# Agent-based modeling 2.0
## Data-driven selection of model structure

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# *Agent-based modeling 2.0: data-driven selection of model structure*

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***Abstract*—Agent-based modeling is useful to simulate the human role in socio-technical systems. Thereby, the complexity of such systems can be captured. For instance, it has shown to be useful at simulating innovation in socio-technical systems. We develop a next step in which laborious model building is automated. We present a working example on innovation diffusion leading to consumers changing their heating behavior.**

***Keywords*—agent-based modeling; simulation; innovation diffusion; automation**

Agent-based modeling is useful for supporting policy decisions by giving insights into the *actor behavior* in a system. It is important for simulation to reveal driving causalities and mechanisms of a system, in which the behavior of actors (the human role) is explicit. This insight eventually helps to further develop theory, and it can be directly applied to develop effective policy interventions [1].

A limitation in agent-based modeling practice is that models are typically developed from a limited variants of actor behaviors (often one), and validated with a limited set of data (often one). This bears the risk of limited understanding [2]. It has therefore been advocated to turn this approach around: defining multiple empirical patterns and then testing multiple actor behaviors for their ability to explain these patterns. Patterns thus identify realistic model variants [3]. We propose to advance modeling practice into this direction by automated model building. Thereby, a multitude of actor behaviors and empirical patterns – instead of increasing complexity of the modeling task – can be modeled labor-efficiently. We coin a method as specified in Fig. 1, comprising the phases *preprocessing*, *inverse modeling*, and *policy simulation*.

*Preprocessing* of input data is provided on agents (i.e. the decision-making entities in an agent-based model) and a network graph, representing interactions between agents. Patterns are provided as functions that each calculate coherence of a simulation run with an empirical 'fact'. A 'target' describes the desired behavior of an accepted simulation model as a cost function, combining the provided patterns in any desired way.

*Inverse modeling* identifies models that satisfy the given target. A collection of models is simulated at varied parameters and model structures. This variation follows a *simulated annealing* optimization to efficiently identify models that meet the target.

*Policy simulation.* User-defined policies can be assessed in an automated way, based on the accepted models. Policy impacts are simulated and reported to the user.

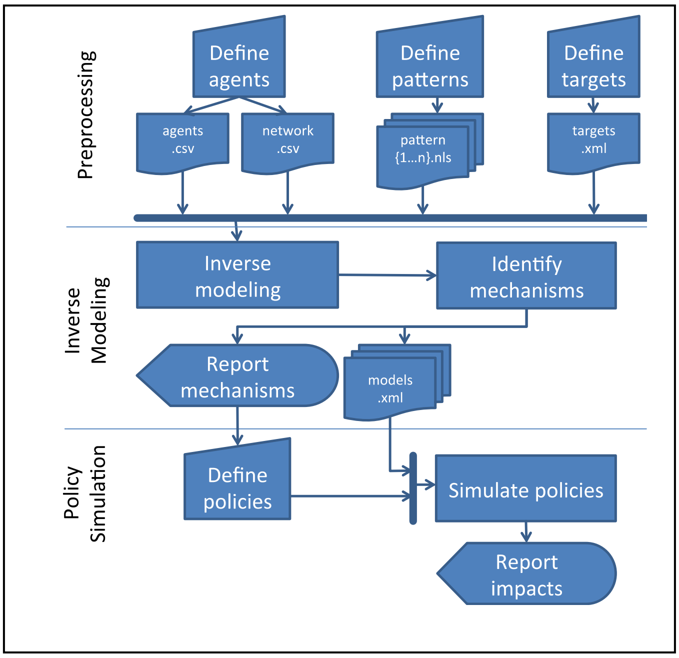


Fig. 1. Specification of automated model building approach

We applied this approach for the first time to the diffusion of green product innovations among households. This improved a previously published model on the diffusion of water-saving shower heads. The automation procedure proposed a change to model structure, which improved realism of simulation results. It also allowed us to identify effective and cost-efficient policies to support the future diffusion of such products.

Future research will tackle more cases of diffusions of innovation, which will be available for presentation at the time of the symposium. We further envision application of this approach to other fields of innovation, e.g. the diffusion of conservation practices among energy consumers.

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