Bare Demo of IEEEtran.cls for Conferences

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***Abstract*—In this paper we present relevant definitions and design considerations of special interest to those interested in human-behavior modeling software. The guidelines presented here are based off of a user-survey and expert-panel review performed in development of the BehaviorSim model-building tool designed especially for use in behavioral science. Lessons learned through iterations of this tool and unique considerations for those targeting behavioral scientists are highlighted. Our initial survey of 12 behavioral scientists reveals the diversity of opinions on and approaches to behavior modeling within the community. In order to address this, a theory-agnostic method for defining Human Behavior Models (HBMs) is proposed and techniques for supporting different modeling paradigms within a single user interface are discussed.**

I. INTRODUCTION

* what is an HBM? (in short)

* why are they important for the future behavioral research? [**?**]

* why do researchers need a tool for HBM development?

II. RELEVANT LIT

* other modeling softwares (and why it doesnt fit this use case)

* HBM examples /citeRivera

A. What is a Human Behavior Model?

In contrast to a cognitive model, a human behavior model attempts to model the human systems conversion of measurable contextual information into measurable behavior outcome. The variety of applications including something which may be considered a human behavior model is vast, but some of these applications better fit with the goal of increasing understanding of human behavior. For our purposes, we describe three classes of human behavior models based on the expected application domain 1) models developed to act as automated decision agents, 2) models developed to identify emergent behavior of a population, and 3) models developed as predictors of behavior. Using this classification scheme, it becomes clear that the methods underlying automated agents and emergent behavior simulations are less in line with the goal of behavioral theory development, and thus a focus on behavioral forecasting models is taken.

1) Automation Agents: Anyone familiar with agent-based modeling is likely familiar with the behavior-desire-intent (BDI) agent architecture which has found countless applications in the automation of industry tasks such as (EXAMPLES). Agents of this type attempt to reproduce specific decision-making tasks reliably and predictably so that the task may be automated. Though extremely useful in robotics and artificial intelligence systems, these models often do not seek to represent true human-like behavior, particularly the seemingly unpredictable and irrational components. The goal of automation agent research is to develop an agent which can be easily told what is to be done, can express an interpretation of the given task, and can automate the task at hand reliably and accurately.

TODO FIGURE: Human-Behavior Models designed to automate tasks such as controlling the flow of fluid between two tanks of liquid.

Agents designed to replicate decision-making tasks have also found use in military strategy planning and video game AI, and through these applications have begun to incorporate variation, randomness, and personality into the agents (http://www.agent-software.com.au/applications/realistic_virtual_actors_2/, cojack,). According the terminology as defined here, this type of agent is no longer classified as an automation agent – though they may be based on the BDI architecture, because the goal is no longer to simply automate a task.

2) Emergent Behavior Studies: Though the term agent-based modeling is often used to refer to models developed for the automation of a task or decision process (such as agents based on the BDI architecture), agent-based modeling techniques are also used to study the emergent behavior of a many-agent system. These emergent-behavior systems typically use a relatively simplistic agent definition and an environment with many agents to observe the behavior of the system as a whole. These agent models have found use in traffic simulation (Zhao 2013), MORE, and even molecular modeling (GROMACS 4.5: a high-throughput and highly parallel open source molecular simulation toolkit, Identifiability and observability analysis for experimental design in nonlinear dynamical models, bionetgen, stochsim).

TODO: Figure: Emergent Behavior studies focus on interactions of many behavioral agents sharing one environment.

Human behavior models developed to explore emergent behavior often neglect the intricacies of each agents inner workings because they are designed for efficient computation and accuracy on the level of the system rather than the individual.

3) Behavioral Forecasting: Lastly, models of human behavior are created to allow for predictive modeling of a behavioral phenomenon. Models in this category fit the definition given by Glanz and Rimer (2005 p4): ”a set of interrelated concepts, definitions and propositions that present a systematic view of events or situations by specifying relations among variables, in order to explain or predict the events or situations”. Since this type of model is useful for predicting and understanding the state of a user, formulations of theory may help overcome one of the most critical hurdles of affective computing and allow for automated intervention personalization and contextualization. A forecasting model can allow a human-computer interface to alter its behavior to help the user achieve a desired state. These models are also useful for those designing a human-computer interface or a cyber-physical system in that they can be used to estimate the ways a human may act.

TODO: Figure: Human behavior models which forecast human behavior focus on the translation of environmental context and internal state to future actions.

These models can be personalized to a subset of the population, to an individual, or may be generalizable to any healthy individual. Many machine learning models of human behavior and cognitive theories both fall into this category, and this type of model is of special importance to the future of automated health management systems. Tailored behavioral interventions, wearable sensing devices, and mHealth applications all operate based on an underlying model of human behavior which has (thus far) remained implicit in nature. Though all three presented classes of human behavior model may contribute to the development of the next generation of models and theories, the primary focus of this paper henceforth is on terminologies as applied to this type of human behavior model (type 3: personal forecasting).

It is important to note that behavioral forecasting models have applications outside of personalized predictions. Behavior forecasting models can be applied in a simulation of a population of virtual humans and compared against real data to examine the fidelity of the model or to analyze the possible effects of certain contextual stimuli.

* UI for specialist systems

III. User Stories

how does HBM model building fit into research process?

IV. Design Guidelines

(overview and definitions)

* single-page design

* information-searching / focus+context design

* walk-through first use instead of tutorial (see, copy, do) /cite?

* use existing terminology (but also define it)

In the ideal modeling toolkit, trained machine learning models can be tested alongside dynamical systems formulations of behavioral theory. Though greater accuracy may often be achieved using a data-driven model, the theoretical formulation may provide additional insight into the system behavior, and connections to conceptual models can be drawn. Enabling easy system configuration allows researchers to leverage the best of all fields, creating a balance between predictive accuracy and model clarity depending on the users needs. The system configuration must have an intuitive high-level representation, and a highly-detailed interface for defining specifics. The user should be given the option to make many modeling assumptions to maximize ease of use, or to make few assumptions to ensure modeling specificity. Model re-use and extension must be supported by allowing concepts to operate in interchangeable modules, requiring carefully-defined standards for interface between modules. The ideal toolkit also supports model evaluation, comparison, optimization, and exploration to aid the user.

A. UI considerations

Ease of use and intuitive user interface is a primary design consideration for existing softwares for modeling and simulation in systems theory. (reference and cite vensim, etc, from here) The ease of use of a system is one of the most important factors in the adoption of the system. (cite technology acceptance model?) The trans-disciplinary nature of a human-behavior modeling toolkit may require special consideration in order to be usable by those who may be unfamiliar with modeling and simulation concepts.

TODO: Figure: path2flow.png example of the rise in model complexity for the theory of planned behavior when mathematical assumptions are made explicit. (from: Ajzen 1985,1991,2002 (left), Nandola et al. 2013 (right))

V. Methodology

* user survey

* expert panel review

VI. Informing User story w/ survey data

what do the users want? (ref user survey)

VII. Design guideline support and examples from past iterations of model builder

* multipage vs single-page (v0.1-¿v0.2)

* inquiries in panel-reviews

* single-page is overwhelming

* multiple terminologies from user surveys /citeontology customizable?

VIII. Conclusion

The conclusion goes here.

REFERENCES

[1] H. Kopka and P. W. Daly, *A Guide to LaTeX*, 3rd ed. Harlow, England: Addison-Wesley, 1999.