



Information and Communication Technologies

Developing the Framework for an Epidemic Forecast Infrastructure

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D4.4 Report for the Epidemic Modeling Platform after release, describing changes and new implemented features, new visualizations and modelling algorithms integrated with the platform, results of user surveys and usage statistics.

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Work package participants

The following partners have taken active part in the work leading to the elaboration of this document, even if they might not have directly contributed writing parts of this document:

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Change log

Version	Date	Amended by	Changes

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Introduction

A data-driven computational framework has been designed and developed during the first three years of the project, relying on the theoretical modeling approaches studied in the other Work Packages, which stands as one of the most advanced tools for assisting epidemic modeling and scenario analysis.

The computational platform deployment and public releasing have been carried on in advance with respect to the planned scheduling because of the exceptional 2009 pandemic event, an opportunity that made the involved teams spend additional effort in the development of realistic modeling software.

The result is a publicly available software system, called “GLEAMviz” (<http://www.gleamviz.org>) that simulates the spread of emerging human-to-human infectious diseases across the world. This software features a user-friendly GUI that can be used for the simulation of a case study, test and validation of specific assumption on the spread of a disease, understanding of observed epidemic patterns, study of the effectiveness and results of different intervention strategies, analysis of risk through model scenarios, forecast of newly emerging infectious diseases.

Since a few public releases have already been done, improving the usability and the visualization components of the first version, the third year has focused mainly on the integration of the work carried on within the WP2 and WP3 packages, and in the consolidation of the computational platform.

More precisely, the goals expected for the present deliverable were achieved in advance and have already been presented during the third review meeting and described in Deliverable D4.3. The public version of the software fully including all the new features and visualizations described in Deliverable D4.3 was released in June 2012, namely GLEAMviz version 3.0, after a careful debugging and testing phase by the partners of the project. Due to the formerly mentioned time advance in respect to the estimated results, The time has been spent in developing an extra release (v4.0) that has entered beta testing in September 2012 and has progressively superseded the v3.0 in October/November 2012.

The GLEAMviz computational platform changes and newly implemented features.

After the delivery of v3.0 the work on the GLEAMviz computational platform has been focused on changes at the level of the server component and additional functionalities in the client application. While the general architecture of the software is unchanged, the following components features have been modified/improved:

- New optimized engine code implementing the Global Epidemic and Mobility model. This improvement although transparent to the user is a major change in the numerical capabilities of the platform. Simulations run approximately ten times faster than before allowing a larger number of realizations runs per user at the same computational cost (CPU time). The structure of the basic algorithm has also been optimized in order to be flexible to the introduction of additional data layers such as age structure of the population.
- We have implemented a new model for human mobility and commuting patterns. This amounts to the possibility of multiple modeling choices for implementing local human mobility (data, gravity models, ABM, etc.). Although the different models have similar performance we provide this optional capability to the user for the testing of different hypotheses of the interplay of human mobility and disease spreading.
- We have developed a new redesigned interface for the simulations management that allows the setting of disease models and interventions that can be geographically dependent (and for specific time period). This is a major advance for the platform as it allows researchers to set up scenarios where containment measures (both pharmaceutical and behavioral) can be implemented locally both in space and time.
- Finally, a new middleware component with a more structured application server and a standardized client-server communication protocol has been developed. These improvements allow a considerable increase of the performance of the server-client communication and data exchanges. Single run visualization time has been drastically reduced by 50% [An absolute time value for the run and visualization after the implementation of the new features cannot be provided as it depends on the quality of the internet connection on the client side].

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The above features have been progressively added to the computational platform after debugging and stability tests.

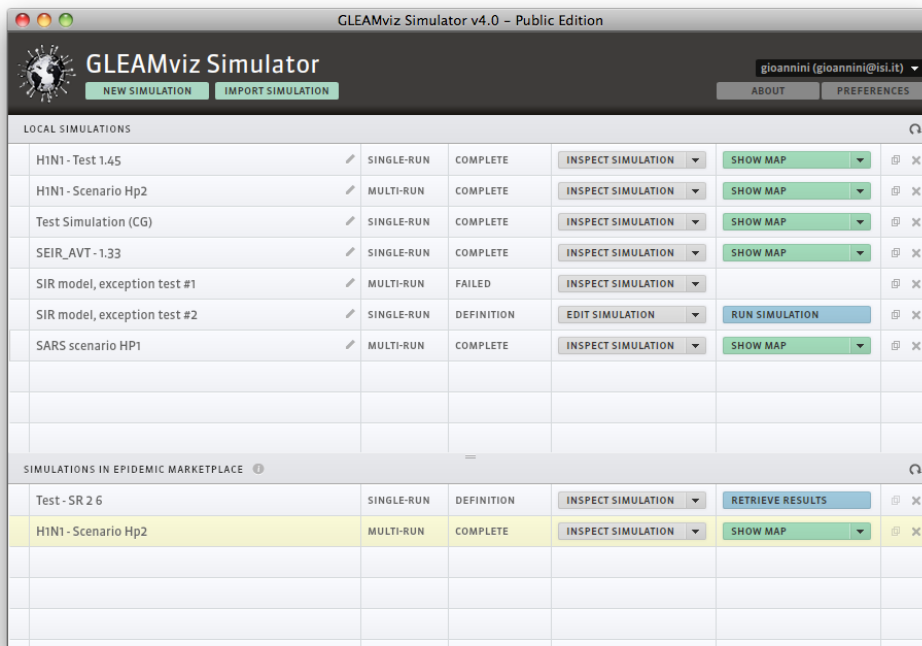


Figure 1: Marketplace communication interface.

Integration with the Marketplace and V4.0 bundle.

A further major achievement for the platform consists in the integration with the Epidemic Marketplace data platform (<http://www.epimarketplace.net>), a data integration system for epidemiological resources. The integration between the two platforms allows the users of the GLEAMviz client to upload and store their simulations on the Epidemic Marketplace. By means of the functionalities available on the Epidemic Marketplace website, it is also possible to share simulations with other GLEAMviz users.

The integration between the GLEAMviz computational platform and the Epidemic Marketplace informational platform is bringing many advantages to the growth of the EPIWORK project. The functionalities provided by the Epidemic Marketplace in terms of annotated and searchable storage, as well in terms of data sharing and access control mechanisms, will enhance the GLEAMviz Simulator potentialities. GLEAMviz simulator client communicates with the Epidemic Marketplace using a set of Web Services that allows

it to upload simulation definitions as well as simulation's output data as searchable resources.

The users of the two platforms are authenticated across a synchronized infrastructure enabling them to transparently access both systems with the same credentials. This also makes the interaction of the GLEAMviz client with the Epidemic Marketplace repository very smooth, avoiding additional user-credential requests upon interaction and therefore allowing seamless single sign-on access to both platforms. Both platforms use OpenLDAP software to manage users and credentials.

All the changes and newly developed features of the computational platform have been bundled in a new public release, the 4.0 version of the GLEAMviz computational platform, with deployment and distribution in October/November 2012. We planned to supersede officially the v3.0 with the new v4.0 at the end of November after stability test of the beta version. The actual release to the public has occurred on Nov. the 20th, 2012.

Usage of the computational tool

Since the public release of the GLEAMviz simulator tool, many users have downloaded the client application and performed pandemic scenarios simulations.

Besides the anonymous Internet downloads, which can be estimated over two hundreds during last year, the software has been used in various workshops and schools as an educational and demonstrative tool.

An average number of one hundred simulations per month are being performed by users not belonging to the research group.

Here is a list of events featuring the usage of the GLEAMviz simulator application as of the date of the current deliverable:

The 2012 Summer Institute in Statistics and Modeling in Infectious Diseases (SISMID).
University of Washington in Seattle, Seattle.
July 15-19, 2012.

Master's class: *From Data to Decision.*

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British Columbia Center for Disease Control, Vancouver.
May 30-June 1st, 2012.

“Dynamics of networks and epidemic spreading“, Summer School on Mathematical Modeling in Population Biology.
International Center for Theoretical Physics ICTP-Brazil, Sao Paulo, Brazil
Spring 2012

Workshop *Evolution and Spread of Diseases*.
Mathematical Biosciences Institute, Ohio State University,
19-23 March 2012.

“Frontiers in multiscale computational modeling for zoonotic epidemics“.
Kansas City.
October 10-12, 2011.

“Modern networks and disease transmission“. Master of Public Health, II year
Ecole des hautes etudes en santé publique (EHESP), Paris, France.
Fall 2011

Workshop *“Data Science and Epidemiology“*.
Center for Infectious Disease Dynamics (CIDD) at Penn State University
October 6 and 7, 2011.

The 2011 Summer Institute in Statistics and Modeling in Infectious Diseases (SISMID).
University of Washington in Seattle, Seattle
June 13-29, 2011.

The GLEAMviz simulator software is also being used by the Joint Research Center of the European Commission located in Ispra, which has been provided a full server setup without the limitations of the public version.

Conclusions

GLEAM is under continuous development and so far it has been used: to assess the role of short-range and long-range mobility in epidemic spread [2]; to retrospectively analyze the SARS outbreak of 2002-2003 in order to investigate the predictive power of the model [4]; to explore global health strategies for controlling an emerging influenza pandemic with pharmaceutical interventions under logistical constraints [3]; estimate the seasonal transmission potential of the 2009 H1N1 influenza pandemic during the early phase of the outbreak to provide predictions for the activity peaks in the Northern Hemisphere [1, 8]; and

more recently to assess the ecotoxicologic risks of a pandemic influenza medical response [10].

Computer-based simulations provide an additional tool for the analysis of emerging infectious-disease preparedness and control, allowing the exploration of diverse scenarios and the evaluation of the impact and efficacy of various intervention strategies. The Epidemic Modeling Platform, developed in the scope of EPIWORK Work Package 4 and here presented, is a computational tool for the simulation of emerging ILI infectious diseases at the global scale based on a data-driven spatial epidemic and mobility model that offers an innovative solution in terms of flexibility, realism, and computational efficiency, and provides access to sophisticated computational models in teaching/training settings and in the use and exploitation of large-scale simulations in public health scenario analysis.

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