

The Shape of Digits

A Bayesian Topological Data Analytic Approach to Classification of Handwritten Digits

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Table of contents

1	Abstract	2
2	Introduction	2
3	Background and Related Work	2
4	Methodology	2
4.1	Traditional Machine Learning	2
4.2	Bayesian TDA Methodology	3
4.3	TDA + ML	3
5	Experiments	3
5.1	Data Summary	3
5.2	NN dropout	3
5.3	NN Ridge	3
5.4	NN Lasso	3
5.5	Multinomial Logistic	3
5.6	Bayes TDA	3
5.7	TDA + ML	3
6	Discussion and Analysis	3
7	Conclusion	3
8	References	4

1 Abstract

*This paper ...*¹

2 Introduction

The motivation for this work “Data has shape, shape has meaning, and meaning brings value.” -
Gunnar Carlsson

3 Background and Related Work

about mnist MNIST Overview

- A Bayesian Framework for Persistent Homology(Maroulas, Nasrin, and Oballe 2020)
- Classification based on Topological Data Analysis(Kindelan et al. 2021)
- A topological data analysis based classification method for multiple measurements(Riihimäki et al. 2019)
- Topology based data analysis identifies a subgroup of breast cancers with a unique mutational profile and excellent survival(Nicolau, Levine, and Carlsson 2011)
- A Topological “Reading” Lesson: Classification of MNIST using TDA(Garin and Tauzin 2019)
- Classification and Evaluation of Machine Learning Algorithms on the MNIST Dataset (Yeboah 2025)

4 Methodology

4.1 Traditional Machine Learning

4.1.1 Neural Networks

Dropout

Ridge

Lasso

Multinomial Logistic Regression as ML

¹Example footnote

4.2 Bayesian TDA Methodology

latex flowchart

4.2.1 Cubical Complexes & Persistent Homology

4.2.2 Marked PPP

4.2.3 Bayes Update & Guassian representation

4.3 TDA + ML

4.3.1 Filtering

5 Experiments

5.1 Data Summary

5.1.1 EDA

5.2 NN dropout

5.3 NN Ridge

5.4 NN Lasso

5.5 Multinomial Logistic

5.6 Bayes TDA

5.7 TDA + ML

6 Discussion and Analysis

Comparing the models

7 Conclusion

8 References

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