Applications of Complexity Theory in Medicine – Course Program

Lecturer: Prof. Dr. J. Marczyk PhD

Introduction Prof. Ing. Alessandro Barazzetti

Course Description:

Because modern science lacks a holistic and systemic perspective favoring super-specialization, a patient is rarely seen and treated as multi-organ dynamic system of systems. Due to this cultural limitation, and because of the overwhelming complexity of the human body, only on very rare occasions is medical science truly quantitative. The goal of Quantitative Complexity Management (QCM) is to provide the medical community with quantitative and systemic information on the state of a patient, as well as on the impact of treatment.

The course introduces the concept of complexity from a quantitative perspective, in opposition to the traditional approach, which sees complexity as a process, not as a property of physical systems. Numerous applications in medicine are illustrated. A workshop with practical exercises concludes the course.

Course participants will be able to appreciate and understand the importance of a systemic and nonlinear approach to data treatment in the context of medicine as well as the fundamentals of a quantitative treatment of complexity. Furthermore, participants will gain appreciation of the importance of structural aspects of data and basics of graph theory.

Course Structure:

The course shall be divided into 8 parts, each comprising two lessons of 45 minutes each.

May 2021
12 – 19 – 26

June 2021
2 – 9 – 16 – 23 - 30

Lectures start at 10am

Content of the course:

PART 1 – 12 MAY 2021

1. Fuzzy Cognitive Maps
2. Input/Output mapping in dynamical systems
3. Monte Carlo Simulation
4. Graphs, maps representations
5. Canonical Decomposition of systems

PART 2 – 19 MAY 2021

6. Correlations (Pearson, Spearman)
7. Visual Analytics
8. Entropy: information, disorder, Shannon's equation
9. Second Law of Thermodynamics

PART 3 – 26 MAY 2021

10. Complexity, conventional approach (no metrics), emergence, self-organization, self-organized criticality
11. Quantitative approach to Complexity, definition and metric, C=*f*(N; S; E),
12. Complexity bounds, Critical complexity, minimum complexity, S=0, E=0
13. Complexity Profiling
14. The Complexity Map

PART 4 – 2 JUNE 2021

15. Software tools – OntoSpace, OntoTest, OntoNet, MAPVIEW, Android App OntoMed, live demos
16. Applications of complexity (economics, finance, manufacturing)
    a. Anomaly detection
    b. Early warnings

PART 5 – 9 JUNE 2021

17. Applications of complexity in medicine:
    a. Cardiology
    b. Neurology
    c. Intensive Care
    d. Pharma
    e. Multimorbidity
    f. Epileptic seizure

PART 6 – 16 JUNE 2021

    g. Measuring the Impact of Therapy
    h. Measuring patient's stability (dC/dt)

PART 7 – 23 JUNE 2021

18. Workshop, exercises

PART 8 – 30 JUNE 2021

19. Literature, further reading

20. Future research and projects:

    a. Protein folding
    b. DNA complexity
    c. Complexity of drugs

Organizational aspects

The course is aimed at individuals holding an MS or PhD degree in technical, engineering and/or life sciences disciplines. Background in mathematics and statistics are prerequisite.

Participants will be required to register.

The course shall be imparted to a live audience, not via pre-recorded lessons. However, live lessons will be recorded and re-transmitted via UCM eLearning platforms.

A certificate of participation shall be released to all students who complete the course.

Course Location

The course is taught by the Professors in Ludes Lugano Campus* classroom, in presence and simultaneously on Microsoft Team. The number of students who can access the classroom will be determined in accordance with the Swiss Covid-19 Pandemic Guidelines, in force at the time the lesson is administered. In any case the student can join the lecture in live, via Microsoft Teams. Lectures are also recorded and made available in the UCM eLearning platform.

How to apply

In order to start the registration process, click the link below and follow the given steps:

https://www.agena-ucm.com/students/register?s=0001

1. Enter the data for registration (obligatory reference site LUDES_LUGANO);
2. Activate your account by clicking on the link you will receive by email;
3. Enter your credentials and click on the course window "Complexity Theory in Medicine - Seat Reservation";
4. Click the "Seat Reservation" button that you will find in the upper right hand corner of the page;
5. Fill out the form, insert your Curriculum Vitae and accept the terms of privacy.

Completed the registration process, you will receive - within 96 hours by email, all the information to access the programme.

*** Campus Ludes**
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