6. Gradient field

Reflect

What we are doing is drawing a vector field. That is, at every point (a, b), we draw a vector $\nabla f = \langle f_x\,(a,b)\,, f_y\,(a,b)\rangle$.

Definition 6.1

A **vector field** on the plane is a function that attaches a vector to each point (x, y) in the plane.

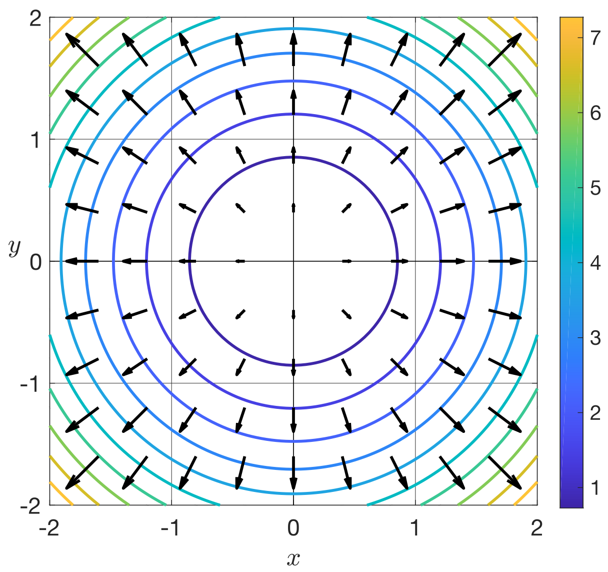
Equivalent definitions:

A vector field is a function $\mathbf{F}$ that maps each point in the plane to a vector:

$$\mathbf{F}\,(x,y) = \langle F_1\,(x,y)\,, F_2\,(x,y)\rangle.$$

A **vector field** is sometimes called a **vector-valued function** .

Example 6.2 The gradient exists at all points where the multivariable function f is defined and differentiable. Therefore we can think of the gradient as a function that attached a vector to every point (x, y). In other words, it is a vector field.



Remark 6.3 Because the lengths of these vectors can be long, it is common when graphing the gradient vectors to scale them down by a constant multiple, so that they are easier to display. This still allows us to make qualitative judgments about the vectors. In the example above, we can still see that the vectors near the origin are shorter than the vectors further from the origin.

The length of the gradient vector does have a concrete meaning, so be careful when interpreting plots of gradient vectors.

Food for thought (to be answered in the next pages):

Why do the vectors of the gradient get larger the farther away from the origin you are? What is the magnitude telling us?

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