Theory of Computation

MIEIC, 2nd Year

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Faculty involved

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  - I121
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Webpage of the Course

- 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=419995
- Moodle:
  - Documents, mailing-lists, news, etc.
  - https://moodle.up.pt/course/view.php?id=1075

Objectives

- To prepare you about computing theory topics with a special emphasis to formal language topics
- You will 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
- You will be able to express computing problems by using formal languages, automata and Turing machines
- In addition, students will learn how to formally specify computing problems related to formal languages and prove related statements

Expected Outcomes

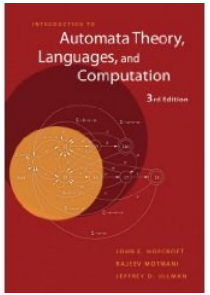
- At the end of the semester, you will be capable of:
  - identifying the important contributions to computing theory and its protagonists
  - identifying the problems that can be solved with finite automata and express them rigorously
  - comparing deterministic finite automata (DFAs), non deterministic 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

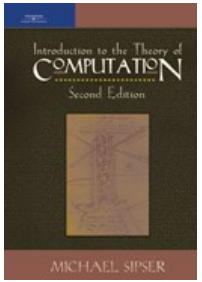
Syllabus

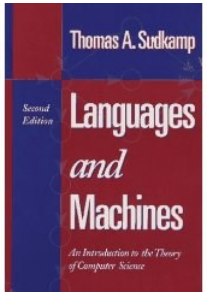
- Automata Theory; Finite Automata
- Regular Expressions and Languages
- Properties of Regular Languages
- Context-Free Grammars and Languages
- Pushdown Automata
- Properties of Context-Free Languages
- Turing Machine

Bibliography

- **Principal**
  - J.E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, *Introduction to Automata Theory, Languages, and Computation*, Third Edition. Addison-Wesley (2006).
- **Complementary**
  - *Michael Sipser, Introduction to the Theory of Computation, second edition*, Course Technology, First edition (1996)
    - **Publisher:** Cengage Learning; 3rd edition (June 27, 2012)
  - Thomas A. Sudkamp, Languages and Machines: *An Introduction to the Theory of Computer Science*, Third Edition, Addison-Wesley Publishing Co., 2006.







Pre-Requisites

- It is recommended that students 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
- Two midterm exams (mini-tests) will be held, approximately six and twelve weeks from the start of the semester, to check if the basic concepts are being understood by the majority of students
- 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: Moodle, every Wednesday, at 15h (3pm)
  - Submission: via Moodle and until the first TP about the subject
- One challenge activity (CA) every Week
  - Goal: to evaluate your knowledge after T and TP about the subject
  - Available: Moodle, every week
  - Submission: via Moodle and until the next lecture (T)
- 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 not inferior to 7 marks, with the grade of each mini-test (MT) not inferior to 6 marks, and a maximum of 3 non-justified absences (25%) on the tutorial classes.
- **Final Grade**
  - **AD**: Distributed Evaluation consists of two components, MT1 and MT2 = 0.5 MT1 + 0.5 MT2 (min: 7 marks)
    - MT1 and MT2: mini-tests 1 and 2, respectively (min: 6 marks for each)
  - **EF**: final exam (min: 7 marks)

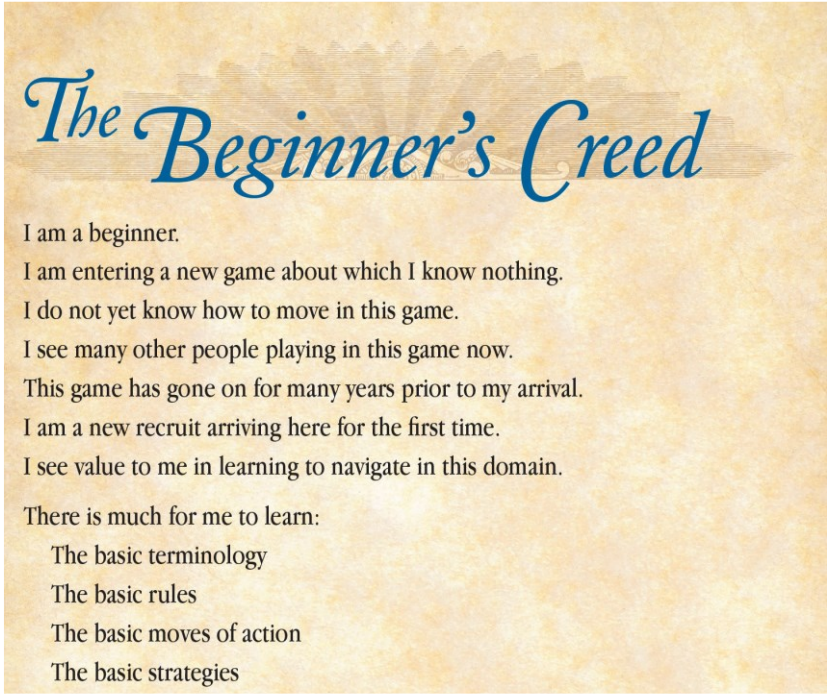
  Final Grade = rounded(0.4 AD + 0.6 EF)

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) + mini-tests (MT)
- 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 of the previous academic year
- Possibility to improve the exam grade by doing a scientific work

Badges and awards

- Participation in:
  - T and TP classes
  - in preparation and challenge activities
- Results in badges!
- Badges can be used in midterm exams (“mini-testes”) and in Exams (“de época normal” and “de recurso”)
  - Badges resultant of T and TP classes and Exercises -> Midterm Exams
  - Badges resultant of Challenges -> Exams
- Badges are used as a bonus!! (see the document with the rules on how to use them)



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

Best wishes for a great success!