# Course Syllabus: CS 150: The Theory of Automata and Formal Languages
# Spring, 2021

**Course Description:** The course introduces some fundamental concepts in automata theory and formal languages including grammar, finite automaton, regular expression, formal language, pushdown automaton, and Turing machine. Not only do they form basic models of computation, they are also the foundation of many branches of computer science, *e.g.* compilers, software engineering, concurrent systems, etc. The properties of these models will be studied and various rigorous techniques for analyzing and comparing them will be discussed, by using both formalism and examples.

**Course format:** The course consists of two 80-minute lectures (Zoom meeting ID: 947 9493 8434) and one 50-minute discussion session per week. The discussion sessions start in the first week of the quarter (*i.e.*, the week of March 29). Each discussion session will be led by a TA and used primarily to enforce concepts and techniques learned in class. Please register in advance for the lectures on Zoom at:
`https://ucr.zoom.us/meeting/register/tJAqfu2hrTMuGdAAE_gNBX3yacQTLI2tcjD5`

**Prerequisite:** CS 14 and CS/MATH 111. The students are expected to have a strong background in the fundamentals of discrete mathematics (symbolic logic, set, induction, number theory, summation, series, combinatorics, graph, recursion, basic proof techniques, etc.), algorithms and data structures. Some knowledge of programming languages, programming, and computer architecture will be helpful.

**Instructor:** Tao Jiang, WCH 336, phone: 827-2991, email: `jiangATcs.ucr.edu`. Office Hours: TR 1-2pm. Zoom meeting ID: 886 998 0294

**Teaching Assistants:** All office hours are held online via Zoom. The TA's (Amir Nodehi Sabet) office hour Zoom meeting ID is 93666508017 (pwd 535919). The readers' (Peter Tran and Shiyi Zhang) Zoom ID is TBA.

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|---|---|---|---|---|---|
| Dis 021 | W 6:00 - 6:50pm | Zoom ID 97197423501 (pwd 454085) | Amir Nodehi Sabet | anode001ATucr | M 3pm |

**UCR Academic Resources Center (ARC):** 156 Skye Hall. See `www.arc.ucr.edu`.

**Textbook:** J. Hopcroft, R. Motwani, and J. Ullman. *Introduction to Automata Theory, Languages, and Computation*, 3rd edition, 2007, Pearson/Addison-Wesley. Available for purchase/rent via the Internet (2nd edition okay too). It can be borrowed for short periods from https://www.hathitrust.org (with UCR NetID) and https://archive.org/account/signup. Relevant chapters are also available on iLearn.

**Lecture Notes:** Copies of slides used in lectures are available on the class homepage `www.cs.ucr.edu/~jiang/150-homepage.html` in the PDF format.

**Reference Books (on reserve at the Science Library):**
(1) P. Linz. *Introduction to Formal Languages and Automata*, 6th edition, 2017 (or 5th or 4th edition), Jones and Barlett.
(2) A. Maheshwari and M. Smid. *Introduction to Theory of Computation*, 2019,
`https://cglab.ca/~michiel/TheoryOfComputation/TheoryOfComputation.pdf`

**Grading:**

5 homework assignments (all paper and pencil) — 40%
Midterm (in class, May 11) — 20%
Final examination (June 5, 3:00-5:50pm) — 40%

**Reading assignment:** You are expected to review, before and after each class, the material to be covered in the class. A reference to the chapters of the text and major reference books that will be covered in lectures can be found in the *tentative timetable* below.

**Assignment Policy:**

1. All assignments will be posted on the class homepage `www.cs.ucr.edu/~jiang/150-homepage.html`, and submitted on Gradescope.
2. You have roughly one and half weeks for each homework assignment.
3. Make sure to always include your full name, ID, *discussion section number*, and the assignment number on the first page.
4. Write legibly. What cannot be read will not be graded.
5. No late assignments will be accepted.

**Academic dishonesty:** Many students find it helpful to consult their peers while doing assignments. This practice is legitimate and to be expected. However, it is not acceptable practice to pool thoughts and produce common answers. To avoid this situation, it is suggested that students not write anything down during such talks, but keep mental notes for later development of their own. Major occurrences of academic dishonesty, such as the submission of work that is not the student's own, will be dealt with according to UCR's policies on academic dishonesty that can be found at webpage `http://conduct.ucr.edu/policies/academicintegrity.html`. Students who allow their files or assignments to be copied are as guilty of academic dishonesty as those who copy and will be treated accordingly. Each student is responsible for taking reasonable precautions to ensure that his/her work is not available for unauthorized use.

*Copying solutions from the Internet or books or any other public sources without explicit citations is prohibited!*

Table 1: Tentative Timetable

| Week of | Topic | Chapters of | | |
|---|---|---|---|---|
| | | [HMU] | [Linz] | [MS] |
| Mar. 29 | basic concepts of finite automata and languages | 1,2 | 1,2 | 1,2 |
| | deterministic finite automaton, nondeterminism | 2 | 2 | 2 |
| Apr. 5$*$ | equivalence between DFA, NFA and $\epsilon$-NFA | 2,3 | 2,3 | 2 |
| | regular expression | | | |
| Apr. 12$*$ | equivalence between regular expression and FA | 3 | 3 | 2 |
| | algebraic laws for regular expressions | 3 | 3 | |
| Apr. 19 | pumping lemma and applications | 4 | 4 | 2 |
| | properties of regular languages | 4 | 4 | |
| Apr. 26$*$ | minimization of automata and applications | 4 | 2 | |
| | context-free grammars and languages | 5 | 5 | 3 |
| May 3 | parsing (or derivation) and parse trees | 5 | 5 | 3 |
| | ambiguity of grammar and language | 5 | 5 | |
| May 10$*$ | **Midterm on May 11** | | | |
| | pushdown automaton (PDA) and various forms | 6 | 7 | 3 |
| May 17$*$ | equivalence between CFG and PDA | 6 | 7 | 3 |
| | deterministic PDA | 6 | 7 | 3 |
| May 24 | Chmosky normal form of CFG | 7 | 6 | 3 |
| | pumping lemma for CFLs | 7 | 8 | 3 |
| May 31 | properties of CFLs | 7 | 8 | 3 |
| | Turing machines and (un)decidability | 8 | 9,12 | 4 |

Legend: $*$ denotes the handing out of homeworks.

**Class Mailing List:** Please subscribe to the class mailing through the class homepage ASAP and remember to confirm the subscription.