Towards an Ontology for Mathematical Modeling with Application to Epidemiology

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Mysore, August 2012

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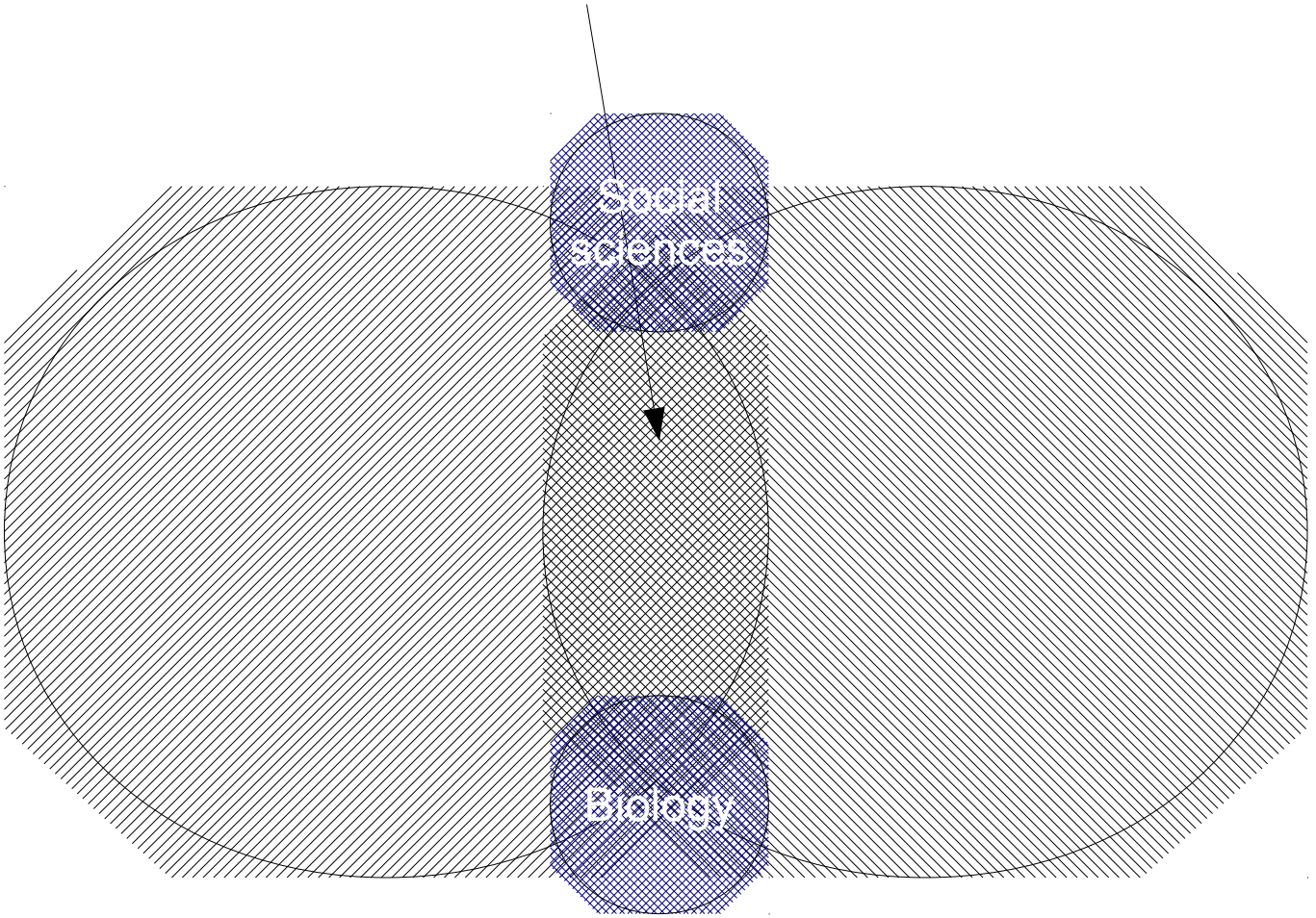
FIOCRUZ

Epidemiological modeling



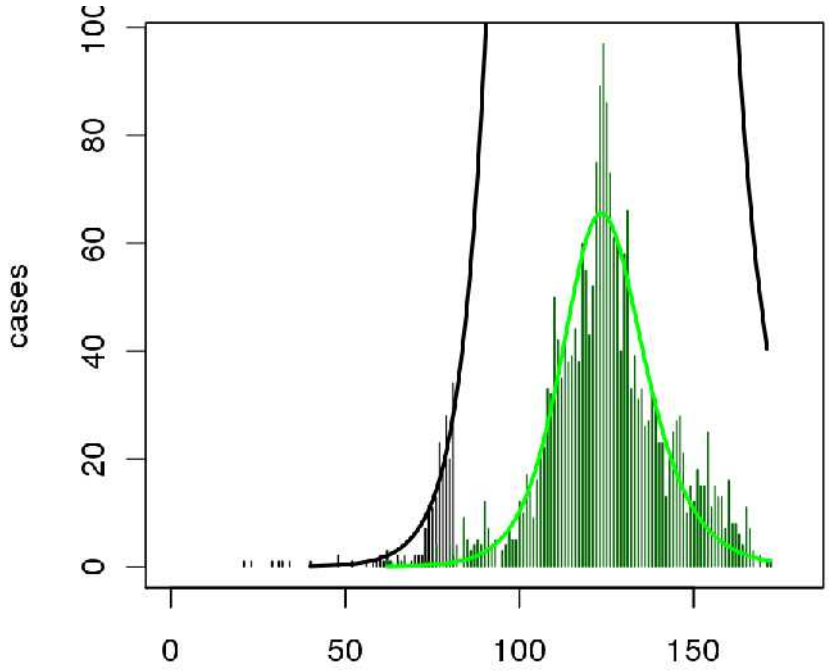
Applied Mathematics

Transmissible Diseases epidemiology

Epidemiological modeling

Statistical inference

Disease data



$$\frac{dS}{dt} = -c\,\rho\,\frac{I}{N}\,S$$

$$\frac{dI}{dt} = c\,\rho\,\frac{I}{N}\,S - rI$$

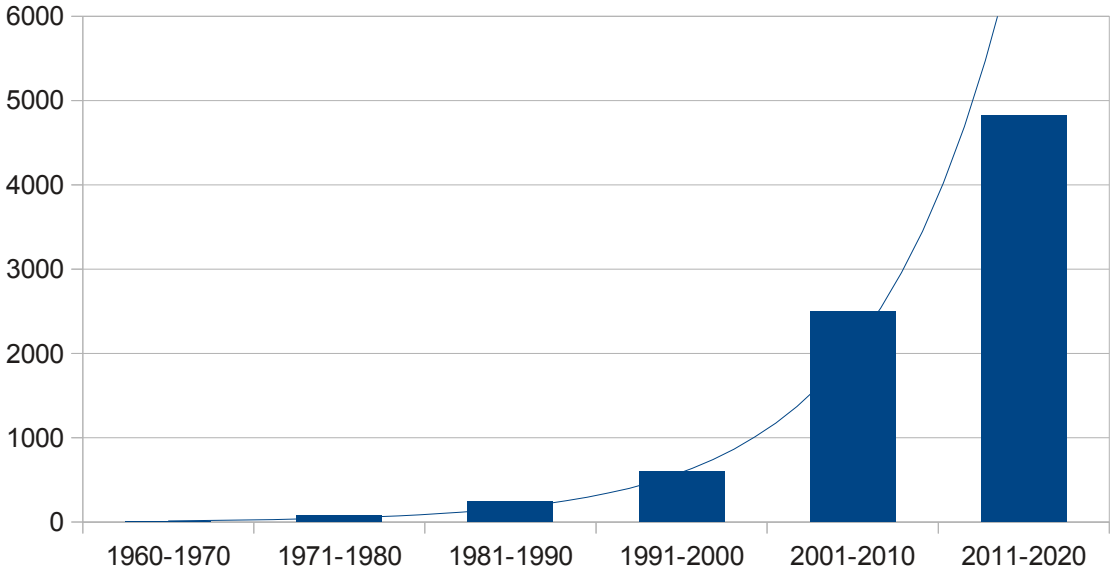
$$\frac{dR}{dt} = rI$$

Epidemiological knowledge

Epidemiological theory
Mathematical reasoning

Epidemiological modeling

8.000 to 10.000 publications in 2020, annual growth rate of 30%



ts =((epidem* or infect*) and (mathematic* or simulat* or comput* or dynamic*) near/2 model*))

The

A is for Assume.

B is for Borrow.

C is for Criticize.

D is for, among other things, Decay.

# of modelling

From *A Concrete Approach to Mathematical Modelling*
by Mike Mesterton-Gibbons
(Wiley, 2007, corrected reprint of 1989 original)

Goals

To build an ontology for epidemic models, to improve the classification and analysis of the literature and accelerate the modeling process.

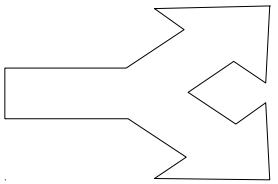
Apply to a specific corpus - *dengue fever modelling* - identifying tendencies and structure (n = 130).

Methodology

Comparative approach (Silva, Souza and Almeida, 2008)

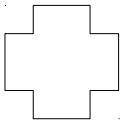
- Motivation Scenarium
- Ontological Scope
- Integration
- Conceptual Model
- Implementation
- Maintainance

To support the task of classification and selection of mathematical models in the field of mathematical epidemiology;



MMO Math Modeling Ontology

EMO Epidemic Modeling Ontology



Protegè-Dublin Core Ontology
IDO Infectious Disease Ontology
Publication Ontology

Protégé 4.2.0 and OWL 2.0.
Cource codes and documentations are maintained under version control on Bitbucket

Methodology

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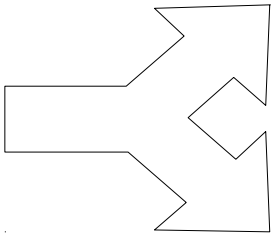

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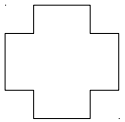

Protegè-Dublin Core Ontology
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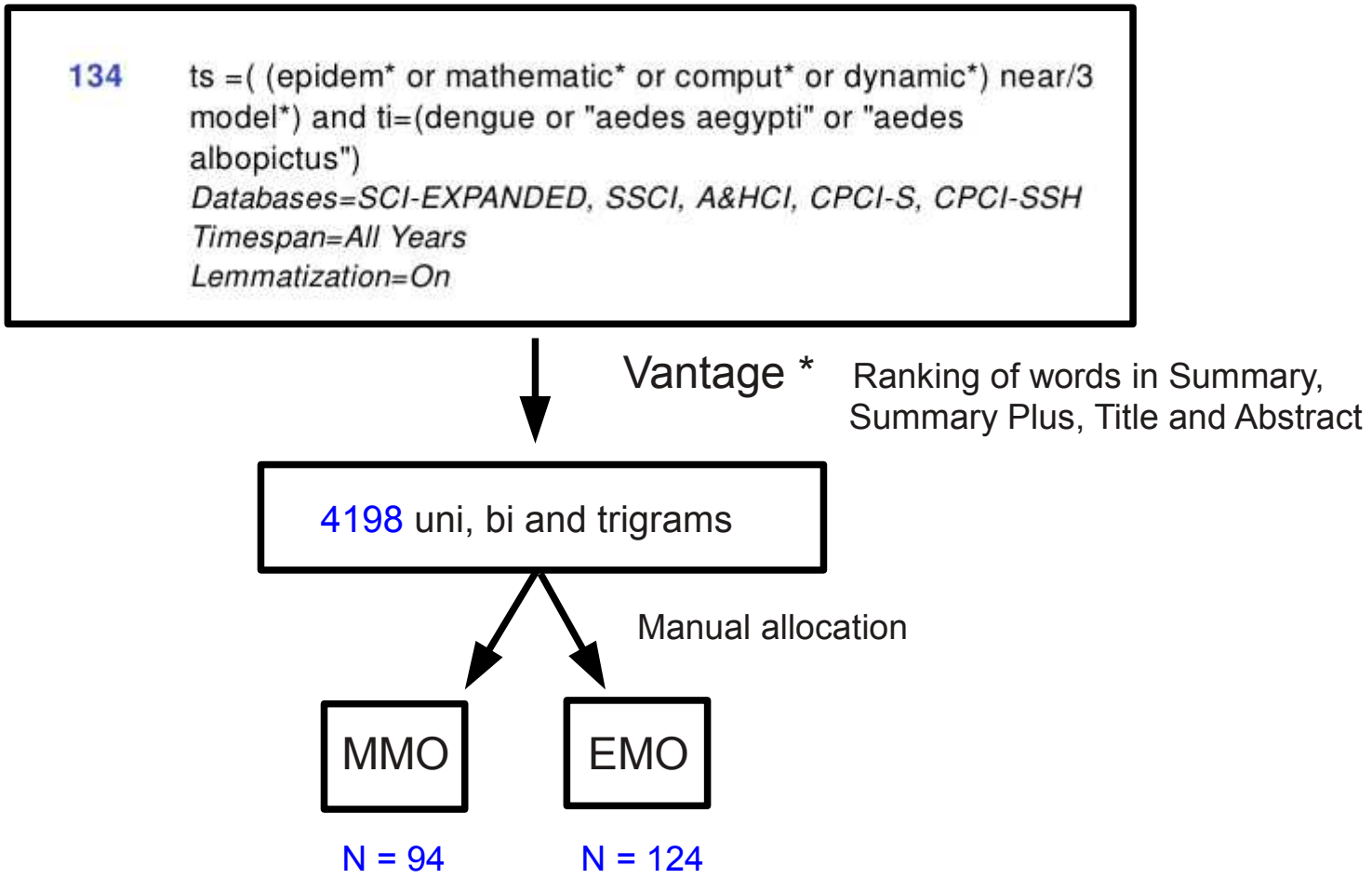
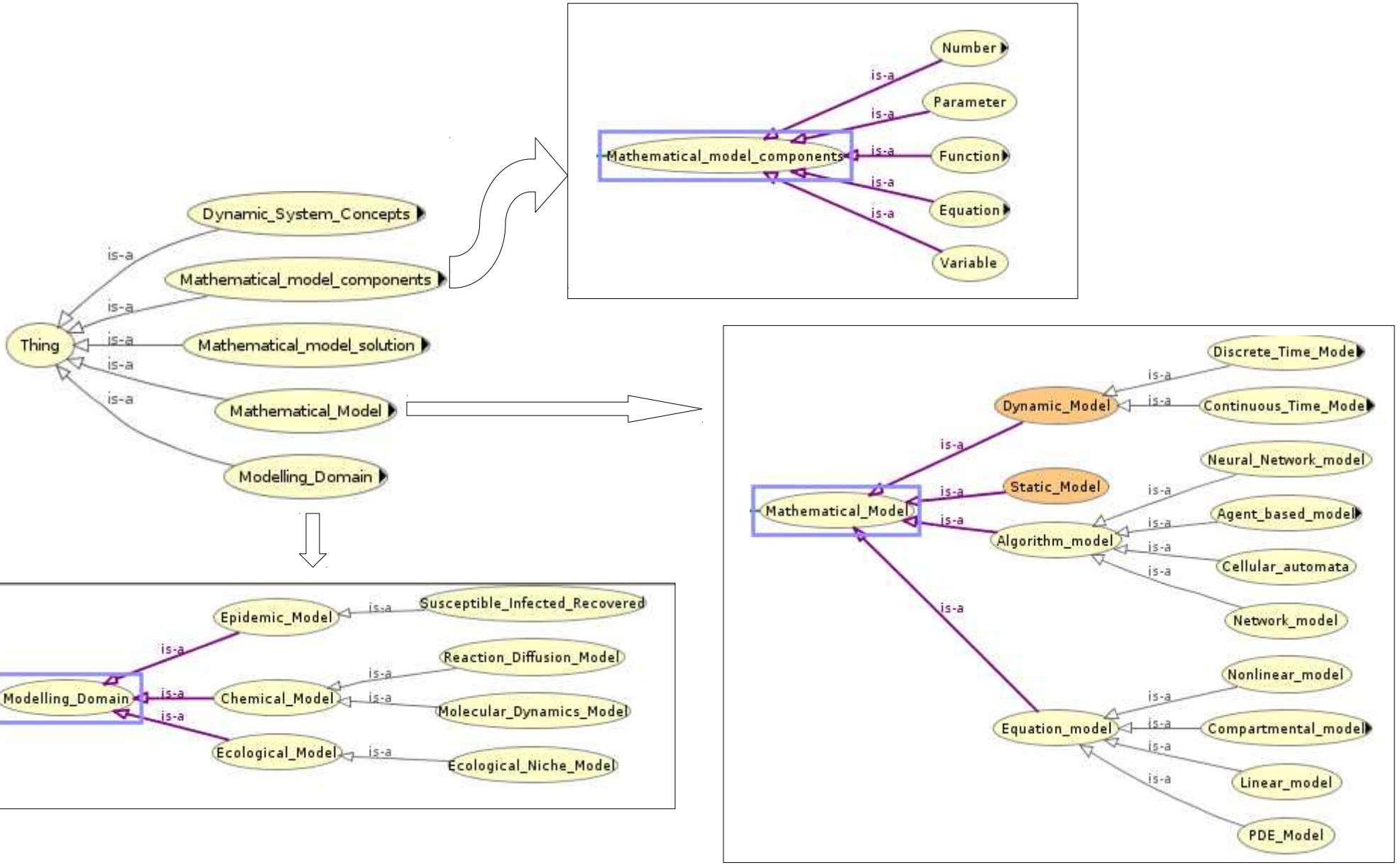
Conceptual model

1. Expert opinion: first hierarchical levels
2. Literature Harvesting – *focused on Dengue Fever Modeling*
3. Complemented with Textbooks and Dictionaries



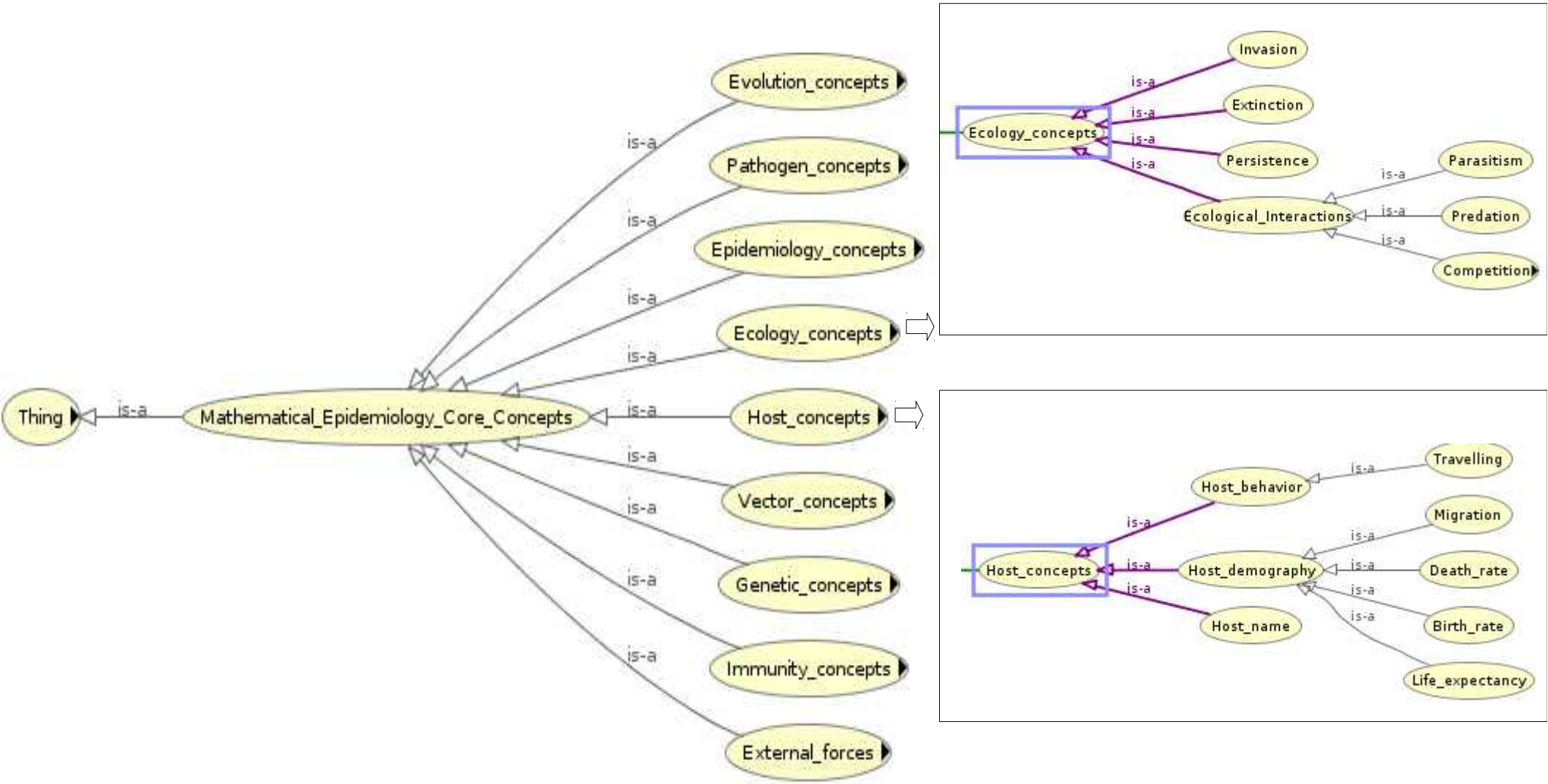
* work done by Simone Alencar (ICICT, Fiocruz)

The MMO: Mathematical Model Ontology



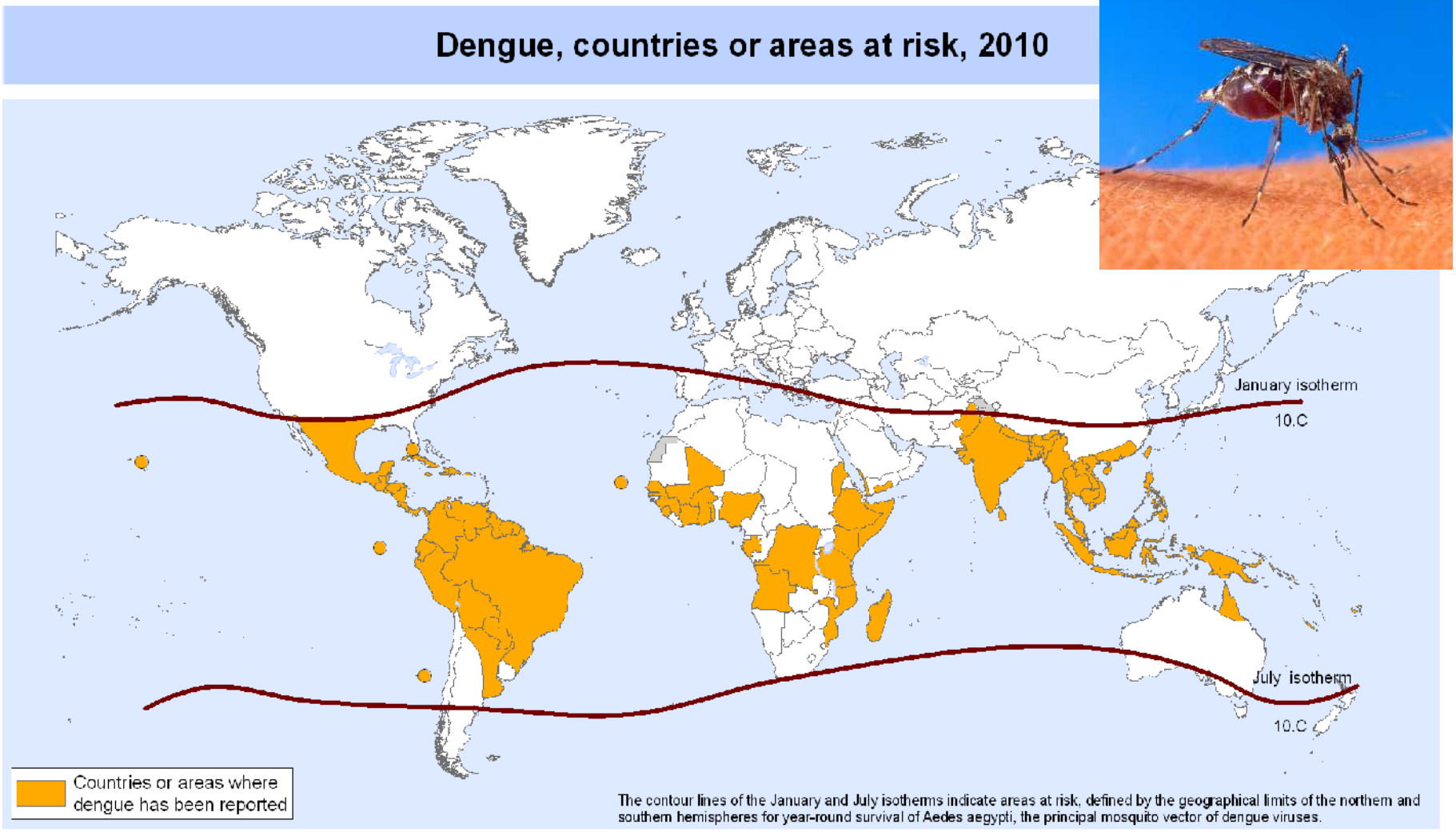
Level	1	2	3	4
N	5	26	51	12

The EMO: Epidemic Model Ontology



Level	1	2	3	4	5
N	1	9	29	62	23

Applying to the Dengue Modelling Literature



The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization
Map Production: Public Health Information and Geographic Information Systems (GIS)
World Health Organization

World Health Organization

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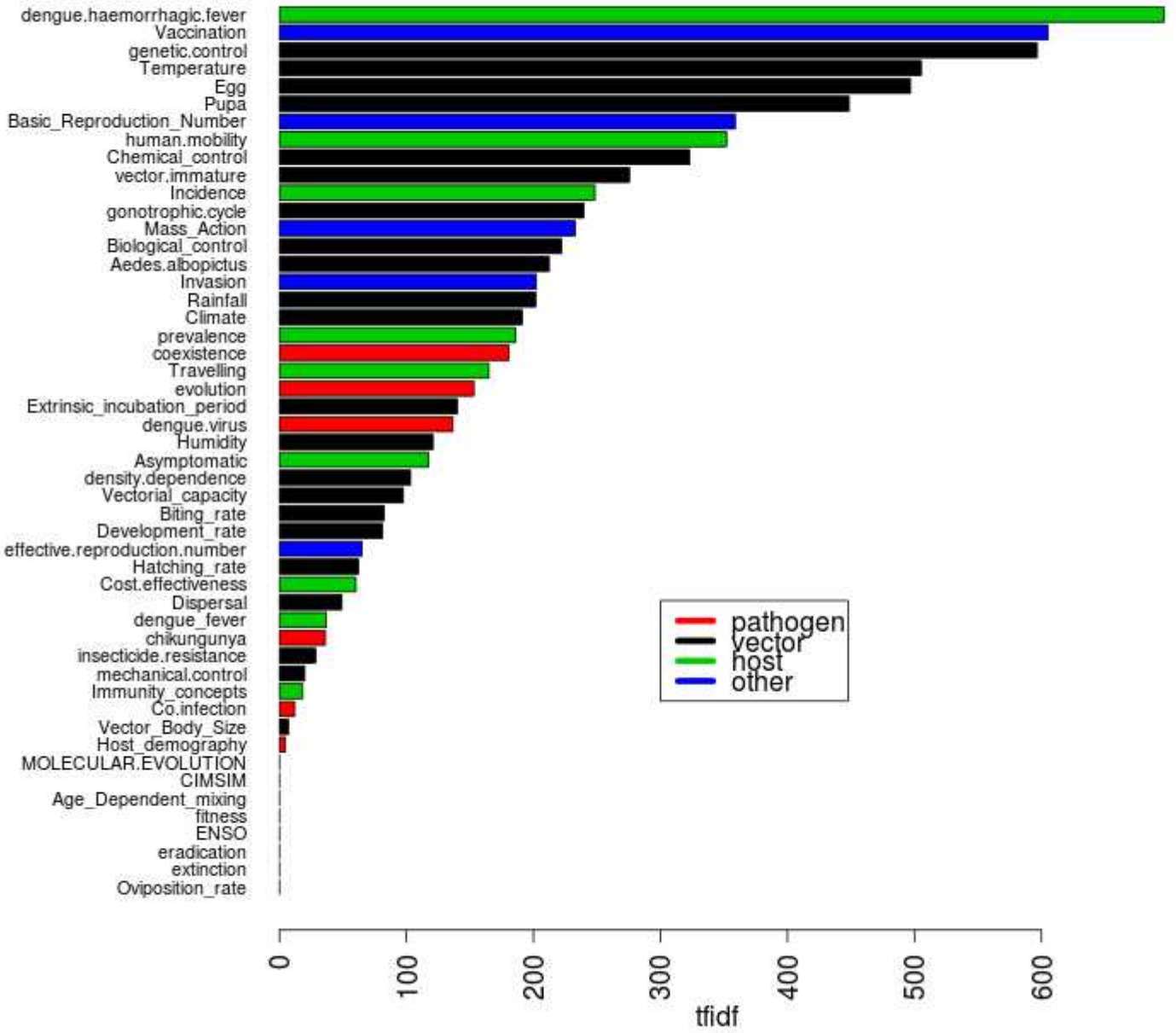
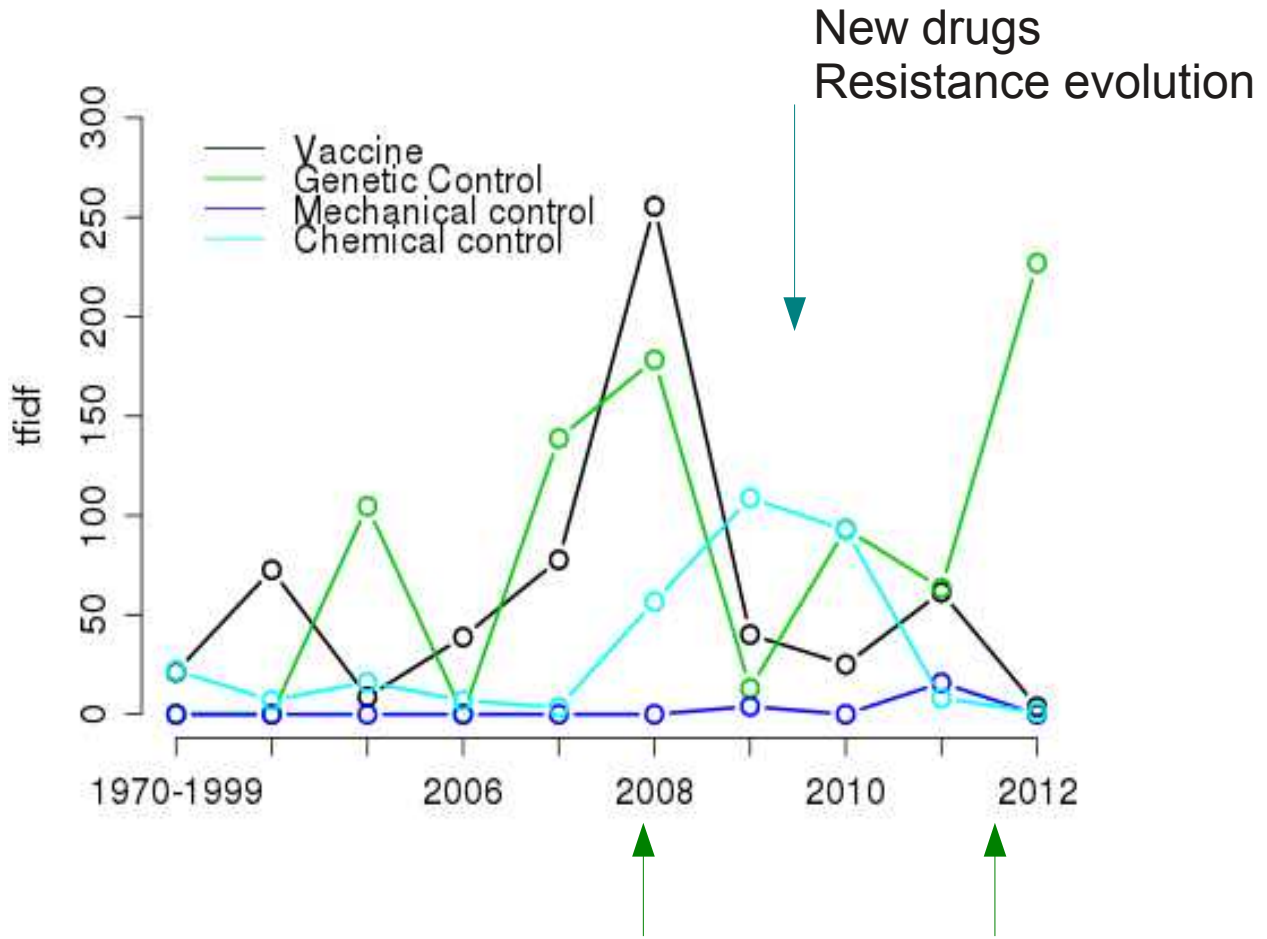
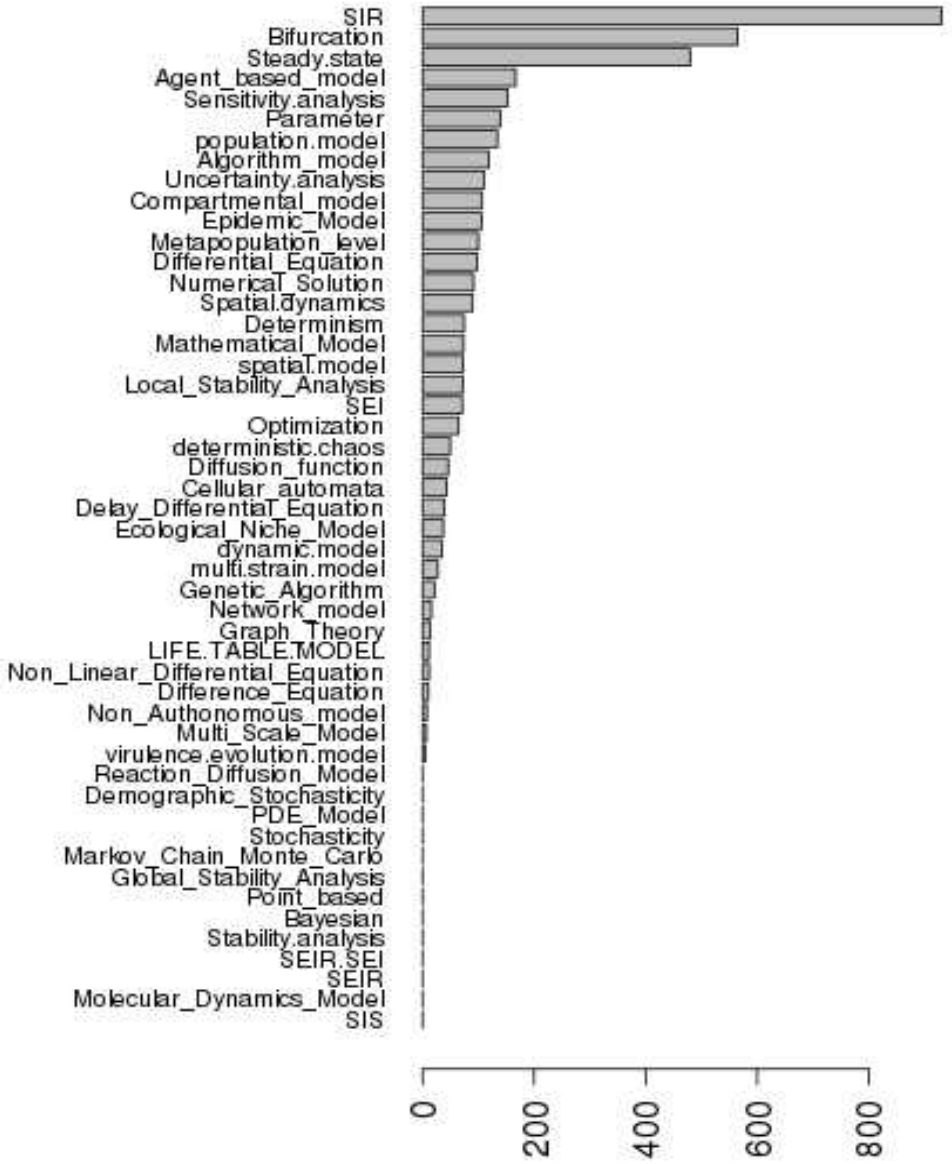
Themes dominating the dengue modeling literature - EMO




New drugs
Resistance evolution
Vaccine
Genetic Control
Mechanical control
Chemical control
tfidf
0
50
100
150
200
250
300
1970-1999
2006
2008
2010
2012
Sterile
males
Immunized
mosquitos

Mathematics dominating the dengue modeling literature - MMO



Conclusions (so far)

- Dengue modeling literature covers a vast ammount of themes.
- Representation is more detailed in the vector component where more control opportunities exist.
- Control oriented models follow the trends in innovation
- Mathematical methods are very conservative

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