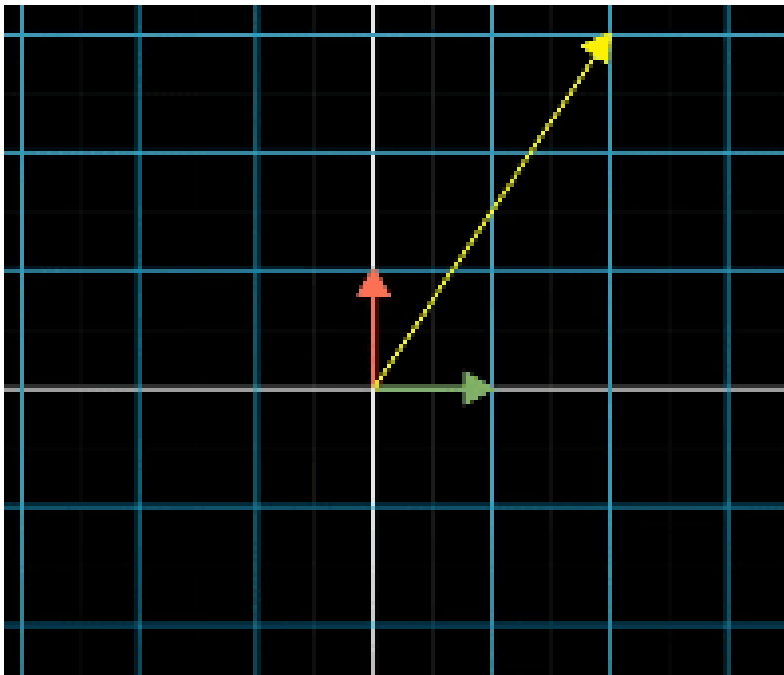


# Matrix multiplication and Composition

In order to describe the effects of multiple sequential matrix transformation, such as a rotate and then a shear, we use matrix multiplication on those individual matrices to create a new matrix, called composition, to perform the action at once.



$$\underbrace{\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}}_{\text{Shear}} \left( \underbrace{\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}}_{\text{Rotation}} \begin{bmatrix} x \\ y \end{bmatrix} \right)$$

$$f(g(x))$$

Read right to left

$$\underbrace{\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}}_{\text{Shear}} \underbrace{\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}}_{\text{Rotation}}$$

$$\underbrace{\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}}_{\text{Shear}} \underbrace{\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}}_{\text{Rotation}} = \underbrace{\begin{bmatrix} 1 & -1 \\ 1 & 0 \end{bmatrix}}_{\text{Composition}}$$

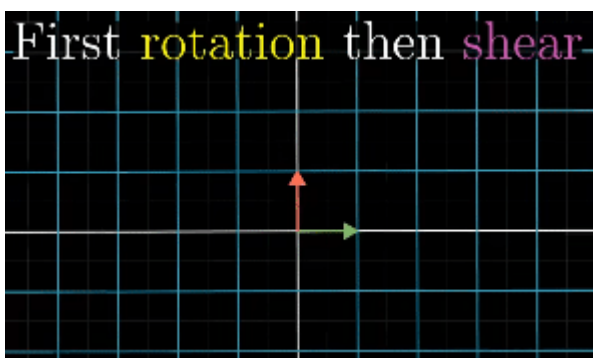
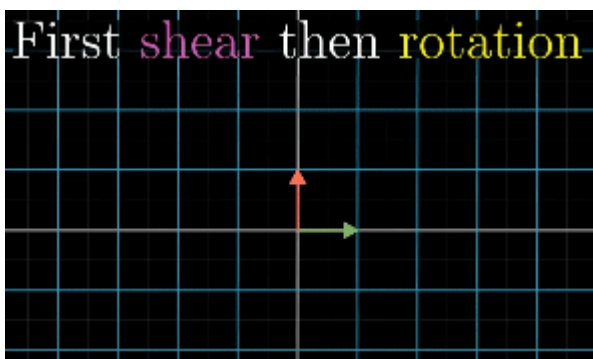
$$\overbrace{\begin{bmatrix} a & b \\ c & d \end{bmatrix}}^{M_2} \overbrace{\begin{bmatrix} e & f \\ g & h \end{bmatrix}}^{M_1} = \begin{bmatrix} ae + bg & af + bh \\ ce + dg & cf + dh \end{bmatrix}$$

$$\begin{bmatrix} -3 & 1 \\ 2 & 5 \end{bmatrix} \begin{bmatrix} 5 & 3 \\ 7 & -3 \end{bmatrix} = \begin{bmatrix} -13 & 16 \\ 38 & -2 \end{bmatrix}$$

Order of the Matrices matter

$$M_1 M_2 \neq M_2 M_1$$

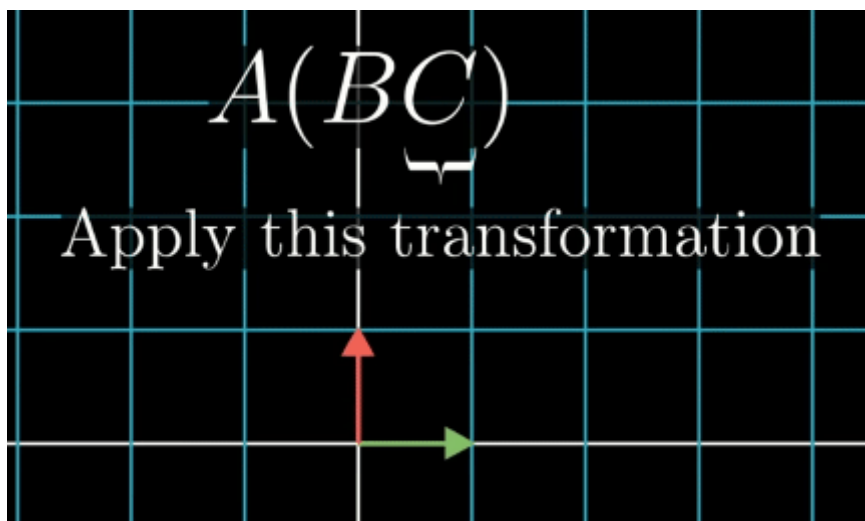
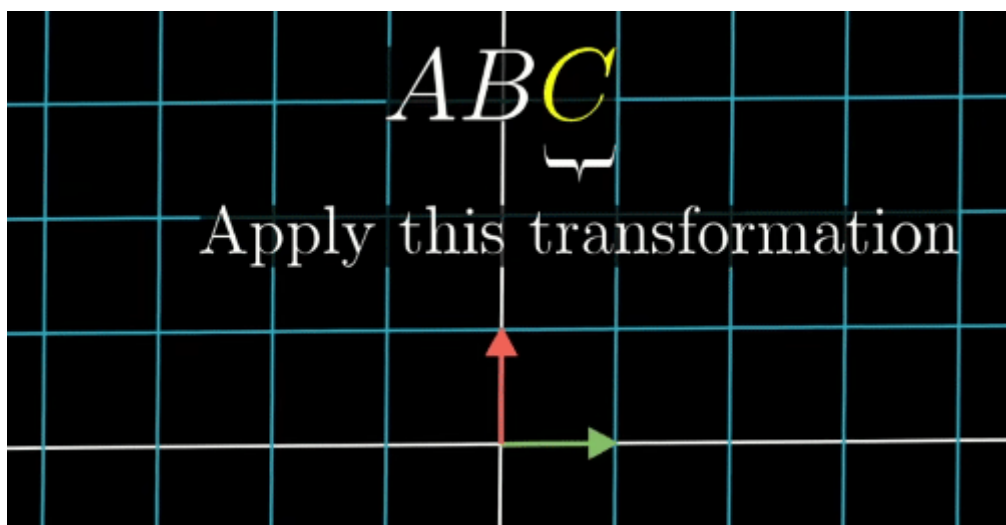
The following demonstrates that if the order is reversed, the vector output will be different



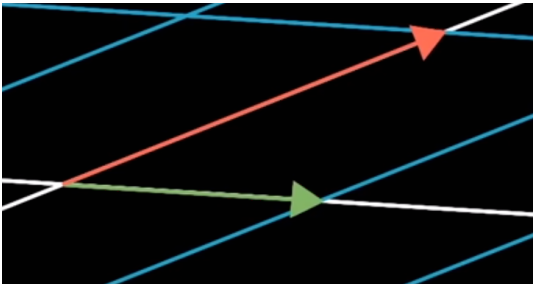
# Matrix Multiplication is Associative

Also this is associative, meaning that parentheses does not matter, the pattern will still have the same result as long as the right to left order is the same

$$(AB)C = A(BC)$$



End result will always look the same



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Revision #7

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