# Models of Natural (Unconv.) Computing

**Fall 2015**

**Instructor**: Dr Giuditta Franco, Researcher, Computer Science Department, Verona Univ.

**Office hours**: Room 72, I floor, Ca' Vignal 2, Thur 14:30-16:30am (Wed 15:30-17:30), or by appointment.

**Phone**: 045 - 802 - 7045 - **E-mail**: giuditta.franco@univr.it.

**Class time**: Tue 9:00 - 11:30am (room A), Wed 9:00 - 10:30am (room C).

The course meets for approximately 48 hours during the first (fall) semester. Successful completion of it merits 6 CFU (university formative credit).

**Attendance Policy**: Attendance is not required but strongly encouraged - your presence will be helpful to you for mastering the material. Students are responsible for learning the material covered in class, they are encouraged to take notes and may tape the lectures, but neither the notes nor the tapes are to be sold. You will be asked to fill in an evaluation form, finally. No use of cellular phones[1], laptop, or other electronic devices is permitted in class.

**Homework** will be assigned but not collected. Success can be easily achieved by just spending few hours of study *lecture by lecture* [2].

**Examinations and Grading Policy**: Any final (oral) exam will cover all and only the subjects explained during the course - understanding the subject is appreciated more than learning it by heart.

Midterm written test will focus on exercises and general questions on traditional computational models (first part of the program), while work assignments will focus on topics of computational genomics (typically dictionary based genomic sequence analysis).

Midterm written test applies only for the exam session in February. In next sessions, only oral exams will be allowed.

**Main textbook**: Infobiotics (Springer, 2013), author: Vincenzo Manca.

Other helpful books available in our library:

1. DNA computing: new computing paradigms, authors: Gheorghe P˘aun, Grzegorz Rozenberg, Arto Salomaa (1998, 2006).
2. Formal Languages and Computation: Models and Their Applications, author: A. Meduna (Auerbach Publications, 2014).
3. Computers and Intractability - A guide to the theory of NP-completeness, authors: Michael R. Garey, David S. Johnson (1979).

Further notes and papers will be either distributed in class by the instructor, or posted on the website of the course, which will be the reference mean for any communication from the instructor.

[1] Please do not hold conversations, either with your classmates or your cell phones, during the lecture sessions (Turn your cell phone off).

[2] "Any student with a disability is encouraged to meet with the instructor privately during the first week of class to discuss accommodations..". "Students who must miss a class period due to a major religious observance must notify the instructor of this absence, in writing, by the end of the second week of classes.."

**Important dates**

- Exams dates: Oral exams may be certified in February (2-27), June 15 - July 31, September (1-30) 2015.
- No classes: November: the 3rd and the 4th, December: 15th or 16th or 22nd.

  Following vacations involve our classes: Dec, the 8th, 23rd; Jan th 5th and 6th.

**Course Goal**: Developing the ability of the student to master basic notions of discrete structures and dynamics, formal languages and automata theory, to deepen his/her notion of Turing computation and extend it to informational processes involving either natural or bio-inspired algorithms.

The course is designed to introduce main models of natural computing, in terms of computational processes observed in and inspired by nature. If necessary, basic concepts (of biology, mathematics, and computer science) are also recalled, to make the course as self-contained as possible.

## Orientative Schedule

- Oct-Nov: Introduction to natural computing, biological algorithms, and life algorithmic strategies, starting by traditional computational models..
  - Basic notions and data structures.
  - Formal languages and grammars, Chomsky hierarchy
  - Specific characterization of REG, REC, CF classes
  - Finite state automata, Turing machines, computational universality and complexity
  - A nutshell of information theory (entropy, codes).

  **Midterm written exam.**
- Nov-Dec: Genomic dictionaries, distributions, profiles. Computational models of biomolecular processes
  - Methods to extract and analyze genomic dictionaries
  - Genomic profiles and distributions of recurrent motifs
  - Software IGtools to analyze and visualize genomic data
  - DNA computing on double strings, and computational complexity of bio-algorithms
  - DNA algorithms to solve a couple of NP-complete problems
  - Metabolic systems and discrete representation of biochemical systems
  - Metabolic grammars, networks, and (inverse) dynamics