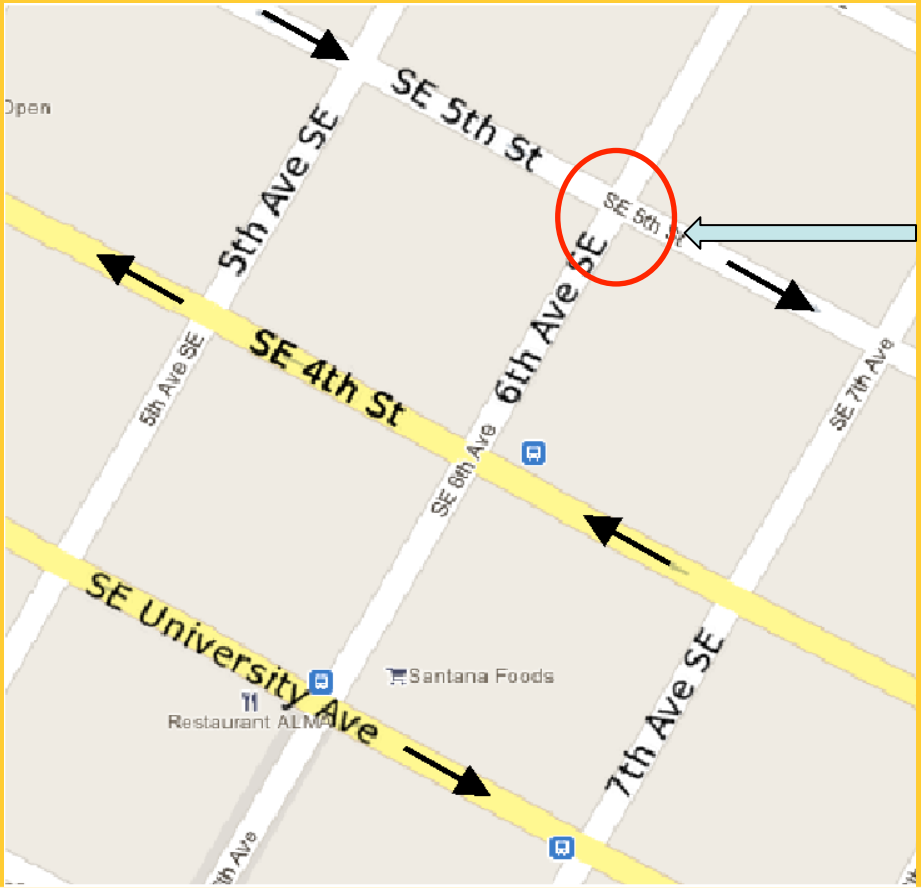
Learning Objectives

- After this segment, students will be able to
  - Describe Conceptual models of Spatial Networks
  - List & compare alternative Graph models

Data Models of Spatial Networks

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

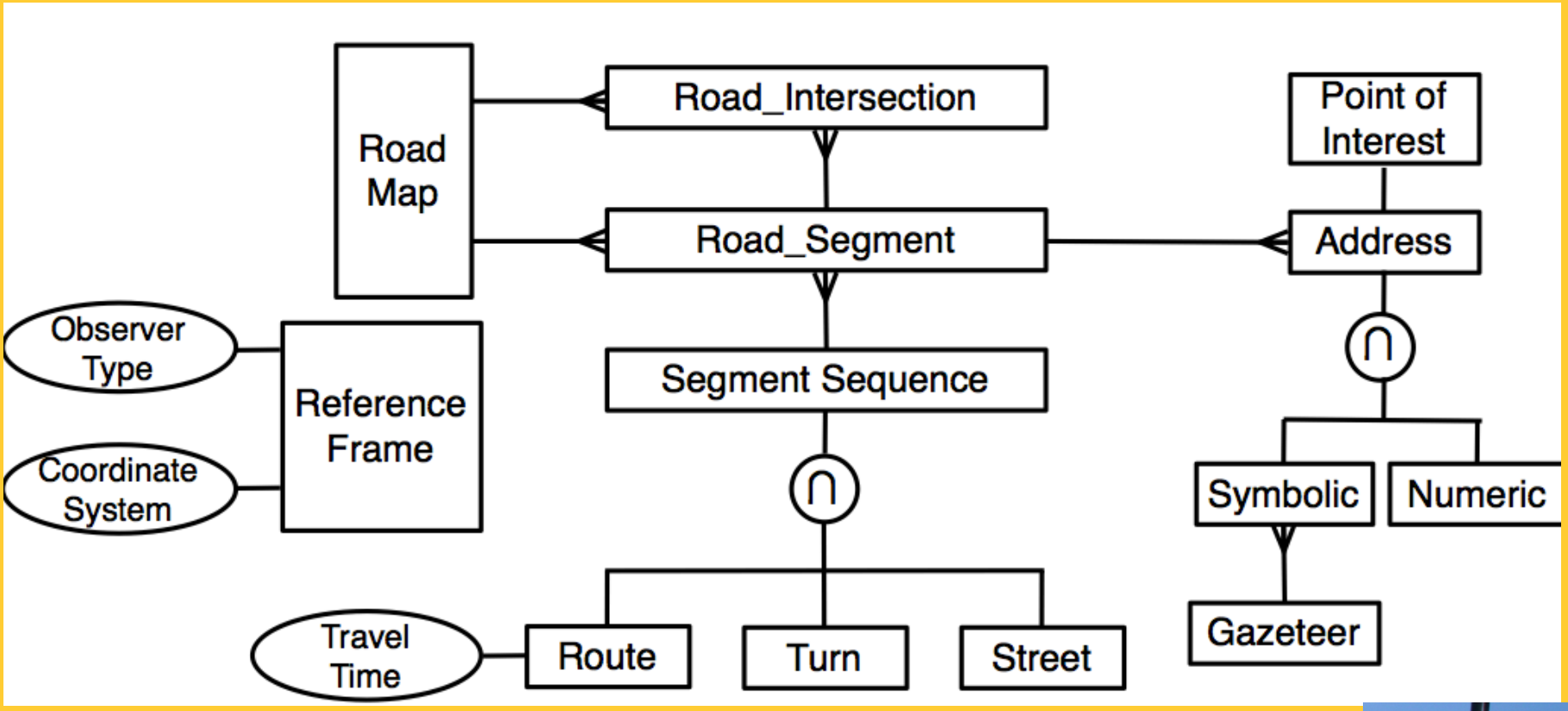
Modeling Roadmaps



Many Concepts, e.g.

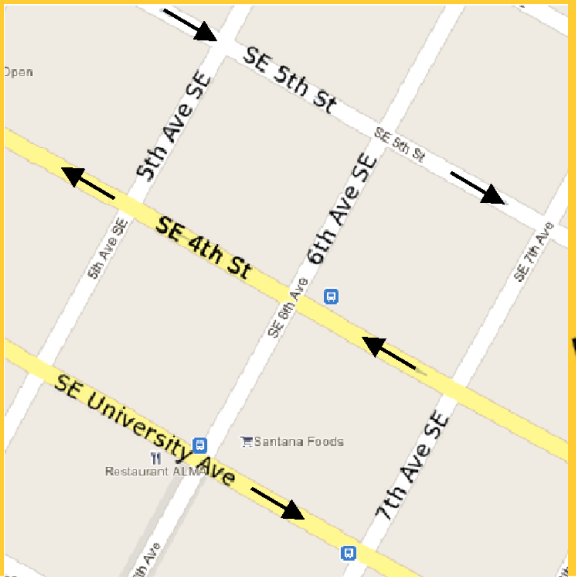
- Roads (or streets, avenues)
- Road-Intersections
- Road-Segments
- Turns   
- …

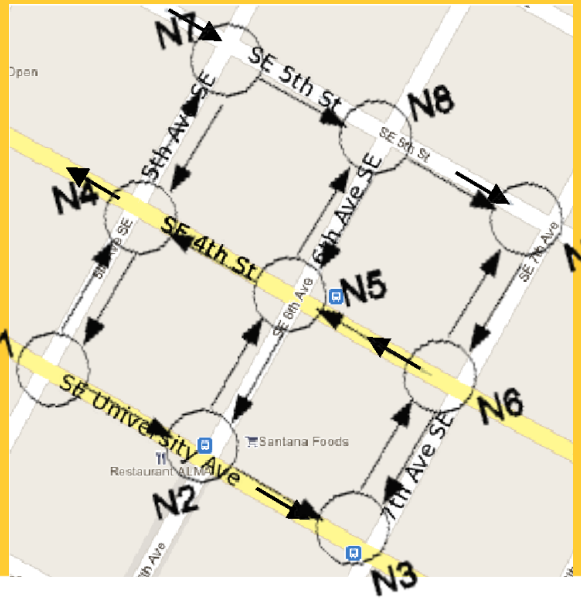
An Entity Relationship Diagram

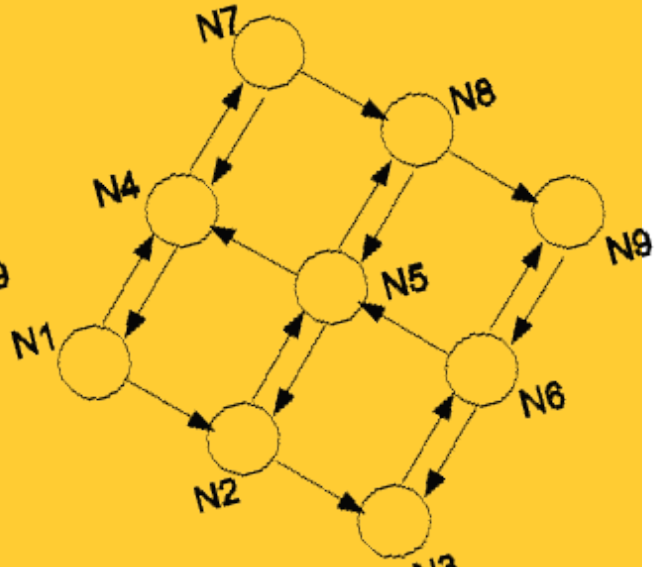


Graph Models

- A Simple Mathematical Model
  - A graph G = (V,E)
  - V = a finite set of vertices
  - E = a set of edges model a binary relationship between vertices
- Example

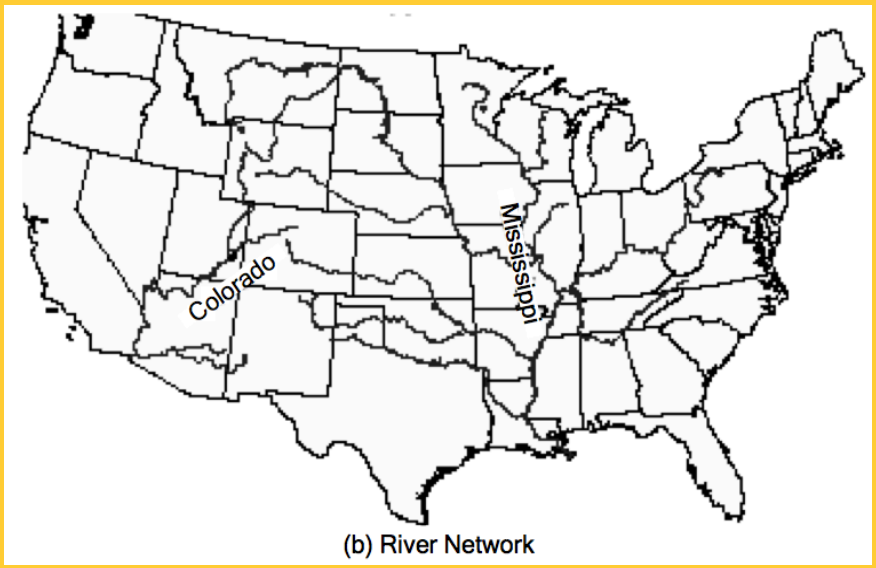


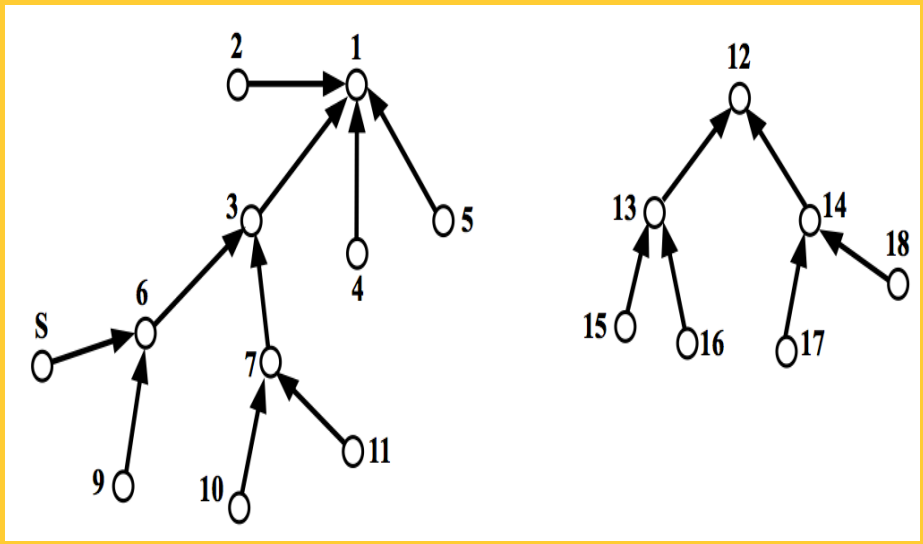




A Graph Model of River Network

- Nodes = rivers
- Edges = A river falls into another river



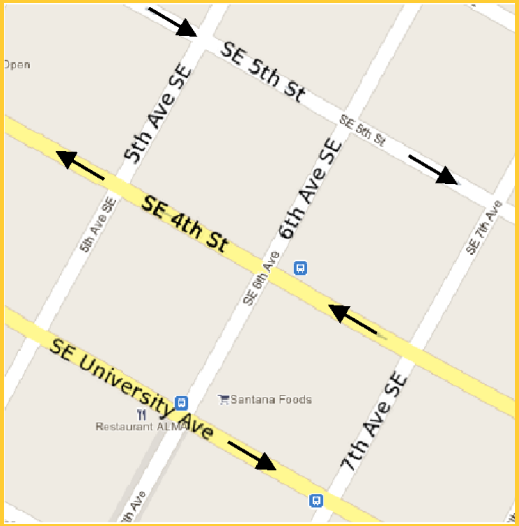


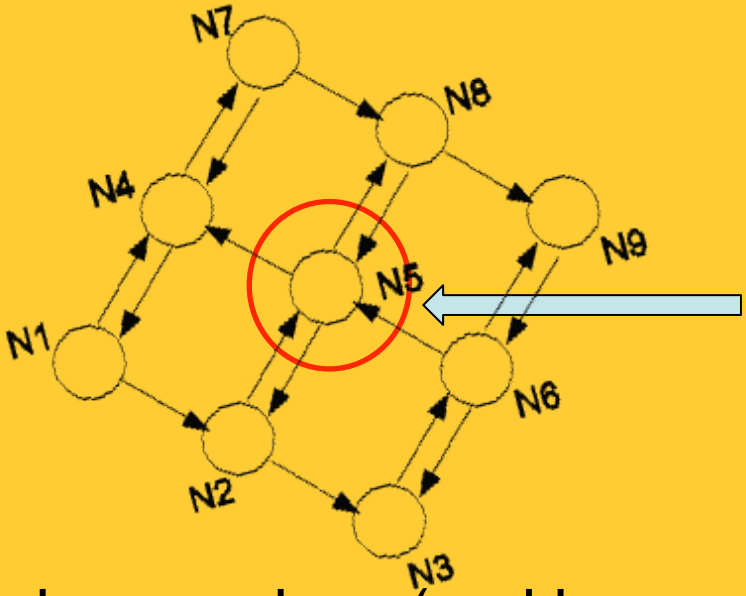
Pros and Cons of Graph Models

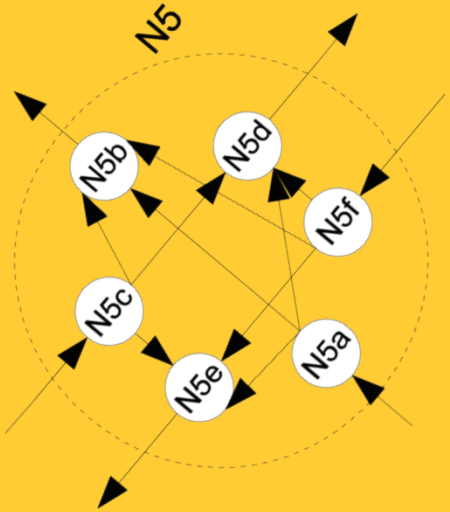
- Strength
  - Well developed mathematics for reasoning
  - Rich set of computational algorithms and data-structures
- Weakness
  - Models only one binary relationship
- Implications
  - A. Difficult to model multiple relationships, e.g., connect, turn
  - B. Multiple graph models possible for a spatial network

Modeling Turns in Roadmaps

- Approach 1: Model turns as a set of connects







- Approach 2: Use hyper-edges (and hyper-graphs)
- Approach 3: Annotate graph node with turn information

Alternative Graph Models for Roadmaps

- Choice 1:
  - Nodes = road-intersections
  - Edge (A, B) = road-segment connects adjacent road-intersections A, B
- Choice 2:
  - Nodes = (directed) road-segments
  - Edge (A,B) = turn from road-segment A to road-segment B
- Choice 3:
  - Nodes = roads
  - Edge(A,B) = road A intersects_with road B