CS3300 - Compiler Design

Introduction

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IIT Madras

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- A common statement – XYZ is an interpreted (or compiled) language.

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- Some languages are both compiled and interpreted
  - Java, Javascript - Interpreter + Just in Time (JIT) Compiler

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- Independently, in the 1950s, **Grace Hopper** developed the COBOL language and a compiler for it.

Images of the day

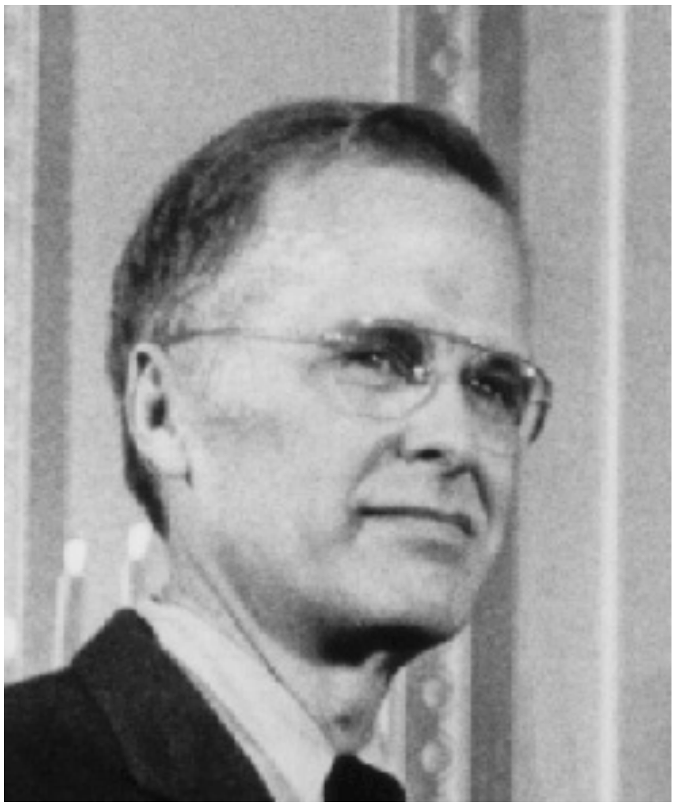

Figure: Turing Award Winners, Grace Hopper and John Backus

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Changes in compilers should prompt changes in architecture

- New languages and features

Interest

Compiler construction is a microcosm of computer science

- **Algo** graph algorithms, union-find, dynamic programming, . . .
- **theory** DFAs for scanning, parser generators, lattice theory, . . .
- **systems** allocation, locality, layout, synchronization, . . .
- **architecture** pipeline management, hierarchy management, instruction set use, . . .
- **optimizations** Operational research, load balancing, scheduling, . . .

Inside a compiler, all these and many more come together. Has probably the healthiest mix of theory and practise.

Intrinsic Merit

Compiler Design is challenging and fun

- interesting problems
- primary responsibility (read:*blame*) for performance
- new architectures ⇒ new challenges
- *real* results
- extremely complex interactions

Compilers have a major impact on how computers are used

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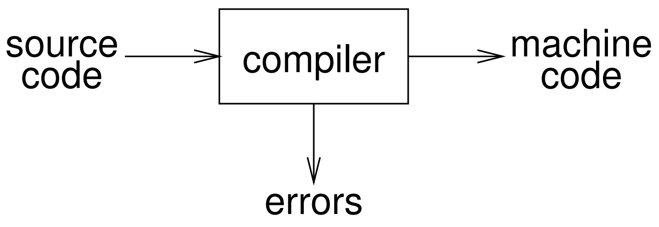
8. Consistent, predictable optimization

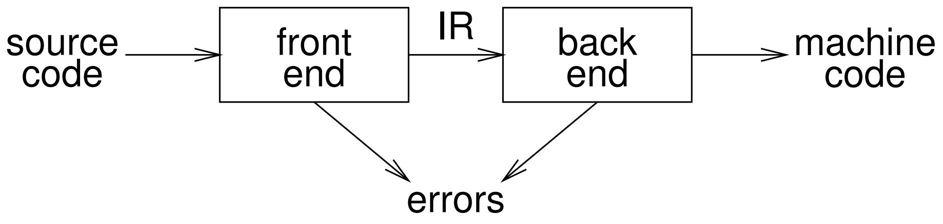
Abstract view



Implications:

- recognize legal (and illegal) programs
- generate correct code
- manage storage of all variables and code
- agreement on format for object (or assembly) code

Traditional two pass compiler



Implications:

- intermediate representation (IR).

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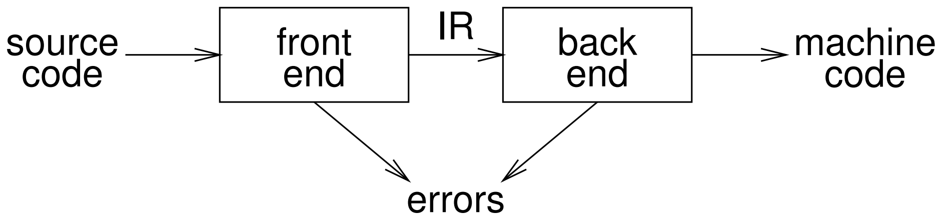

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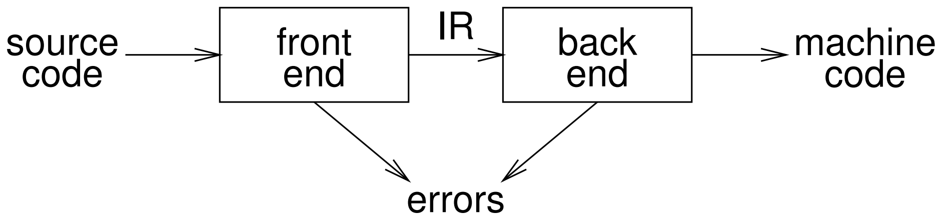

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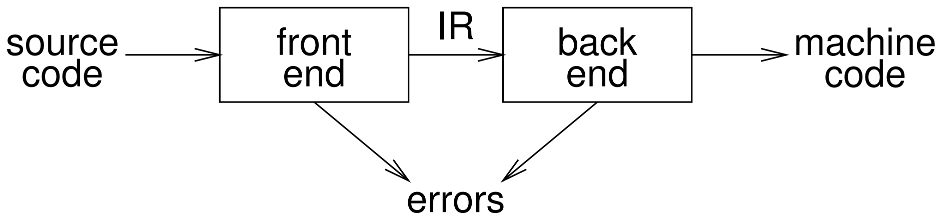

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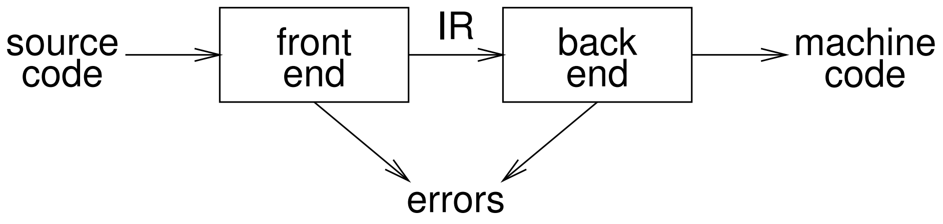

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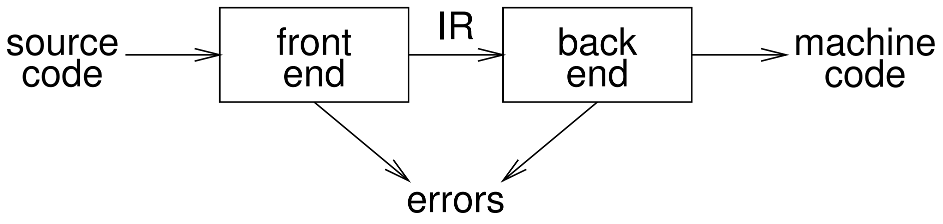

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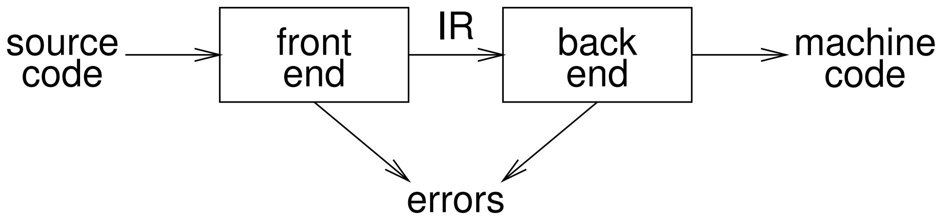
$$\begin{tikzcd}
\text{source code} \arrow[r] & \boxed{\text{front end}} \arrow[r, "\text{IR}"] \arrow[dr] & \boxed{\text{back end}} \arrow[r] \arrow[d] & \text{machine code} \\
& & \text{errors} &
\end{tikzcd}$$

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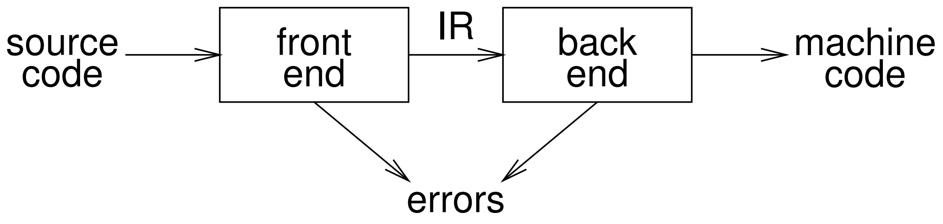

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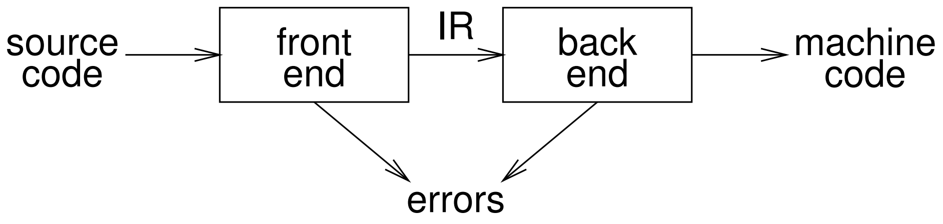

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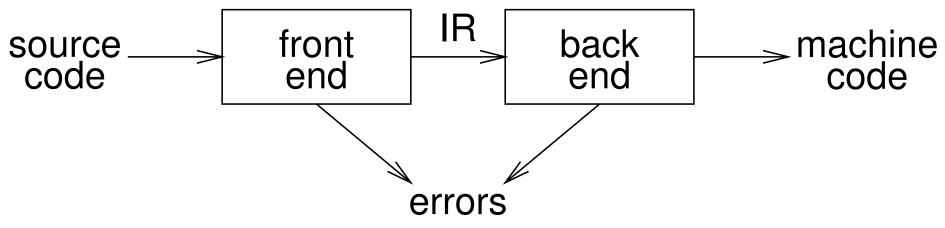

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Our focus: Mainly front end and little bit of back end.

Administrivia

- Lecture Timings
  - Slot B: Monday 9 AM, Wednesday 1 PM, Friday 11 AM
  - Online on Google Meet
- Course Webpage: https://kartiknagar.github.io/courses/compiler/
- Course Moodle page: TBD
  - Lecture slides, links to video lectures, etc. will be uploaded here.
- Course Google group: CS3300-Aug-Nov-2021
- Instructor e-mail address: nagark@cse.iitm.ac.in
  - Instructor Office Hours: None.
  - Feel free to e-mail me if you want to meet. TA Office hours will be announced soon.

Grading Policy (tentative)

- Theory: 60%, Lab: 40%
- Theory
  - Quiz 1: 14%, Quiz 2: 14%, Endsem: 30%
  - Class Participation: 2%.
  - Class Participation will be monitored throughout the semester. You can participate by asking/answering questions during the lectures and/or in the Google group forum.
- Lab: 5 Assignments. More details will be announced by the end of the week.

Course outline

- Overview of Compilers
- Lexical Analysis and Parsing
- Type checking
- Intermediate Code Generation
- Register Allocation
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- Overview of advanced topics.

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Goal of the course: At the end of the course, students will have a fair understanding of some standard passes in a general purpose compiler. Students will have hands on experience on implementing a compiler for a subset of Java.

Course Textbooks

- Compilers: Principles, Techniques, and Tools, Alfred Aho, Monica Lam, Ravi Sethi, Jeffrey D. Ullman. Addison-Wesley, 2007 [**The Dragon Book**].
- Modern compiler implementation in Java, Second Edition, Andrew W. Appel, Jens Palsberg. Cambridge University Press, 2002.

Your friends: Languages and Tools

Start exploring

- C and Java - familiarity a must - Use of a SDE like Eclipse is recommended.
- Flex, Bison, JavaCC, JTB – tools you will learn to use.
- Make / Ant / Scripts – recommended toolkit.

Acknowledgement

These slides are heavily adapted from the slides prepared by Prof. V Krishna Nandivada @ IIT Madras. Liberal portions of text are also taken verbatim from Antony L. Hosking @ Purdue, Jens Palsberg @ UCLA, Alex Aiken @ MIT and the Dragon book.