# Eliciting Information for Multiagent Modeling using Contexts and Scenarios

## Extended Abstract

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**Abstract.** We describe a flexible, transferable and reproducible approach to eliciting information for multiagent modeling built around design elements such as contexts and scenarios. It is intended to be as generative as the socio-scientific paradigm of multiagent systems itself. The approach described performs an important function in policy modeling by grounding the modeling cycle in evidence and first principles, and creating rapport with the policy and decision maker. It furthermore addresses a central, but often overlooked plight: The ontology of the to be elicited data.

**Keywords:** Expert elicitation; Multiagent modeling and simulation; Policy modeling

## 1 Data elicitation for MAS

Eliciting subject matter expert (SME) information is standard practice in research production cycles of policy relevance. Qualitative researchers do it as much as "Bayesians" and multiagent modelers. Whereas many elicitation instruments are domain-free, elicitation requirements are not and should correspond with the inherent ontology of the underlying research paradigm. We will be speaking to elicitation for multiagent modeling, focussing on the implications of a multiagent systems (MAS) ontology for the elicited data, and not on elicitation techniques or data formalization.[1] Examples for elicitation in MAS related work are [2–8]. Specific reasons for why elicitation in policy relevant MAS projects is important are increased data specificity, stakeholder integration and reliance on first principles [6].

Multiagent models are coded by creating artificial humans, their purposive behavior and the environment they live in. Our community call these virtual humans agents. And since a model often has many interacting agents, it is called multiagent. Agents use cognitive and deliberative mechanisms to interact,

[1] One reviewer also noticed structural elements from the so called ODD protocol [1] in our work, which of course is not surprising for we are speaking against the very same multiagent modeling background. However, the ODD protocol is primarily a description protocol (also covering how data was collected), not a framework for how data for multiagent models should be elicited.

generating dynamics of the systems as a function of its initial conditions, agent choices and external shocks. To have agents interact, we simulate the virtual world. This is when multiagent models are sometimes also called social simulations. They can account for heterogeneous, spatial interactions and reflect network effects. Agents can exhibit individual, group or organizational behavior that may be driven by conflicting incentives or result from learning, anticipation and strategic deliberation. High-fidelity social simulations use valid and detailed information on the environment and the behavior of the humans they represent.

It becomes now clear why elicitation for multiagent modeling necessarily has to be idiosyncratic, because

- MAS ontologies are based on agents as decision making entities that reason and (inter-)act;
- causal and social mechanisms for MAS must be fully identified;
- simulations are per definition dynamic.

Elicitation for multiagent modeling must be able to cope with these qualities of MAS. The ideas articulated here spring from previous work of ours, which in recognition of the fact that neither from KISS [9] nor from KIDS [10] a viable data elicitation framework can be derived suggests that a plausible intuition approach [11] coupled with an already existing framework to inform dynamic agent behaviors we call *contexts* appears to be more promising. Ideally, elicitation procedures for multiagent modeling should be generalizable and transferable across cases. Necessarily they need to entice subject matter experts (SMEs) to think "multiagent" about the topic they know best. To do so we ask them about ($a$) idealtypical actors and the environment they are embedded in, their attributes, behaviors and reasoning, and their mutual relationships; ($b$) the interactions between these actors and to what aggregate behaviors that could lead; and ($c$) what plausible futures could result from these agent interactions.

More than one elicitation instrument is suitable to generate answers to these questions, but not every instrument is similarly suitable. To discuss these manifold elicitation techniques in the extended abstract at hand is not our intention. Here we would rather want to enable the reader to develop a sensorium that allows him to*chose* from elicitation instruments that are helpful in multiagent modeling. For these reasons it is important to understand—especially for those unfamiliar with multiagent modeling and simulation and the crossdisciplinary nature of such projects—that we are not only concerned with eliciting knowledge about "facts and figures" (as in $a$), but also with eliciting understanding about mechanisms and processes (as in $b$) and (as in $c$) generating plausible future scenarios based on ($a$) and ($b$).

In the following section we describe the notions of *contexts* and *scenarios*, the cornerstones of elicitation for multiagent models and simulations. In Section 3 we then provide an abstract walk-through example.

## 2 Background: Contexts and scenarios

The broader theoretical circumstances of *contexts* and *scenarios* – in the sense defined below – pertain to the basal debate on structure and agency. Together with [12] and other critical realists we adopt a balanced standpoint between autonomous choice and social constraints, both of which individually and the relationship between them are variable over time. The argument has very practical implications for methodology in the social sciences, including macrosociological approach, methodological individualism, and in fact multiagent modeling and simulation, and should also be reflected, we argue, in elicitation procedures.

*Contexts* were developed to fully specify domain-specific agent behaviors for multiagent modeling. Scenarios is thinking contexts in time. As concepts they cover agency and structure those basal notions so important for MAS and therefore also for informing data elicitation for multiagent modeling.

Context is a minimally sufficient, non-exclusive, nested region of a socio-natural space that explains specific human behaviors in that space. The notion of context divides socio-natural processes into isolated flows by imposing spatial, temporal, cognitive, and agency boundaries on them. The definition of context specifies the following key elements: Behavior, actors, state, context, contingencies, environment and enablers. A template for the description of a context is depicted in Table 1.

**Table 1.** The context template.

| Context name | | |
|---|---|---|
| Initialization | Description of which situation or other context initializes the context. | |
| Actors | Listing of the actors involved in the context. | |
| Decision making | Information | Definition of which information the actors can access to reason in this context. |
| | Objective | Name the objectives of the context. |
| | Actions | List the actions the actors can perform in the context. |
| | Reasoning | Explain the actors' reasoning mechanism. |
| | Contingency triggers | List the contingency contexts the context can trigger. |

Scenarios describe different ways of how plausible futures might unfold. In the case at hand we define a scenario as consisting of an initial situation $S_0$, subsequent situations $S_{t,n}$ that when evolving consecutively form a causal trace and when evolving concurrently constitute alternative scenarios. Each situation is an instantiation of a context. Moving along a trace from situation to situation is the result of agent decision making (if exogenous causes are excluded). Each situation can be described using the context template as depicted in Table 1.

## 3 Elicitation for multiagent modeling in action

The proposed elicitation process starts with eliciting ($a$). To do so the SME is exposed to an $S_0$ in which we lay out our view of the target system. This serves to prime the SME, to create rapport between the SME and us, and to establish a shared understanding of the situation. The SME is then encouraged to think more deeply about $S_0$ by listing actors necessary for $S_0$. This provides the expert with an opportunity to endorse $S_0$ or repudiate and correct it. Through systematic questioning and answering Table 1 is worked through (using various elicitation instruments *to be determined* on a case-by-case basis) and gradually a thicker and thicker description is provided about initialization, actors and decision making, and the web of relations between actors ($b$).[2] An SME owned $S_0$ should be the result.[3]

So far we have adopted a static view. However, MAS are inherently dynamic (and rendered so explicitly expressing them as computer code and running them as simulations). The next step is to therefore continuously explore with the SME the span of possible changes in the contexts as described in Table 1 across situations ($c$), and learn in such a way together with the SME not only about future scenarios evolving out of $S_0$, but also about other contexts and how actor decision making adapts and evolves. For this purpose the SME can be asked to think through specific situations or entire scenarios. For example, the SME can be asked to elaborate on how actors reason differently in different situations or how interaction patterns change. When it comes to entire scenarios, the SME can be either asked to develop herself plausible scenarios $S_{1,1}$, $S_{1,2}$, $S_{1,\ldots}$, $S_{1,n}$ (where the first number in the subscript denotes a moment in time and the second number denotes specific alternative situations in that moment in time) starting with $S_0$ (see above) or the SME can be presented with scenario labels (e.g., crisis, success, etc.) to trigger an explanation of that scenario (if deemed plausible).

The gradual difference between eliciting ($a$), ($b$) and ($c$) is visualized in Figure 1. Each time we inquire about contexts in alternative scenarios—not necessarily

[2] How to deconflict information elicited from different SMEs does not fall under the purview of this extended abstract, although it is an important issue. It should not escape the reader's attention that eliciting diverging plausible futures is the purpose of scenario elicitation.

[3] What individual instrument we used is not important here, suffice to say that we used in the past play cards and whiteboards, but computer assisted classification and pile sorting games can be imagined too.

counterfactual ones—the SME will provide alternative configurations and further details about context initialization, actors and decision making. Instead of a static description of only one situation, a narrative forms gradually across numerous situations—in essence being instantiated contexts—, generating a thicker and thicker description of the phenomenon under investigation.[4]

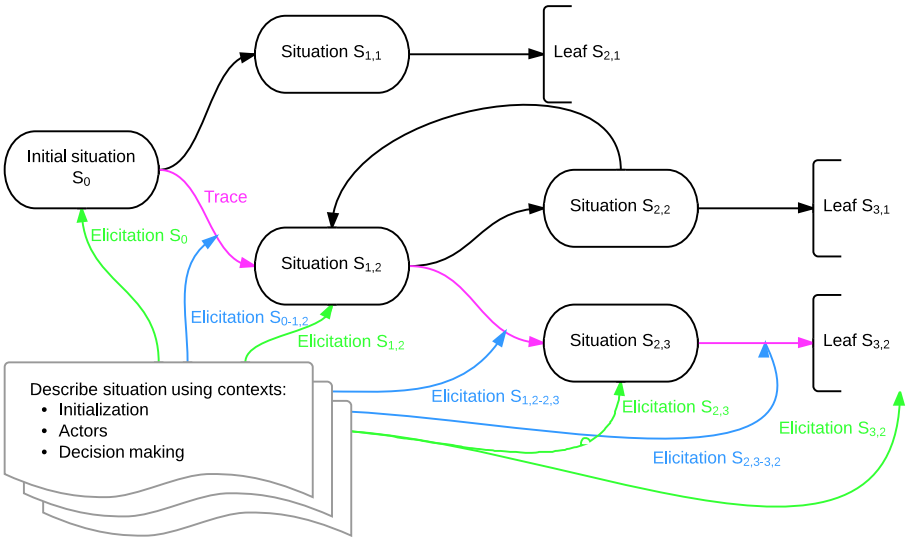


**Fig. 1.** The multiagent modeling elicitation process.

Ultimately it is narrative scenarios that we elicit and they can be visualized as contingency trees as shown in Figure 1. It's instantiated contexts, that is situations that provide the rich content; it's causal linkages of situations across time that creates a narrative, that is a trace. Together they create meaningful *scenarios*.

## 4 Conclusions

The multiagent modeling elicitation process presented is a flexible, transferable and reproducible elicitation framework built around context and scenarios. Unlike most elicitation frameworks it is inherently generative, as are MAS. At this stage, its main purpose is to ontologically align the multiagent paradigm of the model and simulation and the target system in order to elicit the right data. While data collection techniques and data formalization are often thematized, the nature

[4] The semantic proximity to grounded theory is not incidental given its emphasis of concepts, change and choice [13].

of the to be elicited data is not. Using contexts and scenarios in multiagent elicitation furthermore bases the modeling cycle on evidence and first principles and creates rapport between the modeler and the policy and decision maker.

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