Random Matrices

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Winter Semester 2019/20

eigenvalues of sa 2×2-matrix with ± 1 entries

$$\begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix} \quad \begin{pmatrix} 1 & -1 \\ -1 & 1 \end{pmatrix}$$

$$\begin{pmatrix} -1 & -1 \\ -1 & -1 \end{pmatrix} \quad \begin{pmatrix} -1 & 1 \\ 1 & -1 \end{pmatrix}$$

$$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix} \quad \begin{pmatrix} -1 & 1 \\ 1 & 1 \end{pmatrix} \quad \begin{pmatrix} 1 & -1 \\ -1 & -1 \end{pmatrix} \quad \begin{pmatrix} -1 & -1 \\ -1 & 1 \end{pmatrix}$$
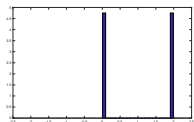
eigenvalues of sa 2×2-matrix with ± 1 entries

$0, 2$
$$\begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix} \quad \begin{pmatrix} 1 & -1 \\ -1 & 1 \end{pmatrix}$$

$-2, 0$
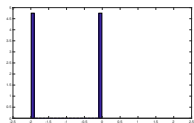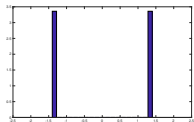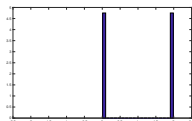$$\begin{pmatrix} -1 & -1 \\ -1 & -1 \end{pmatrix} \quad \begin{pmatrix} -1 & 1 \\ 1 & -1 \end{pmatrix}$$
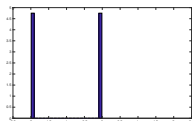
$-\sqrt{2}, \sqrt{2}$
$$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix} \quad \begin{pmatrix} -1 & 1 \\ 1 & 1 \end{pmatrix} \quad \begin{pmatrix} 1 & -1 \\ -1 & -1 \end{pmatrix} \quad \begin{pmatrix} -1 & -1 \\ -1 & 1 \end{pmatrix}$$

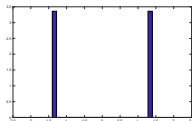# eigenvalues of sa 2×2-matrix with ± 1 entries

$0, 2$

$$\begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix} \quad \begin{pmatrix} 1 & -1 \\ -1 & 1 \end{pmatrix}$$
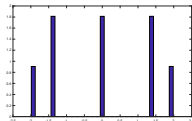

$-2, 0$

$$\begin{pmatrix} -1 & -1 \\ -1 & -1 \end{pmatrix} \quad \begin{pmatrix} -1 & 1 \\ 1 & -1 \end{pmatrix}$$


$-\sqrt{2}, \sqrt{2}$

$$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix} \quad \begin{pmatrix} -1 & 1 \\ 1 & 1 \end{pmatrix} \quad \begin{pmatrix} 1 & -1 \\ -1 & -1 \end{pmatrix} \quad \begin{pmatrix} -1 & -1 \\ -1 & 1 \end{pmatrix}$$
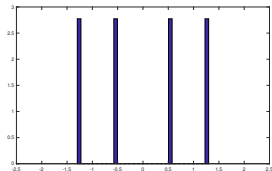
eigenvalues of sa 2×2-matrix with ± 1 entries

$0, 2$

$$\begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix} \quad \begin{pmatrix} 1 & -1 \\ -1 & 1 \end{pmatrix}$$

$-2, 0$

$$\begin{pmatrix} -1 & -1 \\ -1 & -1 \end{pmatrix} \quad \begin{pmatrix} -1 & 1 \\ 1 & -1 \end{pmatrix}$$

$-\sqrt{2}, \sqrt{2}$

$$\begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix} \quad \begin{pmatrix} -1 & 1 \\ 1 & 1 \end{pmatrix} \quad \begin{pmatrix} 1 & -1 \\ -1 & -1 \end{pmatrix} \quad \begin{pmatrix} -1 & -1 \\ -1 & 1 \end{pmatrix}$$

eigenvalues averaged over all $2^3 = 8$ matrices

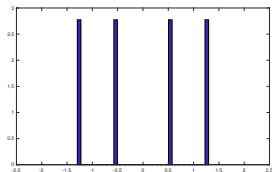# eigenvalues of sa 4×4-matrix with ± 1 entries
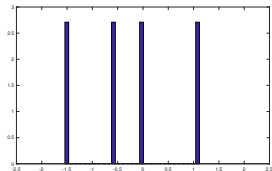
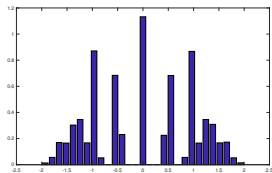one realization

another realization

eigenvalues of sa 4×4-matrix with ± 1 entries
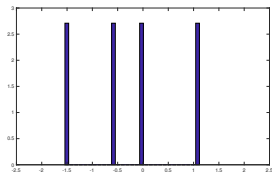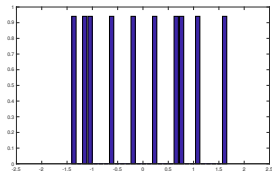

one realization

another realization

averaged over all $2^{10} = 1024$ matrices
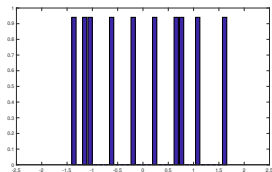
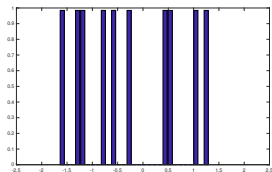# eigenvalues of sa 10×10-matrix with ± 1 entries
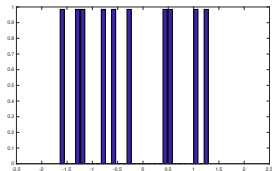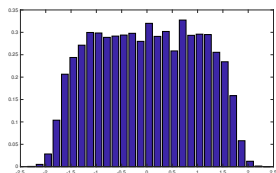

one realization

another realization

eigenvalues of sa 10×10-matrix with ± 1 entries

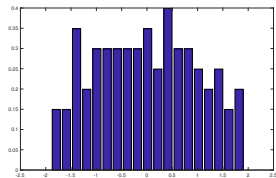
one realization

another realization

averaged over 50.000 of all 2^{55} matrices

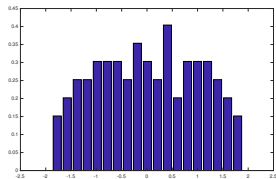# eigenvalues of sa 100×100-matrix with ± 1 entries
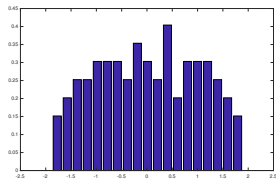
one realization
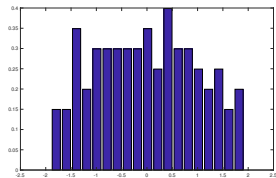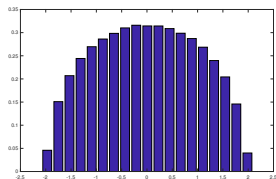

another realization

eigenvalues of sa 100×100-matrix with ± 1 entries
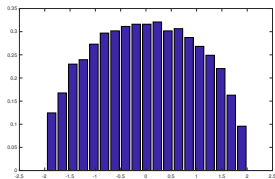

one realization
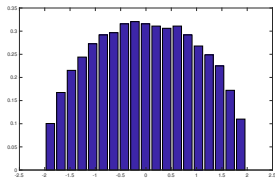

another realization

averaged over 1000 of all $2^{50 \times 101}$ matrices
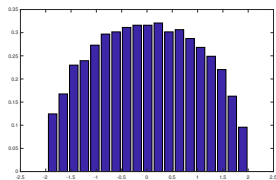
ev of sa 1000×1000-matrix with ± 1 entries
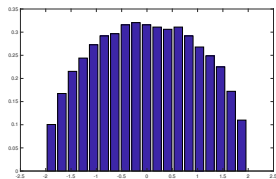

one realization

another realization

ev of sa 1000×1000-matrix with ± 1 entries
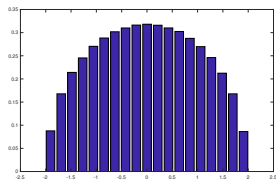

one realization

another realization

averaged over 100 of all $2^{500 \times 1001}$ matrices