

## Homework 3–CSC 320 Summer 2015

Due in class on Tuesday July 7

1. A *TM with stay put instead of left* is similar to an ordinary TM, but the transition function has the form

$$\delta : Q \times \Gamma \rightarrow Q \times \Gamma \times \{R, S\}$$

At each step, the machine can move to the right or stay on the currently scanned square. Show that this TM model is *not* equivalent to the standard model. What class of languages does this model recognize?

2. For each of the following operations, give a high-level explanation of why the decidable languages are closed under the operation
  - (a) Concatenation
  - (b) Intersection
  - (c) Complement

3. Give a high level description of an algorithm to show that

$$L_{nb} = \{\langle M \rangle \mid M \text{ when started on the blank tape, eventually writes a nonblank symbol}\}$$

is decidable. (HINT: If  $M$  has  $m$  states, how many moves will it take before you can tell?)

4. Let  $u, v$  be strings. We will write  $u \prec v$  if  $u$  (strictly) precedes  $v$  in the standard string ordering:  $\epsilon \prec 0 \prec 1 \prec 00 \prec 01 \dots$ . An enumerator  $E$  *respects*  $\prec$  if for any strings  $u$  and  $v$  that it enumerates, if it outputs  $u$  before it outputs  $v$  then it must be the case that  $u \prec v$ . Prove the following: a language  $L$  is Turing-decidable *if and only if* it is enumerated by an enumerator that respects  $\prec$ . string orderin