

CMPS 3560

Spring 2018

Midterm II

4/3/18

Time Limit: 150 minutes

Name (Print): _____

Instructor A. Cruz

This exam contains 10 pages (including this cover page) and 7 problems. Check to see if any pages are missing. Put your initials on the top of every page, in case the pages become separated. You may *not* use your books, notes, or any computer, cell phone, tablet, etc. on this exam. You are required to show your work for each problem in this exam (except multiple choice, or true or false). The following rules apply:

- **You are allowed to have a cheat sheet.** You may write on both sides. The paper must be 8.5x11 inches. You must turn in your cheat sheet at the end of the test. It must have your name on it.
- **An ID is required.** You will not be able to turn in the test unless you show a photo ID. Failure to produce an ID will result in your grade being withheld until you can present an ID to the instructor.
- **Mysterious or unsupported answers will not receive full credit.** A correct answer, unsupported by calculations, explanation, or algebraic work will receive no credit; an incorrect answer supported by substantially correct calculations and explanations might still receive partial credit.
- **Do not write in the table to the right.**

| Problem | Points | Score |
|---------|--------|-------|
| 1 | 7 | |
| 2 | 4 | |
| 3 | 6 | |
| 4 | 9 | |
| 5 | 8 | |
| 6 | 6 | |
| 7 | 6 | |
| Total: | 46 | |

1. The following questions pertain to fuzzy sets and hedges. For each fuzzy set, follow the instructions.

(a) (1 point) Give “very” of the following set.

$$U = \{\{0.00, 10.00\}, \{0.20, 11.00\}, \{0.40, 12.00\}, \{0.60, 13.00\}, \{0.80, 14.00\}, \{1.00, 15.00\}\}$$

(b) (1 point) Give “extremely” of the following set.

$$V = \{\{0.00, 1.00\}, \{0.20, 2.00\}, \{0.40, 3.00\}, \{0.60, 4.00\}, \{0.80, 5.00\}, \{1.00, 6.00\}\}$$

(c) (3 points) Given $U = 11$ and $V = 4$ calculate the fuzzy operation: $\neg(U \cap V)$. Give the expansion of the fuzzy operation and the resultant fuzzy value. Use min/max operations. Use U and V from the previous problems but do not apply a hedge.

(d) (2 points) Given the following membership function, *roughly sketch* the graph of “very” x . Include axes, and labels and tick marks along the x axis.

$$\mu_x(x) = \begin{cases} x - 1 & 1 \leq x < 2 \\ 3 - x & 2 \leq x < 3 \\ 0 & \text{Otherwise} \end{cases}$$

2. This question is about monotonic inference. Consider the following rule:

IF X is A
OR Y is B
THEN Z is C

Given the following membership functions:

$$A = \{\{0.00, -3\}, \{0.20, -2\}, \{0.40, -1\}, \{0.60, 0\}, \{0.80, 1\}, \{1.00, 2\}\}$$

$$B = \{\{0.00, -20\}, \{0.50, -10\}, \{1.00, 0\}, \{0.50, 10\}, \{0.25, 20\}, \{0.00, 30\}\}$$

$$C = \{\{0.00, 10.00\}, \{0.20, 11.00\}, \{0.40, 12.00\}, \{0.60, 13.00\}, \{0.80, 14.00\}, \{1.00, 15.00\}\}$$

- (a) (2 points) Given $A = -2$ and $B = -10$, using probabilistic OR, what is the fuzzy value of C ?

- (b) (2 points) What is the crisp output of C ?

3. This question is about Sugeno inference. Consider the following rule set:

Rule 1:
IF X is A
OR Y is D
THEN Z is R

Rule 2:
IF X is B
AND Y is E
THEN Z is S

Given the following membership functions:

$$A = \{\{0.00, 3.0\}, \{0.20, 9.9\}, \{0.40, 16.7\}, \{0.60, 23.6\}, \{0.80, 30.4\}, \{1.00, 37.3\}\}$$

$$B = \{\{1.00, 3.0\}, \{0.80, 9.9\}, \{0.60, 16.7\}, \{0.40, 23.6\}, \{0.20, 30.4\}, \{0.00, 37.3\}\}$$

$$D = \{\{0.00, 22.0\}, \{0.50, 31.4\}, \{1.00, 40.9\}, \{0.50, 50.3\}, \{0.00, 59.7\}, \{0.00, 69.1\}\}$$

$$E = \{\{0.00, 22.0\}, \{0.00, 31.4\}, \{0.50, 40.9\}, \{1.00, 50.3\}, \{0.50, 59.7\}, \{0.00, 69.1\}\}$$

- (a) (4 points) Given $X = 23.6$ and $Y = 40.9$, using min/max, what is the fuzzy value of each rule?

- (b) (2 points) Given R is a singleton at -1 and S is a singleton at 1 . What is the crisp output of Z ?

4. This question is about Sugeno inference. Consider the following rule set:

Rule 1:
IF X is A
OR Y is D
OR W is F
THEN Z is R

Rule 2:
IF X is B
AND Y is E
THEN Z is S

Rule 3:
IF X is C
THEN Z is T

Given the following membership functions:

$$A = \{\{0.00, 25.0\}, \{0.20, 35.3\}, \{0.40, 45.6\}, \{0.60, 55.9\}, \{0.80, 66.1\}, \{1.00, 76.4\}\}$$

$$B = \{\{1.00, 25.0\}, \{0.80, 35.3\}, \{0.60, 45.6\}, \{0.40, 55.9\}, \{0.20, 66.1\}, \{0.00, 76.4\}\}$$

$$C = \{\{0.00, 25.0\}, \{0.25, 35.3\}, \{0.50, 45.6\}, \{1.00, 55.9\}, \{0.25, 66.1\}, \{0.00, 76.4\}\}$$

$$D = \{\{0.00, 43.0\}, \{0.50, 48.1\}, \{1.00, 53.3\}, \{0.50, 58.4\}, \{0.00, 63.6\}, \{0.00, 68.7\}\}$$

$$E = \{\{0.00, 43.0\}, \{0.00, 48.1\}, \{0.50, 53.3\}, \{1.00, 58.4\}, \{0.50, 63.6\}, \{0.00, 68.7\}\}$$

$$F = \{\{0.00, 50.0\}, \{0.20, 58.1\}, \{0.40, 66.3\}, \{0.60, 74.4\}, \{0.80, 82.6\}, \{1.00, 90.7\}\}$$

- (a) (6 points) Given $W = 90.7$, $X = 55.9$ and $Y = 68.7$, using min/max, what is the fuzzy value of each rule?
- (b) (3 points) Given R , S and T are singletons at 10, 20 and 30 respectively, what is the crisp output of Z ?

5. Consider the following table of data.

| Sample | E | H |
|--------|---|---|
| 1 | 0 | 0 |
| 2 | 1 | 1 |
| 3 | 0 | 1 |
| 4 | 0 | 1 |
| 5 | 0 | 1 |
| 6 | 0 | 0 |
| 7 | 1 | 0 |
| 8 | 1 | 1 |
| 9 | 1 | 0 |
| 10 | 0 | 1 |
| 11 | 1 | 1 |
| 12 | 0 | 0 |

(a) (2 points) Give the table of joint probabilities, the prior probability of E , and the prior probability of H .

(b) (2 points) Calculate MD.

(c) (2 points) Calculate MB.

(d) (2 points) Calculate the certainty factor.

6. The following question pertains to certainty factor inference.

(a) (2 points) Given the following rule:

```
IF test_date is soon
AND difficulty is hard
THEN study_time is alot {cf 0.75}
```

If 'soon' was asserted with 0.2 and 'hard' was asserted with 0.8, what is the certainty factor of 'alot' after the rule is fired?

(b) (2 points) Consider the rule:

```
IF book is closed_book
OR instructor is challenging
THEN study_time is alot {cf 1.00}
```

If 'closed_book' was asserted with -0.4 and 'challenging' was asserted with -0.8 , what is the certainty factor of 'alot' after the rule is fired?

(c) (2 points) If rule one fires, then rule two fires afterward, what is the final certainty factor?

7. Consider the following table of data.

| Sample | E | H |
|--------|---|---|
| 1 | 0 | 0 |
| 2 | 1 | 1 |
| 3 | 0 | 0 |
| 4 | 1 | 1 |
| 5 | 1 | 1 |
| 6 | 0 | 0 |
| 7 | 1 | 0 |
| 8 | 0 | 0 |
| 9 | 1 | 1 |
| 10 | 1 | 1 |
| 11 | 0 | 1 |
| 12 | 1 | 1 |

(a) (2 points) Give the table of joint probabilities, the prior probability of E , and the prior probability of H .

(b) (2 points) Calculate LS.

(c) (2 points) Calculate LN.

Page for scratch work, additional space to answer questions and how AI factors into your plans for global domination.

