

Step 1 of 4

Swap pivot into position:  $R2 \leftrightarrow R1$

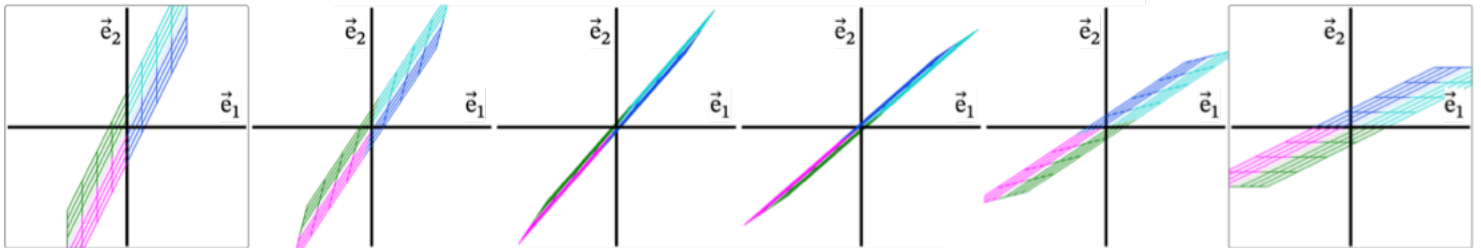
$$\left[ \begin{array}{c|c} 0 & 0.5 \\ \hline -0.3 & 1 \end{array} \right] \rightarrow \left[ \begin{array}{c|c} -0.3 & 1 \\ \hline 0 & 0.5 \end{array} \right]$$

Column directions

Swapping coordinate directions:

the coordinate grid is reflected across  $x_2 = x_1$

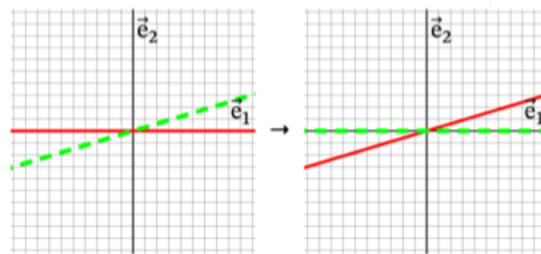
(frames shows the grid moving towards projection and then to reflection)



Row normal lines (red: r1, green: r2)

Swapping lines:

green and red lines exchange places



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Step 2 of 4

Make pivot  $M[2,2] = 1$

$$R2 \leftarrow \left( \frac{1}{M[2,2]} \right) \times R2$$

$$\left[ \begin{array}{c|c} -0.3 & 1 \\ \hline 0 & 0.5 \end{array} \right] \rightarrow \left[ \begin{array}{c|c} -0.3 & 1 \\ \hline 0 & 1 \end{array} \right]$$

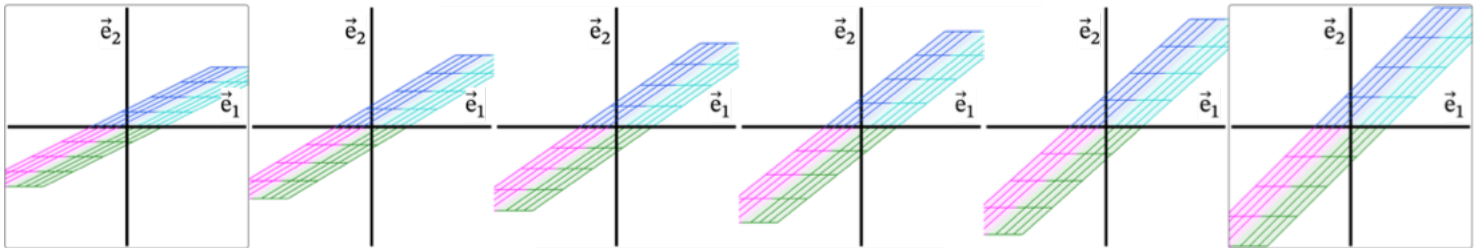
Column directions

Scaling space:

- both columns scale together along  $\vec{e}_2$  direction by 2 scaling coefficient  $> 0$



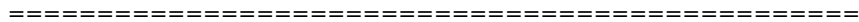
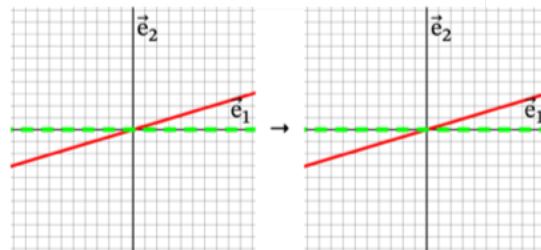
directions are preserved  
(frames show gradual transformation)



Row normal lines (red: r1, green: r2)

Scaling:

row normal lines remain unchanged



Step 3 of 4

Make  $M[1,2] = 0$  using pivot  $M[2,2]$

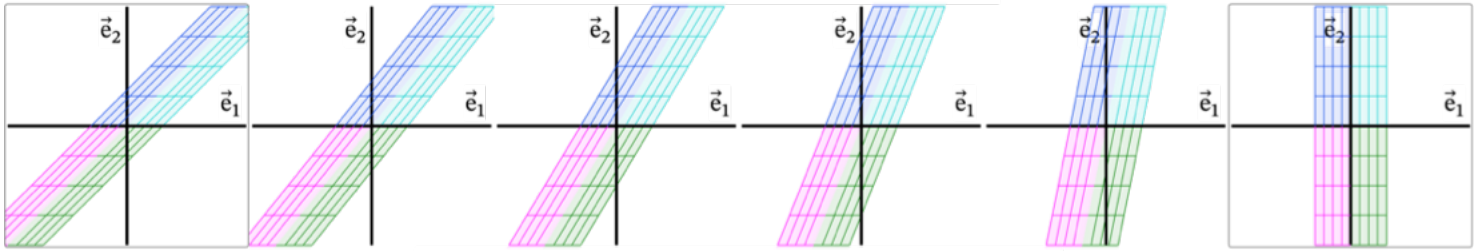
$$R1 \leftarrow R1 - M[1,2]*R2$$

$$\left[ \begin{array}{cc|c} -0.3 & 1 & \\ \hline 0 & 1 & \end{array} \right] \rightarrow \left[ \begin{array}{cc|c} -0.3 & 0 & \\ \hline 0 & 1 & \end{array} \right]$$

Column directions

Shearing space:

- both columns move together
- sheared space straightens along  $\vec{e}_1$  direction  
(frames show gradual transformation)



Row normal lines (red: r1, green: r2)

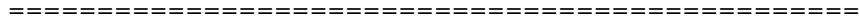
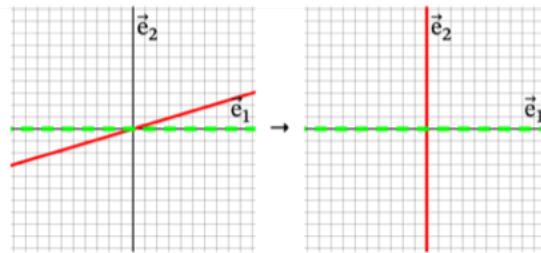
- red line moves

coefficient of  $x_2$  is eliminated in the row equation of row 1



red moves so that

$$(\text{red line normal}) \cdot \vec{e}_2 = 0$$



Step 4 of 4

Make pivot  $M[1,1] = 1$

$$R1 \leftarrow \left( \frac{1}{M[1,1]} \right) \times R1$$

$$\left[ \begin{array}{cc|c} -0.3 & 0 & \\ 0 & 1 & \end{array} \right] \rightarrow \left[ \begin{array}{cc|c} 1 & 0 & \\ 0 & 1 & \end{array} \right]$$

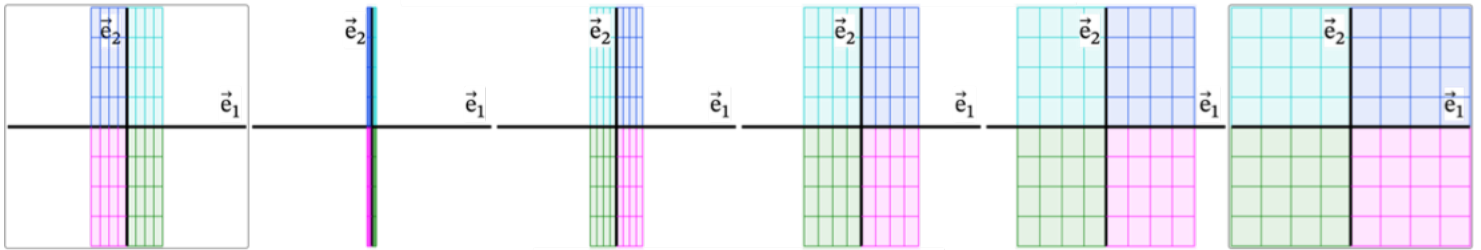
Column directions

Scaling space:

- both columns scale together along  $\vec{e}_1$  direction by  $\approx -3.333$   
scaling coefficient  $< 0$



direction along this axis is reversed  
(frames show gradual transformation)



Row normal lines (red: r1, green: r2)

Scaling:

row normal lines remain unchanged

