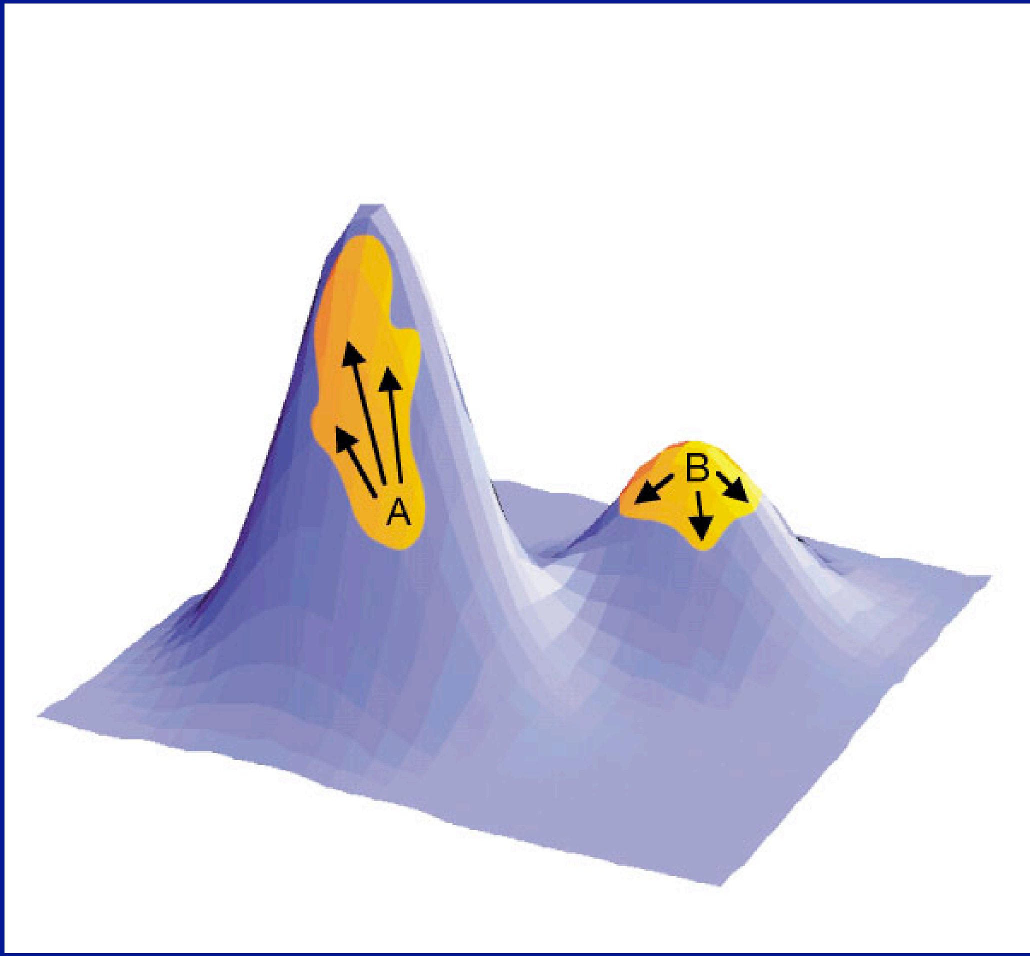
GENETIC ALGORITHMS



2 BOOKS FYI

- Mitchell, M. 1997. An Introduction to Genetic Algorithms.
- Goldberg, D.E. 1989. Genetic algorithms in search, optimization, and machine learning.

A POINT

- Standard optimality models are tactical
- There are many problems in behavioral ecology where the payoff function depends upon the actions of others

A USEFUL ABILITY

- With GA'S we can determine the joint optimum for 2 or more traits i.e. the optimal (or stable) co-adaptive gene complex(es)

ALWAYS KEEP IN MIND

- GA processes are merely analogous to their organic evolutionary counterparts
- GA's are search algorithms that use structured random walks to identify optimal solutions

SOME GA PROJECTS

- Sex allocation decisions in plants - Sargent
- Evolution of tolerance - Robertson
- Growth polymorphisms under frequency dependent predation - McGregor
- Evolution of asexuality - Lalonde
- Frequency dependent life history decisions - Bouskila
- Optimal signal decay rates - Hoffmeister
- Evolution of deceit via mimicry - Tyerman
- Malaria-mosquito co-evolution - Anderson
- Spatially explicit predator-prey games - Hoffmeister
- Evolution of solitary and gregarious parasitoids - Vet

3 PARTS TO A GA

- Description of a population of genotypes (strategies) at Gen_x
- A procedure for assigning fitness values to the different genotypes
- A "mating" protocol within which genotypes may exchange information and contribute to Gen_x

THE CHROMOSOME

- Each chromosome (strategy) has one or more pieces that are analogs of genes

PHENOTYPIC VALUE

- 00010 equals 2
  (ie. 0*16 + 0*8 + 0*4 + 1*2 + 0*1)

- 01001 equals 9
  (ie. 0*16 + 1*8 + 0*4 + 0*2 + 1*1)

A QUESTION

- Why not just build a set of strategies 0 through 31 and let them duke it out - asexually (e.g. replicator dynamics)?
- A: The boolean structured chromosome provides for information exchange that facilitates development if novel solutions.

A FACT

- Every chromosome represents a unique strategy

HOW MANY STRATEGIES?

	1 EGG	*2 EGGS*	*3 EGGS*
HOST HIGH	-	-	-
HOST LOW	+	+	+

ANSWER 2^3 2^3 = 64

A PROBLEM?

- If egg loads vary from 1 to 20 then there are there would be about one trillion unique strategies.

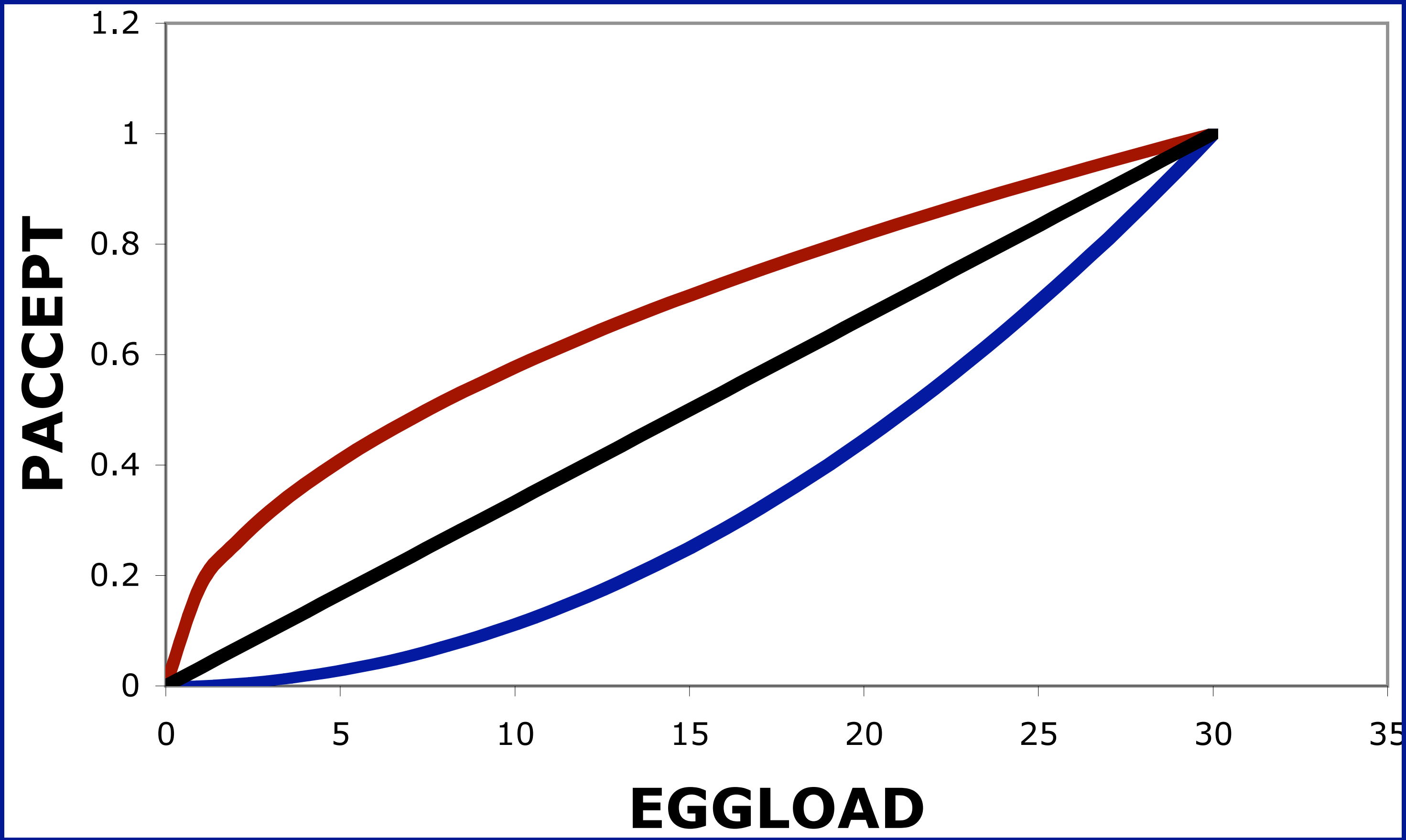
SOLUTION: GENOTYPE TENDENCY

$$\pi_{\varepsilon} = \left(\frac{\varepsilon}{\varepsilon_{\max}} \right)^{\gamma}$$

Where: ε = eggload and

γ = genotype

3 π *f*(ε) Reaction Norms



REMEMBER

- You, the modeler, provide the raw materials for "natural selection" to act upon. Be careful not to bound the problem that forces a particular answer.

A CHROMOSOME

SIMULATION: DETERMINE FITNESS

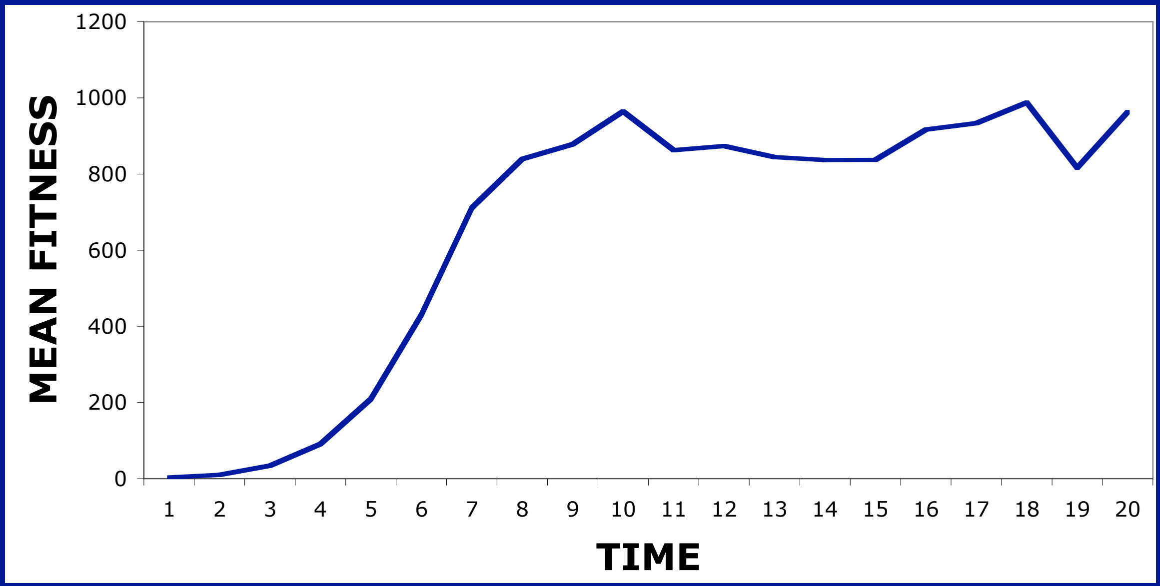
- First, transcribe phenotype from genotype
- Second, play phenotypes in ecological scenario
- Try to employ as few stochastic elements as possible i.e. apply stochasticity when it is at the heart of the problem

TWO PARAMETERS DETERMINE GENOTYPE FITNESS

- Per capita fitness
- Number of individuals of a given genotype

A FACT

- An evolving population should display increasing mean absolute fitness



MATING PROCEDURE

- Weighted random mate selection
- Crossover and mutation
- Create babies by the pair

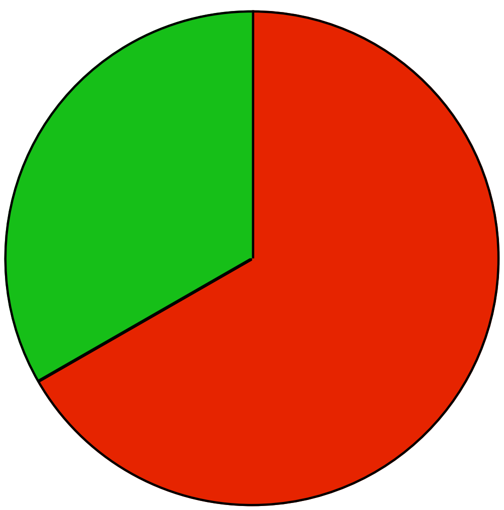
WHAT'S SPECIAL ABOUT THE MATING PROCEDURE

- It provides for novel combinations to emerge and for appropriate strategies to dominate

WHO GETS TO MATE?

Imagine 2 genotypes Red and Green. In generation X Red had 60 individuals each with fitness 3.33 (total 200) and Green had 20 with fitness 5.0 (total 100)

Sample with replacement



IMPLEMENTING A CROSSOVER

1 0 1 0 0 0 0	80
0 0 0 1 0 1 1	11
1 0 1 1 0 1 1	91
0 0 0 0 0 0 0	0

IMPLEMENTING MUTATIONS

Position by position, allow for mutation with some defined probability (e.g. 2%)

1 0 1 1 0 1 1 ➡ 1 1 1 1 0 1 1

0 0 0 0 0 0 0 ➡ 0 0 0 0 0 1 0

SCHEMA CONTEXT

STRATEGY	FITNESS
1 0 1 0 0	.9
0 1 1 0 0	.6
1 0 0 0 1	.85
0 0 0 1 1	.3

SCHEMA CONTEXT

- Def'n - a similarity template that is used to group strings that are similar at particular positions

SOME SCHEMA FACTS

- High performance strings will tend to grow exponentially in the population
- Crossovers destroy schemata
- The longer the schemata the more susceptible to crossover e.g. 10 vs 100001
- Short, high performance schema will grow at high rates

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- How big should populations be?
- Big populations take longer to evaluate but are less susceptible to stochastic elements

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- Normally it is best to start with a random assemblage of strategies (chromosomes)but this should be repeated several times.

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- Use scaling factors e.g. set limits on best performers during early stages. The opposite tact can be taken near the end of runs.

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- How many generations?
- Develop criteria for terminating iterations