11/22/2105

Treating Agent-Based Models as Mathematical groups

# The nature of the group

To be a group an algebraic structure must satisfy four conditions called group axioms: closure, associativity, identity and invertibility. There is an operator which takes two elements of the group and yields a third element.

## An Analysis of a Generic ABM as a Group

### Elements: Following Whitehead (2014), we call the elements of our group *prehensions*. A prehension can be roughly understood as a state of affairs in the world *as seen from a particular point of view*. (In this case the world is the world of our model [see Morgan 2012], but Whitehead views this as a useful metaphysics for the actual world.)

### Operation: The operation •, which we will call “act”, accepts two prehensions as arguments and produces a third prehension.

### Axioms:

#### **Closure:** Every act involving two prehensions will produce a third prehension.

#### **Associativity:** (a • b) • c = a • (b • c) In a typical agent model, this will mean that we must ensure that, say, a neighborhood can interact with a neighborhood (b • c), and then with an agent (a • (b • c)). Furthermore, this must produce an identical prehension to that produced by an agent interacting with one neighborhood and then another one ((a • b) • c).

#### **Identity:** Any prehension acting in concert with the null prehension remains unchanged.

#### **Invertibility:** For any prehension, there is another prehension that combines with it to produce the null prehension.

# The advantages of employing this abstraction

## Why bother?

### We achieve a uniform template for all models. Programming new models becomes much easier.

### We will have taken a huge step towards enabling “fill-in-the-template” style programming of ABMs.

# a sketch of the usual action pattern

An agent gathers together a prehension of its environment, and then combines that with how it presents itself to the environment (how it is prehended) to produce a new prehension, which it adopts as its own. The new prehension may simply be adopted, or it may trigger some further step, such as a move on the part of the agent.

However, while the above may be typical, our model allows the reverse: in some models (e.g., Forest Fire), it may be the environment that adopts the new prehension.

# Bibliography

Morgan, Mary S. 2012. *The World in the Model: How Economists Work and Think*. Cambridge; New York: Cambridge University Press.

Schelling, Thomas C. 2006. *Micromotives and Macrobehavior*. New York: Norton.

Stepanov, Alexander A, and Daniel E Rose. 2015. *From Mathematics to Generic Programming*. Upper Saddle River, NJ [u.a.]: Addison-Wesley.

Whitehead, Alfred North. 2014. *Process and Reality*. [S.l.]: Free Press. http://rbdigital.oneclickdigital.com.