



Tools and Methods for Supporting the Development of Ubiquitous End-User Simulations

Miriam Greis

University of Stuttgart

Institute for Visualization and Interactive Systems

Pfaffenwaldring 5a, 70569 Stuttgart

miriam.greis@vis.uni-stuttgart.de

Abstract. Predictive simulation is a powerful technique used by experts to support them in decision-making. We envision that non-experts will also use this technique in the future. Interfaces showing predictions, as, e.g., navigation systems that predict the arrival time, are already on the market. An important aspect of these interfaces is the uncertainty of the input parameters and the output. In our research, we aim at developing interactive input methods and visualizations for communicating uncertain data. Therefore we develop a modelling and simulation tool for non-experts which allows to evaluate interactive input methods for uncertain parameters and different types of visualization for uncertain data. The results of our research will support the future development of predictive simulations for non-experts and help to avoid unintentional manipulation by choosing the best input methods and visualizations.

1 Introduction

Simulation is a powerful technique to build and examine models of real-world systems. It is one of the most used techniques in research and management science and can be applied in many disciplines [4]. Simulations help to better understand or develop strategies for the management of complex systems in cases where adapting the real system is impossible or too expensive [8].

At the moment, simulations are only used by experts that have specialized knowledge in model building or simulation execution and both programming and mathematical skills. So far, non-experts, which we consider to be people without programming skills and knowledge about simulations are not able to use simulations, although simulations could also support decision-making in everyday life. Nevertheless already today, people rely on predictions about, e.g., the weather or the arrival time when traveling. They additionally use predictions implicitly to foresee future events and plan activities. Predictive simulation would be a powerful technique to support non-experts in making predictions explicit and more reliable.

One key aspect of simulation usage is the input and output of uncertainty. During the modeling process, uncertainty in the assumptions of the model and uncertainty in the parameter choice have to be taken in account. Thus, also

simulation results are uncertain. Allowing the input of parameter uncertainty and communicating the uncertainty in the output is crucial to avoid unintentional manipulation of non-expert users.

The research supervised by Prof. Dr. Albrecht Schmidt therefore aims at developing and evaluating input and output methods for uncertain data in the context of predictive simulations.

2 Related Work

Simulation tools for non-experts with an educational purpose were already developed very early. Two of the first tools were the Alternate Reality Kit [10] and Playground [2]. Smith et al. [9] and Cypher et al. [1] developed the simulation tool KidSim especially for children. It uses the principle of programming by demonstration/example. StarLogo [6] allows the user to attach puzzle pieces to each other instead of programming to construct a model. Another simulation tool for non-experts is NetLogo [11], which requires users to have a basic programming knowledge for creating own models. All these tools use agent-based modeling to impart knowledge about simulations, but could not be used to support decision-making for non-experts in everyday life.

No work so far was done about the input of parameter uncertainty for non-experts, but a lot of previous work exists on the output of uncertain information. One strand of work for example investigated uncertainty information in weather forecasts. Morss et al. [5] found that most people are aware of the uncertainty in deterministic weather forecasts, although the range of this uncertainty was perceived very differently. Additionally, 70 % of the people preferred forecasts that contained information about the uncertainty of the forecast. Studies by Roulston et al. [7] and Joslyn et al. [3] showed that people make better decisions when having information about the uncertainty of a forecast and that information about the uncertainty also increases the trust in a forecast.

Overall, previous work about uncertainty communication focused on very specific scenarios from which results cannot be generalized. Additionally, there was no research-in-the-large approach used so far.

3 Research Approach

Our research approach includes three main aspects. First of all, we investigated strategies and tools used by simulation experts to get an overview about simulation usage and challenges. Second, we started to analyze the usage behavior of non-experts to understand how they currently use predictions and simulation results. Additionally, we identified challenges, benefits, and wishes to develop use cases and requirements for the future

usage of simulation services. The third part of our research approach includes the design and implementation of a simulation tool that allows domain experts to create models that can then be executed by non-experts.

3.1 Research Claim

We assume that non-experts will be able to understand basic concepts of modeling and simulations and can use easy tools to interact with them. This includes the input and understandable output of uncertain data. Input and output modalities for uncertain data can be standardized and categorized to make the input and output of uncertainty easier for users and developers.

3.2 Methods

At the beginning of our work, we used multiple different methods to get insights into current simulation usage of experts and non-experts. We conducted an online survey and a paper questionnaire with researchers working with simulations. We also run a diary study with non-experts to understand how they already use predictive simulations in everyday life and conducted focus groups with both experts from research and non-experts to get insights in their understanding of the term simulation and potential future usage scenarios. We additionally conducted an online survey to compare existing representations that involve uncertainty.

Currently, we plan to do research-in-the-large with an online game and a web-based online modeling tool. With the help of the modeling tool, we plan to investigate a specific usage scenario and evaluate whether non-experts are able to construct valid models with the help of an interactive platform. We additionally will use the web-based tool to run user studies on the usage behavior and user experience of input and output methods for uncertainty for methods that already exist and for methods that we specifically designed. We plan to further evaluate our input and output methods with the help of eye tracking.

3.3 Solution and Contributions

The research work contributes a web-based framework that allows the evaluation of input and output methods for modeling and simulation tasks and will as well support the collection of usage data. The included modeling tool allows non-experts to model relationships for at least one specific use case. The research further contributes ideas, use cases, and prototypes for new simulation services that can support non-experts in everyday life.

With the help of the web-based simulation framework, we will also provide a set of evaluated input methods and a set of evaluated output methods for uncertain data that will be made available for web developers.

4 Open Questions and Issues

Open questions include sharpening the research topic and finding a focus. Additionally, finding connections to current topics in Human Computer Interaction, other researchers, and the community in general is an open issue.

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