CS 3100, Models of Computation, Fall 2019, Lec 8

Ganesh Gopalakrishnan
School of Computing
University of Utah
Salt Lake City, UT 84112

bit.ly/3100f19Syllabus

SCHOOL OF COMPUTING
THE UNIVERSITY OF UTAH

Designing a DFA (General)

- DFA are simplified C / Java programs with finite states

```
state = I  or IF
 While(True) {
  switch state {
  case 'IF' :     switch input {
                   case '0' :  state = ...update it...
                   case '1' :  state = ...update it...
                    }
   case 'A' : ...

  }
 }
```

- More realistic programs are modeled by PDA and <u>all programs</u> are modeled by TM

Why NFA? Many answers!

1. Invented to overcome the limitations of a DFA
    - For some regular languages (that have a DFA), the DFA are **exponentially big**
    - **In many of those cases, an NFA will be linear / polynomial in size**
    - **Therefore reduces tedium (for humans) to specify**
    - **This use of NFA also turns into a syntactic approach called Regular Expressions**

2. **Nondeterminism is a fundamental idea in CS**
    - **Allows us to classify algorithms into "easy" (P) and "hard" (NP)**

Features of an NFA

- Finite states
- Multiple initial states
    - Can begin in any initial state
- Transitions on Sigma
- Transitions also on Epsilon
    - Recall that Epsilon is not in Sigma
- Transitions lead to sets of next states
- Has final states (like before)
- Acceptance:
    - Begin at any initial state
    - A journey described by a string (laden perhaps with Epsilon)
    - Ends in a final state

Two NFA designs for “third last is a 1”

NFA have equivalent DFA - Subset Construction (function nfa2dfa)

- Bascially for each NFA that is in a set of states {S1,S2,S3}
  - For example we assume a set of 3 states an NFA is in.
- First E-close {S1,S2,S3}
  - Let S1 go to S11, S12 on ‘’
  - Let S2 go to S21 on ‘’
  - Let S3 go on S31, S32, S33 on ‘’
  - E-closure ({S1,S2,S3}) = {S11,S12,S21,S31,S32,S33}
- Fire a symbol, say a in Sigma from each of S11, S12,…S33
- Let the resulting SET OF STATES be
  - S11’, S12’, …. , S33’ (these are SETS of states)
- Take a set union of S11’, S12’, …, S33’
  - E-close that state.
- This is what {S1,S2,S3} transitions to, upon an “a” in Sigma
- Do this for Book77 NFA
- Do this for “third last is a 1” NFA

Book’s Figure 7.7 NFA : Write in Jove’s markdown in 2 ways, then convert to DFA via Subset Construction