Random Matrix Analysis

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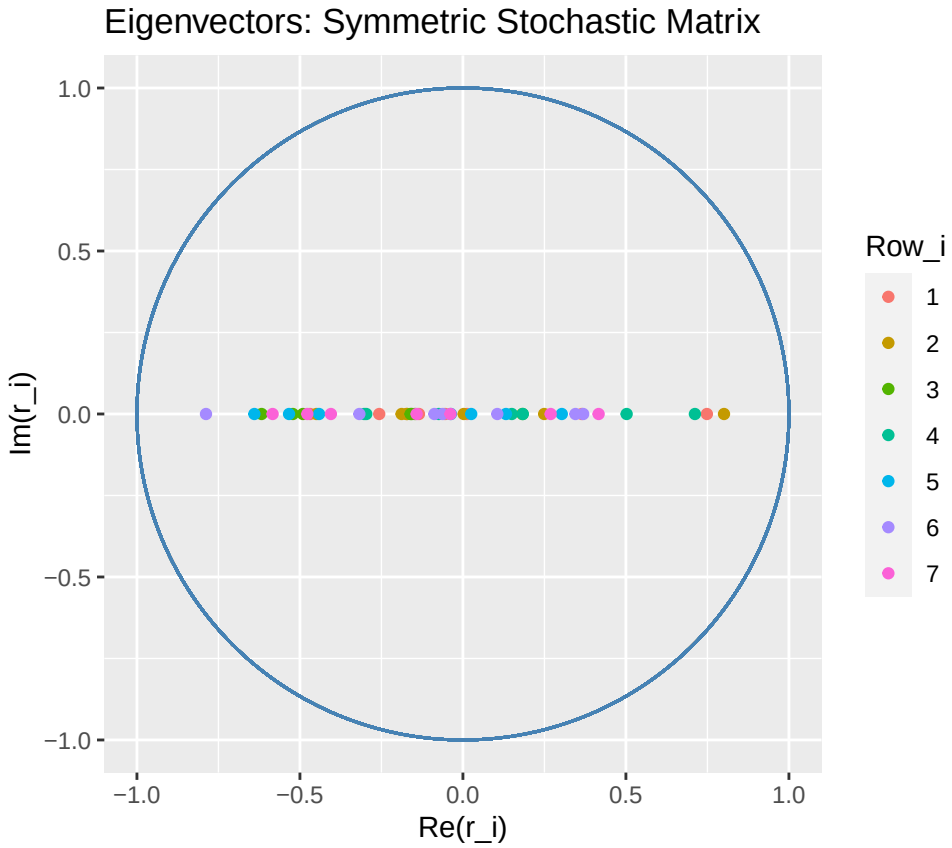
```
bool_plot <- T
M <- 7
```

```
set.seed(23)
P <- rand_M_symm_stoch(M, row_fn = r_zeros)
if(bool_plot){eigen_plot(P, loud = T, "Symmetric Stochastic")}
```

```
##          Re Im row_i
## 1  -0.13480  0     1
## 2  -0.46864  0     1
## 3   0.74843  0     1
## 4   0.36468  0     1
## 5   0.01247  0     1
## 6  -0.05449  0     1
## 7  -0.25679  0     1
## 8  -0.17150  0     2
## 9  -0.44929  0     2
## 10 -0.17258  0     2
## 11  0.24920  0     2
## 12  0.00234  0     2
## 13 -0.18814  0     2
## 14  0.80090  0     2
## 15 -0.15679  0     3
## 16 -0.52173  0     3
## 17 -0.14724  0     3
## 18 -0.49084  0     3
## 19 -0.61762  0     3
## 20  0.18272  0     3
## 21 -0.16053  0     3
## 22 -0.30293  0     4
## 23 -0.07420  0     4
## 24  0.14991  0     4
## 25 -0.29645  0     4
## 26  0.50221  0     4
## 27  0.71161  0     4
## 28  0.18375  0     4
## 29 -0.44131  0     5
## 30  0.02545  0     5
## 31  0.13205  0     5
## 32 -0.53341  0     5
## 33  0.30330  0     5
## 34 -0.63975  0     5
## 35 -0.03697  0     5
## 36 -0.78813  0     6
## 37  0.36895  0     6
```

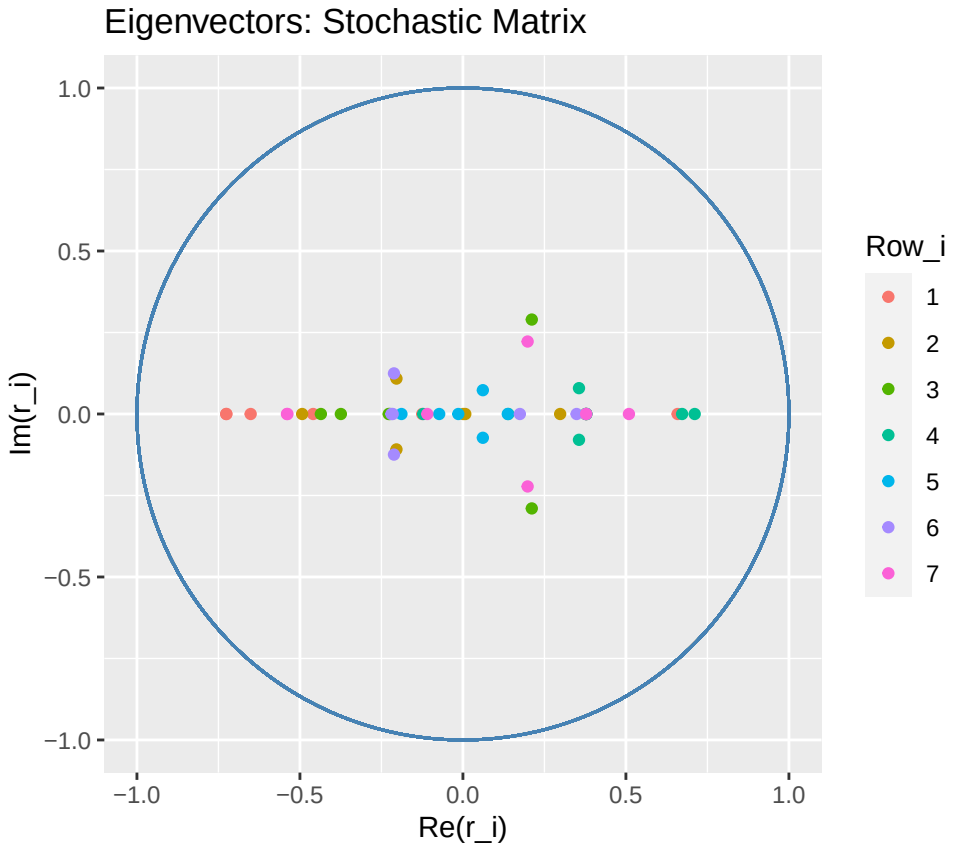
```
## 38 -0.08754  0     6
## 39  0.34518  0     6
## 40 -0.31764  0     6
## 41  0.10548  0     6
## 42 -0.06235  0     6
## 43 -0.14199  0     7
## 44 -0.40502  0     7
## 45 -0.58379  0     7
## 46  0.26912  0     7
## 47  0.41627  0     7
## 48 -0.03812  0     7
## 49 -0.47731  0     7
##            [,1]       [,2]       [,3]       [,4]       [,5]       [,6]
## [1,] 0.51140098 0.16755751 0.13000295 0.10876823 0.06878697 0.00000000
## [2,] 0.16755751 0.24059684 0.20906798 0.06077849 0.05155597 0.07298098
## [3,] 0.13000295 0.20906798 0.39415476 0.07992969 0.10696126 0.00000000
## [4,] 0.10876823 0.06077849 0.07992969 0.22252605 0.23450290 0.24330027
## [5,] 0.06878697 0.05155597 0.10696126 0.23450290 0.37680696 0.40401014
## [6,] 0.00000000 0.07298098 0.00000000 0.24330027 0.40401014 1.00000000
## [7,] 0.00000000 0.24950575 0.17151201 0.05147356 0.02200820 0.05447437
##            [,7]
## [1,] 0.00000000
## [2,] 0.24950575
## [3,] 0.17151201
## [4,] 0.05147356
## [5,] 0.02200820
## [6,] 0.05447437
## [7,] 0.37411980
```




```
set.seed(23)
P <- rand_M_stoch(M, row_fn = r_zeros)
if(bool_plot){eigen_plot(P, loud = T, "Stochastic")}
```

```
##          Re       Im row_i
## 1   0.37796  0.00000     1
## 2  -0.45951  0.00000     1
## 3  -0.65110  0.00000     1
## 4  -0.72588  0.00000     1
## 5  -0.72588  0.00000     1
## 6   0.65862  0.00000     1
## 7  -0.12482  0.00000     1
## 8   0.37796  0.00000     2
## 9  -0.49315  0.00000     2
## 10  0.00722  0.00000     2
## 11 -0.20391 -0.10863     2
## 12 -0.20391  0.10863     2
## 13  0.00091  0.00000     2
## 14  0.29826  0.00000     2
## 15  0.37796  0.00000     3
## 16 -0.43576  0.00000     3
## 17 -0.37441  0.00000     3
## 18  0.21127  0.28968     3
## 19  0.21127 -0.28968     3
## 20 -0.22454  0.00000     3
## 21 -0.22763  0.00000     3
## 22  0.37796  0.00000     4
```

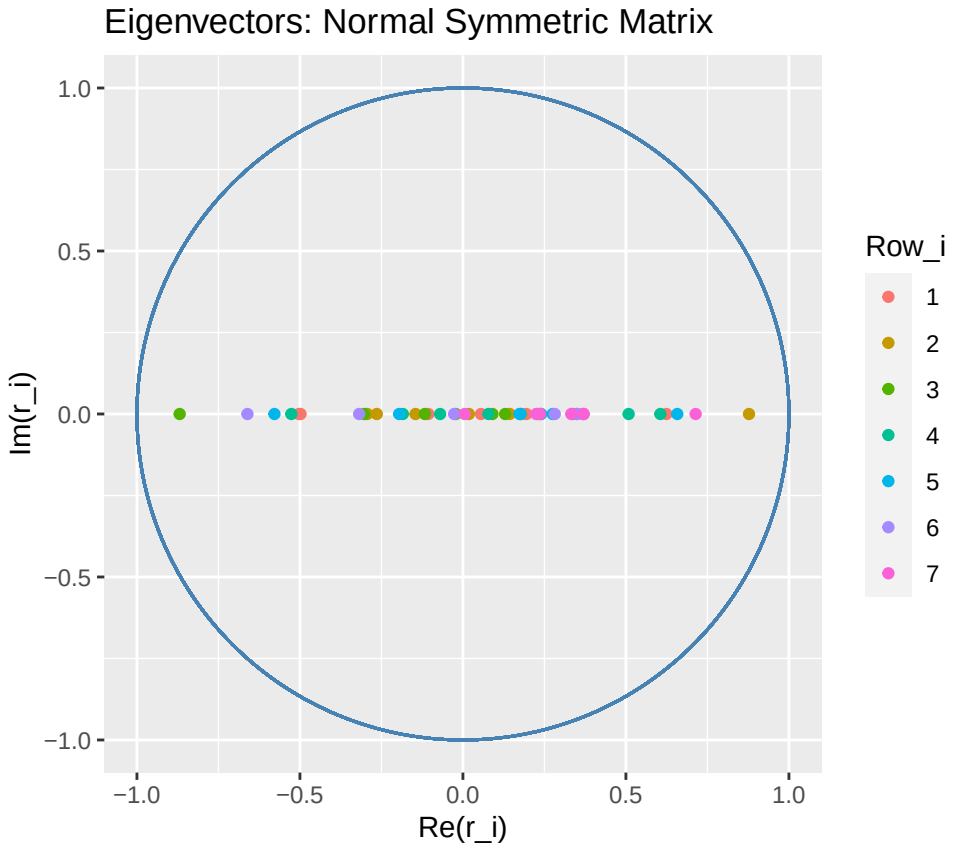
```
## 23 -0.12198  0.00000     4
## 24  0.13896  0.00000     4
## 25  0.35604  0.07924     4
## 26  0.35604 -0.07924     4
## 27  0.67237  0.00000     4
## 28  0.71096  0.00000     4
## 29  0.37796  0.00000     5
## 30  0.13775  0.00000     5
## 31 -0.18858  0.00000     5
## 32  0.06116 -0.07300     5
## 33  0.06116  0.07300     5
## 34 -0.07281  0.00000     5
## 35 -0.01417  0.00000     5
## 36  0.37796  0.00000     6
## 37  0.17464  0.00000     6
## 38  0.34876  0.00000     6
## 39 -0.21156  0.12452     6
## 40 -0.21156 -0.12452     6
## 41 -0.21554  0.00000     6
## 42 -0.21924  0.00000     6
## 43  0.37796  0.00000     7
## 44 -0.53983  0.00000     7
## 45  0.50925  0.00000     7
## 46  0.19844 -0.22228     7
## 47  0.19844  0.22228     7
## 48 -0.10935  0.00000     7
## 49 -0.53844  0.00000     7
##           [,1]       [,2]      [,3]      [,4]       [,5]      [,6]        [,7]
## [1,] 0.0000000 0.00000000 0.0000000 0.4244984 0.00000000 0.0000000 0.575501602
## [2,] 0.0000000 0.31040521 0.2898332 0.1357936 0.07298098 0.0000000 0.190987056
## [3,] 0.0000000 0.53454307 0.0000000 0.0000000 0.00000000 0.2395619 0.225895034
## [4,] 0.2474785 0.02566954 0.0000000 0.2050250 0.24330027 0.2407589 0.037767811
## [5,] 0.0000000 0.00000000 0.0000000 0.1489520 0.40401014 0.4373818 0.009656055
## [6,] 0.0000000 0.00000000 0.0000000 0.0000000 1.00000000 0.0000000 0.000000000
## [7,] 0.1211567 0.32085723 0.5035117 0.0000000 0.05447437 0.0000000 0.000000000
```




```
set.seed(23)
P <- rand_M_symm(M, mu = 0, sd = 1)
if(T){eigen_plot(P, loud = T, "Normal Symmetric")}
```

```
##          Re Im row_i
## 1  -0.50317  0     1
## 2  -0.49808  0     1
## 3   0.19463  0     1
## 4  -0.10600  0     1
## 5   0.05541  0     1
## 6   0.23865  0     1
## 7   0.62418  0     1
## 8  -0.29333  0     2
## 9   0.17884  0     2
## 10 -0.26415  0     2
## 11  0.87755  0     2
## 12 -0.14541  0     2
## 13  0.01820  0     2
## 14  0.14359  0     2
## 15  0.33763  0     3
## 16 -0.30305  0     3
## 17 -0.11691  0     3
## 18 -0.02208  0     3
## 19 -0.86892  0     3
## 20  0.12946  0     3
## 21  0.09069  0     3
## 22  0.50834  0     4
```

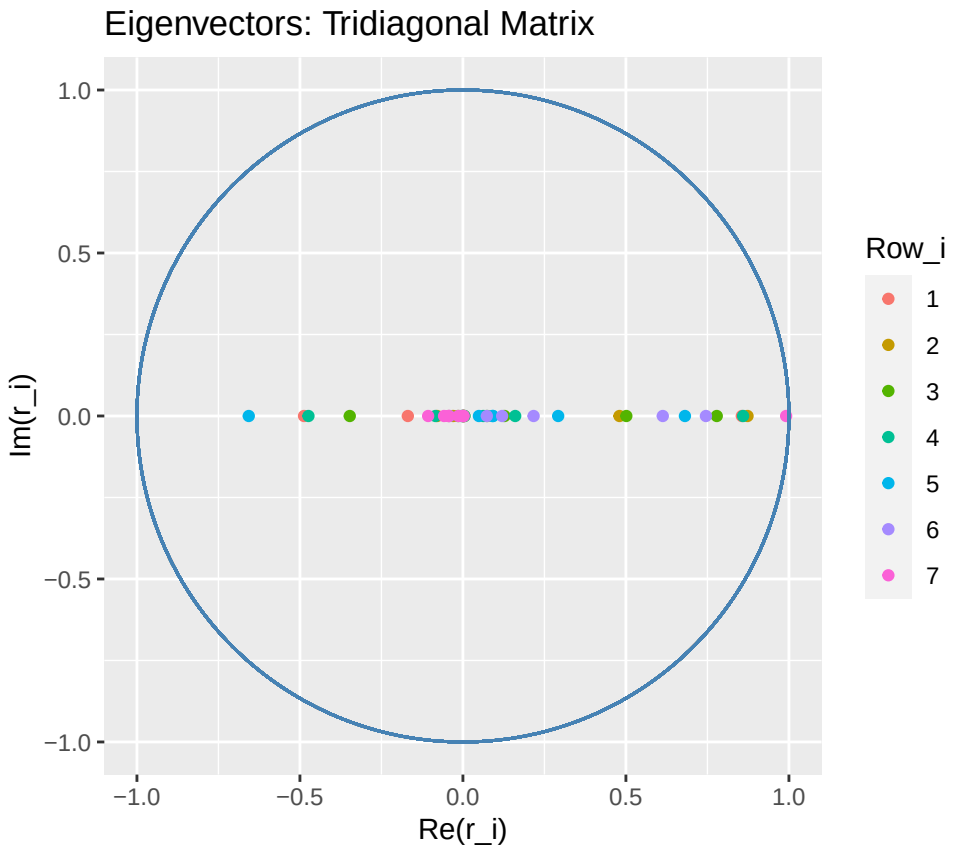
```
## 23 -0.06990  0     4
## 24 -0.18433  0     4
## 25  0.07852  0     4
## 26  0.22950  0     4
## 27 -0.52635  0     4
## 28  0.60568  0     4
## 29  0.17372  0     5
## 30  0.27547  0     5
## 31 -0.57820  0     5
## 32 -0.19562  0     5
## 33  0.17719  0     5
## 34  0.65763  0     5
## 35  0.23975  0     5
## 36  0.34929  0     6
## 37 -0.66091  0     6
## 38 -0.02693  0     6
## 39  0.35085  0     6
## 40  0.36967  0     6
## 41  0.28172  0     6
## 42 -0.31836  0     6
## 43  0.36905  0     7
## 44  0.33246  0     7
## 45  0.71390  0     7
## 46  0.22505  0     7
## 47  0.00550  0     7
## 48  0.37022  0     7
## 49  0.23637  0     7
##           [,1]        [,2]          [,3]      [,4]          [,5]       [,6]
## [1,]  6.573666  0.51114098 -1.0331189917 -3.383182 -3.0000591947  0.8004520
## [2,]  0.511141  4.98204357 -1.4862200170 -1.746600 -0.0524571724 -1.5924527
## [3,] -1.033119 -1.48622002  4.7737330744  2.148072 -0.0005600518  2.8247591
## [4,] -3.383182 -1.74659951  2.1480719648  4.390580  1.4888328209  3.1566190
## [5,] -3.000059 -0.05245717 -0.0005600518  1.488833  3.6978188336 -0.9103084
## [6,]  0.800452 -1.59245268  2.8247591405  3.156619 -0.9103083582  7.1934202
## [7,] -3.496288 -1.19519521  0.2437352145  1.619341 -0.4584371122 -0.2100850
##           [,7]
## [1,] -3.4962883
## [2,] -1.1951952
## [3,]  0.2437352
## [4,]  1.6193410
## [5,] -0.4584371
## [6,] -0.2100850
## [7,]  6.2716093
```




```
set.seed(23)
P <- rand_M_trid(M)
if(T){eigen_plot(P, loud = T, "Tridiagonal")}
```

```
##          Re Im row_i
## 1   0.00109  0     1
## 2   0.00034  0     1
## 3  -0.04305  0     1
## 4   0.85557  0     1
## 5  -0.16901  0     1
## 6  -0.00008  0     1
## 7  -0.48742  0     1
## 8   0.00442  0     2
## 9   0.00092  0     2
## 10 -0.03025  0     2
## 11  0.48023  0     2
## 12 -0.07902  0     2
## 13  0.00007  0     2
## 14  0.87304  0     2
## 15  0.50124  0     3
## 16  0.07404  0     3
## 17 -0.34715  0     3
## 18  0.12752  0     3
## 19  0.77865  0     3
## 20  0.00221  0     3
## 21 -0.01432  0     3
## 22  0.85948  0     4
```

```
## 23  0.06262  0     4
## 24  0.16036  0     4
## 25 -0.08409  0     4
## 26 -0.47387  0     4
## 27 -0.00339  0     4
## 28  0.00450  0     4
## 29  0.09112  0     5
## 30 -0.65698  0     5
## 31  0.68104  0     5
## 32  0.09197  0     5
## 33  0.29224  0     5
## 34  0.04899  0     5
## 35 -0.00031  0     5
## 36 -0.04151  0     6
## 37  0.74540  0     6
## 38  0.61303  0     6
## 39  0.07339  0     6
## 40  0.21679  0     6
## 41  0.12027  0     6
## 42 -0.00009  0     6
## 43  0.00236  0     7
## 44 -0.05791  0     7
## 45 -0.10669  0     7
## 46 -0.01399  0     7
## 47 -0.04410  0     7
## 48  0.99152  0     7
## 49 -0.00003  0     7
##           [,1]        [,2]       [,3]      [,4]       [,5]       [,6]
## [1,] 0.3864247  1.01920549 0.00000000 0.0000000  0.0000000  0.0000000
## [2,] 1.0192055 -0.86936422 0.04543718 0.0000000  0.0000000  0.0000000
## [3,] 0.0000000  0.04543718 1.82653419 1.5757796  0.0000000  0.0000000
## [4,] 0.0000000  0.00000000 1.57577959 3.5867762  0.2182885  0.0000000
## [5,] 0.0000000  0.00000000 0.00000000 0.2182885  1.9932102 -1.0465353
## [6,] 0.0000000  0.00000000 0.00000000 0.0000000 -1.0465353  2.2149810
## [7,] 0.0000000  0.00000000 0.00000000 0.0000000  0.0000000 -0.2886886
##           [,7]
## [1,]  0.0000000
## [2,]  0.0000000
## [3,]  0.0000000
## [4,]  0.0000000
## [5,]  0.0000000
## [6,] -0.2886886
## [7,] -0.5561726
```


Eigenvectors: Tridiagonal Matrix
1.0
0.5
0.0
−0.5
−1.0
Im(r_i)
−1.0
−0.5
0.0
0.5
1.0
Re(r_i)
Row_i
1
2
3
4
5
6
7