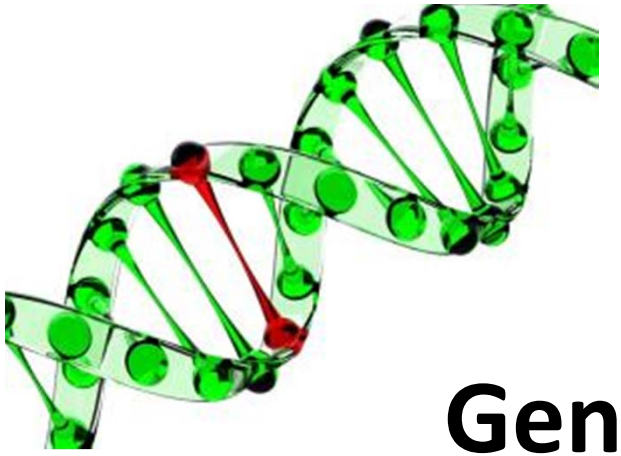
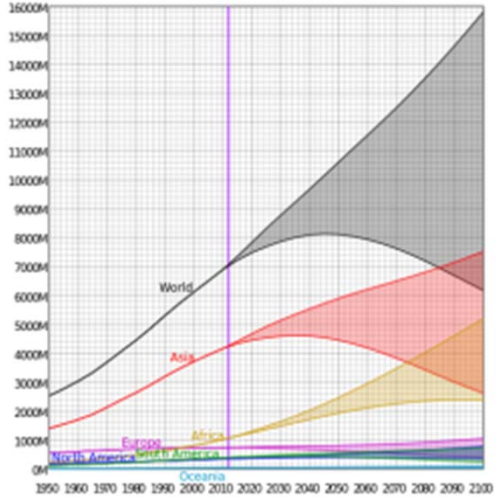
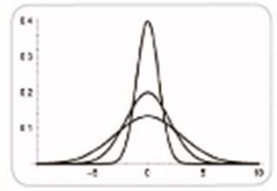


Genes vs. Environment: Breeder's Equation





Trait Variance: Part Genetic & Part Environmental

$$V_P = V_G + V_E$$

- We want to know "how much" genetics and environment contribute to phenotypic variance

- Fraction of total phenotypic variance that's genetic is called "Heritability"

  (V_G/V_P) or $(V_G/(V_G+V_E))$

  Ranges 0 (no genetic) to 1 (all genetic)

Means of assessing heritability: Response to selection

- Average height in population: 5’ 7”
- 6’ 0” male and female have lots of kids
  - How tall will they be?
    - Average 6’ 0” (like parents)?
    - Average 5’ 7” (like original population average)?

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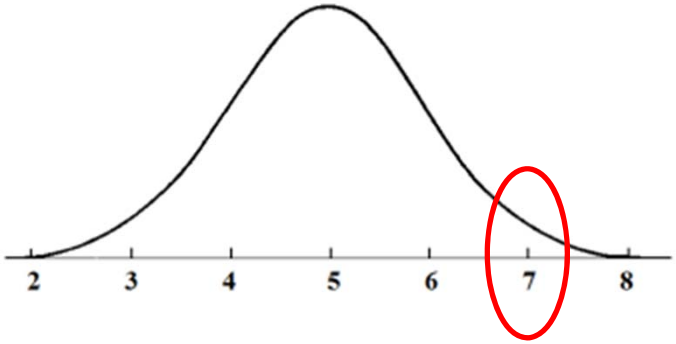
- What if height is purely determined by environment?
- What if height is purely genetic?

We can calculate heritability by response to artificial selection…

- Start with population of corn, average height is **5** feet tall.

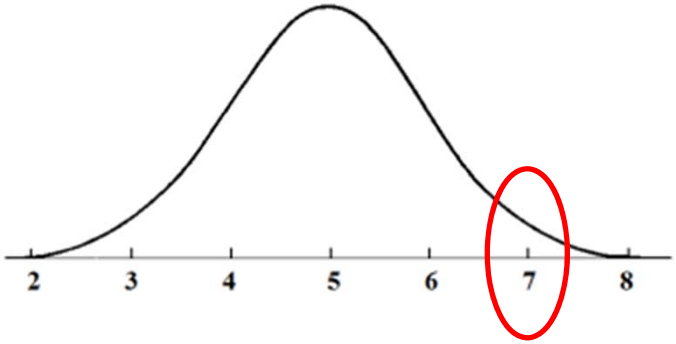


- Select **7** foot corn plants
  - Breed them

- If offspring of 7-foot plants average **7** feet, then variance in height is purely genetic (heritability = 1)

We can calculate heritability by response to artificial selection…

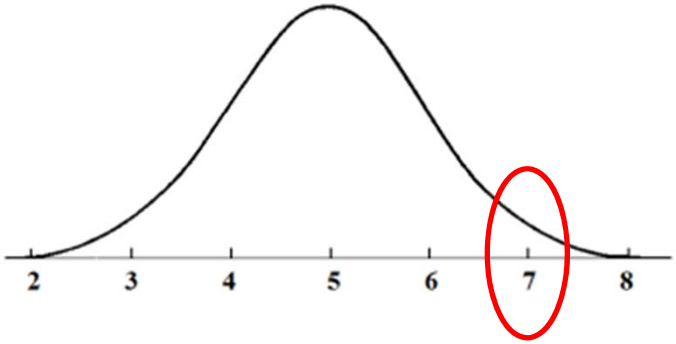
- Start with population of corn, average height is **5** feet tall.



- Select **7** foot corn plants
  - Breed them
- If offspring of 7-foot plants average **5** feet, then variance in height is purely environmental (heritability = 0)

We can calculate heritability by response to artificial selection…

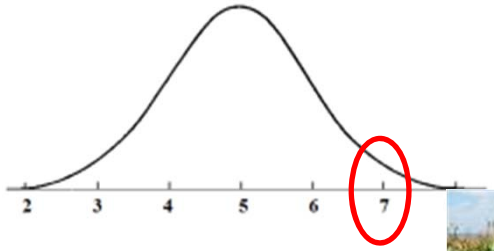
- Start with population of corn, average height is **5** feet tall.
- Select **7** foot corn plants
  - Breed them



- If offspring of 7-foot plants average **6** feet, then heritability = ?

We can calculate heritability by response to artificial selection…

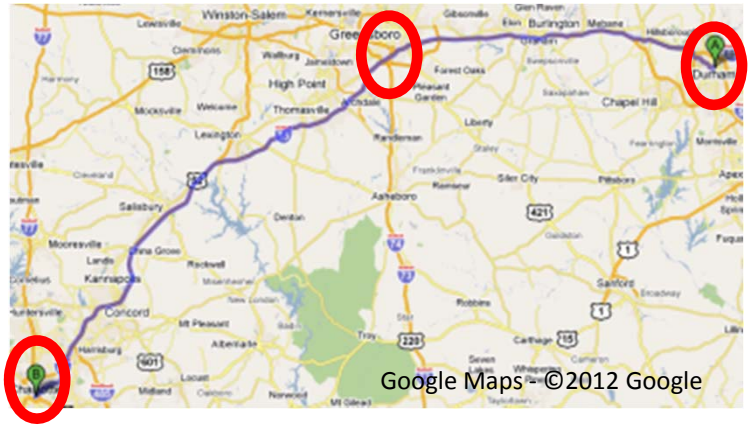
- Starting average **5** feet tall.
- Select **7** foot corn plants



- If offspring average 5 feet, heritability = 0.0
- If offspring average 5.5 feet, heritability = 0.25
- If offspring average 6 feet, heritability = 0.5
- If offspring average 6.5 feet, heritability = 0.75
- If offspring average 7 feet, heritability = 1.0

ANALOGY

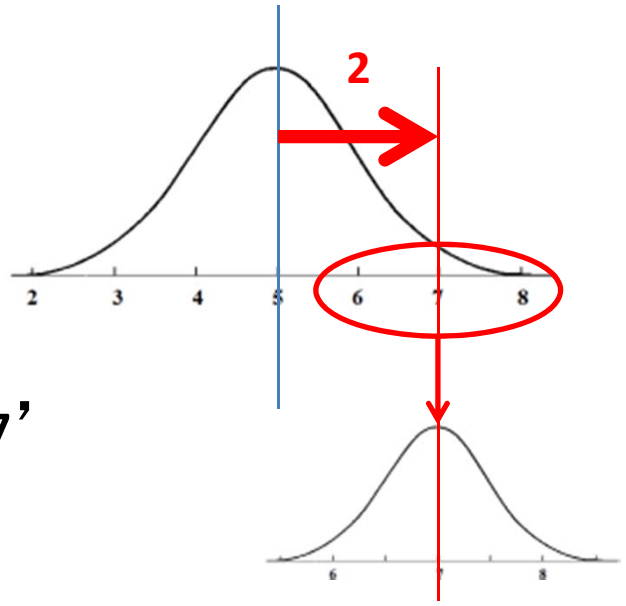
- Starting in Durham.
- Trying to get to Charlotte. (Selection)
  - 150 miles away from Durham
- Get only to Greensboro. (Response)
  - 50 miles away from Durham



- What fraction of the way did you make it to your destination?

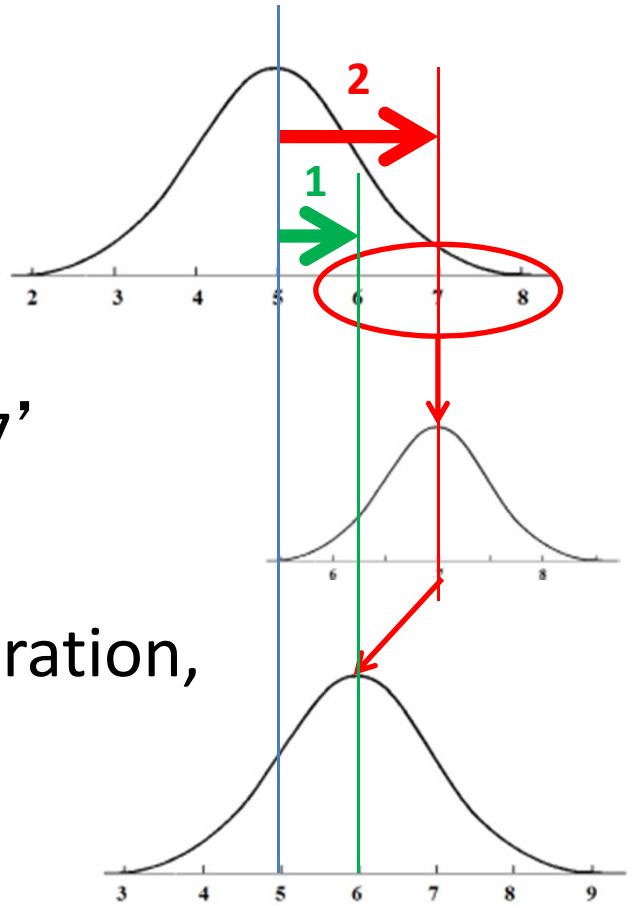
Same thing with artificial selection

- Start with average 5’
- “Selection” for average 7’



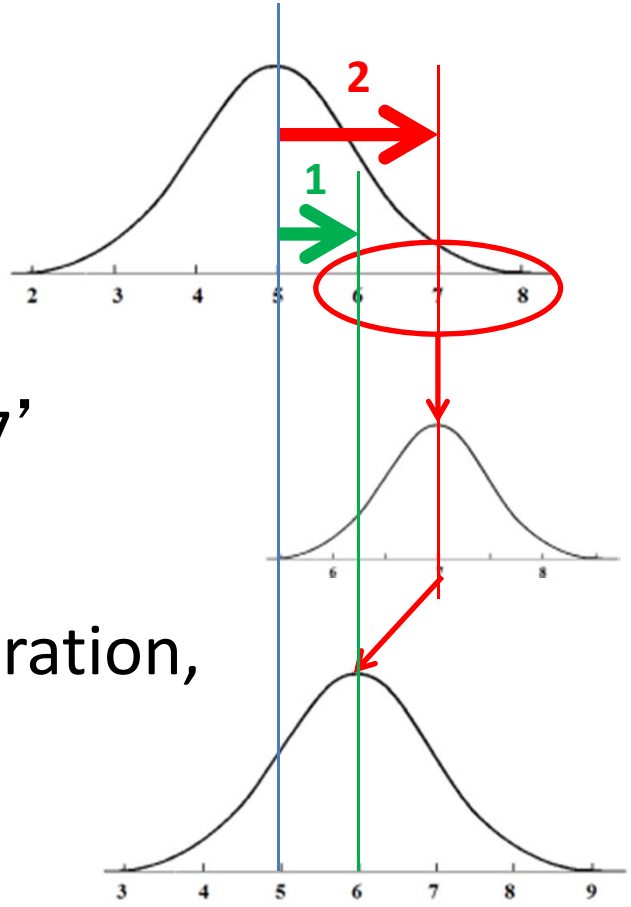
Same thing with artificial selection

- Start with average 5’
- “Selection” for average 7’
- “Response” in next generation, average 6’



Same thing with artificial selection

- Start with average 5’
- “Selection” for average 7’
- “Response” in next generation, average 6’
- Heritability = 1 / 2 = 0.50



Redefining heritability...

- From a one generation selection experiment, heritability is *how far you got* (response) relative to *how far you were trying to get* (selection).
  - Heritability = Response/Selection = R/S

- This measures the fraction of phenotypic variation that is genetic.
  - Heritability = $V_G/(V_G + V_E)$

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Sample problem

- You are selecting for plumper turkeys.
  You start with a population of turkeys with average weight 25 pounds. You select turkeys with average weight 45 pounds. The offspring of the 45-pound turkeys weigh an average of 40 pounds. What is the heritability of weight in these turkeys?

Sample problem

- Start 25 pounds.
- Select 45 pounds.
- Offspring 40 pounds.

Reminder-
these are not "perfect" predictions

- Amount of environmental variance not constant
- Some "populations" may have more genetic variance than others
- **Remember what it is you're calculating:**
  - The fraction of total phenotypic variance that is genetic:

Heritability = $V_G/(V_G + V_E)$

Artificial vs. natural selection

- **Artificial selection**- breeder chooses desirable traits and has organisms with the most extreme desirable traits breed

- **Natural selection**- particular traits facilitate survival/ reproduction, and organisms with the most extreme such traits have more offspring

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