2. Rotations

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Practice

Rotate a Vector

1/1 point (graded)

Recall: The rotation matrix $R_\theta = \begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}$.

Find a two-dimensional vector v such that the angle between v and the vector $\begin{pmatrix} 1 \\ 2 \end{pmatrix}$ is 30°. There is more than one possible answer.

(Enter a vector using notation such as `[a,b]`.)

$v =$ [sqrt(3)/2-1,sqrt(3)+1/2] ✔ **Answer:** [sqrt(3)/2 - 1, sqrt(3) + 1/2]

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Solution:

We have $v = R_{\frac{\pi}{6}} \begin{pmatrix} 1 \\ 2 \end{pmatrix} = \begin{pmatrix} \sqrt{3}/2 - 1 \\ \sqrt{3} + 1/2 \end{pmatrix}$.

It would also be correct to answer $R_{\frac{-\pi}{6}} v = \begin{pmatrix} \sqrt{3}/2 + 1 \\ \sqrt{3} - 1/2 \end{pmatrix}$, or any scalar multiple of these.

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Rotate twice

1/1 point (graded)

Let $M_1 = R_{\frac{\pi}{3}}$ and $M_2 = R_{\frac{\pi}{6}}$. Find the matrix product $M_1 M_2$.

(Enter a matrix using notation such as `[[a,b],[c,d]]`.)

$M_1 M_2 =$ [[0,-1],[1,0]] ✔ **Answer:** [[0,-1],[1,0]]

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Solution:

$M_1 M_2 = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$. This is $R_{\frac{\pi}{2}}$.

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Rotating Complementary Angles

1/1 point (graded)
Suppose θ and ϕ are complementary angles, that is, two angles such that $\theta + \phi = \frac{\pi}{2}$. Compute the product $R_\theta R_\phi$. Your answer should not involve θ or ϕ.

(Enter a matrix using notation such as `[[a,b],[c,d]]`.)

$R_\theta R_\phi =$ [[0,-1],[1,0]] **Answer:** [[0,-1],[1,0]]

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Solution:

The product $R_\theta R_\phi = R_{\theta+\phi} = R_{\frac{\pi}{2}} = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$.

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Power of rotation

1/1 point (graded)
Let $M = R_{\frac{\pi}{4}}$. What is the smallest value of $k > 0$ such that $M^k = I$?

$k =$ 8 **Answer:** 8

Solution:

The product $R_\theta R_\phi = R_{\theta+\phi}$. It takes 8 rotations by $\pi/4$ to come back to the start. Therefore $k = 8$, or any integer multiple of 8.

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