

UNIVERSITY COLLEGE DUBLIN

NATIONAL UNIVERSITY OF IRELAND, DUBLIN

An Coláiste Ollscoile Baile Átha Cliath

Ollscoil na hEireann, Baile Átha Cliath

EXAMINATIONS, 2009

Master's Degree in Advanced Software Engineering

COMPUTER SCIENCE

Knowledge-based Industrial Systems

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Answer three of the four questions. Each is worth 20 marks. *Total marks = 60*

(Time allowed: 2 hours)

1. Diagnosis

- (a) Four students, *Tom*, *Dick*, *Harry* and *John*, undergo a blood test to detect the *Bird Flu* virus. Only *Tom* and *Harry* are infected with the virus, but the test says that only *Tom* and *John* are infected.

Relative to the test, state the *true/false-positive/negative* classification of each student.

(4 marks)

- (b) Based on our sample of four students, what is the Recall and Precision of the test in (a)

(4 marks)

- (c) Examine the following tables, of *formulas* (on the left) and of *measures* (on the right)

| <u>Formulas</u> | <u>Measures</u> |
|---|--------------------------|
| 1. $\frac{\text{number of True Positives}}{\text{number of True Positives} + \text{number of False Positives}}$ | a. Sensitivity |
| 2. $\frac{\text{number of True Positives}}{\text{number of True Positives} + \text{number of False Negatives}}$ | b. Specificity |
| 3. $\frac{\text{number of True Negatives}}{\text{number of True Negatives} + \text{number of False Negatives}}$ | c. Pos. Predictive Value |
| 4. $\frac{\text{number of True Negatives}}{\text{number of True Negatives} + \text{number of False Positives}}$ | d. Neg. Predictive Value |

For each formula (1-4), state the measure that it is used to calculate (a-d).

(4 marks)

- (d) Suppose, in addition to *Tom*, *Dick*, *Harry* and *John*, two more students *Henry* and *Joe* are also diagnosed. Both are told they are healthy, but *Henry* has the infection and does not realize it.

Calculate the value of each of the four measures in (c) above for the diagnoses offered on all six students.

(4 marks)

- (e) Of the formulas in (c) above, which best captures the following measure:

1. Recall of negative instances
2. Recall of positive instances
3. Precision on negative instances only
4. Precision on positive instances only

(4 marks)

2. Measurement and Representation

- (a) What is the generalized formula for calculating the F_β measure in information retrieval?

(3 marks)

- (b) What is the formula for average precision in IR? Why is it so useful in web search?
(3 marks)
- (c) What is the value of F_1 when $P = .6$ and $R = .9$
(2 marks)
- (d) What is the value of F_2 when $P = .6$ and $R = .9$
(2 marks)
- (e) What are the main benefits of a frame-based knowledge representation?
(2 marks)
- (f) Name the equivalent of a frame structure in RDFS.
(1 mark)
- (g) How might a spreadsheet be seen as a frame system?
(3 marks)
- (h) In what sense can the demons in a frame system be viewed as *cooperating strangers*?
(2 marks)
- (i) How do Gruber and Guarino each define an ontology?
(2 marks)

3. Annotation and Agreement

- (a) What is Cohen's Kappa measure? How is it different from the probability of agreement?
(3 marks)
- (b) An email routing application is a system that automatically classifies incoming email messages into different categories, such as Personal, Work-related, or Spam, and then places the messages into a corresponding folder. An application like this could be used to sort our personal emails from friends into a special Personal folder, our work-related emails from co-workers into a Work folder, and to dump spam emails directly into the Trash.

Which email-routing system is the best? Let's test two of them, system **R1** and system **R2**.

Both systems are used to classify the same 36 incoming emails. The emails are classified as either **Personal** (P), **Work** (W) or **Spam** (S).

Here is how **R1** and **R2** rated all 36 messages:

R1: PPWSPWSPSWSPWWPWWPPSPSSWPPWSPWPWP
R2: PSWPWWSPSWSPSWWWPPWWPWPWSPPPSPSWWSPP

Based on these agreements / disagreements, draw the contingency table for these results.
 (4 marks)

- (c) Calculate Cohen's kappa for the above data.
 (4 marks)
- (d) Why is Cohen's Kappa called a *non-inferential statistic*?
 (3 marks)
- (e) Suppose R1 is always right. What is the F_1 score of R2 at detecting spam?
 (3 marks)
- (f) Suppose R2 is always right. What is the sensitivity of R1 to work-related emails?
 (3 marks)

4. The Semantic Web

- (a) How are the conceptual terms in an ontology referenced on the semantic web?
 (2 marks)
- (b) What are the key differences between XML and RDF?
 (2 marks)
- (c) What is OWL? Name the variants of OWL, in increasing order of expressive power.
 (4 marks)
- (d) What form of description logic corresponds to each variant of OWL?
 (3 marks)
- (e) What is the difference between a `DataTypeProperty` and an `ObjectProperty`?
 (2 marks)
- (f) What is the difference between the T-Box and A-Box in description logic?
 (2 marks)
- (g) Is it possible for a property to be both inverse and functional?
 (2 marks)
- (h) In a DL-based system, the A-Box contains the statement that John's mother is Mary. What additional statements should the A-Box and T-Box contain, if any, for the system to be able to prove that John's mother is not Michelle.
 (3 marks)