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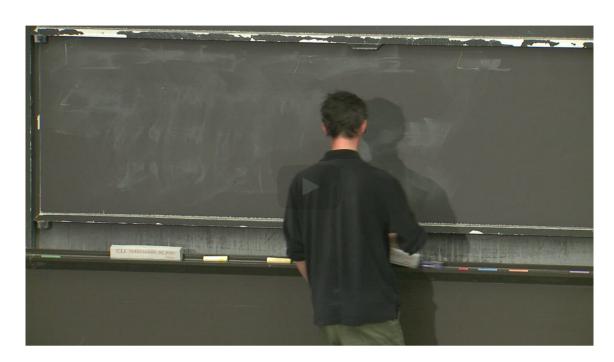


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2D linear approximation



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PROFESSOR: OK.

OK, so the linear approximation for f of (x, y) is supposed to, it gives a good approximation to how f behaves if we change x a little bit, or we change y a little bit, or both. So if we start at a point (x0, y0), and then we imagine changing x a little bit by adding delta x,

and we change wa little hit hy

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Given a function $f\left(x,y
ight)$, the linear approximation of f near $\left(x_{0},y_{0}
ight)$ is

$$f\left(x_0 + \Delta x, y_0 + \Delta y
ight) pprox f\left(x_0, y_0
ight) + rac{\partial f}{\partial x}(x_0, y_0) \, \Delta x + rac{\partial f}{\partial y}(x_0, y_0) \, \Delta y$$

Recall: $\frac{\partial f}{\partial x}$ measures how f changes when we change x a little, and $\frac{\partial f}{\partial y}$ measures how f changes when we change \boldsymbol{y} a little.

Example 6.1

We start with a function we've seen before.

Let's find the linear approximation of the function $f(x,y)=x^2+y^2$ near the point (-1,1).

To get started, we need to compute the partial derivatives of $f\left(x,y
ight)$ at $\left(-1,1
ight)$.

To compute $oldsymbol{f_x}$, differentiate with respect to $oldsymbol{x}$ treating $oldsymbol{y}$ as a constant:

$$f_{x}\left(x,y
ight) =2x+0,\qquad f_{x}\left(-1,1
ight) =2\left(-1
ight) =-2.$$

■ Calculator

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To compute $oldsymbol{f_y}$, differentiate with respect to $oldsymbol{y}$ treating $oldsymbol{x}$ as a constant:

$$f_{y}\left(x,y
ight) =0+2y,\qquad f_{y}\left(-1,1
ight) =2\left(1
ight) =2.$$

Find the value of the function at (-1,1)

$$f(-1,1) = (-1)^2 + (1)^2 = 2.$$

Plug in the values for $f\left(-1,1
ight)$, $f_{x}\left(-1,1
ight)$, and $f_{y}\left(-1,1
ight)$ found above to get

$$f\left(-1+\Delta x,1+\Delta y
ight)pprox \underbrace{2}_{f(-1,1)}+\underbrace{-2}_{f_x(-1,1)}\Delta x+\underbrace{2}_{f_y(-1,1)}\Delta y.$$

6. Linear approximation: multivariable version

Topic: Unit 1: Functions of two variables / 6. Linear approximation: multivariable version

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