

编译原理概述

魏恒峰

hfwei@nju.edu.cn

2021 年 11 月 02 日 (周二)



2 个月 = 8 周 = 16 次课



作业 (15 分): 7 + 1 次作业, 每周 1 ~ 2 题

期末测试 (40 分): 考试周统一安排; 2 小时; 闭卷

实验 (45 分): 4 次必做实验 + 1 次选做实验 (+5 分)
(更多实验项目, 陆续宣布)



邀请码: JCZ837HE

每周五晚上布置作业

下周五 **23 : 55** 前提交作业

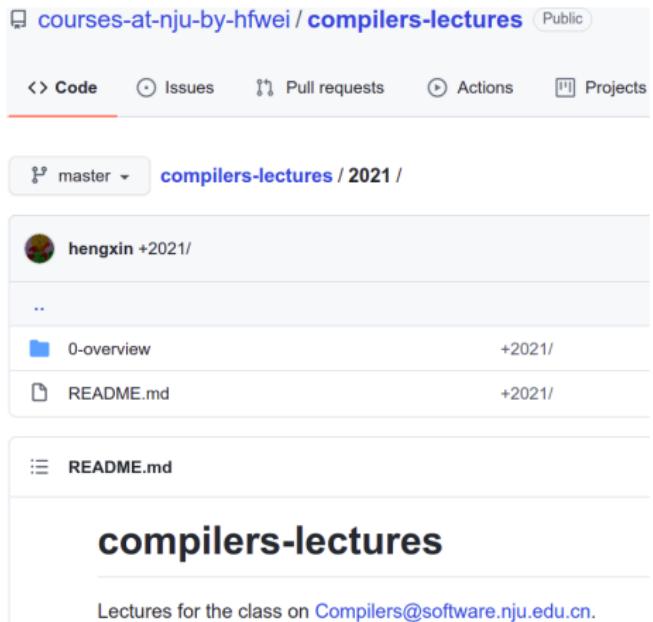
QQ 群号: 711805817



作业助教: 何伟、龙嘉蓓

实验助教: 王腾、黄孟斌、邱星曜

QQ 验证: 2021-编译原理

 courses-at-nju-by-hfwei / compilers-lectures (Public)

Code Issues Pull requests Actions Projects

master / compilers-lectures / 2021 /

hengxin +2021/

..

0-overview +2021/

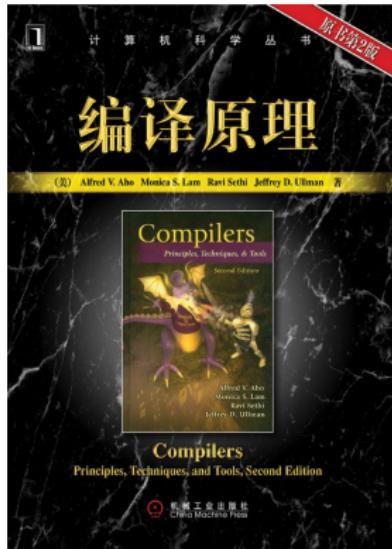
README.md +2021/

README.md

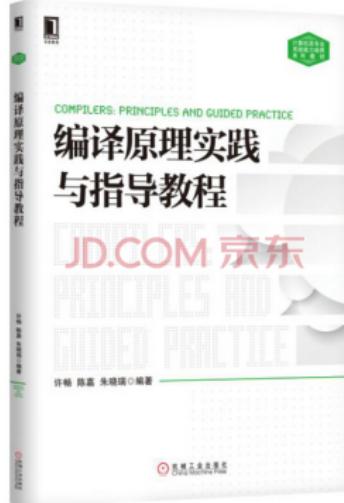
compilers-lectures

Lectures for the class on Compilers@software.nju.edu.cn.

<https://github.com/courses-at-nju-by-hfwei/compilers-lectures/tree/master/2021>



也可使用“**本科教学版**”



[https://cs.nju.edu.cn/
changxu/2_compiler/index.html](https://cs.nju.edu.cn/changxu/2_compiler/index.html)



Flex: 词法分析器生成器



Bison: 语法分析器生成器



Flex: 词法分析器生成器



Bison: 语法分析器生成器

不够现代



Terence Parr

<https://www.antlr.org/index.html>

The Definitive ANTLR 4 Reference



Terence Parr

The
Pragmatic
Programmers

Language Implementation Patterns

Create Your Own Domain-
Specific and General
Programming Languages

Edited by Przemysław Dominiak, Pradeep

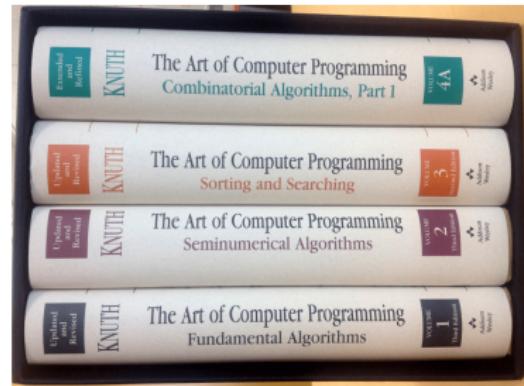
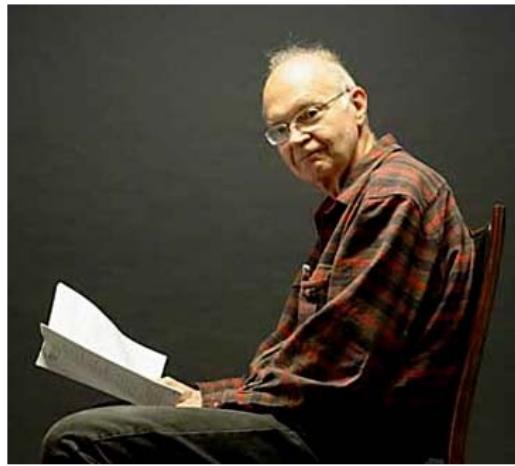
Terence Parr

The
Pragmatic
Programmers





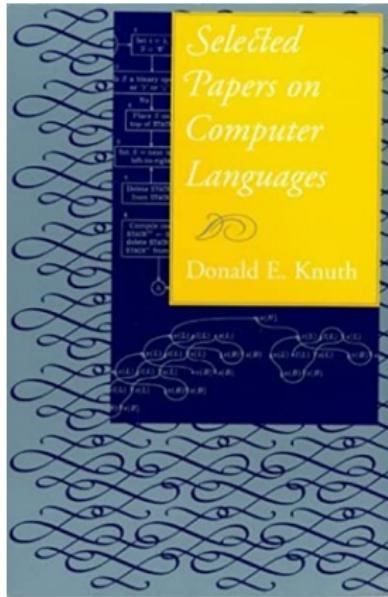
the “father of the analysis of algorithms”



Donald E. Knuth (1938 ~)

Turing Award, 1974

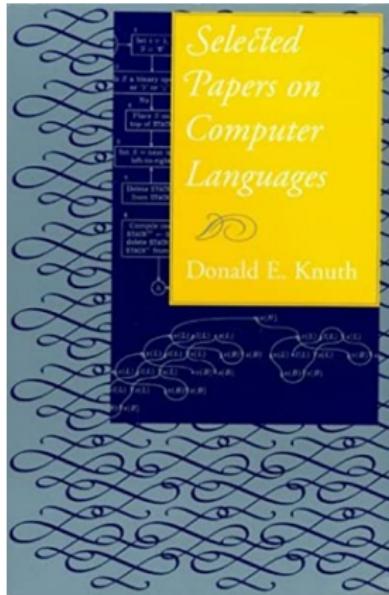
“Selected Papers on Computer Languages”



LR Parser (语法)

Attribute Grammar (语义)

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Attribute Grammar (语义)

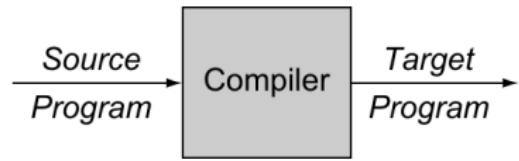
ALGOL 58 Compiler



“I got a job at the end of my senior year
to write a compiler for Burroughs”

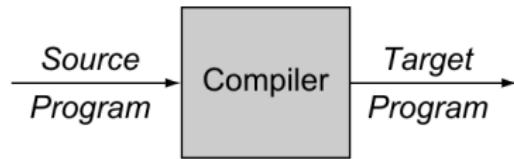
“高级”语言 \Rightarrow (通常) “低级”语言 (如, 汇编语言)

汇编语言经过**汇编器**生成机器语言



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GopherJS - A compiler from Go to JavaScript

godoc reference PASSED

GopherJS compiles Go code (golang.org) to pure JavaScript code. Its main purpose is to give you the opportunity to write front-end code in Go which will still run in all browsers.

Q : 机器语言是如何跑起来的?

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作业 (P1 ~ P8): <https://www.bilibili.com/video/BV1EW411u7th>

语言类应用程序

- ▶ 配置文件解析 (.properties)
- ▶ CSV 文件 (Comma-Separated Values)
- ▶ JSON 文件 (JavaScript Object Notation)

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- ▶ L-System (Cantor Set)

The tomassetti.me website has changed: it is now part of strumenta.com. You will continue to find all the news with the usual quality, but in a new layout.

Our articles

Here we talk about parsing, tools and libraries, natural language processing and Kotlin

Edited by [Federico Tomassetti](#)



[tomassetti.me](#)



alda

[install](#) [tutorial](#) [cheat sheet](#) [docs](#) [community](#)

Alda is a text-based programming language for music composition. It allows you to write and play back music using only a text editor and the command line.

```
piano:  
o3  
g8 a b > c d e f+ g | a b > c d e f+ g4  
g8 f+ e d c < b a g | f+ e d c < b a g4  
<< g1/>g/>g/b/>d/g
```

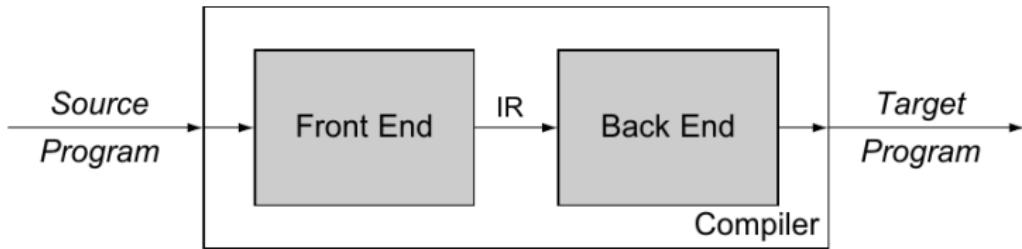
The language's design equally favors aesthetics, flexibility and ease of use.

[alda.io](#)

两个月的“编译器设计原理”之旅

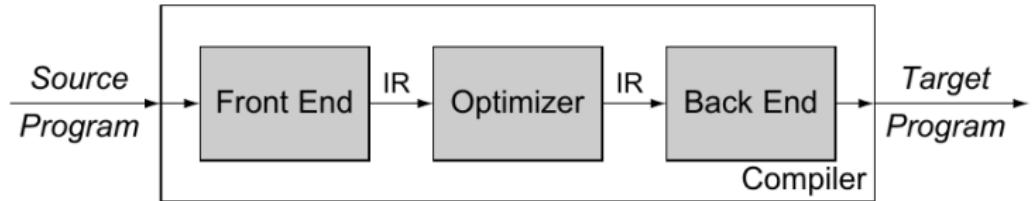


IR: Intermediate Representation (中间表示)



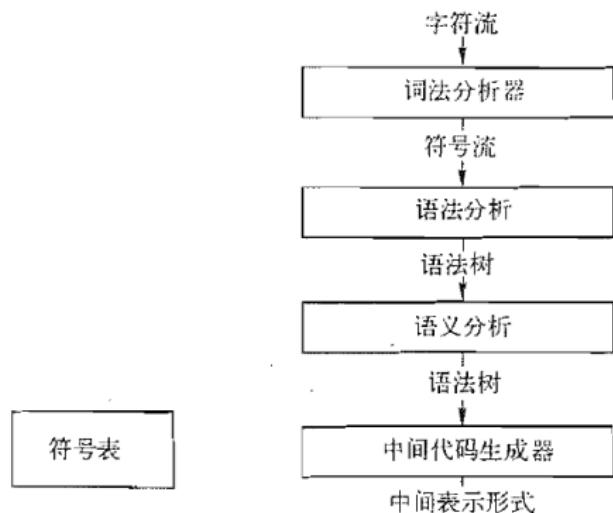
前端（分析阶段）: 分析源语言程序, 收集所有必要的信息

后端（综合阶段）: 利用收集到的信息, 生成目标语言程序



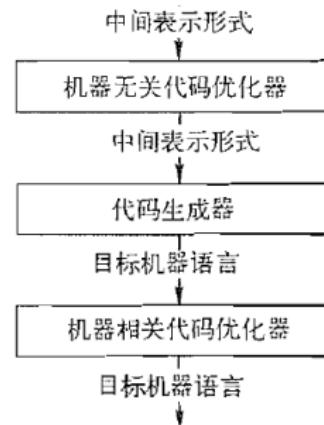
机器无关的中间表示优化

编译器前端：分析阶段



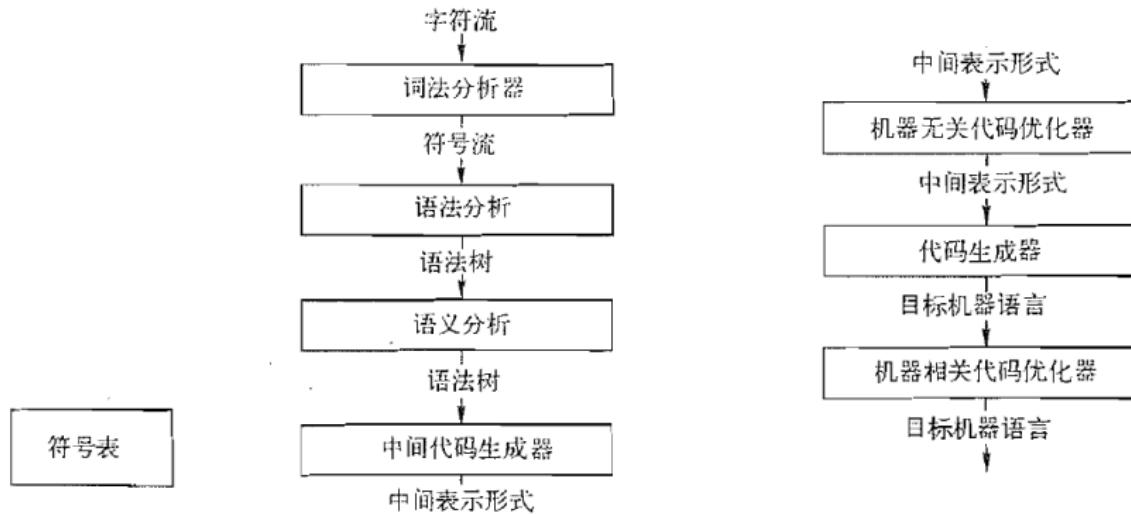
前四次必做实验

编译器后端：综合阶段



第五次选做实验

时间苦短，来不及优化



在设计实际生产环境中的编译器时，**优化**通常占用了大多数时间



方舟编译器

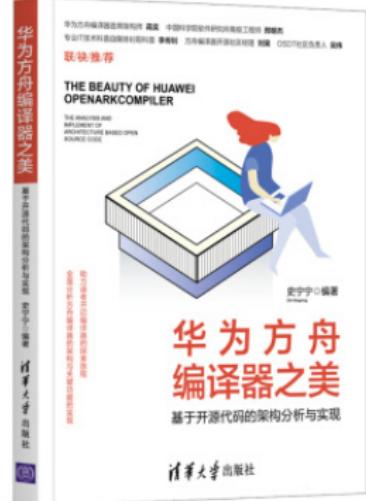
多端多语言，轻量低开销

立即下载

快速入门



查看源码



Maple IR 及其各种优化技术

```
position = initial + rate * 60
```

作为一名**程序员**, 你看到了什么?

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但是, 作为**编译器**, 它仅仅看到了一个**字符串**

词法分析器 (Lexer/Scanner): 将字符流转化为词法单元 (token) 流。

token : <token-class, attribute-value>

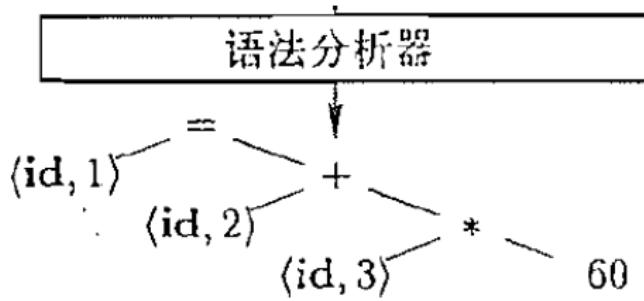
```
position = initial + rate * 60
```

<**id**, 1> <ws> <**assign**> <ws> <**id**, 2> <ws>
<+> <ws> <**id**, 3> <ws> <*> <ws> <**num**, 4>

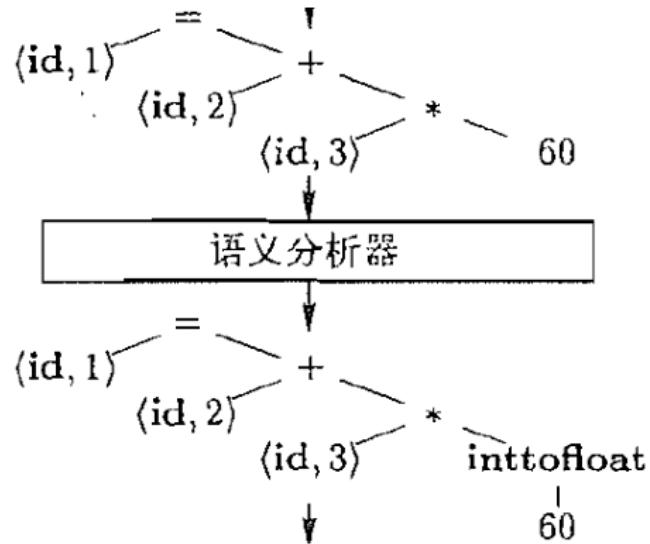
(此处, 1, 2, 3, 4 是指向**符号表**的指针)

语义分析器 (Parser): 构建词法单元之间的语义结构, 生成**语义树**

```
position = initial + rate * 60
```

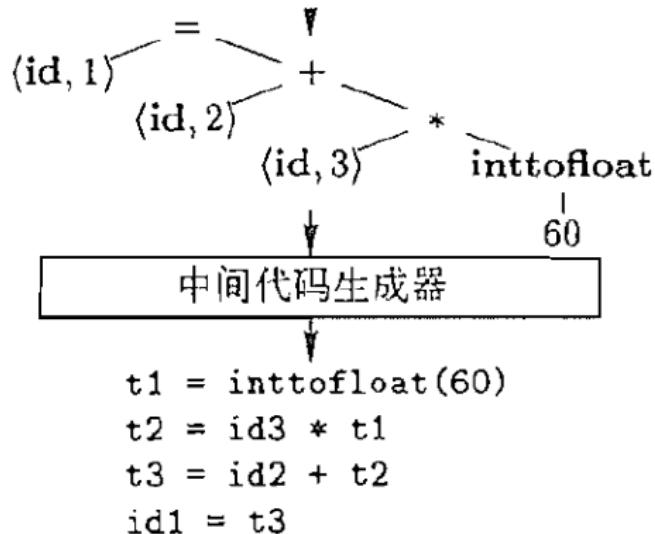


语义分析器：语义检查，如类型检查、“先声明后使用”约束检查



通过语法树上的遍历来完成

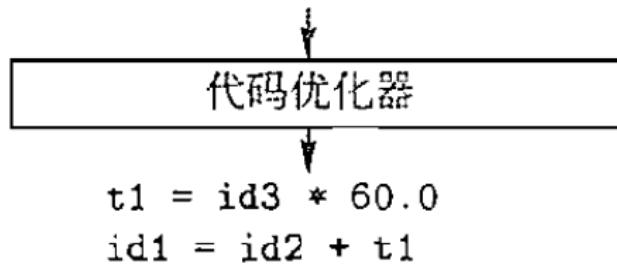
中间代码生成器：生成中间代码，如“三地址代码”



中间代码类似目标代码，但不含有机器相关信息（如寄存器、指令格式）

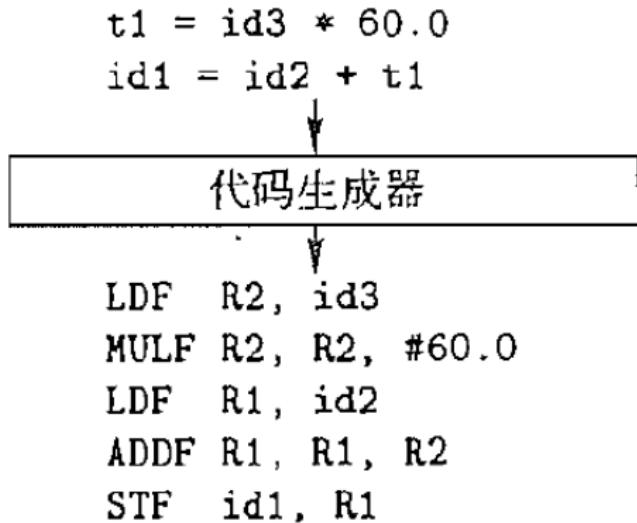
中间代码优化器

```
t1 = inttofloat(60)
t2 = id3 * t1
t3 = id2 + t2
id1 = t3
```



编译时计算、消除冗余临时变量

代码生成器: 生成目标代码, 主要任务包括**指令选择、寄存器分配**



符号表: 收集并管理变量名/函数名相关的信息

变量名:

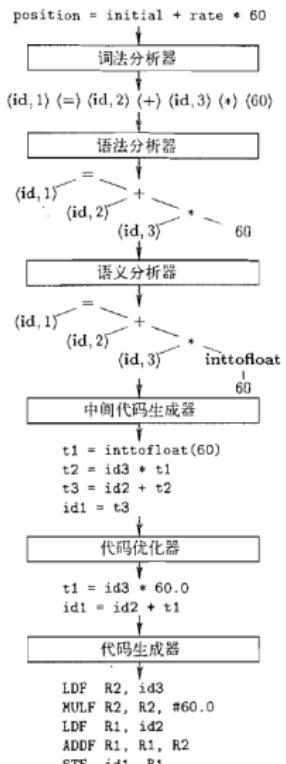
类型、寄存器、内存地址、行号

函数名:

参数个数、参数类型、返回值类型

1	position	...
2	initial	...
3	rate	...

符号表

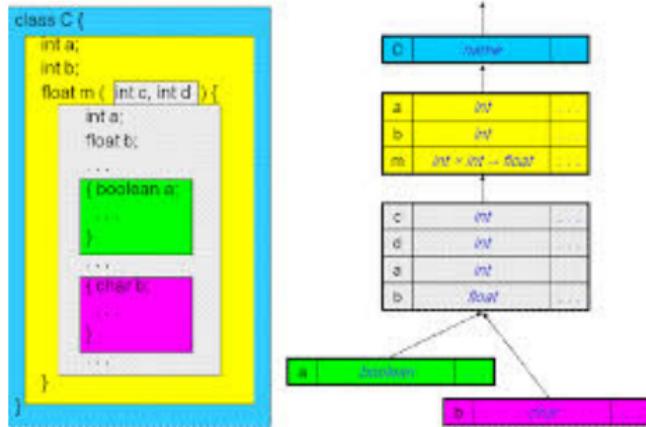


```
public class ST<Key extends Comparable<Key>, Value>
```

ST()	<i>create an empty symbol table</i>
void put(Key key, Value val)	<i>associate val with key</i>
Value get(Key key)	<i>value associated with key</i>
void remove(Key key)	<i>remove key (and its associated value)</i>
boolean contains(Key key)	<i>is there a value associated with key?</i>
int size()	<i>number of key-value pairs</i>
Iterable<Key> keys()	<i>all keys in the symbol table</i>

红黑树 (RB-Tree)、哈希表 (Hashtable)

为了方便表达嵌套结构与作用域, 可能需要维护多个符号表





Hello.g4

SimpleExpr.g4

Expr.g4

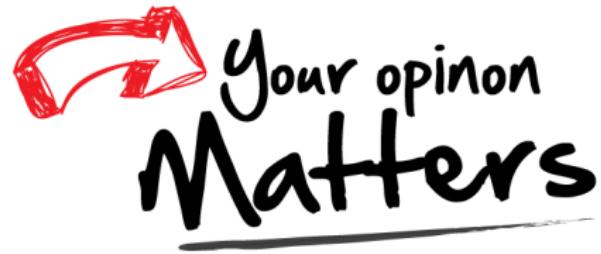
Hello.g4

SimpleExpr.g4

Expr.g4

grammars-v4 @ github

Thank You!



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