Game Theory in Evolutionary Biology

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Overview

- Very brief introduction to Darwinian Evolution
- Very brief introduction to game theory
- Evolution of the male and female gamete
- The Battle of the Sexes
- The game theoretic model
- Moral and philosophical conclusions
- Discussion/Questions

Survival of The Fittest!

- Competition for Resources

- Best survives

- Best reproduces

Game Theory

- Game theory deals with strategic decision making: my decision can affect your outcome

- Can be applied in Evolutionary Biology

- **Strategy: B**ehavior in strategic situation. Not conscious, programmed by the genes

The tale of the Egg and the Sperm

- **Egg:** Bigger, More Nutrition => Greater Chance of Survival

- **Sperm:** Smaller, More Number => Greater Chance of Survival (of the genes)

The Parenting Game

Rules of the Game

- Both male and female have interest in survival of child

- Female, more investment, so more to lose if progeny dies

- Male, less to lose, also prone to be promiscuous to increase chances of survival
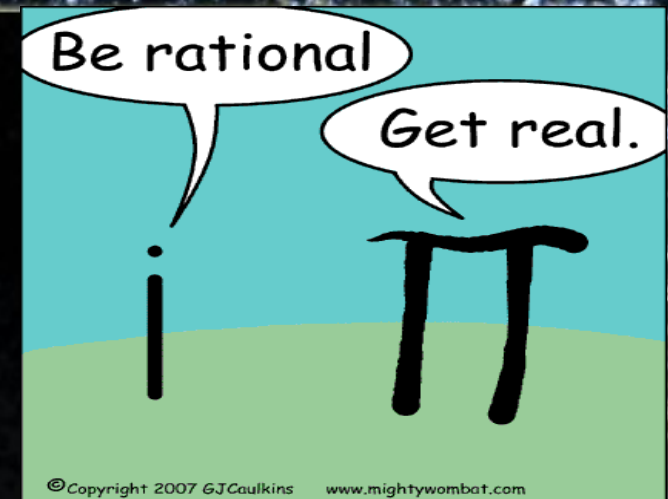
The Parenting Game

Rules of the Game

- Female may demand an Engagement Period

- Male may agree or not to be engaged

Some Numbers

- **+15 : Score for successful birth and full growth of progeny.**

- **-20 : Penalty for taking care of the child.**

- **-3   : Penalty for the engagement period.**

Some Male Strategies

- **Faithful:** These males agree to an engagement period, and also take care of the child after conception.

- **Casanova:** These males do not agree to the engagement period, nor do they take care of the child.

Some Female Strategies

- **Coy:** She asks for an engagement period.

- **Fast :** She does not ask for an engagement period.

Strategic Interplay

	Coy	Fast
Faithful	M: +15 – 10 – 3 = +2 F : +15 – 10 – 3 = +2	M: +15 – 10 = +5 F: +15 – 10 = +5
Casanova	M: 0 F: 0	M: +15 F: +15–20 = -5

Nash Equilibrium

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If each player has chosen a strategy and no player can benefit by changing his or her strategy while the other players keep theirs unchanged, then the current set of strategy choices and the corresponding payoffs constitute a Nash equilibrium.

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Some math, finally!

Definitions:

- Fraction of males who are faithful = r
- Fraction of males who are casanova = 1−r
- Fraction of females who are coy   = q
- Fraction of females who are fast = 1−q

The Evolutionary Stable Strategy

Expected payoff for a faithful = Expected payoff for a Casanova

$$2q + 5(1- q) = 0q + 15(1 - q)$$

$$q = 10/12 = \textcolor{red}{83\%}$$

Expected payoff for a coy = Expected payoff for a fast

$$2r + 0(1 - r) = 5r + (-5)(1 - r)$$

$$r = 5/8 = \textcolor{red}{62.5\%}$$

Something Interesting....

Average Male Payoff = $2q + 5(1 - q)$ = 2.5

Average Female Payoff = $5r + (-5)(1 - r)$ = 1.25

Is Nature exploiting the females??

Consequences on Morality?

We, humans are above nature in several regards. We must rectify nature's mistake, and proceed doing what we humans perceive as morally correct, irrespective of what our genes tell us to do.

Otherwise we are no better than Animals, the blind servants of Darwinian Evolution