CSE322
Chomsky classification

Lecture #14

Chomsky's four types of grammars

- Type-0 grammars (unrestricted grammars)

  languages recognized by a Turing machine
- Type-1 grammars (context-sensitive grammars)

  Turing machine with bounded tape
- Type-2 grammars (context-free grammars)

  non-deterministic pushdown automaton
- Type-3 grammars (regular grammars)

  regular expressions, finite state automaton

Grammars, Languages, Machines

Type-0		
Recursively enumerable	Turing machine	No restrictions
Type-1		
Context-sensitive	Linear-bounded non-deterministic Turing machine	$\alpha A \beta \rightarrow \alpha \gamma \beta$
Type-2		
Context-free	Non-deterministic pushdown automaton	$A \rightarrow \gamma$
Type-3		
Regular	Finite state automaton	$A \rightarrow aB$ $A \rightarrow a$

PROBLEM

Find the highest type number which can be applied to the following productions:

(a) $S \rightarrow Aa, \quad A \rightarrow c \mid Ba, \quad B \rightarrow abc$

(b) $S \rightarrow ASB \mid d, \quad A \rightarrow aA$

(c) $S \rightarrow aS \mid ab$

Solution

(a) $S \rightarrow Aa$, $A \rightarrow Ba$, $B \rightarrow abc$ are type 2 and $A \rightarrow c$ is type 3. So the highest type number is 2.

(b) $S \rightarrow ASB$ is type 2, $S \rightarrow d$, $A \rightarrow aA$ are type 3. Therefore, the highest type number is 2.

(c) $S \rightarrow aS$ is type 3 and $S \rightarrow ab$ is type 2. Hence the highest type number is 2.