ST0270 Formal Languages and Compilers

2024-2
Assignment 1
Finite Automata
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1 Deadline

The deadline date and time are available in the Interactiva mailbox.

2 Preliminaries

For this assignment some definitions and notions are required. Let $M = (Q, \Sigma, \delta, s, F)$ be a deterministic finite automaton (DFA).

1. **Inaccessible states.** A state $q \in Q$ is said to be **inaccessible** if there is no string $x \in \Sigma^*$ such that $\hat{\delta}(s, x) = q$.

2. **Equivalent states.** A pair of states $p, q \in Q$ is said to be **equivalent** if and only if

$$(\forall x \in \Sigma^*)(\hat{\delta}(p, x) \in F = \hat{\delta}(q, x) \in F).$$

   That is, any string x that from p allows us to access a final state, must also allows us to reach a final state from q, and vice versa.

3. We say that two states can be **collapsed** if they are equivalent.

3 Assignment

The assignment is to implement the minimization algorithm presented in Kozen 1997, Lecture 14. Given a DFA with no inaccessible states, the algorithm returns the states that are equivalent. Therefore, such states can be collapsed and we shall obtain a minimized automaton.

4 Input/output

Your program should fulfill the following specifications.

Input

A case is a DFA M with no inaccessible states.

You may assume states are denoted by natural numbers and the initial state s is always 0 (zero). Alphabets are formed with letters of the latin alphabet (with 26 letters). In ASCII code, characters from 97 to 122.

The input of the program is as follows

1. A line with a number $c > 0$ indicating how many cases you will receive.
2. For each case, in a single line the number $n > 0$ of states of M.
3. Then, a single line with the alphabet of M. Symbols are separated by a single blank space.
4. Then, the final states of M separated by blank spaces.
5. Finally, n lines, one for each state. Each line contains a row of the table that represents M. Assume that the symbols of the alphabet appear in the table in the same order as they were given in step 3. If the automaton is

	a	b
$\rightarrow 0$	1	2
1F	3	4
2	4	5
3	5	5
4F	5	5
5F	5	5

the n lines are

```
0 1 2
1 3 4
2 4 3
3 5 5
4 5 5
5 5 5
```

Output

For each case, print the pairs of states that are equivalent in lexicographical order. All the pairs in a single line separated by blank spaces.

5 Delivery

1. The homework solution is in groups of 2, and the defense is individual.
2. You must deliver the implementation compressed in a zip file on Interactiva by the deadline.
3. Additionally, provide a link to a Replit workspace with the solution, enabling editing permissions.
4. Deliver a document in English containing the following information:
    - Your full name.
    - Versions used of the operating system, programming language, and tools in your implementation to run the code without using Replit.
    - Detailed instructions for running your implementation without using Replit.
    - Do not include unnecessary files or directories in the delivery in zip.

References

[1] Kozen, Dexter C. *Automata and Computability*. Springer, Third printing, 1997 [2012]. Undergraduate Texts in Computer Science. https://doi.org/10.1007/978-1-4612-1844-9.

6 Example I/O

Input

```
4
6
a b
1 2 5
0 1 2
1 3 4
2 4 3
3 5 5
4 5 5
5 5 5
6
a b
3 4 5
0 1 2
1 3 4
2 4 3
3 5 5
4 5 5
5 5 5
6
a
1 4
0 1
1 2
2 3
3 4
4 5
5 0
4
a b
0 1
0 1 2
1 1 2
2 3 1
3 3 3
```

Output

```
(1, 2) (3, 4)
(1, 2) (3, 4) (3, 5) (4, 5)
(0, 3) (1, 4) (2, 5)
(0, 1)
```