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 $\varepsilon$
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 power set 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
Non-regular Languages (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
• Note: I won’t ask you to show anything is non-regular, since you didn’t have any homework problems on this yet
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
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 union
Give the state diagram of an NFA recognizing the language \((01 \cup 10)^* \circ 1\)
Give an equivalent regular expression for the following NFA

\[
\begin{array}{c}
q_0 \\
\longrightarrow \\
0,1 \\
\longrightarrow \\
q_1 \\
\end{array}
\]
For a language $L$ over $\{0, 1\}$, define the operation $\text{split}(L) = \{x#y \mid x, y \in L\}$. Show that the regular languages are closed under split.
Is the following language regular? $\{a^n a^n \mid n \geq 0\}$
Is the following language regular?
\{0^n1^n \mid 0 \leq n \leq 2022\}
How many states does a DFA recognizing \( \{0^n1^n \mid 0 \leq n \leq 2022\} \) require?