VERA: Analysis of Simulations based upon Cognitive Models

Kuhu Gupta
College of Computing
Georgia Institute of Technology
Atlanta, USA
kuhu.gupta@gatech.edu

***Abstract*—In this paper, we represent an interactive system called VERA designed for generating agent based simulations from conceptual models of ecological systems. Designed with STEM education in mind, it becomes really important to carefully analyze and examine the tool to enumerate the salient features as well as identify areas of improvement.**

***Index Terms*—cognitive, agent based simulation, ecological,**

I. Introduction

Virtual Ecological Research Assistant (VERA) is is an interactive tool developed at Design and Intelligence Lab, Georgia Tech that facilitates interactive construction of conceptual models of ecological phenomena and automatically creates simulation models from the conceptual models. The tool uses Encyclopedia of Life (EOL) database of biological species and other biodiversity information and related biodiversity data sources. It integrates these data sources with VERA for information extraction, modeling and simulation.

II. Description of the Model

For the project, I have tried to model a basic ecological phenomena that is, a food chain. The model has 4 components containing 1 Abiotic and 3 Biotic components. These components were looked up from the EOL database. The abiotic component chosen is Sunlight and Homo Sapiens(Cro-Magnon-Mensch), Sus Celebensis (Celebes wild Boar) and Cynosurus Cristatus (crested dogstall grass) is chosen as biotic components as shown in Figure 1. These components hold casual relationship of ”consumes” among themselves. The intial value of the parameters are being set as - for grass the initial population is 900 (due to the VERA's constraint of 1000), population of boar and humans is 100 and minimum amount of sunlight is 100.

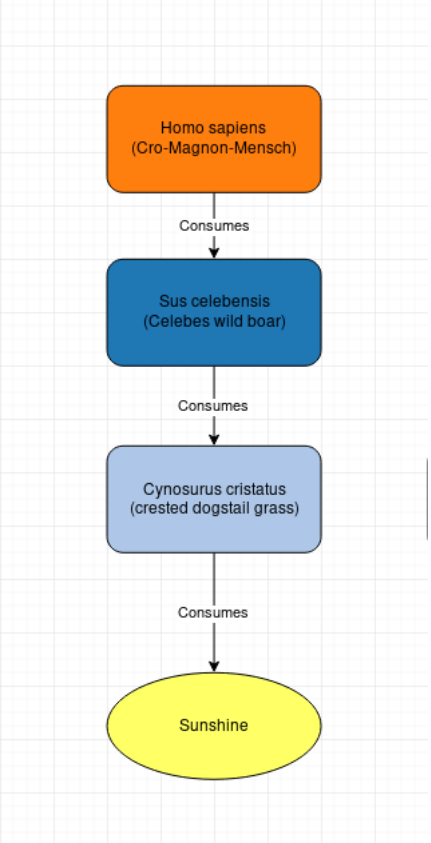

Fig. 1. A model of the food chain

After running simulations for sunlight,grass and boar, real time changes could be seen in the visualization shown by Simulation generation engine. Figure 2 shows relation between population count and months for boar,grass and sunlight. As seen in Figure 2, the sunlight is constant across temporal axis while grass starts with the initial population 0f 100 and then reduces a bit and then there is a sudden bump(first increase and reaches a peak and then sudden decrease) in the population between 50 to 230 months. The increase in grass population is consumed by the boar population as soon as its energy level is below the threshold. After consuming all the grass, there is an exponential increase in the population of boar and grass is reduced to zero. The rise in boar population seems to be infinite but it will stop at a certain point because boars will begin to die of starvation as the grass population is zero.

On running simulations, significant changes can be seen in all the agents of the model as seen in Figure 2. All the agents starts with initial population as stated earlier. Fromm 0

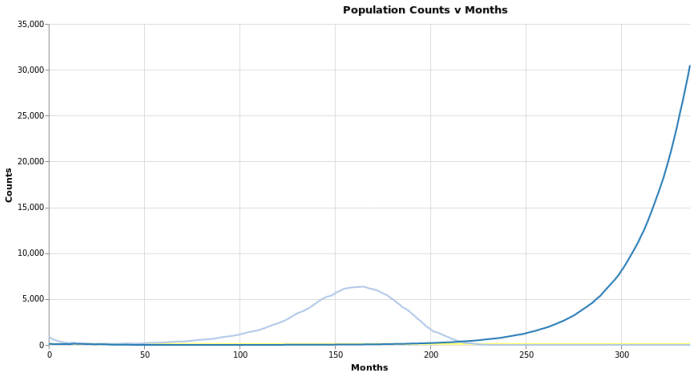

Fig. 2. Change in the population of Grass, Boar and Sunshine

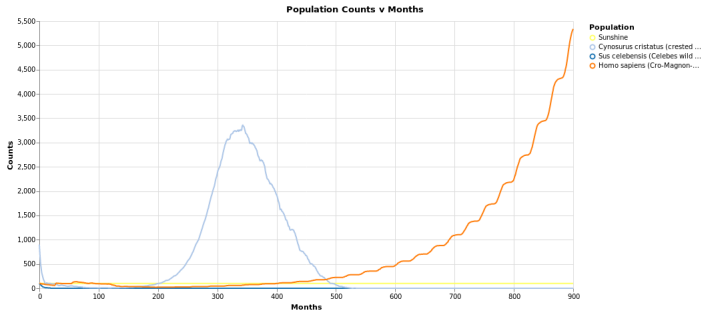

Fig. 3. Change in the population of Grass, Boar, Humans and Sunshine

to 130 months, there is an increase in the human population as it consumes on both grass and boar due to its energy level reaching below the threshold. However, at 190 months there is a sudden increase in the population of grass which continues till around 510 months. During this time, the boar consumes grass and humans consumes both boar and grass. Gradually, the population of humans grows exponentially as it is surviving on both boars and grass while the population of boar is reduced to zero and there is some population of grass left. The rise in human population seems to be infinite but it will stop at a certain point because humans will begin to die of starvation as the grass population is zero.

III. Salient Features of VERA cognitive model and interactive tool

- The modelling process is easy and systematic. The different visual representations for biotic and abiotic is easy to differentiate. The ”drag and drop” feature for easy navigation of individual components. The color feature helps in easy identification of components. Moreover, the text boxes for playing around with parameter for individual components are insightful. This provides a fine grained control over the entire process of modelling.
- The assumptions taken into consideration for the simulation generation engine in the cognitive model is easy for the user to understand after using VERA. Several assumptions based on the components and relationships among the components made at the cognitive modelling end are fairly simple and which are intutive and visible at the interactive end of the tool upon use.
- The Encyclopedia of Life (EOL) database connection with VERA for the lookup of biotic components provides a wide variety of biological species. This large database allow users to model several real world phenomena to a large extent including most of the biological species present in the world.
- The simulation generation engine iterates over the agents in the simulation and their interactions, and creates the visualizations. Each variable or component is added to the visualization in form of a line and can individual agent's change and movement can be tracked and observed on the temporal scale.

IV. Improvements the VERA cognitive model and interactive tool

- The tool lacks an understanding of division of ecologies. Some biotic components like sheep or wolf are mostly in groups while animals like fox and lion are lone animals. The system lacks the ability to treat them different which could have created a significant impact on the modelling process if taken into consideration
- There is no way the tool can measure the intelligence and the inherent behavior of similar biotic components. For example, Sparrow and Crow are considered to be similar biotic components but inherently crow is an intelligent species as compared to sparrow. In real world, whenever sparrow and crow will compete, the crow will always win. This feature is not incorporated into the VERA tool.
- In the real world, there could be several reasons responsible for the decrease in the population of biotic components. Some of the reasons are human interventions, disease outbreak and killed for other purposes(herbivores killing a carnivore in certain circumstances). These aspects are not considered by the simulation generation engine of the VERA tool.
- The tool fails to take weather conditions into considerations. Harsh weather conditions could affect the population of biotic components. These negative abiotic componets are not considered by VERA during simulation,
- The nutritional requirements of a biotic agent undergoes significant change over its entire lifespan. For example, a cub in its initial days feed only on the mother's milk, therefore, it is only after certain age it starts feeding on other biotic components. Thus, it is clearly visible that VERA fails to model biological processes.
- The tool could improve on the user experience by making some subtle changes which could help in better understanding of the cognitive modelling. The segregation of tuning paramenters in different classes could simplify the process of tuning the parameters.For example, modelling parameters, respiratory parameters and reproduction parameters could be separated out in different sections.

- Speaking of user interface, inclusion of "compare" feature for the visualization would be really helpful. In order to study the changes made in one parameter for same set of agents, multiple charts placed side by side could be really helpful in understanding the modelling processes as well as make clear comparison in the population of different agents.

V. An analysis of VERA as a tool for learning about ecology and about modeling

VERA as a tool for learning and modelling really stands out in most of the aspects. A person for whom the world of ecology is completely new, the tool seems to be guiding light as it is easy to learn. The Encyclopedia of Life (EOL) database connection with VERA gives a wide variety of organisms along with scientific names and general characteristics to explore and choose from for modeling. The uniform interface of the tool facilitates easy navigation of components as well as choice of colors and shape for representing agents clearly add to the understanding. Moreover, students who are studying ecology and if they use all the features of VERA, it will do a really good job in that way. It will easier for them capture complex ecological phenomena if they put the use of all the features of VERA in the right direction. All in all, I believe VERA is a good starting point for both learning and modelling purposes with some constraints which could be resolved gradually with regular revisions of the tool.

VI. Acknowledgements

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