CS3300 Compiler Design: A tutorial on JavaCC/JTB

`Parsers, Syntax-Tree Builders, and Visitors`

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Introduction

Goals of this tutorial

Given a grammar in LL(k) format, in this tutorial, we will learn :

A. how to *automatically* create :
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C. how to write custom visitors to **analyze** (and transform) the programs.

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This is my post-lunch nap time! Why shall I focus?

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Also, ...

... rest of the ***assignments*** *use JavaCC/JTB :-)*

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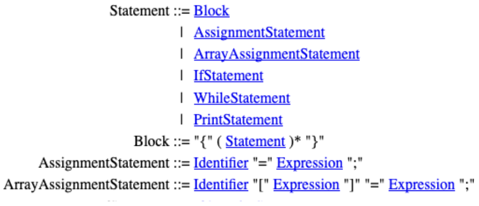
Outline

JavaCC grammar : An example

Note a sample grammar, and its JavaCC format below.



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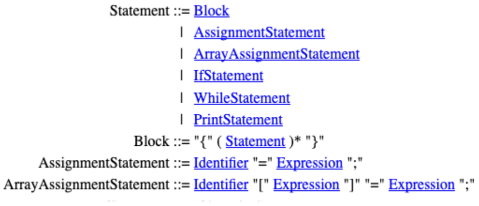

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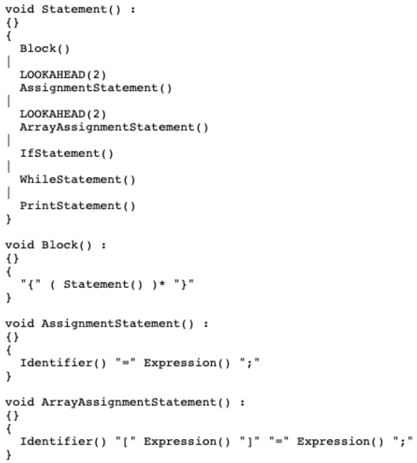

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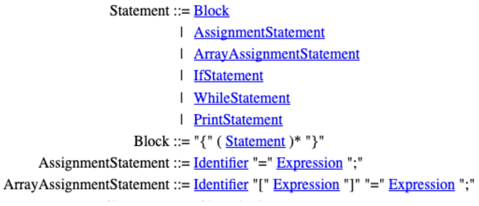

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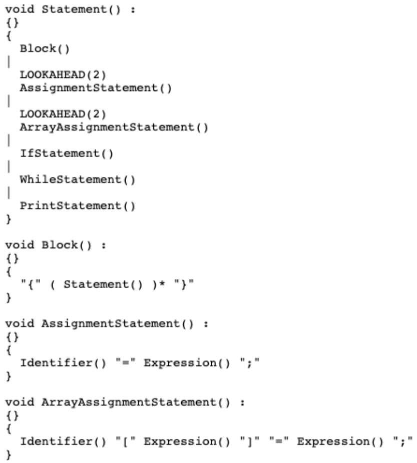

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Note: You will get JavaCC grammars as input in your assignments.

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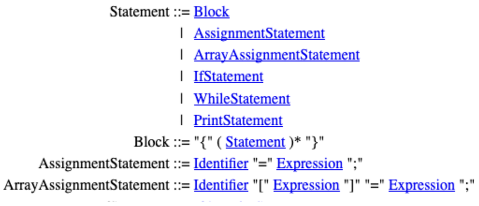

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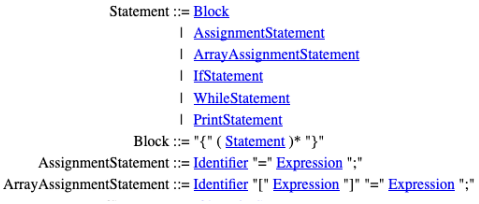

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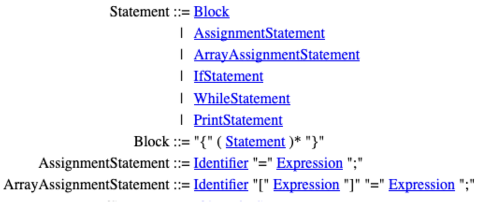

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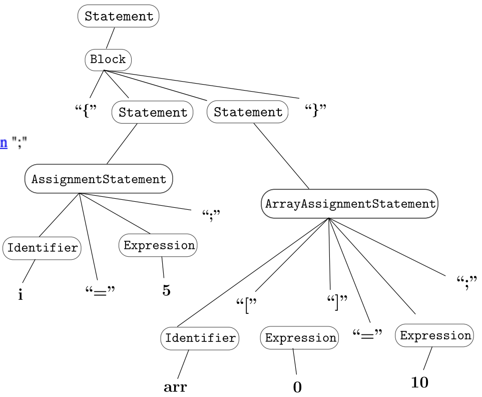

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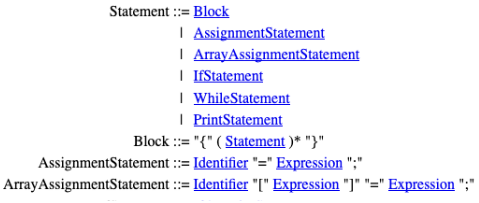

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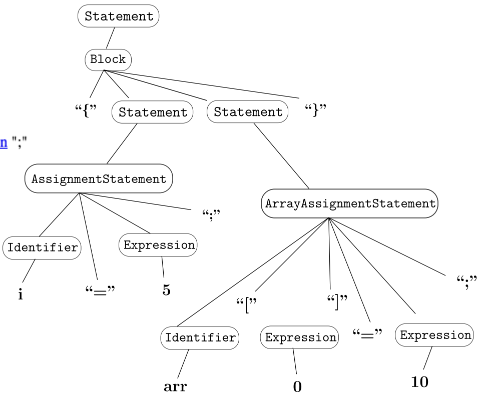

Note: Your parser will automatically generate the AST for any given input.

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What is JTB?

Input: Plain JavaCC grammar.
Output:

- Syntax-tree classes (for non-terminals and terminals).
- Annotated JavaCC grammar, which builds the syntax-tree during parsing.
- Default visitors over the AST.

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Suggestion : After these steps, open your project in Eclipse.

Demo

Demonstration of setting up a MiniJava parser.

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The syntaxtree package

- All syntax-tree classes implement the Node interface.
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Note : In general, you do not need to modify any of the syntax-tree files.

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Walkthrough of syntax-tree classes.

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Note : In each assignment, your key task would revolve around writing one or more visitors, and using them in your main program.

Default visitors by JTB

The `visitor` package

- Contains various default depth-first visitor classes for the AST.
- Categorized according to whether the visits
  - take any arguments (sent to the child node), and/or
  - return any values (back to the parent node).

Demo

Walkthrough of visitor classes.

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Practice!

Example visitors

Let's start writing some visitors then!

- Write a visitor to print the name of all the classes.
- Count the number of explicit operators in the program.
- Print the fully-qualified name of all integer fields.
- TODO : Write a visitor to calculate the cost of each expression being printed, in terms of number of explicit operators present in the print expression. e.g., `System.out.println((2 + x) * y)` has cost of 2 (one for +, and one for ∗).
- TODO : Modify the previous visitor to calculate the cost of expressions, as per the following :
  - Cost of reading a constant : 0; that of reading a variable : 1
  - Cost of each arithmetic operator : 1; of array dereference : 2; other operators : 0
  - Cost of a method call : 4
- TODO : Write a pretty-printer (one which prints the program, taking care of newlines and indentations.)

Thank you!

Outline

Installation notes

Installing JavaCC

- Download and unzip `javacc-5.0.tar.gz`, say, at your home directory.

  https://java.net/projects/javacc/downloads/download/javacc-5.0.tar.gz

  ```
  $ cd ~
  $ tar xvzf javacc-5.0.tar.gz
  ```

- Set the path to `javacc` (present in `javacc-5.0/bin`) in your `PATH` environment variable.

  ```
  $ export PATH="~/javacc-5.0/bin:$PATH"
  ```

  Save this command in your `~\.bashrc` or `~\.bash_profile`.

Installing JTB

- *None required.* Simply download and use the `jar` file from

  http://compilers.cs.ucla.edu/jtb/Files/jtb132.jar

Special sub-classes of Node

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  Field `choice` refers to the chosen node (of type `B` or `C`).
- *TODO :* Check what are `NodeSequence`, `NodeListOptional` and `NodeOptional` classes.

Advanced programming tips (1/2)

- Revise/learn Java Generics and Collections API.
- Decide whether you need to send information from parent to child, from child to parent, in both directions, or in neither. Accordingly pick an existing visitor.
- To create a custom visitor, start it as a copy of the selected visitor, make it extend the selected visitor, and then edit the copy.
- When passing information from child to parent, it might be easier to code the `visit()` methods in a bottom-up order.
  (e.g., expressions → statements → methods → classes).
- When passing information from parent to child, fill the `visit()` methods in top-down order.
  (e.g., classes → methods → statements → expressions).
- While writing `visit()` methods that call each other recursively, take each `visit()` one-by-one, and *assume* that the other `visit()` methods are already implemented while writing its code.

Advanced programming tips (2/2)

- Some situations may require more than one visitors.
- To keep your code clean, remove all those methods from your custom visitor that do not modify the inherited definition from selected visitor.
- Do not call `accept()` on those portions of AST which need not be processed.
- Java `Strings` can be passed as an argument to the parser, by wrapping it in a `ByteArrayInputStream`.
- The parser can be invoked on *any* non-terminal, not just the start symbol. Hence, AST for code *snippets* (e.g., a while loop) can be created with ease.