Math 230B Lecture Notes

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Chapter 1

Week 1

1.1 Lecture 1

1.1.1 Topics

- The derivative
- Continuity and Differentiability
- Differentiability Rules

Definition (Differentiability). (*) Let $I \subseteq \mathbb{R}$ be an interval, $f : I \to \mathbb{R}$, $c \in I$. We say f is **differentiable** at c if

$$\lim_{x \to c} \frac{f(x) - f(c)}{x - c}$$

exists (that is, it equals a real number).

(*) In this case, the quantity $\lim\limits_{x \to c} \frac{f(x)-f(c)}{x-c}$ is called the derivative of f at c and is denoted by

$$f'(c), \frac{df}{dx}(c), \left.\frac{df}{dx}\right|_{x=c}$$

(*) If $f : I \to \mathbb{R}$ is differentiable at every point $c \in I$, we say f is differentiable (on I).

Remark. The following are equivalent characterizations of the differentiability:

$$\begin{aligned} f'(c) = L &\iff \lim_{x \to c} \frac{f(x) - f(c)}{x - c} = L \\ &\iff \forall \varepsilon > 0 \ \exists \delta > 0 \text{ such that if } 0 < |x - c| < \delta \text{ then } \left| \frac{f(x) - f(c)}{x - c} - L \right| < \varepsilon \\ &\iff \forall \varepsilon > 0 \ \exists \delta > 0 \text{ such that if } 0 < |h| < \delta \text{ then } \left| \frac{f(c+h) - f(c)}{h} - L \right| < \varepsilon \\ &\iff \lim_{h \to 0} \frac{f(c+h) - f(c)}{h} = L \end{aligned}$$

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