Want to Write a Compiler?

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COMP 3002

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What is a Compiler?

- From Day 1:
  - A compiler is a program that translates
  - from a source language S
  - into a target language T
  - while preserving semantics
- Often (but not always)
  - S is a programming language
  - T is a machine language

Want to Write a Compiler?

- A compiler has 3 main parameter
  - Source language (S)
    - What kind of input does the compiler take?
    - C, C++, Java, Python, ...
  - Implementation language (I)
    - What language is the compiler written in?
    - C, Java, i386, x84_64
  - Target language (T)
    - What is the compiler's target language
    - i386, x86_64, PPC, MIPS, ...

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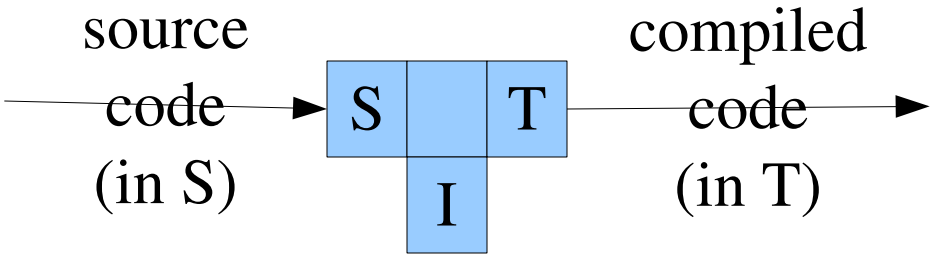


Source Language Issues

- Complexity
  - Is a completely handwritten compiler feasible?
- Stability
  - Is the language definition still changing?
- Novelty
  - Do there already exist compilers for this language?
- Complicated, or still-changing languages promote the use of compiler generation tools

Target Language Issues

- Novelty
  - Is this a new architecture?
  - Are there similar architectures/instruction sets?
- Available tools
  - Is there an assembler for this language?
  - Are there other compilers for this language?

Performance criteria

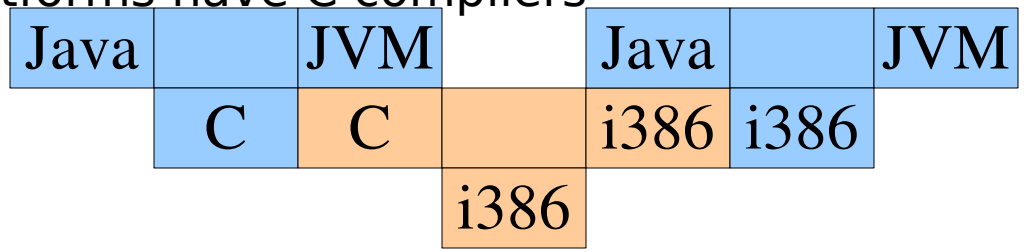
- Speed
  - Does it have to be a fast compiler?
  - Does it have to be a small compiler?
  - Does it have to generate fast code?
- Portability
  - Should the compiler run on many different architectures (*rehostability*)
  - Should the compiler generate code for many different architectures (*retargetability*)

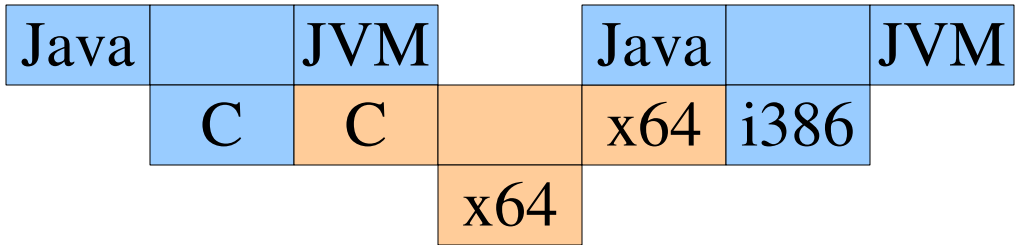
Possible Workarounds

- Rewrite an existing front end
  - when the source is new
  - reuse back (code generation) end of the compiler
- Rewrite an existing back end
  - when the target architecture is new
  - retarget an existing compiler to a new architecture
- What happens when both the source language and target language are new?
  - Write a compiler from scratch?
  - Do we have other options?

Composing Compilers

- Compilers can be composed and used to compile each other
- Example:
  - We have written a Java to JVM compiler in C and we want to make it to run on two different platforms i386 and x86_64
  - both platforms have C compilers





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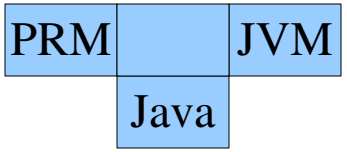
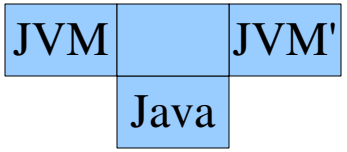
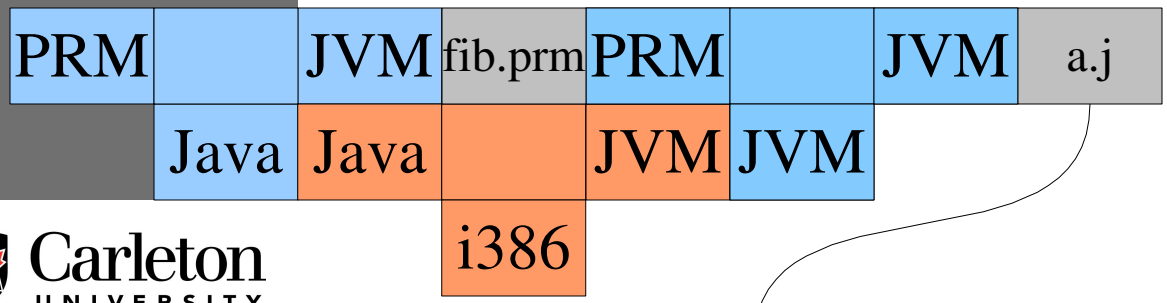
Example

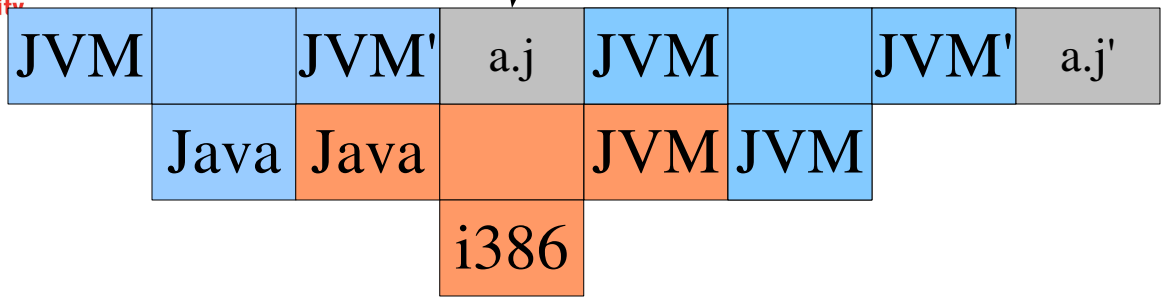
- Assignment 3:



- Assignment 4:







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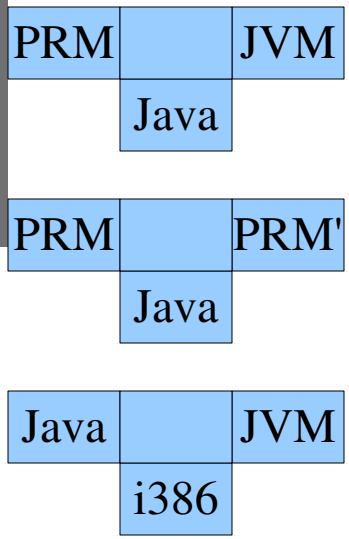
Example

- Show how to
  - To take your PRM compiler and make it faster
  - To take your Jasmin optimizer and make it faster



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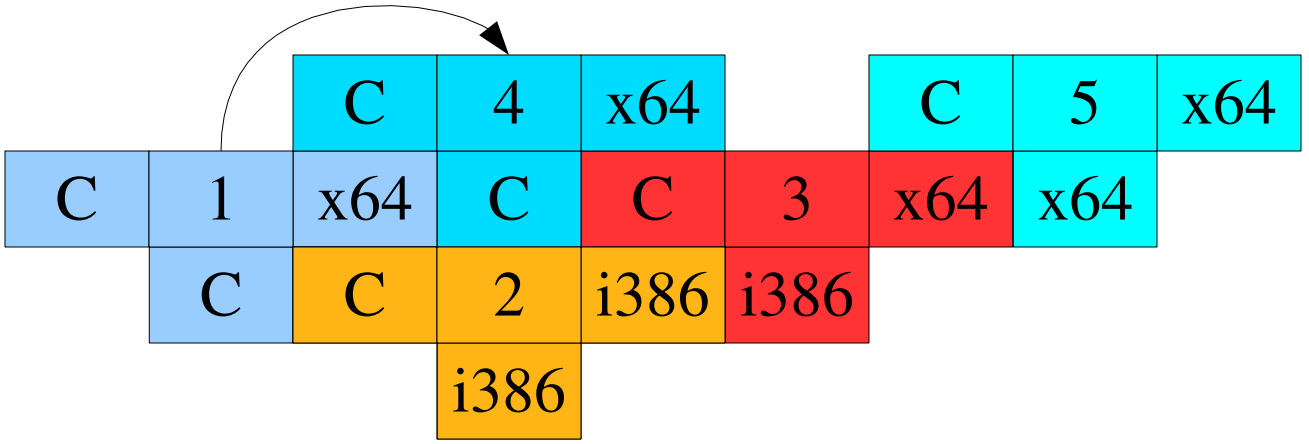
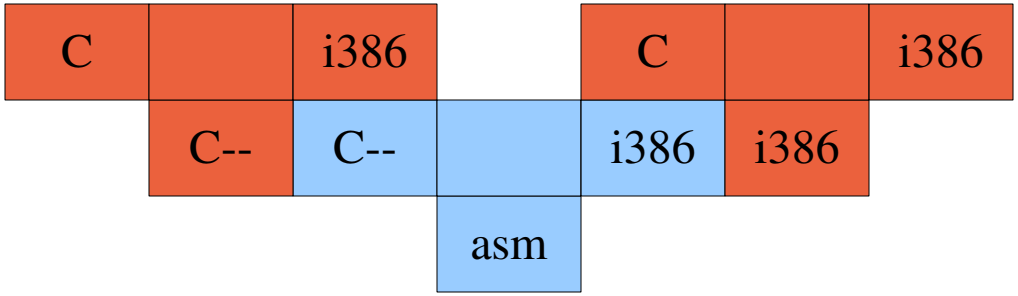
Bootstrapping by cross-compiling

- Sometimes the source and implementation language are the same
  - E.g. A C compiler written in C
- In this case, cross compiling can be useful



Bootstrapping Cont'd

- Bootstrapping by reduced functionality
  - Implement, in machine language, a simplified compiler
    - A subset of the target language
    - No optimizations
  - Write a compiler for the full language in the reduced language



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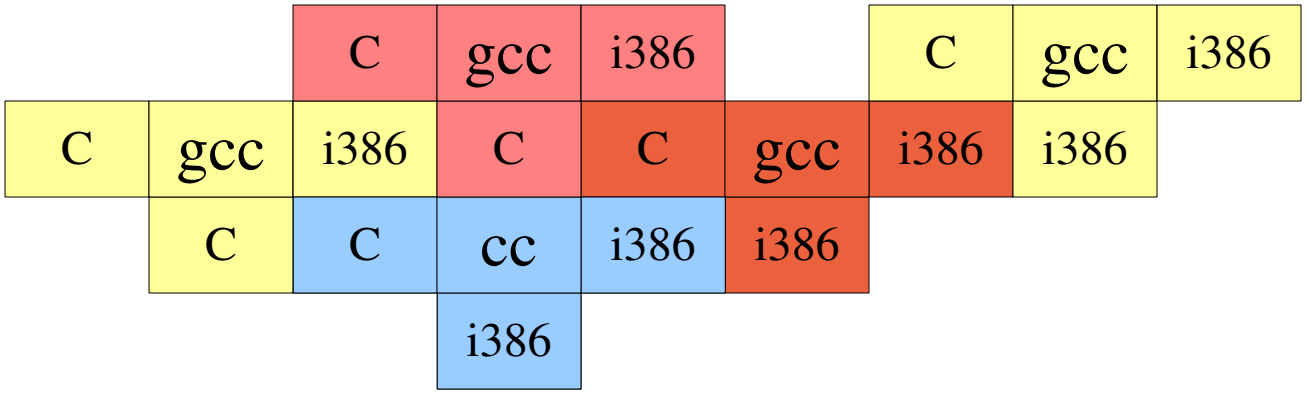
Bootstrapping for Self-Improvement

- If we are writing a good optimizing compiler with I=S then
  - We can compile the compiler with itself
  - We get a fast compiler
- gcc does this (several times)



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Summary

- When writing a compiler there are several techniques we can use to leverage existing technology
  - Reusing front-ends or back ends
  - Cross-compiling
  - Starting from reduced instruction sets
  - Self-compiling