Agents acquiring Resources through Social Positions: An Activity-based Approach

George Lekeas and Kostas Stathis
Intelligent Computing Environments
Department of Computing, City University
Northampton Square, LONDON EC1V 0HB.
{g.k.lekeas, k.stathis}@city.ac.uk

1. Introduction

The main assumption of this paper is that we will need to use artificial agent societies [1, 11] in order to manage intelligently the resources and the interactions envisaged in socio-cognitive grids. We are motivated by scenarios where location-independent smart-services provide the social and cognitive resources that agents will need to acquire in order to satisfy their users' needs.

More concretely, we are investigating the situation where an agent who is trying to achieve a goal in a specific environment realises that it needs to join an artificial agent society in that environment (or possibly in another environment), which possesses the resources necessary for the agent to achieve the goal [14]. For example, if you travel to a foreign place for business purposes, you would expect your agent to join the artificial agent society of a train station, so that you can receive advice on how to buy a train ticket [5].

We start from the work described in [14] but we extend it one step further as follows. For an agent to achieve a goal it needs to enter a society with a specified social position [12]. By social position, we mean assigning to an instance of an agent a non-empty set of roles. By role we mean an expected set of behaviours that "tell" the agent how it should behave in a specific society whose organisation relies on that role; for example if an agent has a social position that contains the role receptionist of a hotel, then that role tells the agent that it should not steal credit card numbers.

Following the society classification presented in [4], we are interested in *semi-open societies*, where membership is by application only. In this context, we are investigating in detail the activities between (a) agents, which apply to artificial societies for membership and (b) the societies, which will respond to the agent's application for the requested social position. For this purpose, we take an activity-based approach and we propose a set of UML activity diagrams to model the required interactions.

Although it has been argued [6] that UML is not sufficient for modelling agent activities (because of agents' richer properties [9] and the fact that UML does not have clear semantics [10]), we use UML as in [9] to visualise interaction processes between agents, by representing concurrent and asynchronous processing and expressing simultaneous communications with several correspondents. It is also important to add that here we are particularly concerned with giving a top-level picture of the entry of an agent to a society, the life-cycle of the agent while a member of that society, and the exit of the agent from that society, rather than investigating the meaning of the interactions that take place in the artificial society. Activity diagrams can be useful for this purpose as they exhibit very clear processing-thread semantics [9].

The structure of this short paper is as follows. In section 2 we discuss the different steps that an agent needs to take in order to apply for membership of a particular society; section 3 deals with the activities of an agent whilst been part of the society and section 4 looks at the activities related to exiting the society. Section 5 is the concluding section.

2. Entering a society

As mentioned above, an agent will be interested in joining a society because it holds the resources the agent needs in order to accomplish the task that was assigned to it. The sequence of activities for joining a society is illustrated in Figure 1.

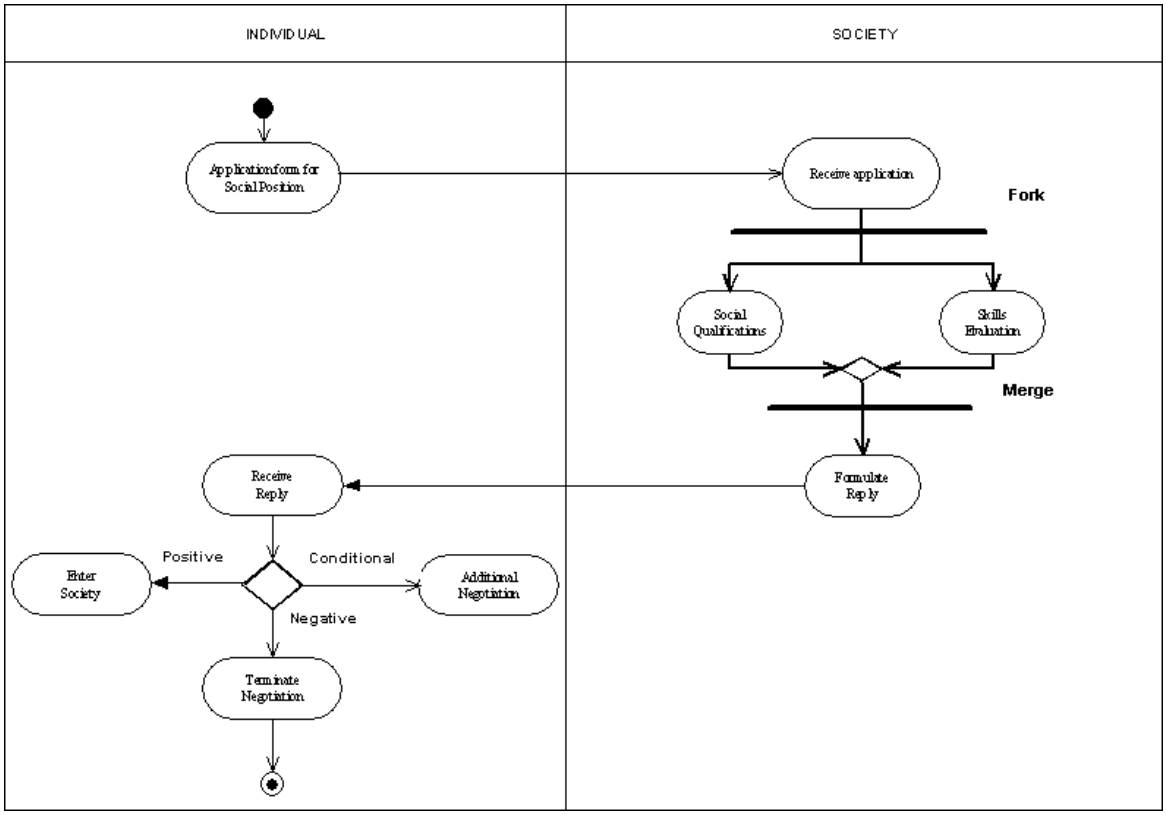

Fig. 1: UML activity diagram for entering a society.

Motivated by the need of the society's resources, the agent initiates the process by "filling" in an application form for a specific social position to the society; in the *Leaving San Vincenzo* scenario [5], the application will be made for the social position of a traveller. The application will, then, have to be evaluated against a set of *social qualifications* – the requirements for entering the society, and a set of *skills* - abilities that will assist the agent in performing the tasks of the social position it is applying for, required for the social position under consideration. Based on the same scenario, an example of a social qualification might be that the user, and as a result his/her agent, are already members of a mobile phone provider, while a skill might be the agent's ability to connect to a specific type of database and retrieve information from it.

After an agent has contacted the society, the society will eventually formulate a reply that will be sent back to the agent. The agent will then have to decide what is the appropriate action to take based on the contents of the reply. If the reply is positive, the agent enters the society; if the reply is negative, it will have to seek alternative ways for realising its goal. In the case, however, that the reply is conditional, the agent will have to enter another negotiation cycle for becoming a member (we leave out for the moment the possibility where the agent's needs and priorities might change by the time a positive or conditional reply comes from the society).

3. An agent's life-cycle while in an artificial society

If the application for membership has been successful, then the agent enters the society; the activities performed in that case are demonstrated in Figure 2. It will be given a social position [12], which will correspond to a number of roles been assigned to it. We use roles [2],[3],[7],[12],[15],[16] to specify the expected behaviours of an agent holding a social position; this is achieved by assigning or removing roles at runtime. However, we also have the notion of *skill acquisition*, which caters for the introduction of new skills and the upgrade of existing ones. One can easily imagine a socio-cognitive grid for a business organisation where employees have agents as their electronic counterparts, and in this context, if an employee gets promoted, then his agent will have to "get promoted" too, by acquiring the new skills required to play the additional roles corresponding to the new social position.

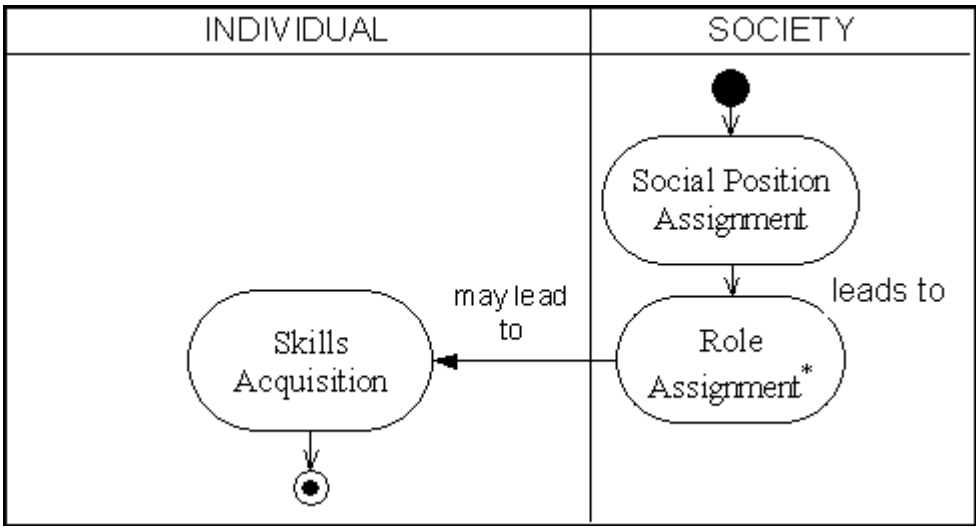

Fig. 2: A UML activity diagram of an agent's life-cycle while in an artificial society.

4. Leaving a society

Over time, the social position of the agent will need to be revised, as demonstrated in Figure 3. On one hand the agent will have to evaluate its current status, according to the goals it has and the perceived limitations about the society, and act accordingly (if the goal of the agent is achieved or the agent failed in that respect, then membership with the current status is terminated and the agent leaves the society). On the other hand, the society will evaluate the current status of agents and revise it (if an agent does not qualify anymore to be a member of the society, the society will have to either suspend an agent's

membership or expel the agent from it). Otherwise, the agent acquires the new social position that was assigned to it (see Figure 2). For example, in the *Leaving San Vincenzo* [14] scenario, once the agent of the businessman has retrieved the desired information, it can exit the train society, having accomplished its goal.

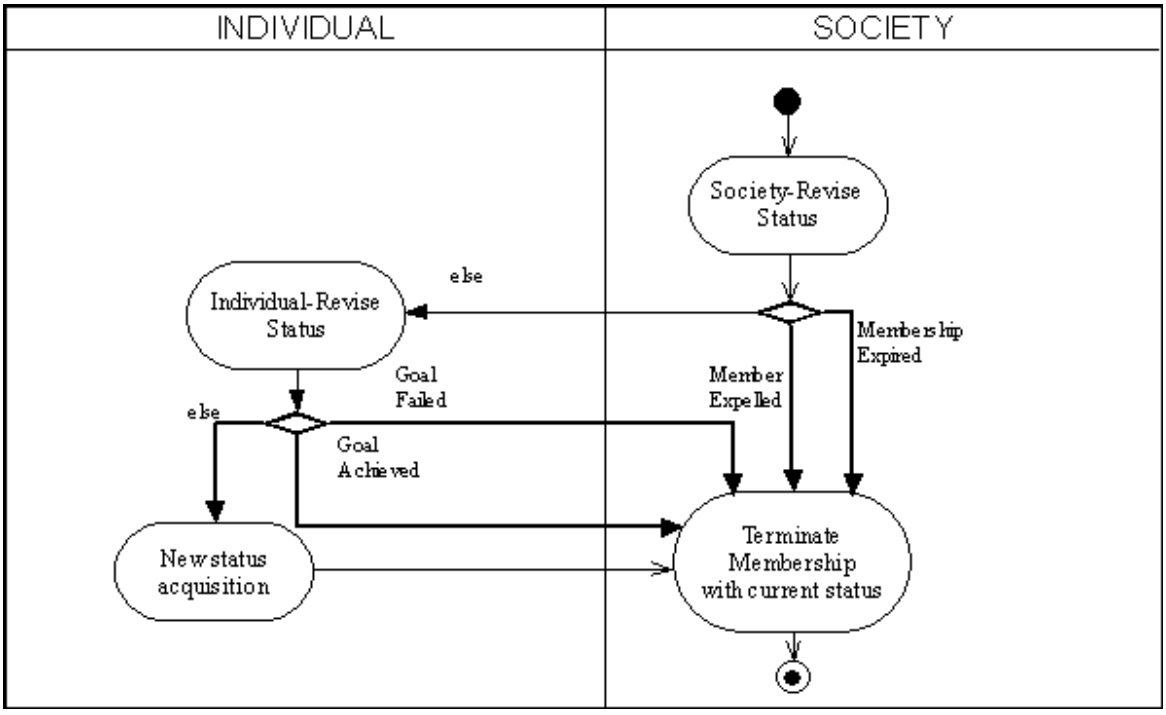

Fig. 3: UML activity diagram for an agent leaving an artificial society.

5. Discussion

Socio-cognitive grids based on artificial agent societies will have to deal with the resource-acquisition problem, following the assumption that an agent will need to join an artificial society in order to acquire the resources it needs for achieving its goals. This work has discussed the general context of this problem and it has modelled it by means of activities illustrated as UML diagrams. The potential of the approach relies on the concept of social position, which allows different degrees of resource acquisition to be achieved, depending upon how high or low this social position is.

As we have already indicated in the introduction, this work attempts to extend the framework presented in [6]. As a result, it makes the assumption that it is artificial societies that is the best tool for supporting socio-cognitive grids. It is however our intention to compare our approach with approaches that could potentially manage socio-cognitive grids with frameworks other than artificial societies such as for example information ecosystems [8]. The detailed comparison between the two is in our plans for future work.

The research presented here leaves a number of issues open; we have not tackled the problem of evaluating skills against the roles the agent has and we have not provided a comprehensive description of what a skill is. We have also left open the concrete framework that will enable assignment and removal of roles, including possible role-conflicts, i.e. how to examine whether an agent already having a set of roles should acquire a new role or not [12]. These issues are beyond the scope of this extended abstract, but we hope to address them as part of our future research.

We have already performed some preliminary experiments using the framework presented in [13], in order to deal with the way agents play their roles; more specifically, we have implemented the specification of an auction according to the roles and skills of *auctioneer* and *bidder*. The results have been quite satisfactory in that the approach gives us a systematic way of adding a behaviour component to the agent. However, the original framework needs to be extended to accommodate for skills associated with roles and role conflict. We hope to present our approach also as part of future work.

Acknowledgements

This work was partially supported by Nuffield Foundation UK, Grant no: NAL/00320/G.

References

1.Artikis A. and Pitt J., 2001. A Formal Model of Open Agent Societies, in the Proceedings of Autonomous Agents 2001, p.p. 192-193, Montreal, 2001.
2.Biddle, B.J. and Thomas E.J., 1979b. *Role Theory: Concepts and Research*, R.E.Kriger Publishing Company, Huntingdon, New York, 1979.
3.Biddle, B.J.,1979a. *Role Theory, Expectations Identities and Behaviour*: Academic Press Inc.
4.Davidsson P., 2002. Categories of artificial societies *In*: *Omicini A, Petra P. and Tolksdorf R.* ed., *The Proceedings of Engineering Societies in the Agents World 2001*, 7 July 2001, Prague, Springer Verlag LNAI 2203,2001.
5.de Bruijn O. and Stathis K., 2003. Socio-cognitive Grids: The Net as a Universal Human Resource, in Proceedings of Tales of the Disappearing Computer, June 2003 (to appear).
6.Kavi K.,Kung David C.,Bhambhani H.,Pancholi G. and Kanikarla M., Extending UML for Modelling and Design of Multi-Agent Systems, in Proceedings of 2nd International Workshop on Software Engineering for Large-Scale Multi-Agent Systems 2003, Portland, Oregon-USA.
7.Kendall, E., " Role Modeling for Agent System Analysis, Design, and Implementation," First International Symposium on Agent Systems and Applications (ASA'99), Third International Symposium on Mobile Agents (MA'99), Palm Springs, October, 1999.
8.Marrow P., Koubarakis M., van Lengen R.H., Valverde-Albacete F., Bonsma E., . Cid-Suerio J, Figueiras-Vidal A.R., Gallardo-Antolin A., Hoile C., Koutris T., . Molina-Bulla H, Navia-Vazquez A., Raftopoulou P., Skarmeas N., Tryfonopoulos C., Wang F. and Xiruhaki C., *Agents in Decentralised Information Ecosystems: The DIET Approach*. Symposium on Information Agents for E-Commerce, AISB'01 Convention, 21st - 24th March 2001 University of York, United Kingdom.
9.Odell J., Parunak Van Dyke H. and Bauer B., Extending UML for Agents, AOIS Workshop at AAAI 200.
10.Pitt J., Kamara L. and Artikis A., Interaction Patterns and Observable Commitments in a Multi-Agent Trading Scenario, in the Proceedings of Autonomous Agents 2001, pp. 481-489, 2001.
11.Pitt J.V., Mamdani A., and Charlton P.,2001. The open agent society and its enemies: a position statement and research programme, *Special Issue on LocalNets: Environments for Community-Based Interactive Systems, Journal of Telematics and Informatics,* Elsevier, 18(1), 2001. pp67-87.
12.Skarmeas N., Organisations through Roles and Agents, In *Imagine Project Final Report*, pages 185-194, IMAGINE Consortium, November 1993
13.Stathis K., 2000.A Game-based Architecture for developing Interactive Components in Computational Logic. J*ournal of Functional and Logic Programming*, Special Issue on Logical Formalisms for Program Composition, Antonio Brogi and Pat Hill (Eds), 2000(1), MIT Press, March 2000. ISSN 1080-5230.
14.Toni F. and Stathis K., 2002. Access-as-you-need: a computational logic framework for accessing resources in artificial societies, *In*: *The Proceedings of Engineering Societies in the Agents World 2002*, Madrid, Spain, 16-17 September 2002, *223-237*.
15.Wooldridge M., Jennings N. R., and Kinny D.,2000. The Gaia Methodology for Agent-Oriented Analysis and Design. In *Journal of Autonomous Agents and Multi-Agent Systems*. 3(3):285-312.2000.
16.Yu, L., 2000. Agent Oriented Role Based Business Process Management for Computational Media. PhD Thesis, Der Universitat Zurich.