Welcome to 01418333 Formal Language and Automata Theory

Why Study Automata?

The slides are created by Jeffrey D. Ullman
http://infolab.stanford.edu/~ullman/ialc/spr10/spr10.html#LECTURE

How Could That Be?

- Regular expressions are used in many systems.
  - E.g., UNIX a.*b.
  - E.g., DTD's describe XML tags with a RE format like person (name, addr, child*).

*.txt

- Finite automata model protocols, electronic circuits.
  - Theory is used in *model-checking*.

CFG

How? – (2)

if (___)

if a > b

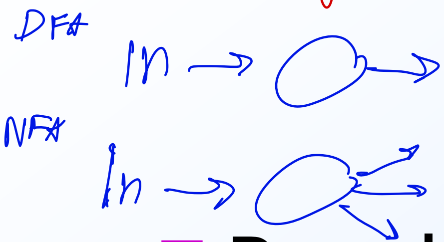
grammar ของหลักการ ภาษา

- Context-free grammars are used to describe the syntax of essentially every programming language.
    - Not to forget their important role in describing natural languages.
- And DTD's taken as a whole, are really CFG's.

How? – (3)

- When developing solutions to real problems, we often confront the limitations of what software can do.
  - แก้ไม่ได้
    Undecidable things – no program whatever can do it.
  - แก้ได้ แต่นาน
    Intractable things – there are programs, but no fast programs.

ปากต่อออกหลายทาง



Course Outline

เดียว
รับ Input มา ต้องได้ผลลัพธ์แน่นอน

FA < DFA, NFA

- Regular Languages and their descriptors:

NFA รับ Input เดียว ได้หลาย output

FA

  - Finite automata, nondeterministic finite automata, regular expressions.
  - Algorithms to decide questions about regular languages, e.g., is it empty?
  - Closure properties of regular languages.

Course Outline – (2)

CFL

- Context-free languages and their descriptors:
  - CFG
  - Context-free grammars, pushdown automata.
  - Decision and closure properties.

Course Outline – (3)

- Recursive and recursively enumerable languages.
  - Turing machines, decidability of problems.
  - The limit of what can be computed.
- Intractable problems.
  - Problems that (appear to) require exponential time.
  - NP-completeness and beyond.

Text

- Hopcroft, Motwani, Ullman, *Automata Theory, Languages, and Computation* 3rd Edition.
- Course covers essentially the entire book.

Finite Automata

Motivation
An Example

The slides are created by Jeffrey D. Ullman
http://infolab.stanford.edu/~ullman/ialc/spr10/spr10.html#LECTURE

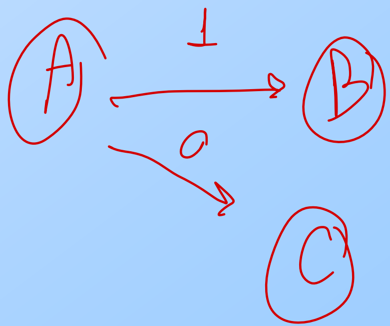
Informal Explanation

- Finite automata are finite collections of states with transition rules that take you from one state to another.
- Original application was sequential switching circuits, where the "state" was the settings of internal bits.
- Today, several kinds of software can be modeled by FA.

Representing FA

- Simplest representation is often a graph.
  - Nodes = states.
  - เส้นเชื่อม
    Arcs indicate state transitions.
  - Labels on arcs tell what causes the transition. input

A → B



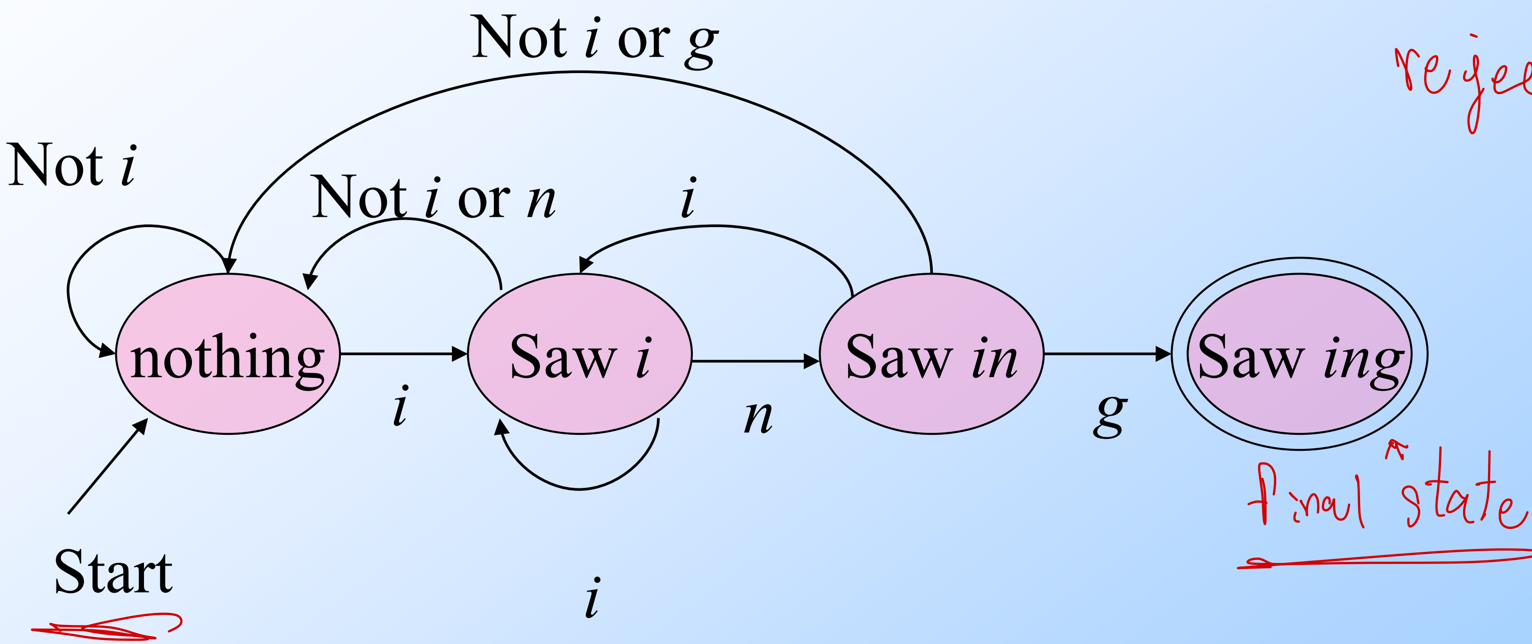
Example: Recognizing Strings Ending in "ing"

Being ✓

accept ✓

reject ✗

Accept and Final state can be multiple but start must have only one



play → reject

ingby → reject

HW

วาด State หลาย เส้นให้ ครบ. ทดอีกไปตกด้วย.

Automata to Code

- In C/C++, make a piece of code for each state. This code:
  1. Reads the next input.
  2. Decides on the next state.
  3. Jumps to the beginning of the code for that state.

Example: Automata to Code

```
2: /* i seen */
  c = getNextInput();
  if (c == 'n') goto 3;
  else if (c == 'i') goto 2;
  else goto 1;
3: /* "in" seen */
  . . .
```

Automata to Code – Thoughts

- How would you do this in Java, which has no goto?
- You don’t really write code like this.
- Rather, a code generator takes a “regular expression” describing the pattern(s) you are looking for.
  - Example: `.*ing` works in grep.

Example: Protocol for Sending Data