INDIAN INSTITUTE OF TECHNOLOGY MADRAS

सिद्धिर्भवति कर्मजा

IIT Madras

ONLINE DEGREE

Mathematics for Data Science 2
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Week 10 - Tutorial 01

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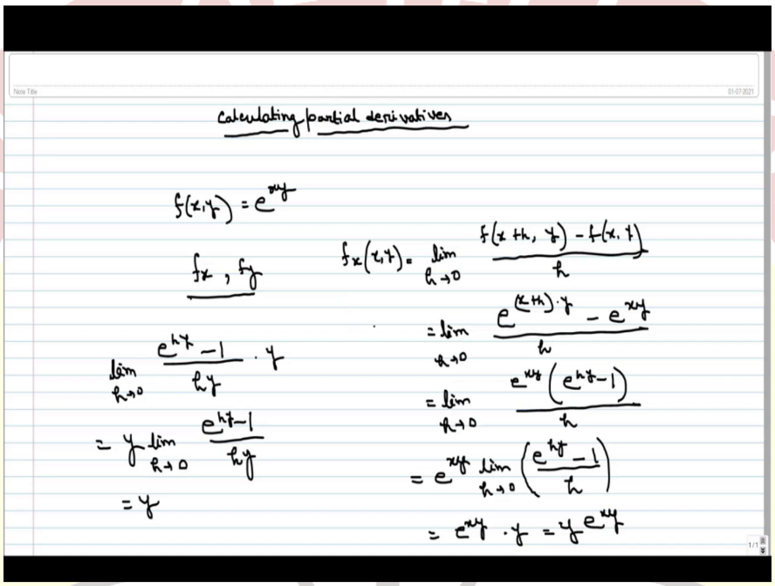

Hello everyone, in this video we will try to calculate partial derivative of a function. So, we will consider this function $f(x, y) = e^{xy}$. And we will use the definition of partial derivative to calculate the partial derivative f_x and f_y, that mean with respect to x and with respect to y.

So, this is a scalar two variable function. So, let us try to calculate the $f_x(x, y)$. So, from the definition, we know that this is nothing but $\lim_{h\to 0} \frac{f(x+h,\ y)-f(x,\ y)}{h}$. So, we only change along the x variable, so, this will give us limit $h \to 0$. So, what is $(x + h)y$?

It is nothing but $\lim_{h\to 0} \frac{e^{(x+h).y} - e^{xy}}{h}$. So, here we get $\lim_{h\to 0} \frac{e^{xy}(e^{hy}-1)}{h}$. Now, this is, here we are considering only $\lim_{h\to 0}$. So, e^{xy} does not depend on h, so, we can take that out. So, we can take that outside because it does not depend on h.

So, we will keep only those terms which are dependent on h. So, we have to calculate $e^{xy} \lim_{h\to 0} \frac{(e^{hy}-1)}{h}$. Now, let us see what this is. So, $\lim_{h\to 0} \frac{(e^{hy}-1)}{h}$, now, this is a function of h, so we can treat y as a constant here. So, what we can do, we can multiply y in both numerator and denominator. So, we will get this. So, we will take y outside as it is independent of h. So, we get this function.

So, and we know from the one variable calculus we have calculated this limit of this function, $\lim_{h \to 0} \frac{(e^{hy}-1)}{hy}$ this is nothing but one so, it is y. So, the limit we get here is what? Sorry, y, so we get e^{xy} into y that is ye^{xy}. So, this is the partial derivative of this function with respect to x. Similarly, now we will do the calculation for the partial derivative with respect to y.

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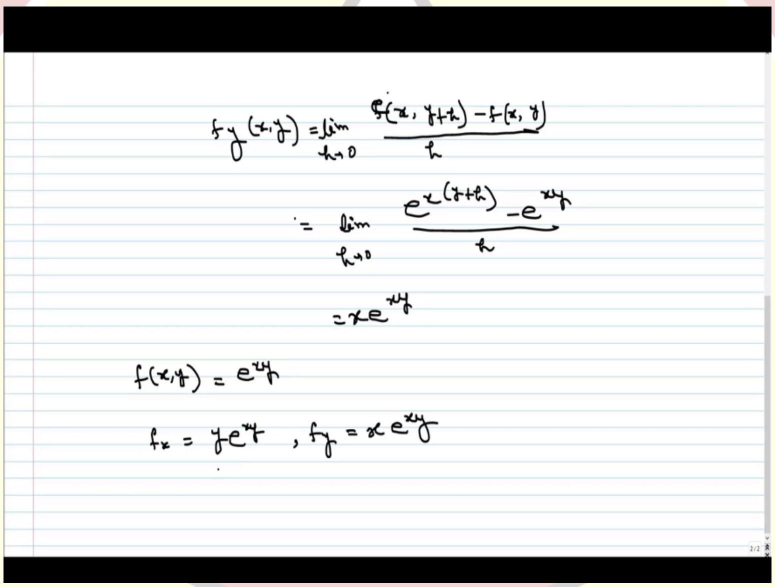

So, when we want to calculate the partial derivative with respect to y, we will do this, this is $\lim_{h \to 0}$. Now, we will change the inclination in terms of y. So, it is nothing but $\lim_{h \to 0} \frac{f(x,\ y+h)-f(x,\ y)}{h}$. So, now we will add h with y because we are calculating f_y. So, what we get is $\lim_{h \to 0} \frac{e^{x(y+h)} \ -e^{xy}}{h}$.

So basically, you are seeing that now the roles of x and y have interchanged. So, if we calculate this thing as the earlier we will get xe^{xy}. So, for this function, $f(x, y) = e^{xy}$, $f_x = ye^{xy}$, and $f_y = xe^{xy}$. So, you can see that if we, when we are differentiating with respect to x, then we treating y as a constant.

And similarly, when we are differentiating with respect to y, we are treating x as a constant. That is how we get these two functions. And clearly you can see that from the definition what will be uploaded is matching with that thing. So, this is the way you can calculate the partial derivative of multivariable function. Thank you.