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TRABAJO FIN DE GRADO

DESIGN AND IMPLEMENTATION OF AN AGENT-BASED SOCIAL SIMULATION OF BINGE DRINKING AMONG SPANISH YOUNGSTERS

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TRABAJO DE FIN DE GRADO

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Resumen

Uno de los entretenimientos favoritos de los jóvenes es pasar tiempo en bares, discotecas o socializar en lugares públicos con otros jóvenes. En esta actividad el alcohol juega un papel importante, lo que causa agresiones y otros daños más graves, especialmente en países como España, donde hay una gran cultura del alcohol.

Este problema no es nuevo en absoluto; se han propuesto políticas diferentes y variadas relacionadas con el alcohol, pero hay poca evidencia que respalde su efectividad antes de que sean implementadas.

En este trabajo, se diseña e implementa una simulación social basada en agentes de 15-30 años en diferentes entornos. Esto permite probar diferentes políticas y su efectividad en diferentes áreas de una ciudad, lo que podría mejorar la toma de decisiones de los ayuntamientos de las ciudades donde se use esta simulación. Los entornos se pueden cambiar seleccionando el número y los tipos de establecimientos deseados dependiendo del área que el usuario quiera simular. En esta tesis, la efectividad y la viabilidad de seis políticas diferentes se han probado y analizado en diferentes entornos.

Este modelo incluye parámetros biológicos, de comportamiento y sociodemográficos. Se han analizado diferentes parámetros para probar su contribución a los daños experimentados por los jóvenes en una noche, lo que permite diseñar nuevas políticas y tener un mejor conocimiento de qué entornos son más propensos a causar problemas. Esto ha sido posible gracias a un análisis de sensibilidad local y global.

En resumen, este modelo puede ayudar a mejorar las políticas existentes y diseñar nuevas, lo que podría llevar a una mejora de la calidad de vida de los jóvenes y la toma de decisiones sociopolíticas.

Palabras clave: simulación social basada en agentes, Soil, análisis de sensibilidad, alcohol, salud pública, python.

Abstract

One of the favourite pastimes of young adults is spending time in bars, discos or in public socializing with others. In this activity alcohol plays an important part, which causes aggressions and other major harms, specially in countries like Spain where there is a big drinking culture. This problem is not new at all; different and varied alcohol related policies have been proposed, but there is little evidence to support their effectiveness before being implemented.

In this thesis, an agent-based social simulation of 15-30 year olds in different environments is designed and implemented. This allows to test different policies and their effectiveness in different areas of a city, which could improve decision-making from the council of the cities where this simulation is tested. Environments can be changed selecting the number and types of venues desired depending on the area the user wants to simulate. In this project, the effectiveness and the viability of six different policies has been tested and analysed in different environments.

This model includes biological, behavioural and socio-demographic parameters. Different parameters have been analysed to test their contribution to the harms experienced by youngsters in a night out which allows designing new policies and have a better knowledge in which environments harms are more likely to happen. Local and global sensitivity analysis has made this possible

To sum up, this model can help to improve existing policies and help to design new ones, which could lead to an improvement of youngsters quality of life and sociopolitical decision-making.

Keywords: agent-based social simulation, Soil, sensitivity analysis, alcohol, public health, python.

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Me gustaría en este apartado agradecer a las personas cercanas que me han ayudado y apoyado en la realización de este trabajo y al grupo de sistemas inteligentes por darme esta oportunidad, en especial a J. Fernando Sánchez-Rada y a Carlos Ángel Iglesias por haberme ayudado y orientado durante el proceso.

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CHAPTER 1

Introduction

1.1 Context

One of the most important things for the young people is their spare time, ahead of education, money, sexuality and other important topics, as we can see in recent studies [2].

Youngsters spent much of their spare time in nightlife environments drinking in bars, discos or in public [3]. This particular scenario is especially interesting because aggressions and other major harms related to alcohol consumption are more likely to happen, taking into account Spanish drinking culture.

Weekends and nightlife are, for the youngsters, a way of breaking with the daily routine, avoid external control, escape from responsibilities and get rid of inhibitions which explains why young adults spend much of their spare time doing this activity [3] [4].

In the past few years, it has been common to do research on the habits youngsters have, giving answers on how much money they have available to spend in their spare time in a month, how many times they hang out in a month, how many times they get drunk... We can find a lot of this data from different sources, such as INJUVE, Centro Reina Sofía and others, but research related on how they act and why in a single night is not that easy to find. This data would be especially interesting for our purpose. There is a need to know what decisions young adults take in a night out, and what are these decisions based on: What kind of venues do they visit and why? What do they drink and why? How are groups formed? When do they decide to go home and why? Do they drink more in some specific dates? It is also important to comprehend the different decisions based on their age, gender, place where they hang out, and other variables.

Thus, new ways of analysing youngster's behavior in a nightlife environment are needed, to comprehend how and why they act in such ways and to be able to minimize the harms they experience in these situations.

Taking all of this in consideration, we can model a night out as a social network where vertices represent young people and links represent the friendship between members, being the venues the environment of the simulation where agents spend their night. Group of friends share information during the night, which makes possible decision-making on what venue should be next, if it's time to go home, or if a altercation is taking place. Using an Agent-based Social Simulation (ABSS) we can track the interactions and information flowing between agents and their effect to the environment.

1.2 Project goals

This thesis describes an agent-based model of 15-30 year olds in a nightlife environment in order to find new ways of analysing youngsters' behaviour in this particular environment, comprehend how and why they act in such ways and to be able to minimize the harms they experience in these situations. Other important purpose is having a way to test night-life environment related policies and their effectiveness in different zones with different characteristics.

The main goals are:

- Investigation of Network Simulators and agent-based simulations
- Simulate youngsters behaviour and how it changes the environment during a night
- Simulate different alcohol related policies
- Being able to do simulations in different areas
- Extract valuable data from the results

1.3 Structure of this document

In this section we provide a brief overview of the chapters included in this document. The structure is as follows:

Chapter 1 presents an introduction of the project. Main goals are explained as well as the motivations for doing this thesis.

Chapter 2 describes the state of art. In this chapter the most recent data related to alcohol habits among Spanish youngsters is explained, as well as previous simulations already done related to this topic and the analysis of technologies that are used in this project.

Chapter 3 provides a description of the model: parameters, agents' behaviour and how the simulation is set.

Chapter 4 explains the results obtained in this project as well as the validation of the model.

Chapter 5 discusses the conclusions and future work.

CHAPTER 2

State of art

In this section the state of art is presented. Firstly, in section 2.1, the most recent data related to Spanish youngsters and their habits related to alcohol is shown. Section 2.2 includes an explanation of Soil, a platform designed in Python to do agent-based simulations. Lastly, in section 2.3, simulations already used to study public health topics and alcohol in particular are explained.

2.1 Effects and Dynamics of Alcohol on young people

Youngster's behaviour and the way they relate with others in a nightlife environment differs from their behaviour in other times and spaces of their life. Their habits in this context are an important topic due to the risks (alcohol intoxication, fights...) that they are exposed to [2]. In this section, we provide an overview of the insights provided by different studies [2–13] regarding the relationships of youngsters and alcohol on weekends. In particular, we have reviewed the following aspects: youngsters' expectations (Section 2.1.1), schedule they have at night (Section 2.1.2), zones and paths they follow (Section 2.1.3), money available for hanging out (Section 2.1.4), youngsters' alcohol habits (Section 2.1.5), most usual harms experienced (Section 2.1.6) and lastly, some policies applied to solve this harms (Section

2.1.7).

2.1.1 Youngters' expectations

Analysing data in [4] we can see the meaning that young adults give to this activity, as show in Table 2.1.

As we can see, half of the interviewees hang out to do something different and get out of the daily routine and almost 75% think that going out at night is different that going out during the day.

Taking this data into account together with a recent study of FAD (FAD, Fundación de Ayuda contra la Drogadicción, Drug Addiction Aid Fund) [3], weekends and nights mean doing extraordinary activities and a rupture with their weekly routine. Therefore, it means more than a way of dividing the time during the week; it means new experiences and ways of relating.

Meaning	Percentage
Sense of freedom	9.3%
Sense of doing something different	50.8%
Night adds charm to what I do	9.2%
Night is the time to young people	25.1%
Hang out at night or day is the same thing	21.8%
At night I get rid of inhibitions	17.1%

Table 2.1: What does hanging out at night means to you?

2.1.2 Schedule

In Tables 2.2 and 2.3 we have the times youngsters go out and go home, depending on their age and gender [2]. Research on the times youngsters go out is limited, but we can deduce the hours based on the Table 2.2 elaborated from data in [7].

We can conclude that 15-19 year old women are the ones that go home sooner and 20-24 year old men are the ones that go home later. Men hang out for longer periods of time as we can see comparing both tables.

	Gender		Age		
	Male	**Female**	**15-19**	**20-24**	**25-30**
At 10 pm or before	28.07%	18.1%	39.63%	15.19%	20.41%
At 11pm	30.7%	37.93%	26.42%	26.58%	44.9%
At 12pm	35.96%	32.76%	26.42%	49.37%	26.53%
At 1am or later	5.26%	11.21%	7.55%	8.86%	8.16%

Table 2.2: Going out schedule

	Gender		Age		
	Male	**Female**	**15-19**	**20-24**	**25-30**
Before 12pm	10.1%	10.9%	16.3%	7.8%	8.2%
Between 12pm and 1am	7.3%	11.6%	13.6%	7.4%	8.1%
Between 1am and 2am	9.8%	10.9%	10.8%	10.1%	10.3%
Between 2am and 3am	15.0%	17.0%	13.6%	15.6%	18.5%
Between 3am and 4am	14.8%	15.5%	12.7%	17.2%	15.3%
Between 4am and 5am	14.0%	9.4%	10.1%	12.8%	12.0%
Between 5am and 6am	9.7%	9.5%	9.2%	10.2%	9.5%
After 6am	10.5%	7.1%	6.9%	10.4%	8.9%
I don't go home until next morning	5.1%	2.8%	3.3%	5.1%	3.4%
N.A	3.6%	5.2%	3.6%	3.5%	5.9%

Table 2.3: At what time do you go home?

2.1.3 Zones and paths

Youngsters choose the places where they are going to hang out depending on different factors: type of music, price, venue's schedule and capacity [5]. Considering this factors and the data from [2], we can see in the Table 2.4 what venues young adults attend depending on their age and gender.

	Gender		**Age**		
	Male	**Female**	**15-19**	**20-24**	**25-30**
Bars	63.3%	61.9%	53.1%	66.8%	66.7%
Discos	37.4%	39.7%	41.7%	44.2%	30.4%
Street/public	22.7%	14.8%	28.8%	20.2%	8.8%

Table 2.4: Activities practised on weekends at night

In this table we can see that gender is not that relevant. However, age makes a difference: bars are more visited by 20-30 year olds and discos are more visited by 15-24 year olds. Street/public drinking is not very popular among 24-30 year olds, and more popular among teenagers; the main reason behind this is the difference in price and the money that both groups have available. It is also important to consider what paths they follow. In [6], Pallarés and Freixa, identify four paths:

- People who hardly ever or never go to discos. Their path consists on going from bar to bar. It is dominated by 24-30 year olds.
- People who frequently go to discos. It is dominated by 16-24 year olds.
- People who combine paths 1 and 2. They might follow one path on Friday and another on Saturday.
- The ones that don't visit neither bars nor discos.

It is common also among younger adults to do public drinking in the first hours on the night and then go to a bar or a disco. Between 2am and 6am discos are more visited.

With regard to the times that youngsters change venue, 72% of them visit between four and eight venues during a night, and 13% more than eight. The average of visited venues is 5.8.

2.1.4 Money

Logically, 25-30 year olds have more than double the money that younger adults have. This affects on the venues and the paths they follow; 15-19 year olds drink in public due to the low price of the alcohol when bought in a shop [2].

	Gender		Age		
	Male	**Female**	**15-19**	**20-24**	**25-30**
Average	90.25€	73.59€	58.62€	77.30€	106.59€

Table 2.5: Money available per month to hang out

2.1.5 Alcohol habits

Alcohol is present in the nightlife environment among youngsters, even though it's forbidden its vending to minors. In the research done in [8] and [9], we can see that 67% of the 15-24 year old and 75% of the 25-34 year old interviewees had consumed alcohol in the last twelve months. We also observe that more men had consumed alcohol compared to the women.

We should also consider how often do youngsters do binge drinking.

	Age	
	15-24	**25-34**
Daily	0.2%	0.2%
1 to 4 times per week	5.6%	5.6%
1 to 3 times per month	16.5%	16.3%
Less that once per month	27.9%	26%
Never	49.9%	51.8%

Table 2.6: How often do you do binge drinking?

Binge drinking data in both age groups is very similar, but it changes if we compare data based on gender, we observe that men perform episodes of heavy drinking more often

(Table 2.7).

		Age	
		15-24	**25-34**
Gender	**Male**	18.2%	23%
	Female	9.8%	9.7%

Table 2.7: Proportion of interviewees that do binge drinking once or more times a month

In [7], data shows us that 15-24 year olds get drunk more often than 24-30 year olds.

2.1.6 Risks and harms

In the research done in [3], a list of the most common risks youngsters are exposed to when hanging out is done: have a sexual intercourse without using a condom with someone that is not your partner, drive when drunk, drive when drugs have been taken, travel in a car driven by a drunk or drugged person, be involved in fights, provoke a fight and getting drunk.

In this article, youngsters are divided into four groups depending on their attitude towards risks which allow us to see what types take some risks more often than others:

- Type 1: Adaptive. Same proportion of men and women. Some of them are 15-20, but the majority are 20-24 year olds.
- Type 2: Quasi-experimenters. Higher proportion of men and 15-24 year olds.
- Type 3: Prudent. A higher proportion of women. Higher proportion of 15-19 year olds.
- Type 4: Confused. Same proportion of men and women. More of 50% are 20-24 year olds.

Taking data in [3] into account, we can conclude that type 2 youngsters are involved in fights more often, caused by a high proportion of men. With regard to the risks related with alcohol consumption (intoxication), we can see that type 2 is the one that get drunk more often followed by type 1. Having a sexual intercourse without using a condom with someone that is not your partner is more common among type 4, and risks related to drive or travel in a car with a drugged or drunk driver is practised more often by groups 1 and 2.

2.1.7 Policies

In [11] a research on different policies applied in the past to solve the problems caused by nightlife environments is done, being these the most important ones:

- Don't allow to sale alcohol to minors. This action doesn't have much effectiveness, since a big part of youngsters claim to have bought alcohol being an underage (57.7% in bars, 47.1% in discos and 61.8% in supermarkets).
- Give venue's workers educational courses. This is a popular action, but its implementation is low in Spain.
- Venue's maintenance and safe environments: it consists of maintaining a proper level of cleanness and lighting, proper conditions to access the venue, avoid long queues in the counter and toilets... "Safer bars", "Bar Veiling" and "Best Bar None" are good examples.
- Alcohol sale regulation: low prices and special offers are related with a higher consumption on alcohol, so minimum prices for alcohol are established. It consists also in schedule regulation for alcohol sale. Price related policies are significant since young adult drinkers are particularly price-sensitive.
- Individuals are allowed to remain in venues but no longer enter after a particular time [14].
- Forbid public drinking in a effective way [15].
- Limit venues' schedule, making the closing time sooner [16].

2.2 Technologies

Agent-based Social Simulation (ABSS) is one of the most common techniques used for analysing and simulating social networks in order to understand basic aspects of social phenomena, predict events and work with long-term processes.

Numerous ABSS platforms with different characteristics have been developed in the last few years. In [1], researchers review fourteen platforms to evaluate their suitability for

Name	Domain	Language	SNs	SNA	OS
Cormas	Generic	Visual Works	Yes	No	Yes
NetLogo	Generic	NetLogo, Scale & Java	Yes	No	Yes
Swarm	Generic	Objective-C, Java	Yes	No	Yes
MadKit	Generic	Java	Yes	No	Yes
MASON	Generic	Java	Yes	No	Yes
Repast	Generic	Java	Yes	Yes	Yes
SeSam	Generic	Java	No	No	Yes
MASeRaTi	Generic	Java	No	No	Yes
Mesa	Generic	Python	No	No	Yes
UbikSim	AmI	Java	No	No	Yes
EscapeSim	Evacuation	Java	No	No	Yes
HashKat	Social networks	C ++	Yes	Yes	Yes
Krowdix	Social networks	Java	Yes	Yes	No
Soil	Social networks	Python	Yes	Yes	Yes

Table 2.8: Review of ABSS platforms from [1]

modelling social networks, taking into account the following aspects: (1) type of platform (whether the platform has been developed for general purpose or for a specific domain), (2) programming language, (3) expertise in its application to Social Networks (SNs), (4) whether the framework provides Social Network Analysis (SNA) facilities and (5) whether the license is Open Source (OS). The results can be observed in Table 2.8.

After an analysis, Soil platform has been chosen due to its characteristics and advantages. In Section 2.2.1, the platform Soil and the reason of its election is explained with further details.

2.2.1 Soil

Soil is a platform design by GSI-UPM [1] to do ABSS which uses Python, due to its popularity, readability, clear syntax and availability of libraries for network processing. Moreover, this platform provides interactive analysis thanks to IPython so the user can get real time results of the model such as graphs, parameters, etc.

Soil also uses NetworkX, which is a Python package for the creation and manipulation of complex networks that provides graph models and graph generators as well as graph algorithms for analysing graph properties. NetworkX is the standard library to analyse social networks of a small or medium size and can operate with different graph formats such as GML, GraphML JSON and GEXF.

Gephi is used for network visualization. This software is open source and the leading network and graph interactive analysis software for all types of graphs.

2.2.1.1 Soil elements

The four main elements of Soil simulations are:

- **Configuration**: the YAML file configuration includes things such as number of agents to use, type of agents that will be used, proportion of each agent type, network topology to use (generate one or use a NetworkX topology) as well as other parameters related to the simulation.
- **Agents**: they are characterised by their state. Every step of the simulation agents will behave according to their state, the state of other agents and the environment.

  We can find two type of agents: 1) network agents, linked to a node in the topology, and 2) environment agents, which are freely assigned to the environment.
- **Environment**: It assigns agents to nodes in the network, and stores the environment parameters (shared state for all agents).

Relations between this elements are represented in Figure 2.1, taken from Soil Documentation [1].

2.2.1.2 Simulation workflow

As shown in Figure 2.2, in the first step the main parameters such as number of nodes, number of trials, maximum steps of the simulation, network graph type and others are

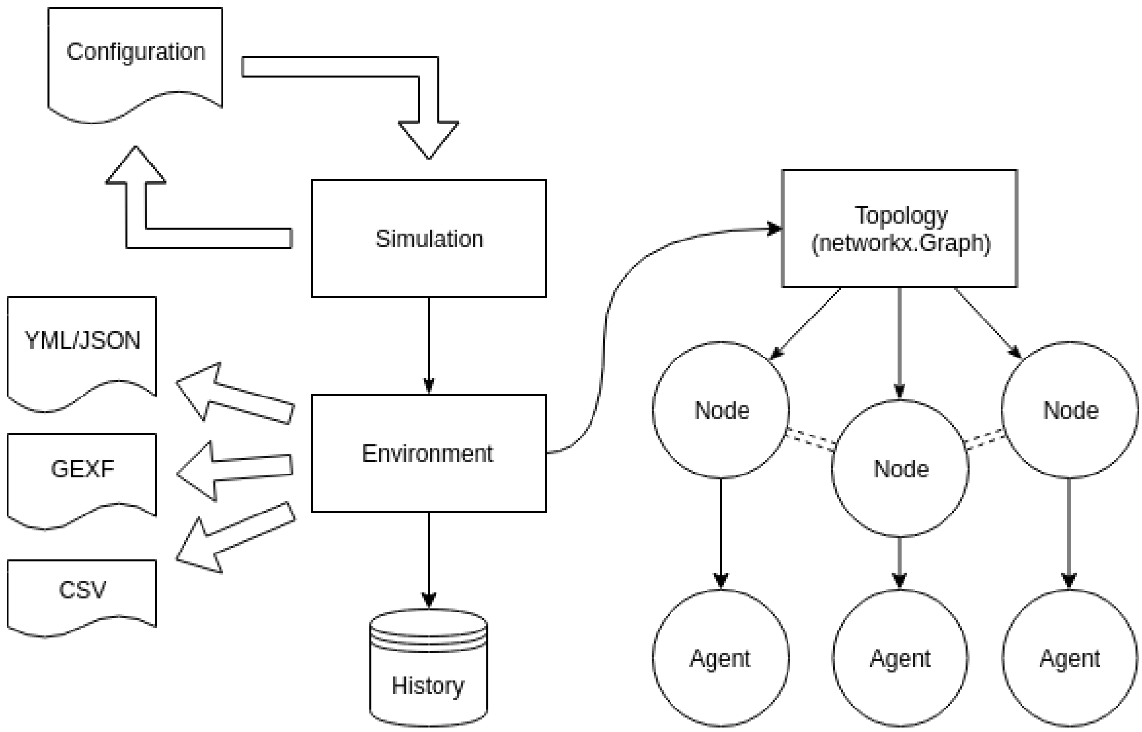

Figure 2.1: Soil elements

fixed in the configuration file. It is also available to add more than one type of agent, and controlling the proportion of each type using the weight property. The weight property also allows to manipulate the proportion of agents with certain characteristics in your model (e.g it is possible to set that your model has 40% of agents with the characteristic “male”, so 40% of your agents are male).

Once the configuration file is finished, simulation can be done step by step or a number of steps. The status and parameters of every agent in every step is stored to future analysis after the simulation is finished. Four types of files are saved once the simulation finishes gathering all the information related to parameters and graphs: a pickle of the simulation; a YAML file that represents the simulation, a CSV file and the network topology in GEXF format which can be open with Gephi.

Finally, the user can use all this information to analyse the results of the simulation.

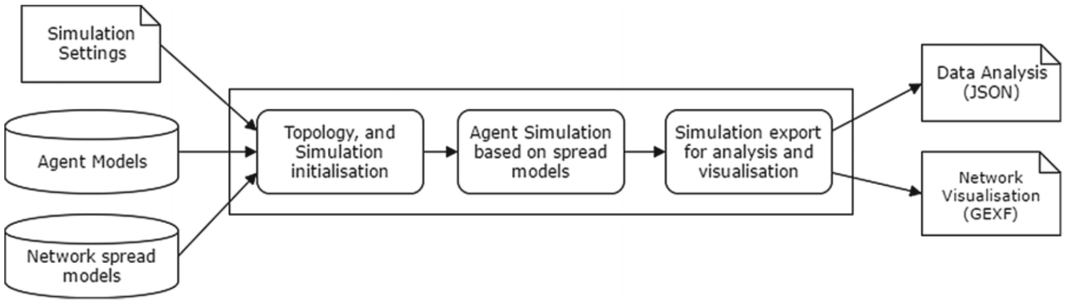

Figure 2.2: Simulation workflow

2.3 ABSS application to this problem

Agent-based simulations have been already used to study public health topics such as infectious disease transmission and drugs and alcohol use.

With regards to alcohol use, in [12] a same level of alcohol consumption among teenage friends is studied, as well as a possible cause: the influence of friends and the selection of friends who consume similar levels of alcohol. In [13], a social simulation is used to analyse the rapid growth of binge drinking in the United Kingdom, which leads to anti-social and criminal behaviour. In a similar manner to [12], it is shown that binge drinking is a fashion-related phenomenon. In [17] a model is used to demonstrate that the basic dynamics that explain drinking behaviour are highly influenced by relations between drinkers and the features of environments where they drink. These models are not used only to simulate youngsters' behaviour but also adult population and binge drinking in other parts of the population, as we can see in [18].

In the context of policies related to alcohol consumption, the Organisation for Economic Co-operation and Development did a simulation in 2015, where policies related to prices, regulation and enforcement, education programmes and health care interventions were tested. Policies related to prices (tax increases) and fast interventions in primary care resulted in big health gains. Regulation and enforcement policies impact depended on the setting. The least promising were school-based programme policies [19].

However, the researches just mentioned are not focused in a single night but on longer term behavioural changes among individuals; We can find several researches that attempt to understand youngsters' decisions on a single night, and its consequences as well as policies related to the environment where all this alcohol activity occur and how these might affect outcomes.

In 2015, an agent-based NetLogo Model of 18-25 year old heavy alcohol drinkers on a night out in Melbourne was done [14]. The model consists of groups of friends moving between different kind of venues (private, public-commercial and public-niche). Depending on the alcohol they have taken during the night they can experience consumption-related harms such as verbal violence, or have difficulty getting home. Agents' behaviour depend not only on their own alcohol consumption but also in their friends' alcohol consumption and harms experienced. At the end of the night, agents have the option to go home using their own car, by train (if train is already available), walking... This model permits to test and quantify the effects of policies related to a change in transport schedule, changes in the regulation of alcohol, public venue closing times and drink prices. Model's environment is based on Melbourne's characteristics, and it can be used in other locations changing parameters. In [20] we see a similar model, but it takes into account biological parameters such as the status of neurotransmitters (Serotonin, GABA, Glutamate and Dopamine) of each agent. It also consider police stations, hospitals and even rehab centres in the environment of the simulation.

But, in [14] the true structure of the street networks is not considered; on the other hand the model in [21] relies on exact locations using OpenStreetMap, which is open-data collaborative project to create a free editable map of the entire planet. In the paper, without considering groups of friends, the authors attempt to identify areas at risk of alcohol related harms. They base their approach in the assumption that the more people are in an area the higher levels of alcohol related violence are. In this model, an agent starts initially at home and moves from one venue to the next as long as is open. In each venue, the agent spends an amount of time drinking until this time passes. Every time an agent drinks, its blood alcohol content rise. When moving from one place to another, agents chose the shortest path and have a walking pace of 1.4 meters per second.

CHAPTER 3

Pubcrawl model description

In this chapter, the agent-based simulation of youngsters in a nightlife environment is introduced.

Every element of the simulation is represented in Figure 3.1. As we can see, we can find three elements:

- The environment, consisting of a group of venues, where the simulation happens and that encompasses everything. The environment is described in Section 3.1 and its parameters could be set to simulate specific areas of a city.
- Youngster. This is the first type of agent and represents the behaviour of a 15-30 year old youngster in a night out, explained in Section 3.2.1
- Bouncer. This is the second type of agent and represents the behaviour of a bouncer. This agent visits every venue in every step and have different behaviours depending on the simulation as a way of testing different policies. and is described in Section 3.2.2.

For both types of agents their behaviour and their parameters will be explained. In Section 3.3, parameters used to set the simulation and the steps followed by the simulation are presented.

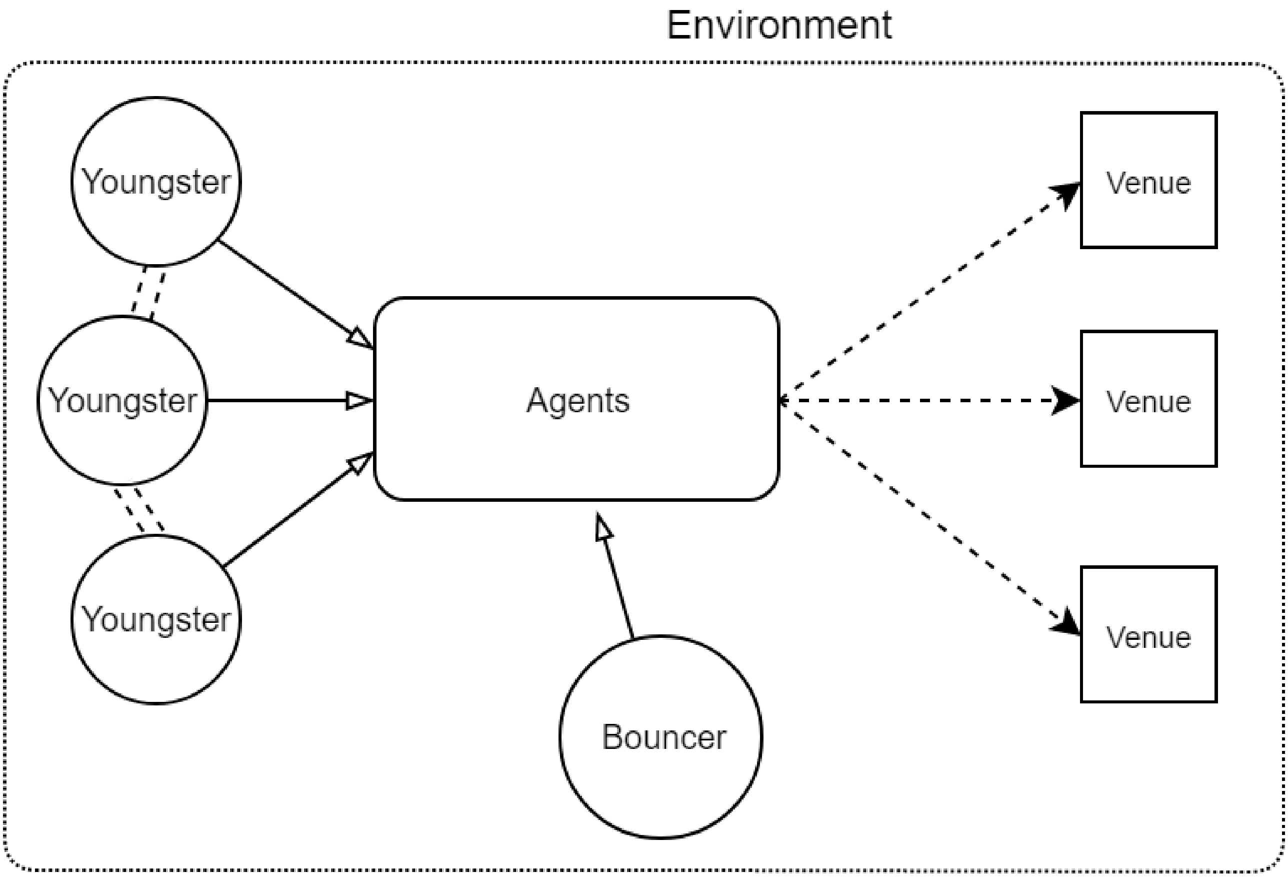

Figure 3.1: Global diagram

3.1 Model environment and venue properties

The model environment consists of a group of different venues with different characteristics. The venues can be a bar, a disco or a street, as this are the most visited venues by youngsters [2]. The proportion of each venue type in this area depends on the zone we want to model (i.e in Malasaña district in Madrid we would find a higher proportion of bars and less streets and discos). Number of bars, discos and streets are fixed in the YAML file, and an environment with those characteristics is set.

Venues have different parameters as it can be seen in Table 3.1. Bars would typically have a lower capacity than discos and streets. Streets represent zones where people do street drinking, and don't have a capacity limit. With regards to the entry price, discos usually charge around 15-20€ and bars do not usually charge anything for admission. The parameter "price" refers to the price of a two standard unit of alcohol: a single shot is one unit, while a pint of beer or a cocktail is equivalent to two units of alcohol. Finally, "open" depends on the schedule a venue has; when the closing time arrives, everyone inside goes to another venue. As well as "open" parameter, "occupancy" is also a tracking parameter that keeps an account of people inside the venue and never exceeds venue's capacity.

Parameter	**Value**	**Description**
capacity	Disco: Normal(1300,300) Pub: Normal(100,20) Street: (Infinite)	Maximum people that can fit inside a venue
price	Disco: Between 7 and 12 Pub: Between 5 and 8 Street: Between 2 and 5	Price of a drink
type	Disco, pub or street	Venues can be a bar, disco or a street
entry	Disco: Between 15 and 20 Pub: 0 Street: 0	Entry price
opening_time	Disco: Step 10 (12pm) Pub: Step 2 (10 pm) Street: Step 2 (10 pm)	Venue's opening time
closing_time	Disco: Step 32-36 (5:30-6:30 am) Pub: Step 20-24 (2:30-3:30 am) Street: Open all the time	Venue's closing time
open	Initial value: False	It tracks if the venue is closed or open
occupancy	Depends on the model's step	Keeps an account of people inside the venue

Table 3.1: Venues' parameters

3.2 Agents

In this model two type of agents can be found: Youngsters and Bouncer. The first one represent youngsters behaviour and Bouncer is an agent that visits all the venues in every step and make different actions (kick out intoxicated agents, kick out minors...). In the following sections their parameters and behaviour are explained with further details, starting with Youngster agent in Section 3.2.1 and lastly Bouncer agent in Section 3.2.2.

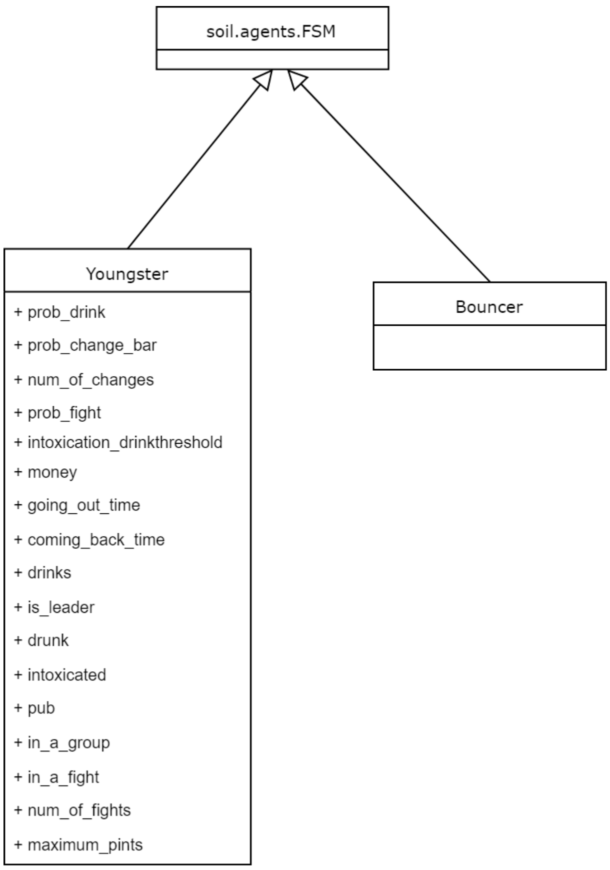

Figure 3.2: Agents' class diagram

In the class diagram represented in Figure 3.2 the two types of agents are represented. In the Figure, we can observe the parameters that are explained later in this document in Section 3.2.1.2. As is explained in 3.2.2, Bouncer agent do not have parameters, but ask venues for their parameters and act accordingly to the received information. Both Bouncer and Youngster inherit from soil.agents.FSM class which is provided by Soil and responsible for controlling the transitions between the different states.

3.2.1 Youngster

3.2.1.1 Behaviour

In the first steps of the model, Youngsters form their group looking for people who are the same age. The groups are formed by 5 people or less 10% of the time, six to ten people 31.1% of the time and more than ten in 58.9% of cases as we can see in [22]. Each agent forms fixed links to every member in the group and only one leader is elected in every group.

After groups are formed, once their going out time arrives, they look for a venue to start the night in. After a venue is chosen, the simulation creates a link between the leader of the group and the venue.

Starting time and place, as well as the path followed during the night depends on the group members' age, as shown in Table 2.4. For example, a group formed by 25-30 year olds, have a chance of 63% of starting their night in a bar, an as a consequence, following path one described in 2.1.3.

Once they are in a venue, in every step Youngsters are offered the chance of having a drink, changing venue, having a fight or going home. The reasons that can end a Youngster's night are: 1) Half of friends in the group have already gone home [14]. 2) It is its time to go home (coming_back_time is less than or equal to the current step). 3) With a probability of 70% if a friend has had a fight or is intoxicated [14]. 4) They can't keep following the paths explained in Section 2.1.3. This could happen when venues close, and Youngsters don't have a place to go.

Also, in every step, the model checks if a Youngster is drunk or intoxicated; if so, its state changes.

Youngsters' behaviour can be found in Figure 3.3 where the five states are represented: looking_for_friends, looking_for_pub, sober_in_pub, drunk_in_pub and finally at_home.

3.2.1.2 Properties

From now on, it must be taken into consideration that Youngster agents are divided into three age groups due to the similarities of behaviour within those groups as shown in [2].

The first parameter set in this model is group_size, which is the size of the group of a certain Youngster. This is fixed based on [22].

With regards to the probability of having a drink in a step of the model (15 minutes),

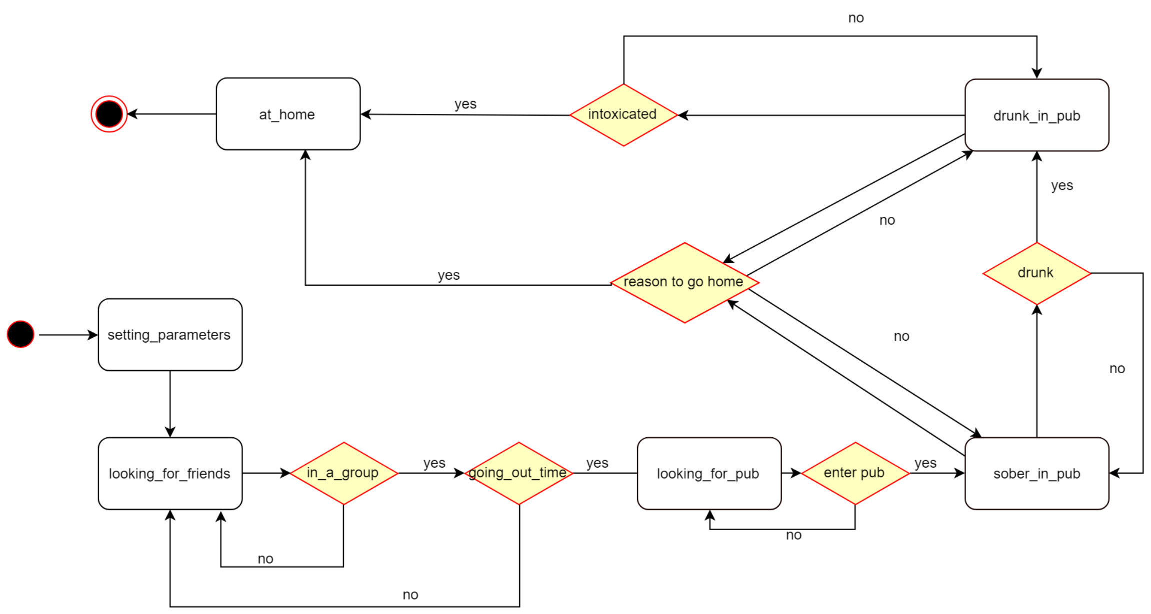

Figure 3.3: Youngsters' behaviour

we have the following values depending on age and gender:

15-24 year old males:

$$prob\_drink = \begin{cases} 0,6 & going\_out\_time \leq step < going\_out\_time + 4 \\ 0,6 & going\_out\_time + 4 \leq step < going\_out\_time + 8 \\ 0,5 & step \geq going\_out\_time + 8 \end{cases}$$

25-30 year old males:

$$prob\_drink = \begin{cases} 0,5 & going\_out\_time \leq step < going\_out\_time + 4 \\ 0,5 & going\_out\_time + 4 \leq step < going\_out\_time + 8 \\ 0,4 & step \geq going\_out\_time + 8 \end{cases}$$

15-30 year old females:

$$prob\_drink = \begin{cases} 0,3 & going\_out\_time \leq step < going\_out\_time + 4 \\ \\ 0,25 & going\_out\_time + 4 \leq step < going\_out\_time + 8 \\ \\ 0,2 & step \geq going\_out\_time + 8 \end{cases}$$

The probability of having a drink is higher in the two first hours of the night (eight first steps). 15-24 year old males have a higher probability of drinking in each step and females drink less frequently during the night, as a result of research done in [7], [8] and [9].

On the other hand, the probability of having a fight depends on the level of alcohol, gender and age rather than the hour of the night. Considering this, we present the values hereafter:

15-24 year old males:

$$prob\_fight = \begin{cases} 0,003 \times pints & pints < max\_pints \\ \\ 0,004 \times pints & pints \geq max\_pints \end{cases}$$

25-30 year old males:

$$prob\_fight = \begin{cases} 0,002 \times pints & pints < max\_pints \\ \\ 0,003 \times pints & pints \geq max\_pints \end{cases}$$

15-30 year old females:

$$prob\_fight = \begin{cases} 0,001 \times pints & pints < max\_pints \\ \\ 0,002 \times pints & pints \geq max\_pints \end{cases}$$

The probability of changing venue depends on the time of the night and the venue a Youngster is at a certain moment of the night; taking into account paths in section 2.1.3, we can define the value of prob_change_bar: if a group of Youngsters are at a street or a pub, prob_change_bar = 0,2. If a group of Youngsters is at a disco, they won't change venue.

In the next Table the rest of Youngsters' parameters are explained. In order facilitate comprehension and clarity of this table, the next equivalences should be mentioned: (1) match with the group of 15-19 year old males, (2) with 15-19 year old females, (3) with 20-24 year old males, (4) with 20-24 year old females, (5) with 25-30 year old males and (6) with 25-30 year old females.

Parameter	**Value**	**Description**	**Source**
max_pints	(1) Normal(4,1) (2) Normal(3,0.5) (3) Normal(6,1) (4) Normal(4,1) (5) Normal(6,1) (6) Normal(4,1)	Maximum drinks that a Youngster can have before getting drunk	Based on [8] and [9]
intoxication_drinkthreshold	(1) 2 * max_pints (2) 2 * max_pints (3) 2 * max_pints (4) 2 * max_pints (5) 2 * max_pints (6) 2 * max_pints	Maximum drinks that an Youngster can have before getting intoxicated	Based on [8] and [9]

money	(1) Normal(25,5) (2) Normal(25,3) (3) Normal(40,7) (4) Normal(35,7) (5) Normal(65,15) (6) Normal(60,10)	Money that Youngsters start with	Based on [2] and [23]
going_out_time	According to Table 2.2	Step of the model when a Youngster goes out	Based on [2] and [7]
coming_back_time	According to Table 2.3	Step of the model when a Youngster comes back	Based on [2] and [7]

Table 3.2: Remaining Youngsters' parameters

Other parameters are used to track the state of the Youngsters in a certain time of the model. These parameters are presented in the next Table and are used to verify if a Youngster has already a group of friends or not, if its drunk, if the Youngster is a leader, etc.

Parameter	**Bounds**	**Description**	**Initial Value**
drinks	1-N	Number of drinks that a Youngster has had	0
is_leader	True or False	True if Youngster is the leader of the group	False
drunk	True or False	True if Youngster is drunk	False
intoxicated	True or False	True if Youngster is intoxicated	False
pub	Name of pub	Pub where a Youngster is	None

in_a_group	True or False	True if Youngster has a group of friends	False
in_a_fight	True or False	True if Youngster is fighting	False
num_of_fights	1-N	Number of fights that a Youngster has had	0
num_of_changes	1-N	Number of changes that a Youngster has done	0

Table 3.3: Youngsters' tracking parameter

3.2.2 Bouncer

3.2.2.1 Behaviour

As explained before, Bouncer visits every venue asking for their parameters to make decisions. Bouncer kicks out intoxicated Youngsters and Youngsters who have had a fight if they are in a pub or a disco. The Bouncer also checks if the venue is full; if so, it does not let more people in. When a Bouncer visits a street, it does the same except it don't kick out Youngsters who have had a fight.

Bouncer also close and open venues when its their time.

Other behaviours related to different policies are implemented in this agent in order to analyse if harms decrease when implementing the following policies:

- Don't sell alcohol to minors so any Youngster who is under age can't drink alcohol.
- Alcohol sale regulation: minimum prices for alcohol are established.
- Schedule regulation for alcohol sale. Bars and discos can't sell alcohol after a certain time.
- Forbid public drinking in a effective way so any Youngster won't be able to do public drinking.
- Individuals are allowed to remain in venues but no longer enter after a particular time.

- Limit venues' schedule, making the closing time sooner.

Bouncer agent only have one state, in which checks everything explained in this section.

3.2.2.2 Properties

Bouncer agent do not have properties. This agent, when visiting a venue, asks for its parameters and depending on the values, act in one way on another. For example, if Bouncer visits a venue in the step 12 and "opening_time" has a value of 12, Bouncer opens the bar and changes "open" parameter from False to True. Properties asked by the Bouncer have been already explained previously in Section 3.1.

3.3 Setting up a simulation

In the following Table parameters used to set up the simulation are summarized; this parameters are set in the YAML file.

Parameter	Value	Description
Number of nodes	1500	Number of nodes in our model
Network type	Empty graph	Topology that the model uses
Max time	37	Maximum steps in the simulation
Num trials	1	Number of simulation trials
Agent distribution	15% of 15-19 year old men 15% of 15-19 year old women 20% of 20-24 year old men 20% of 20-24 year old women 15% of 25-30 year old men 15% of 25-30 year old women	Distribution of Youngsters based on age and gender

Table 3.4: Simulation parameters

The model is initialized according to the steps below:

1) Generating venues based on the distribution fixed with number_of_discos, number_of_pubs and number_of_streets parameters.

2) Setting venues' properties based on the parameters described in Table 3.1.

3) Generating as many Youngsters as nodes have been set in the first parameter of the Table 3.4 (number of nodes). Their age and gender depends on the agent distribution defined in the YAML file.

4) Setting initial values for every parameter in Table 3.2 and Table 3.3 except for the parameter going_out_time which is fixed later. The parameters in Table 3.2 depend on age and gender and are allocated in line with this criteria. However, Youngsters' tracking parameters' values are assigned always with the same initial value.

5) Forming groups based on age as explained in 3.2.1.2 in this thesis.

6) Setting the same going_out_time for every member of a group.

7) Making Youngsters inactive until it is their time to go out. Then, they go out and look for a venue where starting.

Once they go out, each time step in the model represents fifteen minutes of the night. The night starts at 10pm, represented by step 2 (In step 0 parameters for the Youngsters are set and in step 1 Youngsters form their group). The model finishes at 7am (step 38).

CHAPTER 4

Model validation

In this chapter the results of the simulations are presented and interpreted taking Section 2.1 data into account. At the end, a sensitivity analysis to test the model robustness is done.

4.1 Results

The first thing that is done in this section is the comparison between the data extracted from the model and data in Section 2.1. The data which is analysed is related to the harms experienced by the agents in the model and alcohol consumed. The possible harms that an agent can have are fights and intoxications. An agent could drink a lot, but not get intoxicated, that's why the percentage of drunk agents compared to the total of agents is studied as well. To test if our model is having results close to reality, data is classified based on age and gender.

As we can see in Figure 4.1, we obtain expected results, which is the first step to check that our model is valid:

- Males are involved far more in fights than women.

- 15-24 year olds are involved in fights more often.
- Males get drunk more often than females.
- The older agents are, the less they get drunk.
- Females get intoxicated more often.

All this results are aligned with with conclusions in [3], [5], [8] and [9].

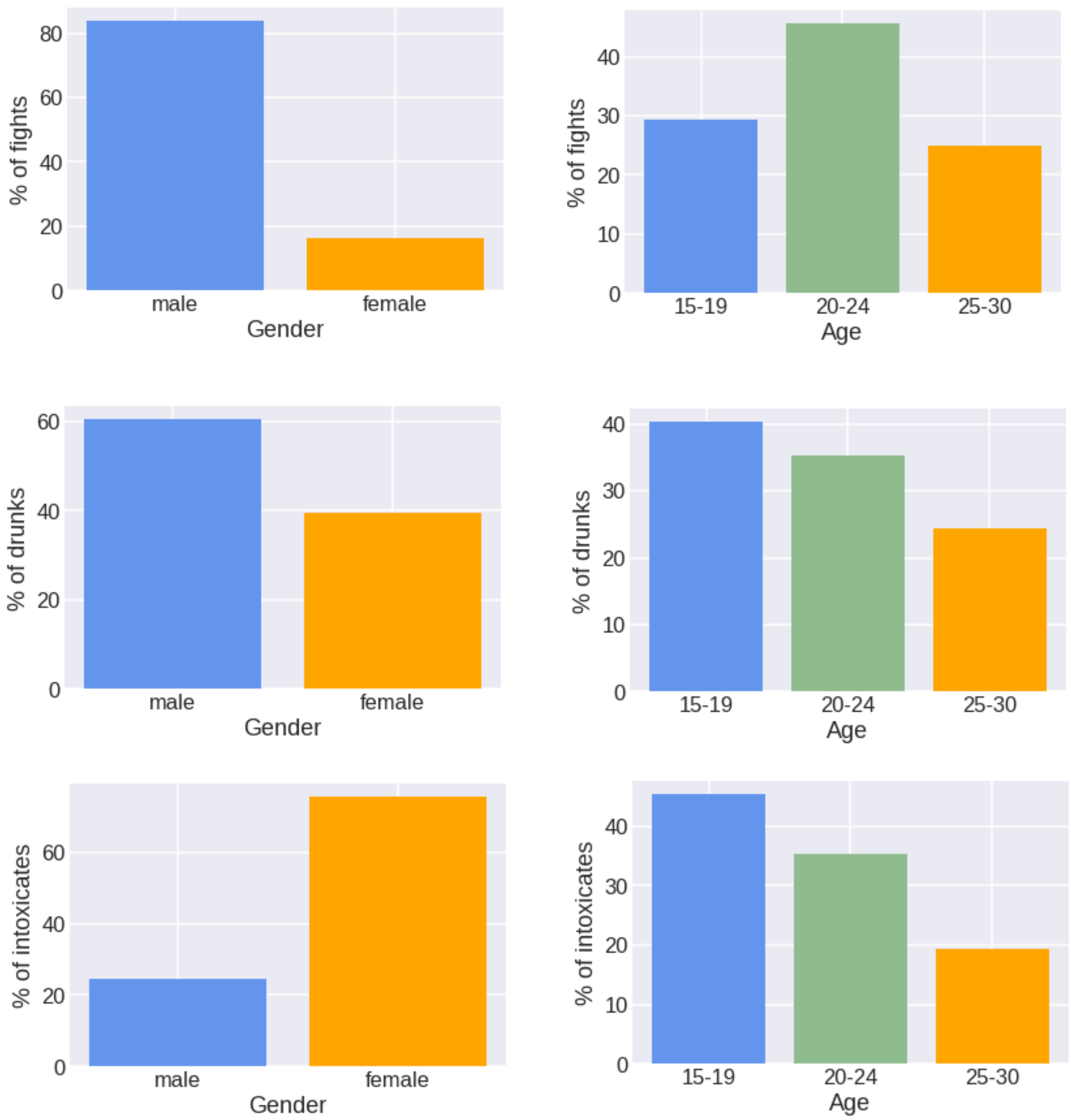

Figure 4.1: Simulations' data

Even though males have more probability of drinking and get drunk more than females, they get intoxicated less frequently. This can be caused by a lower alcohol limit of females.

This result match with results in research done in [14]. From simulations we also get that streets and discos are more visited by 15-24 year olds and streets are specially visited by 15-19 year olds. This explains that most of the harms experienced by agents occur in this types of venues, which is an important factor to take into account when designing policies oriented to decrease these harms. This particular factor is analysed with more detail later in this section.

Lastly, in 4.2 we can observe what are the hours with more activity during the night. Due to the closing time of the pubs and the schedule youngsters typically have, we can see that most harms occur between steps 10 and 24 (between 12pm and 3:30am), being the worst steps 10, 11, 12 and 13 (12pm to 1am).

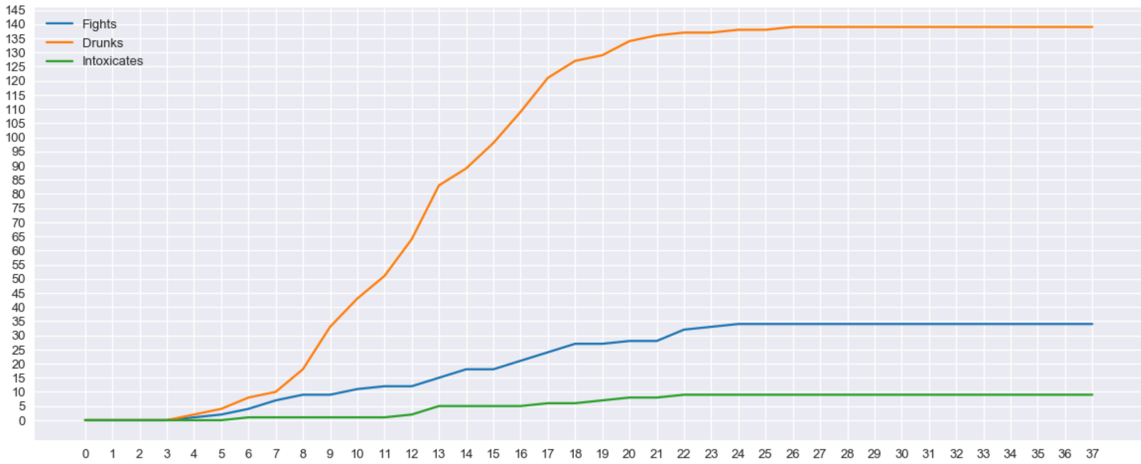

Figure 4.2: Activity in every step

From all this data we can conclude that in both the simulation and reality, the profile that is involved in more harms is a 15-19 year old male in a street between 12pm and 3:30am.

All this data can help to understand the effectiveness of the following policies that have been tested in the model:

- Policy 1: Schedule regulation for alcohol sale. Bars and discos won't be able to sell alcohol after 2am. The hour is chosen based on Figure 4.2.
- Policy 2: Alcohol sale regulation: minimum prices for alcohol are established. The price increases in 20%.
- Policy 3: Don't sell alcohol to minors so any Youngster who is under age won't be able to drink alcohol.

- Policy 4: Forbid public drinking in a effective way so any Youngster won't be able to do public drinking. As a consequence, agents can't drink in public.
- Policy 5: Individuals are allowed to remain in venues but no longer enter after a particular time. This time is 2:30am in pubs and 5am in discos.
- Policy 6: Limit venues' schedule, making the closing time sooner. All discos close at 5am and all pubs close at 2am.

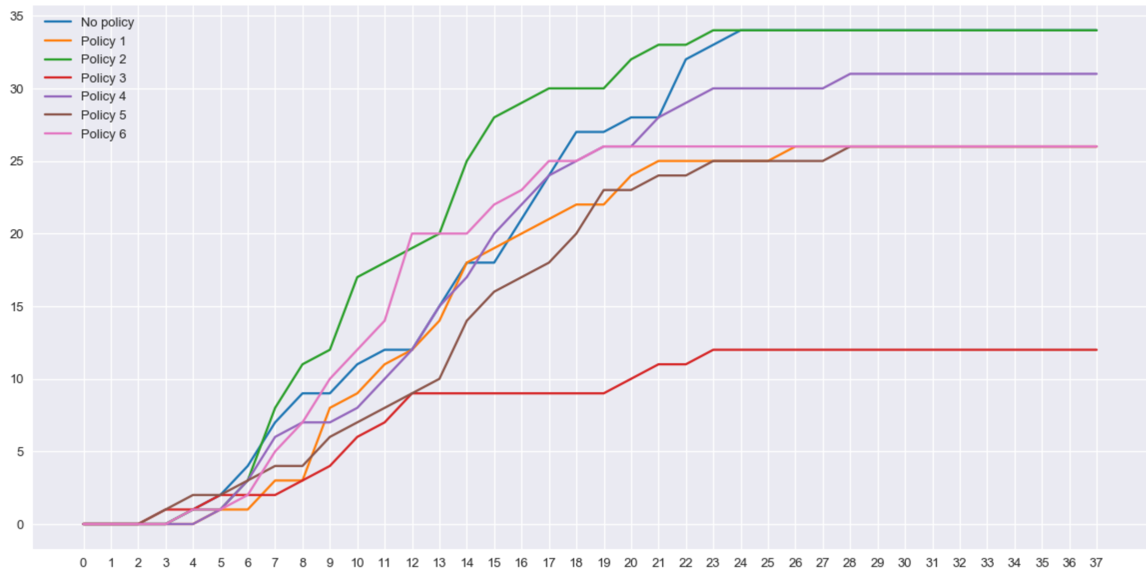

Figure 4.3: Fights depending on policy

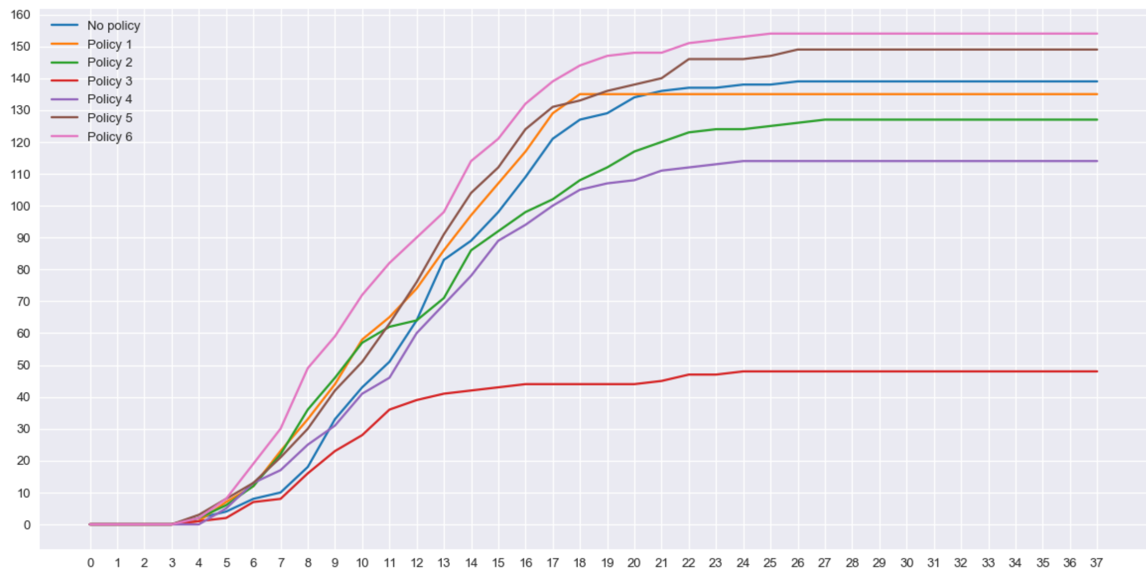

Figure 4.4: Drunks depending on policy

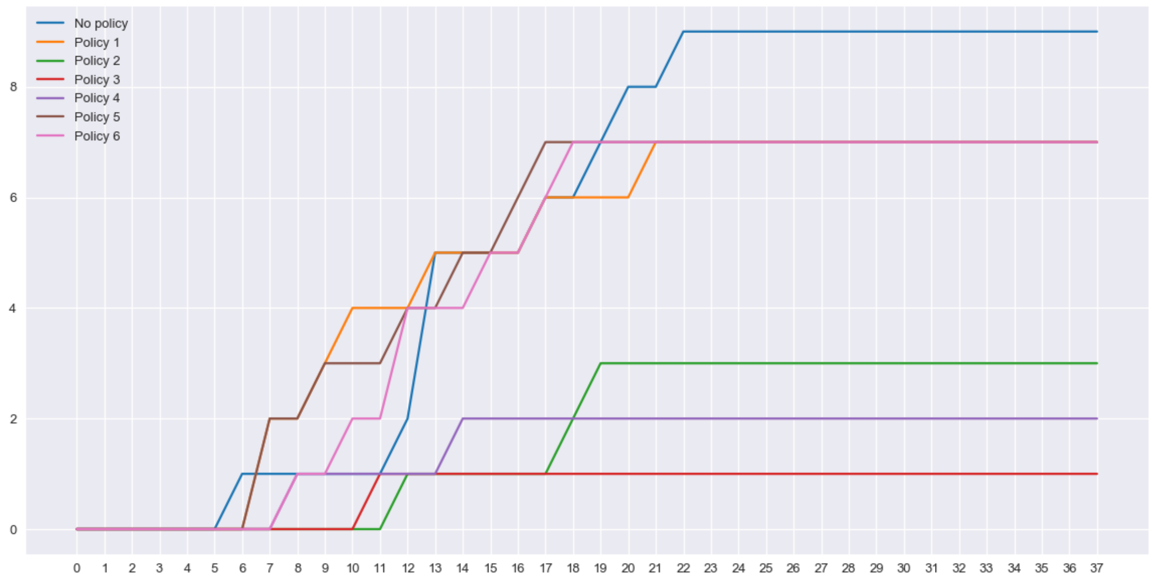

Figure 4.5: Intoxicated depending on policy

For clarity, it should be remembered that venues' behaviour when no policy is applied is described in Section 3.2.2.

As it's shown in the previous figures, Policy 3 is the most effective one. This is a consequence of 15-19 year olds being the ones that are more involved in harms. This kinds of policies have been implemented in other countries, such as Sweden. In Stockholm the program STAD has been implemented since 1999. It has been very successful, since delinquency has dropped in a 29% and a continuous decrease of sale of alcohol to minors. But, as researches from [11] concluded, this is a difficult thing to fulfill, specially in Spain where the culture of drinking in very strong.

Since Policy 6 is specially difficult to implement, it could be interesting to compare the others policies.

A low price of alcohol beverages and promotions are related to a higher drinking rate and harms related to alcohol [11]. Minimum prices for alcohol is not a new policy as is implemented in different countries such as Russia, United States and Canada. Policies related to price are effective as is shown in the simulation (Policy 2) and the research done in [24]. Spain's alcohol tax policy is specially low compared to other countries of Europe, so there is room for maneuver. Moreover, the cost of implementation of price related policies is low.

Policy 1 represents policies related to the restriction of alcohol sale schedule. This restriction can be applied to places where the drink is not drunk directly (supermarkets) or venues where youngsters buy and drink alcohol (pubs, discos, bars). In this model we have focused in the second case. As shown in Figure 4.3, this policy reduces fights in 13% and intoxicated agents in 22.2%. In Spain there are no state-level policies of this kind applied even though it does not implies a high cost.

Streets and public places have a higher proportion of 15-24 year olds than pubs and discos. Taking into account data in Figure 4.1, we can deduce that a high proportion of harms occur in streets, which explains the effectiveness of this policy (Policy 4). This measures are already applied in Spain, as it is forbidden to drink in public. But in reality, most of youngsters do public drinking. This policies have a higher cost than the others, because it requires police action.

Policies 5 and 6 are related to limit venues' schedule and have a similar effectiveness reducing fights and intoxicated agents. The cost is low as well.

By way of summary, this table shows the conclusions reached about policies.

Policy	**Type**	**Effectiveness**	**Cost**
3	Alcohol sale regulation (underage)	+++	Low
2	Alcohol sale regulation (price)	++	Low
4	Forbid public drinking	++	Medium
1	Alcohol sale regulation (schedule)	++	Low
5	Venues' schedule regulation	++	Low
6	Venues' schedule regulation	++	Low

Table 4.1: Comparison of policies

4.2 Sensitivity Analysis

Sensitivity Analysis is an important technique when developing a model. It allows to investigate how changes in the output of a model can be attributed to variations of its input parameters and conclude which parameters are the most contributing ones and what parameters do not change the output (and can be ignored). Sensitivity Analysis is used for different purposes: including uncertainty evaluation, model calibration and robust decision-making [25]. The sensitivity of inputs can be represented by the sensitivity index, as is explained in [26]:

- First-order indices: it measures the contribution of one single input parameter to the output of the model; the input parameter is varied alone while the other inputs remain constant.
- Second-order indices: it measures the output of a model varying two input parameters.
- Total-order index: measures the contribution of the whole model input to the output. It includes the first-order effects and second-order effects, as well as higher order interactions.

In this thesis, the output of the model is composed of three parameters: percentage of drunk agents, percentage of agents that have had a fight, and percentage of intoxicated agents from the total of agents taking part in the simulation. Two types of SA have been performed: local sensitivity analysis, explained in Section 4.2.1 and a global sensitivity analysis shown in Section 4.2.2.

4.2.1 One At a Time

Local sensitivity analysis is the evaluation of the impact of input parameters' variation on model response. When evaluating the impact of a single input parameter, the values of other input factors are kept constant.

When models are large and have a lot of input parameters, it is often the case that the sensitivity of factors is not clear, caused by the influence of other factors. However it can give us a hint of the slope of the model's response given the input. The so-called brute-force is the easiest way of calculating first order indices. It requires the simulation to be completely rerun to test the sensitivity to each individual parameter with defined bounds [25].

To do this analysis, the next input parameters have been selected with their own bounds:

- Probability of change venue: this parameter represents the probability that an agent has of changing venue in a step of the model. The minimum value of this parameter is 0.1 and the maximum 0.8.
- Number of agents: number of agents that participate in the model. The minimum is 500 and the maximum 1500. This range has been chosen based on the time simulations take and other similar models [14].
- Number of pubs: number of pubs in the environment of the model. This could affect the results since pubs have different characteristics than discos and streets. The minimum value is 0 and the maximum is 7. This has been chosen based on the number of agents of the simulation and capacity of pubs.
- Number of streets: number of streets in the environment of the model. This could affect the results for the same reason than the number of pubs. The minimum value is 0 and the maximum is 2, since areas do not generally have more that two zones where youngsters meet to drink in public.
- Male proportion: proportion of men in the model. This parameter obviously affects female proportion. The range goes from 0% of males to a 100%.
- 15-19 year olds proportion: proportion of 15-19 year olds. This affects also the proportion of the other age groups. The range goes from 0% to a 100%.

Each input parameter has been changed while the others have remained constant. After every simulation the percentage of fights and intoxicated agents have been calculated. The results are presented in Figure 4.6 and Figure 4.8.

As shown in the figures, fights increase when the simulation has a higher proportion of men, higher proportion of 15-19 year olds or more pubs in the environment, making a special mention to the number of pubs that has a greater effect on the output. On the other hand, more agents result in less fights. The probability of changing venue and the number of streets do not have a clear effect; this is analysed in Section 4.2.2.

With regard to intoxications, as had been mentioned already in Section 4.1, decrease as there is a higher proportion of men in the simulation. Number of bars in also an important factor. However a higher proportion of 15-19 year olds have the opposite effect.

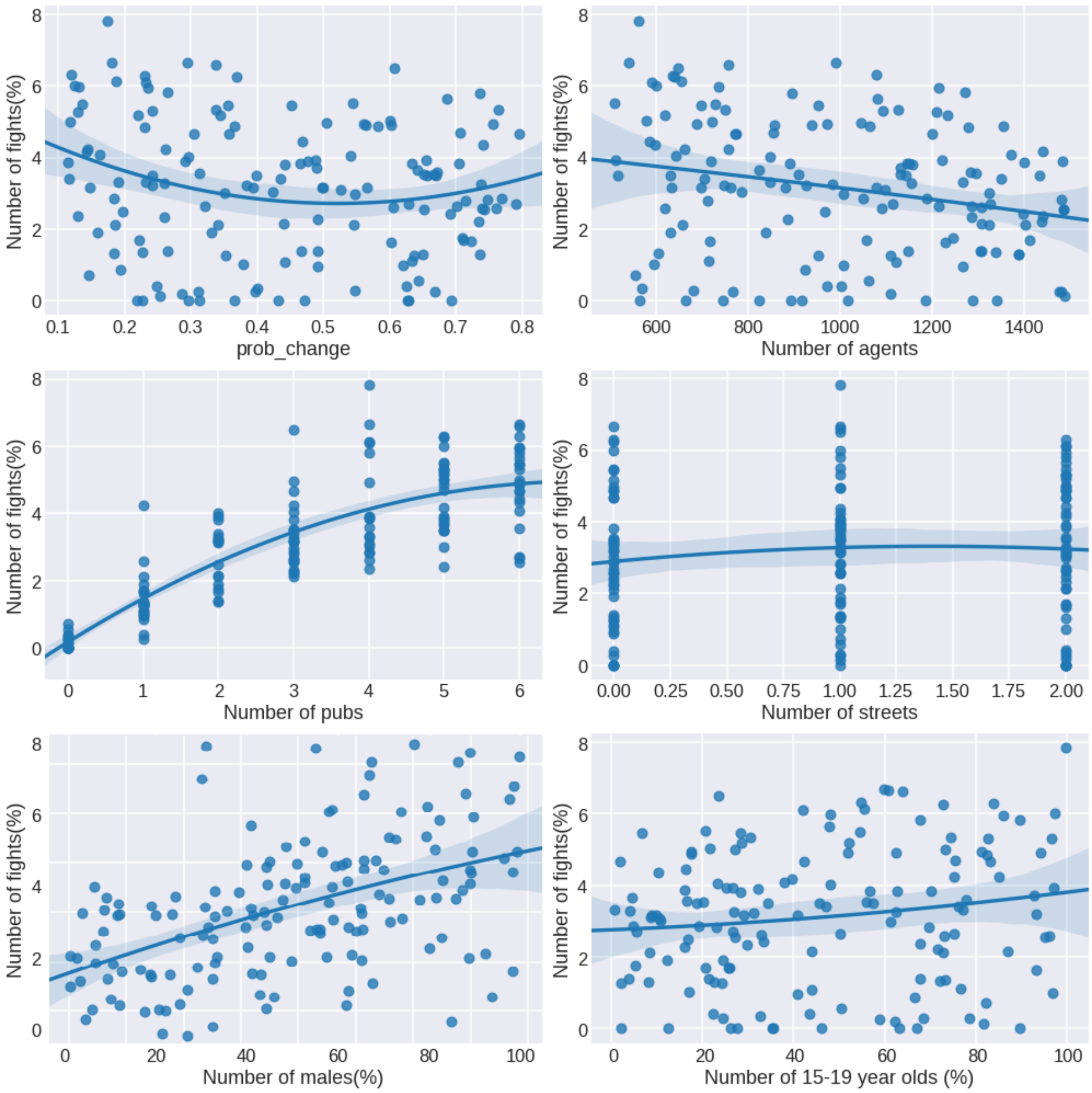

Figure 4.6: Local sensitivity analysis: fights

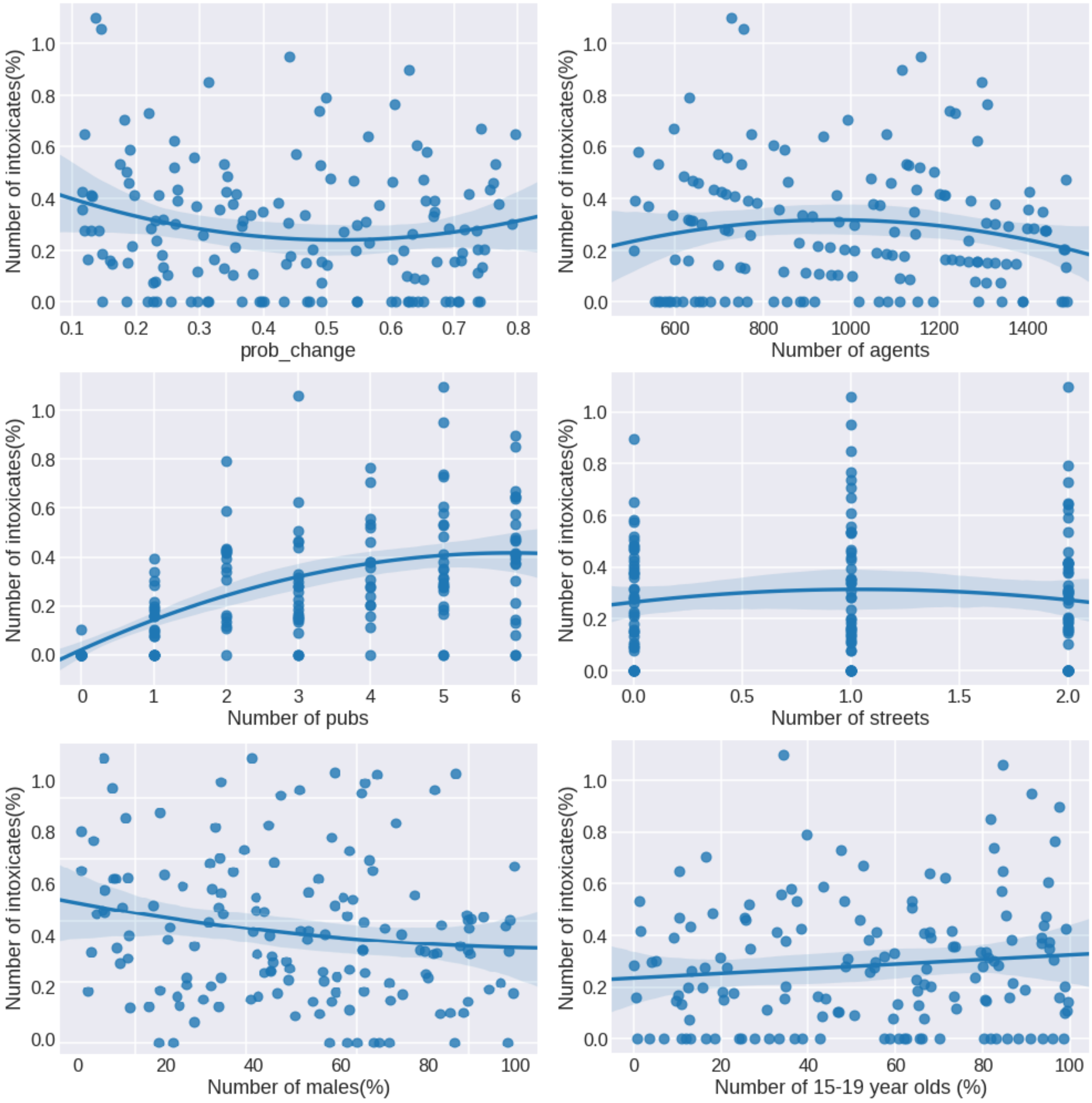

Figure 4.7: Local sensitivity analysis: intoxications

Local sensitivity analysis is a limited technique in case the model is nonlinear and does not take into account that the uncertainties of input factors could be in different orders of magnitude. In the next Section a global analysis is presented.

4.2.2 Morris

Global sensitivity analysis measures the contribution of all input parameters' ranges varied simultaneously to the output. When complex and nonlinear phenomenons occur in the model, this analysis is needed, because input factors interact with other input factors.

This analysis quantifies the importance of model inputs and their interactions with others with respect to model output. It provides an overall view rather than the view obtained from the previous analysis (Section 4.2.1). Global sensitivity requires intensive computational demand due to its characteristics. There are different methods including the Sobol's sensitivity analysis, the Fourier amplitude sensitivity test (FAST), the Monte-Carlo-based regression–correlation indices and Morris [27]. In this project we use the last method enumerated together with SALib library for python [26].

As is explained in [25], Morris' method allows to classify the inputs of the model in three groups: (1) inputs having negligible effects, (2) inputs having large linear effects without interactions and (3) inputs having large non-linear and/or interaction effects.

In Morris' method the input space in discretized for each variable, and then a number of OAT (One At a Time) is performed. The designs of this experiments are randomly chosen in the input space, as well as the the variation direction. These steps are repeated allowing a estimation of the effects of each inputs and the total order indexes.

If we discretize the input space in a $d-$dimensional grid with n levels by input, being $E_j^{(i)}$ the elementary effect of the $j-$th variable obtained at the $i-$th repetition, we can define it as:

$$E_j^{(i)} = \frac{f(X^{(i)} + \Delta e_j) - f(X^{(i)})}{\Delta}$$

where Δ is a predetermined multiple of $\frac{1}{n-1}$ and e_j a vector of the canonical base.

Indices are calculated as follows:

$$\mu_j^* = \frac{1}{r} \sum_{i=1}^{r} \left| E_j^{(i)} \right|$$

$$\sigma_j = \sqrt{\frac{1}{r} \sum_{i=1}^{r} \left(E_j^{(i)} - \frac{1}{r} \sum_{i=1}^{r} E_j^{(i)} \right)^2}$$

where μ_j^* is a measure of influence of the $j-$th input on the output. The larger μ_j^* is, the more the $j-$th input contributes to the output. σ_j is a measure of non-linear and/or interaction effects. If this number is small, it suggests a linear relationship between the studied input and the output. On the other hand, if σ_j is large, it is less likely the linear relationship and is considered to has non-linear effects.

This analysis allow us to understand the effects of the six inputs described in 4.2.1.

After the local sensitivity analysis the relation between some inputs and outputs was not clear enough. After using Morris' method with the help of SALib library in python, we present the values of σ, μ and μ^* in Table 4.2

Parameter	**Fights**			**Intoxications**		
	μ	μ^*	σ	μ	μ^*	σ
prob_change_venue	-0.651128	0.978346	1.45045	-0.341654	0.461654	0.509084
male_proportion	-0.875489	0.979549	1.26246	-0.193835	0.245564	0.359743
number_pubs	3.69684	3.69684	2.09474	0.574887	0.620902	0.527926
number_streets	0.18391	0.885564	1.33056	0.0421053	0.279098	0.425784
num_agents	0.14782	0.639549	1.18377	0.119398	0.229474	0.320639
15-19_proportion	0.104662	0.694135	0.92804	0.0866165	0.295038	0.501123

Table 4.2: Morris indices

As we can see, all parameters have an influence on the output, both for fights output and for intoxications output due to the values of μ^* that we got after the analysis.

In the case of the fights output, listed from highest to lowest, the biggest contributions come from number of pubs, proportion of male agents, probability of changing venue, number of streets, proportion of 15-19 year olds and number of agents.

In the other case, listed in the same way, we have number of pubs, probability of changing venue, proportion of 15-19 year olds, number of streets, proportion of men and number of agents.

The biggest contribution comes from the number of pubs placed in the environment of the simulation as can be observed also in Figures 4.8 and 4.9, which tell us that environment is an important factor to consider.

To see if the effects are linear or not, we have the following figures. As we can see, all inputs have strong influence with non-linear and/or interaction effects [25]. We know this because σ and μ^* have the same order of magnitude.

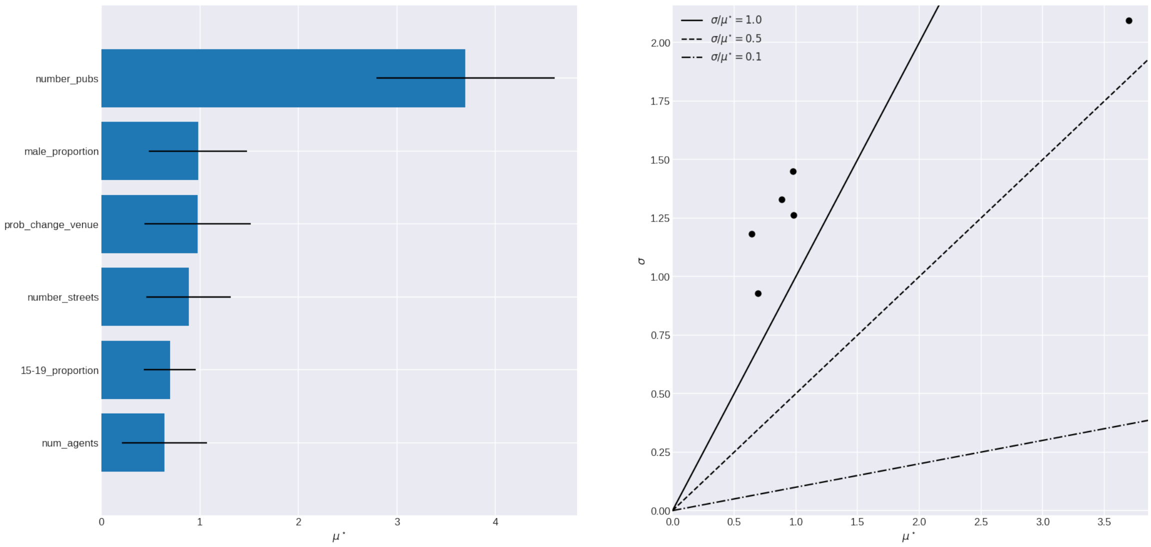

Figure 4.8: Global sensitivity analysis: fights

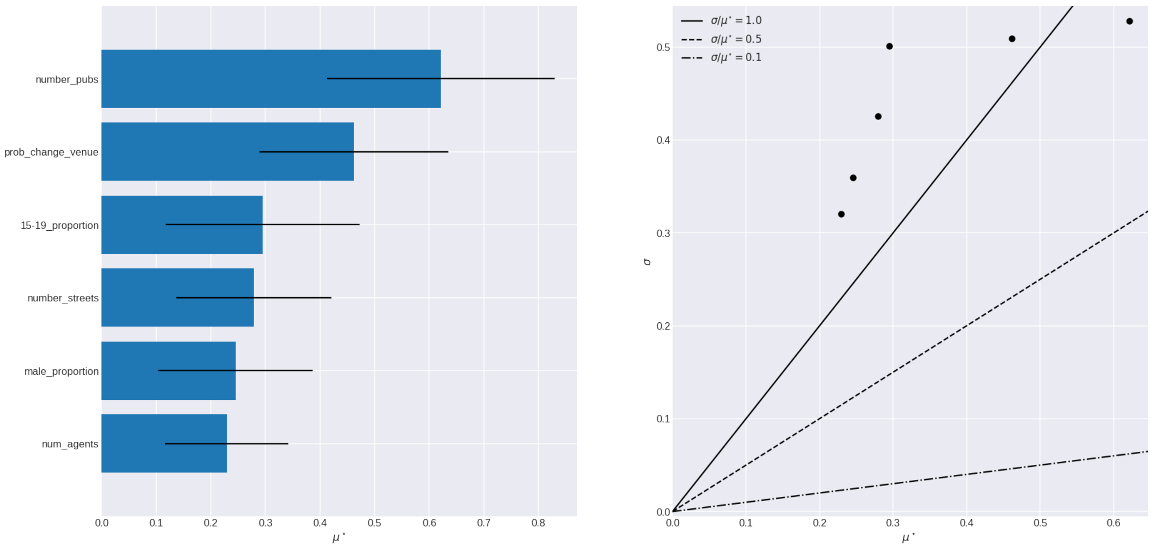

Figure 4.9: Global sensitivity analysis: intoxications

CHAPTER 5

Conclusions and future work

In this chapter we present the conclusions extracted from this project in Section 5.1, then the achieved goals in Section 5.2 and finally the possible future work in Section 5.3.

5.1 Conclusions

To conclude, we are going to summarize the concepts that have been already explained in the previous sections in this document. The harms that young adults suffer in nightlife environments is a public health issue that can be interesting to study, specially from the point of view of agent-based social with the goal of minimizing this problems. This technology can help to understand how and why they act in such ways.

A model that can be used to simulate youngsters in a night-life environment has been designed and implemented. In this model is possible to simulate venues' behaviour and different policies to reduce harms related to alcohol consumption. We have done also a research of different policies that has been already implemented in other countries as well as possible policies that can be interesting to study for a future implementation.

After doing simulations and a sensitivity analysis, we have been able to understand which parameters make harms increase and which ones are more sensible, which can help to design new policies. It has been also useful to test the validity of this project. We also have been able to test policies that already exist and compare their effectiveness and feasibility.

5.2 Achieved goals

Investigation of Network Simulators and agent-based simulations

Before start designing this model, it has been necessary to gather information and do research on social simulations, how they work, what platforms were the most suitable for this particular project.

Design and implementation of the model

Once the study of networks simulators and social networks was completed the design of the model was started. Research has been done on similar simulations to choose the most important parameters and its value. After that, all the information related to the design and required to implement the model had been gathered . Finally, the simulation was implemented getting the desired behaviours.

Investigation of alcohol-related policies

A research on already existing policies designed to minimize has been necessary as well as research on youngsters public health issues. This research was needed to decide which policies to test and which ones were the most interesting to use in this project.

Simulate different alcohol related policies

With the information collected in the previous point, we were able to simulate different policies and conclude which one are more interesting to focus in.

Being able of doing simulations in different areas

The simulation allows the environment to be change. The user can choose the number of pubs, streets and discos in the area which would have different results in the simulation. This feature can be used to test areas, events, different days of the week, etc.

Extract and show valuable data from the results

Once the simulations were done, we extracted data to determine the validity of the model as well to draw conclusions valuable to design policies.

5.3 Future work

In this section, ideas for improvement of this software are presented.

Use of OpenStreetMap

OpenStreetMap is an open-data collaborative project to create a free editable map of the entire planet. With the use of this tool exact locations can be simulated, and real venues can be located in the map. This can achieve a better accuracy in agent's behaviour. In the current model agents change venue based on their age, size of the group and other parameters; but using OpenStreetMap distance to other venues can be introduced into the model so the agents based their decision also on the distance from the venue they are to the destination. It can also be helpful to calculate the time a group of agents would spend going to other places of the environment.

Visualization

In the future it would be interesting to use any visualization tool to be able to see the changes in the simulation in the process and to interact with the simulation in real time.

Test policies in different conditions

Even though we have seen the effect of changes in the environment in the sensitivity analysis policies could be test in different areas to see in what environments their effectiveness change. This can give information about where a policy should or should not be implemented.

Introduce more interactions

More interactions can be introduced among members of the same or different group. It could be also interesting to make groups interact with other and allow members to form new groups during the night.

Introduce means of transport

Agents decisions could be also based on the schedule of public transport, taxis available (which could depend on the area where the simulation is happening). It is also a opportunity to explore traffic accidents related to alcohol consumption, which is an important topic currently.

Introduce drugs

Alcohol is more common among youngsters than any other dangerous substance, but drugs could be considered in the model as they could have also an impact.

Introduce biological parameters

Alcohol has a different effect in each person. Biological parameters such as the status of neurotransmitters could help to make the simulation more accurate and draw better conclusions.

APPENDIX A

Impact of this project

This appendix explains the possible impacts, whether they are positive or negative). We consider social impact (Section A.1), economic impact (Section A.2), environment impact (Section A.3) and ethical implications (Section A.4).

A.1 Social impact

It has been common in the past few years to do research on youngsters' habits, lifestyle, hobbies, etc. Young adults are specially interesting for all of us because they are the future and it is a vulnerable part of society.

Nightlife environments are particularly dangerous for young adults due to the presence of alcohol and other harms, which makes this particular scenario interesting to do research on. New points of view of investigating a way of reducing alcohol related harms are needed and social simulation is one of them. Agent-based social simulations, like the one developed in this project, can help to anticipate problems derived of this situations.

A way of testing alcohol policies and investigate if they are effective or not could prevent a high number of damages to youngsters on a short-term basis. It also can has long-term effect, since this policies could reduce alcohol consumption which can cause damages in their health.

But these harms do not only affect youngsters but also the citizens living in areas where is common to hang out. In cities like Madrid noise pollution is a problem that causes sleep disturbance, stress, hearing loss, etc.

In conclusion, the results derived from this project (and other similar ones) could have a very positive impact in our society.

A.2 Economic impact

The use of alcohol in nightlife environments also has a negative economic impact.

As is shown in [28] alcohol implies high economic costs. It is estimated that in rich countries it costs 1-3% of the gross domestic product due to loss of productivity. This happens because alcohol causes traffic accidents, crime and deaths and these problems carry a high cost in public health.

These project can help to reduce alcohol drinking in early ages which would have a positive economic impact.

It should be also mentioned that some policies produces high costs. Having a simulation that can help to decide if some policies are good or not can prevent cities to implement policies that have high costs and not the expected impact reducing harms and damages derived from alcohol.

From other point of view, it should be also taken into account that a lot of people live off of the alcohol industry, specially in Spain due to its drinking culture. The implementation of some policies could affect the economy of workers and venues' owners, as well as companies.

A.3 Environment impact

The aim of this project is having a tool to reduce alcohol related damages on young adults. Agent-based social simulations themselves do not have any environmental impact; however, this project has needed a intensive use of a computer, with the environmental impact that implies.

This project has not a big impact on environment besides that.

A.4 Ethical implication

We find two ethical implications in this project. First of all, as has been mentioned in A.2, a lot of people in Spain live off of the alcohol industry. The use of our system to reduce alcohol consumption and harms derived from it could destroy jobs and lifestyle of people.

Lastly, this thesis is based on research and investigations on people and their habits. This information should be used in a ethical way and should keep in mind that this information could never be public or used in other ways.

APPENDIX B

Economic budget

This appendix details an adequate budget needed to be able to run this project. Physical resources (Section B.1), human resources (Section B.2), licenses (Section B.3) and taxes (Section B.4) are specified.

B.1 Physical resources

This project provides a simulation that can be run in a computer which is the only necessary physical resource to be able to run the software.

The characteristics of the computer can be very varied, but it should be mentioned that the minimum required characteristics are not very demanding. As a example the characteristics of the computer where this project has been developed are presented:

- RAM: 8 GB
- Hard disk: 10 GB space
- CPU: Intel Core i5 3.2 GHz x 4

A computer with this characteristics costs around 700 €.

B.2 Human resources

In this section we detail the cost of the software developer responsible for designing and implementing the simulation. Hours employed to developed the software and the salary of an engineer are considered.

Taking into account that a month has approximately twenty-two working days, and four hours of working per day together with the six months that has been used to develop this software, the estimated cost is 2700 € (450 € per month).

B.3 Licenses

This section specifies the cost of software needed to develop our simulation, however, all the software used in this project is open source, which means that the cost of the licenses would be 0 €.

B.4 Taxes

In this section we consider the case where the project is sold. In this case, taxes should be taken into account.

According to the Statute 4/2008 of Spanish law in the sale should be considered a tax of 15% of the total price of the software. In case of sale to a foreign company different taxes should be considered, but this scenario is not expected.

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