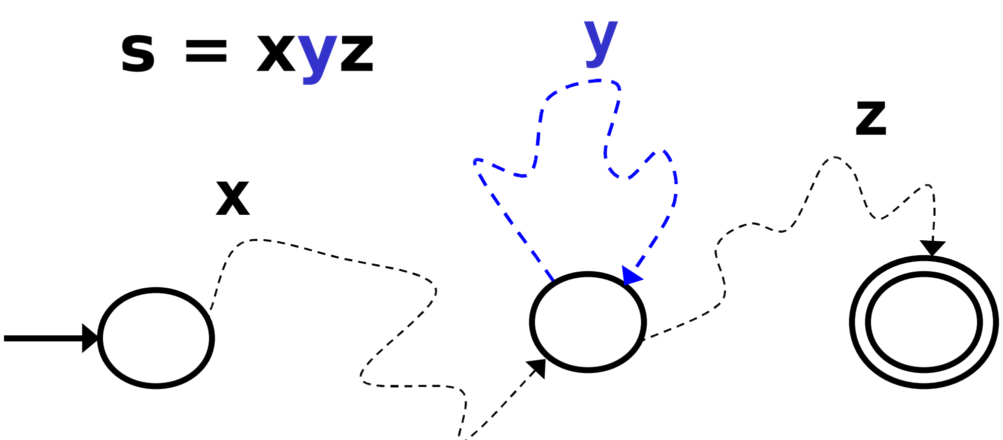
CS310

Pumping Lemma

Oct 22, 2008

Quick Review

- Pumping Lemma
- If A is a regular language, then there is a number p where, if s is any string in A of length at least p, then s may be divided into three pieces, s = xyz, satisfying the following conditions:



1. $i >= 0, xy^iz \in L(M)$
2. $|y| > 0$ (x, z may be ε)
3. $|xy| <= p$

Motivation

- This is a regular language:

  1^*00

  How do we know it is regular?

  Draw a DFA

  Find a string, s, whose length is >= p

  $p = |Q|$

  Determine: $s = xyz$

  What is y? Where is the unbounded repetition?

1. $i >= 0, xy^i z \in L(M)$
2. $|y| > 0$
3. $|xy| <= p$

Regular vs Non-Regular

$\{\ 1^* \ \}$

$\{\ 1^*0^* \ \}$

$\{\ 1^n \mid n \geq 0 \ \}$

$\{\ 0^n1^n \mid n \geq 0 \ \}$

Examples Galore!

- $L = \{ a^n b^m : m > n \}$
- $L = \{ a^n b^m : m < n \}$
- $L = \{ a^n b^m : m == n \}$
- $L = \{ a^{2*n} : n > 0\}$
- $L = \{ a^n : n \text{ is prime } \}$
- $L = \{ a^n b^m c^{n+m} : n, m > 0 \}$
- $L = \{ a^n b a^n : n >= 0 \}$
- $L = \{wbbw \mid w \in \{a, b\}^*\}$
- $L = \{ (ac)^n b^m : n > m >= 0 \}$
- $L = \{ a^n b^m : m, n >0 \}$

Show for each language:

- A string that does pump
- A string that does not pump
- Are any of these languages regular?
  Can we write any of them as a regular expression?

How many are CFL?