Problem Set 1

Due Monday 4 March 2019

Roughly speaking, a universal Turing machine is one that can simulate the action of any Turing machine. The goal of the problems set is to give an informal description of a universal Turing machine. The first difficulty is that any universal Turing maching has only a fixed finite number of states and a fixed finite alphabet, while for Turing machines in general these sets of states and letters can be of any finite size. This entails that arbitrary Turing machines, ones with vast sets of states and letters, must be encoded in order that they can be treated as inputs to the universal Turing machine you are to devise. You should try to be explicit about how such an encoding can be done.

I suggest that you use at least 3 tapes for your universal machine: one to hold the code of the Turing machine to be simulated, one to initially hold the code of the input for the simulated machine (and during the course of the universal machine's computation, this tape might be updated). The third tape might be handing for scratch work of the universal Turing machine.

You will discover that there will be a lot of copying of codes from one place to another and a lot of shifting to open up enough space to replace codes of one size with a codes of a different size. Your write-up will be stronger if some of this is done by explicit Turing machine instructions.