Logic of Animal Conflict With Scripting

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Abstract

Before 1960s, until some renowned writers like G. C. Williams, David Lack, John Maynard Smith and G. R. Rice gave a different perspective to look at the conflicts between the animals of the same species, it was considered to be a feature that was for the betterment of the species. It is so common observation that animals are always fighting over some or the other resource. And the reason is, the resource over which they fight is limited. The uncommon part out of all this was these conflicts never lasted till someone was seriously injured; instead they were resolved by a trial of strength. In this trial the weak opponent always surrendered all the resources to the stronger one.

The paper [1] mentions the flaw in the above idea of ”Good of the Species”;and goes on to explain their reasons with concrete method. We have used this paper as reference to create a computational model for testing whether there is a possibility for ”limited war” situation when individual selection are made.

1 Introduction

The author starts by mentioning all the advantages that a winner receives after winning the conflict. According to paper [1], whenever there is a conflict between two animals of the same species; the winner gets to dominate, gains lots of fellow mates company, also acquires the resource or territory over which the conflict was. Moreover, with very high probability these winning genes are transmitted to the future generations, than the losing ones.

Also the paper [1] states that one might get an idea, if there was a natural selection of the opponents for the conflict, then both would develop efficient weapons and fighting tactics over the period of time. With these improved fighting styles there is a possibility of ”total war” strategy, which in turn might lead to death. But somehow, it is just the virtual assumption, in real scenario the fights between the same species are usually of ”limited war” type, which evolves inefficient weapons and the traditional tactics that just serves as the reason for no serious injury.

Definition for the above terms ”limited war” and ”total war”:

- Limited War:

The combat between two males of the same species that seldom causes serious injury. Here, the fight is more like competition and not a source to kill the enemy or opponent.

- Total War:
The combat between two males that causes serious injury or even lead to the death of either one of the contestant.

Going ahead in paper [1], the author explains the ”limited war” behavior in three different examples:

- Example 1:
This observation is done in many snake species, whenever two male snakes fight the simply wrestle and never use their fangs to defeat the opponent snake.

- Example 2:
Two mule deers will fight with each other furiously by crashing and pushing their antlers against each other’; however, they will never harm each other. Whenever the opponent turns away and resists from fighting more, the opponent never attacks back. They avoid foul play, when the other contestant are not ready for the fight.

- Example 3:
This example talks about the Arabian oryx, which have extremely long and backward pointing horns. These horns are not so efficient weapons when considered for fighting. The animal has to kneel down with their head between the knees, to fight using the horns.

2 Problem Statement

The author, in paper [1], explains the above oddness in the behavior of the animals and contradicts the previous conventional explanation of ”Good of the Species”. The traditional explanation states that if there was no idea for the ”Good of the Species”, then many of the animals would have been seriously injured and also might have dies resulting in the extinction of the species.

The paper [1] states that this explanation was based on the assumption of ”group selection” acting as the sole reason for the behavioral adaptations for limited war type. But the author has the insight that, there might be ”individual selection” which creates adaptations for limited war and also has some advantages at individual level.

The approach in the paper [1] considers simple models of conflicts and determines which strategy will prove beneficial for the individual selection. For this, two different situations have been considered.

- Considering the species having wild weapons and capable of causing serious injuries.

- Considering the species that are not capable of causing serious injuries and the winner of the conflict is decided based on the stamina to stay for long without giving up on the fight.

Then for each conditions, the paper [1] measures the ESS ”Evolutionarily Stable Strategy”; which is nothing but a strategy, if adopted, will give highest reproductive fitness.

3 Methodology

Let us first understand the terminology used by authors in the paper [1].

3.1 Variables Used

Assumption made is, there are two categories of conflict tactics and one move of retreat:

C : ”Conventional Tactics”, which will not cause serious injury.

D : ”Dangerous Tactics”, which might cause serious injury for the opponent if used for long.

R : ”Retreat Move”; a contestant is allowed to retreat back and loose the conflict.

Example explaining the above tactics as per [1] is:
A snake if uses wrestling then it means he is implementing the *C* tactic; and if is using its fangs then it means it is involved in *D* tactic.

Some thumb rules are:

- A contestant is allowed to play either C, D or R move.

- If D is played then there is fixed probability with which the opponent will be seriously injured.

- And the contestant that is seriously injured has to preform the R move.

3.2 Defining Rules

- Probe or Provocation:
As per [1], a move is called the Probe or Provocation if a contestant plays *D* on the first move of contest, or plays *D* as response to *C* move, which was played by the opponent.

- Escalate:
A probe made after the first move is played; then it is said to Escalate the contest from *C* to *D*.

- Retaliate:
When a contestant plays *D* as the response for any Probe move which was played; then it is said as Retaliate.

3.3 Strategies

As per the paper [1], a ”strategy” is nothing but a set of rules which define the probability that next move would be either *C*, *D* or *R*.

Note: Assumption is made that no contestant has the memory of previous contests happened. They play fresh.

For programming purpose, the paper [1] defined five different set of rules of strategies. They are as follows:

- Mouse:

1. Never plays *D*.
2. Plays retreat move *R*, as soon as it receives *D* from the opponent.
3. Because of the above behavior of retreating, there is no chance of Mouse receiving any serious injury.
4. If none of the above, then it plays *C* move until the contest has reached the pre-defined number of moves.

- Hawk:

1. Always plays *D*; will never play *C*.
2. Continues until he is seriously injured or the opponent plays retreat move *R*.

- Bully:

1. Will always play *D*, if he is the one making the first move.
2. Will always play move *D*, as soon as it receives *C* from the opponent.
3. Will always play move *C*, as soon as it receives *D* from the opponent.
4. Will always play retreat move *R*, as soon as it receives the second *D* from the opponent.

- Retaliator:

1. Will always play *C*, if he is the one making the first move.
2. With a high probability will play move *D*, as soon as it receives *D* from the opponent.
3. Will always play move *C*, in response to *C* from the opponent; or will play *R* in case the

contest has lasted for pre-defined number of moves.

- Prober-Retaliator:

1. With a high probability plays *C* and with low probability plays *D*; if it is making the first move or after the opponent has played *C*.
2. Plays retreat move *R* in case the contest has lasted for pre-defined number of moves.
3. After it has given a Probe, it reverts back to play *C* if the opponent retaliates, but plays *D* if the opponent responds to the probe with *C*.
4. After it receives a Probe, with high probability plays *D*.

Some of the assumptions made in the paper [1], as well as followed by us are:

- All contestants have same fighting prowess, they differ only in the strategies.
- Mouse, Retaliator and Prober-Retaliator follows "Limited War" strategy.
- Hawk follows "Total War" strategy.

3.4 Assumed Probabilities

The paper [1], as well as the Script we developed uses the following probabilities:

- Probability of serious injury from a single move $D = 0.10$

- Probability that a Prober-Retaliator will probe on the first move of the contest or after the opponent has played $C = 0.05$

- Probability that a Retaliator or a Prober-Retaliator will retaliate after receiving a probe (condition that it is not injured) from the opponent = 1.0

3.5 Pay-off Calculation

After each contest, the paper [1] mentions to calculate the pay-off for each contestant that participated in the contest.

These pay-offs take in to account 3 different factors:
- What are the advantages of winning as compared to losing the contest.
- What are the disadvantages of being seriously injured in the contest.
- What is the disadvantage of wasting time and energy for the contest.

Pay-offs are calculated in the paper [1] as follows:

- Pay-off for winning the contest = +60.

- Pay-off for receiving serious injury = -100.

- Pay-off for each *D* move that is received and does not count to serious injury (may be accounts for a scratch) = -2.

- Pay-off for saving time and energy (this is awarded only to those contestants who are not seriously injured) = varies from 0 (a contest with maximum length) to +20 (a contest with shortest length).

With the five different strategies, fifteen different types of two-opponent contests are possible. Twenty thousand contests of each type were played during the simulation. Based on these the ESS "Evolutionarily Stable Strategy" was calculated.

3.6 Calculation of ESS

Consider a strategy as opponent to all the other four strategies. Calculate the pay-off for those four strategies. Once you get the pay-off; find the average of all the four pay-offs. Compare this average pay-off against all the four individual pay-offs. If any of the individual pay-off is greater than the average pay-off; then that selected opponent is not an ESS. Otherwise it qualifies to be an ESS.

Based on the silmulations and the test conducted, Retaliator and Prober-Retaliator turns out to be an ESS. So in the case, most of the population mainly consists of Retaliator and Prober-Retaliator. The balance between these two types will be done by the frequency of Mouse, as the probing attack plays an advantage only with the Mouse strategy. Thus the test shows the superiority, based on individual selection, of limited war strategies.

4 Conclusion

As per the paper [1], the results obtained using the above pre-defined probabilties can be altered and checked for different conditions.

For example:

- Changing the probability of serious injury from a single *D* from 0.10 to 0.90 will give scope for "Pre-emptive Strike" skillset, making Hawk an ESS.

- If the same pay-off penalty is applied as that serious injury, for the contestants who retreat uninjured; then the results would favor "Total War" behavior.

Based on the simulation performed in the paper[1] as well as using the script designed by us; we adequately support the statement of the author that individual selection can explain why potentially dangerous weapons are rarely used in the intraspecific contests. For a strategy to be stable, a contestant should respond by escalation move if he receives an escalated attack.

Additionally, the paper [1] states if the contests are settling by the process of attrition, then ESS requires that the population be genetically polymorphic, or that individuals vary their behavior from contest to contest.

5 Future Scope

According to the paper [1], a lot of complications are left out and the computer model is made more simpler. Below are few possibilities that if considered might change the results:

- In real world, there is not only category distinction like *C* or *D* tactics; but also individual differences in the intensity these tactics are used. The tactics *D* might move in increasing order of intensity.

- Moreover, the paper [1] also mentions that the animals, in reality, understand the corelation between the prowess in both the tactics and can gain a lot of information about the opponent's potential. For example, an animal in contest is more likely to probe if it understands that its opponent is inferior than him. With this the animals could adapt to different strategies based upon the opponent they confront. Thus making the results more interesting.

Both these, are added by the paper [1] as the future work; as they include more complexities.

References

[1] J. M. Smith and G. R. Price. The logic of animal conflict. Technical report, November 1973.