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Development of mathematical and statistical models for biological processes

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Abstract:

Research activities carried out at the Dept. of Agricultural Sciences involve: i) the development of process-based mechanistic models for the quantitative analysis of biological systems using several approaches such as Ordinary and Partial Differential Equations (ODE and PDE) and Individual-Based (IBM). In this context we work on the integration of different approaches to simulate the temporal and spatial dynamics at different scales; ii) the use of System Dynamic models (ODE) to simulate the growth of microbial cultures mainly driven by metabolic fluxes. PDE models have been used to simulate the emergence of vegetation patterns simulating plant-soil interactions and, with a similar approach, the differentiation of vascular tissues in plants; iii) the implementation of hybrid modeling aiming at integrating continuous approaches (ODE, PDE) within an IBM framework. Such models have been proposed and applied at ecological scale to simulate the formation of vegetation patterns and at tissue/organ scale to simulate xylogenesis and wound closure in plants. The hybrid modeling approach has the big advantage of simulating complex systems as sets of different modules, which can be implemented in different mathematical approaches most appropriate to render the subsystem under consideration; iv) the implementation of pest models in a geospatial framework including cyberinfrastructures to enhance model development and exploitation. There is a strong connection with the data management part, since climate, environmental and pest parameters geospatial data (cubes) support the deployment and the geospatial usage of the model.

Recent publications:

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- Carteni, F., Occhicone, A., Giannino, F., Vincenot, C. E., de Alteriis, E., Palomba, E., & Mazzoleni, S. (2020). A General Process-Based Model for Describing the Metabolic Shift in Microbial Cell Cultures. Frontiers in Microbiology, 11, 521368.
- Caputo, B., Langella, G., Petrella, V., Virgillito, C., Manica, M., Filipponi, F., Varone, M., Primo, P., Puggioli, A., Bellini, R., D'Antonio, C., Iesu, L., Tullo, L., Rizzo, C., Longobardi, A., Sollazzo, G., Perrotta, M. M., Fabozzi, M., Palmieri, F., … Salvemini, M. (2021). Aedes albopictus bionomics data collection by citizen participation on Procida Island, a promising Mediterranean site for the assessment of innovative and community-based integrated pest management methods. PLoS Neglected Tropical Diseases, 15(9), e0009698.
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- Terribile, F., Bonfante, A., D'Antonio, A., De Mascellis, R., De Michele, C., Langella, G., Manna, P., Mileti, F. A., Vingiani, S., & Basile, A. (2017). A geospatial decision support system for supporting quality viticulture at the landscape scale. Computers and Electronics in Agriculture, 140, 88–102.
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