Building and Describing an ABM

WORDS COUNT: 1080

1. Research Question

How are personality traits transmitted and influenced within families, marriages, and social networks? And regarding the collective impact on the social personality diversity, how will personality and values evolute across generations?

2 ODD Description

2.1 Purpose and patterns

2.1.1 Purpose

The purpose of this model is to propose a potential explanation for the processes that shape and modify personality, in which individuals continuously inherit across generations and influenced by social networks. This dynamic reflects on the collective values of the societal group as a whole.

The mechanism driving this explanation involves complex social interactions, where individuals learn initial personality from parents, and imitate behaviours from their peers, while also trying to connecting with people who is sharing similar personalities with them. These processes, influenced by various factors, collectively contribute to the shaping of individuals' personality and values.

2.1.2 Patterns

We evaluate our model by its ability to reproduce two patterns.

The first one is inheriting mechanism, "Like Parents, Like Children". The majority of personality traits are stably transmitted across generations within families (Eaves *et al.*, 1999).

The second one is grouping mechanism, by which people are more willing to make connection with whoever more similar with ourselves(Schneider *et al.*, 1998). Consequently, all members in each societal group might share the similar characteristics in some ways.

2.2 Entities, state variables, and scales

2.2.1 Entities

The following entities are included in the model: agents representing human individuals, and the global environment representing the social interaction space. Grid cells represent virtual human society of 50*50. The observer or global environment is the only entity on the system level, defining the social interaction network system and the whole space where humans live.

2.2.2 State Variables

There are 6 agents state variables illustrated in Table 1.

Table 1 Agents state variables

Variable Name	Variable type and units	Meaning
Gender	Binary, 0 or 1	0 for female; 1 for male
Age	Integer number	The age of agents (years old)
Max-age	Integer number	The predetermined lifespan of each agent
Personality-vector	List	A multi-dimensional vector embedding agents personality traits/characteristics
Heading	Real number	Moving direction of agents (0 to 360°)
If-married	Binary, 0 or 1	0 for single, 1 for married

Also, the observer is a single entity that controls the global variables and sub-models. Observer state variables (Table 2) are global variables that change over time.

Table 2 Observer state variables

Variable Name	Variable type and units	Meaning
Population	Integer number	The total population of agents
Total eigenvector	List (multi-dimensional vector)	The mean vectors of all agents
Similarity Degree	Decimal number	The standard deviation of all agents' vectors

2.2.3 Scales

The model's spatial extent is a square of 50*50 square cells, relatively simulating a spacy room for human's moving and social interaction. And the temporal scale is set as years because agents' ages are counted in years. A

tick in this ABM means a year.

2.4 Process overview and scheduling

The simulation process begins with the setup procedure where an initial population of agents is generated. Each agent is assigned a gender, age, maximum age, a 5-dimensional personality vector, an initial moving direction, and marital status. This setup represents the initial state from which the model evolves.

The go procedure operates the simulation's progression, executed at each tick, signifying the passage of simulated time. Within this procedure, each human agent ages (age-step), may die if they surpass their maximum age (die-if-old), potentially changes their moving direction based on the similarity of nearby agents (change-direction), moves within the environment (move), engages in the process of marrying and reproduction if conditions are met (marry-and-reproduce), and undergoes personality influences from their social network (influence-personality).

In addition to agent-specific actions, global metrics like total-eigenvector are calculated at each tick to reflect the collective state or traits of the population over time.

This scheduling ensures that the simulation captures both the individual-level dynamics—such as aging, movement, and personality development—and the population-level phenomena, including social structure formation and evolution based on personality similarities, marriage, and reproduction dynamics.

2.5 Design concepts

2.5.1 Emergence

The model illustrates how social structures and relationships emerge from individual interactions and decisions, not pre-defined by the system. This includes the formation of social networks, partnerships, and the distribution of personality traits within the population.

2.5.2 Adaptation

Agents adapt their behaviours based on personal experiences and interactions. This includes changing moving directions towards similar individuals, decisions on marriage and reproduction based on age, marital status, and personality compatibility, and alterations in personality vectors influenced by social surroundings.

2.6 Initialisation

The simulation initializes with a defined population of human agents, each randomly assigned gender, age, maximum age, a unique personality vector, moving direction, and marital status. This diversity establishes the groundwork for complex interactions and dynamics to unfold, reflecting the variability inherent in human societies.

2.7 Input data

The model operates autonomously without external time-series data, relying instead on interactions within the simulated environment and the intrinsic attributes of agents to drive dynamics. This setup allows for the exploration of emergent behaviours and societal structures based purely on agent characteristics and their decisions.

2.8 Submodels

Age-Step & Die-If-Old: Agents' age over time and may die if they exceed their maximum age, simulating a natural aging process.

Change-Direction: Agents may change their direction based on the similarity to nearby agents, fostering clustering of similar personalities.

Move: Agents move within the environment, simulating spatial dynamics and interactions.

Marry-and-Reproduce: Eligible agents may marry and reproduce based on age, marital status, and personality compatibility, influencing population dynamics and social structures.

Influence-Personality: Agents' personalities are influenced by their social networks, reflecting the social shaping of individual traits over time.

3 Brief Methodology

This model could simulate both individual and collective behaviours within a virtual society, capturing the complex dynamics of personality evolution and social interactions.

The methodology emphasizes the system's emergent properties, particularly how individual-level interactions lead to the formation of distinct social structures and behaviour patterns. By analyzing the model's ability to replicate observed social phenomena, such as the transmission of personality traits within families(Chen *et al.*, 2024) and the tendency for individuals to form connections with others who are like themselves(Sayehmiri *et al.*, 2020), the

study aims to shed light on the underlying mechanisms driving these dynamics.

This framework facilitates exploration of various scenarios and interventions, offering insights into how individual changes can impact broader societal outcomes. By employing this ABM methodology, the research addresses crucial questions about the role of inheritance, social influence, and individual choice in shaping personality traits and values across generations, contributing to our understanding of social diversity and cohesion.

Reference:

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