

PROYECTO FIN DE CARRERA

Título: Diseño e implementación de una herramienta web para el análisis y simulación con MASON de redes sociales

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PROYECTO FIN DE CARRERA

**DESIGN AND IMPLEMENTATION OF A WEB
FRAMEWORK FOR THE ANALYSIS AND
SIMULATION WITH MASON OF SOCIAL
NETWORKS**

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Resumen

El objetivo de este proyecto fin de carrera es el desarrollo e implementación de una aplicación web que permita la simulación de redes sociales para poder analizar la difusión de rumores de acuerdo a la conexión entre los distintos tipos de usuarios. Con este propósito, se ha desarrollado un framework web capaz de generar redes a partir de un número inicial de nodos introducido por el usuario, también se le ofrece la posibilidad de diseñar gráficamente una red propia o bien cargar una red creada anteriormente. La red generada se puede guardar para posteriores simulaciones. A los agentes, los usuarios de la red, se les asigna un comportamiento dependiendo del número de conexiones con el resto de agentes. Como última funcionalidad de la herramienta, se le permite al usuario realizar distintos tipos de análisis de red así como obtener la topología de la red analizada en lenguaje GEXF (Graph Exchange XML Format) para exportar la información a otras herramientas de análisis de redes sociales. Un último añadido al proyecto es la posibilidad de descargarse el código y ejecutarlo en una máquina propia de modo que pueda adaptar o extender el comportamiento de los agentes de la red a sus necesidades.

En la memoria se muestran la elaboración de la herramienta parte por parte y la posterior conexión entre todas ellas para conformar la herramienta final. También se incluye un análisis de las distintas herramientas utilizadas indicando el porqué de su elección o su desestimación así como un estudio del estado del arte. Finalmente se incluyen unos anexos con el fin de ampliar algunos aspectos y así facilitar la comprensión de estos y algunos manuales para proveer la información necesaria para el mantenimiento y desarrollo de posibles mejoras.

Palabras clave: simulación social, red social, usuario, grafo, comportamiento, relación, análisis de redes sociales, Big Data, Twitter.

Abstract

The aim of this project is the development and implementation of a web framework which allows the creation and simulation of social networks in order to analyse the diffusion of hearsay in accordance to the relationship between the different types of users. With this purpose, a web framework has been developed capable of generating networks from an initial number of nodes inserted by the user, a possibility of creating an own network inserting each node and its relationship with each other or loading a network created previously. The generated network, can be saved for future simulations. A behaviour will be assigned to each agent (users of the network) depending on the number of its relations with the others agents. As last functionality, the user can download the red in a GEXF (Graph Exchange XML Format) file in order to process it with a SNA software. A last functionality added to the project is the possibility of download the code in order to extend the behaviour of the agents to adapt it to the user's needs.

This report presents the build-up of the framework piecemeal and subsequent connection between them in order to shape the final framework. An analysis of the different tools used and why they are chosen or not is included too. Finally, some appendixes are included to extend some aspects and facilitate the understanding of these, and some tutorials to provide the needed information to maintain and develop future improvements.

Keywords: Social simulation, social network, user, graph, behaviour, relationship, social network analysis, Big Data, Twitter.

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Introduction

This chapter provides an introduction to the problem which will be approached in this project. It provides the context and the importance of the software SNSA (social network simulation and analysis). Exposes the goals of the master thesis, structure of this master thesis and a short representation of the state of art.

1.1 Context

Agent-based social simulation (ABSS) computer-assisted simulation technique used to model artificial societies populated with multiple autonomous entities, called agents, which act autonomously by employing some knowledge or representation of their beliefs, desires and intentions. ABSS is an innovative approach to open questions in a wide range of scientific domains, including economics, biology, chemistry, ecology and sociology [1].

On the other hand, the social network analysis (SNA in advance) has emerged like a key methodology in fields like social sciences, in which are included sociology, social psychology, economy. Moreover it has also gained a significant support in other fields like biology or physics [2].

This project deals with SNSA (social network simulation and analysis) which joins these two research fields, ABSS and SNA.

Currently, the social networks have reached a great impact in the relationships between persons and enterprises thanks to applications like Twitter, Facebook or similar. These have a great importance in order to know the people opinion about various topics and how the relations among these persons change depends of their opinion.

The analysis of this behavior through traditional methods has a large cost in time and money. At this point, the SNA software has a great importance because it reduces the cost of the analysis to a large degree.

Nowadays, there are variety of frameworks that allow making SNSA. The disadvantage is that these frameworks are closed sourced or a programmer is needed to program and configure the simulation.

With this project, the possibility of accessing a social network analysis framework through the web is offered, with a simple front end and open source so the disadvantages mentioned in the previous paragraph are solved. Apart from the framework, the user can download the code too in order to code new behaviours that improve the tool.

1.2 Master thesis goals

The principal objectives of the project are the followings:

- Developing a free web framework to facilitate the access to SNSA tools for any user independently of his computer skills.

- Saving time to the users when they want to make a SNSA implementing a framework that allows an easy configuration of the network and of the simulation.
- Integrating Big Data technologies into the framework. More specifically, with a noSQL graph database
- Facilitating familiarization of new developers with the SNSA tools because it offers a base for supply new developments.

1.3 Structure of this Master Thesis

In this section we will provide a brief overview of all the chapters of this Master Thesis. It has been structured as follows:

Chapter 1 provides an introduction to the problem which will be approached in this project. It provides an overview of the benefits of SNSA framework. Furthermore, a deeper description of the project and its environment is also given.

Chapter 2 contains an overview of the existing technologies on which the development of the project will rely.

Chapter 3 describes one of the most important stages in software development: the requirement analysis using different scenarios. For this, a detailed analysis of the possible use cases is made using the Unified Modelling Language (UML). This language allows us to specify, build and document a system using graphic language. The result of this evaluation will be a complete specification of the requirements, which will be matched by each module in the design stage. This helps us also to focus on key aspects and take apart other less important functionalities that could be implemented in future works.

Chapter 4 describes the architecture of the system, divided in several modules with its own purpose and functions.

Chapter 5 describes a selected use cases. It is going to be explained the running of all the tools involved and its purpose. It allows us to test the application and give us some feedback to improve our system and repair bugs and errors.

Chapter 6 sums up the findings and conclusions found throughout the document and gives a hint about future development to continue the work done for this master thesis.

Finally, the appendix provides useful related information, especially covering the installation and configuration of the tools used in this thesis.

1.4 State of art

In this section we are going to explain how the SNSA software works actually. For this we have chosen two frameworks that give us a start point to begin our project:

1.4.1 Ohal



Figure 1.1: Ohal Logo.

1. **Interesting aspects:** it adapts to real models, using networks and social media with its users and relations between them. Each agent has individual characteristics. The response of each scenario change according the characteristics of the agents and the messages. It allows two types of transmission: viral and social pressure. It also allows “if” scenarios.
2. **Simulated market:** social networks (in general any social media).
3. **Objectives:** studying the best way to propagate hearsays in Twitter and Facebook.
4. **How it works:** it creates the initial network with its characteristics (topology, propagation mode, agents and the seeding). Then it starts the simulation and analyses how the hearsays are propagated. When the simulation ends, data is extracted and a anew simulation is started modifying the initial characteristics. Data of the second simulation is compared with the first one.
5. **Agent type:**
 - Initial agent: it generates the initial message.
 - Propagator agent: it has a lot of contacts and a great capacity for influence its contacts, it propagates the message generated by the initial agent.
 - User agent: final user that receives the message, it can propagate the message too but only to its inner contacts circle.
6. **Agent properties:** it establishes different types of relationships:

- Two-way: both agents can influence each other.
 - One-way: one agent influences another but this second agent cannot influence the first one:
7. **Implementation available:** contact with them and then they realize the study, but the software is not available.
 8. **Comments:** its mechanics are interesting but they have not software available. ¹

1.4.2 ThinkVine



Figure 1.2: ThinkVine Logo.

- **Interesting aspects:** it generates future ideas based on marketing strategies. It allows watching the impact of different marketing strategies on different users groups. This framework also has the capacity of manage a lot of “if” scenarios. Finally it allows self-learning.
- **Simulated market:** marketing in a heterogeneous society.
- **Objectives:** it allows watching how the social media influence the buying habits in heterogeneous societies and foresee the impact in these habits according the society evolution.
- **How it works:** firstly it creates a mathematical model of consumers agents based on a demographic census, then it adapts the behaviour of the agents according real buying habits. Watching the data of previous years, it assigns to each agent a buying frequency. It introduces the data provided by the enterprise about its marketing strategies and the consumers and its habits. Finally it recreates the sales using its own rules
- **Agent type:**
 - Consumers: they establish relationships between them and with the environment variables.

¹<http://www.ohal-group.com/>

- **Agent Properties:**

- The agents are based on real demographic statistics.
- The models are created taking samples from the society whose simulation is wanted.
- Buying habits and social media use behaviours are assigned to the consumers.
- A variation in a single person does not change the behaviour of the whole society.

- **Implementation available:** like in the previous case, the software is not available.

- **Comments:** it is a very interesting framework for building the model of each agent.

2

²<http://www.thinkvine.com/>

Enabling technologies

This chapter introduces which technologies have made possible this project. First of all, we must introduce MASON, an ABSS tool. After that, we speak about Gephi, a SNA tool. Then we comment Neo4J a graph database. Finally, we present the other technologies that have helped us to develop this project

2.1 MASON



Figure 2.1: MASON Logo.

MASON Stands for Multi-Agent Simulator Of Networks¹.

It is a fast discrete-event multiagent simulation library core in Java, designed to be the foundation for large custom-purpose Java simulations, and also to provide more than enough functionality for many lightweight simulation needs. MASON contains both a model library and an optional suite of visualization tools in 2D and 3D.

MASON is a joint effort between George Mason University's Evolutionary Computation Laboratory and the GMU Center for Social Complexity.

MASON features:

- 100% Java (1.3 or higher).
- Fast, portable, and fairly small.
- Models are completely independent from visualization, which can be added, removed, or changed at any time.
- Models may be checkpointed and recovered, and dynamically migrated across platforms.
- Can produce results that are identical across platforms.
- Models are self-contained and can run inside other Java frameworks and applications.
- 2D and 3D visualization.
- Can generate PNG snapshots, Quicktime movies, charts and graphs, and output data streams.

These features make MASON a good choice for coding the simulation. In our project, we will need to simulate the behaviour of a complex society so we must code a simulation, MASON will facilitate us these task because it is coded in Java so it adapts perfectly to our purpose. For the visualization and build the graph (the nodes and their relationships),

¹<http://cs.gmu.edu/~eclab/projects/mason/>

we will choose other tool than fill in better way to our needs. In coming chapters, we will explain with more detail how MASON is used to build the simulation.

2.2 Gephi



Figure 2.2: Gephi Logo.

Gephi is an interactive visualization and exploration platform for all kinds of networks and complex systems, dynamic and hierarchical graphs².

Gephi has been used in a number of research projects in the university, journalism and elsewhere, for instance in visualizing the global connectivity of New York Times content and examining Twitter network traffic during social unrest along with more traditional network analysis topics.

The Gephi Consortium is a French non-profit corporation which supports development of future releases of Gephi. Members include SciencesPo, Linkfluence, WebAtlas, and Quid.

Gephi inspired the LinkedIn InMaps and was used for the network visualizations for Truthy.

We will use Gephi in this project in two ways:

- BigMarket allows the user to download an .gexf file. Once he/she has download this file, it can analyse it by using Gephi Framework so the user must have Gephi installed in its own computer.
- The other way that we use Gephi in our project is using its Java API for analyse the graph in the web framework. In this way, the user do not need to have installed Gephi in his computer, BigMarket do the SNA analyse in combination with the Gephi API.

For more information about the integration between BigMarket and Gephi API please refer to the chapter 4.

²<http://gephi.github.io/>

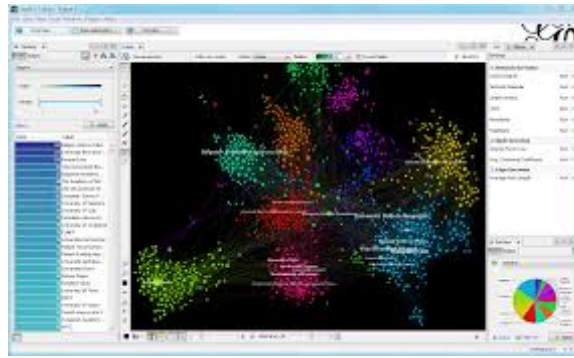


Figure 2.3: Gephi Framework.

2.3 Neo4J



Figure 2.4: Neo4J Logo.

Neo4J is an open-source graph database, implemented in Java. The developers describe Neo4j as “embedded, disk-based, fully transactional Java persistence engine that stores data structured in graphs rather than in table”³.

Neo4J features:

- **Performance:** Neo4j’s native graph engine is engineered to let navigate hyper-connectivity at speed. Built from the bottom up to support property graphs, Neo4j allows you to connect the nodes easily, and with unparalleled performance and reliability.
- **Scalability:** Neo4j scales up and out, supporting tens of billions of nodes and their relationships, and hundreds of thousands of ACID (Atomicity, Consistency, Isolation and Durability) transactions per second.

In our project, we will need a database in order to store the simulations so that the user can recover a simulation that he have made in the past. BigMarket uses graphs to represent a social network (or a society) representing the people like nodes and the relations between them like edges. Thus if we have a graph to represent the society, we will need a graph database in order to store it.

³<http://neo4j.com/>

Our project is focus in Big Data so we will need store a big amount of nodes and its relationships. As we see in the second feature of Neo4J, it supports a lot of relationships and transactions becoming Neo4J the best choice for store ours graphs.

Neo4J also offers a graphic interface in order to see the data store in the database and allow us to create a new graph using Neo4J commands (in general do any action). So that this feature will add more functions to our tool.

So in sight of our needs, working with graphs and a lot of nodes and relationships, we consider Neo4J a good choice for our project.

In chapter 4, we will speak more about the way that BigMarket store the graph in the database and how the user can recover the information.

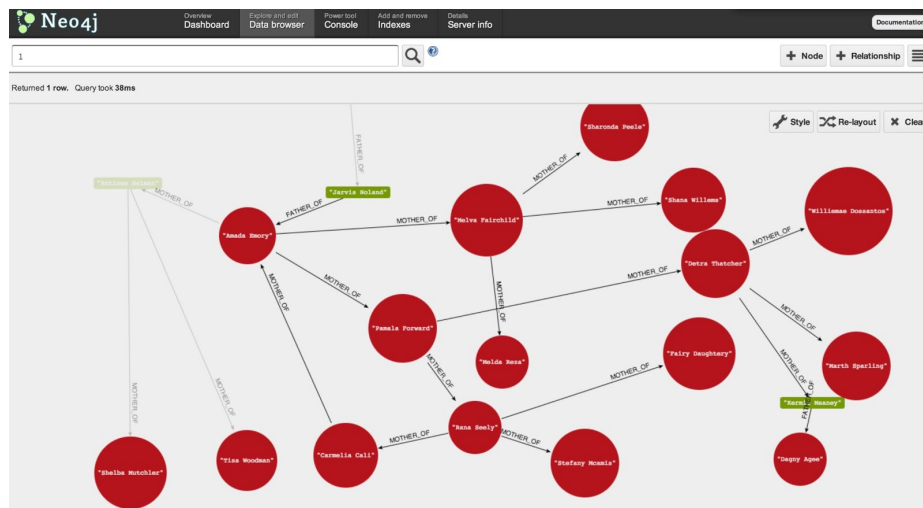


Figure 2.5: Neo4J Framework.

2.4 GraphStream



Figure 2.6: GraphStream Logo.

GraphStream is a graph handling Java library that focuses on the dynamics aspects of graphs. Its main focus is on the modelling of dynamic interaction networks of various sizes⁴.

⁴<http://graphstream-project.org/>

The goal of the library is to provide a way to represent graphs and work on it. To this end, GraphStream proposes several graph classes that allow us to model directed and undirected graphs, 1-graphs or p-graphs (a.k.a. multigraphs, that are graphs that can have several edges between two nodes).

GraphStream allows us to store any kind of data attribute on the graph elements: numbers, strings, or any object.

Moreover, in addition, GraphStream provides a way to handle the graph evolution in time. This means handling the way nodes and edges are added and removed, and the way data attributes may appear, disappear and evolve.

In order to handle dynamic graphs, the library defines in addition to graph structures the notion of “stream of graph events”, which as you guessed, is at the origin of the library name. The number of events is restricted they are:

- node addition,
- node removal,
- edge addition,
- edge removal,
- graph/node/edge attribute addition,
- graph/node/edge attribute change,
- graph/node/edge attribute removal.
- step

Inside the library, a lot of components can generate such streams of events. These components are called sources. Other components can receive these events and process them, they are in fact very comparable to listeners, a concept widely used in the Java world. We call such components sinks.

When a component is able to both receive graph events (sink) and produce them (source) we call it a pipe. The graph structures in GraphStream are pipes. There are many kinds of pipes, that can act as filter, removing some events, or adding more events, or allow to cross the network, or communicate between threads.

At the start of the chapter, we talked about MASON. Although MASON has mechanisms to build graphs, it is hard to build dynamic graph and modify the visualization in

real time. With GraphStream, we do not have these problems. In GraphStream we count with layouts too that allows us to represent the graphs in a way that is easier to identify the elements.

So these features makes GraphStream a good graph builder and visualizator for our purposes, removing the visualization part of MASON.

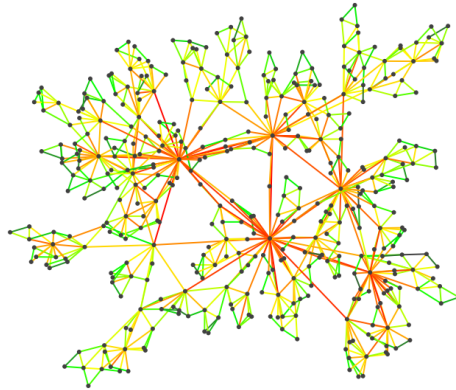


Figure 2.7: GraphStream Graph Example.

2.5 Other technologies

In this section, we talk about other technologies that help us to build our project but they are well known or they have contributed in a lesser way to our project so we will extend less explaining these technologies.

2.5.1 Apache Tomcat



Figure 2.8: Apache Tomcat Logo.

Apache Tomcat is an open-source web server and servlet container developed by the Apache Software Foundation (ASF). Tomcat implements several Java EE specifications including Java Servlet, JavaServer Pages (JSP), Java EL, and WebSocket, and provides a

“pure Java” HTTP web server environment for Java code to run in⁵.

In our project, we will use Tomcat to publish the service and make it accessible from Internet.

2.5.2 Java



Figure 2.9: Java Logo.

Java is a general-purpose computer programming language that is concurrent, class-based, object-oriented, and specifically designed to have as few implementation dependencies as possible. It is intended to let application developers “write once, run anywhere” (WORA), meaning that compiled Java code can run on all platforms that support Java without the need for recompilation. Java applications are typically compiled to bytecode that can run on any Java virtual machine (JVM) regardless of computer architecture⁶.

2.5.3 HTML5



Figure 2.10: HTML5 Logo.

HTML5 is a core technology markup language of the Internet used for structuring and presenting content for the World Wide Web. As of October 2014 this is the final and complete fifth revision of the HTML standard of the World Wide Web Consortium (W3C). The previous version, HTML 4, was standardised in 1997.

Its core aims have been to improve the language with support for the latest multimedia while keeping it easily readable by humans and consistently understood by computers and

⁵<http://tomcat.apache.org/>

⁶<https://www.java.com/en/>

devices (web browsers, parsers, etc.). HTML5 is intended to subsume not only HTML 4, but also XHTML 1 and DOM Level 2 HTML⁷.

2.5.4 CSS3



Figure 2.11: CSS3 Logo.

Cascading Style Sheets (CSS) is a style sheet language used for describing the look and formatting of a document written in a markup language. While most often used to change the style of web pages and user interfaces written in HTML and XHTML, the language can be applied to any kind of XML document, including plain XML, SVG and XUL. Along with HTML and JavaScript, CSS is a cornerstone technology used by most websites to create visually engaging webpages, user interfaces for web applications, and user interfaces for many mobile applications⁸.

2.5.5 SigmaJS



Figure 2.12: SigmaJS Logo.

Sigma is a JavaScript library dedicated to graph drawing. It makes easy to publish networks on Web pages, and allows developers to integrate network exploration in rich Web applications⁹.

⁷<http://www.w3schools.com/html/default.asp>

⁸<http://www.w3schools.com/css/default.asp>

⁹<http://sigmajs.org/>

Requirement Analysis

This chapter describes one of the most important stages in software development: the requirement analysis using different scenarios. For this, a detailed analysis of the possible use cases is performed using the Unified Modelling Language (UML). This language allows us to specify, build and document a system using graphic language.

3.1 Overview

The result of this chapter will be a complete specification of the requirements, which will be matched by each module in the design stage. This also helps us to focus on key aspects and take apart other less important functionalities that could be implemented in future works.

3.2 Use cases

These sections identify the use cases of the system. This helps us to obtain a complete specification of the uses of the system, and therefore define the complete list of requisites to match. First, we will present a list of the actors in the system and a UML diagram representing all the actors participating in the different use cases. This representation allows, apart from specifying the actors that interact in the system, showing the relationships between them.

These use cases will be described the next sections, including each one a table with their complete specification. Using these tables, we will be able to define the requirements to be established.

3.2.1 Actors dictionary

The list of primary and secondary actors is presented in table 3.1. These actors participate in the different use cases, which are presented later.

Actor identifier	Role	Description
ACT-1	User	End user that uses BigMarket in order to make a new simulation or load a previous simulation to study possible marketing strategies.
ACT-2	Developer	Technical developer which code their own behaviours and networks for use them in BigMarket.
ACT-3	Admin	Administrator of BigMarket, this actor will be implemented in future works, its principal purpose will be to manage the users accounts, maintainant the service and lookup that all services (server, database, etc) are up.

Table 3.1: Actors list.

3.2.2 BigMarket user use cases

This use case package collects the user functionalities of BigMarket, as shown in 3.1.

The use cases presented in this section are as shown in the Figure 3.1:

- *Setup the network*: detailed in sub-section 3.2.2.1.
- *Creating new random network*: detailed in sub-section 3.2.2.2.
- *Creating network with Neo4j*: detailed in sub-section 3.2.2.3.
- *Loading network from database*: detailed in sub-section 3.2.2.4.
- *Running the simulation*: detailed in sub-section 3.2.2.5.
- *Saving the simulation in database*: detailed in sub-section 3.2.2.6.
- *Analysing the network*: detailed in sub-section 3.2.2.7.
- *Downloading the graph*: detailed in sub-section 3.2.2.8.
- *Network visualization*: detailed in sub-section 3.2.2.9.

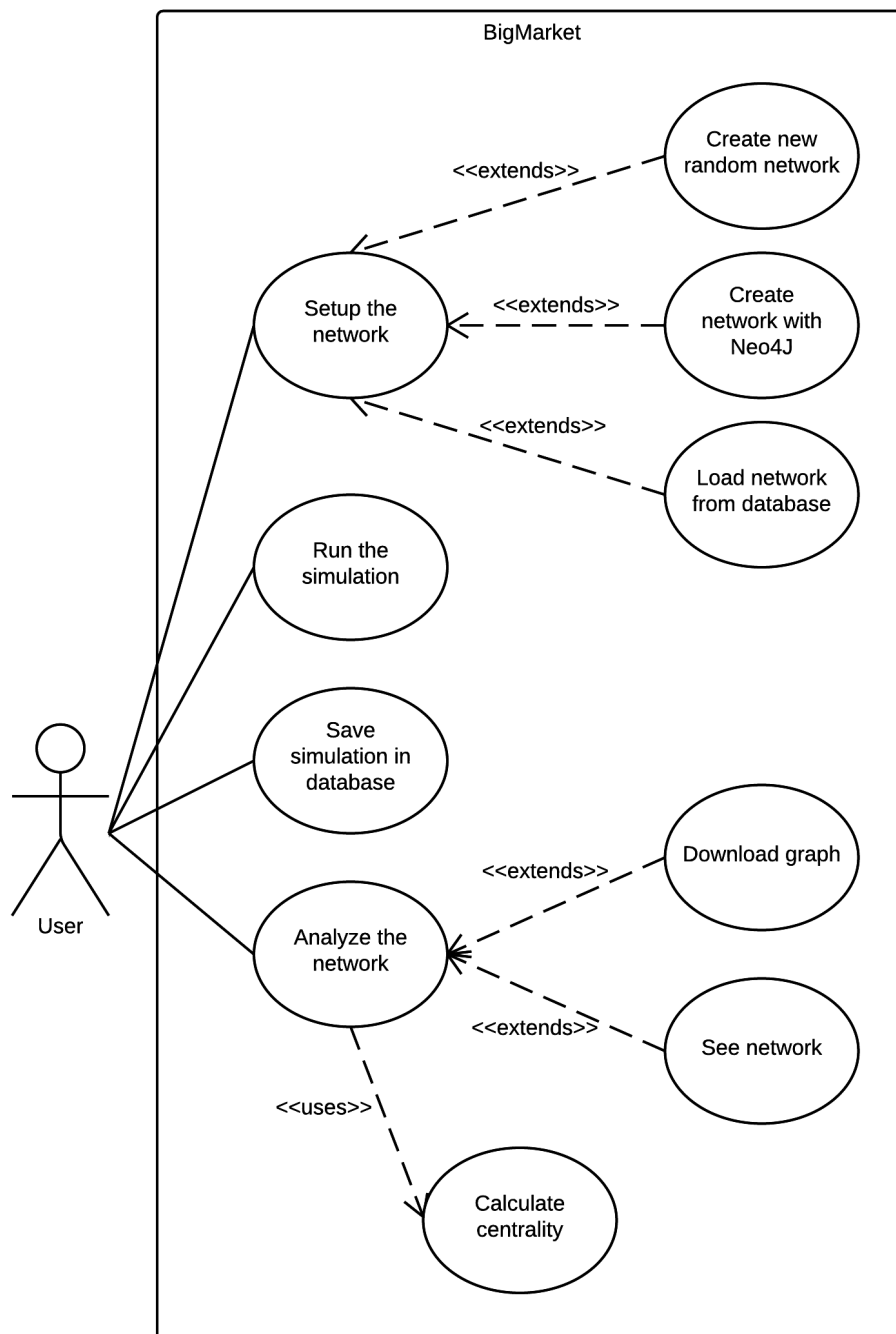


Figure 3.1: User use cases.

3.2.2.1 Setup the network

This use case represent the action of creating a network. In this case, we will not enter in details about the way to create the network (loading from database, new random network, etc). At the begin of this use case, the servlet should be started and the “Setup simulation” screen must be displayed. At the end of the use case, the network will be created. This table also represent the flow of events that allows creating the network.

Use Case Name	Setup the network		
Use Case ID	UC1.1		
Pre-Condition	The “Setup simulation” screen has been displayed.		
Post-Condition	The network, which will be used in the simulation, has been created successfully.		
Flow of Events		Actor Input	System Response
	1	The user clicks on the “Start” button in the index screen.	The “Setup simulation” screen is displayed.
	2	The user selects how he/she want to create the network.	The fields to setup the network in order to the selection of the user are enabled.
	3	The user fills the mandatory fields.	The “Setup” button becomes enabled.
	4	The user clicks on the “Setup” button.	The network is created.

Table 3.2: Setup the network use case.

3.2.2.2 Creating new random network

This use case is an extend use case of the previous use case. In this case the action will be to create a new random network. Like the previous use case, at the begin, we have the servlet started and the “Setup simulation” screen displayed. At the end of the use case, a new random network will have been created. The table also represent the flow of the events of the use case.

Use Case Name	Creating new random network		
Use Case ID	UC1.2		
Pre-Condition	The “Setup simulation” screen has been displayed.		
Post-Condition	The network, which will be use in the simulation, has been created successfully.		
Flow of Events		Actor Input	System Response
	1	The user selects “New random network”.	The fields for creating new random network become enabled.
	2	The user fills the new random network fields.	The “Setup!” button becomes enabled.
	3	The user clicks on the “Setup!” button.	The network is created.

Table 3.3: Creating new random network use case.

3.2.2.3 Creating network with Neo4j

This use case represents the creation of a network using the Neo4J web interface. It extends from Setup the network use case. Like the previous use case, at the begin, we have the servlet started and the “Setup simulation” screen displayed. At the end of the use case, the network will have been created and stored in the database. The table also represent a flow of events of the use case.

Use Case Name	Creating network with Neo4j		
Use Case ID	UC1.3		
Pre-Condition	The “Setup simulation” screen has been displayed.		
Post-Condition	The network, which will be used in the simulation, has been created successfully.		
Flow of Events		Actor Input	System Response
	1	The user selects load network.	Create simulation button becomes enabled.
	2	The user clicks on “Create network”.	The system opens a new window with the Neo4J interface.
	3	The user creates the network using Neo4j commands.	Neo4j store the new network in database.

Table 3.4: Creating network with Neo4j use case.

3.2.2.4 Loading network from database

This use case also extends from Setup network use case. In this case, a network will be loaded from the database. Like the previous use case, at the begin we have the servlet started and the “Setup simulation” screen displayed. At the end of the use case, we have a network loaded from the database. The table also represents the flow of events of the use case.

Use Case Name	Loading network from database		
Use Case ID	UC1.4		
Pre-Condition	The “Setup simulation” screen has been displayed.		
Post-Condition	The network, which will be used in the simulation, has been loaded successfully.		
Flow of Events		Actor Input	System Response
	1	The user selects “Load network from database”.	The fields for loading network become enabled.
	2	The user fills the load network fields.	The “Setup!” button becomes enabled.
	3	The user clicks on the “Setup!” button.	The network is loaded from database.

Table 3.5: Loading network from database use case.

3.2.2.5 Running the simulation

This use case represents the execution of a simulation using a network created with some of the previous use cases. So, at the beginning of the use case, we have a network and the “Running screen” displayed. The table also represents the flow of events of the use case.

Use Case Name	Running the simulation		
Use Case ID	UC1.5		
Pre-Condition	The network has been created and the running screen has been displayed.		
Post-Condition	The results screen is displayed and the simulation stored in the database.		
Flow of Events		Actor Input	System Response
	1	The user clicks on the “Run one step” or “Run” button).	The simulation starts.
	2a	The user clicks on “Pause” button.	The simulation is paused.
	2b	The user clicks on “Stop” button.	The simulation is stopped and it is stored in the .
	3a	The user repeats the step 1.	N/A.
	3b	The user clicks on “Stop” button.	The simulation is stopped and stored in the database.

Table 3.6: Running the simulation use case.

3.2.2.6 Saving the simulation in database

This use case represents the storing of the simulation in database. As pre-condition we have the simulation must be running. At the end of this use case, the simulation is stored in the database. The table also represents the flow of events of the use case.

Use Case Name	Running the simulation		
Use Case ID	UC1.6		
Pre-Condition	The simulation is running.		
Post-Condition	The simulation is stored in the database.		
Flow of Events		Actor Input	System Response
	1	The user clicks on the “Stop” button.	The simulation is stopped and stored in the database. The “Results” screen is displayed.

Table 3.7: Saving the simulation in database use case.

3.2.2.7 Analysing the network

This use case represents the analysis of the network. At the beginning of the use case, the simulation has been stored and the “Results screen” has been displayed. The table also represents the flow of events of the use case.

Use Case Name	Analysing the network.		
Use Case ID	UC1.7		
Pre-Condition	The simulation has been stopped and stored in the database. The “Results” screen has been displayed.		
Post-Condition	N/A.		
Flow of Events		Actor Input	System Response
	1	The user can analyze the results and restart a new simulation going to the “Setup simulation” screen.	N/A.

Table 3.8: Analysing the network use case.

3.2.2.8 Downloading the graph

This use case represents the option to download the graph that contains the information of the network in order to analyse it with a SNA tool. At the beginning of the use case, the simulation has been stored and the “Results screen” has been displayed. Finally, the user will have in his/her computer the GEXF file that represents the network.

Use Case Name	Downloading the graph.		
Use Case ID	UC1.8		
Pre-Condition	The simulation has been stopped and stored in the database. The “Results” screen has been displayed.		
Post-Condition	The user has in his/her computer the .GEXF file with the network.		
Flow of Events		Actor Input	System Response
	1	The user clicks on “Download graph” button.	A new window appear asking to the user where he/she wat to save the file.
	2	The user selects the path where the file will be saved.	The file is downloaded to the user.

Table 3.9: Downloading the graph use case.

3.2.2.9 Network visualization

This use represents the possibility to see the network online without the necessity of downloading the graph. At the beginning of the use case, the simulation has been stored and the “Results screen” has been displayed. Finally, a new window with the network visualization is displayed.

Use Case Name	Network visualization.		
Use Case ID	UC1.9		
Pre-Condition	The simulation has been stopped and stored in the database. The “Results” screen has been displayed.		
Post-Condition	A new window is displayed with a representation of the network.		
Flow of Events		Actor Input	System Response
	1	The user clicks on “See network” button.	A new window appear with a representation of the network.

Table 3.10: Network visualization use case.

3.2.3 Developer use cases

This use case package collects the developer functionalities of BigMarket, as shown in 3.2.

The use cases presented in this section are as shown in the Figure 3.2:

- *New user behaviour*: detailed in sub-section 3.2.3.1.
- *New network building algorithm*: detailed in sub-section 3.2.3.2.

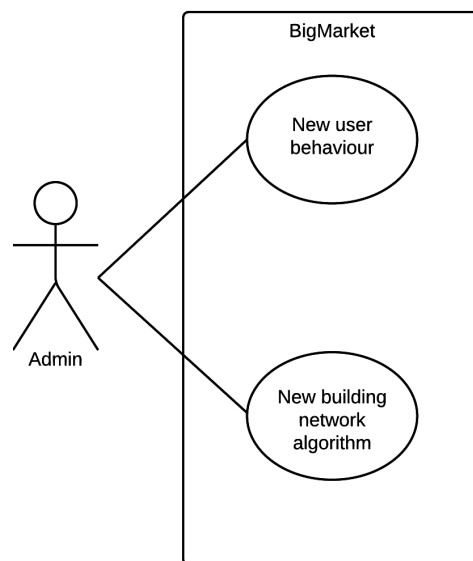


Figure 3.2: Developer use cases.

3.2.3.1 New user behaviour

This use case represents the possibility that a developer user codes his/her own user behaviour. First of all, the user should have download the code in his/her computer. Finally, he/she can develop the behaviour.

Use Case Name	New user behaviour		
Use Case ID	UC2.1		
Pre-Condition	The developer has downloaded the code		
Post-Condition	N/A.		
Flow of Events		Actor Input	System Response
	1	The developer imports the project in Eclipse.	The developer can code his/her own class in which the developer defines the new behaviour.

Table 3.11: New user behaviour use case.

3.2.3.2 New network building algorithm

This use case represent the possibility to develop a new network algorithm. To do this, the developer should download the code to his/her computer. Then he/she can develop his/her own network building algorithm.

Use Case Name	New network building algorithm		
Use Case ID	UC2.2		
Pre-Condition	The developer has download the code		
Post-Condition	N/A.		
Flow of Events		Actor Input	System Response
	1	The developer imports the project in Eclipse.	The developer can code his/her own class in which the developer defines the new algorithm in order to build the network.

Table 3.12: New network building algorithm use case.

3.2.4 Admin use cases

This use case package collects the admin functionalities of BigMarket, as shown in 3.3.

The use cases presented in this section are as shown in the Figure 3.3. The functions of the admin actor will be implemented in future works:

- *Manage the database:* detailed in sub-section 3.2.4.1.
- *Manage the user's permissions:* detailed in sub-section 3.2.4.2.

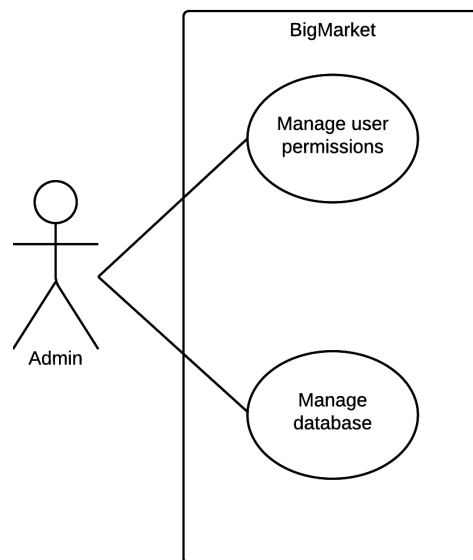


Figure 3.3: Admin use cases.

3.2.4.1 Manage the database

In this use case, the possibility to manage the database by an admin is represented.

Use Case Name	Manage the database		
Use Case ID	UC3.1		
Pre-Condition	The database needs to be repair (delete registers, resolve problems, etc).		
Post-Condition	N/A		
Flow of Events		Actor Input	System Response
	1	The admin logs in the database interface as superuser.	The actions for managing the database become enabled.
	2	The admin performs an action in order to solve database problems.	The problems of the database are solved.

Table 3.13: Manage the database use case.

3.2.4.2 Manage the user's permissions

This use case represents the possibility to manage the user's permissions. In the future, the users will have different permissions that allow them to use BigMarket in a way or other.

Use Case Name	Manage the user's permissions		
Use Case ID	UC3.2		
Pre-Condition	An user needs to change its permissions, or a user have to be banned for using BigMarket.		
Post-Condition	N/A		
Flow of Events		Actor Input	System Response
	1	The admin log in BigMarket as superuser.	The administration windows are opened.
	2	The admin selects the user and his/her new permissions.	The user is updated with the new permissions.

Table 3.14: Manage the user's permissions use case.

3.2.5 Conclusions

With the use cases described we have introduced the basic functionalities that have been implemented in this project. They help us to understand the different actors that can interact. They can serve as a base for further development and different use cases that can come to mind.

Architecture and implementation

This chapter describes in depth how the system is structured in different modules and how the users interact with them. In order to make the chapter more understandable to the users, we will attach to each module its implementation. We will describe each one of these modules describing its main purpose, structure and function (including the module implementation). After reading this chapter, the user will know how the application and each of its modules work and how BigMarket implements these functions.

4.1 Introduction

In this chapter, we show two detailed diagrams. First, we can see a class diagram that represents the class structure of BigMarket, this diagram is represented by figure 4.1. Following this diagram, we can see the diagram [4.2] that represents the complete architecture of BigMarket. In the first section we introduce both schemes and the behaviour and the main function of each of the modules and components. After this, in the following subsections we describe each module in depth showing specific diagrams, screenshots and detailing their particular operation, also, to help the user to understand how each module works, we attach the implementation of each function.

4.2 Architecture

To define the architecture of BigMarket, we have built two diagrams. The first of them, is a class diagram built following the specifications of UML Class Diagrams. UML 2 class diagrams are the mainstay of object-oriented analysis and design. UML 2 class diagrams show the classes of the system, their interrelationships (including inheritance, aggregation, and association), and the operations and attributes of the classes. Class diagrams are used for a wide variety of purposes, including both conceptual/domain modeling and detailed design modelling¹.

Following this diagram we can find a component diagram that give us a global vision of the architecture of BigMarket, to make the component diagram we have following the specifications of UML Component Diagrams ².

¹<http://www.agilemodeling.com/artifacts/classDiagram.htm>

²<http://agilemodeling.com/artifacts/componentDiagram.htm>

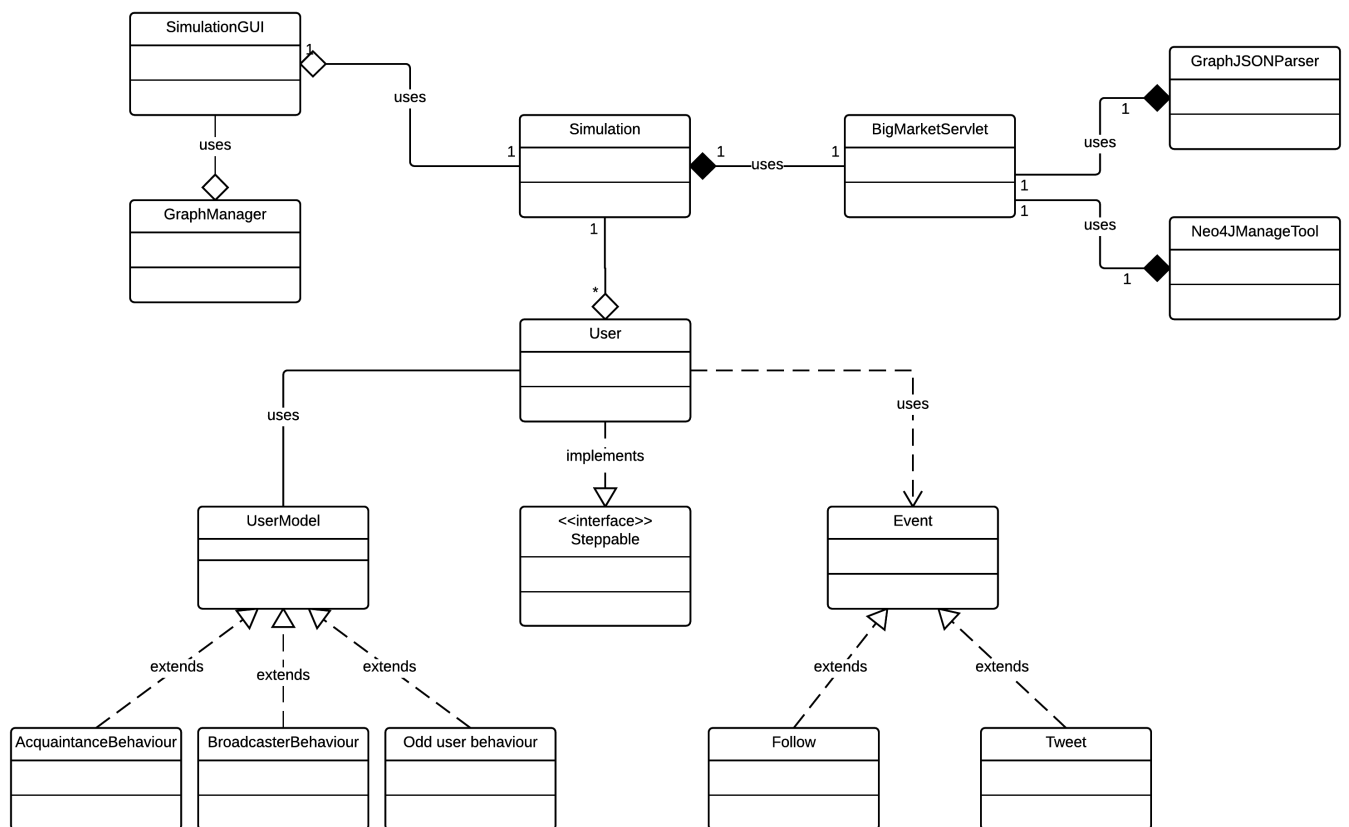


Figure 4.1: UML class diagram.

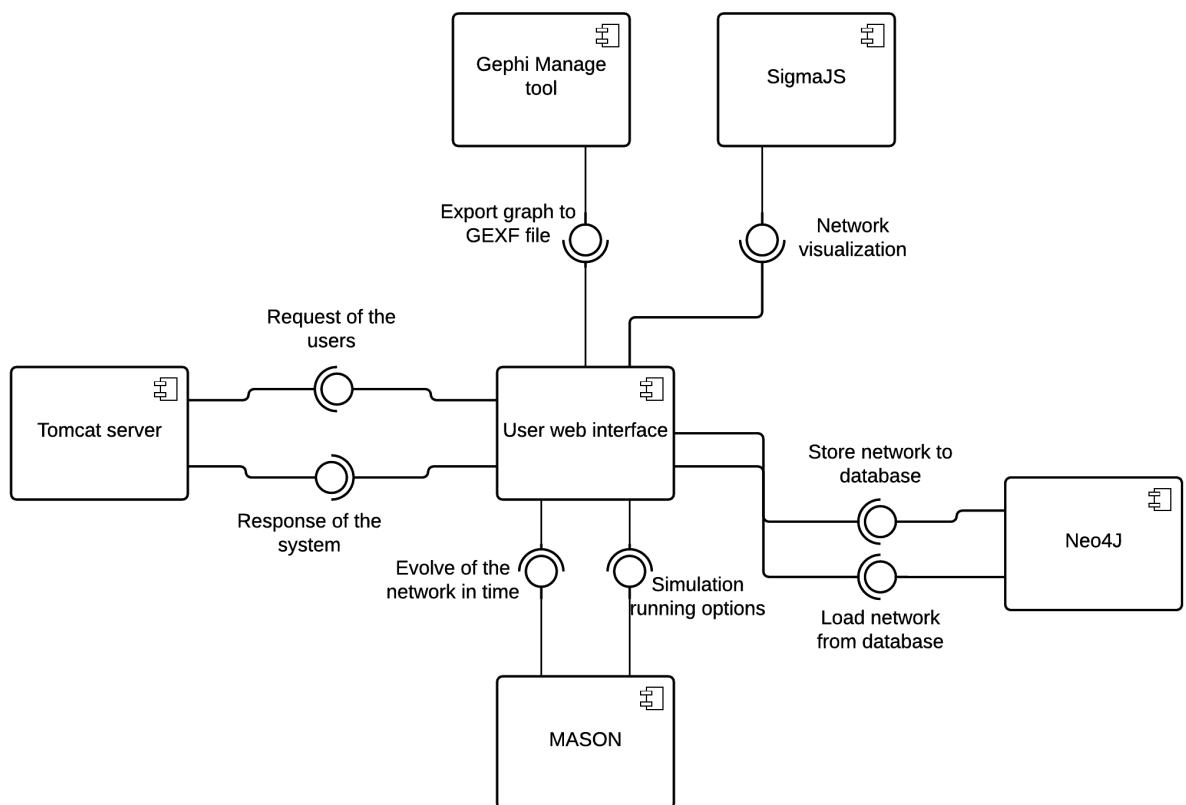


Figure 4.2: UML component diagram.

In the next paragraphs we will do a simply introduction of how BigMarket works, and in the following sections we will explain each part with more detail.

Since the main purpose of this master thesis is to develop an HTML5 Framework to build, analyse and represent the evolve of a social network in the time, the whole actions that the users can do will be done through a web interface that will connect with a servlet that receives the request of the user and will do the properly action depending the request.

In order to create the initial network, non-technical users can use the automatic BigMarket network builder engine in order to create their own networks, this engine builds a network with the number of the initial nodes using an algorithm based on the popularity of each user, it means that a new user is more probably that follows an old user that has a lot of followers instead of an user that has less followers. The more technical users, can build their networks using the queries provided by Neo4J, with this method, the user of BigMarket is who establish how many nodes are in the begin of the simulation and how they are connected. Once the network is created, BigMarket will use in each step the same algorithm explained with the non-technical users to introduce and connect the new nodes.

Once the network is created and the user starts the simulation, the MASON step engine takes the control. In each step, MASON step engine introduce a new number of users depending on the actual number of users and the time that the simulation is running (we understand the time like the number of steps since the simulation began), connect the new users with the oldies using the algorithm explained in the previous paragraph, makes new relationships between the old users and, finally, modify the behaviour of the users according to the new network structure.

When the user stops the simulation, Neo4J enter in action. First of all, the network is parser into JSON format in order to adapt it to Neo4J query format. This query is made by an http request that store the simulation in the database.

Once the simulation is completely stored in the database, BigMarket represent in the screen four centrality analysis: betweenness, closeness, in degree and out degree. If the user wants to analyse the network with more detail, BigMarket enables the possibility to download the graph that contains the network in a .GEXF file in order to analyse it with a SNA tool (like Gephi). In the results screen, the user have the possibility to see the network too. This visualization will be showed in a new window and the nodes and their relationships will be represented.

4.3 MASON engine and its implementation

As we explained in the past section, BigMarket uses the MASON step engine in order to make the network evolve in time. MASON also allows a GUI if we execute BigMarket in our own computer. As we comment in the past section, MASON follows these points in each execution:

- *Network growth*: first of all, MASON introduce a number of new users in the network. This number depends of the number of actual users in the network and the steps from the beginning of the simulation. This growth follows the next expression extracted from [3]: $e^{(t^0.239)*1.67}$

The implementation of this network growth can see in the following block:

Listing 4.1: Network growth

```
long t = simulation.schedule.getSteps();
double exponent = (1190.0/5000.0);
double r = Math.pow(t, exponent);
double integralResult = (1565*r)/937;
double n = initialPopulation*Math.exp(integralResult);
int nt = (int) Math.round(n);
```

- *Connecting the new users*: once the new users are added, is time to connect them with the old users of the network. To do this we will use an algorithm that makes more possible that new users connect with other that has a lot of followers instead of an user that has less followers. In order to help to the users to understand this function, we attach the implementation of the connecting new users function:

Listing 4.2: Connecting new users

```
public void lookForNewUsers(Simulation sim){
    Graph graph = sim.getGraphManager().getGraph();
    for(User u: sim.getUsers()){
        if(u.getFollowed().size() == 0 && u.getFollowers().size()
           == 0){
            Node n2 = graph.getNode(u.getId());
            int random = (int) (Math.random()*popularity.size());
```

```

        Node n1 = graph.getNode(popularity.get(random));
        connectNewUsers(sim, n1, n2);
    }
}

public void connectNewUsers(Simulation sim, Node n1, Node n2){
    Graph graph = sim.getGraphManager().getGraph();
    graph.addEdge(Integer.toString(graph.getEdgeCount()+1), n2,
        n1, true);
    Follow f = new Follow("Follow " + graph.getEdgeCount()+1, "
    TS " + graph.getEdgeCount()+1
        , sim.getUsers().get(n1.getIndex()), sim.getUsers().get
        (n2.getIndex()));
}

```

- *Establishing new relations:* when the new users and their relationships are incorporate in the network, the next step is establish new relations between the old users. We will use the same algorithm of the last point to do this. You can see the implementation of this function in the following block:

Listing 4.3: Establishing new relations

```

public void lookForNewUsers(Simulation sim){
    Graph graph = sim.getGraphManager().getGraph();
    for(User u: sim.getUsers()){
        if(u.getFollowed().size() == 0 && u.getFollowers().size()
            == 0){
            Node n2 = graph.getNode(u.getId());
            int random = (int) (Math.random()*popularity.size());
            Node n1 = graph.getNode(popularity.get(random));
            connectNewUsers(sim, n1, n2);
        }
    }
}

```

- *Modifying the behaviour:* BigMarket assign the behaviour to each user according their followers. If the users have a lot of followers, we assume that the user is a broadcaster, if he/she has a normal number of followers, he/she is catalogued like acquaintance and finally if the user has a few number of followers, he/she is and odd user. Because of

this, BigMarket modify the behaviour of the users at the end of each simulation step, once the new users and their relationships are added and the old users relations are modified. Finally, this is the code that allows BigMarket to modify the users behaviour:

Listing 4.4: Modifying behaviour

```
private void setUserType(Simulation sim, User user){
    Graph graph = sim.getGraphManager().getGraph();
    double enteredEdges = 0.0;
    double totalEdges = graph.getEdgeCount();
    double percentage = 0.0;
    enteredEdges = user.getFollowers().size();
    percentage = enteredEdges/totalEdges;
    if(percentage >= 0.3){
        user.setType(Constants.USER_TYPE_BROADCASTER);
        //System.out.println("EL usuario " + user.getUserName()
        //    + " es un " + Constants.USER_TYPE_BROADCASTER);
    }else if(0.3 > percentage && percentage >= 0.1){
        user.setType(Constants.USER_TYPE_ACQUAINTANCES);
        //System.out.println("EL usuario " + user.getUserName()
        //    + " es un " + Constants.USER_TYPE_ACQUAINTANCES);
    }else{
        user.setType(Constants.USER_TYPE_ODDUSERS);
        //System.out.println("EL usuario " + user.getUserName()
        //    + " es un " + Constants.USER_TYPE_ODDUSERS);
    }
}
```

4.4 Neo4J database and its implementation

The main purpose of the part composed by the Neo4J tools is, apart of its use like database, create and modify the network. The user can use BigMarket to open a new window with the Neo4J interface, which allows us to build a new network from scratch or modify a previous stored network using Neo4J queries.

The Neo4J interface also allows the user to see the networks stored in the database. Actually there is not any security (like sessions, it will be implemented in future networks), so an user can watch all the networks stored in the database.

Once we have created (or modify) a network, we can use BigMarket to load it and run a simulation using this loaded network. For do this, the user web interface simplify the method of write queries for Neo4J (we will explain it in user web interface section).

Neo4J implements a REST API that allows us to send JSON objects with the information of the network in order to store it in the database.

Now we have introduce each part of the Neo4J used in BigMarket, we will explain it in more detail. We show too the implementation of each part in order to make this module more comprehensible by the users:

- *Create network with Neo4J queries:* as we comment at the start of this section, Neo4J allows us to create (or modify) a network using its queries. Like Neo4J is a graph database, its queries are oriented to the building of graphs so we can create a network or modify and existing network using few queries (note that if you want to do more complex networks, maybe you should study with more detail the possibilities of Neo4J). So the basics queries that allows us to interact with the graphs that store our networks are the following:

Listing 4.5: Query get data

```
MATCH (n) RETURN n LIMIT 100
```

Listing 4.6: Create node

```
CREATE (n {name: "World"}) RETURN "hello", n.name
```

Listing 4.7: Query relationship

```
MATCH (martin { name: 'Martin Sheen' })-->(movie)
```

- *Save network in database:* to do this, we will use the Neo4J REST API, with this, we can send a request to Neo4J with the information of the network in a JSON object. The code that allow us to do this is.

Listing 4.8: Save network

```
private void createNodes() {
```

```

String location = null;
nodeUris.clear();
System.out.println("SIMULATION NODES : " + sim.
    getGraphManager().getGraph().getNodeCount());
for(org.graphstream.graph.Node n : sim.getGraphManager().
    getGraph().getNodeSet()){
    System.out.println("NODE " + n.getId());
    try{
        String nodePointUrl = this.SERVER_ROOT_URI + "/db/data/
            node/";
        String dataset = "dataset";
        HttpClient client = new HttpClient();
        PostMethod mPost = new PostMethod(nodePointUrl);

        Header mtHeader = new Header();
        mtHeader.setName("content-type");
        mtHeader.setValue("application/json");
        mtHeader.setName("accept");
        mtHeader.setValue("application/json");
        mPost.setRequestHeader(mtHeader);

        StringRequestEntity requestEntity = new
            StringRequestEntity("{",
                "application/json",
                "UTF-8");
        mPost.setRequestEntity(requestEntity);
        client.executeMethod(mPost);
        mPost.getResponseBodyAsString();
        Header locationHeader = mPost.getResponseHeader("
            location");
        location = locationHeader.getValue();
        mPost.releaseConnection();

        String data = sim.getSimDataset();

        nodeUris.put(n.getId(), location);

        this.saveNodeRelations(location,
            sim.getUsers().get(n.getIndex()).getFollowers());
        this.addProperty(location, dataset, data);
        this.addLabel(location, data);
    }
}

```

```

    }catch(Exception e){
        System.out.println("Exception in creating node in neo4j
                           : " + e);
    }
}
}

```

- *Load network from database:* at the same way like save network in database, we can load a network stored previously in the database. To do this we follow a method similar to that used to save a network in the database:

Listing 4.9: Load network

```

public void getNodesPerLabel(String labelName){
    try{
        String response = "";
        String nodePointUrl = "http://localhost:7474/db/data/
                               label/" + labelName + "/nodes";
        HttpClient client = new HttpClient();
        GetMethod mGet = new GetMethod(nodePointUrl);

        Header mtHeader = new Header();
        mtHeader.setName("accept");
        mtHeader.setValue("application/json");
        mGet.setRequestHeader(mtHeader);

        client.executeMethod(mGet);
        response = mGet.getResponseBodyAsString();

        JSONArray root = (JSONArray)new JsonParser().parse(
            response);

        for(int i = 0; i < root.size(); i++){
            JsonElement e = root.get(i);
            JsonObject obj = e.getAsJsonObject();
            String s = obj.get("self").toString();
            String finalS = s.substring(1, s.length()-1);
            nodesRetrieve.add(finalS);
        }
    }
}

```



```

    } catch (Exception e) {
        System.out.println("Exception in creating node in neo4j : "
            + e);
    }

    System.out.println(nodesRetrieve);
}

public void getNodeRelations() {
    for (String s : nodesRetrieve) {
        try {
            String response = "";
            String nodePointUrl = s + "/relationships/out";
            HttpClient client = new HttpClient();
            GetMethod mGet = new GetMethod(nodePointUrl);

            Header mtHeader = new Header();
            mtHeader.setName("accept");
            mtHeader.setValue("application/json");
            mGet.setRequestHeader(mtHeader);

            client.executeMethod(mGet);
            response = mGet.getResponseBodyAsString();

            JSONArray root = (JSONArray) new JsonParser().parse(
                response);
            for (int i = 0; i < root.size(); i++) {
                JsonElement e = root.get(i);
                JsonObject obj = e.getAsJsonObject();
                String st = obj.get("end").toString();
                String finalS = st.substring(1, st.length() - 1);
                relationsRetrieve.put(s, finalS);
            }

        } catch (Exception e) {
            System.out.println("Exception in creating node in neo4j
                : " + e);
        }
    }

    System.out.println(relationsRetrieve);
}

```

```
}
```

4.5 SigmaJS graph visualizator and its implementation

In this section we will explain how the user can see the structure of the network at the end of the simulation simply with one click. This representation helps the user to see a final photography of the network.

SigmaJS allows us to represent a graph in an HTML file using JavaScript and JSON. For a correct visualization of the network, first of all, we have to parse the network to JSON. Once the JSON is built and save in a file, we can attach it to the HTML that includes the JavaScript code for SigmaJS. To understand it better we provide here an example of a little network in JSON format and the lines of JavaScript necessary in our HTML file.

First, we can see the implementation of the function than extract the information of the network in a JSON file. Then, we show the code necessary to visualise the network in an HTML file:

Listing 4.10: Network in JSON

```
{
  "nodes": [
    {
      "id": "0",
      "label": "0",
      "x": 1,
      "y": 2,
      "size": 6
    }, {
      "id": "1",
      "label": "1",
      "x": 0,
      "y": 2,
      "size": 6
    }, {
      "id": "2",
      "label": "2",
      "x": 1,
      "y": 0,
```

```

"size": 6
},
"edges": [
{
"id": "0_1",
"source": "0",
"target": "1"
},
{
"id": "2_0",
"source": "2",
"target": "0"
}
]
}

```

Listing 4.11: Java script code for network visualization

```

<script src="js/sigma.min.js"></script>
<script src="js/sigma.layout.forceAtlas2.min.js"></script>
<script src="js/sigma.parsers.json.min.js"></script>

<script>
  sigma.parsers.json('networkGraph.json', {
    container: 'container',
    settings: {
      defaultNodeColor: '#337AB7'
    }
  }, function(s) {
    s.startForceAtlas2();
  });
</script>

```

4.6 Gephi and export to GEXF file implementation

Despite of Gephi is no part of BigMarket, we will talk about it because is the tool that we have use to open the .GEXF files generated by BigMarket.

Once the simulation has finished, BigMarket offers us the option to download the graph in a .GEXF file in order to make network analysis with more detail. To achieve this, BigMarket converts the graph to Graph Exchange XML Format (GEXF) and saves it in a file. This file will be download to the user's computer.

The code that allows this conversion is the following:

Listing 4.12: Save graph in .GEXF file

```
private void exportGraphGEXF() {
    String path = getServletContext().getRealPath("/") + "
        grafoInicial.gexf";
    FileSinkGEXF file = new FileSinkGEXF();
    try {
        file.writeAll(sim.getGraphManager().getGraph(), path);
    } catch (IOException e) {
        e.printStackTrace();
    }
}
```

4.7 User web interface and Servlet and their implementation

In this section we will explain how works the user web interface and the BigMarket servlet. We explain this at the end of the chapter because these parts are the glue that tie the parts explained until now. In this section, we explain the code, leaving the explanation of the GUI for the chapter 5.

First of all we have the index page, in which we find a bit introduction of what is BigMarket. Once we click on “Start”, we enter to the “Setup simulation” screen. In this screen, we can choose how we are going to build our initial network. This page contains a form that allows the servlet knows what options the user has chosen (create random network, load network or create network with Neo4J). The implementation of the form is the following:

Listing 4.13: Save graph in .GEXF file

```
<form action="BigMarketServlet" method="POST" name="setup-form">
    <input type="hidden" name="formName" value="setupForm"/>
    <div class="jumbotron">
```

```

<h4>Select an option:</h4>
<p><input type="radio" name="networks" id="random" value="
    random" onclick="randomNetworkSelected()">New random
    network </p>
<p><input type="radio" name="networks" id="load" value="
    load" onclick="loadNetworkSelected()">Load network from
    DataBase</p>
</div>

<div class="row">
  <div class="col-lg-4" id="col-left">
    <h4>New random network</h4>
    <p>Number of initial nodes: <input type="text" class="
        form-control" id="numNodes" name="numNodes" disabled="
        true"></p>
    <p></p>
    <p>Simulation name: <input type="text" class="form-
        control" id="nameRandom" name="nameRandom" disabled="
        true"></p>
  </div>
  <div class="col-lg-4" id="col-right">
    <h4>Load network from DataBase</h4>
    <p>Dataset identifier: <input type="text" class="form-
        control" id="datasetIdentifier" name="dataset"
        disabled="true"></p>
    <p>New name for simulation:
    <input type="text" class="form-control" id="newLoadName"
        name="newLoadName" disabled="true"></p>
    <p><input type="button" class="btn btn-primary" value="
        Create network" id="createButton" disabled="true"
        onclick="createNetwork()"></p>
  </div>
</div>
<div class="setup-button">
  <p align="center"><button type="submit" class="btn btn-
    primary" id="submitButton">Setup!</button></p>
</div>
</form>

```

The form has an option to mark if the user wants to create a random network or load

a network (the option of create a new network using Neo4J has not a call to the servlet because it just open a new window with the Neo4J interface). Then, depending of the option marked, create random network or load network fields are enabled respectively. Once the user fills the mandatory fields, he/she clicks on the “Setup” button and submit the form to the servlet.

The servlet has a doGet method to handle this form, specifically the part corresponding to this form is the following:

Listing 4.14: Servlet handle setup form

```
String formName = request.getParameter(Constants.FORMNAME);
if(formName.equals(Constants.SETUP.FORMNAME)){
    String radioButtons = request.getParameter(Constants.
        RADIO.BUTTONS.NAME);
    if(radioButtons.equals(Constants.RANDOM.SELECTED)){
        int numberOfNodes = Integer.parseInt(request.getParameter(
            Constants.NUMBER.OF.NODES));
        String randomNetworkName = request.getParameter(Constants.
            RANDOM.NETWORK.NAME);
        launchSimulation(request, response, numberOfNodes,
            randomNetworkName);
    } else if(radioButtons.equals(Constants.LOAD.SELECTED)){
        Neo4JManageTool n = new Neo4JManageTool();
        n.launchLoad(request.getParameter("datasetIdentifier"));
        sim = new Simulation(System.currentTimeMillis());
        sim.setDataBase(n);
        sim.setFlag(2);
        String data = request.getParameter("newLoadName");
        sim.setSimDataSet(data);
        Launcher launcher = new Launcher(sim);
        launcher.start();

        request.setAttribute("broadUsers", getBroadUsers(sim));
        request.setAttribute("acqUsers", getAcqUsers(sim));
        request.setAttribute("oddUsers", getOddUsers(sim));
        request.setAttribute(Constants.STEPS, sim.schedule.getSteps
            ());
        request.setAttribute(Constants.SIM, sim);
        request.getRequestDispatcher(Constants.RUNNING.PAGE).
            forward(request, response);
    }
}
```

```
}
```

First of all, the servlet checks if the form submitted is a Setup simulation form. Then, check if the user wants to create a random network or load a network. Depending of the user's choice, the servlet execute a code block or other.

Once the initial network has been setup, the user can run the simulation. To do this, BigMarket enables in the Running page a form similar to the Setup form. The code of this form is the following:

Listing 4.15: Servlet handle setup form

```
<div class="action-buttons">
  <form action="BigMarketServlet" method="POST" name="running"
    ">
    <input type="hidden" name="formName" value="runningForm"
      />
    <input type="submit" class="btn btn-primary" value="Run
      one step" id="runOneStepButton" onClick="clickROS()">
    <input type="submit" class="btn btn-primary" value="Run"
      id="runButton" onClick="clickRun()">
    <input type="submit" class="btn btn-primary" value="Pause
      " id="pauseButton" onClick="clickPause()">
    <input type="submit" class="btn btn-primary" value="Stop"
      id="StopButton" onClick="clickStop()">
    <input name="actionSelected" type="hidden" value="default
      " id="actionSelected">
  </form>
</div>
```

This form has a hidden field which store the value of the option selected by the user. This field will be read by the servlet in order to make an action according to the user choice.

The running page also show dynamically the information about the simulation (steps, number and types of users and number of tweets of each user type). The code that allows this is the following:

Listing 4.16: Servlet handle setup form

```
<%
```

```

Integer broadUsers = (Integer)request.getAttribute("
    broadUsers");
Integer acqUsers = (Integer)request.getAttribute("acqUsers");
Integer oddUsers = (Integer)request.getAttribute("oddUsers");
Integer oddTweets = (Integer)request.getAttribute("oddTweets"
    );
Integer acqTweets = (Integer) request.getAttribute("acqTweets
    ");
Integer broadTweets = (Integer) request.getAttribute("
    broadTweets");
Long steps = (Long)request.getAttribute("steps");
Simulation sim = (Simulation)request.getAttribute("sim");
%>

<div class="jumbotron">
    <table class="table table-striped" id="tableA">
        <tr>
            <th>Time step</th>
            <td>×%=steps%</td>
        </tr>
    </div>

<div class="row">
    <table class="table table-striped" id="tableB">
        <tr>
            <th>User type</th>
            <th>Number of users</th>
            <th>Number of tweets writed</th>
        </tr>
        <tr>
            <th>Broadcaster</td>
            <td>×%=broadUsers%</td>
            <td>×%=broadTweets%</td>
        </tr>
        <tr>
            <th>Acquaintances</td>
            <td>×%=acqUsers%</td>
            <td>×%=acqTweets%</td>
        </tr>
        <tr>
            <th>Odd users</td>

```



```

        <td>%=oddUsers%</td>
        <td>%=oddTweets%</td>
    </tr>
</table>
</div>

```

The first part extract from the response of the servlet (request seen from the JSP file) the information about the simulation and represent it in a table to make it easy to understand by the user.

How the servlet manage all of this? Easy, with a block of code similar to the block of code of the previous part.

Listing 4.17: Servlet handle setup form

```

} else if (formName.equals(Constants.RUNNING_FORMNAME)) {
    String actionSelected = request.getParameter(Constants.
        ACTION_SELECTED);
    if (actionSelected.equals(Constants.RUN_ONE_STEP)) {
        clickRunOneStep(request, response);
    } else if (actionSelected.equals(Constants.RUN)) {
        clickRun(request, response);
    } else if (actionSelected.equals(Constants.PAUSE)) {
        clickPause(request, response);
    } else {
        clickStop(request, response);
    }
}
}

```

First, the servlet checks if the form submitted is a Running form. In case of success, it checks if the button selected is a run one step, run, pause or stop button. But, how the servlet give to the JSP the information about the simulation? To answer this question here it goes an example:

Listing 4.18: Servlet handle setup form

```

request.setAttribute("broadUsers", getBroadUsers(sim));
request.setAttribute("aqUsers", getAqUsers(sim));
request.setAttribute("oddUsers", getOddUsers(sim));
request.setAttribute(Constants.STEPS, sim.schedule.getSteps());

```

```
request.setAttribute(Constants.SIM, sim);
request.setAttribute("oddTweets", sim.getEventManager().
    getStatistics().getOddTweets());
request.setAttribute("broadTweets", sim.getEventManager().
    getStatistics().getBroadTweets());
request.setAttribute("acqTweets", sim.getEventManager().
    getStatistics().getAcqTweets());
request.getRequestDispatcher(Constants.RUNNING_PAGE).forward(
    request, response);
```

The servlet stores in variables the information about the simulation, once all the necessary variables are filled, the servlet sends to the JSP page all the information in last line of code.

Run one step, run and pause button have a similar behaviour, but “Stop” button is a bit special. If the user clicks this button, the servlets executes the code necessary for store the simulation in the database and calculate the centrality of the network. The code that manage this is the following:

Listing 4.19: Servlet handle setup form

```
private void clickStop(HttpServletRequest request ,
    HttpServletResponse response) throws ServletException ,
    IOException{
    sim.getGui().getConsole().pressStop();

    sim.finish();
    neoDB.setSim(sim);
    neoDB.launchDatabaseTool();
    GraphJSONParser g = new GraphJSONParser(sim.getGraphManager().
        getGraph());
    String path = getServletContext().getRealPath("/") + "
        networkGraph.json";
    g.launchParser(path);
    exportGraphGEXF();
    calculateCloseness(request, response);
    calculateBetweenness(request, response);
    request.getRequestDispatcher(Constants.ACTIONS_PAGE).forward(
        request, response);
}
```

Like we can see in the code, first of all the simulation is finished, then the Neo4J tool is

initialized and launched (it stores the network in the database). Then, the JSON file for the network visualization is generated. Next step is saving the graph in a GEXF file and finally, the centrality is calculated and the user interface goes to the next screen (Actions page).

In this last screen of the simulation, called “Actions” we can see four tables with the information about the centrality and two buttons that allows us to see the network and y download the graph in a GEXF file.

The way to represent the centrality in the tables is similar to the way showed for the simulation information so we have no copy here the code. The “See network” visualization simply opens a new window with the visualization showed at 4.5 and the “Download graph” saves the GEXF file in the user’s computer as we explained in section 4.6.

4.8 Conclusion

In this chapter, we have seen how each part of BigMarket works and how all interact between them to build a simply SNSA framework. In the next chapter, we select an use case and we will use it to explain in detail how the user interface works.

Prototype and example usage

In this chapter, we are going to describe a selected use case by explaining the running of all the tools involved and its purpose and responses. Thank to these use cases, we will show the overall performance of the application and all the main functions available to the user.

5.1 Introduction

In this chapter, we will explain in detail a use case. For explain with more detail the use of BigMarket we will create three networks at the begin (in order to explain the three ways to create and use a network in the simulation). Then we will choose one of the three networks created and we will use it for run a simulation. After, we will see the results of the centrality analysis and the network using the SigmaJS visualizator. Finally, we will download the graph in a GEXF file and we will analyse it with the Gephi framework.

These three networks will be the next:

- *Random network:* with this option we will create a new random network with a initial number of nodes of 100. The BigMarket engine will be the responsible of establishing the relationships between each node.
- *Creating network with Neo4J:* we will create a new network using the Neo4J framework. In the past section, we will show a few queries that allows us to create nodes and relationships between them. Now, we will use them to create a full network.
- *Loading network from database:* the last network selected will be a network stored in the database, we will use the network created in the previous point.

5.2 Random network

Once we are in the setup screen, we will select the option of create a new random network. We will introduce an initial number of nodes of 100 and we will call the network “Random network”. So when we have completed these steps we will have a “Setup simulation” screen like the figure 5.1

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About BigMarket Set up Simulation Running Actions Contact

Select an option:

☒ New random network

☐ Load network from DataBase

New random network

Number of initial nodes:

Simulation name:

Load network from DataBase

Dataset identifier:

New name for simulation:

Create network

Setup!

Figure 5.1: 100-Node Random network setup.

Finally we click on “Setup” button and the network will be created (This action does not save the network in the database, just create the network to use it in the simulation).

5.3 Creating network with Neo4J

For creating a new network using the queries from Neo4J, first, we have to go to the “Setup simulation” screen and select the option “Load network from database”. Once we have selected this option, the button for creating a new network (or modify an existing network) will be enabled. If we click this button, a new window displaying the Neo4J web interface will be opened.

In this new window, represented in the figure 5.2, we will use the Neo4J queries to create the nodes and establish relationships between them. A network with three nodes and two relationships will be enough.

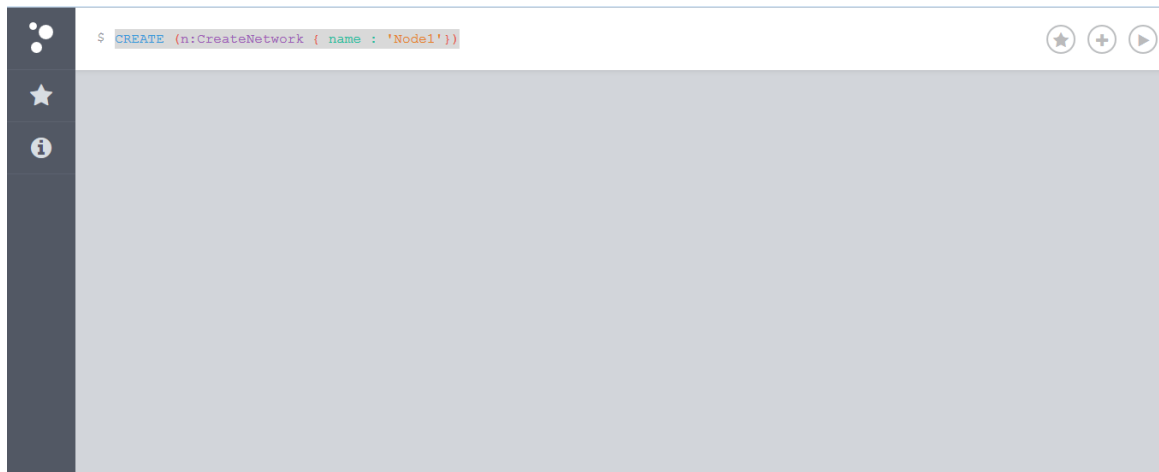


Figure 5.2: Neo4J interface.

First of all, we will create the three nodes. To do this, we write these queries in the Neo4J interface.

Listing 5.1: Creating node 1

```
CREATE (n:CreateNetwork { name : 'Node1' })
```

Listing 5.2: Creating node 2

```
CREATE (n:CreateNetwork { name : 'Node2' })
```

Listing 5.3: Creating node 3

```
CREATE (n:CreateNetwork { name : 'Node3' })
```

The label (CreateNetwork) will be used to know to what simulation belongs the node and the name (Node1, Node2 and Node3) will identify the node inside the simulation.

Once we have created the three nodes we can see them using the next query:

Listing 5.4: Nodes created

```
MATCH (n:CreateNetwork) RETURN n LIMIT 25
```

In the figure 5.3 we can see a representation of the previous query:

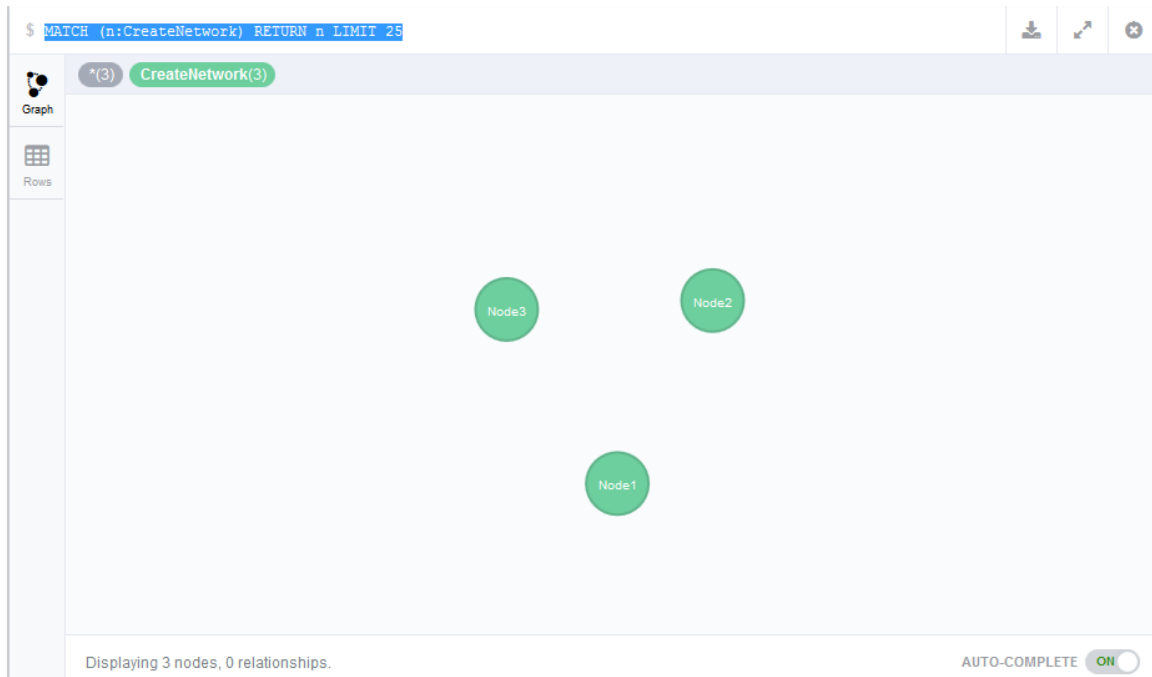


Figure 5.3: Nodes created.

Now is time to create the relations between nodes. We will join the node 1 with the node 2 and the node 3 with the node 1. Note the direction of the relationship is important so:

- Node1 — Node2
- Node3 — Node1

To do this we write in the Neo4J interface the next query:

Listing 5.5: Nodes created

```
MMATCH (a:CreateNetwork),(b:CreateNetwork)
WHERE a.name = 'Node1' AND b.name = 'Node2'
CREATE (a)-[r:RELTYPE]->(b)
```

To see the final network created we can execute the query used in the previous pint to see the nodes created. So the final network would be:

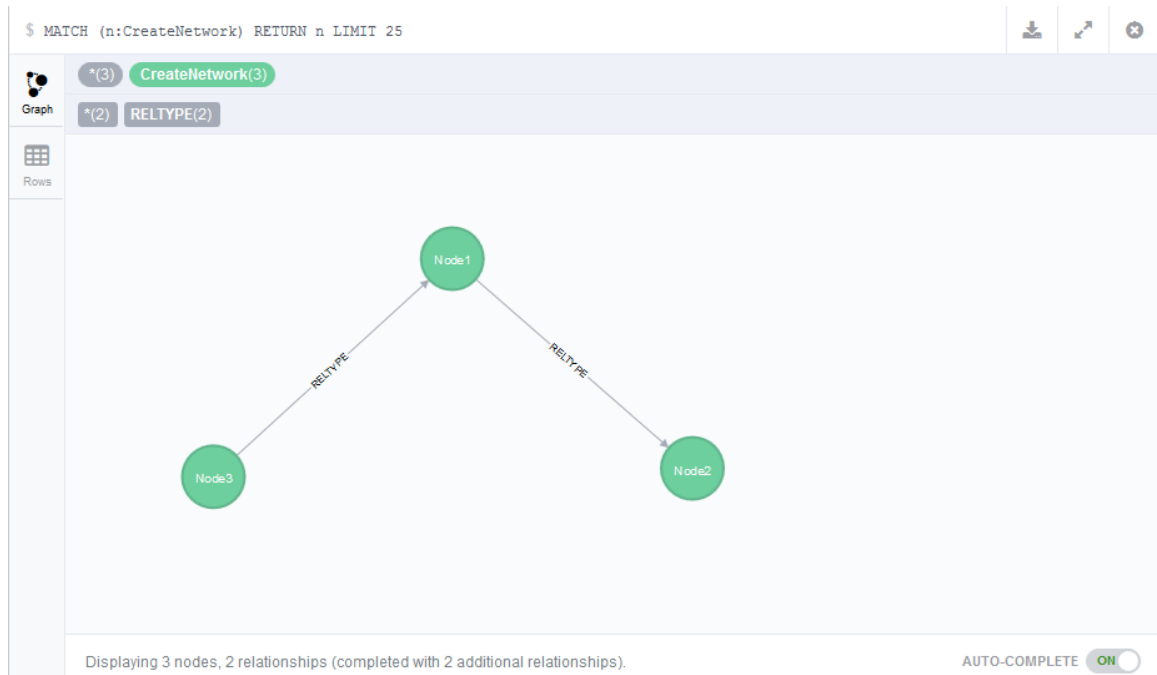


Figure 5.4: Final network.

5.4 Loading network from database

In the last sections, we had created two networks. Now, it's time to load one of these and execute a simulation with it. We will load the network created using Neo4J. To do this, in the "Setup simulation", we have to select the options and fill the fields like in the figure 5.5. In the "Dataset identifier" field we will introduce the name of the simulation that we want to load and in the "New name for simulation field", we will introduce the name which the network will be saved at the end of the simulation.

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About BigMarket Set up Simulation Running Actions Contact

Select an option:

☐ New random network

☒ Load network from DataBase

New random network

Number of initial nodes:

100

Simulation name:

Random network

Load network from DataBase

Dataset identifier:

CreateNetwork

New name for simulation:

LoadNetwork

Create network

Setup!

Figure 5.5: Load network setup.

Finally we click on “Setup” button and the network will be loaded. In the next section we will run a simulation with this network.

5.5 Running the simulation of the loaded network

Once we have clicked on the “Setup!” button, BigMarket leads us to the “Running” screen. Meanwhile, the MASON step engine is booted.

In this screen we have the option to run one step of the simulation or simply let it running indefinitely until we want to pause it. In this screen we can also see the information of the simulation (number of users and its type, the tweets and the steps) like we can see in the figure 5.6. Once we want to finish the simulation, we have to click the “Stop” button and Neo4J will save the simulation for us.

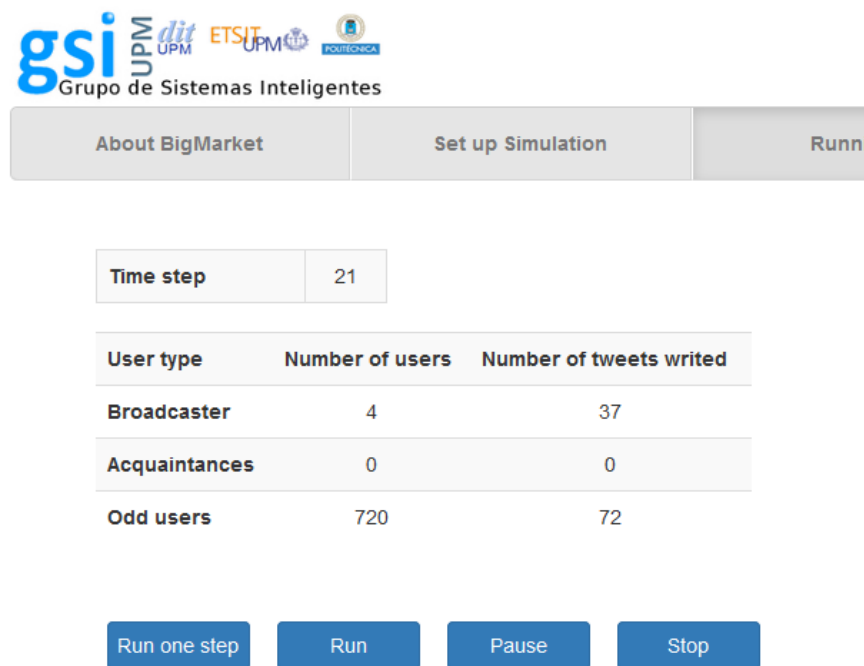


Figure 5.6: Running the simulation.

As we can see in the figure 5.6, in the step 21 we have 4 broadcasters that have written 37 tweets and 720 odd users that have written 72 tweets. In this point we can resume the simulation or finish it.

5.6 Results screen and final actions

The last screen of our simulation shows the results of four centrality measures: betweenness, closeness, in degree and out degree, like we can see in the figure 5.7. We can reach this screen by pushing the “Stop” button in the “Running” screen.

In this screen showed in the figure 5.7 we have the option to see the network created during the simulation and download it for analyze with a SNA tool.

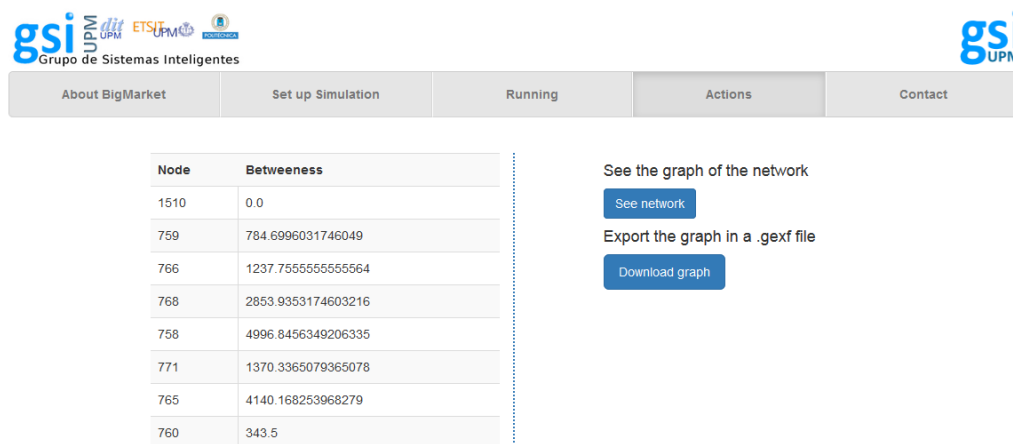


Figure 5.7: Results of the simulation.

If we click on the “See network button” we can see the network at the end of the simulation like we show in the figure 5.8.

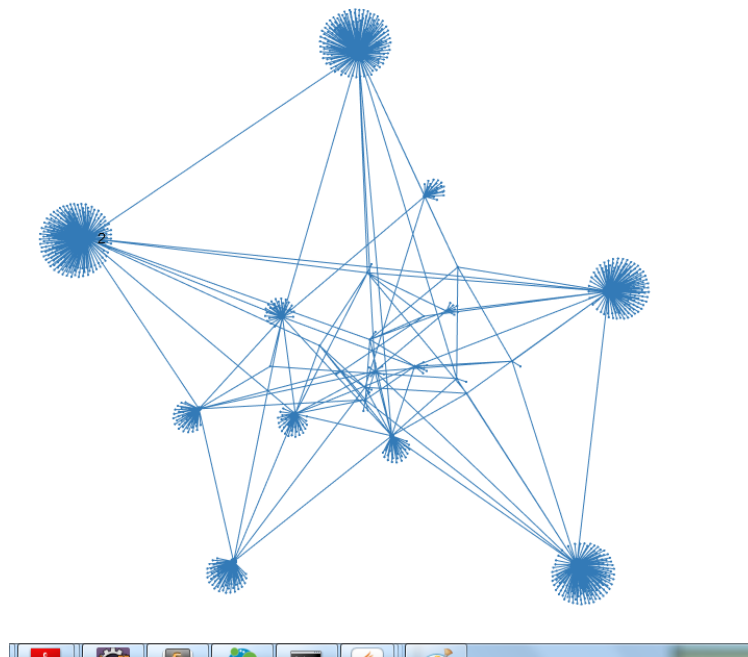


Figure 5.8: Network visualization.

Finally, we can download the graph in a GEXF file and analyse it with Gephi.

5.7 Conclusion

In this chapter, we have explained and extended use case for BigMarket, so that the user can have a global view of the BigMarket framework. In the next chapter, we will resume the conclusions and the results of this master thesis.

Conclusions and future lines

This chapter summarizes the conclusions extracted from this master thesis and the objectives achieved are evaluated. After that, we describe thinking about future work.

6.1 Conclusions

By using different papers that represent a variety of mathematics models [3] [4] that allows modelling different types of networks, we have created a tool that allows the user to build a network from zero and make it evolve in time simply selecting the number of initial nodes.

Due to integration with a database, the user is able to store the network that he/she has been created in order to recover the network for future uses for restarting it or simply change the conditions and see how the simulation and the network evolves in the new situations.

The tool also provides a functionality for creating an specifv network using the Neo4J query commands. Thanks to this, the user is able to build a network that satisfies his/her needs, like a specific start situation, the relationships between the users at the beginning of the simulation, establish the broadcasters, the acquaintances and the odd users, etc.

Finally, the tool allows the user to see the network that he/she has been created on the browser, or download it in a file in order to analyse it with and SNA tool. Although BigMarket gives to the user some SNA data like closeness or betweenness, the user maybe wants to achieve their own analysis.

6.2 Achieved goals

In this section, we will analyse the goals established at the beginning of this master thesis and see if them has been achieved:

- *Developing a free web framework to facilitate the access to SNSA (social network simulation and analysis) tools for any user independently of his/her computer skills:* this goal has been achieved successfully. We have developed a tool that allows the user to build a network from scratch and run a simulation without any programing knowledge, simply following the steps in the GUI and all of it in his/her browser. Also he/she can obtain the results of the SNA directly in the browser. BigMarket allows analyse the following results: betweenness, closeness, in degree and out degree.
- *Saving time to the users when they want to make a SNSA implementing a framework that allows an easy configuration of the network and of the simulation:* this goal has been achieved successfully. BigMarket allows the user to build a network and configure a simulation with few steps so it saves the user time.
- *Integrating Big Data technologies into the framework. More specifically, with a noSQL*

graph database: this goal has been achieved successfully. We have integrating into the framework Neo4J database, it allows the user to store his/her simulation and the network in a database.

- *Facilitating familiarization of new developers with the SNSA tools because it offers a base for supply new developments*: this goal has been achieved successfully. BigMarket has been programmed following the rules of modularity. The behaviours of the users are independent, it means that you can program your own behaviour and assign it to an user of the network. You can also program how the network evolve in time.

In view of these results we can say that all the goals marked at the beginning of this master thesis has been achieved successfully.

6.3 Future work

There are several lines than can be followed to continue and extend features of this work.

In the following points some fields of study or improvement are presented to continue the development.

- In order to make the framework more accessible, it will be necessary to make it responsive, so the user can use BigMarket from a tablet or smartphone in order to make the application more accessible and that it can reach more users.
- Implement user session. The idea is to make a simple login in order to allow the user to store their networks and simulations with privacy, so only him/her can load these simulations in the future.
- Modify the behaviours in real time. Now, once the network has been created, the user have not control over it, the BigMarket engine is the one which controls the behaviour assignment. So in the future the idea is that the user can stop the simulation and modify it introducing new agents or modifying whose exist yet.
- List with examples of simulations. Give to the user a group of example networks. Simply accessible by deploying a list in the tool GUI.
- Implement the role of administrator. Create the role of administrator of BigMarket, who manages the permissions of the different users, manage the database, solve the problems of the users, etc.

Installing and running a BigMarket server

This tutorial goes through the process of installing and running BigMarket in any computer with a Windows OS. Project's code is available at <https://github.com/gsi-upm/BigMarket.git>. After the installation, the user will be able to run the application itself or to modify the source files in order to introduce his own changes.

A.1 Installation

A.1.1 Requirements

- JDK 1.7 ¹
- Apache Tomcat 7.0 ²
- Eclipse ³
- Neo4J ⁴
- Gephi ⁵
- Git ⁶

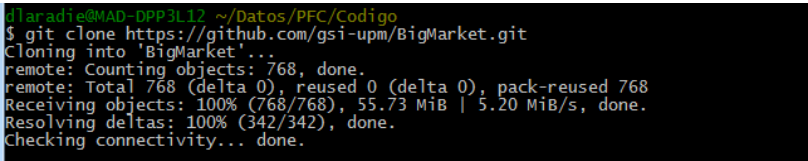
A.1.2 Downloading the source code

For downloading the source code from Git, you have to follow these steps:

1. Create the file system where you are going to clone the git repository.
2. Open Git Bash and go to the path created in the previous step.
3. Once you are in the path, execute the next command:

```
git clone https://github.com/gsi-upm/BigMarket.git
```

If all has gone well, you have to see a screen like this:



```
llaradie@MAD-DPP3L12 ~/Datos/PFC/Codigo
$ git clone https://github.com/gsi-upm/BigMarket.git
Cloning into 'BigMarket'...
remote: Counting objects: 768, done.
remote: Total 768 (delta 0), reused 0 (delta 0), pack-reused 768
Receiving objects: 100% (768/768), 55.73 MiB | 5.20 MiB/s, done.
Resolving deltas: 100% (342/342), done.
Checking connectivity... done.
```

Figure A.1: Git Bash console capture.

Now you have the source code in your own computer.

¹<http://www.oracle.com>

²<http://tomcat.apache.org/>

³<https://eclipse.org/>

⁴<http://neo4j.com/>

⁵<http://gephi.github.io/>

⁶<http://git-scm.com/>

A.1.3 Importing the project in Eclipse

In this section, we will explain how to import the project in Eclipse. In the previous section, we obtained the source code from GitHub, so we will continue from that point. In order to import the project in Eclipse, you have to follow the next steps:

1. Open Eclipse
2. Right click on the Project explorer view and select Import.
3. In the new window, select Git - Projects from Git.

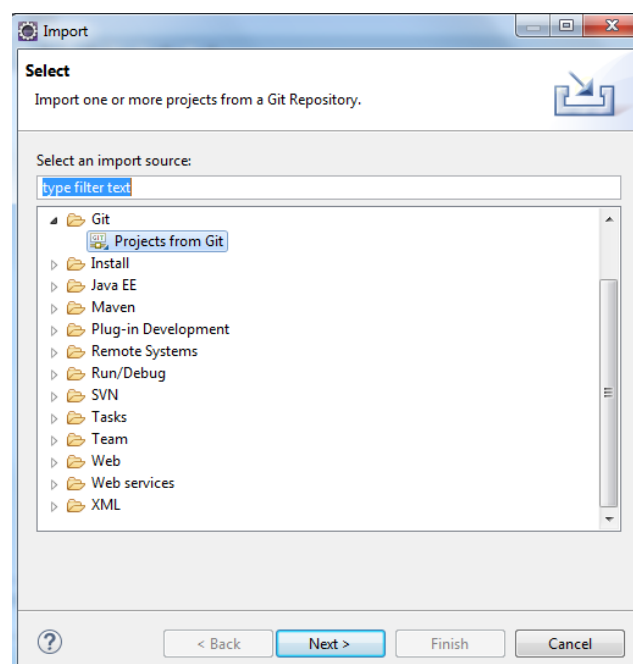


Figure A.2: Import project from Git step 3.

4. Select “Existing local repository”.

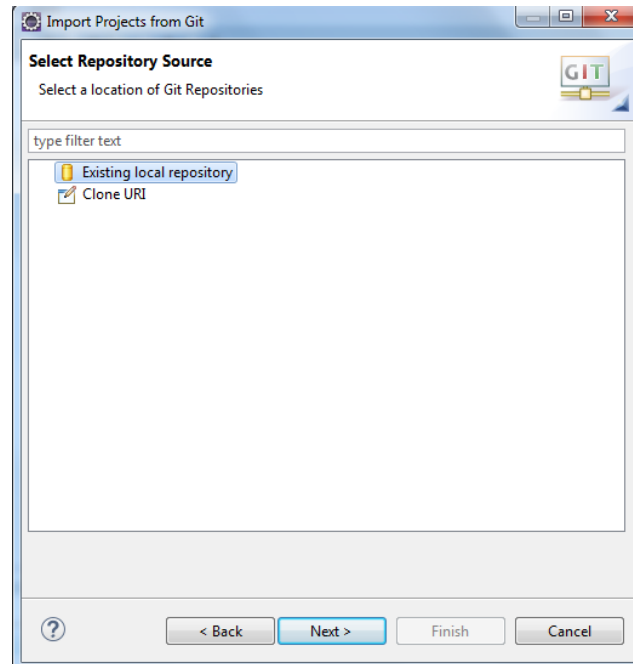


Figure A.3: Import project from Git step 4.

5. Click in “Add” in order to add a new Git repository.

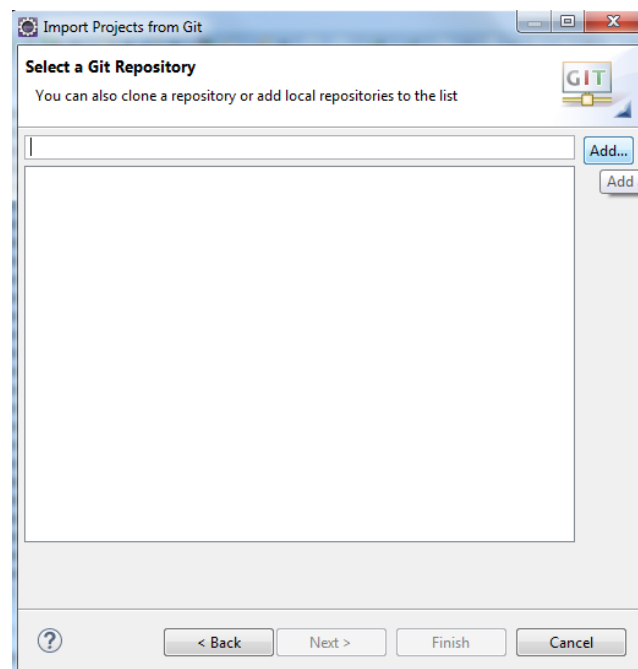


Figure A.4: Import project from Git step 5.

6. Select the path where you downloaded the BigMarket code in the previous section, mark the repository and click in finish.

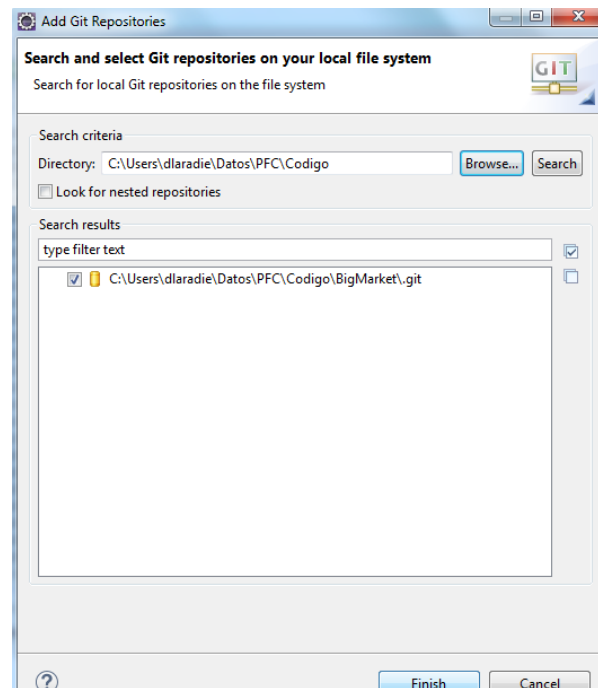


Figure A.5: Import project from Git step 6.

7. Once you have chosen the repository, click in Next.

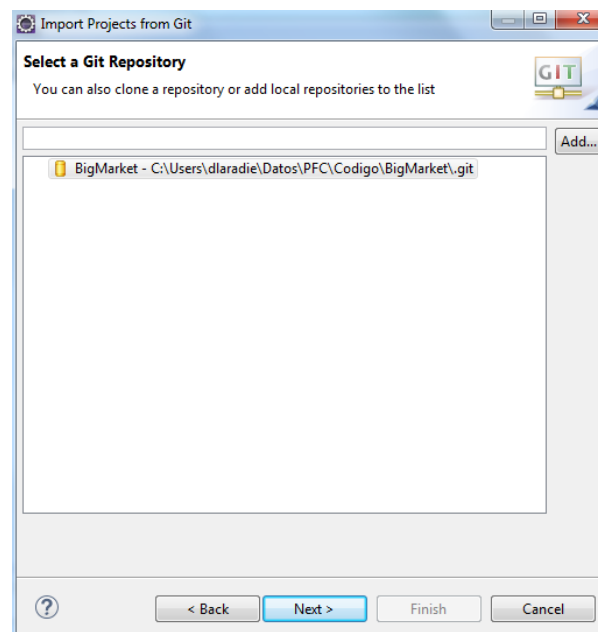


Figure A.6: Import project from Git step 7.

8. Now select the option “Import as general project” and click in Next.

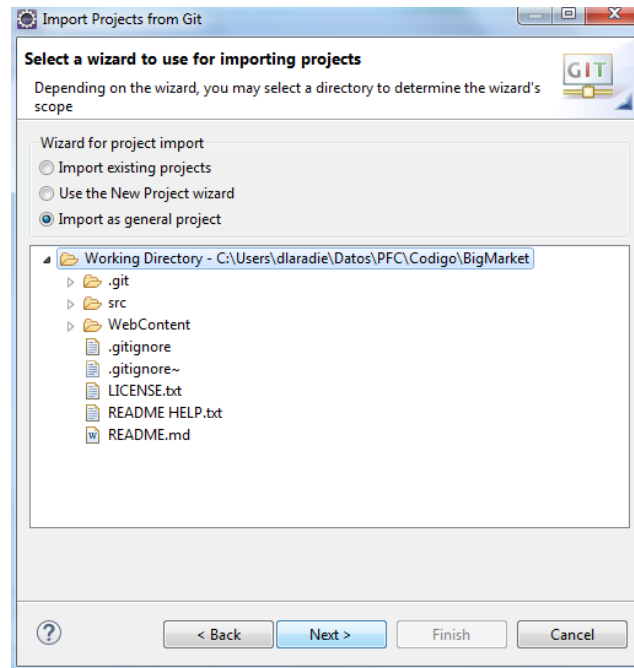


Figure A.7: Import project from Git step 8.

9. Finally, choose a name for your project (in our case BigMarket) and click in Finish.

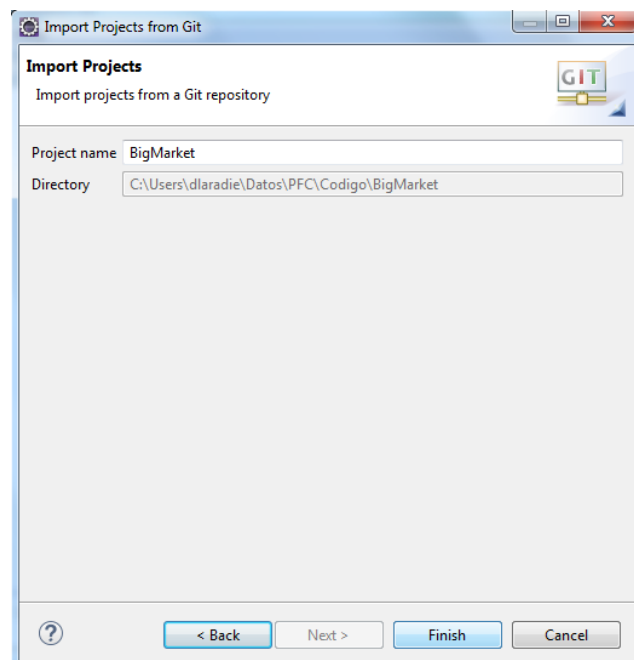


Figure A.8: Import project from Git step 9.

Now you have the project imported in Eclipse. But it is not an Eclipse project yet, so in the next lines, we will explain you how to convert the project imported into an Eclipse project.

A.1.4 Converting the project into an Eclipse project

In the last section, we saw how to import the project downloaded from Git in Eclipse. Now, is time to convert this project into an Eclipse project in order to work with it in our workspace.

To do this, you have to complete this step:

Select the project and click on Project - Properties - Project Facets. Once you are in this windows, select the boxes like in the figure A.9. When you have marked the boxes, click on Apply and Ok.

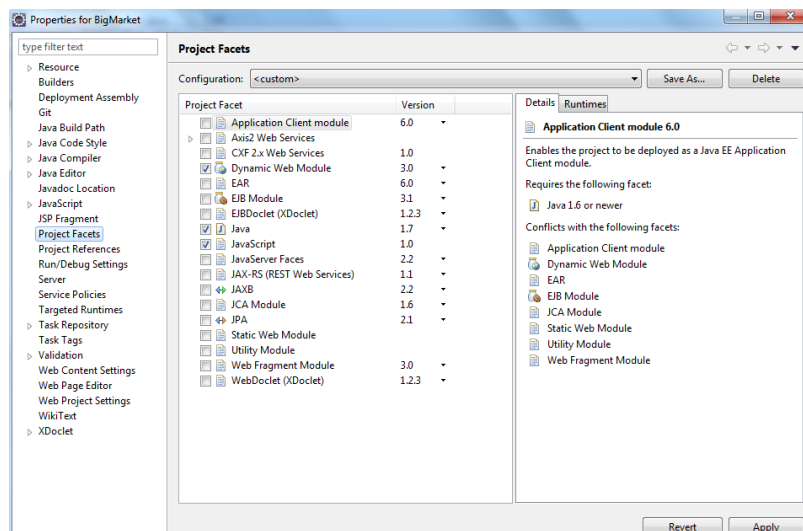


Figure A.9: Convert the project into Eclipse project step 1.

Now, you have the project converted into a Eclipse project (specifically a Dynamic Web Project), but there are errors in our project. In order to solve this, you have to import the library *servlet-api*. To import a determined library in Eclipse, you have to follow the next steps:

1. Right click on our project and select Build path - Configure build path...

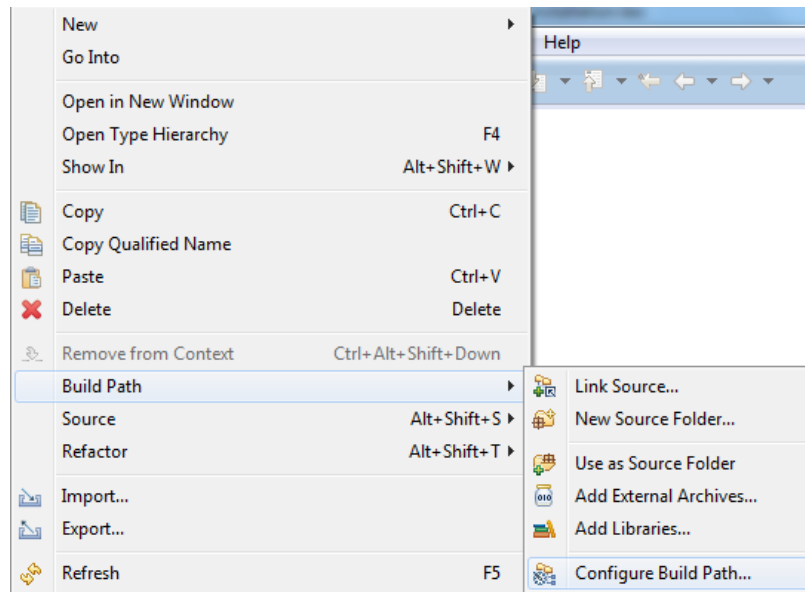


Figure A.10: Import libraries in an Eclipse project step 1.

2. In the new window, select “Add external JARs...”.

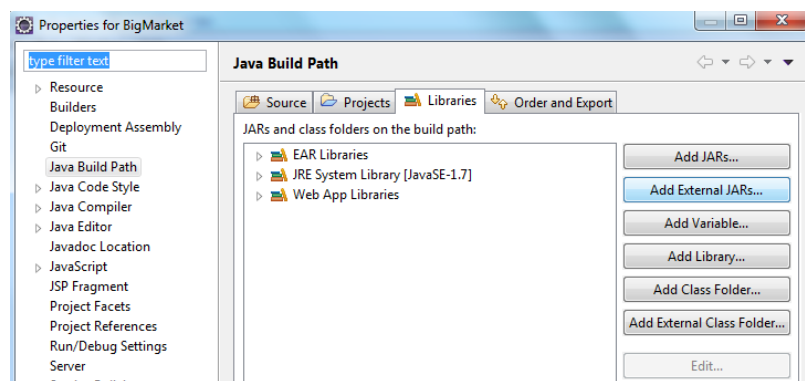


Figure A.11: Import libraries in an Eclipse project step 2.

3. In the JAR selection window, go to the path where you installed Apache Tomcat 7. Once you are in it, go into folder *lib* and double click on *servlet-api*.

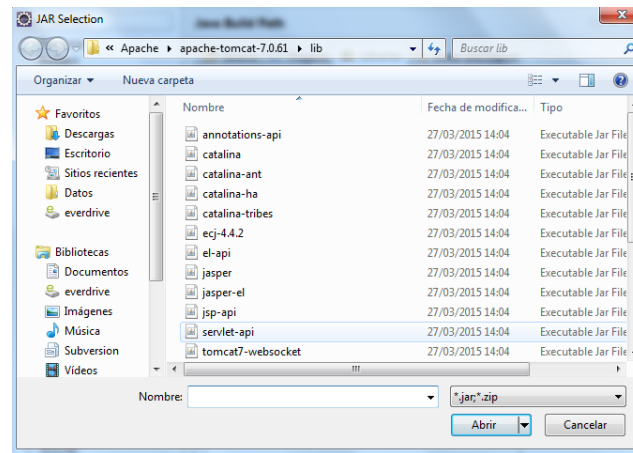


Figure A.12: Import libraries in an Eclipse project step 3.

4. Finally, click on “Ok” and see how the errors are solved.

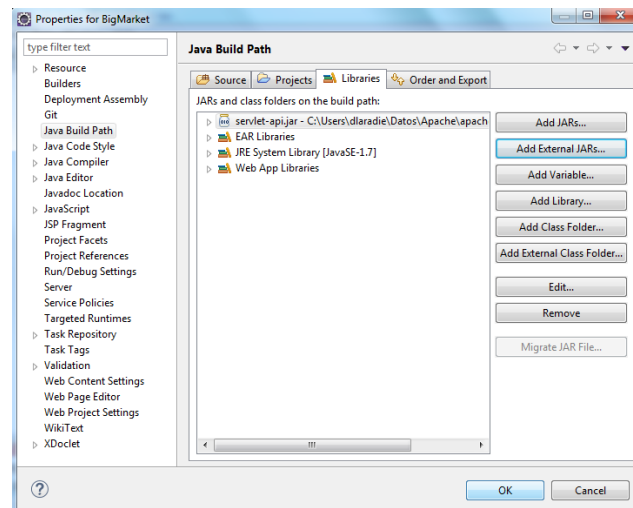


Figure A.13: Import libraries in an Eclipse project step 4.

A.1.5 Running the Neo4J database

In this subsection, we will teach you how to download the database and run it in order to store your simulations.

1. First of all, you have to download the Neo4J database .exe from this link:

<http://neo4j.com/download/>

2. Once you have downloaded the .exe, execute it and follow the instructions.
3. When the installer ends the installation, you have to run the database server. To do this, execute Neo4J Community application.
4. In the new window, click on “Start” and you will have finished this section.

A.2 Run a BigMarket Server

A.2.1 Introduction

In the past section, we saw how to import the project from Github, convert it into an Eclipse project and finally how to solve the errors that appeared. Now, it is time to run the server. In order to achieve this, we guide you through the next sections.

A.2.2 Building the WAR (Web application ARchive)

Apache Tomcat requires a WAR file to publishes a web application, so build a WAR file from the project will be our first step. To achieve this, follow the next steps:

1. Firstly, right click on our project in Eclipse and select “Export”.

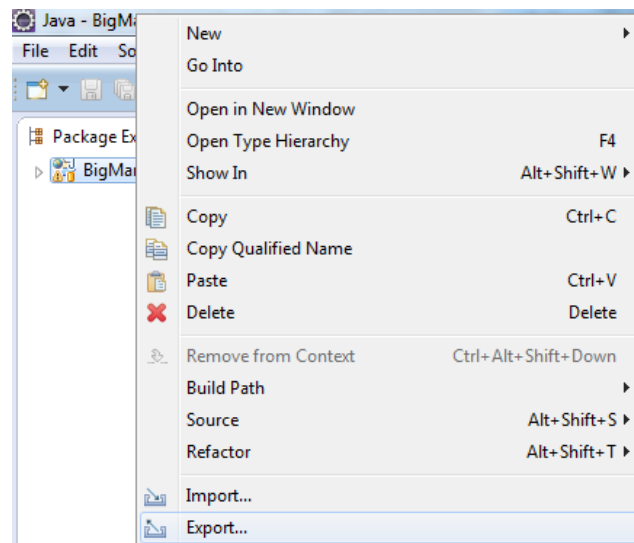


Figure A.14: Building the WAR step 1.

2. In the new window, click on Web folder and select *WAR file*, then click in “Next”.

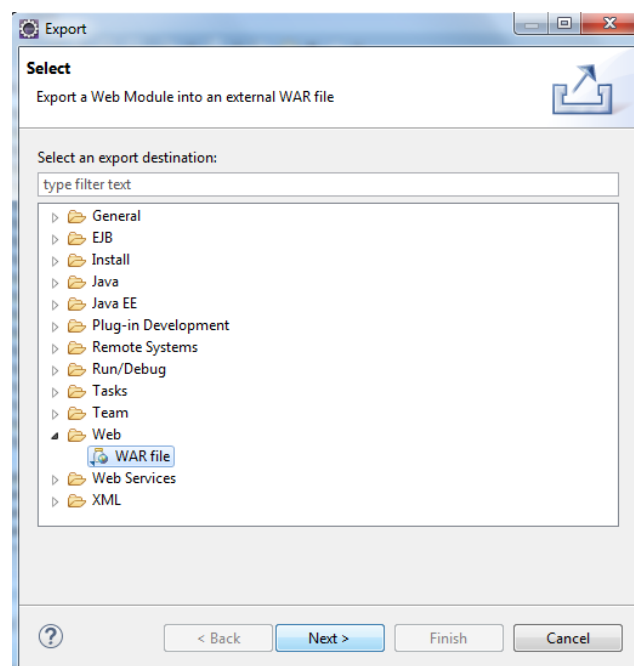


Figure A.15: Building the WAR step 2.

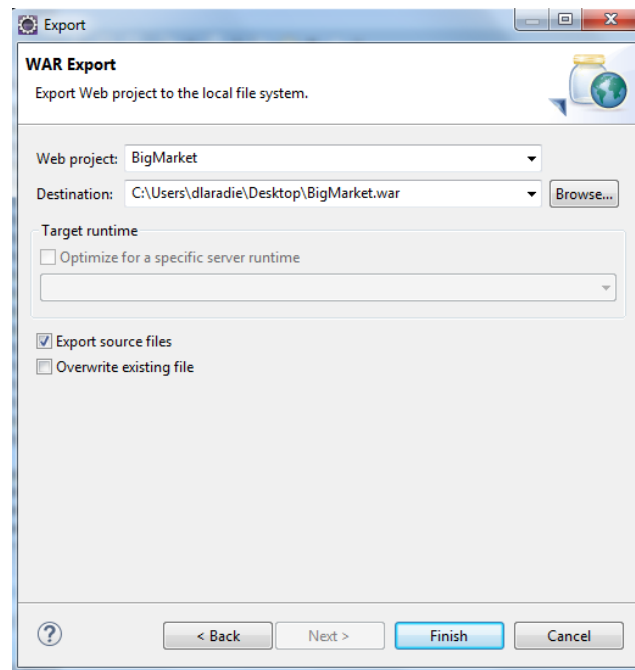


Figure A.16: Building the WAR step 3.

A.2.3 Running a the application

There are two ways for running the application:

- *Running the application in Eclipse:* this way allows you to run Big Market in Eclipse. To do this, follow the next steps:

1. Select the project and open the run icon. Select “Run As” and finally click on “Run on server”.

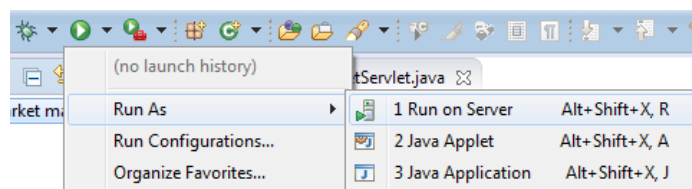


Figure A.17: Running Big Market in Eclipse step 1.

2. In the new window, open the Apache folder and select “Tomcat v7.0 server”, then click on “Next”.

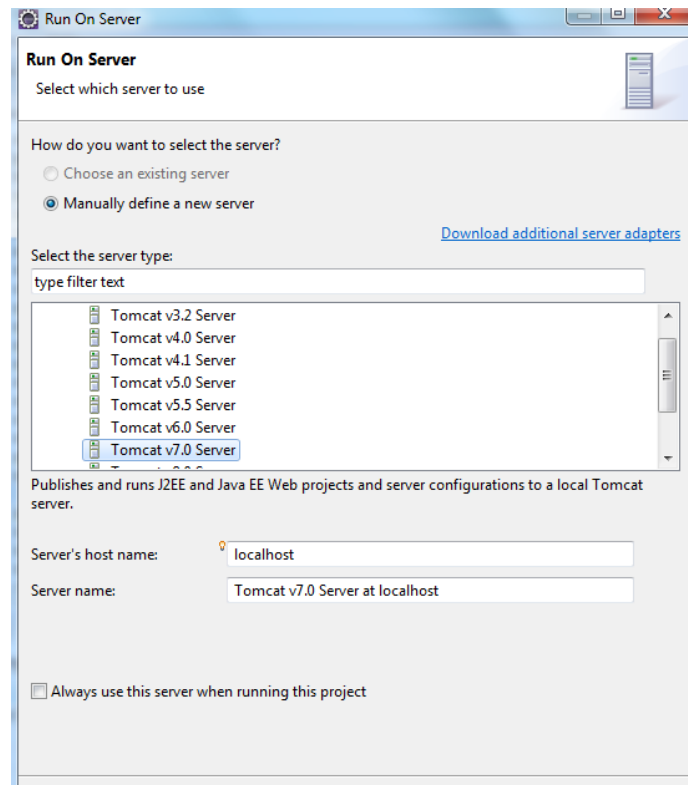


Figure A.18: Running Big Market in Eclipse step 2.

3. In the last screen, select the path where you installed Apache Tomcat and finally click on “Finish”.

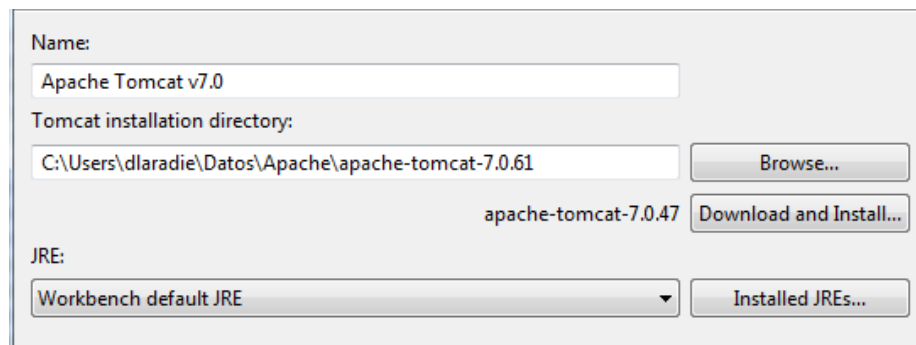


Figure A.19: Running Big Market in Eclipse step 3.

- *Deploying the WAR file in an Apache Tomcat server:* by this way, you can deploy the application in a Tomcat Server and run this server in order to make the application accessible from the Internet or simply to test it by yourself. To achieve this objective, follow the next steps:

1. In the previous subsection (Building the WAR), we built the WAR. Now, is time

to deploy it in our Apache Tomcat Server. To do this, go to the path where you saved the WAR, copy the WAR generated, and finally, paste it in the following path:

TOMCATHOME/webapps

2. Now, for running the server, open a shell (in Windows a cmd) and go to TOMCATHOME/bin. Once you are in this path, execute the next command:

```
startup.bat
```

If all has gone well, a new window will be opened (do not close this windows) and few seconds later you should see this line:

```
Server startup in X ms
```

3. Finally, in order to check that all is alright, open a browser and go to:

*<http://localhost:8080/BigMarket/>*⁷

Now, you know how to import the code in your own computer, how to import it in Eclipse in order to adapt the project to your own purposes and finally, you have learnt how to run the application in a server in order to test it and probe the changes that you will make to the code. In the next Appendix, we will teach you how to use the application on the scenarios exposed in the use cases from the Chapter 3.

⁷Change localhost to the IP address of the server machine if the client is in another host.

User manual

This user manual goes through the most important features for users. Like we mentioned in the last appendix, the code of the project is available at <https://github.com/gsi-upm/BigMarket>.

B.1 Run new random network simulation

In this section, we will explain you how to create a new random network simulation. This is the simplest way to use BigMarket. In order to create a new random network simulation, you have to follow the next steps.

1. First of all you have to have deployed the WAR in an Apache Tomcat Server and run the server like we explained in the Appendix A.
2. Once you have completed the step 1, open a browser and go to <http://localhost:8080/BigMarket>.
3. Now, you should see the index page of the application. In this screen, click on start in order to go to the set up screen.



Figure B.1: New random network simulation step 1.

4. Like the objective of this section is to teach you how to run a simulation for a random network, you have to select “New random network” in the Set up screen like you can see in the figure B.2. Then, you have to introduce the number of initial nodes of your network. Finally, choose a name for your simulation (this name is important because it will be the ID of your simulation when you have to store it in the database). Once you have configured your simulation, click on “Set up!”.

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About BigMarket Set up Simulation Running Actions Contact

Select an option:

☒ New random network

☐ Load network from DataBase

New random network

Number of initial nodes:

4

Simulation name:

MySim

Load network from DataBase

Dataset identifier:

New name for simulation:

Create network

Setup!

Figure B.2: New random network simulation step 2.

5. In the running screen, you can start the simulation and establish if it runs without stopping or just step by step. You have the following options:

- Run: with this option, the simulation will run until you press stop or pause button.
- Run one step: as its own name means, with this option, you will run the simulation one step.
- Pause: this button allows you to pause the simulation if it is running.
- Stop: this button ends the simulation and leads you to the next screen.

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About BigMarket Set up Simulation Ru

Time step 0

User type	Number of users	Number of tweets written
Broadcaster	0	null
Acquaintances	null	null
Odd users	0	null

Run one step Run Pause Stop

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Figure B.3: New random network simulation step 3.

Once you press stop button, BigMarket will start to store the data in the database (if you run BigMarket in your own computer, pay attention that Neo4J server is up like we explained you in the previous appendix).

6. The next screen is the Actions screen. This screen is divided in two parts:
 - SNA results: this part contains a table that represents the results from the analysis of the simulation of the network that you have been created in the previous steps.
 - Actions: this part have two buttons. The first of them, the “See network” button, allows you to see the network in a new window. The second button, “Download graph” button, let you to download the graph in order to analyse it with a SNA tool (like Gephi).

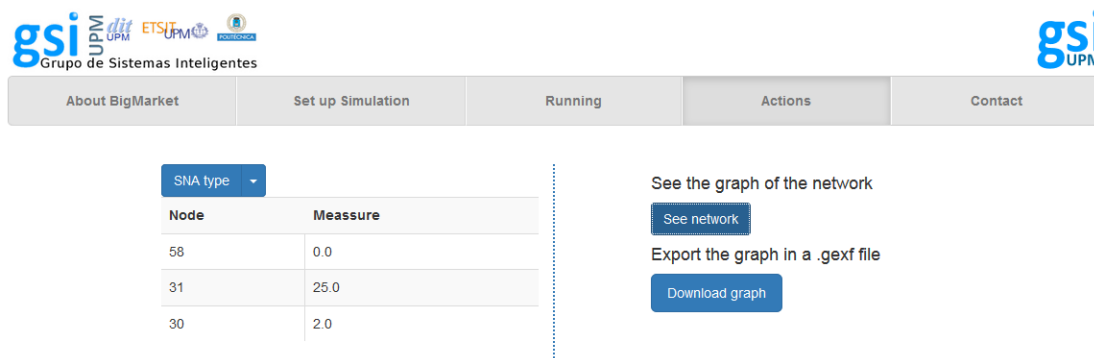


Figure B.4: New random network simulation step 4.

B.2 Load network

In this section, we will explain you how to load a network from a previous simulation. If you run BigMarket in your own computer, pay attention to have the Neo4J server up. Now, to load a network, follow the next steps:

1. In the index screen, press the “Start” button like in the step 1 of the previous section.
2. Now, in the “Set up” screen, you have to select the “Load network from DataBase”. Then write the identifier of the simulation that you want to load and finally establish a new name for the simulation in order to store it in the database. Once you have fill all the fields, press the “Setup!” button.

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About BigMarket Set up Simulation Running Actions Contact

Select an option:

☐ New random network

☒ Load network from DataBase

New random network

Number of initial nodes:

Simulation name:

Load network from DataBase

Dataset identifier:

New name for simulation:

Create network

Setup!

Figure B.5: Load network step 1.

In the following section, we will explain you the use of the “Create network” button.

3. The next screen is the “Running” screen, and its use is the same as we explained in the step 5 of the previous section.
4. The use of the last screen, “Actions” screen, is the same of the step 6 of the previous section.

B.3 Create a network

This section explain you how to create a network. The creation of a network is based on the Neo4J database that allows you create nodes and its relationships using the Neo4J commands. You can find the API in the Neo4J web page ¹.

To create a network, select “Load a network from database” on “Setup” screen and click on “Create network”. It will open you a new window with a visualization of Neo4J server

In this new window, you have to use the Cypher query language of Neo4J to create the network. You can find a complete tutorial in this link:

<http://neo4j.com/developer/cypher-query-language/>

¹<http://neo4j.com/developer/cypher/>

Bibliography

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- [2] E. Otte and R. Rousseau, “Social network analysis: a powerful strategy, also for the information sciences,” *Journal of Information Science*, vol. 28, no. 6, pp. 441–453, 2002.
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- [4] A. Hummel, H. Kern, S. Kühne, and A. Döhler, “An agent-based simulation of viral marketing effects in social networks,” *26th European Simulation and Modelling Conference - ESM’2012*, p. 212–219, 2012.

