

**Title:**

Mathematical models for the ward atmosphere in a medical unit

**Speaker:**

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**Abstract:**

This talk will present recent studies aimed at analyzing the performance and clinical outcome of an existing medical unit. Two different mathematical models have been implemented and numerically tested on the basis of a four-year-long experimental data set.

The first model is of statistical nature. It is based on the time evolution equations for the population distributions over a "microscopic" state regarded as a random variable, which in the literature on generalized kinetic models is referred to as \*activity\*. Evolution is driven both by the interactions among the system \*actors\* (in our case, patients and staff), and by various external and internal events, which are suitably modeled after the experimental data available. The dynamics of the system is assumed to be connected to (and to some extent driven by) a "macroscopic" variable known in the specialized medical literature as "ward atmosphere", which refers to the perceived social and organizational climate, as well as the comfort and ease realized in the ward. Internal and external actions are taken into account by means of direct interactions and ensemble terms, and the problem, under suitable simplifying assumptions, is reduced to a sequence of correlated initial value problems for a system of 10 coupled, nonlinear, nonlocal ordinary differential equations for the probability density distributions.

The second model relies on the implementation of artificial neural networks (ANNs) to ultimately predict the ward atmosphere in the said medical unit. Specifically, we have implemented a dynamic feed-forward ANN where all the experimental data collected on a daily basis in the medical unit have been regarded as inputs/outputs of the network. An optimization of the network architecture has been carried out to identify the number of neurons, nodes in the hidden layers, network options, etc., in order to achieve the best balance between a satisfactory agreement during the training phase and the simplicity of the implementation. Advantages of the ANN technique over more traditional mathematical/statistical models are twofold: On one hand, this approach deals quite naturally with a large number of parameters/variables, and also allows to identify those variables which do not play a crucial role in the system dynamics. On the other hand, the implemented ANN can be more easily used by a staff of non-mathematicians in the unit, as an on-site predictive tool.

The predictions from the ANN technique are then compared and contrasted with those obtained from the generalized kinetic approach.

This talk is based on joint work with Enzo Serio (Universita' del Salento, Italy), Mauro Lo Schiavo (Universita' di Roma "La Sapienza", Italy) and Jessica Gronski (UCCS).

**References:**

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