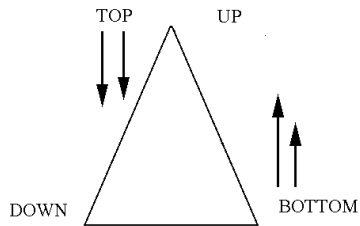


Bottom-Up Parsing

Brian Malloy
Clemson University
School of Computing



Resources

Introduction

Shift-Reduce Parsing

Conflicts



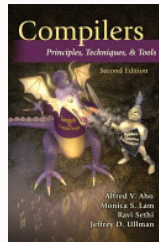
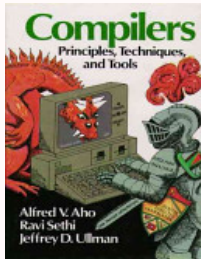
Slide 1 of 10

Go Back

Full Screen

Quit

1. Resources



Bison

The Incompatible Parser Generator
10 October 2013, Bison Version 3.0.2

by Charles Donnelly and Richard Stallman



Resources

Introduction

Shift-Reduce Parsing

Conflicts



Slide 2 of 10

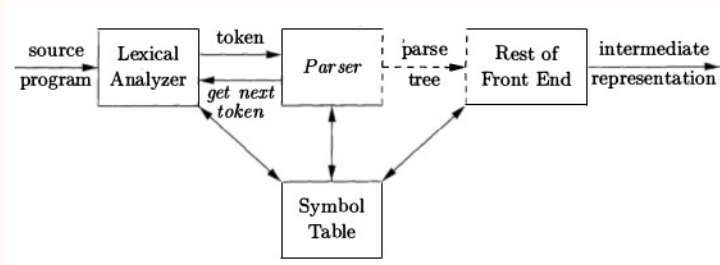
Go Back

Full Screen

Quit

2. Introduction

- The goal of parsing: recognize sentences.



Resources

Introduction

Shift-Reduce Parsing

Conflicts



Slide 3 of 10

Go Back

Full Screen

Quit

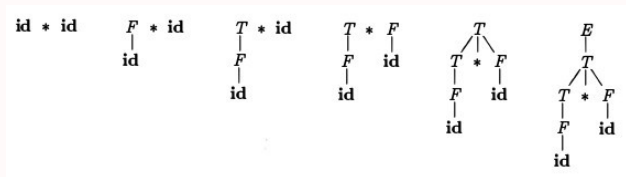


2.1. Bottom-Up Parsing

- A bottom-up parser builds a parse tree by starting at the leaves and works to the root:

Left to right scan of input, right-most derivation in reverse. (p. 235, dragon)

- The parse tree is likely implicit.
- Consider a parse of $\text{id} * \text{id}$ (p. 234 dragon):



Resources

Introduction

Shift-Reduce Parsing

Conflicts



Slide 4 of 10

Go Back

Full Screen

Quit



3. Shift-Reduce Parsing

- A stack holds grammar symbols
- Input buffer holds rest of string to be parsed
- \$ marks bottom of stack & end of input
- handle always appears on top of stack
- rightmost derivation: try to reduce a sub-string (handle) back to a non-terminal.

Resources

Introduction

Shift-Reduce Parsing

Conflicts



Slide 5 of 10

Go Back

Full Screen

Quit



3.1. What's a **handle**?

- substring that matches the rhs of a production

$$\begin{aligned} E &\rightarrow E + T \mid T \\ T &\rightarrow T * F \mid F \\ F &\rightarrow (E) \mid \text{id} \end{aligned}$$

RIGHT SENTENTIAL FORM	HANDLE	REDUCING PRODUCTION
$\text{id}_1 * \text{id}_2$	id_1	$F \rightarrow \text{id}$
$F * \text{id}_2$	F	$T \rightarrow F$
$T * \text{id}_2$	id_2	$F \rightarrow \text{id}$
$T * F$	$T * F$	$E \rightarrow T * F$

Resources

Introduction

Shift-Reduce Parsing

Conflicts



Slide 6 of 10

Go Back

Full Screen

Quit



3.2. Shift-Reduce: How it works

- Initially, stack is empty, w is entire input

STACK	INPUT
\$	w \$

- During left to right scan of input, parser:
 - shifts zero or more input symbols onto stack,
 - until it can reduce a string β to appropriate non-terminal
 - Repeat until: error or only start symbol on stack

Resources

Introduction

Shift-Reduce Parsing

Conflicts



Slide 7 of 10

Go Back

Full Screen

Quit

3.3. Example of s/r Parsing

$$\begin{aligned} E &\rightarrow E + T \mid T \\ T &\rightarrow T * F \mid F \\ F &\rightarrow (E) \mid \text{id} \end{aligned}$$

STACK	INPUT	ACTION
\$	id₁ * id₂ \$	shift
\$ id₁	* id₂ \$	reduce by $F \rightarrow \text{id}$
\$ F	* id₂ \$	reduce by $T \rightarrow F$
\$ T	* id₂ \$	shift
\$ T *	id₂ \$	shift
\$ T * id₂	\$	reduce by $F \rightarrow \text{id}$
\$ T * F	\$	reduce by $T \rightarrow T * F$
\$ T	\$	reduce by $E \rightarrow T$
\$ E	\$	accept

Resources

Introduction

Shift-Reduce Parsing

Conflicts



Slide 8 of 10

Go Back

Full Screen

Quit



3.4. Shift-Reduce Operations

- **shift:** shift next input symbol on top of stack; handle is always on top of stack, never inside → **stack**
- **reduce:** locate left end of string on stack, replace with non-terminal rhs
- **accept:** successful completion of parse
- **error:** Discover a syntax error; call error recovery routine

Resources

Introduction

Shift-Reduce Parsing

Conflicts



Slide 9 of 10

Go Back

Full Screen

Quit

4. Conflicts

- There are cfgs for which s/r parsing cannot be used
- **shift/reduce conflict:** The parser can reach a configuration in the grammar where it cannot decide to shift or reduce
- **reduce/reduce conflict:** The parser can reach a configuration in the grammar where it cannot decide which of several reductions
- An ambiguous grammar is not an LR grammar.



Resources

Introduction

Shift-Reduce Parsing

Conflicts



Slide 10 of 10

Go Back

Full Screen

Quit