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

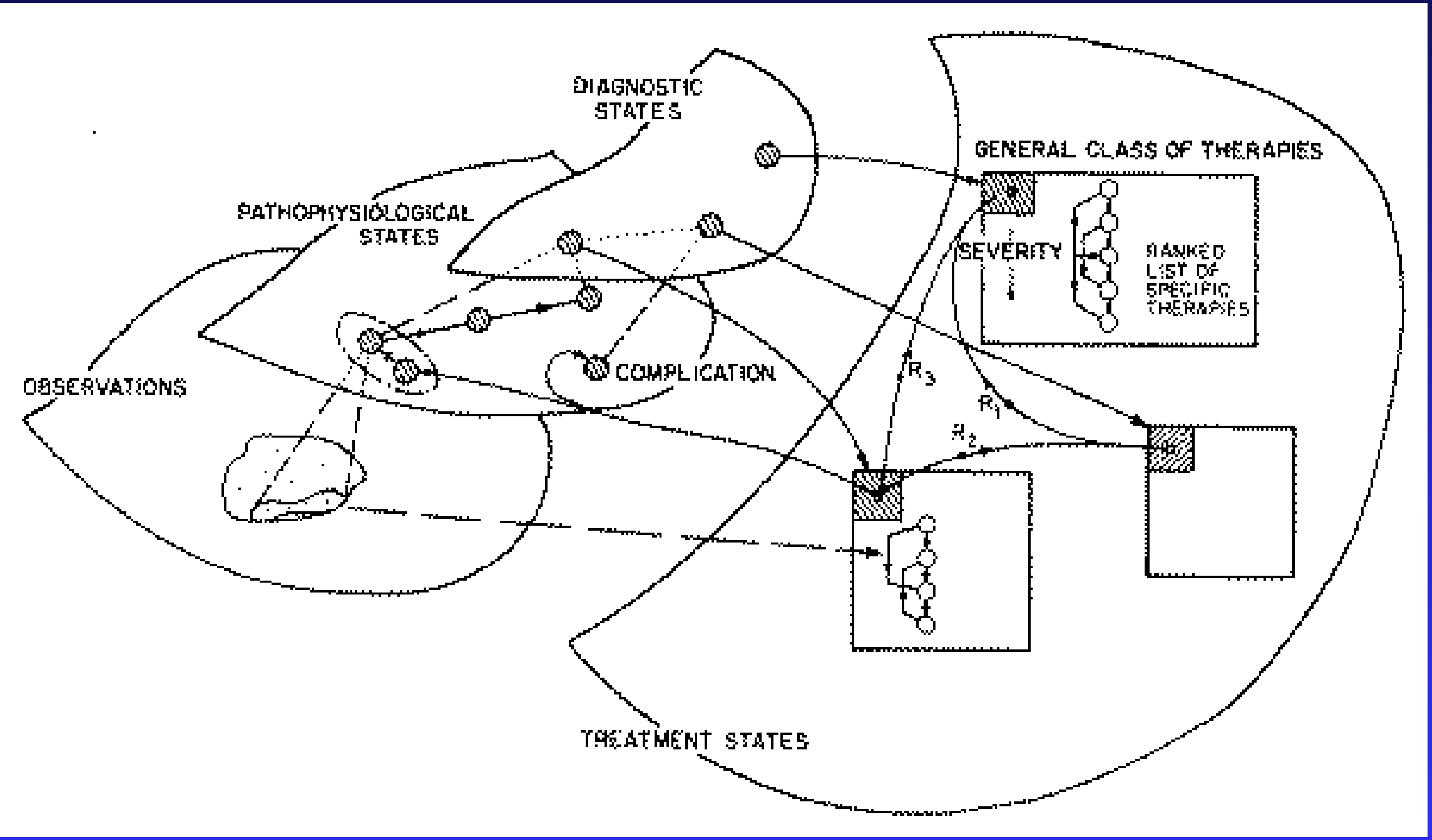
Descriptive Component

- Elements
  - Observations
    - Signs, symptoms, & test results
  - Pathophysiological 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) -> 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) -> 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
  - $W(I|J) = [W(I|J) * W(I)]/W(J)$
- Overall Weight
  - $W(I) = Max(Wf(I), Wi(I))$

ONET

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

Conclusions

- CASNET is a success