

Eigenvalues and Eigenvectors¹

1. Try the following commands

- (a) `digits(4)`
- (b) `A = sym([1,1; 0,1])`
- (c) `E = eig(A)`
- (d) `[V,E] = eig(A)`

Find the eigenvalues and eigenvectors for this matrix by hand and interpret the output.

2. Input the **symbolic** matrix (use `sym` as above):

$$B = \begin{bmatrix} 3 & -1 & -1 \\ -1 & 0 & 2 \\ 1 & 1 & -3 \end{bmatrix}$$

and try the commands:

- (a) `SE = eig(B)` Finds eigenvalues symbolically.
 - (b) `NE = eig(vpa(B))` `vpa` changes from symbolic to numeric.
 - (c) `[SV,SE] = eig(B)`
 - (d) `[NV,NE] = eig(vpa(B))`
3. Create a matrix using the command: `C = sym(hilb(5))`
and repeat the process in the previous part.
4. What are your observations about symbolic vs. numerical computations from the last two parts?
5. Using complete sentences and standard mathematical notation, write a brief report. Show your hand calculations and answer all the questions.

In the first example students must consider multiplicities. The last part should lead to a discussion of the fact that polynomials of degree 5 or higher cannot in general be solved symbolically and so exact symbolic eigenvalues cannot be found for 5 by 5 matrices. They should also notice that symbolic solutions are sometimes too complicated to be useful.

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