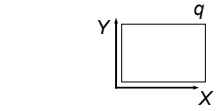
Beispiele

- *Example 1:*
  IF (ultrasonic of pancreas is pathological)
  THEN (pancreatic cancer)
  WITH (0.75 = often, 0.25 = weak)

- *Example 2:*
  IF (tophi)
  THEN (gout)
  WITH (0.25 = seldom, 1.00 = always)

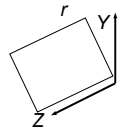
- *Example 3:*
  IF (lower back pain $\wedge$ limitation of motion of the lumbar spine $\wedge$ diminished chest expansion $\wedge$ male patient $\wedge$ age between 20 and 40 years)
  THEN (ankylosing spondylitis)
  WITH (υ, 0.90 = very strong)

Komposition von Relationen



Es seien X, Y (gewöhnliche) Mengen.

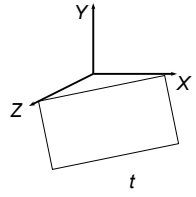
Eine *Relation* q von X in Y ist eine Teilmenge des Kartesischen Produktes $X \times Y$ *und*



Eine *Relation* r von Y in Z ist eine Teilmenge des Kartesischen Produktes $Y \times Z$*:*

$t := q \circ r$ ist eine Relation von X in Z,

$t := q \circ r = \{(x,z) | \exists\, y : (x,y) \in q \wedge (y,z) \in r\}$



Komposition von Fuzzy-Relationen

Seien X, Y (gewöhnliche) Mengen und sei $X \times Y$ *deren Kartesisches Produkt.*

- $L(X)$: die Menge aller Fuzzy sets in X.
- $L(Y)$: die Menge aller Fuzzy sets in Y.
- $L(X \times Y)$: die Menge aller Fuzzy sets in $X \times Y$.

Eine *Relation* der beiden Mengen X und Y ist Teilmenge von $X \times Y$.
Eine *Fuzzy Relation* R von X und Y ist F*uzzy*-Teilmenge von $L(X \times Y)$.

Seien drei Mengen X, Y, Z und zwei Fuzzy-Relationen *gegeben* :

- Q in $L(X \times Y)$,
- R in $L(Y \times Z)$.

Wie lassen sich die Fuzzy-Relationen Q und R *zu einer neuen Fuzzy-Relation* $T \in L(X \times Z)$ kombinieren?

Lotfi Zadeh, 1973: Komposition von Fuzzy-Relationen

$\wedge$ (“und”) $\rightarrow$ *min*
V (“oder”) $\rightarrow$ *max*

- Q ist Fuzzy-Relation von X und Y, d. h. Q ist Fuzzy-Teilmengen von $L(X \times Y)$,
- R ist Fuzzy-Relation von Y und Z, d. h. R ist Fuzzy-Teilmenge von $L(Y \times Z)$.
- $T = Q \circ R$ ist Fuzzy-Relation von X und Z,

d.h.: T ist Fuzzy-Teilmenge von $L(X \times Z)$ mit Zugehörigkeitsfunktion

$$\mu_T(x,z) = \max_{x \in X} \min \{\mu_Q(x,y); \mu_R(y,z)\},\ y \in Y$$

Outline of a New Approach to the Analysis of Complex Systems and Decision Processes

Medizinisches Wissen

S : Menge von Symptomen,
D : Menge von Krankheiten,

P : Menge von Patienten

Q : Fuzzy-Relation von *P* und *S,*
R : Fuzzy-Relation von *S* und *D,*
T : Fuzzy-Relation *von P und D.*

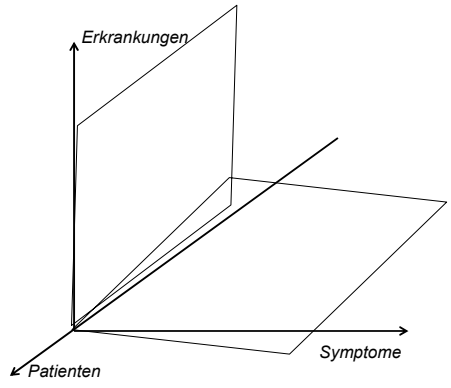
Medical Knowledge is a network of relations of symptoms and diseases.
Perez-Ojeda (1976)

Medical knowledge is a network of fuzzy relations of symptoms and diseases.
Elie Sanchez: (1979)

Max-min Komposition: *T = Q ° R mit Zugehörigkeitsfunktion:*

$$\mu_{PD}(P, D_j) = \max_{S_i} \min\left[\mu_{PS}(P, S_i); \mu_{SD}(S_i, D_j)\right]$$

Symptome-Diagnosen-Patienten-Fuzzy-Relation



CADIAG II

Inferenz

When P_k has S_i with $\mu_{PS}(P_k,S_i)$ and
when S_i implies D_j with $\mu_{SD}c(S_i, D_j)$,
then P_k has D_j with $\mu_{PD}(P_k, D_j)$.

$$\mu_{PD}(P_k, D_j) = \underset{S_i}{Max}\, Min\left[\mu_{PS}(P_k, S_i); \mu_{SD}c(S_i, D_j)\right]$$

When P_k has S_i mit $\mu_{PS}(P_k,S_i)$, and
when S_i implies S_j with $\mu_{SS}c(S_i, S_j)$ and
when S_j implies D_i with $\mu_{SD}c(S_j, D_i)$ and
when D_i implies D_j with $\mu_{DD}c(D_i, D_j)$
then P_k has D_j with $\mu_{PD}(P_k, D_j)$.

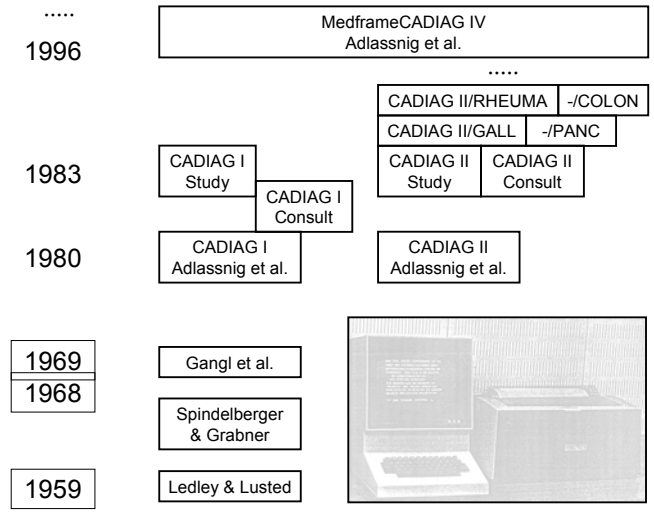
CADIAG II

Ergebnisse

- Rheumatology
  - more than 200 disease profiles, more than 2.000 findings
  - more than 50.000 finding-disease-relationships
  - more than 160 complex rules
- Hepatology and Gastroenterology
  - more than 100 disease profiles, more than 1.000 findings
  - more than 30.000 symptom-disease-relationships
  - more than 40 complex rules

Evaluation

Medical area	Cases	Confirmed diagnoses	Hypotheses	Confirmed diagnoses or hypotheses
Rheumatology	426	274	125	399 (93%)
Pancreatic diseases	47	3	40	43 (91%)
Gall bladder and Bile duct diseases	103	9	84	93 (90%)
Total	576	286	249	535 (93%)

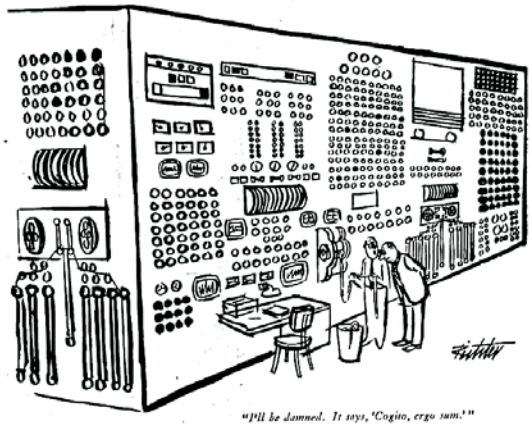


Results With CADIAG-II/RHEUMA

Clinical diagnosis	Cases	Confirmed	Hypothesis	Confirmed or Hyp.
Rheumatoid arthritis (100%)	282		224	58 282
Gout	54	12	28	40 (74%)
Ankylosing spondylitis	34	30	4	34 (100%)
Psoriatic arthritis	26	0	21	21 (80%)
Sjögren's disease	13	7	6	13 (100%)
SLE	7	1	6	7 (100%)
Reiter's disease	5	0	0	0 (0%)
Scleroderma	5	0	2	2 (40%)
Total	426	274	125	399 (93%)

Clinical diagnosis	Cases	Confirmed	Hypothesis	Confirmed or Hyp.
Pancreatic cancer	22	3	17	20 (90%)
Chronic pancreatitis	10	0	9	9 (90%)
Acute pancreatitis	5	0	4	4 (80%)
Pancreatic pseudocyst & chronic pancreatitis	4	0	4 & 4	4 (100%)
Pancreatic pseudocyst & acute pancreatitis	2	0	2 & 2	2 (100%)
Zollinger-Ellison syndrome	3	0	3	3 (100%)
Insulinoma	1	0	1	1 (100%)
Total	47	3	40	43 (91%)

I'll be damned. It says 'Cogito, ergo sum.' The New Yorker, 1958

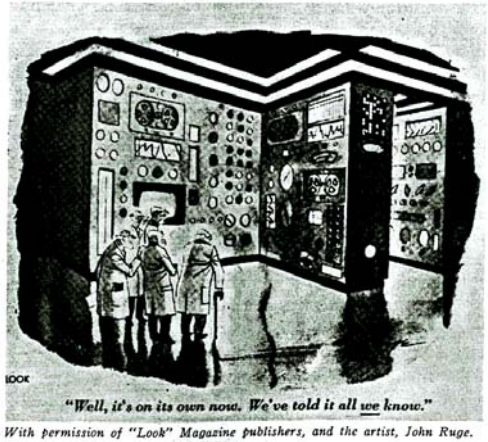


"I'll be damned. It says, 'Cogito, ergo sum.'"

Drawing by Richter; © 1958 "The New Yorker" Magazine, Inc.

Cartoon A.

Well, it's on ist own now. We've told it all we know. Look, 1958



With permission of "Look" Magazine publishers, and the artist, John Ruge.

Cartoon B.