Exploiting Vague Spatial Information in Geographic IR

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http://www.cwi.ugent.be
http://www.fuzzy.ugent.be

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Geographic IR: local search

Search for:
- restaurants
- e.g. restaurants, dentists, museums
- Make this my default Yahoo! location

Location:
- Brussels
- Address, City & State, or ZIP

Search Tips

Search Yahoo! Local from your desktop. Get Yahoo! Search Widget

⚠️ Your search matched multiple cities
Please select the correct location:
- Brussels, IL
- Brussels, WI

Cancel  Select & Search
Geographic IR: local search

1. Cascadia Restaurant
   (206) 448-8884  2328 1st Ave, Seattle, WA 0.31 mi
   Map | Directions | Send to Phone | Save to Collection

   "...most accessible. The same is true of Cascadia, his landmark restaurant in Belltown. The..."
   more

   See all: All Bars, Pubs & Clubs - Restaurants - American Restaurants
   www.cascadiarestaurant.com
Geographic IR: local search

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★★★★★ (8)

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Description
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www.cascadiarestaurant.com/z
Typical architecture

User

Local Search Service

Gazetteer
- Atomium
- Paleis der Academiën
- Brussels airport
- Grand Place

List of businesses
- Hotel$_1$
- Hotel$_2$
- Restaurant$_1$
- Restaurant$_2$
Problems

- Limited coverage
  - E.g. no businesses in Belgium
  - Some shops, restaurants, hotels are missing
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- **Limited support for landmarks**
  - Some landmarks have more than one name
  - Many landmarks are not covered by a typical gazetteer
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- **Limited support for neighborhoods/regions**
  - Most neighborhoods are unknown to the system
  - Some neighborhoods are reduced to their centroid
Proposed solution

User

Local Search Service

Gazetteer

List of businesses

WWW

Semi-structured information

Unstructured information
http://www.hotel-rates.com/belgium/brussels/

Semi-structured information

Name
Address
Coordinates
geocoding
Aris Grand Place Hotel Brussels
Grasmarktstraat 78 80
BRUSSELS, BE 1000

The new Aris Centre Hotel is extremely well situated near the world-famous Grand Place in Brussels. It is located in the heart of the old city, next to the picturesque Rue des Bouchers and all of the city's major shopping and sightseeing opportunities.

The hotel has 55 modern and large rooms, each of which is fully equipped with all new facilities including air-conditioning, television, telephone, internet and laptop connection, private safe-deposit box, work desk and a newly remodeled bathroom.

The hotel staff is eager to please and guarantees professional and multilingual service. Feel free to relax in the hotel's charming lobby. Metro and bus lines are easily accessible, and an underground car park is available 50 meters from the hotel. The Central Railway Station is 300 meters away. Whether it's business or pleasure that brings you to Brussels, the Aris Centre Hotel is the ideal choice.
Representing closeness

a is located at walking distance from b

\[ d(a,b) \]
Location approximation

x is located at walking distance from a
Location approximation

x is located two kilometers from b
x is located near c
Location approximation
What are the boundaries for neighborhoods such as
- European Quarter
- City Center
- Quartier Louise
Neighborhoods

- What are the boundaries for neighborhoods such as
  - European Quarter
  - City Center
  - Quartier Louise

- Boundaries are often vague
  - Gazetteers contain no information on the boundaries
  - Sometimes a centroid is provided
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Boundaries could be useful
- To support queries like “Restaurants in the European quarter”
- To interpret natural language statements such as “The hotel is located in the European quarter”
The footprint of a region $R$ is represented as a fuzzy set

- Mapping $m$ from locations to $[0,1]$
- $m(x) = 1$ iff $x$ belongs to $R$
- $m(x) = 0$ iff $x$ does not belong to $R$
- $m(x) \in ]0,1[$ iff $x$ more or less belongs to $R$
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Extraction based on set of locations that are known to lie in the neighborhood
- “Hotel $X$ is located in Brussel’s EU neighborhood”
- Additional heuristics
Obtaining footprints
Obtaining footprints
It may be of interest to know that neighborhood A
- is a part of neighborhood B: PP(A,B)
- borders neighborhood B: EC(A,B)
- overlaps with neighborhood B: PO(A,B)
Spatial relationships

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- Such relationships are useful
  - for query relaxation
  - for supporting neighborhoods with an unknown footprint
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- Pattern-based approach
  - the <NP> neighborhood includes <NP>, <NP>, and <NP>
  - located on the boundary between <NP> and <NP>
Inconsistencies arise because

- Some relationships are wrong: $PP(a,b)$ and $PP(b,a)$
- Some relationships are vague: $PP(a,b)$ and $EC(a,b)$
Inconsistencies arise because
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- Some relationships are vague: PP(a,b) and EC(a,b)

Consistency checking & reasoning are based on a fuzzification of the RCC calculus in which
- Regions can be vague (fuzzy footprints)
- Spatial relations can be satisfied to some degree (i.e. spatial relations are fuzzy relations)
Our goal is to improve local search services based on semi-structured and unstructured web-information
  – Support for neighborhoods
  – Better support for landmarks
  – Increased coverage

This requires a formalism that is tolerant for imprecision
  – Fuzzy relations to represent closeness information
  – Fuzzy footprints to delineate neighborhoods
  – Fuzzy relations to represent qualitative spatial relations