Chapter 19. Understanding Queries and Signals

The Quest for Artificial Intelligence, Nilsson, N. J., 2009.

Lecture Notes on Artificial Intelligence

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- DARPA's policy change caused by Mansfield amendment
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- Approaches to understand machines queries
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  - 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

Chapter 19. Understanding Queries and Signals

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

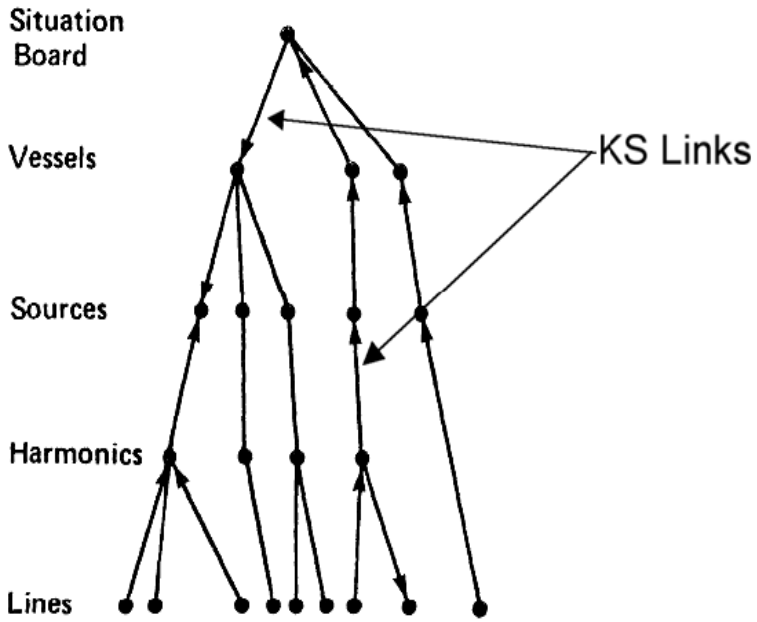

Figure 19.6:
A network structure linking data at different levels.

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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

George Heilmeier

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

Chapter 19. Understanding Queries and Signals

19.2 Natural Language Access to Computer System

19.2.1 LIFER

Gary Hendrix

- 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

    - simplied 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 int 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 tool into account the actual organization of the database

```
-What is the speed of the Kitty Hawk
PARSED!
((SPEED 35 KNOTS))

-Of the Ethan Allen
TRYING ELLIPSIS:  WHAT IS THE SPEED OF THE ETHAN ALLEN
((SPEED 30 KNOTS))

-Displacement
TRYING ELLIPSIS:  WHAT IS THE DISPLACEMENT OF THE ETHAN ALLEN
((STANDARD-DISPLACEMENT 6900 HUNDRED-TONS))

-length of the fastest Soviet sub
TRYING ELLIPSIS:  WHAT IS THE LENGTH OF THE FASTEST SOVIET SUB
((LENGTH 285 FEET / SPEED 30 KNOTS))

-Who onws the KIEV
     OWNS <==(assumed spelling error)
PARSED!
((COUNTRY USSR))

-who owns the JFK
TRYING ELLIPSIS:  ELLIPSIS HAS FAILED
THE PARSER DOES NOT EXPECT THE WORD "JFK" TO FOLLOW "WHO OWNS THE"
OPTIONS FOR NEXT WORD OR META-SYMBOL ARE:
<SHIP-NAME>

-Define JFK to be like Kennedy
PARSED!
 . {JFK is now a synonym for KENNEDY, which is a ship name}
 .
-REDO -2          {that is, parse WHO OWNS THE JFK}
PARSED!
((COUNTRY USA))

-? BUILT LAFAYETTE
TRYING ELLIPSIS:  ELLIPSIS HAS FAILED
 . {error message omitted}
 .
-Let "? built Lafayette" be a paraphrase of "who built the Lafayette"
PARSED!
 .
 .
-? built Lafayette
PARSED!
((BUILDER GENERAL.DYNAMICS))

-owns longest nuclear submarine
TRYING ELLIPSIS:  ? OWNS LONGEST NUCLEAR SUBMARINE
((COUNTRY USSR / LENGTH 426 FEET))
```

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)

WORLDC

NAME	CONTINENT	CAPITAL	AREA	POP
Afghanistan	Asia	Kabul	260,000	17,450,000
Albania	Europe	Tirana	11,100	2,620,000
Algeria	Africa	Algiers	919,951	18,510,000

BCITY

NAME	COUNTRY	POP
Brussels	Belgium	1,050,787
Buenos Aires	Argentina	8,925,000
Canberra	Australia	210,600

CONT

NAME	HEMI	AREA	POP
Africa	S	11,500,000	41,200,000
Antarctica	S	5,000,000	500
Asia	N	16,990,000	2,366,000,000

PEAK

NAME	COUNTRY	HEIGHT	VOL
Aconcagua	Argentina	23,080	N
Annapurna	Nepal	26,504	N
Chimborazo	Ecuador	20,702	Y

Figure 19.4: Files used in a TEAM database

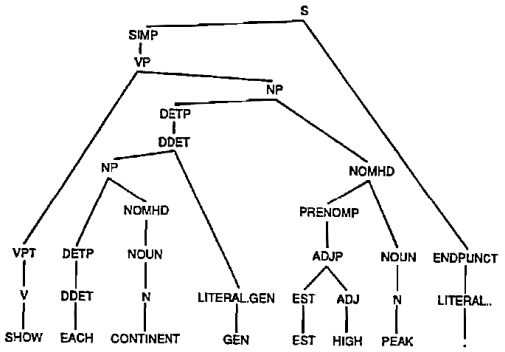

Figure 19.5: A parse tree for "Show each continent's highest peak."

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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

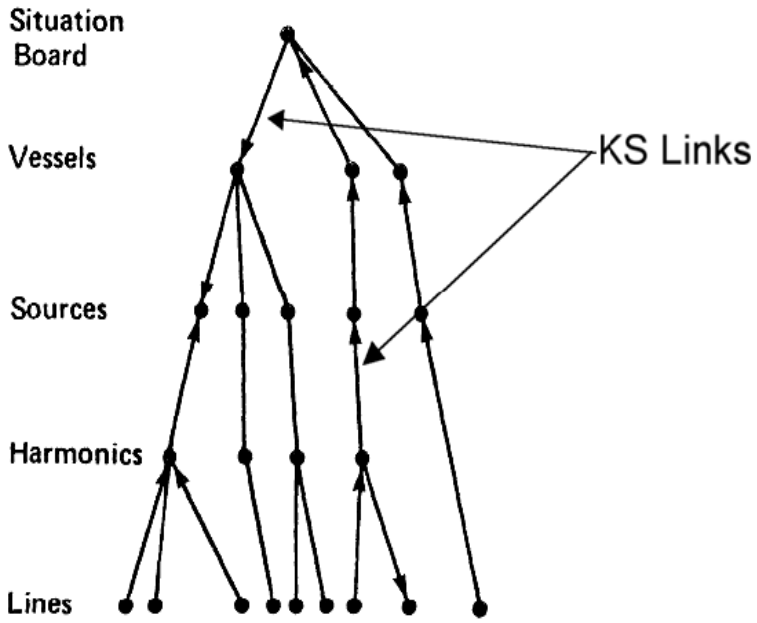

Figure 19.6:
A network structure linking data at different levels.

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