Math 22 Fall 2004

Linear Algebra with Applications

Linear Transformations

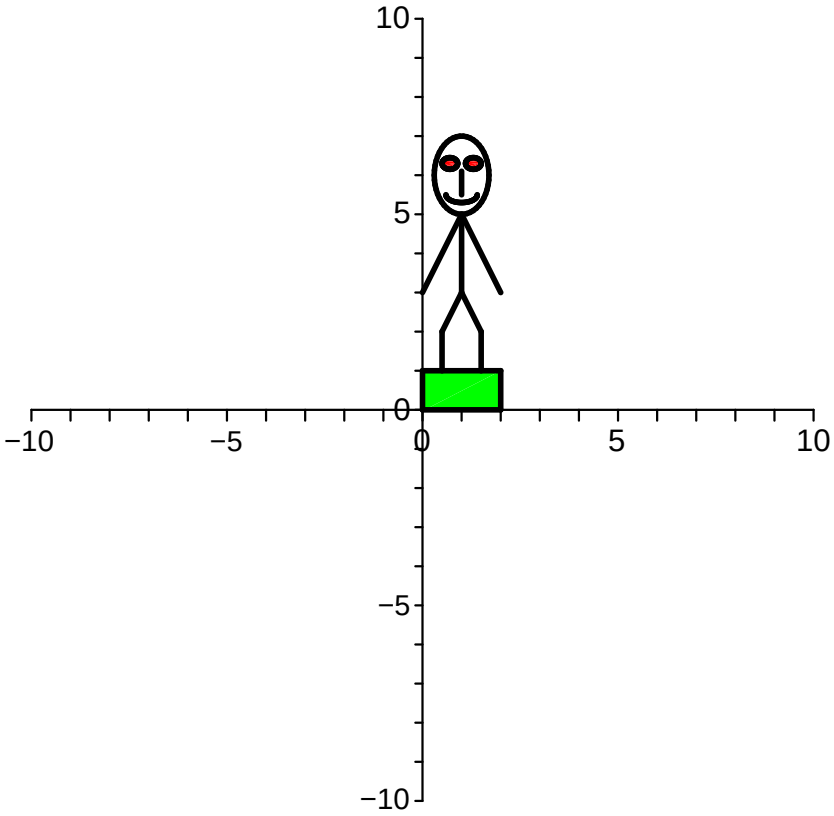
October 6, 2004

Load the packages for graphics and Linear Algebra

```
> with(Student[LinearAlgebra]): with(plottools): with(plots):
Warning, the previous binding of the name arrow has been removed and it now
has an assigned value
```

Define an object in the plane we are going to play with

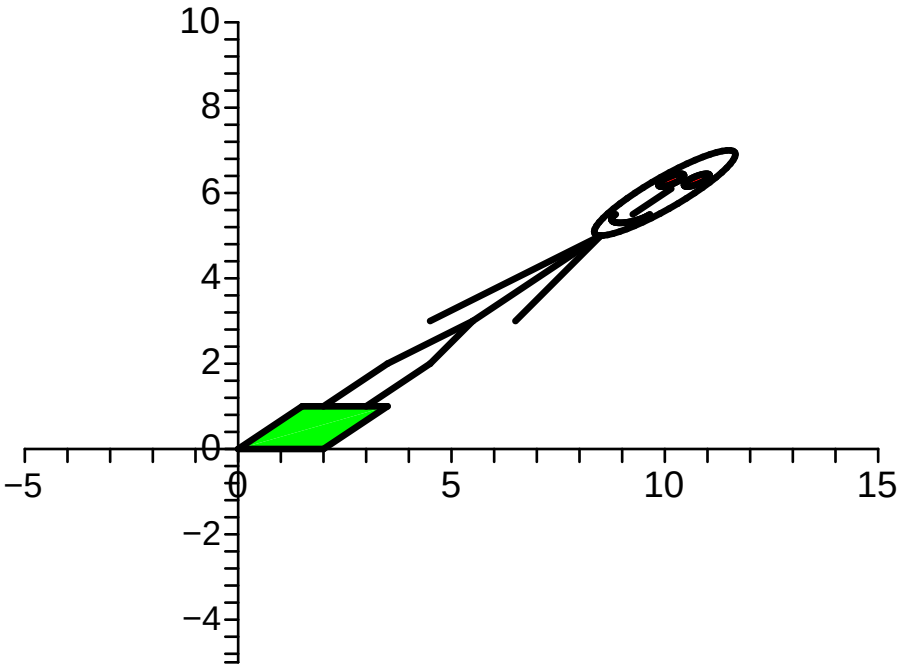
```
> box := rectangle([0, 0], [2, 1], color = green):
  face := ellipse([1, 6], 0.7, 1):
  lefteye := ellipse([0.7, 6.3], 0.2, 0.15, filled = true, color = red):
  righteye := ellipse([1.3, 6.3], 0.2, 0.15, filled = true, color = red):
  nose := line([1, 6.1], [1, 5.5]):
  smile := ellipticArc([1, 5.5], 0.4, 0.2, Pi..2*Pi):
  body := line([1, 5], [1, 3]):
  leftarm := line([1, 5], [0, 3]):
  rightarm := line([1, 5], [2, 3]):
  leftleg := line([1, 3], [0.5, 2]), line([0.5, 2], [0.5, 1]):
  rightleg := line([1, 3], [1.5, 2]), line([1.5, 2], [1.5, 1]):
> guy := [face, lefteye, righteye, nose, smile, body, leftarm, rightarm,
  leftleg, rightleg]:
> picture := display(box, guy, scaling=constrained, view = [-10..10, -10..10]
  thickness = 2):
> display(picture);
```



Perform a shear transformation

```
> A := <<1, 0> | <1.5, 1>>;
  ApplyLinearTransformPlot(A, picture, output = animation, iterations = 1,
  view = [-5..15, -5..10], title = "");
```

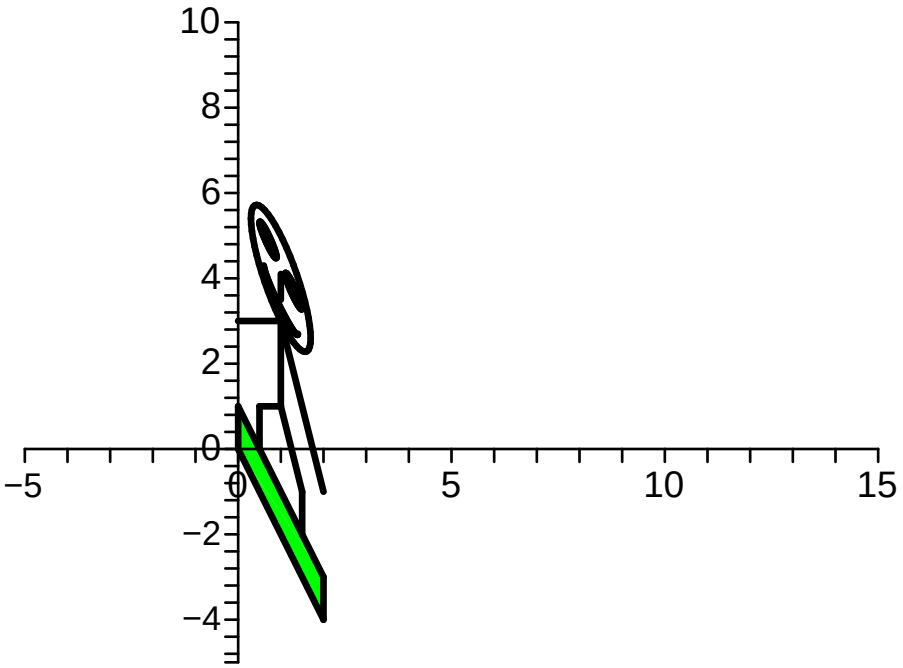
$$A := \begin{bmatrix} 1 & 1.5 \\ 0 & 1 \end{bmatrix}$$



Another shear transformation

```
> A := <<1, -2> | <0, 1>>;
  ApplyLinearTransformPlot(A, picture, output = animation, iterations = 1,
  view = [-5..15, -5..10], title = "");
```

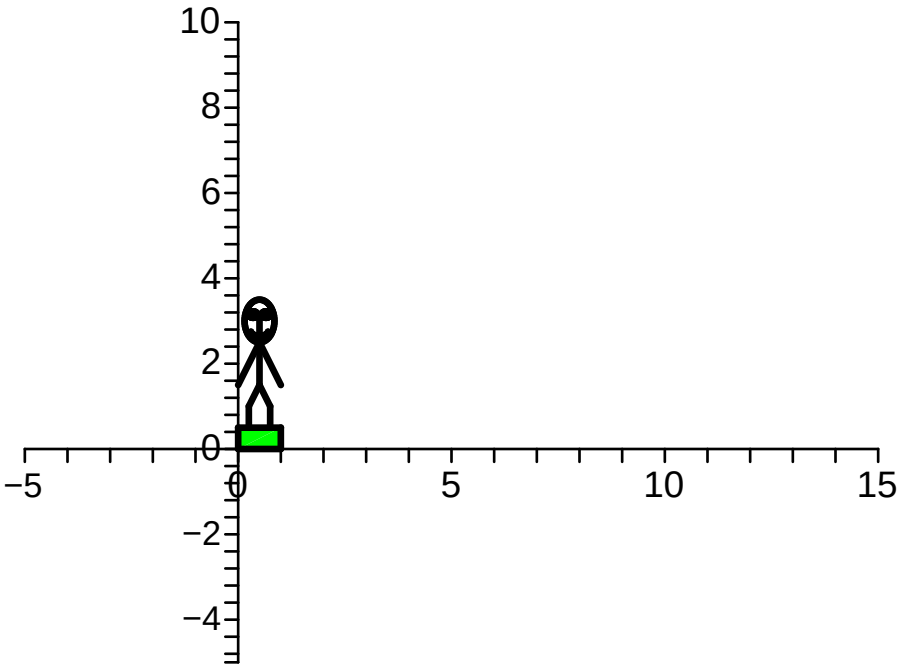
$$A := \begin{bmatrix} 1 & 0 \\ -2 & 1 \end{bmatrix}$$



Perform a contraction . . .

```
> A := <<0.5, 0> | <0, 0.5>>;
  ApplyLinearTransformPlot(A, picture, output = animation, iterations = 1,
  view = [-5..15, -5..10], title = "");
```

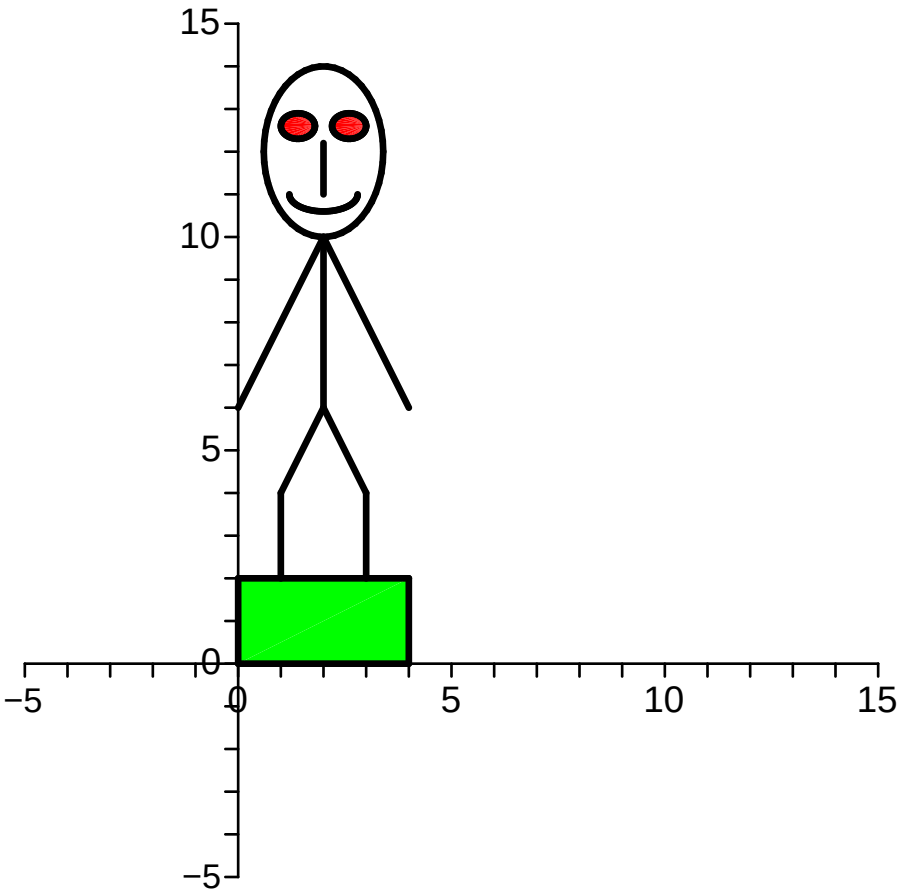
$$A := \begin{bmatrix} 0.5 & 0 \\ 0 & 0.5 \end{bmatrix}$$



. . . and dilation

```
> A := <<2, 0> | <0, 2>>;
  ApplyLinearTransformPlot(A, picture, output = animation, iterations = 1,
  view = [-5..15, -5..15], title = "");
```

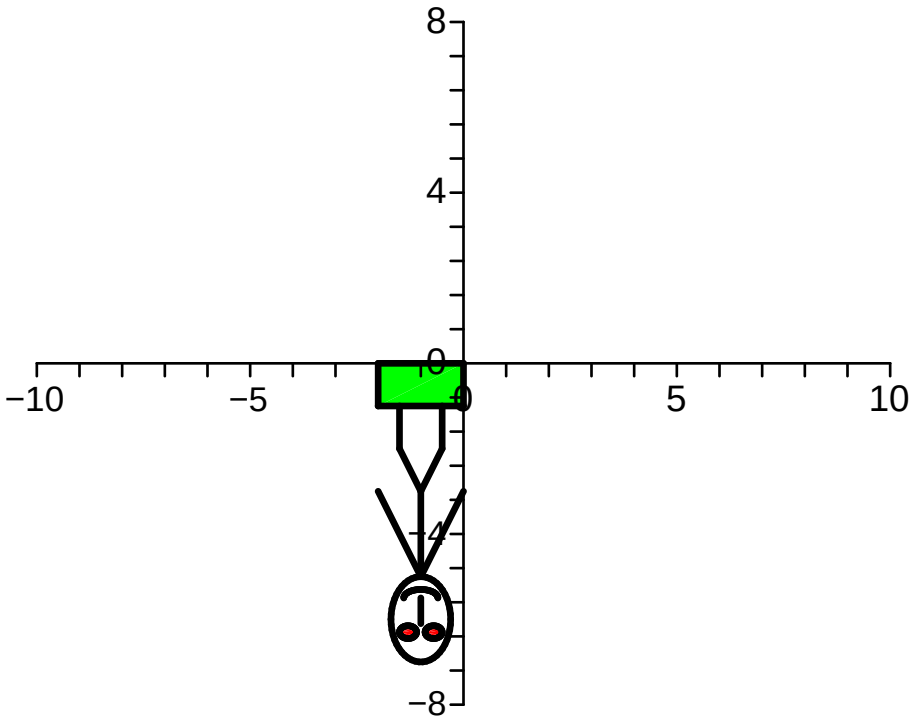
$$A := \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$$



Also a reflection . . .

```
> A := <<-1, 0> | <0, -1>>;
  ApplyLinearTransformPlot(A, picture, output = animation, iterations = 1,
  view = [-10..10, -8..8], title = "");
```

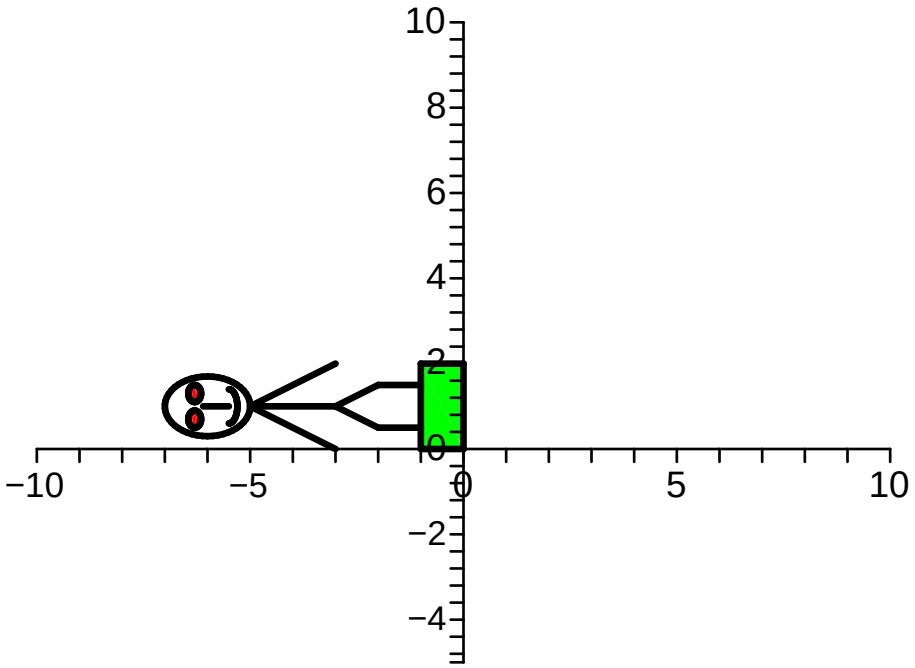
$$A := \begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$$



. . . and rotation

```
> A := <<0, 1> | <-1, 0>>;
  ApplyLinearTransformPlot(A, picture, output = animation, iterations = 1,
  view = [-10..10, -5..10], title = "");
```

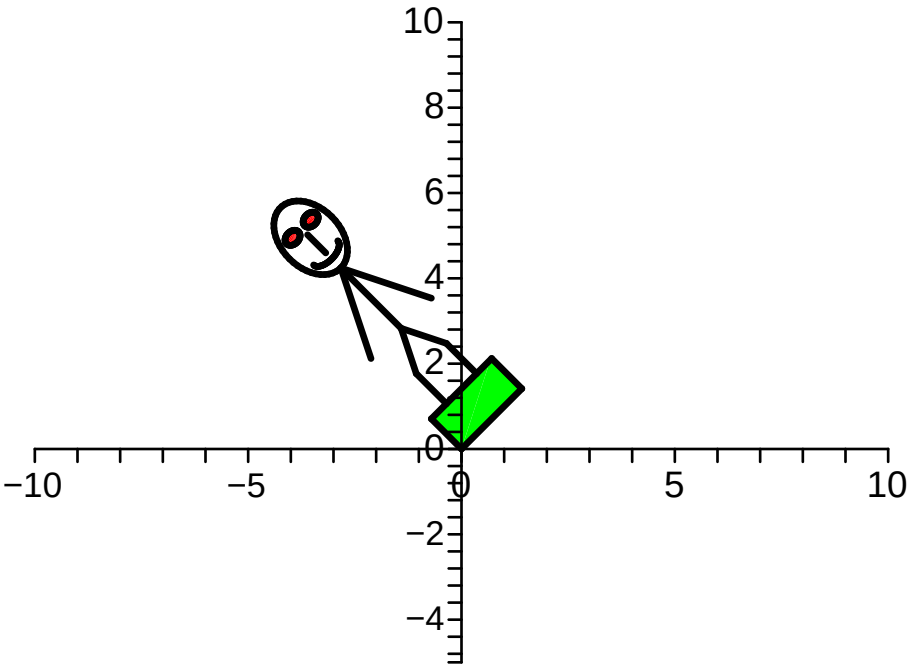
$$A := \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$$



Another rotation

```
> A := <<1/sqrt(2), 1/sqrt(2)> | <-1/sqrt(2), 1/sqrt(2)>>;
  ApplyLinearTransformPlot(A, picture, output = animation, iterations = 1,
  view = [-10..10, -5..10], title = "");
```

$$A := \begin{bmatrix} \frac{1}{2}\sqrt{2} & -\frac{1}{2}\sqrt{2} \\ \frac{1}{2}\sqrt{2} & \frac{1}{2}\sqrt{2} \end{bmatrix}$$


10
8
6
4
2
0
−2
−4
−10
−5
0
5
10

>