



# Mathematical Foundations of Spectral Graph Theory

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## Introduction

This is an unofficial template for Florida State Mathematics poster presentation prepared by Rafiq Islam[1]. Here is how you use plain text  
Spectral graph theory studies properties of a graph in relationship to the eigenvalues and eigenvectors of matrices associated with the graph, such as the adjacency matrix  $A$ , degree matrix  $D$ , and Laplacian  $L = D - A$ .

## Mathematical Background

Let  $G = (V, E)$  be an undirected graph. The Laplacian matrix is given by

$$L_{ij} = \begin{cases} \deg(v_i) & \text{if } i = j, \\ -1 & \text{if } i \neq j \text{ and } (i, j) \in E, \\ 0 & \text{otherwise.} \end{cases}$$

The eigenvalues of  $L$  reveal key structural properties such as connectivity.

## Tikz Picture

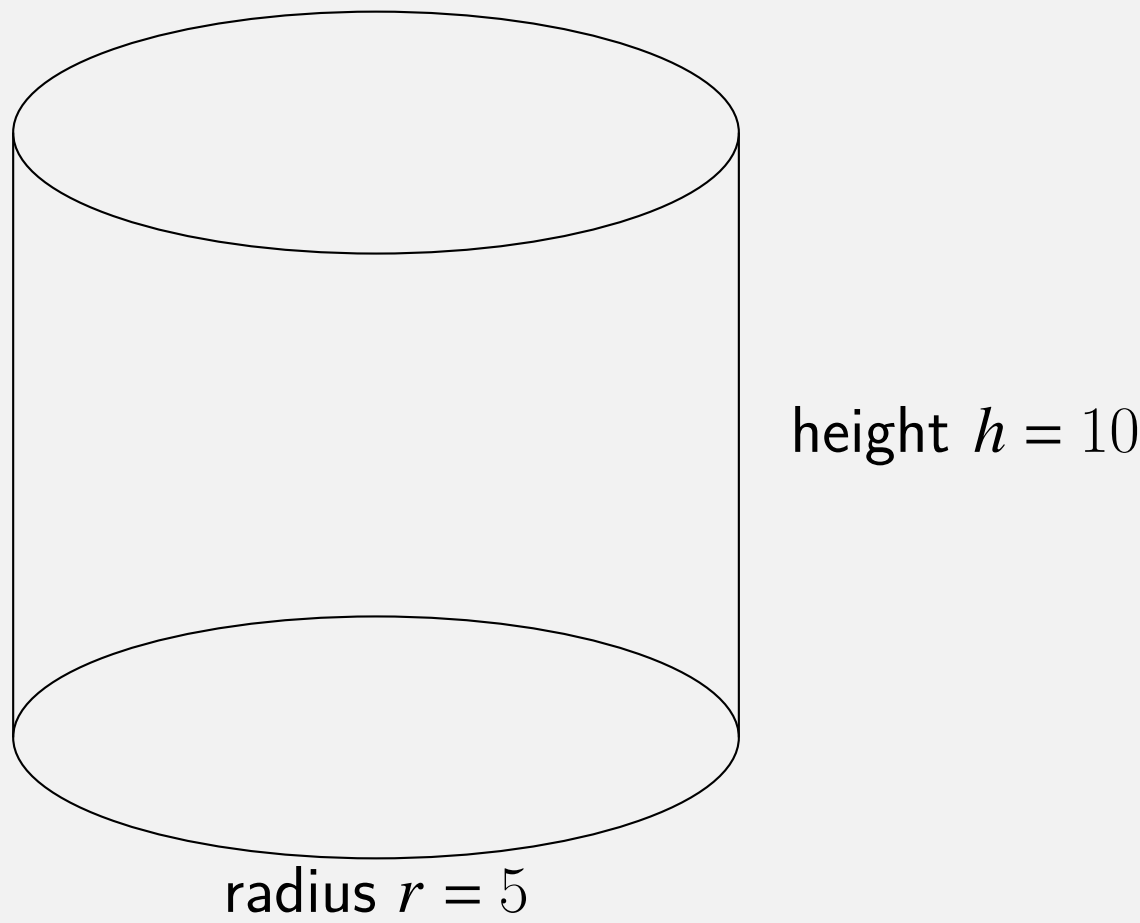


图 1: Spherical Cylinder with radius  $r = 5$ m and height  $h = 10$  m

## Objectives

- Explore classical ML models for text classification
- Apply preprocessing techniques like TF-IDF
- Evaluate models using accuracy, precision, recall

## Why Text Classification?

This is an alert block where you can mention an important fact or result.

- Used in spam detection, sentiment analysis, topic labeling
- Helps automate information filtering at scale

## Methodology

Numbered items where the number elements will display in garnet color.

1. Dataset cleaning: lowercasing, punctuation removal
2. Tokenization and stop-word removal
3. Feature extraction via TF-IDF
4. Training Logistic Regression, Naive Bayes, and SVM

## Visualization



图 2: Florida State Seminole (Photo credit: Wikipedia)

## Table

| Graph               | Nodes ( $n$ ) | Edges ( $m$ ) | 2nd Eigenvalue $\lambda_2$ |
|---------------------|---------------|---------------|----------------------------|
| Cycle $C_6$         | 6             | 6             | 1.0                        |
| Complete $K_4$      | 4             | 6             | 4.0                        |
| Star $S_5$          | 5             | 4             | 1.0                        |
| Path $P_5$          | 5             | 4             | 0.3819                     |
| Random $G_{10,0.5}$ | 10            | 23            | 1.823                      |

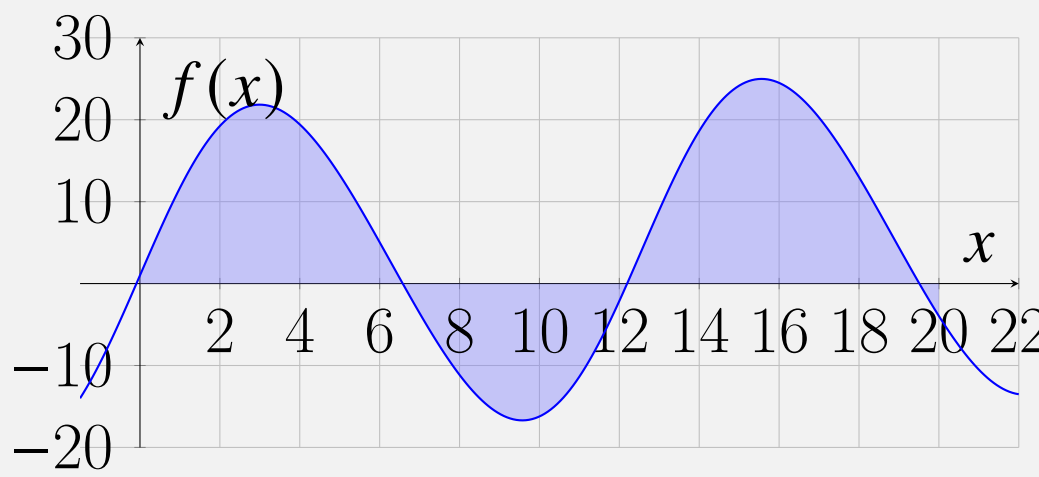
表 1: Comparison of different graphs and their spectral properties.

## More General block

The more accurate approximation could be found by increasing the number of sub-intervals. That is

$$\int_0^{20} f(x)dx = \lim_{n \rightarrow \infty} \sum_{i=1}^n f(x_i^*)\Delta x \approx 144.15 \quad (1)$$

irrespective of the left-hand point or the right-hand point we take to draw the rectangles.



This expression

$$\int_0^{20} f(x)dx$$

is called the definite integral that finds the area under and/or above the curve  $f(x)$  and the  $x$  axis.

## Conclusion

- SVM performed best with highest accuracy
- TF-IDF improved performance over raw counts
- Logistic Regression was more interpretable

## References

- 1. Rafiq Islam.  
Fsu mathematics general poster design.  
Technical report, Florida State University, 2025.