

Praktikum 3 Sistem pakar

Wildcard Pattern
Rule dengan probability (Certainty Factor)

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Wildcard pattern

- ▶ **Wildcard Pattern** merupakan cara yang digunakan untuk menggantikan suatu simbol yang terdapat di bagian antesenden suatu aturan (LHS)



Wildcard pattern

- ▶ Terdapat dua jenis wildcard pattern yang sering digunakan:

?x : mengambil satu simbol yang sesuai
 \$? : boleh tidak mengambil atau
 mengambil lebih dari satu simbol
 (biasanya digunakan pada multislot)



ConTOH 1

Contoh 1 (band.clp)

```
(deftemplate member_bands
  (multislot member-of))

(deffacts nama_band
  (member_bands (member-of beatles john_lennon
    paul_mccartney george_harrison ringo_starr))
  (member_bands (member-of smash roger_daltrey
    pete_townsend keith_moon))
  (member_bands (member-of kangen_band tracey_thorn
    ben_watt)))

(defrule bands
  (member_bands (member-of ?band $?))
  =>
  (printout t "there is a band called " ?band crlf))
```



CONTOH 2

Contoh 2 (akses_single_member.clp)

```
(deftemplate member_bands
  (multislot member-of))
(deffacts nama_band
  (member_bands (member-of beatles john_lennon
paul_mccartney george_harrison ringo_starr))
  (member_bands (member-of smash roger_daltrey pete_townsend
keith_moon))
  (member_bands (member-of kangen_band tracey_thorn
ben_watt)))
(defrule band-members
  (member_bands (member-of ?band ?member $?))
  =>
  (printout t ?member " is a member of " ?band crlf))
```



CONTOH 3

Contoh 3 (akses_multi_member.clp)

```
(deftemplate member_bands
  (multislot member-of))

(deffacts nama_band
  (member_bands (member-of beatles john_lennon
paul_mccartney george_harrison ringo_starr))
  (member_bands (member-of smash roger_daltrey pete_townsend
keith_moon))
  (member_bands (member-of kangen_band tracey_thorn
ben_watt)))

(defrule band-members
  (member_bands (member-of ?band $?members))
  =>
  (printout t "The members of " ?band " are " $?members
crlf))
```

Supaya lebih elegan

Hasilnya???

```

CLIPS 6.3 - [Dialog Window]
File Edit Buffer Execution Browse Window Help
CLIPS> (load "E:/Users/fidie/Desktop/Asprak/sem 8/Sistem Pakar/prak 3/pr_edit.clp")
Defining deftemplate: mahasiswa
Defining deftemplate: mutu
Defining deffacts: 11kwa
Defining defrule: n1 +j+j
Defining defrule: n2 +j+j
Defining defrule: n3 +j+j
Defining defrule: n4 +j+j
Defining defrule: n5 +j+j
Defining defrule: n6 +j+j
TRUE
CLIPS> (reset)
<== f-0 (initial-fact)
==> f-0 (initial-fact)
==> f-1 (mahasiswa (nama aa) (nrp g61) (nilai 10))
==> f-2 (mahasiswa (nama bb) (nrp g62) (nilai 9))
==> f-3 (mahasiswa (nama cc) (nrp g63) (nilai 8))
==> f-4 (mahasiswa (nama df) (nrp g64) (nilai 7))
==> f-5 (mahasiswa (nama ee) (nrp g65) (nilai 6))
==> f-6 (mahasiswa (nama fd) (nrp g66) (nilai 5))
CLIPS> (run)
FIRE 1 n6: f-6
==> f-7 (mutu (nrp g66) (nilai-mutu C))
FIRE 2 n5: f-5
==> f-8 (mutu (nrp g65) (nilai-mutu C))
FIRE 3 n4: f-4
==> f-9 (mutu (nrp g64) (nilai-mutu B))
FIRE 4 n3: f-3
==> f-10 (mutu (nrp g63) (nilai-mutu B))
FIRE 5 n2: f-2
==> f-11 (mutu (nrp g62) (nilai-mutu A))
FIRE 6 n1: f-1
==> f-12 (mutu (nrp g61) (nilai-mutu A))
CLIPS>

```

Certainty Factor

Uncertainty

There is a uncertainty in the mind
Of experts when make a decision
accordance their expertise



Causes of Uncertainty

- Not completely and uncertainty information
- Unknown data
- Unify the different of view point of experts
- Imprecise language (always,often,seldom,some times)

Certainty Theory

- Certainty factor (cf), value to measure degree of belief from expert.
- Maximum value of cf is +1.0 (definitely true) and minimum -1.0 (definitely false).
- Two aspects:
 - Certainty in the Evidence
 - ***The evidence can have a certainty factor attached***
 - Certainty in Rule



Computation of Certainty Factors

1. Model 'Net Belief' (Shortliffe dan Buchanan)

$$CF(\text{Rule}) = MB(H,E) - MD(H,E)$$

$$MB(H,E) = \begin{cases} 1 ; & \text{if } P(H)=1 \\ \max[P(H|E), P(H)] - P(H) / 1 - P(H) ; & \text{Otherwise} \end{cases}$$

$$MD(H,E) = \begin{cases} 1 ; & \text{if } P(H)=0 \\ \min[P(H|E), P(H)] - P(H) / 1 - P(H) ; & \text{Otherwise} \end{cases}$$



Certainty Factors

2. Direct Interview with Expert

Uncertain Term	Certainty Factor
Definitely not	-1.0
Almost certainly not	-0.8
Probably not	-0.6
Maybe not	-0.4
Unknown	-0.2 to +0.2
Maybe	+0.4
Probably	+0.6
Almost certainly	+0.8
Definitely	+1.0

Example :

Expert : "If headache and have a cold and fever, then most possibility is influenza"

Rule : IF evidence 1 = headache AND evidence 2 = have a cold AND evidence 3 = fever

THEN seek = influenza

(cf = 0.8)

Expert System With CF

In Expert System with CF, knowledge base composed of set of rules with syntax:

```
IF      <evidence>
THEN  <hypothesis>      {cf }
```

- CF refers to degree of belief for hypothesis H when evidence E occurred.



Example

- Degree of belief for hypothesis H when evidence E occurred.

$$\square \text{cf} (H,E) = \text{cf} (E) * \text{cf}(\text{Rule})$$

- e.g:

```
IF      sky is clear
THEN  the forecast is sunny {cf 0.8}
```

- With cf of “sky is clear” is 0.5

$$\square \text{cf} (H,E) = 0.5 * 0.8 = 0.4$$



Multiple Antecedents

- How the CF if we have two evidence?
- With conjunction (i.e. and)
 - Use minimum *cf* of evidence
- With disjunction(i.e. or)
 - Use maximum *cf* of evidence



Conjunctive Antecedents - Example

- Conjunctive Rules:

$$cf(H, E_1 \text{ and } E_2 \text{ and } \dots E_i) = \min\{cf(E_1, E_2, \dots E_i)\} \\ *cf(\text{Rule})$$

IF there are dark clouds E_1

AND the wind is stronger E_2

THEN it will rain {cf 0.8}

- If $cf(E_1) = 0.5$ and $cf(E_2) = 0.9$, then

$$cf(H, E) = \min\{0.5, 0.9\} * 0.8 = 0.4$$



Disjunctive Antecedents - Example

□ Disjunctive Rules:

$$cf(H, E_1 \text{ or } E_2 \text{ or } \dots E_i) = \max\{cf(E_1, E_2, \dots E_i)\} \\ * cf(\text{Rule})$$

IF there are dark clouds E_1
 OR the wind is stronger E_2
 THEN it will rain $\{cf\ 0.8\}$

□ If $cf(E_1) = 0.5$ and $cf(E_2) = 0.9$, then

$$cf(H, E) = \max\{0.5, 0.9\} * 0.8 = 0.72$$



Similarly Concluded Rules

How to determine CF if two rules have similar conclusion?

Rule 1:

IF weatherperson predicts rain (E_1)
 THEN it will rain
 $\{cf_1\ 0.7\}$

Rule 2:

IF farmer predicts rain (E_2)
 THEN it will rain
 $\{cf_2\ 0.9\}$



Similarly Concluded Rules

Formula :

$$CF_c(CF_1, CF_2) =$$

$CF_1 + CF_2(1 - CF_1)$	if both > 0
$CF_1 + CF_2(1 + CF_1)$	if both < 0
$CF_1 + CF_2 / (1 - \min(CF_1 , CF_2))$	if one < 0



Similarly Concluded Rules

New CF value from facts above above can be formulated:

$$\begin{aligned}
 cf(cf_1, cf_2) &= cf_1 + cf_2 * (1 - cf_1) \\
 &= 0.7 + 0.9(1 - 0.7) \\
 &= 0.97
 \end{aligned}$$



EXERCISE

Determine New Value of CF from some facts in below

:

1. IF fever

THEN typhus {cf -0.39}

2. IF amount of thrombosis is low

THEN typhus {cf -0.51}

3. IF the body is weak

THEN typhus {cf 0.87}

4. IF diarrhea/constipation

THEN typhus {cf 0.63}



Combining CF with CLIPS

```
(defrule start
(declare (salience 1000))
(initial-fact)
=>
(set-fact-duplication TRUE))
```



Combining CF with CLIPS

```
(defrule both-positif
?fact1<- (pasien ?sakit ?tifus ?c1&:(>= ?c1 0))
?fact2<- (pasien ?sakit ?tifus ?c2&:(>= ?c2 0))
(test (neq ?fact1 ?fact2))
=>
(retract ?fact1 ?fact2)
(bind ?c3 (- (+ ?c1 ?c2) (* ?c1 ?c2)))
(assert (pasien ?sakit ?tifus ?c3)))
```

Combining CF with CLIPS

```
(defrule both-negatif
?fact1<- (pasien ?sakit ?tifus ?c1&:(< ?c1 0))
?fact2<- (pasien ?sakit ?tifus ?c2&:(< ?c2 0))
(test (neq ?fact1 ?fact2))
=>
(retract ?fact1 ?fact2)
(bind ?c3 (+ (+ ?c1 ?c2) (* ?c1 ?c2)))
(assert (pasien ?sakit ?tifus ?c3)))
```

Combining CF with CLIPS

```
(defrule opposite-sign
?fact1<- (pasien ?sakit ?tifus ?c1)
?fact2<- (pasien ?sakit ?tifus ?c2)
(test (< (* ?c1 ?c2) 0))
(test (neq ?fact1 ?fact2))
=>
(retract ?fact1 ?fact2)
(bind ?c3 (/ (+ ?c1 ?c2) (- 1 (min (abs ?c1) (abs ?c2)))))
(assert (pasien ?sakit ?tifus ?c3)))
```

Combining CF with CLIPS

```
(deffacts rumahsakit
(pasien sakit tifus -0.39)
(pasien sakit tifus -0.51)
(pasien sakit tifus 0.87)
(pasien sakit tifus 0.63))
```

Lakukan Beberapa Langkah

- Load -> Reset -> (agenda)
- Perhatikan urutan *rule* yang dijalankan

Rule dengan Saliency yang lebih besar akan dieksekusi terlebih dahulu

Modifikasi Saliency dari Rule

```
(defrule both-positif
  (declare (saliency 6)) ....
  ....
  ....)
```

```
(defrule both-negatif
  (declare (saliency 10))
  ....
  ....
  ....)
```

Lakukan langkah yang sama : Load -> Reset -> Agenda

Lihat pada Agenda:

Akan terlihat bahwa *rule* dengan salience tinggi, akan dijalankan terlebih dahulu



Combining CF with CLIPS

$$Cf = 0.8390766$$

