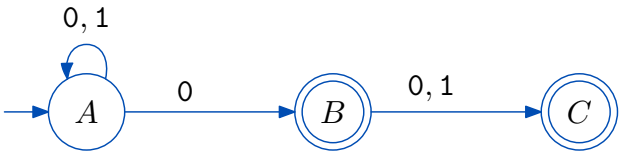
CpSc 3500 — Goddard

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.

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

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

   (c) The set of all binary strings of odd 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`

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

5. Consider the following CFG with start variable S:

   $S \to \mathtt{0}T\mathtt{0} \mid \mathtt{1}\mathtt{T}\mathtt{1} \mid \mathtt{0}T\mathtt{1} \mid \mathtt{1}T\mathtt{0} \mid \varepsilon$
   $T \to \mathtt{0}S \mid \mathtt{1}S \mid \varepsilon$

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

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