BU CS 332 – Theory of Computation

Lecture 9:

- Test 1 Review

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Test 1 Topics

Sets, Strings, Languages (0)

- Know the definition of a string and of a language (and the difference between them)
- Understand operations on strings: Concatenation, reverse
- Understand operations on languages: Union, intersection, concatenation, reverse, star, complement
- Know the difference between $\emptyset$ and ε

Deterministic FAs (1.1)

- Given an English or formal description of a language L, draw the state diagram of a DFA recognizing L (and vice versa)
- Know the formal definition of a DFA (A DFA is a 5 tuple…) and convert between state diagram and formal description
- Know the formal definition of how a DFA computes
- Construction for closure of regular languages under complement

Nondeterministic FAs (1.2)

- Given an English or formal description of a language L, draw the state diagram of an NFA recognizing L (and vice versa)
- Know the formal definition of an NFA
- Know the subset construction for converting an NFA to a DFA
- Proving closure properties: Know the constructions for union, concatenation, star
- Know how to prove your own closure properties

Regular Expressions (1.3)

- Given an English or formal description of a language L, construct a regex generating L (and vice versa)
- Formal definition of a regex
- Know how to convert a regex to an NFA
- Know how to convert a DFA/NFA to a regex

Limitations of DFAs (Myhill-Nerode Note)

- Understand the statements of the distinguishing set method for proving DFA size lower bounds / non-regularity
- Understand the proof of why the distinguishing set method works, and be able to use it to prove similar statements
- Know how to apply the method to specific languages
- Know how to use the distinguishing set method (Myhill-Nerode) to prove that languages are non-regular

Test format

Problem 1: “Check your type checker”

E.g., Is aabba a string, language, or a regex?

How about {ab} U {aab}?

Problem 2: True/false with **justification**

Either provide a convincing explanation or a specific counterexample

Problems 3-5(?) Homework-style problems

Study tips

- Make sure you know how to solve the problems on the practice test and are familiar with the format. The format/length of the real test will be very similar.

- If you need more practice, there are lots of problems in the book. We're happy to talk about any of these problems in office hours.

- You may bring a page of notes (writing on both sides ok) to the test. Preparing this note sheet is a great study aid.

Test tips

- You may cite without proof any result…
  - Stated in lecture
  - Stated and proved in the main body of the text (Ch. 0-1.3)
  - These include worked-out examples of state diagrams, regexes
- Not included above: homework problems, discussion problems, (solved) exercises/problems in the text

- Showing your work / explaining your answers will help us give you partial credit
- Make sure you're interpreting quantifiers (for all / there exists) correctly and in the correct order

Practice Problems

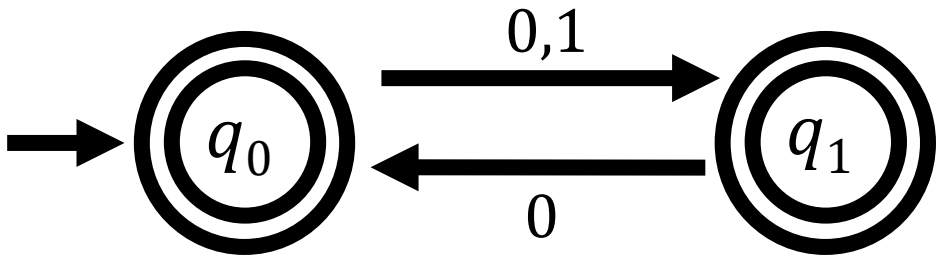
Name six operations under which the regular languages are closed

Prove or disprove: All finite languages are regular

Prove or disprove: The **non-**regular languages are closed under intersection

Give the state diagram of an NFA recognizing the language $(01 \cup 10)^* \circ 1$

Give an equivalent regular expression for the following NFA



For a language L over $\{0, 1\}$, define the operation $\mathbf{split}(L) = \{x\#y \mid x, y \in L\}$. Show that the regular languages are closed under split

For a language L over alphabet Σ, define the operation $\mathbf{drop}(L) = \{xyz \mid xyz \in L, xy \in \Sigma^*, z \in \Sigma\}$. Show that the regular languages are closed under $\mathbf{drop}$.

Is the following language regular?
$\{0^n1^n \mid 0 \leq n \leq 2024\}$

Is the following language regular? $\{a^n a^n \mid n \geq 0\}$

How many states does a DFA recognizing $\{0^n1^n \mid 0 \leq n \leq 2024\}$ require?