

CS 320 Concepts of Programming Languages • 3 credits • Spring 2018

CRN: 31176 • MW 10:30-11:45 • Dana 318

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Office Hours Mondays 12:00-1:30 & Wednesdays 12:00-3:00 and by appointment – Dana 335

Course Description

Introduction to programming language paradigms including imperative, functional, object-oriented, logic, and concurrent. Example languages of each paradigm is compared and contrasted. Abstract programming language description is introduced.

Course Objectives

The goal of this course is to provide students with the tools necessary for the critical evaluation of existing and future programming languages and constructs. It should answer a myriad of questions including: Why are there so many different programming languages? How and why were they developed? In what ways are they similar? What are their differences? What kinds of programming languages may be developed and used in the future? Why wouldn't we simply continue to use what we have now?

Outcomes:

1. Students will be able to understand and write context-free grammars using BNF/EBNF notations and syntax diagrams.
2. Students will be able to understand core programming language concepts that include types, polymorphism, scopes, memory management, parameter passing styles, and formal semantics.
3. Students will be able to understand and use the concepts of:
 1. functional programming - pattern matching, type inference, parametric polymorphism, nested functions, higher-order functions, data and type constructors,
 2. object-oriented programming - inheritance, encapsulation, subtyping polymorphism, dynamic dispatch, and exception handling,
 3. logic programming - resolution and unification.
4. Students will be able to write simple programs using the programming languages Scheme, ML, Java, C, C++, and Prolog.

Course Pre-requisites

CS 220

Expectations

Each student is expected to attend classes and take notes. Read the textbook(s) before attending class. Turn in homework, and other assignments on time. Take quizzes and exams as scheduled. The instructor is available for help during scheduled office hours (check "Instructor Information") and also by appointment. Please do not wait until an exam to get help. Seek help as soon as possible. You will need to allocate about **12 hours of your week** towards this course. This time will be used for the following:

- reading the chapters in the text book assigned
- completing activities assigned
- completing homework assignments
- studying for tests and exams

If you need help with the course, please do not wait until it's too late. Your first course of action is to ask to meet your instructor. You may also see CS tutors in the CS Lab. If you need help resolving a programming error, please send only the lines of code necessary (not the entire program) and explain what is happening or not happening carefully.

Textbooks

	<p>Modern Programming Languages</p> <ul style="list-style-type: none">• Author: Webber• ISBN: 9781590282502• Edition: 2nd• Publisher: Franklin, Beedle & Associates• Paperback or e-book• Errata, source code, etc.
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Software

Latest versions of:

1. Racket (Scheme) at <http://racket-lang.org/>. The Racket Guide at <https://docs.racket-lang.org/guide/index.html>.
2. Standard-ML (ML) at <http://www.smlnj.org/> or online at https://www.tutorialspoint.com/execute_smlnj_online.php
3. SWI-Prolog (Prolog) at <http://www.swi-prolog.org/> or https://www.tutorialspoint.com/execute_prolog_online.php
4. Java SE Development Kit (Java) at <http://www.oracle.com/technetwork/java/javase/downloads/jdk-7u2-download-1377129.html> Also, the Oracle tutorial is at <http://docs.oracle.com/javase/tutorial/>
5. Visual Studio (C++) at <http://www.microsoft.com/visualstudio/eng/downloads#d-express-windows-desktop>

CS Computer Account

All CS students have been given a "CS Account". This computer account works in Dana 230 (CS lab) and Dana 318 (CS classroom). The software required for this course are available in these rooms.

Hardware Notes

- Data is erased from lab computers in D318 and D230 every time you log out. You must remember to manage the various files you use/create accordingly.
- Students may choose to use a USB flash drive (jump drive) to store their work. If so, you will need a 1GB or larger drive and you should bring it to every class. Alternatively, you may store your data on the CS department file server (accessible as the G: drive) or you may upload your files to the cloud.
- Remember that computer storage devices do fail. You are advised to make regular backups of your work using multiple devices. Loss of data due to disk failure is not an acceptable excuse for missing a homework deadline.

Grading Policy

All oral and written work submitted must be of the highest quality. You will be graded on your performance and quality of the work required and not on the amount of time spent nor amount of effort. Any piece of work turned in for a grade is subject to an oral examination and the grade for the work hinges on the result of the student's knowledge, not what is submitted.

Final grades are calculated as follows:

Assignments	35%
Research Project	10%
Tests	35%
Final Exam	20%

Final letter grades are assigned as follows:

$\geq 94 = A$	86.67 to 89.99 = B+	76.67 to 79.99 = C+	66.67 to 69.99 = D+	$\leq 59.99 = F$
	83.34 to 86.66 = B	73.33 to 76.66 = C	63.33 to 66.66 = D	
90.00 to 93.99 = A-	80.00 to 83.33 = B-	70.00 to 73.33 = C-	60.00 to 63.33 = D-	

Pass/No Pass Option Students: Students who are registered with a PASS/NO PASS option must receive a final grade of 65 or better to receive a P.

"My Grades"

Up-to-date grade information is available 24/7 under "My Grades". It also shows your "Weighted Total". This is your up-to-date, cumulative, weighted grade.

Class Participation

Even though class participation is not figured into your final grade, your attendance and participation is crucial to your success in this class. The following should give you a guideline on how to actively and positively participate.

Level of participation	Rubric
A	Actively supports, engages and listens to peers (ongoing) Arrives fully prepared at every class Plays an active role in discussions (ongoing) Comments advance the level and depth of the dialogue (consistently) Group dynamic and level of discussion are consistently better because of student's presence
B	Makes a sincere effort to interact with peers (ongoing) Arrives mostly, if not fully, prepared (ongoing) Participates constructively in discussions Makes relevant comments based on the assigned reading material (ongoing) Group dynamic and level of discussion are occasionally better (never worse) because of the student's presence
C	Limited interaction with peers Preparation, and therefore level of participation, are both inconsistent When prepared, participates constructively in discussions and makes relevant comments based on the assigned material Group dynamic and level of discussion are not affected by the student's presence
D	Virtually no interaction with peers Rarely prepared Rarely participates Comments are generally vague or drawn from outside of the assigned material Demonstrates a noticeable lack of interest (on occasion) Group dynamic and level of discussion are harmed by the student's presence

F	No interaction with peers Never prepared Never participates Demonstrates a noticeable lack of interest in the material (ongoing) Group dynamic and level of discussion are significantly harmed by the student's presence
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Assignment Policy

Expect one homework assignment every chapter covered - about one a week.

Work independently All homework assignments are to be worked on independently by each student. Discussions as to what the problem is and very general, top-level solutions are allowed between students. Work may not be copied from another source and will constitute cheating if done so. Any work, or part of your work, that is borrowed from another source must be stated so in the assignment and must be pre-approved by the instructor or preceptor. Failure to do so will constitute plagiarism. All assignment submitted is subject to an oral examination. Upon the request of the instructor, the student will explain (in person) the work submitted. The grade of the assignment hinges on how well the student knows and understands what was submitted.

Submission Each assignment must be submitted by following instructions posted on Blackboard. Electronic submissions are due at the end of the day (11:59 pm) on the date due. All assignments must be submitted through Blackboard (View/Complete... link). Do not email your assignment to the instructor; no homework is accepted via email. Similarly, no assignment will be submitted through the Digital Dropbox unless it is pre-approved by the instructor.

Late Penalty Any assignment that is late will receive a deduction of 10% every 24 hours (a day). Work that is more than **3 days late will not be accepted**. Assignments of which answers have been given will also not be accepted. For example, if an assignment is due Friday evening and if you turn it in anytime on Sunday, the grade is deducted 20%; any work turned in after the following Monday will receive a grade of 0.

Tests and Examination Policy

All tests and exams are closed book exams and typically take the entire class period. Make up exams will not be given except in cases of extremely extenuating circumstances and are pre-arranged.

UH Academic Honesty Policy: Strictly Enforced

University of Hartford Academic Honesty Policy

The purpose of the academic honesty policy is to provide a clear statement to students and faculty of the University's expectations regarding academic honesty and to set forth procedures for the enforcement of that policy. The procedures in this academic honesty policy are administrative functions and are not subject to the same rules as in criminal or civil proceedings. Throughout the following policy, the term college refers to any one of the schools or colleges of the University. The term University-wide program refers to programs such as multimedia Web design and development or the Bachelor of University Studies, which do not reside in a college. The term department chair refers to a department chair or, in the case of colleges that do not have departments, the equivalent of a department chair.

- All students are expected to observe generally accepted principles of scholarly writing in all examinations, compositions, papers, essays, tests, quizzes, reports, and dissertations whether written in the class room or outside. Sources of information used by a student in the preparation of work submitted as a basis for credit, or for a grade, or to satisfy graduate or undergraduate thesis requirements shall be clearly indicated in some conventional manner, such as by the use of quotation marks, footnotes, and bibliography.
- Students are forbidden to submit as their own any project, paper, or creative work that is in whole or part the work of another.
- The use of a term-paper writing service is prohibited. Also prohibited is the use of term papers obtained from the Internet, in whole or in part.
- All examinations and quizzes are to be completed without reference to books or notes except when the instructor of a course shall have given explicit authorization for an "open-book examination" or some other specified sort of assistance. Except as authorized by the instructor, no student is to give or receive assistance in the completion of an examination or a quiz.
- Other examples of academic dishonesty include, but are not limited to, the falsification of academic documents, such as transcripts, registration materials, withdrawal forms, or grade reports, as well as the unauthorized reading, removing, or copying of any academic document or record maintained by any member of the faculty or administration.

The Academic Honesty Policy procedure will be enforced.

Your work for this course (assignments, labs, quizzes, tests, exams) must be completed by you - the student - without the help of external sources such as the Internet or a friend. **Searching answers online is NOT ACCEPTABLE and constitutes academic dishonesty.**

At the first violation of academic dishonesty, the student receives a 0 for the work. On second offense, the student receives an F for the course.

A&S Academic Misconduct: In the event that it is determined that you violated the Academic Honesty Policy, found in The Source, the dean of your college will be notified and a note will be placed in your permanent file. If previous violations have been filed, any penalty that may be assigned for the offense may be more severe than for a first time offense. If this is the first recorded offense, subsequent violations of the honesty policy may then incur a steeper penalty.

Email and Blackboard

Course materials (announcements, homework assignments, etc.) will be made available through Blackboard at <http://blackboard.hartford.edu>. Blackboard is to be used as a supplement to class lectures. All important announcements will be made in class. Routine announcements will be made available on Blackboard. However, you are responsible for all announcements and expectations explained in both Blackboard and during class. You are not to rely solely on Blackboard.

Your Blackboard account allows you to personalize your information, including your preferred email account. In your "Blackboard Home Page" on the left frame, there is a "Personal Information" link which allows you to edit your information. It is your responsibility to make sure that the email account set here is the one you check regularly and that the Inbox for that email is not rejecting incoming mail.

Student Illness

The instructor recognizes that students may occasionally become incapacitated by a brief illness or injury and will be unable to attend class or complete a graded assignment or test on time. In the latter case, you are expected to notify your instructor (in advance if at all possible) that you cannot complete the work due to illness or injury. Following the [University of Hartford's Policy of Student Illness](#) as listed on [The Source](#), the student must:

1. visit the University Health Center, a doctor, or hospital for treatment on the day that you are sick and get documentation of the visit,
2. email the instructor in advance (or if not possible, within 24 hours of missed class, test, or assignment) to tell her that you cannot attend (and/or complete work) and that you are seeking or have sought treatment, and
3. as soon as you are able to come to class, bring your documentation of your doctor's visit to your instructor and arrange to make up missed work.

Allowing you to make up missed tests and assignments is at the instructor's discretion. For extended illness (a week or more), email the academic services office of YOUR college or school. Documentation of treatment is required. Do not visit the University Health Center after the day you are sick. They will not issue documentation that you were sick on the previous day.

Participation & Attendance

Students are expected to attend ALL classes and are responsible for missed classes and lecture materials. Again, you are expected to attend every single class during the semester. Additional material will be provided and covered in class as the instructor deems appropriate. Any material and information you miss is your responsibility. No excuses will be accepted for poor grades. If you must be absent from a class, you must let me know either by phone or e-mail and you are responsible for any material covered or homework assigned. Informing me of your absence does NOT excuse you from any work due that day nor permit you to makeup an exam.

Computer and Other Electronic Equipment-use Policy

When classes meet in a room equipped with computers, students are expected to use the computers for the purposes of completing assigned work only. At no circumstances will a student be allowed to surf the Internet, check email during a class, or use the computers for any other purpose. In violation, a student will face serious consequences.

Use of any electronic equipment (or otherwise) that is annoying or disrupting is not allowed in class. Such devices include mobile phones, beepers, PDAs, laptops, among others.

Students with Special Needs

Student athletes and students registered with Learning Plus must inform the instructor of their special needs as soon as possible. This also applies to other students with any other concerns. The instructor will accommodate the student based on their special needs.

Assigned Reading and Topics

<i>Subject to Change</i>				
Week #	Week Day	Date	Topics - Read before class	
1	Wed	Jan-24	Syllabus	
			Chapter 1 Programming Languages 1	
			1.1 Introduction 1	
			1.2 The Amazing Variety 2	
			Imperative Languages 2	
			Functional Languages 3	
			Logic Programming Languages 3	
			Object-Oriented Languages 4	
			1.3 The Odd Controversies 5	
			1.4 The Intriguing Evolution 6	
1.5 The Many Connections 7				
1.6 A Word about Application Programming Interfaces 8				
1.7 Conclusion 9				
	Mon	Jan-29	Chapter 1 continued	
2	Wed	Jan-31	Chapter 2 Defining Program Syntax 10	
			2.1 Introduction 10	
			2.2 A Grammar Example for English 11	
			2.3 A Grammar Example for a Programming Language 12	
			2.4 A Definition of Grammars: Backus-Naur Form 13	
			2.5 Writing Grammars 15	
			2.6 Lexical Structure and Phrase Structure 17	
			2.7 Other Grammar Forms 19	
			BNF 19	
			EBNF 20	
Syntax Diagrams 21				
Formal, Context-free Grammars 23				
2.8 Conclusion 23				

	Mon	Feb-5	Chapter 2 continued
3	Wed	Feb-7	Chapter 3 Where Syntax Meets Semantics 27 3.1 Introduction27 3.2 Operators29 3.3 Precedence29 3.4 Associativity32 3.5 Other Ambiguities35 3.6 Cluttered Grammars37 3.7 Parse Trees and EBNF.....38 3.8 Abstract Syntax Trees39 3.9 Conclusion40
	Mon	Feb-12	Chapter 3 continued
4	Wed	Feb-14	Test 1
	Mon	Feb-19	Chapter 4 Language Systems 43 4.1 Introduction43 4.2 The Classical Sequence43 Optimization 48 4.3 Variations on the Classical Sequence49 Hiding the Steps 49 Integrated Development Environments..... 49 Interpreters 50 Virtual Machines 51 Delayed Linking 53 Profiling 54 Dynamic Compilation 55 4.4 Binding Times55 Language-Definition Time 56 Language-Implementation Time 56 Compile Time 56 Link Time 56 Load Time 56 Runtime 57 4.5 Debuggers57 4.6 Runtime Support58 4.7 Conclusion59
5	Wed	Feb-21	Chapter 4 continued
	Mon	Feb-26	Chapter 5 A First Look at ML 65 5.1 Introduction65 5.2 Getting Started with an ML Language System66 5.3 Constants67 5.4 Operators68 5.5 Conditional Expressions70 5.6 Type Conversion and Function Application71 5.7 Variable Definition73 5.8 Garbage Collection74 5.9 Tuples and Lists74 5.10 Function Definitions78 5.11 ML Types and Type Annotations81 5.12 Conclusion83
6	Wed	Feb-28	Chapter 5 continued
	Mon	Mar-5	Test 2
7	Wed	Mar-7	Chapter 6 Types 86 6.1 Introduction86 6.2 A Menagerie of Types87 A Type Is a Set 87 Primitive Types and Constructed Types 88 Enumerations 89 Tuples 90 Arrays, Strings, and Lists 92 Unions 93 Subtypes 95 Function Types 96 6.3 Uses for Types97 Type Annotations 97 Type Inference 98 Type Checking 98 Type-Equivalence Issues 100 6.4 Conclusion101

	Mon	Mar-12	Chapter 6 continued
8	Wed	Mar-14	Chapter 7 A Second Look at ML 103 - 3/13, 3/25 7.1 Introduction103 7.2 Patterns You Already Know103 7.3 More Simple Patterns104 7.4 Complex Patterns.....105 7.5 A Summary of ML Patterns So Far106 7.6 Using Multiple Patterns for Functions106 7.7 Pattern-Matching Style107 7.8 Local Variable Definitions110 7.9 Nested Function Definitions114 7.10 Conclusion115
	Mon	Mar-19	Spring Break
9	Wed	Mar-21	Spring Break
	Mon	Mar-26	Chapter 7 continued
10	Wed	Mar-28	Test 3
	Mon	Apr-2	Supplementary Material Polymorphism in ML and C++ Object-Oriented C++
11	Wed	Apr-4	OO continued
	Mon	Apr-9	OO continued
12	Wed	Apr-11	Chapter 19 A First Look at Prolog 382 - 4/3, 4/10 19.1 Introduction382 19.2 The Building Blocks—Prolog Terms383 19.3 Getting Started with a Prolog Language System385 19.4 Rules389 19.5 The Two Faces of Prolog393 19.6 A Word about Term Interpretation395 19.7 Operators395 19.8 Lists397 Special Notation for Lists 397 append and Other Flexible Predicates 398 reverse and Other Inflexible Predicates 401 The Anonymous Variable 403 19.9 Negation and Failure404 19.10 What Prolog Is Good For406 19.11 Conclusion409
	Mon	Apr-16	Chapter 19 continued
13	Wed	Apr-18	Chapter 20 A Second Look at Prolog 414 20.1 Introduction414 20.2 Unification415 The Occurs Check 417 20.3 A Procedural View418 Backtracking 419 Substitution 419 20.4 An Implementational View421 The Resolution Step 421 The Prolog Interpreter 422 Collecting the Substitutions 424 20.5 An Abstract View—Proof Trees425 Proof-Tree Definition 426 Infinite Proof Trees 427 Variable Renaming 429 20.6 The Lighter Side of Prolog431 Quoted Atoms as Strings..... 431 write and read 432 assert and retract 433 The Cut 434 An Adventure Game 435 20.7 Conclusion442
	Mon	Apr-23	Chapter 20 continued
14	Wed	Apr-25	Presentations
	Mon	Apr-30	
15	Wed	May-2	
	Mon	May-7	

	Fri	May-11	Final Exam 11AM-1PM
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