

Mathematical Concepts Presentation

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Table of Contents

- 1 Introduction & Objectives
- 2 Set Theory Fundamentals
- 3 Calculus: Product Rule
- 4 Applications & Conclusion

Introduction & Objectives

Presentation Goals:

- Introduce fundamental set theory concepts
- Explain common mathematical sets
- Demonstrate calculus product rule
- Show practical applications

Key Topics:

- Sets and elements
- Special number sets (\mathbb{N} , \mathbb{Z} , \mathbb{Q} , \mathbb{R})
- Derivative product rule



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Set Theory Fundamentals

Basic Definitions:

- Set: Collection of objects
- Example:
 $Z = \{\text{cow, pig, elephant}\}$
- Element: $\text{cow} \in Z$
- Common sets:
 - $\mathbb{N} = \{1, 2, 3, \dots\}$ (Natural)
 - $\mathbb{Z} = \{\dots, -2, -1, 0, 1, 2, \dots\}$ (Integer)
 - $\mathbb{Q} = \{p/q : p, q \in \mathbb{Z}, q \neq 0\}$ (Rational)
 - $\mathbb{R} = \text{Decimal numbers}$ (Real)

Set Operations:

- Union:
 $A \cup B = \{x : x \in A \text{ or } x \in B\}$
- Intersection:
 $A \cap B = \{x : x \in A \text{ and } x \in B\}$
- Difference:
 $A \setminus B = \{x : x \in A \text{ and } x \notin B\}$

Example: If $A = \{1, 2, 3\}$ and $B = \{2, 3, 4\}$:

- $A \cup B = \{1, 2, 3, 4\}$
- $A \cap B = \{2, 3\}$
- $A \setminus B = \{1\}$

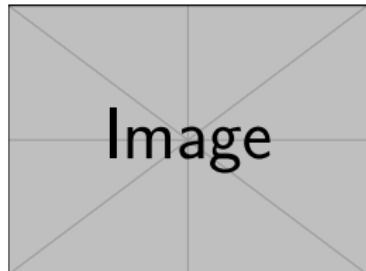
Calculus: Product Rule

Product Rule Formula:

$$\frac{d}{dx}[f(x)g(x)] = f'(x)g(x) + f(x)g'(x)$$

Example: For $f(x) = x^2 \cdot \sin(x)$:

$$\begin{aligned}f'(x) &= \frac{d}{dx}(x^2) \cdot \sin(x) + x^2 \cdot \frac{d}{dx}(\sin(x)) \\&= 2x \cdot \sin(x) + x^2 \cdot \cos(x)\end{aligned}$$



Visual: Product rule

Proof Outline:

- Start with definition:
$$f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h)-f(x)}{h}$$
- For $f(x) = g(x)h(x)$:
- Add and subtract $g(x+h)h(x)$
- Result: $f'(x) = g(x)h'(x) + g'(x)h(x)$

Key Insight: The derivative of a product is NOT the product of derivatives!

$$(fg)' \neq f'g'$$

Applications & Conclusion

Applications:

- **Physics:** Motion equations, force calculations
- **Engineering:** Signal processing, control systems
- **Computer Science:** Algorithms, machine learning
- **Economics:** Optimization, modeling



Key Takeaways:

- ① Sets provide foundation for mathematical structures
- ② Product rule is essential for calculus operations
- ③ These concepts enable real-world problem solving

Thank You!

Questions?

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