



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

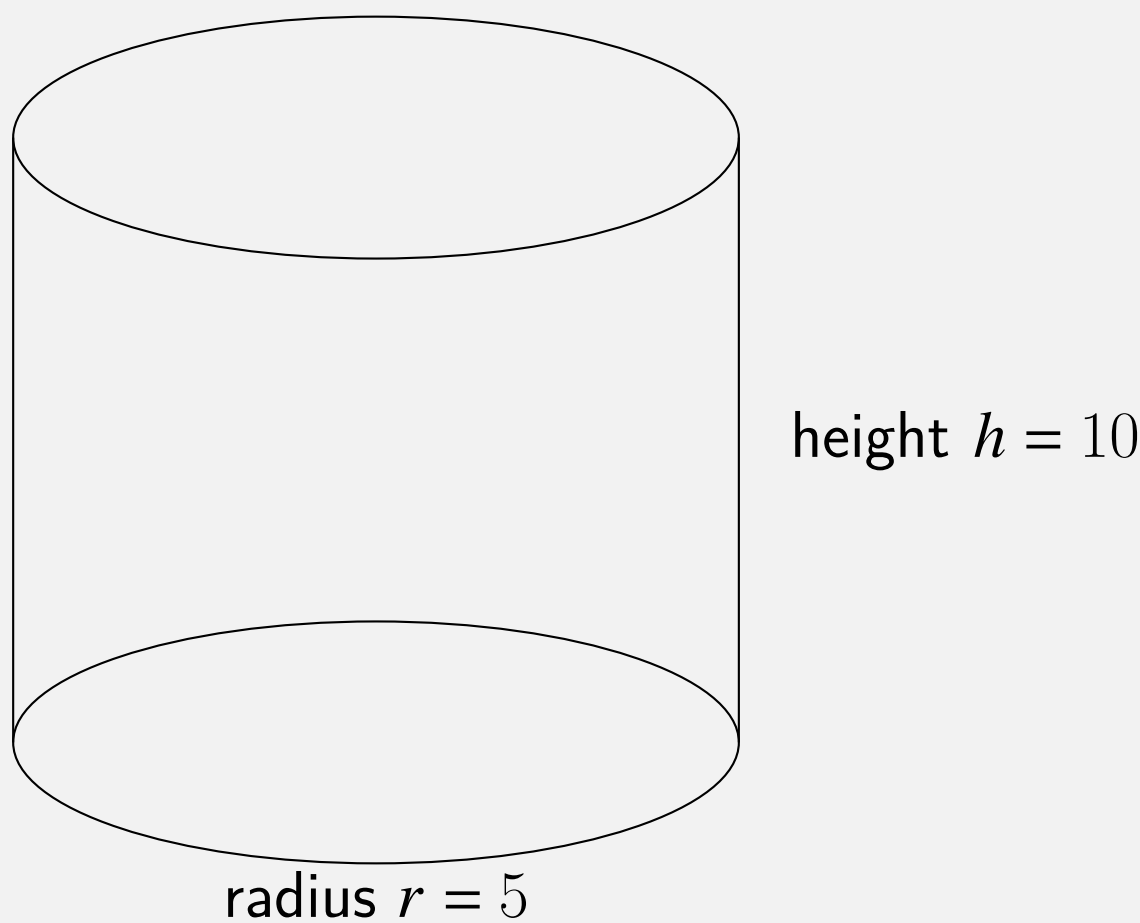


Figure 1: Spherical Cylinder with radius $r = 5$ m and height $h = 10$ m

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



Figure 2: Florida State Seminoles (Photo credit: Wikipedia)

Table

Graph	Nodes (n)	Edges (m)	2nd Eigenvalue λ_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

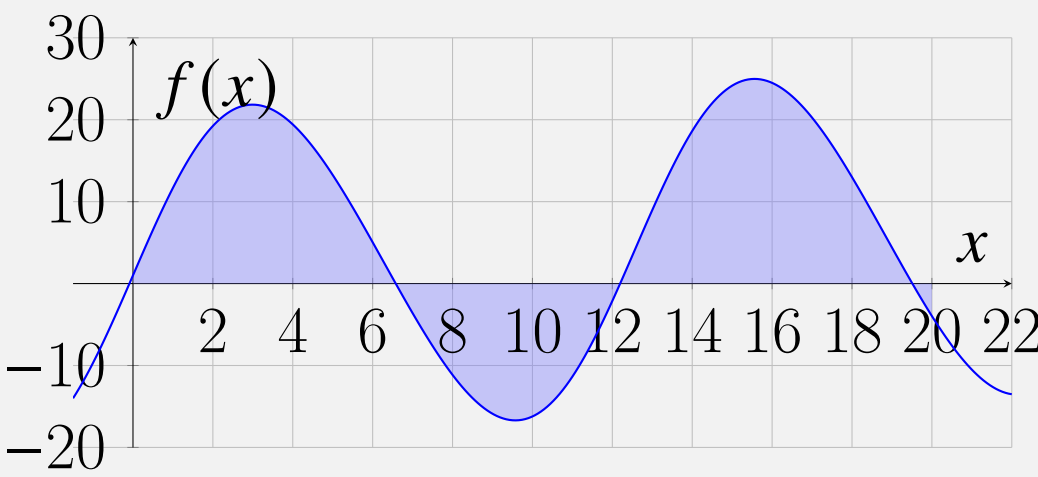
Table 1: Comparison of different graphs and their spectral properties.

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.