Syllabus
Theory of Computation (CSCI:3500)

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Contents

Staff

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Description

Welcome! The core of computer science deals in the area of problem solving using mathematical precise tools called computational devices, e.g. computers, cell phones, cars, air planes, and any other device with an embedded computer inside. These devices are tools of the computer scientist, and it is their job to understand how best to use them, and even more importantly what the limits of their power are. Yes, that is right, computers do have limits. However, to be able to understand what these limits are one must be able to know how to mathematically define computation. In fact, what does it mean for a function to be computable? These are the core questions studied in the field of theory of computation, and this is the topic of this course.

We will begin by trying to understand basic mathematical devices for recognizing formal languages called finite state automata, and regular expressions. Regular expressions are a very useful tool for describing languages, for example, `<([^">]+(?:"[^"]+")*[^>]+)>` is a Perl regular expression that matches every HTML tag with an attribute. HTML is an example of a formal language. How would you write a program that takes a regular expression and a string, and then test if that string falls within the language the regular expression generates? This is one practical example of a finite state automata. We will see that regular expressions and finite automata are intimately related.

Finite state automata are really fascinating, but they have limits. In fact, there are formal languages that cannot be recognized by any regular expression! These are called context-free languages, and these are the

types of formal languages that correspond to most programming languages. We will see that context-free languages can be described by what are called context-free grammars.

Following our stint into formal language theory is the part of theory of computation that is very fun and interesting. We will see that all of computation can be described by two very simple formal theories one called Turing machines, and the other called the λ-calculus. These are actually equivalent, and it can be shown that all of what modern computational devices can be do, can be done by these simple theories. If time permits we may discuss a bit about how Turing machines can be used to describe the limits of computation.

- Book (PDF)
- Course Calendar

Prerequisites

- (CSCI:3030) Mathematical Structures in CS
- (CSCI:3400) Data Structures

Office Hours

Office hours will be held virtually by appointment. Please schedule using Slack.

Course Goals

The goals of this course consist of global goals and specialized goals. The former is a set of goals that I believe will benefit the student in a wider area of life than this course, while the specialized goals are the goals of understanding the basic theory of computation.

Global Goals

The global goals seek to help the student with broad knowledge that will help them throughout life. For example, in other courses and in their future (or current) jobs. It could be argued that all of this course fits this perspective, but not every student will become theoretical computer scientists.

The global goals can be summarized as goals that aim to train the student in critical thinking, and mathematical and logical reasoning. Specifically, we will attempt to understand some of mathematical proof and logic.

Topics

- Finite State Machines
- Regular Languages
  - Deterministic Finite Automata
  - Non-deterministic Finite Automata
  - Minimization
- Context Free Languages
  - Context Free Grammars
  - Push Down Automata
  - Parsing
- Turing-Recognizable Languages
  - Turing Machines
  - Decidability
  - Undecidability
  - Turing-Unrecognizable Languages
- Short introduction to complexity

Graded Work

- (40%) 4 10-point graded homework assignments.
- (30%) A take-home midterm exam.
- (30%) A final take-home exam.

No scores will be curved throughout the semester. Please use the following scoring table:

- A : $88\% - 100\%$
- B : $78\% - 87\%$
- C : $68\% - 77\%$
- D : $58\% - 67\%$
- F : $0\% - 57\%$

Turning in Homework

All homework is to be turned in via D2L. Please write out your homework and then take pictures, or scan in your homework, where each problem is placed on its own page, and the pages are in order within the PDF file. Then upload the PDF to the homeworks designated submission folder on D2L.

There are two homework deadlines for this class:

- Deadline: By 11:59pm on the Wednesday 7 days after the homework is released.
- Hard Deadline: By 11:59pm on the Friday 9 days after the homework is released.

Course Communication

This course has a slack channel.

All course discussion and annoucements will take place on Slack. The only time Slack should not be used is when discussing grades. I will not respond to questions via email unless they are grade specific.

Slack Rules:

- No inapprorpiate messages will be tolerated.
- You must add your fullname (First and Last) to your profile.
- All course annoucements will be shared in #annoucements.
- All course related questions/discussion should be asked in #questions_and_answers.
- For fun I've created #random for sharing all the gifs and memes.

Attendance

Attendance is optional, but highly encouraged.

Getting Help

Professors like students have many duites and commitments, and so to be better prepared to help the students outside of class I have the following office rules that must be adhered to:

- If a student needs help, and the question is small – takes at most five minutes to answer – then the student may visit my office at any time, but
- if the question takes longer than five minutes, then the student is required to make an appointment by slack, or attend office hours.

If a student comes to my office unannounced and the question takes longer than five minutes, then that student will be instructed to make an appointment or to come back during office hours.

Appointments are to be scheduled via slack and must contain the following:

- The students name,
- a brief description of what the problem is, and
- a time the student would like to meet.

Collaboration is important in all areas of study. So I recommend talking to other students for help. However, there is a rule that must be followed: **while discussing homework solutions in a group of two or more no one is allowed to write anything down, and each student must prepare their solution in isolation**.

AUGUSTA UNIVERSITY POLICIES

The Augusta University faculty and administration believe that, for students to be prepared for career success, it is important for them not only to know the subject matter in their majors, but also to demonstrate professional, ethical, and responsible business and social behavior. Whether a person is interviewing for a job, participating in a business or academic social event, or attending class, there are some important characteristics of personal behavior that are expected by colleagues and administrators. In the business work environment, employees can be dismissed for behavior that is distracting or disruptive to other employees, customers, or administrators.

Class Attendance

If the student has been absent for more than the equivalent of 10 percent of class time, regardless of cause, then the professor may withdraw the student from the class for excessive absences. It is important to note that the instructor may—or may not—withdraw a student from class based upon attendance. In any case, a student should not assume that the instructor has initiated the withdrawal form. A student not withdrawn from a course who stops attending class (or who never attends class) is subject to receiving a grade of WF or F for the course. Please reference the Class Attendance section of the Augusta University Student Manual for further details.

Each student is expected to attend class regularly, to arrive on time, and to remain until class is dismissed. Tardiness and leaving class early are disruptive for other students and the faculty and are behaviors that are not acceptable in a classroom or business setting. Students who do not arrive promptly or leave early may be noted as absent, at the faculty member's discretion. Absences in excess of the maximum prescribed in the course syllabus may result in the faculty member's withdrawing the student from the course.

Code of Conduct

Please review the Student Code of Conduct in the Augusta University Student Manual. It outlines your responsibilities as students and those of a faculty member to maintain the integrity of the learning environment. As outlined in the handbook, disorderly or distracting conduct may result in expulsion from the class. Moreover, any form of academic dishonesty will not be tolerated. Should you be caught cheating or plagiarizing the work of another the procedures as outlined in the handbook and catalog will be followed.

The classroom should be considered a place of business - academic business. Distracting behavior such as uninvited casual talk among students, use of cell phones and beepers, sleeping, or inappropriate behavior toward fellow students or faculty will not be tolerated any more than they would be in a business setting. Faculty have the right and the responsibility to maintain a classroom free of such distractions. Students who persist in such behavior may be asked to leave the class and may be counted absent for the session. Persistent disruptive behavior may result in the faculty member's withdrawing the student from the course.

Disabilities

Students with disabilities must contact the Office of Testing and Disability Services (706-737-1469) before the start of the semester. If you require special accommodation, the office will send a classroom accommodation

form to affected faculty. Should you require special accommodations, please contact me at the beginning of the semester to determine how they will be implemented. Please reference the Testing and Disability Services section of the Augusta University Student Manual for further details.

Academic Dishonesty

In an academic community, honesty and integrity must prevail if the work done and the honors awarded are to receive their respect. The erosion of honesty is the academic community's ultimate loss. The responsibility for the practice and preservation of honesty must be equally assumed by all of its members. Any type of dishonesty in securing those credentials therefore invites serious sanctions, up to and including, a WF in the course, and expulsion from the institution. Examples of dishonesty include actual or attempted cheating, plagiarism, or knowingly furnishing false information to any university employee. Please reference the Academic Honesty section of the Augusta University Student Manual for further details and specific definitions of cheating and plagiarism.

Unethical behavior of students in any form is not acceptable and will not be tolerated. Academic dishonesty (see definitions in the following sections) - cheating on exams, plagiarism of the work of others, unapproved collaboration on graded work, and the like - will be dealt with immediately and with clear consequences. Depending on the nature and severity of the problem, a student who is guilty of any such violation may be: 1) withdrawn from the course with a grade of WF (counted as an F in the GPA); 2) given a grade of zero on the assignment; 3) given a grade of F in the course; or 4) otherwise penalized, at the discretion of the faculty member. Two occurrences of a WF grade for academic dishonesty will result in a student's being expelled from the University, per current University policy as described in the University Catalog.

Student Appeals and Grievances

Any student who believes that he or she has been treated unfairly under these guidelines should first address the matter with the faculty member responsible for the class. If the problem is not resolved, the student may meet with the Dean or follow procedures outlined in the Academic Grievance Policy section of the Augusta University Student Manual.

Campus Carry Law

The USG guidance on House Bill 280, commonly known as the "campus carry" legislation, effective as of July 1, 2017 – http://www.usg.edu/hb280,

ACADEMIC DISHONESTY DEFINITIONS

Any attempt to present intentionally the work or knowledge of others as your own on a graded test or assignment constitutes academic dishonesty. The following illustrations do not include every possible variation of academic dishonesty, but they are examples of the kinds of infractions that will be considered academic dishonesty violations. If you have questions about academic dishonesty, please ask any faculty member or any administrator in the School of Computer and Cyber Sciences. It is your responsibility to recognize and avoid initiating or contributing to academically dishonest behavior.

CHEATING ON A TEST, EXAM, OR ASSIGNMENT

- **Closed-book, closed-notes tests.** The use of any materials except those provided by the faculty member or provided for in test instructions is considered cheating. The use of prepared notes, electronic aids, assistance from others, or the use of any information obtained from others (with or without their permission) during the test is considered cheating.

- **Open-book, open-notes tests**. Assistance from others or the use of any information obtained from others (with or without their permission) during the test, without the permission of the instructor, is considered cheating.
- **Independent projects or papers**. If the faculty member's instructions require independent, unassisted work on a project or paper, no portion of the assignment may be prepared by anyone else. Having any part of the assignment prepared by someone else, or in collaboration with someone else, is considered cheating unless the instructor's instructions specifically call for such collaboration.
- **Assisting others with test information**. Because many courses are taught at multiple times, it is important that students in one section of a course not provide information about a test to any student in another section who will take the same or a similar test at a later time. To do so will be considered cheating.

PLAGIARISM

- **Failure to give credit to others**. On individual and group assignments – projects, papers, presentations, research studies, and the like – no portion of the work may contain quotations of or paraphrasing (rewording) of the work of others unless each such reference is clearly identified with an appropriate footnote or bibliographical reference to the original source and author. To not give credit to others in each such instance is to present the work of others as if you had written it yourself. That is considered plagiarism. Style manuals (such as the American Psychological Association manual) provide guidelines for footnoting, quotations, and other means of giving credit for the work of others. Your instructor may prefer some particular style. If no guidelines are provided, it is your responsibility to use a standard style or ask the faculty member for guidance.
- **Ghost writing**. It should go without saying that having someone else write some or all of a paper or do a project for which you are individually responsible constitutes academic dishonesty. Whether the author is a friend, a paid writer, or a person who offers such services on a web site, the result is an intention to present someone else's work as your own and will be treated as an academic dishonesty infraction.

Extra Resources

The Reese Library's Cyber Resource Center: http://guides.augusta.edu/friendly.php?s=cyber.