AUTOMATA THEORY AND FORMAL LANGUAGES

2022-23

PRESENTATION OF THE SUBJECT

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AUTOMATA THEORY AND FORMAL LANGUAGES

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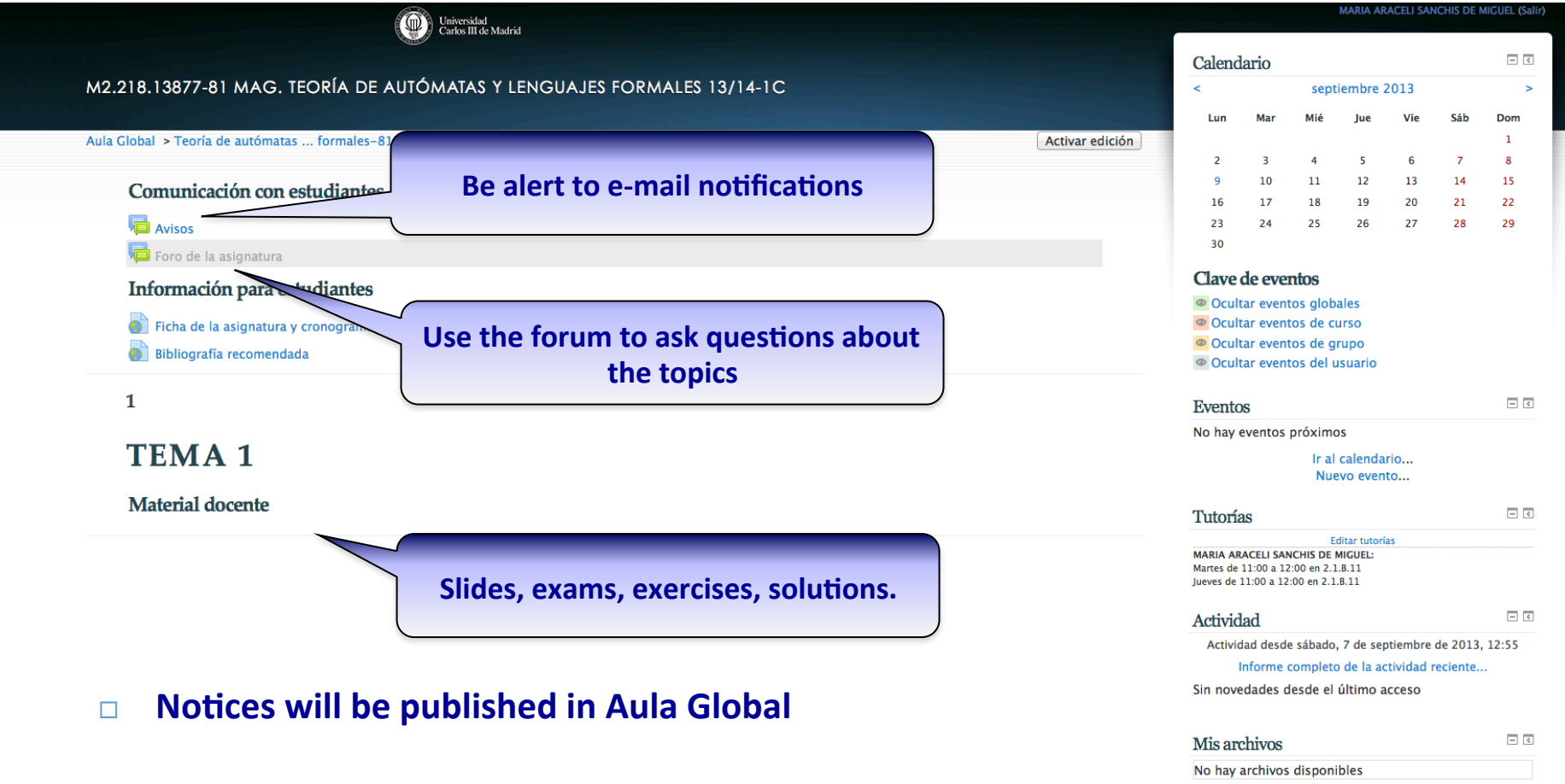
Aula Global



- **Notices will be published in Aula Global**
- **Questions will be posted in the FORUM so that all students can see them**

Outline

- **Why to take this course?**
- **Context of the subject (UC3M and Computer Science Degree)**
- **Material**
- **Methodology**
- **Planning**
- **Evaluation**
- **Questions and doubts**

Why to take this course?

- Understand programming languages:
  - Understand the code structure.
  - Understand the mathematical structures that can be used for their analysis.
  - Become a better programmer.
- Prerequisite for future subjects.

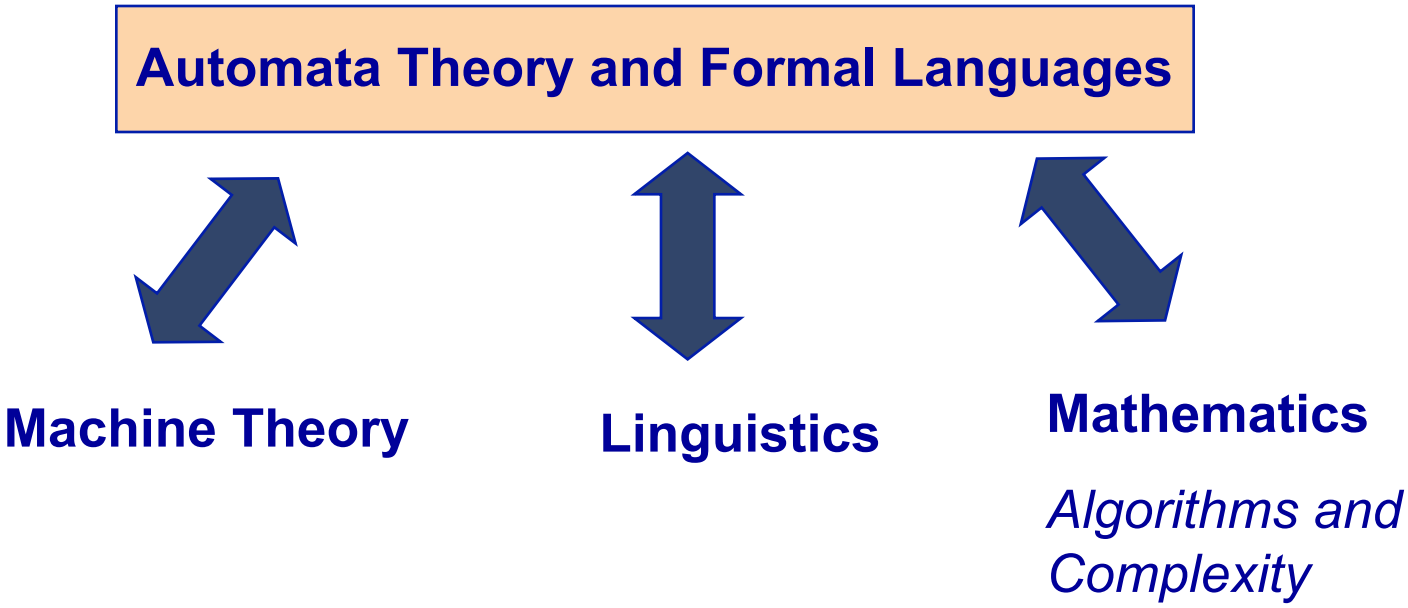
Why to take this course?

- This course is designed to introduce the student to the basic knowledge about classical and contemporary theory of computation.

- Inside this field, we will cover the main computational mechanisms and structures. What are they? How they work?

Why to take this course?

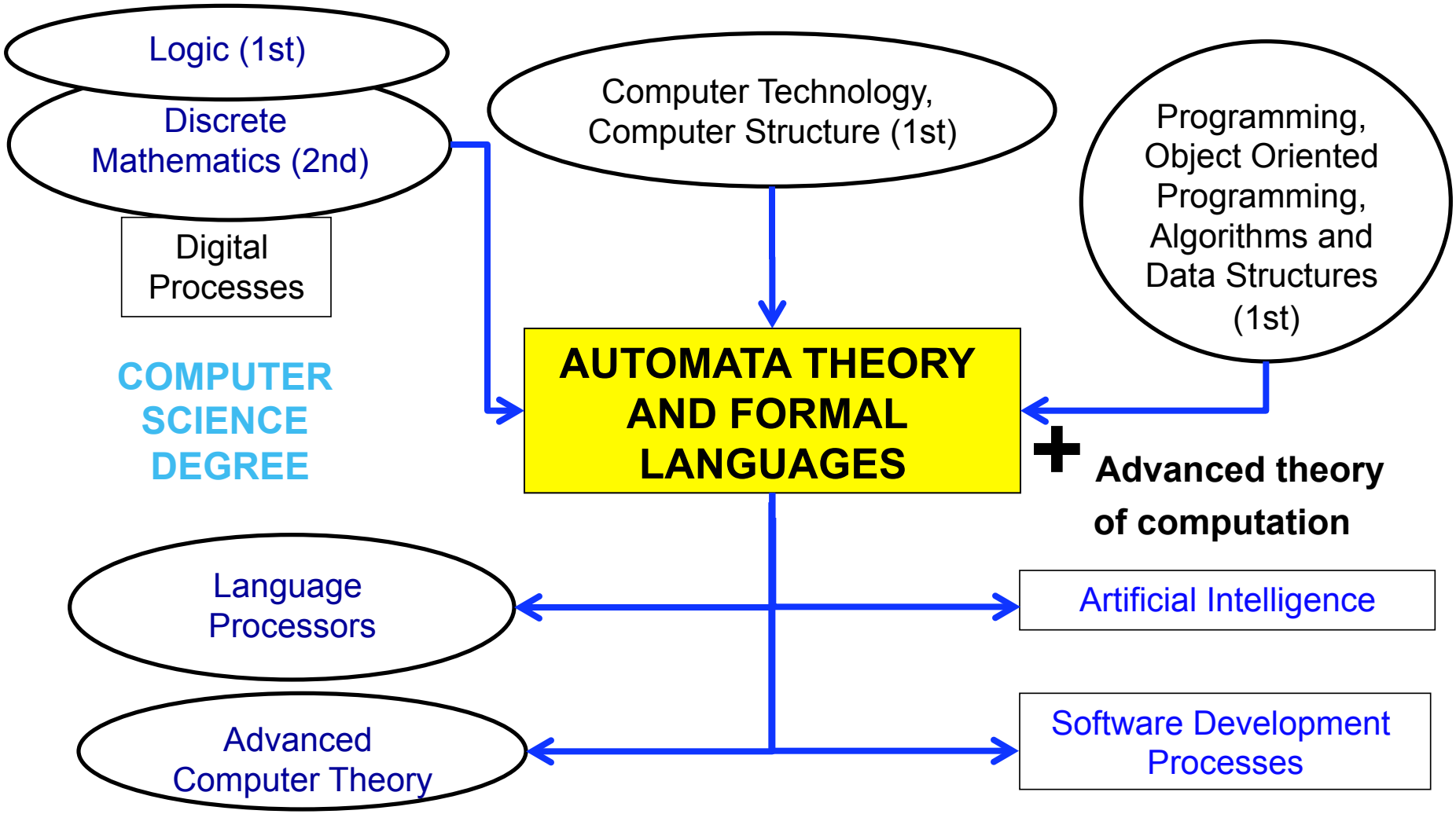
- **Brief History:**
  - Classic field in Computer Science.
    - Created before electronic computers and programming techniques.
    - Computer Sciences studies in Spain since 1976.



Why to take this course?

- Theory is essential to understand programming devices and structures required for its analysis.
- ATFL is applicable to other fields:
  - Compiler and Interpreters design;
  - Electronic devices analysis;
  - ADN and biological studies;
  - Fluid Flow;
  - Snowflake and crystal formation;
  - Chaos theory;
  - Cosmology;
  - Financial analysis;
  - …

Context of the Subject



Material

- Subject Information

  http://www3.uc3m.es/reina/Fichas/Idioma_2/218.13877.html

- Subject Planning

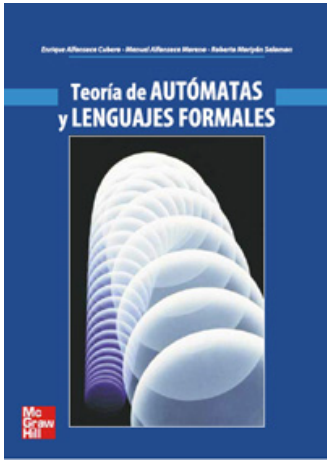
- Bibliography

- Aula Global

Methodology

- **Master lectures.**
  - Students: Required preparation.
- **Problems, Exercises, Practical exercises.**
  - Students: Required preparation.
- **Partial Exams.**
- **Practical exercises at Lab. (jflap tool)**

Bibliography



Teoría de autómatas y lenguajes formales

Enrique Alfonseca Cubero, Manuel Alfonseca Moreno, Roberto Moriyón Salomón

McGraw-Hill, 2007

Introduction to Automata Theory, Languages and Computation

John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman

Pearson Addison Wesley , cop. 2008

Bibliography

Lenguajes, gramáticas y autómatas : un enfoque práctico

Pedro Isasi Viñuela, Paloma Martínez Fernández, Daniel Borrajo Millán

Addison-Wesley Iberoamericana, [1997]

Teoría de lenguajes, gramáticas y autómatas

Manuel Alfonseca, Justo Sancho, Miguel Martínez Orga

R.A.E.C. , [1997]

Bibliography

- **Basic Bibliography:**

  - Enrique Alfonseca Cubero, Manuel Alfonseca Cubero, Roberto Moriyón Salomón. *Teoría de Autómatas y Lenguajes Formales*. McGraw-Hill (2007).
  - John E. Hopcroft y Jefrey D. Ullman. *Introduction to Automata Theory, Languages and Computation*. Ed. Pearson Addison-Wesley, (Third edition).
  - M. Alfonseca, J. Sancho, M. Martínez. *Teoría de Lenguajes, Gramáticas y Autómatas*, R.A.E.C., ISBN: 8460560929. Madrid, (1997).
  - Pedro Isasi, Paloma Martínez, Daniel Borrajo. *Lenguajes, Gramáticas y Autómatas, un Enfoque Práctico*. Addison-Wesley, (1997).
  - Susan H. Rodger and Thomas W. Finley. *JFLAP: An Interactive Formal Languages and Automata Package*. 2006. Jones & Barlett Publishers, Sudbury, MA. ISBN: 0763738344.

Bibliography

- **Complementary Bibliography:**

  - Gregorio Fernández, Fernando Sáez de Vacas. *Fundamentos de Informática: Lógica, Autómatas y Lenguajes*. Anaya Multimedia, (1997).
  - J.G. Brookshear. *Teoría de la Computación. (Lenguajes Formales, Autómatas y Complejidad).* Addison-Wesley Iberoamericana, (1993).
  - Peter J. Denning, Jack B. Dennis y Joseph E. Qualitz. *Machines, Languages and Computation.* Prentice-Hall, (1978).
  - Michael Sipser, *Introduction to the Theory of Computation*. Thomson Course Technology, (2nd Edition, 2006)

Bibliography

- **Complementary Bibliography:**

  - David Leavitt. The man who knew too much. *Alan Turing and the invention of the computer*. Phoenix Paperback, (2006).
  - Andrew Hodges. *Alan Turing The Enigma.* Vintage Books, (2012).
  - R. Penrose. *The Emperor's new mind*. *Concerning Computers, Minds, and the Laws of Physics*. Oxford University Press, (1999).
  - *El rival de Prometeo*. *Vidas de autómatas ilustres*, VV.AA. Ed. Sonia Gómez-Tejedor, Marta Peirano. Impedimenta, Madrid, (2009).

Evaluation

- **Evaluation criteria:**
  - Qualification: Continuous assessment (50%) + Final Exam (50%).
  - **Continuous assessment**:
    - 0.7/5 : first jflap evaluable lab (grammars)
    - 0.7/5 : second jflap evaluable lab (Turing Machines)
    - 1,2/5 : first exam (units 2 and 3)
    - 1,2/5 : second exam (units 4 and 5)
    - 1,2/5 : third exam (units 5,6 and 7)

Evaluation

- **Final Exam**
  - Theoretical Part (Test + short questions) 25%

    (Select **only one** correct answer to each question)

    (no answer or wrong answer penalizes)
  - Practical exercises 75%
    - You can use two sheets (four pages) with formulas, algorithms, examples, etc.
  - 4/10 points required to pass the subject.
- **Final Mark:**
  - IF you have done at least 1 EC.

    Final mark = final exam mark * 0,5+ ECs marks * 0,5
  - Otherwise

    Final mark = final exam mark * 0,6

    (To add EC marks you must obtain at least 4 in the exam)

Extraordinary call

- **Exam: 100%**
- **ECs will be taken into account if**

  (exam mark * 0.5) + (EC * 0.5) > exam mark,

  Exam mark: at least 4

Planning

Lectures

Tuesday (R121, R88, R89) 17:00-19:00

R88 Thurs.	15:00 - 17:00	Exercises and labs.
R89 Fri.	17:00 - 19:00	Exercises and labs.
R121 Thurs.	17:00 - 19:00	Exercises and labs.

Lab sessions (JFLAP) **(compulsory attendance)**

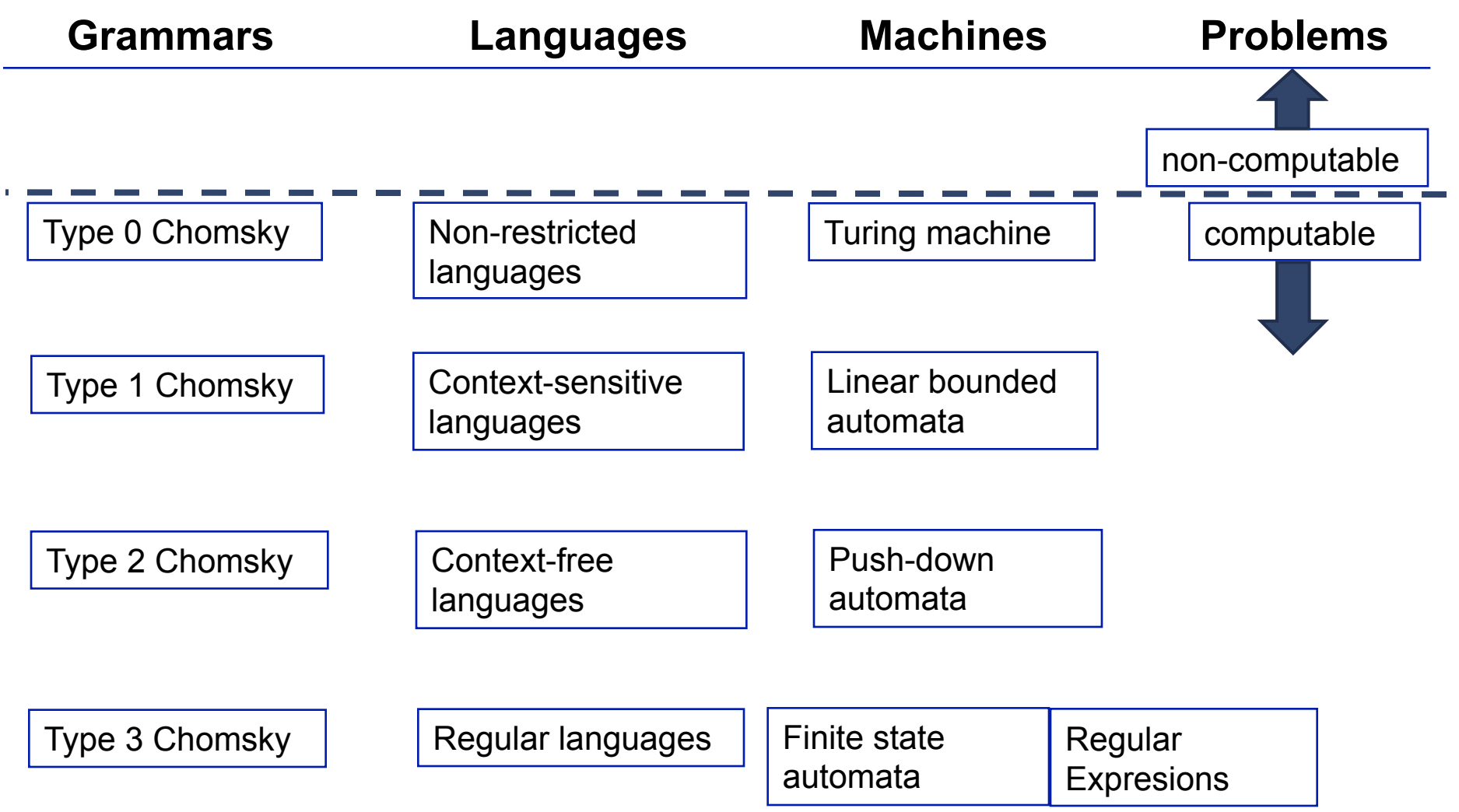
Session 1: 6th-7th October
Session 2: 10th - 11th November (eva.)
Session 3: *pending*
Session 4: 15th -16th December (eva.)

Three Partial Exams

Exam 1: 18th October
Exam 2: 08th November
Exam 3: 13th December

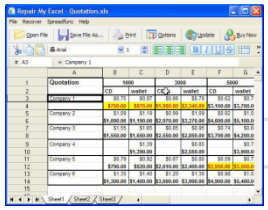
Final Exams
January (Ord.)
June (Ext.)

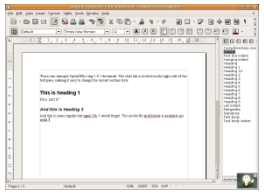
Goals


Grammars
Languages
Machines
Problems
non-computable
computable
Type 0 Chomsky
Non-restricted languages
Turing machine
Type 1 Chomsky
Context-sensitive languages
Linear bounded automata
Type 2 Chomsky
Context-free languages
Push-down automata
Type 3 Chomsky
Regular languages
Finite state automata
Regular Expresions

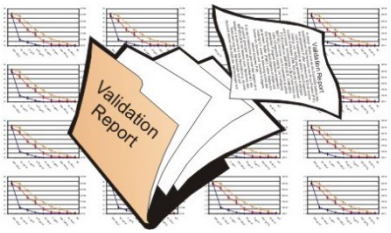
Goals

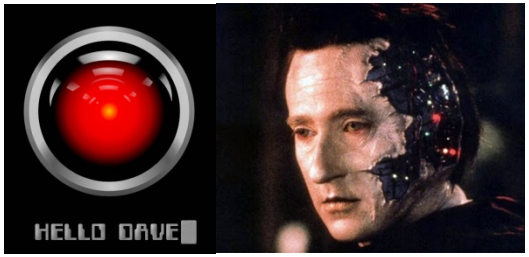
Grammars **Languages** **Machines** **Problems**





$$A = \{a^m b^m c^n \mid m, n \geq 0\}$$





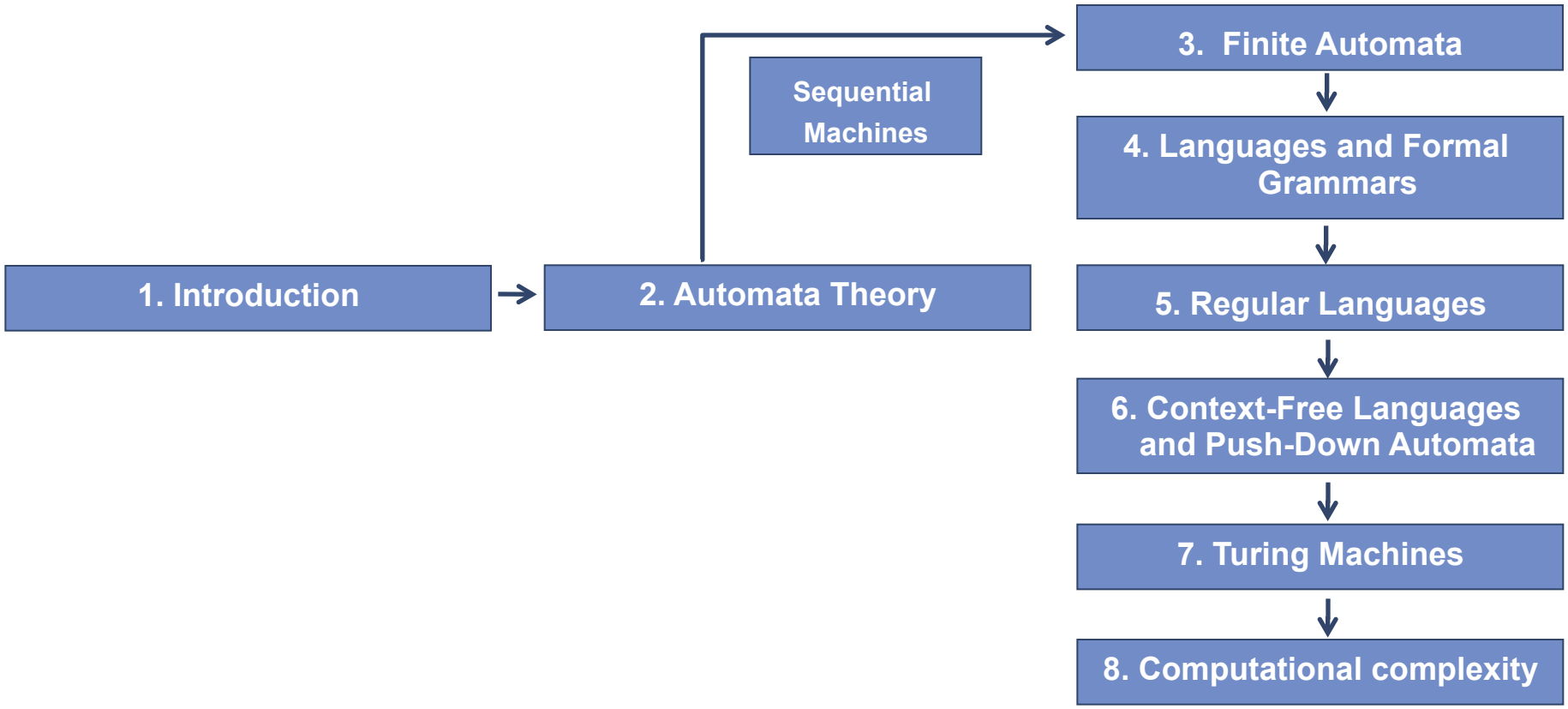
Type 3 Chomsky

Type 2 Chomsky

Type 1 Chomsky

Type 0 Chomsky

Contents distribution



Exercises, Problems and Practical Exercises

Goals

- At the end of the course you should know:
  - Formal theories for languages description.
  - Concept of formal grammar and its types.
  - Finite automata as recognizer of regular languages.
  - Regular expressions as the description of a regular languages.
  - Push-down automata for the recognition of every context-independent language.
  - Turing machines for the recognition of every non-restricted language.
  - Correspondence among grammars, languages and recognizers.

After this presentation…

- Review the presentation of the subject (and your annotations)
- Read the timetable and detailed planning.
- Define your **daily** timetable/schedule to study and work for the subject.
- Prepare Unit 2 using at least one of the recommended books in the basic bibliography.

Questions