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5. Directional derivatives given an angle

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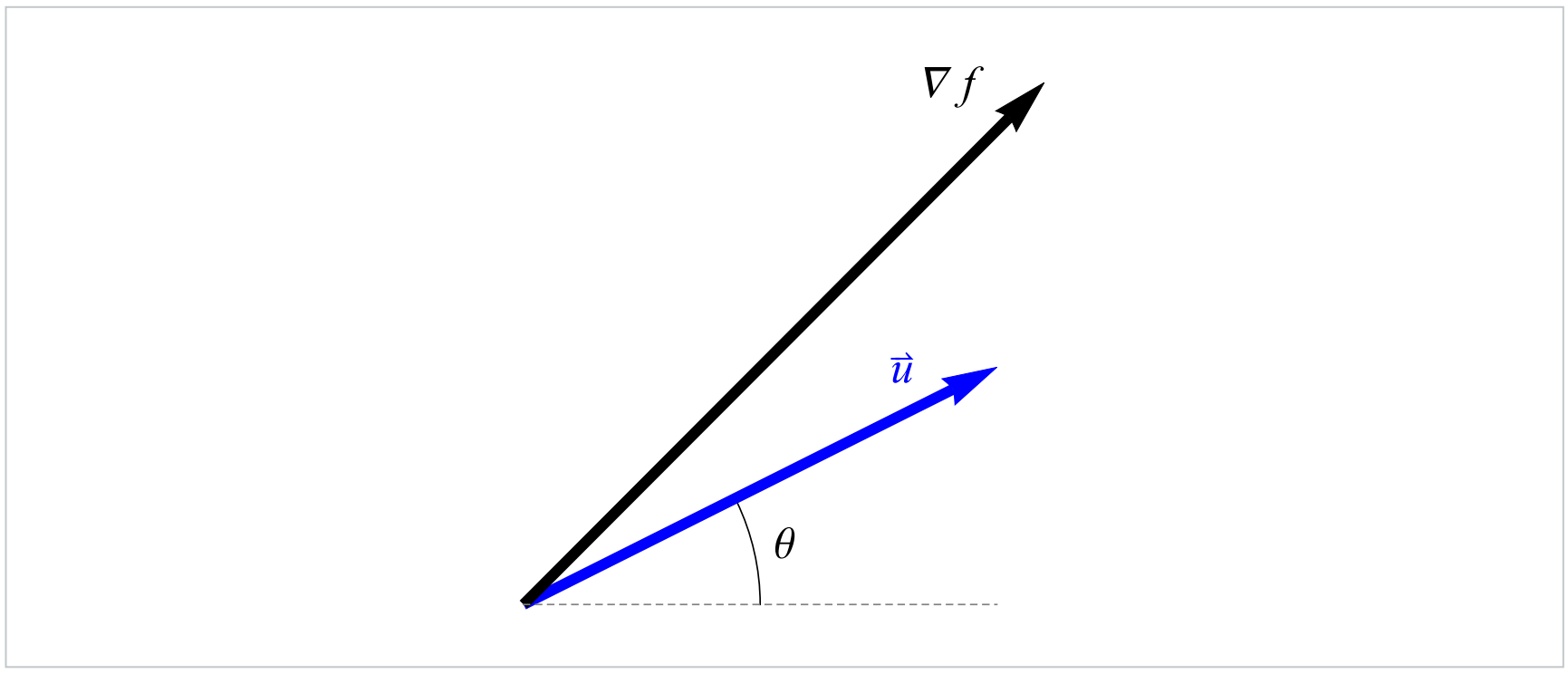
Unit vector given an angle

2.0/2 points (graded)

Let $\hat{\boldsymbol{u}}$ be a unit vector that makes an angle $\boldsymbol{\theta}$ with the positive $\boldsymbol{x}$-axis.



Enter the missing coefficients in terms of $\boldsymbol{\theta}$ that describe the directional derivative in the direction of $\hat{\boldsymbol{u}}$.

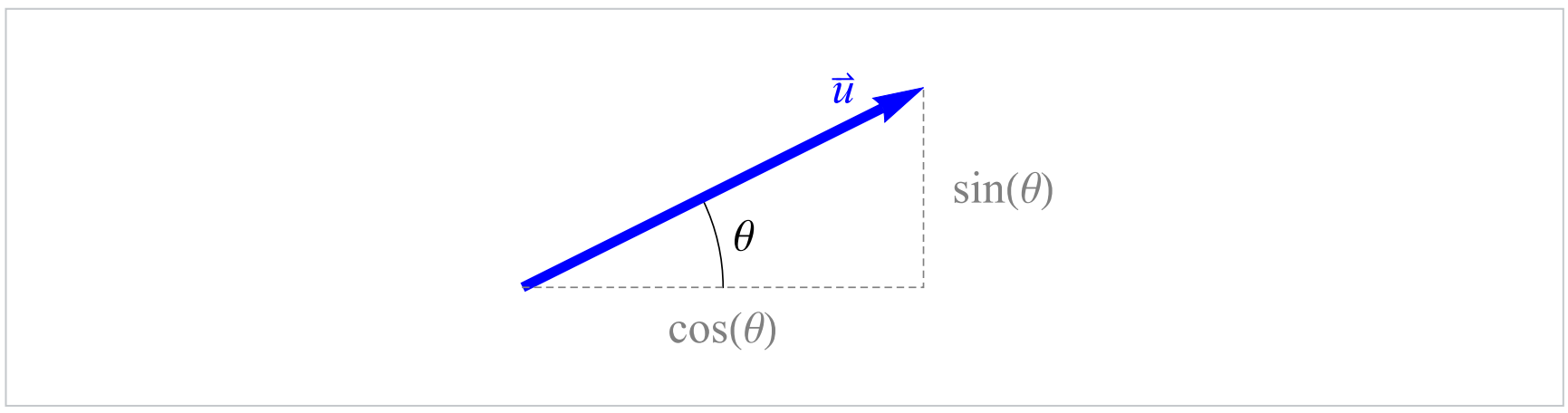
$D_{\hat{u}} f(x,y) =$ cos(theta) $f_x(x,y) +$ ✔ **Answer:** cos(theta)

sin(theta) $f_y(x,y)$ ✔ **Answer:** sin(theta)

Solution:

By drawing a right triangle whose hypotenuse is $\hat{\boldsymbol{u}}$, we see that the unit vector in the direction of $\boldsymbol{\theta}$ is

$$\hat{u} = \langle \cos\theta, \sin\theta \rangle.$$



Then

$$D_{\hat{u}} f(x,y) = \nabla f(x,y) \cdot \hat{u} = \cos\theta f_x(x,y) + \sin\theta f_y(x,y).$$

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Answers are displayed within the problem

Practice

1/1 point (graded)

Let $f(x,y) = x^2y^3 - xe^y$. Find the directional derivative of f at the point $(3,0)$ in the direction $\theta = \frac{\pi}{6}$.

$D_{\hat{u}} f(3,0) =$ -sqrt(3)/2-3/2 ✔ **Answer:** -3/2-sqrt(3)/2

Solution:

We have

$$f_x = 2xy^3 - e^y \text{ and } f_y = 3x^2y^2 - xe^y.$$

So

$$\nabla f = \langle 2xy^3 - e^y, 3x^2y^2 - xe^y \rangle$$

and

$$\nabla f(3,0) = \langle -1, -3 \rangle.$$

Then we compute

$$D_{\hat{u}} f(3,0) = \nabla f(3,0) \cdot \hat{u} = \langle -1, -3 \rangle \cdot \langle \cos(\pi/6), \sin(\pi/6) \rangle = -\frac{\sqrt{3}}{2} - \frac{3}{2}.$$

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5. Directional derivatives given an angle

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