CSE 322

Exam Reviews

Basic Concepts

- Formal Languages
  - Alphabet (Σ)
  - String (Σ*)
  - Length (|x|)
  - Empty String (ε)
  - Empty Language (∅)

- Language/String Operations
  - "Regular" Operations:
    - Union (∪)
    - Concatenation (•)
    - (Kleene) Star (*)
  - Other:
    - Intersection
    - Complement
    - Reversal
    - Shuffle
    - ...

Finite Defns of Infinite Languages

- English, mathematical
- DFAs
  - States
  - Start states
  - Accept states
  - Transitions (δ function)
  - M accepts w ∈ Σ*
  - M recognizes L ⊆ Σ*

- Nondeterminism
- NFAs
  - Transitions (δ relation)
    - Missing out-edges
    - Multiple out-edges
    - ε-moves
  - N accepts w ∈ Σ*
  - N recognizes L ⊆ Σ*
- Regular Expressions
  - ∅ , ε, a ∈ Σ, ∪, •, * , ( )
- GNFAs

Key Results, Constructions, Methods

- L is regular iff it is:
  - Recognized by a DFA
  - Recognized by a NFA
  - Recognized by a GNFA
  - Defined by a Regular Expr

Proofs:

GNFA → Reg Expr

(Kleene/Floyd/Warshall: R_{ik} R_{kk}* R_{kj})

Reg Expr → NFA

(join NFAs w/ ε-moves)

NFA → DFA

(subset construction)

DFA → GNFA

(special case)

- The class of regular languages is closed under:
  - Regular ops: union, concatenation, star
  - Also: intersection, complementation, (& reversal, prefix, no-prefix, …)
- NOT closed under ⊆, ⊇
- Also: Cross-product construction (union, …)

Applications

- “globbing”
  - lpr   *.txt
- pattern-match searching:
  - grep “Ruzzo.*terrific” *.txt

- Compilers:
  - Id ::= letter (letter|digit)*
  - Int ::= digit digit*
  - Float ::=
    d d* . d* (ε | E d d*)
  - (but not, e.g. expressions with nested, balanced parens, or variable names matched to declarations)
- Finite state models of circuits, control systems, network protocols, API’s, etc., etc.