Lecture 12

Syntax Analysis

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Take aways from the last class

- Applying symbols to state

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- Goto Operations

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- Sets of Item

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- Sets of Item
- Limitations of SLR Parser
- Closure operation on LR(1)

Example

- Consider the following grammar
  $S' \rightarrow S$
  $S \rightarrow CC$
  $C \rightarrow cC|d$
- Compute closure(I) where $I = [S' \rightarrow .S, \quad \$]$
  $S \rightarrow .S, \quad \$$
  $S \rightarrow .CC, \quad \$$
  $C \rightarrow .cC, \quad c$
  $C \rightarrow .cC, \quad d$
  $C \rightarrow .d, \quad c$
  $C \rightarrow .d, \quad d$

Example

Construct sets of LR(1) items for the grammar on previous slide

- $I_0 : S \rightarrow .S, \$$
  $S \rightarrow .CC, \$$
  $C \rightarrow .cC$, c/d
  $C \rightarrow .d$, c/d
- $I_1 : goto(I_0, S)$
  $S' \rightarrow S.,\$$
- $I_2 : goto(I_0, C)$
  $S \rightarrow C.C,\$$
  $C \rightarrow .cC,\$$
  $C \rightarrow .d,\$$
- $I_3 : goto(I_0, c)$
  $C \rightarrow c.C$, c/d
  $C \rightarrow .cC$, c/d
  $C \rightarrow .d$, c/d
- $I_4 : goto(I_0, d)$
  $C \rightarrow d.$, c/d
- $I_5 : goto(I_2, C)$
  $S \rightarrow CC.,\$$
- $\mathrm{I}_6 : goto(I_2, c)$
  $C \rightarrow c.C,\$$
  $C \rightarrow .cC,\$$
  $C \rightarrow .d,\$$
- $I_7 : goto(I_2, d)$
  $C \rightarrow d.,\$$
- $I_8 : goto(I_3, C)$
  $C \rightarrow cC.$,c/d
- $I_9 : goto(I_6, C)$
  $C \rightarrow cC.,\$$

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- If $[S' \rightarrow S., \$]$ is in I_i then `action[i,$] = accept`
- If $goto(I_i, A) = I_j$ then `goto[i,A] = j` for all non terminals A

Parse table

State	c	d	$	S	C
0	s3	s4		1	2
1			acc		
2	s6	s7			5
3	s3	s4			8
4	r3	r3			
5			r1		
6	s6	s7			9
7			r3		
8	r2	r2			
9			r2		

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due to more number of states in CLR, it is memory inefficient.
Decrease number of states in LALR

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- Merge LR(1) items having the same core

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- Construct action table as was done earlier
- Let $J = I_1 \cup I_2 \cdots \cup I_k$
  since $I_1, I_2 \cdots, I_k$ have same core, $goto(J, X)$ will have the same core
  Let $K = goto(I_1, X) \cup goto(I2, X) \cdots goto(I_k, X)$ the $goto(J, X) = K$

LALR parse table ...

State	c	d	$	S	C
0	s36	s47		1	2
1			acc		
2	s36	s47			5
36	s36	s47			89
47	r3	r3	r3		
5			r1		
89	r2	r2	r2		

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  - Assume states $[X \rightarrow \alpha., a], [Y \rightarrow \alpha., b] and [X \rightarrow \alpha., b], [Y \rightarrow \alpha., a]$

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and CLR have more number of states than LALR | SLR...
states (CLR) >= states (LALR) = states (SLR)

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LR means CLR by default.

- LALR parser can have new reduce-reduce conflicts
  - Assume states $[X \rightarrow \alpha., a], [Y \rightarrow \alpha., b] and [X \rightarrow \alpha., b], [Y \rightarrow \alpha., a]$
  - Merging the two states produces $[X \rightarrow \alpha., a/b], [Y \rightarrow \alpha., a/b]$

there are two reduce possibilities when a/b comes in input when this state is at top of stack,

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  - LL(k) $\leq$ LR(k)

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errors will not arise from goto table

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  - stack the state $goto[S, A]$ and resume parsing.
- Choice of A: Normally these are non terminals representing major program pieces such as an expression, statement or a block. For example if A is the nonterminal stmt, a might be semicolon or end

Parser Generator

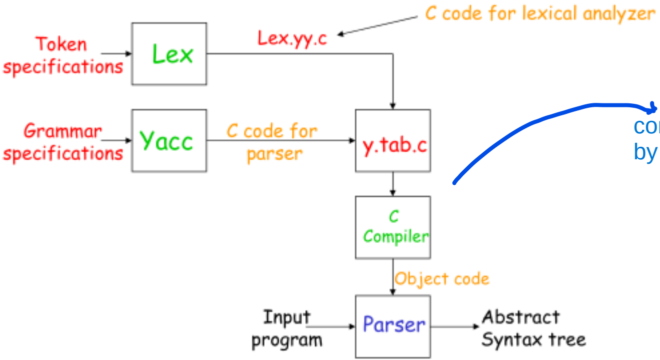
- Some common LR parser generators
  - YACC: Yet Another Compiler Compiler
  - Bison: GNU Software

by default, they generate LALR parsers.

- Yacc/Bison source program specification (accept LALR grammars)

declaration
%%
translation rules
%%
supporting C routines

Yacc and Lex schema



compile both y.tab.c (parser) and lex.yy.c (lexer) by using G++ or GCC.