

# Research Methods in Computer Science

An Introduction to Academic Presentations

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# Introduction

- Academic presentations communicate research findings effectively
- A consistent visual identity strengthens institutional recognition
- This template follows the TU Berlin corporate design guidelines

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- Built on **Touying**, a modern presentation framework for Typst
- Supports animations, multi-column layouts, and structured slides

1. Introduction and motivation
2. Research methodology
3. Results and discussion
4. Conclusion and future work

# Methodology

We employ a mixed-methods approach combining:

1. **Quantitative analysis** — statistical evaluation of experimental data
2. **Qualitative review** — expert assessment of design patterns
3. **Comparative study** — benchmarking against existing solutions



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The methodology follows established best practices in the field.

## Traditional Methods

- Manual data collection
- Limited scalability
- High cost per sample
- Established validity

## Modern Methods

- Automated pipelines
- Horizontally scalable
- Reduced marginal cost
- Requires validation

# Results

**Main Result:** The proposed approach achieves a 35% improvement over the baseline while maintaining statistical significance ( $p < 0.01$ ).

Supporting observations:

- Consistent performance across all test conditions
- Robust to variations in input parameters
- Generalizes well to unseen data distributions

The combination of automated data collection and rigorous statistical testing enables reproducible research at scale.

The analysis reveals three key factors:

1. **Data quality** has the strongest effect on outcomes
2. **Sample size** matters beyond  $n = 100$
3. **Method selection** has diminishing returns after optimization

The optimization objective<sup>1</sup> is defined as:

$$\min_{\theta} \mathcal{L}(\theta) = \frac{1}{N} \sum_{i=1}^N \ell(f_{\theta}(x_i), y_i) + \lambda \|\theta\|_2^2$$

where:

- $f_{\theta}$  is the parameterized model
- $\ell$  is the loss function
- $\lambda$  controls regularization strength

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<sup>1</sup>Boyd & Vandenberghe, *Convex Optimization*, Cambridge University Press, 2004.

## Theorem

For any convex function  $f : \mathbb{R}^n \rightarrow \mathbb{R}$ , a local minimum is also a global minimum.

## Definition

A function  $f$  is **convex** if for all  $x, y \in \text{dom } f$  and  $0 \leq \theta \leq 1$ :

$$f(\theta x + (1 - \theta)y) \leq \theta f(x) + (1 - \theta)f(y)$$

## Example

The function  $f(x) = x^2$  is convex on  $\mathbb{R}$ , since  $f''(x) = 2 > 0$  everywhere.



*If we knew what it was we were doing, it would not be called research, would it?*

— Albert Einstein

*Premature optimization is the root of all evil.*

— Donald Knuth

# Conclusion

## Contributions

- Novel methodology for data analysis
- Open-source implementation
- Reproducible experimental setup
- Comprehensive evaluation

## Future Work

- Extension to larger datasets
- Cross-domain validation
- Real-time processing pipeline
- Community benchmarking

**Thank You!**

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*Questions?*