Chapter 19. Understanding Queries and Signals

Lecture Notes on Artificial Intelligence

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   HASP/SIAP
Overview of Chapter 19

- DARPA’s policy change caused by Mansfield amendment
  - Mansfield amendment: Defense Department research be relevant to military needs

- Approaches to understand machines queries
  - Systems to handle natural language queries as “Front ends” for accessing databases easily
  - Examples) LIFER, LADDER, CHAT-80
  - To develop Transportable query system

- Approaches to understand machines signals
  - Systems to identify and tracking ships and submarines using acoustic data from concealed hydrophone arrays
  - HASP/SIAP
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19.1 The Setting
Fund environment change

- DARPA’s policy change caused by Mansfield amendment
  - Mansfield amendment: Defense Department research be relevant to military needs

- Focuses of AI research
  - Text-based, natural language access to large, distributed databases
    - Can be seen as ‘command and control test-bed systems’
  - Automating the analysis of aerial photos
    - Can help as tools intelligence analysts for spotting targets of military interest in photos
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19.2 Natural Language Access to Computer System
Understanding queries

- Systems to handle natural language queries as “Front ends” for accessing databases easily
  - Ellipsis: error correcting and query auto-completing
  - Using rules and grammars with logical expression
  - English query
    → a hypothetical database query
    → actual database queries
- Example systems
  - LIFER, LADDER, CHAT-80

- Transportable query system
  - The system can be adapted to serve as natural language front ends to a variety of different databases
  - Example system: TEAM
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19.3 HASP/SIAP
Understanding signals

- Systems to identify and tracking ships and submarines using acoustic data from concealed hydrophone arrays

- HASP/SIAP
  - Blackboard model
    - Situation board
    - Vessels
    - Sound sources: engines, shafts, propellers and etc.
  - Spectral features abstracted from the acoustic data

- KS-link
  - KS cause inference
  - Allowing another KS to draw an additional inference, and so on in cascade until all relevant information had been used
  - One of types: IF-THEN rule

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Figure 19.6: A network structure linking data at different levels.
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Appendix
Chapter 19. Understanding Queries and Signals

19.1 The Setting
Funding environment change

- DARPA’s policy change caused by Mansfield amendment
  - Mansfield amendment: Defense Department research be relevant to military needs
- DARPA director Heilmeier’s list which IPTO (Information Processing Technique Office) could do
  - Get computers to read Morse code in the presence of other code and noise
  - Get computers to identify/detect key words in a stream of speech
  - Solve DoD’s “software problem”
  - Make a real contribution to command and control
  - Do a good thing in sonar
Focuses of AI research

- Text-based, natural language access to large, distributed databases
  - Can be seen as ‘command and control test-bed systems’

- Automating the analysis of aerial photos
  - Can help as tools intelligence analysts for spotting targets of military interest in photos

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19.2 Natural Language Access to Computer System
19.2.1 LIFER

- Language Interface Facility with Elliptical and Recursive Features
- A system for rapid development of natural language “front ends” to databases and other software

Features

- Parser translated sentences and requests into appropriate interactions with the software
- Ellipsis: Mechanisms for handling incomplete inputs
  - Correcting spelling errors
  - Allowing novices to extend the language through the use of paraphrases
- The language was defined in terms of “Patterns”
  - Pattern example)
    WHAT IS THE <ATTRIBUTE> OF <PERSON>

- Query example)
  WHAT IS THE HEIGHT OF SUSAN

- Simplified augmented transition network to check whether input sentence matches the patterns
LADDER

- Language Access to Distributed Data with Error Recovery

- LIFER was used on LADDER

- Translating the English query into a hypothetical database query

- Using a system called IDA (Intelligent Data Access), the hypothetical query was transformed into a series of actual database queries that took into account the actual organization of the database

Figure 19.3: Sample interactions with LADDER
19.2.2 CHAT-80

- **Goal**
  - Able to answer rather complex questions, posed in English, about a database of geographical facts

- **Grammar (Definite Clause Grammars (DCGs))**
  - Logical formulas stated in the PROLOG language
  - **Example**
    - Situation: There is a sentence between points S0 and S in a string (of words) if there is a noun phrase with number N (that is, singular or plural) between points S0 and S1, and a verb phrase with number N between points S1 and S.

```
sentence(s(NP,VP), S0,S) :- noun phrase(NP, N, S0,S1), verb phrase(VP, N, S1,S)
```
19.2.2 CHAT-80

Examples of queries that CHAT-80 was able to answer:

Q: What is the capital of Upper Volta?
A: Ouagadougou

Q: Which country's capital is London?
A: united kingdom

Q: What is the ocean that borders African countries and that borders Asian countries?
A: indian ocean

Q: What are the capitals of the countries bordering the Baltic?
A: denmark:copenhagen; east germany:east berlin; finland:helsinki; poland:warsaw; soviet union:moscow; sweden:stockholm; west germany:bonn

Q: What is the total area of countries south of the Equator and not in Australasia?
A: 10,228 ksqmiles

Q: What are the continents no country in which contains more than two cities whose population exceeds 1 million?
A: africa, antarctica, australasia

Q: Which country bordering the Mediterranean borders a country that is bordered by a country whose population exceeds the population of India?
A: turkey
19.2.3 Transportable Natural Language Query Systems

- **Transportable query system**
  - The system can be adapted to serve as natural language front ends to a variety of different databases

- **Examples**
  - ASK, Caltech
  - EUFID, SDC
  - IRUS, BBN
  - LDC-1, Duke University
  - NLP-DBAP, Bell Lab
  - TEAM, SRI
TEAM

- Transportable English Database Access Medium
- Design goals
  - Acquiring information about a database from a DB administrator
  - Interpreting and answering questions of the DB that are posed in a subset of English appropriate for that DB
  - Information needed to adapt and the subject matter acquired from an expert

- Case study for geographical data: 4 Databases (Fig. 19.4)
- DIALOGIC
  - subsystem converting English query into a logical expression
  - Performing syntactic analysis using DIAGRAM (Fig. 19.5 for the example query)

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Figure 19.4: Files used in a TEAM database

Figure 19.5: A parse tree for “Show each continent's highest peak.”
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19.3 HASP/SIAP
HASP/SIAP

- HASP (Heuristic Adaptive Surveillance Program)
- SIAP (Surveillance Integration Automation Program)

Goal
- Identifying and tracking ships using acoustic data from concealed hydrophone arrays

Blackboard model (used in HEARSAY-II)
- Situation board
  - symbolic model of the unfolding ocean situation of all ships with a confidence level
- Vessels
  - class, location, current speed, course, and destination, each with a confidence weighting
- Sound sources: engines, shafts, propellers and etc.
  - Locations and confidence weightings.
- Spectral features abstracted from the acoustic data

Figure 19.6: A network structure linking data at different levels.
HASP/SIAP

- **KS-link (knowledge source)**
  - Spanning multiple levels and make inferences upward, downward, or within a level
  - KS cause inference
    - Allowing another KS to draw an additional inference, and so on in cascade until all relevant information had been used

- One type of KS: IF-THEN rules
  - IF: a source was lost due to fade-out in the near-past, and a similar source started up in another frequency, and the locations of the two sources are relatively close,
  - THEN: they are the same source with confidence of 3