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6. Linear approximation: multivariable version

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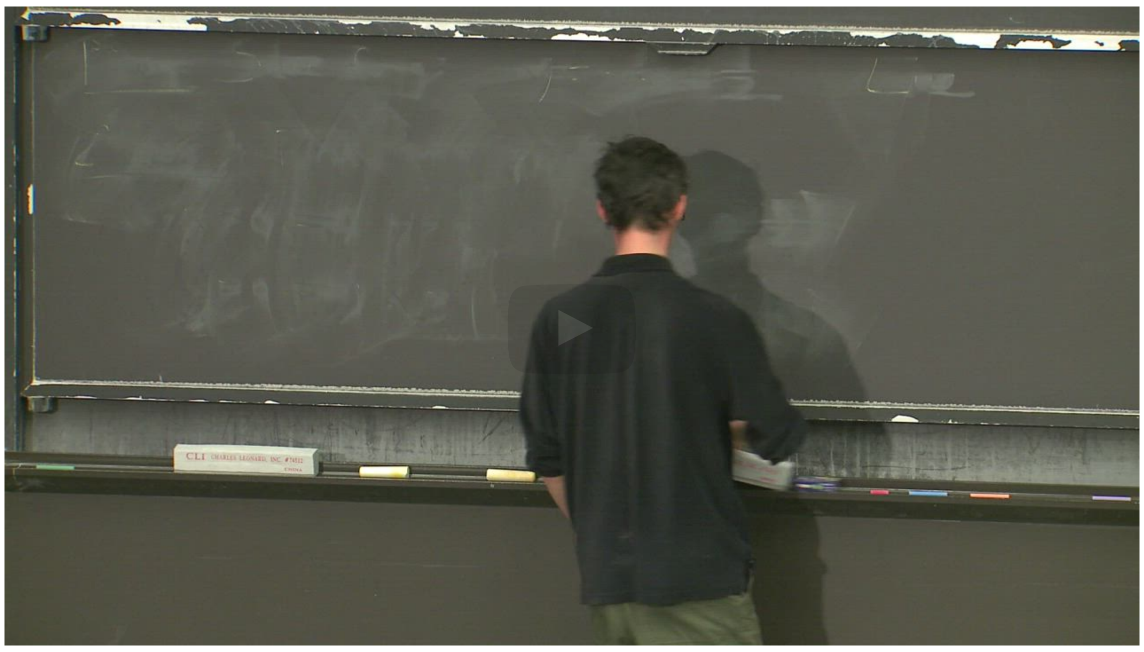
2D linear approximation



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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,

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Given a function $f(x,y)$, the linear approximation of f near (x_0,y_0) is

$$f(x_0+\Delta x, y_0+\Delta y) \approx f(x_0,y_0) + \frac{\partial f}{\partial x}(x_0,y_0)\,\Delta x + \frac{\partial f}{\partial y}(x_0,y_0)\,\Delta y$$

Recall: $\dfrac{\partial f}{\partial x}$ measures how f changes when we change x a little, and $\dfrac{\partial f}{\partial y}$ measures how f changes when we change 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 $f(x,y)$ at $(-1,1)$.

To compute f_x, differentiate with respect to x treating y as a constant:

$$f_x(x,y) = 2x+0, \qquad f_x(-1,1) = 2(-1) = -2.$$

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To compute f_y, differentiate with respect to y treating x as a constant:

$$f_y(x,y) = 0 + 2y, \qquad f_y(-1,1) = 2(1) = 2.$$

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

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

Plug in the values for $f(-1,1)$, $f_x(-1,1)$, and $f_y(-1,1)$ found above to get

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

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? Change both x and y at the same time 2

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