Learning Objectives

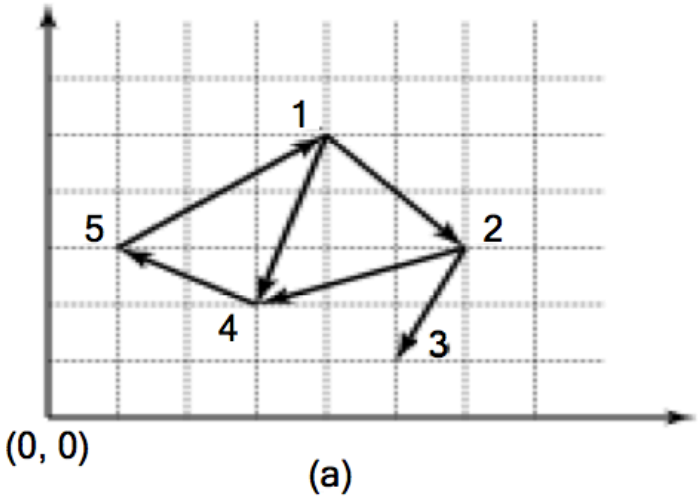
- After this segment, students will be able to
  - List main-memory data-structures for Graphs
  - Describe disk-based file-structures for Graphs

Data Models of Spatial Networks

1. Conceptual Model : Entity Relationship Diagrams, Graphs
2. Logical Data Model : Abstract Data types , Custom Statements in SQL
3. Physical Data Model
   - Storage: Data-Structures, File-Structures
   - Algorithms for common operations

Main Memory Data-Structures

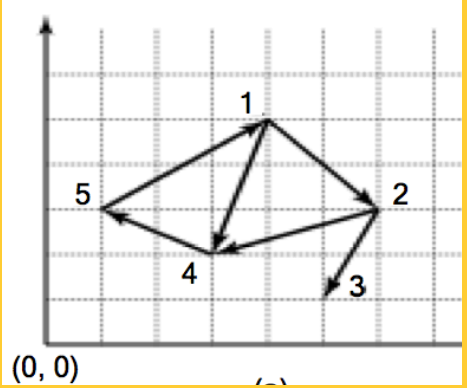
- Adjacency matrix
  - M[A, B] = 1 if and only if edge(vertex A, vertex B) exists
- Adjacency list :
  - maps a vertex to a list of its successors



(a)

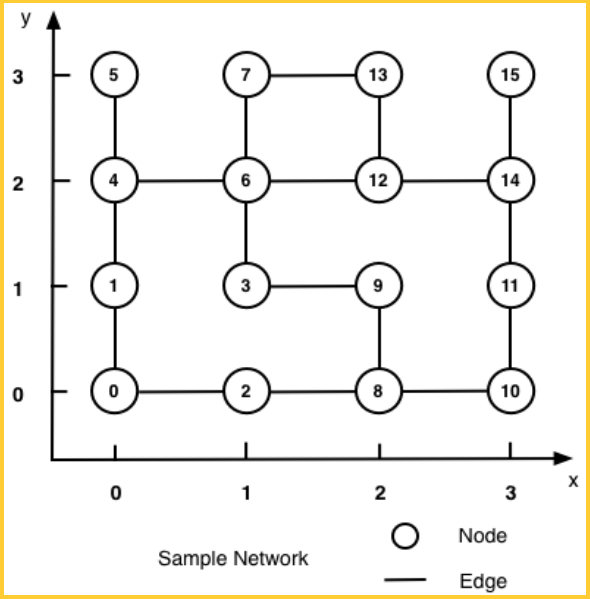
Disk-based Tables

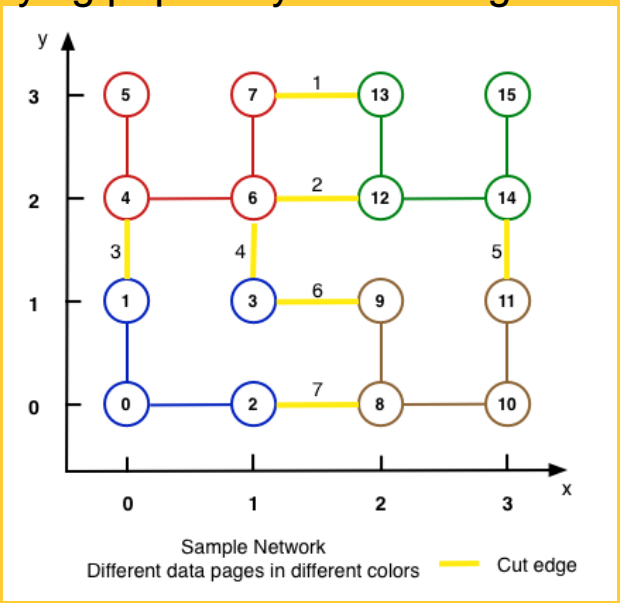
- Normalized tables
  - one for vertices, other for edges
- Denormalized
  - one table for nodes with adjacency lists

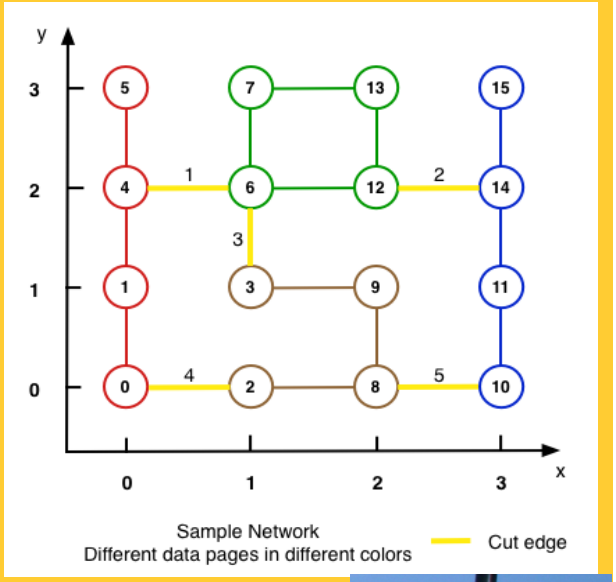


File-Structures:
Partition Graph into Disk Blocks

- Which partitioning reduces disk I/O for graph operations?
  - Choice 1: Geometric partition
  - Choice 2: min-cut Graph Partition
  - Choice 2 cuts fewer edges and is preferred
  - Assuming uniform querying popularity across edges

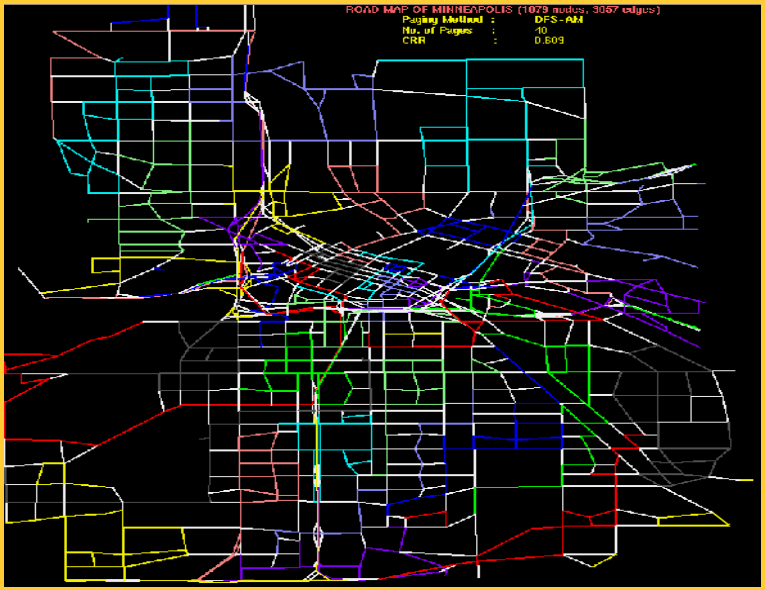


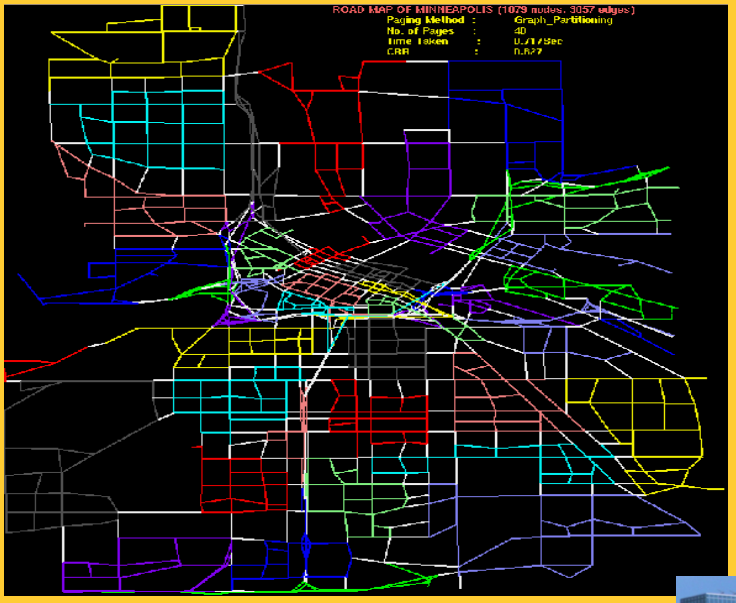




Graph Based Storage Methods

- Consider two disk-paging of Minneapolis major roads
  - Non-white edges => node pair in same page
  - White edge are cut-edges
  - Node partitions on right has fewer cut-edges and is preferred

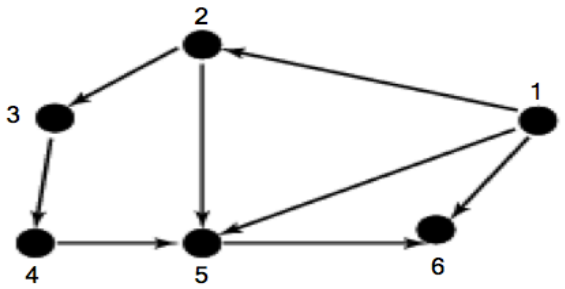




Exercise: Graph Based Storage Methods

- Consider spatial network on right
- If a disk page holds 3 records, which partitioning will has fewest cut-edges?

(a) (1, 2, 3), (4,5,6)
(b) (2, 3, 4), (1, 5, 6)
(c) (1, 2, 6), (3, 4, 5)
(d) (1, 3, 5), (2, 4, 6)



Node

nid	x	y	Successors	Predecessors
1	—	—	(2,5,6)	()
2	—	—	(3,5)	(1)
3	—	—	(4)	(3)
4	—	—	(5)	(3)
5	—	—	(6)	(2,1)
6	—	—	()	(1,5)