

Carleton University, School of Computer Science

Comp 3002 Compiler Construction, Winter 2023

Class Times: Wed 6pm (3 hours), Room 502 Southampton Hall

Instructor: Wilf Lalonde contact: wilf.lalonde@gmail.com

TAs:

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Help Sessions (voluntary but recommended) Sat 9am (4th year labs, as long as you want). The idea is to work on the actual assignments with help from me and Tas. If there is demand, we can schedule additional weekday labs.

Course Description: This course will provide students with several important skills:

- (a) A better understanding of parser/scanner constructors since we will be implementing most parts.
- (b) A better understanding of compilers since we will learn how to build one.

Course Goals: To develop the tools needed to write a compiler for a simple language and to write a compiler using those tools.

Contact: wilf.lalonde@gmail.com

Notes: Available through brightspace

Text: None although you may reference any compiler book using LR(k) technology. The course, however, deals with more advanced technology.

Help session: Provide advice and help as you work on the assignments.

Prerequisites: One of COMP 2402, SYSC 2100.

Course Work: Approximately 10. Last year, we used Smalltalk (hand in entire Smalltalk folder). This year, Swift is being considered as an alternative for Smalltalk but will require extra effort on your part since there are no formal Swift training sessions. No tests or exams.

Handing in: Assignments generally handed out at Wednesday class and due 8 days later Thursday at midnight to take advantage of the Saturday help session. Marked A, B, C, F for **100%, 70%, 50%, 0%..** Hand-in via <https://carleton.ca/brightspace/>

Course Outline

Novelty

Compilers consist of a 3 translators: scanner, parser, code generator. The details are traditionally introduced in that order. Instead, we consider code generators first making it clear that translation is the essence of each stage.

Introduction:

A quick review of the components of a compiler, table driven scanners, table driven tree building parsers, tree walkers for code generation. A quick review of the process of designing a language for which a compiler is to be built.

Scanner/Parsers

A discussion of the details of a table driven scanner/parser and how it works.

The infrastructure for parsers/scanners

Detailed discussion of finite state machines and regular expressions and their use in transduction grammars. This includes operations such *, +, &, |, -, and . (concatenation).

Converting a transduction grammar with regular expression right parts into a transduction grammar with FSM right parts.

This is a tree walking process akin to code generation but used instead in the context of grammar conversion.

Theoretical underpinnings for transduction grammars

Regular grammars, context free grammars, regular right part grammars, parse trees versus abstract syntax trees, handles, regular right part transductions grammars, LL(k) versus LR(k) grammars.

Constructing tables for regular right part grammars

More than shift-reduce tables; specifically, how to construct readahead FSMs for finding the right end of a handle, readback FSMs for finding the left end of a handle, and semantic action states for tree building along with their conversion into table format for use by scanners/parsers. Overview of the process followed by detailed coverage.

Symbol tables

Techniques for dealing with scoping in typical programming languages.

Code Generation Basics

Machine versus virtual machine instruction sets. Code generation basics for virtual machine instruction sets. The distinction between expression contexts which requires a value on the virtual machine stack versus statement contexts which do not with several examples of language constructs that can be used in both contexts.

More advanced code generation

Dealing with if statements, while loops, for loops. Dealing with short circuit boolean operations such as &&, ||, and ! which DO NOT require the use of And, Or, or Not virtual machine instructions.

Other Topics

Chain reduction optimizations for parsers. Non-canonical parsers.

Undergraduate Academic Advisor

The Undergraduate Advisor for the School of Computer Science is available in Room 5302C HP; by telephone at 520-2600, ext. 4364; or by email at undergraduate_advisor@scs.carleton.ca. The undergraduate advisor can assist with information about prerequisites and preclusions, course substitutions/equivalencies, understanding your academic audit and the remaining requirements for graduation. The undergraduate advisor will also refer students to appropriate resources such as the Science Student Success Centre, Learning Support Services and Writing Tutorial Services.

SCS Computer Laboratory

SCS students can access one of the designated labs for your course. The lab schedule can be found at: <https://carleton.ca/scs/tech-support/computer-laboratories/>. All SCS computer lab and technical support information can be found at: <https://carleton.ca/scs/technical-support/>. Technical support is available in room HP5161 Monday to Friday from 9:00 until 17:00 or by emailing support@scs.carleton.ca.

University Policies

For information about Carleton's academic year, including registration and withdrawal dates, see [Carleton's Academic Calendar](#).

Pregnancy Obligation. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, visit [Equity Services](#).

Religious Obligation. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, visit <https://carleton.ca/equity/focus/discrimination-harassment/religious-spiritual-observances/>.

Academic Accommodations for Students with Disabilities If you have a documented disability requiring academic accommodations in this course, please contact the Paul Menton Centre for Students with Disabilities (PMC) at 613-520-6608 or pmc@carleton.ca for a formal evaluation or contact your PMC coordinator to send your instructor your Letter of Accommodation at the beginning of the term. You must also contact the PMC no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with your instructor as soon as possible to ensure accommodation arrangements are made. For more details, visit the [Paul Menton Centre website](#).

Survivors of Sexual Violence. As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: carleton.ca/sexual-violence-support

Accommodation for Student Activities. Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see [the policy](#).

Student Academic Integrity Policy. Every student should be familiar with the Carleton University student academic integrity policy. A student found in violation of academic integrity standards may be awarded penalties which range from a reprimand to receiving a grade of *F* in the course or even being expelled from the program or University. Examples of punishable offences include: plagiarism and unauthorized co-operation or collaboration. Information on this policy may be found [here](#).

Plagiarism. As defined by Senate, "plagiarism is presenting, whether intentional or not, the ideas, expression of ideas or work of others as one's own". Such reported offences will be reviewed by the office of the Dean of Science. Standard penalty guidelines can be found [here](#).

Unauthorized Co-operation or Collaboration. Senate policy states that "to ensure fairness and equity in assessment of term work, students shall not co-operate or collaborate in the completion of an academic assignment, in whole or in part, when the instructor has indicated that the assignment is to be completed on an individual basis". Please refer to the course outline statement or the instructor concerning this issue.

Special Information

It is important to remember that COVID is still present in Ottawa. The situation can change at any time and the risks of new variants and outbreaks are very real. There are a number of actions you can take to lower your risk and the risk you pose to those around you including being vaccinated, wearing a mask, staying home when you're sick, washing your hands and maintaining proper respiratory and cough etiquette.

Feeling sick? Remaining vigilant and not attending work or school when sick or with symptoms is critically important. If you feel ill or exhibit COVID-19 symptoms do not come to class or campus. If you feel ill or exhibit symptoms while on campus or in class, please leave campus immediately. In all situations, you must follow Carleton's symptom reporting protocols.

Masks: Carleton has paused the COVID-19 Mask policy, but continues to strongly recommend masking when indoors, particularly if physical distancing cannot be maintained. It may become necessary to quickly reinstate the mask requirement if pandemic circumstances were to change.

Vaccines: While proof of vaccination is no longer required as of May 1 to attend campus or in-person activity, it may become necessary for the University to bring back proof of vaccination requirements on short notice if the situation and public health advice changes. Students are strongly encouraged to get a full course of vaccination, including booster doses as soon as they are eligible, and submit their booster dose information in cuScreen as soon as possible. Please note that Carleton cannot guarantee that it will be able to offer virtual or hybrid learning options for those who are unable to attend the campus.

All members of the Carleton community are required to follow requirements and guidelines regarding health and safety which may change from time to time. For the most recent information about Carleton's COVID-19 website and review the Frequently Asked Questions (FAQs). Should you have additional questions after reviewing, please contact covidinfo@carleton.ca.

Doctor's note or medical certificate: in effect for Winter 2023 term. In place of a doctor's note or medical certificate, students are advised to complete the [self-declaration form](#) available on the Registrar's Office website to request academic accommodation for missed course work including exams and assignments. Students should also discuss with the course instructor the required accommodations arising from the COVID-19 situation.