

18.06 2020 HW#0 (no credit)

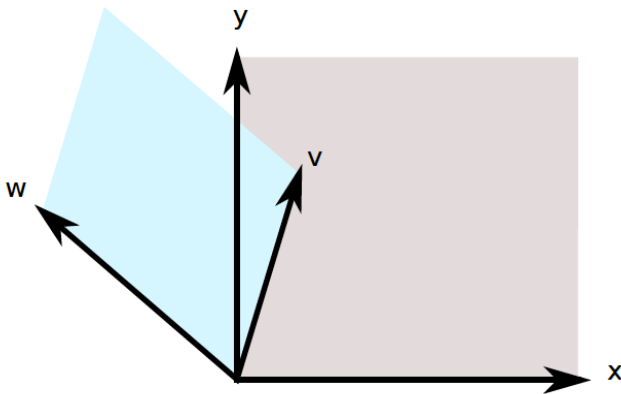
Submit your homework through [gradescope](#) by Wednesday 11:59pm to get into good habits, though you can submit this hw (only!) later.

1. Written assignment -- worth thinking about

(Inspired by Strang 1.1 problem 18 page 9) Draw two non-colinear vectors v and w , and the region that consists of all combinations $cv+dw$ where $0 \leq c \leq 1$ and $0 \leq d \leq 1$. Now consider the linear transformation of the unit square (all points (c,d) with $0 \leq c \leq 1$ and $0 \leq d \leq 1$) by the 2×2 matrix with first column v and second column w . Are these two regions the same?

ANSWER:

They are the same.



The region consisting of all $cv+dw$ with $0 \leq c \leq 1$ and $0 \leq d \leq 1$ is drawn in blue which is the same as the image of the unit square (gray) under the linear transformation $[v \ w]$. One way to see this is to consider the “column view” of matrix multiply described in GS section 1.3.

2. [Download Julia \(1.3.1\)](#). (choose from windows, mac, linux). Please let us know if it takes more than 2 or 3 minutes. Start up the Julia application, type $1 + 1$ and see if you can get 2. (This is called a “hello world”). Please let us know if we should make julia available on athena workstations for any reason. (e.g., you don't have a laptop of your own, or a friend's you can borrow. You prefer athena. Any reason at all.)

(Nothing to hand in, if there are no issues)

REMARK:

Not a single student reported an issue!

3. Let's learn some linear algebra words by executing Julia commands (without knowing what they are! It is not a good idea to look these ideas up at this time.) The purpose of this is to simply "hear" the words in your inner mind. First load the LinearAlgebra package.

```
julia> using Pkg
julia> Pkg.add("LinearAlgebra")
julia> using LinearAlgebra
```

Next define a matrix

```
julia> A = [1 2 ; 3 4]
```

and tell us which commands below return a 2x2 matrix and which a vector of length 2.

```
julia> inv(A)
```

```
julia> eigvals(A)
```

```
julia> svdvals(A)
```

```
julia> A*A
```

Please include a screen copy of your execution of the above four commands.

ANSWER:

We include a screen copy on the next page. We see that the commands `inv(A)` and `A*A` return a 2x2 matrix while `eigvals` and `svdvals` each return a vector of length 2.

```

[julia> A=[1 2;3 4]
2×2 Array{Int64,2}:
 1  2
 3  4

[julia> inv(A)
2×2 Array{Float64,2}:
-2.0  1.0
 1.5 -0.5

[julia> eigvals(A)
2-element Array{Float64,1}:
-0.3722813232690143
 5.372281323269014

[julia> svdvals(A)
2-element Array{Float64,1}:
 5.464985704219043
 0.36596619062625746

[julia> A*A
2×2 Array{Int64,2}:
 7  10
15  22

```

4. If you would like to try Jupyter notebooks do

```

julia> Pkg.add("IJulia")
julia> using("IJulia")
julia> notebook()

```

More on this at another time.

REMARK:

Many students tried and were able to run Jupyter notebooks. Fun fact: the name “Jupyter” refers to Julia, Python, and R.

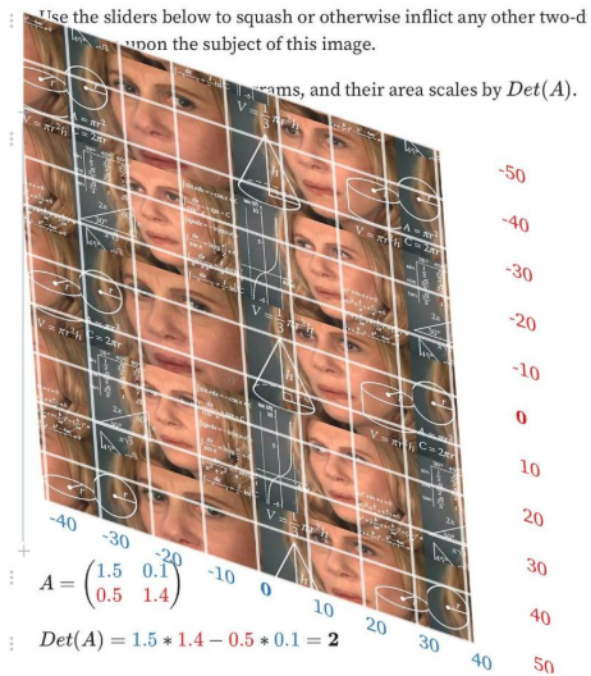
5. (late addition) Completely optional but fun:

Place your favorite photo, and pick a linear transformation on the [class demo of 2d linear transformations](#) and include in your submission. Best photo+transformation will be praised and honored in class.

Some fun linear transformations are included in the next pages.

FUN TRANSFORMATIONS

1. Confused Math Person

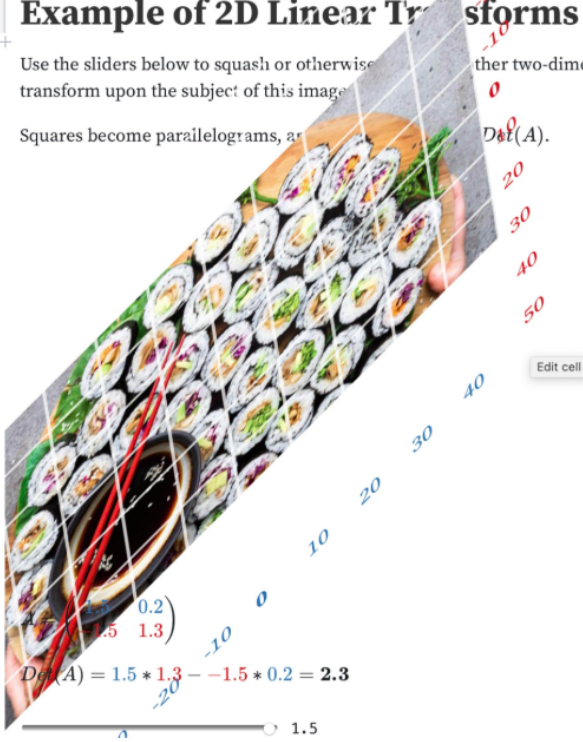


2. Sushi

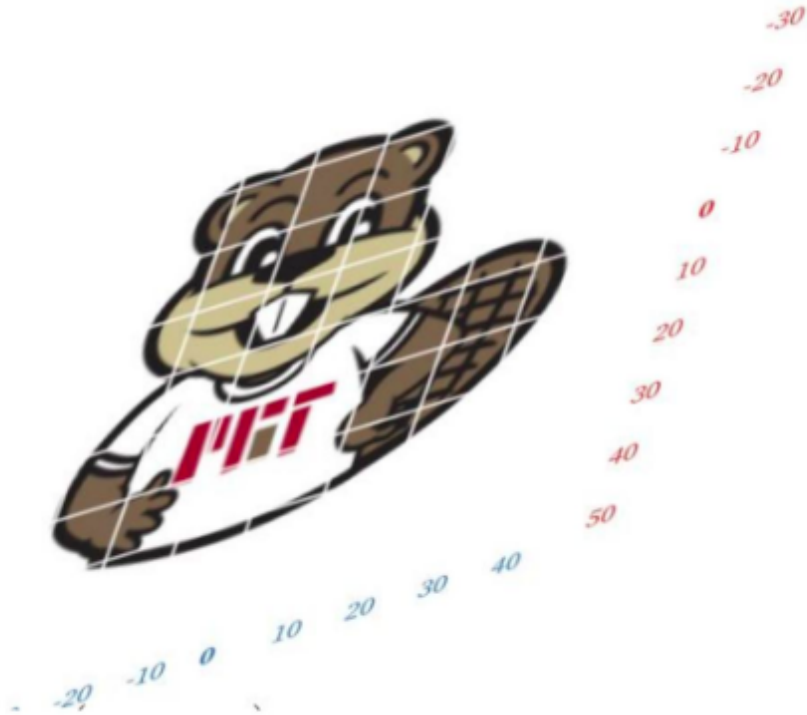
Example of 2D Linear Transforms

Use the sliders below to squash or otherwise transform other two-dimensional images. The image below shows the result of a linear transform upon the subject of this image.

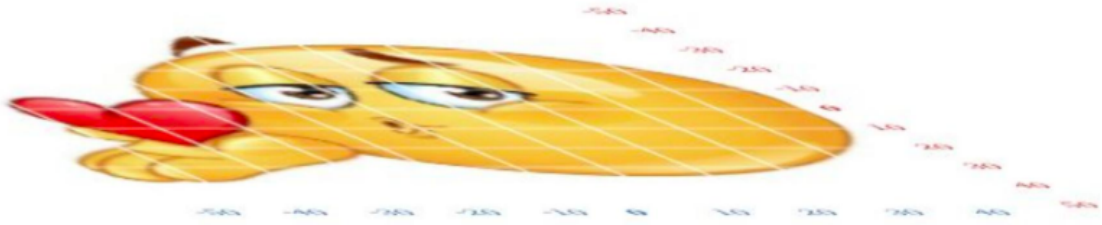
Squares become parallelograms, and the determinant of the transformation matrix is $\text{Det}(A)$.



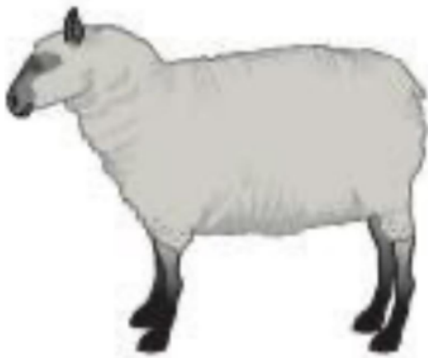
3. Beaver



4. Emoji



5. Sheared Sheep (get it?)



sheep



sheared sheep

6. Ironman blasting a taco to Kirby

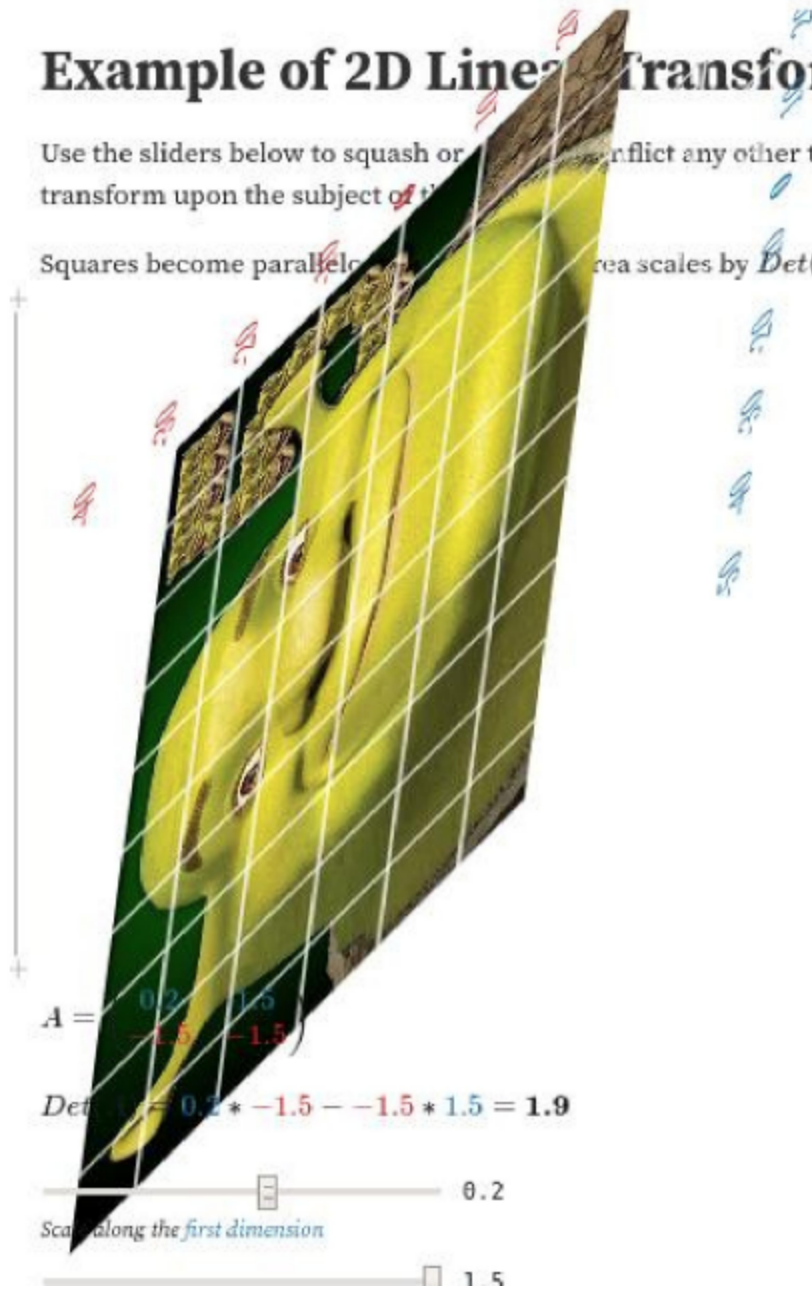
The image displays three browser windows illustrating 2D linear transformations. The left window, titled "Example of 2D Linear Transform:", shows a screenshot of Ironman from the movie "Iron Man 3" with a white grid overlaid on it. Below the image, the transformation matrix is given as $A = \begin{pmatrix} 1.5 & 1.5 \\ -0.1 & 1.5 \end{pmatrix}$ and the determinant is calculated as $\text{Det}(A) = 1.5 * 1.5 - -0.1 * 1.5 = 2.4$. The middle window shows a screenshot of a taco with a white grid overlaid on it. The right window, titled "Example of 2:", shows a screenshot of Kirby from the video game "Kirby's Dream Land" with a white grid overlaid on it. Below the image, the transformation matrix is given as $A = \begin{pmatrix} -1.5 & -0.2 \\ -1.2 & 1.5 \end{pmatrix}$ and the determinant is calculated as $\text{Det}(A) = -1.5 * 1.5 - 0.2 * 1.2$. A Windows PowerShell window is also visible in the background, showing a list of installed packages.

7. Shrek

Example of 2D Linear Transforms

Use the sliders below to squash or stretch or reflect any other two-dimensional linear transform upon the subject of the image.

Squares become parallelograms and area scales by $\text{Det}(A)$.

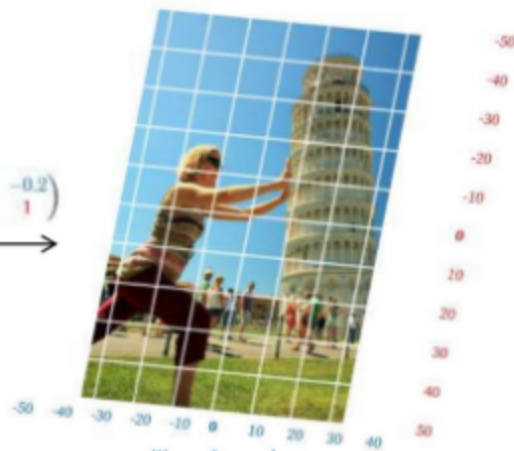


- 8.
9. Righting Pisa



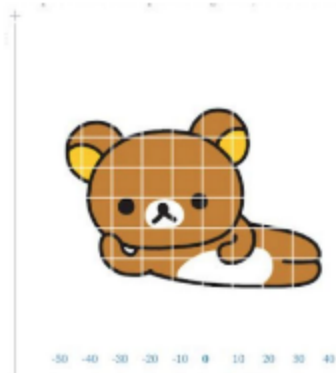
Original

$$\begin{pmatrix} 1 & -0.2 \\ 0.1 & 1 \end{pmatrix}$$



Transformed

10. Anime Bear



$$A = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$$

$$\text{Det}(A) = 1 \times 1 - 0 \times 0 = 1$$

5.

^reclining bear

Example of 2D transforms

Use the matrices below to transform upon it!

Squares (see

any other two-dimensional linear

$\%A$).



$$A = \begin{pmatrix} -1 & 1 \\ 1 & 1 \end{pmatrix}$$

$$\text{Det}(A) = -1 \times 1 - 1 \times 1 = -2$$

^superhero bear (imagine a cape!!)