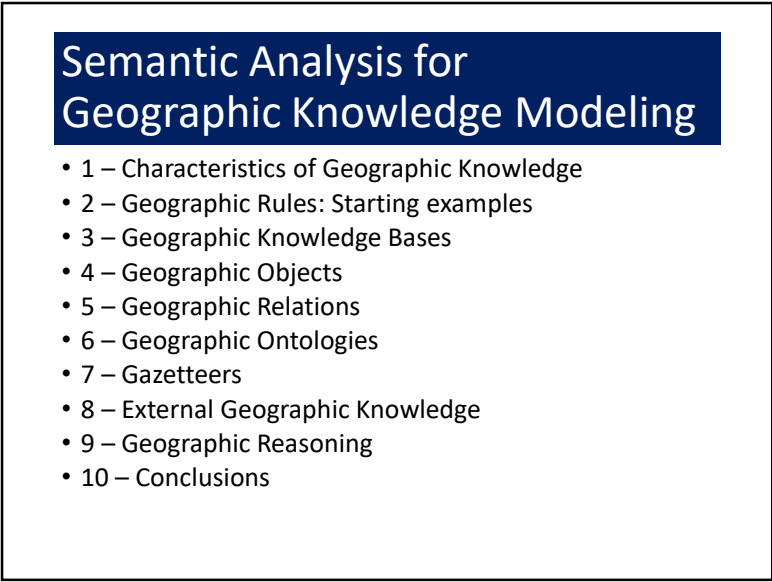
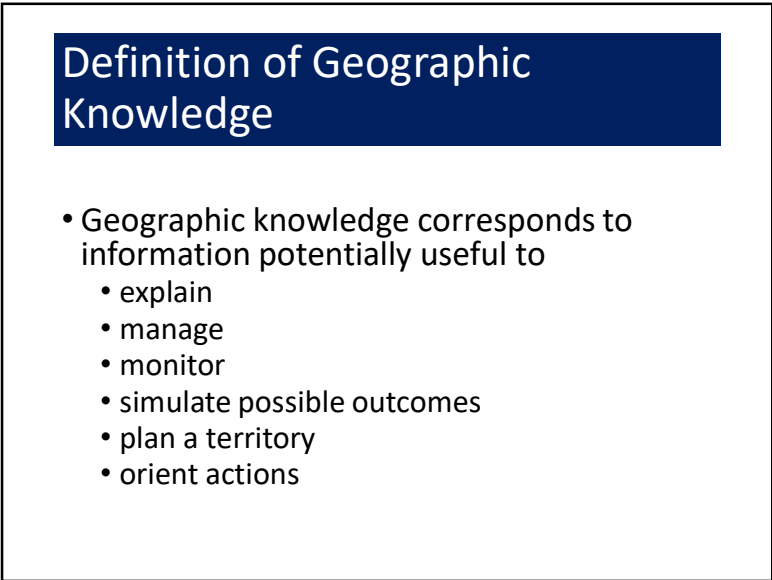
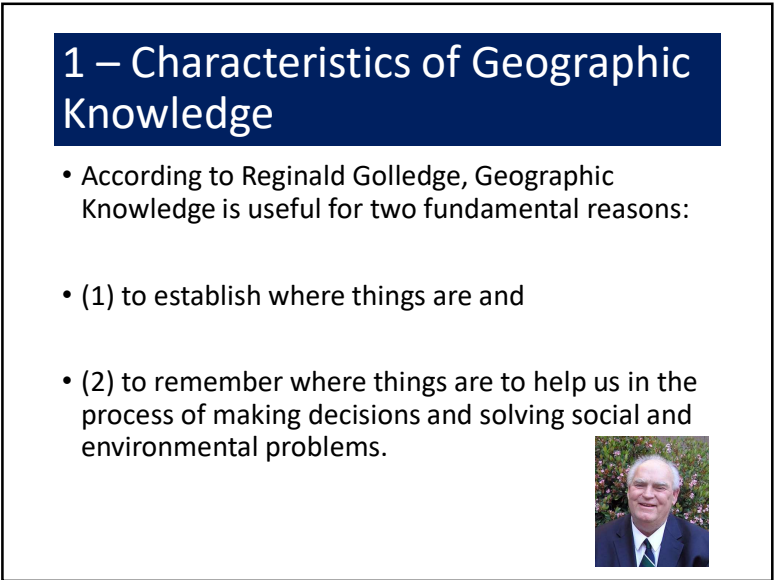




1



2



4

2 – Geographic Rules: Starting examples

- In Pacific Ocean, finding a way
- Mapping electricity plugs
- Examples of geographic rules

5

In New Zealand

Finding their way

Pacific voyagers could not rely on chance to explore the ocean. Some of their discoveries would have been by accident or from being driven off course in storms. But to survive and return home they had to know where they were or at least how near they were to land.

Sailing direction

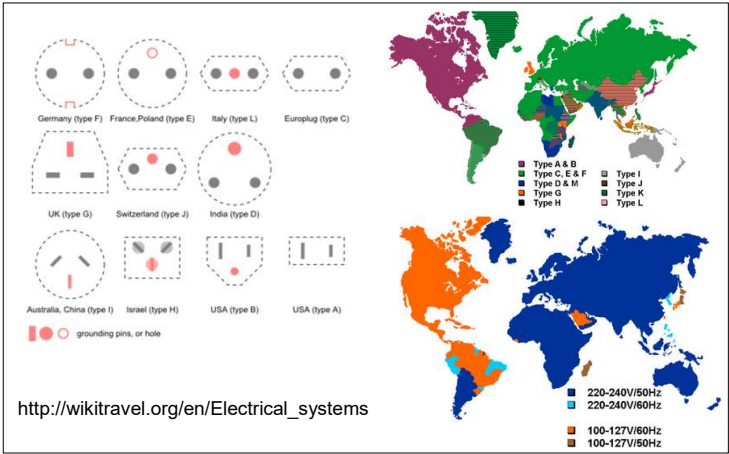
These explorers deliberately searched for new land. As part of their strategy, they sailed into the wind. If their search failed, they could return home quickly and safely, with the wind behind them.

Observation and sensing

These are some of the techniques the Pacific navigators can use without the aid of modern instruments:

- landmarks to see the drift of currents
- star paths (a series of stars that rise or set at the same point) and the path of the sun
- ocean swell patterns, by sight and feel
- the patterns of winds throughout the year
- cloud patterns, colours and speed that indicate the presence of land
- flight paths of land-based seabirds returning home at dusk.

6



Examples of Geographic Rules (1/2)

- in the United Kingdom, we drive on the left;
- in Canada, the majority of the population lives along the border with the United States;
- each capital city has an international airport nearby;
- between the two capital cities, in general, there are direct flights;
- in the Northern Hemisphere, the more you are going to the north, the colder (but locally this is not always true);
- when you want to install a metro-line under a street, move underground networks to another place;

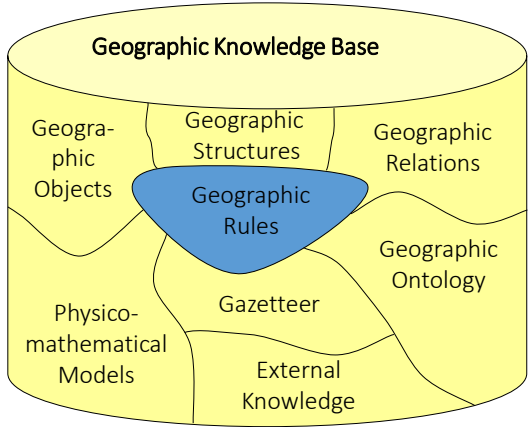
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Examples of Geographic Rules (2/2)

- mosques are oriented towards Mecca;
- if a zone is a swamp, it is necessary to prohibit construction;
- if there is unemployment, the creation of companies or industrial areas must be encouraged;
- if a plot is adjacent to an airport, it is necessary to limit the height of buildings;
- it is forbidden to open a new tobacco shop within 500 meters of an another already existing;
- in air polluted and windy areas, winds spread air pollutants;

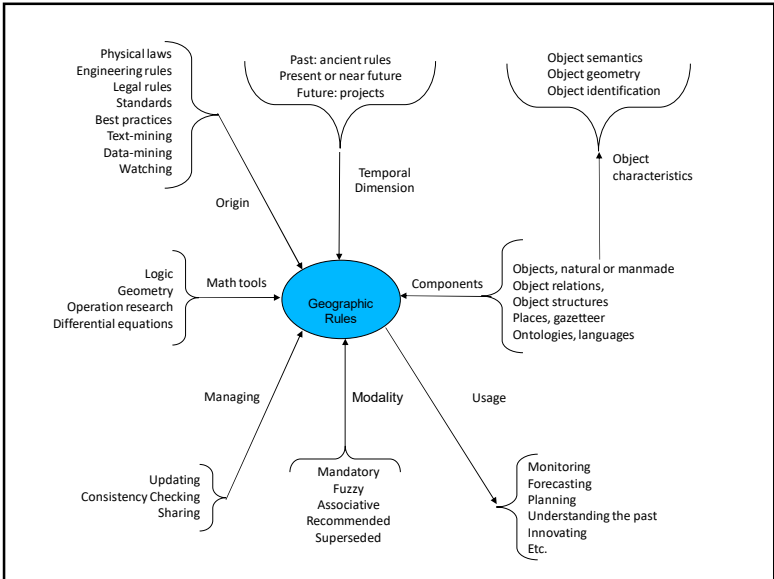
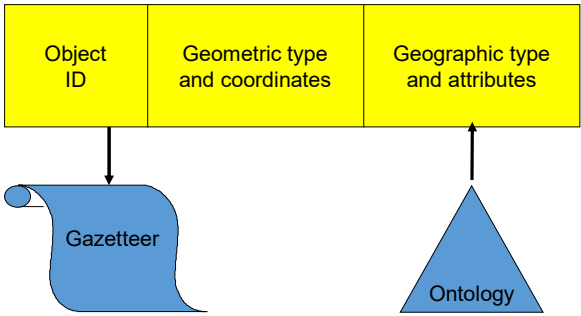
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3 – Geographic Knowledge Bases



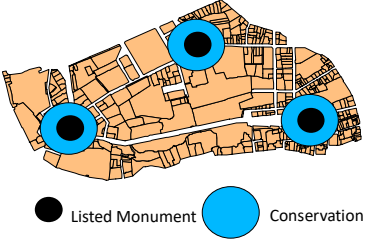
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Links between components



12

Listed historic monuments

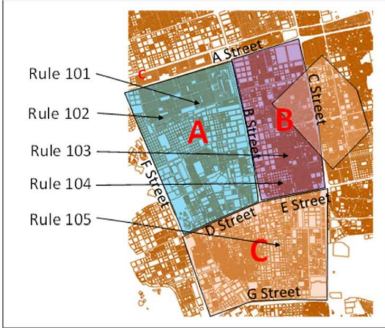


● Listed Monument ● Conservation area

$$\begin{aligned} &\forall T \in \text{Earth}, \forall B \in \text{PROJECT}, \exists M \in \text{Geo-Objects}, \\ &\quad \Omega\text{-Type}(B) = \text{"Building"}, \\ &\quad \Omega\text{-Type}(M) = \text{"Listed_Monument"}, \\ &\quad \text{Inside}(\text{Geom}(B), T), \text{Inside}(\text{Geom}(M), T): \\ &\quad \text{Disjoint}(\text{Geom}(B), \text{Union}(\text{Buffer}(\text{Geom}(M), 100))) \\ &\quad \Rightarrow \\ &\quad \text{State}(B) = \text{"LM_Approved"} \end{aligned}$$

13

Located Rules



Rule 101
Rule 102
Rule 103
Rule 104
Rule 105

$$\begin{aligned} &\exists C \in \text{City}, \forall B \in \text{Project}, \exists \text{ZoneA} \in \text{Terr}, \\ &\text{Geom}(\text{ZoneA}) \equiv \text{SurroundedByStreet}(\text{A_Street}, \\ &\quad \text{B_Street}, \text{D_Street}, \text{F_Street}) \\ &\quad \vdots \\ &\text{Contains}(\text{Geom}(\text{ZoneA}), \text{Geom}(B)) \\ &\quad \Rightarrow \\ &\{ \text{AppliedRule}(101); \text{AppliedRule}(102) \} \blacksquare \end{aligned}$$

Rule 17

14

4 – Geographic Objects

- Geodetic objects
- Administrative objects
- Manmade objects (crisp boundaries)
- Natural objects
- With fuzzy boundaries
- Continuous fields

15

Administrative objects

- Without considering disputes at borders
- Non-connected polygons
- Often organized in hierarchical tessellations
 - Countries, regions, provinces, municipalities
 - Parks
- Total coverage of the Earth
- At some scales, they can disappear

16

Manmade Objects

- Manmade
 - Buildings, bridges, streets, etc.
- Usually Euclidean objects
- Modeled as non-connected polygons
- At some scales
 - Roads can become linear
 - They can disappear

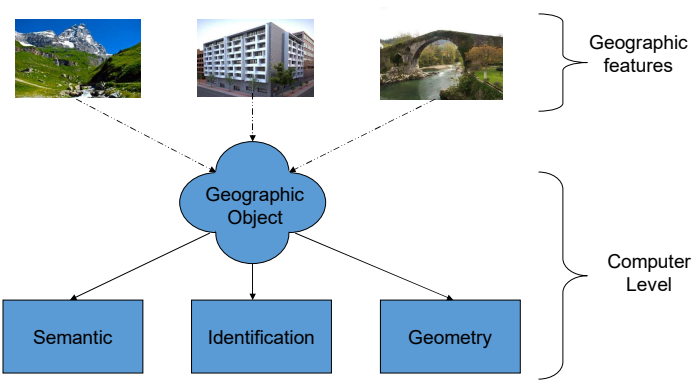
17

Natural Objects

- Shape can evolve
 - River, minor and major beds
- Boundary not easy to define
- Fractal geometry can be useful
 - Multi-scale
- Fuzzy sets
 - Egg-yolk

18

Characteristics of Geo Objects



19

What is it?



20

Geometric types

- Math tradition
 - Points
 - Lines
 - Areas
- Proposition
 - Ribbons
 - Areas
- Problems of scale
- Measurement errors

For mathematical modeling

For geographic modeling

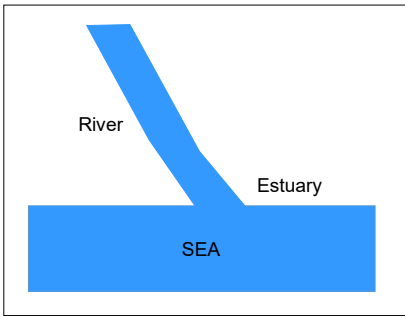
21

5 – Geographic Relations

- Topological Relations
- Projective and Other Spatial Relations
- Others: Rectangle Relations

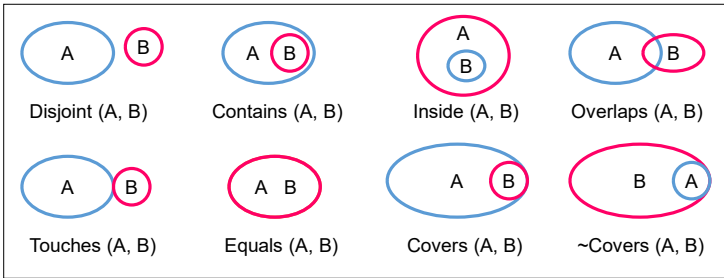
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Example of topological relation



23

Egenhofer Relations



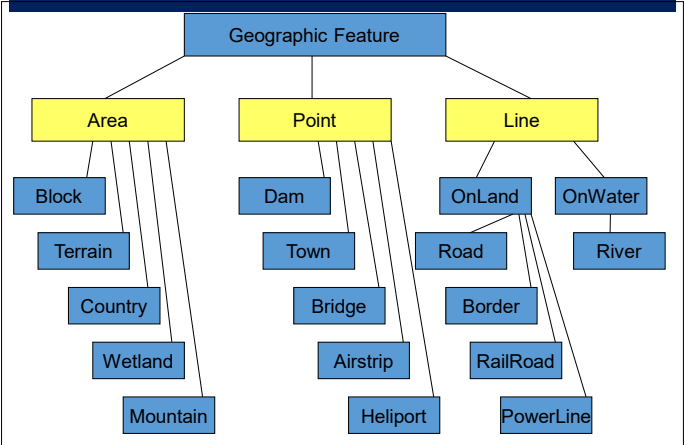
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6 – Geographic Ontologies

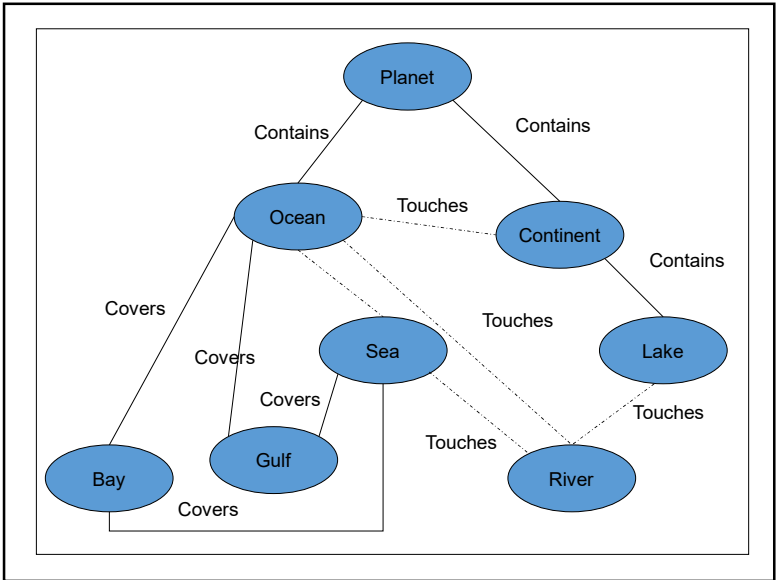
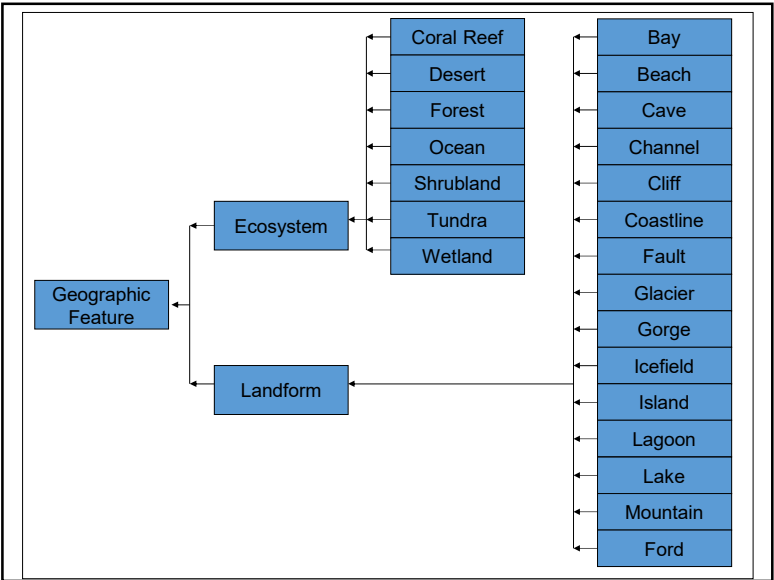
- Classical ontologies of geographic objects
 - Ontologies with conventional relations
 - Poor geometric modeling
- Ontologies with spatial relations (topology, etc.)

25

Sowa's ontology



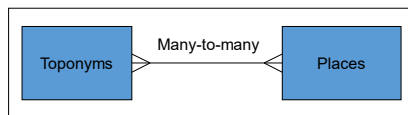
26



28

7 – Gazetteers

- Placenames / toponyms
- Can change over time
- Multiple translations
- Different places can have same name



29

Problems regarding toponyms (1/6)

- “Mississippi” can be the name of a river or of a state.
- The city, “Venice”, Italy, is also known as “Venezia”, “Venise”, “Venedig”, respectively, in Italian, French and German.
- The local name of the Greek city of “Athens” is “Αθήνα”; read [a’θina].
- “Istanbul” was known as “Byzantium” and “Constantinople” in the past.
- The modern city of Rome is much bigger than in Romulus’s time.

30

Problems regarding toponyms (2/6)

- There are two Georgias, one in the United States and another one in Caucasia.
- The toponym “Milano” can correspond to the city of Milano or the province of Milano.
- Sometimes, names of places can be also names of something else; for instance, “Washington” can also refer to George Washington or anybody with this first name or last name.
- In the U.K., there are several rivers named Avon.

Problems regarding toponyms (3/6)

- Some place names are formed of two or several words; for instance, “New Orleans”, “Los Angeles”, “Antigua and Barbuda”, “Trinidad and Tobago”, “Great Britain”, “Northern Ireland”, “Tierra del Fuego”, “El Puente de Alcántara”, etc.
- Some very long names can have simplifications; the well-known Welsh town “LlanfairpwllgwyngyllgogerychwyrndrobwlIantysiliogogoch” is often simplified to “Llanfair PG” or “Llanfairpwll”.

32

Problems regarding toponyms (4/6)

- Some abbreviations can be common, such as “L.A.” for “Los Angeles”, whereas its name at its inception was “El Pueblo de Nuestra Señora la Reina de los Angeles del Rio de la Porciúncula”;
- Peking became Beijing after a change of transcription to the Roman alphabet; but the capital of China has not modified its name in Chinese.

33

Problems regarding toponyms (5/6)

- In some languages, grammatical gender is important, so that place names can be feminine or masculine; for instance, in French, Italian and Spanish, names such as “Japan”, “Brazil” and “Portugal” are masculine, whereas “Argentina”, “Bolivia” and “Tunisia” are feminine.
- As the great majority of toponyms are singular, some can be plural, like “The Alps”;
- but for “The Netherlands”, the situation is more complex: plural in French (Les Pays-Bas), in Italian (I Paesi Bassi) and in Spanish (Los Países Bajos), whereas singular and plural are both acceptable in English (The Netherlands are, The Netherlands is);

34

The case of Danube

- The river “Danube” crosses several European countries; practically in each country, it has a different name,
- “Donau” in Germany and Austria,
- “Dunaj” in Slovakia,
- “Duna” in Hungary,
- “Dunav” in Croatia and Serbia,
- “Dunav” and “Дунав” in Bulgaria,
- “Dunărea” in Romania and in Moldova
- and “Dunaj” and “Дунай” in the Ukraine.
- It is also called
 - “Danubio” in Italian and Spanish,
 - “Tonava” in Finnish
 - and “Δούναβης” in Greek.
- Moreover, its name is feminine in German and masculine in some other languages.



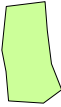
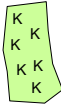
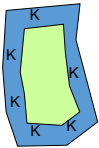
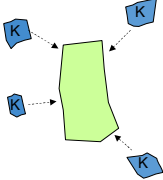
35

8 – External Geographic Knowledge

- Definition of external knowledge
- Tobler’s law
- Objectives
- Semantics of borderlines
- Objects and network continuity
- Technology and sociological watching for local authorities
- Organizing external knowledge

36

Definition of External Knowledge

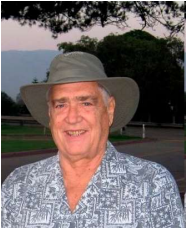
			
A City	Internal Knowledge	External Neighboring Knowledge	External Outside Knowledge

37

Tobler’s law

• ***“Everything is related to everything else, but near things are more related than distant things”.***

This statement may be seen as a key-concept for organizing geographic knowledge systems



38

Objective

- Show the importance of external knowledge
- Analyze the consequences for
 - Structuring GK bases
 - Ensuring reasoning continuity
 - Updating

39

Semantics of borderlines

- Land-Sea borders
 - importance of harbors
- Mountains
 - Physical barriers (Andes)
 - importance of passes
- Rivers, roads and rail tracks
 - One bank belongs to x, one bank to y
 - Traversing flows

40

Example



41

Object and network continuity

- Object continuity:
 - Sometimes geographic objects are artificially cut by borders.
 - Reconstruction of this object (beware of measure discrepancies)
- Network continuity:
 - Edge and node continuity
 - Reconstruction of the graph (beware of measure discrepancies)
- Others
 - Ontologies, gazetteers

42

Technology and sociological watching for local authorities

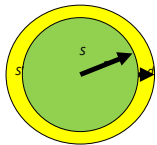
- Importance of technology watching not only for companies but also for local authorities
 - Example: biking renting system
 - Riverbank promenade
- Sociological watching
 - New experiences for public participation

Case-based reasoning can be a possibility,
but how to compare two places?

43

Organizing external neighboring knowledge

- Delimitation of a crown
 - Out-buffer
 - Which size?
- What kind of information or knowledge to include
- Updating
 - Via a protocol with neighboring entities
- External knowledge
 - Integrated or separated repository ?



44

Example of external rule

- Closing of an enterprise located in the crown with effect in the main town.

```

    ∀p ∈ Person, ∀t ∈ Town,
      ∀e ∈ Entreprise,
        livesIn (p, t), WorksIn (p, e),
        Contains (Geom (Crown(t), Geom (e))
          :
          State (e) = Closure
          ⇒
          Unemployed (p)

```

45

9 – Geographic Reasoning

- Not only to uncover hidden knowledge by chaining implications (more than an inference engine)
- Rather
 - To make diagnosis,
 - To identify problems
 - To set objectives
 - To design projects
 - To assess them according to several criteria
- Importance of planning and design

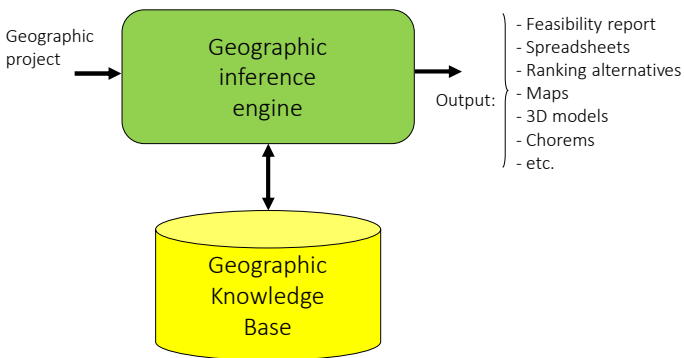
46

Territorial Projects

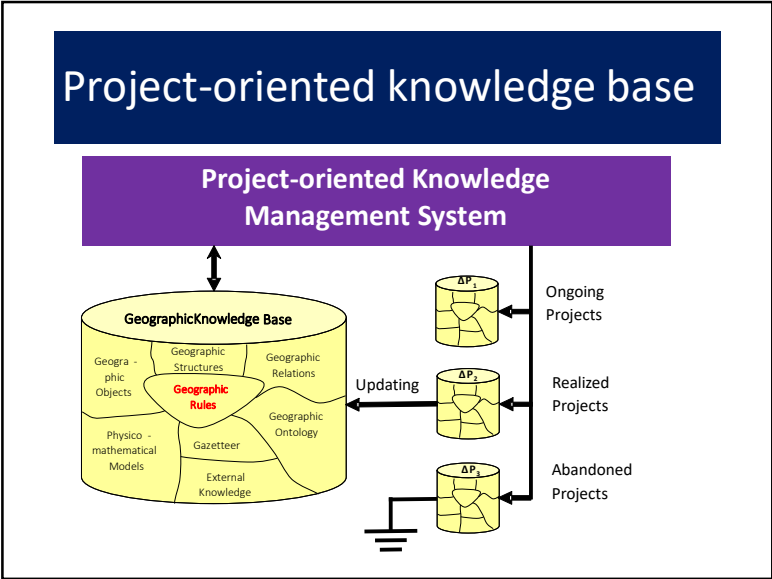
- Where to put a new airport, a new hospital, a new stadium, etc.?
- Is this construction compliant to planning rules?
- Best way to get from A to B
- Decide priority and location
- Organize a policy for green spaces
- Transit policies (for trucks)
- Schedule a tour
- Etc.

47

Usage



48



49

10 – Conclusions (1/2)

- Very particular semantics
 - Topology, computational geometry, etc.
- Ontologies with topological relations
- Gazetteers
- Problems with natural languages
- Design of located projects
- Lessons learnt from abandoned project

50

A few perspectives

- Identify complete semantics
- Computer language to encode rules
- Indexing of rules
 - Spatial, temporal, semantic
- Design of a complete system for geographic reasoning
 - Links with Smart Cities planning
- Acceptation by local authorities
- Citizen empowerment

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53