CASNET

An example of model based expert system.
Basic Information on CASNET

- A consultant to ophthalmologists for complex cases of Glaucoma.
- Uses a model of the disease to diagnose causes of the patient’s ailments and recommend therapies.
- Relies on a national network of experts to refine its model.
History

- Developed by Rutgers Research Resource
- Used as a vehicle for research in medical modeling and decision-making
- Was a prototype for testing the feasibility of applying AI methods to biomedical interpretation problems
- 1971 - 1978
Why Glaucoma?

- Able to explain most phenomena via causal models
- Minimal interaction with other organs
- Treatment selection based on the mechanisms of the disease
- Significant and complex enough to have an large impact in the medical world
The CASNET System

- Consists of three separate programs
  - A model-building program
  - A consultation program
  - A database program

- Database
  - More than
    - 100 states, 400 tests, 75 classification tables, 200 diagnostic and treatment statements
The CASNET Model

- Causal-associational network
- Few levels of uncertainty
- Keeps data separate from decision-making strategies
- Is able to reason with information from experts with differing opinions including currently highly debated topics
Why a model based system?

- Unease working with probabilistic systems
  - Models are closer to the way human experts think
- Humans vs. statistical machines
  - Redundancy
  - Number of errors in calculation
  - Tend to focus on the exceptions.
The CASNET model

- Wanted to include two different types of knowledge
  - Theoretical knowledge
  - Practical knowledge
  - Created a two-part model
The Descriptive Model

- Theoretical knowledge
- Characterization of disease processes
- General to specific inferences
Normative Model

- Practical knowledge
- Characterize the manner in which decisions are made
- Specific to General Inferences
Descriptive Component

- **Elements**
  - **Observations**
    - Signs, symptoms, & test results
  - **Pathophysiologic states**
    - Internal abnormal conditions that directly cause the observed phenomena
Descriptive Component

- Elements continued ..
  - **Disease States**
    - Can subsume a pattern of Pathophysiological states
  - **Treatment Plans**
    - Linked among themselves by constraints (interactions, toxicity, etc..)
    - Linked to the pathophysiological states and diseases that they cover
Descriptive Component
Normative Component

- Decision-rules
  - describe relationships between the descriptive elements
  - Examples
    - Observation-to-state
    - State-to-state
    - State-to-disease
    - Rules on preference of treatment
Overview of Scoring Functions

- Observations to States
- States to Disease Categories and Classification Tables
- Between Disease States
- Test Result Interpretation
- Test Selections
Observations to States

- $Q(I, J)$
- $T(I) \rightarrow N(J)$

- $T$ is an observation
- $N$ is a pathophysiological state
- $Q$ is a confidence value (-1 to 1)
P-States to Disease Categories And Classification Tables

- $N(1)$ AND NOT $N(2)$ -> $D(1)$ AND $T(2)$

- $N$ are pathophysiological states
- $D$ is a disease
- $T$ is a treatment class
Between Disease States

- $A(I, J)$
- $N(I) \rightarrow N(J)$

- $N$ are states
- $A$ is the strength of causation
  - in terms of frequency
Test Result Interpretation

- IF $|CF| < |Q(I, J)|$ THEN $CF = Q(I, J)$
- IF $CF = -Q(I, J)$ THEN $CF = 0$
  - Contradiction
- ELSE $CF = CF$
Test Selections

- Admissible pathway
- Weight of entering a node
  - Product of transitions from last confirmed node
- Total Forward Weight
  - Sum of all weights of entering a node
Test Selections

- **Inverse Weight**
  - \( W(I|J) = \frac{[W(I|J) \times W(I)]}{W(J)} \)

- **Overall Weight**
  - \( W(I) = \text{Max} (W_f(I), W_i(I)) \)
ONET

- Collaborating clinical experts in Glaucoma
- Dial-in to a single database
- Speeds up validation of findings
Conclusions

- CASNET is a success