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System Simulation by SEMoLa

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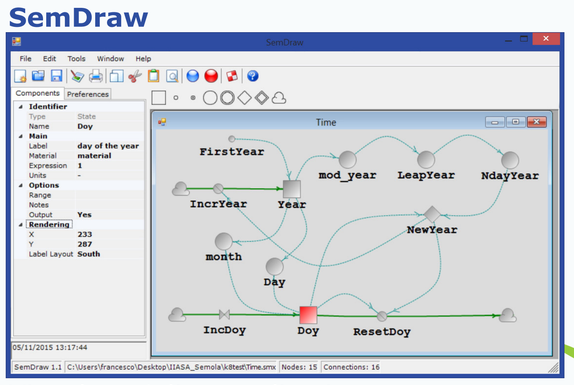
SEMoLa Platform

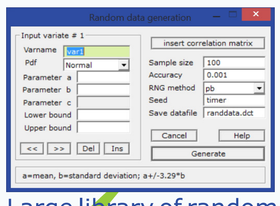
The development of software modelling frameworks able to handle knowledge-models-modules integration in environmental and agricoltural sciences is still an open burning issue[1-2]. SEMoLa[3] (Simple, Easy to use, Modelling Language) is a platform for system knowledge integration and modelling. It creates computer models for dynamic systems and manages different types of information. The user-oriented development allows SEMoLa platform to simplify the routinely tasks of creating, debugging, evaluating, and deploying computer simulation models, but also to create user libraries of script commands, user function and model components (DLL). The platform is able to combine components and modules to produce modelling solutions.

SemDraw



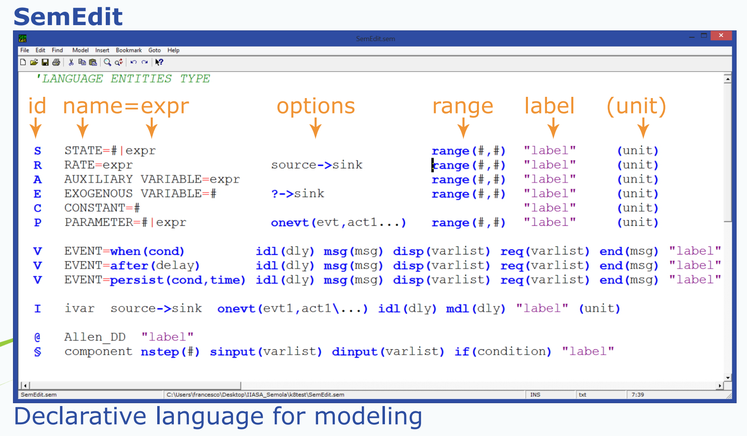
Visual modeling application

- Support for fuzzy logic expert systems
- Functions for uncertainty analysis
- Wide set of statistical tools
- Scripting capability



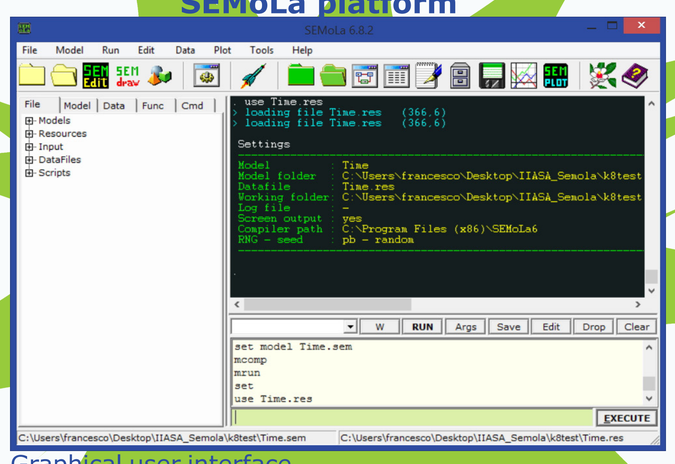
Large library of random number generators

SemEdit



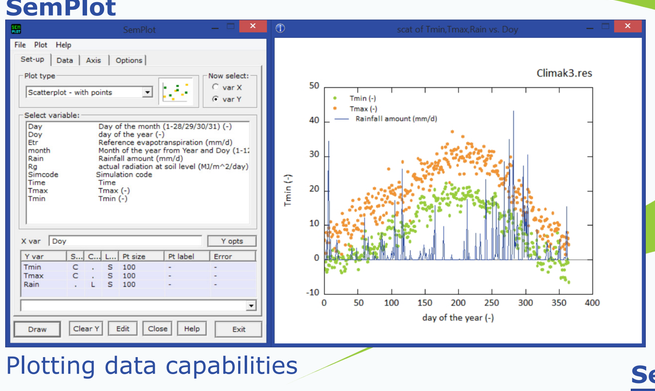
Declarative language for modeling

SEMoLa platform



Graphical user interface

SemPlot



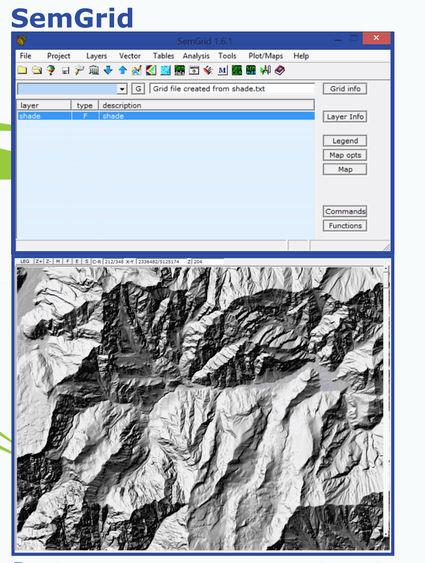
Plotting data capabilities

SemData

Data base management system

Neural networks builder

SemGrid



Raster maps management system

The core part of the platform is the declarative modelling language. It relies on and extends the system dynamics principles with an integrated view to represent dynamic systems through different modelling approaches (state/individual-based, continuous/event driven, deterministic/stochastic, distributed parameters, agents based) without requiring specific programming skills.
SEMoLa language is based on an ontology closer to human reasoning rather than computer logics and also constitutes a paradigm for knowledge management.

Creating a Modelling Solution

SEMoLa speeds component combining into modelling solution up. it deals with modularity by creating three type of modelling resources: modules (SEMoLa code), user functions (Basic code) and components (DLL, Dynamic-Link Library). DLL components can be reused to create modelling solution, even in other software framework. Moreover, SEMoLa can generate components for the BioMA[4] platform. As example of SEMoLa capability to manage GIS maps and functions and to perform complex calcalculation dealing with cell interactions, a toy model is presented.

Watershed Model

This model (modified from Costanza et al. 2004[5]) simulates the water and sediments dynamics of the Silisia stream basin feeding Lake Ca'Selva (PN,Italy) at a daily time step, from doy 1 to 365, in a 862x756 grid map, with a cell size of 10 m.
Model input layers: elevation map (*DTM*, m), maximum infiltration rate map (*MaxInf*, %) in ArcGis ASCII grid format.
Model output layers: runoff water (*Water*, mm), snow accumulation (*Snow*, mm) and sediments deposition (*DepSed*, mm) in ArcGis ASCII grid format

Components of watershed model

Component	Description	Resource type
Water	Runoff water flow simulator	SEMoLa Module
Snow	Snow accumulation and melting simulator	SEMoLa Module
Sediments	Sediments deposition simulator	SEMoLa Module
Climak3[6]	Stochastic WG for Tmax, Tmin and Rain variable	DLL component
Et0	Evapotranspiration estimator based on Penman–Monteith equation	User Function
Rg	Global radiation estimator based on neural network trained on Tmax, Daily thermal excursion and DayLenght.	User Function
Daylenght	Photoperiod calculator based on latitude and day of the year.	User Function

Conclusion

The declarative language, the wide set of tools, the early error trapping, the automatic CHM help building, and the modular approach make SEMoLa a complete, flexible and reliable platform which can be used to quickly create components and modelling solution. SEMoLA can be used to create executable models components libraries for different domains and new commands using its scripting capabilities.

References
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