SIG Proceedings Paper in LaTeX Format

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ABSTRACT

MOMA is a agent-based model that simulates the population dynamics and the interactions of the main vector of the dengue virus, a female *Aedes Aegypti*. Three agents were used in this study: **Aedes**, **Spatial Objects** and **World**. In this model, the agent Aedes utilizes a behavioural decision making process which determines its next decision in what stage it is in. Interactions between the agents are specified by Aedes to Spatial Objects, vice-versa and Spatial Objects to World, again, vice-versa.

This model also has a time element implemented into it. This aspect determines what stage the Aedes is in or what the temperature and precipitation currently are. Having this element helps give an insight as to the breeding site dynamics and population dynamics of the Aedes in a specific spot in the urban location.

The agent Aedes has a detailed behaviour embedded into each one. This behaviour is determined by what stage and what the best target for the Aedes in the current time is. Some spatial object agents have a submodel implemented into them, this determines their situation and how large their effect is on the agent Aedes' movement and behaviour.

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1 INTRODUCTION

It has been estimated that 50 million dengue cases infect people per year and there are approximately 2.5 billion people living in dengue-prone areas (tropics and urban settings). The number of dengue cases have been higher than ever. In 1955-1959 only 908 cases of dengue were recorded. A very steep rise in just a span of 60 years. This is mostly caused by the rise in population and having more dense urban living space.

The main vector for the dengue virus, mosquito *Aedes Aegypti*, has adapted to the conditions of urban areas in humid and temperate countries. In locations where clear water is abundant and its temperature is just right, the female Aedes lays her eggs. Studying the vectors in this certain environment can be helpful in the planning and mapping of the locations of prime breeding locations and "hotspots" for female Aedes. Having this ability means being able to control Aedes population.

Models which utilize spatial aspects and also include time in their construction makes control more efficient. **MOMA** (Model Of Mosquito Aedes) is a model developed with space and time in mind and also utilizes the geographical outline and formation of a certain neighbourhood. This model uses Geographical Information Systems and Agent-Based Models for mapping the objects in this environment and the latter for giving the Aedes mosquito detailed behaviour

2 BACKGROUND

2.1 Previous Models

MOMA is a behavioural model that surveys a large area representing a neighbourhood. It takes into account breeding sites, human density, topology and this sets it apart from previous models.

2.1.1 Skeeter-Buster. Skeeter-Buster's main focus is on breeding site dynamics. It is a stochastic, spatially-explicit model that models cohorts of mosquitoes at a very fine spatial scale, down to the level of individual breeding sites for immature cohorts, or individual houses for adults. Skeeter Buster additionally includes a detailed genetic component, and can therefore model the genetics of Ae. aegypti populations, making it a crucial tool in the evaluation and development of genetic control strategies.

The main difference of it from MOMA is that Skeeter-Buster does not incorporate blood stocks from humans. It also differs from MOMA because of its scale. Skeeter-Buster focuses on the contents of individual houses and the individual water-containers where the Aedes lays their egg and where their eggs develop into other vectors.

2.1.2 SimPopMosq. This model is the considered closest to the MOMA. It includes the blood stock in the model for the mosquitoes. This model allows for interactions between the mosquito and people but only in a very small vicinity. It adds a spatial aspect to the frequently used CIMSiM model.

The CIMSiM Model estimates the capacity of the production of mosquito larvae in a vector site under varying temperatures and humidity or precipitation. This approach was also utilized and adapted by Skeeter Buster to model intra-container development.

The SimPopMosq model is based on the interaction of agent-based model made up of four classes (Aedes,human,dog and cat) with environmental data (vector,bedroom and garden). This model is used to study the dispersal and movement

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of Aedes indoors and gardens, and also studies the effeciency of mosquito trap placements.

2.2 Assumptions

The breeding site dynamics are mainly affected by temperature, precipitation and the land-use categories of the location generated by the Geographical Information System. It can speed up, slow down or kill Aedes offsprings. We can also assume that the urban space and topology will affect the population dynamics of our dengue vector. As these items locate where possible breeding sites of the Aedes will be, locations of the blood stocks (humans) and areas with shade is also defined by the urban topology of the desired location.

3 METHODS

The model was created using Gama 1.6.1. This software gives the ability to use graphical modelling tools and manipulation of the GIS data. Being able to manipulate the GIS data in this software is the main reason this tool was used. Other softwares used in this study are QGIS (2.6.1) and R (x64 3.2.0). QGIS was used for obtaining the environmental data of the model and R was used for analysis of simulation results.

3.1 Significance of model

This model's main purpose is that it models and watches Aedes population dynamics in an urban setting having a dense and cramped setting. The main agent observed in this model is the agent Aedes, this agent is our main vector for the dengue virus. This agent is able to bite, mate, rest, oviposit, and interact with objects that consume space.

The setting of this model is affected by the real-world meteorogical data and the daily temperature of the desired location to simulate. In this study a neighbourhood in Delhi, India; was simulated. In this setting, precipitation is high and temperature for breeding sites is near or is ideal, since this India has a tropic climate.

A HEADINGS IN APPENDICES

The rules about hierarchical headings discussed above for the body of the article are different in the appendices. In the **appendix** environment, the command **section** is used to indicate the start of each Appendix, with alphabetic order designation (i.e., the first is A, the second B, etc.) and a title (if you include one). So, if you need hierarchical structure *within* an Appendix, start with **subsection** as the highest level. Here is an outline of the body of this document in Appendix-appropriate form:

A.1 Introduction

A.2 The Body of the Paper

A.2.1 Type Changes and Special Characters.

A.2.2 Math Equations.

Inline (In-text) Equations.

Display Equations.

A.2.3 Citations.

A.2.4 Tables.

A.2.5 Figures.

A.2.6 Theorem-like Constructs.

A Caveat for the TEX Expert.

A.3 Conclusions

A.4 References

Generated by bibtex from your `.bib` file. Run latex, then bibtex, then latex twice (to resolve references) to create the `.bbl` file. Insert that `.bbl` file into the `.tex` source file and comment out the command `\thebibliography`.

B MORE HELP FOR THE HARDY

Of course, reading the source code is always useful. The file `acmart.pdf` contains both the user guide and the commented code.

ACKNOWLEDGMENTS

Acknowledgments here...