

CS 160 Compilers

Lecture 1: Hello World!

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WeChat: cstutorcs

Yu Feng
Spring 2023

Introducing the cast

Instructor: Yu Feng yufeng@cs.ucsb.edu

Course website: <https://github.com/fredfeng/CS160>
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Research areas: <https://tutorcs.com> programming languages, program analysis,
program synthesis, software and blockchain security
WeChat: [estutorcs](#)

Website: <http://fredfeng.github.io/>

Office hour: Wed 3-4pm (HFH 2157)

Introducing the cast

TA: Junrui Liu (junrui@ucsb.edu)

Office hour: Fri TBD

TA: ~~Assignment Project Exam Help~~ Thanawat Techaumnaiwit
(thanawat@umail.ucsb.edu)

Office hour: <https://tutorcs.com> Tue TBD

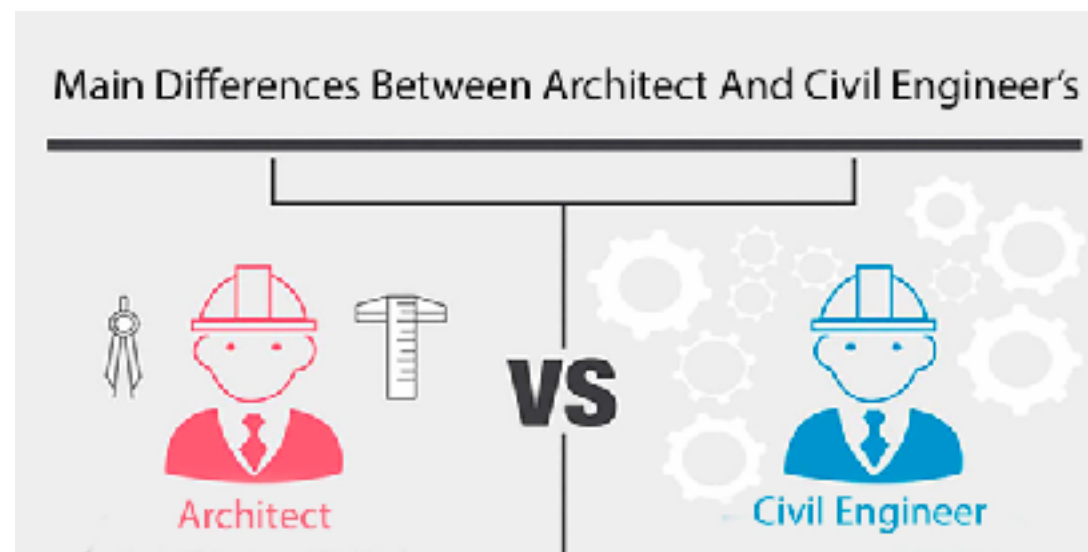
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TA: Jingtao Xia (jingtaoxia@ucsb.edu)

Office hour: Thur TBD

Discussion session: Fri 9am - 11:50am

PL (CS162) v.s. Compiler (CS160)



What can we learn

You will learn:

- Functional programming in OCaml
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- Lexing/Parsing/Codegen
<https://tutorcs.com>
- How high-level languages are implemented in machine language
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- A little about programming language semantics & types
- build a compiler (Patina) from scratch
- A deeper understanding of code: a better programmer

<https://junrui-liu.github.io/patina/>

What is a compiler

- A compiler is a program that translates from one programming language to another
- High-level source code to low-level machine code

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History of compilers

What is the first language?

- Until the 1950's: computers were programmed in assembly.
- 1951—1952: Grace Hopper
 - developed the A-0 system for the UNIVAC I
 - Contributed significantly to the design of COBOL
- 1957: FORTRAN compiler built at IBM
- 1960's: development of the first bootstrapping compiler for LISP
- Today: thousands of languages (most little used)



Source Code

- Optimized for human readability

Why do we need compiler?

- Expressive: matches human ideas of grammar / syntax / meaning
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- Redundant: more information than needed to help catch errors
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- Abstract: data structures, design patterns, etc.

```
#include <stdio.h>

int factorial(int n) {
    int acc = 1;
    while (n > 0) {
        acc = acc * n;
        n = n - 1;
    }
    return acc;
}

int main(int argc, char *argv[]) {
    printf("factorial(6) = %d\n", factorial(6));
}
```


Machine Code

- Optimized for Hardware
- Machine code hard for people to read
- Reduce redundancy & ambiguity
- Abstractions & information about intent is lost
- Assembly language — then machine language

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```
_factorial:
## BB#0:
    pushl   %ebp
    movl    %esp, %ebp
    subl    $8, %esp
    movl    8(%ebp), %eax
    movl    %eax, -4(%ebp)
    movl    $1, -8(%ebp)
LBB0_1:
    cmpl    $0, -4(%ebp)
    jle     LBB0_3
## BB#2:
    movl    -8(%ebp), %eax
    imull   -4(%ebp), %eax
    movl    %eax, -8(%ebp)
    movl    -4(%ebp), %eax
    subl    $1, %eax
    movl    %eax, -4(%ebp)
    jmp     LBB0_1
LBB0_3:
    movl    -8(%ebp), %eax
    addl    $8, %esp
    popl    %ebp
    retl
```

How to translate

- Mismatch between source code and machine code
- Some languages are farther from machine code than others: C++, Java, Lisp, ML, Haskell, Ruby, Python, Javascript...

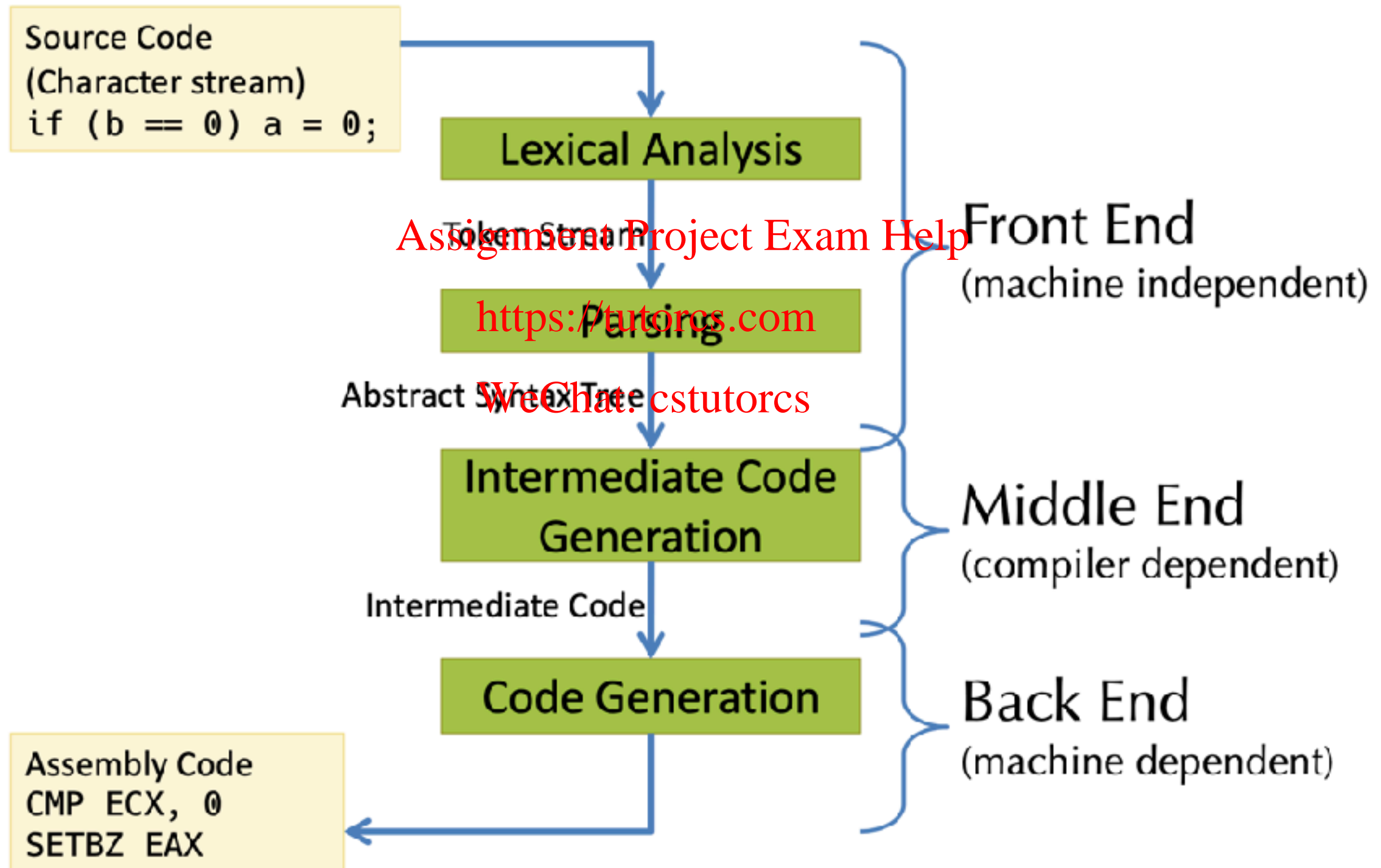
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- Goals of translation:
 - Source level expressiveness for the task
 - Best performance for the concrete computation
 - Reasonable translation efficiency
 - Maintainable code – Correctness!

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Compiler Structure



Red or Blue

THE CHOICE IS YOURS

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Grading

- Programming assignments: 100%
- 5 (PA1-PA5) programming assignments, 20% each

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Programming assignments

- Please check the website regularly
- Deadline extension:
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 - Ten “late days” <https://tutorcs.com>
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 - Plan ahead, no other extensions

Programming assignments

Unfamiliar languages

OCaml is hard

+ Unfamiliar environments

+ Racket is @!#@%

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Start early!

<https://tutorcs.com>

Start early!



Free your mind

Academic integrity

- All assignments should be done ALONE
- We use MOSS to detect plagiarism
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- Have code from public repos
<https://tutorcs.com>
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- Make sure your repo private
- “F” if you violate the honor code

Course logistics

Website: <https://github.com/fredfeng/CS160>

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Q&A: Please join us ASAP via this QR code
<https://tutorcs.com>



TODOs by next lecture

- Join Slack for CS160!
- Install/try OCaml on your laptop
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- Get familiar with your new friend: Patina manual
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