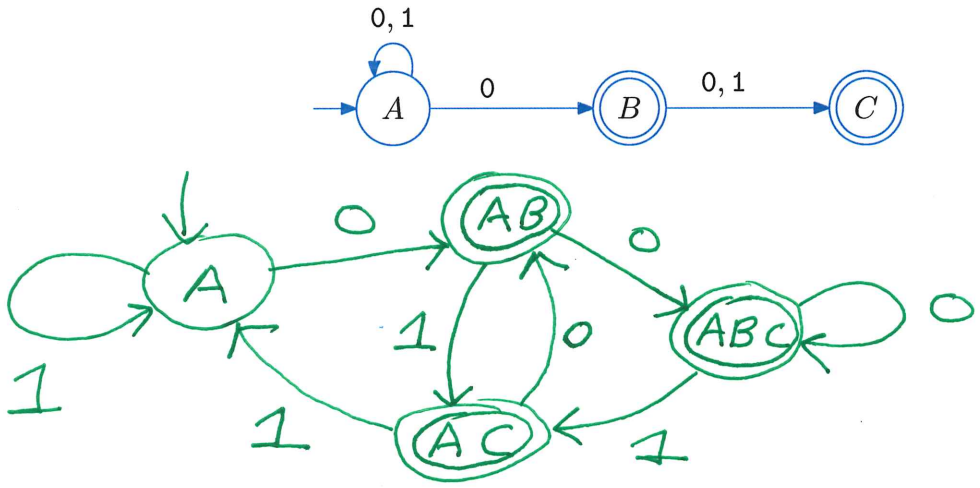
CpSc 3500 — Goddard

Warmup 2: Regular Languages and CFGs

1. Apply the **subset construction** to produce a DFA that accepts the same language as the following NFA.



2. Given a string x, an expansion of x is any string obtained by repeating each of the letters at least once. For example, both CCAATT and CCCCCCAAATT are expansions of CAT. Given a language L, the expansion of L is all possible expansions of strings in L. Describe an algorithm that, on input an FA, outputs the FA for the expansion thereof.

take FA and replace each transition with a transition to a new [reject] state and out of there with a loop! to original destination

e.g. 

3. For each language, give 3 strings that are pairwise distinguishable with respect to that language:

   (a) The set of all binary strings whose first and last bit are the same

   e.g. 00, 01, 11 [first & last bits matter]

   (b) The set of all binary strings that contain 101 as substring

   e.g. ε, 1, 10, 101 [progress on containing 101]

   (c) The set of all binary strings of odd length.

   only two possible:
   one of odd length, one of even length

4. For the alphabet $\{\mathtt{a}, \mathtt{b}\}$, give a CFG for:

   (a) the set of all strings that start and end with `abba`

$S \to abbaTabba \mid abba \mid abbabba$

$T \to aT \mid bT \mid \varepsilon$

   (b) the set of all even-length palindromes that contain `abba` as a substring.

[abba can be middle or elsewhere]

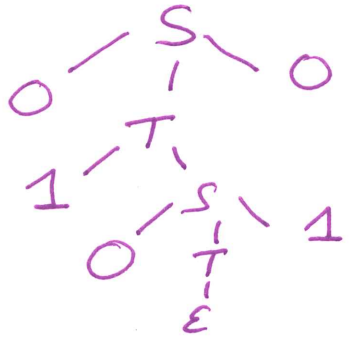
$P \to aPa \mid bPb \mid abbaQabba \mid abba$

$Q \to aQa \mid bQb \mid \varepsilon$

5. Consider the following CFG with start variable S:

$S \to 0T0 \mid 1T1 \mid 0T1 \mid 1T0 \mid \varepsilon$
$T \to 0S \mid 1S \mid \varepsilon$

   (a) Give a derivation tree for the string `01010`



   (b) Describe in English the language of this grammar.

all binary strings
except those of length 1