Mid-term 1
September 21, 2018

(1) (20 points) Construct a DFA that accepts precisely the strings on $\Sigma = \{a, b\}$ which do not have three consecutive identical letters. (For example, the empty string, $a$, and $aabbabbaa$ should be accepted, but $aabbabbaaa$ should not.)
(2) (16 points) Consider the following NFA. Construct a DFA that accepts the same language.
(3) (16 points) Construct an NFA that accepts precisely the strings that match the regular expression \( (aa^*b + ba)^*b + aba \).
(4) (18 points) Suppose we have a grammar $G = (V, \Sigma, S, P)$. Give the formal definition for what it means for a string $u \in \Sigma^*$ to produce the string $v \in \Sigma^*$ (using the grammar) in one step. Suppose $(A, xyAzB) \in P$ is a production. Explain why, in terms of the definition you have given, the string $yABz$ produces $yx yAzBBz$ in one step.
(5) (10 points) Give a right regular grammar (it suffices to write the production rules) that generates the language accepted by the NFA drawn below.
(6) (20 points) Given a language \( L \) on \( \Sigma = \{a, b, c\} \), let \( da(L) \) be the language consisting of all strings formed by deleting one \( a \) from a string in \( L \). (For example, if \( abaca \in L \), then that implies \( baca, abca, \) and \( abac \) are all in \( da(L) \).) Explain why, if \( L \) is regular, then \( da(L) \) must also be regular. (Hint: Given an NFA \( M \) that accepts \( L \), construct a new machine that looks like 2 copies of \( M \) connected in some way.)