Because of the power outages, the due date has been pushed back slightly. Assignments are to be submitted by email in a plain text (ascii) attachment (not html, doc or any other format); this must be produced by editing the file “ass2.txt” which can be found in MUSO. The subject line of your email should be:

3305ass2; student id; last name, first name

where you have replaced "student id" with your student id and "last name, first name" with your last name and first name, but with "3305ass2" and semi-colons appearing as indicated. Similarly, the student declaration at the beginning of “ass2.txt” must be filled in appropriately. The assignment must be submitted from your student email account. Not following these instructions may result in the mark 0.

Whenever possible, answers are to be in the form: “Num: Ans” one per line, where “Num” is replaced by the problem number and “Ans” is replaced by the answer number. E.g., to choose answer 4 to problem 1 type “1:4”. Non-multiple choice questions should be in the form: “Num: Ans” beginning on a new line, with “Ans” free-form text until the next answer. For full submission instructions see MUSO.

Marks total 80. Note that there may be more than one correct answer. In such cases, full credit will be awarded only to responses indicating all such correct answers; use the form: “Num: Ans1, Ans2, etc.”.

Problem 1 (10 marks)

Which of the following propositional sentences below are satisfiable?

1. \((p \rightarrow q) \land (\neg q \land (\neg p \rightarrow q))\)
2. \((q \rightarrow r) \rightarrow ((p \rightarrow q) \rightarrow (p \rightarrow t))\)
3. \((p \rightarrow (p \rightarrow q))\)
4. \((p \rightarrow (q \rightarrow p))\)
5. \((\neg p \lor r) \leftrightarrow ((p \rightarrow q) \land (\neg q \rightarrow r))\)
Problem 2 (5 marks)

CNF for \((p \rightarrow q) \land (\neg q \land (\neg p \rightarrow q))\) is:

1. \((\neg p \lor q) \land \neg q \land (p \lor \neg q)\)
2. \((\neg p \lor q) \land (\neg q \lor p) \land (\neg q \lor \neg q)\)
3. \((\neg p \lor q) \land (\neg q \land (p \lor \neg q))\)
4. \((p \rightarrow q) \rightarrow ((\neg p \rightarrow q) \rightarrow q)\)

Problem 3 (5 marks)

\(X\) takes eight states with the probabilities \(\langle 0, 1/8, 1/8, 1/4, 0, 1/2, 0, 0 \rangle\). \(H(X)\) is (using log base 2):

1. \(2 \ 1/2\)
2. \(\infty\)
3. \(0\)
4. \(1 \ 3/4\)

Problem 4 (5 marks)

Identify which of the following are algorithmically random numbers:

1. \(e\)
2. \(1\)
3. \(\aleph_1\)
4. \(\pi\)
Problem 5 (5 marks)

You have a series of yes/no questions which all have probability 0.5 of either answer being correct. How many questions must be asked on average to identify one among 3.2 million Melburnians?

1. About \( \log_2 3200000 \)
2. About 12
3. About 32
4. About 22

Problem 6 (5 marks)

Let \( Y \) be a function of \( X \). Then \( H(X, Y) \) is:

1. \( H(X) + H(Y|X) \)
2. \( H(X|Y) \)
3. \( H(X) \)
4. \( H(Y, X) \)

Problem 7 (5 marks)

A coin has probability 0.4 of landing heads. What is the probability that more than five tosses will be required to get two or more heads?

1. About 0.337
2. About 0.663
3. About 0.68
4. About 0.5
Problem 8 (20 marks)

The Tower of Hanoi Problem is:

There are three pegs labeled A, B and C. A set of \( n \) disks are stacked on A in order of decreasing size. All disks are to be moved to C and stacked in the same order. Two rules must be obeyed: (1) at each turn one disk is to be moved from one peg to another, until the goal is achieved; (2) no disk may be stacked on top of a smaller disk.

1. Define (describe) the state space for this problem.
2. Define an admissible heuristic function.
3. Prove that your heuristic is admissible.

Problem 9 (10 marks)

Consider the sequence \( S = (s_1, s_2, s_3, \ldots) = \langle 010011000011110000000011111111 \ldots \rangle \) in other words, strings of 0s and 1s double in length without end.

1. For \( n > 1 \) identify bounds for \( \frac{\sum_{i=1}^{n} s_i}{n} \)
2. What is \( \lim_{n \to \infty} \frac{\sum_{i=1}^{n} s_i}{n} \)

Problem 10 (10 marks)

The Kolmogorov complexity of a string of \( n \) zeroes is:

1. A linear increasing function of \( n \)
2. Undefined
3. \( \log n \)
4. A small constant