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Abstract

Please insert your abstract below. For research papers, the abstract typically ranges from 200 to 300 words, whereas review papers should aim for a length between 150 and 300 words. The abstract should maintain a continuous narrative without subheadings or structured sections. It should not contain any reference citations. Abbreviations that occur only once in the abstract should be written in full. If an abbreviation appears multiple times, provide its full definition on the first mention before using the abbreviated form in subsequent instances.

1 Introduction

The introduction should offer relevant background or context, highlighting the nature of the problem and its importance. Clearly state the study's objective, purpose, or hypothesis being tested. Include only essential references directly related to the topic, avoiding the presentation of data or conclusions from the research being reported.

1.1 Background and Motivation

Recent advances in data collection technologies have led to datasets with thousands or millions of variables. Traditional statistical methods often fail in such high-dimensional settings due to computational constraints and statistical challenges such as overfitting and multicollinearity. See Fan et al. [1]

2 Methodology

2.1 Theoretical Framework

Let $X \in R^{n \times p}$ denote the design matrix with n observations and p predictors. We consider the linear model:

$$Y = X\beta + \epsilon \quad (1)$$

where $Y \in R^n$ is the response vector, $\beta \in R^p$ is the coefficient vector, $\epsilon \sim N(0, \sigma^2 I_n)$. See Fan and Li. [2].

2.2 Estimation Procedure

Our estimation procedure combines regularization techniques with adaptive weighting schemes to achieve both sparsity and predictive accuracy. The proposed estimator minimizes:

$$\hat{\beta} = \arg arg \left\{ \|Y - X\beta\|_2^2 + \lambda \sum_{j=1}^{p} w_j |\beta_j| \right\} \quad (2)$$

3 Simulation Studies

Extensive simulation studies were conducted to evaluate the performance of our method under various scenarios. The results demonstrate superior performance compared to existing approaches in terms of both estimation accuracy and variable selection consistency. See Fig 1.

Figure 1: Schematic representation of XXX

4 Real Data Applications

We applied our methodology to three real-world datasets from genomics, finance, and climate science. In all cases, our approach provided interpretable models with excellent predictive performance. See Table 1.

Table 1: Summary of data sets.

Data	MLE		K-S(P-value)
	γ	ξ	
A	3.1060(2.0884)	0.2686(0.2306)	0.0974(0.903)
B	2.4927(1.9108)	6.4536(6.5258)	0.2069(0.479)
C	3.6396(3.4353)	1.4080(1.6457)	0.1503(0.702)

5 Discussion

The proposed framework offers a flexible and powerful tool for statistical modeling in high-dimensional settings. Future research directions include extensions to non-Gaussian responses and time-series data.

6 Conclusion

This paper has presented a comprehensive framework for advanced statistical modeling that addresses key challenges in analyzing high-dimensional data. Both theoretical analysis and empirical studies support the effectiveness of our approach.

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Data Availability

Authors are required to clearly state the availability of the data supporting their findings. If the data are publicly available, the repository name, permanent link, and access conditions should be provided (e.g., “Data are available in [repository name] at [DOI or URL]”). If the data are not publicly available due to privacy or ethical restrictions, authors should specify the reason and indicate whether access may be granted upon reasonable request to the corresponding author.

Conflicts of Interest:

Authors must declare any potential conflicts of interest. If there are none, use the following statement: “The authors declare no conflicts of interest regarding this study.”.

Author Contributions

Conceptualization, Author 1 and Author 2; Methodology, Author 1 and Author 3; Software, Author 3; Validation, Author 2 and Author 3; Formal Analysis, Author 1; Investigation, Author 2; Resources, Author 3; Data Curation, Author 2; Writing—Original Draft Preparation, Author 1; Writing—Review and Editing, Author 2 and Author 3; Visualization, Author 3; Supervision, Author 1; Project Administration, Author 1; Funding Acquisition, Author 3. All authors have read and agreed to the published version of the manuscript.

AI Usage Statement:

Artificial intelligence tools (such as ChatGPT and other large language models) were used to assist in language editing, formatting, and improving clarity of expression in this manuscript. The authors reviewed and verified all generated content to ensure accuracy and integrity of the scientific

information. No AI-based tools were used in the generation, writing, revising, analysis, or interpretation of the research data and findings presented in this article.

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