

Analysis of the Data from Epithelial-Mesenchymal Transition (EMT)

```
clearvars  
addpath(genpath('..'))
```

Data Loading and Pre-processing

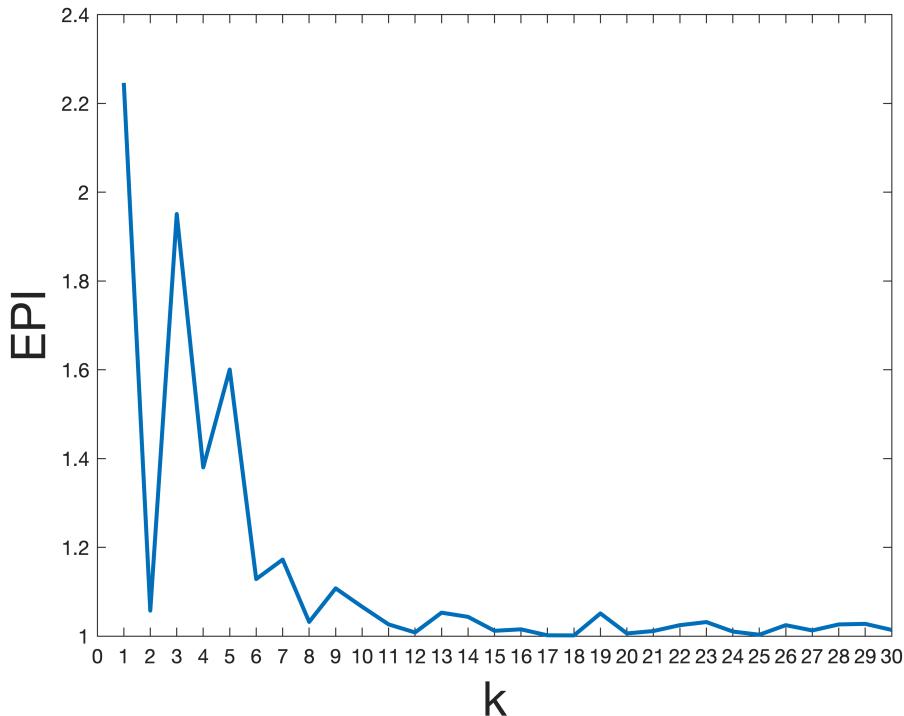
```
load emt.mat  
data_raw = data;  
data = double(data_raw)';  
data = log(data+1);  
data = (data-mean(data))./std(data);  
[N_cell,N_genes] = size(data);
```

cluster number inference from EPI

```
par.choice_distance = 'cosine';  
out = EstClusterNum(data,par);
```

```
Mean value of sigma: 0.31814  
Minimum value of sigma: 0.17427  
Maximum value of sigma: 0.54514
```

```
plot(out.ratio(1:30), 'linewidth', 2.0)  
xlabel('k', 'FontSize', 24);  
ylabel('EPI', 'FontSize', 24);  
xticks(0:30);
```



MuTrans Dynamical Analysis of the Single-Cell Data

parameter and option settings

```
rng(1)
par.perplex = 150;
par.K_cluster = 3;
par.trails = 100;

% Dynamical Analysis and Output
tic;
Output = DynamicalAnalysis (data, par);
```

```
Mean value of sigma: 0.32322
Minimum value of sigma: 0.17809
Maximum value of sigma: 0.55449
Mean value of sigma: 0.18717
Minimum value of sigma: 0.11115
Maximum value of sigma: 0.27474
Iteration 10: error is 39.9362
Iteration 20: error is 38.9726
Iteration 30: error is 38.8242
Iteration 40: error is 38.7715
Iteration 50: error is 38.8351
Iteration 60: error is 39.2251
Iteration 70: error is 39.501
Iteration 80: error is 38.9632
Iteration 90: error is 38.9589
Iteration 100: error is 2.7378
Iteration 110: error is 1.2881
Iteration 120: error is 0.89344
Iteration 130: error is 0.82907
Iteration 140: error is 0.80289
Iteration 150: error is 0.78541
Iteration 160: error is 0.77
Iteration 170: error is 0.76193
Iteration 180: error is 0.75586
Iteration 190: error is 0.74816
Iteration 200: error is 0.74491
Iteration 210: error is 0.74188
Iteration 220: error is 0.73981
Iteration 230: error is 0.73805
Iteration 240: error is 0.73641
Iteration 250: error is 0.73574
Iteration 260: error is 0.73322
Iteration 270: error is 0.73109
Iteration 280: error is 0.72939
Iteration 290: error is 0.72812
Iteration 300: error is 0.72706
Iteration 310: error is 0.72605
Iteration 320: error is 0.72529
Iteration 330: error is 0.72473
Iteration 340: error is 0.72438
Iteration 350: error is 0.72408
Iteration 360: error is 0.72382
Iteration 370: error is 0.72355
Iteration 380: error is 0.72328
Iteration 390: error is 0.72289
Iteration 400: error is 0.72251
Iteration 410: error is 0.72187
Iteration 420: error is 0.72132
Iteration 430: error is 0.72086
Iteration 440: error is 0.72057
```

```
Iteration 450: error is 0.72036
Iteration 460: error is 0.72025
Iteration 470: error is 0.72018
Iteration 480: error is 0.72013
Iteration 490: error is 0.7201
Iteration 500: error is 0.72008
Iteration 510: error is 0.72006
Iteration 520: error is 0.72004
Iteration 530: error is 0.72003
Iteration 540: error is 0.72002
Iteration 550: error is 0.72
Iteration 560: error is 0.71999
Iteration 570: error is 0.71999
Iteration 580: error is 0.71998
Iteration 590: error is 0.71997
Iteration 600: error is 0.71997
Iteration 610: error is 0.71996
Iteration 620: error is 0.71996
Iteration 630: error is 0.71995
Iteration 640: error is 0.71995
Iteration 650: error is 0.71995
Iteration 660: error is 0.71994
Iteration 670: error is 0.71994
Iteration 680: error is 0.71994
Iteration 690: error is 0.71994
Iteration 700: error is 0.71993
Iteration 710: error is 0.71993
Iteration 720: error is 0.71993
Iteration 730: error is 0.71993
Iteration 740: error is 0.71992
Iteration 750: error is 0.71992
Iteration 760: error is 0.71991
Iteration 770: error is 0.7199
Iteration 780: error is 0.71987
Iteration 790: error is 0.73306
Iteration 800: error is 0.73466
Iteration 810: error is 0.72952
Iteration 820: error is 0.72548
Iteration 830: error is 0.72492
Iteration 840: error is 0.72473
Iteration 850: error is 0.72469
Iteration 860: error is 0.72467
Iteration 870: error is 0.72465
Iteration 880: error is 0.72449
Iteration 890: error is 0.72162
Iteration 900: error is 0.72078
Iteration 910: error is 0.72029
Iteration 920: error is 0.72016
Iteration 930: error is 0.72013
Iteration 940: error is 0.72012
Iteration 950: error is 0.72011
Iteration 960: error is 0.7201
Iteration 970: error is 0.7201
Iteration 980: error is 0.72009
Iteration 990: error is 0.72009
Iteration 1000: error is 0.72009
J_new = 3.6918
J_new = 3.6739
J_new = 3.6684
J_new = 3.6514
J_new = 3.6439
J_new = 3.6431
J_new = 3.6409
J_new = 3.6386
J_new = 3.6384
```

```
J_new = 3.6384
Mean value of sigma: 0.18717
Minimum value of sigma: 0.11115
Maximum value of sigma: 0.27474
Iteration 10: error is 40.7451
Iteration 20: error is 38.9618
Iteration 30: error is 38.8461
Iteration 40: error is 39.2274
Iteration 50: error is 38.919
Iteration 60: error is 39.3066
Iteration 70: error is 39.4009
Iteration 80: error is 39.4204
Iteration 90: error is 38.5392
Iteration 100: error is 2.599
Iteration 110: error is 1.3074
Iteration 120: error is 0.94443
Iteration 130: error is 0.8191
Iteration 140: error is 0.77522
Iteration 150: error is 0.75765
Iteration 160: error is 0.74724
Iteration 170: error is 0.74101
Iteration 180: error is 0.73591
Iteration 190: error is 0.73291
Iteration 200: error is 0.72762
Iteration 210: error is 0.72483
Iteration 220: error is 0.72247
Iteration 230: error is 0.72086
Iteration 240: error is 0.71929
Iteration 250: error is 0.71763
Iteration 260: error is 0.71544
Iteration 270: error is 0.71304
Iteration 280: error is 0.71123
Iteration 290: error is 0.71002
Iteration 300: error is 0.70907
Iteration 310: error is 0.7083
Iteration 320: error is 0.70767
Iteration 330: error is 0.70716
Iteration 340: error is 0.70642
Iteration 350: error is 0.70605
Iteration 360: error is 0.70581
Iteration 370: error is 0.70562
Iteration 380: error is 0.70547
Iteration 390: error is 0.70533
Iteration 400: error is 0.70521
Iteration 410: error is 0.7051
Iteration 420: error is 0.70502
Iteration 430: error is 0.70491
Iteration 440: error is 0.70467
Iteration 450: error is 0.70455
Iteration 460: error is 0.70451
Iteration 470: error is 0.70447
Iteration 480: error is 0.70444
Iteration 490: error is 0.70441
Iteration 500: error is 0.70439
Iteration 510: error is 0.70437
Iteration 520: error is 0.70435
Iteration 530: error is 0.70433
Iteration 540: error is 0.70432
Iteration 550: error is 0.70431
Iteration 560: error is 0.7043
Iteration 570: error is 0.70429
Iteration 580: error is 0.70428
Iteration 590: error is 0.70427
Iteration 600: error is 0.70427
Iteration 610: error is 0.70426
```

```
Iteration 620: error is 0.70425
Iteration 630: error is 0.70425
Iteration 640: error is 0.70425
Iteration 650: error is 0.70424
Iteration 660: error is 0.70424
Iteration 670: error is 0.70424
Iteration 680: error is 0.70424
Iteration 690: error is 0.70423
Iteration 700: error is 0.70423
Iteration 710: error is 0.70423
Iteration 720: error is 0.70423
Iteration 730: error is 0.70423
Iteration 740: error is 0.70423
Iteration 750: error is 0.70422
Iteration 760: error is 0.70422
Iteration 770: error is 0.70422
Iteration 780: error is 0.70422
Iteration 790: error is 0.70422
Iteration 800: error is 0.70422
Iteration 810: error is 0.70422
Iteration 820: error is 0.70422
Iteration 830: error is 0.70422
Iteration 840: error is 0.70422
Iteration 850: error is 0.70422
Iteration 860: error is 0.70422
Iteration 870: error is 0.70422
Iteration 880: error is 0.70422
Iteration 890: error is 0.70422
Iteration 900: error is 0.70422
Iteration 910: error is 0.70422
Iteration 920: error is 0.70422
Iteration 930: error is 0.70422
Iteration 940: error is 0.70422
Iteration 950: error is 0.70422
Iteration 960: error is 0.70422
Iteration 970: error is 0.70422
Iteration 980: error is 0.70422
Iteration 990: error is 0.70422
Iteration 1000: error is 0.70422
J_new = 3.6661
J_new = 3.6456
J_new = 3.6439
J_new = 3.6409
J_new = 3.6386
J_new = 3.6384
J_new = 3.6384
Mean value of sigma: 0.18717
Minimum value of sigma: 0.11115
Maximum value of sigma: 0.27474
Iteration 10: error is 40.2148
Iteration 20: error is 38.9454
Iteration 30: error is 39.1685
Iteration 40: error is 39.2285
Iteration 50: error is 39.0008
Iteration 60: error is 38.8344
Iteration 70: error is 39.4285
Iteration 80: error is 38.9363
Iteration 90: error is 39.2074
Iteration 100: error is 2.7739
Iteration 110: error is 1.6764
Iteration 120: error is 1.0987
Iteration 130: error is 0.91524
Iteration 140: error is 0.84203
Iteration 150: error is 0.79523
Iteration 160: error is 0.78381
```

Iteration 170: error is 0.77531
Iteration 180: error is 0.76909
Iteration 190: error is 0.76475
Iteration 200: error is 0.76194
Iteration 210: error is 0.75922
Iteration 220: error is 0.75718
Iteration 230: error is 0.75575
Iteration 240: error is 0.75372
Iteration 250: error is 0.75309
Iteration 260: error is 0.75086
Iteration 270: error is 0.74876
Iteration 280: error is 0.74726
Iteration 290: error is 0.74608
Iteration 300: error is 0.74518
Iteration 310: error is 0.74449
Iteration 320: error is 0.74391
Iteration 330: error is 0.7434
Iteration 340: error is 0.74302
Iteration 350: error is 0.74276
Iteration 360: error is 0.74255
Iteration 370: error is 0.74237
Iteration 380: error is 0.74223
Iteration 390: error is 0.74211
Iteration 400: error is 0.742
Iteration 410: error is 0.74192
Iteration 420: error is 0.74185
Iteration 430: error is 0.74179
Iteration 440: error is 0.74174
Iteration 450: error is 0.74169
Iteration 460: error is 0.74166
Iteration 470: error is 0.74162
Iteration 480: error is 0.74156
Iteration 490: error is 0.74151
Iteration 500: error is 0.74148
Iteration 510: error is 0.74146
Iteration 520: error is 0.74144
Iteration 530: error is 0.74143
Iteration 540: error is 0.74141
Iteration 550: error is 0.7414
Iteration 560: error is 0.74139
Iteration 570: error is 0.74139
Iteration 580: error is 0.74138
Iteration 590: error is 0.74137
Iteration 600: error is 0.74137
Iteration 610: error is 0.74136
Iteration 620: error is 0.74136
Iteration 630: error is 0.74136
Iteration 640: error is 0.74135
Iteration 650: error is 0.74135
Iteration 660: error is 0.74135
Iteration 670: error is 0.74135
Iteration 680: error is 0.74134
Iteration 690: error is 0.74134
Iteration 700: error is 0.74134
Iteration 710: error is 0.74134
Iteration 720: error is 0.74134
Iteration 730: error is 0.74134
Iteration 740: error is 0.74134
Iteration 750: error is 0.74134
Iteration 760: error is 0.74134
Iteration 770: error is 0.74134
Iteration 780: error is 0.74133
Iteration 790: error is 0.74133
Iteration 800: error is 0.74133
Iteration 810: error is 0.74133

```
Iteration 820: error is 0.74133
Iteration 830: error is 0.74133
Iteration 840: error is 0.74133
Iteration 850: error is 0.74133
Iteration 860: error is 0.74133
Iteration 870: error is 0.74133
Iteration 880: error is 0.74133
Iteration 890: error is 0.74133
Iteration 900: error is 0.74133
Iteration 910: error is 0.74133
Iteration 920: error is 0.74133
Iteration 930: error is 0.74133
Iteration 940: error is 0.74133
Iteration 950: error is 0.74133
Iteration 960: error is 0.74133
Iteration 970: error is 0.74133
Iteration 980: error is 0.74133
Iteration 990: error is 0.74133
Iteration 1000: error is 0.74133
J_new = 3.6969
J_new = 3.6949
J_new = 3.6927
J_new = 3.6820
J_new = 3.6784
J_new = 3.6742
J_new = 3.6723
J_new = 3.6664
J_new = 3.6598
J_new = 3.6439
J_new = 3.6431
J_new = 3.6409
J_new = 3.6386
J_new = 3.6384
J_new = 3.6384
Mean value of sigma: 0.18717
Minimum value of sigma: 0.11115
Maximum value of sigma: 0.27474
Iteration 10: error is 41.0325
Iteration 20: error is 39.3411
Iteration 30: error is 39.0633
Iteration 40: error is 39.6634
Iteration 50: error is 38.7398
Iteration 60: error is 38.6214
Iteration 70: error is 40.1035
Iteration 80: error is 38.7378
Iteration 90: error is 39.1593
Iteration 100: error is 2.8016
Iteration 110: error is 1.4428
Iteration 120: error is 0.97223
Iteration 130: error is 0.87372
Iteration 140: error is 0.85255
Iteration 150: error is 0.83837
Iteration 160: error is 0.82922
Iteration 170: error is 0.81635
Iteration 180: error is 0.81103
Iteration 190: error is 0.79632
Iteration 200: error is 0.78974
Iteration 210: error is 0.78471
Iteration 220: error is 0.78187
Iteration 230: error is 0.77976
Iteration 240: error is 0.77742
Iteration 250: error is 0.77578
Iteration 260: error is 0.77317
Iteration 270: error is 0.77093
Iteration 280: error is 0.7694
```

Iteration 290: error is 0.76826
Iteration 300: error is 0.76739
Iteration 310: error is 0.76664
Iteration 320: error is 0.76609
Iteration 330: error is 0.76565
Iteration 340: error is 0.76532
Iteration 350: error is 0.76508
Iteration 360: error is 0.76489
Iteration 370: error is 0.76473
Iteration 380: error is 0.76459
Iteration 390: error is 0.76448
Iteration 400: error is 0.76439
Iteration 410: error is 0.76431
Iteration 420: error is 0.76425
Iteration 430: error is 0.7642
Iteration 440: error is 0.76415
Iteration 450: error is 0.76411
Iteration 460: error is 0.76408
Iteration 470: error is 0.76405
Iteration 480: error is 0.76403
Iteration 490: error is 0.764
Iteration 500: error is 0.76399
Iteration 510: error is 0.76397
Iteration 520: error is 0.76396
Iteration 530: error is 0.76395
Iteration 540: error is 0.76394
Iteration 550: error is 0.76393
Iteration 560: error is 0.76392
Iteration 570: error is 0.76391
Iteration 580: error is 0.76391
Iteration 590: error is 0.7639
Iteration 600: error is 0.7639
Iteration 610: error is 0.76389
Iteration 620: error is 0.76389
Iteration 630: error is 0.76389
Iteration 640: error is 0.76389
Iteration 650: error is 0.76388
Iteration 660: error is 0.76388
Iteration 670: error is 0.76388
Iteration 680: error is 0.76388
Iteration 690: error is 0.76388
Iteration 700: error is 0.76388
Iteration 710: error is 0.76388
Iteration 720: error is 0.76388
Iteration 730: error is 0.76388
Iteration 740: error is 0.76387
Iteration 750: error is 0.76387
Iteration 760: error is 0.76387
Iteration 770: error is 0.76387
Iteration 780: error is 0.76387
Iteration 790: error is 0.76387
Iteration 800: error is 0.76387
Iteration 810: error is 0.76387
Iteration 820: error is 0.76387
Iteration 830: error is 0.76387
Iteration 840: error is 0.76387
Iteration 850: error is 0.76387
Iteration 860: error is 0.76387
Iteration 870: error is 0.76387
Iteration 880: error is 0.76387
Iteration 890: error is 0.76387
Iteration 900: error is 0.76387
Iteration 910: error is 0.76387
Iteration 920: error is 0.76387
Iteration 930: error is 0.76387

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Iteration 940: error is 0.76387
Iteration 950: error is 0.76387
Iteration 960: error is 0.76387
Iteration 970: error is 0.76387
Iteration 980: error is 0.76387
Iteration 990: error is 0.76387
Iteration 1000: error is 0.76387
J_new = 3.6834
J_new = 3.6752
J_new = 3.6692
J_new = 3.6616
J_new = 3.6569
J_new = 3.6465
J_new = 3.6392
J_new = 3.6383
J_new = 3.6363
J_new = 3.6341
J_new = 3.6339
J_new = 3.6339
Mean value of sigma: 0.18717
Minimum value of sigma: 0.11115
Maximum value of sigma: 0.27474
Iteration 10: error is 40.179
Iteration 20: error is 38.3016
Iteration 30: error is 38.4452
Iteration 40: error is 38.9801
Iteration 50: error is 38.8513
Iteration 60: error is 39.073
Iteration 70: error is 39.0182
Iteration 80: error is 39.0239
Iteration 90: error is 39.3794
Iteration 100: error is 2.8325
Iteration 110: error is 1.5965
Iteration 120: error is 1.041
Iteration 130: error is 0.89341
Iteration 140: error is 0.83285
Iteration 150: error is 0.79059
Iteration 160: error is 0.77537
Iteration 170: error is 0.76925
Iteration 180: error is 0.75867
Iteration 190: error is 0.74957
Iteration 200: error is 0.74017
Iteration 210: error is 0.73736
Iteration 220: error is 0.73493
Iteration 230: error is 0.73317
Iteration 240: error is 0.73149
Iteration 250: error is 0.73014
Iteration 260: error is 0.72816
Iteration 270: error is 0.72576
Iteration 280: error is 0.72384
Iteration 290: error is 0.72157
Iteration 300: error is 0.72008
Iteration 310: error is 0.71934
Iteration 320: error is 0.71877
Iteration 330: error is 0.71834
Iteration 340: error is 0.71798
Iteration 350: error is 0.71767
Iteration 360: error is 0.7174
Iteration 370: error is 0.7172
Iteration 380: error is 0.71703
Iteration 390: error is 0.71688
Iteration 400: error is 0.71676
Iteration 410: error is 0.71664
Iteration 420: error is 0.71649
Iteration 430: error is 0.71638
```

```
Iteration 440: error is 0.7163
Iteration 450: error is 0.71623
Iteration 460: error is 0.71617
Iteration 470: error is 0.71612
Iteration 480: error is 0.71608
Iteration 490: error is 0.71604
Iteration 500: error is 0.71601
Iteration 510: error is 0.71599
Iteration 520: error is 0.71596
Iteration 530: error is 0.71594
Iteration 540: error is 0.71592
Iteration 550: error is 0.71591
Iteration 560: error is 0.71589
Iteration 570: error is 0.71588
Iteration 580: error is 0.71587
Iteration 590: error is 0.71586
Iteration 600: error is 0.71585
Iteration 610: error is 0.71584
Iteration 620: error is 0.71583
Iteration 630: error is 0.71583
Iteration 640: error is 0.71582
Iteration 650: error is 0.71581
Iteration 660: error is 0.71581
Iteration 670: error is 0.7158
Iteration 680: error is 0.7158
Iteration 690: error is 0.71579
Iteration 700: error is 0.71579
Iteration 710: error is 0.71579
Iteration 720: error is 0.71578
Iteration 730: error is 0.71578
Iteration 740: error is 0.71578
Iteration 750: error is 0.71578
Iteration 760: error is 0.71577
Iteration 770: error is 0.71577
Iteration 780: error is 0.71577
Iteration 790: error is 0.71577
Iteration 800: error is 0.71577
Iteration 810: error is 0.71577
Iteration 820: error is 0.71576
Iteration 830: error is 0.71576
Iteration 840: error is 0.71576
Iteration 850: error is 0.71576
Iteration 860: error is 0.71576
Iteration 870: error is 0.71576
Iteration 880: error is 0.71576
Iteration 890: error is 0.71576
Iteration 900: error is 0.71576
Iteration 910: error is 0.71576
Iteration 920: error is 0.71576
Iteration 930: error is 0.71576
Iteration 940: error is 0.71575
Iteration 950: error is 0.71575
Iteration 960: error is 0.71575
Iteration 970: error is 0.71575
Iteration 980: error is 0.71575
Iteration 990: error is 0.71575
Iteration 1000: error is 0.71574
J_new = 3.7040
J_new = 3.6965
J_new = 3.6861
J_new = 3.6842
J_new = 3.6784
J_new = 3.6742
J_new = 3.6723
J_new = 3.6664
```

```
J_new = 3.6598
J_new = 3.6439
J_new = 3.6431
J_new = 3.6409
J_new = 3.6386
J_new = 3.6384
J_new = 3.6384
Mean value of sigma: 0.18717
Minimum value of sigma: 0.11115
Maximum value of sigma: 0.27474
Iteration 10: error is 40.1965
Iteration 20: error is 38.4318
Iteration 30: error is 38.9146
Iteration 40: error is 39.1539
Iteration 50: error is 39.2604
Iteration 60: error is 39.1936
Iteration 70: error is 39.7727
Iteration 80: error is 39.2417
Iteration 90: error is 39.7982
Iteration 100: error is 2.7001
Iteration 110: error is 1.652
Iteration 120: error is 1.086
Iteration 130: error is 0.89127
Iteration 140: error is 0.82342
Iteration 150: error is 0.80029
Iteration 160: error is 0.78523
Iteration 170: error is 0.76208
Iteration 180: error is 0.75045
Iteration 190: error is 0.7452
Iteration 200: error is 0.74268
Iteration 210: error is 0.73829
Iteration 220: error is 0.73527
Iteration 230: error is 0.73285
Iteration 240: error is 0.72906
Iteration 250: error is 0.72468
Iteration 260: error is 0.72097
Iteration 270: error is 0.72161
Iteration 280: error is 0.71619
Iteration 290: error is 0.71272
Iteration 300: error is 0.71173
Iteration 310: error is 0.70958
Iteration 320: error is 0.70864
Iteration 330: error is 0.70804
Iteration 340: error is 0.70755
Iteration 350: error is 0.70702
Iteration 360: error is 0.70669
Iteration 370: error is 0.70629
Iteration 380: error is 0.70544
Iteration 390: error is 0.70482
Iteration 400: error is 0.7045
Iteration 410: error is 0.70397
Iteration 420: error is 0.7038
Iteration 430: error is 0.7037
Iteration 440: error is 0.70363
Iteration 450: error is 0.70339
Iteration 460: error is 0.70325
Iteration 470: error is 0.70316
Iteration 480: error is 0.70311
Iteration 490: error is 0.70308
Iteration 500: error is 0.70305
Iteration 510: error is 0.70302
Iteration 520: error is 0.703
Iteration 530: error is 0.70298
Iteration 540: error is 0.70296
Iteration 550: error is 0.70295
```

```
Iteration 560: error is 0.70293
Iteration 570: error is 0.70292
Iteration 580: error is 0.70291
Iteration 590: error is 0.70291
Iteration 600: error is 0.7029
Iteration 610: error is 0.70289
Iteration 620: error is 0.70289
Iteration 630: error is 0.70288
Iteration 640: error is 0.70288
Iteration 650: error is 0.70287
Iteration 660: error is 0.70287
Iteration 670: error is 0.70287
Iteration 680: error is 0.70286
Iteration 690: error is 0.70286
Iteration 700: error is 0.70286
Iteration 710: error is 0.70286
Iteration 720: error is 0.70286
Iteration 730: error is 0.70286
Iteration 740: error is 0.70285
Iteration 750: error is 0.70285
Iteration 760: error is 0.70285
Iteration 770: error is 0.70285
Iteration 780: error is 0.70285
Iteration 790: error is 0.70285
Iteration 800: error is 0.70285
Iteration 810: error is 0.70285
Iteration 820: error is 0.70285
Iteration 830: error is 0.70285
Iteration 840: error is 0.70285
Iteration 850: error is 0.70285
Iteration 860: error is 0.70285
Iteration 870: error is 0.70285
Iteration 880: error is 0.70285
Iteration 890: error is 0.70285
Iteration 900: error is 0.70285
Iteration 910: error is 0.70285
Iteration 920: error is 0.70285
Iteration 930: error is 0.70285
Iteration 940: error is 0.70285
Iteration 950: error is 0.70285
Iteration 960: error is 0.70285
Iteration 970: error is 0.70285
Iteration 980: error is 0.70285
Iteration 990: error is 0.70285
Iteration 1000: error is 0.70285
J_new = 3.6863
J_new = 3.6776
J_new = 3.6594
J_new = 3.6439
J_new = 3.6431
J_new = 3.6409
J_new = 3.6386
J_new = 3.6384
J_new = 3.6384
Mean value of sigma: 0.18717
Minimum value of sigma: 0.11115
Maximum value of sigma: 0.27474
Iteration 10: error is 40.08
Iteration 20: error is 38.9809
Iteration 30: error is 38.7702
Iteration 40: error is 38.8414
Iteration 50: error is 39.2922
Iteration 60: error is 38.4783
Iteration 70: error is 38.4834
Iteration 80: error is 39.4465
```

Iteration 90: error is 39.07
Iteration 100: error is 2.7045
Iteration 110: error is 1.4631
Iteration 120: error is 1.0411
Iteration 130: error is 0.88016
Iteration 140: error is 0.83397
Iteration 150: error is 0.79242
Iteration 160: error is 0.77745
Iteration 170: error is 0.76841
Iteration 180: error is 0.76289
Iteration 190: error is 0.75814
Iteration 200: error is 0.75522
Iteration 210: error is 0.75213
Iteration 220: error is 0.74957
Iteration 230: error is 0.74721
Iteration 240: error is 0.74557
Iteration 250: error is 0.7439
Iteration 260: error is 0.74169
Iteration 270: error is 0.73837
Iteration 280: error is 0.73549
Iteration 290: error is 0.73466
Iteration 300: error is 0.73295
Iteration 310: error is 0.73216
Iteration 320: error is 0.73142
Iteration 330: error is 0.73089
Iteration 340: error is 0.73032
Iteration 350: error is 0.72959
Iteration 360: error is 0.7286
Iteration 370: error is 0.7282
Iteration 380: error is 0.72801
Iteration 390: error is 0.72787
Iteration 400: error is 0.72772
Iteration 410: error is 0.72757
Iteration 420: error is 0.72731
Iteration 430: error is 0.72668
Iteration 440: error is 0.72517
Iteration 450: error is 0.72442
Iteration 460: error is 0.72394
Iteration 470: error is 0.72376
Iteration 480: error is 0.72365
Iteration 490: error is 0.72359
Iteration 500: error is 0.72351
Iteration 510: error is 0.72343
Iteration 520: error is 0.72335
Iteration 530: error is 0.72329
Iteration 540: error is 0.72324
Iteration 550: error is 0.7232
Iteration 560: error is 0.72316
Iteration 570: error is 0.72314
Iteration 580: error is 0.72312
Iteration 590: error is 0.7231
Iteration 600: error is 0.72309
Iteration 610: error is 0.72308
Iteration 620: error is 0.72307
Iteration 630: error is 0.72306
Iteration 640: error is 0.72306
Iteration 650: error is 0.72305
Iteration 660: error is 0.72305
Iteration 670: error is 0.72304
Iteration 680: error is 0.72304
Iteration 690: error is 0.72303
Iteration 700: error is 0.72303
Iteration 710: error is 0.72303
Iteration 720: error is 0.72303
Iteration 730: error is 0.72303

```
Iteration 740: error is 0.72302
Iteration 750: error is 0.72302
Iteration 760: error is 0.72302
Iteration 770: error is 0.72302
Iteration 780: error is 0.72302
Iteration 790: error is 0.72302
Iteration 800: error is 0.72302
Iteration 810: error is 0.72302
Iteration 820: error is 0.72302
Iteration 830: error is 0.72301
Iteration 840: error is 0.72301
Iteration 850: error is 0.72301
Iteration 860: error is 0.72301
Iteration 870: error is 0.72301
Iteration 880: error is 0.72301
Iteration 890: error is 0.72301
Iteration 900: error is 0.72301
Iteration 910: error is 0.72301
Iteration 920: error is 0.72301
Iteration 930: error is 0.72301
Iteration 940: error is 0.72301
Iteration 950: error is 0.72301
Iteration 960: error is 0.72301
Iteration 970: error is 0.72301
Iteration 980: error is 0.72301
Iteration 990: error is 0.72301
Iteration 1000: error is 0.72301
J_new = 3.6899
J_new = 3.6855
J_new = 3.6748
J_new = 3.6728
J_new = 3.6685
J_new = 3.6660
J_new = 3.6578
J_new = 3.6465
J_new = 3.6392
J_new = 3.6383
J_new = 3.6363
J_new = 3.6341
J_new = 3.6339
J_new = 3.6339
Mean value of sigma: 0.18717
Minimum value of sigma: 0.11115
Maximum value of sigma: 0.27474
Iteration 10: error is 39.7571
Iteration 20: error is 38.9729
Iteration 30: error is 38.4796
Iteration 40: error is 39.5342
Iteration 50: error is 38.7719
Iteration 60: error is 39.6383
Iteration 70: error is 39.209
Iteration 80: error is 39.8573
Iteration 90: error is 39.3033
Iteration 100: error is 2.7864
Iteration 110: error is 1.456
Iteration 120: error is 0.93694
Iteration 130: error is 0.81041
Iteration 140: error is 0.78004
Iteration 150: error is 0.76553
Iteration 160: error is 0.75681
Iteration 170: error is 0.75113
Iteration 180: error is 0.74628
Iteration 190: error is 0.74208
Iteration 200: error is 0.73786
Iteration 210: error is 0.73552
```

Iteration 220: error is 0.73343
Iteration 230: error is 0.73172
Iteration 240: error is 0.73002
Iteration 250: error is 0.72889
Iteration 260: error is 0.72657
Iteration 270: error is 0.72385
Iteration 280: error is 0.72189
Iteration 290: error is 0.72057
Iteration 300: error is 0.71959
Iteration 310: error is 0.7188
Iteration 320: error is 0.7182
Iteration 330: error is 0.71756
Iteration 340: error is 0.71691
Iteration 350: error is 0.71651
Iteration 360: error is 0.71625
Iteration 370: error is 0.71606
Iteration 380: error is 0.71585
Iteration 390: error is 0.71568
Iteration 400: error is 0.71555
Iteration 410: error is 0.71544
Iteration 420: error is 0.71536
Iteration 430: error is 0.71528
Iteration 440: error is 0.71522
Iteration 450: error is 0.71517
Iteration 460: error is 0.71512
Iteration 470: error is 0.71508
Iteration 480: error is 0.71505
Iteration 490: error is 0.71502
Iteration 500: error is 0.71499
Iteration 510: error is 0.71497
Iteration 520: error is 0.71495
Iteration 530: error is 0.71494
Iteration 540: error is 0.71492
Iteration 550: error is 0.71491
Iteration 560: error is 0.7149
Iteration 570: error is 0.71489
Iteration 580: error is 0.71488
Iteration 590: error is 0.71488
Iteration 600: error is 0.71487
Iteration 610: error is 0.71487
Iteration 620: error is 0.71486
Iteration 630: error is 0.71486
Iteration 640: error is 0.71485
Iteration 650: error is 0.71485
Iteration 660: error is 0.71485
Iteration 670: error is 0.71484
Iteration 680: error is 0.71484
Iteration 690: error is 0.71484
Iteration 700: error is 0.71484
Iteration 710: error is 0.71484
Iteration 720: error is 0.71484
Iteration 730: error is 0.71483
Iteration 740: error is 0.71483
Iteration 750: error is 0.71483
Iteration 760: error is 0.71483
Iteration 770: error is 0.71483
Iteration 780: error is 0.71483
Iteration 790: error is 0.71483
Iteration 800: error is 0.71483
Iteration 810: error is 0.71483
Iteration 820: error is 0.71483
Iteration 830: error is 0.71483
Iteration 840: error is 0.71483
Iteration 850: error is 0.71483
Iteration 860: error is 0.71483

```
Iteration 870: error is 0.71483
Iteration 880: error is 0.71483
Iteration 890: error is 0.71483
Iteration 900: error is 0.71483
Iteration 910: error is 0.71483
Iteration 920: error is 0.71483
Iteration 930: error is 0.71483
Iteration 940: error is 0.71483
Iteration 950: error is 0.71483
Iteration 960: error is 0.71483
Iteration 970: error is 0.71483
Iteration 980: error is 0.71483
Iteration 990: error is 0.71483
Iteration 1000: error is 0.71483
J_new = 3.7069
J_new = 3.6916
J_new = 3.6879
J_new = 3.6845
J_new = 3.6740
J_new = 3.6731
J_new = 3.6698
J_new = 3.6667
J_new = 3.6578
J_new = 3.6465
J_new = 3.6392
J_new = 3.6383
J_new = 3.6363
J_new = 3.6341
J_new = 3.6339
J_new = 3.6339
Mean value of sigma: 0.18717
Minimum value of sigma: 0.11115
Maximum value of sigma: 0.27474
Iteration 10: error is 40.5487
Iteration 20: error is 38.5803
Iteration 30: error is 39.2751
Iteration 40: error is 39.3446
Iteration 50: error is 37.9407
Iteration 60: error is 38.6197
Iteration 70: error is 39.1545
Iteration 80: error is 38.7356
Iteration 90: error is 39.5674
Iteration 100: error is 2.6905
Iteration 110: error is 1.3675
Iteration 120: error is 0.98181
Iteration 130: error is 0.89205
Iteration 140: error is 0.79208
Iteration 150: error is 0.76531
Iteration 160: error is 0.75292
Iteration 170: error is 0.74463
Iteration 180: error is 0.73937
Iteration 190: error is 0.73586
Iteration 200: error is 0.7323
Iteration 210: error is 0.72925
Iteration 220: error is 0.72709
Iteration 230: error is 0.72522
Iteration 240: error is 0.72363
Iteration 250: error is 0.7223
Iteration 260: error is 0.72022
Iteration 270: error is 0.71793
Iteration 280: error is 0.71615
Iteration 290: error is 0.71492
Iteration 300: error is 0.71401
Iteration 310: error is 0.71332
Iteration 320: error is 0.71276
```

Iteration 330: error is 0.71231
Iteration 340: error is 0.71196
Iteration 350: error is 0.71168
Iteration 360: error is 0.71145
Iteration 370: error is 0.71126
Iteration 380: error is 0.71109
Iteration 390: error is 0.71088
Iteration 400: error is 0.71072
Iteration 410: error is 0.71059
Iteration 420: error is 0.7105
Iteration 430: error is 0.71043
Iteration 440: error is 0.71036
Iteration 450: error is 0.71031
Iteration 460: error is 0.71027
Iteration 470: error is 0.71023
Iteration 480: error is 0.71019
Iteration 490: error is 0.71016
Iteration 500: error is 0.71014
Iteration 510: error is 0.71012
Iteration 520: error is 0.7101
Iteration 530: error is 0.71008
Iteration 540: error is 0.71007
Iteration 550: error is 0.71005
Iteration 560: error is 0.71004
Iteration 570: error is 0.71003
Iteration 580: error is 0.71002
Iteration 590: error is 0.71002
Iteration 600: error is 0.71001
Iteration 610: error is 0.71
Iteration 620: error is 0.71
Iteration 630: error is 0.70999
Iteration 640: error is 0.70999
Iteration 650: error is 0.70999
Iteration 660: error is 0.70998
Iteration 670: error is 0.70998
Iteration 680: error is 0.70998
Iteration 690: error is 0.70997
Iteration 700: error is 0.70997
Iteration 710: error is 0.70997
Iteration 720: error is 0.70997
Iteration 730: error is 0.70997
Iteration 740: error is 0.70997
Iteration 750: error is 0.70997
Iteration 760: error is 0.70996
Iteration 770: error is 0.70996
Iteration 780: error is 0.70996
Iteration 790: error is 0.70996
Iteration 800: error is 0.70996
Iteration 810: error is 0.70996
Iteration 820: error is 0.70996
Iteration 830: error is 0.70996
Iteration 840: error is 0.70996
Iteration 850: error is 0.70996
Iteration 860: error is 0.70996
Iteration 870: error is 0.70996
Iteration 880: error is 0.70996
Iteration 890: error is 0.70996
Iteration 900: error is 0.70996
Iteration 910: error is 0.70996
Iteration 920: error is 0.70996
Iteration 930: error is 0.70996
Iteration 940: error is 0.70996
Iteration 950: error is 0.70996
Iteration 960: error is 0.70996
Iteration 970: error is 0.70996

```
Iteration 980: error is 0.70996
Iteration 990: error is 0.70996
Iteration 1000: error is 0.70996
J_new = 3.7031
J_new = 3.6895
J_new = 3.6845
J_new = 3.6740
J_new = 3.6731
J_new = 3.6698
J_new = 3.6667
J_new = 3.6578
J_new = 3.6465
J_new = 3.6392
J_new = 3.6383
J_new = 3.6363
J_new = 3.6341
J_new = 3.6339
J_new = 3.6339
Mean value of sigma: 0.18717
Minimum value of sigma: 0.11115
Maximum value of sigma: 0.27474
Iteration 10: error is 40.1664
Iteration 20: error is 38.8326
Iteration 30: error is 39.2885
Iteration 40: error is 38.5749
Iteration 50: error is 38.6575
Iteration 60: error is 39.3464
Iteration 70: error is 38.8147
Iteration 80: error is 39.2263
Iteration 90: error is 39.9334
Iteration 100: error is 2.784
Iteration 110: error is 1.5344
Iteration 120: error is 1.0363
Iteration 130: error is 0.87781
Iteration 140: error is 0.82812
Iteration 150: error is 0.81958
Iteration 160: error is 0.80666
Iteration 170: error is 0.79509
Iteration 180: error is 0.7893
Iteration 190: error is 0.786
Iteration 200: error is 0.78216
Iteration 210: error is 0.77904
Iteration 220: error is 0.77691
Iteration 230: error is 0.77466
Iteration 240: error is 0.77264
Iteration 250: error is 0.76997
Iteration 260: error is 0.76487
Iteration 270: error is 0.76243
Iteration 280: error is 0.75848
Iteration 290: error is 0.75151
Iteration 300: error is 0.74905
Iteration 310: error is 0.74786
Iteration 320: error is 0.74723
Iteration 330: error is 0.7466
Iteration 340: error is 0.74436
Iteration 350: error is 0.74351
Iteration 360: error is 0.74259
Iteration 370: error is 0.74223
Iteration 380: error is 0.74202
Iteration 390: error is 0.74187
Iteration 400: error is 0.74175
Iteration 410: error is 0.74166
Iteration 420: error is 0.74158
Iteration 430: error is 0.74151
Iteration 440: error is 0.74145
```

```
Iteration 450: error is 0.7414
Iteration 460: error is 0.74136
Iteration 470: error is 0.74132
Iteration 480: error is 0.74129
Iteration 490: error is 0.74126
Iteration 500: error is 0.74124
Iteration 510: error is 0.74122
Iteration 520: error is 0.7412
Iteration 530: error is 0.74118
Iteration 540: error is 0.74117
Iteration 550: error is 0.74116
Iteration 560: error is 0.74114
Iteration 570: error is 0.74114
Iteration 580: error is 0.74113
Iteration 590: error is 0.74112
Iteration 600: error is 0.74111
Iteration 610: error is 0.74111
Iteration 620: error is 0.7411
Iteration 630: error is 0.7411
Iteration 640: error is 0.7411
Iteration 650: error is 0.74109
Iteration 660: error is 0.74109
Iteration 670: error is 0.74109
Iteration 680: error is 0.74109
Iteration 690: error is 0.74108
Iteration 700: error is 0.74108
Iteration 710: error is 0.74108
Iteration 720: error is 0.74108
Iteration 730: error is 0.74108
Iteration 740: error is 0.74108
Iteration 750: error is 0.74108
Iteration 760: error is 0.74108
Iteration 770: error is 0.74107
Iteration 780: error is 0.74107
Iteration 790: error is 0.74107
Iteration 800: error is 0.74107
Iteration 810: error is 0.74107
Iteration 820: error is 0.74107
Iteration 830: error is 0.74107
Iteration 840: error is 0.74107
Iteration 850: error is 0.74107
Iteration 860: error is 0.74107
Iteration 870: error is 0.74107
Iteration 880: error is 0.74107
Iteration 890: error is 0.74107
Iteration 900: error is 0.74107
Iteration 910: error is 0.74107
Iteration 920: error is 0.74107
Iteration 930: error is 0.74107
Iteration 940: error is 0.74107
Iteration 950: error is 0.74107
Iteration 960: error is 0.74107
Iteration 970: error is 0.74107
Iteration 980: error is 0.74107
Iteration 990: error is 0.74107
Iteration 1000: error is 0.74107
J_new = 3.6902
J_new = 3.6824
J_new = 3.6789
J_new = 3.6735
J_new = 3.6727
J_new = 3.6698
J_new = 3.6667
J_new = 3.6578
J_new = 3.6465
```

```
J_new = 3.6392
J_new = 3.6383
J_new = 3.6363
J_new = 3.6341
J_new = 3.6339
J_new = 3.6339
Mean value of sigma: 0.18717
Minimum value of sigma: 0.11115
Maximum value of sigma: 0.27474
Iteration 10: error is 40.4388
Iteration 20: error is 38.7425
Iteration 30: error is 39.8129
Iteration 40: error is 39.2901
Iteration 50: error is 39.7077
Iteration 60: error is 39.4615
Iteration 70: error is 39.3598
Iteration 80: error is 39.5325
Iteration 90: error is 39.6774
Iteration 100: error is 2.6725
Iteration 110: error is 1.3544
Iteration 120: error is 0.9465
Iteration 130: error is 0.83465
Iteration 140: error is 0.8055
Iteration 150: error is 0.79022
Iteration 160: error is 0.77941
Iteration 170: error is 0.77347
Iteration 180: error is 0.76907
Iteration 190: error is 0.76502
Iteration 200: error is 0.76172
Iteration 210: error is 0.76012
Iteration 220: error is 0.75722
Iteration 230: error is 0.75545
Iteration 240: error is 0.75381
Iteration 250: error is 0.75261
Iteration 260: error is 0.75092
Iteration 270: error is 0.74845
Iteration 280: error is 0.7467
Iteration 290: error is 0.74417
Iteration 300: error is 0.74307
Iteration 310: error is 0.74235
Iteration 320: error is 0.74155
Iteration 330: error is 0.74703
Iteration 340: error is 0.74508
Iteration 350: error is 0.74069
Iteration 360: error is 0.73677
Iteration 370: error is 0.73461
Iteration 380: error is 0.73425
Iteration 390: error is 0.73407
Iteration 400: error is 0.73391
Iteration 410: error is 0.73382
Iteration 420: error is 0.73371
Iteration 430: error is 0.73362
Iteration 440: error is 0.73356
Iteration 450: error is 0.73351
Iteration 460: error is 0.73346
Iteration 470: error is 0.73343
Iteration 480: error is 0.73339
Iteration 490: error is 0.73337
Iteration 500: error is 0.73334
Iteration 510: error is 0.73332
Iteration 520: error is 0.73331
Iteration 530: error is 0.73329
Iteration 540: error is 0.73328
Iteration 550: error is 0.73327
Iteration 560: error is 0.73326
```

```
Iteration 570: error is 0.73325
Iteration 580: error is 0.73324
Iteration 590: error is 0.73323
Iteration 600: error is 0.73323
Iteration 610: error is 0.73322
Iteration 620: error is 0.73322
Iteration 630: error is 0.73321
Iteration 640: error is 0.73321
Iteration 650: error is 0.7332
Iteration 660: error is 0.7332
Iteration 670: error is 0.7332
Iteration 680: error is 0.7332
Iteration 690: error is 0.7332
Iteration 700: error is 0.73319
Iteration 710: error is 0.73319
Iteration 720: error is 0.73319
Iteration 730: error is 0.73319
Iteration 740: error is 0.73319
Iteration 750: error is 0.73319
Iteration 760: error is 0.73319
Iteration 770: error is 0.73319
Iteration 780: error is 0.73319
Iteration 790: error is 0.73318
Iteration 800: error is 0.73318
Iteration 810: error is 0.73318
Iteration 820: error is 0.73318
Iteration 830: error is 0.73318
Iteration 840: error is 0.73318
Iteration 850: error is 0.73318
Iteration 860: error is 0.73318
Iteration 870: error is 0.73318
Iteration 880: error is 0.73318
Iteration 890: error is 0.73318
Iteration 900: error is 0.73318
Iteration 910: error is 0.73318
Iteration 920: error is 0.73318
Iteration 930: error is 0.73318
Iteration 940: error is 0.73318
Iteration 950: error is 0.73318
Iteration 960: error is 0.73318
Iteration 970: error is 0.73318
Iteration 980: error is 0.73318
Iteration 990: error is 0.73318
Iteration 1000: error is 0.73318
J_new = 3.7057
J_new = 3.6985
J_new = 3.6879
J_new = 3.6845
J_new = 3.6740
J_new = 3.6731
J_new = 3.6698
J_new = 3.6667
J_new = 3.6578
J_new = 3.6465
J_new = 3.6392
J_new = 3.6383
J_new = 3.6363
J_new = 3.6341
J_new = 3.6339
J_new = 3.6339
Mean value of sigma: 0.18717
Minimum value of sigma: 0.11115
Maximum value of sigma: 0.27474
Iteration 10: error is 41.0188
Iteration 20: error is 39.367
```

Iteration 30: error is 38.5172
Iteration 40: error is 39.3998
Iteration 50: error is 39.4067
Iteration 60: error is 39.1167
Iteration 70: error is 39.2142
Iteration 80: error is 39.3747
Iteration 90: error is 39.7239
Iteration 100: error is 2.8385
Iteration 110: error is 1.5412
Iteration 120: error is 0.98133
Iteration 130: error is 0.85524
Iteration 140: error is 0.80196
Iteration 150: error is 0.76903
Iteration 160: error is 0.75545
Iteration 170: error is 0.7474
Iteration 180: error is 0.74107
Iteration 190: error is 0.73542
Iteration 200: error is 0.7325
Iteration 210: error is 0.72985
Iteration 220: error is 0.727
Iteration 230: error is 0.72522
Iteration 240: error is 0.72369
Iteration 250: error is 0.7225
Iteration 260: error is 0.72028
Iteration 270: error is 0.71777
Iteration 280: error is 0.71576
Iteration 290: error is 0.71413
Iteration 300: error is 0.71258
Iteration 310: error is 0.71139
Iteration 320: error is 0.71052
Iteration 330: error is 0.70983
Iteration 340: error is 0.70922
Iteration 350: error is 0.70811
Iteration 360: error is 0.70586
Iteration 370: error is 0.70417
Iteration 380: error is 0.70201
Iteration 390: error is 0.70129
Iteration 400: error is 0.70076
Iteration 410: error is 0.70046
Iteration 420: error is 0.70018
Iteration 430: error is 0.69998
Iteration 440: error is 0.6999
Iteration 450: error is 0.69985
Iteration 460: error is 0.6998
Iteration 470: error is 0.69976
Iteration 480: error is 0.69973
Iteration 490: error is 0.6997
Iteration 500: error is 0.69967
Iteration 510: error is 0.69965
Iteration 520: error is 0.69963
Iteration 530: error is 0.69961
Iteration 540: error is 0.69959
Iteration 550: error is 0.69954
Iteration 560: error is 0.69947
Iteration 570: error is 0.69945
Iteration 580: error is 0.69944
Iteration 590: error is 0.69943
Iteration 600: error is 0.69943
Iteration 610: error is 0.69942
Iteration 620: error is 0.69941
Iteration 630: error is 0.69941
Iteration 640: error is 0.69941
Iteration 650: error is 0.6994
Iteration 660: error is 0.6994
Iteration 670: error is 0.69939

```
Iteration 680: error is 0.69939
Iteration 690: error is 0.69939
Iteration 700: error is 0.69939
Iteration 710: error is 0.69938
Iteration 720: error is 0.69938
Iteration 730: error is 0.69938
Iteration 740: error is 0.69938
Iteration 750: error is 0.69938
Iteration 760: error is 0.69938
Iteration 770: error is 0.69938
Iteration 780: error is 0.69938
Iteration 790: error is 0.69938
Iteration 800: error is 0.69937
Iteration 810: error is 0.69937
Iteration 820: error is 0.69937
Iteration 830: error is 0.69937
Iteration 840: error is 0.69937
Iteration 850: error is 0.69937
Iteration 860: error is 0.69937
Iteration 870: error is 0.69937
Iteration 880: error is 0.69937
Iteration 890: error is 0.69937
Iteration 900: error is 0.69937
Iteration 910: error is 0.69937
Iteration 920: error is 0.69937
Iteration 930: error is 0.69937
Iteration 940: error is 0.69937
Iteration 950: error is 0.69937
Iteration 960: error is 0.69937
Iteration 970: error is 0.69937
Iteration 980: error is 0.69937
Iteration 990: error is 0.69937
Iteration 1000: error is 0.69937
J_new = 3.6964
J_new = 3.6743
J_new = 3.6723
J_new = 3.6664
J_new = 3.6598
J_new = 3.6439
J_new = 3.6431
J_new = 3.6409
J_new = 3.6386
J_new = 3.6384
J_new = 3.6384
Mean value of sigma: 0.18717
Minimum value of sigma: 0.11115
Maximum value of sigma: 0.27474
Iteration 10: error is 40.4332
Iteration 20: error is 39.2931
Iteration 30: error is 39.2205
Iteration 40: error is 39.2892
Iteration 50: error is 39.8494
Iteration 60: error is 39.3365
Iteration 70: error is 39.949
Iteration 80: error is 40.1364
Iteration 90: error is 39.6206
Iteration 100: error is 2.806
Iteration 110: error is 1.4154
Iteration 120: error is 1.0009
Iteration 130: error is 0.82641
Iteration 140: error is 0.77456
Iteration 150: error is 0.75851
Iteration 160: error is 0.74977
Iteration 170: error is 0.7433
Iteration 180: error is 0.7384
```

Iteration 190: error is 0.73407
Iteration 200: error is 0.73094
Iteration 210: error is 0.72806
Iteration 220: error is 0.72621
Iteration 230: error is 0.72412
Iteration 240: error is 0.72253
Iteration 250: error is 0.72127
Iteration 260: error is 0.71924
Iteration 270: error is 0.71686
Iteration 280: error is 0.71519
Iteration 290: error is 0.7139
Iteration 300: error is 0.71252
Iteration 310: error is 0.71145
Iteration 320: error is 0.71074
Iteration 330: error is 0.71021
Iteration 340: error is 0.7098
Iteration 350: error is 0.70946
Iteration 360: error is 0.70915
Iteration 370: error is 0.70892
Iteration 380: error is 0.70874
Iteration 390: error is 0.70858
Iteration 400: error is 0.70842
Iteration 410: error is 0.70826
Iteration 420: error is 0.70804
Iteration 430: error is 0.70787
Iteration 440: error is 0.7078
Iteration 450: error is 0.70775
Iteration 460: error is 0.7077
Iteration 470: error is 0.70766
Iteration 480: error is 0.70762
Iteration 490: error is 0.70759
Iteration 500: error is 0.70757
Iteration 510: error is 0.70754
Iteration 520: error is 0.70752
Iteration 530: error is 0.7075
Iteration 540: error is 0.70748
Iteration 550: error is 0.70746
Iteration 560: error is 0.70745
Iteration 570: error is 0.70744
Iteration 580: error is 0.70743
Iteration 590: error is 0.70742
Iteration 600: error is 0.70741
Iteration 610: error is 0.70738
Iteration 620: error is 0.70735
Iteration 630: error is 0.70734
Iteration 640: error is 0.70734
Iteration 650: error is 0.70733
Iteration 660: error is 0.70733
Iteration 670: error is 0.70732
Iteration 680: error is 0.70732
Iteration 690: error is 0.70732
Iteration 700: error is 0.70732
Iteration 710: error is 0.70731
Iteration 720: error is 0.70731
Iteration 730: error is 0.70731
Iteration 740: error is 0.70731
Iteration 750: error is 0.70731
Iteration 760: error is 0.70731
Iteration 770: error is 0.7073
Iteration 780: error is 0.7073
Iteration 790: error is 0.7073
Iteration 800: error is 0.7073
Iteration 810: error is 0.7073
Iteration 820: error is 0.7073
Iteration 830: error is 0.7073

```
Iteration 840: error is 0.7073
Iteration 850: error is 0.7073
Iteration 860: error is 0.7073
Iteration 870: error is 0.7073
Iteration 880: error is 0.7073
Iteration 890: error is 0.7073
Iteration 900: error is 0.7073
Iteration 910: error is 0.7073
Iteration 920: error is 0.7073
Iteration 930: error is 0.7073
Iteration 940: error is 0.7073
Iteration 950: error is 0.7073
Iteration 960: error is 0.7073
Iteration 970: error is 0.7073
Iteration 980: error is 0.7073
Iteration 990: error is 0.70729
Iteration 1000: error is 0.70729
J_new = 3.6834
J_new = 3.6746
J_new = 3.6730
J_new = 3.6664
J_new = 3.6598
J_new = 3.6439
J_new = 3.6431
J_new = 3.6409
J_new = 3.6386
J_new = 3.6384
J_new = 3.6384
Mean value of sigma: 0.18717
Minimum value of sigma: 0.11115
Maximum value of sigma: 0.27474
Iteration 10: error is 39.6477
Iteration 20: error is 38.9695
Iteration 30: error is 38.7333
Iteration 40: error is 38.9043
Iteration 50: error is 38.9789
Iteration 60: error is 39.6912
Iteration 70: error is 38.9356
Iteration 80: error is 39.1724
Iteration 90: error is 39.2358
Iteration 100: error is 2.624
Iteration 110: error is 1.4153
Iteration 120: error is 0.99166
Iteration 130: error is 0.87884
Iteration 140: error is 0.83255
Iteration 150: error is 0.81027
Iteration 160: error is 0.78967
Iteration 170: error is 0.77723
Iteration 180: error is 0.77175
Iteration 190: error is 0.76583
Iteration 200: error is 0.76161
Iteration 210: error is 0.75825
Iteration 220: error is 0.7559
Iteration 230: error is 0.75392
Iteration 240: error is 0.75232
Iteration 250: error is 0.75096
Iteration 260: error is 0.75083
Iteration 270: error is 0.74764
Iteration 280: error is 0.74622
Iteration 290: error is 0.74444
Iteration 300: error is 0.74366
Iteration 310: error is 0.74209
Iteration 320: error is 0.74119
Iteration 330: error is 0.74066
Iteration 340: error is 0.74028
```

Iteration 350: error is 0.74002
Iteration 360: error is 0.73979
Iteration 370: error is 0.7396
Iteration 380: error is 0.73943
Iteration 390: error is 0.73926
Iteration 400: error is 0.73912
Iteration 410: error is 0.73902
Iteration 420: error is 0.73895
Iteration 430: error is 0.73888
Iteration 440: error is 0.73883
Iteration 450: error is 0.73878
Iteration 460: error is 0.73874
Iteration 470: error is 0.73871
Iteration 480: error is 0.73867
Iteration 490: error is 0.73865
Iteration 500: error is 0.73862
Iteration 510: error is 0.7386
Iteration 520: error is 0.73859
Iteration 530: error is 0.73857
Iteration 540: error is 0.73856
Iteration 550: error is 0.73855
Iteration 560: error is 0.73854
Iteration 570: error is 0.73853
Iteration 580: error is 0.73852
Iteration 590: error is 0.73851
Iteration 600: error is 0.73851
Iteration 610: error is 0.7385
Iteration 620: error is 0.7385
Iteration 630: error is 0.73849
Iteration 640: error is 0.73849
Iteration 650: error is 0.73849
Iteration 660: error is 0.73848
Iteration 670: error is 0.73848
Iteration 680: error is 0.73848
Iteration 690: error is 0.73848
Iteration 700: error is 0.73847
Iteration 710: error is 0.73847
Iteration 720: error is 0.73847
Iteration 730: error is 0.73847
Iteration 740: error is 0.73847
Iteration 750: error is 0.73847
Iteration 760: error is 0.73847
Iteration 770: error is 0.73847
Iteration 780: error is 0.73847
Iteration 790: error is 0.73846
Iteration 800: error is 0.73846
Iteration 810: error is 0.73846
Iteration 820: error is 0.73846
Iteration 830: error is 0.73846
Iteration 840: error is 0.73846
Iteration 850: error is 0.73846
Iteration 860: error is 0.73846
Iteration 870: error is 0.73846
Iteration 880: error is 0.73846
Iteration 890: error is 0.73846
Iteration 900: error is 0.73846
Iteration 910: error is 0.73846
Iteration 920: error is 0.73846
Iteration 930: error is 0.73846
Iteration 940: error is 0.73846
Iteration 950: error is 0.73846
Iteration 960: error is 0.73846
Iteration 970: error is 0.73846
Iteration 980: error is 0.73846
Iteration 990: error is 0.73846

```
Iteration 1000: error is 0.73846
J_new = 3.6829
J_new = 3.6495
J_new = 3.6441
J_new = 3.6437
J_new = 3.6409
J_new = 3.6386
J_new = 3.6384
J_new = 3.6384
Mean value of sigma: 0.18717
Minimum value of sigma: 0.11115
Maximum value of sigma: 0.27474
Iteration 10: error is 40.4617
Iteration 20: error is 38.8442
Iteration 30: error is 39.2178
Iteration 40: error is 39.0711
Iteration 50: error is 39.6639
Iteration 60: error is 38.9999
Iteration 70: error is 38.9457
Iteration 80: error is 39.5318
Iteration 90: error is 39.2959
Iteration 100: error is 2.7759
Iteration 110: error is 1.4963
Iteration 120: error is 1.0012
Iteration 130: error is 0.87261
Iteration 140: error is 0.80984
Iteration 150: error is 0.79162
Iteration 160: error is 0.76509
Iteration 170: error is 0.75552
Iteration 180: error is 0.74535
Iteration 190: error is 0.73552
Iteration 200: error is 0.73242
Iteration 210: error is 0.73009
Iteration 220: error is 0.72792
Iteration 230: error is 0.72659
Iteration 240: error is 0.72481
Iteration 250: error is 0.72331
Iteration 260: error is 0.72119
Iteration 270: error is 0.71862
Iteration 280: error is 0.71653
Iteration 290: error is 0.71509
Iteration 300: error is 0.71417
Iteration 310: error is 0.71352
Iteration 320: error is 0.713
Iteration 330: error is 0.71261
Iteration 340: error is 0.71228
Iteration 350: error is 0.71202
Iteration 360: error is 0.71181
Iteration 370: error is 0.71164
Iteration 380: error is 0.7115
Iteration 390: error is 0.71138
Iteration 400: error is 0.71128
Iteration 410: error is 0.7112
Iteration 420: error is 0.71113
Iteration 430: error is 0.71107
Iteration 440: error is 0.71102
Iteration 450: error is 0.71098
Iteration 460: error is 0.71094
Iteration 470: error is 0.71091
Iteration 480: error is 0.71088
Iteration 490: error is 0.71086
Iteration 500: error is 0.71084
Iteration 510: error is 0.71082
Iteration 520: error is 0.7108
Iteration 530: error is 0.71079
```

```
Iteration 540: error is 0.71077
Iteration 550: error is 0.71075
Iteration 560: error is 0.7107
Iteration 570: error is 0.71061
Iteration 580: error is 0.71026
Iteration 590: error is 0.71001
Iteration 600: error is 0.70976
Iteration 610: error is 0.70955
Iteration 620: error is 0.70944
Iteration 630: error is 0.70937
Iteration 640: error is 0.70929
Iteration 650: error is 0.70926
Iteration 660: error is 0.70926
Iteration 670: error is 0.70925
Iteration 680: error is 0.70925
Iteration 690: error is 0.70925
Iteration 700: error is 0.70922
Iteration 710: error is 0.70921
Iteration 720: error is 0.70921
Iteration 730: error is 0.70921
Iteration 740: error is 0.70921
Iteration 750: error is 0.70921
Iteration 760: error is 0.70921
Iteration 770: error is 0.7092
Iteration 780: error is 0.7092
Iteration 790: error is 0.7092
Iteration 800: error is 0.7092
Iteration 810: error is 0.7092
Iteration 820: error is 0.7092
Iteration 830: error is 0.7092
Iteration 840: error is 0.7092
Iteration 850: error is 0.7092
Iteration 860: error is 0.7092
Iteration 870: error is 0.7092
Iteration 880: error is 0.70919
Iteration 890: error is 0.70919
Iteration 900: error is 0.70918
Iteration 910: error is 0.70917
Iteration 920: error is 0.70914
Iteration 930: error is 0.70894
Iteration 940: error is 0.70834
Iteration 950: error is 0.70808
Iteration 960: error is 0.708
Iteration 970: error is 0.70798
Iteration 980: error is 0.70797
Iteration 990: error is 0.70797
Iteration 1000: error is 0.70796
J_new = 3.6735
J_new = 3.6629
J_new = 3.6610
J_new = 3.6493
J_new = 3.6392
J_new = 3.6388
J_new = 3.6363
J_new = 3.6341
J_new = 3.6339
J_new = 3.6339
Mean value of sigma: 0.18717
Minimum value of sigma: 0.11115
Maximum value of sigma: 0.27474
Iteration 10: error is 39.6656
Iteration 20: error is 38.6813
Iteration 30: error is 39.0853
Iteration 40: error is 38.9435
Iteration 50: error is 38.7193
```

Iteration 60: error is 39.6479
Iteration 70: error is 38.8933
Iteration 80: error is 39.5419
Iteration 90: error is 39.5387
Iteration 100: error is 2.7813
Iteration 110: error is 1.379
Iteration 120: error is 0.99816
Iteration 130: error is 0.90091
Iteration 140: error is 0.828
Iteration 150: error is 0.79736
Iteration 160: error is 0.78579
Iteration 170: error is 0.77887
Iteration 180: error is 0.77297
Iteration 190: error is 0.76692
Iteration 200: error is 0.75915
Iteration 210: error is 0.75515
Iteration 220: error is 0.75174
Iteration 230: error is 0.74515
Iteration 240: error is 0.73867
Iteration 250: error is 0.73632
Iteration 260: error is 0.73415
Iteration 270: error is 0.73179
Iteration 280: error is 0.72987
Iteration 290: error is 0.72854
Iteration 300: error is 0.72755
Iteration 310: error is 0.72676
Iteration 320: error is 0.72608
Iteration 330: error is 0.72558
Iteration 340: error is 0.72518
Iteration 350: error is 0.72485
Iteration 360: error is 0.7246
Iteration 370: error is 0.72438
Iteration 380: error is 0.72421
Iteration 390: error is 0.72407
Iteration 400: error is 0.72395
Iteration 410: error is 0.72385
Iteration 420: error is 0.72377
Iteration 430: error is 0.7237
Iteration 440: error is 0.72364
Iteration 450: error is 0.72359
Iteration 460: error is 0.72354
Iteration 470: error is 0.7235
Iteration 480: error is 0.72344
Iteration 490: error is 0.72339
Iteration 500: error is 0.72335
Iteration 510: error is 0.72332
Iteration 520: error is 0.72328
Iteration 530: error is 0.72325
Iteration 540: error is 0.7232
Iteration 550: error is 0.72312
Iteration 560: error is 0.72295
Iteration 570: error is 0.72275
Iteration 580: error is 0.7226
Iteration 590: error is 0.72247
Iteration 600: error is 0.72237
Iteration 610: error is 0.72232
Iteration 620: error is 0.72228
Iteration 630: error is 0.72226
Iteration 640: error is 0.72225
Iteration 650: error is 0.72224
Iteration 660: error is 0.72223
Iteration 670: error is 0.72223
Iteration 680: error is 0.72222
Iteration 690: error is 0.72222
Iteration 700: error is 0.72221

```
Iteration 710: error is 0.72221
Iteration 720: error is 0.72221
Iteration 730: error is 0.72221
Iteration 740: error is 0.72221
Iteration 750: error is 0.72221
Iteration 760: error is 0.7222
Iteration 770: error is 0.7222
Iteration 780: error is 0.7222
Iteration 790: error is 0.7222
Iteration 800: error is 0.7222
Iteration 810: error is 0.7222
Iteration 820: error is 0.7222
Iteration 830: error is 0.7222
Iteration 840: error is 0.7222
Iteration 850: error is 0.7222
Iteration 860: error is 0.7222
Iteration 870: error is 0.7222
Iteration 880: error is 0.7222
Iteration 890: error is 0.7222
Iteration 900: error is 0.7222
Iteration 910: error is 0.7222
Iteration 920: error is 0.7222
Iteration 930: error is 0.7222
Iteration 940: error is 0.7222
Iteration 950: error is 0.7222
Iteration 960: error is 0.7222
Iteration 970: error is 0.7222
Iteration 980: error is 0.7222
Iteration 990: error is 0.7222
Iteration 1000: error is 0.7222
J_new = 3.7002
J_new = 3.6903
J_new = 3.6880
J_new = 3.6844
J_new = 3.6793
J_new = 3.6742
J_new = 3.6723
J_new = 3.6664
J_new = 3.6598
J_new = 3.6439
J_new = 3.6431
J_new = 3.6409
J_new = 3.6386
J_new = 3.6384
J_new = 3.6384
Mean value of sigma: 0.18717
Minimum value of sigma: 0.11115
Maximum value of sigma: 0.27474
Iteration 10: error is 40.5941
Iteration 20: error is 38.8952
Iteration 30: error is 38.8945
Iteration 40: error is 39.081
Iteration 50: error is 39.0779
Iteration 60: error is 39.926
Iteration 70: error is 39.2905
Iteration 80: error is 39.1042
Iteration 90: error is 39.7908
Iteration 100: error is 2.5746
Iteration 110: error is 1.7064
Iteration 120: error is 1.1452
Iteration 130: error is 0.99057
Iteration 140: error is 0.89863
Iteration 150: error is 0.87054
Iteration 160: error is 0.83586
Iteration 170: error is 0.8261
```

Iteration 180: error is 0.81334
Iteration 190: error is 0.80606
Iteration 200: error is 0.79452
Iteration 210: error is 0.78877
Iteration 220: error is 0.79174
Iteration 230: error is 0.77874
Iteration 240: error is 0.77188
Iteration 250: error is 0.77017
Iteration 260: error is 0.76804
Iteration 270: error is 0.76549
Iteration 280: error is 0.76165
Iteration 290: error is 0.75952
Iteration 300: error is 0.75865
Iteration 310: error is 0.75757
Iteration 320: error is 0.75698
Iteration 330: error is 0.75658
Iteration 340: error is 0.75627
Iteration 350: error is 0.75601
Iteration 360: error is 0.75578
Iteration 370: error is 0.75561
Iteration 380: error is 0.75546
Iteration 390: error is 0.75534
Iteration 400: error is 0.75524
Iteration 410: error is 0.75516
Iteration 420: error is 0.75508
Iteration 430: error is 0.75502
Iteration 440: error is 0.75497
Iteration 450: error is 0.75493
Iteration 460: error is 0.75489
Iteration 470: error is 0.75486
Iteration 480: error is 0.75483
Iteration 490: error is 0.75481
Iteration 500: error is 0.75478
Iteration 510: error is 0.75477
Iteration 520: error is 0.75475
Iteration 530: error is 0.75474
Iteration 540: error is 0.75473
Iteration 550: error is 0.75472
Iteration 560: error is 0.75471
Iteration 570: error is 0.7547
Iteration 580: error is 0.75469
Iteration 590: error is 0.75469
Iteration 600: error is 0.75468
Iteration 610: error is 0.75468
Iteration 620: error is 0.75467
Iteration 630: error is 0.75467
Iteration 640: error is 0.75467
Iteration 650: error is 0.75466
Iteration 660: error is 0.75466
Iteration 670: error is 0.75466
Iteration 680: error is 0.75466
Iteration 690: error is 0.75466
Iteration 700: error is 0.75465
Iteration 710: error is 0.75465
Iteration 720: error is 0.75465
Iteration 730: error is 0.75465
Iteration 740: error is 0.75465
Iteration 750: error is 0.75465
Iteration 760: error is 0.75465
Iteration 770: error is 0.75465
Iteration 780: error is 0.75465
Iteration 790: error is 0.75465
Iteration 800: error is 0.75465
Iteration 810: error is 0.75465
Iteration 820: error is 0.75465

```
Iteration 830: error is 0.75465
Iteration 840: error is 0.75465
Iteration 850: error is 0.75465
Iteration 860: error is 0.75465
Iteration 870: error is 0.75465
Iteration 880: error is 0.75465
Iteration 890: error is 0.75465
Iteration 900: error is 0.75464
Iteration 910: error is 0.75464
Iteration 920: error is 0.75464
Iteration 930: error is 0.75464
Iteration 940: error is 0.75464
Iteration 950: error is 0.75464
Iteration 960: error is 0.75464
Iteration 970: error is 0.75464
Iteration 980: error is 0.75464
Iteration 990: error is 0.75464
Iteration 1000: error is 0.75464
J_new = 3.7284
J_new = 3.6968
J_new = 3.6948
J_new = 3.6927
J_new = 3.6820
J_new = 3.6784
J_new = 3.6742
J_new = 3.6723
J_new = 3.6664
J_new = 3.6598
J_new = 3.6439
J_new = 3.6431
J_new = 3.6409
J_new = 3.6386
J_new = 3.6384
J_new = 3.6384
Mean value of sigma: 0.18717
Minimum value of sigma: 0.11115
Maximum value of sigma: 0.27474
Iteration 10: error is 39.8273
Iteration 20: error is 38.4806
Iteration 30: error is 39.0218
Iteration 40: error is 39.5027
Iteration 50: error is 39.062
Iteration 60: error is 38.7505
Iteration 70: error is 39.963
Iteration 80: error is 39.6541
Iteration 90: error is 39.1256
Iteration 100: error is 2.8054
Iteration 110: error is 1.527
Iteration 120: error is 1.0555
Iteration 130: error is 0.96882
Iteration 140: error is 0.90844
Iteration 150: error is 0.84639
Iteration 160: error is 0.81282
Iteration 170: error is 0.76015
Iteration 180: error is 0.75315
Iteration 190: error is 0.74917
Iteration 200: error is 0.74632
Iteration 210: error is 0.74377
Iteration 220: error is 0.74142
Iteration 230: error is 0.73958
Iteration 240: error is 0.73825
Iteration 250: error is 0.73712
Iteration 260: error is 0.73525
Iteration 270: error is 0.73324
Iteration 280: error is 0.7317
```

Iteration 290: error is 0.73064
Iteration 300: error is 0.72979
Iteration 310: error is 0.72915
Iteration 320: error is 0.72848
Iteration 330: error is 0.72739
Iteration 340: error is 0.72689
Iteration 350: error is 0.72646
Iteration 360: error is 0.72609
Iteration 370: error is 0.72571
Iteration 380: error is 0.72555
Iteration 390: error is 0.72541
Iteration 400: error is 0.7253
Iteration 410: error is 0.72521
Iteration 420: error is 0.72513
Iteration 430: error is 0.72506
Iteration 440: error is 0.72501
Iteration 450: error is 0.72496
Iteration 460: error is 0.72492
Iteration 470: error is 0.72489
Iteration 480: error is 0.72485
Iteration 490: error is 0.72483
Iteration 500: error is 0.72481
Iteration 510: error is 0.72479
Iteration 520: error is 0.72477
Iteration 530: error is 0.72476
Iteration 540: error is 0.72475
Iteration 550: error is 0.72473
Iteration 560: error is 0.72473
Iteration 570: error is 0.72472
Iteration 580: error is 0.72471
Iteration 590: error is 0.7247
Iteration 600: error is 0.7247
Iteration 610: error is 0.72469
Iteration 620: error is 0.72469
Iteration 630: error is 0.72469
Iteration 640: error is 0.72468
Iteration 650: error is 0.72468
Iteration 660: error is 0.72468
Iteration 670: error is 0.72467
Iteration 680: error is 0.72467
Iteration 690: error is 0.72467
Iteration 700: error is 0.72467
Iteration 710: error is 0.72467
Iteration 720: error is 0.72467
Iteration 730: error is 0.72466
Iteration 740: error is 0.72466
Iteration 750: error is 0.72466
Iteration 760: error is 0.72466
Iteration 770: error is 0.72466
Iteration 780: error is 0.72466
Iteration 790: error is 0.72466
Iteration 800: error is 0.72466
Iteration 810: error is 0.72466
Iteration 820: error is 0.72466
Iteration 830: error is 0.72466
Iteration 840: error is 0.72466
Iteration 850: error is 0.72466
Iteration 860: error is 0.72466
Iteration 870: error is 0.72466
Iteration 880: error is 0.72466
Iteration 890: error is 0.72466
Iteration 900: error is 0.72466
Iteration 910: error is 0.72466
Iteration 920: error is 0.72466
Iteration 930: error is 0.72466

```
Iteration 940: error is 0.72466
Iteration 950: error is 0.72466
Iteration 960: error is 0.72466
Iteration 970: error is 0.72466
Iteration 980: error is 0.72466
Iteration 990: error is 0.72466
Iteration 1000: error is 0.72466
J_new = 3.6751
J_new = 3.6678
J_new = 3.6661
J_new = 3.6544
J_new = 3.6439
J_new = 3.6431
J_new = 3.6409
J_new = 3.6386
J_new = 3.6384
J_new = 3.6384
Mean value of sigma: 0.18717
Minimum value of sigma: 0.11115
Maximum value of sigma: 0.27474
Iteration 10: error is 40.0532
Iteration 20: error is 38.7881
Iteration 30: error is 38.4032
Iteration 40: error is 38.9906
Iteration 50: error is 39.4356
Iteration 60: error is 38.9883
Iteration 70: error is 39.0822
Iteration 80: error is 39.374
Iteration 90: error is 39.5842
Iteration 100: error is 2.7931
Iteration 110: error is 1.5437
Iteration 120: error is 0.95182
Iteration 130: error is 0.84007
Iteration 140: error is 0.80718
Iteration 150: error is 0.78285
Iteration 160: error is 0.77307
Iteration 170: error is 0.75964
Iteration 180: error is 0.75131
Iteration 190: error is 0.74695
Iteration 200: error is 0.7438
Iteration 210: error is 0.74115
Iteration 220: error is 0.73934
Iteration 230: error is 0.73753
Iteration 240: error is 0.73579
Iteration 250: error is 0.73461
Iteration 260: error is 0.73263
Iteration 270: error is 0.73058
Iteration 280: error is 0.72909
Iteration 290: error is 0.72799
Iteration 300: error is 0.72714
Iteration 310: error is 0.72648
Iteration 320: error is 0.72598
Iteration 330: error is 0.72559
Iteration 340: error is 0.72528
Iteration 350: error is 0.72503
Iteration 360: error is 0.72483
Iteration 370: error is 0.72467
Iteration 380: error is 0.72453
Iteration 390: error is 0.72442
Iteration 400: error is 0.72433
Iteration 410: error is 0.72426
Iteration 420: error is 0.72419
Iteration 430: error is 0.72413
Iteration 440: error is 0.72409
Iteration 450: error is 0.72405
```

```
Iteration 460: error is 0.72401
Iteration 470: error is 0.72398
Iteration 480: error is 0.72396
Iteration 490: error is 0.72393
Iteration 500: error is 0.72391
Iteration 510: error is 0.7239
Iteration 520: error is 0.72388
Iteration 530: error is 0.72387
Iteration 540: error is 0.72386
Iteration 550: error is 0.72385
Iteration 560: error is 0.72384
Iteration 570: error is 0.72383
Iteration 580: error is 0.72383
Iteration 590: error is 0.72382
Iteration 600: error is 0.72382
Iteration 610: error is 0.72381
Iteration 620: error is 0.72381
Iteration 630: error is 0.72381
Iteration 640: error is 0.7238
Iteration 650: error is 0.7238
Iteration 660: error is 0.7238
Iteration 670: error is 0.72379
Iteration 680: error is 0.72379
Iteration 690: error is 0.72379
Iteration 700: error is 0.72378
Iteration 710: error is 0.72377
Iteration 720: error is 0.72371
Iteration 730: error is 0.72291
Iteration 740: error is 0.72132
Iteration 750: error is 0.72082
Iteration 760: error is 0.72143
Iteration 770: error is 0.71776
Iteration 780: error is 0.71549
Iteration 790: error is 0.71483
Iteration 800: error is 0.7147
Iteration 810: error is 0.71466
Iteration 820: error is 0.71464
Iteration 830: error is 0.71464
Iteration 840: error is 0.71464
Iteration 850: error is 0.71464
Iteration 860: error is 0.71464
Iteration 870: error is 0.71464
Iteration 880: error is 0.71464
Iteration 890: error is 0.71464
Iteration 900: error is 0.71464
Iteration 910: error is 0.71464
Iteration 920: error is 0.71464
Iteration 930: error is 0.71464
Iteration 940: error is 0.71464
Iteration 950: error is 0.71464
Iteration 960: error is 0.71464
Iteration 970: error is 0.71464
Iteration 980: error is 0.71464
Iteration 990: error is 0.71464
Iteration 1000: error is 0.71464
J_new = 3.6670
J_new = 3.6487
J_new = 3.6396
J_new = 3.6388
J_new = 3.6363
J_new = 3.6341
J_new = 3.6339
J_new = 3.6339
Mean value of sigma: 0.18717
Minimum value of sigma: 0.11115
```

Maximum value of sigma: 0.27474
Iteration 10: error is 40.5323
Iteration 20: error is 38.6387
Iteration 30: error is 38.1761
Iteration 40: error is 38.5269
Iteration 50: error is 38.7793
Iteration 60: error is 39.3043
Iteration 70: error is 39.1559
Iteration 80: error is 39.4385
Iteration 90: error is 39.4235
Iteration 100: error is 2.6954
Iteration 110: error is 1.4222
Iteration 120: error is 0.98975
Iteration 130: error is 0.86307
Iteration 140: error is 0.82074
Iteration 150: error is 0.79573
Iteration 160: error is 0.77956
Iteration 170: error is 0.76958
Iteration 180: error is 0.7593
Iteration 190: error is 0.74818
Iteration 200: error is 0.74221
Iteration 210: error is 0.73825
Iteration 220: error is 0.73574
Iteration 230: error is 0.73303
Iteration 240: error is 0.72803
Iteration 250: error is 0.72513
Iteration 260: error is 0.72135
Iteration 270: error is 0.71796
Iteration 280: error is 0.71558
Iteration 290: error is 0.71345
Iteration 300: error is 0.71185
Iteration 310: error is 0.71065
Iteration 320: error is 0.7098
Iteration 330: error is 0.70919
Iteration 340: error is 0.70849
Iteration 350: error is 0.70714
Iteration 360: error is 0.70664
Iteration 370: error is 0.70629
Iteration 380: error is 0.70605
Iteration 390: error is 0.70585
Iteration 400: error is 0.70568
Iteration 410: error is 0.70552
Iteration 420: error is 0.70536
Iteration 430: error is 0.70508
Iteration 440: error is 0.70419
Iteration 450: error is 0.70339
Iteration 460: error is 0.70309
Iteration 470: error is 0.70274
Iteration 480: error is 0.70258
Iteration 490: error is 0.70251
Iteration 500: error is 0.70248
Iteration 510: error is 0.70245
Iteration 520: error is 0.70243
Iteration 530: error is 0.70241
Iteration 540: error is 0.7024
Iteration 550: error is 0.70238
Iteration 560: error is 0.70237
Iteration 570: error is 0.70236
Iteration 580: error is 0.70235
Iteration 590: error is 0.70234
Iteration 600: error is 0.70233
Iteration 610: error is 0.70232
Iteration 620: error is 0.70232
Iteration 630: error is 0.70231
Iteration 640: error is 0.70231

```

Iteration 650: error is 0.7023
Iteration 660: error is 0.7023
Iteration 670: error is 0.7023
Iteration 680: error is 0.70229
Iteration 690: error is 0.70229
Iteration 700: error is 0.70229
Iteration 710: error is 0.70229
Iteration 720: error is 0.70229
Iteration 730: error is 0.70228
Iteration 740: error is 0.70228
Iteration 750: error is 0.70228
Iteration 760: error is 0.70228
Iteration 770: error is 0.70228
Iteration 780: error is 0.70228
Iteration 790: error is 0.70228
Iteration 800: error is 0.70228
Iteration 810: error is 0.70228
Iteration 820: error is 0.70228
Iteration 830: error is 0.70228
Iteration 840: error is 0.70228
Iteration 850: error is 0.70228
Iteration 860: error is 0.70228
Iteration 870: error is 0.70227
Iteration 880: error is 0.70227
Iteration 890: error is 0.70227
Iteration 900: error is 0.70227
Iteration 910: error is 0.70227
Iteration 920: error is 0.70227
Iteration 930: error is 0.70227
Iteration 940: error is 0.70227
Iteration 950: error is 0.70227
Iteration 960: error is 0.70227
Iteration 970: error is 0.70227
Iteration 980: error is 0.70227
Iteration 990: error is 0.70227
Iteration 1000: error is 0.70227
J_new = 3.7057
J_new = 3.6985
J_new = 3.6879
J_new = 3.6845
J_new = 3.6740
J_new = 3.6731
J_new = 3.6698
J_new = 3.6667
J_new = 3.6578
J_new = 3.6465
J_new = 3.6392
J_new = 3.6383
J_new = 3.6363
J_new = 3.6341
J_new = 3.6339
J_new = 3.6339
E_best = 0.7571

```

Iteration	Func-count	f(x)	Step-size	First-order optimality
0	1	3.63523		0.00013
1	8	3.58394	32054.8	0.00186
2	10	3.57643	0.44598	0.0013
3	12	3.56578	0.280039	0.000851
4	13	3.56093	1	0.000829
5	14	3.557	1	0.000726
6	16	3.55523	0.328736	0.0006
7	17	3.55417	1	0.000641
8	18	3.55233	1	0.000573
9	19	3.55128	1	0.0006

10	20	3.55024	1	0.000317
11	21	3.54936	1	0.000454
12	22	3.54868	1	0.000912
13	23	3.54747	1	0.000386
14	24	3.54727	1	0.000411
15	25	3.54666	1	0.000318
16	26	3.54634	1	0.000169
17	27	3.54594	1	0.000192
18	28	3.54564	1	0.000284
19	29	3.54542	1	0.000192
First-order				
Iteration	Func-count	f(x)	Step-size	optimality
20	30	3.54525	1	0.000183
21	31	3.54506	1	8.45e-05
22	32	3.5449	1	0.000191
23	33	3.54475	1	0.000171
24	34	3.54463	1	8.5e-05
25	35	3.54457	1	0.000102
26	36	3.54447	1	6.49e-05
27	37	3.5444	1	7.56e-05
28	38	3.54435	1	6.16e-05
29	39	3.5443	1	6.58e-05
30	40	3.54427	1	4.22e-05
31	41	3.54425	1	4.16e-05
32	42	3.54423	1	5.91e-05
33	43	3.54421	1	3.74e-05
34	44	3.5442	1	2.68e-05
35	45	3.54418	1	2.88e-05
36	46	3.54416	1	6.2e-05
37	47	3.54414	1	4.34e-05
38	48	3.54412	1	5.59e-05
39	49	3.5441	1	5.72e-05
First-order				
Iteration	Func-count	f(x)	Step-size	optimality
40	50	3.54408	1	3.6e-05
41	51	3.54408	1	1.8e-05
42	52	3.54407	1	2.88e-05
43	53	3.54407	1	1.45e-05
44	54	3.54407	1	1.65e-05
45	55	3.54406	1	1.76e-05
46	56	3.54406	1	8.4e-06
47	57	3.54406	1	1.35e-05
48	58	3.54406	1	7.13e-06
49	59	3.54406	1	1.09e-05
50	60	3.54406	1	5.61e-06
51	61	3.54406	1	6.5e-06
52	62	3.54406	1	1.95e-05
53	63	3.54405	1	1.09e-05
54	64	3.54405	1	1.1e-05
55	65	3.54405	1	1.01e-05
56	66	3.54405	1	1.2e-05
57	67	3.54404	1	1.24e-05
58	68	3.54404	1	1.15e-05
59	69	3.54404	1	1.05e-05
First-order				
Iteration	Func-count	f(x)	Step-size	optimality
60	70	3.54404	1	8.85e-06
61	71	3.54403	1	6.69e-06
62	72	3.54403	1	4.86e-06
63	73	3.54403	1	3.54e-06
64	74	3.54403	1	3.19e-06
65	75	3.54403	1	2.5e-06
66	76	3.54403	1	2.17e-06
67	77	3.54403	1	1.96e-06
68	78	3.54403	1	1.88e-06

69	79	3.54403	1	1.46e-06
70	80	3.54403	1	2.03e-06
71	81	3.54403	1	2.05e-06
72	82	3.54403	1	1.64e-06
73	83	3.54403	1	2.05e-06
74	84	3.54403	1	2.3e-06
75	85	3.54403	1	1.94e-06
76	86	3.54403	1	2.58e-06
77	87	3.54403	1	2.21e-06
78	88	3.54403	1	2.22e-06
79	89	3.54403	1	2.03e-06
First-order				
Iteration	Func-count	f(x)	Step-size	optimality
80	90	3.54403	1	2.86e-06
81	91	3.54403	1	3.26e-06
82	92	3.54403	1	3.61e-06
83	93	3.54403	1	4.12e-06
84	94	3.54403	1	4.06e-06
85	95	3.54403	1	5.39e-06
86	96	3.54403	1	5.1e-06
87	97	3.54402	1	3.74e-06
88	98	3.54402	1	2.52e-06
89	99	3.54402	1	3.36e-06
90	100	3.54402	1	3.72e-06
91	101	3.54402	1	2.32e-06
92	102	3.54402	1	2.82e-06
93	103	3.54402	1	5.28e-06
94	104	3.54402	1	7.08e-06
95	105	3.54402	1	7.39e-06
96	106	3.54402	1	6.21e-06
97	107	3.54402	1	4.99e-06
98	108	3.54402	1	3.44e-06
99	109	3.54402	1	2.66e-06
First-order				
Iteration	Func-count	f(x)	Step-size	optimality
100	110	3.54402	1	3.53e-06
101	111	3.54402	1	3.37e-06
102	112	3.54402	1	3.17e-06
103	113	3.54402	1	1.72e-06
104	114	3.54402	1	1.64e-06
105	115	3.54402	1	2.34e-06
106	116	3.54401	1	1.84e-06
107	117	3.54401	1	1.67e-06
108	118	3.54401	1	1.49e-06
109	119	3.54401	1	1.54e-06
110	120	3.54401	1	1.21e-06
111	121	3.54401	1	1.09e-06
112	122	3.54401	1	9.01e-07

Optimization completed: The first-order optimality measure, 9.008008e-07, is less than options.OptimalityTolerance = 1.000000e-06.

Elapsed time is 1.963829 seconds.

toc;

Elapsed time is 1.966771 seconds.

Visualization of Results

```
rng(1)
class_order = Output.class_order;
H = Output.H;
```

```

data_perm = Output.data_perm;

k = par.K_cluster;
colors_class = brewermap(k,'set1');
choice_distance = 'cosine';
Dist = squareform(pdist (data_perm,choice_distance));
ydata = tsne_d(Dist,[],[],40);

```

```

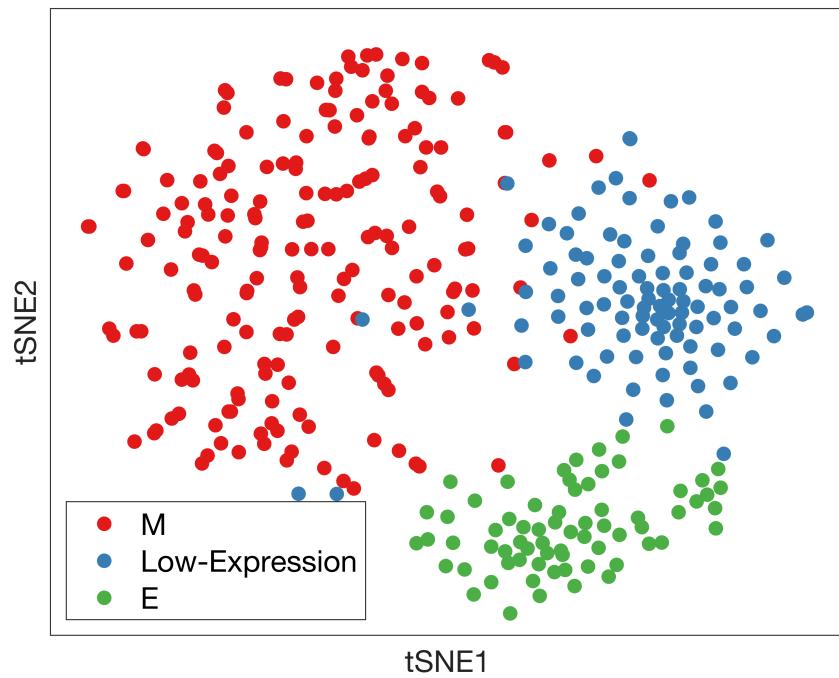
Mean value of sigma: 0.20095
Minimum value of sigma: 0.1177
Maximum value of sigma: 0.28366
Iteration 10: error is 39.3603
Iteration 20: error is 38.4097
Iteration 30: error is 38.4984
Iteration 40: error is 38.8211
Iteration 50: error is 38.7838
Iteration 60: error is 39.2535
Iteration 70: error is 38.7153
Iteration 80: error is 39.4146
Iteration 90: error is 39.2564
Iteration 100: error is 2.3223
Iteration 110: error is 1.3942
Iteration 120: error is 0.90064
Iteration 130: error is 0.77604
Iteration 140: error is 0.74845
Iteration 150: error is 0.73867
Iteration 160: error is 0.73347
Iteration 170: error is 0.72971
Iteration 180: error is 0.72636
Iteration 190: error is 0.72435
Iteration 200: error is 0.72285
Iteration 210: error is 0.7217
Iteration 220: error is 0.72061
Iteration 230: error is 0.71962
Iteration 240: error is 0.71866
Iteration 250: error is 0.71775
Iteration 260: error is 0.71395
Iteration 270: error is 0.71075
Iteration 280: error is 0.70473
Iteration 290: error is 0.699
Iteration 300: error is 0.68419
Iteration 310: error is 0.68065
Iteration 320: error is 0.6796
Iteration 330: error is 0.67939
Iteration 340: error is 0.67796
Iteration 350: error is 0.67617
Iteration 360: error is 0.67341
Iteration 370: error is 0.67013
Iteration 380: error is 0.66883
Iteration 390: error is 0.66777
Iteration 400: error is 0.66797
Iteration 410: error is 0.66757
Iteration 420: error is 0.66752
Iteration 430: error is 0.66751
Iteration 440: error is 0.66744
Iteration 450: error is 0.66747
Iteration 460: error is 0.66744
Iteration 470: error is 0.66742
Iteration 480: error is 0.66743
Iteration 490: error is 0.66741
Iteration 500: error is 0.6674
Iteration 510: error is 0.66739
Iteration 520: error is 0.66739

```

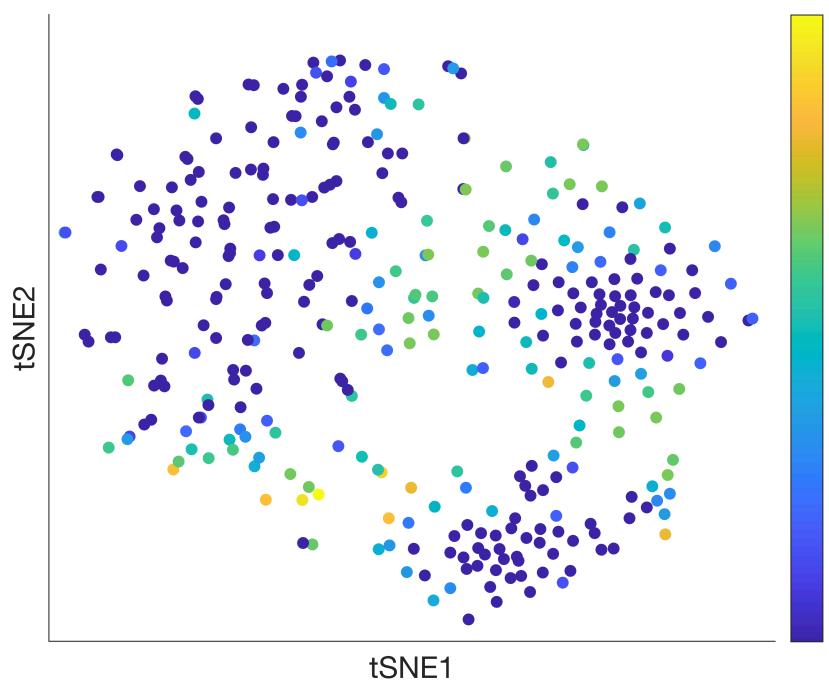
```
Iteration 530: error is 0.66739
Iteration 540: error is 0.66739
Iteration 550: error is 0.66739
Iteration 560: error is 0.66739
Iteration 570: error is 0.66739
Iteration 580: error is 0.66738
Iteration 590: error is 0.66738
Iteration 600: error is 0.66738
Iteration 610: error is 0.66738
Iteration 620: error is 0.66738
Iteration 630: error is 0.66738
Iteration 640: error is 0.66738
Iteration 650: error is 0.66738
Iteration 660: error is 0.66738
Iteration 670: error is 0.66737
Iteration 680: error is 0.66737
Iteration 690: error is 0.66737
Iteration 700: error is 0.66737
Iteration 710: error is 0.66737
Iteration 720: error is 0.66737
Iteration 730: error is 0.66737
Iteration 740: error is 0.66737
Iteration 750: error is 0.66737
Iteration 760: error is 0.66737
Iteration 770: error is 0.66737
Iteration 780: error is 0.66737
Iteration 790: error is 0.66737
Iteration 800: error is 0.66737
Iteration 810: error is 0.66737
Iteration 820: error is 0.66737
Iteration 830: error is 0.66737
Iteration 840: error is 0.66737
Iteration 850: error is 0.66737
Iteration 860: error is 0.66737
Iteration 870: error is 0.66737
Iteration 880: error is 0.66737
Iteration 890: error is 0.66737
Iteration 900: error is 0.66737
Iteration 910: error is 0.66737
Iteration 920: error is 0.66737
Iteration 930: error is 0.66737
Iteration 940: error is 0.66737
Iteration 950: error is 0.66737
Iteration 960: error is 0.66737
Iteration 970: error is 0.66737
Iteration 980: error is 0.66737
Iteration 990: error is 0.66737
Iteration 1000: error is 0.66737
```

```
score = ydata;

% MuTrans attractors
figure;
gscatter(score(:,1),score(:,2),class_order,colors_class,[],25);
set(gca,'xtick',[])
set(gca,'ytick',[])
legend({'M','Low-Expression','E'},'Fontsize',15,'Location','SouthWest')
xlabel('tSNE1','Fontsize',15)
ylabel('tSNE2','Fontsize',15)
```

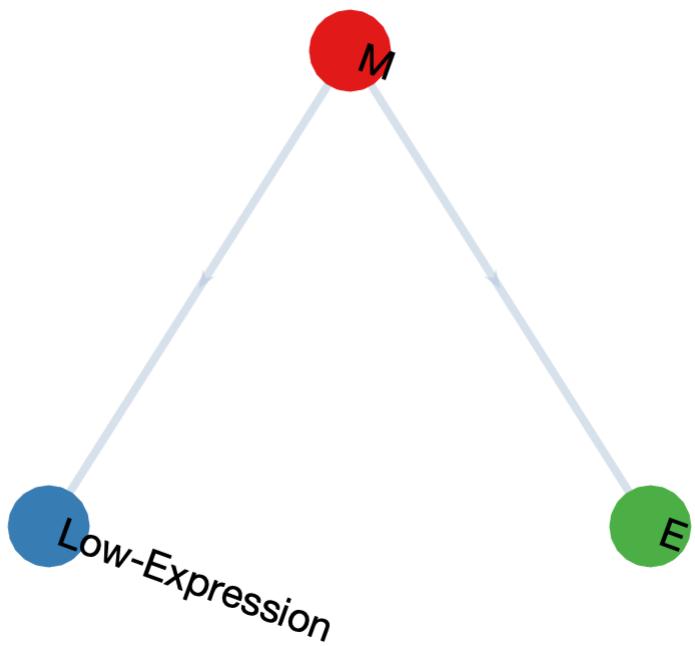


```
% Entropy of transition cells
figure;
scatter(score(:,1),score(:,2),[],H,'filled');
set(gca,'xtick',[])
set(gca,'ytick',[])
colorbar('Ticks',[]);
xlabel('tSNE1','Fontsize',15)
ylabel('tSNE2','Fontsize',15)
```



Infer the Cell Lineage (MPFT)

```
par.legend_text = {'M', 'Low-Expression', 'E'}; %can also specify root by specifying par.root  
InferLineage(Output, par)
```



To infer the MPPT (transition trajectory), we recommend to use the python package in the new version of MuTrans.

Cell-fate Landscape Visualization

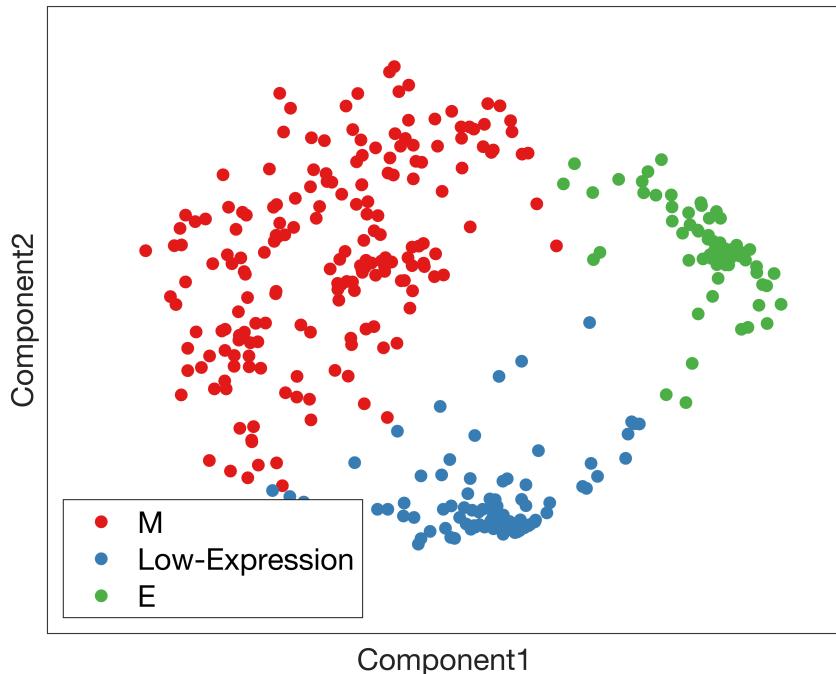
2d Projection

```
P_perm = Output.P_perm;
P_rho = Output.P_rho;

w = 0.5;
P_w = w*P_perm+(1-w)*P_rho;
par.dims = 5;
par.isomap_kn = 50;
score_2d = SC_forced2d (P_w,par);
```

Constructing neighborhood graph...
Computing shortest paths...
Constructing low-dimensional embedding...

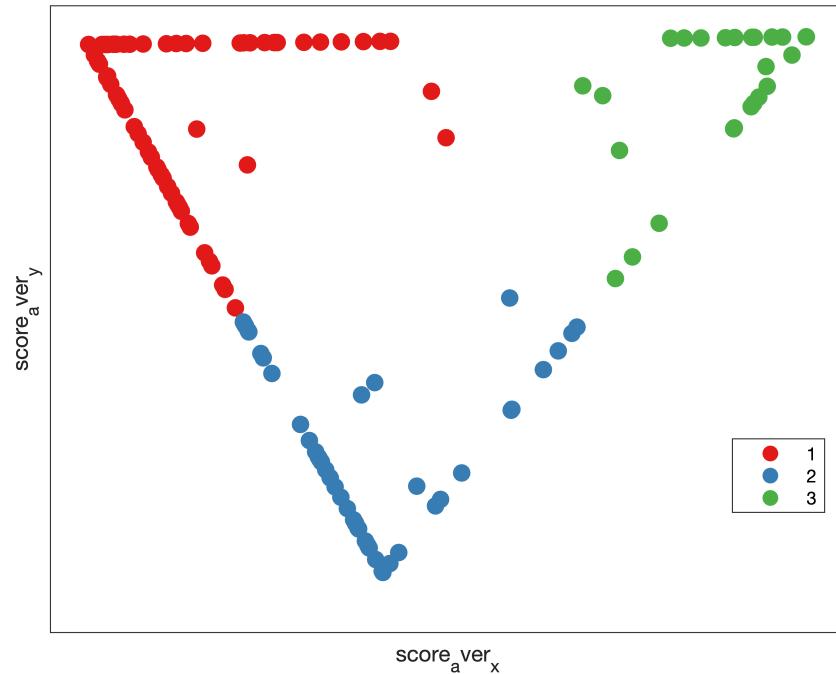
```
figure;
class_order = Output.class_order;
gscatter(score_2d(:,1),score_2d(:,2),class_order,colors_class,[],22);
legend({'M','Low-Expression','E'},'Fontsize',15,'Location','SouthWest')
set(gca,'xtick',[],'ytick',[]);
xlabel('Component1','Fontsize',15)
ylabel('Component2','Fontsize',15)
```



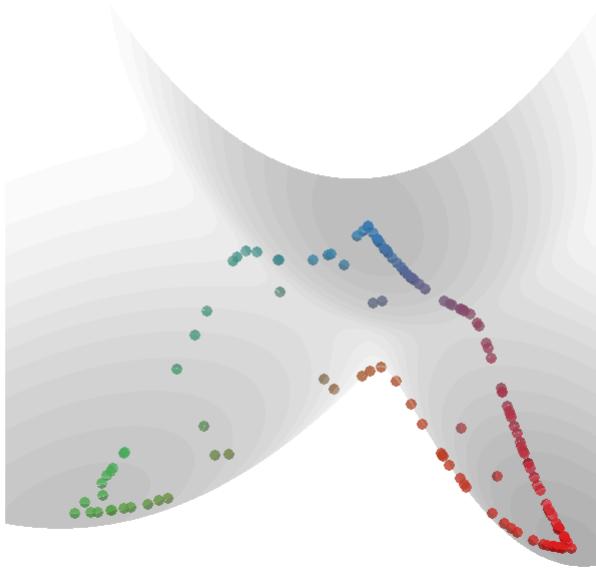
```
Output.embedding_2d = score_2d;
```

Landscape Construction

```
par.legend_text = {'M', 'Low-Expression', 'E'};  
par.colors = colors_class ;  
par.mksize = 30;  
land = ConstructLandscape (Output, par);
```



```
view([180 60])
```

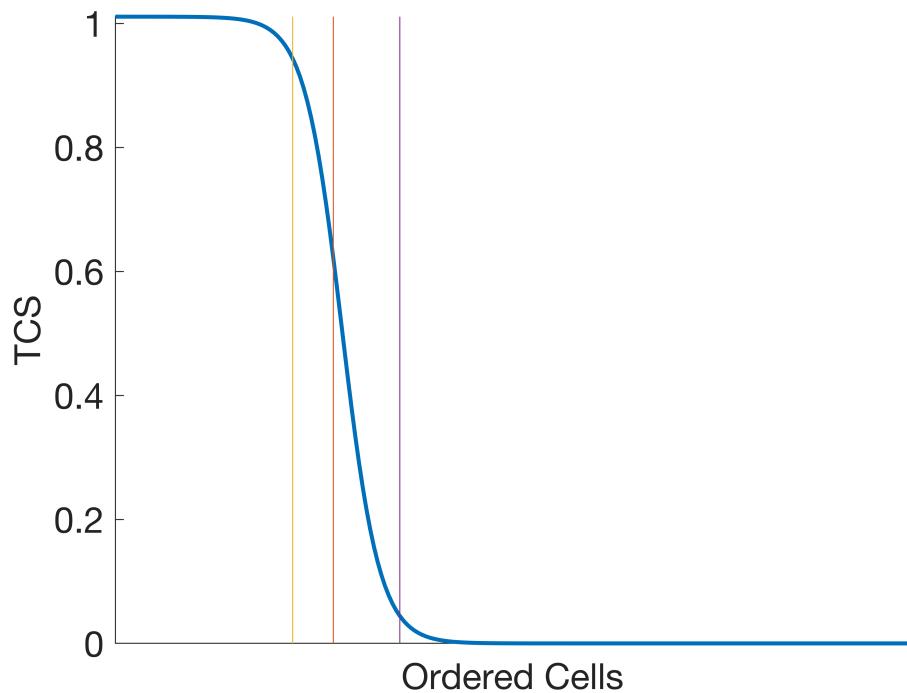


Transition Gene Analysis

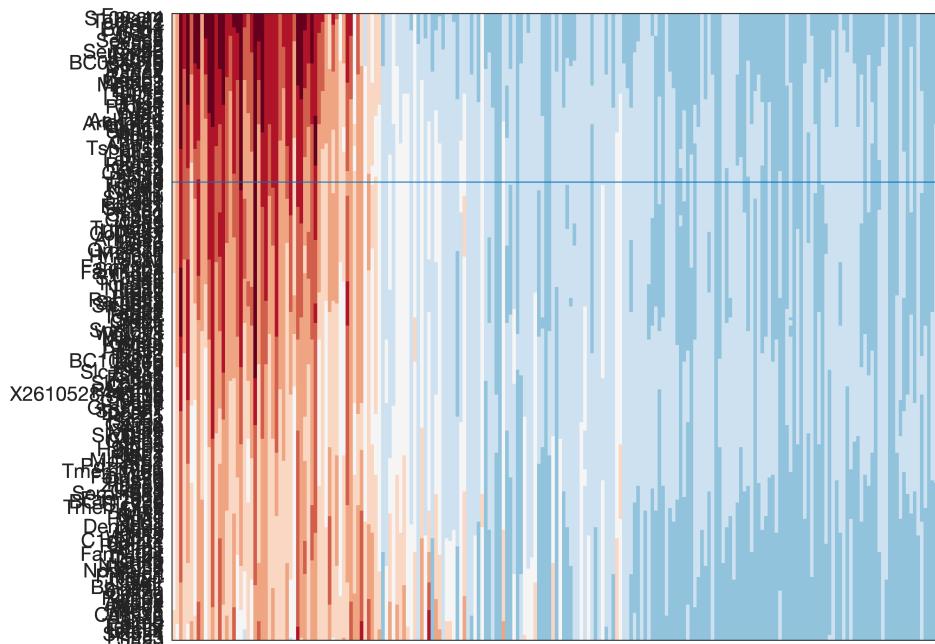
```
labs_perm = Output.labs_perm;
par.display_genes_label = true;
par.display_mixing_id = false;
par.genes = genes;
par.thresh_de_pvalues = 1e-3;
par.thresh_ms_pvalues = 1e-4;
par.flip = false;
```

Direct transition from E to M

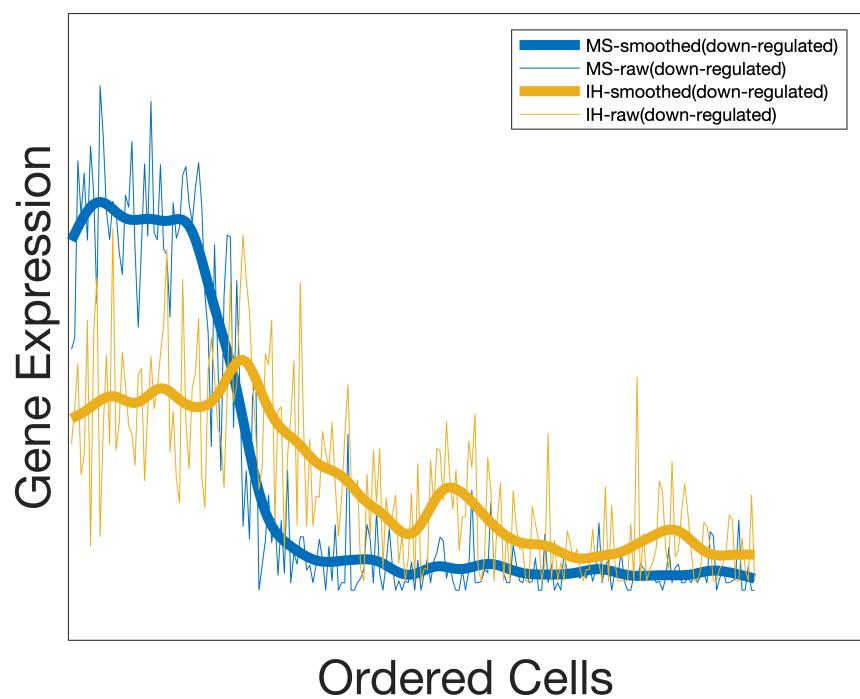
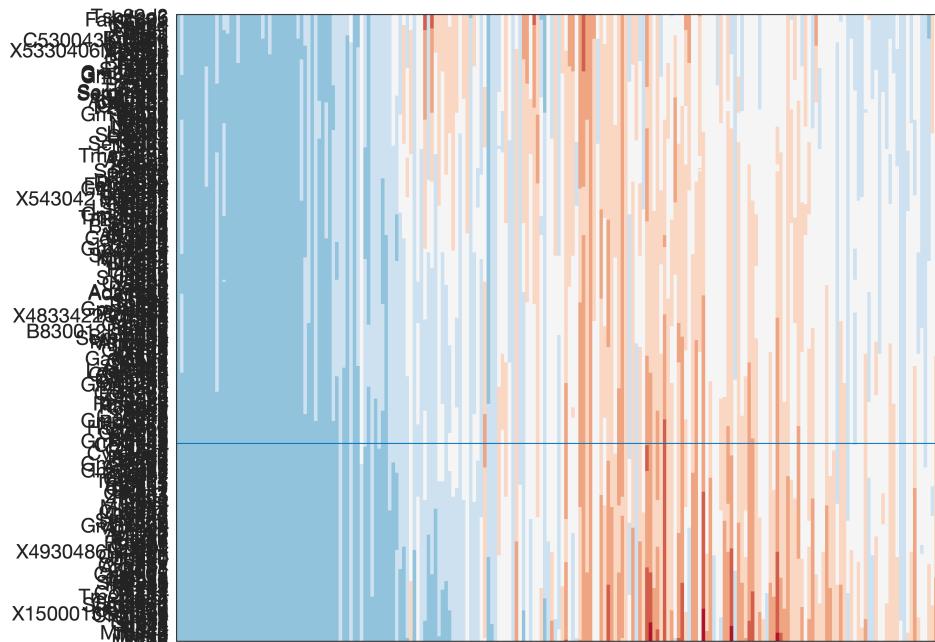
```
genes_analysis_out_direct = GeneAnalysis(3, 1, Output, par);
```

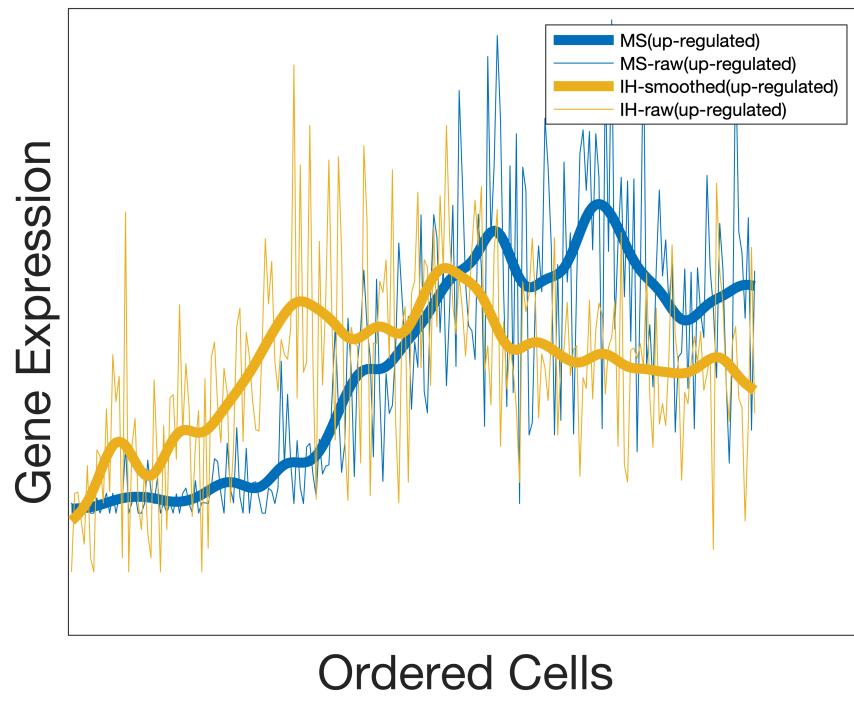


Below is the heatmap of down-regulated MS/IH genes



Below is the heatmap of up-regulated MS/IH genes





Find the list of MS genes in E state

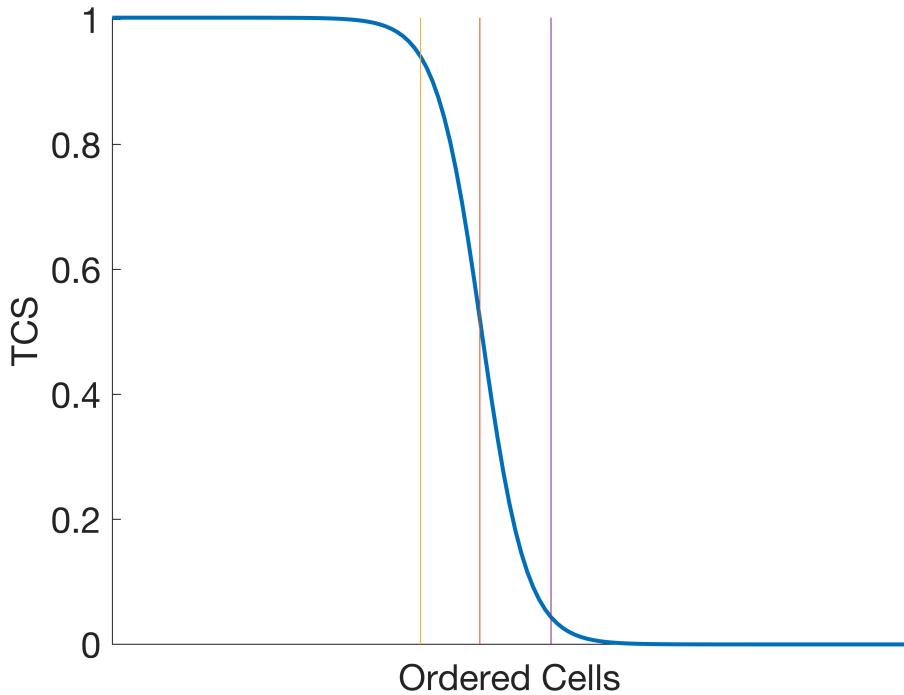
```
disp(genes_analysis_out_direct.genes_ms_g1)
```

```
{'Epcam'      }
{'S100a14'    }
{'Tacstd2'    }
{'Cdh1'       }
{'Krt17'      }
{'Fgfbp1'     }
{'Tnf'        }
{'Prss22'     }
{'Dsg3'       }
{'Serinc2'    }
{'Ctsh'       }
{'Fxyd3'     }
{'Gpx2'       }
{'Serpincb5'}
{'Bcam'       }
{'Lypd3'      }
{'Cstb'       }
{'BC064078'}
{'Sox15'      }
{'Trim29'     }
{'Eya2'       }
{'Cldn4'      }
{'Rab25'      }
{'Cdcp1'      }
{'Lamb3'      }
{'Mfsd2a'     }
{'Efna1'      }
{'Dmkn'       }
{'Il117re'    }
{'Il11a'      }
{'Lamc2'      }
```

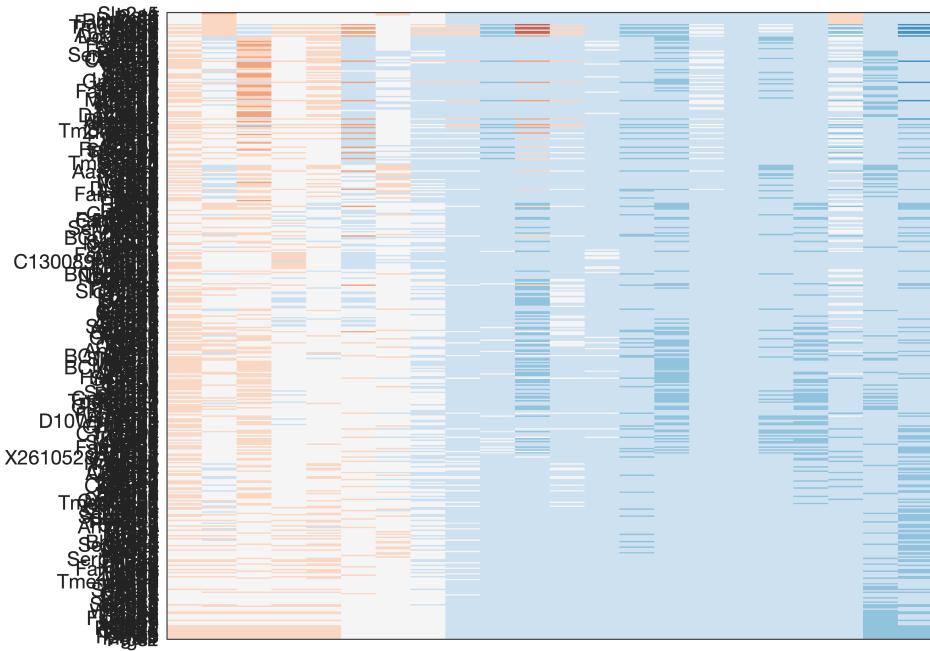
```
{'Perp'      }
{'Tns4'      }
{'Ptprz1'    }
{'Ehf'       }
{'Vwa1'      }
{'Fgfr3'     }
{'Ptprf'     }
{'Ankrd22'   }
{'Arhgef16'}
{'Ckmt1'     }
{'Rab15'     }
{'Spint2'    }
{'Itgb6'     }
{'Krt6a'     }
{'Il1rn'     }
{'Car12'     }
{'Apoc1'     }
{'Tspan12'   }
{'Urah'      }
{'Il24'      }
{'Krt5'      }
{'Lama3'     }
{'Pitx1'     }
{'Parm1'     }
{'Cldn8'     }
{'Krt14'     }
{'Calml3'    }
{'Sfn'       }
{'Pinlyp'    }
{'Aqp3'      }
```

transition from E to LE

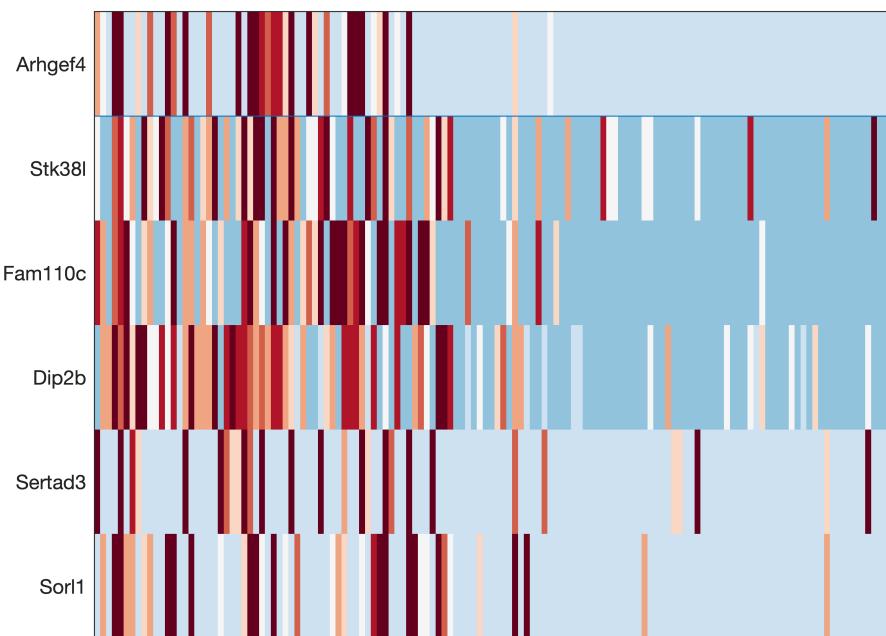
```
genes_analysis_out_indirect_1 = GeneAnalysis(3, 2, Output,par);
```



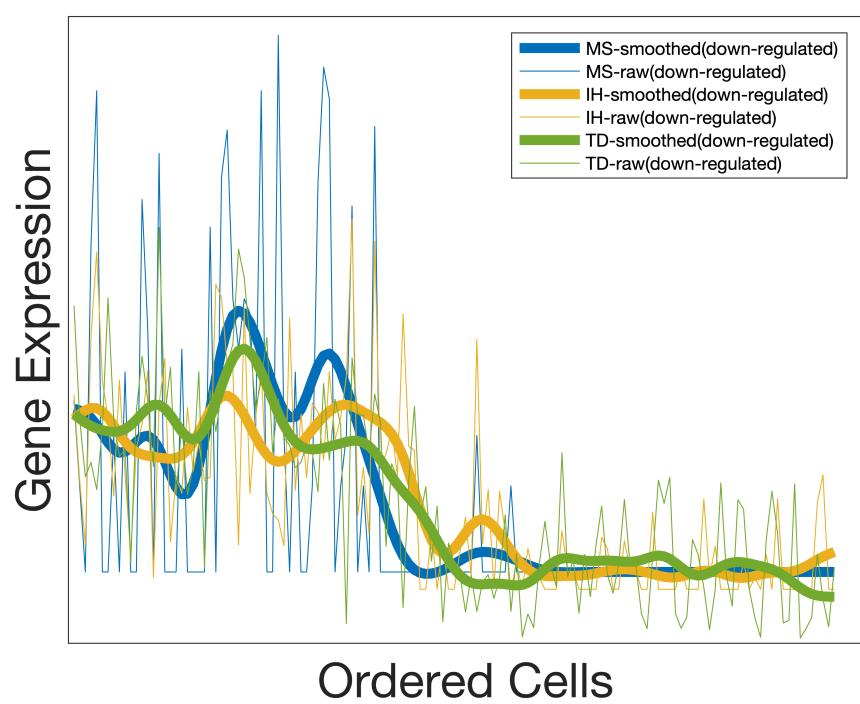
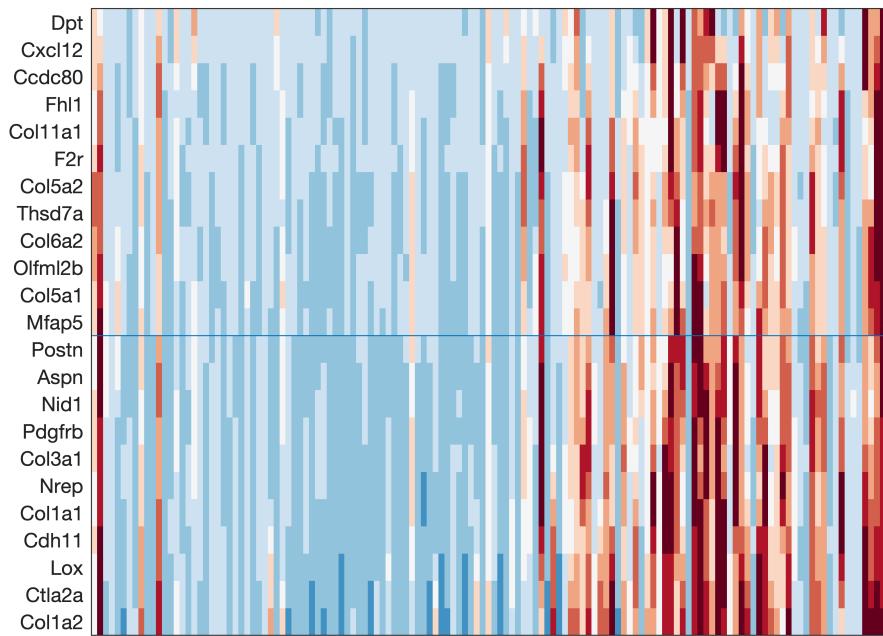
Below is the heatmap of transition genes

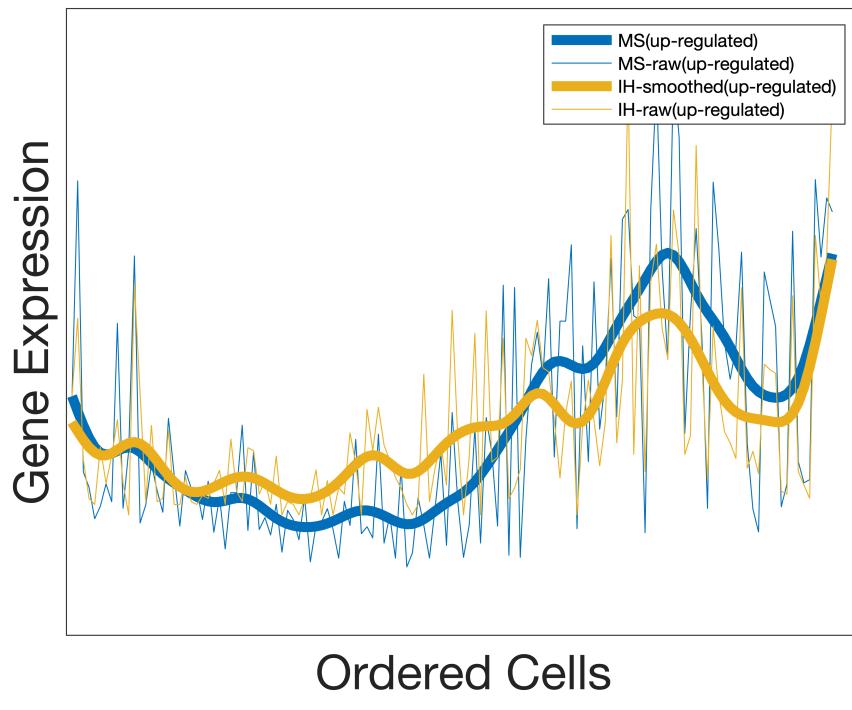


Below is the heatmap of down-regulated MS/IH genes



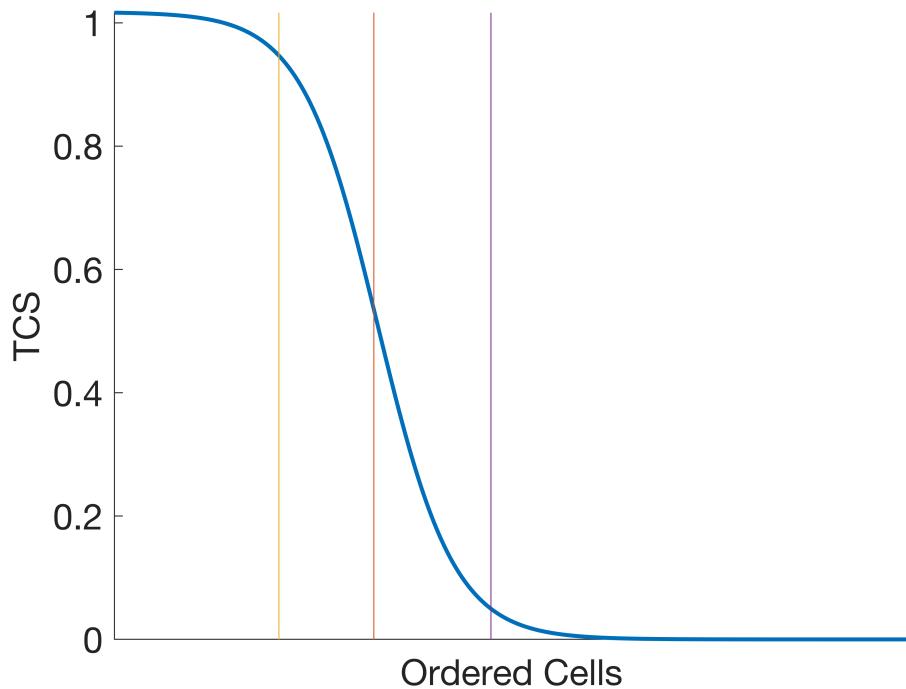
Below is the heatmap of up-regulated MS/IH genes



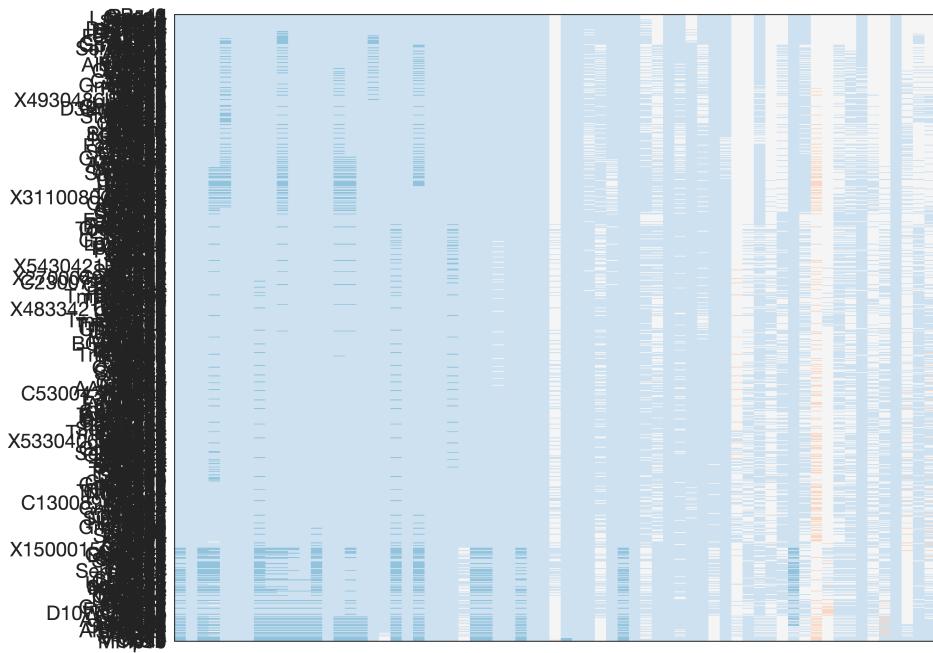


transition from LE to M

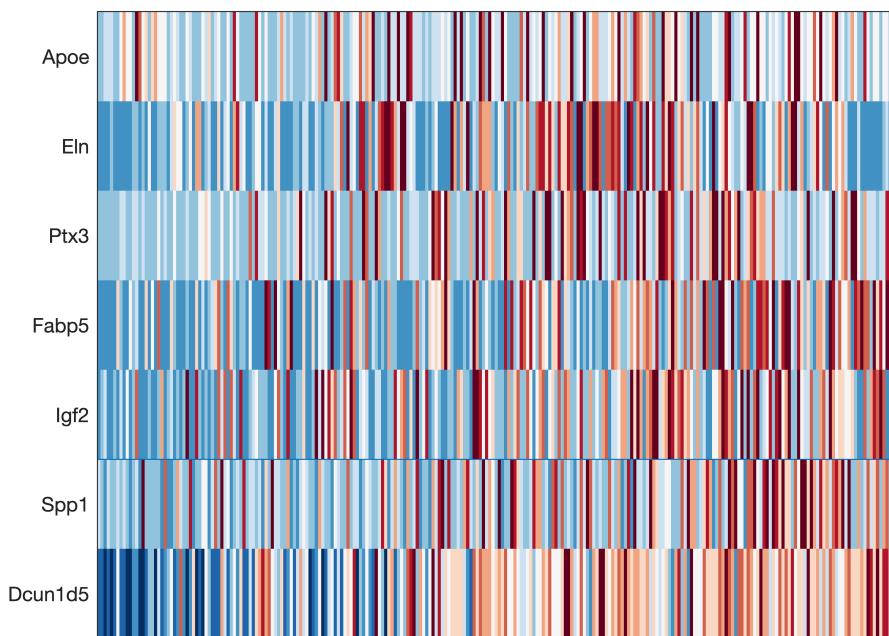
```
genes_analysis_out_indirect_2 = GeneAnalysis(2, 1, Output,par);
```

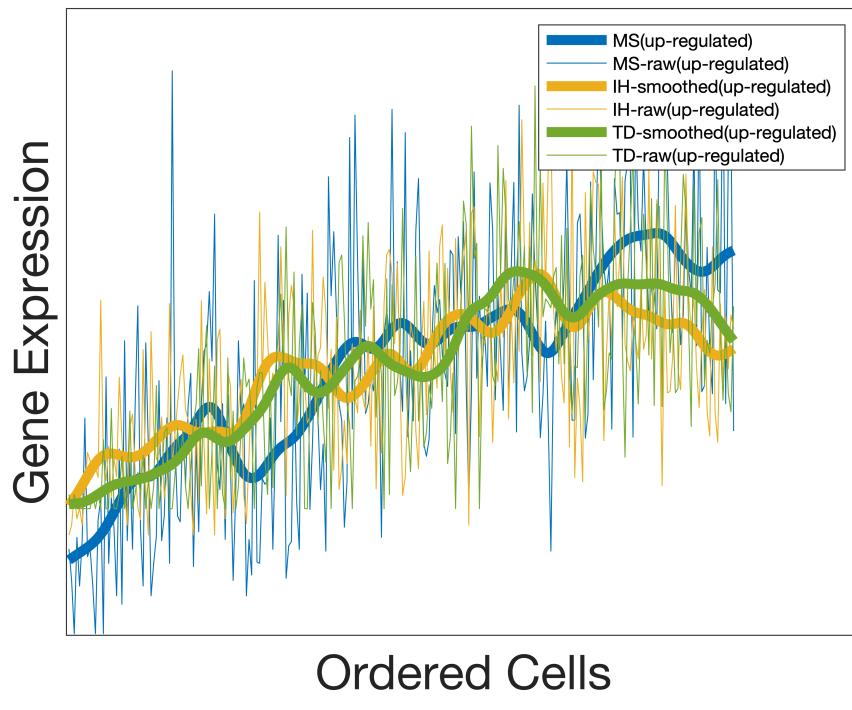


Below is the heatmap of transition genes



Below is the heatmap of up-regulated MS/IH genes





Additonal figures of MuTrans Output

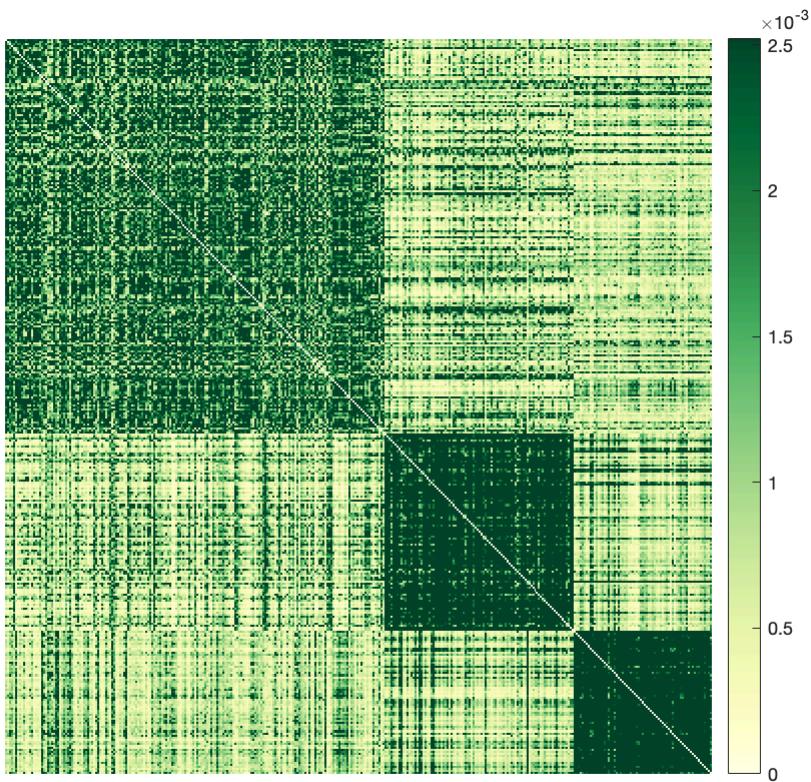
```

rho_class = Output.rho_class;
perm_class = Output.perm_class;
P_hat = Output.P_hat;
P_appr_perm = Output.P_appr_perm;
mu_hat = Output.mu_hat;
k = Output.k;
H = Output.H;

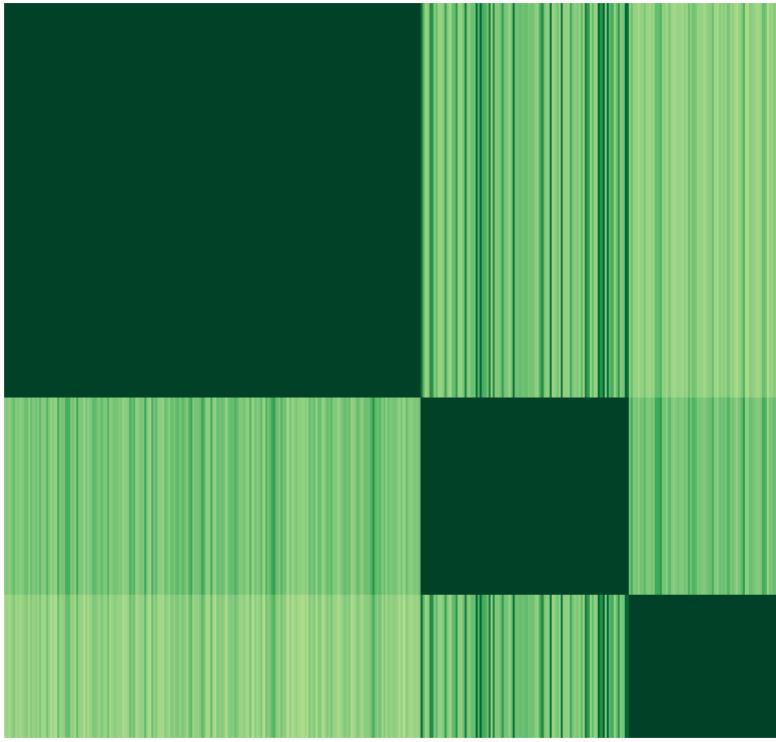
max_P = 0.2* max(max(P_rho));
c_lim = [0 max_P];
cmp = 'ylgn';

figure('rend','painters','pos',[10 10 500 450])
colormap(brewermap([],cmp))
imagesc(P_perm);
axis off
set(gca,'xtick',[],'ytick',[]);
caxis(c_lim)
colorbar;

```

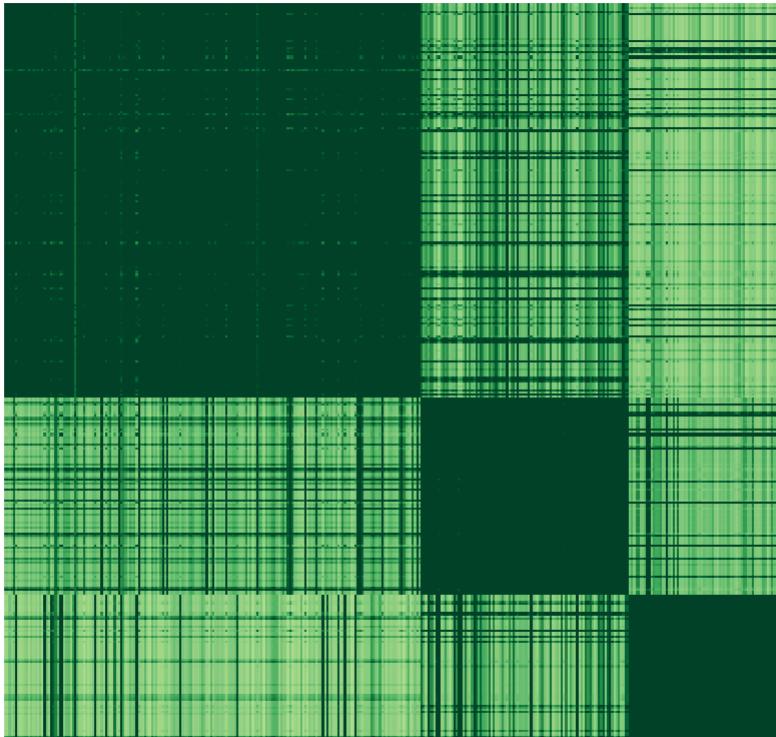


```
figure('rend','painters','pos',[10 10 500 450])
colormap(brewermap([],cmp))
imagesc(P_appr_perm);
axis off
set(gca,'xtick',[],'ytick',[]);
caxis(c_lim)
```

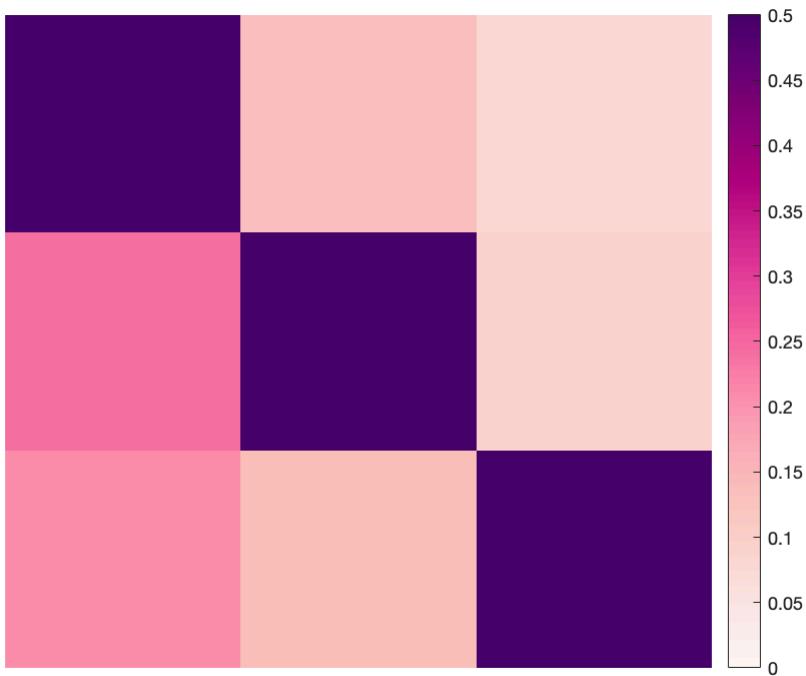


```
%colorbar;

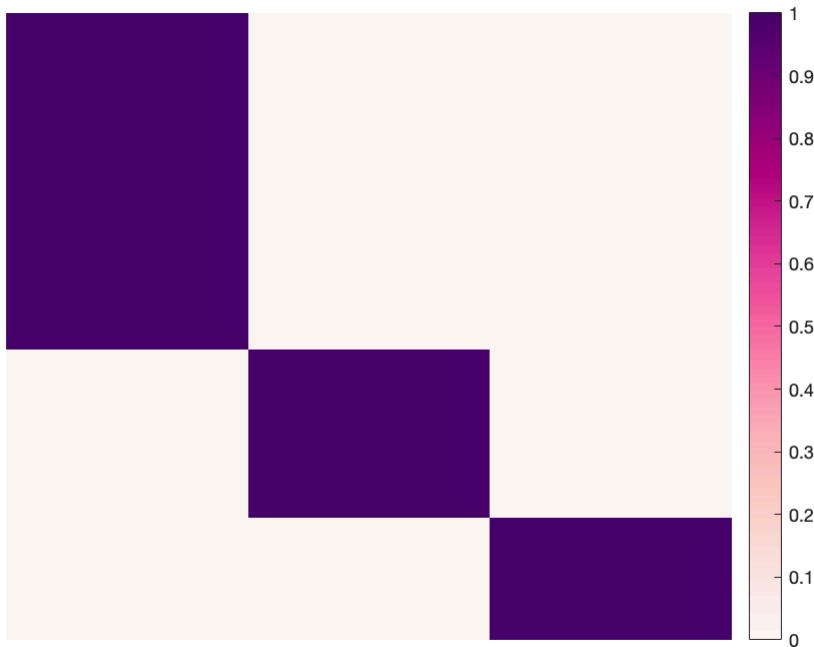
figure('rend','painters','pos',[10 10 500 450])
colormap(brewermap([],cmp))
imagesc(P_rho);
axis off
set(gca,'xtick',[],'ytick',[]);
caxis(c_lim)
%colorbar;
box off
```



```
cmp = 'rdpu';
figure('rend','painters','pos',[10 10 500 400])
colormap(brewermap([],cmp))
imagesc(P_hat);
caxis([0 0.5])
axis off
set(gca,'xtick',[],'ytick',[]);
box off
colorbar;
```



```
figure;
for id_cluster = 1:k
member(:,id_cluster) = (class_order == id_cluster)';
end
colormap(brewermap([],cmp))
imagesc(member);
caxis([0 1])
colorbar;
axis off
set(gca,'xtick',[],'ytick',[]);
box off
```



```
figure;
colormap(brewermap([],cmp))
imagesc(rho_class);
caxis([0 1])
colorbar;
axis off
set(gca,'xtick',[],'ytick',[]);
box off
```

