An agent-based model of knowledge transferral: Exploring the need for closure and cognition

This item was submitted to Loughborough University's Institutional Repository by the/author.


Additional Information:

- This is a conference paper.

Metadata Record: https://dspace.lboro.ac.uk/2134/21702

Version: Accepted for publication

Publisher: © The Operational Research Society

Rights: This work is made available according to the conditions of the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0) licence. Full details of this licence are available at: https://creativecommons.org/licenses/by-nc-nd/4.0/

Please cite the published version.
AN AGENT-BASED MODEL OF KNOWLEDGE TRANSFERRAL: EXPLORING THE NEED FOR CLOSURE AND COGNITION

Dr. Duncan A. Robertson
Loughborough University
Loughborough, LE11 3TU, UK
d.a.robertson@lboro.ac.uk

Prof. L. Alberto Franco
Loughborough University
Loughborough, LE11 3TU, UK
l.a.franco@lboro.ac.uk

ABSTRACT

We set out a model of inter-team knowledge evolution through inter-group interaction. We investigate individuals’ Need for Closure and Need for Cognition and the effect on the quality of the group’s decision. We set out a description of the model and representative results.

Keywords: agent-based model, knowledge transfer, decision making, social networks

1 INTRODUCTION

Agent-based modelling and complexity science have been cited as possible solutions for investigating team interactions. At its heart lies the interaction between human agents within and comprising a complex system of interactions.

Agent-based models have been thought of as dividing into two camps: as a method for studying the dynamics of social systems (the ‘microworld approach’), or as a type of boundary object (Elsawah et al 2015). The use of agent-based models within operational research has been limited, with debate existing as to the use of agent-based models rather than actually building agent-based models. While the microworld and boundary object perspectives are not necessarily mutually exclusive, this paper takes the former approach: modelling the actors within the social system.

2 MOTIVATION

A recent stream of research has studied the interactions between individuals within workshop settings (Tavella and Franco 2014), groups (Arrow and Henry 2010), and dialogue (Tsoukas 2009). We combine this with agent-based approaches of firm interaction (Robertson and Caldart 2009) and the dissemination of culture (Axelrod 1997) to create a model of inter-personal interaction within workshop settings.

We instead use an agent-based simulation approach to explore the Need for Cognition and the Need for Closure that play a part in group decision making.

Need for Closure (NFClos) (Kruglanski and Webster 1996) is a desire for information, where individuals are goal oriented. High NFClos individuals are typically inclined to (Kruglanski and Fishman 2009): attain closure as quickly as possible, and maintain it for as long as possible; they achieve this by relying on past knowledge and avoiding new information.

The Need for Cognition (NFCog) however shows a tendency to engage in and enjoy cognitive efforts (Cacioppo and Petty 1982). High NFCog individuals typically: care about how and why something works, not only that it works; are more likely to engage in information seeking, seek more information, and evaluate information more thoroughly.
Previous work on the modelling of group process modelling have included Larson’s (2007) $N$ dimensional problem space model where heterogeneous groups produce better solutions. This work is restricted to a Boolean search space with little interaction between members. Rousseau and van der Veen’s (2006) work shows the emergence of a shared identity but with a limited number of possible outcomes and with the restriction of being a cellular automata model.

3 AGENT-BASED MODEL

We first generate a fitness landscape (Wright 1932, Levinthal 1997) over which agents can move. This is created by adding $M$ Gaussians at random positions. Figure 1 shows a fitness landscape for $M=1$ – one central peak.

![Figure 1 Fitness Landscape](image)

We then add $N$ participants – agents – who are positioned randomly on the fitness landscape. In our model, the fitness of the solution is represented by the height of the landscape.

Each participant has a NFClos boundary – if another participant is within this boundary, the participants will ‘seize and freeze’ (Kruglanski and Webster 1996). Participants who have not frozen will continue to move around the fitness landscape. This movement is confined to the NFCog radius. Figure 2 shows (in purple) the NFClos radius, and (in red) the NFCog radius. The grey dots show areas that are searched as part of the search process, and the brightness of the green shows the height of the landscape (this is another view of Figure 1, except viewed from above).

Another parameter of the model is the ability to accept a participant’s viewpoint. We model this by setting a minimum threshold for the height of the participant with which the interaction is taking place. If their height is below the threshold, they will continue to search.
If another participant is not found when the locations within the NFCog radius are searched, the participant will move to the highest location that they have searched within the NFCog radius. This repeats until all participants are ‘closed’ or after a certain time period.

3.1 Parameters of the Model

Model parameters include:

- **Number of participants**: the number of participant agents that are initialized. This number remains fixed over each simulation run;
- **Need for closure radius**: at each tick of the simulation run, a participant will search for a partner within this radius
- **Need for cognition radius**: if a participant is not closed, they will search a radius around their initial location.
- **Height threshold**: if a participant detects a partner, they will have to meet this height requirement in order for the agent to be closed.
3.2 Model Logic

The model logic is shown in Figure 3 below.

![Diagram of Model and Agent Behaviour]

Figure 3 Model and Agent Behaviour

4 RESULTS

By controlling the number of participants in each run of the model, we are able to determine the effect on the quality of the group’s solution (measured by the average height of participants on the fitness landscape).

4.1 Effect of Need for Closure

Figure 4 shows the effect of varying the participants’ Need for Closure. Increasing Need for Closure decreases the best solution, which is more pronounced with more participants.
4.2 Effect of Partner Height Threshold

Experiments were conducted to determine the effect of varying the height threshold. As can be seen from Figure 5a (for two participants) and 5b (for four participants) below, the results for a zero threshold revert to the results shown in Figure 4.

For two participants (Figure 5a), when the threshold is set at 100 (the maximum height of the fitness landscape), the results are largely independent of the Need for Closure. This is due to the participants being trapped in a loop of dissatisfaction – where they will continue to search. This leads to local movement around the landscape peak.

For four participants (Figure 5b), the efficacy of the threshold diminishes. This is due to the participants requiring only their partner to be above the threshold. When there are two participants, A requires B to be above the threshold and B requires A to be over the threshold; this mutuality is destroyed with more than two participants.
Figure 5a The Effect of varying Height Threshold with two participants

Figure 5b The Effect of varying Height Threshold with four participants
4.3 Effect of Need for Cognition

As the Need for Cognition radius increases, there is a decrease of height of the participants for height thresholds of zero and 100. This is due to the participants being unclosed at the end of the simulation, meaning that they are searching for a solution. As the Need for Cognition variable increases, the search area scales approximately as its square, meaning that participants are likely to be further away from the peak of the landscape, and as such the quality of their solution decreases. This is shown in Figure 6, below.

![Figure 6](image.png)

**Figure 6** The Effect of varying Height Threshold with four participants

5 DISCUSSION

For the first time, we have produced a model that combines Need for Closure and Need for Cognition. The use of agent-based modelling allows us to extend these models to intra-group heterogeneity, and opens up a wide range of extensions to the model.

The results are consistent with existing understanding of the Need for Closure – that high Need for Closure individuals can get trapped into sub-optimal equilibria. The introduction of a threshold for partner solution height produces interesting results, particularly at very high or very low levels. This is particularly important in two-person situations, where the existence of mutual thresholds produce better outcomes.

Furthermore, the results show a counter-intuitive results where increased Need for Cognition (which extant literature sees as an individual asset) can result in lower results in a group situation.
REFERENCES


AUTHOR BIOGRAPHIES

DUNCAN ROBERTSON joined the MSOM Group at Loughborough in 2014. Prior to that, he held posts at Warwick Business School (as Assistant Professor of Strategic Management), Manchester Business School, UAE London, Sun Yat-sen University in China, as well as holding a visiting post at The Wharton School of the University of Pennsylvania and teaching at London Business School. He is a Fellow and Trustee of St Catherine’s College in the University of Oxford. Before undertaking his DPhil at Saïd Business School at the University of Oxford, he qualified as a Chartered Accountant with KPMG working in the City of London, Australia, and New Zealand, where he specialized in advisory and corporate finance roles within the banking sector. He originally trained as a physicist at Imperial College London.

ALBERTO FRANCO is Professor of Management Sciences at the School of Business and Economics, Loughborough University. With a background in civil engineering, he worked as a consultant in the area of soil mechanics before moving to academia. During 1997-2000, he held research positions at the London School of Economics and Strathclyde Business School, followed by a three-year lectureship post at Kingston Business School. He then spent 8 years at Warwick Business School (2003-2011), first as assistant professor and, from 2006, as associate professor. During his time at Warwick he was Course Director of the MSc in Operational Research and Management Science (2006-2010), and led the design
Robertson and Franco

and launch of the MSc in Business Analytics and Consulting, also as Course Director (2008-2010). He was also a Visiting Professor for the 2007-2008 academic year at IE Business School (Spain). Prior to joining Loughborough, he was Professor of Problem Structuring Methods at the Centre for Systems Studies, University of Hull (2011-2013). Alberto joined Loughborough in 2013 as Head of the Management Science and Operations Management Discipline Group.