Success-Based Inheritance in Cultural Evolution

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Project Information

Publication(s):

- Feldbacher-Escamilla, Christian J. and Baraghith, Karim (2020). "Cultural Inheritance in Generalized Darwinism". In: *Philosophy of Science* 87.2, pp. 237–261. DOI: 10.1086/707564.

Talk(s):

- Baraghith, Karim and Feldbacher-Escamilla, Christian J. (2018-01-31/2018-02-03). *Success-Based Inheritance in Cultural Evolution*. Conference. Presentation (contributed). The Generalized Theory of Evolution. University of Düsseldorf: DCLPS.
- Baraghith, Karim and Feldbacher-Escamilla, Christian J. (2017-04-20/2017-04-21). *Success-Based Inheritance in Cultural Evolution*. Conference. Presentation (contributed). Meeting of the Nordic Network for Philosophy of Science. University of Copenhagen: NNPS.

Workshop(s):

- Baraghith, Karim, Feldbacher-Escamilla, Christian J., et al. (2018-01-31/2018-02-03). *The Generalized Theory of Evolution*. Conference. Organization. Facts: est. 70 participants; 6 invited: Daniel Dennett, Eva Jablonka, Ruth Mace, Alex Mesoudi, Thomas Reydon, Brian Skyrms. Conference report in the JGPS. Conference report in The Reasoner. Conference report in Kriterion - Journal of Philosophy. (Programme- and Local Organizing Committee). University of Düsseldorf. URL: http://dclps.phil.hhu.de/genevo/.

Project(s):

- DFG funded research unit *New Frameworks of Rationality* (SPP1516); subproject *The Role of Meta-Induction in Human Reasoning*.

Introduction

Cultural evolution is described via principles for:

- Variation $E, m_{v \longrightarrow v'}$
- Selection s
- Reproduction $X^n \ \Rightarrow \ X^{n+1}$

However, contrary to natural evolution in culture there seems to be blending of traits and by this one can distinguish only quasispecies.

In this talk we provide a model for such *blending inheritance*.

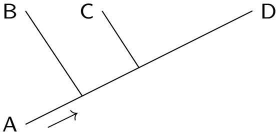
Contents

Quasispecies & Blending Inheritance

Is Cultural Evolution really "Treelike"?

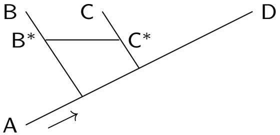
The Quasispecies-Problem (cf. Gould 1991; Schurz 2011):

(1) Biological: Tree of descent



A,B,C,D... species

(2) Cultural



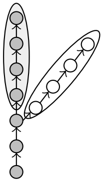
B*,C*... intermediate ancestors

Blending Inheritance: Repsonsible for Quasispecies

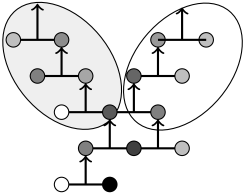
Two definitions of blending inheritance within the framework of cultural evolution:

1. Traits/information frequently "flow" from one (quasi)species (e.g type of reproduced convention) to another (Schurz 2011): macro-perspective.
2. Reproduction not of one trait but the average of reproduced traits (Boyd and Richerson 1988; Mesoudi 2011) – similar to success-based/conditional imitation: micro-perspective.

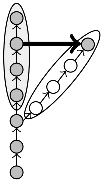
Inheritance: Four Possibilities



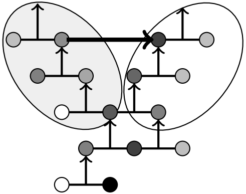
(1) Discrete inheritance



(3) Microblending



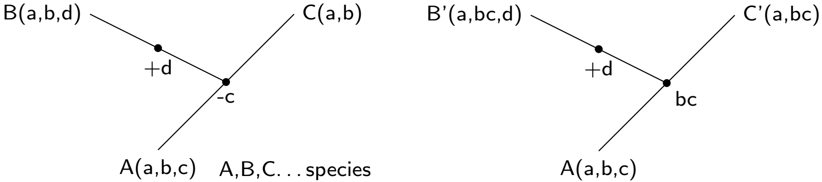
(2) Macroblending (cultural diffusion)



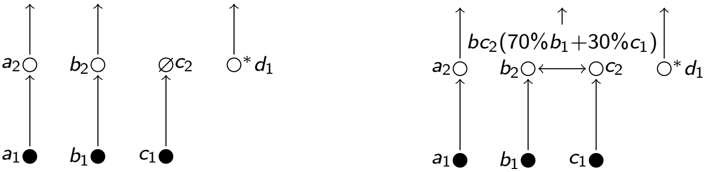
(4) Multiblending

Blending Inheritance: Success-Based Fitness Enhancement

Macrolevel



Microlevel

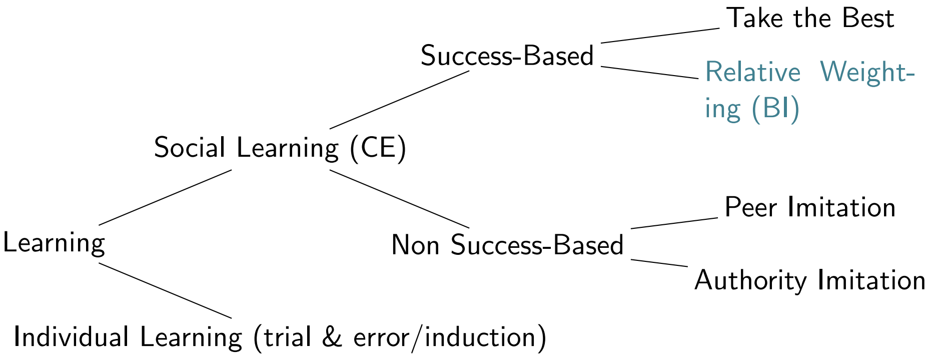


a,b,c,d. . . traits

Example

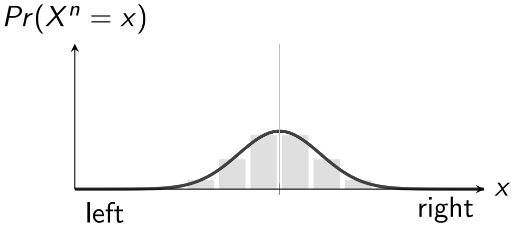
- Let a, b and c represent political attitudes
- Let the generations be election cycles
- Let a signify an extreme left wing position and c an extreme right wing position, whereas b stands for an intermediate value
- Agent (politician within election campaign) normally passes on moderate b-attitudes
- Notices change in the political environment by observing behaviour of her opponents (e.g. due to past poll ratings)
- Decides to merge useful parts of another political attitude with her own
- Promising strategic decision: figuring out what parts exactly seem attractive (might grant success) in the present situation and adopt them into the set of her own public attitudes.
- Given that the agent expects that c is about to fail in total but still *contains success promising parts*, it is rational to apply them and pass them on to the next election cycle (blending inheritance).

Learning: An Overview

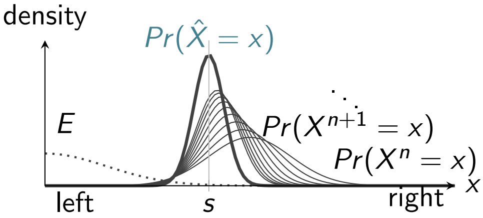


Two Models of Cultural Evolution

A Learning Model by (Boyd and Richerson 1988)



A Learning Model by (Boyd and Richerson 1988)



Given a fixed l and $\mu(E) = 0$ (unbiased error/mutation)

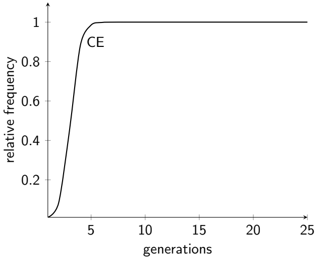
It holds for the equilibrium state $\hat{X}$: $\mu(\hat{X}) = s$

A Population Dynamical Model

The model consists of (cf. Schurz 2011):

- $v_1, \ldots, v_k$ ... possible variants/values of a system
- $Pr(X^n = v_i)$ ... probability of X^n taking value v_i
- Generations: $X^0, \ldots, X^n, X^{n+1}, \ldots$

$$Pr(X^{n+1} = v_i) = \frac{Pr(X^n = v_i) \cdot s_i(Pr(X^n = v_i)) - \sum_{i \neq o = 1}^{k} Pr(X^n = v_i) \cdot m_{v_i \longrightarrow v_o}}{\sum_{j=1}^{k} Pr(X^n = v_j) \cdot s_j(Pr(X^n = v_j)) - \sum_{j \neq o = 1}^{k} Pr(X^n = v_j) \cdot m_{v_j \longrightarrow v_o}}$$



Pros & Cons

Model of (Boyd and Richerson 1988):

- \+ allows for *blending inheritance* via social learning s, l
- − idealisation of unbiased error E (mutation)
- − learning l is independent of a variants' reproductive success

The population dynamical model (cf. Schurz 2011):

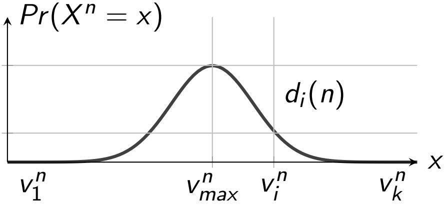
- \+ avoids these idealisations
- − does not implement *blending* directly

In the following part we are going to try to combine both advantages within one model.

A Success-Based Model

Implementation of Success-Based Weighting

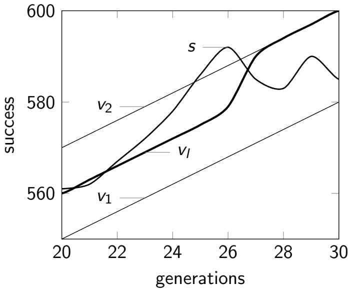
- We define a normalised ($\in [0,1]$) distance measure: between the frequency of a variant from the best fitted variant in a generation n: $d_i(n)$



- Then we define a measure for absolute success by averaging: $as_i(n)$
- Then a measure for relative success by cutting off worse variants: $rs_i(n)$
- Based on $rs_i(n)$ we define a weight for $n+1$ by normalising: $w_i(n)$
- Finally, based on $w_i(n)$ we define the social learning of variant v_l as:

$$v_l^{n+1} = \sum_{l \neq j = 1}^{k} w_j(n) \cdot v_j$$

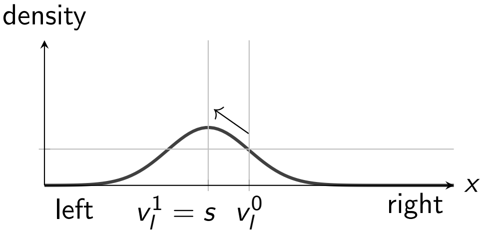
Result



Example of relative-success-based blending

If *frequency of the* *best fitted non-learning variant* $= s$

$$lim_{n \longrightarrow \infty} Pr(\hat{X} = v_l^n) = s$$



Summary

- We started with the problem of quasispecies (due to macroblending).
- Then we discussed four kinds of Blending Inheritance (BI) and focused on microblending.
- (Boyd and Richerson 1988)'s model of BI, $\mu(E) = 0$ and fixed I
- Population dynamical model with $m_{v_i \longrightarrow v_j}$, and Pr-dependent s, but no BI
- Our model: BI, $m_{v_i \longrightarrow v_j}$, and Pr-dependent s

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