

PAC4: Raonament aproximat

Presentació

Quarta PAC del curs d'Intel·ligència Artificial

Competències

En aquesta PAC es treballen les següents competències:

Competències de grau:

 Capacitat d'analitzar un problema amb el nivell d'abstracció adient a cada situació i aplicar les habilitats i coneixements adquirits per abordar-lo i solucionar-lo.

Competències específiques:

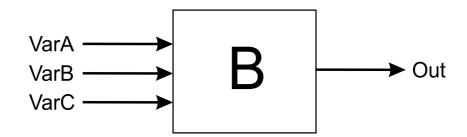
- Conèixer els diferents models de representació del coneixement (marcs, sistemes basats en regles, raonament basat en casos, ontologies, programació lògica).
- Raonament basat en lògica difosa.

Objectius

Aquesta PAC pretén avaluar diferents aspectes de lògica difusa: representació i ús de termes lingüístics, i mètodes d'inferència.

Descripció de la PAC a realitzar

Considerem un **sistema expert difús** composat d'un bloc de regles (B) amb 3 variables d'entrada (VarA, VarB, VarC) i 1 de sortida (Out), com es mostra a la figura següent:



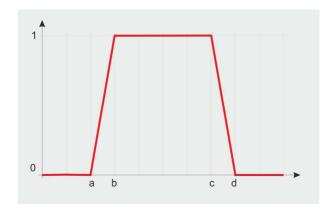


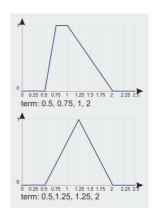


A continuació es detallen els termes lingüístics associats a cadascuna de les quatre variables:

Variable	Rar	ıa	Terme lingüístic : punts (a,b,c,d) *
VarA	Min:	0	low (L) (0, 0, 0, 4)
	Max:	9	medium (M) (2, 3, 7, 8)
			high (H) (5, 8, 8, 9)
VarB	Min:	0	low (L) (0, 0, 1, 3)
	Max:	9	medium (M) (1, 3, 5, 7)
			high (H) (2, 6, 8, 9)
VarC	Min:	0	very-low (VL) (0, 0, 0.2, 0.6)
	Max:	2	low (L) (0, 0.4, 0.6, 1.4)
			medium (M) (0.8, 1, 1, 1.2)
			high (H) (0.6, 1.4, 1.6, 2)
			very-high (VH) (1.4, 1.8, 2, 2)
Out	Min:	-5	very-low (VL) (-5, -5, -5, -1)
	Max:	5	low (L) (-5, -3, -2, 1)
			medium (M) (-2, -1, 1, 2)
			high (H) (-1, 2, 3, 5)
			very-high (VH) (1, 4, 5, 5)

(*) A continuació es presenta com s'ha d'interpretar la seqüència de punts (a,b,c,d). A més, al costat dret s'afegeixen dos exemples il·lustratius, un terme trapezoïdal (dalt) i un terme triagonal (sota).







A continuació, detallem el conjunt de regles associades al bloc de regles B. Bloc B

ld. regla	VarA		VarB		VarC	Out
01	L	AND	L	AND	VL	VL
02	L	AND	L	AND	L	VL
03	L	AND	L	AND	M	VL
04	L	AND	L	AND	Н	VL
05	L	AND	L	AND	VH	L
06	L	AND	M	AND	VL	VL
07	L	AND	M	AND	L	VL
08	L	AND	M	AND	M	VL
09	L	AND	M	AND	Н	L
10	L	AND	M	AND	VH	L
11	L	AND	Н	AND	VL	VL
12	L	AND	Н	AND	L	L
13	L	AND	Н	AND	M	L
14	L	AND	Н	AND	Н	M
15	L	AND	Н	AND	VH	Н
16	M	AND	L	AND	VL	M
17	M	AND	L	AND	L	M
18	M	AND	L	AND	M	M
19	M	AND	L	AND	Н	M
20	M	AND	L	AND	VH	M
21	M	AND	M	AND	VL	M
22	M	AND	M	AND	L	M
23	M	AND	M	AND	M	M
24	M	AND	M	AND	Н	M
25	M	AND	M	AND	VH	Н
26	M	AND	Н	AND	VL	M
27	M	AND	Н	AND	L	Н
28	M	AND	Н	AND	M	M
29	M	AND	Н	AND	Н	Н
30	M	AND	Н	AND	VH	Н
31	Н	AND	L	AND	VL	M
32	Н	AND	L	AND	L	M
33	Н	AND	L	AND	M	M
34	Н	AND	L	AND	Н	Н
35	Н	AND	L	AND	VH	Н
36	Н	AND	M	AND	VL	M
37	Н	AND	M	AND	L	Н
38	Н	AND	M	AND	M	M
39	Н	AND	M	AND	Н	Н
40	Н	AND	M	AND	VH	Н
41	Н	AND	Н	AND	VL	Н
42	Н	AND	Н	AND	L	Н
43	Н	AND	Н	AND	M	VH
44	Н	AND	Н	AND	Н	VH
45	Н	AND	Н	AND	VH	VH

Preguntes

Considerar un sistema Mamdani amb t-norma min i t-conorma max.







- 1) Representar gràficament les variables del sistema amb els termes lingüístics. Calcular les funcions de pertinença de totes de les variables.
- 2) Determinar la sortida Out considerant el bloc de regles B mostrat anteriorment i les entrades següents:

$$(VarA, VarB, VarC) = (2.5, 2.5, 0.9)$$

3) Crear un nou bloc de regles B i determinar de nou la sortida Out pels mateixos valors d'entrada de la pregunta anterior.

Aquest nou bloc ha de composar-se de regles amb connectors OR enlloc de connectors AND com s'ha fet en la pregunta anterior.

El bloc ha de constar de com a mínim 10 regles.

Dissenyeu el bloc per a que, com a mínim, una regla es compleixi pels valors d'entrada donats.

Notes preguntes 2) i 3):

Pel càlcul del valor nítid de la variable Out utilitzeu el mètode de centre de masses amb una resolució de 10E-3.

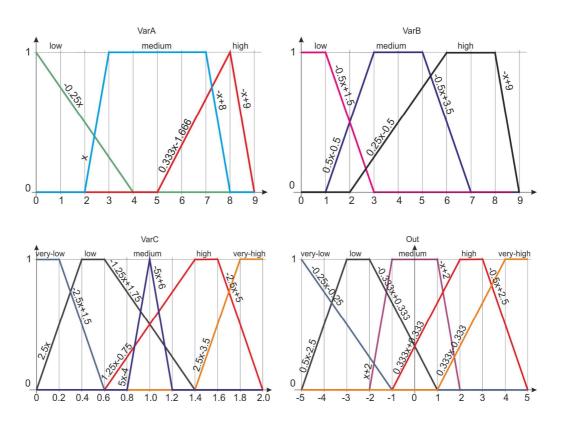
En tots els casos descriviu quines regles s'activen, representar gràficament la sortida obtinguda, i el procés seguit per obtenir el resultat.





Solucions

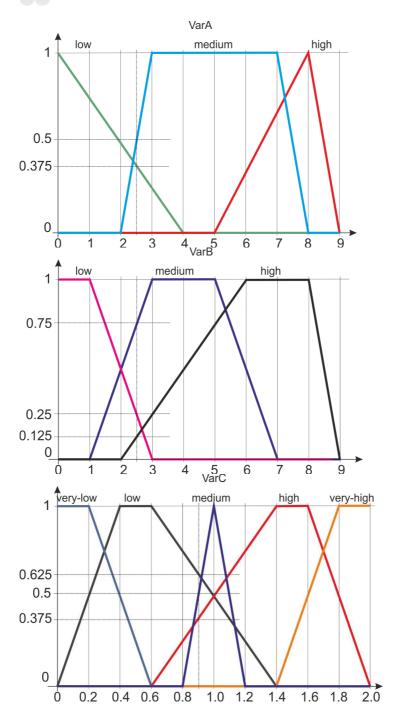
1) A continuació es detallen les funcions de pertinença per les variables del sistema per cadascun dels trams.



2) Determinar el procés d'inferència pels valors d'entrada donats. Els valors d'entrada donats, tallen de la següent forma cadascun dels termes:







El valor d'entrada VarA = 2.5, talla els termes L a nivell 0.375 i M a nivell 0.5. El valor d'entrada VarB = 2.5, talla el terme L a 0.25, terme M a 0.75, i el terme H a nivell 0.125.

Finalment, el valor VarC = 0.9, talla el terme L a 0.625, M a nivell 0.5 i terme H a nivell 0.375.







Si traslladem aquests nivells al bloc de regles B, podem avaluar tots els antecedents activats i quines regles finalment activen els conseqüents.

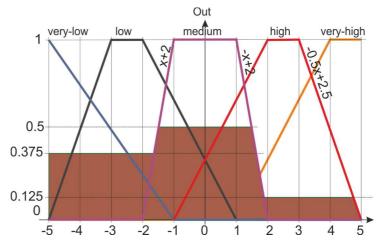
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Apliquem la t-norma min en les regles que s'activen (destacades en vermell), i obtenim els conseqüents que es destaquen en la darrera columna junt amb el seu nivell d'activació.

Com es pot veure, per trobar el valor final de cada terme activat cal aplicar la t-conorma max resultant que la variable Out activa els termes: VL amb un nivell 0.375, el terme L amb un nivell 0.375, el terme M amb un nivell 0.5 i finalment el terme H queda activat amb un nivell 0.125.



Formalment, la funció de pertinença resultant és la següent:

Out(x) = 0.375 per
$$-5 \le x < -1.625$$
,
= x+2 per $-1.625 \le x < -1.5$,
= 0.5 per $-1.5 \le x < 1.5$,
= -x+2 per $1.5 \le x < 1.875$,
= 0.125 per $1.875 \le x < 4.75$,
= -0.5x+2.5 per $4.75 \le x \le 5$.

I si calculem el valor nítid, resulta en -0.851:

$$CoG = \frac{\sum_{x=-5}^{5} (i\mu(x))}{\sum_{x=-5}^{5} \mu(x)} = \frac{-2819.484}{3312.766} = -0.851.$$



3) Per aquesta pregunta, ens demanen construir un bloc de regles amb connexions OR i amb un mínim de 10 regles.

No hi ha cap regla per construir el bloc d'aquesta forma. Pot ser complet o incomplet, és a dir, que tingui en compte tots els casos, o no. També, podem composar regles considerant tots els termes o no. Tots aquests aspectes fan que el disseny sigui *totalment obert*.

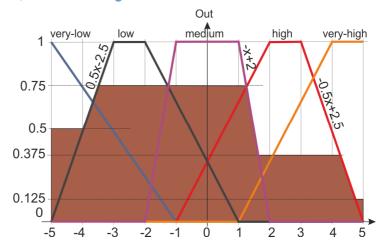
A continuació, es defineix un bloc de regles.

ld. regla	VarA		VarB		VarC	Out
01	L (0.5)	OR	L (0.25)			VL (0.5)
02			L (0.25)	OR	VL	VL (0.25)
03	M (0.375)	OR	M (0.75)			L (0.75)
04	Н	OR	H (0.125)			M (0.125)
05	L (0.5)	OR	M (0.75)	OR	VL	L (0.75)
06	L (0.5)	OR	M (0.75)	OR	L (0.625)	M (0.75)
07			H (0.125)	OR	H (0.375)	H (0.375)
08			H (0.125)	OR	VH	VH (0.125)
09	Н	OR		•	VH	VH
10	Н	OR		•	H (0.375)	H (0.375)

Per les connexions OR, els antecedents s'acompleixen amb la t-conorma perquè enlloc d'aplicar la restricció més alta com seria el cas de connexions AND, és just el contrari. Els conseqüents finals, això sí, es calculen de la mateixa forma que en el cas de la pregunta anterior.

En vermell assenyalem totes les regles activades. El resultat final és el següent: terme VL actiu 0.5, terme L actiu 0.75, terme M actiu 0.75, terme H actiu a 0.375, i terme VH actiu a 0.125.

Gràficament, obtenim el següent resultat:







Formalment, la funció de pertinença resultant és la següent:

Out(x) = 0.5 per
$$-5 \le x < -4$$
,
= 0.5x+2.5 per $-4 \le x < -3.5$,
= 0.75 per $-3.5 \le x < 1.25$,
= -x+2 per 1.25 \le x < 1.625,
= 0.375 per 1.625 \le x < 4.25,
= -0.5x+2.5 per 4.25 \le x < 4.75,
= 0.125 per 4.75 \le x < 5.

I si calculem el valor nítid, resulta en -0.615:

$$CoG = \frac{\sum_{x=-5}^{5} (i\mu(x))}{\sum_{x=-5}^{5} \mu(x)} = \frac{-3525.7854}{5726.996} = -0.615$$
.

Recursos

Per a fer aquesta PAC el material imprescindible és el Tema 2 – Sistemes difusos, del mòdul 4.

Criteris de valoració

La pregunta 1 val 2 punts. Les preguntes 2 i 3 valen 4 punts cadascuna.

Format i data de lliurament

Per a dubtes i aclariments sobre l'enunciat, adreceu-vos al consultor responsable de la vostra aula.

Cal lliurar la solució en un fitxer PDF fent servir una de les plantilles lliurades conjuntament amb aquest enunciat. Adjunteu el fitxer a un missatge a l'apartat Lliurament i Registre d'AC (RAC).

El nom del fitxer ha de ser *CognomsNom_*IA_PAC4 amb l'extensió .pdf (PDF).

La data límit de lliurament és el: 15 de desembre (a les 24 hores).

Raoneu la resposta en tots els exercicis. Les respostes sense justificació no rebran puntuació.





Telecomunicacions



Nota: Propietat intel·lectual

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Per tant, en presentar una pràctica que faci ús de recursos aliens, s'ha de presentar juntament amb ella un document en què es detallin tots ells, especificant el nom de cada recurs, el seu autor, el lloc on es va obtenir i el seu estatus legal: si l'obra està protegida pel copyright o s'acull a alguna altra llicència d'ús (Creative Commons, llicència GNU, GPL ...). L'estudiant haurà d'assegurar-se que la llicència que sigui no impedeix específicament seu ús en el marc de la pràctica. En cas de no trobar la informació corresponent haurà d'assumir que l'obra està protegida pel copyright.

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