

Overview, Design, and Details. Protocol to describe the stylized Agent-Based model of the Unification Conditions of Civilization Patterns project

1. Overview

This document describes the Overview, Design concepts and Details (Lenin and Chretien) of the Unification Conditions of Civilization Patterns model. The model has been formalized within Netlogo 6.1 software. This document follows the ODD protocol to structure the description of this agent-based model concisely and neatly.

1.1 Purpose

After the axial age (Eisenstadt and Wittrock, 2005), ancient China in the Spring-Autumn periods formed the unification pattern of Chinese culture. However, the unified pattern is unsustainable for the western world and belongs to the disunity pattern in the western states (Morley, 2010).

The model of Chinese and Western civilization patterns can help understand how civilizations formed, how they evolved by themselves, and the difference between the unity of China and the disunity of the Western. The previous research had examined historical phenomena about civilization patterns with subjective, static, local, and inductive methods (Turchin, 2018). Therefore, we propose a general model of history dynamics for civilizations pattern, which contains both China and the West, to improve our understanding of civilization formation and the factors influencing the pattern of civilization. And at the same time, the model is used to find the boundary conditions of two different patterns.

1.2 Entities, state variables, and scales

To describe the mutual relation between agents by the model, we set the entities, state variables, attributes, and extents of the model.

(a) Agent. There are 148 agents in the model, divided into strong agents and weak states

according to the difference in power. We set four basic attributions about warfare for them. The first attribution is bellicosity propensity (F_i), which is used to launch wars to obtain more people and land. The second attribution is the war costs. In our model, we set the failure cost to l , the victory cost to w , and for the balancing outcome, we set the cost to b . The third attribution is alliance propensity (p_i) to describe the possibility that a state may cooperate with other states. The last attribution is opportunists O , representing the number of agents who betray the alliances. But beyond these, we use the indicator of "power" Pwr to model the comprehensive force of states.

(b) Environment. In the Spring-autumn period, for states, the borders and areas will change as time goes on (Biersteker, 2002) because of the fierce process of wars and annexations in history. We input the map of the Spring-autumn period to set the region size in the model.

2. Process overview and scheduling

In the model, when the model is initiated, the "Setup" push-button will create 148 agents and build the virtual environment. Then, the "go" push button will activate the sequence of procedures to simulate the dynamics and the interaction between different agents. The interactions between agents are decided into three procedures.

The first procedure to be activated is "Alliance." The strong agent (i) randomly provides the offer to a possible ally (j). The agents j who received multiple (n) offers will ally with the strongest states. The second procedure to be activated is "War." In the model, all the agents have the initial bellicosity (F_i) and at the same time, the bellicosity (F_i) will grow randomly and increase by 0 to 0.2 per tick. For the potential target (j) at T , when the power Pwr_i of agent (i) is larger than the agent (j), if the bellicosity F_i of state (i) exceed the threshold value of bellicosity F_i War will break out. The agents who participate in the war will pay for damages (w, l, b). The third procedure to be activated is "betray." When the agents are too weak, the allies will betray the alliance to seek other alliance networks. After the three procedures, the power Pwr of the agents will change. If $Pwr \leq 0$, the agents will die. If $0 < Pwr < 90$, the agents are

regarded as the weak agents(states), if $Pwr \geq 90$, the agents are considered to be the strong agents(states).

3. Design concepts

3.1 Basic Principles

The war made the states in this period, as it guaranteed the security and survival of local conditions or regimes (Hofmann, 2012). After frequent wars, efficiency-oriented instrumentalism begins to dominate the history of China (Zhao, 2015). During this period, short and weak-scale wars became the driving factor of the final unified state (Xiao-sheng, 2012). To achieve unity, war is the main contributing element (Mann, 2012b, Mann, 2012a). During this period, war dynamics dominated social development and economic recovery (Hui, 2005). For the data of the real historical process, states' size, power, duration, and war behaviors are essential information that should precisely match our model and simulations.

3.2 Emergence

In the model, influenced by the procedures of wars, alliances, cost, and opportunists, the power of agents will change, which will cause a change in the agents' number. We will observe the number of strong, weak, and total agents. And finally, we will observe the time of the simulation.

3.3 Adaptation

Under different conditions, every agent will change their strategy of launching a war, making an alliance, or betraying the alliance. Thus, in the model, the power, bellicosity, alliance propensity, cost, and the possibility of betrayal of each agent are constantly adjusted according to the outcome of simulations at each tick. And the number of strong & weak agents, the duration of simulations will also change accordingly.

3.4 Objectives

The comparison between simulated results and historical data is the primary method to examine the validity and robustness of our model in the pattern formation of human civilizations (Rubio-Campillo, 2016). For our simulation, the number of solid

& weak states and the duration of the time are three key indicators of the model. We obtain the observed value Y_i of the three key indicators in real history. Then, we run 200 simulations to obtain simulated outcomes and calculate the mean of \hat{Y}_i . The goal of our model is to find the best-fitted combination of parameter values (Par^*), which minimize the difference Δ between the target function, $f_{real}(\cdot) = \{Y_i\}$, and the simulation function, $f_{sim}(\cdot) = \{\hat{Y}_i\}$. And we also explore the different factors that caused the difference between the unified pattern in China and the disunified pattern in the West.

4. Details

4.1 Initialization

The initial state of the model world is shown in table 1.

Table 1: Overview default settings input-parameters

Types		Variables	Initial Value	Value Ranges
Time		T	1	Dynamic change with time
The number of states		N	148	Dynamic Outcomes
		N_{strong}	10	Dynamic Classified
		N_{weak}	138	Dynamic Classified
Bellicosity		F_i	0.2	{0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0}
Costs	Victory	w	3	{1, 2, 3, 4, 5, 6, 7, 8}
	Failure	l	9	{9, 10, 11, 12, 13, 14, 15}
	Balance	b	6	$b \equiv 6$
Alliance Propensity		p_i	0.35	{0.1, 0.2, 0.3, 0.4, 0.5}
The number of opportunists		O	148	{1, 2, 3, 4, 5, 6, 7, 8 ..., 148}

4.2 Input data

In the application of the model, further inputs from extremal sources such as data files are not required once the model is initialized.

Reference

BIERSTEKER, T. J. 2002. State, sovereignty, and territory. *Handbook of international relations*, 157-176.

EISENSTADT, S. S. N. & WITTROCK, B. 2005. *Axial civilizations and world history*, Brill.

HOFMANN, C. 2012. *A study of Central Eurasian innovations in warring states China and their*

- impact on war and domination*. uniwiien.
- HUI, V. T.-B. 2005. *War and state formation in ancient China and early modern Europe*, Cambridge University Press.
- LENIN, V. I. I. & CHRETIEN, T. 2015. *State and revolution*, Haymarket Books.
- MANN, M. 2012a. *The sources of social power: volume 1, a history of power from the beginning to AD 1760*, Cambridge university press.
- MANN, M. 2012b. *The sources of social power: volume 2, the rise of classes and nation-states, 1760-1914*, Cambridge University Press.
- MORLEY, N. 2010. *The Roman Empire: roots of imperialism*, Pluto Press.
- RUBIO-CAMPILLO, X. 2016. Model selection in historical research using approximate Bayesian computation. *PloS one*, 11, e0146491.
- TURCHIN, P. 2018. Historical dynamics. *Historical Dynamics*. Princeton University Press.
- XIAO-SHENG, L. 2012. On the State Form and the Political Control at the Periods of the Spring and Autumn and the Warring States. *Journal of Fujian Normal University (Philosophy and Social Sciences Edition)*, 05.
- ZHAO, D. 2015. *The Confucian-legalist state: A new theory of Chinese history*, Oxford University Press.