant 15: 0.02
Participant 16: 0.01
Participant 17: 0.02
Participant 18: 0.02
Participant 19: 0.02
Participant 20: 0.02
```

For 3 sec

```
Participant 1: 0.01
Participant 2: 0.01
Participant 3: 0.01
Participant 4: 0.01
Participant 5: 0.01
Participant 6: 0.01
Participant 7: 0.01
Participant 8: 0.01
Participant 9: 0.01
Participant 10: 0.01
Participant 11: 0.01
Participant 12: 0.01
Participant 13: 0.01
Participant 14: 0.01
Participant 15: 0.01
Participant 16: 0.01
Participant 17: 0.01
Participant 18: 0.01
Participant 19: 0.01
Participant 20: 0.01
```

For 9 sec

```
Participant 1: 0.02
Participant 2: 0.02
Participant 3: 0.02
Participant 4: 0.02
Participant 5: 0.02
Participant 6: 0.02
Participant 7: 0.02
Participant 8: 0.02
Participant 9: 0.02
Participant 10: 0.02
Participant 11: 0.02
Participant 12: 0.02
Participant 13: 0.02
Participant 14: 0.02
Participant 15: 0.02
Participant 16: 0.02
Participant 17: 0.02
Participant 18: 0.02
Participant 19: 0.02
Participant 20: 0.02
```

```
#!/usr/bin/env python
# coding: utf-8

# In[3]:


import pandas as pd
import numpy as np
from scipy.stats import ttest_ind
from scipy import stats

read1 is 0.75s
read2 is 1.5s
read3 is 3s
read4 is 8s
read5 is 9s
# In[4]:


read1 = pd.read_excel('Assignment3-Q2Bdata.xls',header=None)
read1 = read1.fillna(0)

standard = read1.iloc[2:22,1:101]
deviant = read1.iloc[24:44,1:101]

standMean = standard.mean(axis=0)
stanStd = standard.std(axis=0)
stanMedian = np.median(standard,axis=0)
stanMode = stats.mode(standard)
```

```
standvar = np.var(standard,axis =0)

devMean = deviant.mean(axis=0)
devStd = deviant.std(axis=0)
devMedain = np.median(deviant,axis =0)
devMode = stats.mode(deviant)
devVar = np.var(deviant,axis =0)

print("Standard Mean is {}".format(standMean))
print()
print("Standard deviation is {}".format(stanStd))
print()
print("Standard Median is {}".format(stanMedian))
print()
print("Standard Mode is {}".format(stanMode))
print()
print("Standard Variance {}".format(standvar))
print()


print("Deviant Mean is {}".format(devMean))
print()
print("Deviant standard deviation is {}".format(devStd))
print()
print("Deviant Median is {}".format(devMedain))
print()
print("Deviant Mode is {}".format(devMode))
print()
print("Deviant Variance is {}".format(devVar))


# For 1.5s

# In[5]:


read2 = pd.read_excel('Assignment3-Q2Bdata.xls',header=None,sheet_name = 1)
read2 = read2.fillna(0)

standard = read2.iloc[2:22,1:101]
deviant = read2.iloc[24:44,1:101]

standMean = standard.mean(axis=0)
stanStd = standard.std(axis=0)
stanMedian = np.median(standard,axis=0)
stanMode = stats.mode(standard)
standvar = np.var(standard,axis =0)

devMean = deviant.mean(axis=0)
```

```
devStd = deviant.std(axis=0)
devMedain = np.median(deviant,axis =0)
devMode = stats.mode(deviant)
devVar = np.var(deviant,axis =0)

print("Standard Mean is {}".format(standMean))
print()
print("Standard deviation is {}".format(stanStd))
print()
print("Standard Median is {}".format(stanMedian))
print()
print("Standard Mode is {}".format(stanMode))
print()
print("Standard Variance {}".format(standvar))
print()


print("Deviant Mean is {}".format(devMean))
print()
print("Deviant standard deviation is {}".format(devStd))
print()
print("Deviant Median is {}".format(devMedain))
print()
print("Deviant Mode is {}".format(devMode))
print()
print("Deviant Variance is {}".format(devVar))


# For 3s

# In[6]:


read3 = pd.read_excel('Assignment3-Q2Bdata.xls',header=None,sheet_name = 2)
read3 = read3.fillna(0)

standard = read3.iloc[2:22,1:101]
deviant = read3.iloc[24:44,1:101]

standMean = standard.mean(axis=0)
stanStd = standard.std(axis=0)
stanMedian = np.median(standard,axis=0)
stanMode = stats.mode(standard)
standvar = np.var(standard,axis =0)

devMean = deviant.mean(axis=0)
devStd = deviant.std(axis=0)
devMedain = np.median(deviant,axis =0)
devMode = stats.mode(deviant)
```

```
devVar = np.var(deviant,axis =0)

print("Standard Mean is {}".format(standMean))
print()
print("Standard deviation is {}".format(stanStd))
print()
print("Standard Median is {}".format(stanMedian))
print()
print("Standard Mode is {}".format(stanMode))
print()
print("Standard Variance {}".format(standvar))
print()


print("Deviant Mean is {}".format(devMean))
print()
print("Deviant standard deviation is {}".format(devStd))
print()
print("Deviant Median is {}".format(devMedain))
print()
print("Deviant Mode is {}".format(devMode))
print()
print("Deviant Variance is {}".format(devVar))


# For 8s

# In[7]:


read4 = pd.read_excel('Assignment3-Q2Bdata.xls',header=None,sheet_name = 3)
read4 = read4.fillna(0)

standard = read4.iloc[2:22,1:101]
deviant = read4.iloc[24:44,1:101]

standMean = standard.mean(axis=0)
stanStd = standard.std(axis=0)
stanMedian = np.median(standard,axis=0)
stanMode = stats.mode(standard)
standvar = np.var(standard,axis =0)

devMean = deviant.mean(axis=0)
devStd = deviant.std(axis=0)
devMedain = np.median(deviant,axis =0)
devMode = stats.mode(deviant)
devVar = np.var(deviant,axis =0)

print("Standard Mean is {}".format(standMean))
```

```
print()
print("Standard deviation is {}".format(stanStd))
print()
print("Standard Median is {}".format(stanMedian))
print()
print("Standard Mode is {}".format(stanMode))
print()
print("Standard Variance {}".format(standvar))
print()


print("Deviant Mean is {}".format(devMean))
print()
print("Deviant standard deviation is {}".format(devStd))
print()
print("Deviant Median is {}".format(devMedain))
print()
print("Deviant Mode is {}".format(devMode))
print()
print("Deviant Variance is {}".format(devVar))


# For 9s

# In[8]:


read5 = pd.read_excel('Assignment3-Q2Bdata.xls',header=None,sheet_name = 4)
read5 = read5.fillna(0)

standard = read5.iloc[2:22,1:101]
deviant = read5.iloc[24:44,1:101]

standMean = standard.mean(axis=0)
stanStd = standard.std(axis=0)
stanMedian = np.median(standard,axis=0)
stanMode = stats.mode(standard)
standvar = np.var(standard,axis =0)

devMean = deviant.mean(axis=0)
devStd = deviant.std(axis=0)
devMedain = np.median(deviant,axis =0)
devMode = stats.mode(deviant)
devVar = np.var(deviant,axis =0)

print("Standard Mean is {}".format(standMean))
print()
print("Standard deviation is {}".format(stanStd))
print()
```

```
print("Standard Median is {}".format(stanMedian))
print()
print("Standard Mode is {}".format(stanMode))
print()
print("Standard Variance {}".format(standvar))
print()


print("Deviant Mean is {}".format(devMean))
print()
print("Deviant standard deviation is {}".format(devStd))
print()
print("Deviant Median is {}".format(devMedain))
print()
print("Deviant Mode is {}".format(devMode))
print()
print("Deviant Variance is {}".format(devVar))


# Now for the time scale of echoic memory.
For 0.75s
# In[17]:


echoicTime = 4
samples = int(echoicTime * 1000)
for i in range(2,22):
    data = read1.iloc[i,1:101].to_numpy()
    amplitude = np.mean(np.abs(data[:4000]))
    print(f'Participant {i-1}: {amplitude:.2f}')


# For 1.5s

# In[13]:


echoicTime = 4
samples = int(echoicTime * 1000)
for i in range(2,22):
    data = read2.iloc[i,1:101].to_numpy()
    amplitude = np.mean(np.abs(data[:4000]))
    print(f'Participant {i-1}: {amplitude:.2f}')


# for 3 s

# In[14]:
```

```
echoicTime = 4
samples = int(echoicTime * 1000)
for i in range(2,22):
    data = read3.iloc[i,1:101].to_numpy()
    amplitude = np.mean(np.abs(data[:4000]))
    print(f'Participant {i-1}: {amplitude:.2f}')


# for 8 sec

# In[15]:


echoicTime = 4
samples = int(echoicTime * 1000)
for i in range(2,22):
    data = read4.iloc[i,1:101].to_numpy()
    amplitude = np.mean(np.abs(data[:4000]))
    print(f'Participant {i-1}: {amplitude:.2f}')


# for 9 sec

# In[16]:


echoicTime = 4
samples = int(echoicTime * 1000)
for i in range(2,22):
    data = read4.iloc[i,1:101].to_numpy()
    amplitude = np.mean(np.abs(data[:4000]))
    print(f'Participant {i-1}: {amplitude:.2f}')


# In[ ]:
```

Now to explain cognitive science's consistent rationale behind the calculation and reported time scale.

Echoic memory usually lasts for a few seconds, about 4-5 seconds.

Now in this experiment listening with different stimulus intervals. Now EEG is pre-processed and used to calculate the amplitude for the first 4 seconds.

By measuring the amplitudes of the EEG signal, we can get the strength of the neural network.

Lastly, by comparing the results of stimulant conditions, we can know how the brain works and process auditory information. Now this can have an understanding of neutal networks.