

# Overview of the Course



#### Welcome to CISC 672 — Advanced Compiler Construction

<u>Topics</u> in the design of programming language translators, including parsing, semantic analysis, error recovery, code generation, and optimization

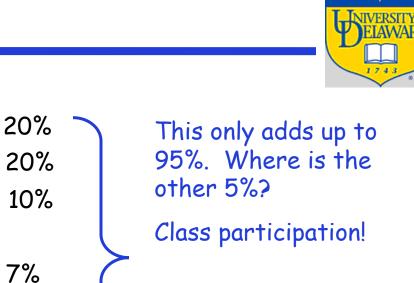
- Instructor: Dr. John Cavazos (cavazos@cis.udel.edu)
- Office Hours: Tues/Thurs 3PM to 4PM, Smith Hall 412
- Text: Engineering a Compiler by Keith Cooper and Linda Torzcan
- Web Site: http://www.cis.udel.edu/~cavazos/CISC672
  - → Lab handouts, homework, slides, practice exams, ...
  - $\rightarrow$  I will not have handouts in class; get them from the web

Lab data is on the web site

Basis for	Grading
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→ Midterm

Exams 



Projects 

 $\rightarrow$  Final

Quizzes

- $\rightarrow$  Scanner
- $\rightarrow$  Parser
- $\rightarrow$  Semantic Analyzer
- 15%  $\rightarrow$  Code Generation

Notice: Any student with a disability requiring accommodations in this class is encouraged to contact me after class or during office hours, and to contact UDel's Coordinator for Disabled Student Services.

8%

15%



## Basis for Grading



<ul> <li>Exams         <ul> <li>→ Midterm</li> <li>→ Final</li> </ul> </li> </ul>	<ul> <li>◆ Closed-notes, closed-book</li> <li>◆ Old exam on web site as an example</li> </ul>
• Quizzes	<ul> <li>Reinforce concepts</li> <li>Number of quizzes <i>t.b.d.</i></li> </ul>
<ul> <li>Projects         <ul> <li>→ Parser (&amp; scanner)</li> <li>→ Semantic Analyzer</li> <li>→ Code Generation</li> </ul> </li> </ul>	<ul> <li>Parser lab might be a team lab</li> <li>High ratio of thought to programming</li> <li>Will build a compiler for a language called COOL (Java)</li> </ul>

## Rough Syllabus

•	Overview	§ 1
•	Scanning	§ 2
•	Parsing	§ 3
•	Context Sensitive Analysis	§ 4
•	Inner Workings of Compiled Code	§6,7
•	Introduction to Optimization	§ 8
•	Instruction Selection	§ 11
•	Instruction Scheduling	§ 12
•	Register Allocation	§ 13
	Mana Optimization (time normitting)	

• More Optimization (*time permitting*)



### Class-taking technique for CISC 672



- I will use projected material extensively
  - → I will moderate my speed, you sometimes need to say "STOP"
- You should read the book
  - $\rightarrow$  Not all material will be covered in class
  - $\rightarrow$  Book complements the lectures
- You are responsible for material from class
  - $\rightarrow$  The tests will cover both lecture and reading
  - $\rightarrow$  I will probably hint at good test questions in class
- CISC 672 is not a programming course
  - → Projects are graded on functionality, documentation, and lab reports more than style (*results matter*)
- It will take me time to learn your names (please remind me)

ELAWARE 1743

• What is a compiler?



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  - → A program that translates a program in one language into a program in another language
  - → The compiler should improve the program, *in some way*
- What is an interpreter?



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- C is typically compiled, Scheme is typically interpreted
- Java is compiled to bytecodes (code for the Java VM)
  - $\rightarrow$  which can then interpreted
  - $\rightarrow$  Or a hybrid strategy is used
    - Just-in-time compilation

- Compiler Technology
  - → Offline
    - Typically C, C++, Fortran
  - → Online
    - Typically Java, C##
  - $\rightarrow$  Goals: improved performance and language usability
    - Making it practical to use the full power of the language
  - → Trade-off: preprocessing time versus execution time (or space)
  - → Rule: performance of both compiler and application must be acceptable to the end user



### Why Study Compilation?



- Compilers are important system software components
  - → They are intimately interconnected with architecture, systems, programming methodology, and language design
- Compilers include many applications of theory to practice
  - $\rightarrow$  Scanning, parsing, static analysis, instruction selection
- Many practical applications have embedded languages
   Commands, macros, formatting tags ...
- Many applications have input formats that look like languages,
  - → Matlab, Mathematica
- Writing a compiler exposes practical algorithmic & engineering issues
  - → Approximating hard problems; efficiency & scalability



Compiler construction involves ideas from many different parts of computer science

Artificial intelligence	Greedy algorithms Heuristic search techniques
Algorithms	Graph algorithms, Dynamic programming
Theory	DFAs & PDAs, pattern matching Fixed-point algorithms
Systems	Allocation & naming, Synchronization, locality
Architecture	Pipeline & hierarchy management Instruction set use



- Compiler construction poses challenging and interesting problems:
  - $\rightarrow$  Compilers must do a lot but also run fast
  - → Compilers have responsibility for run-time performance
  - → Compilers are responsible for making it acceptable to use the full power of the programming language
  - → Computer architects perpetually create new challenges for the compiler by building more complex machines
  - → Compilers must hide that complexity from the programmer
  - → Success requires mastery of complex interactions



"Optimization for scalar machines is a problem that was solved ten years ago." David Kuck, Fall 1990



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- Architectures keep changing
- Languages keep changing
- Applications keep changing
- When to compile keeps changing



- My own research
  - → Applying machine learning to solve hard systems problems
  - → Compiling for advanced microprocessor systems
  - $\rightarrow$  Interplay between static and dynamic compilation
  - → Optimization for embedded systems (*space, power, speed*)
  - $\rightarrow$  Interprocedural analysis and optimization
  - → Nitty-gritty things that happen in compiler back ends
  - → Distributing compiled code in a heterogeneous environment
  - $\rightarrow$  Rethinking the fundamental structure of optimizing compilers
- Thus, my interests lie in
  - → Building "Intelligent" Compilers
  - → Quality of generated code(smaller, more efficient, faster)
  - $\rightarrow$  Interplay between compiler and architecture
  - → Static analysis to discern program behavior
  - $\rightarrow$  Run-time performance analysis

#### Next class



- The view from 35,000 feet
  - $\rightarrow$  How a compiler works
  - $\rightarrow$  What I think is important
  - $\rightarrow$  What is hard and what is easy