CS 164, Spring 2015 **CS 164: Homework #2** **P. N. Hilfinger**

Due: Wednesday, 7 February 2018 at 2400

Please submit this homework electronically. See Submitting Your Work in Using Git in CS164 on the class web page.

You'll find templates for some solutions in the directory `~cs164/hw/hw2` and in the `shared` repository. Place answers to any questions that don't require programs in a file called **hw2.txt**.

Problems 1 and 2 call for the use of the **fsasim** program, which is a Python3 program that is available from your instructional account (you can download it from `~cs164/bin`; at home, you'll have to change the first line to wherever you have Python installed, or run fsasim using the `python` (or `python3`) command). There is a manual for **fsasim** available from the CS164 home page. The program is also in the `software` branch of the `shared` repository. To get it from there, we suggest you set up a separate directory (let's say `cs164-software` as an example), and use the command

```
git clone -b software cs164-taa@ashby.cs.berkeley.edu:shared cs164-software
```

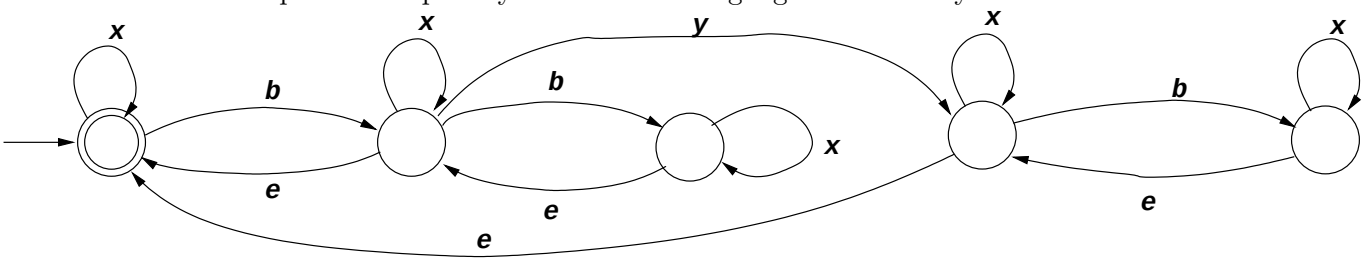
0. First, please fill out our background survey, also available on the homework page.

1. Find the simplest NFA you can for problem 2c in HW#1. Turn in a file called **2c.nfa** containing your answer in **fsasim** format.

2. Find the simplest DFA you can for problem 2c in HW#1. Turn in a file called **2c.dfa** containing your solution in **fsasim** form (see above).

3. Suppose that I have two NFAs, M_1 and M_2, recognizing the languages L_1 and L_2, respectively. Give a general algorithm for constructing an NFA that recognizes the language $L_1 - L_2$, which is the set of all strings in L_1 that are not in L_2. You don't need to write a program, just the give the algorithm in sufficient detail that a reasonable programmer could fill in the details.

4. Give the simplest description you can of the language described by the DFA below:



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5. Note #2 describes the *pumping lemma,* which says that for any FSA, there is a length M (depending on the FSA) such that for any *accepted* input string, S, where $|S| \geq M$ ($|S|$ is the length of S), S must have the form uxv for some strings u, x, and v (depending on S), where

- $|x| > 0$;
- $|ux| \leq M$; and
- the FSA also accepts *all* strings of the form $ux * v$ (that is, any number of x's can be "pumped" in between u and v and still yield an accepted string).

a. It's easy to come up with examples of FSAs that *cannot* be pumped in this fashion. Why does this not violate the theorem? Characterize the set of all such machines.

b. Given a machine, R, what is a suitable value for M?

c. Prove the pumping lemma constructively: that is, describe a procedure that, for any string S with $|S| \geq M$ (with M as determined in part b), finds suitable strings u, x, and v.

d. Use the pumping lemma to demonstrate that the set of all strings of the form yy^r (y^r is the reverse of y) is *not* recognizable by a FSA.

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6. The configuration file I use for `gitolite`, the system that maintains all our GIT repositories, contains entries that look like this:

```
repo users/cs164-xx
     RW+                = @admins
     R                  = @instructors cs164-raa
     RW  refs/tags/     = cs164-xxx
     -   refs/tags/     = cs164-xxx
     RW+                = cs164-xxx
repo teams/My_Team
     R                  = @instructors
     RW+                = cs164-ra @admins cs164-raa
     RW  refs/tags/     = @My_Team
     -   refs/tags/     = @My_Team
     RW+                = @My_Team
repo shared
     RW+                = @instructors
     R                  = @all
```

(The syntax is simplified for the purposes of this problem; in particular, blank lines are not allowed.) The file contains blocks, each starting with a `repo` line designating a repository, followed by one or more access declarations, indicating who may access what parts repository and what they may do to those parts (read, write, modify, etc.). Each clause (`repo` or access declaration) is on one line; blanks may be inserted freely; and blanks separate adjacent words. All names (of individuals and paths) can contain alphanumerics, slashes, periods, underscores, and dashes, and start with an alphanumeric. Group names ('`@`' followed by a name) may appear only after '`=`' signs in access declarations. There must be at least one entry to the right of each '`=`'. To the left of each '`=`' is one of the strings 'R', 'RW', 'RW+', or '-', followed optionally by a name (of a GIT reference, if you're curious).

Write a program using full Python regular expressions to search such a file for cases where there are (at least) two blocks with the same repository name (in their `repo` lines) and remove all but the last of these blocks, using the template file in cs164/hw/hw1/cleanup.py. You will probably want to consult the entry in the Python library reference documentation for the `re` module. To (considerably) simplify your task, it is *not* necessary that your pattern rejects syntactically invalid configurations, just as long as it works on correct ones.