

Lecture 30 - UM 102 (Spring 2021)

Vamsi Pritham Pingali

IISc

Recap

- Proved the chain rule

- Proved the chain rule for scalar fields.

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- Did level sets and

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- Directional derivatives and differentiability for vector fields. Derivative matrix. Differentiability implies continuity.

Chain rule for scalar fields

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- Proof: Define $h_2(x) = \frac{f(x) - f(a) - f'(a)(x - a) - \frac{f''(a)}{2}(x - a)^2}{(x - a)^2}$. At this point, one may use L'Hopital's rule (yes, there is a rigorous version; no I am not going to bore you with it) twice to see the result. (The proof is easier (using the fundamental theorem of calculus and integration by parts) if we assume that f''' exists and

Second-order Taylor theorem (Wikipedia is not a bad resource for this)

- Recall that if f is differentiable at a then $f(x) = f(a) + f'(a)(x - a) + h_1(x)(x - a)$ where $h_1(x) \rightarrow 0$ as $x \rightarrow a$.
- If f is once-differentiable in $(a - \epsilon, a + \epsilon)$ for some $\epsilon > 0$, and twice-differentiable at a then Taylor's theorem holds:
$$f(x) = f(a) + f'(a)(x - a) + \frac{f''(a)}{2}(x - a)^2 + h_2(x)(x - a)^2$$
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