

MAP-AWARE NON-UNIFORM AUTOMATA (MANA)—A NEW ZEALAND APPROACH TO SCENARIO MODELLING

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Abstract: New Zealand's Defence Technology Agency (DTA) has developed a model to explore new methodologies for modelling warfare. The model, Map-Aware Non-Uniform Automata (MANA), is based on the ideas of complexity science, and is intended to capture at least some of the non-linear dynamics inherent in actual combat. It does so by treating the many "intangible" aspects of combatant behaviour in terms of simple rules subject to a stochastic process. It is evident by examining the model that even simple rules lead to complex behaviour. The simple nature of the model allows both rapid parameter space exploration and experimentation with co-evolving tactics, yet it has enough sophistication to produce realistic looking behaviours and tactics. This paper discusses the model and its philosophy.

INTRODUCTION

Origins

Map-Aware Non-Uniform Automata (MANA) was designed by the Operational Analysis Section of the New Zealand Defence Technology Agency (DTA), as a result of limitations experienced with the other models available through the America Britain Canada Australia (ABCA) agreement, namely CAEn and Janus. While these models purport to be detailed, highly physics-based and rigorous, it becomes immediately clear that they are quite limited once one starts to try to analyse the value of things such as situational awareness, command and control, the informational edge that enhanced sensors provide, and the personalities of the protagonists.

This is principally because these aspects can only be represented within these two standard models in an arbitrary way. Furthermore, the behaviour of the entities within these two models is largely pre-potted. It is difficult to get the entities to behave in a way that is realistic, particularly if circumstances change from run to run.

MANA is based on two key ideas:

- that the behaviour of the entities within the model (both friend and foe) is a critical component of the analysis; and
- that highly detailed models are often too focused on irrelevant aspects to be useful for determining robust force mixes which survive under a wide range of circumstances.

DTA is not alone in this frustration with the array of conventional combat models available. We have been collaborating in this work with several groups, including Australia's Defence Science and Technology Organisation (DSTO) Land Operations Division and the US Marine Corps Combat Development Command's Project Albert [1] initiative. Our mutual aim is to develop models and tools for better describing complexity on the battlefield and exploring the associated parameter spaces.

Emphasis on Behaviour

Although entities in the MANA model are assigned behavioural characteristics, it is not intended to be able to describe every aspect of a military operation. There is no

inbuilt "intelligence" which determines the plan to which the MANA entities work. Consequently, careful thought must be given to setting up a scenario, with a clear idea of which aspect of warfare the scenario is addressing.

Though such an approach may seem pre-potted, the non-linear nature of the model ensures that, regardless of the modeller's preconception, a startlingly large number of outcomes are possible even for moderately complicated scenarios. This leads to a much greater likelihood of extreme cases being generated by the model, so that a much larger number of runs are needed to generate robust statistics. For example, CAEn is typically run by ABCA countries 30-odd times per parameter set, and typically generates approximately normal probability distributions. By contrast, a relatively simple MANA scenario (like that shown in the following section) takes around 600 runs to settle to a robust estimate of the mean, as Figure 1 shows. This demonstrates the dramatic change in the nature of the analysis once entity behaviour is taken into account.

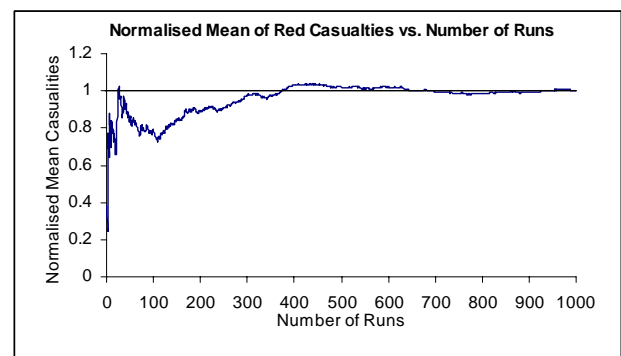


Figure 1. The figure shows that for a simple MANA parameter set (scenario), like that shown in Figure 2, the mean takes considerably longer to settle (some 600 runs are necessary), than is typically used and assumed for other models, such as CAEn.

Furthermore, for many MANA scenarios the distribution of outcomes exhibit a "fat-tail" of extreme results [2]. That is to say, the distribution of results is not a nice bell-shaped curve. This seems to fit well with real-life experiences, where on a patrol, for example, most of the time things run smoothly, but occasionally the patrol gets caught in an awkward position and a disaster occurs.

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