CITS2211 Discrete Structures
Week 12 Exercises – Turing Machines

2022

For an *implementation-level description* of a Turing Machine you do not have to give a formal specification of the machine's moves, but only to explain the algorithm in English prose in terms of the series of steps the machine would use for this calculation.

1. Give a brief explanation for the following terms in the context of Turing Machines: state, input tape, move, halt, halting problem, recognise (a language), compute (a function).

2. Outline an *implementation-level description* of a Turing machine that recognises the language $(10)^*$. State any assumptions you make.

3. Write a state machine version of your Turing machine to recognise the language $(10)^*$ (as in the previous question). Show all the moves of this machine.

4. Outline an *implementation-level description* of a Turing machine that computes the function $f(n) = n - 2$ where a natural number n is represented in unary. (That means 1 represents the natural number 0, and 11 represents the natural number 1, and 111 represents the natural number 2, 1111 represents 3 and so on.)

5. Outline an *implementation-level description* of a Turing machine that acts as a "doubler". For Input: A string of 1s of length n and for Output: A string of 1s of length $2n$. Note, this machine calculates the function $f(n) = n + n$ where a natural number n is represented in unary.

6. Outline an *implementation-level description* of a Turing machine that computes the function $f(x, y) = max(x, y)$ where x and y are represented in unary number notation separated by a separator symbol $*$. The machine starts at the leftmost non-blank cell. It should leave the tape containing z in unary, where z is the maximum of x and y. Do not use any symbols other than 1, the separator $*$ and blank at any time.