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L'Hospital's Rule

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$\lim_{x \to a} \frac{f(x)}{g(x)}$ ← indet

$L = \lim_{x \to a} \frac{f}{g} = \lim_{x \to a} \frac{f'}{g'}$

① indet: $\frac{0}{0}$, $\frac{\infty}{\infty}$, $\infty - \infty$, $0 \cdot \infty$

Must convert the limit into $\frac{f}{g}$

So the only 2 indet forms: $\frac{\infty}{\infty}$, $\frac{0}{0}$

e.g. $\lim_{x \to -\infty} xe^x = "-\infty \cdot 0"$

↳ $\lim_{x \to -\infty} \frac{x}{e^{-x}}$

② Multiple L'H applications needed! ← MUST VERIFY ind

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L'Hospital's Rule

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$\lim_{x \to a} \frac{f(x)}{g(x)}$ ← indet

$L = \lim_{x \to a} \frac{f}{g} = \lim_{x \to a} \frac{f'}{g'}$

(1) Indet: $\pm \frac{\infty}{\infty}$, $\frac{0}{0}$, $\infty - \infty$, $0 \cdot \infty$

Must convert the limit into $\frac{f}{g}$

So the only 2 indet forms:

$\pm \frac{\infty}{\infty}$, $\frac{0}{0}$

e.g. $\lim_{x \to -\infty} x e^x = -\infty \cdot 0$

↳ $\lim_{x \to -\infty} \frac{x}{e^{-x}}$

(2) Multiple L'H applications needed! ← MUST VERIFY indet

Ex $\lim_{x\to 0} \frac{\sin x}{x} = \frac{0}{0}$ indet!

L'H ↳ $\lim_{x\to 0} \frac{\cos x}{1} = \frac{1}{1} = 1$.

NOTE: what if apply L'H?

$\lim_{x\to 0} \frac{\cos x}{1} = \lim_{x\to 0} \frac{-\sin x}{0}$ undef

wrong

check $\lim_{x\to 0} \frac{\cos x}{1}$ ← NOT indet,

so L'H NOT applicable.

Ex $\lim_{x\to 0} \frac{1-\cos 2x}{x} = \frac{1-1}{0} = \frac{0}{0}$

L'H ↳ $\lim_{x\to 0} \frac{2\sin 2x}{1} = \frac{2(0)}{1} = 0$ indet!

Ex $\lim_{x\to 0} \frac{1-\cos 2x}{x^2} = \frac{1-1}{(0)^2} = \frac{0}{0}$ ← indet

↳ $\lim_{x\to 0} \frac{2\sin 2x}{2x} = \frac{2(0)}{2(0)}$ ← indet

$$\lim_{x\to 0} \frac{2\sin 2x}{2x} = \lim_{x\to 0} \frac{\sin 2x}{x}$$

L'H $\lim_{x\to 0} \frac{2\cos 2x}{1}$

$$= \frac{2(1)}{1} = 2$$

Ex $\lim_{x\to -\infty} xe^x = "-\infty \cdot 0"$

$$= \lim_{x\to -\infty} \frac{x}{e^{-x}} \leftarrow \text{indet!}$$

L'H $\lim_{x\to -\infty} \frac{1}{-e^{-x}} = \frac{1}{-"\text{very big}"} = 0$