



Rigour for Agent-Based Modellers
– *an accessible guide for the perplexed*
(*as well as for the over-confident*
who ***might*** not be perplexed but ***should*** be)

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What do I mean by “*rigour*”?

- **Stakeholders** (those who use the results of our simulations) need to know they can **rely** on the results (or, more accurately: *what* to rely on it for, *when* and *how* they can rely on them)
- They will not be able to sufficiently assess the quality of the simulation – they need the modelling community to have ensured this, by imposing sufficient standards to ensure quality, etc.
- **Other modellers** need to know you are not wasting their time when they give your simulation and its results their attention
- Adhering to sufficient checks and procedures to achieve this is what I mean by “*rigour*”

But standards are double-edged



- Having agreed standards ensures that all simulation work has gone through a minimum of checks and adheres to core principles
- But everybody (*secretly*) **hates** standards – it imposes more work on them and they may not agree with their exact formulation
- We all want everybody else to adhere to them, but they make research less fun for us
- Standards can be inflexible and can date quickly (rigour mortis?)
- Researchers often respond to such lists with a shallow, tick-box, approach – going through the motions but not taking them seriously

Agreeing what is in the standard is *hard*



- Everybody has their own favourite issues, what is important and what is not so important
- We all want to include what we routinely do, but not the things we do not currently do
- There is a danger of “*purity spirals*” developing, where people compete to be the “true adherents”, making it very hard for newcomers
- Checks and processes are often purpose- and situation-dependent, making them difficult to describe concisely (but long standards are not read)

The approach I am suggesting...



- *Aims* to encourage higher quality standards
- *Is appropriate* to the situation it is going to be presented/used within
- *Is staged*, so that newcomers are presented with something they can cope with, but are added to as one progresses further – a “quality ratchet”
- Is presented as *a set of norms* – you do not have to adhere to them all the time, but you have to justify any deviations from them
- I am only presenting *a starting point* – I hope many others will contribute in the spirit they are meant so they become a *community* standard

I suggest *four* levels



- (1) for one's own understanding
- (2) when presenting a model to an audience for discussion
- (3) when publishing in a journal article
- (4) where the modelling may influence decisions that affect people's lives

Different levels of rigour are appropriate for each, as errors have different consequences in each

Modellers naturally progress through these, roughly in this order

For the detail you will have to read the paper!

Level 1: *for one's own understanding*



The danger is you confuse yourself and waste time

1. Get on top of the modelling basics before worrying about rigour – make it somehow work
2. **Think** about *what* you are trying to achieve with your model at any point in time
3. **Keep track** of your model code *as* it develops
4. Find out more about *what is happening* in your model by *messing* with it 😊
 - a) Program lots of graphs, measurements, traces etc. to show what is happening in your model
 - b) Do lots of different experiments with it

Level 2: *presenting to others for discussion*



The danger is you waste others' time with flawed results or bad code and it can be embarrassing

1. Adopt an adversarial approach to your model, as if it is trying to deceive you –a “threat analysis”:
 - a) Identify limits/possible weaknesses
 - b) Plan how to mitigate/guard against these
 - c) Assess the success of these and remaining limits
2. Document your modelling clearly, in your code and using ODD or similar

Level 2: *presenting to others for discussion*



3. Actively look for bugs in your code:
 - a) Think about your code
 - b) Anticipate some of the possible errors and check this
4. Do *systematic* experiments
5. Assess your progress and be honest about achievements and limitations:
 - a) *What do we know **with** the model that we would not know **without it**?*
 - b) *How might you be wrong about your conclusions?*

Level 3: *when publishing in a journal or top-level conference*



The danger is that you waste *many* people's time, confuse with mistaken results and take up space that could have been better used by another. Once a paper is cited it is hard to undo its influence

1. Get serious – deciding your *exact* model purpose, plan what to do, keep to this plan
2. Make your model “open” – freely available on a public archive with ***complete, multi-level documentation*** and appropriate ***licensing***

Level 3: *when publishing in a journal or top-level conference*



3. Use **well-structured code** with **internal checks**, lots of **monitors**, **graphs**, **visualisations** etc.
4. **Justify** and **fully describe** runs and results. The audience should be clear why you are doing these runs, and what you are measuring
5. **Strong validation** of any conclusions (the inference from simulation+results → conclusions should be water-tight) this should be relative to your declared model purpose
6. Use **honest** and **cautious** language – resist speculating about what the model might do

Level 4: *when modelling results might affect people's lives*



Danger is that results are not reliable, are not well understood and so might deceive policy makers into making bad decisions.

- Mistakes at this level might bring ABM and social simulation into disrepute as well as causing harm
- This needs considerable community agreement and development, with high standards
- Thus I do not describe these in the paper or here
- This is developing work – please get involved! 😊

The End!

References and a set of developing links and resources on rigour for ABM:

<http://cfpm.org/rigour>

Bruce Edmonds: <http://bruce.edmonds.name>

Centre for Policy Modelling: <http://cfpm.org>