APPLICATIONS OF GRAPH THEORY IN REAL LIFE PROBLEMS

>Presentation Topic: Applications of Graph Theory

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Introduction:

- Graph Theory:

  A branch of discrete mathematics, finds application in various real-life problems.

- Graph Theory provides a mathematical framework to study and model relationships between objects represented as vertices connected by edges.

- Graph theory serves as a powerful tool for analyzing and solving complex real-life problems across diverse domains.

- **Airline Schedules:** Group theory optimizes flight routes by identifying symmetries and patterns, minimizing costs for airlines while maximizing efficiency.
- **Direction in Maps:** Leveraging map symmetries, group theory aids navigation algorithms in calculating accurate routes and handling map transformations effectively.
- **Sudoku's Puzzles:** Group theory insights inform efficient solving algorithms by analyzing symmetries within Sudoku puzzles.
- **Search Engines Algorithm:** Group theory enhances search algorithms by analyzing web page structures, improving indexing and relevance of search results.
- **Social Media Marketing:** Utilizing social network structures, group theory assists marketers in targeting demographics and refining advertising strategies for maximum impact.

Airline Scheduling (Flow Problem)

Airline scheduling can indeed be formulated as a flow problem in graph theory. Here's a basic outline of how you could approach it.

- **Model the Network:** Create a graph where nodes represent airports and directed edges represent flights between airports. Assign capacities to edges based on factors like the size of the aircraft or the availability of seats.

- **Define the Source and Sink:** Designate a source node (where passengers originate) and a sink node (where passengers end their journey).

- **Assign Demands:** Determine the demand for passengers traveling from the source to the sink. This could be based on ticket sales, historical data, or other factors.

Airline Scheduling (Flow Problem)

- **Solve the Flow Problem:** Apply a flow algorithm to find the maximum flow from thesource to the sink, considering the capacities of the edges.

- **Interpret Results:** The maximum flow represents the maximum number of passengers that can be accommodated on the scheduled flights. Any remaining demand indicates potential issues such as overbooking or insufficient capacity.

- **Optimization:** If needed, adjust the schedule or capacities to optimize the flow and meet demand constraints.

By applying graph theory and flow algorithms, you can effectively model and solve airline scheduling problems to ensure efficient use of resources.

Direction in Maps(Shortest Path)

Graph theory plays a crucial role in maps and geographical information systems (GIS). Here are some of the key uses of graph theory in maps:

- Routing and Navigation: Graphs are used to model road networks, and algorithms
- Network Analysis: Graph theory helps analyze the connectivity of transportation networks.
- Spatial Analysis: Graphs are used to represent spatial relationships.
- Emergency Response Planning: Graph algorithms can assist in determining the fastest routes for emergency vehicles during crises. They help optimize evacuation plans and resource allocation.

Direction in Maps(Shortest Path)

- Logistics and Supply Chain Management: Graph theory is applied to model logistics and supply chain networks, optimizing the distribution of goods and minimizing transportation costs.

- Geographic Connectivity: Graphs help model connectivity in natural features such as rivers, mountains, and wildlife corridors.

- Utility Networks: Graph theory is applied to model utility networks, such as water supply, electricity, and gas. It aids in planning maintenance, detecting faults, and optimizing resource allocation.

- Geocoding and Location-Based Services: Graphs are used to associate physical locations with geographical coordinates.

Graph theory is a powerful tool for modeling and solving spatial problems, making it essential in the field of maps, geography, and location-based services.

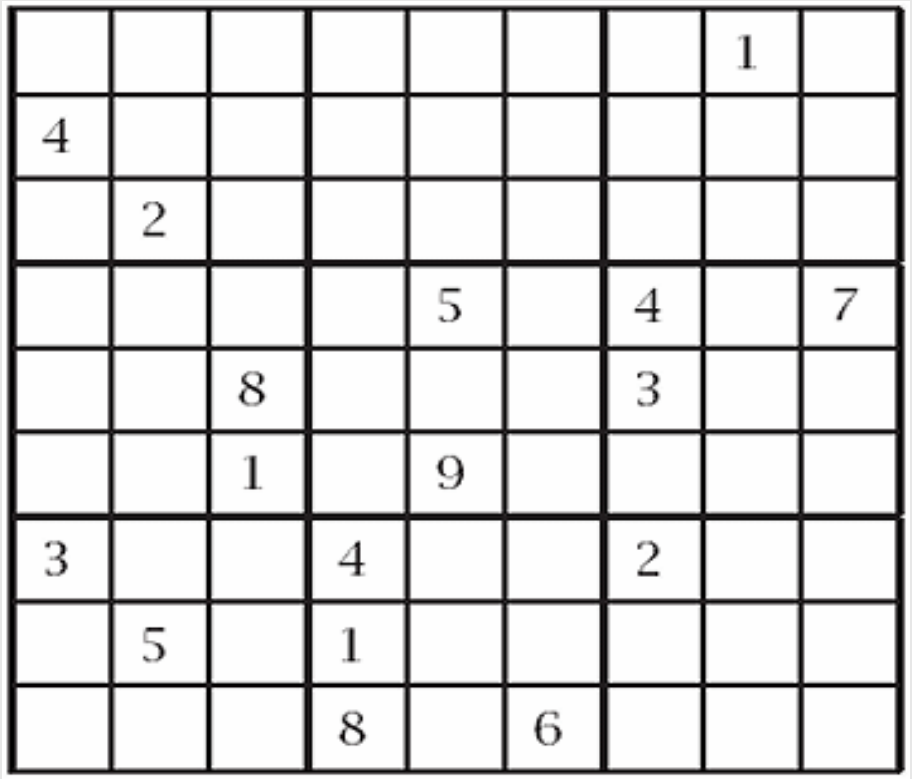
Solving Sudoku's Puzzles (Graph coloring)

- Sudoku is a popular puzzle with a 9x9 grid that needs to be filled with numbers from 1 to 9.
- A few numbers are given as a clue and the remaining numbers needed to be filled follow a simple rule:

  They cannot be repeated in the same row, column or region.
- This puzzle, despite using numbers, is not a mathematical puzzle, but a combinational puzzle that can be solved with the help of graph coloring.

How Sudoku can be solved using Graph Coloring

Sudoku Graph is a graph with 81 vertices (or nodes) .
Each cell in the Sudoku can be seen as a node of the graph.
Each node (or cell) has an edge to every other node (cell) in its respective column, row, and 3 x 3 grid.



How Sudoku can be solved using Graph Coloring

1	2	3	4
3	4	1	2
2	3	4	1
4	1	2	3

Social Media Marketing(Community detection)

Using graph theory in social media marketing can be quite insightful and effective. Here are a few ways it can be applied :

- Network Analysis: Graph theory can help analyze the structure of social networks on platforms like Facebook, Twitter, or LinkedIn. By examining connections between users (nodes) and their interactions (edges), marketers can identify key influencers, communities, and trends within their target audience.

- Content Optimization: Graph algorithms can be used to analyze user engagement with different types of content. By mapping how users interact with posts, videos, or ads, marketers can optimize their content strategy to better resonate with their audience and increase engagement.

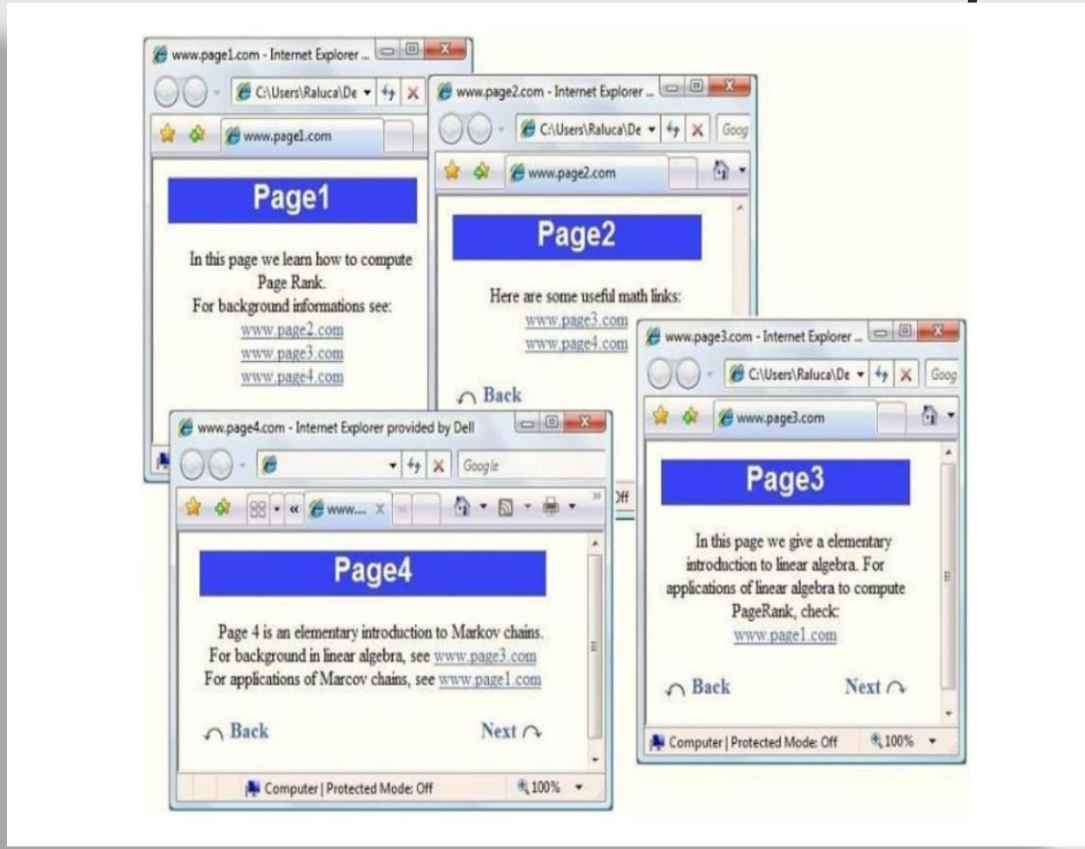
- Community Detection: Graph clustering algorithms can identify communities or groups of users with similar interests or behavior patterns. Marketers can use this information to tailor their messaging and campaigns to specific community preferences, fostering deeper engagement and loyalty.

Search Engine Algorithm(Page Rank Algorithms)

1.How does Google search engine works?

2.Suppose for instance, that we have a small Internet consisting of just 4 websites www.page1.com, www.page2.com, www.page3.com, www.page4.com, referencing each other.

3. First create a web graph, a graph where the vertices are the websites and the directed edges follows hyperlinks within those websites.

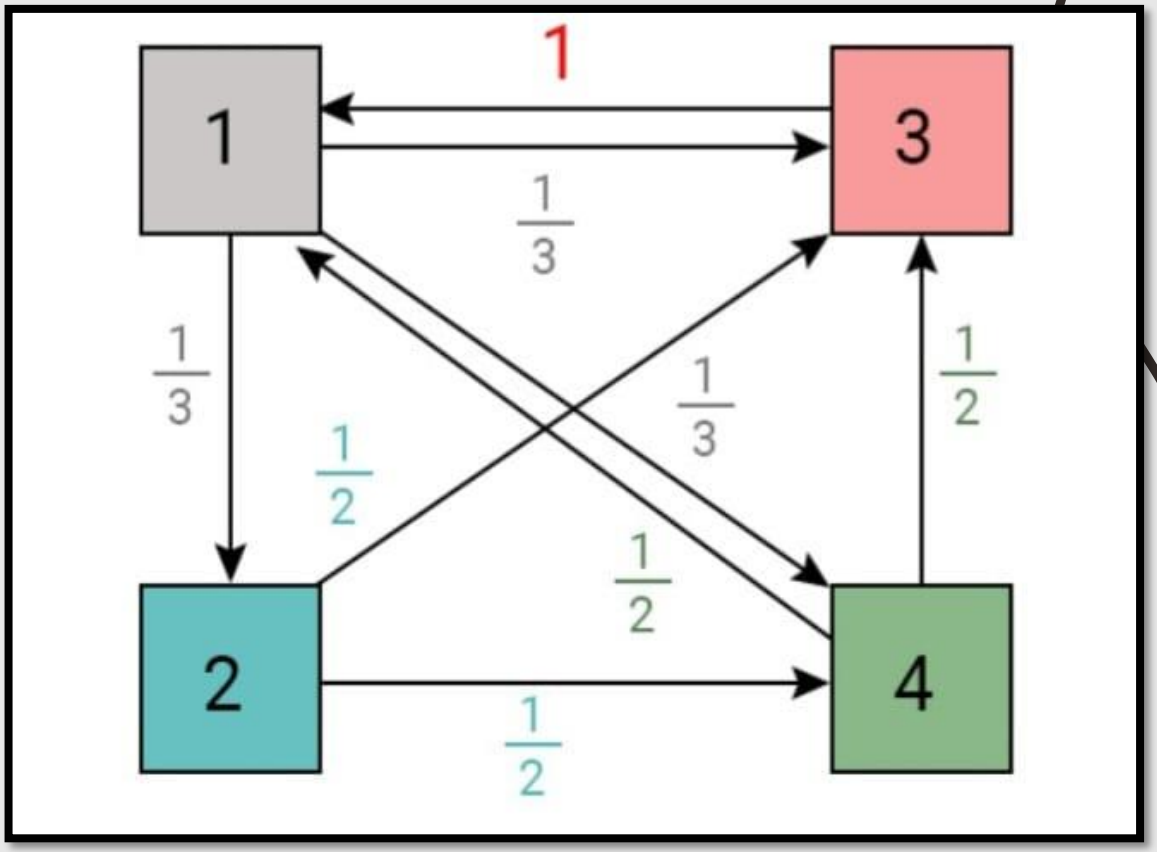


Search Engine Algorithm(Page Rank Algorithms)

4.Each page should transfer evenly it's importace to the pages that it links to.

5. For (1) 1+1/2 = 1.5
For(2) 1/3 = 0.33
For(3) 1/3+1/3+1/2= 1.16
For (4) 1/2 + 1/3 = 0.83

6.The order of importance
1>3>4>2



Conclusion:

Graph theory is foundational in addressing real-life problems across various domains. Its applications span from social networks, transportation systems, and communication networks to biology, computer science, and logistics. By modeling entities and their relationships as nodes and edges, graph theory provides powerful tools for analyzing complex systems, optimizing routes, identifying patterns, and solving problems efficiently. Overall, the versatility and practicality of graph theory make it an indispensable tool in addressing real-world challenges.

Thank You!