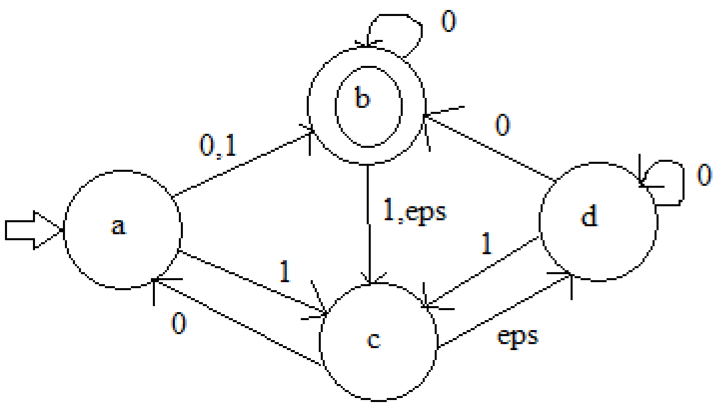
<u>COT 4210 Quiz #1B Solutions</u>

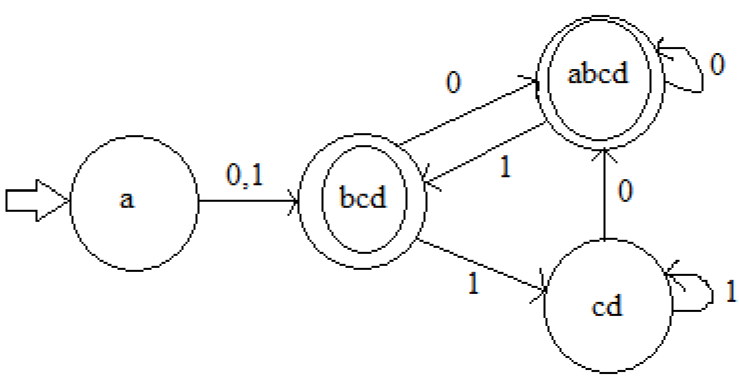
2/4/2021

4) (10 pts) Below is an NFA with states Q = {a, b, c, d}, the alphabet Σ = {0, 1}, and the start state q_0 = a. Convert this NFA to an equivalent DFA using the algorithm shown in class. Only include reachable states in your DFA. Label the states in your DFA with each letter from the subset of states it represents. For example, if one could be in state a, c or d in the NFA, please label the corresponding state in the DFA acd. Draw your DFA using the previously stated guidelines.



<u>Solution</u>

We start in the subset of states {a} because there are no epsilon transitions from the start state a. From here, though, on a 0, we can get to states b, c or d. The same is true for a 1, because we can go to state b, and then take epsilon transitions from b to c and c to d. From b, c or d, we can reach any state on a 0. But, on a 1, from b, c and d, we can only reach c and d, as there are no epsilons or 1 arrows into state b. This concludes all unique states that get reached and we can then complete all other transitions as follows:



Grading: **1 pt for start state a, 1 pt per transition arrow (8 pts total)**
1 pt for properly labeling the accept states.

5) (10 pts) Let L = { w | w contains twice as many a's as b's} be a language over the alphabet {a, b}. Using the pumping lemma, prove that L is NOT regular.

<u>Solution</u>

We will show that L is not regular by proving that L does NOT satisfy the pumping lemma for regular languages. Let p be the pumping length for the language. The pumping lemma states that for all strings of length p or greater in the language, that there exists a way to partition the string into three parts x, y and z, such that $|xy| \leq p$, $|y| > 0$ and xy^*z is an element of L.

Consider the string $s = a^{2p}b^p$. This string is in L and is of length p or greater. We will show that there exists no way to partition this string into segments x, y and z under the given restrictions such that xy^*z is always in L.

Since $|xy| \leq p$, it must be the case that $x = a^i$, $y = a^j$ and $z = a^{2p-i-j}b^p$, where $i + j \leq p$ and $j > 0$.

Now, consider the string $xz = a^i a^{2p-i-j}b^p = a^{2p-j}b^p$. According to the pumping lemma, this string must be in L. However, since $j > 0$, $2p-j < 2p$, and it follows that the string does NOT have twice as many a's and b's and hence is NOT in L.

Since we've found a string that can not be partitioned as prescribed in the pumping lemma, it follows that the language L is NOT regular.

Grading Criteria: **2 pts for picking a string of length p or greater**
2 pts for picking a string that can work
2 pts for listing all possible partitions of the string
2 pts for writing which string of the form xy^*z isn't in the language
2 pts for proving that string isn't in the language.

Max credit 1/10 if it's not clear which string is chosen.

6) (1 pt) From what country did the coffee called "Café Cubano", originate?

<u>Solution</u>

Cuba =) **1 pt give to all**