Deriving place graphs from spatial databases

Ehsan Hamzei
Hao Chen
Hua Hua
Maria Vasardani
Martin Tomko
Stephan Winter
Introduction

- Human place knowledge vs spatial databases / maps
  - e.g., The Convention Centre is on the south bank of the Karrawirra Parri, near the InterContinental.

- Place graphs:
  An abstract representation of human place knowledge
Introduction

- Analysing place descriptions / applying place graphs:
  - Extracting landmarks
  - Creating sketch maps
  - Answering place questions

  - e.g., Answering place questions:
    - “Where is Faro in Portugal?”
    - Disambiguation and analysis
      - e.g., <Faro, in, Portugal>
    - Answering in natural language
      - e.g., “In the southern part of Portugal”

Motivation

• Extraction of human place knowledge for Question-Answering
• Place graphs currently created from collecting place descriptions
  • difficult to collect / sparse
• Complementary approaches needed
Hypothesis and Questions
Hypothesis and Questions

• Hypothesis:
  • Place graphs can be generated from information stored in spatial databases.

• Research questions:
  • What are the cognitive factors in human place descriptions?
  • How to generate place graphs from spatial databases?
Method
Method

• Cognitive factors:
  • Hierarchical structure in human cognitive map and natural language place descriptions
  • Human short memory capacities (seven plus/minus two)

• Supporting:
  • Only polygons
  • Cardinal directions and topological relationships


George A Miller. The magical number seven, plus or minus two: some limits on our capacity for processing information. Psychological Review, 63(2):81, 1956.
Method – Step 1

- Extracting hierarchical structure:
  - Containment relationships (a topological relation)
  - Based on the point in polygon algorithm
Method – Step 2

- Updating hierarchical structure:
  - Similar to human cognitive map
  - Quad-tree strategy
    - Dividing the polygon into four meaningful partition
Method – Step 3

- Extracting qualitative spatial relationships:
  - Between the sibling nodes
  - Cardinal directions and topological relationships
Implementation and Results
Implementation
Experiments

Neighbourhoods of Melbourne Cricket Ground

Geographic Area:
Max (Latitude): -37.816166
Min (Latitude): -37.8333225
Max (Longitude): 144.999666
Min (Longitude): 144.9686385

#Extracted Polygons: 98

Neighbourhoods of the Melbourne CBD

Geographic Area:
Max (Latitude): -37.7768969
Min (Latitude): -37.8642848
Max (Longitude): 145.0451277
Min (Longitude): 144.9030481

#Extracted Polygons: 3088

Melbourne

Geographic Area:
Max (Latitude): -37.4838639
Min (Latitude): -38.1856803
Max (Longitude): 145.4551932
Min (Longitude): 144.411885

#Extracted Polygons: 17002
Results

- #Nodes and #Edges compared to fully connected graph
Conclusions
Conclusions and Future Work

• Conclusions:
  • Deriving place graphs from spatial databases
  • A complementary approach to generating place graphs from NL place descriptions
  • Designed based on cognitive factors
  • Evaluated regarding the fully connected approach (baseline)

• Future work:
  • Supporting more relationships
    – Relative directions (e.g., left of)
    – Distance relationships (e.g., near)
  • Supporting points and linear features
Thanks