

CENG 280

Formal Languages and Abstract Machines

Spring 2022-2023

Homework I

Due date: 26 03 2023, Sunday, 23:55

Question 1 (20 points)

State whether the following are true or false. Explain your reasoning in one sentence. In case of unclear interpretation of terms, refer to the lecture notes and recordings or the related sections from the textbook.

- a) (5 points) All real numbers can be represented as strings over the alphabet $\Sigma = \{0, 1, 2, \dots, 9\}$.
- b) (5 points) All languages are finitely representable.
- c) (5 points) $bba \in \mathcal{L} = a^*b^*a^*b^*$
- d) (5 points) $a^+b^+(a \cup b)^*$ represents the set of all strings over $\{a, b\}$ that has ab as prefix.

Question 2 (40 points)

Give a DFA that recognizes the language;

$$\{\omega \in \{a, b\}^* : \omega \text{ does NOT have } aba \text{ as a substring}\}$$

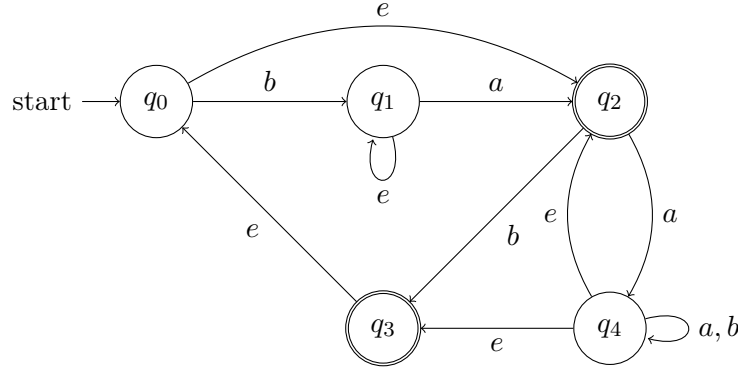
- a) (20 points) Formally define the DFA as a quintuple $M = \{K, \Sigma, \delta, s, F\}$. Give each of K, Σ, δ, s, F .
 K :
 Σ :
 s :
 F :
 δ :

- b) (20 points) For this DFA trace the input $abbaabab$ and write the computation. Does the DFA accept the input?

Question 3 (40 points)

This question adheres to the notation used in the proof of **Theorem 2.2.1** in the textbook.

a) (10 points) Consider the NFA $M = \{K, \Sigma, \Delta, s, F\}$ below. For each state $q \in K$ calculate $E(q)$.



b) (30 points) The following is a set of instructions to convert an NFA M into a DFA M' . It is known that M does not have any empty transitions from its starting state. Identify in which steps the instructions go astray. State your reasons and correct the steps.

Let $M = \{K, \Sigma, \Delta, s, F\}$ and $M' = \{K', \Sigma', \delta, s', F'\}$.

1. Define K' as the set consisting of all subsets of K .
2. Define the alphabet Σ' as precisely the set Σ .
3. Define the set of starting states, s' as the set whose only element is s .
4. Define the set of final states, F' as those elements of K' which consists of only the states $q \in F$.
5. Define the transition function δ as taking two inputs: an element Q of K' and an element a of Σ' . The function returns the set whose elements are precisely those states p in K for which there exists a $q \in Q$ and $(q, a, p) \in \Delta$.

Specifications

- **Deadline:** The deadline for this homework is strict and no late submissions will be accepted. Submission deadlines are **not** subject to postponement.
- **Grading:** “sufficiently reasonable” solutions will get full credit for the subject question, even if it is partially incorrect. Rough criteria for a solution to be sufficiently reasonable are being the student’s original answer and at least partially relying on a correct approach/method even if the application is not totally correct.
- **Cheating:** Any type of cheating or extensive collaboration is strictly prohibited. In case of cheating, the cheater’s all homeworks will be graded zero (0); further, university regulations about cheating will be applied.
- **Updates:** Follow the course page on ODTUClass for any updates and clarifications. Please ask your questions on ODTUClass instead of e-mailing if they do not contain some part of the solution. Otherwise, you can send an email to “mduyumus@ceng.metu.edu.tr” and/or “mferhata@ceng.metu.edu.tr”.

Submission

Submissions will be done via ODTUClass. You are expected to submit a single **searchable/vectorized** PDF file named “hw1.pdf”.