CS310

Strings, String Operators, and Languages

Sections:

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Quick Review

- Sets (Union, Intersection, [Proper] Subset)

  { n | rule about n}

  Cross Product/Power Set
- Sequences/Tuples
- Functions

  $f : D \rightarrow R$
- Relation

  $f : A_1 \times A_2 \times \ldots \times A_n \rightarrow$ {TRUE, FALSE}

  Equivalence Relations: 3 conditions

Strings

- Alphabet: Any finite set, $\sum = \{a, b\}$
- String: Any finite sequence of symbols from a given alphabet

  w = ababaabba, string over $\sum$

  ε = empty string, zero symbols

  length of w: |w| = number of symbols it contains

  |ε| = |w| =
- Strings are building blocks of computer science

  strings can represent: data sets (DNA),

  source code, files…

String Operations

- Closure ($\sum^*$): set of all strings over $\sum$, including ε.

  $\sum = \{a, b\}$ $\sum^* = \{\varepsilon, a, b, ab, ba, aa, bb, \ldots\}$

- Concatenations

  If x,y ϵ $\sum^*$, then xy is defined to the be concatenation of strings x, y

  x=aba y=bab xy=

  x^k is k copies of x concatenated

  x^2 =

String Operations

- Prefix/Suffix

  $z = xy$ for $x,y,z \in \Sigma^*$, x is a prefix of z

  y is a suffix of z

- Reverse

  $x \in \Sigma^*$, x^R is the reverse of x

  $x = ab$, $x^R = ba$

Languages

- Language

  Language L over $\sum$ is a subset of $\sum^*$

  $L = \{ x \in \{a,b\}^* \mid |x| \text{ is even} \}$

  $= \{\varepsilon, aa, ab, \quad , \quad \}$

- Complement of a language L over $\sum$

  $\sum^* - L = L'$

- Concatenation of languages

  L_1 and L_2 over $\sum$

  $L_1L_2 = \{xy \mid x \in L_1, y \in L_2\}$

  $L^2 = LL$

Languages

- Union of languages

  L_1 and L_2 over $\sum$

  $L_1 \cup L_2 = \{x \mid x \in L_1 \text{ or } x \in L_2\}$

  L1 = {0}*

  L2 = {1}*

  what is in $L_1 \cup L_2$?

  what is in $L_1 L_2$?

Languages

- Kleene Star

  L* = set of strings formed by concatenating any number of strings from L

  L = { x ϵ { a, b}* | |x| is odd}

  What does L contain:

  { }

  L* = {ε, , , }

Languages

- Recursive Definitions

  Define L over $\sum = \{0,1\}$ as

  1. $\varepsilon \in L$
  2. If $x \in L$ then $0x1 \in L$

  What is in L? L= { }

- Can we prove that {ε,01,0011,000111,…} is equivalent to $\{0^i1^i \mid i>=0\}$?
- Show L is subset of $\{0^i1^i \mid i>=0\}$ and the reverse

Proof

- For x,y ϵ $\sum^*$, show $(xy)^R = y^R x^R$