Exploring Complexity

In Science and Technology

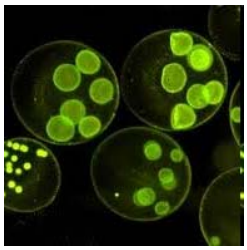
Oct. 18, 2010

Jeff Fletcher

Logistics

- HW2 due today
- Wednesday
  - HW3 due in class
  - Lab2 (Information) due on Blackboard
- Questions?
- Lab1 grades on Blackboard (scoring)
- If can't upload to Blackboard, please see OIT help desk, Smith basement

Life



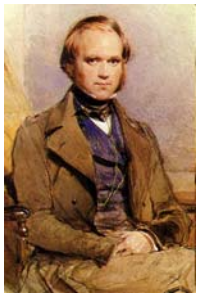
- Definition of life?
- "nature gives us a singular counterexample [of 2nd law]: Life." (p. 71)
  - 2nd law says TOTAL entropy increases (in a closed systems)
  - It does not say entropy increases everywhere within the system
- "Edge of Chaos"
  - http://en.wikipedia.org/wiki/Edge_of_chaos

Darwin's Influences

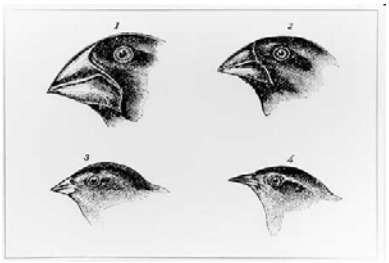
- Charles Lydell's
  - Principles of Geology (1830)
- Thomas Malthus
  - An Essay on the Principle of Population (1798-1826 several versions)

- Adam Smith
  - Wealth of Nations (1776)
  - Invisible hand
- His Data!

Charles Darwin



- Galapagos Finches
- Main Premise
  - Common ancestor
  - Not all offspring survive
  - Inheritance of traits that affect survival, with variation
  - Change gradual, accumulate small changes
- Who get's credit?
  - Alfred Wallace
  - Patrick Matthew



Gregor Mendel

- Diploid inheritance
- Experiments with peas
- 1865 in obscure journal, 1900 rediscovered
- Example: Rh factor in blood
- Most traits are more continuous

Modern Synthesis

- Ronald Fischer, JBS Haldane, Sewall Wright
- Population genetics, allele frequencies
- Fisher vs. Wright Debate
  - Natural Selection vs. Genetic Drift
- Main Conclusions
  - Natural Selection is major mechanism for change
  - Evolution is gradual
    - based on random variation (mutation & recombination
  - Macro-scale (e.g. origin of species) explained by micro-scale processes

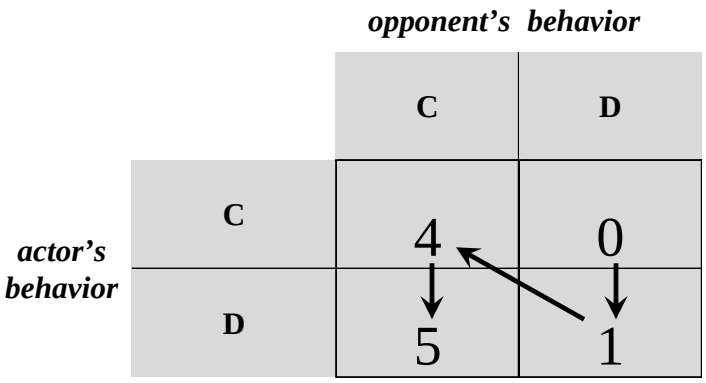
Challenges to Modern Synthesis

- Steven Jay Gould
  - Punctuated Equilibrium
  - Historical Contingency

- Motoo Kimura
  - Neutral Selection Theory
- Group Selection
- Reductionists vs. Whole-ists
  - Splitters and Lumpers

Prisoner's Dilemma (PD)

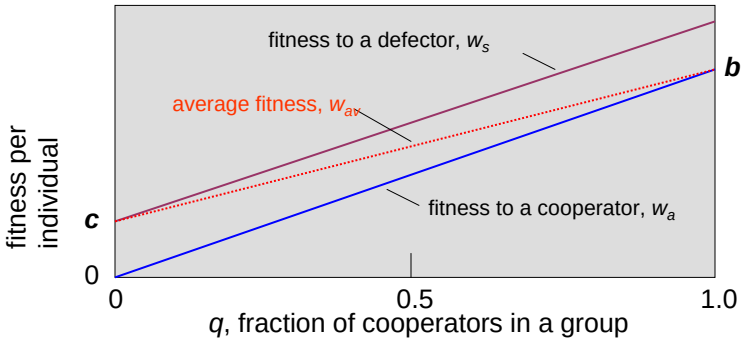
Actor's Fitness (Utility)



- Individually rational to defect
- Collectively irrational

N-Player Prisoner's Dilemma

(Tragedy of the Commons)



- Individually rational to defect: $w_s > w_a$ for all q
- Collectively irrational outcome: $w_s(0.0) < w_a(1.0)$

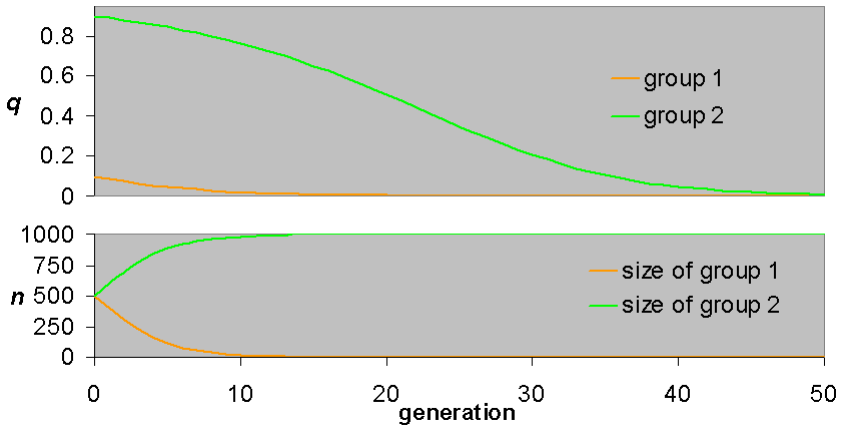
Multilevel Selection Model Based on NPD

- Start simple: just two groups of equal size that vary only in initial fraction of cooperators (q_i)
- PD parameters varied are slope (b) of utility lines and intercept difference (c), $b > c$
- Fecundity = fitness from PD functions

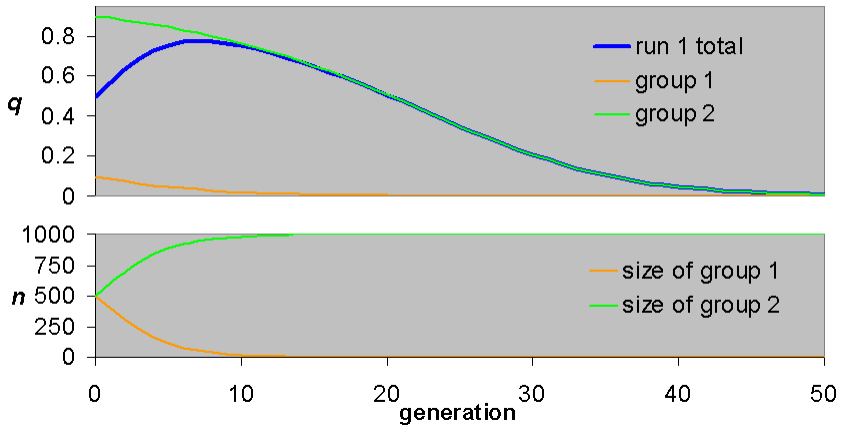
  $a_i' = a_i(1 + bq_i)$

  $s_i' = s_i(1 + bq_i + c)$

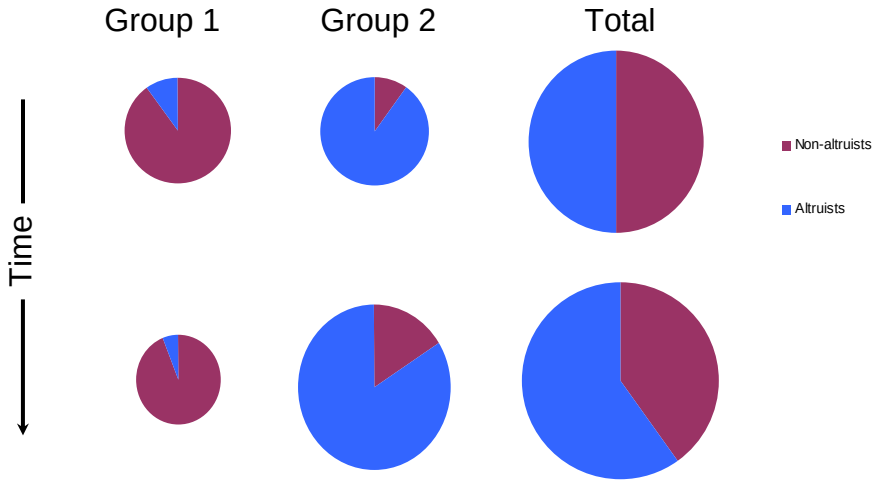
Altruism Decreases in All Groups



Simpson's Paradox



Simpson's Paradox & Multilevel Selection



- Fraction altruists (*q*) decreases in each group, but increases overall

Genetics Basics