Application of Linear Algebra Using Graph Theory in Epidemiology

Robust Model for Disease Spread

INTRODUCTION

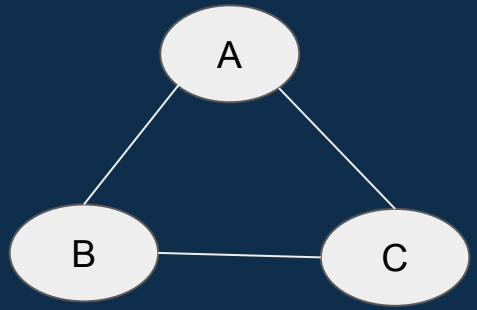
- Diseases spread through human contact. Graph theory helps map these interactions.
- Linear algebra uses matrices to analyze how fast and far diseases can spread.

STUDY OBJECTIVE

- To apply matrix analysis to predict outbreak potential.
- To support public health decisions like vaccination or lockdown.

METHODOLOGY

- Construct a contact network:
  - Nodes= individuals.
  - Edges =interactions/ contact event.
- Calculate eigenvalues and eigenvectors:
  - Largest eigenvalue = Potential growth rate of infection.
  - Eigenvector = Identifies influential individuals.
- If a square matrix M and a nonzero vector X then $MX = \lambda X$.



Adjacency Matrix

0	1	1
1	0	1
1	1	0

M

DATA ANALYSIS

Eigenvalues :
$\lambda = (-1,2,-1)$

Largest eigenvalue = 2
For $\lambda = 2$,

Eigenvector: $V = \begin{vmatrix} -0.816 \\ 0.408 \\ 0.408 \end{vmatrix}$

This is the dominant eigenvector. It reflects the most influential direction of spread in the network. Node A have more negative influence; nodes B and C contribute positively.

DECISIONS

- Here the largest eigenvalue is >1 , an outbreak is possible in this network.
- Remove edge to reduce eigenvalues and reduce epidemic risk.