Describing economic agent-based models – Dahlem ABM documentation guidelines

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Abstract

This working paper presents guidelines for the documentation of economic agent-based models, based upon – but differing from – the ODD protocol Grimm et al. (2006, 2010). The guidelines were developed by a group of people during the 100th Dahlem Conference, New Approaches in Economics after the Financial Crisis, Berlin, Aug 28-31, 2010. This text merely states the first version of the guidelines for reference. A paper that also discusses the motivation for coming up with a new set of guidelines for describing (large scale) economic agent-based models is in preparation.

1 The Dahlem ABM documentation guidelines

The authors should provide a description of their model using the following template, consisting of overview, design concepts, and functional specification. This description concerns the model per se; specific research questions and computational experiments are not considered here. Modellers are encouraged to make source code and data publicly available. If this is not possible, it should be stated.

1.1 Overview (max. 3 pages)

This section gives an overview of the model in natural language (with embedded technical concepts). Authors are encouraged to illustrate it by an image they find appropriate. This overview should fit into the following structure.

- Rationale
  What is the object under consideration (e.g. a financial market, the world economy)? What is the intended usage of the model (e.g., theory generation, forecasting, policy analysis, etc.)? Which issues can be investigated (e.g. determinants of wages, evolution of trade networks)?

- Agents
  What kind of agents (decision-making entities) are considered in the model? Is there a refined taxonomy of agents? In particular, are there agent groupings which are considered relevant?

- Other entities
  What are the other entities which are time-evolving but not decision-making?

- Boundaries
  What are additional inputs to the model at runtime? Which outside influences on the model are hence represented?

- Relations
  What kind of relationships structure the agents' interactions (e.g. networks)? To which extent do these represent institutions (e.g. labor market, states)?

- Activities
  What kind of actions and interactions are the agents engaged into?

1.2 Design Concepts (max. 3 pages)

In this part of the documentation various aspects of the general modelling approach should be spelled out using natural language. Details of how the actual model looks like should be provided in the following section 'Functional Specification'.

- Time, activity patterns and activation schemes
  What is the basic sequence of events in the model? Are activities by agents triggered by a central clock or by actions, respectively messages sent, by other agents? What is the interpretation of one time unit in the model?

- Interaction protocols and information flows
  What are the general properties of the protocols governing the interaction between agents? How is determined which agents can interact with each other (e.g. all agents, local interaction, networks, ...)? What kind of information is available to each agent? If agents interact within institutional frameworks like firms or markets, what are the main properties of these institutions (e.g. auction markets, matching markets,...)?

- Forecasting
  Are agents in the model forward looking or purely backward looking? If agents are forward looking, what is the basic approach to modelling forecasting behaviour (e.g. naive forecasting, econometric methods, CI-methods,...)?

- Behavioural Assumptions and Decision Making
  Based on which general concepts is decision making behaviour of the different types of agents modelled (e.g. based on experimental evidence, solution of some optimization problem, heuristics, documented behaviour of real world firms, established models from the literature,..)? If the decision making of certain agents is influenced by their beliefs, how are these beliefs formed?

- Learning
  Are decision rules of agents changed over time? If yes, which types of algorithms are used to do this?

- Population Demography
  Can agents drop out of the population and new agents enter the population during a simulation run? If yes, how are exit and entry triggered?

- Levels of Randomness
  How do random events and random attributes affect the model?

- Miscellaneous
  Any important aspects of the used modelling approach that do not fit any of the items above should be explained here. For example, mathematical properties of the model that are considered relevant should be stated here.

1.3 Functional Specification

This section provides a detailed description of the agents, other entities, their actions and interactions, the initialization procedure, and runtime-input requirements. It is closer to the implementation of the model, but need not be so detailed as to allow the reader to re-implement it. Rather, the level of detail should be determined by what is needed to provide a good understanding while not overly straining the reader's patience. Using natural language and pseudocode is encouraged.

- Description of Agents and Other Entities, action and interaction

name	type	description	updating	initialization
Firm				
region	Region	Region where the Firm is located	fixed	computed
circulatingInputCoefficients	$[0,1]^{N_G}$	Input coefficients for circulating capital	periodicity w	computed
producedQuantity	$\mathbb{R}_+$	Quantity of good produced	periodicity 1	0
wage	$\mathbb{R}_+$	Wage offered in new work contracts	volatile	user input

Table 1: Extract from a possible table of firms' state variables. Here, "Region" is an object in the model, N_G denotes the number of goods (sectors) in the model, w the periodicity of the step that can change the circulating input coefficients of a firm, "volatile" means that a variable can change more than once per period. Any useful categories can be used in the last two columns, given that they are also explained.

- *What, in detail, are the Agents and Other Entities in the model? What Agent/Other Entity does what and in which order? For each kind of Agents/Other Entities, what are the model state variables (in principle what is needed to restart a simulation, i.e., all auxiliary variables that can be computed from these do not need to be listed) and parameters? List their type, that is, dimensions and admissible range, a short description of what they represent, units of measurement, how often they are updated (in models with different time scales) and how they are initialized, e.g., as a fixed value, from user-given input data or by a computation out of these data. The following table is an example, further columns can be added if other information seems useful. Depending on the length, the table should be put into an appendix.*

What information and with whom does each kind of agent exchange for decision-making? When are state variables updated? How are state variables updated (specify equations, diagrams, or pseudocode for algorithms related to rules-of-thumb, learning, adaptation, forecasting, interaction, etc)?

- Initialization
How is the model initialized? Which kind of input is needed? How is the initial state obtained from the input? Are the initial values chosen arbitrarily or based on data? In the latter case, what kind of data is needed?

- Run-time input
Does the model use input from external sources that drive the model (Drive means that one or more state variables or processes are affected by how these external variables change over time, but these external variables are not themselves affected by the internal variables of the model)? Are there data files or other models that represent these external processes? If so, what kind of data is required to feed the model at runtime, (e.g. time series of the oil price or temperature data)? Include, if possible, references to relevant literature, or a description of the external models. If a model does not use external data, please state this here.

2 Summary template

2.1 Overview (max. 3 pages)

- Rationale

- Agents

- Other entities

- Relations

- Activities

2.2 Design Concepts (max. 3 pages)

- Time, activity patterns and activation schemes

- Interaction protocols and information flows

- Forecasting

- Behavioural Assumptions and Decision Making

- Learning

- Population Demography

- Levels of Randomness

- Miscellaneous

2.3 Functional Specification

- Description of Agents and Other Entities, action and interaction

- Initialization

- Run-time input

References

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