# The Spatialization of the Web

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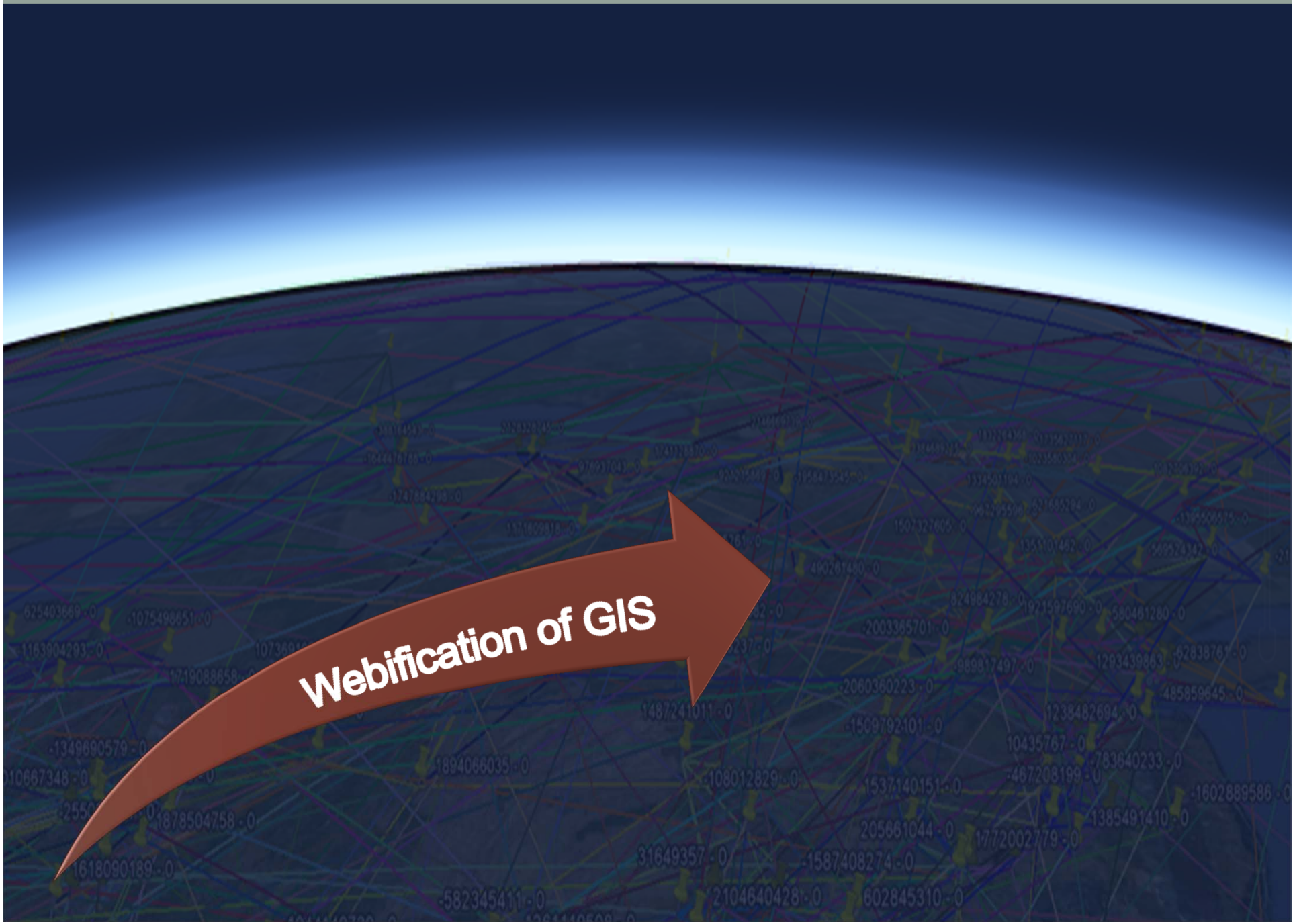
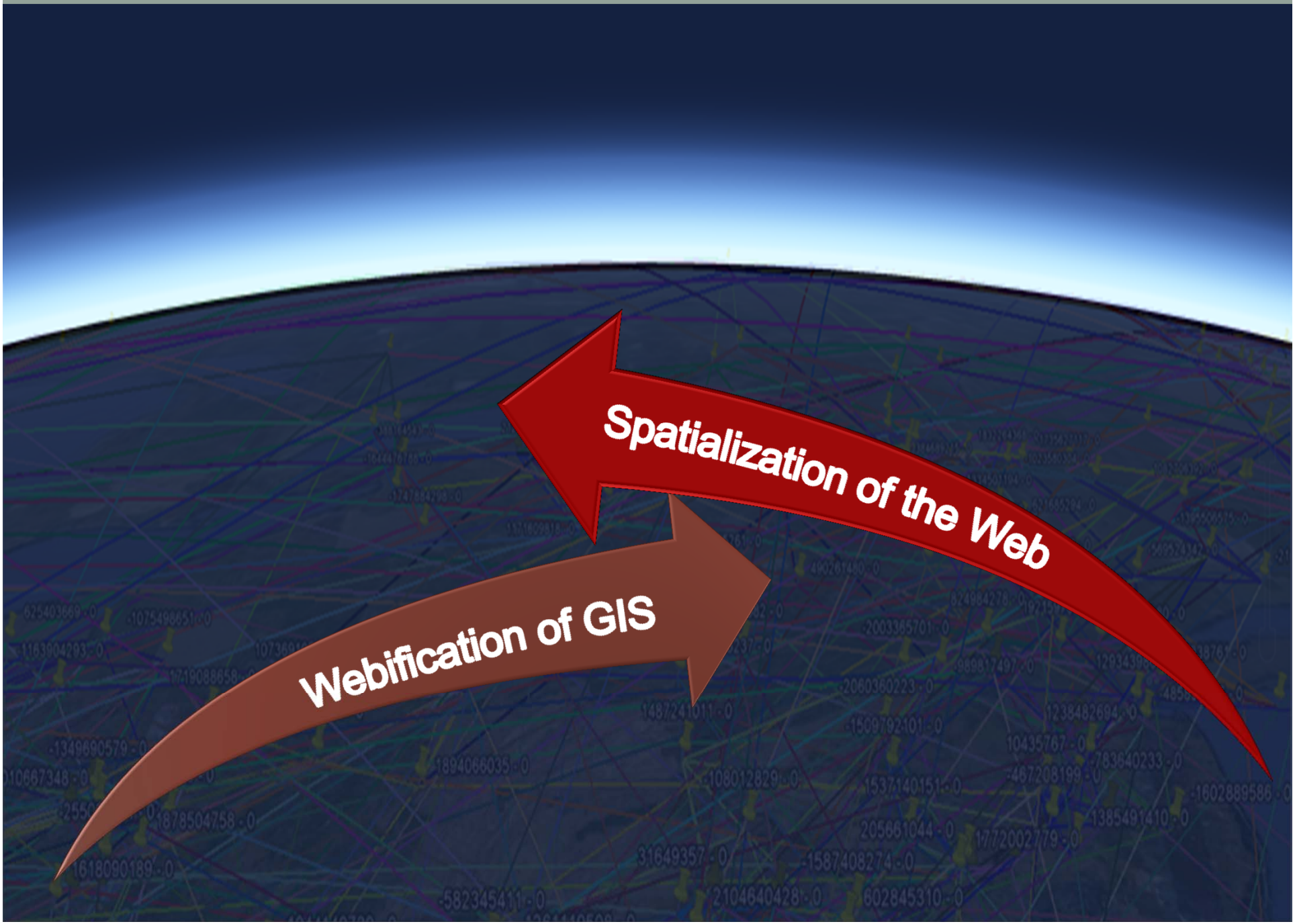

Webification of GIS


Spatialization of the Web
Webification of GIS

# The «modern» Web…

# The «modern» Web…

- …a Web of Prosumers

- The change to Web 2.0 is a *change towards a Web of participation*, where an ever increasing number of users simultaneously acts as producer and consumer of content.

- In 2015 more then 70 % of the WWW`s content is going to be user generated!

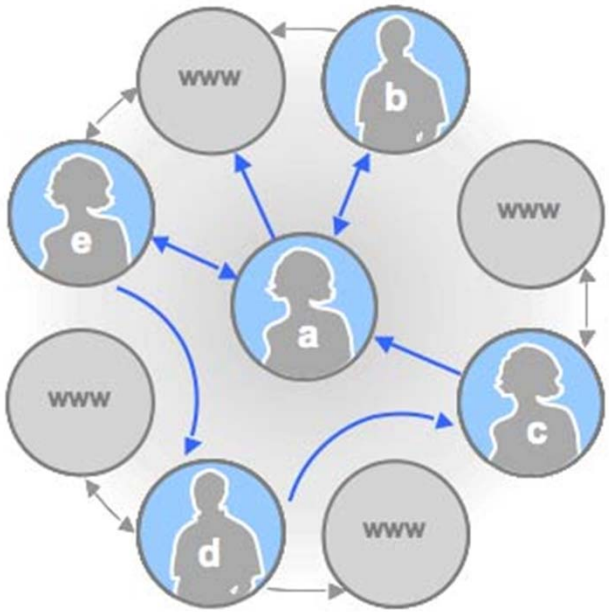
# The «modern» Web…

## …a social Web

The *change from* 1:n publication of “cold” (often factual) information with a globally comprehensible semantics for an unspecified audience

*to* personal n:m communication of “warm” personal content in Social Networking and the Social Web with a more restricted contextual scope and validity.

personal queries for information are often directed to friends in SN platforms instead of querying centralized anonymous search engines.

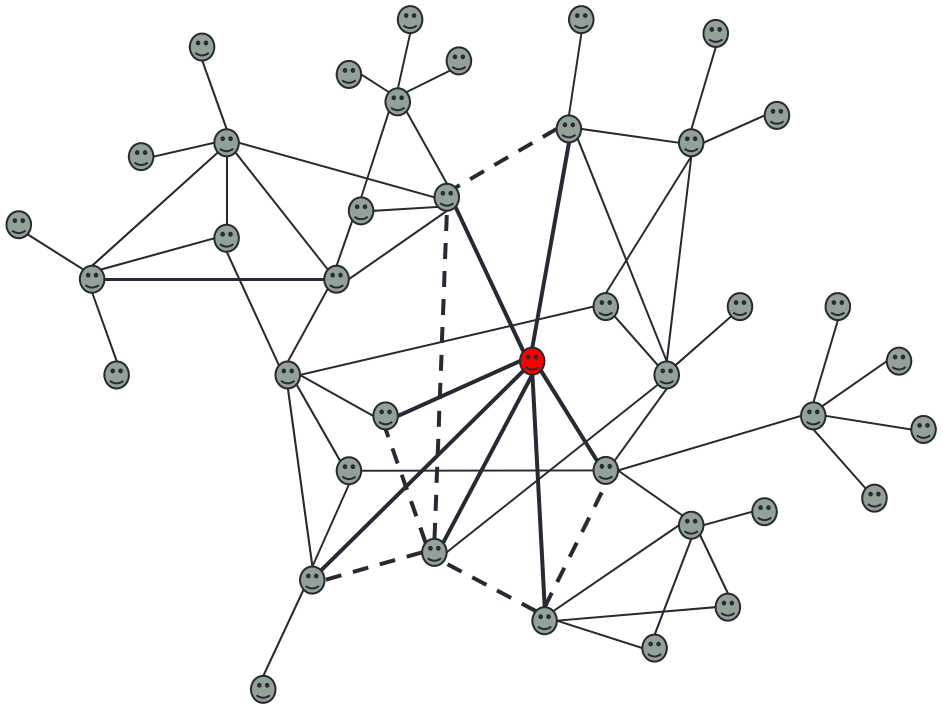


# The «modern» Web…
## The Small World Phenomenon

„*six degrees of separation*“ in the human social network
[Milgram1967]

**Structural characteristics:**
type of graph that is characterized by characteristically **large clustering coefficient** and a **small diameter**

**Algorithmic characteristic:**
Routing without global knowledge of the network but with local knowledge only is possible.
→ **decentralized Search**



**Can be found in:**

- human social network
- US Power-Grid
- Neural Network
- link-graph of the Web

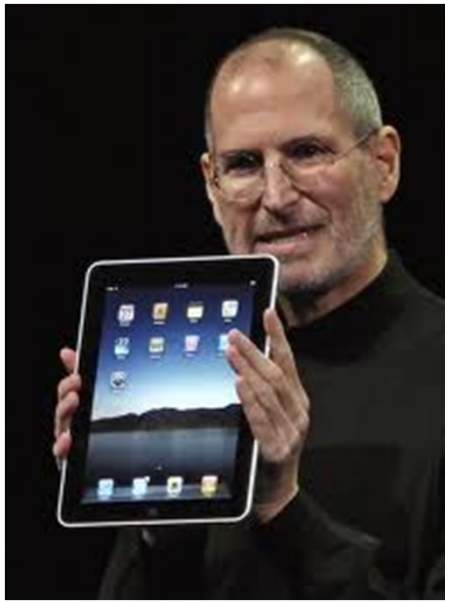
# The Small World Phenomenon

http://oracleofbacon.org/

# The «modern» Web…

## …a mobile and ubiquitous Web

New classes of mobile devices like smartphones or net-books allow for an *ever deeper and smoother integration of the Web into our everyday lives* and blur the borderlines between virtual and real world.

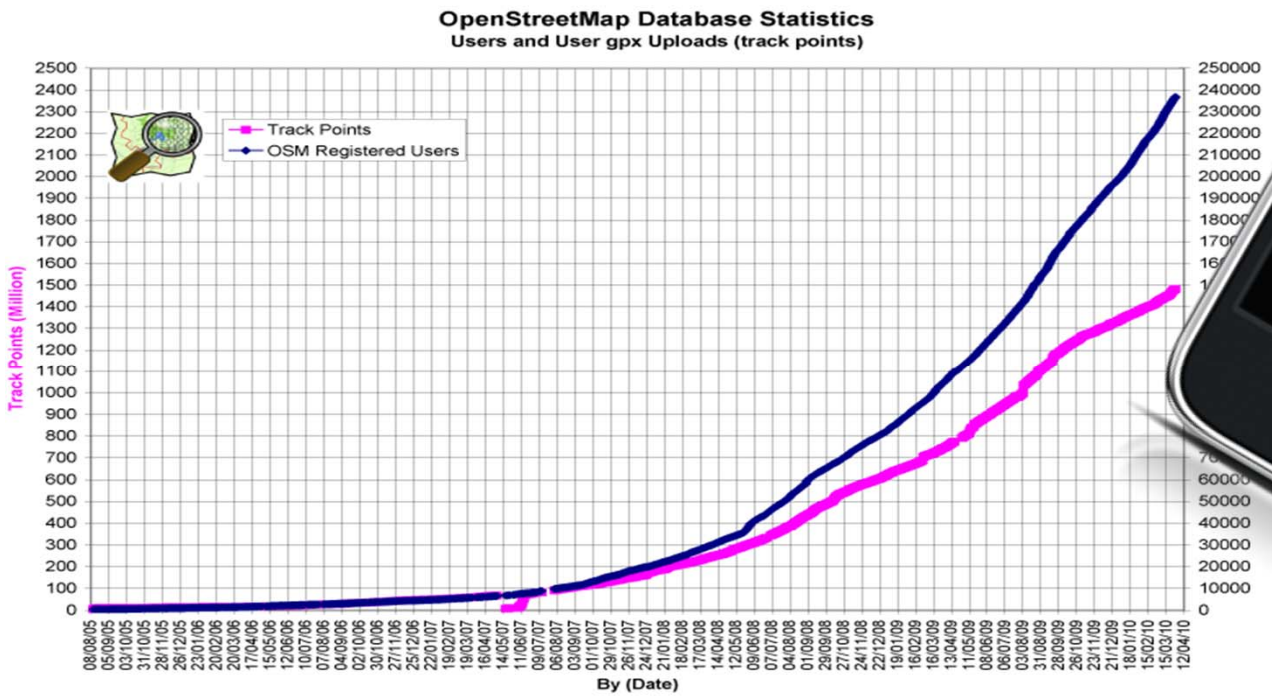


# The «modern» Web…

…a geospatial Web

Geo-enabled Devices (e.g. smartphones with GPS)

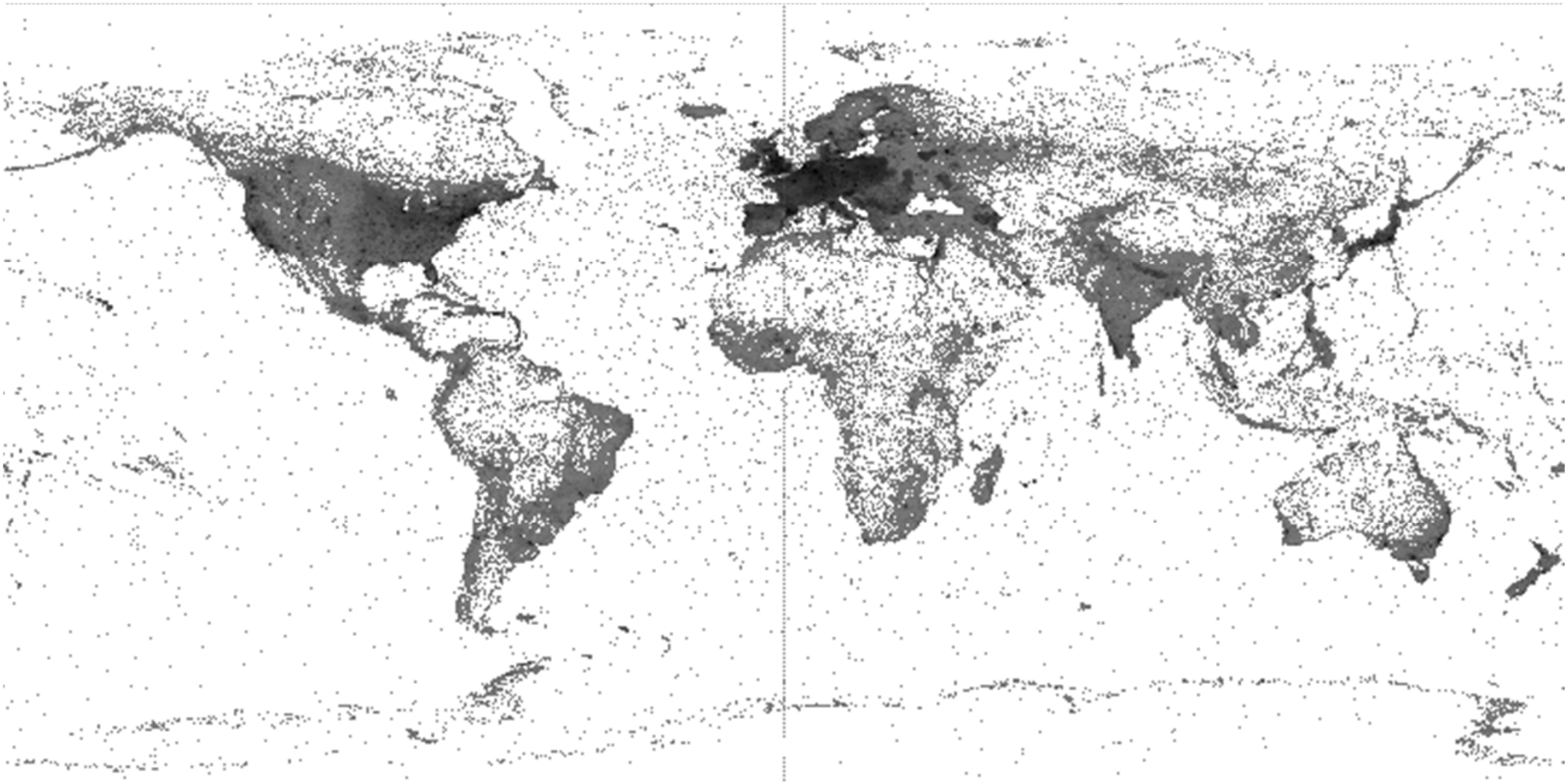
User Generated Geo-Content and Collaborative Geo-Applications





*[Image sources: wiki.openstreetmap.org and apple.com (modified)]*

# Spatial distribution of Wikipedia articles



# Spatial distribution of Facebook`s 800 million people and there social graph

# (Geographic) Information Retrieval

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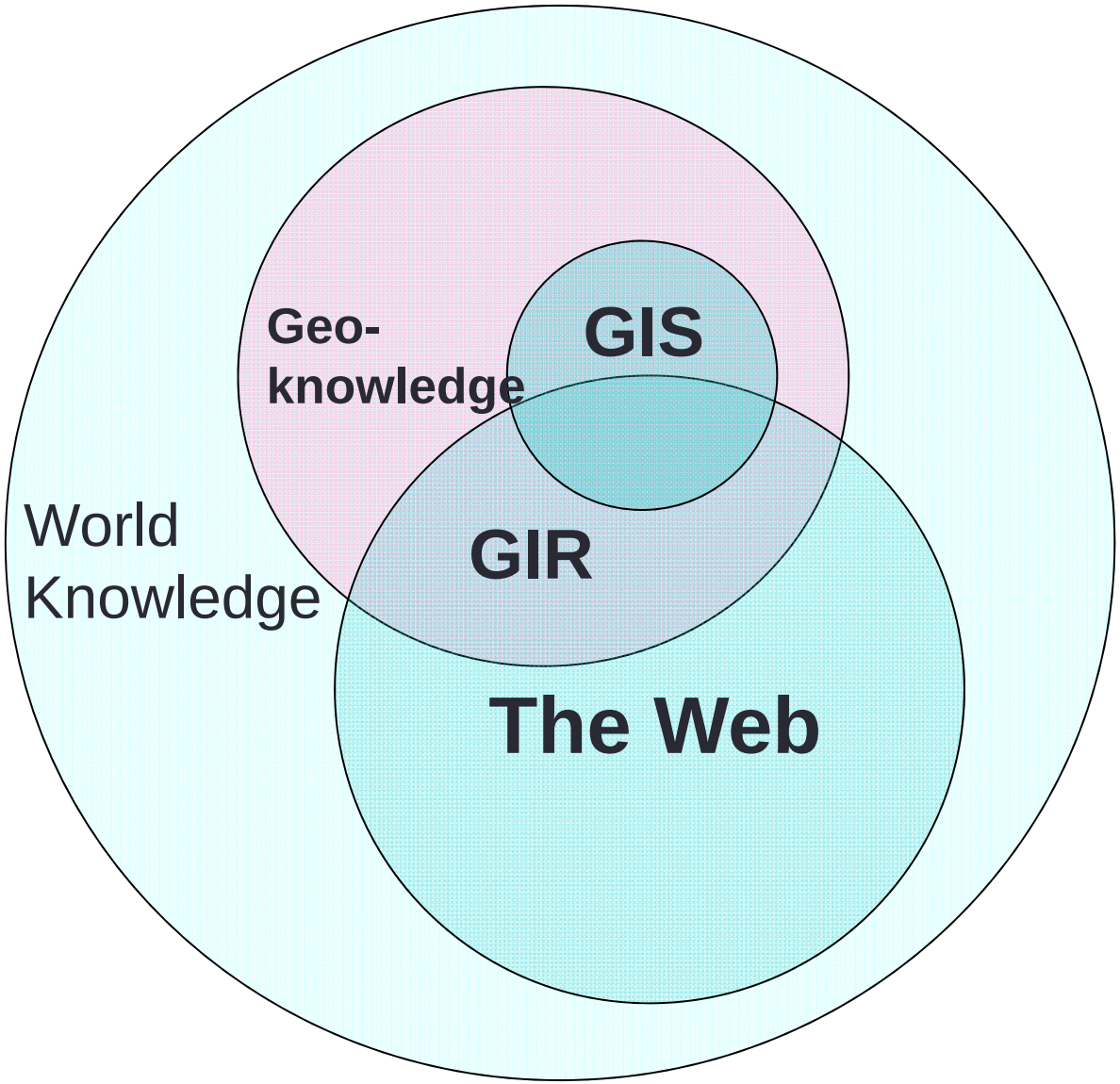


# (Geographic) Information Retrieval

**GIS** is concerned with exact spatial representations and complex analysis at the level of the individual spatial object or field.
→ Users are experts, information is structured and unambiguous!

**GIR** is concerned with retrieving geo-referenced information resources that **may be relevant** to a geographic query region.
→ Unstructured and ambiguous information, everyday applications!

*Similar to the difference between search engines and relational database systems!*

# (Geographic) Information Retrieval

## Current motivation of GIR:

about 80 % of all decisions of an individual are related to a direct or indirect spatial reference

about 20 % of all Web-searches (not distinguishing between mobile and desktop access) have a geographic context.

Find geo-specific resources on the Web

*<topic keywords, spatial relation, location>*

Something ***related_to*** **Somewhere**

*related_to* = in, near, within x km, north_of ..etc.

# Natural IR Principles

**Cognitive process of searching for information:**

1. asking yourself (WHAT) → formulate your "information need"

2. (WHO) to ask for this information
   ←→ (WHAT) the topic
   ←→ (WHERE) the geographic context
   ←→ (WHEN) the temporal context

3. (WHERE) the aforementioned source (WHO) is

**WHO←→WHERE←→WHAT←→WHEN**

In the real world, we discover that people can successfully find relevant information for questions by just asking the "right" people through their social network.

# (Geographic) Information Retrieval

**Geo-Tagging** = Geo-Parsing + Geo-Coding

**Geo-Parsing**

Geographic context embedded in natural language descriptions

Recognising geographic references with Named Entity Recognition (NER) from Natural Language Processing (NLP).

**Geo-Coding** (grounding)

Attaching a unique quantitative location (footprint) to Named Entities

# Geo-Parsing

Place names can be recognised with gazetteers

Some types of true geographic reference:

- the name of the place
- an address (address fragment)
- a postcode / zip code
- a phone number

Some types of false geographic reference:

- Personal names (e.g. Jack London)
- Business name (e.g. York Hotel)
- Street names (e.g. Oxford Street)
- Common words that are also places

→ distinguishing between false and true geo-references

# Geo-Coding

Geo-coding (grounding) the genuine geo-references

From a Named Entity to a footprint

(e.g. with a gazetteer)

NE(“Santa Barbara”)

# Existing Gazetteers

- Alexandria Digital Library (ADL) Gazetteer
  - ~6 million entries
  - Has tried to standardize the format, description, and distribution of gazetteer data.
  - Has a published, detailed schema.
  - Basis for OGC standard.
- GeoNames website
  - Integrates information from multiple sources.
  - Publishes OWL ontology.
  - ~6 million entries
- Google / Bing / Yahoo…
  - All have proprietary gazetteers available through public APIs

# Spatio-temporal Indexing

Typical strategy is to have separate indexes.

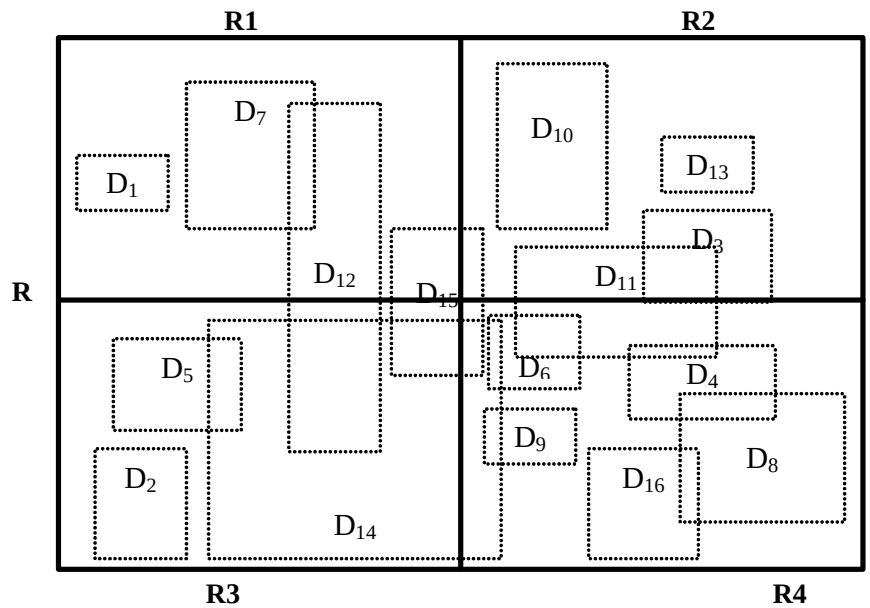
- Inverted index for text.
- R-tree for footprints.

→ Access spatial index with query footprint.

→ Access text index with query terms.

→ Merge results and find the intersection.

| | |
|---|---|
| **Term1** | D1, D2, D23, … |
| Term2 | D9, D11, D100, … |
| Term3 | D27, D85, .. |



# Tobler`s First Law of Geography

*"All things are related,*
*but nearby things are more related than distant things"*

→ "nearby things are more similar than distant things"

[W.R.Tobler, 1970. *A computer movie simulating urban growth in the Detroit region.* Economic Geography46]

## Formalization in Geostatistics

–variogram, covariogram
–measuring how similarity decreases with distance
–spatial autocorrelation
–IDW and Kriging

## The First Law of Cognitive Geography

"People think closer things are more similar" [Montello and Fabrikant]

# Spatio-temporal Ranking

Spatial similarity can indicate relevance

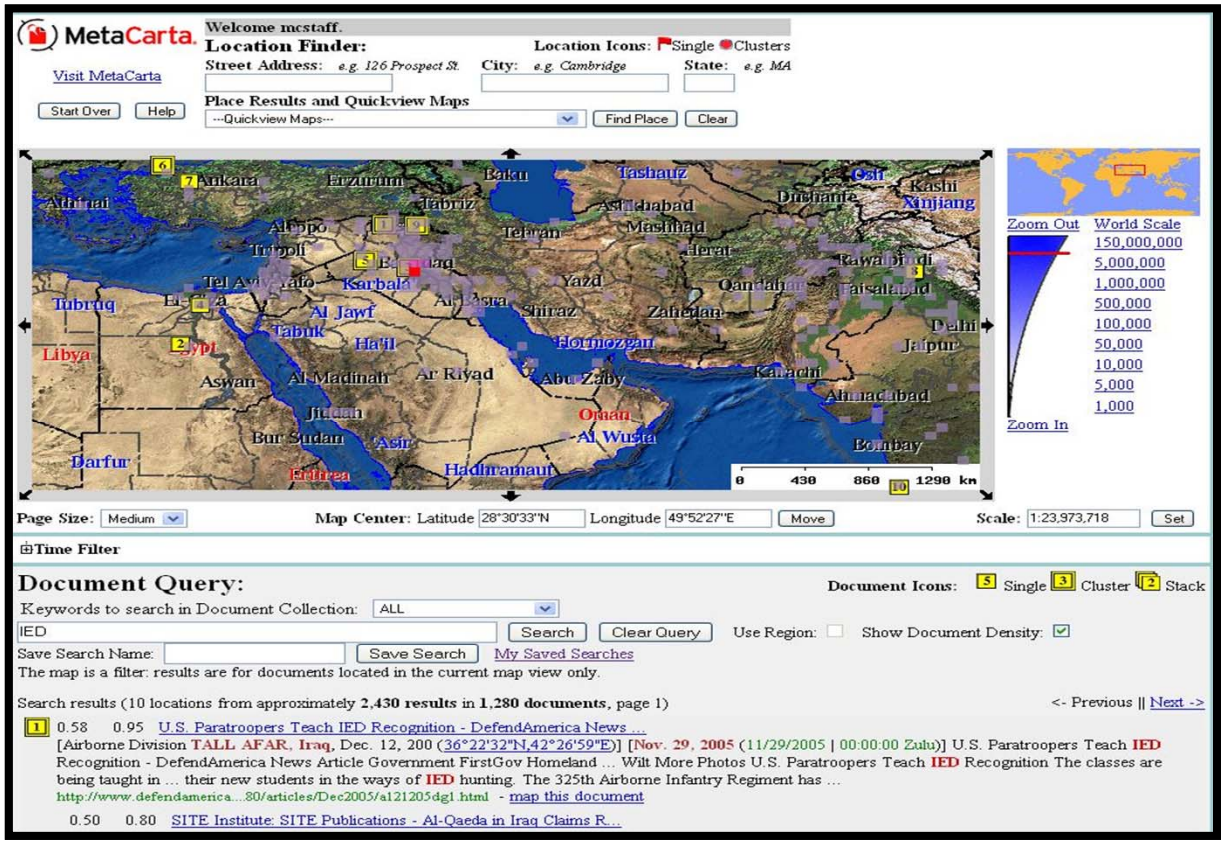
- Documents whose spatial content is more similar to the spatial content of the query should appear first.

But we need to consider both, the

- Thematic relevance
- Geographic relevance
  Geometric (e.g. distance) and non-geometric (e.g. topology)

State of the art consists of doing a linear combination.

- The MetaCarta system
  - Pioneer system addressing all aspects given in this talk.
  - Conducts geo-parsing and geo-coding of text documents, and sends back possible location references with relative strength scores.
  - Uses NLP to find possible location references.
  - Contains a gazetteer of ~14 million entries.



"… identify the themes that are most closely associated with places around the world."

- ~ 275,000 Travelblogs
  - Each blog tagged to one specific location
  - Approached each location as a corpus
- Divided the world up into ¼ degree grid cells
  - Approx. 10,000 locations
- Latent Dirichlet allocation
  - 200 Topics


hike
top
climb
trail
mountain
rock
steep
desert
dune
sand
star
camel
festival
dance
people
celebration
parade
crowd
london
ben
england
pub
walk
incredible
absolutely
lovely
beautiful
amazing
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camp
tent
campsite
river
bridge
water
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cheese
breakfast
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taste
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garden
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flower
plant
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sea
whale
dolphin
penguin
seal
island
bird
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peru
lima
arequipa
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bus
canyon
monday
weekend
saturday
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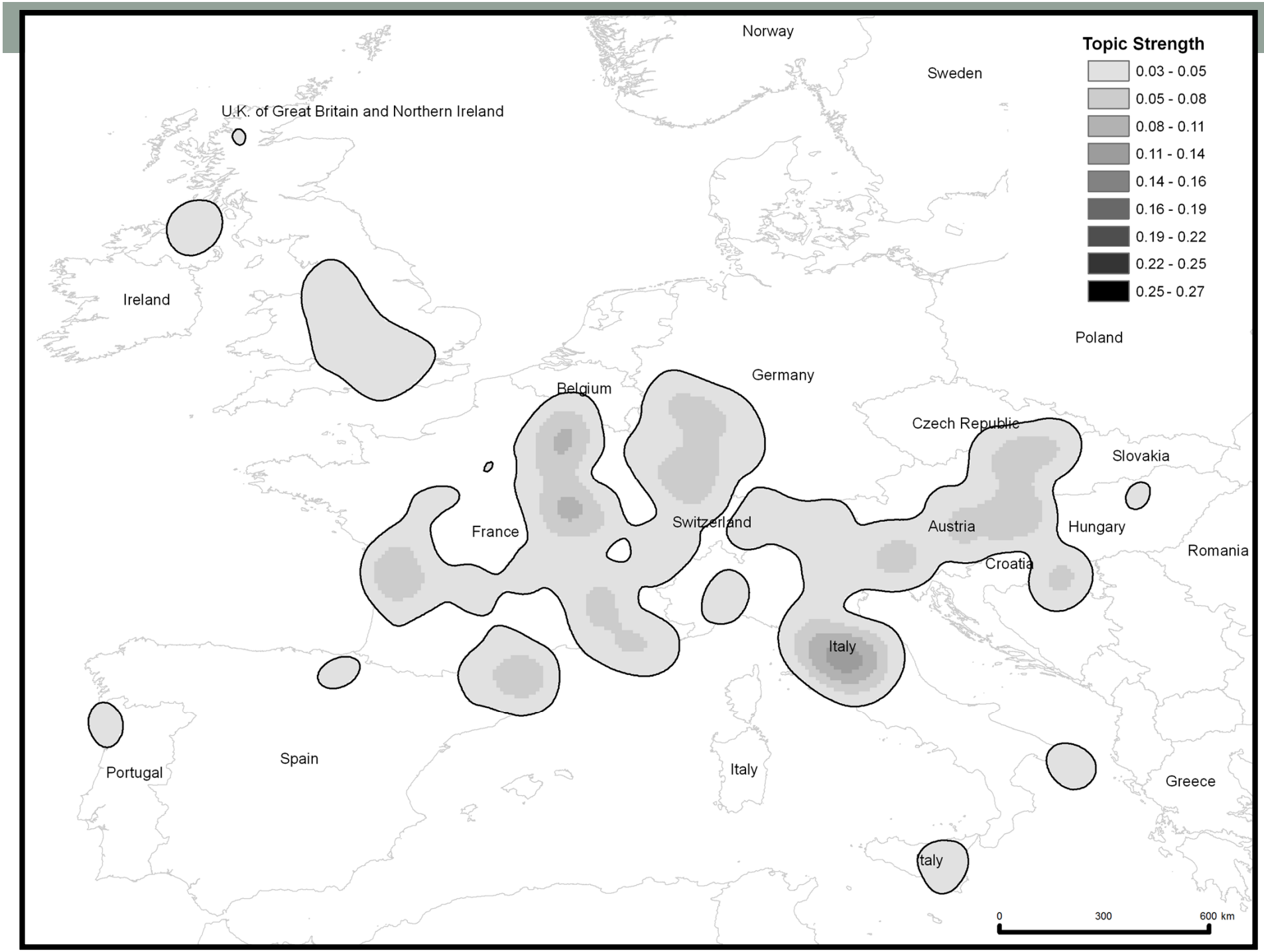
Topic Strength
0.03 - 0.05
0.05 - 0.08
0.08 - 0.11
0.11 - 0.14
0.14 - 0.16
0.16 - 0.19
0.19 - 0.22
0.22 - 0.25
0.25 - 0.27
Norway
Sweden
U.K. of Great Britain and Northern Ireland
Ireland
Poland
Germany
Belgium
Czech Republic
Slovakia
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Italy
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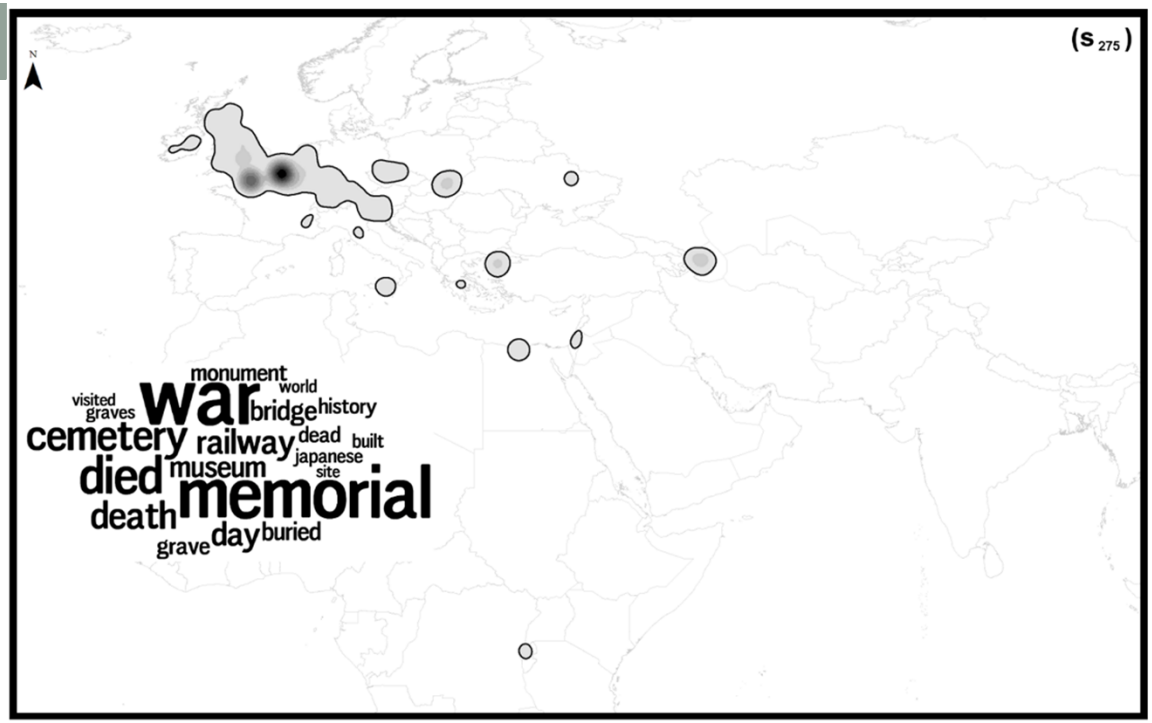
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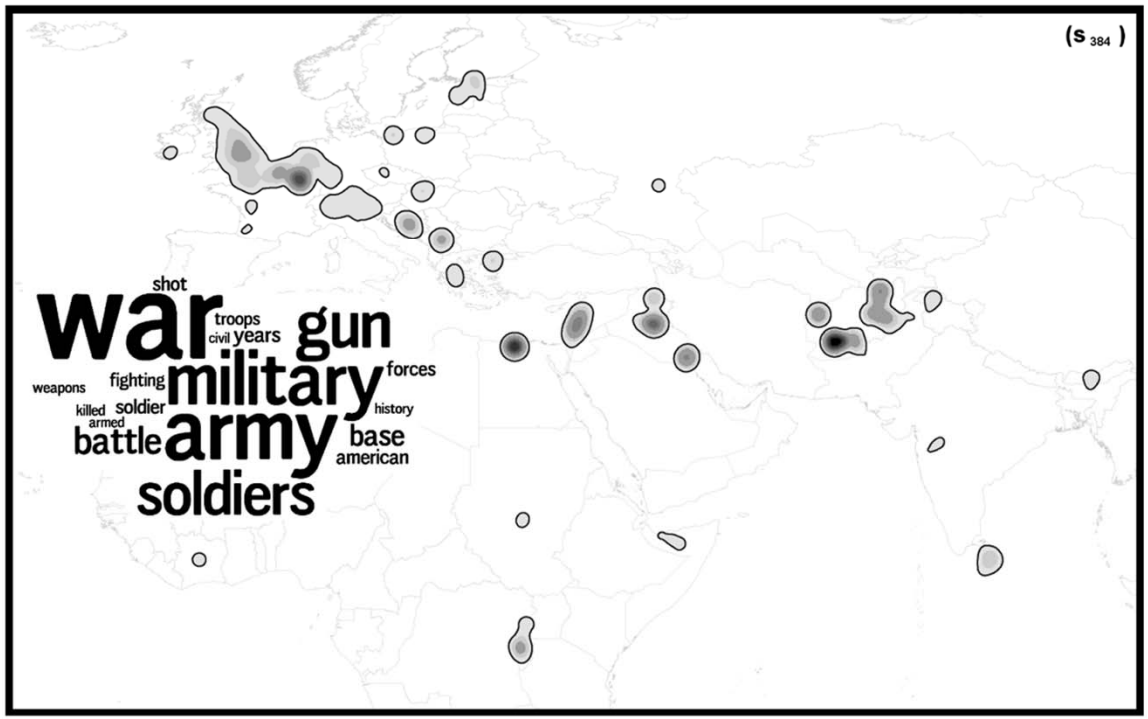
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Topic Dominance
Both Human & Physical Characteristics
Physical Characteristics
Human Characteristics
0 175 350 km

# Current Challenges in Geographic IR

## Improve “conventional GIR” components and methods

- Geo-tagging, spatio-textual indexing and geo-relevance ranking.
- Improved understanding of spatial natural language terminology.
- Better user interfaces for exploration of GIR results.

## Integration of geographical with temporal aspects

- Everything we do happens in space and time!

## Creation of place ontologies with world-wide coverage

- e.g. Fuzzy regions and intra-urban placenames

# What this means to you…

- You are the next generation of “spatial thinkers” and GIS experts.
- Understand not only how GIS has been influenced by the modern web, but also how the modern web has been influenced by GIS.
- Huge advancements in the area of Information retrieval. Spatial science has a big role to play
- Realize that GIS is not separate from your everyday lives.