编译原理概述

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2022 年 11 月 07 日 (周一)

吾与离散数学，孰难？

吾与离散数学，孰难？

对于本学期课程，编译器实践比编译器理论更重要

7 周 = 14 次课 < 8 周 = 16 次课

本学期课程的考核方式做了较大调整

平时作业 (15 分): $7+1$ 次作业, 每周 $1\sim2$ 题

期末测试 (40 分): 考试周统一安排; 2 小时; 开卷

课程实验 (45 分): 4 次必做实验 + 1 次选做实验 (5 分)

平时作业 (15 分): $7+1$ 次作业, 每周 $1\sim2$ 题

期末测试 (40 分): 考试周统一安排; 2 小时; 开卷

课程实验 (45 分): 4 次必做实验 + 1 次选做实验 (5 分)

这是去年的啦 ...

平时作业 (00 分): 7 次作业, 每周 1 ∼ 2 题

平时作业 (00 分): 7 次作业, 每周 1 ∼ 2 题

课程实验 (60 分): 7 次必做实验 + 1 次选做实验 (5 分)

平时作业 (00 分): 7 次作业, 每周 1 ∼ 2 题

课程实验 (60 分): 7 次必做实验 + 1 次选做实验 (5 分)

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期末测试 (40 分): 考试周统一安排; 2 小时; 开卷

附加作业 (05 分): 报告 + 录屏方式

每周三晚上发布作业　　下周三 23 : 55 前自愿提交作业

邀请码: 5JP57Q5H

发布阅读材料　　发布调查问卷　　发布作业答案

课程实验：开发 SysY 语言编译器

小步迭代、多步迭代、贴合课堂讲授进度

L0: 环境配置 今晚 18:00 发布

(20221107 ~ 20221113)

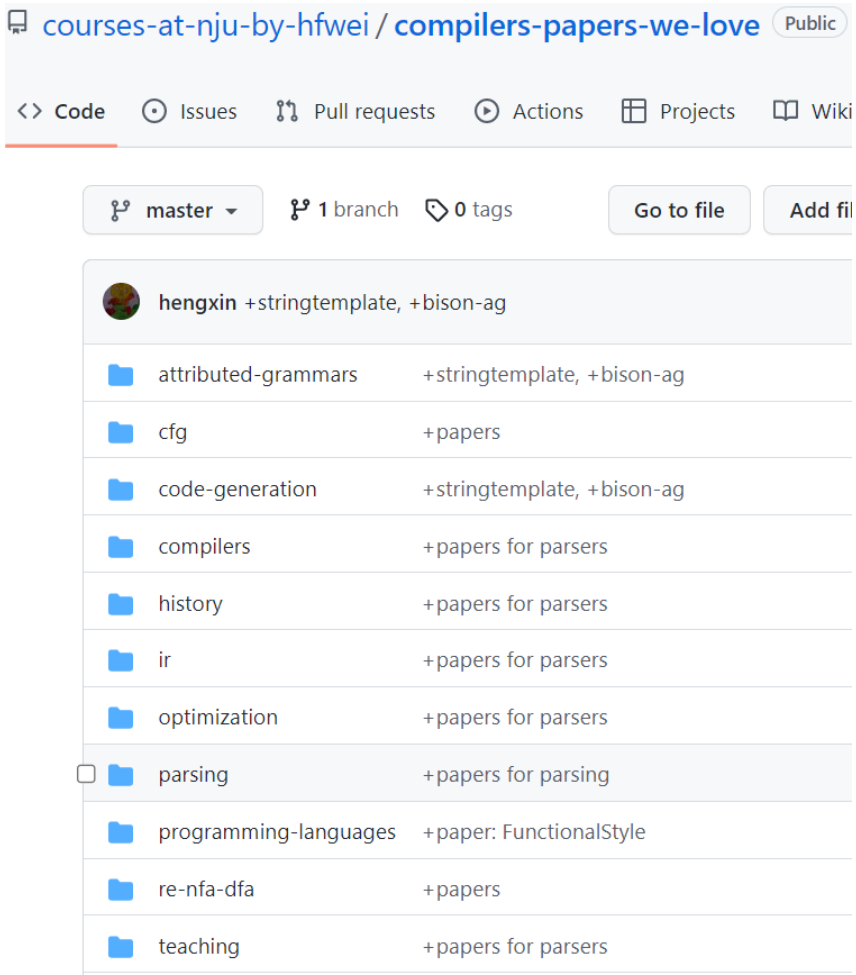
L0: 环境配置 今晚 18:00 发布

(20221107 ∼ 20221113)

L1: 词法分析 本周三 18:00 发布

(20221109 ∼ 20221116)

附加作业：报告 + 录屏方式，了解更现代的编译器原理与技术



鼓励讨论，但需独立编码完成课程实验

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课程实验: 抄袭者当次实验计 0 分

附加作业: 抄袭者当次作业计 0 分

请**经常**使用 Git/GitHub 保留代码编写记录 (OJ 系统原生支持)

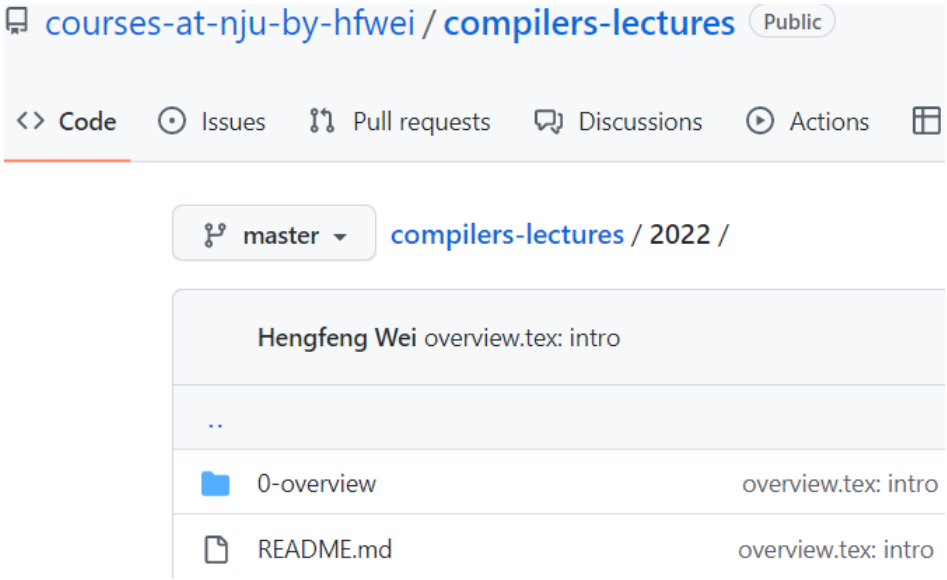
如果你不确定自己的行为是否构成抄袭, 请**事先**咨询助教。

QQ 群号: **755783220**

助教: 夏宇、潘昱光、顾龙、...

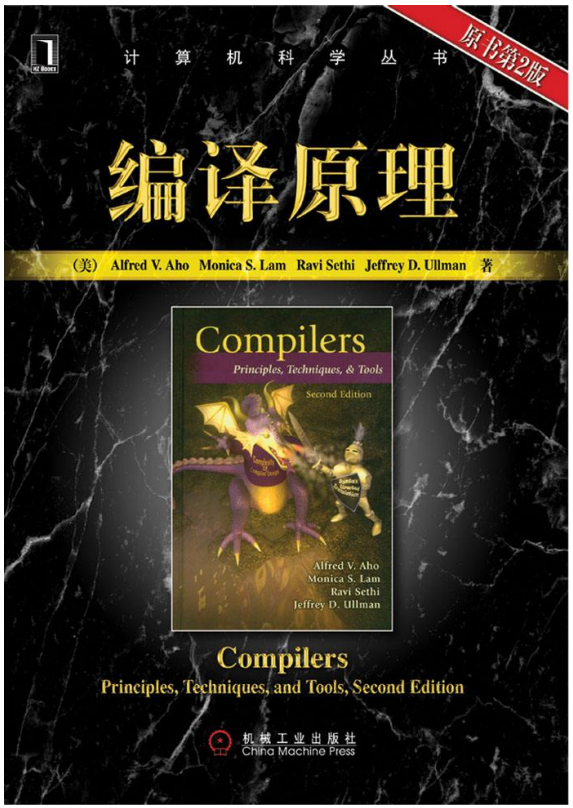
http://47.96.123.231:8081

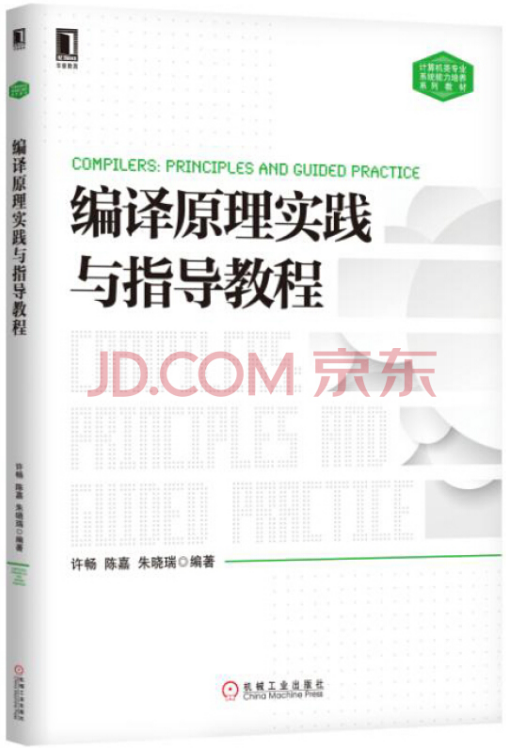
编译原理课程网站，请**收藏**并及时关注网站更新



https://github.com/courses-at-nju-by-hfwei/compilers-lectures/tree/master/2022

(本书仅供参考)



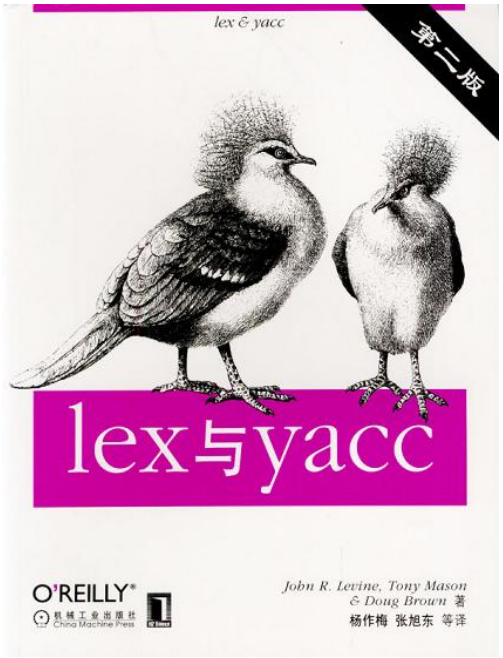


也可使用“**本科教学版**”

https://cs.nju.edu.cn/changxu/2_compiler/index.html

(本学期对课程实验做了大幅改动)

Flex: 词法分析器生成器



Bison: 语法分析器生成器

不够现代, 本学期课程实验**不再支持**这些工具

(Since 1988)

Terence Parr (University of San Francisco)

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

https://www.antlr.org/tools.html (IntelliJ Plugin)

在线玩: http://lab.antlr.org/

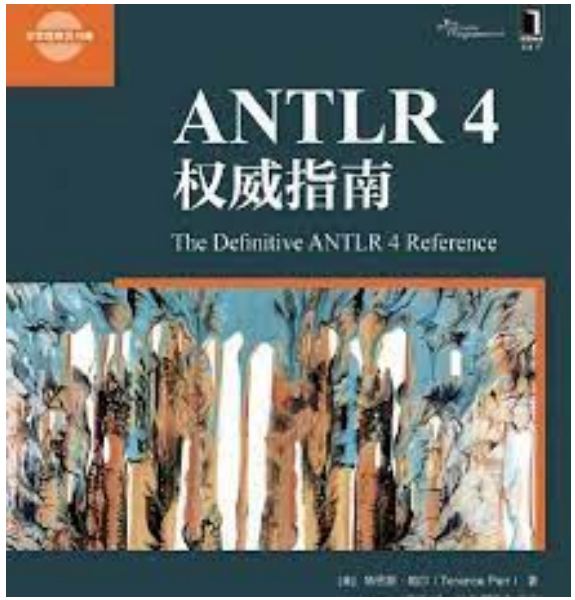
arithmetic: `number1.txt, simple2.txt`

fol: `example1.txt`

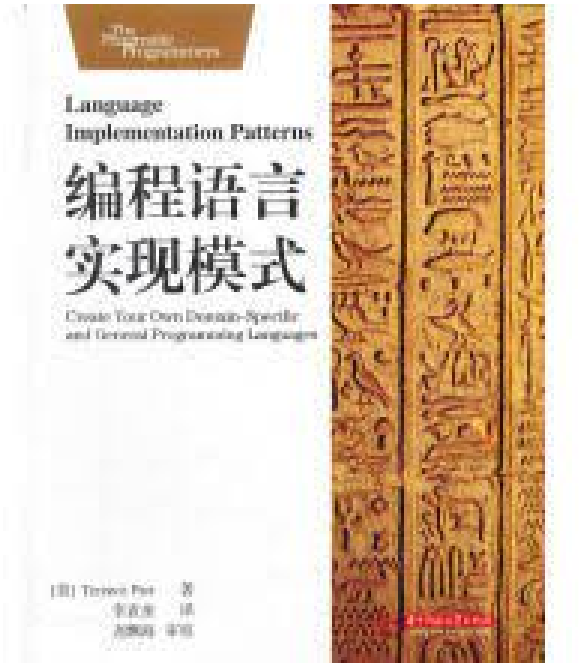
guitartab: `example1.txt`

xyz: `example1.txt`

C: `add.c`

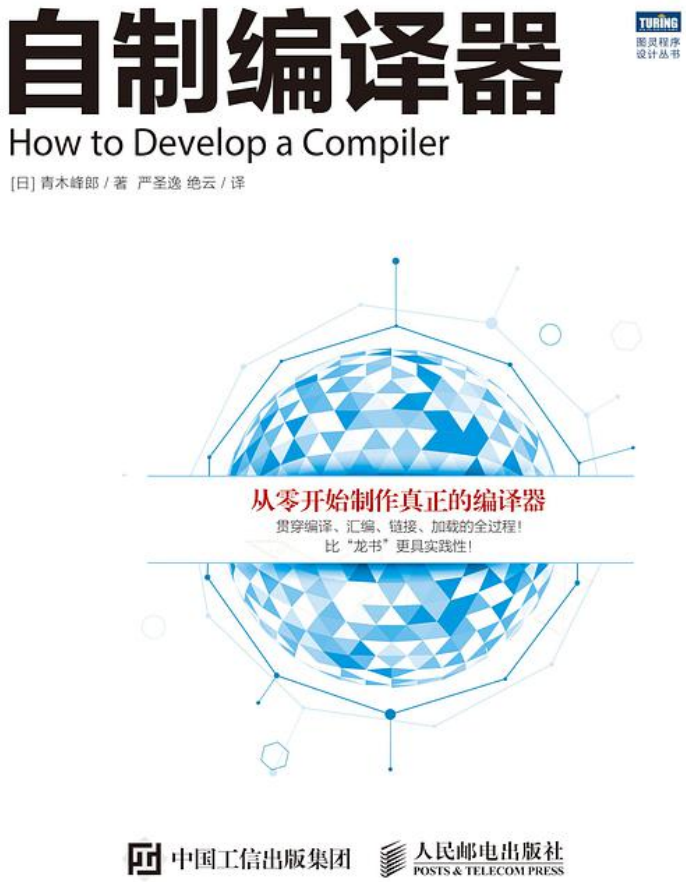


基于 ANTLR 4，是课程实验指导的**重要**参考资料

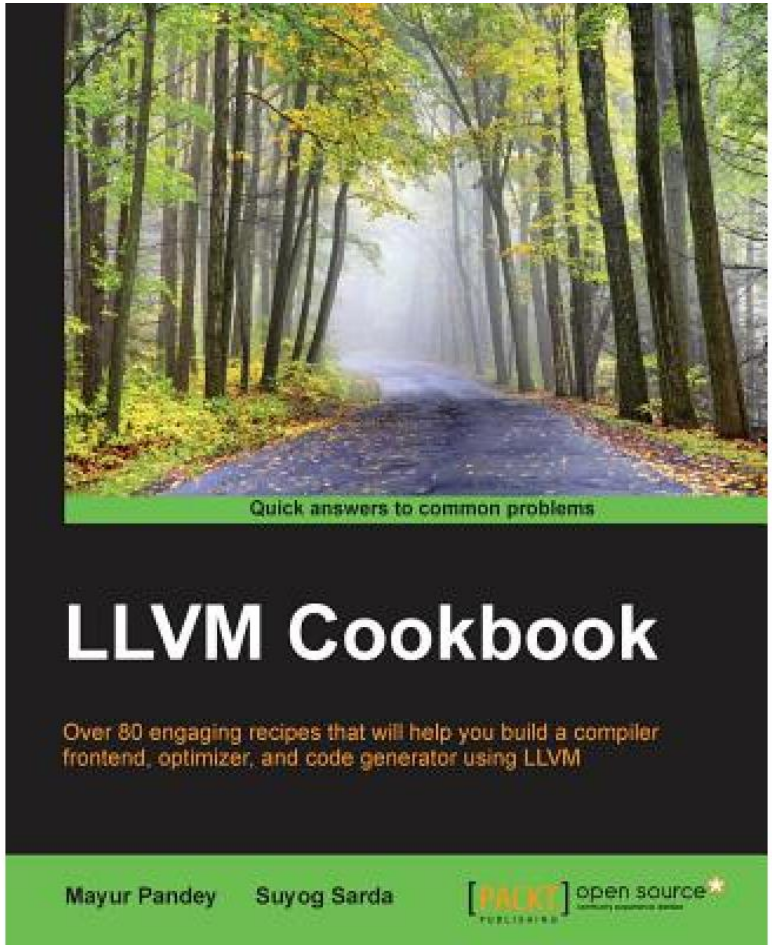


基于 ANTLR 3，与 ANTLR 4 相比，有些过时，

但可以看作理解 ANTLR 4 的基础



“从零开始制作真正的编译器”，对课程实验很有帮助，**强烈推荐**

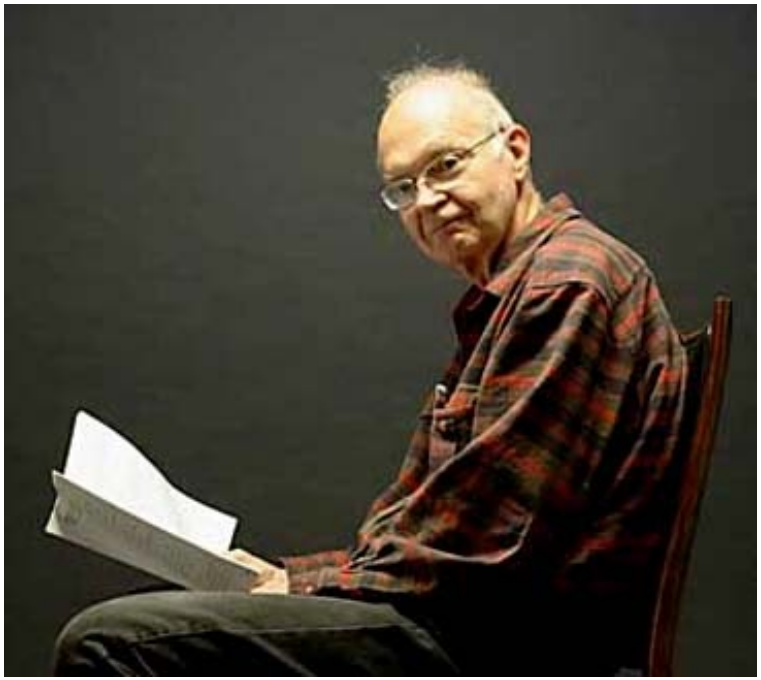


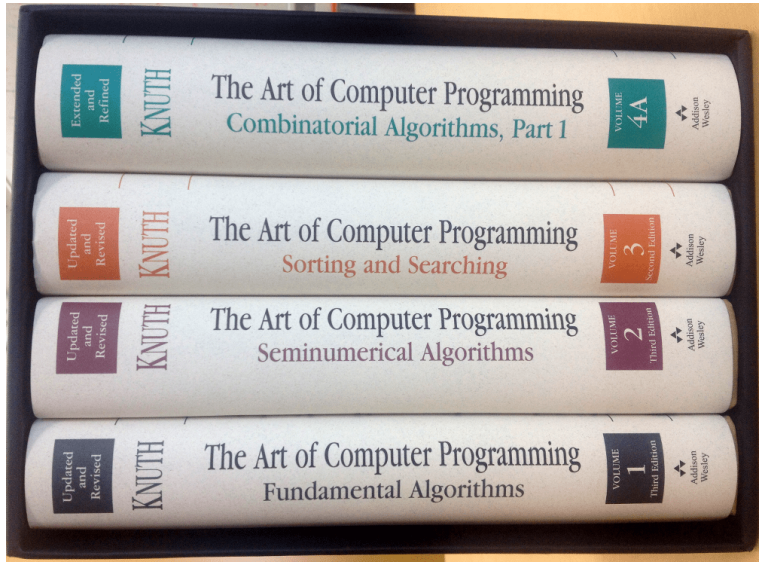
本学期课程实验引入了 LLVM (https://llvm.org/)

LLVM 简介 @ Bilibili


welcome
again

the “father of the analysis of algorithms”

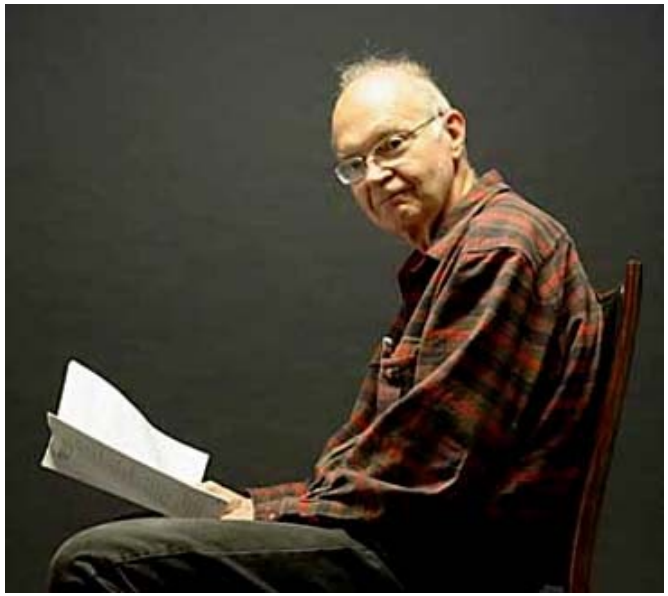




(Since 1962; 计划 7 卷)

Donald E. Knuth (1938 ∼)

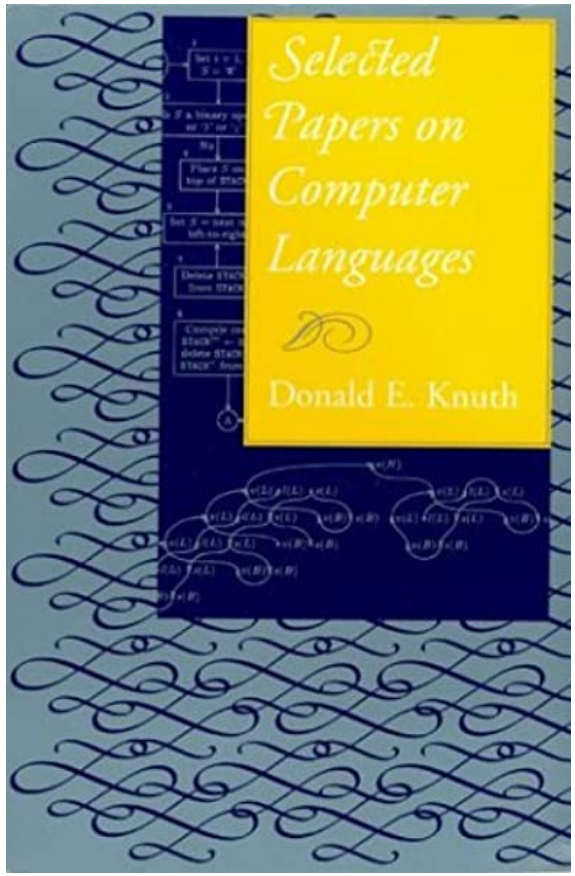
Turing Award, 1974



"For his major contributions to the analysis of algorithms and the design of programming languages, and in particular for his contributions to "The Art of Computer Programming" through his well-known books in a continuous series by this title."

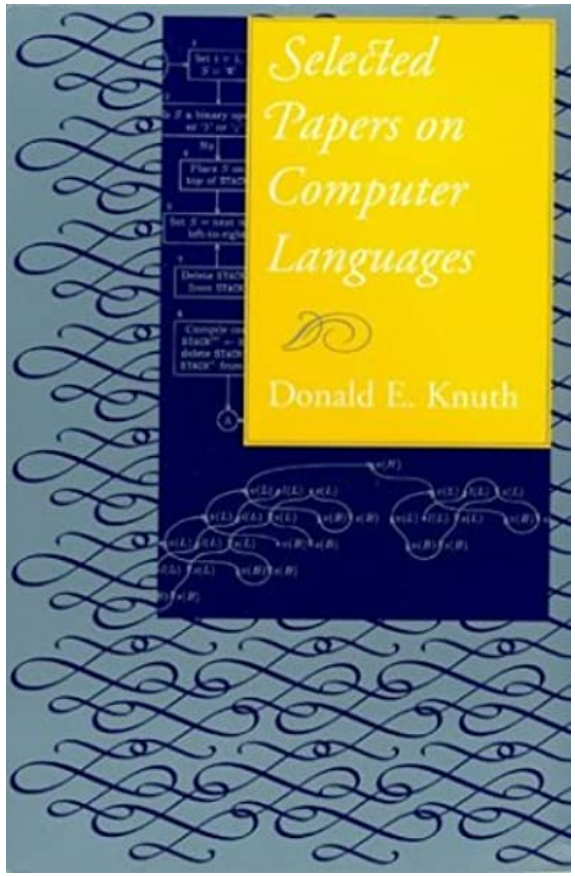
— Turing Award, 1974

"Selected Papers on Computer Languages"



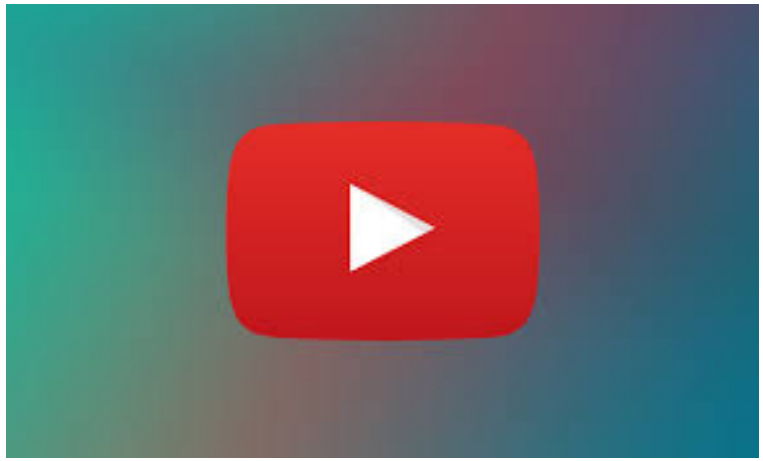
LR Parser (语法) **Attribute Grammar (语义)**

"Selected Papers on Computer Languages"



LR Parser (语法) **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 $\Longrightarrow$ (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 | used by 1.2k projects | 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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- C/C++ 语言编译器

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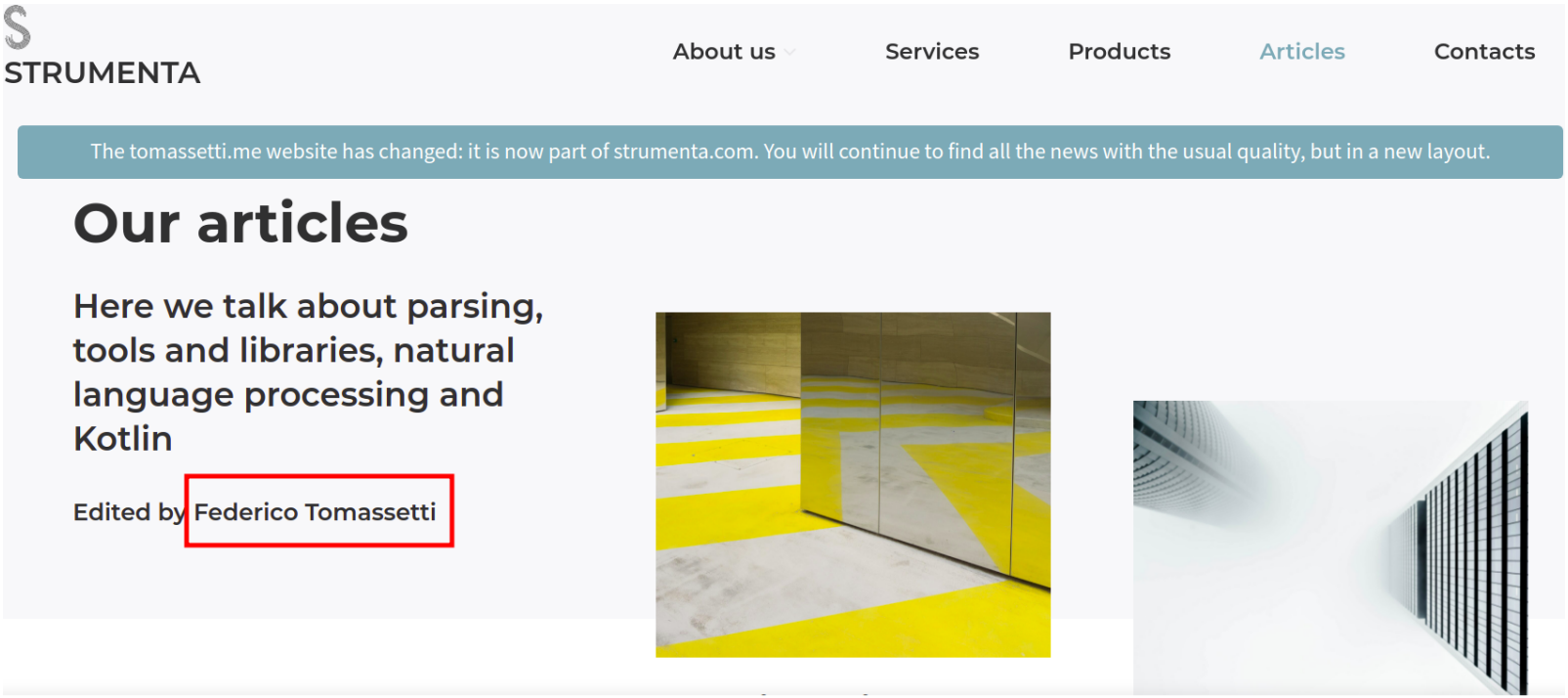
- L-System (Cantor Set)



tomassetti.me

alda.io

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.

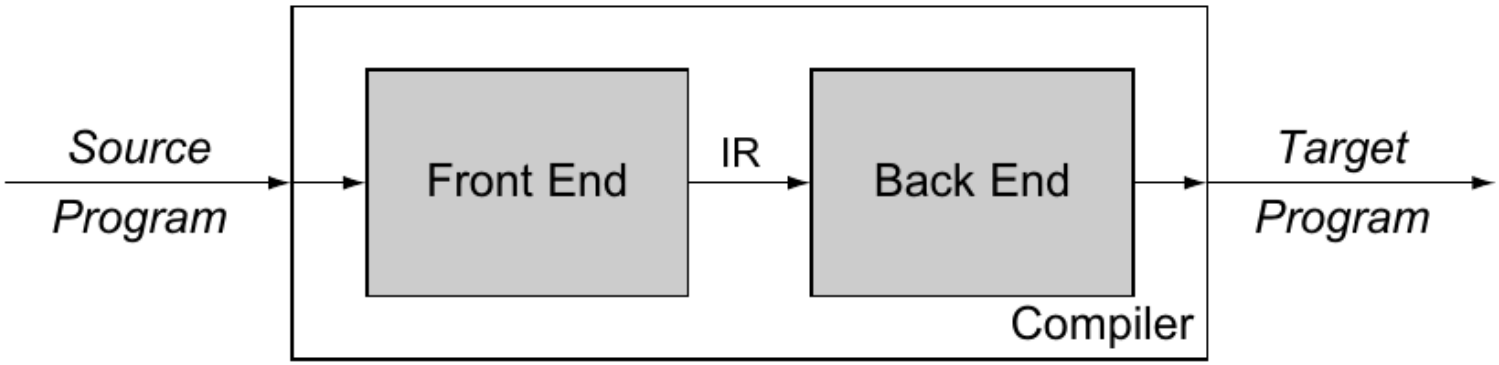
```
piano:
  o3
  g8 a b > c d e f+ g | a b > c d e f+ g4
  g8 f+ e d c < b a g | f+ e d c < b a g4
  << g1/>g/>g/b/>d/g
```

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

alda @ 知乎

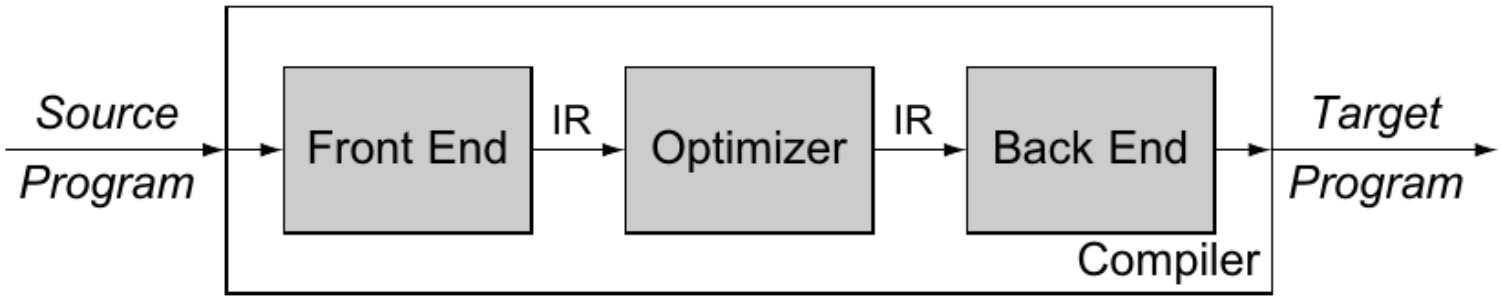
两个月的“编译器设计原理”之旅

IR: Intermediate Representation (中间表示)



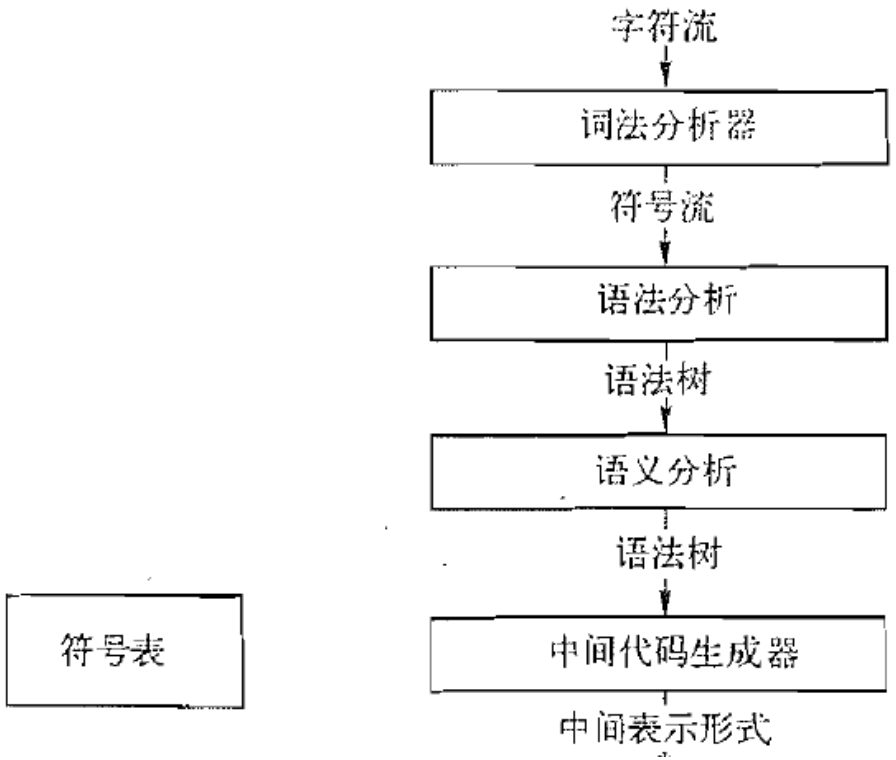
前端 **(分析阶段)**: 分析源语言程序, 收集所有必要的信息

后端 **(综合阶段)**: 利用收集到的信息, 生成目标语言程序

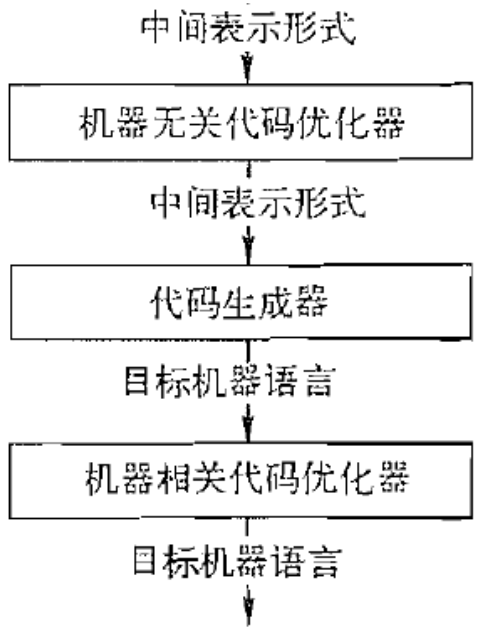


机器无关的中间表示优化

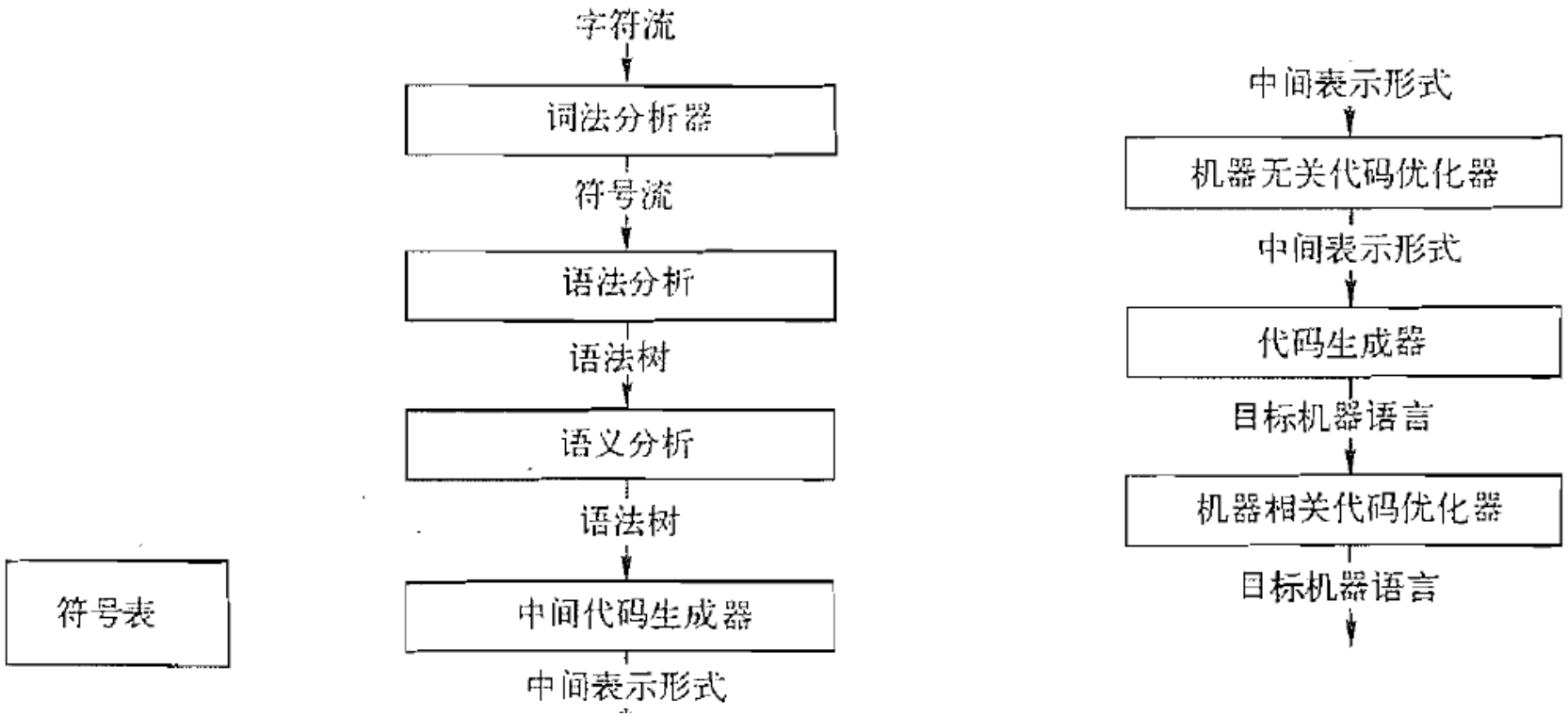
编译器前端：分析阶段



编译器后端：综合阶段



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

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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词法: 标识符、数字、运算符

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语法: 包含算术运算的赋值语句

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语义: `position`, `initial`, `rate` 是数值类型

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物理定律: 当前位置 = 初始位置 + 速度 × 时间

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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。

$$\boxed{\text{token} : \langle \text{token-class}, \text{attribute-value} \rangle}$$

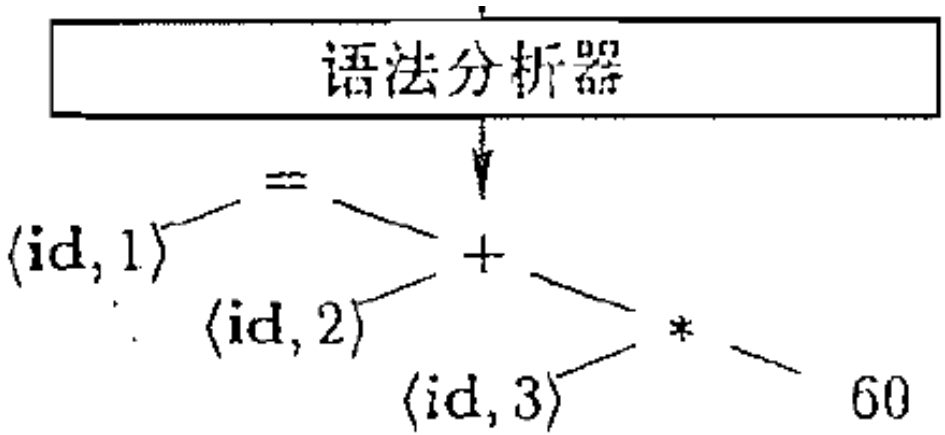
```
position = initial + rate * 60
```

$$\langle \mathbf{id}, 1 \rangle \quad \langle \mathbf{ws} \rangle \quad \langle \mathbf{assign} \rangle \quad \langle \mathbf{ws} \rangle \quad \langle \mathbf{id}, 2 \rangle \quad \langle \mathbf{ws} \rangle$$
$$\langle + \rangle \quad \langle \mathbf{ws} \rangle \quad \langle \mathbf{id}, 3 \rangle \quad \langle \mathbf{ws} \rangle \quad \langle * \rangle \quad \langle \mathbf{ws} \rangle \quad \langle \mathbf{num}, 4 \rangle$$

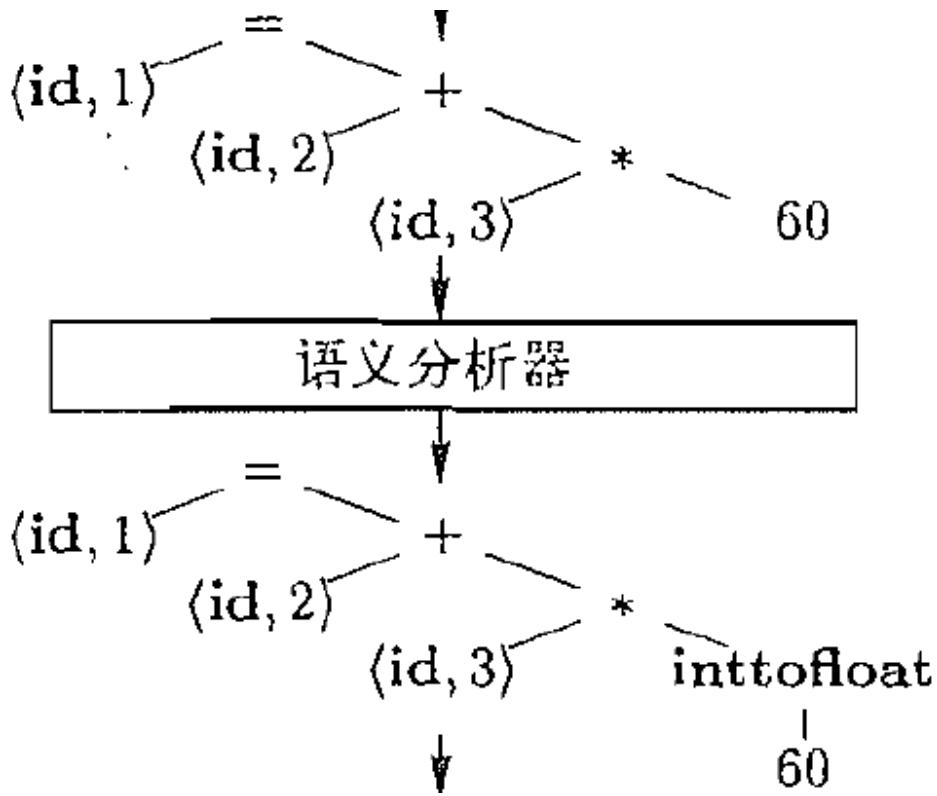
(此处, $1, 2, 3, 4$ 是指向**符号表**的指针)

语法分析器 (Parser): 构建**词法单元**之间的语法结构, 生成**语法树**

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

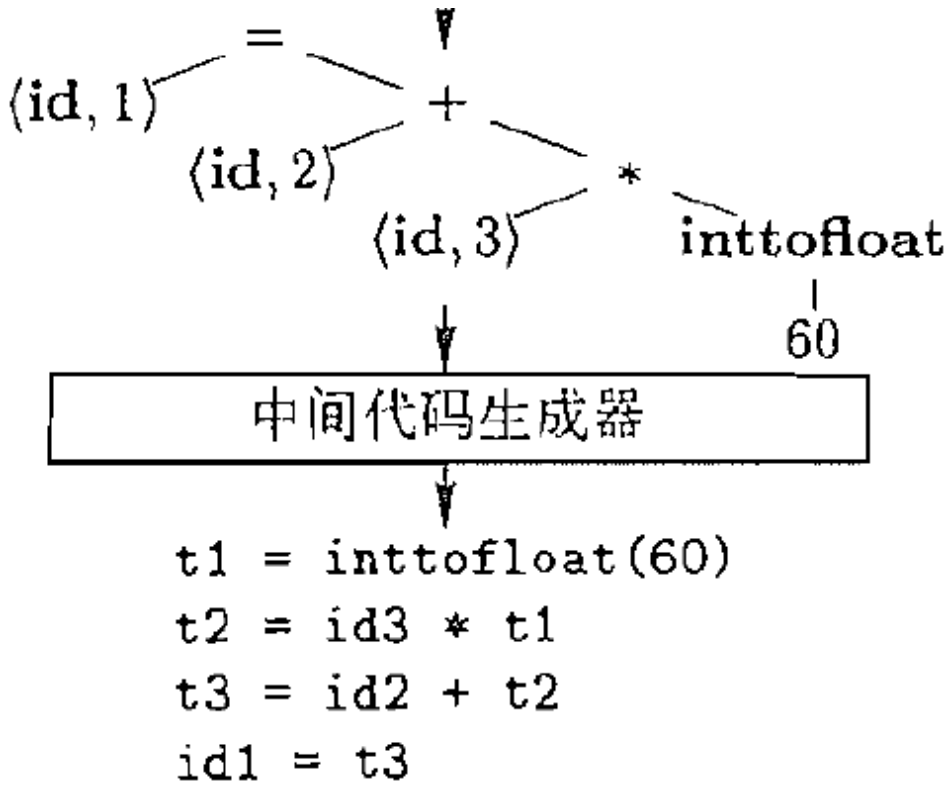


语义分析器：语义检查，如**类型检查、“先声明后使用”约束检查**



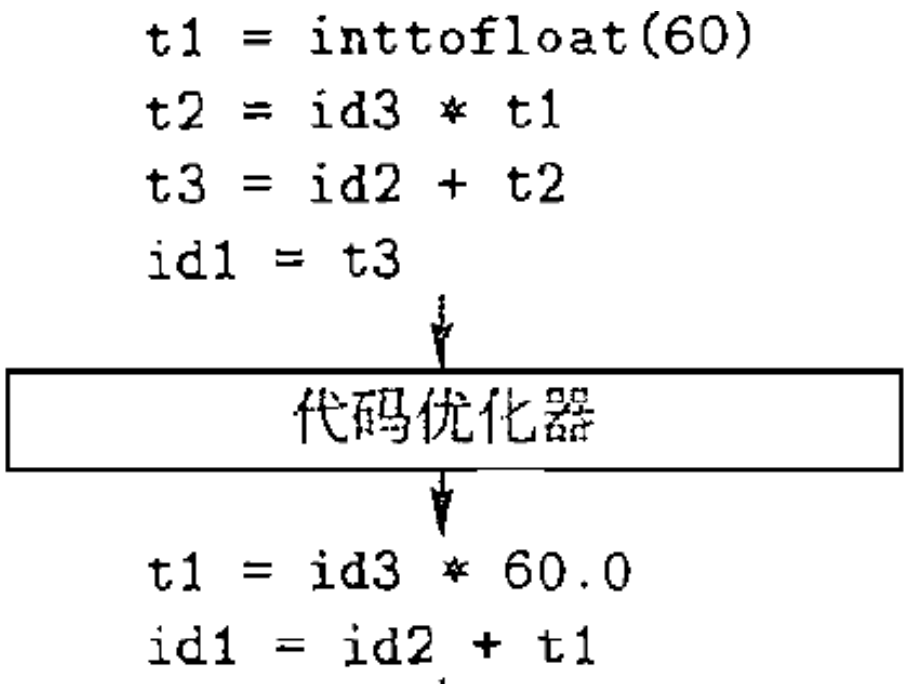
通过语法树上的遍历来完成

中间代码生成器: 生成中间代码, 如 “**三地址代码**”



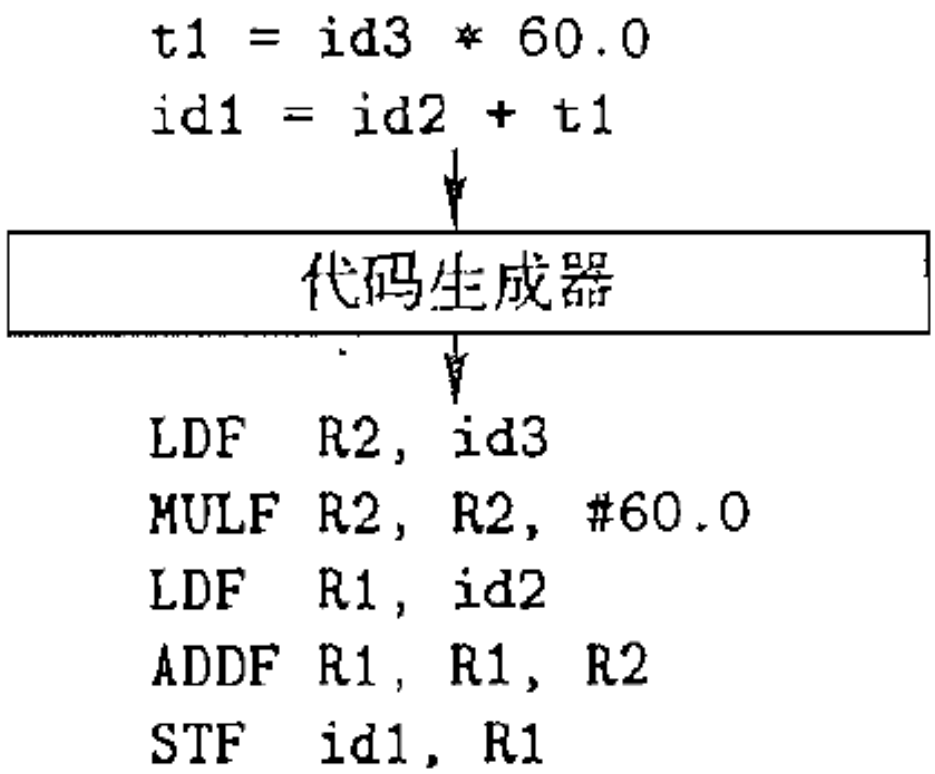
中间代码类似目标代码, 但不含有机器相关信息 (如寄存器、指令格式)

中间代码优化器



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:

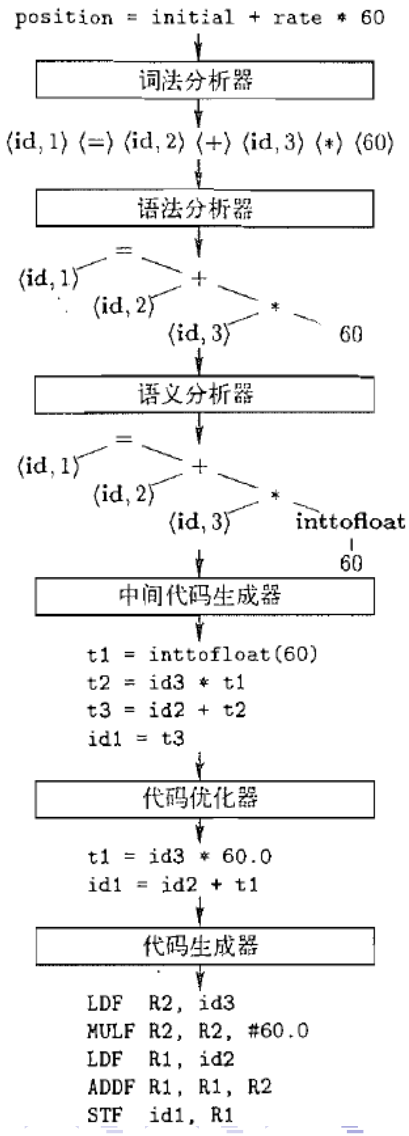
类型、寄存器、内存地址、行号

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

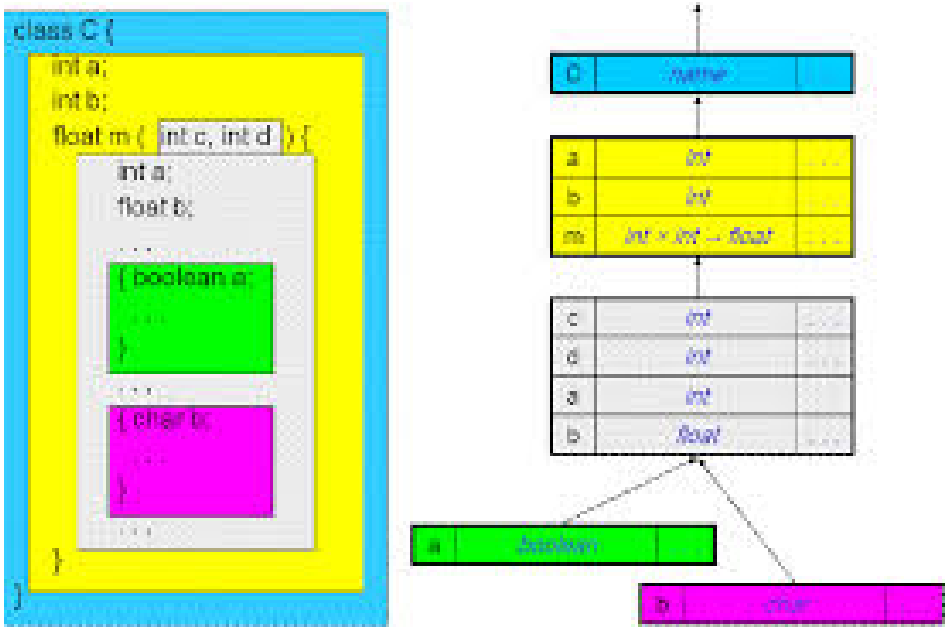


```
public class ST<Key extends Comparable<Key>, Value>
```

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

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




TIME FOR ACTION

Hello.g4

SimpleExpr.g4

Expr.g4

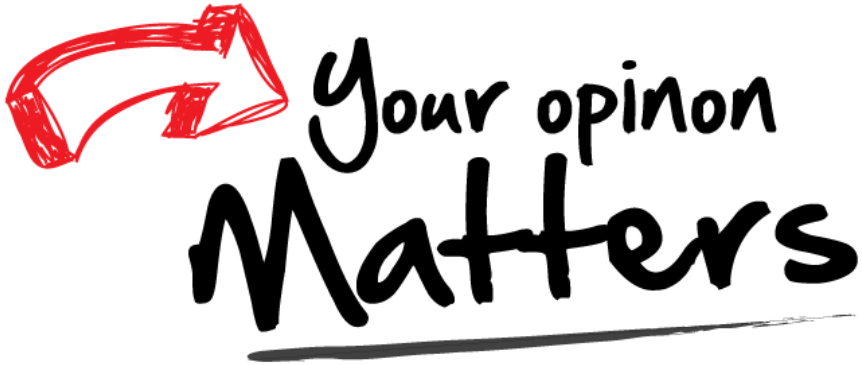
Hello.g4

SimpleExpr.g4

Expr.g4

grammars-v4 @ github


Thank
You!



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