Lecture 21 - UM 102 (Spring 2021)

Vamsi Pritham Pingali

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- Defined open balls, interior points, and open sets. Gave examples and non-examples.

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- Sandwich law: If $\|\vec{f}(\vec{x})\| \le \|\vec{g}(\vec{x})\|$ and as $\vec{x} \to \vec{a}$ the limit of $\vec{g}(\vec{x})$ exists and equals $\vec{0}$, then $\vec{f}(\vec{x}) \to \vec{0}$:

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• Suppose
$$\lim_{x_1 \to a_1} g(x_1) = b$$
 where

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• Suppose $\lim_{x_1\to a_1} g(x_1) = b$ where $g : \mathbb{R} \to \mathbb{R}$ is a function then $\lim_{\vec{x}\to\vec{a}} g(x_1)$ exists and equals b.

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Suppose lim_{x1→a1} g(x1) = b where g : ℝ → ℝ is a function then lim_{x→a} g(x1) exists and equals b. Now |g(x1) - b| < ε whenever 0 < |x1 - a1| < δ.

Suppose lim_{x1→a1} g(x₁) = b where g : ℝ → ℝ is a function then lim_{x→a} g(x₁) exists and equals b. Now |g(x₁) - b| < ε whenever 0 < |x₁ - a₁| < δ. Thus |g(x) - b| < ε whenever 0 < |x₁ - a₁| < δ.

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- Suppose lim_{x1→a1} g(x₁) = b where g : ℝ → ℝ is a function then lim_{x→a} g(x₁) exists and equals b. Now |g(x₁) b| < ε whenever 0 < |x₁ a₁| < δ. Thus |g(x) b| < ε whenever 0 < |x₁ a₁| < δ. So lim_{(x,y)→(0,0)} x² = 0.
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- The limit $\lim_{(x,y)\to(0,0)} \frac{xy}{x^2+y^2}$ does NOT exist:

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- Suppose lim_{x1→a1} g(x1) = b where g : ℝ → ℝ is a function then lim_{x→a} g(x1) exists and equals b. Now |g(x1) b| < ε whenever 0 < |x1 a1| < δ. Thus |g(x) b| < ε whenever 0 < |x1 a1| ≤ δ. So lim_{(x,y)→(0,0)} x² = 0.
- The limit $\lim_{(x,y)\to(0,0)} \frac{xy}{x^2+y^2}$ does NOT exist: Indeed, suppose it does and equals *L*. This means that $|f(x,y) L| < \frac{1}{100}$ when $0 < ||(x,y)|| < \delta$.

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- The limit $\lim_{(x,y)\to(0,0)} \frac{xy}{x^2+y^2}$ does NOT exist: Indeed, suppose it does and equals *L*. This means that $|f(x,y) - L| < \frac{1}{100}$ when $0 < ||(x,y)|| < \delta$. Thus if y = x or y = 2x and $0 < |x| < \frac{\delta}{\sqrt{5}}$, then $|f(x,y) - L| < \frac{1}{100}$.

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- The limit $\lim_{(x,y)\to(0,0)} \frac{xy}{x^2+y^2}$ does NOT exist: Indeed, suppose it does and equals *L*. This means that $|f(x,y) - L| < \frac{1}{100}$ when $0 < ||(x,y)|| < \delta$. Thus if y = x or y = 2x and $0 < |x| < \frac{\delta}{\sqrt{5}}$, then $|f(x,y) - L| < \frac{1}{100}$. This means that

- Suppose lim_{x1→a1} g(x₁) = b where g : ℝ → ℝ is a function then lim_{x→a}g(x₁) exists and equals b. Now |g(x₁) b| < ε whenever 0 < |x₁ a₁| < δ. Thus |g(x) b| < ε whenever 0 < |x₁ a₁| < δ. So lim_{(x,y)→(0,0)} x² = 0.
- The limit $\lim_{(x,y)\to(0,0)} \frac{xy}{x^2+y^2}$ does NOT exist: Indeed, suppose it does and equals *L*. This means that $|f(x,y) - L| < \frac{1}{100}$ when $0 < ||(x,y)|| < \delta$. Thus if y = x or y = 2x and $0 < |x| < \frac{\delta}{\sqrt{5}}$, then $|f(x,y) - L| < \frac{1}{100}$. This means that $|\frac{1}{2} - L| < \frac{1}{100}$ and

- Suppose lim_{x1→a1} g(x1) = b where g : ℝ → ℝ is a function then lim_{x→a} g(x1) exists and equals b. Now |g(x1) b| < ε whenever 0 < |x1 a1| < δ. Thus |g(x) b| < ε whenever 0 < |x1 a1| ≤ δ. So lim_{(x,y)→(0,0)} x² = 0.
- The limit $\lim_{(x,y)\to(0,0)} \frac{xy}{x^2+y^2}$ does NOT exist: Indeed, suppose it does and equals *L*. This means that $|f(x,y) - L| < \frac{1}{100}$ when $0 < ||(x,y)|| < \delta$. Thus if y = x or y = 2x and $0 < |x| < \frac{\delta}{\sqrt{5}}$, then $|f(x,y) - L| < \frac{1}{100}$. This means that $|\frac{1}{2} - L| < \frac{1}{100}$ and $|\frac{2}{5} - L| < \frac{1}{100}$

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