EMYCIN

CPSC 433
Tyson Kendon
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Calculate This:

- Group the rules that lead to the conclusion h you want into set e.
- If |e| = 1 only one rule ($P_1 \wedge \ldots P_n \Rightarrow_i h$).
  - $MB(h, e) = I(P_1 \wedge \ldots P_n \Rightarrow_i h) * \max(0, \min(I(P_1), \ldots I(P_n)))$
- If $|e| \geq 2$ ($e = \{e1, e2\}$)
  - $MB(h, \{e1, e2\}) = MB(h,\{e1\}) + MB(h, \{e2\}) * (1 - MB(h, \{e1\}))$
  - $MB(h, \{e1, e2\}) = 0$, if $MD(h, \{e1, e2\}) = 1$
- MD is calculated the same way, but now we want the rules $P_1 \wedge \ldots P_n \Rightarrow_i \neg h$
- $I(h) = MB(h) - MD(h)$

A Problem (with numbers)

- If a student has good funding and a good GPA then there is a good chance (0.8) that the student will be accepted to grad school.
- If a student has a high community involvement and a low amount of outside obligations then there is a good chance (0.7) that they will be accepted to grad school.
- If a student has bad funding and a high amount of outside obligations then there is a chance (0.6) that the student will not be accepted to grad school.
- If a student has a low GPA, but has good research potential there is a chance (0.5) that they will be accepted to grad school.

Rules

- (e1): Funding(X, good) ∧ GPA(X, good) $\Rightarrow_1$ Accepted (X); I(e1) = 0.8
- (e2): Involvement(X, high) ∧ Obligations (X,low) $\Rightarrow_2$ Accepted(X); I(e2) = 0.7
- (e3): Funding(X, bad) ∧ Obligations (X, high) $\Rightarrow_3$ ¬Accepted(X); I(e3) = 0.6
- (e4): GPA(X, low) ∧ Potential(X, high) $\Rightarrow_4$ Accepted(X); I(e4) = 0.5

Other Inferences

- I(Funding(Bob, good)) = 0.7
- I(GPA(Bob, high)) = 0.8
- I(Involvement(Bob, high)) = 0.6
- I(Obligations(Bob, low)) = 0.7
- I(Funding(Bob, bad)) = 0.2
- I(Obligations(Bob, high)) = 0.4
- I(GPA(Bob, low)) = 0.2
- I(Potential(Bob, high)) = 0.9

So?

- Will Bob be accepted to grad school?
- Accepted(Bob)
- We need to know the measure of belief (MB) and the measure of disbelief (MD) of Accepted(Bob)
- MB and MD are not probabilities,
  - so MB = 1-MD is no necessarily true.

No Grad School for Bob

- $MD(\neg h, e) = I(P_1 \wedge \ldots P_n \Rightarrow_i \neg h) * \max(0, \min(I(P_1), \ldots I(P_n)))$
- MD(Accepted(Bob), e3) = I(Funding(X, bad) $\wedge$ Obligations (X, high) $\Rightarrow_3$ ¬Accepted(X)) * max (0, min(I(Funding(Bob, bad)), I(Obligations(Bob, high))))

No Grad School for Bob

- $MD(\neg h, e) = I(P_1 \wedge \ldots P_n \Rightarrow_i \neg h) * \max(0, \min(I(P_1), \ldots I(P_n)))$
- $MD(Accepted(Bob), e3) = I(Funding(X, bad) \wedge Obligations(X, high) \Rightarrow_3 \neg Accepted(X)) * \max(0, \min(I(Funding(Bob, bad)), I(Obligations(Bob, high))))$
- $MD(Accepted(Bob), e3) = 0.6 * \max(0, \min(0.2, 0.4))$

No Grad School for Bob

- MD $(\neg h, e) = I(P_1 \wedge \ldots P_n \Rightarrow_i \neg h) * \max(0, \min(I(P_1), \ldots I(P_n)))$
- MD(Accepted(Bob), e3) = I(Funding(X, bad) $\wedge$ Obligations (X, high) $\Rightarrow_3$ $\neg$Accepted(X)) * max (0, min(I(Funding(Bob, bad)), I(Obligations(Bob, high))))
- MD(Accepted(Bob), e3) = 0.6 * max(0, min(0.2, 0.4))
- MD(Accepted(Bob), e3) = 0.6 * 0.2

No Grad School for Bob

- $MD(\neg h, e) = I(P_1 \wedge \ldots P_n \Rightarrow_i \neg h) * \max(0, \min(I(P_1), \ldots I(P_n)))$
- MD(Accepted(Bob), e3) = I(Funding(X, bad) ∧ Obligations (X, high) $\Rightarrow_3$ ¬Accepted(X)) * max (0, min(I(Funding(Bob, bad)), I(Obligations(Bob, high))))
- MD(Accepted(Bob), e3) = 0.6 * max(0, min(0.2, 0.4))
- MD(Accepted(Bob), e3) = 0.6 * 0.2
- MD(Accepted(Bob), e3) = 0.12

Grad School for Bob

Grad School for Bob

- MB(Accepted(Bob, {e1})) = I({e1}) * max(0, min(I(Funding(Bob, good)), I(GPA(Bob, high))))

Grad School for Bob

- MB(Accepted(Bob, {e1})) = I({e1}) * max(0, min(I(Funding(Bob, good)), I(GPA(Bob, high))))
    - = 0.8 * max(0, min(0.7, 0.8))

Grad School for Bob

- MB(Accepted(Bob, {e1})) = I({e1}) * max(0, min(I(Funding(Bob, good)), I(GPA(Bob, high))))
  - = 0.8 * max(0, min(0.7, 0.8))
  - = 0.8 * 0.7 = 0.56

Grad School for Bob

- MB(Accepted(Bob, {e1})) = I({e1}) * max(0, min(I(Funding(Bob, good)), I(GPA(Bob, high))))
  - = 0.8 * max(0, min(0.7, 0.8))
  - = 0.8 * 0.7 = 0.56
- MB(Accepted(Bob, {e2})) = I({e2}) * max(0, min(I(Involvement(Bob, high)), I(Obligations (Bob,low))))

Grad School for Bob

- MB(Accepted(Bob, {e1})) = I({e1}) * max(0, min(I(Funding(Bob, good)), I(GPA(Bob, high))))
  - = 0.8 * max(0, min(0.7, 0.8))
  - = 0.8 * 0.7 = 0.56
- MB(Accepted(Bob, {e2})) = I({e2}) * max(0, min(I(Involvement(Bob, high)), I(Obligations (Bob,low))))
  - = 0.7 * max(0, min(0.6, 0.7))

Grad School for Bob

- MB(Accepted(Bob, {e1})) = I({e1}) * max(0, min(I(Funding(Bob, good)), I(GPA(Bob, high))))
  - = 0.8 * max(0, min(0.7, 0.8))
  - = 0.8 * 0.7 = 0.56
- MB(Accepted(Bob, {e2})) = I({e2}) * max(0, min(I(Involvement(Bob, high)), I(Obligations (Bob,low))))
  - = 0.7 * max(0, min(0.6, 0.7))
  - = 0.7 * 0.6 = 0.42

Grad School for Bob

- MB(Accepted(Bob, {e1})) = I({e1}) * max(0, min(I(Funding(Bob, good)), I(GPA(Bob, high))))
    - = 0.8 * max(0, min(0.7, 0.8))
    - = 0.8 * 0.7 = 0.56
- MB(Accepted(Bob, {e2})) = I({e2}) * max(0, min(I(Involvement(Bob, high)), I(Obligations (Bob,low))))
    - = 0.7 * max(0, min(0.6, 0.7))
    - = 0.7 * 0.6 = 0.42
- MB(Accepted(Bob, {e4})) = I({e4}) * max(0, min(I(GPA(Bob, low)) $\wedge$ I(Potential(Bob, high))))

Grad School for Bob

- MB(Accepted(Bob, {e1})) = I({e1}) * max(0, min(I(Funding(Bob, good)), I(GPA(Bob, high))))
  - = 0.8 * max(0, min(0.7, 0.8))
  - = 0.8 * 0.7 = 0.56
- MB(Accepted(Bob, {e2})) = I({e2}) * max(0, min(I(Involvement(Bob, high)), I(Obligations (Bob,low))))
  - = 0.7 * max(0, min(0.6, 0.7))
  - = 0.7 * 0.6 = 0.42
- MB(Accepted(Bob, {e4})) = I({e4}) * max(0, min(I(GPA(Bob, low)) $\wedge$ I(Potential(Bob, high))))
  - = 0.5 * max(0, min(0.2, 0.9))

Grad School for Bob

- MB(Accepted(Bob, {e1})) = I({e1}) * max(0, min(I(Funding(Bob, good)), I(GPA(Bob, high))))
  - = 0.8 * max(0, min(0.7, 0.8))
  - = 0.8 * 0.7 = 0.56
- MB(Accepted(Bob, {e2})) = I({e2}) * max(0, min(I(Involvement(Bob, high)), I(Obligations (Bob,low))))
  - = 0.7 * max(0, min(0.6, 0.7))
  - = 0.7 * 0.6 = 0.42
- MB(Accepted(Bob, {e4})) = I({e4}) * max(0, min(I(GPA(Bob, low)) $\wedge$ I(Potential(Bob, high))))
  - = 0.5 * max(0, min(0.2, 0.9))
  - = 0.5 * 0.2 = 0.1

Grad School for Bob

Grad School for Bob

- MB(Accepted(Bob), {e2, e4}) = MB(Accepted(Bob), {e2}) + MB(Accepted(Bob), {e4) * (1 - MB(Accepted(Bob), {e2}))

Grad School for Bob

- MB(Accepted(Bob), {e2, e4}) = MB(Accepted(Bob), {e2}) + MB(Accepted(Bob), {e4) * (1 - MB(Accepted(Bob), {e2}))
  - = 0.42 + 0.1 * 0.58

Grad School for Bob

- MB(Accepted(Bob), {e2, e4}) = MB(Accepted(Bob), {e2}) + MB(Accepted(Bob), {e4) * (1 - MB(Accepted(Bob), {e2}))
  - = 0.42 + 0.1 * 0.58
  - = 0.48

Grad School for Bob

- MB(Accepted(Bob), {e2, e4}) = MB(Accepted(Bob), {e2}) + MB(Accepted(Bob), {e4) * (1 - MB(Accepted(Bob), {e2}))
  - = 0.42 + 0.1 * 0.58
  - = 0.48
- MB(Accepted(Bob, e) = MB(Accepted(Bob), {e1, {e2, e4}) = MB(Accepted(Bob), {e1}) + MB(Accepted (Bob), {e2, e4}) *(1 - MB(Accepted(Bob), {e1})

Grad School for Bob

- MB(Accepted(Bob), {e2, e4}) = MB(Accepted(Bob), {e2}) + MB(Accepted(Bob), {e4) * (1 - MB(Accepted(Bob), {e2}))
    - = 0.42 + 0.1 * 0.58
    - = 0.48
- MB(Accepted(Bob, e) = MB(Accepted(Bob), {e1, {e2, e4}) = MB(Accepted(Bob), {e1}) + MB(Accepted (Bob), {e2, e4}) *(1 - MB(Accepted(Bob), {e1})
    - = 0.56 + 0.48 * 0.44

Grad School for Bob

- MB(Accepted(Bob), {e2, e4}) = MB(Accepted(Bob), {e2}) + MB(Accepted(Bob), {e4) * (1 - MB(Accepted(Bob), {e2}))
  - = 0.42 + 0.1 * 0.58
  - = 0.48
- MB(Accepted(Bob, e) = MB(Accepted(Bob), {e1, {e2, e4}) = MB(Accepted(Bob), {e1}) + MB(Accepted (Bob), {e2, e4}) *(1 - MB(Accepted(Bob), {e1})
  - = 0.56 + 0.48 * 0.44
  - = 0.77

Solution

Solution

- $I(h) = MB(h) - MD(h)$

Solution

- I(h) = MB(h) - MD(h)
- I(Accepted(Bob)) = MB(Accepted(Bob)) - MD (Accepted(Bob))

Solution

- I(h) = MB(h) - MD(h)
- I(Accepted(Bob)) = MB(Accepted(Bob)) - MD (Accepted(Bob))
- I(Accepted(Bob)) = 0.77 - 0.12

Solution

- I(h) = MB(h) - MD(h)
- I(Accepted(Bob)) = MB(Accepted(Bob)) - MD (Accepted(Bob))
- I(Accepted(Bob)) = 0.77 - 0.12
- I(Accepted(Bob)) = 0.65