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sandipan_dey >

☆ Course/ Unit 1: Functions of two vari... / Lecture 2: Linear approximations and tangent ...

Discussion

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(1)

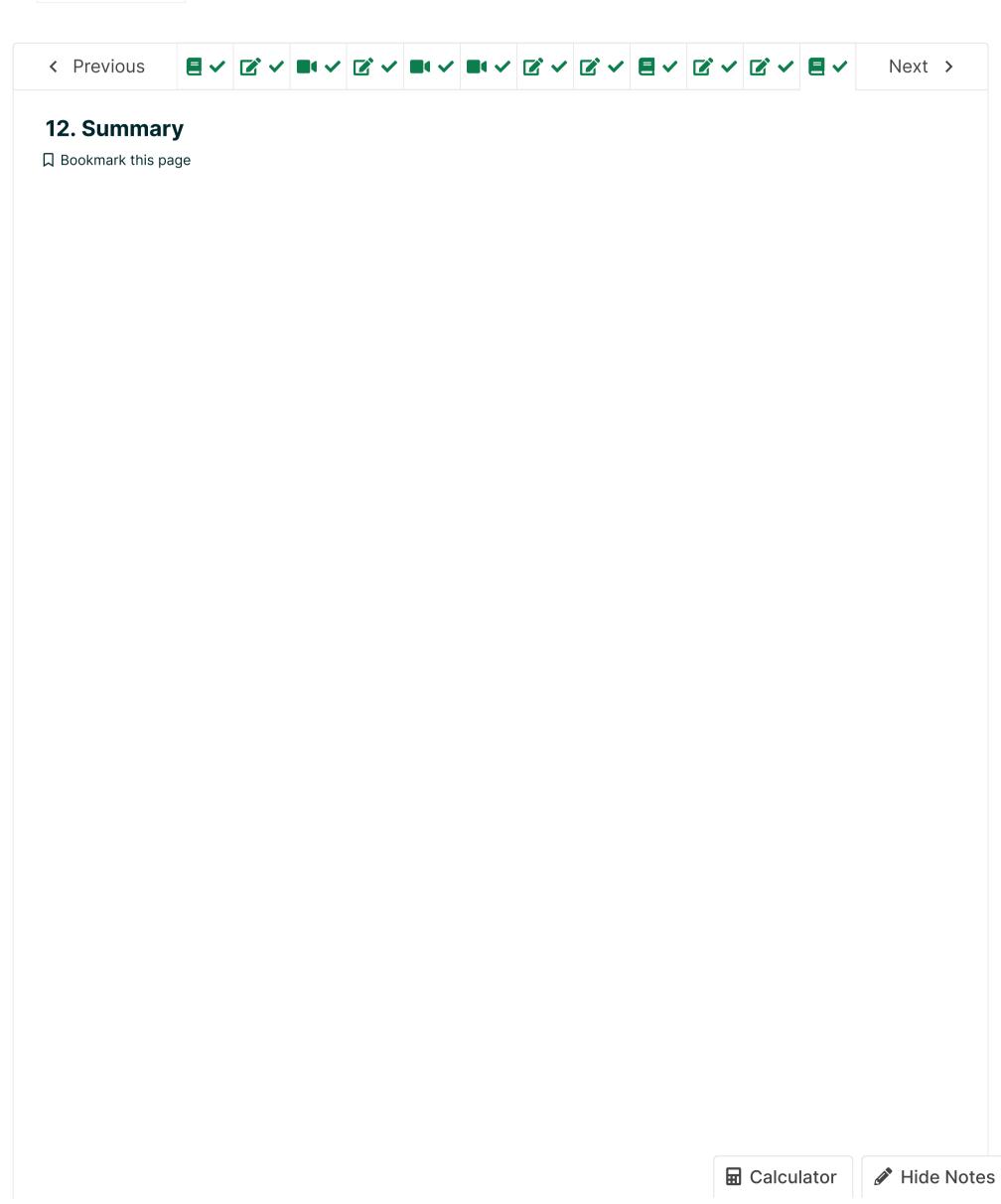
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Summarize

Big Picture

- 1. When you zoom in on the level curves of any function near a point where the function is differentiable, the level curves begin to look like parallel lines.
- 2. The level curves of a plane are parallel lines.
- 3. Close enough to a point, a function can be well approximated by its tangent plane.

Mechanics

Equations of lines and planes

1 variable y=ax+b line 2 variables z=ax+by+c plane

Given a function f(x,y), the **linear approximation** of f near (x_0,y_0) is the **tangent plane** given by the equation

$$f\left(x_{0}+\Delta x,y_{0}+\Delta y
ight)pprox f\left(x_{0},y_{0}
ight)+f_{x}\left(x_{0},y_{0}
ight)\Delta x+f_{y}\left(x_{0},y_{0}
ight)\Delta y$$

Ask Yourself

◆ Can we do linear approximation on the equation for a plane?

You can, but it won't be useful. If f(x,y) is the equation for a plane, it means that f is already a linear function. If you carry out the steps of linear approximation, you will just end up with an approximation $f(x,y) \approx f(x,y)$. In a phrase, if f(x,y) is the equation for a plane, then the equation for the tangent plane is f(x,y) itself.

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▶ Do you need to graph a 2 variable function to find its tangent plane approximation?

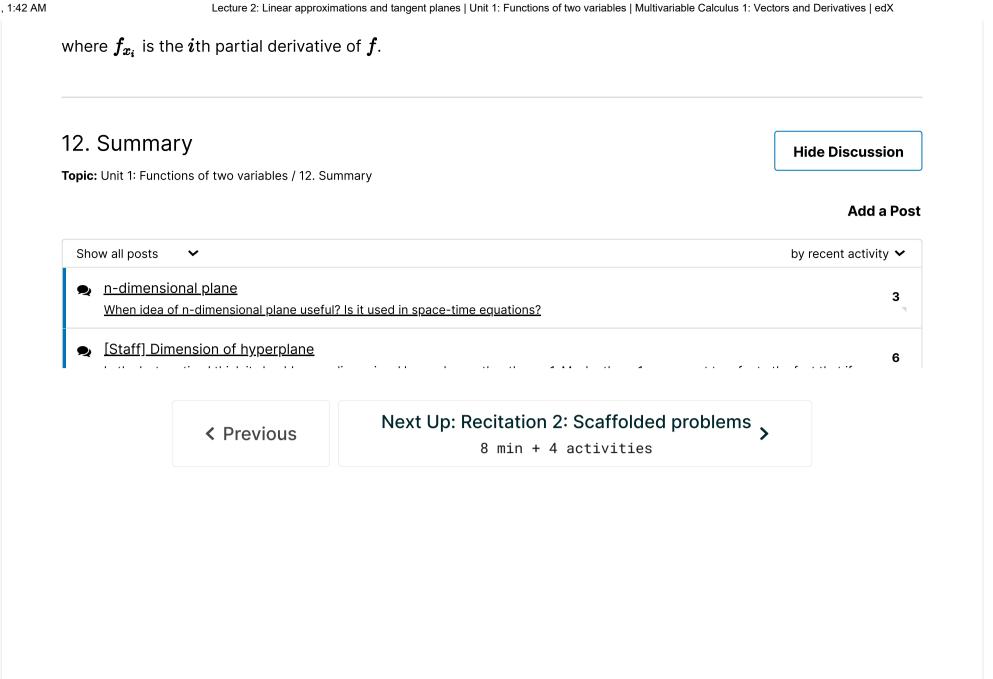
No, we find the tangent plane approximation by taking partial derivatives, which we get from the formula for f(x,y). We don't have to graph anything to do linear approximation. This is good news, since visualizing z = f(x,y) can quickly become difficult. One of the uses for linear approximation is to get some insight into what's going on with f(x,y) without relying on a picture.

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Extensions to higher dimensions

Given a function $f(x_1,\ldots,x_i,\ldots,x_n)$, the linear approximation of f near $(\tilde{x}_1,\ldots,\tilde{x}_i,\ldots,\tilde{x}_n)$ is an n dimensional hyperplane defined by the equation

$$f(ilde{x}_1+\Delta x_1,\ldots, ilde{x}_i+\Delta x_i,\ldots, ilde{x}_n+\Delta x_n) ~~pprox~~ f(ilde{x}_1,\ldots, ilde{x}_i,\ldots, ilde{x}_n)+f_{x_1}\left(ilde{x}_1,\ldots, ilde{x}_i,\ldots, ilde{x}_n
ight)\Delta x_1 \ +\cdots+f_{x_n}\left(ilde{x}_1,\ldots, ilde{x}_i,\ldots, ilde{x}_n
ight)\Delta x_i \ +\cdots+f_{x_n}\left(ilde{x}_1,\ldots, ilde{x}_i,\ldots, ilde{x}_n
ight)$$



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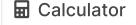
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