Assignment 11, Authomata Theory

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1 Problems

1.1 Problem 1

Given following languages over the alphabet $\{a, b\}$

- $L_1 = \emptyset$.
- $L_2 = \{\epsilon, aa\}$.
- $L_3 = \{\epsilon, a, aa, ab, abb\}$.
- $L_4 = \{aabb, aabbb, aa, aaa\}$.
- $L_5 = \{\epsilon, b, bbb, abab, abba, aabb\}$.
- $L_6 = \{\epsilon, bbbaa, baba, aaab, aabba, aa\}$.

1. What are the following languages:
   - $L_4 L_4$.
   - $(L_1 \cup L_2 \cup L_3)^R$.
   - $L_3 L_1 L_6$.
2. Define exponentiation as follows: $L^K = \{x \in L \mid \exists y \in K.(|y| = |x|)\}$. What are the languages $L_4^{L_5}$ and $L_6^{L_1}$.

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:- use_module(library(lists)).

concatentated_member(L1, L2, L3) :-
    member(M1, L1), member(M2, L2),
    string_concat(M1, M2, L3).

concatentated(L1, L2, L3) :-
    findall(X, concatentated_member(L1, L2, X), X),
    list_to_set(X, L3).

assignment_11a :-
    X = ["aabb", "aabbb", "aa", "aaa"],
    concatentated(X, X, Y),
    [First | Rest] = Y,
    write("$$\\{"),
    write(First),
    maplist(format(',\\allowbreak ~s'), Rest),
    write("\\}$$").
```

$\{aabbaabb, aabbaabbb, aabbaa, aabbaaa, aabbbaabb, aabbbaabbb, aabbbaa, aabbbaaa, aaaabb, aaaabbb, aaaa, aaaaa, aaaaabb, aaaaabbb, aaaaaa\}$

1.1.1 Answer 1

1. Concatenation of L_4 with itself gives: $L_4L_4 = \{aabbaabb, aabbaabbb, aabbaa, aabbaaa, aabbbaabb, aabbbaa, aabbbaaa, aaaabbb, aaaa, aaaaa, aaaaabb, aaaaabbb\}$
2. $(L_1 \cup L_2 \cup L_3)^R = \{\epsilon, a, aa, ba, bba\}$.
3. $L_3L_1L_6 = \emptyset$. This is so because there are no words in language L_1 to concatenate with.

1.1.2 Answer 2

1. $L_4^{L_5} = \{aaa, aabb\}$.
2. $L_6^{L_1} = \emptyset$.