

FIGURE 1.  $2x^2 + 2xy + 3y^2 = 1$  and E-vectors/L-values of  $A = \begin{bmatrix} 2 & 1 \\ 1 & 3 \end{bmatrix}$

## 1. ASSIGNMENT

This lab explores the connections between graphs of equations of the form

$$ax^2 + 2bxy + cy^2 = 1$$

and properties of the matrix

$$A = \begin{bmatrix} a & b \\ b & c \end{bmatrix}$$

discovered by iteration. You will be given a pair of symmetric matrices and for each  $2 \times 2$  matrix (like  $A$  above) on your list you will have to use Scilab to plot (on the same plot) both the conic section (this is described in qform.pdf) and the arrows like in lambda.pdf. Explicitly your code should find the L-values and E-vectors by iterations, and compute the angle between each E-vectors and the  $x$ -axis and put the answers in table like Figure 2. Note that the entries in the table are not rounded off, they have as many digits as scilab gives by default.

## 2. EXAMPLE

If  $A = \begin{bmatrix} 2 & 1 \\ 1 & 3 \end{bmatrix}$  then Figure 1 shows the sample plot. Important features of this plot include: 1. the scale in the  $x$  and  $y$  are the same, (an easy check: the red and green arrows are perpendicular, do they look perpendicular?); 2. The conic section is ellipse not a circle, (the conic for your second matrix is a pair of hyperbolas (so 4 curves)); 3. Each arrowhead just touches the curve. 4. The points of contact are extrema, points nearest or farthest from the origin.

Ellipse	L-value	E-vector	$\theta$ (radians)	$\theta$ (degrees)
Max	3.618034	(0.525731, 0.850651)	1.01722	58.282525
Min	1.381966	(0.850651, -0.525731)	-0.553544	-31.717474

FIGURE 2. Table of answers for the ellipse  $A$

### 3. DELIVERABLES

It will be multiple pages which must be stapled. Paper clips and dog ears will earn a grade of zero. Your lab 4 assignment must be a hardcopy document, no electronic files will be accepted. If you need help, I will look at text or pdf files in email, but no word doc files. Each matrix needs a plot, a table, some code (error free and not filled with iterations). Note that the assignment is due at 3pm Friday June 6 and not 5pm as usual.

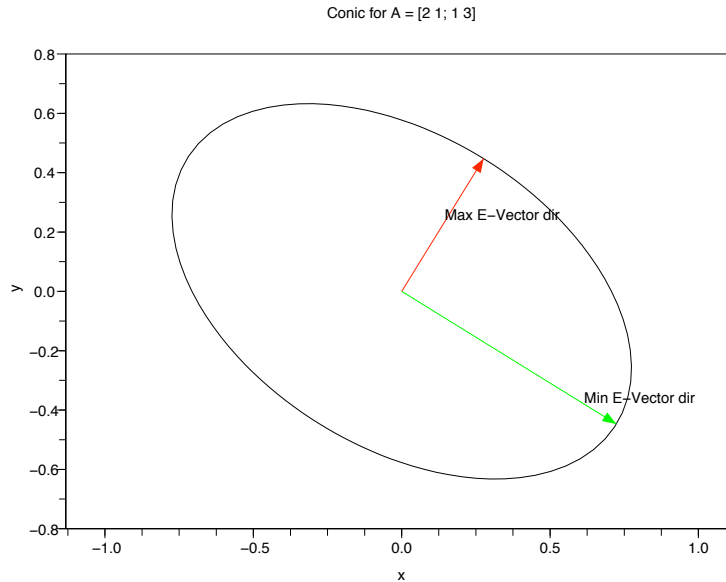
A sample document follows.

### 4. HOW THE HYPERBOLIC CASE DIFFERS FOR THE ELLIPTIC CASE

One of the L-values will be negative, which means the X in the iteration will always alternate signs. You will need to keep the last 3 iterations on the negative L-value. The given plotquad.in will need to be followed by a suitable isoview command.

## REQUIRED SOLUTION FORMAT

My name is S. Bellenot, student #5 on the list and my ellipse matrix is  $\begin{bmatrix} 2 & 1 \\ 1 & 3 \end{bmatrix}$ . Here is my plot, and table for this matrix.



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## SCILAB CODE

(Note: This must be edited. All errors must be removed and all iterations but the first two and the last two must be removed for each Lvalue, Evector.)

```
A=[2 1; 1 3]; X=[1;0];
exec('iterate2d.in')
N = 2.236068, X = [0.894427; 0.447214], i = 1
N = 3.162278, X = [0.707107; 0.707107], i = 2
  16 iteration lines deleted
N = 3.618034, X = [0.525731; 0.850651], i = 9
N = 3.618034, X = [0.525731; 0.850651], i = 10
LMAX=N; EMAX=X; Theta=sign(X(2,1))*acos(X(1,1)); Tdegrees = Theta*180/%pi;
```

(repeated for LMIN)

```
exec('plotquad.in');
[here is where the isoview command goes for hyperbolic case.]
code to made the arrows and labels
```