

# Introduction to Computation and Complexity

## Exercise Sheet 1

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### Exercise 1

We want to implement the *shifting over* operation, that is, inserting an extra cell at the current head position. Obviously, we cannot directly edit the tape this way. Nonetheless, design  $M$  such that for  $w, w' \in \{0, 1\}^*$ ,  $wq_0w' \vdash_M^* wq_aBw'$ .

### Exercise 2

Design a Turing machine  $M$  such that  $M$  reverses its input, i.e. for  $w \in \{0, 1\}^*$ ,  $q_0w \vdash_M^* q_aw^R$ , where  $w^R$  is the reverse of the word  $w$ .

### Exercise 3

We consider the class of Turing machines with a *semi-infinite* tape. Prove informally that any Turing machine can be simulated by a Turing machine with a semi-infinite tape.

**Hint:** almost each cell of the semi-infinite tape can feature two sub-cells.