

Context-Free Grammars

Atri Rudra

May 3, 2006

Announcements

- Pick up solutions to H/W #4
- (Hopefully) graded H/W #4 would be handed out tomorrow
- Extra copies of solutions to H/W #1-3

Midterm exam

- This Friday, May 5th, in class
- Review session on Thursday May 4th, 4:30pm
 - Location : TBA
- Exam is closed book and closed notes, except
 - One 8 1/2" X 11" review sheet
 - You can use **only one side**
 - Do not spend all your time cramming stuff into the sheet

Puzzle

- Design a context free grammar for the following language
- Set of all string composed of (and) such that they are properly nested parens except
 - There is *exactly* one extra (
- For example, () (, () (()) should be generated but not (() (())) or (((

Last lecture

- Context Free Grammars
- Context Free Languages
- Derivation/ Parse Tree

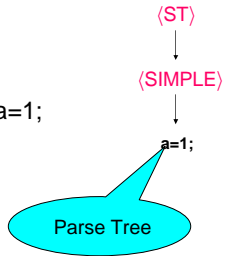
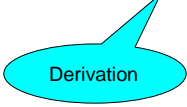
Segment of simplified C grammar

- $\langle ST \rangle \rightarrow \langle SIMPLE \rangle \mid \langle FOR-ST \rangle$
- $\langle FOR-ST \rangle \rightarrow \text{for condition } \{ \langle ST \rangle \}$
- $\langle SIMPLE \rangle \rightarrow a=1;$

Derivation/ Parse trees

$\langle \text{ST} \rangle \rightarrow \langle \text{SIMPLE} \rangle \mid \langle \text{FOR-ST} \rangle$
 $\langle \text{FOR-ST} \rangle \rightarrow \text{for condition } \{ \langle \text{ST} \rangle \}$
 $\langle \text{SIMPLE} \rangle \rightarrow a=1;$

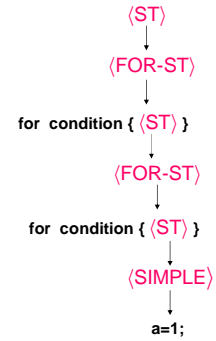
■ $\langle \text{ST} \rangle \Rightarrow \langle \text{SIMPLE} \rangle \Rightarrow a=1;$



Another example

$\langle \text{ST} \rangle \rightarrow \langle \text{SIMPLE} \rangle \mid \langle \text{FOR-ST} \rangle$
 $\langle \text{FOR-ST} \rangle \rightarrow \text{for condition } \{ \langle \text{ST} \rangle \}$
 $\langle \text{SIMPLE} \rangle \rightarrow a=1;$

■ for condition{
for condition{
a=1;}}



Questions ?

Formal definition

- $G = \langle V, \Sigma, R, S \rangle$
 - V : set of variables
 - Σ : set of terminals
 - $S \in V$: start variable
 - R : collection of rules
 - A rule is of the form $\langle \text{LHS} \rangle \rightarrow \langle \text{RHS} \rangle$
 - $\langle \text{LHS} \rangle \in V$
 - $\langle \text{RHS} \rangle \in (\Sigma \cup V)^*$

An example

■ $\langle \text{ST} \rangle \rightarrow \langle \text{SIMPLE} \rangle \mid \langle \text{FOR-ST} \rangle$
 ■ $\langle \text{FOR-ST} \rangle \rightarrow \text{for condition } \{ \langle \text{ST} \rangle \}$
 ■ $\langle \text{SIMPLE} \rangle \rightarrow a=1;$

■ $V = \{ \langle \text{ST} \rangle, \langle \text{SIMPLE} \rangle, \langle \text{FOR-ST} \rangle \}$
 ■ $\Sigma = \{ \text{for, condition, } \{, \}, a=1; \}$
 ■ $S = \langle \text{ST} \rangle$

Derivation

- Given $u, v, w \in (V \cup \Sigma)^*$ and rule $A \rightarrow w$
- uAv yields uwv
 - $uAv \Rightarrow uwv$
- u derives v if
 - $u = v$, or
 - $u \Rightarrow u_1 \Rightarrow u_2 \dots \Rightarrow u_k \Rightarrow v$, for some $k \geq 0$
 - Denoted by $u \Rightarrow^* v$

0 or more applications of \Rightarrow

An example

$\langle \text{ST} \rangle \rightarrow \langle \text{SIMPLE} \rangle \mid \langle \text{FOR-ST} \rangle$
 $\langle \text{FOR-ST} \rangle \rightarrow \text{for condition } \{ \langle \text{ST} \rangle \}$
 $\langle \text{SIMPLE} \rangle \rightarrow a=1;$

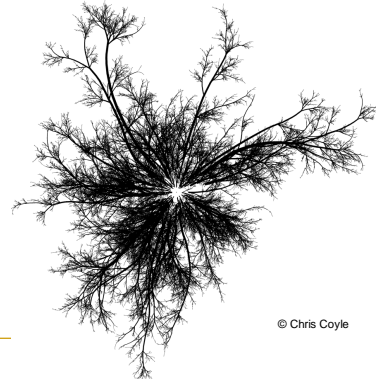
- $\langle \text{ST} \rangle \Rightarrow^*$ for condition{a=1;}
- $\langle \text{ST} \rangle \Rightarrow \langle \text{FOR-ST} \rangle \Rightarrow \text{for condition } \{ \langle \text{ST} \rangle \}$
 $\Rightarrow \text{for condition } \{ \langle \text{SIMPLE} \rangle \}$
 $\Rightarrow \text{for condition } \{ a=1; \}$

Using the formal definition

$$L(G) = \{ w \in \Sigma^* \mid S \Rightarrow^* w \}$$

Questions ?

Let's look at a picture



© Chris Coyle

Any ideas as to how it was generated ?

- Context Free Grammar !
- Tool called Context Free Design Grammar
 - Chris Coyne
 - <http://chriscoyne.com/cfdg/>
- a **startshape**; this is just the name of an object you make up
- **rules for growth**; you can replace any object with any other objects, at **relative** positions, orientations, colors, brightnesses, and sizes.
- **circles** and **squares**; they are special objects and they are drawn rather than replaced.

Thus ends...

- My first set of slides without any silly pictures