Chapter 10
Spatio-temporal Databases

- Temporal GIS and Applications
- Time Geography
- Processes and Events
- Spatio-temporal Query Language
- Continuous Queries in Spatio-temporal Databases
- Moving Object Languages
- Modeling with Spatial and Temporal Uncertainty

Tim Jinfei Yin & Michael Moore
Knowing how something is (or was) often isn't enough. We may want to know how something has changed or is changing.
Societal and GIS Motivation

To see where Spatiotemporal GI Systems would be helpful, just add "over time" to any subject.

- Spread of epidemics...
- Weather...
- Crime Analysis...
- Traffic routing...
- Air quality...

Models for predicting the future are built on analysis of past events!

Over Time could mean historic data analysis, or could mean real-time updates. Could mean over one day, or over 1000s of years.
Time is Relevant and Complicated

Spatiotemporal data doesn't work well with current:

- Database models
- Query language
- Algorithms
Novel Concepts From The Articles

1. Additional concepts/definitions related to temporal spatial information system
   eg. Time geography, modeling, queries, uncertainty, events & processes

2. Clarify the geographic, computer science and mathematical basis
   eg. Time geography, modeling, queries, uncertainty, events & processes
   space-time path & space-time prism, potential path tree & potential network area,
   MOST model & FTL language, Spatio-temporal Query Languages

3. Introduce lots of applications/research areas that involved with those concepts or techniques
   eg. Public Health, Earth and Atmospheric Sciences, Location-Based E-commerce, Climate Analysis and Predicting

4. Information about their development history
   eg. evolutions of concepts and modifications of models
Just as changing from 1d to 2d, and from 2d to 3d introduce new complications in queries and algorithms, adding time as another dimension further complicates the system.

(Topological Relationships in 1d and 2d space)
Related Material in Textbook

Chapter 4 (*Models of Geospatial Information*)
- Definitions of overlap/inside/outside/etc.

Chapter 6 (Structures and Access)
- Searching, indexing

Chapter 10 (*Time*)
- Evolution of spatiotemporal system
- Temporal/spatiotemporal information systems
- Spatial Index and Queries
Novelty in Encyclopedia Articles

Alternative ways to model time
- moving point or moving region

Possible query languages
- Find number of cars in bad weather for > 30 minutes:
  - \( \text{SELECT count(*) FROM cars AS c, weather AS w WHERE duration(deftime(intersection(c.trip, w.area)))) > 1800} \)

Time Geography
- "examines how humans allocate scarce time resources among activities in geographic space"
Computer Science Motivation

- New query language constructs
- New modeling challenges
- New data storage challenges
- New algorithms for evaluating queries
Continuous Queries in Spatio-temporal Databases

Continuous Query, Moving Object
- Show me all gas stations near where I am now

Static Query, Continuously Moving Objects
- Show me all buses near my house

Moving Queries, Moving Object
- Police Helicopter Chasing Suspect in Car

Moving Queries, Moving Object, Future Prediction
- Warn me when two airplanes are on a collision course
Time Geography

Predicting the future, determining the past
Questions?
Comments?
Concerns?

Thank you!