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4. Writing equations as dot products

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Reflect

In the worked examples that follow, we encourage you to determine how to solve the following by using a dot product. If you get stuck, that is OK! There is a solution provided. You can also watch the video that works through these problems instead. Whether or not you find the answer before reading or watching the solution, we recommend thinking through each step of the solution and making justifications to make sure you understand why each step is true.

Question: Find a vector $\vec{v}$ that is perpendicular to $\langle 1, 1/2 \rangle$.

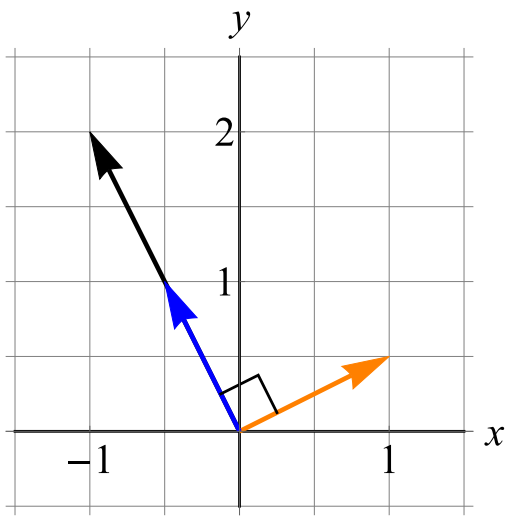
Answer

We want a vector that satisfies

$$0 = \vec{v} \cdot \langle 1, 1/2 \rangle = v_1 + \frac{1}{2} v_2.$$

There are many answers. We could choose any value for v_1 and then solve for v_2. Some possible answers are $\langle -1, 2 \rangle$ and $\langle -1/2, 1 \rangle$.

Let's draw these vectors.



Notice that the vectors we found are both in the same direction. This makes sense because they are both perpendicular to $\langle 1, 1/2 \rangle$ and so they both have to lie at a right angle to $\langle 1, 1/2 \rangle$. You can also check that

$$\langle -1, 2 \rangle = 2 \langle -1/2, 1 \rangle.$$

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Question: Find a vector perpendicular to the line $x + \frac{1}{2} y = 0$.

Hint: Look for a hidden dot product! That is, write the equation for the line as a dot product of vectors.

Answer

We can write the equation for the line as the following dot product:

$$x + \frac{1}{2} y = \langle x, y \rangle \cdot \langle 1, \frac{1}{2} \rangle.$$

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Suppose the point (x, y) is on the line. That means that x and y satisfy the equation

$$0 = x + \frac{1}{2}y = \underbrace{\langle x, y \rangle}_{\text{any point on line}} \cdot \langle 1, \frac{1}{2} \rangle.$$

where we move between thinking of (x, y) as a point, to thinking of it as a vector $\langle x, y \rangle$. So $\langle 1, \frac{1}{2} \rangle$ is perpendicular to the line $x + \frac{1}{2}y = 0$.

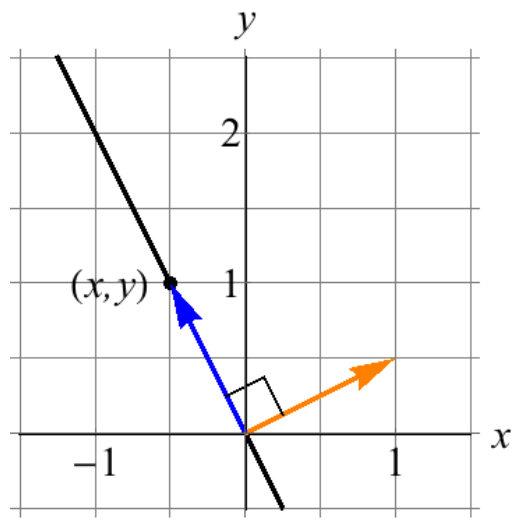
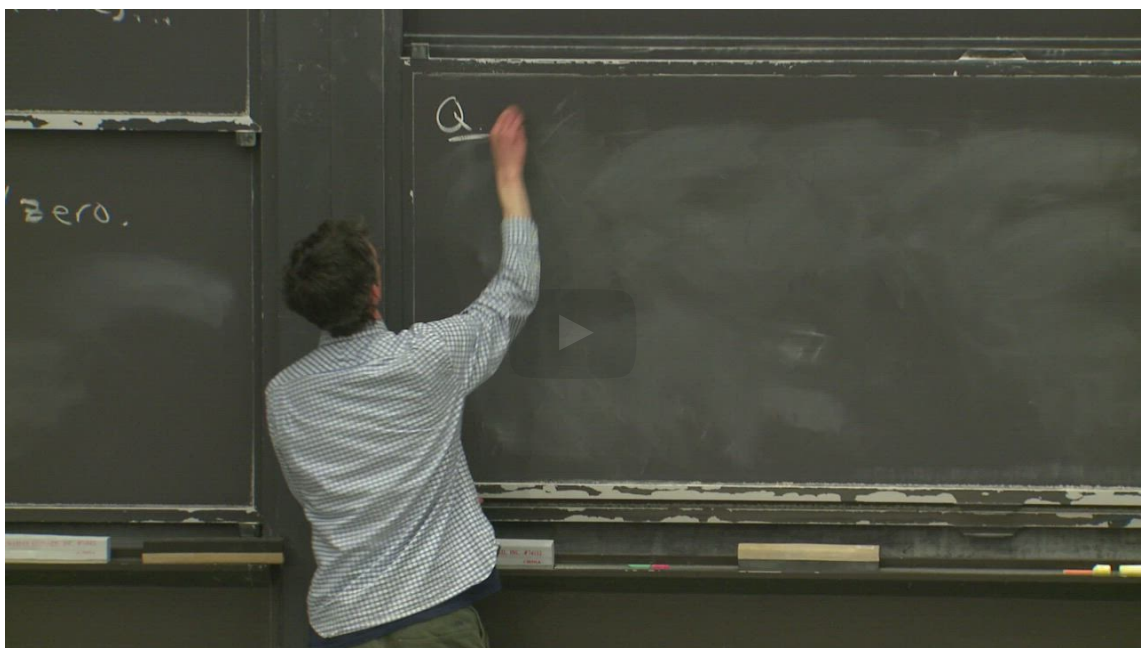


Figure 15: A point (x, y) lies on the line $x + \frac{1}{2}y = 0$. The vector $\langle x, y \rangle$ is perpendicular to the vector $\langle 1, 1/2 \rangle$.

Hide

Find a perpendicular vector



Start of transcript. Skip to the end.

PROFESSOR: OK, so here's the question.

Find a vector v which is perpendicular to say,

1, comma, one-half, (1, 1/2).

OK, so answer, we can test whether it's

perpendicular by taking the dot product.

We want the dot product to be zero.

And if we write out this dot product

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4. Writing equations as dot products

Topic: Unit 2: Geometry of Derivatives / 4. Writing equations as dot products

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? Question: How to think about (0,0) satisfying the equation (x,y).(1,1/2) 3

Hi, I suppose (0,0) is a special case. It's perpendicular to any 2D vector, including (1, 1/2). It's hard for me to wrap my mind around (0,...

(-1/2,1)

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