Theory of Computation

MIEIC, 2nd Year

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Faculty involved

- João MP Cardoso
  - Gab. I012B (Head of DEI office), I137
- Pedro Ângelo
  - J204
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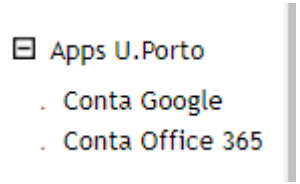
- João Bispo
  - J204

Webpage and Platform

- Sigarra (UPorto Information System):
  - Program, bibliography, timetable, summaries, faculty involved, assessment rules
  - https://sigarra.up.pt/feup/pt/ucurr_geral.ficha_uc_view?pv_ocorrencia_id=459475
- Teams:
  - Documents, chats, news, etc.
  - See next slide

Teams

- SIGARRA after login:
  - Rightmost Menu (at the bottom), select “Conta Office 365”
  - This provides your email address: @ms.uporto.pt



- Link to TCOM @Teams:
  - https://teams.microsoft.com/l/team/19%3a417423a2f61d4d2e849ab4b8b2db0469%40thread.tacv2/conversations?groupId=c09b3b55-dc28-4524-acec-246e3527523a&tenantId=b7821bc8-67cc-447b-b579-82f7854174fc
  - Sign-in using your @ms.uporto.pt email address
  - You can use the *windows app* or the *web app*

Objectives

- To prepare you about computing theory topics with a special emphasis to formal language topics
- To learn about regular languages, regular expressions, non-regular languages, deterministic and nondeterministic finite automata, context-free languages and grammars, deterministic and nondeterministic pushdown automata, and Turing machines, and how to apply these topics to problems
- To express computing problems by using formal languages, automata and Turing machines
- To learn how to formally specify computing problems related to formal languages and prove related statements

Expected Outcomes

At the end of the semester, you will be capable of:

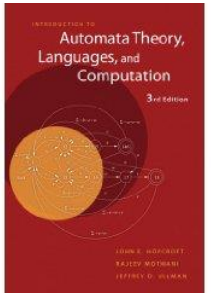
- identifying the important contributions to computing theory and its protagonists
- identifying the problems that can be solved with finite automata and express them rigorously
- comparing deterministic finite automata (DFAs), non-deterministic finite automata (NFAs), regular expressions and regular languages
- applying the properties of regular languages
- identifying problems which can be handled by context- free grammars (CFGs)
- relating context-free grammars and pushdown automata (PDAs) in the processing of context-free languages
- expressing computing problems by using Turing machines
- relating the studied computing models with their applications in the computability theory and complexity theory

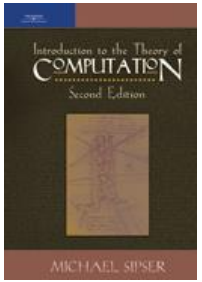
Syllabus

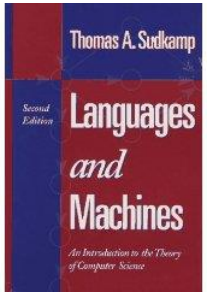
- Automata Theory. Finite Automata
- Regular Expressions and Languages
- Properties of Regular Languages
- Context-Free Grammars and Languages
- Pushdown Automata
- Properties of Context-Free Languages
- Turing Machine

Bibliography

- **Principal**
  - J.E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, *Introduction to Automata Theory, Languages, and Computation*, 3rd Edition. Addison-Wesley (2006).
- **Complementary**
  - *Michael Sipser, Introduction to the Theory of Computation, second edition*, Cengage Learning; 3rd edition (June 27, 2012)
  - Thomas A. Sudkamp, Languages and Machines: *An Introduction to the Theory of Computer Science*, 3rd Edition, Addison-Wesley Publishing Co. (2006).







Pre-Requisites

- It is recommended that you have attended the Discrete Mathematics course
- Knowledge of Computational Logic and of Programming

Teaching Methods

- In lectures (T), the contents are formally exposed along with presentation and discussion of topics and examples
- In TP classes, application exercises are proposed and discussed
- Weekly quizzes will allow students to assess their progress
- Videos and information in diverse formats will be used
- The foreseen effort beyond classes is of about 4h per week

Activities

- One preparation activity (PA) every week
  - Goal: to prepare for the exercises of the following week of TP classes
  - Available: quiz @Teams, every Thursday, at 16h (4pm), in the end of the lecture, each quiz focus on the topics of the classes (TP) of the following week
  - Submission: via Teams and until the next Friday
- One assessment activity (AA) every week
  - Goal: to evaluate your knowledge after the classes about the subjects
  - Available: quiz @Teams, every Friday, at 18h (6pm), each quiz focus on the topics of the classes (TP) of the previous week
  - Submission: via Teams and with deadline after two weeks of the publication date
- Challenge Activities (CAs): three challenges
  - Goal: to evaluate your knowledge after the classes about the subjects
  - Available: @Teams
  - Submission: via Teams and with deadline after two weeks of the publication date
- Feedback to answers to exercises and challenges will be given at Moodle

Useful Software

- **JFLAP Version 7.0**
  - http://www.jflap.org/
- Web applications developed by MIEIC students
  - Example: Turing Machine simulator

Assessment Rules

- **Assessment Mode**
  - Distributed evaluation with Final Exam
- **Passing in the distributed evaluation**
  - Distributed evaluation (AD) not inferior to 7.0 marks and a maximum of 3 non-justified absences (25%) on the tutorial classes.
- **Final Grade**
  - **AD**: Distributed Evaluation consists of three components (min: 7.0 marks)
    - Preparation activities (1 quiz per week): 10% (marks solely based on participation)
    - Evaluation activities (1 quiz per week): 60%
    - Challenges activities (3 challenges during the semester): 30%
  - **EF**: final exam (min: 7.0 marks)
  - **AD Grade (ADG)** =
    - AD **if** AD <= EF+3
    - EF+3, **otherwise**
  - **Final Grade** = rounded(0.25 ADG + 0.75 EF)

Assessment Rules (cont.)

- Assessment for Students under a special enrollment (TE, DA, ...)
  - One of the following possibilities (selected by the student):
    - Final Exam
    - Final Exam (EF) + Activities (AD)
- Students who have concluded the AD with success in the previous academic year and who don't want to repeat the AD will have the final grade given by:
  - **Final Grade** = rounded(0.4 AD + 0.6 EF)**,** where the AD is the AD grade obtained in the previous academic year
- *Possibility to improve the exam grade by doing a scientific work*

Badges and awards

- Participation in:
  - T and TP classes (including chats)
- Results in badges!
- Badges can be used in Exams (“de época normal” and “de recurso”)
- Badges are used as a bonus!! (see the document with the rules on how to use them)

Best wishes for a great TCOM success!

The Beginner's Creed

I am a beginner.
I am entering a new game about which I know nothing.
I do not yet know how to move in this game.
I see many other people playing in this game now.
This game has gone on for many years prior to my arrival.
I am a new recruit arriving here for the first time.
I see value to me in learning to navigate in this domain.

There is much for me to learn:

- The basic terminology
- The basic rules
- The basic moves of action
- The basic strategies

While I am learning these things I may feel various negative reactions:

- Overwhelmed at how much there is to learn
- Insecure that I do not know what to do
- Inadequate that I lack the capacity to do this
- Frustrated and discouraged that my progress is so slow
- Angry that I have been given insufficient guidance
- Anxious that I will never perform up to expectations on which my career depends
- Embarrassed that everyone can see my mistakes

But these moods are part of being a beginner. It does not serve my goal and ambition to dwell in them. Instead,

- If I make a mistake, I will ask what lesson does this teach.
- If I make a discovery, I will celebrate my aha! moment.
- If I feel alone, I will remember that I have many friends ready to help.
- If I am stuck, I will ask for help from my teachers.

Over time, I will make fewer mistakes.
I will gain confidence in my abilities.
I will need less guidance from my teachers and friends.
I will gain familiarity with the game.
I will be able to have intelligent conversations with others in the game.
I will not cause breakdowns for promises that I lack the competence to keep.
I have an ambition to become competent, perhaps even proficient or expert in this game. But for now,
I am a beginner.

—By Peter J. Denning

Peter J. Denning. 2017. The beginner's creed. *Commun. ACM* 60, 7 (June 2017), 30-31. DOI: https://doi.org/10.1145/3097352

Versão online: https://cacm.acm.org/magazines/2017/7/218869-the-beginners-creed/fulltext