Chapter Name and Number

Encyclopedia Articles

• Location Based Services: Practices and Products, J. Francica, pp. 623-627.
• Homeland Security and Spatial Data Mining, V. Janeja and N. Adam, pp. 434-440.
• Crime Mapping and Analysis, Ron Wilson, pp. 180-186
• Pandemic Detection and Management, C. Barrett, S. Eubank, B. Lewis, M. Marathe, pp. 839-843.
• Change Detection, J. Theau, pp. 77-84.

Team Members
Reasoning and Uncertainty
Chapter 9

Encyclopedia Articles

• Imprecision and Spatial Uncertainty, M. Goodchild, page 480-483.
• Positional Accuracy Improvement, C. Ronsdorf, page 885-891.
• Uncertain Environmental Variables in GIS, G. Heuvelink, J. Brown, page 1184-1189.
• Moving Object Uncertainty, G. Trajcevski, P. Sheuermann, page 740-746.

Brad Johnston, Norine Wilczek
Relevance to Course

• Spatial uncertainty: difference between contents of spatial database and corresponding phenomena in the real world.

• Results of GIS analysis are presented as being far more accurate than they really are.

• Abstractions and simplifications (generalization) of the real world are necessary when resources are limited.
  – Spatial objects - positional (houses, fields, rivers, cities)
  – Attributes - (sq. ft, crop density, water quality, population)
Related Material in Textbook

• Uncertainty is closely related to data and information.

• Fuzzy Set Theory: aim to classify objects or pixels based on nearness.

• Consistency:
  – The existence of logical contradictions within the data
  • Population example
Novelty in Encyclopedia Articles

- Geostatistics – smooth the extremes in data (public health data)
- Moving object uncertainty – tracking objects that use satellite-tracking and errors in time keeping & predictions
  - Traffic information, meteorology, forest fires, etc.
- Positional Accuracy Improvement –
  - Relative positional accuracy: difference between 2 defined points in a dataset, and true distance between said points with overall reference system
  - Absolute positional accuracy: distance between a defined point in a dataset and its true position in reference system
Societal Motivation

• Medical Geography, Criminology
  – Identify disease and crime hot spots
  – Uncertainty presents itself in “small number problem”

• Medical Geography
  – Allows us to trace source of outbreaks
    • Began in 1854 when Dr. John Snow traced cholera to water pump

• Criminology
  – Allows us to allocate crime-prevention resources to areas of highest need
Moving Object Uncertainty

• Important in GIS (ex: tracking forest fires), Meteorology (ex: tracking storms), Location-Based Services (ex: travel information)
  – Made possible with the advent of mobile networks
  – Spurred the creation of Moving Object Databases (MOD)

• Uncertainty arises in between updates from mobile sensor to MOD
Moving Object Uncertainty

- Three models of representing future locations of moving objects
  - Frequent updates to MOD
    - Sends time and location to MOD
  - Occasional updates to MOD
    - Sends time, location, velocity
    - Velocity used to calculate future locations; objects are allowed to deviate from expected route within predefined tolerance
  - Trajectory Model
    - MOD receives start and end locations, start time, and possibly points to be visited, from which route is generated
Computer Science Motivation

• Moving Objects Databases
  – Utilize continuous queries to update database with new locations with time

• Algorithms have been developed to process continuous queries for the various models of moving objects