DUE Monday, 10/24/16

CSCI 48400
Assignment 9-10

I. Pencil and paper work from the textbook (for Instructor)

Section 10.4 #9 There are two things to prove. In each case, describe in detail how the two sets are to be combined, don't just give an example.

Additional problem (not in text):

Notation:
f: S -> T means f is a function with domain S and codomain T

The cardinality of the set N (the set of positive integers) is $\aleph_0$. (ℵ is the first letter in the Hebrew alphabet, pronounced "aleph".)

If S and T are finite with |S| = m and |T| = n, then the number of functions f: S -> T is n^m (consult a discrete structures book). This formula applies to infinite sets as well. Hence the number of functions f: N -> N is $\aleph_0^{\aleph_0}$.

Fact: A set with cardinality $\aleph_0^{\aleph_0}$ is an uncountable set. [For you mathematicians, $\aleph_0^{\aleph_0}$ is equal to the cardinality of the power set of N, $2^{\aleph_0}$, which is also the cardinality of the set of real numbers.]

Definition: a function f is called **effectively computable** if there is an algorithm to compute the function, that is, an algorithm that, when given the value of n, allows one to compute the value of f(n).

Problem: Prove that there exist functions f: N -> N that are not effectively computable. (Note - don't ask to see such a function because how could we describe it without trying to resort to an algorithm for the mapping?)

Hint: The solution is based on material in Section 10.4.

I. Pencil and paper work from the textbook (for TA)

Section 9.1 #6 The figure in the text has an error; the transition labeled b; b, R should go from q_0 to q_2. Find some reasonable way to describe the language, and be careful.

II. Use JFLAP to solve these problems from the textbook and turn in the JFLAP files (clearly named).

The definition of a Turing machine in JFLAP allows the possibility of a Stay (S) action in addition to an L or R move. The textbook allows only L and R moves. When you create your JFLAP Turing machines do **not allow** any S moves unless you are using a multitape machine, in which case the ability to do a Stay move is sometimes really convenient, so use it there if you wish. But see page 3 about the preference file for JFLAP.

Some extra things to note - a final state cannot have any transitions, you halt when you get there. Also, for the transducer, the output is whatever is under and to the right of the read head, so you have to end up with the read head on the left end of your output string.

For testing a TM, it is often useful to use the Input/Step mode so you can see the effect of each transition.

In each of the JFLAP files, use a note field (in Attribute mode, right-click somewhere on the screen) to describe your overall "plan" for how your machine works. And turn in your screen snapshots in a Word document.

JFLAP issues: JFLAP does NOT handle nondeterministic TMs correctly; instead it seems to follow only one of the possible paths, so try to avoid nondeterminism. Also, for a multitape TM, test only using Step mode because if you use Fast Run or Multiple Run, everything gets rejected.

Section 9.1 #3, #8(d), 8(h), 11

Section 10.4 #6 Use # as the special tape symbol and label your special state as state "s".

Section 10.5 #1(a) Your solution must be an lba, so to be sure that your computation never exceeds certain bounds, although you can use multiple tapes within those bounds.

III. Problems from JFLAP Activities.pdf file

Section 2.8 #5

Section 2.9 #1 (We know from Example 8.2 that this language is not context-free.)

Hint on preference file for Jflap.

It may be that you cannot see the "Stay" option in the dropdown for direction of move in a Turing machine transition. If this is the case look at your jflapPreferences.xml file (you must open it in Notepad) to see the setting of the preference. It should be set to **true** as shown in the second snapshot below. Edit and save.

Not this

```
  <?xml version="1.0" encoding="UTF-8"?>
  <!--Created with JFLAP 6.4.-->
- <structure>
      <empty_string>u03BB</empty_string>
      <turing_final>false</turing_final>
      <undo_amount>50</undo_amount>
      <turing_accept_by_final_state>true</turing_accept_by_final_state>
      <turing_accept_by_halt>false</turing_accept_by_halt>
      <turing_allow_stay_on_transition>false</turing_allow_stay_on_transition>
  </structure>
```

but this

```
  <?xml version="1.0" encoding="UTF-8"?>
  <!--Created with JFLAP 6.4.-->
- <structure>
      <empty_string>u03BB</empty_string>
      <turing_final>false</turing_final>
      <undo_amount>50</undo_amount>
      <turing_accept_by_final_state>true</turing_accept_by_final_state>
      <turing_accept_by_halt>false</turing_accept_by_halt>
      <turing_allow_stay_on_transition>true</turing_allow_stay_on_transition>
  </structure>
```