Visualization of Norms Creation

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1 Introduction

Cultural norms play an important part in the development of society. Rather than being formal and planned, they form out of many generations. Often it may not be evident what the origin or purpose of them is to the individuals following the norm, only its importance in social position and relations. Cultural norms govern much more than just an individual's behavior but can influence social structures and organizational behavior. These can play a crucial role in the formation and the success or failure of an organization or society. It is therefore desirable to understand the process by which social norms are developed and evolve.

1.1 Axelrod's Model

Two models of developing norms in an evolutionary fashion was proposed by Axelrod [1]. The first model is a simple model wherein individuals from a population have the opportunity to defect and other individuals have the opportunity to punish, based on their inherteded tendency to be bold (defect) or be vengeant (or punish defectors when they see them). While defecting produces a negative consequence to everyone else in the society H, there is a temptation payoff T that is awarded when defecting. The motivation, therefore is that when another agent sees the defection, the opportunity to punish provides an ability to discourage future generations from doing so. Punishing carries a negative payoff for the defector of P and a cost to the punisher of E.

After everyone's score has been determined, the agents that have a score of higher than one standard deviation are stronger and reproduce twice as many offspring (cloned with a small genetic mutation indroduced by small probability). The agents lower than one standard deviation or weaker individuals do not reproduce, while the agents within one standard deviation from the mean are able to procreate and have one child. Each of these progeny have the same index of boldness and vengeance.

While this initial model approximates forces that are evident in daily life, it was insufficient in Axelrod's simulation so a second model was proposed. This model includes an extension of the first by including Metanorms. Metanorms is a procedure by which an observer's decision not to punish the defector can also bear punishment. If another agent catches this initial agent, he may be punished by the amount P' for not carrying out punishment. Here, the effort or cost exerted by the third agent is of E'. This model, according to Axelrod, approximates better to reality, in which people's boldness to defect diminishes over time after procreation.

2 Algorithm

Axelrod describes an algorithm to simulate these models. The Algorithms 1, 2, 3, and 4 make up the components required to run a full simulation of this model.

Algorithm 1 Simulation of Axelrod's Model

```
procedure AxelrodSimulation(listOfAgents)
    for number of generations do
        CalculateScores(listOfAgents)
        Procreate(listOfAgents)
    end for
end procedure
```

Algorithm 2 Calculation of Scores using payoffs and punishments

```
procedure CalculateScores(listOfAgents)
    for each agent a in listOfAgents do
        for 4 defection opportunities do
            S ← rand(0, 1)                                  ▷ a value between zero and one
            if a.bravery > S ∗ 8 then
                a.score ← a.score + T
                for each agent b in listOfAgents where b ≠ a do
                    b.score ← b.score − H
                    dice ← rand(0, 1)
                    if dice < S then                        ▷ Agent b saw the defection
                        dice ← rand(0, 1)
                        if dice ∗ 8 < b.vengeance then      ▷ Agent b will punish agent a
                            b.score ← b.score − E
                            a.score ← a.score − P
                        else
                            MetaNormsSimulation(a, b)
                        end if
                    end if
                end for
            end if
        end for
    end for
end procedure
```

Algorithm 3 Simulate the MetaNorms punishing behavior

```
procedure MetaNormsSimulation(listOfAgents, a, b)           ▷ Agent b did not punish agent a
    for each agent c in listOfAgents, where c ≠ b & c ≠ a do
        S ← rand(0, 1)                                      ▷ a value between zero and one
        dice ← rand(0, 1)
        if dice < S then                                    ▷ Agent b was seen not punishing a
            dice ← rand(0, 1)
            if dice ∗ 8 < c.vengeance then                  ▷ Vengeance takes place
                c.score ← c.score − E′
                b.score ← b.score − P′
            end if
        end if
    end for
end procedure
```

Algorithm 4 Process of procreation

```
procedure Procreate(listOfAgents)                           ▷ Time to go to next generation
    Sort agents by score
    for the top 15% agents a in listOfAgents do
        AddToList(newList, a)
        AddToList(newList, a)
        RemoveFirstElement(listOfAgents)
        RemoveLastElement(listOfAgents)
    end for
    for agents a in listOfAgents do     ▷ The list now only contains scores one std deviation away from mean
        AddToList(newList, a)
    end for
end procedure
```

3 Model Visualization

The simulation of Axelrod's model was conducted with the parameters he proposed in his paper. These include social hurt from someone's defection $H = -1$, the punishment on the defector $P = -8$, and on the non-punisher $P' = 8$, the cost of punishment efforts $E' = E = -2$, and the temptation $T = 3$. The variables in this model are the boldness and vengefulness of each agent randomly generated at the beginning of the simulation for a given population, and then of the subsequent generations procreated thereafter. This simulation is conducted over 1000 generations with groups of people with a population of 40. This simulation was repeated a total of 50 times with each configuration to show images that capture the trend at when using the given parameters.

In Figure 1, we observe the evolutionary progress of the creation of norms using the first model proposed with only one defecting opportunity. Here, the colors of each segment represent a generation. For instance blue is the first generation, yellow is the second, green is the third and so on. Here we notice that the initial sample of population must be a good random sample, because the starting point observed is of the average of the population. The reader can observe that all the starting points originate toward the middle of the possible values of vengefulness and boldness. The first observed trend is that of a falling of boldness and a slightly faster falling of vengefulness. after this vengefulness begins to rise once more as boldness continues to fall forming a mirrored letter J. One possible explanation of this result is that boldness fell and as a result vengefulness had fewer occasions to punish and therefore incur the cost of enforcing. Then vengefulness did not bring a cost and was allowed to rise without negative effects to the individual and collective score. A low level of boldness and high level of vengefulness is a signal that a social norm was successfully created. This is because the population will effectively punish the defections and defectors are getting lower and lower scores, which virtually eliminates bold decision policies.

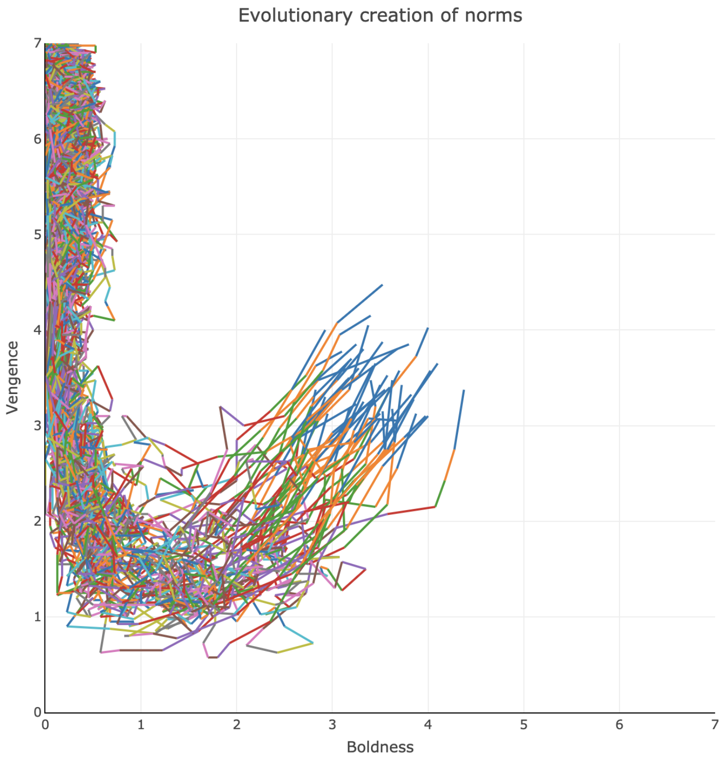

Figure 1: Axelrod Norms Simulation

In Figure 2, we use the same parameters to simulate the Metanorms variant of Axelrod's model. Surprisingly, the boldness generated in the first few generations results in an increased boldness. When the limits of the boldness is reached, vengefulness starts to slowly chip away at the levels of boldness in the evolutionary process of doubly reproducing strong and eliminating weak agents each subsequent generation. This process ultimately leads to the same result of a high vengefulness and low boldness, which is a signal that a social norm has been created.

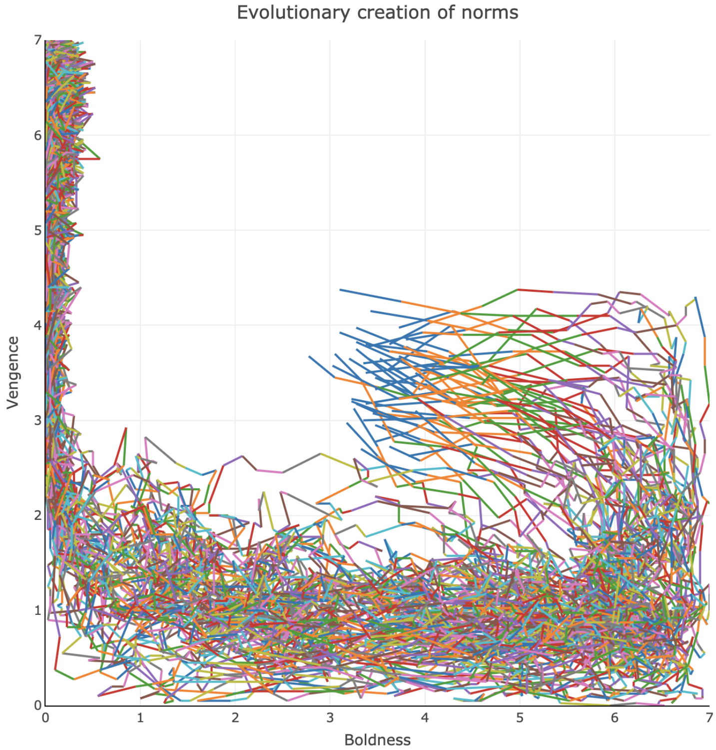

Figure 2: Axelrod Norms Simulation with Metanorms

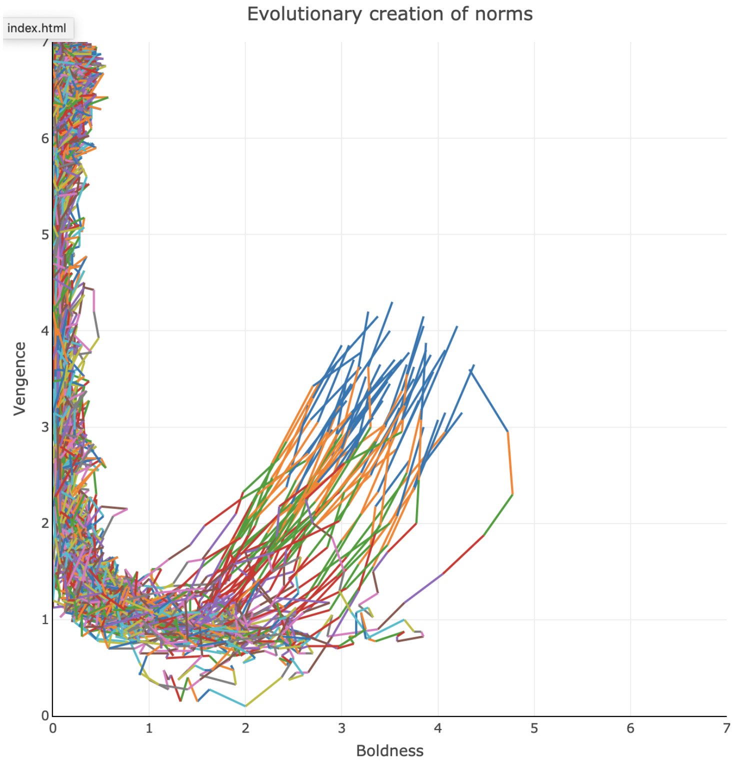

Figure 3: Axelrod Norms Simulation (4 deferral opportunities)

In Figures 3 and 4 the same initial populations are iterated but this time with the opportunity for an agent to defect up to 4 times if the chances of being seen are relatively smaller than the probability of being observed. The result in Figure 3 is that norms are created much more quickly when using the original model. However the opposite occurs when using the modified Metanorms model variant. As observed in Figure 4, the result is a population with low vengefulness and therefore the incapacity to bring down the level of boldness required to for a norm to be created. What is ocurring in practical terms this defecting behavior happens all too frequently and punishing it becomes a losing strategy that becomes weak in the evolutionary perspective and is replaced with more bold and successful policies.

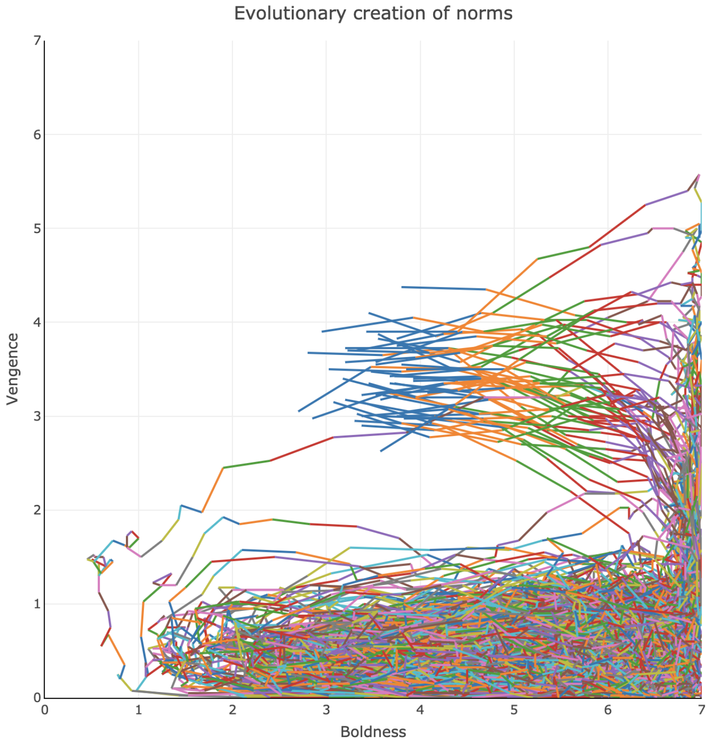

Figure 4: Axelrod Norms Simulation with Metanorms (4 deferral opportunities)

In Figure 1

4 Conclusion and Future research

Axelrod's model proposes an evolutionary perspective that is based on successful decisions policies being reproduced and unsuccessful decision policies failing. This represents thousands of decisions and samples. While there are a number of ways this model might be extended, an observation is that while the social cost of H as a result of defection is a logical parameter within the model, there is no mechanism by which this hurt produces incentive to punish. In the model H only manages to weaken those who are not bold, and limiting the number of times individuals are hurt from defection is not a reward to anyone. In essence it only succeeds in increasing the relative differential between the agent deferring to the rest of the population. A more realistic model could be to build the punishment to be proportional to the amount of times that individuals have been hurt. In spite of this weakness, Axelrod's model does effectively demonstrate how the development of norms and metanorms can be modeled using an evolutionary approach through social punishments and individual rewards.

References

[1] Robert Axelrod. An evolutionary approach to norms. *American Political Science Review*, 80(04):1095–1111, December 1986.