

Informatics 1 - Computation & Logic: Tutorial 0

Forty Questions

Week 2: 25–29 September 2017

Please attempt the entire worksheet in advance of the tutorial, and bring all work with you. Tutorials cannot function properly unless you study the material in advance. Attendance at tutorials is **obligatory**; please let the ITO know if you cannot attend.

You may work with others, indeed you should do so; but you must develop your own understanding; you can't phone a friend during the exam. If you do not master the coursework you are unlikely to pass the exams.

This tutorial concerns finite sets, and statements that may be true or false. In preparation for your tutorial session in week 2, **watch** the [video](#) (see below), **read** §1.1–1.7 of [Mathematical Methods in Linguistics](#) ([click to download](#)) (MML), and **answer** the five questions below. (Exercises 1-4 are adapted from MML.)

Notation

\top : **true**

\perp : **false**

\emptyset : the Empty Set $\{\}$

$\{a, b, c\}$: the set with three elements, a, b, c

\mathbb{Z} : the Integers

$\{x \in A \mid P(x)\}$: the set of those x in A
that have the property P

\mathbb{N} : the Natural Numbers
(non-negative integers)

$A \subseteq B$: A is a subset of B

$a \in B$: a is a member of the set B

$A \subset B$: A is a proper subset of B

$a \notin B$: a is not a member of B

$\wp A$: powerset
the set of (all) subsets of A

Before your first tutorial please take an hour to watch Google's unconscious bias video (click on, or copy this barely legible url):

<https://rework.withgoogle.com/guides/unbiasing-raise-awareness/steps/watch-unconscious-bias-at-work/>

Questions

Bring your answers to the tutorial.

1. Given the following sets:

$$\begin{array}{lll} A = \{a, b, c, 2, 3, 4\} & D = \{b, c\} & G = \{\{a, b\}, \{c, 2\}\} \\ B = \{a, b\} & E = \{a, b, \{c\}\} & \\ C = \{c, 2\} & F = \emptyset & \end{array}$$

say whether each of the following statements is true or false:

- | | | |
|---------------------------------|----------------------------------|---|
| (a) $c \in A$ true | (g) $D \subset A$ true | (m) $B \subseteq G$ false |
| (b) $c \in F$ false | (h) $A \subseteq C$ false | (n) $\{B\} \subseteq G$ true |
| (c) $c \in E$ false | (i) $D \subseteq E$ false | (o) $D \subseteq G$ false |
| (d) $\{c\} \in E$ true | (j) $F \subseteq A$ true | (p) $\{D\} \subseteq G$ false |
| (e) $\{c\} \in C$ false | (k) $E \subseteq F$ false | (q) $G \subseteq A$ false |
| (f) $B \subseteq A$ true | (l) $B \in G$ true | (r) $\{\{c\}\} \subseteq E$ true |

2. For any arbitrary set S ,

- (a) is S a member of $\{S\}$? **yes**
- (b) is $\{S\}$ a member of $\{S\}$? **no**
- (c) is $\{S\}$ a subset of $\{S\}$? **yes**
- (d) what is the set whose only member is $\{S\}$? **$\{\{S\}\}$**

3. Write a specification by rules and one as $\{x \in \mathbb{Z} \mid P(x)\}$, for some predicate, P , for each of the following sets of integers. Remember that there is no order assumed in the list, so you cannot use words like *the first* or *the latter*. Recall also that a recursive rule may contain more than one if-then statement.

- (a) $\{5, 10, 15, 20, \dots\}$

$$\begin{array}{l} 5 \in S \\ n \in S \rightarrow n + 5 \in S \\ \{5 + 5n \mid n \in \mathbb{N}\} \end{array}$$

- (b) $\{7, 17, 27, 37, \dots\}$

$$\begin{array}{l} 7 \in S \\ n \in S \rightarrow n + 10 \in S \\ \{7 + 10n \mid n \in \mathbb{N}\} \end{array}$$

(c) $\{300, 301, 302, \dots, 399, 400\}$

$$\{n \in \mathbb{N} \mid 300 \leq n \leq 400\}$$

(d) $\{3, 4, 7, 8, 11, 12, 15, 16, 19, 20, \dots\}$

$$3 \in S, \quad 4 \in S$$

$$n \in S \rightarrow n + 4 \in S$$

$$\{n + 3 \mid n \in \mathbb{N} \wedge n \bmod 4 \leq 1\}$$

(e) $\{0, 2, -2, 4, -4, 6, -6, \dots\}$

$$0 \in S$$

$$x \in S \rightarrow 2 + x \in S$$

$$x \in S \rightarrow -x \in S$$

$$\{n \in \mathbb{Z} \mid n = 0 \pmod{2}\}$$

(f) $\{1, 1/2, 1/4, 1/8, 1/16, \dots\}$

$$1 \in S$$

$$x \in S \rightarrow x/2 \in S$$

$$\{1/2^n \mid n \in \mathbb{N}\}$$

4. How big is each of the following sets? Specify each set by listing its members:

(a) $\wp\{a, b, c\} \quad 8 = 2^3$

$$\{\}, \{a\}, \{b\}, \{c\}, \{a, b\}, \\ \{a, c\}, \{b, c\}, \{a, b, c\}$$

(d) $\wp\{\emptyset\} \quad 2 = 2^1$

$$\{\}, \{\{\}\},$$

(b) $\wp\{a\} \quad 2 = 2^1$

$$\{\}, \{a\},$$

(c) $\wp\emptyset \quad 1 = 2^0$

$$\{\}$$

(e) $\wp\wp\{a, b\} \quad 16 = 2^4 = 2^{2^2}$

(f) $\wp\wp\{a, b, c\} \quad 256 = 2^8 = 2^{2^3}$

5. In tutorials you will be in groups of five or six students, sharing a table. We want each group to try to find three (or, if necessary, more) yes/no questions that, taken together serve to distinguish every member of the group.

To prepare for this task, you should each think up six yes-no questions, that you will ask the other members of the group. For example, you might ask, *Do you have red hair?* or *Were you born in Scotland?*

You may be more imaginative, but have to take some care choosing your questions – they should be questions that everyone should be willing and able to answer truthfully with a *Yes* or *No*.

You should come to the tutorial with a print-out of this page, on which you have written your questions, and filled in the first answer column. Write your name in the space provided and make a mark in the box for each question for which your answer is *Yes*; if your answer is *No* leave the box blank.

You will be given further instructions at your tutorial.

Write questions below and names to the right.						
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Tutorial Activities

You should have five or six students at each table. If there are more than six one of you must move; if fewer than five you must steal someone from a group with six.

A number of tutors will be available to give help or advice. If at any point your group needs help please raise a hand to draw our attention.

From time-to-time, we may briefly interrupt proceedings to clarify any common confusions or misconceptions. We may also call on you to contribute.

1. Start with question 5, to help you to get to know one another.

10m First get the other students at your table to answer your questions and fill in their names and answers on your question sheet. Take turns to do this so you all hear all the questions and answers.

If anyone is uncomfortable or unable to answer any question then circle the box to show that they have not answered it. Discuss any such questions with your group.

The answers to your six questions give a six digit binary code for each student. Are all these codes different? If so we say that the questions discriminate the set of students at your table.

- 5m As a group can you think of a few inappropriate questions – ones that it would not have been good to ask?

Work together as a group to find the smallest subset of the union of all your question sets that discriminates the set of students at your table.

What makes a question good as a member of a discriminating set?

2. This is the technical part ...

4 × 5m For each of questions 1-4, split your group 2-2-2 or 2-3 (using a different split for each question) and, working in 2s or 3s, compare your answers to the question.

Discuss any differences and see if you can agree on the correct answer.

- 5m As a group, check whether you can all agree on your final answers to all four questions. If you need help raise a hand.

3. As a group, discuss the Google unconscious bias video. You should ensure that everyone's views are heard.

5m Have you any personal experience of bias? How might unconscious bias affect your activities as a group?

5m Discuss the four methods used to combat implicit bias at Google. Are they relevant to your interactions as students in Informatics? Are there any other ways you might suggest?

*This tutorial exercise sheet was written by Michael Fourman.
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