



Expert System

Expert System

- One of AI's greatest areas of success was the development of large-scale problem solving systems Originally called expert systems, they would mimic the problem solving processes of domain experts Such as **doctors performing diagnosis**, or **engineers performing design**, or **wall street analysts selecting stock transactions etc.**
- It was discovered that many problems were being solved by chaining through rules (if-then statements) that would operate on a collection of facts and partial conclusions Called working memory



Dendral (DENDRitic ALgorithm) (Source: wiki)

- Dendral was a project in artificial intelligence (AI) of the 1960s, and the computer software expert system that it produced. Its primary aim was to study hypothesis formation and discovery in science.
- For that, **a specific task in science was chosen**: help organic chemists in identifying unknown organic molecules, by analyzing their mass spectra and using knowledge of chemistry.
- It was done at Stanford University by Edward Feigenbaum, Bruce G. Buchanan, Joshua Lederberg, and Carl Djerassi, along with a team of highly creative research associates and students. It began in 1965 and spans approximately half the history of AI research.



DENDRAL's Processes

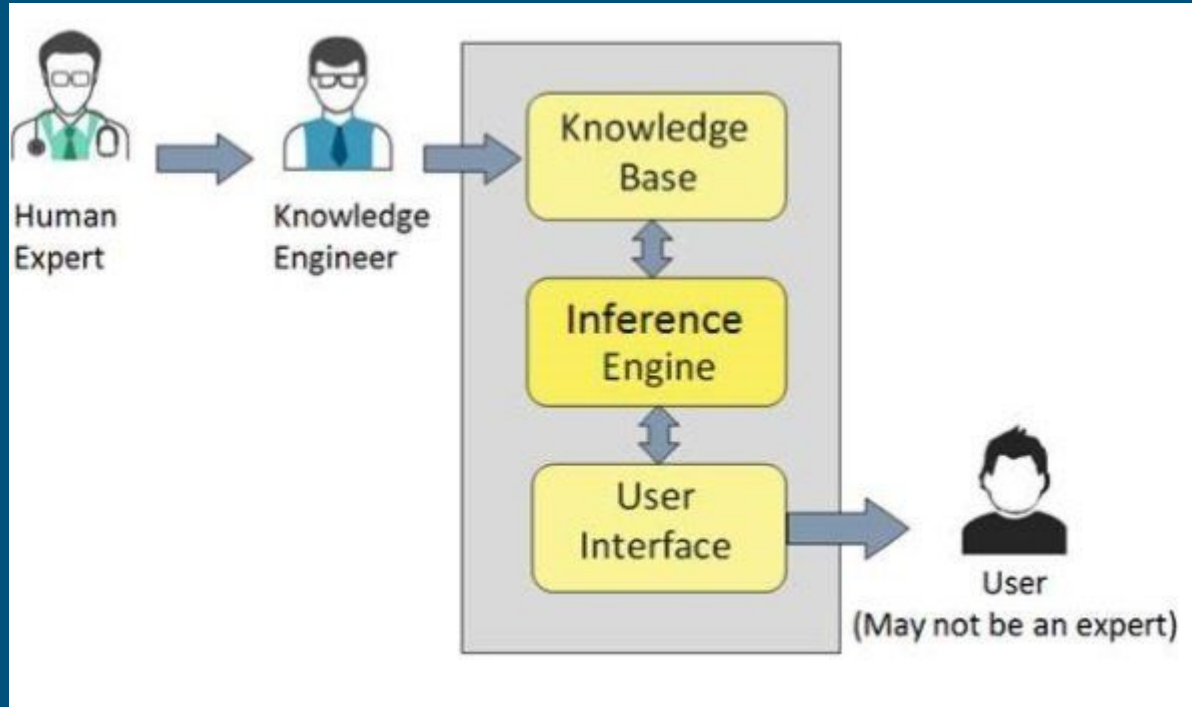
DENDRAL's Processes

Operation	Component (program)	Input	Output
Planning	<ul style="list-style-type: none">•MOLION•PLANNER	<ul style="list-style-type: none">•Mass spectrum•Planning rules	<ul style="list-style-type: none">•Ion constraints•Other constraints•Superatoms
Generating	<ul style="list-style-type: none">•CONGEN•GENOA•STEREO	<ul style="list-style-type: none">•Constraints	<ul style="list-style-type: none">•Candidate molecular structures
Testing	<ul style="list-style-type: none">•PREDICTOR•MSPRUNE	<ul style="list-style-type: none">•Candidate molecular structures•Mass spectrometry rules•Reaction chemistry rules	<ul style="list-style-type: none">•Most plausible structures•Structures consistent with spectrum•Structures consistent with known reactions

Each of the component programs was written in Lisp

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- The software program Dendral is considered the first expert system because it automated the decision-making process and problem-solving behavior of organic chemists.
 - The project consisted of research on two main programs Heuristic Dendral and Meta-Dendral, and several sub-programs.
 - It was written in the Lisp programming language, which was considered the language of AI because of its flexibility.

Pattern Matching



- Expert Systems consisted of two major components

- **A knowledge base**

- The knowledge that the system would use to come to conclusions

- In Dendral, this would be chemical elements, compounds, the the mass spectrogram data that could arise from any element

- In Mycin, this would be bacteriological infection knowledge

- **An inference engine**

- How to apply the knowledge

- For Dendral, this was done by generate-and-test, a very weak form of search

- Mycin would perform backward chaining through rules

- More generally though, the inference engine would embody some form of pattern matching

Expert System

ELIZA

One of the first systems that clearly demonstrated pattern matching was Eliza. Eliza was a spoof of an expert system but the code will show us how pattern matching works.

about:

ELIZA is an early natural language processing computer program created from 1964 to 1966] at MIT by Joseph Weizenbaum

```
Welcome to
          EEEEEEE LL      IIII  ZZZZZZ  AAAAA
          EE      LL      II      ZZ      AA  AA
          EEEEE  LL      II      ZZ      AAAAAA
          EE      LL      II      ZZ      AA  AA
          EEEEE  LLLLLL IIII  ZZZZZZ  AA  AA

Eliza is a mock Rogerian psychotherapist.
The original program was described by Joseph Weizenbaum in 1966.
This implementation by Norbert Landsteiner 2005.

ELIZA: Is something troubling you ?
YOU:   Men are all alike.
ELIZA: What is the connection, do you suppose ?
YOU:   They're always bugging us about something or other.
ELIZA: Can you think of a specific example ?
YOU:   Well, my boyfriend made me come here.
ELIZA: Is it important to you that your boyfriend made you come here ?
YOU:   He says I'm depressed much of the time.
ELIZA: I am sorry to hear that you are depressed.
YOU:   It's true. I am unhappy.
ELIZA: Can you explain what made you unhappy ?
YOU:
```


- Repeat
 - Input a sentence
 - Find a rule in the Eliza knowledge-base that matches the pattern
 - Attempt to perform pattern match
 - Attempt to perform segment match
 - If rule found, select one of the responses randomly (each pattern will have at least one response)
 - Fill in any variables
 - Substitute values (you for I, I for you, me for you, am for are, etc)
 - Respond
- Until user quits
- Most of the work goes on in the pattern match and segment match functions



Thank You!