Genetic Drift and Natural Selection:
An Exploration of Allele Frequencies Within a Population

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Math 164: Scientific Computing

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Presentation Outline

- Definition of an allele
- Modeling genetic drift
- Trends in genetic drift
- Modeling natural selection
- Future work

What is an allele?

- A given population often contains many versions of the same gene.
- An allele is one version of a gene at a given location, or *locus*, along a chromosome.
- Each person inherits two alleles for each gene—one allele from each parent.

What is an allele?
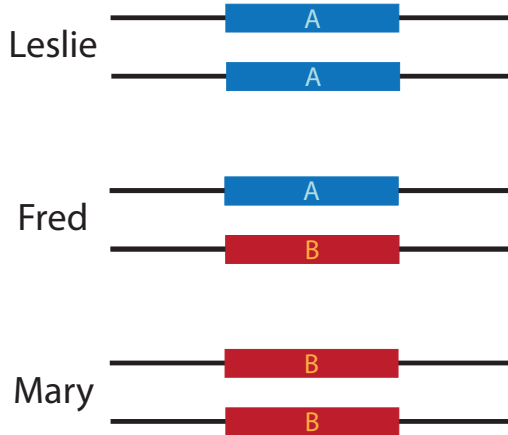
Genetic Drift

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- The population contains only two types of the allele of interest
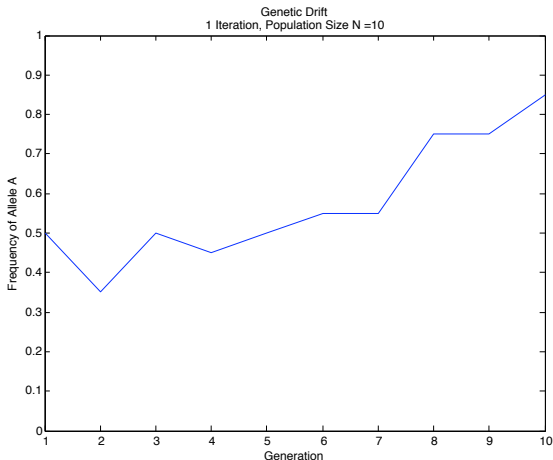
An Example of Genetic Drift
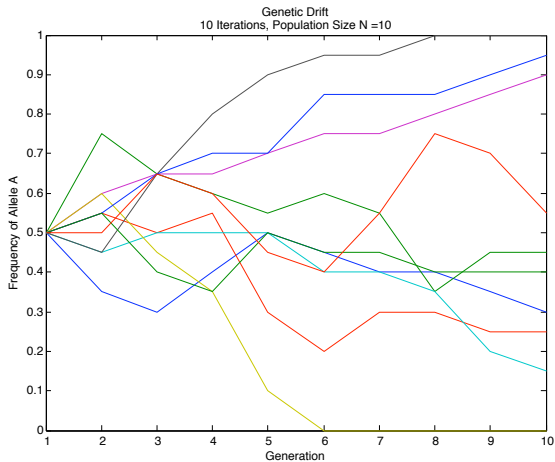

Generation 1
10 A, 10 B
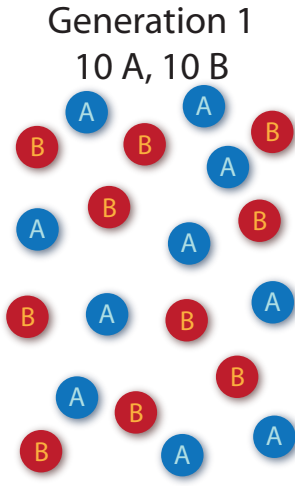
Generation 2
? A, ? B

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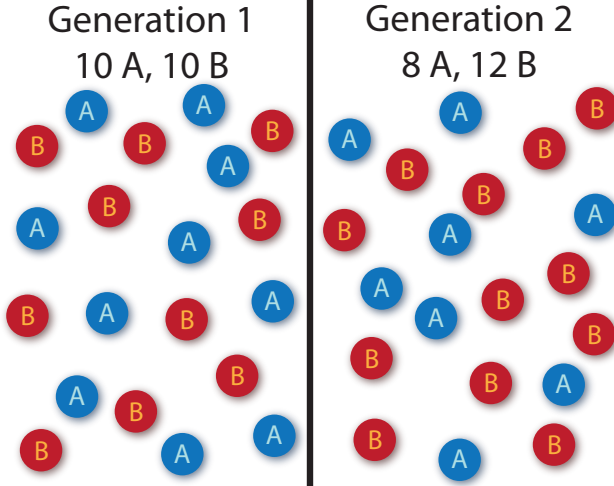
Genetic Drift Over Several Generations

Genetic Drift Over Several Generations

Two Ways to Model Genetic Drift

"Brute Force" Method

- Directly simulates random picking of gametes from a gene pool
- Create a vector of "alleles"
  - Random real numbers on the unit interval
- If less than frequency of allele A, reset number to 1
  - Otherwise, reset number to 0
- Summing the components and dividing by the number of alleles gives the new frequency of allele A
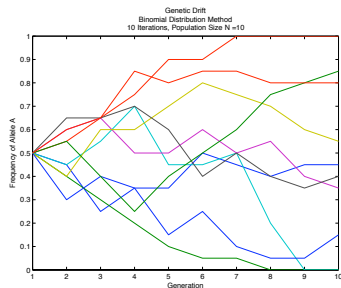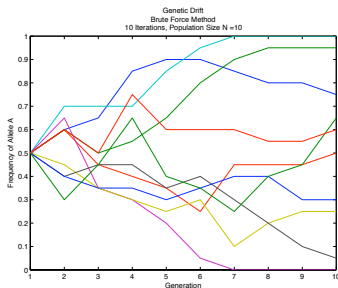
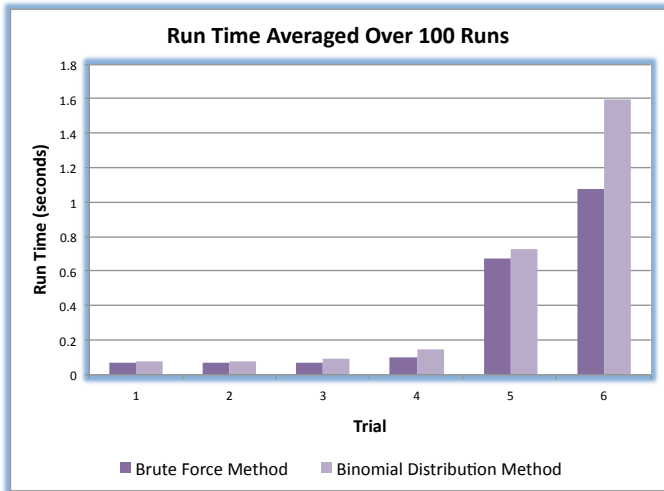## Two Ways to Model Genetic Drift

Binomial Distribution Method

- Uses MATLAB's binornd(n,p) function to generate random numbers from the binomial distribution
    - sample size = number of gametes
    - probability = frequency of allele A in the previous generation
- The output of the function gives the allele frequency of the subsequent generation
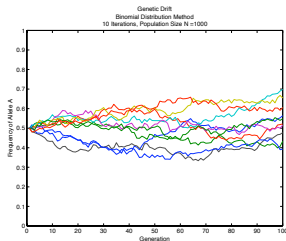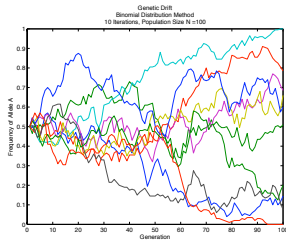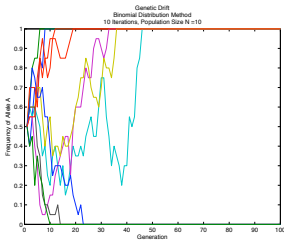
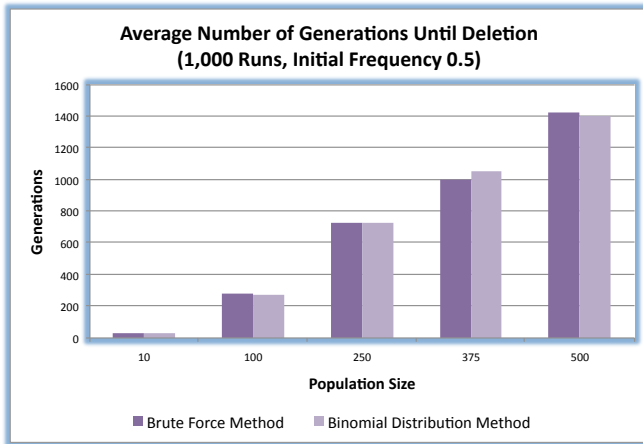# Visual Comparison of the Two Techniques

Comparison of Runtimes

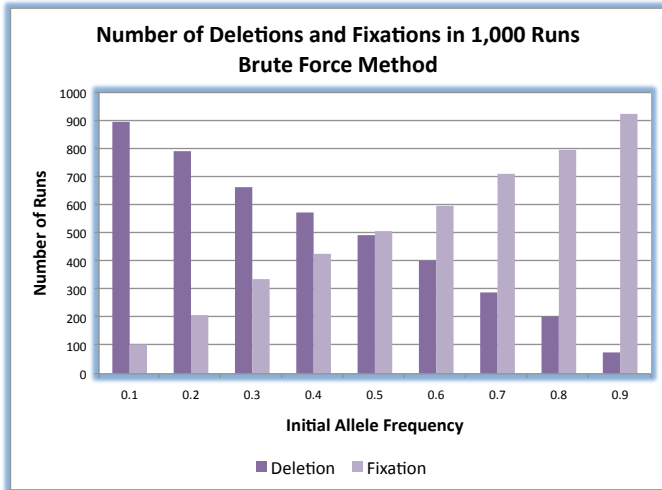# Effects of Population Size

Effects of Population Size

**Average Number of Generations Until Deletion
(1,000 Runs, Initial Frequency 0.5)**

■ Brute Force Method ■ Binomial Distribution Method

Effects of Changing Initial Frequency

Number of Deletions and Fixations in 1,000 Runs
Brute Force Method

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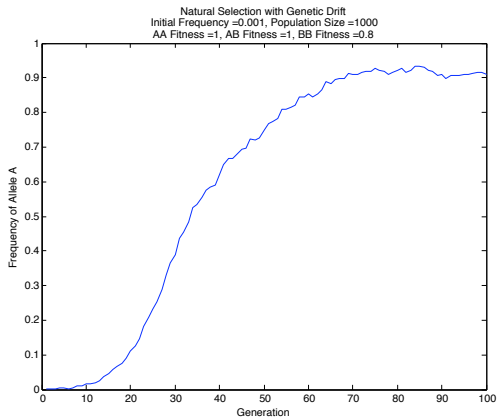- An individual's fitness depends only on his genes—not on the environment

Natural Selection

What happens when individuals with a particular allele always reproduce and individuals without it reproduce less often?
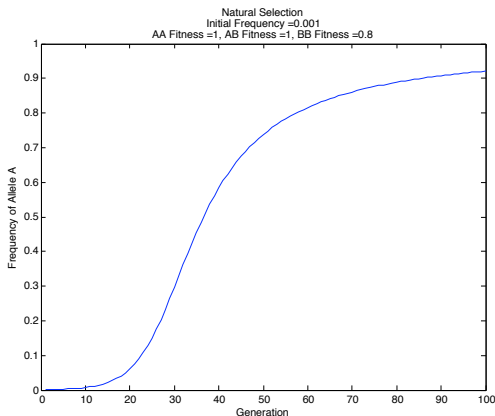
Natural Selection *and* Genetic Drift

When both genetic drift and natural selection are at work...

Future Work

Natural Selection

- Extensively explore the effect of changing fitness levels and
  initial allele frequency