CS 3823 - Theory of Computation: Syllabus

Dimitris Diochnos

School of Computer Science
The University of Oklahoma

Fall 2025

Time and Location

Tuesdays & Thursdays, 12:00pm-1:15pm, Nielsen Hall 0170.

Website: https://www.diochnos.com/teaching/CS3823/2025F/index.php

Canvas: Canvas will be used in order to distribute homework assignments and potentially other reading materials.

Instructor

Dimitris Diochnos, 230 Devon Energy Hall (DEH), diochnos@ou.edu .

Teaching Assistants

- **Preston Weinheimer** (`Preston.N.Weinheimer-1`) and
- **Ujwala Vasireddy** (`Ujwala.Vasireddy-1`).

Inside the parentheses you can see the username of the student such that if you append `@ou.edu` you can send an email to them directly.

Office Hours

The office hours of the teaching assistants will be announced here soon. Meanwhile, my office hours will be held on:

- **Tuesdays** between **3:00pm-3:50pm** (Dimitris Diochnos),
- **Thursdays** between **3:00pm-3:50pm** (Dimitris Diochnos),
- **Fridays** between **1:30pm-2:20pm** (Dimitris Diochnos), or
- **by appointment**.

As I am teaching two courses this semester, please note that while anyone is welcome during my office hours (Dimitris Diochnos), students from CS 4713/5713 will have precedence on Fridays, while students from CS 3823 will have precedence on Tuesdays and Thursdays.

Prerequisite Background

The prerequisites for the course are (CS 2413 or CS 2414 and CS 2813 or Math 2513) or CS 5005 or DSA 5005.

Topics and Course Description

(As listed in the undergraduate catalog:) Introduction to abstract machine theory and formal language theory. Topics include Turing machines, finite/pushdown automata, deterministic versus nondeterministic computations, context-free grammars, and mathematical properties of these systems.

Learning Outcomes

The learning outcomes for this course are as follows.

Fundamental Theoretical Concepts. Students should be able to apply and comprehend the core concepts of the field.

- **Finite Automata and Regular Languages:** Analyze regular languages and design finite automata (deterministic and non-deterministic) to recognize them.
- **Context-Free Languages and Pushdown Automata:** Design and understand pushdown automata and context-free grammars for context-free languages.
- **Turing Machines:** Construct and use simple Turing machines as a model of general computation.

  Language Hierarchy: Compare and contrast the different types of languages and computational models, including regular, context-free, recursive, and recursively enumerable languages.

Analytical and Problem-Solving Skills. The course should develop a student's ability to reason about computational problems.

- **Formal Proofs:** Construct formal proofs about the properties of languages or computational models, such as proving that a language is not regular or context-free.
- **Modeling and Equivalence:** Understand the equivalence of different computational models, for example, converting between regular expressions, non-deterministic finite automata, and deterministic finite automata.
- **Algorithm Design:** Design algorithms for different machine models to solve computational problems.

Application to Practical Computing. Theory of computation is not just an abstract topic. The theory is connected to practical applications.

- **Tradeoffs in Design:** Demonstrate comprehension of the tradeoffs involved in design choices by applying mathematical foundations, algorithmic principles, and theory to model and design computer-based systems.
- **Problem-Solving with Theory:** Analyze complex computing problems and apply principles of computing theory to identify effective solutions.

- **Software Development:** Apply computer science theory to the production of robust and well-founded computing-based solutions.

These outcomes ensure that graduates not only understand the theoretical limits and capabilities of computation but can also apply these foundational principles to practical software engineering and computing challenges.

Schedule of Classes

The syllabus is continuously updated and subject to change. We will cover the material at a pace that is comforable. Our **first meeting** is on **Tuesday, Auguest 26, 2025** and our **last meeting** is on **Thursday, December 11, 2025**.

We will cover most of the Chapters 1-10 of the textbook well as some topics not covered in the book.

The **final exam** is **in-class** (Nielsen Hall 0170) on **Wednesday, December 17, 2025** between **1:30pm and 3:30pm**. **I will not accommodate rescheduling of the exam because you have a coflict with another course. Be wise and enroll in this class only if you can have the final exam at the above date and time.**

This course is a theory course and our primary focus is on abstract, theoretical ideas, though we may touch on relevant applications at various points (and especially in the topics discussed in the end)

A **rough outline** for the course, which is subject to change slightly depending on our pace, is shown in Table 1.

Textbook, Notes and Related Reading Materials

Textbook

The textbook for the course is ***Introduction to the Theory of Computation (3rd Edition)***, by Michael Sipser [9].

Other Books of Interest

- *An Introduction to Formal Languages and Automata (7th Edition)*, by Peter Linz [6].
- *Computability and Unsolvability*, by Martin Davis [1].
- *Computational Complexity*, by Christos Papadimitriou [7].
- *Computers and Intractability: A Guide to the Theory of NP-Completeness*, by Michael Garey and David Johnson [4].

A book which can be inspiring providing patterns for problem-solving strategies, is the one by George Pólya,

- *How to Solve It: A New Aspect of Mathematical Method* [8].

Another interesting book that can give you a good flavor of the other course that I am teaching in computational learning theory, is one by Leslie Valiant that is listed below. With this book you can explore connections between the theory of machine learning and artificial intelligence on one hand, and the theory of computation on the other hand. This book is

Table 1: Tentative Course Schedule

Period	Topics
Week 1	Syllabus, expectations, mathematical background
Week 2	Deterministic finite automata (DFAs). Introduction to non-determinism.
Week 3	Non-deterministic finite automata (NFAs). Equivalence between NFAs and DFAs. Discussion on TEX/ LATEX.
Week 4	Closure under the regular operators. Thursday's class is not happening due to career fair.
Week 5	Regular expressions. Equivalence between DFAs and regular expressions.
Week 6	Pumping lemma for regular languages. Examples uses for proving non-regularity of certain languages.
Week 7	More examples on the pumping lemma. **First midterm** to take place on Thursday of this week.
Week 8	Context-free grammars (CFGs), ambiguity, normal forms.
Week 9	Discussion of solutions for first midterm. Introduction to (nondeterministic) push-down automata (PDAs).
Week 10	More on PDAs. MoneyCoach presentation by Cami Sheaffer.
Week 11	Pumping lemma for context-free languages. Proving that certain languages are not context-free.
Week 12	Introduction to Turing machines. Recognizable versus decidable languages. Hilbert's tenth problem.
Week 13	Preparation for the midterm (answering questions, going over homework). **Second midterm**.
Week 14	Equivalence of models for Turing machines. **Thanksgiving**.
Week 15	Chomsky hierarchy. Undecidability. The acceptance problem, the halting problem, and the Post correspondence problem. Complexity classes P and NP.
Week 16	Discussion of solutions for second midterm. The million dollar question of **P vs NP**.

- *Probably Approximately Correct: Nature's Algorithms for Learning and Prospering in a Complex World* [10].

Finally, due to the close interaction of modern mathematics and complexity theory, other fun books that revolve around mathematics, or the history of mathematics, also come to mind and one can enjoy in their free time.

- *Logicomix: An epic search for truth*, by Apostolos Doxiadis and Christos Papadimitriou [3].
- *The Parrot's Theorem: A Novel*, by Denis Guedj [5].
- *Uncle Petros and Goldbach's Conjecture: A Novel of Mathematical Obsession*, by Apostolos Doxiadis [2].

Grading

Grading will be based on the following:

- **45% homework assignments**,
- **30% midterm exams (15% each midterm)**,
- **25% final exam**.

Grades may also be adjusted slightly upward or downward depending on class participation. I expect grading to be along the lines shown in the table below:

Percentage	Grade
$\geq 90\%$	A
$\geq 80\%$	B
$\geq 70\%$	C
$\geq 60\%$	D
otherwise	F

Students should submit one assignment per group.

- If a student submits more than one assignment we will take into account the latest one. Please note that there is no way for us to tell if you have submitted additional/other files in your previous submissions as these are overwritten on Canvas. So, you are responsible that you submit all files with your latest submission.
- If more than one student submits the assignment, the TAs are allowed to grade any one of them they like and this may very well mean that you will receive a smaller grade for your group compared to what you could receive with a full/latest submission.
- The TAs are allowed to apply a small penalty (e.g., up to 8% of the maximum grade) for situation where multiple submissions are made per group. So, please make sure that only one person submits what is needed per group and that person should be responsible for making a complete submission each time.

Examinations

- We will have **two midterm exams**, both are going to be in-class.
- The **final exam** is **in-class** on **Wednesday, December 17, 2025** between **1:30pm and 3:30pm**.
- Exams will be closed-book written exams.
- Use of any electronic equipment during the exam will result in an immediate zero.

Important: You will not be able to take the exam another day because you have a conflict with another course. Make sure you understand this now and choose wisely the courses in which you enroll.

Homework Assignments

There will be 5-6 homework assignments; most likely five, with a tentative schedule as shown in Table 2.

The assignments will be weighted roughly evenly. In other words the contribution for the 45% of your grade based on homework assignments will be computed by adding up all the grades that you receive from the individual assignments and then dividing by the maximum amount of grades that you could gather from all these assignments.

Table 2: Tentative Homework Schedule

Homework	Assigned	Due
1	Week 2 (end)	Week 3 (end)
2	Week 5 (beginning)	Week 6 (end)
3	Week 9 (beginning)	Week 10 (beginning)
4	Week 11 (beginning)	Week 12 (end)
5	Week 14 (beginning)	Week 16 (beginning)

Course Policies

Collaboration Policy

Students **must** form **groups of 4 to 5 people** and work together on the homework assignments. You cannot work alone. You cannot work in a group of less than 4 people.

- Collaborators must be named (together with their university IDs) at the top of every assignment.
- The study groups are intended to foster collaborations, encourage brainstorming, create excitement, and make the learning process more fun. Each study group should meet regularly (say once or twice per week throughout the semester). Everyone in the study group should contribute fairly to the overall group effort. Ideally, equal group effort should be put by everyone in the group in each assignment. Please form your study groups early in the semester (by the second week) and meet regularly.
- Students are allowed to leave their group once and move to a different group, as long as the group that they are leaving does not end up with less than 4 members. Therefore, from the point in time where one leaves from the initial group they were members of, then they cannot move to another group. Of course the consistency of one's group may change because other members may flow in/out of the group – this does not count as a group change for the person who has not requested a group change as they remain in the group with the same groupID throughout the entire time.

  An exception to this rule is if you are asked by a TA or an instructor to change to a different group; but most likely this will not happen to any one of you during the course.
- Form groups before you submit the first homework assignment.

General Remarks. Please note the following two.

- **If you are unsure if something is permitted, consult with me before doing it.**
- **For exams** (whether midterms or final), **students are required to work alone** and follow the stated rules exactly.

Late Work Policy

You can postpone once your homework submission by 24 hours without any penalty. After the first time that you have a late submission, a 10% (of the maximum possible grade) penalty will be applied for every day that is late – the maximum delay can be 3 days (including the first time that you have a late submission). This penalty is applied of course to every member of the group where you belong to.

We will be using an electronic system (Canvas) for the students' submissions and therefore it is your responsibility to turn in your homework (or an exam, should this be the case) on time. **Please**

coordinate within your group and make one submission per group. Apart from electronic submissions (Canvas), you can turn-in homework sets also in-class, by the end of the class on the day they are due.

Chegg and Other Online Tutoring Sources

There are a wide variety of tutoring resources available through paid websites. Many of these sites have students upload assignments and solutions and surreptitiously provide these documents to other students. What appears to be a session with a tutor may be, behind the scenes, the tutor doing a search of their company database of solutions to share. By using these sites you risk being charged with academic misconduct, either by supplying other students with answers they did not author or by receiving someone else's answer that you did not author. Since these companies are not open with students about their practices, you cannot know whether a tutor is providing meaningful support (for example, identifying misunderstandings of content and explaining them) or simply feeding you someone else's solution a bit at a time. The tutor's actions can result in different students submitting answers that are identical, which may be flagged as academic misconduct during grading.

Use of Generative Artificial Intelligence

Providing solutions generated by a computer program instead of being generated from a student's mind does not demonstrate student learning. Students who learn to rely on generative AI technology may not be able to argue about computer science topics independently, as is necessary for examinations in this course and for their future careers. Amongst other problems, generative AI tools are not fact checkers and do not necessarily produce correct solutions to problems. They are sensitive to small changes in prompts. They do not quote and cite sources properly. Students who copy generated AI results into assignments are committing plagiarism, just as if they had copied from another student.

- Use of generative AI tools is only allowed when the assignment specifically permits it. **If the assignment is silent on the use of generative AI tools, they are not allowed.**
- If a generative AI tool is used in an assignment, the student must provide a summary of how the tool was used. This would include the name of the tool (including version) and a detailed description of how it was used and what work the student contributed to the assignment. Students must substantially contribute to the solution to avoid plagiarism.
- When AI tools are allowed on an assignment, students may request an alternate assignment if they have an objection to using these tools.
- If there is a question about whether a student completed work independently or with the use of these tools, I will invite the student to my office to explain the assignment in detail. **Students who choose to not come or who cannot explain the work they submitted will be charged with an academic integrity violation.**

Make-Up Midterms

In some rare cases I can offer a makeup midterm to a student (subject to my schedule and availability as well). However, if the student misses their rescheduled midterm, the percentage points of the midterm as a contribution towards their final grade will transfer to their final exam. For example, if in a class each of two midterms contributes 15% to the total final grade and the final exam contributes 25% of the total final grade, then missing one midterm would cause the final exam to contribute 40% towards the final (overall) grade that the student will receive in the class.

Furthermore, for every midterm that a student misses beyond one (e.g., a student misses both makeup midterms), then for every such midterm apart from one, the student will receive a zero.

Missing a midterm without previously informing me about this (and making arrangements ahead of time for a make-up midterm) will result in receiving a zero (0) for that particular midterm. Please read the following section for further clarification on the matter.

Not Showing Up on Midterms

Not showing up on a midterm without a reasonable justification that can explain why you have not arranged ahead of time a make-up midterm, will immediately lead to a ZERO (0) for your grade.

Claiming that you were not aware that we had a midterm on a particular day and you scheduled another appointment (e.g., doctor's appointment), or you just decided not to come to class simply because you did not want to come to class one day, is not a valid excuse. It is your responsibility to make sure that you receive all the notifications from Canvas. Additionally, a rough expectation regarding when the midterms will take place is announced in this syllabus in the tentative schedule of classes (Table 1) as well as on the webpage that we are maintaining for the course. Again, the latest and greatest information for the exam will be communicated via Canvas and also discussed in class. So, there are no cheap excuses for no-shows on the day a midterm is scheduled to take place. I will not even follow-up with an email asking you what happened. You will automatically be assigned a zero (0).

If you want, you are free to explain your case within 48 hours as to why you did not show up in class for the midterm and provide some valid justification for some extreme event that happened to you. However, I will not initiate this communication asking you why you did not show up in class for the midterm. It is your responsibility to do so.

Final Exam Rescheduling

The final exam cannot be rescheduled. If you miss it you will get a zero (0).

Classroom Conduct

Disruptions of class will not be permitted. Examples of disruptive behavior include:

- Allowing a cell phone or pager to repeatedly beep audibly.
- Playing music or computer games during class in such a way that they are visible or audible to other class members.
- Exhibiting erratic or irrational behavior.
- Behavior that distracts the class from the subject matter or discussion.
- Making physical or verbal threats to a faculty member, teaching assistant, or class member.
- Refusal to comply with faculty direction.

In the case of disruptive behavior, I may ask that you leave the classroom and may charge you with a violation of the Student Code of Responsibilities and Conduct.

Class Web Page

The main web page for the class is

https://www.diochnos.com/teaching/CS3823/2025F/index.php

Login to the Canvas website using your 4+4 (first four letters of your last name followed by the last four digits of your student number), using your standard OU password. If you have difficulty logging in, call 325-HELP. This software provides a number of useful features, including a list of assignments and announcements, an electronic mailing list, newsgroups, and grade book. All handouts are available from Canvas. You should check the site daily. When I update the site, I will post an announcement telling you what has been added and where it is located. You are responsible for things posted on the site with a 24 hour delay.

Student's Feedback for the Course

The College of Engineering utilizes students' feedback as one of the bases for evaluating the teaching effectiveness of each of its faculty members. The results of these forms are important data used in the process of awarding tenure, making promotions, and giving salary increases. In addition, the faculty uses these forms to improve their own teaching effectiveness. The original request for the use of these forms came from students, and it is students who eventually benefit most from their use. Please take this task seriously and respond as honestly and precisely as possible, both to the machine-scored items and to the open-ended questions.

Class Email Alias

Urgent announcements will be sent through email. It is your responsibility to:

- Have your university supplied email account properly forwarded to the location where you read email.
- Make sure that your email address in Canvas is correct, and forwards email to the place where you read it. I'll send out a test message during the first week of class. If you do not receive this message, it is your responsibility to get the problem resolved immediately.
- Have your email program set up properly so that replying to your email will work correctly the first time. You can send email to yourself and reply to yourself to test this.

If you need assistance in accomplishing any of these tasks, contact 325-HELP.

Newsgroups and Email

The newsgroup on Canvas should be the primary method of communication, outside of class. This allows everyone in the class to benefit from the answer to your question. If you email me a question of general interest, I may post your question and my answer to the newsgroup. Matters of personal interest should be directed to email instead of to the newsgroup, e.g. informing me of an extended personal illness. Posting guidelines for the newsgroup are available on Canvas.

Incompletes

The grade of I is intended for the rare circumstance when a student who has been successful in a class has an unexpected event occur shortly before the end of the class. I will not consider giving a student a grade of I unless the following three conditions have been met.

1. It is within two weeks of the end of the semester.
2. The student has a grade of C or better in the class.
3. The reason that the student cannot complete the class is properly documented and compelling.

Add/Drop/Withdrawal Deadlines. Please consult the OU academic calendar (as well as the policies of the School of Engineering) for the following deadlines:

- **Add a course**
- **Drop a course without penalty (course removed from transcript)**
- **Drop a course with a W on transcript**

University Policies

The instructor reserves the right to add, remove, or change any element of class policy at any time and for any reason, within the limits of University policy.

OU is committed to creating a learning environment that meets the needs of its diverse student body. If you anticipate or experience any barriers to learning in this course, please feel welcome to discuss your concerns with me.

Mental Health Support Services

Support is available for any student experiencing mental health issues that are impacting their academic success. Students can either been seen at the University Counseling Center (UCC) located on the second floor of Goddard Health Center or receive 24/7/365 crisis support from a licensed mental health provider through TimelyCare. To schedule an appointment or receive more information about mental health resources at OU please call the UCC at 405-325-2911 or visit University Counseling Center. The UCC is located at 620 Elm Ave., Room 201, Norman, OK 73019.

Title IX Resources and Reporting Requirement

The University of Oklahoma faculty are committed to creating a safe learning environment for all members of our community, free from gender and sex-based discrimination, including sexual harassment, domestic and dating violence, sexual assault, and stalking, in accordance with Title IX. There are resources available to those impacted, including: speaking with someone confidentially about your options, medical attention, counseling, reporting, academic support, and safety plans. If you have (or someone you know has) experienced any form of sex or gender-based discrimination or violence and wish to speak with someone confidentially, please contact OU Advocates (available 24/7 at 405-615-0013) or University Counseling Center (M-F 8 a.m. to 5 p.m. at 405-325-2911).

Because the University of Oklahoma is committed to the safety of you and other students, and because of our Title IX obligations, I, as well as other faculty, Graduate Assistants, and Teaching Assistants, are mandatory reporters. This means that we are obligated to report gender-based violence that has been disclosed to us to the Institutional Equity Office. This means that we are obligated to report gender-based violence that has been disclosed to us to the Institutional Equity Office. This includes disclosures that occur in: class discussion, writing assignments, discussion boards, emails and during Student/Office Hours. You may also choose to report directly to the Institutional Equity Office. After a report is filed, the Title IX Coordinator will reach out to provide resources, support, and information and the reported information will remain private. For more information regarding the University's Title IX Grievance procedures, reporting, or support measures, please visit Institutional Equity Office at 405-325-3546.

Adjustments for Pregnancy and Related Issues

Should you need modifications or adjustments to your course requirements because of pregnancy or a pregnancy-related condition, please request modifications via the Institutional Equity Office website

or call the Institutional Equity Office at 405/325-3546 as soon as possible. Also, see the Institutional Equity Office FAQ on Pregnant and Parenting Students' Rights for answers to commonly asked questions.

Reasonable Accommodation Policy

The University of Oklahoma (OU) is committed to the goal of achieving equal educational opportunity and full educational participation for students with disabilities. If you have already established reasonable accommodations with the Accessibility and Disability Resource Center (ADRC), please log into iAdvise to request your semester accommodations as soon as possible and contact me privately, so that we have adequate time to arrange your approved academic accommodations.

If you have not yet established services through ADRC, but have a documented disability and require accommodations, please complete ADRC's pre-registration form to begin the registration process. ADRC facilitates the interactive process that establishes reasonable accommodations for students at OU. For more information on ADRC registration procedures, please review their website. You may also contact them at (405)325-3852 or adrc@ou.edu, or visit www.ou.edu/adrc for more information.

Note: disabilities may include, but are not limited to, mental health, chronic health, physical, vision, hearing, learning and attention disabilities, pregnancy-related. ADRC can also support students experiencing temporary medical conditions.

Religious Observance

It is the policy of the University to excuse the absences of students that result from religious observances and to reschedule examinations and additional required classwork that may fall on religious holidays, without penalty. [See Faculty Handbook 3.15.2]

Final Exam Preparation Period

Pre-finals week will be defined as the seven calendar days before the first day of finals. Faculty may cover new course material throughout this week. For specific provisions of the policy please refer to OU's Final Exam Preparation Period policy.

Emergency Protocol

During an emergency, there are official university procedures that will maximize your safety.

Severe Weather: If you receive an OU Alert to seek refuge or hear a tornado siren that signals severe weather.

1. Look for severe weather refuge location maps located inside most OU buildings near the entrances.
2. Seek refuge inside a building. Do not leave one building to seek shelter in another building that you deem safer. If outside, get into the nearest building.
3. Go to the building's severe weather refuge location. If you do not know where that is, go to the lowest level possible and seek refuge in an innermost room. Avoid outside doors and windows.
4. Get in, Get Down, Cover Up
5. Wait for official notice to resume normal activities.

Additional Weather Safety Information is available through the Department of Campus Safety.

The University of Oklahoma Active Threat Guidance

The University of Oklahoma embraces a Run, Hide, Fight strategy for active threats on campus. This strategy is well known, widely accepted, and proven to save lives. To receive emergency campus alerts, be sure to update your contact information and preferences in the account settings section at one.ou.edu.

RUN: Running away from the threat is usually the best option. If it is safe to run, run as far away from the threat as possible. Call 911 when you are in a safe location and let them know from which OU campus you're calling from and location of active threat.

HIDE: If running is not practical, the next best option is to hide. Lock and barricade all doors; turn of all lights; turn down your phone's volume; search for improvised weapons; hide behind solid objects and walls; and hide yourself completely and stay quiet. Remain in place until law enforcement arrives. Be patient and remain hidden.

FIGHT: If you are unable to run or hide, the last best option is to fight. Have one or more improvised weapons with you and be prepared to attack. Attack them when they are least expecting it and hit them where it hurts most: the face (specifically eyes, nose, and ears), the throat, the diaphragm (solar plexus), and the groin.

Please save OUPD's contact information in your phone.

NORMAN campus: *For non-emergencies call (405) 325-1717. For emergencies call (405) 325-1911 or dial 911.*

TULSA campus: *For non-emergencies call (918) 660-3900. For emergencies call (918) 660-3333 or dial 911.*

Fire Alarm/General Emergency

If you receive an OU Alert that there is danger inside or near the building, or the fire alarm inside the building activates:

1. *LEAVE* the building. Do not use the elevators.
2. *KNOW* at least two building exits
3. *ASSIST* those that may need help
4. *PROCEED* to the emergency assembly area
5. *ONCE* safely outside, *NOTIFY* first responders of anyone that may still be inside building due to mobility issues.
6. *WAIT* for official notice before attempting to re-enter the building.

OU Fire Safety on Campus

References

[1] Martin D. Davis. *Computability and Unsolvability.* Dover, 1982. ISBN 0-486-61471-9.

[2] Apostolos Doxiadis. *Uncle Petros and Goldbach's Conjecture: A Novel of Mathematical Obsession.* Bloomsbury USA, 2001. ISBN 978-1582341286.

[3] Apostolos Doxiadis and Christos Papadimitriou. *Logicomix: An epic search for truth.* Bloomsbury USA, 2009. ISBN 978-1596914520.

[4] Michael R. Garey and David S. Johnson. *Computers and Intractability: A Guide to the Theory of NP-Completeness*. W. H. Freeman & Co., New York, NY, USA, 1979. ISBN 0716710447.

[5] Denis Guedj. *The Parrot's Theorem: A Novel*. St. Martin's Griffin, 2002. ISBN 978-0312303020.

[6] Peter Linz and Susan H. Rodger. *An Introduction to Formal Languages and Automata*. Jones & Bartlett Learning, seventh edition, 2022. ISBN 978-1284231601, 1284231607.

[7] Christos H. Papadimitriou. *Computational Complexity*. Addison-Wesley, 1994. ISBN 978-0-201-53082-7.

[8] George Pólya. *How to Solve It: A New Aspect of Mathematical Method*. Princeton University Press, 1971. ISBN 069116407X 978-0691164076.

[9] Michael Sipser. *Introduction to the Theory of Computation*. Cengage Learning, third edition, 2012. ISBN 978-1133187790, 113318779X.

[10] Leslie Valiant. *Probably Approximately Correct: Nature's Algorithms for Learning and Prospering in a Complex World*. Basic Books (AZ), 2013.