CulSim: Emergence and Resilience of Cultural Diversity in a Computer Simulator

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MOTIVATION

The existence of diverse cultural groups is paradoxical (e.g. [1]); we live in an interconnected world where individuals constantly share information with each other, and yet, diversity remains.

Diversity persists despite ***events*** that can occur in real life, including those in online social networks. These ***events*** can be, for example, institutional collapses, invasions, and mergers of social platforms, server crashes or user trolling.

CulSim allows the exploration of emergence and resilience of cultural groups when they are faced with such events. Additionally, the combination of events allows researchers to approximate more realistic scenarios. One of several computer models [2,3,4] can be chosen as a basis for such explorations.

CULSIM

- 4 models: Axelrod [2], multilateral social influence [3], multilateral social influence and homophily [3], **institutional** [4]
- 11 parameters: grid size, neighbourhood radius, number of features and traits, perturbations (mutation and selection error) institutional parameters (influence, loyalty, democracy, propaganda)
- 7 events: decimation, apostasy, settlement, immigration, institutional destruction, institutional content removal, and institutional conversion
- 6 configurable event distributions, e.g. normal and uniform
- 20 response variables on display (e.g. similarity measurements, cultural diversity, energy, number of institutions, foreigners), and additional ones in the output files
- Graphical user interface which allows visual exploration of singular scenarios, or simple experimental designs
- A command-line interface to configure comprehensive experimental designs on computer servers

INSTITUTIONAL MODEL

CulSim [5] includes my recently proposed model [4] (Fig. 1.), which introduced institutions in order to:

- Increase the robustness of the emergence of cultural diversity against mutations [6] and selection error [3]
- Explore effects of institutional influence and institutional mechanisms such as propaganda or democracy
- Analyze events that target institutions

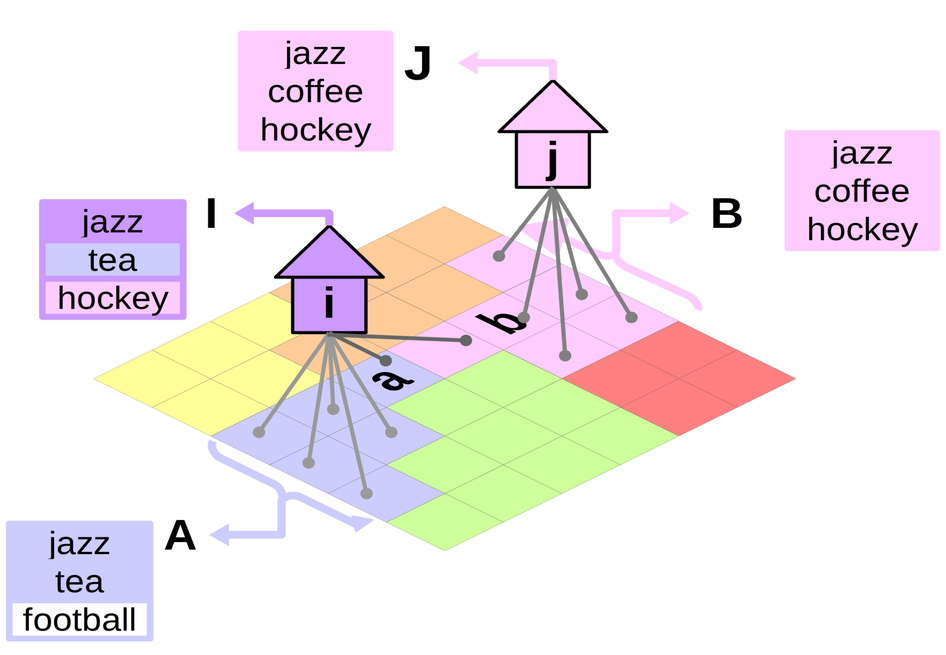

Fig. 1. Overview over a world state in CulSim using the institutional model. The grid shows 6 cultural groups (colored) in a grid. The houses i and j represent two institutions. Grey lines represent subscriptions between agents and institutions. Cultural vectors A and B are representative of each agent of the blue and pink groups respectively (each agent has its own vector), and I and J are representative of institutions i and j.

EXAMPLE

Fig. 2. illustrates a comparison of two events: (1) Decimation: *all cultural traits from a set of agents are removed*, and (2) Settlement: *all traits from a set of agents are replaced with foreigner traits*. The set of agents is selected using a 2D normal probability distribution function (sd = 0.2) with its maximum value (1.0) at the center of the grid. The state just before the event is produced after 1000000 iterations (agents' cultural vectors where randomly initialized) using the institutional model [4] with the following fixed parameters: institutional influence of 0.65, grid size of 50x50, 6 cultural features, 14 cultural traits, Von Neumann neighborhood of radius 3, mutation and selection error with probability 0.001, agent loyalty to 0.5, and no propaganda or democracy.

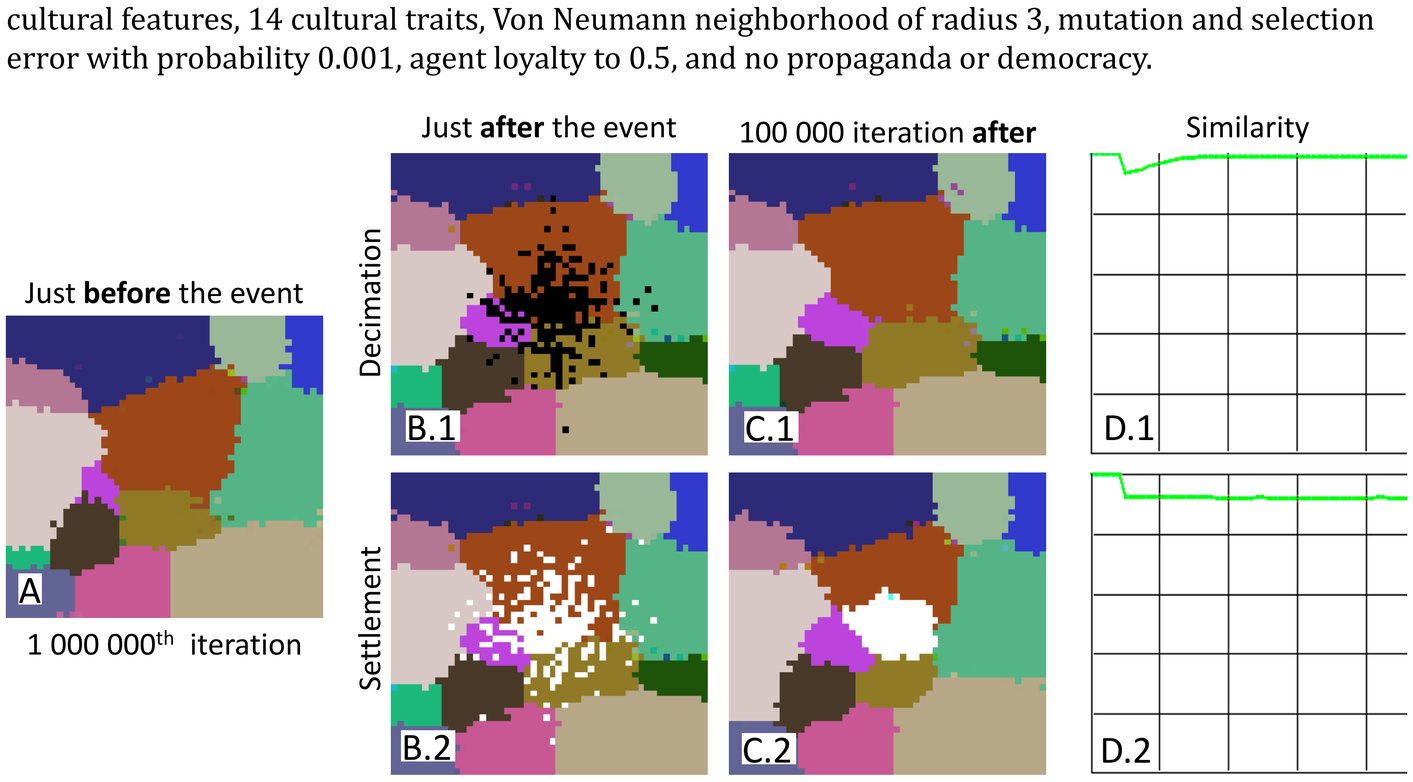

Fig. 2. Cultural spaces before and after decimation and settlement. State A shows the cultural space after 1000000 iteration from a random initial state. States B (B.1 and B.2) and C (C.1 and C.2) show, respectively, the state just after the event, and 100000 iterations after the event; Event in B.1 and C.1. is Decimation, and event in B.2 and C.2 is Settlement. The black cells in B.1 represent the dead agents, and white cells in B.2 represent settlers. D.1 and D.2 show the similarity (green lines) between the state just before the event and the state in the 50 consecutive iterations (X-axis) after it. The similarity is calculated by comparing the cultural vectors of each cell in two states of the simulation.

RESULTS

Fig. 3. shows the results for seven events in two versions of two scenarios: (1) many cultures, *agents' cultural vectors where randomly initialized, and cultures emerged after 100000 iterations*; (2) one culture, *all agents contain the same cultural traits and belong to the same institution*. The simulation was run using the institutional model [4] with the following fixed parameters: 5 cultural features, 15 cultural traits, mutation and selection error with probability 0.001, agent loyalty of 0.5, and no propaganda or democracy. Grid size, neighborhood, and institutional influence where varied according to the legend of the figure.

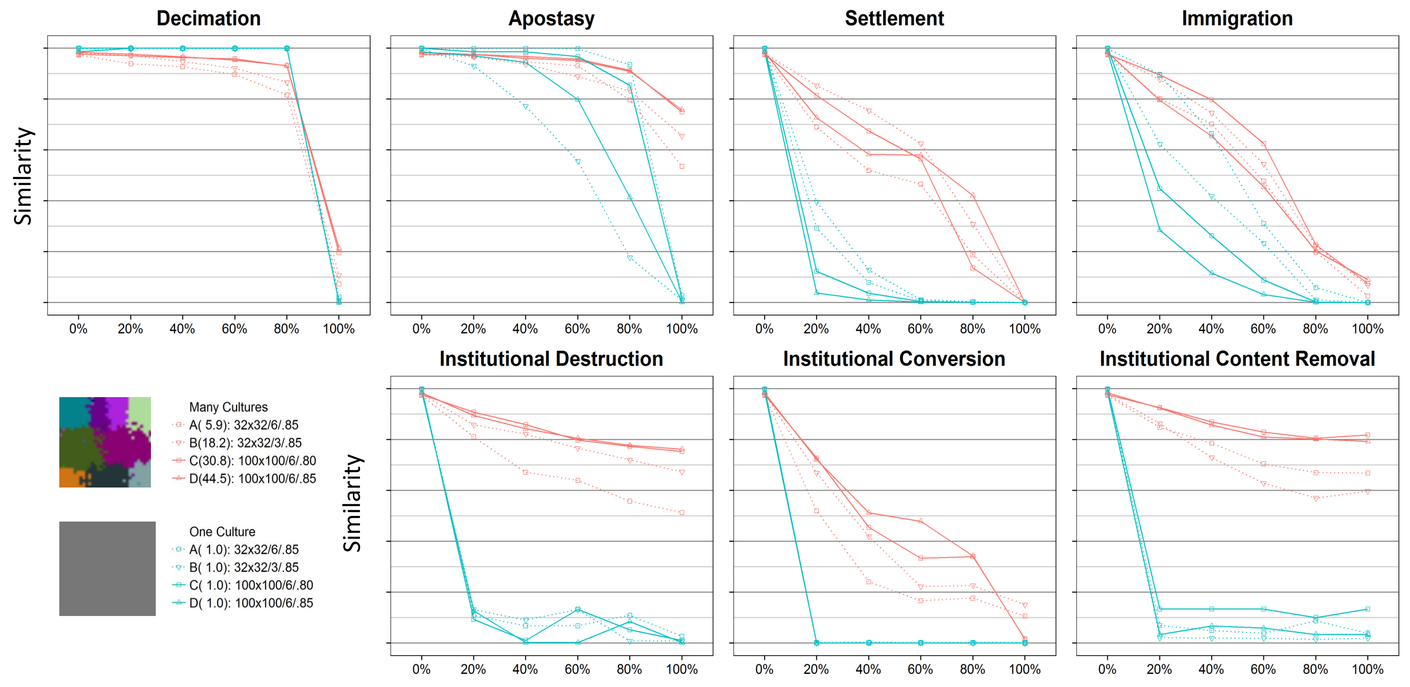

Fig3. Effects of events on diverse and monoculture scenarios with normal distributions. Blue lines represent the monoculture version of four scenarios, and Red lines the diverse version. The symbols in the legend denote parameters that characterize scenarios in the format S(G): NxN/R/I where S is the identifier; G is the average number of cultural groups; NxN is the grid size; R is the distance for neighborhood interaction; I is the level of institutional influence. The response variable (Y-axis) is the similarity between the state just before the event (1000000th iteration), and 100000 iterations after the event. The X-axis shows the size of the event as a percentage of the affected agents, traits or institutions.

DISCUSSION AND FUTURE DIRECTIONS

Cultural diversity is suggested as a mechanism of resilience. Future work will focus on analyzing the interaction between diversity and the number of institutions in terms of resilience.

CulSim has recently been used to explore case studies about the Maya: Collapse, Spanish Invasion and Civil War (1980), illustrating its applicability to real life scenarios and across different disciplines.

The ideas presented here, in particular institutional factors, can be explored with dynamic social networks. This might help us to better understand how polarization, such as the one we observe in current world political affairs, occurs in spite of increased communication everywhere.

References: [1] Robert P. Abelson, in:, N. Frederiksen, H. Gulliksen (Eds.), Contributions to Mathematical Psychology, Holt, Rinehart and Winston, New York, 1964, pp. 142–160. [2] R. Axelrod, Journal of Conflict Resolution 41 (1997) 203–226. [3] A. Flache, M.W. Macy, Journal of Conflict Resolution 55 (2011) 970–995. [4] R. Ulloa, C. Kacperski, F. Sancho, PLOS ONE 11 (2016) e0153334. [5] R. Ulloa, SoftwareX (In Press). [6] K. Klemm, V.M. Eguiluz, R. Toral, M.S. Miguel, Physical Review E 67 (2003).