Introduction

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Outline

Lecturer In Charge

- **My name:** Nguyen Hua Phung
- **Email:** nhphung@hcmut.edu.vn
- **Office hour:** 10:00-11:30 Wednesday at CS1
- **Office hour:** 16:00-17:30 Thrusday at Room 703-CS2
- **Sakai:** https://elearning-cse.hcmut.edu.vn

References

- Programming Languages: Principles And Paradigms, Maurizio Gabbrielli and Simone Martini, Springer, 2006.
- Programming Languages: Principles and Practices, Kenneth C. Louden, Thomson Brooks/Cole, 2003.
- Ngon Ngu Lap Trinh: Cac nguyen ly va mo hinh, Cao Hoang Tru, 2004.

Assessment

- Tutorial/Lab/Online: 10%
- Assignment: 30%
- Midterm: 20%
- Final: 40%

Note: Assignment is calculated by the following formula:

$$Assignment = 2 * \frac{A * B}{A + B}$$

where A is from some given project and B is from some questions in midterm or final

Objectives

After complete this subject, students are able to:

- describe formally lexicon and grammar of a programming language
- describe and explain some mechanism of a programming language
- implement a interpreter/compiler for a simple programming language

Benefits of Studying

- Increased capacity to express idea
- Improved background for choosing appropriate languages
- Increased ability to learn new languages
- Better understanding of the significance of implementation
- Better use of languages that are already known
- Overall advancement of computing

Programming Domains

- Scientific Applications
  Fortran, ALGOL 60
- Business Applications
  COBOL
- Artificial Intelligence
  LISP, Prolog
- Systems Programming
  PL/S, BLISS, Extended ALGOL, and C
- Web Software
  XHTML, JavaScript, PHP

Language Characteristics

- Simplicity
- Orthogonality
- Support of abstraction (Control, Data)
- Safety
- ...

Evaluation

- Readability
- Writability
- Reliability
- Cost

Influences on Language Design

- Computer Architecture
  - Von Neumann
- Programming Methodologies
  - Imperative
    - Machine-based
    - Procedural
  - Declarative
    - Logic
    - Functional
    - Constraint
    - Query-based
  - Object-Oriented
  - ...

Computer Architecture Influence

- Well-known computer architecture: Von Neumann
- Imperative languages, most dominant, because of von Neumann computers
  - Data and programs stored in memory
  - Memory is separate from CPU
  - Instructions and data are piped from memory to CPU
  - Basis for imperative languages
  - Variables model memory cells
  - Assignment statements model writing to memory cell
  - Iteration is efficient

Programming Methodologies Influences

- 1950s and early 1960s: Simple applications; worry about machine efficiency
- Late 1960s: Efficiency became important; readability, better control structures
  - Structured programming
  - Top-down design and step-wise refinement
- Late 1970s: Process-oriented to data-oriented
  - data abstraction
- Middle 1980s: Object-oriented programming
  - Data abstraction + inheritance + polymorphism

Language Paradigms

- Imperative (C, Pascal)
  - Central features are variables, assignment statements, and iteration
- Functional (LISP, Scheme, Haskel, Ocaml, Scala)
  - Main means of making computations is by applying functions to given parameters
- Logic (Prolog)
  - Rule-based (rules are specified in no particular order)
- Object-oriented (Java, C++, Scala)
  - Data abstraction, inheritance, late binding
- Markup (XHTML, XML)
  - New; not a programming per se, but used to specify the layout of information in Web documents

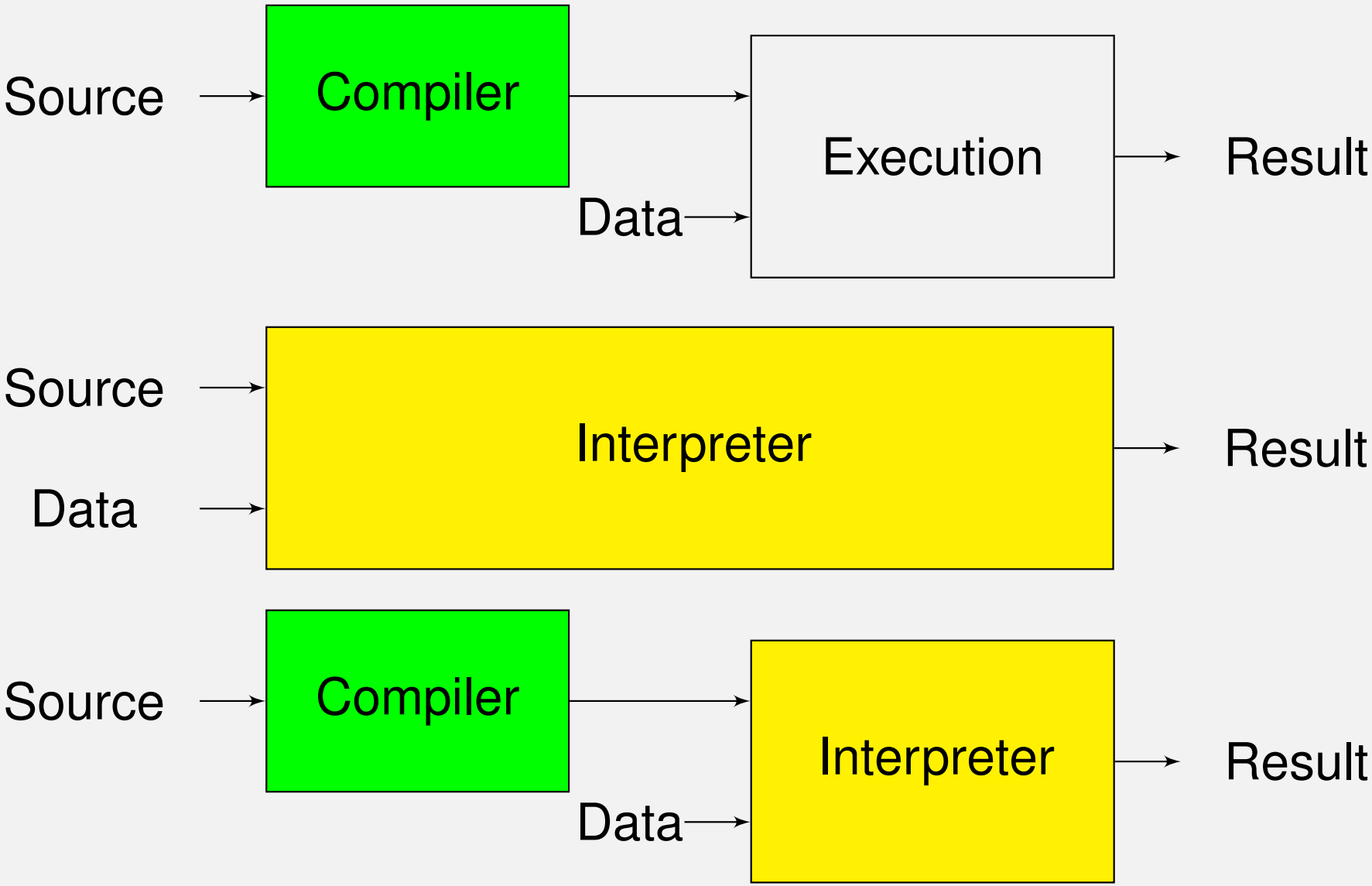
Language Design Trade-Offs

- Reliability vs. cost of execution
  - Conflicting criteria
  - Example: Java demands all references to array elements be checked for proper indexing but that leads to increased execution costs
- Readability vs. writability
  - Another conflicting criteria
  - Example: APL provides many powerful operators (and a large number of new symbols), allowing complex computations to be written in a compact program but at the cost of poor readability
- Writability (flexibility) vs. reliability
  - Another conflicting criteria
  - Example: C++ pointers are powerful and very flexible but not reliably used

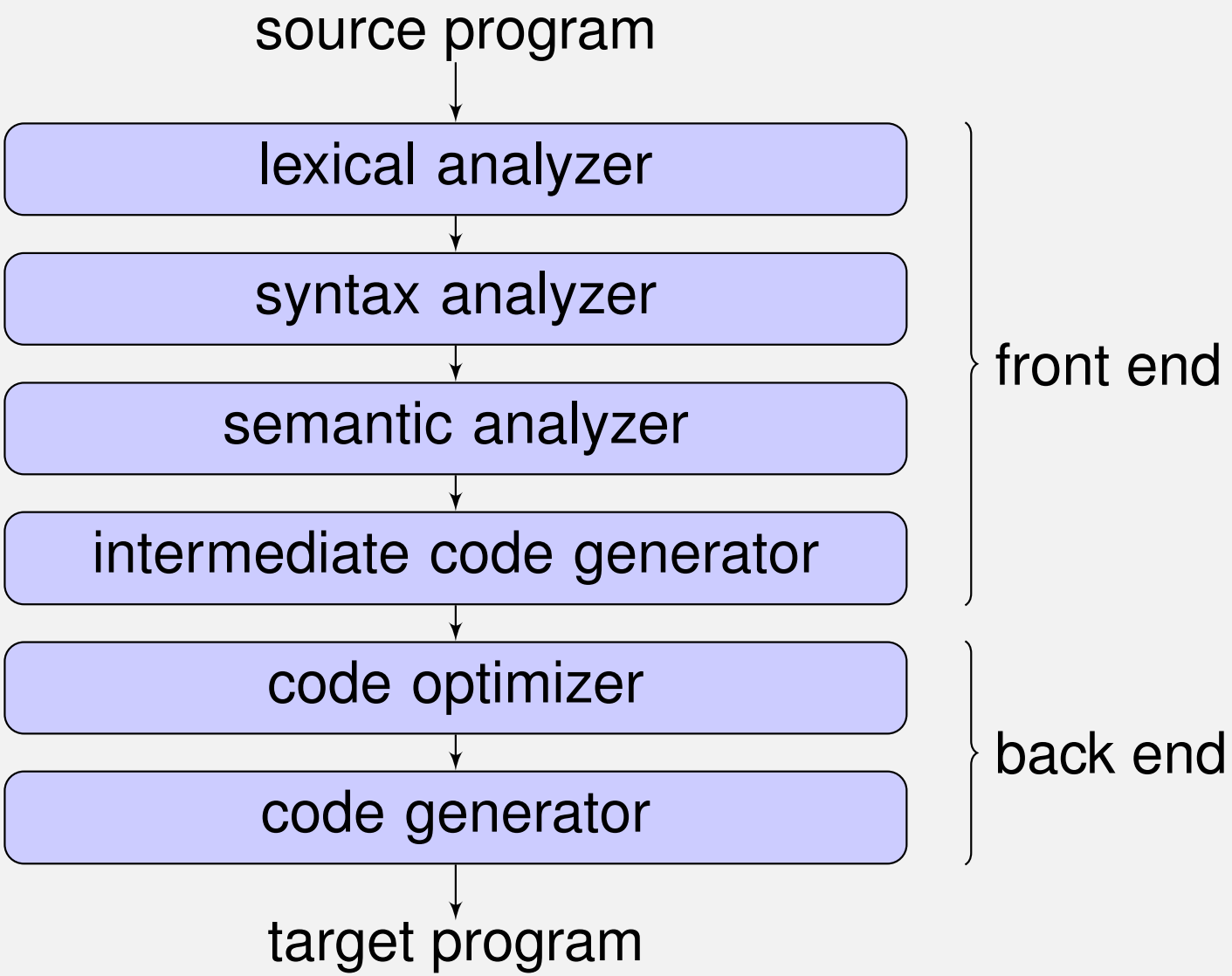
Implementation Methods

- **Compilation**
  Programs are entirely translated into machine language and then executed
- **Pure Interpretation**
  Programs are translated and executed line-by-line
- **Hybrid Implementation Systems**
  A compromise between compilers and pure interpreters
- **Just-in-time Compiler**
  A compiler inside an interpreter compiles just hot methods

Implementation Methods



Compilation Phases



Related Programs

- Preprocessor
- Assembler
- Linker
- Loader
- Debugger
- Editor

Summary

What are still in your mind?