ARGOS: Simulating Migration Processes (Demonstration)

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ABSTRACT

In this paper a MAS simulation environment is proposed to simulate the migration process in order to observe dynamic behaviours that may emerge at macro level. As a result of this analysis, it has been possible to identify behaviour patterns that can be represented using agent-based models. Moreover, with this approach predictive techniques has been included in order to represent the complex environment of the migration process and its interaction with other processes like Labour and Financial Markets and Security Forces Management.

Categories and Subject Descriptors

I.6 [**Computing Methodologies**]: SIMULATION AND MODELING

General Terms

Experimentation

Keywords

Emergent behavior, Social simulation

1. INTRODUCTION

The Migration Process is a phenomenon that includes a variety of actors, societies and political issues at different levels. In the migration problem, it is then possible to observe complex interactions among different entities. These interactions have been traditionally represented by mathematical approaches that do not allow including flexibility, autonomy, adaptive and pro-activity features that are present into the dynamic and complex real life migration scenarios. On the other hand, the Multiagent System (MAS) paradigm has been successfully applied in studies related to mass movement in complex environments. In this paper a MAS simulation approach is proposed to simulate the migration process and to model micro-level interaction protocols among the participating entities in order to observe dynamic behaviours that may emerge at macro level. Thus, a MAS model allow to simulate simultaneous behavior of multiple agents to show and predict actions of complex phenomena. The Agent-based Social Simulation (ABSS) studies the social phenomenon by using computational models. These models may represent the people and their interactions with other people as agents [1]. The ABSS is focused on the emergence properties of big agent groups that react to its environment following a set of rules. The MAS paradigm has been applied in studies related to mass movement by defining agent-based models to simulate the rural-urban movement according to social learning [2] [3], an Ethnic Migration Model [4], and Schelling Segregation Model that shows the emergence of socio-spatial patterns [5].

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2. ARGOS DEMOSTRATOR

2.1 The problem

The problem we are trying to simulate is an scenario in which there are complex links among the entities involved in the migration processes (migrants, transport service providers, security forces, labour market mediators, employer service providers and financial market managers) together with the pro-active behaviour of migrants that are trying to move from one country to another. The goal is to model the micro-level agent features of the migration interaction in order to observe the macro-level behaviour of the entire system. To do this we have implemented (i) a MAS supported simulator called ARGOS that is a MAS which simulates the migration scenario, (ii) a web-based simulation player, called ARGOS Player, that displays the simulation execution on top of Google maps, and (iii) ARGOS Data which exports simulation statistics in different formats in order to analyze the simulation execution. We have tested ARGOS with real migration routes from African countries to Spain. In this scenario there are migrants that try to reach Spain by mean of different transportation services, such as plains, boats and buses. The security forces are implemented in the frontier police controls of the country borders. On the other hand, migrants can settled temporarily on different cities of the migration routes to work and save enough money to continue the journey. To simulate this we have implemented labour markets in different route nodes (cities). In the following section ARGOS is detailed.

2.2 The simulator

The simulation environment called ARGOS includes the following key entities of the migration problem: Migrants, Transport Service Providers, Security Forces, Labour Market Mediators, Employer Services Providers, Financial Mar-

ket Managers, and Radar Stations. ARGOS simulates the migration process in specific regions. The Regions are configured before the simulation is executed. We have tested ARGOS with two specific regions. In the first region, the main source of migrants are Nouakchott and Tidjikja (Mauritania) whose main goal is to reach Cadiz and Sevilla (Spain). In the second region, the main source of migrants are Tambacounda (Senegal), Gao (Mali), Kano (Nigeria), Agadez (Niger), Tamanrasset (Argelia), Maghnia (Algeria), and Oujda (Morroco) whose main goal is to reach Melilla and Ceuta (Spain). The regions include specific migration hubs called nodes in which it is possible to observe migration activities like departure/arrival of Migrants, Labour and Financial Markets Management, and Security Patrols. The simulation includes predefined routes that Migrants use. The routes connect specific region nodes. Thus, the demonstrator includes communication protocols that agents use according to specific scenarios. Financial Market is based on the Leontief Matrix and its behaviour influences the Labour Market behaviour. ARGOS also includes a weather information model between nodes. This model is used in order to compute the probability for successful arrival to nodes when the routes include maritime sectors. The control architecture for maritime borders include: coast modelling, radar stations, arrival paths, algorithms for calculating the detection probability of illegal boats reaching the coast and their graphical representation.

The main scenarios included are: a) Migrants that look for transport to move along migration routes, b) Negotiation among Transport Service Providers and Migrants, c) Movement of migrants with different means of transportation, d) Migrants that look for a job to earn money, e) Labour Market Mediators that execute auctions in order to link position vacancies to workers, f) Security Forces which patrol specific places (not maritime), g) Security Forces which capture illegal migrants that arrive to a specific place, h) Security Forces which verify documentations of captured Migrants, i) Automatic changes on labor demand that affects the Financial Market and influence the positions that Labour Market manages, j) Use of prospective model for decision-making processes made by Immigrants, k) Use of situational awareness by Immigrants during decision-making processes, l) Patrol Nodes by defining control stations that use radars for specific sea areas, m) Security Forces which apply specific algorithms for the evaluation of captured Migrants. ARGOS also allows the User to track the behaviour of agents in specific nodes by using graphic data that show arriving/departing Migrants, position vacancies and dynamic payment by capabilities, changes on Financial Markets and results from the security patrol execution (Migrants that have been retained and released), and data of radar stations (illegal transports detected or not). Moreover, ARGOS Data generates simulation data that is used for external analysis. This generated data can be used to analyze previous situations and predict future actions. The prospective model used by Immigrants takes into account the incomes, outcomes and her/him current wealth to determine if an Immigrant can stay in its current node or if it must try to move to another. Transport Service Providers and Labour Market Mediators publish Situational Awareness information about: transport proposals and labour vacancies. When an Immigrant is reasoning about to where he/she can move, he/she evaluates the situation applying a prospective decision model taking into account the posts that are in the Situational Awareness and its own attributes such as his/her own risk perception or available money. The Security Forces use radars on specific sea areas to detect illegal transports (boats) that are trying to reach Spain. A transport can be detected by one or more radars. It is possible to get the performance of radars (number of illegal transports detected). Therefore, Security Forces also include the use of Retention Centers to temporally retain Immigrants. Security Forces apply different algorithms to evaluate the people that have been retained. During simulation, Migrants share their experiences about the status of Labour Markets and the migration routes (as part of the Social Situational Awareness) with other migrants. The migrants take into account the shared information evaluating it according to the influence level of the migrant that have posted it. The information that migrant receives and the programmed events that the user can introduce in Argos (change on employment rate, change on cost living, change on security forces strictness) allows updating its environment knowledge as part of its Individual Situational Awareness. The migrant uses the Individual Situational Awareness during its decision making process.

3. CONCLUSIONS

In this paper a MAS simulation approach, called ARGOS[1] , has been presented, which allows the simulation of the migration process and to model micro-level interaction protocols in order to observe dynamic behaviours that may emerge at macro level. Some features that ARGOS includes are: decision algorithms that Security Forces uses on borders control, the activation of radars at specific maritime control stations, a blackboard for Social Situational Awareness that is fed by the Transport Services Suppliers and Labour Services Suppliers and consulted by Immigrants. Argos also includes too a prospective model for decision-making processes that Immigrants made when they have to decide if they can stay in the current place or if they have to move to another place, and a Real-life based algorithms that Security Forces use when Immigrants are captured. The proposed approach allows the improvement of maritime frontiers monitoring by using maritime control stations and the definition of a social network that allows connecting the immigrants by defining a specific influence level among them.

4. REFERENCES

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