The Amusement Internal Modelling for Believable Behaviour of Avatars in an Intelligent Virtual Environment

Ricardo Imbert, María Isabel Sánchez, Angélica de Antonio, Javier Segovia[1]

Virtual Environments Research Group

Computer Science School

Technical University of Madrid

Spain

E-mail: Ricardo Imbert - ricardo@gordini.ls.fi.upm.es

María Isabel Sánchez - maribel@gordini.ls.fi.upm.es

Angélica de Antonio - angelica@fi.upm.es

Javier Segovia - fsegovia@fi.upm.es

Telephone: (+34) 1 336 73 68

ABSTRACT

Nobody has doubts about the Virtual Environments as a tool with a future: their possible applications are huge and they are very attractive for users. However, the lack of believability of virtual characters leads the users to get bored of these Virtual Environments or, at least, to lose the impression of being interacting with other real users, instead of a simple avatar. It becomes necessary a model which provides a rich internal representation, full believability and easiness of use by means of an intelligent automation.

*KEYWORDS: Intelligent Virtual Environments, believability, avatars, internal social-psychological model, intelligent agents, **Amusement** project.*

1. Introduction

The field of Artificial Life, discipline of Artificial Intelligence (AI/ALIFE), in spite of its relative youth, has been very productive in theories and techniques. One of the main reasons is the excellent testbed found for its aims: the Virtual Environments (VE).

At the beginning, the VE only tried to simulate real life scenarios with participants performing some kind of actions or roles, or extracting knowledge from the surrounding

environment. Nowadays, perhaps owed to the AI/ALIFE influence, the interaction channels between VE users (through their virtual representations, called avatars) are increasing in importance, offering a wide range of new possibilities. From the join of AI/ALIFE and VE arises the concept of Intelligent Virtual Environments (IVE).

As a matter of fact, we bet on the great importance of VE in the future as a **natural** way of interaction between individuals, perhaps very distant physically. However, most current VE have not produced the necessary qualitative jump in interaction procedures, on one hand influenced by existent precursor systems (mainly by MUD), and on the other hand owed to the limitations imposed by the existent technology.

> *One of the key steps in creating quality interactive drama is the ability to create quality interactive characters (or believable agents).*
>
> *[REIL96]*

When a participant joins a VE, he/she often has no feeling of reality. Several reasons, such as the static representation of avatars, the disability for communicating any kind of emotion, or an interaction based exclusively on limited channels, such as reading and writing, originate this lack of believability. The user then easily loses the interest and the aim of the VE fails.

Nevertheless, we think that this suspension of disbelief, or believability, does not require realism [PERL96] in the avatars and/or VE representation, but the use of every communication channel that is available in interaction mechanisms in real life: speech (spoken and heard), gestures, sounds, music, onomatopoeias and reflex movements.

It is needed to research these new communication facets in order to make a VE user feels that he/she is interacting with another real user. We are developing the **Amusement** Project[2] with the purpose of exploring and exploiting the possibilities of meta-communication that these channels can offer to us.

One of the aims of the **Amusement** Project is to reach a suitable degree of interaction between its users. We have seen above, one of the deficiencies in the interaction between participants of most current virtual worlds is the apparent lack of emotion and

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life of the avatars that act on behalf of their users, what limits the expressiveness of that interaction and rests motivation to the participants. Therefore, if believable characters are desired, an appropriate internal modelling of them is needed. That will provide what Joseph Bates calls the *illusion of life* [BATE94] for the avatars.

On the other hand, while a user is maintaining a conversation, playing or arguing with other participants, it can become tedious to pay attention to making the adequate gesture or to updating the avatar mood, so the user can end up forgetting to use the utilities provided with that aim. One solution may be to try to automate those functions, acting as the user would do, what reinforces the need of modelling the personality of the avatars.

2. Related Work

Since 1985, when Lucasfilm created the first networked virtual world called Habitat, dozens of similar Internet-based systems have emerged. Some of them have added 3D visualisation, sound support, building capabilities, avatar creation capability, etc., with the aim of making them more attractive and friendly for users.

WorldChat [DAME98] from World Inc., was the first one which incorporated 3D graphics. **On Live** [DAME98] was the first one which included voice communication and implemented lip-synchronisation, but it does not implement avatar gestures.

Another example is **The CyberCafe** [ROUS97], where the concept of "synthetic actors" is introduced. These actors are able to improvise their behaviour in an interactive environment and they own a repertoire of actions which are automatically planned to achieve each activity. They even reflect aspects of personality traits and mood. **Bodychat** [VILH97], also tries to automate the communicative behaviour in avatars. Here the concept of "Intention" is introduced. Intentions are described as:

> *"Set of control parameters that are sent from the user's Client to all Clients, where they are used to produce the appropriate behaviour in the user's Shadow avatars."*
> *[VILH97]*

Improv [PERL96], offers an environment where an avatar can generate motions in real-time, but however, the conversation between avatars is not addressed. **Advanced OZ** [DAME98], implements gestures (called motions), taking advantage of this natural and intuitive communication mode.

All of these environments are more or less rich about the above mentioned features, but when users come into a virtual environment it is also important that they feel as they are and it is important the credibility of their avatars.

As we mentioned in the Introduction, "Realism" doesn't mean "Believability". In fact, everybody believes in Bugs Bunny [PERL96], of course it is not real, but it is transmitting us lots of life signals and these are what make it believable. In the **Amusement** project we focus our research in the credibility of avatars, but always having in mind the other characteristics named above.

When we are looking at a virtual mountain, the most significant thing is the beauty of the landscape. Nowadays the technology has solved this challege, so we think the next step is to make the user of a virtual world feel that his/her avatar can **interact** in the virtual world as he/she can do it in real life. This implies the need of studying sociological and psychological theories and the use of artificial intelligence to help achieve this goal.

3. Interaction in IVE

The concept of "avatar" has been understood to date as a simple disguise or external representation; we think this concept needs more richness. The simple appearance is not enough to denote credibility ; we think it is needed to complement the concept of avatar with an intelligent behaviour which will give the feeling of life that will let avatars, as representations of real humans, **interact** in the same way as humans interact in real life. We think this is the way you will feel your avatar is alive and represents yourself.

Our view of the future usage of virtual worlds, is an environment where the user can perform tasks where many people are involved, and which implies a faithful representation of human behaviour.

The richer is the concept of avatar, the more things we have to control. This is good for increasing the credibility but makes more intricate the management of the avatar. We think the user must be able to decide which things he/she wants to manage, and which others not, because they make tedious or boring his/her stay in the virtual world.

Experience shows that if we excessively overload the user-virtual world interface, the user will discard all the incidental options, and will only use very few functions. That

means that we now have a very rich system with a very poor use (what is, in practice, the same as a poor system).

The user must be freed from the compulsory management of every procedure that we can automate.

The user will choose to take absolute control over his/her avatar actions or maybe he/she will only want to operate over some of the features his/her avatar has. There are many ways for an avatar to interact with others, so we are interested on graduating the interaction ability of the avatar.

We understand the management of avatars with a range of values as it is represented in Figure 1.

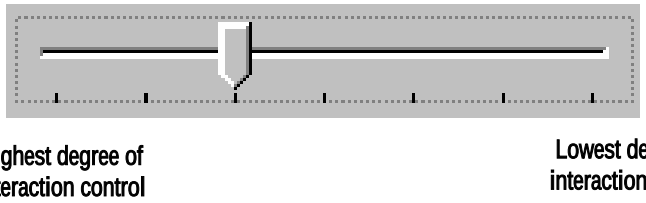

Figure 1. Interaction control range

In the right extreme there is the lowest degree of interaction control by the user over the avatar. This means that the user will allow the avatar to interact freely in the virtual world, and it implies the use of some AI techniques such as intelligent agents, which will be a loyal representation of the way the user would interact. In the other extreme of the range we find the situation in which the user wants to manage all the interaction that takes place with his/her avatar. In this case the degree of interaction control is absolute.

For instance, if a participant has a very nice avatar which always greets to any other avatar he/she meets, the participant has the possibility of indicating his/her avatar the detailed way of doing that greeting - e. g. raising its eyebrows, weaving a hand and smiling - (what results quite inconvenient). This means that the user has a high degree of interaction control over the avatar. On the other hand, the participant should only indicate his/her intention of greeting and an intelligent agent would show the avatar the way to do it, according to the user's personality traits. Any intermediate degree of interaction control matches with this case. Finally, the user could delegate the action of greeting in a personalised intelligent agent, which will decide to greet whenever it meets

someone his/her master would greet. This is what happens when the user has the lowest degree of interaction control over his/her avatar.

We bet for the intermediate solution, where many gestures, motions, etc.., which are implicit in the avatar personality traits, and which are very expressive, and of course needed for a rich interaction and believability, can be generated automatically, and some others can be dependent on the user.

A park for interaction in "Brightown"

As an example of application of the above, we propose to use it in "Brightown", with the aim of creating a park where people can interact as well as enjoy the scenery. The extreme of “lowest degree of interaction control”, would be the case of an ice-cream seller, because when you buy an ice-cream you do not expect an special interaction; he is simply waiting for you to ask for an ice-cream, he gets the money, returns the change, and that is all. In the other extreme of the range, there may be any situation where the user wants to use his/her avatar as a simple puppet, managing absolutely every thing the avatar does.

In the case of people playing something, for example sitting around a table playing cards, the degree of interaction control could take any value in the above range, depending on the user will. The idea is to let the user the possibility to decide which things he/she wants to control and which not.

4. Believability for Avatars in a VE

There are many events which can have some influence when an avatar has to select an action to perform, as it is shown in Figure 2.

The **Amusement** Project copes with the modelling of every one of these facts. However, the specific item that contributes in our model to make the avatar more believable is the representation of the *internal state of the participant*, where the social-psychological model of the character is defined and initialised.

A design-based theory of the self, self-reference,
introspection, identity, and self-control is required.
[WRIG97]

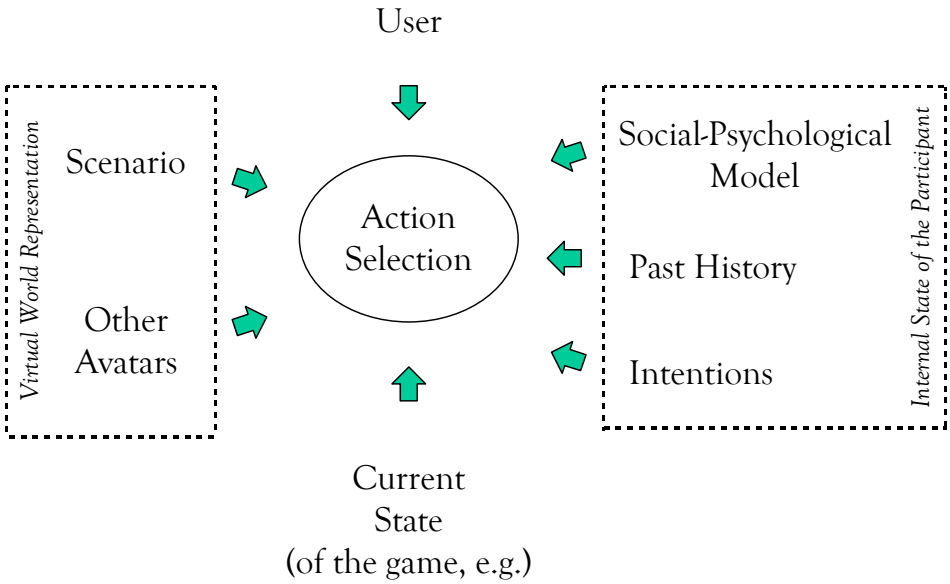

Figure 2. Influential factors in an avatar's action selection.

Thus, the avatar behaviour will be dependent on its user state, and, therefore, we will obtain the believability sought.

1 Internal State of the Participant

As the internal state of the participant, **Amusement** distinguishes a social-psychological model, the past history, and possible intentions entrusted to the avatar. These last ones only appear if a high degree of autonomy is given to it.

The social-psychological model is the component that makes possible to obtain avatars as social individuals with personality and emotions. In [ROUS97], a social-psychological model is presented, consisting of personality traits, moods and attitudes. However, this description does not take into account the avatar-user (also depending on the autonomy degree) intentions, which can be observed by other participants, giving them clues about his/her internal state, and providing a new source of information to select the avatar next actions, according to his/her current internal state.

Vilhjálmsson, in [VILH97] notes that the user can show his/her current intentions through the behaviour of his/her avatar. Still, as he develops a system for interaction in a 3D virtual world, but only using conversation, the intentions reflected by him are strongly limited to a chatting system. He describes three possible user intentions: to indicate to another avatar his/her *availability*, showing interest in having a conversation; to indicate who is a *potential conversational partner* for the user, whom he/she is interested in having a conversation with; and to indicate the user willingness to *break*

away a conversation. This set of intentions can be enough if only a conversational oriented virtual world is expected. However, it must be increased and completed if a higher level of interaction is sought.

Thus, taking these ideas as a starting point, the **Amusement** Project social-psychological model will consist of:

- ***Personality traits***, which mark out the general lines of the behaviour of each participant. Personality traits will hardly ever change throughout time, and if they do, it will be very slowly. Examples of personality traits are friendliness or self-confidence.
- ***Moods***, which show the emotional state of a participant in a given moment. Moods are usually very variable over time, though a participant should have a prevailing value for every mood. Happiness or boredom are examples of moods.
- ***Attitudes***, which determine the behaviour of a participant in his/her relationship with another participant. As the attitude of a user can be different according to different participants, he/she can have several attitude values, one for every participant. Attitudes can be very variable over time or not, depending on the values of other personality traits and moods. Examples of attitudes are liking or confidence.

Other characteristics that have some influence in the participant internal model are:

- ***Intentions*** will express the availability or the willingness of the participant to do something. Intentions are proposed in very specific moments, and are more dependent on the user directions than personality traits, moods or attitudes. The willingness of establishing a conversation is an example of intention. Once the goals (intentions) are established, certain behaviours can be inferred in particular situations [CARB80].
- ***Past history*** will be useful to maintain a coherent behaviour and to have some memory to make intelligent decisions and actions.

All these characteristics are closely connected. Thus, as shown in Figure 3, personality traits have influence in a higher or lower degree over moods and attitudes. E.g. the happiness degree will be lower for a nasty person than for a nice one.

On the other hand, attitudes have also influence over moods. For instance, if an individual hates another one, the first one will turn angry when the second one appears.

As it was commented above, personality traits can have a slow evolution over time. Moods or attitudes will affect these changes. Moreover, a personality trait can affect the value of other personality traits.

These three social-psychological characteristics - personality traits, moods and attitudes - plus intentions and the past history, will determine the peculiarities of the user's behaviour and the way he/she will perform some actions. E.g. a sad individual will walk looking at the floor and dragging his/her feet.

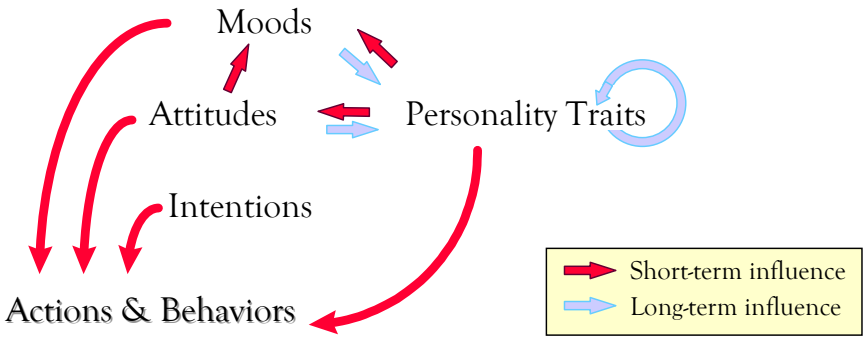

Figure 3. Relationship among traits.

Another important decision to be made is how to express the value of each one of these characteristics. For Rousseau and Hayes-Roth, in [ROUS97], the quantification of a trait is numerical, with a value being an integer on the interval [-10,10]. This facilitates the task of establishing a correlation between different traits, since they can make use of arithmetical operators to obtain the value for another trait. For instance, they determine that the friendliness degree is (0.7 * degree of sympathy) + (0.3 * Anger). However, it can be very difficult and artificial to obtain a proper correlation value (Why 0.7 instead of 0.6?). Besides, if the user wants to change the current value of a trait, it can be very inexpressive to specify that 5 is the new degree of friendliness.

Our proposal is to use something more flexible and expressive, such as fuzzy labels. It will be easier for a user to determine that an avatar has a *high* degree of happiness. Thus, instead of integer values, we will set the value of our traits in terms of fuzzy concepts, as Zadeh proposed in [ZADE83].

2 The Ability for Simulation

The **Amusement** model has a feature that no other known project includes, as it is the possibility of **simulating a mood**, different from the **real mood** of the individual. This consideration can be essential in gaming environments - that is the case of **Amusement** -, to try to deceive the adversaries, although it is also useful for any VE, for example, if someone hates another one, but he/she wants to greet him/her friendly (that is what in real life is called *diplomacy*).

For instance, in a card game, a player with a very good set of cards in his/her hands may want to make their rivals believe that he/she has been unlucky, showing a sad mood. Thus, he will have a real mood, e.g. "*high* degree of happiness", and a simulated mood, e.g. "*low* degree of happiness" (which is the same as a "*high* degree of sadness").

This characteristic contributes to the believability of the VE, since the user can *play* with the possibility of simulating his/her mood or his/her attitudes towards other individuals. This takes place without loosing the coherence with his/her internal social-psychological model (e.g. although someone is simulating sadness, his/her avatar has a coherent internal model with the proper actual degree of happiness).

The ability for simulation, however, does not mean that every avatar is a *great pretender*. An individual has a degree for each mood trait identified in the model. Besides, he/she can indicate a different degree for the mood he/she wants to simulate. In the set of personality traits defined for an individual, there is one called *ability for simulation*. To typify the relationship between the mood value that the individual wants to simulate, and his/her real mood value, **Amusement** makes use of a fuzzy function called *approach*. Depending on the *ability for simulation* degree, the mood degree that the avatar shows will be near from the real mood degree or from the simulated mood degree.

3 Updating the Internal State

The process to update the internal social-psychological model, once an initial personality profile has been previously selected or defined, as it is shown in the Figure 4, can be summarised in the following steps:

- Each time the user wants to modify his/her mood values, attitudes or intentions, he/she provides the new values for this characteristics. According

to his/her personality traits, attitudes until the moment, and to the correlation values defined in the model between characteristics, the mood values and attitudes are handled to obtain others nearer to the participant's personality. The correlation model used is written in an english-like scripting language.

- In a second step, user's intentions are applied, what can considerably modify the values obtained in the previous step (e.g. when the participant wants to simulate a different mood value). These intentions are applied according to the participant personality trait values.
- In a third step, the new values calculated for every characteristic are adapted to the previous mood values, the previous attitudes, and the past history, to maintain a certain coherence in the acts of the avatar (it avoids extreme changes in the participant mood, what could give the impression of having a schizophrenic avatar).
- Then, the participant internal state is actualised, saving the participant current attitudes and new mood degree, and updating the user's past history.
- Finally, with the definitive correlated values, the external representation of the avatar is generated.

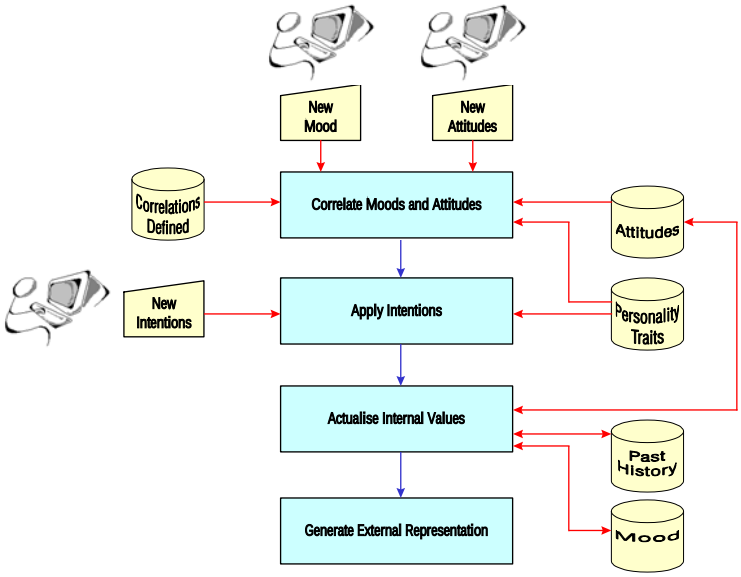

Figure 4. Internal social-psychological model updating process

This updated set of moods, attitudes and intentions is used to reflect through the avatar behaviour (gestures, movements, way of speaking…) its current internal state. Thus, when another user watches this avatar, he/she can understand how the other feels, and

react consistently, as in real life. This is a very important characteristic to be taken into account if a believable interaction in VE is desired.

5. The Intelligent Automation of the Model

As we commented in a previous point, the aim of the **Amusement** project internal modelling of the avatars is to find a balance between the believability of the virtual character and the easiness of its control by the user. A certain degree of automation of the model is required.

To begin with, there are several aspects which contribute to increase the avatar's appearance of life, such as breathing, blinking and having a dynamic glance [VILH97]. The user must be freed from the management of all these reflex tasks. Given that they are very related to the personality and mood of the avatar (e.g. the breathing rhythm increases when someone is very nervous, and reduces when he/she becomes calmed), a proactive attitude is required to manage them.

On the other hand, when an action has to be performed, it must be done as the user would do it, according to his/her personality. He/she may want to move from a place to another or to greet to another avatar, but the way to develop those tasks depends on the current mood of the user, his/her personality traits, attitudes… Again, a personalised and proactive control must be provided.

Finally, the avatar must show always an external expression coherent with its internal social-psychological model. The management of this external expression can be automated, learning from the user behaviour to provide the right appearance in each moment. Thus, if a nasty avatar greets to another, although it is very happy, its smile, for instance, will not be as broad as the one of a nice avatar. Also, if a user wants to simulate another mood, and he/she has a low degree of *ability for simulation* he/she will not attain exactly the desired mood appearance.

In order to respond in an intelligent way to all of these situations we propose the use of an agent that will act as a personalised assistant, and that will provide a coherent proactive control of the avatar behaviour, freeing the user from all the compulsory management. This agent attends to every user command, but tries to anticipate always to his/her desires.

6. Preliminary Results

In order to validate the correctness of the proposed model, a reduced but representative release of it has been developed to be tested in a game environment, where participants can play a Spanish card game called *Mus*. The main aim of this IVE has been to verify the major issues of the model: personality traits, moods, intentions and correlation among them. Other issues, such as the accuracy of the external representation, the attitudes towards other avatars, or the influence of past history in the behaviour of the avatar are current goals of our tests.

The avatars and the environment have been modelled with *Alias|Wavefront PowerAnimator 8.5*, and exported to *Sense 8 WorldUp* to generate the IVE, while the personality control engine for this first approximation has been implemented in C++.

The *Mus* game IVE consist mainly of two scenarios: a first one where the user can select the external appearance of his/her avatar (from a set of possible avatars) and specify its personality traits. The user then can interact with the virtual world to see how will it be the appearance of the avatar when a mood or intention is chosen, according to the traits selected. In this card game, the players are allowed to interact by means of a closed and standard set of signs; in this scenario, the participant can also check how is the appearance of his/her avatar when each sign is made. If the user does not like the external representation observed, he/she can dynamically modify his/her avatar personality traits.

The second scenario is the *Mus* game itself. There, the user can interact with other participants playing cards, making signs and chatting. The view you have of the virtual world is the one seen through the eyes of your avatar. Besides, as in real life, if the participants are playing around a table, a sign will go unnoticed if your avatar is not looking at the source of the sign. To free the user from the tedious task of having to select every mood degree and intention when a new set of cards is received, when a bet is to be done by any player or, in general, whenever the user wants to show a new internal status, he/she does it by giving a valuation of his/her cards or his/her new intentions. This is very easy to do, simply by pressing a single - virtual - button.

7. Conclusions

When an acceptable degree of believability within VE is sought, the first step to be taken is to build a rich and expressive environment, in order to make the user feel what the virtual world wants to say. E.g. if we are in a virtual desert we must feel heat, thirst and desolation. Current techniques already address this topic.

A second step is to provide a believable way for an avatar to show these sensations, so that the rest of the users can perceive them. This is one of the aims of the **Amusement** project.

This task implies providing the user with a lot of control elements to properly trigger the different communication channels. However, a great richness of these items can overload the user interface making tedious his/her stay in the IVE.

The **Amusement** project copes with this difficulty by automating in an intelligent way the user interface, with a complex but flexible personality model under this interface. Besides some characteristics hold by other personality models, we add some personality traits, mood and attitudes to make it more complete. On the other hand, it has some new features as intentions or the ability for simulation, hardly mentioned in the current bibliography.

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