Kecerdasan Buatan

Studi Kasus Sistem Pakar

Oleh Politeknik Elektronika Negeri Surabaya

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Konten

- Definisi Centainty Factor
- Metode Centainty Factor

Tujuan Instruksi Umum

Mahasiswa memahami filosofi Kecerdasan Buatan dan mampu menerapkan beberapa metode Kecerdasan Komputasional dalam menyelesaikan sebuah permasalahan, baik secara individu maupun berkelompok/kerjasama tim.

Certainty Factor (CF)

- Dalam menganalisa sebuah informasi dimungkinkan seorang pakar mengungkapkan informasi berupa pernyataan yang tidak pasti seperti:
  - mungkin
  - kemungkinan besar
  - hampir pasti
- Salah satu metode yang dapat digunakan dalam mengatasi ketidakpastian adalah metode certainty factor.
- Certainty factor merupakan metode yang mendefinisikan ukuran kepastian terhadap fakta atau aturan untuk menggambarkan keyakinan seorang pakar terhadap masalah yang sedang dihadapi.
- Certainty factor adalah derajat yang menunjukkan kita percaya bahwa fakta benar.
- Contoh: Hari ini akan hujan CF 0.6.

Certainty Factor (CF)

- *Certainty factor* (CF) merupakan nilai parameter klinis yang diberikan MYCIN untuk menunjukkan besarnya kepercayaan.
- *Certainty factor* didefinisikan sebagai berikut (Giarattano dan Riley, 1994):

$$CF[H,E] = MB[H,E] - MD[H,E]$$

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- CF(H,E) : *certainty factor* dari hipotesis H yang dipengaruhi oleh gejala (*evidence*) E.
  - Besarnya CF berkisar antara –1 sampai dengan 1 **(-1 ≤ CF[H,E] ≤ 1).**
  - Nilai –1 menunjukkan ketidakpercayaan mutlak
  - Nilai 1 menunjukkan kerpercayaan mutlak.
  - Jika CF bernilai positif, artinya gejala E mendukung hipotesis, karena

    MB[H,E] >MD[H,E]
- MB(H,E) : ukuran kenaikan kepercayaan (*measure of increased belief*) terhadap hipotesis H yang dipengaruhi oleh gejala E.

  0 ≤ MB[H,E] ≤ 1
- MD(H,E) : ukuran kenaikan ketidakpercayaan (*measure of increased disbelief*) terhadap hipotesis H yang dipengaruhi oleh gejala E.

  0 ≤ MD[H,E] ≤ 1

Certainty Theory

- CF bernilai -1 berarti completely false
- CF bernilai -1 berarti completely true
- Negative values degree of disbelief
- Positive values degree of belief

- Rage of CF values

False	-1	Measures of disbelief
Possibly false		
Unkown	0	
Possible True		Measures of belief
True	1	

Certainty Theory: Values Interpretation

Uncertain Term	CF
Definitely not (pasti tidak)	-1.0
Almost certainly not (hampir pasti tidak)	-0.8
Probably not (kemungkinan besar tidak)	-0.6
Maybe not (mungkin tidak)	-0.2
Unknown (tidak tahu)	-0.2 sampai 0.2
Maybe (mungkin)	0.4
Probably (kemungkinan besar)	0.6
Almost certainly (hampir pasti)	0.8
Definitely (pasti)	1.0

Certainty Theory

- Basic structure of rule in certainty model

  IF E THEN H CF (Rule)

- CF (Rule) = level of belief of H given E

- Given that E is true, we believe H according to:

  CF (H, E) = CF (Rule)

Certainty Theory

- Example:

  IF There are dark cloud -> E

  THEN It will rain -> H →CF = 0.8

- This rule reads:

  "If there are dark clouds then it will almost certainly rain"

- CF (H, E) similar P (H|E)

Certainty Factor Propagation (C.F.P)

CFP FOR SINGLE PREMISE RULE

- Menetapkan tingkat kepercayaan pada konklusi suatu rule (H) ketika fakta (E) yang termuat dalam rule premise tidak pasti

  CF (H, E) = CF (E) * CF (RULE)

- Example

  From previous rule:

  CF (E) = 0.5

  C.F.P. is

  CF (H, E) = 0.5 x 0.8

  = 0.4

- In words: It maybe raining

Certainty Factor Propagation (C.F.P)

- For same rule, with negative evidence for rule premise to the degree of CF (E) = -0.5

- C.F.P is

  CF (H, E) = -0.5 * 0.8

  = -0.4

- **In words:** It maybe not raining.

Certainty Factor Propagation (C.F.P)

CFP FOR MULTIPLE RULE PREMISE

- For rules with more than one premises:
  - conjunctive rules (AND)
  - disjunctive rules (OR)

Kombinasi Evidence Antecedent

Evidence, E	*Antecedent* Ketidakpastian
E_1 DAN E_2	$\min[CF(H,E_1), CF(H,E_2)]$
E_1 OR E_2	$\max[CF(H,E_1), CF(H,E_2)]$
TIDAK E	$- CF(H,E)$

Contoh Kombinasi Evidence

E : (E1 DAN E2 DAN E3) ATAU (E4 DAN BUKAN E5)

E : max[min(E1, E2, E3), min(E4, -E5)]

Misal:

E1 : 0.9 E2 : 0.8 E3 : 0.3

E4 : -0.5 E5 : -0.4

Hasilnya adalah:

E : max [min(0.9, 0.8, 0.3), min(-0.5, 0.4)]

: max(0.3, -0.5)

: 0.3

Evidence, E	*Antecedent* Ketidakpastian
E_1 DAN E_2	min[CF(H,E_1), CF(H,E_2)]
E_1 OR E_2	max[CF(H,E_1), CF(H,E_2)]
TIDAK E	- CF(H,E)

Certainty Factor Propagation (C.F.P)

CFP FOR MULTIPLE RULE PREMISE

- Conjunctive Rule

  IF EI **AND** E2 **AND** ... **THEN** H → CF (RULE)

  CF (H, E1 **AND** E2 **AND**..)

  = min {CF (Ei)} * CF (RULE)

- min function returns minimum value of a set of numbers.

Certainty Factor Propagation (C.F.P)

- Example:

IF	The sky is dark	→ E1
AND	The wind is getting stronger	→ E2
THEN	It will rain	→ CF(Rule) = 0.8

- Assume:

CF (the sky is dark) = CF(E1) = 1.0

CF (the wind is getting stronger) = CF(E2) = 0.7

- Calculate:

CF (It will rain) = min {CF (Ei)} * CF (RULE)

= min {1.0, 0.7} * 0.8

= 0.56

- In words: It probably will rain

Certainty Factor Propagation (C.F.P)

CFP FOR MULTIPLE RULE PREMISE

- Disjunctive Rule (OR)

  IF E1 **OR** E2 **OR** ... **THEN** H → CF (RULE)

  CF (H, E1 **OR** E2 **OR**..)

  = **Max** {CF (Ei)} * CF (RULE)

- Max function returns the maximum value of a set of numbers

Certainty Factor Propagation (C.F.P)

- Example:

IF	the sky is dark	→ E1
OR	the wind is getting stronger	→ E2
THEN	It will rain	→ CF(Rule) = 0.9

- Assume:

CF (the sky is dark) = CF(E1) = 1.0

CF (the wind is getting stronger) = CF(E2) = 0.7

- Calculate:

CF (It will rain) = **max** {CF (Ei)} * CF (RULE)

= max {1.0, 0.7} * 0.9

= 0.9

- In words: It almost certainly will rain

Certainty Factor Propagation (C.F.P)

CFP SIMILARLY CONCLUDED RULES

- For multiple rules that support a hypothesis (**same hypothesis**)

- Consider from 2 individuals:
  - weatherman
  - farmer

Certainty Factor Propagation (C.F.P)

- RULE 1

  IF the weatherman says it is going to rain → (E1)

  THEN It is going to rain → (H)

  CF (Rule 1) = 0.8
- RULE 2

  IF the farmer says it is going to rain → (E2)

  THEN It is going to rain → (H)

  CF (Rule 2) = 0.8
- CF of both rules set to equal implying equal confidence in the 2 sources
- Naturally more confident in conclusion.

Certainty Factor Propagation (C.F.P)

FOR INCREMENTALLY ACQUIRED EVIDENCE

CFcombined (CF1, CF2)

$$= CF1 + CF2 * (1 - CF1) \qquad \textbf{Both > 0}$$

$$= \frac{CF1 + CF2}{1 - \min\{|CF1|, |CF2|\}} \qquad \textbf{One < 0}$$

$$= CF1 + CF2 * (1 + CF1) \qquad \textbf{Both < 0}$$

where,

CF1 = confidence in H established by one rule (RULE 1)

CF2 = confidence in it established by one rule (RULE 2)

CF1 = CF1 (H, E)

CF2 = CF2 (H, E)

Certainty Factor Propagation (C.F.P)

- There are 2 properties of the equations:
  - Commutative:
    - allow evidence to be gathered in any order
  - Asymptotic:
    - If more than one source confirm a hypothesis then a person will feels more confident.
    - Incrementally add belief to a hypothesis as new positive evidence is obtained

Certainty Factor Propagation (C.F.P)

- Example:
  Consider Rain Prediction: Rule 1 and 2
  Explore several cases

- Case 1: Weatherman and Farmer Certain in Rain
  CF(E1) = CF(E2) = 1.0
  CF1 (H, E1) = CF (E1) * CF (RULE 1)
  = 1.0 * 0.8 = 0.8

  CF2 (H, E2) = CF (E2) * CF (RULE 2)
  = 1. 0 * 0.8 = 0.8

C.F.P. for single Premise Rule

Certainty Factor Propagation (C.F.P)

- Since both > 0,

  CFcombine (CF1, CF2) = CF1 + CF2 * (1 - CF1)

  = 0.8 + 0.8 * (1 - 0.8)

  = 0.96

- CF supported by > 1 rule can be incrementally increase more confident

Certainty Factor Propagation (C.F.P)

Case 2: Weatherman certain in rain, Farmer certain no rain

CF (E1) = 1.0 CF (E2) = -1.0

CF1 (H, E1) = CF (E1) * CF (RULE 1)

= 1.0 * 0.8 = 0.8

CF2 (H, E2) = CF (E2) * CF (RULE 2)

= -1.0 * 0.8 = -0.8

Since either one < 0

$$CFcombined(CF1, CF2) = \frac{CF1 + CF2}{1 - \min\{|CF1|,|CF2|\}} = \frac{0.8 + (-0.8)}{1 - \min\{0.8,0.8\}} = 0$$

CF set to unknown because one say "no" and the other one say "yes"

Certainty Factor Propagation (C.F.P)

Case 3: Weatherman and Farmer believe at different degrees that it is going to rain

CF (E1) = -0.8 CF (E2) = -0.6

CF1 (H, E1) = CF (E1) * CF (RULE 1)

= -0.8 x 0.8 = -0.64

CF2 (H, E2) = CF (E2) * CF (RULE 2)

= -0.6 * 0.8

= -0.48

Since both < 0

CFcombined (CF1, CF2) = CF1 + CF2 * (1 + CF1)

= - 0.64 - 0.48 * (1 - 0.64)

= -0.81

Show incremental decrease when more than one source disconfirming evidence is found.

Certainty Factor Propagation (C.F.P)

Case 4: Several Sources Predict Rain at the same level of belief but one source predicts no rain

If many sources predict rain at the same level, CF(Rain) = 0.8, the CFvalue converge towards 1

CFcombined (CF1, CF2 ..)

CFold = 0.999

CFold = collected old sources info.

If new source say negative

CFnew = -0.8 then,

CFcombined (CFold, CFnew)

$$= \frac{CFold + CFnew}{1 - \min\{CFold, CFnew\}}$$

$$= \frac{0.999-0.8}{1 - 0.8}$$

= 0.995

Shows single disconfirming evidence does not have major impact.

Certainty Factor Propagation (C.F.P)

CERTAINTY PROPAGATION FOR COMPLEX RULES

Combination of conjunctive and disjunctive statement ("AND", "OR")

Example:

IF	E1	
AND	E2	→ min
OR	E3	→ max
AND	E4	→ min
THEN	H	

CF (H) = max {min (E1, E2), min (E3, E4)} * CF (RULE)

Certainty Factors

- Consider two rules:

  IF (R1) hasHair THEN mammal CF(R1) = 0.9

  IF (R2) forwardEyes AND sharpTeeth THEN mammal CF(R2) = 0.7

- We now know that:

  CF(hasHair) = 0.8

  CF(forwardEyes) = 0.75

  CF(sharpTeeth) = 0.3

  CF(forwardEyes AND sharpTeeth) = min(0.75, 0.3) = 0.3

- Given the premise CF, how do you combine with the CF for the rule ?

  CF(H, Rule) = CF(E) * CF(Rule)

  So, CF(mammal, R1) = CF(hasHair) * CF(R1) = 0.8 * 0.9 = 0.72

  CF(mammal, R2) = CF(forwardEyes AND sharpTeeth) * CF(R2)

  = 0.3 * 0.7

  = 0.21

Certainty Factors

Given different rules with same conclusion, how do you combine CF's?

CF(H, Rule1 & Rule2)

= CF(H, Rule1) + CF(H, Rule2)*(1- CF(H,Rule1))

So, **CF(mammal, R1 & R2)**

= CF(mammal, R1) + CF(mammal, R2)*(1- CF(mammal,R1))

= 0.72 + 0.21*0.28

= 0.72 + 0.0588

= 0.7788

Note: **CF(mammal, R1 & R2) = CF(mammal, R2 & R1)**

Kelebihan Metode CF

- Suatu model komputasi yang sederhana yang memungkinkan pakar mengestimasi kepercayaaannya dalam konklusi.
- Mengijinkan ekspresi kepercayaan dan ketidakpercayaan dalam tiap hipotesis.
- Menggabungkan nilai CF lebih mudah dibandingkan metode lain.

Latihan Soal

1. Apa tujuan dari sistem pakar dan pemindahan kepakaran?
2. Dilihat dari struktur, apa perbedaan dari Human Expert dan Expert System?
3. Apa itu knowledge base dan peranannya dalam sistem pakar?
4. Apa yang sekiranya terjadi bila sistem pakar tidak memiliki knowledge base?
5. Apa itu working memory dan peranannya dalam sistem pakar?

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bridge to the future

http://www.eepis-its.edu