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# Graph coloring and applications of graph coloring in our life

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**Abstract**

**Introduction:**

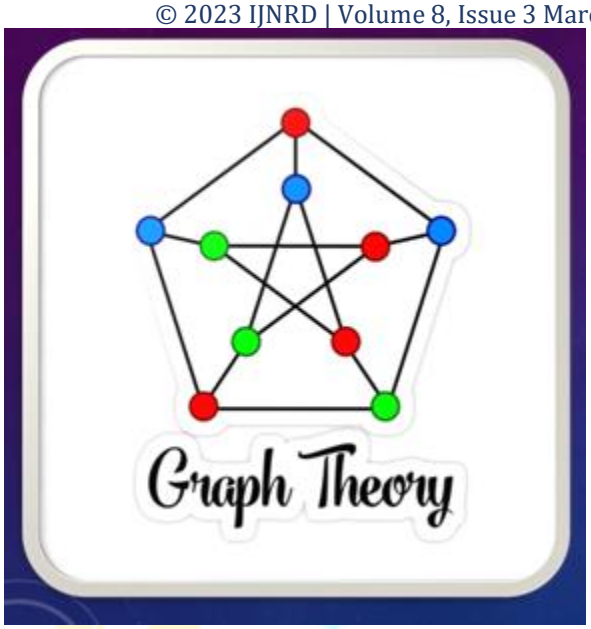
Graph coloring is one of the most important concepts in graph theory and is used in many real time applications in computer science.

**Explanation:**

The main aim of this paper is to present the importance of graph coloring ideas in various areas of compute applications for researches that they can use graph coloring concepts for the research. Graph coloring used in various research areas of computer science such data mining, image segmentation, clustering, image capturing, networking etc. This papers mainly focused on important applications such as Map coloring.

**Conclusion:**

The smallest number of colors required to color a graph G is called its chromatic number of that graph.



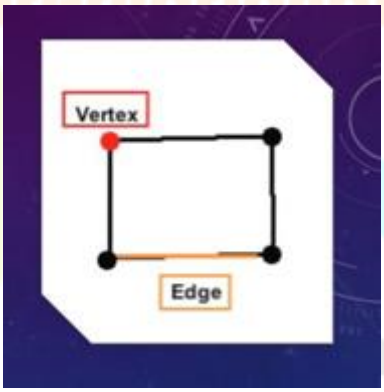

In mathematics, graph theory is **the study of graphs, which are mathematical structures used to model pairwise relations between objects**. A graph in this context is made up of vertices (also called nodes or points) which are connected by edges (also called links or lines).

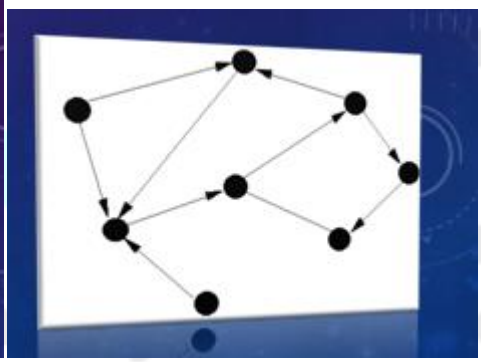
- **GRAPH :**

A graph G consists of a pair V(G),X(G) where V(G) is a non-empty finite set whose elements are called points or "**vertices**".

The element X(G) are called a lines or "**edges**". X(G) is the ordered pair of distinct elements of V(G).

Let G be a graph embedded on a plane π. Then π-G is the union of disjoint regions such a regions are called "**faces**" of G.



- **GRAPH COLORING :**

In graph theory, graph coloring is a special case of graph labeling; it is an assignment of labels traditionally called "**colors**" to elements of a graph subject to certain constrains.

1. In it's simplest form, it is a way of coloring the vertices of a graph such that no two adjacent vertices are of the same color; this is called a "**vertex coloring**".

2. Similarly, an "**edge coloring**" assigns a color to each edge so that no two adjacent edge are of the same color.

3. A "**face coloring**" of a planar graph assigns a color to each face or region so that no two faces that share a boundary have the same color. It is also called as region coloring.

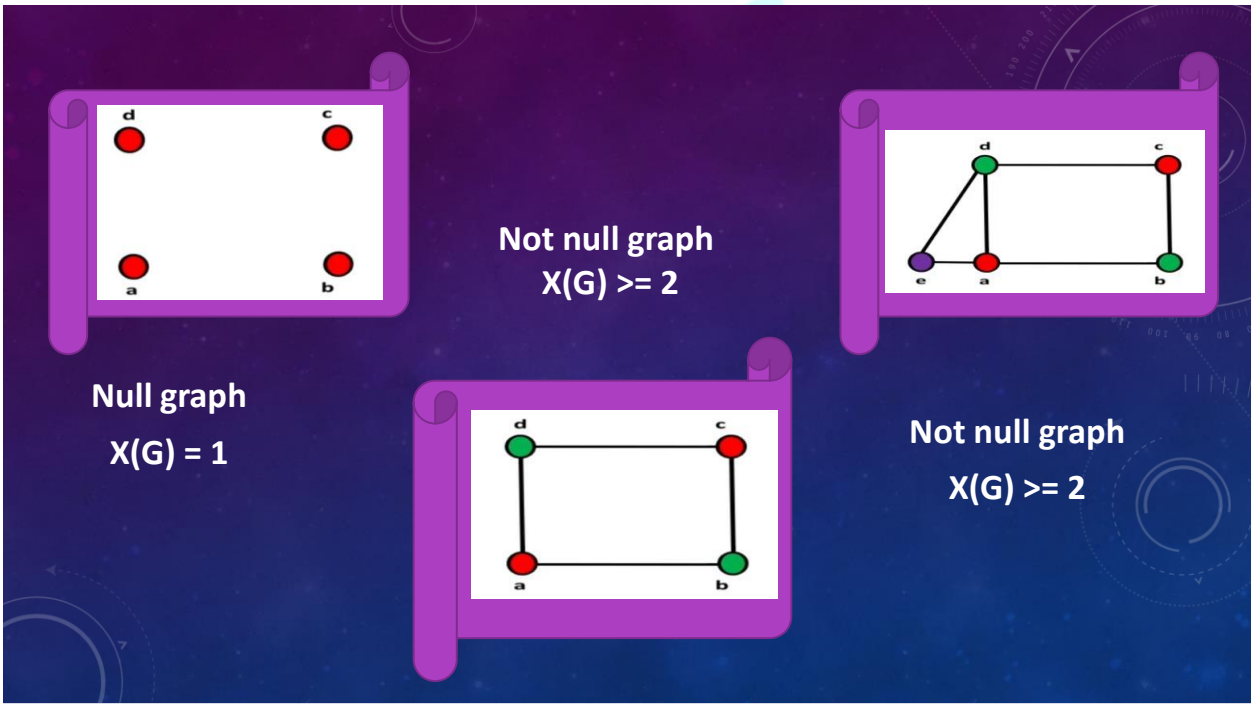
- **Vertex coloring :**

Vertex Coloring is an assignment of colors to the vertices of the graph 'G' such that no two adjacent vertices have the same color. Simply put, no two vertices of an edge should be the same color.

**Chromatic number:**

The minimum number of colors required for vertex coloring of graph 'G' is called as the chromatic number of G by **X(G)**.

X(G) = 1 if and only if 'G' is a null graph. If 'G' is not a null graph then X(G) >= 2.



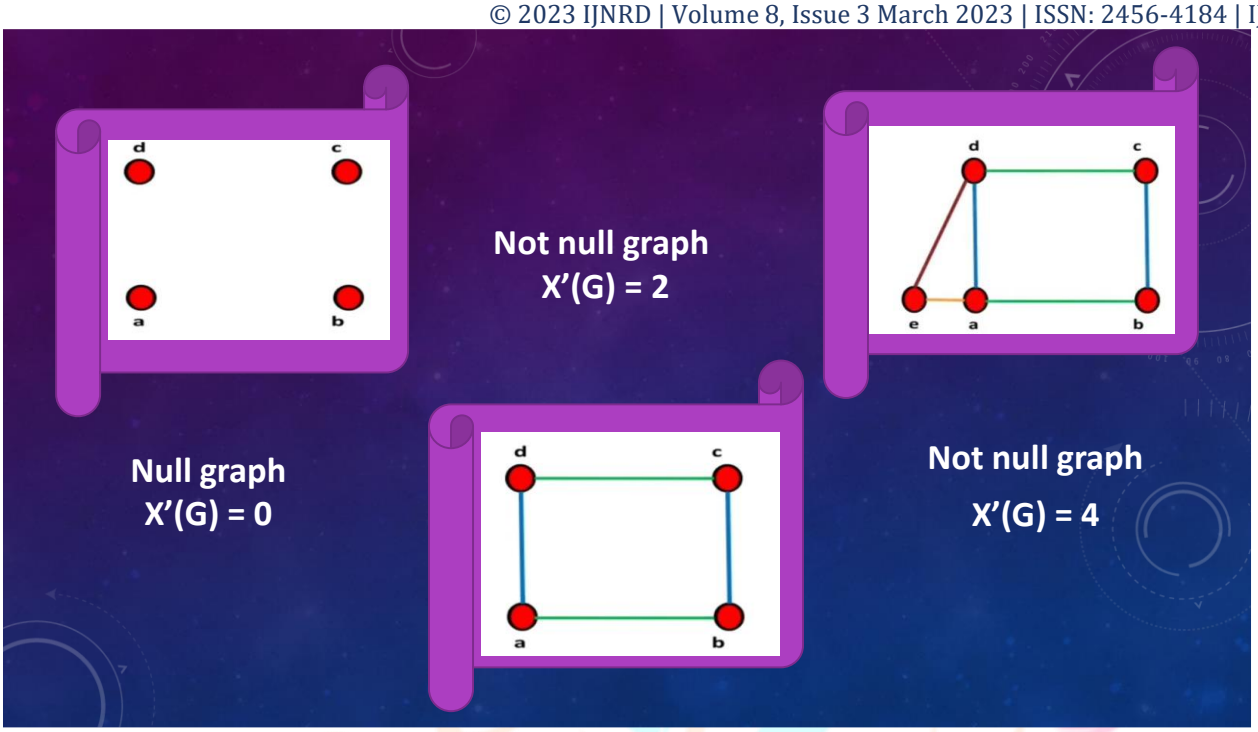

- **Edge coloring :**

A Edge Coloring of a graph is a proper coloring of graph edges, meaning an assignment of colors to edges so that no vertex is incident to two edges of the same color. An edge coloring with k colors is called a k- edge coloring and is equivalent to the problem of partitioning the edge set into k matching.

**Edge chromatic index :**

The minimum number of colors required for edge coloring of graph 'G' is called as the edge chromatic index of G, denoted by **X'(G)**.

X'(G) = 0 if and only if null graph. If G is not a null graph, then X'(G) >=1.



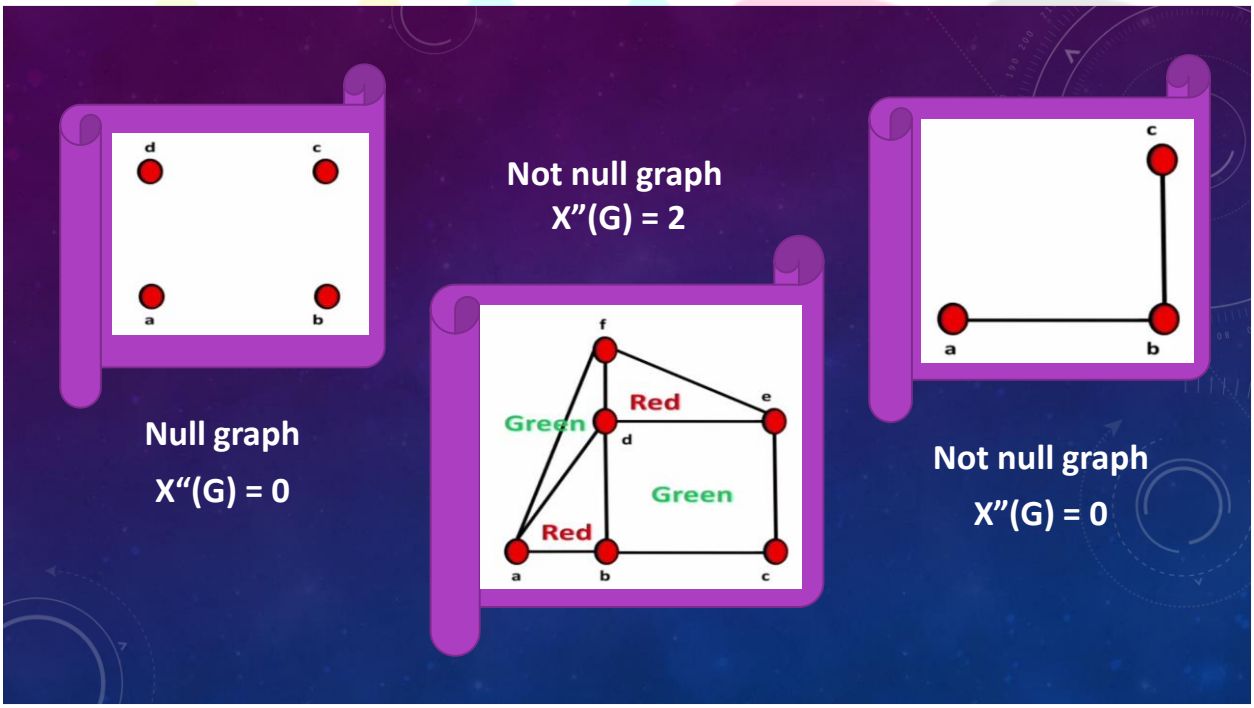

- **Face / region coloring :**

Face / Region Coloring is an assignment of colors to the regions of a planar graph such that no two adjacent regions have the same color. Two regions are said to be adjacent if they have a common edge.

**Face chromatic number :**

The minimum number of colors required for coloring of region of planar graph 'G' is called as the face chromatic number of G, denoted by **X"(G)**.

X"(G) = 0 if G' is null graph or not closed curved. If 'G' is not null graph or not closed curved, then X"(G) >= 1.



- **APPLICATIONS OF GRAPH COLORING :**

Graph coloring is one of the most important concept in graph theory. It is used in many real time applications of computer science such as:

- Clustering
- Data mining
- Image capturing
- Image segmentation
- Networking
- Resource allocation
- Processes scheduling.

- **Clustering :**

Cluster analysis or clustering is the task of grouping a set of objects in such a way that objects in the same group are more similar to each other than to those in other groups.

Retail companies often use clustering to identify groups of households that are similar to each other. For example, a retail company may collect the following information on households: Household income, Household size.

- **Networking :**

Networking, also known as computer networking, is the practice of transporting and exchanging data between nodes over a shared medium in an information system.

We can define different cables with different colours in networking.

- **Resource allocation :**

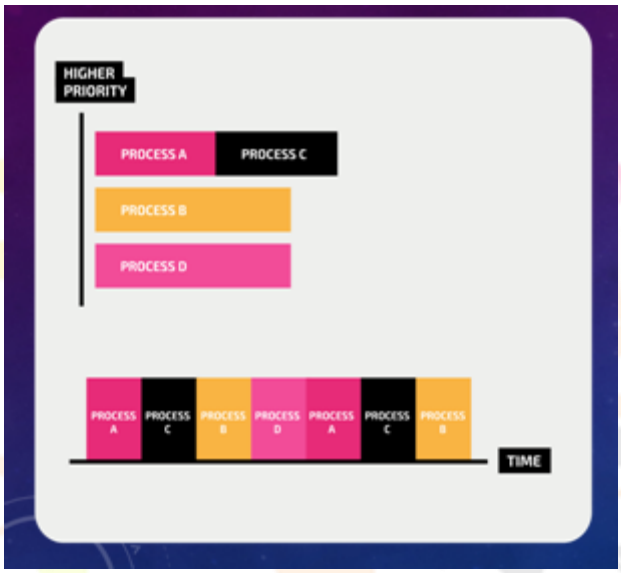
Resource allocation is the process of assigning and managing assets in a manner that supports an organization's strategic planning goals. Resource allocation includes managing tangible assets such as hardware to make the best use of softer assets such as human capital.

The resource allocation graph is the pictorial representation of the state of a system. As its name suggests, the resource allocation graph is the complete information about all processes which are holding some resources or waiting for some resources.

- **PROCESSES SCHEDULING :**

In computing, scheduling is the action of assigning resources to perform tasks. The resources may be processors, network links or expansion cards. The tasks may be threads, processes or data flows. The scheduling activity is carried out by a process called scheduler.

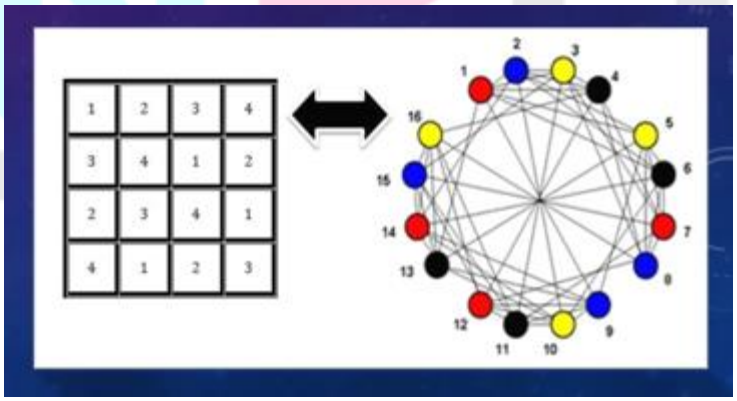
If there are no multiple edges in the graph G that means no two tasks require the same two processors then the edge coloring technique can be adopted.



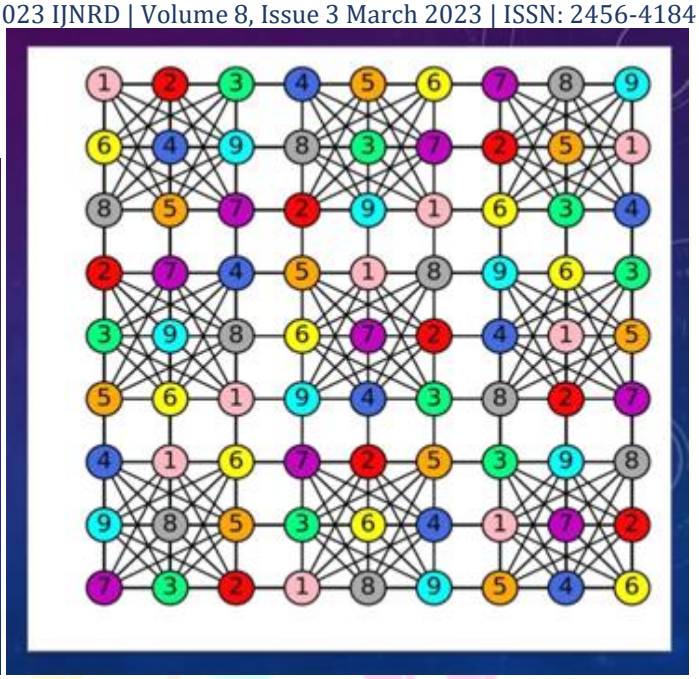

- **Solving suduko puzzles :**

Sudoku is also a variation of Graph coloring problem where every cell represents a vertex. There is an edge between two vertices if they arein same row or samecolumn or same book.

Fill in the blanks cells so that each row, column and 2×2 box has the characters 1 to 4 exactly once.

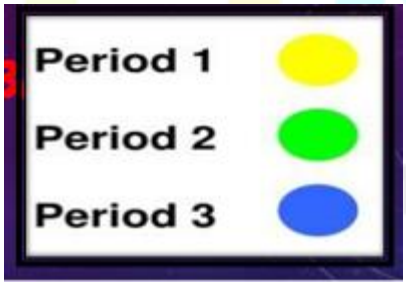



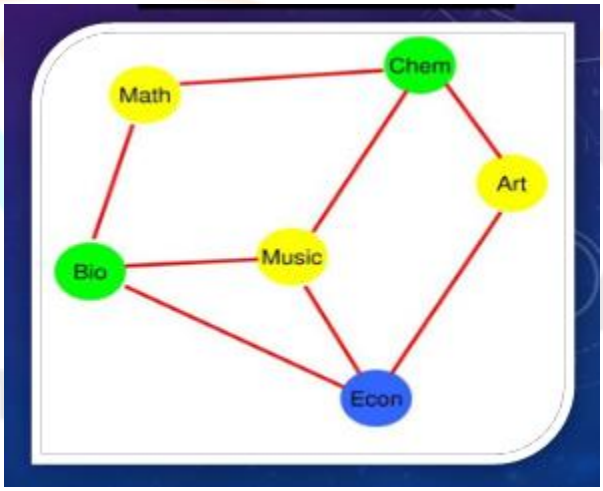

Fill in the blanks cells so that each row, column and 3×3 box has the characters 1 to 9 exactly once



- ***Making Schedule or Time Table:***

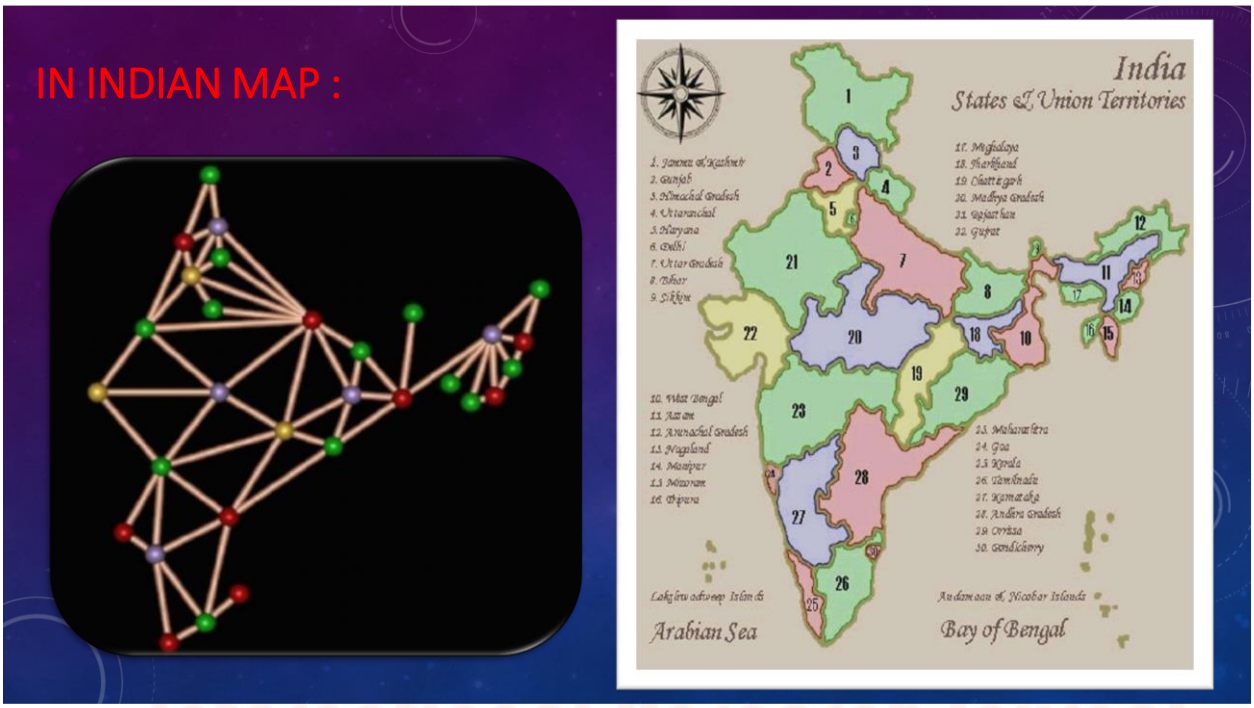
Suppose we want to make am exam schedule for a university. We have list different subjects and students enrolled in every subject. Many subjects would have common students (of same batch, some backlog students, etc). *How do we schedule the exam so that no two exams with a common student are scheduled at same time? How many minimum time slots are needed to schedule all exams?* This problem can be represented as a graph where every vertex is a subject and an edge between two vertices mean there is a common student. So this is a graph coloring problem where minimum number of time slots is equal to the chromatic number of the graph.




- **Graph coloring In map :**

Topological graph theory is the map-colouring problem. This problem is an outgrowth of the well-known **four-colour map** problem, which asks whether the countries on every map can be coloured by using just four colours in such a way that countries sharing an edge have different colours.

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