

Deductive Coordination of Multiple Geospatial Knowledge Sources

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Deductive inference is applied to choreograph the cooperation of multiple knowledge sources to respond to geospatial queries. When no one source can provide an answer, the response may be deduced from pieces of the answer provided by many sources. Examples of sources include

- The Alexandria Digital Library Gazetteer, a repository that gives the locations for almost six million place names,
- The Cia World Factbook, an online almanac with basic information about more than 200 countries.
- The SRI TerraVision 3D Terrain Visualization System, which displays a flight-simulator-like interactive display of geographic data held in a database,
- The NASA GDACC WebGIS client for searching satellite and other geographic data available through OpenGIS Consortium (OGC) Web Map Servers, and

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- The Northern Arizona University Latitude/Longitude Distance Calculator.

Queries are phrased in English and are translated into logical theorems by the Gemini Natural Language Parser. The theorems are proved by SNARK, a first-order-logic theorem prover, in the context of an axiomatic geospatial theory. The theory embodies a representational scheme that takes into account the fact that the same place may have many names, and the same name may refer to many places. SNARK has built-in procedures (RCC8 and the Allen calculus, respectively) for reasoning about spatial and temporal concepts. External knowledge sources may be consulted by SNARK as the proof is in progress, so that most knowledge need not be stored axiomatically. The Open Agent Architecture (OAA) facilitates communication between sources that may be implemented on different machines in different computer languages. An answer to the query, in the form of text or an image, is extracted from the proof. Currently, three-dimensional images are displayed by TerraVision but other displays are possible. The combined system is called Geo-Logica.

Some sample queries that can be handled by Geo-Logica include

- Show the petrified forests in Oregon north of Portland.
- Show the lake in Argentina with the highest elevation.
- Show the IGPB land cover classification, derived using MODIS, of Montana for July, 2000.

Use of a theorem prover allows sources to cooperate even if they adapt different notational conventions and representation schemes and have never been designed to work together. New sources can be added without reprogramming the system, by providing axioms that advertise their capabilities. Future directions include entering into a dialogue with the user to clarify ambiguities, elaborate on previous questions, or provide new information necessary to answer the question. In addition, of particular interest is to deal with temporally varying data, with answers displayed as animated images.