Random Matrix Analysis
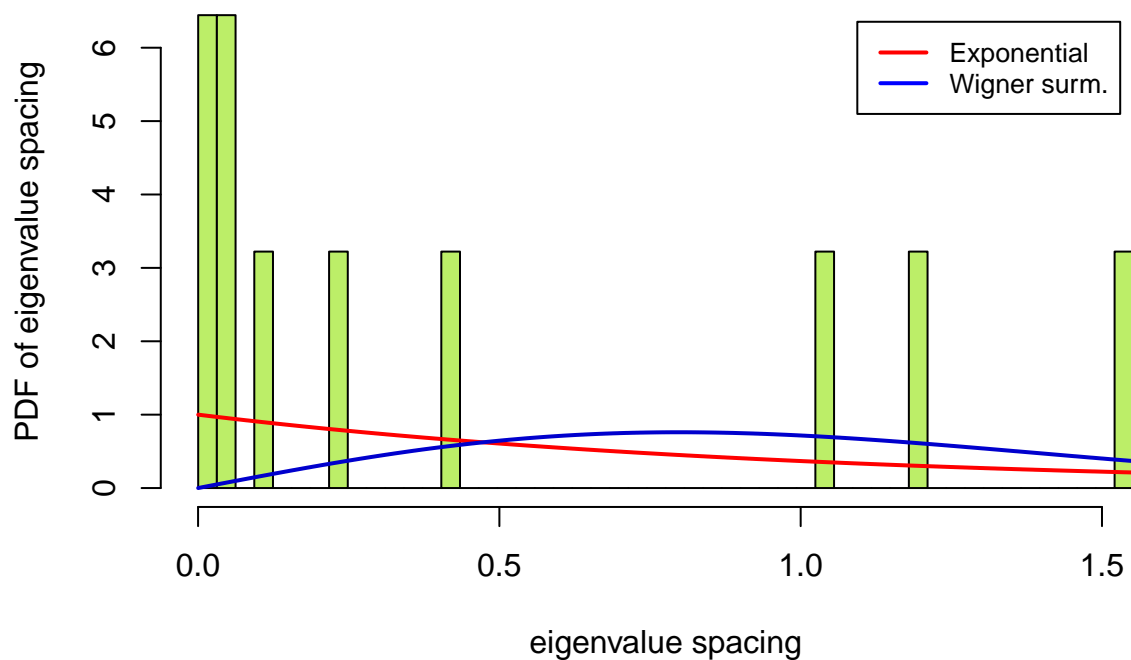
Ali Taqi

Symmetric Stochastic Matrices

```
set.seed(23)
symm_stoch(M)
```

```
## # A tibble: 10 x 3
##    row_i prop_reals is_real
##    <dbl>      <dbl> <lgl>
## 1     1          1 TRUE
## 2     2          1 TRUE
## 3     3          1 TRUE
## 4     4          1 TRUE
## 5     5          1 TRUE
## 6     6          1 TRUE
## 7     7          1 TRUE
## 8     8          1 TRUE
## 9     9          1 TRUE
## 10   10          1 TRUE
```
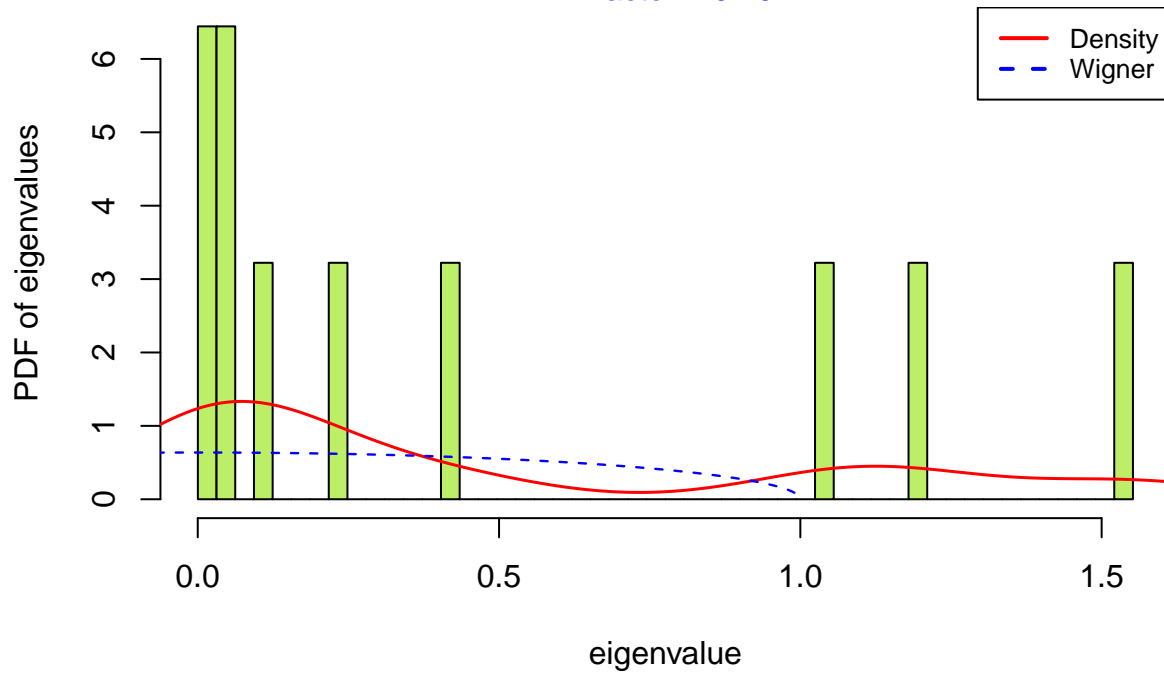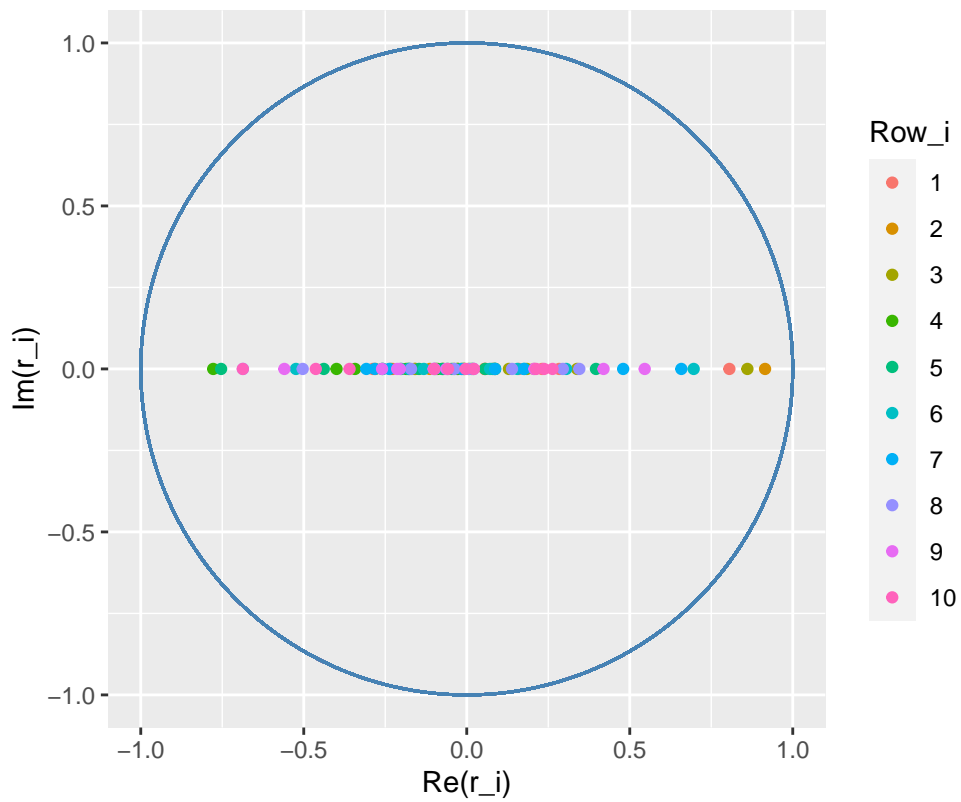
Eigenvalue spacing distribution (NNSD)

Eigenvalue density distribution

Fill factor = 0.297

Eigenvectors: Symmetric Stochastic Matrix


```
symm_stoch(M)
```

```
## # A tibble: 10 x 3
```
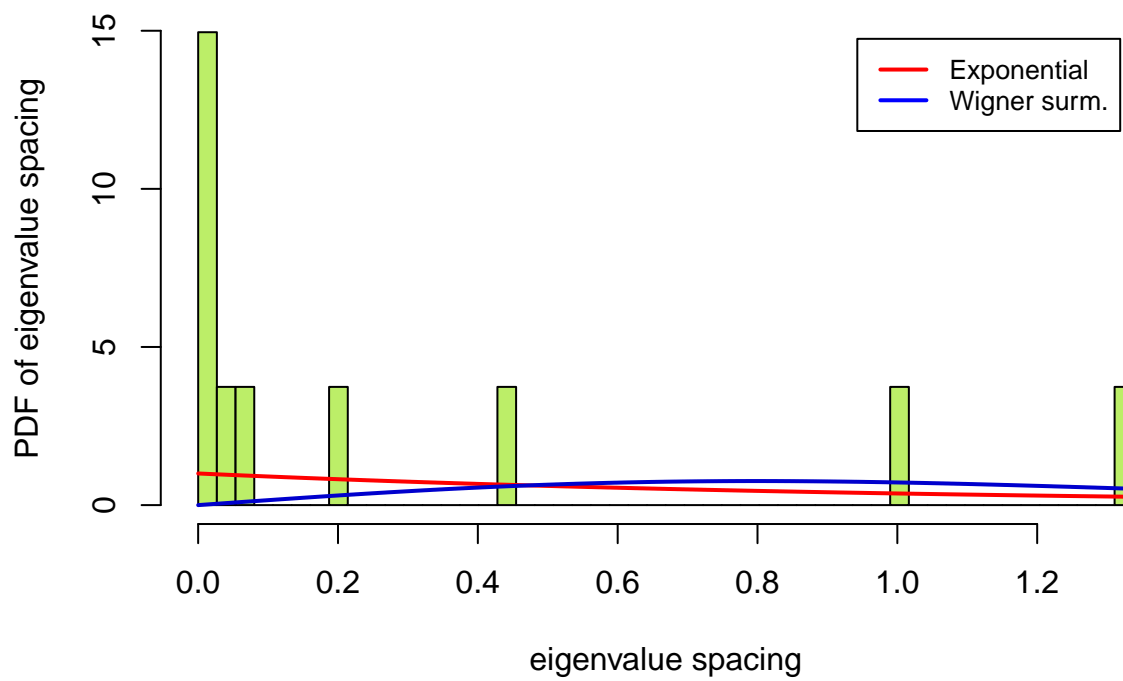
```
##    row_i prop_reals is_real
##    <dbl>      <dbl> <lgl>
##  1     1          1 TRUE
##  2     2          1 TRUE
##  3     3          1 TRUE
##  4     4          1 TRUE
##  5     5          1 TRUE
##  6     6          1 TRUE
##  7     7          1 TRUE
##  8     8          1 TRUE
##  9     9          1 TRUE
## 10    10          1 TRUE
```
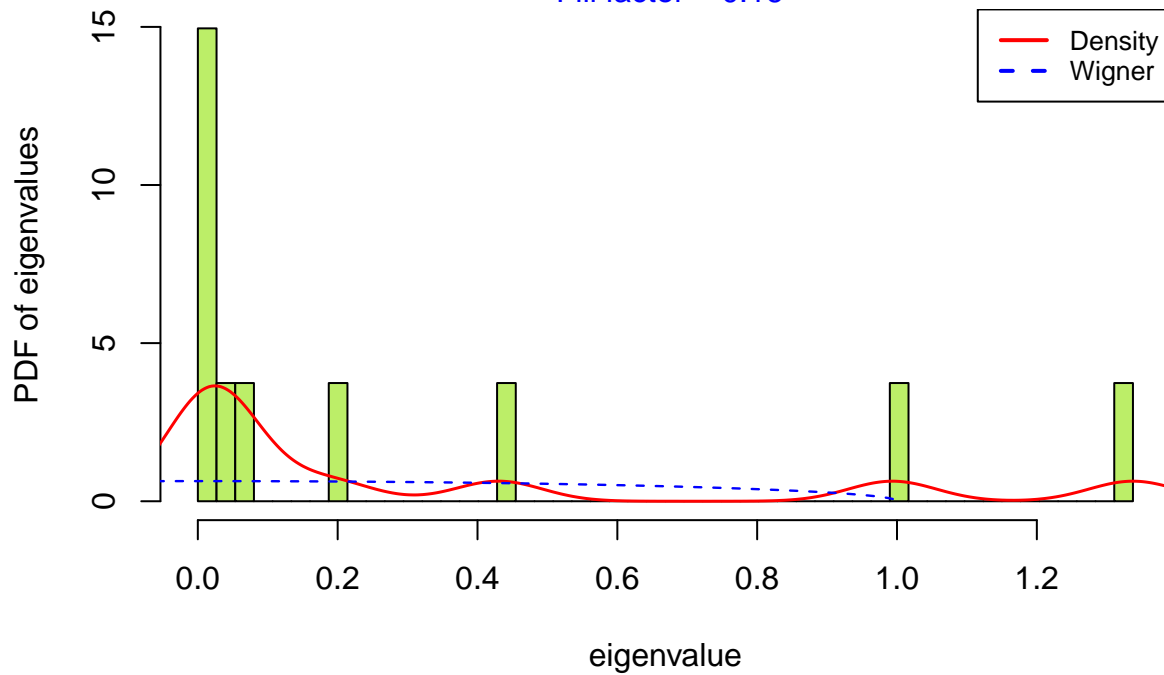
Eigenvalue spacing distribution (NNSD)

Eigenvalue density distribution

Fill factor = 0.16

Eigenvectors: Symmetric Stochastic Matrix


```
symm_stoch(M)
```

```
## # A tibble: 10 x 3
```

```
##    row_i prop_reals is_real
##    <dbl>      <dbl> <lgl>
## 1      1          1 TRUE
## 2      2          1 TRUE
## 3      3          1 TRUE
## 4      4          1 TRUE
## 5      5          1 TRUE
## 6      6          1 TRUE
## 7      7          1 TRUE
## 8      8          1 TRUE
## 9      9          1 TRUE
## 10    10          1 TRUE
```
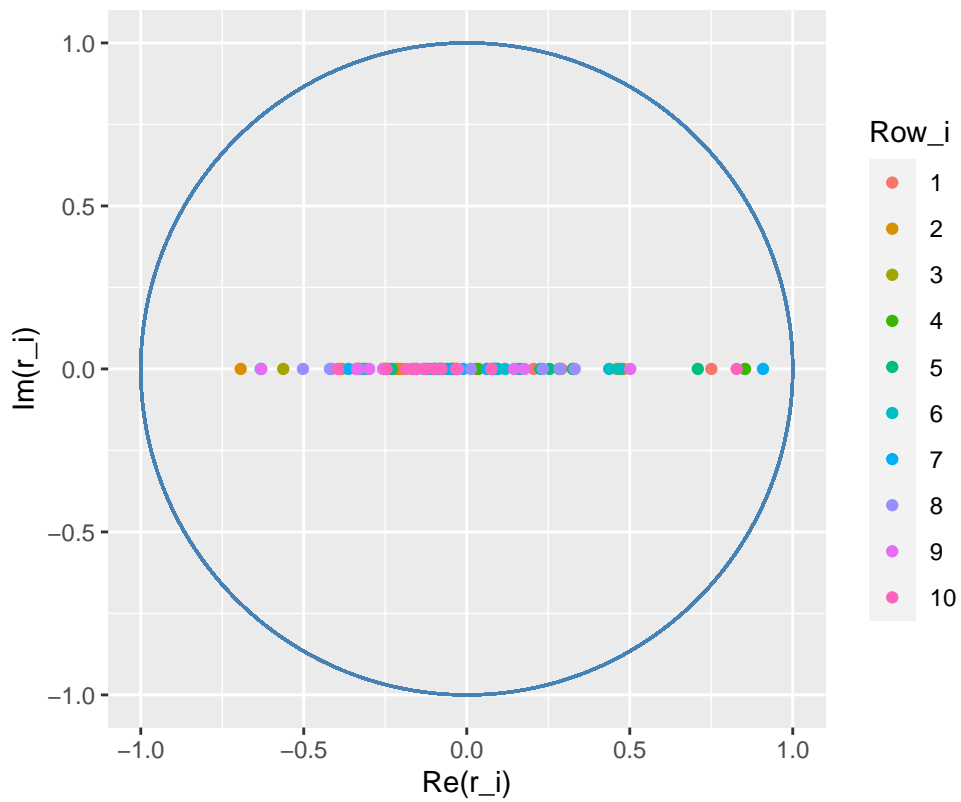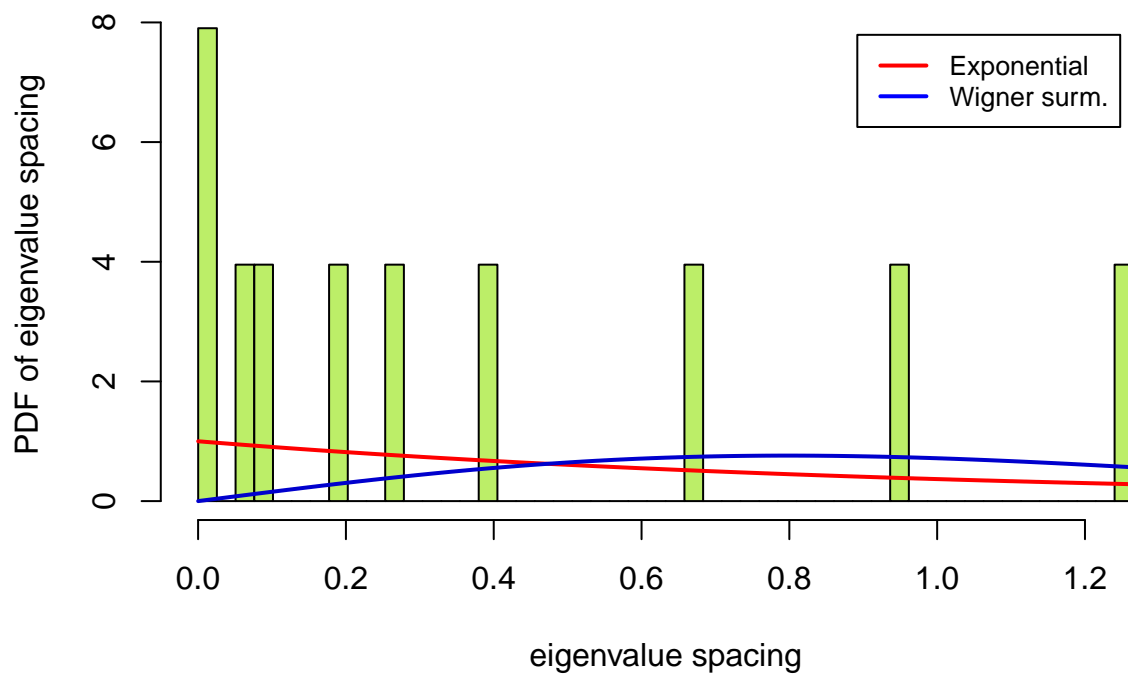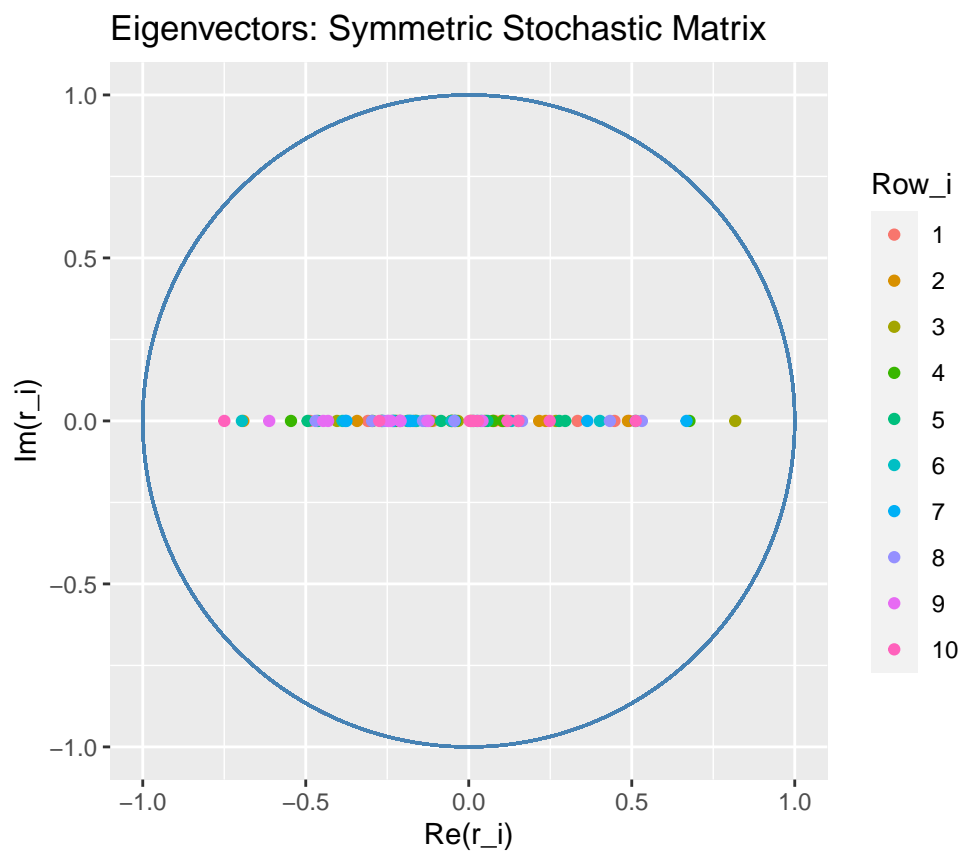
Eigenvalue spacing distribution (NNSD)

Eigenvalue density distribution

Fill factor = 0.336

Eigenvectors: Symmetric Stochastic Matrix
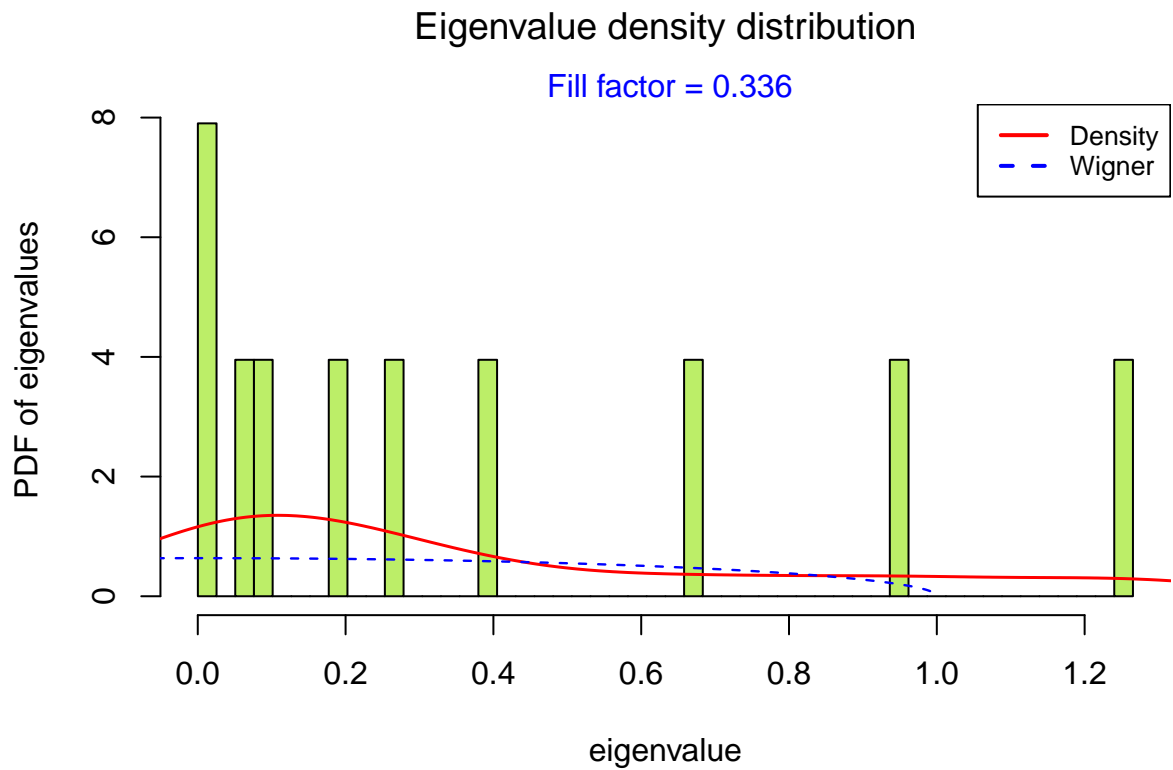


```
symm_stoch(M)
```

```
## # A tibble: 10 x 3
```

```
##    row_i prop_reals is_real
##    <dbl>      <dbl> <lgl>
## 1      1          1 TRUE
## 2      2          1 TRUE
## 3      3          1 TRUE
## 4      4          1 TRUE
## 5      5          1 TRUE
## 6      6          1 TRUE
## 7      7          1 TRUE
## 8      8          1 TRUE
## 9      9          1 TRUE
## 10    10          1 TRUE
```
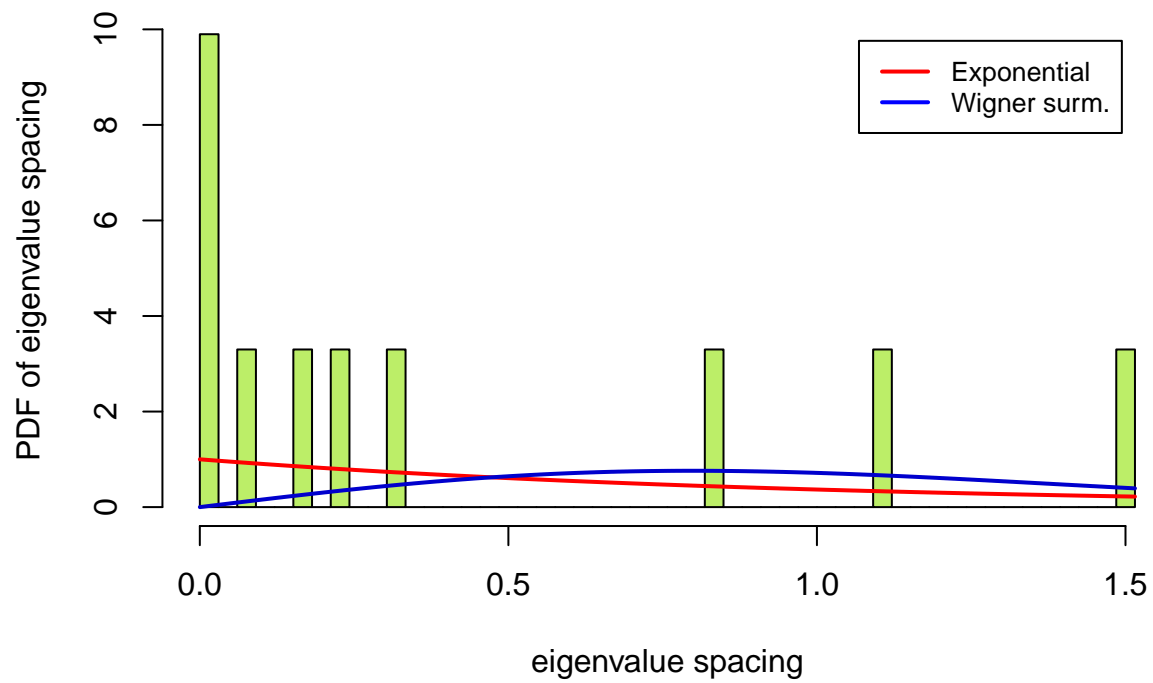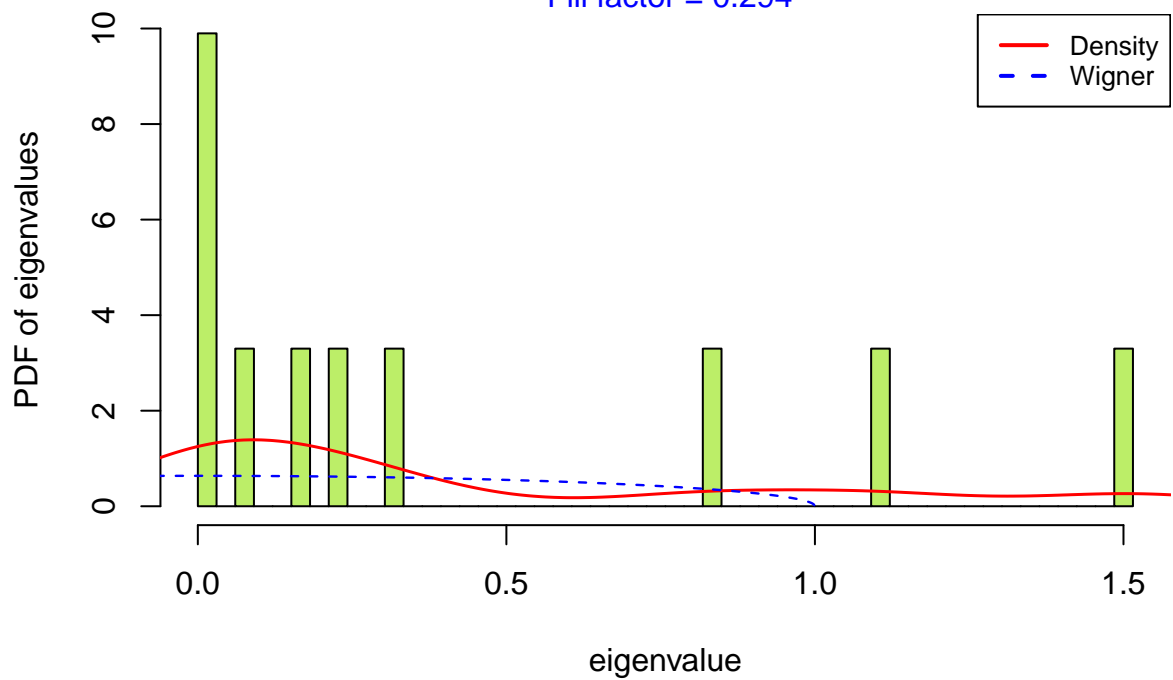
Eigenvalue spacing distribution (NNSD)

Eigenvalue density distribution

Fill factor = 0.294

Eigenvectors: Symmetric Stochastic Matrix

Normal Symmetric Matrices

```
symm_norm(M)
```

```
## # A tibble: 10 x 3
##    row_i prop_reals is_real
##    <dbl>      <dbl> <lgl>
##  1     1          1 TRUE
##  2     2          1 TRUE
##  3     3          1 TRUE
##  4     4          1 TRUE
##  5     5          1 TRUE
##  6     6          1 TRUE
##  7     7          1 TRUE
##  8     8          1 TRUE
##  9     9          1 TRUE
## 10    10          1 TRUE
```
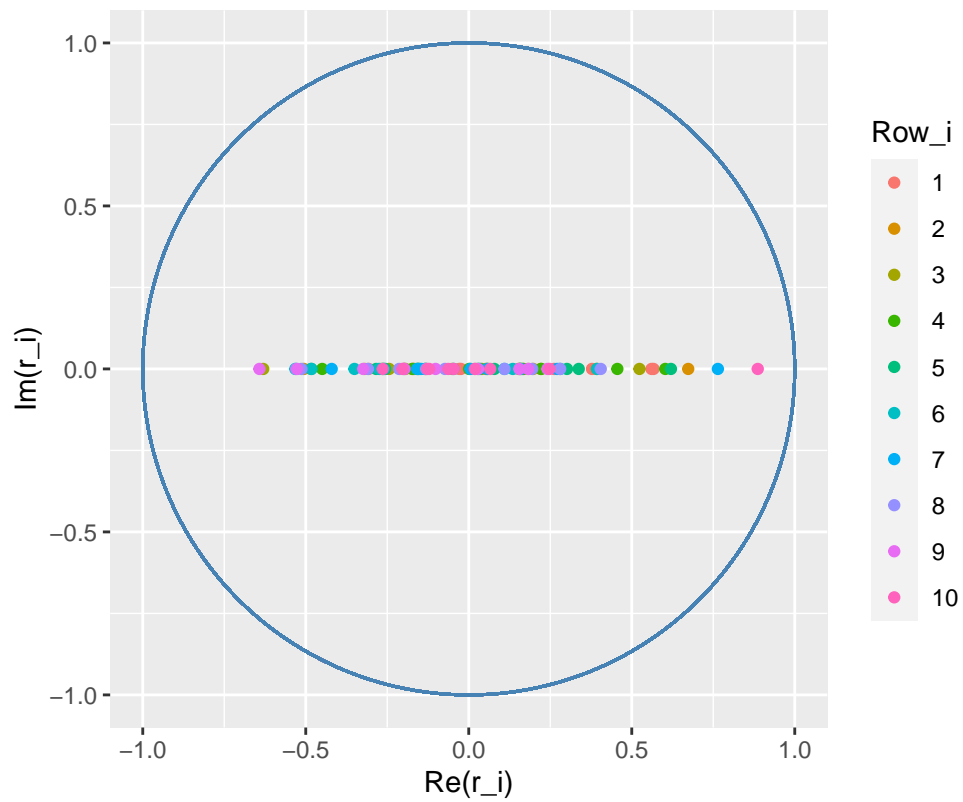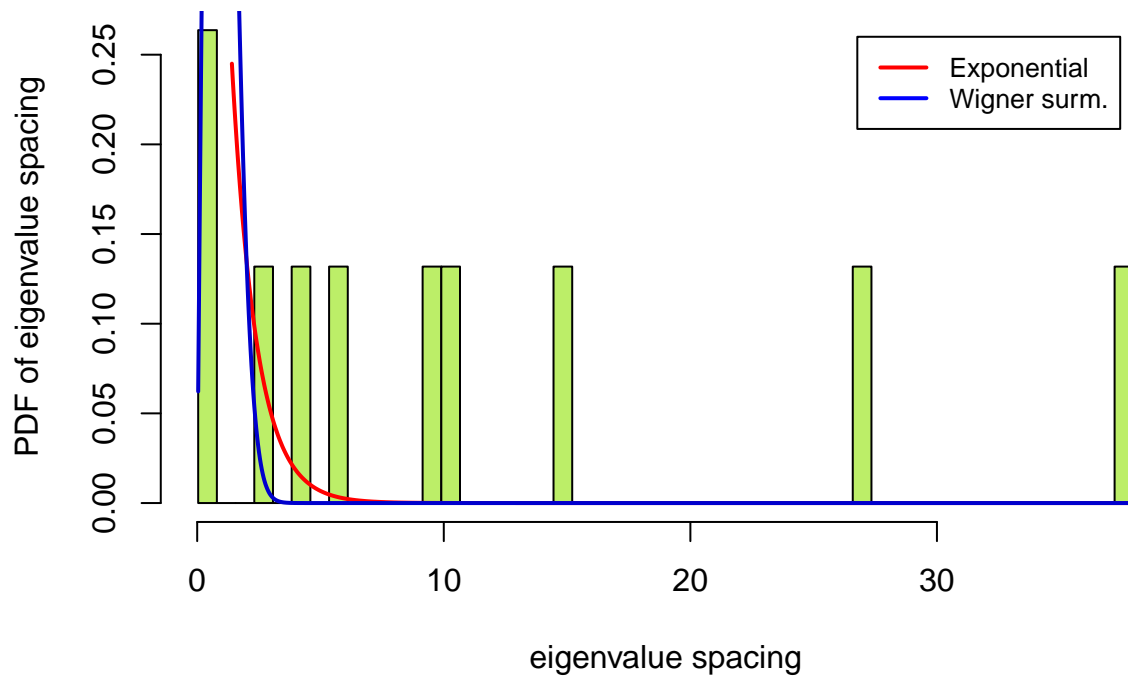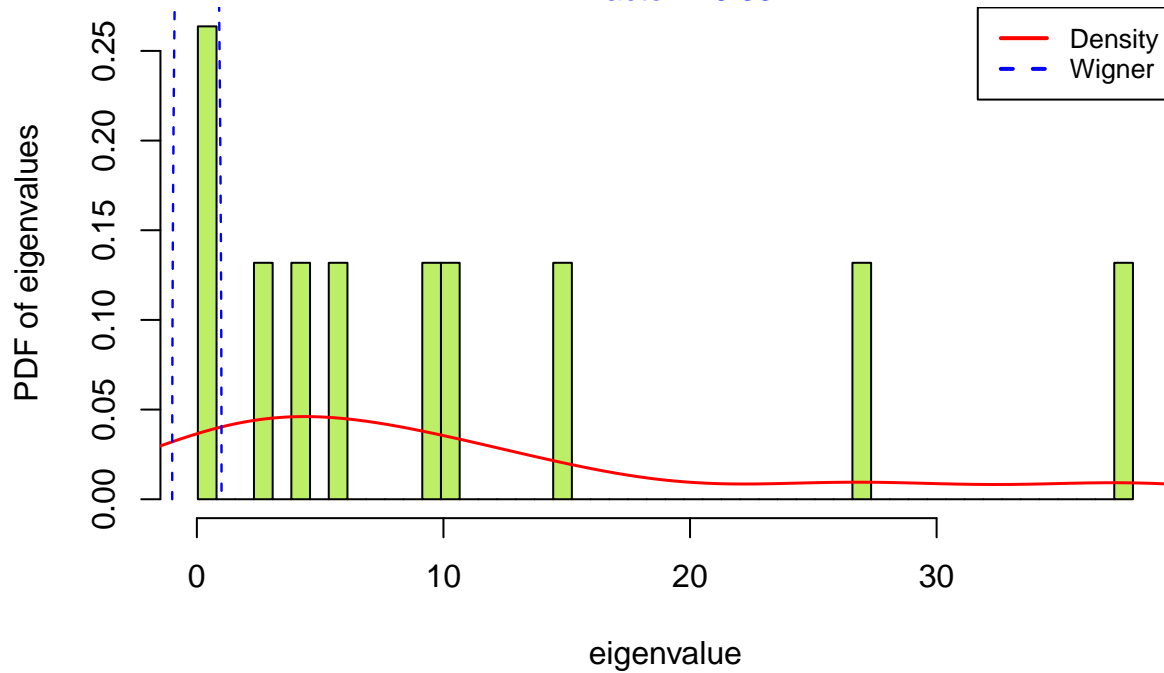
Eigenvalue spacing distribution (NNSD)

Eigenvalue density distribution

Fill factor = 0.332


```
symm_norm(M)
```
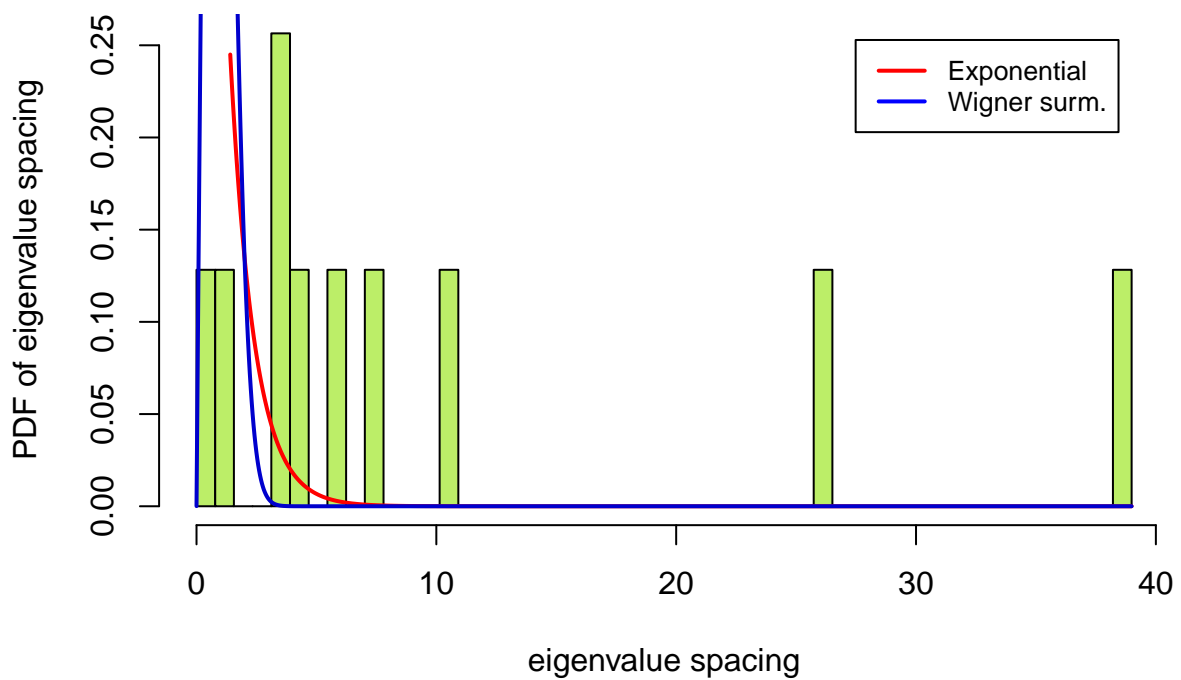
```
## # A tibble: 10 x 3
##     row_i prop_reals is_real
##     <dbl>      <dbl> <lgl>
##  1      1          1 TRUE
##  2      2          1 TRUE
##  3      3          1 TRUE
##  4      4          1 TRUE
##  5      5          1 TRUE
##  6      6          1 TRUE
##  7      7          1 TRUE
##  8      8          1 TRUE
##  9      9          1 TRUE
## 10     10          1 TRUE
```
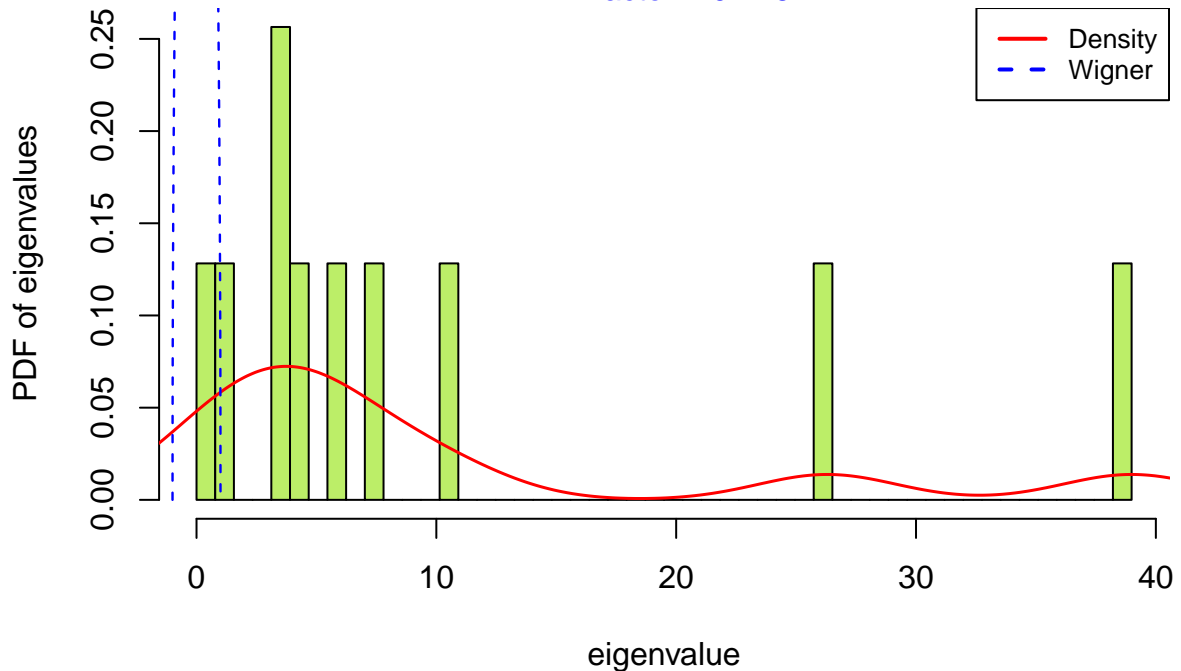
Eigenvalue spacing distribution (NNSD)

Eigenvalue density distribution


```
symm_norm(M)
```
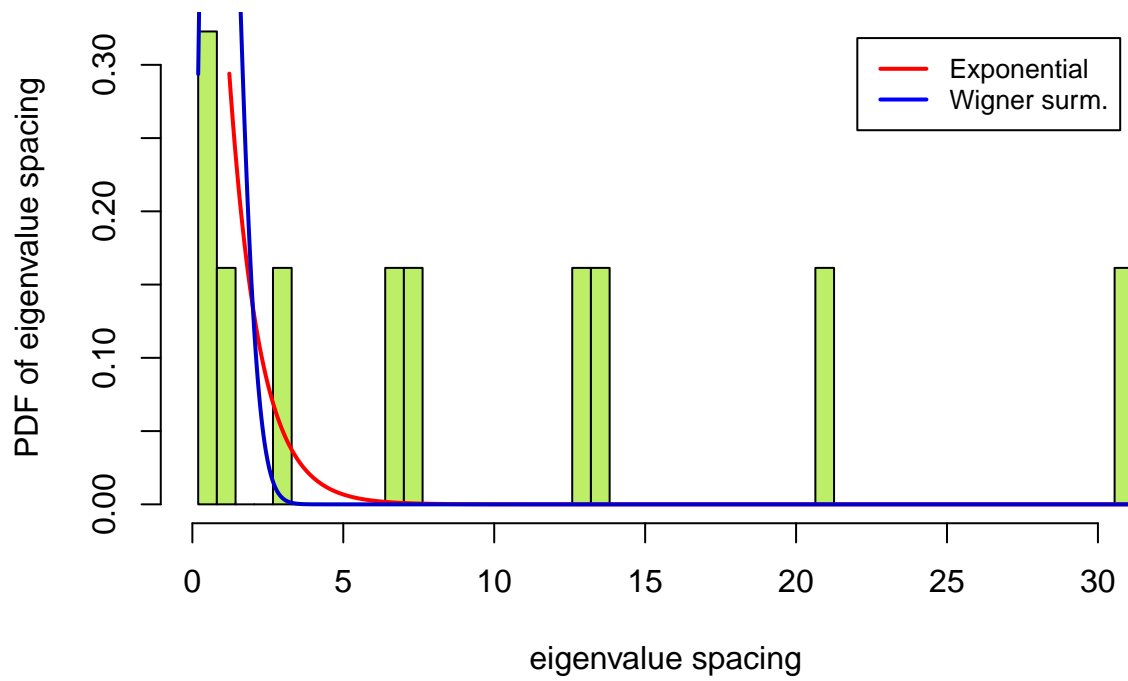
```
## # A tibble: 10 x 3
##    row_i prop_reals is_real
##    <dbl>      <dbl> <lgl>
```

```
## 1    1       1 TRUE
## 2    2       1 TRUE
## 3    3       1 TRUE
## 4    4       1 TRUE
## 5    5       1 TRUE
## 6    6       1 TRUE
## 7    7       1 TRUE
## 8    8       1 TRUE
## 9    9       1 TRUE
## 10  10       1 TRUE
```
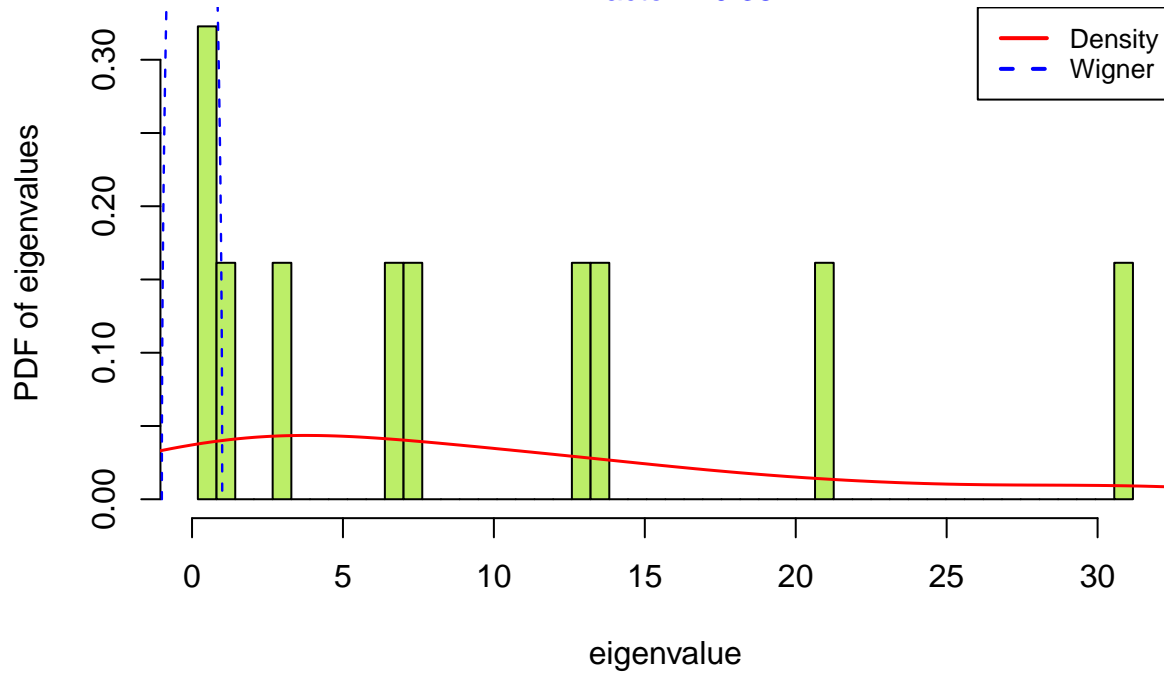
Eigenvalue spacing distribution (NNSD)

Eigenvalue density distribution

Fill factor = 0.381


```
symm_norm(M)
```
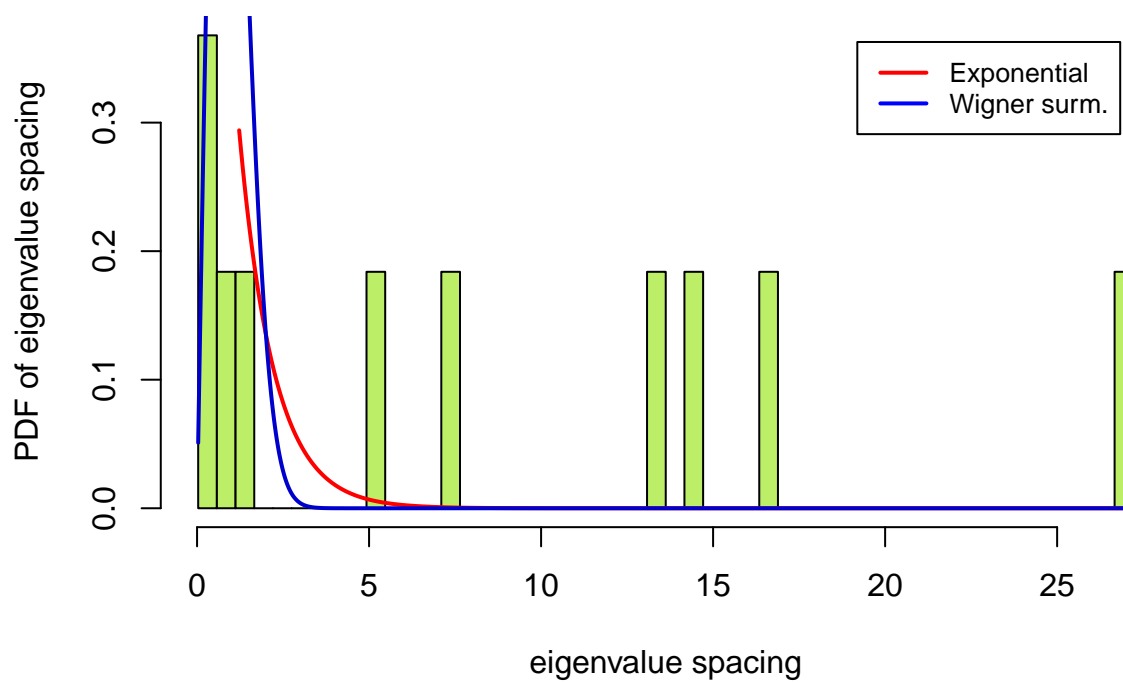
```
## # A tibble: 10 x 3
##     row_i prop_reals is_real
##     <dbl>      <dbl> <lgl>
##  1     1          1 TRUE
##  2     2          1 TRUE
##  3     3          1 TRUE
##  4     4          1 TRUE
##  5     5          1 TRUE
##  6     6          1 TRUE
##  7     7          1 TRUE
##  8     8          1 TRUE
##  9     9          1 TRUE
## 10    10          1 TRUE
```
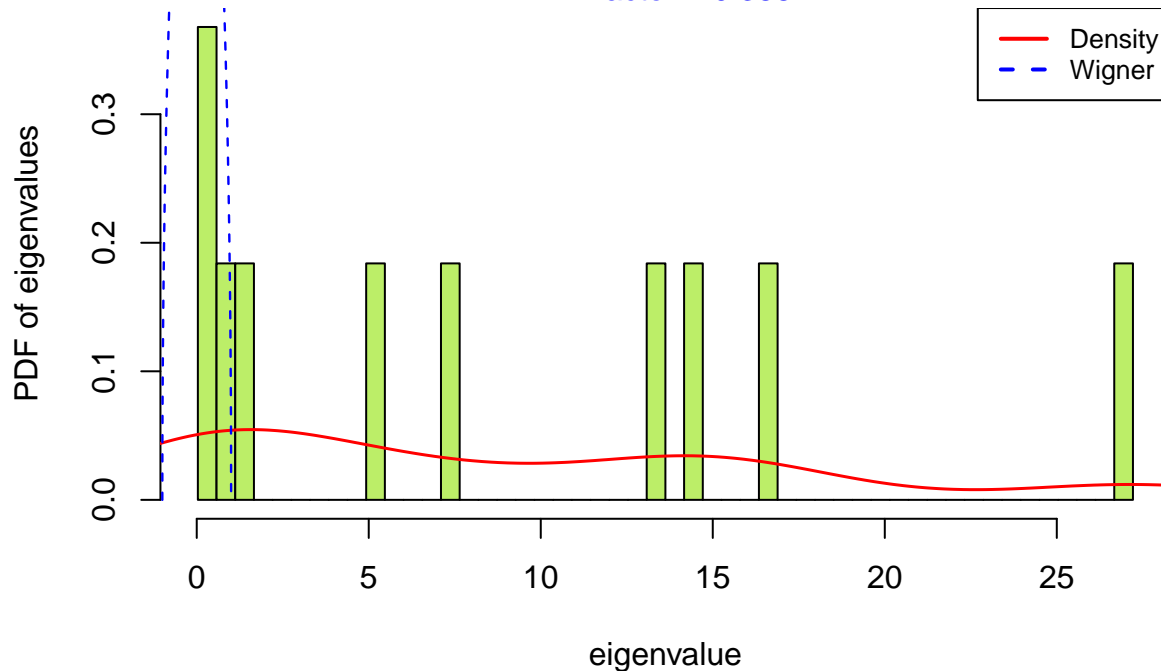
Eigenvalue spacing distribution (NNSD)

Eigenvalue density distribution

Fill factor = 0.388
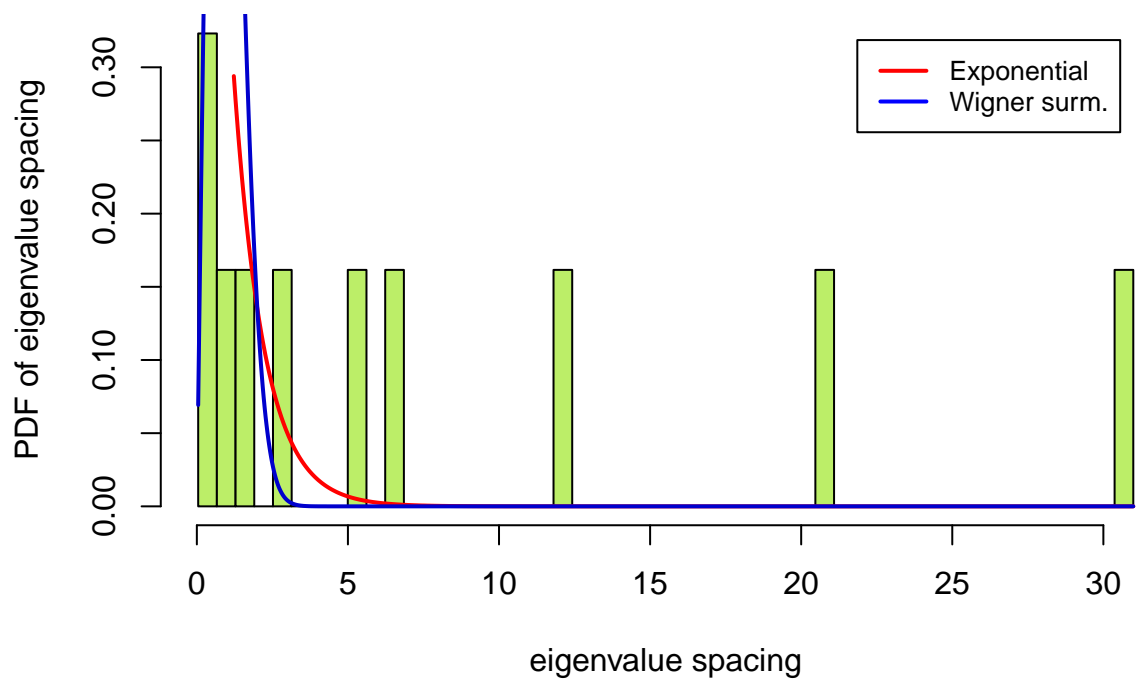


```
symm_norm(M)
```

```
## # A tibble: 10 x 3
##    row_i prop_reals is_real
##    <dbl>      <dbl> <lgl>
```

```
## 1    1         1 TRUE
## 2    2         1 TRUE
## 3    3         1 TRUE
## 4    4         1 TRUE
## 5    5         1 TRUE
## 6    6         1 TRUE
## 7    7         1 TRUE
## 8    8         1 TRUE
## 9    9         1 TRUE
## 10   10        1 TRUE
```
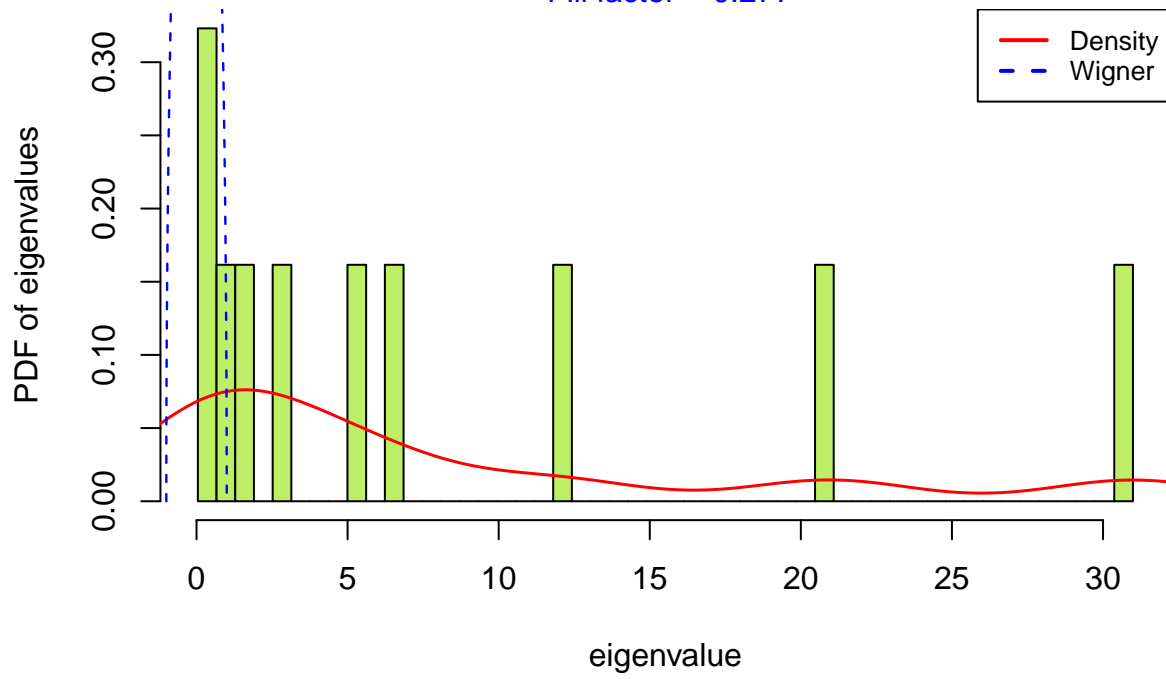
Eigenvalue spacing distribution (NNSD)

Eigenvalue density distribution

Fill factor = 0.277

Tridiagonal Matrices
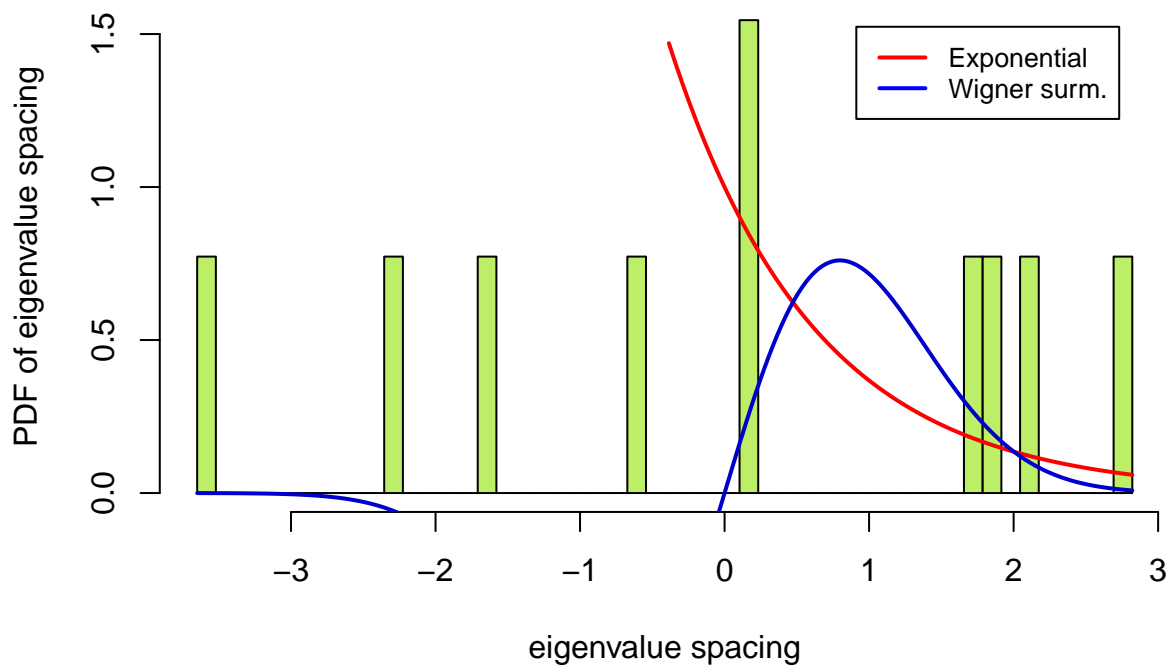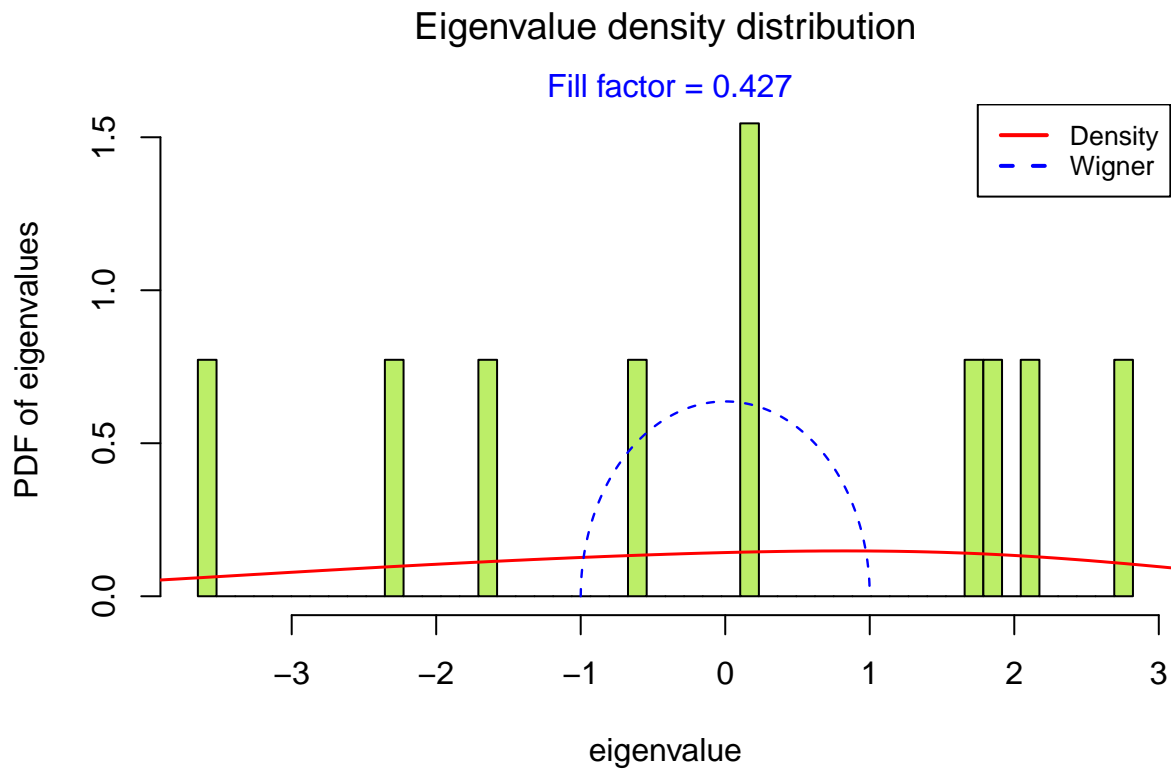
```
tridiag(M)
```

```
## # A tibble: 10 x 3
##     row_i prop_reals is_real
##     <dbl>      <dbl> <lgl>
## 1      1          1 TRUE
## 2      2          1 TRUE
## 3      3          1 TRUE
## 4      4          1 TRUE
## 5      5          1 TRUE
## 6      6          1 TRUE
## 7      7          1 TRUE
## 8      8          1 TRUE
## 9      9          1 TRUE
## 10    10          1 TRUE
```


Eigenvalue spacing distribution (NNSD)

Eigenvalue density distribution

Fill factor = 0.427


```
tridiag(M)
```

```
## # A tibble: 10 x 3
##     row_i prop_reals is_real
##     <dbl>      <dbl> <lgl>
##  1      1          1 TRUE
##  2      2          1 TRUE
##  3      3          1 TRUE
##  4      4          1 TRUE
##  5      5          1 TRUE
##  6      6          1 TRUE
##  7      7          1 TRUE
##  8      8          1 TRUE
##  9      9          1 TRUE
## 10     10          1 TRUE
```
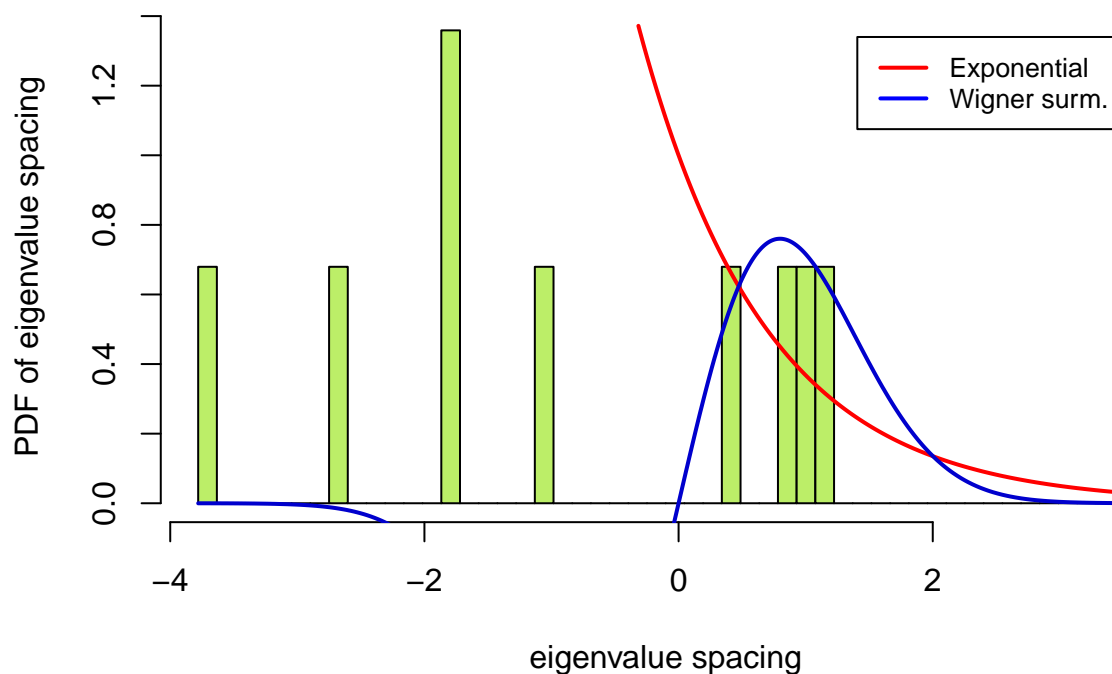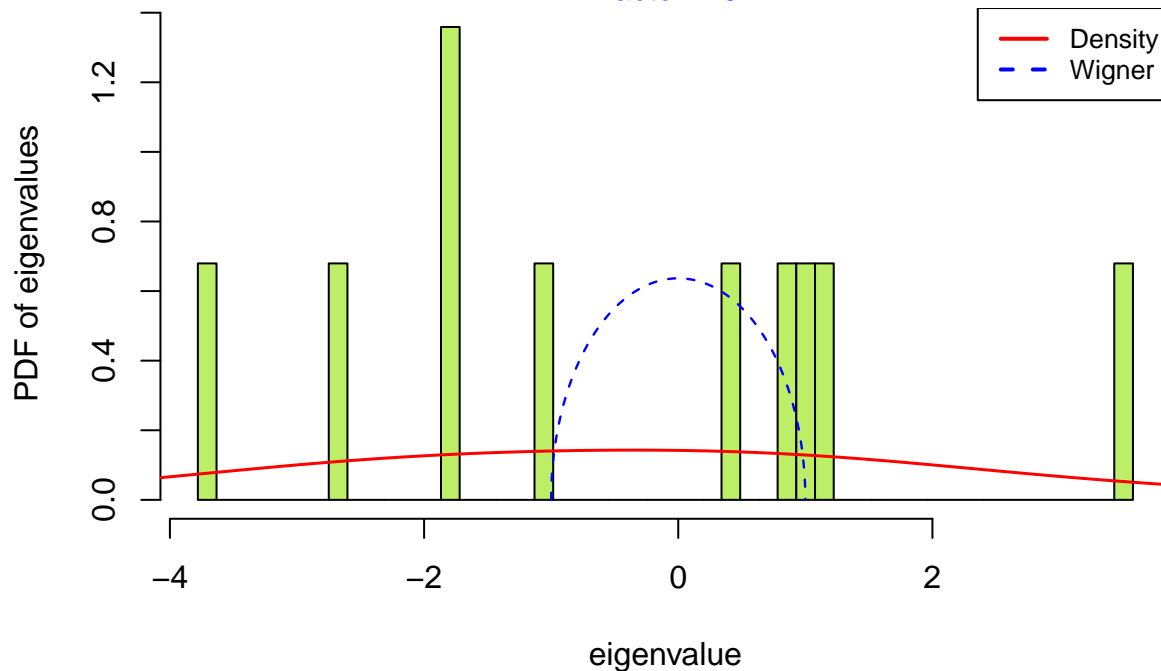
Eigenvalue spacing distribution (NNSD)

Eigenvalue density distribution

Fill factor = 0.41

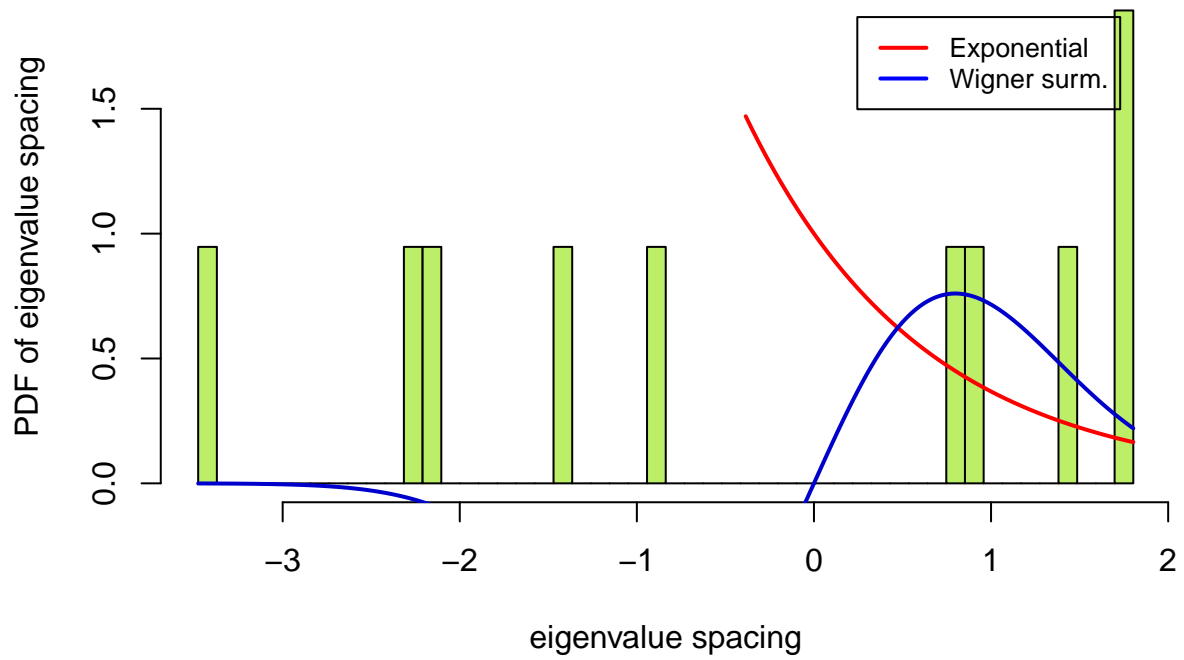```
tridiag(M)
```

```
## # A tibble: 10 x 3
##    row_i prop_reals is_real
##    <dbl>      <dbl> <lgl>
```

```
## 1    1         1 TRUE
## 2    2         1 TRUE
## 3    3         1 TRUE
## 4    4         1 TRUE
## 5    5         1 TRUE
## 6    6         1 TRUE
## 7    7         1 TRUE
## 8    8         1 TRUE
## 9    9         1 TRUE
## 10   10        1 TRUE
```
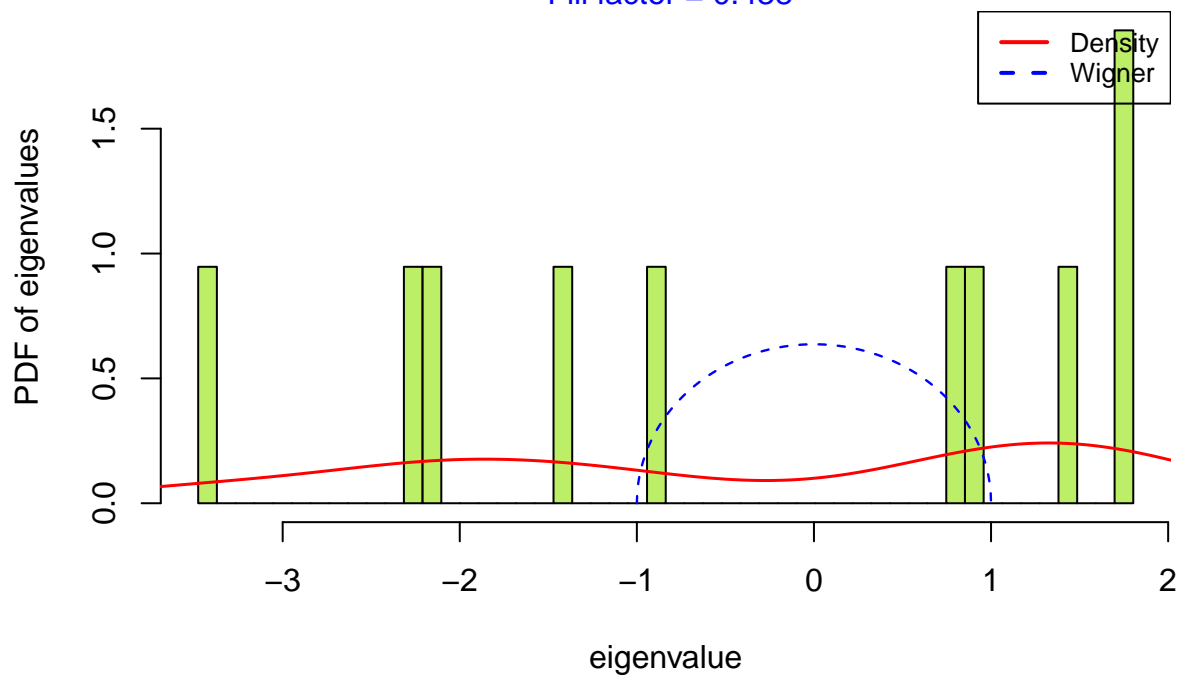
Eigenvalue spacing distribution (NNSD)

Eigenvalue density distribution

Fill factor = 0.438


```
tridiag(M)
```
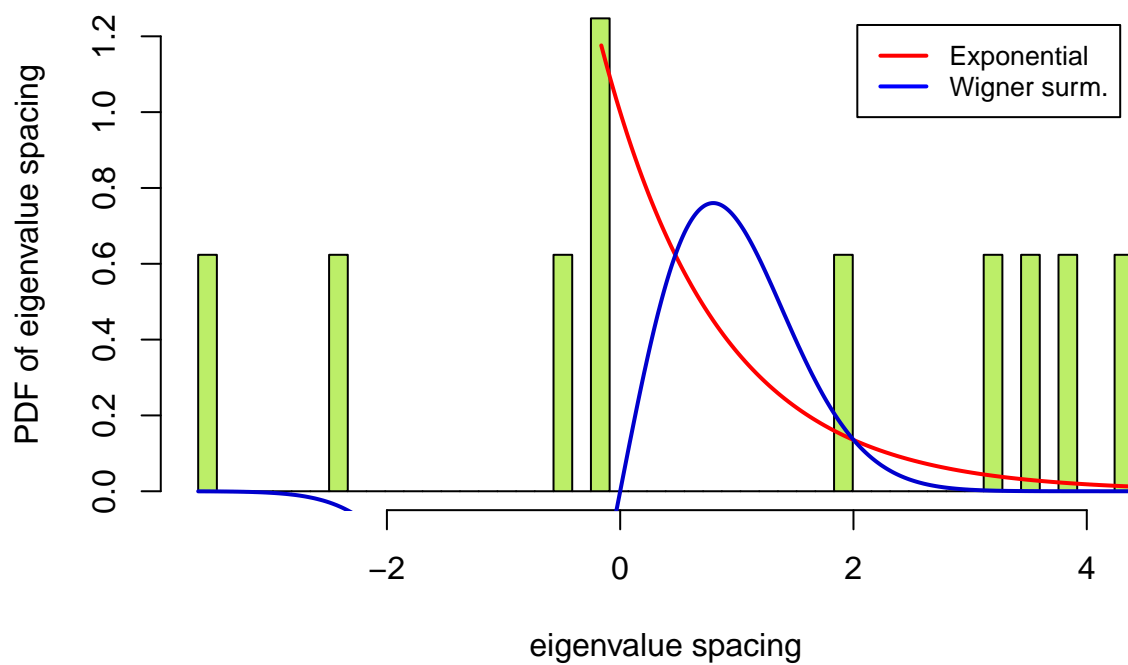
```
## # A tibble: 10 x 3
##     row_i prop_reals is_real
##     <dbl>      <dbl> <lgl>
## 1      1          1 TRUE
## 2      2          1 TRUE
## 3      3          1 TRUE
## 4      4          1 TRUE
## 5      5          1 TRUE
## 6      6          1 TRUE
## 7      7          1 TRUE
## 8      8          1 TRUE
## 9      9          1 TRUE
## 10    10          1 TRUE
```
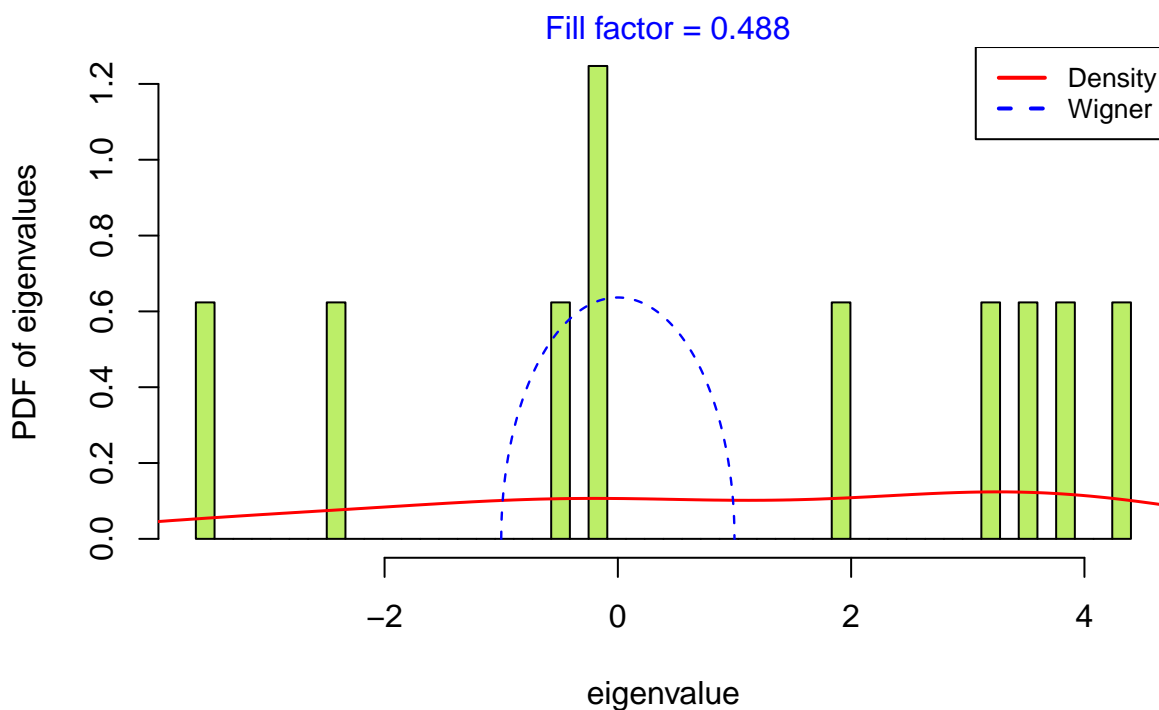
Eigenvalue spacing distribution (NNSD)

Eigenvalue density distribution


```
tridiag(M)
```

```
## # A tibble: 10 x 3
##    row_i prop_reals is_real
##    <dbl>      <dbl> <lgl>
```

```
## 1    1          1 TRUE
## 2    2          1 TRUE
## 3    3          1 TRUE
## 4    4          1 TRUE
## 5    5          1 TRUE
## 6    6          1 TRUE
## 7    7          1 TRUE
## 8    8          1 TRUE
## 9    9          1 TRUE
## 10   10         1 TRUE
```

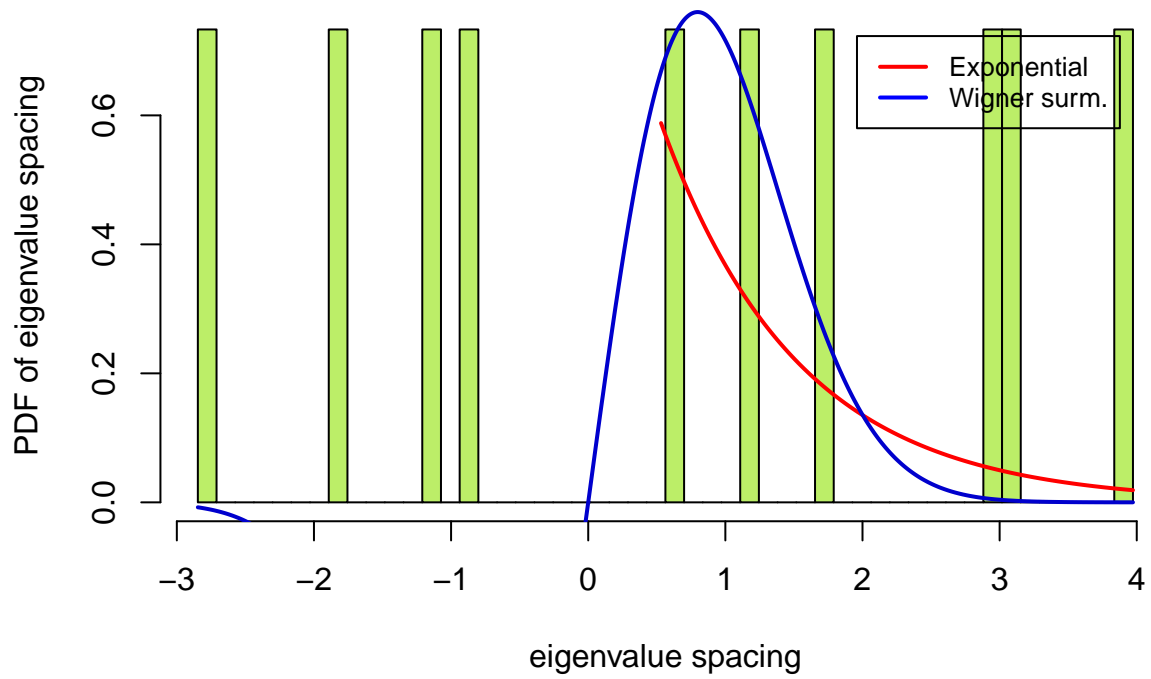### Eigenvalue spacing distribution (NNSD)

Eigenvalue density distribution

Fill factor = 0.459