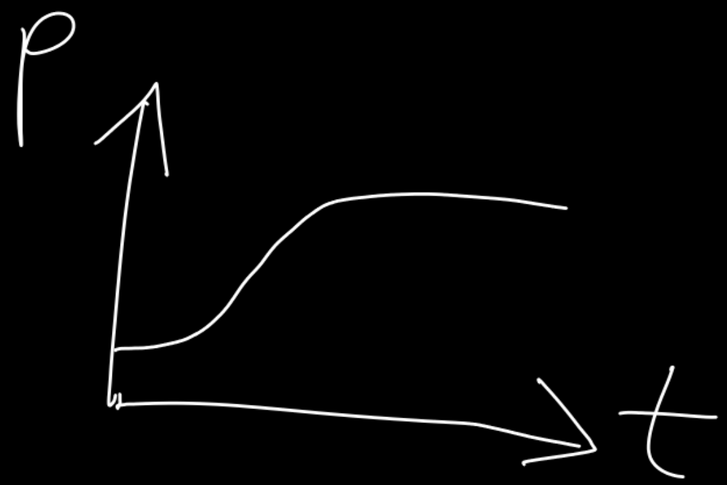
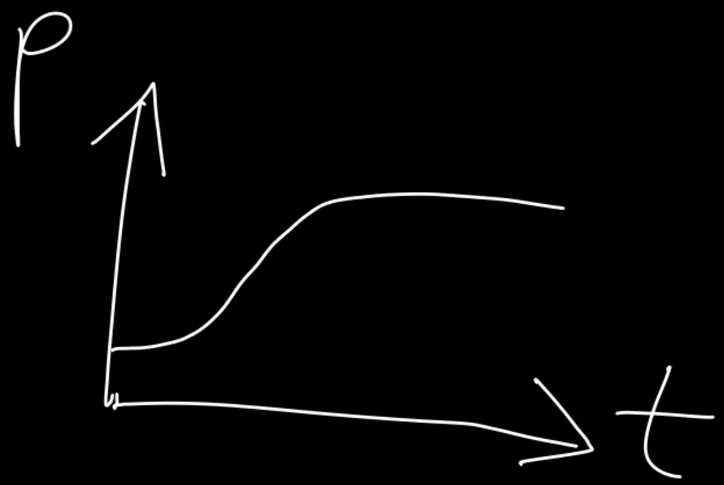
Evolutionary Quantitative Genetics

Raphaël Scherrer

Population genetics



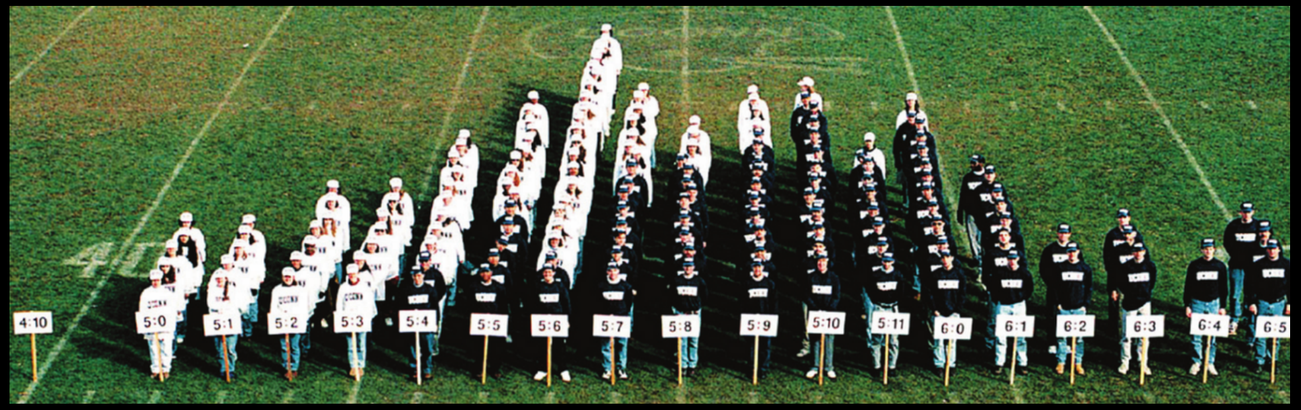
Population genetics



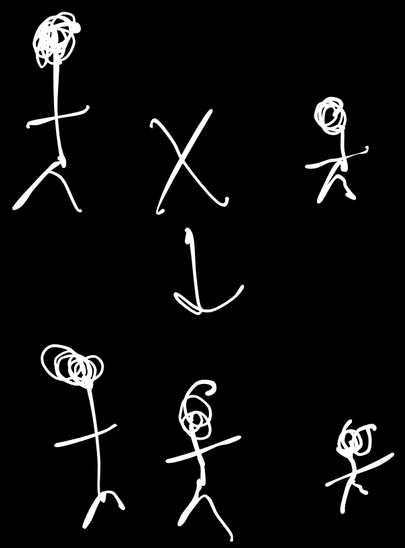
CFTR Blood type

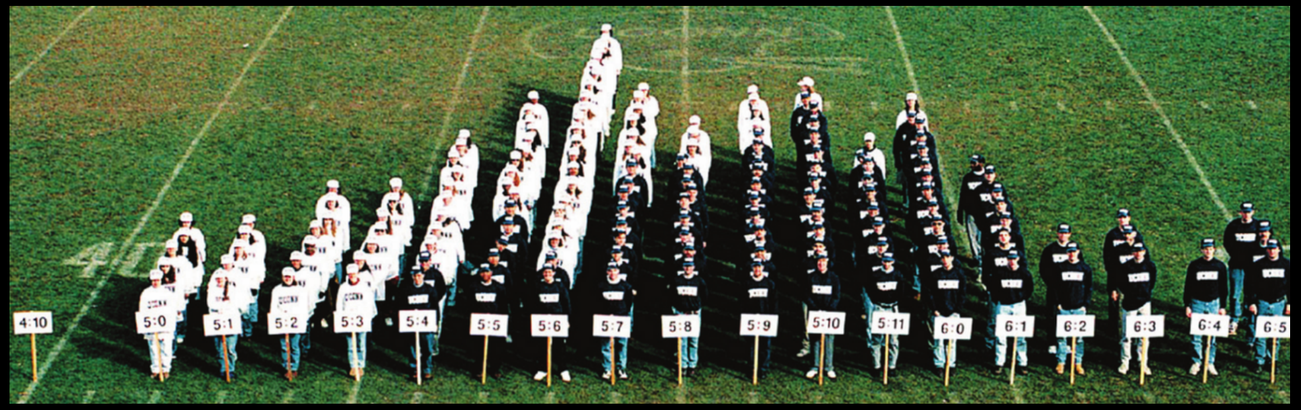
CCR5

Mendelian traits



Quantitative traits





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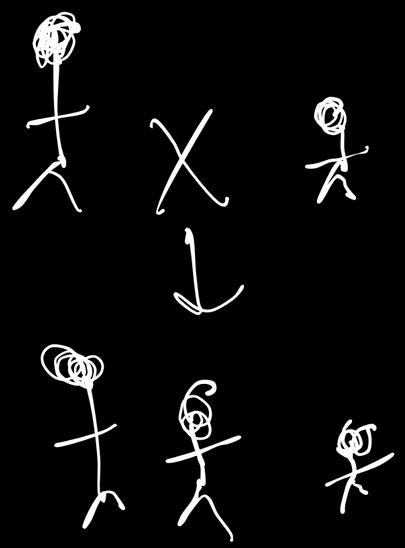
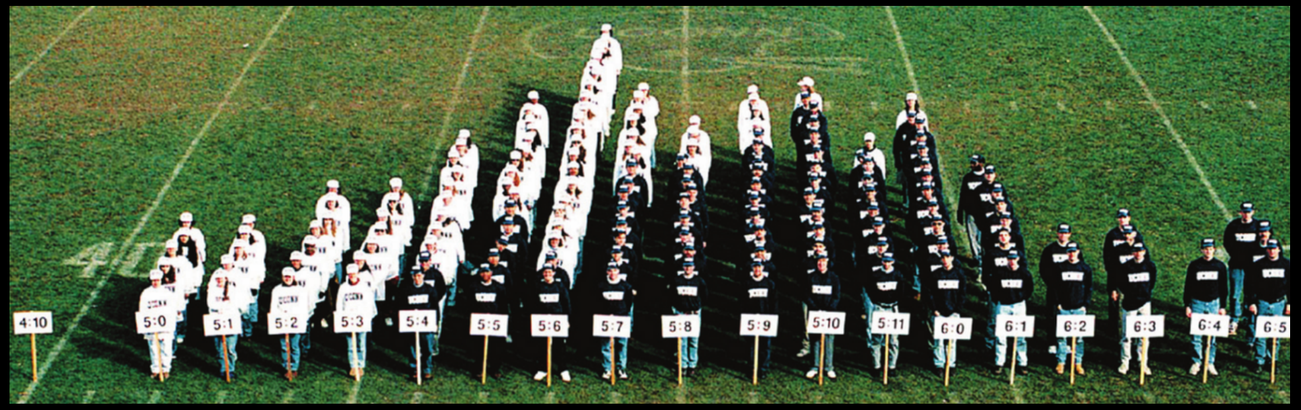
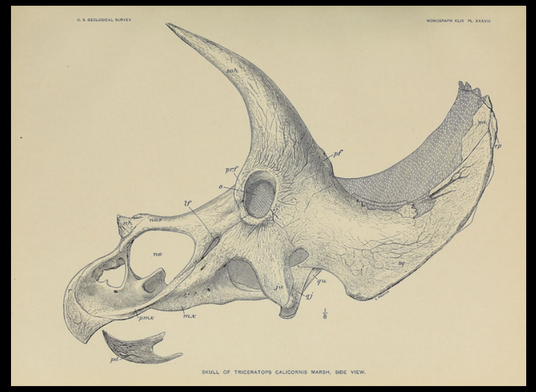
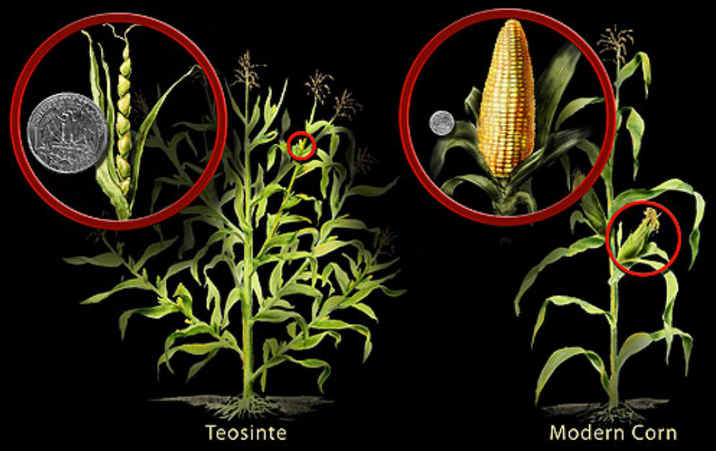
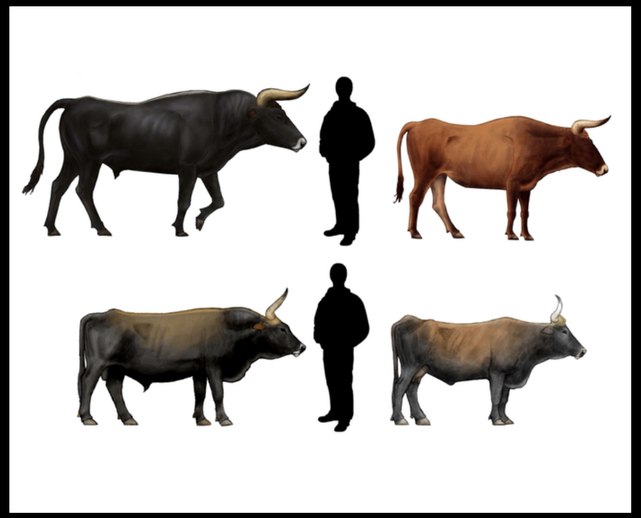






Quantitative traits



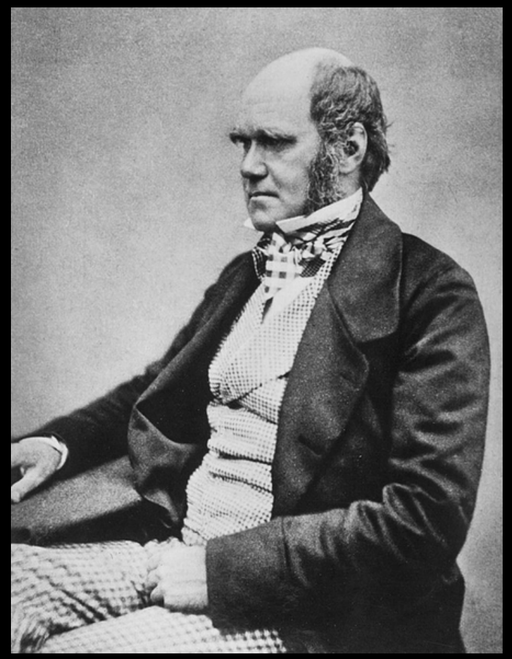


Selective breeding

Population genetics

Mendelian traits

Quantitative traits

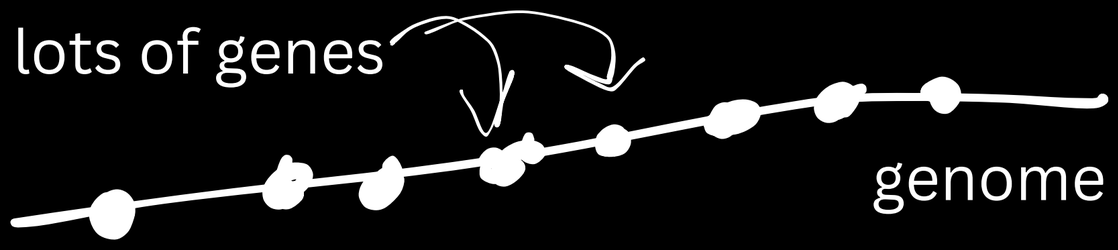


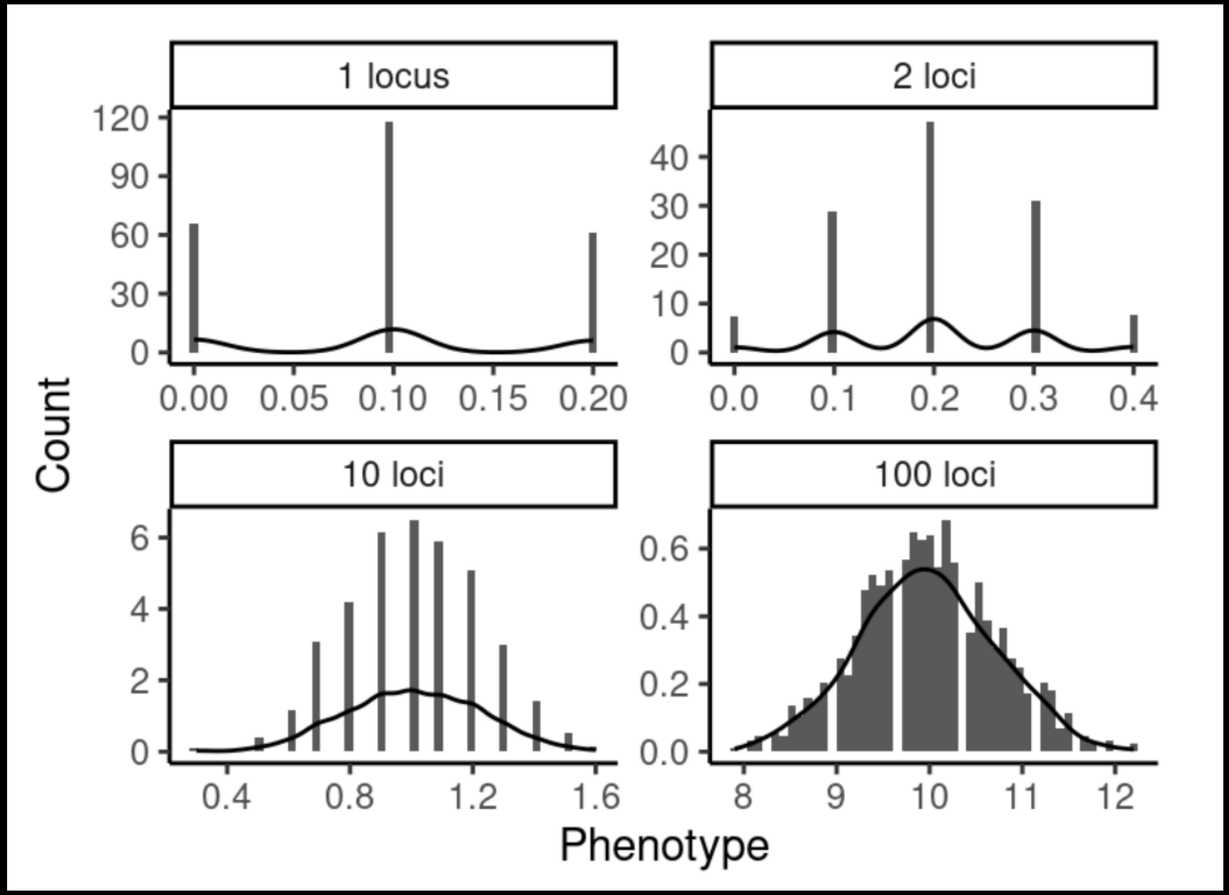
Darwin

Mendel

unit of inheritance

genes



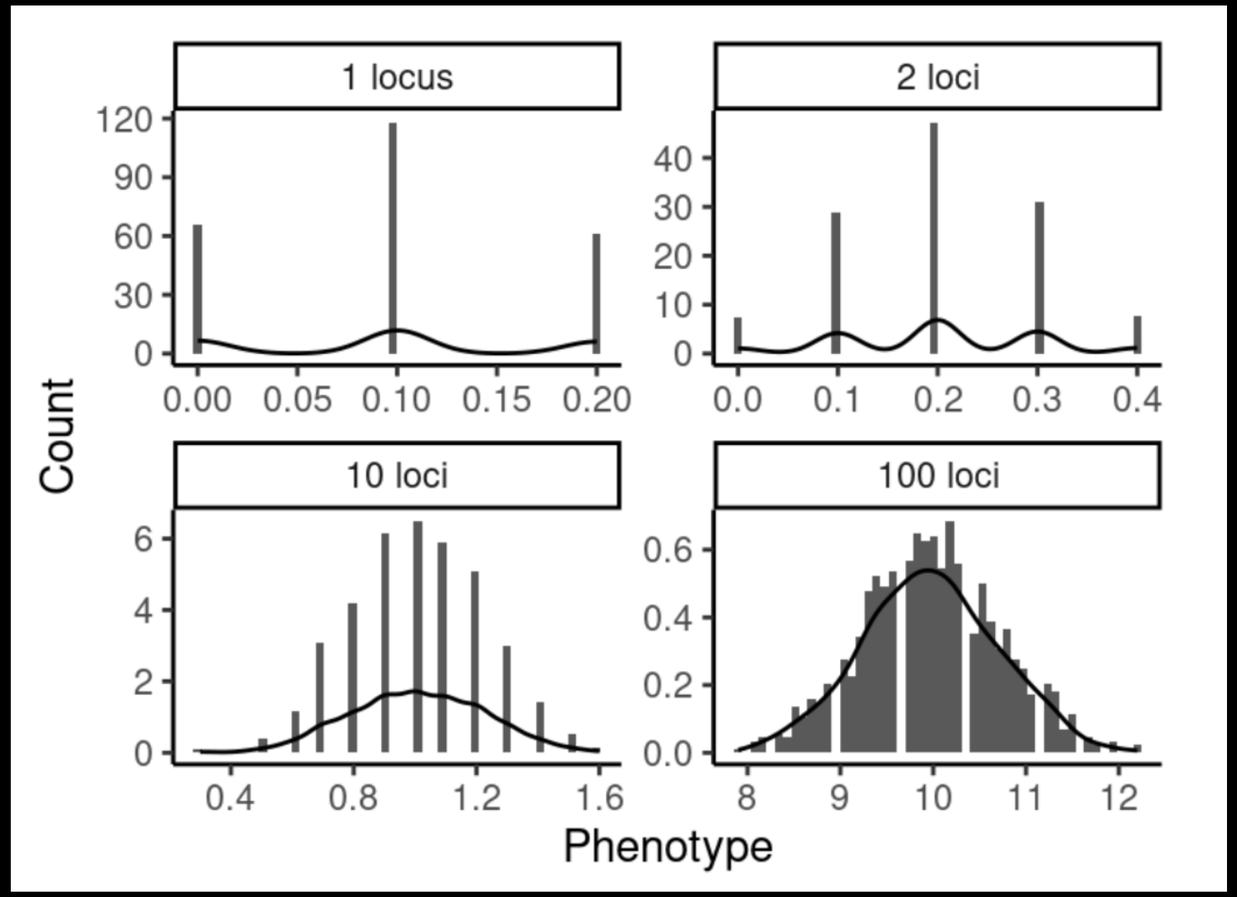


quantitative traits

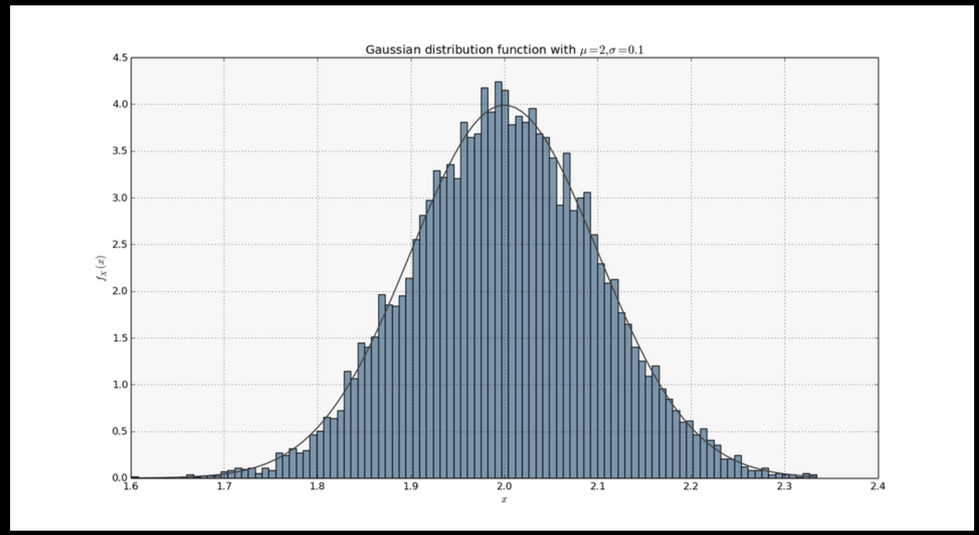
complex traits

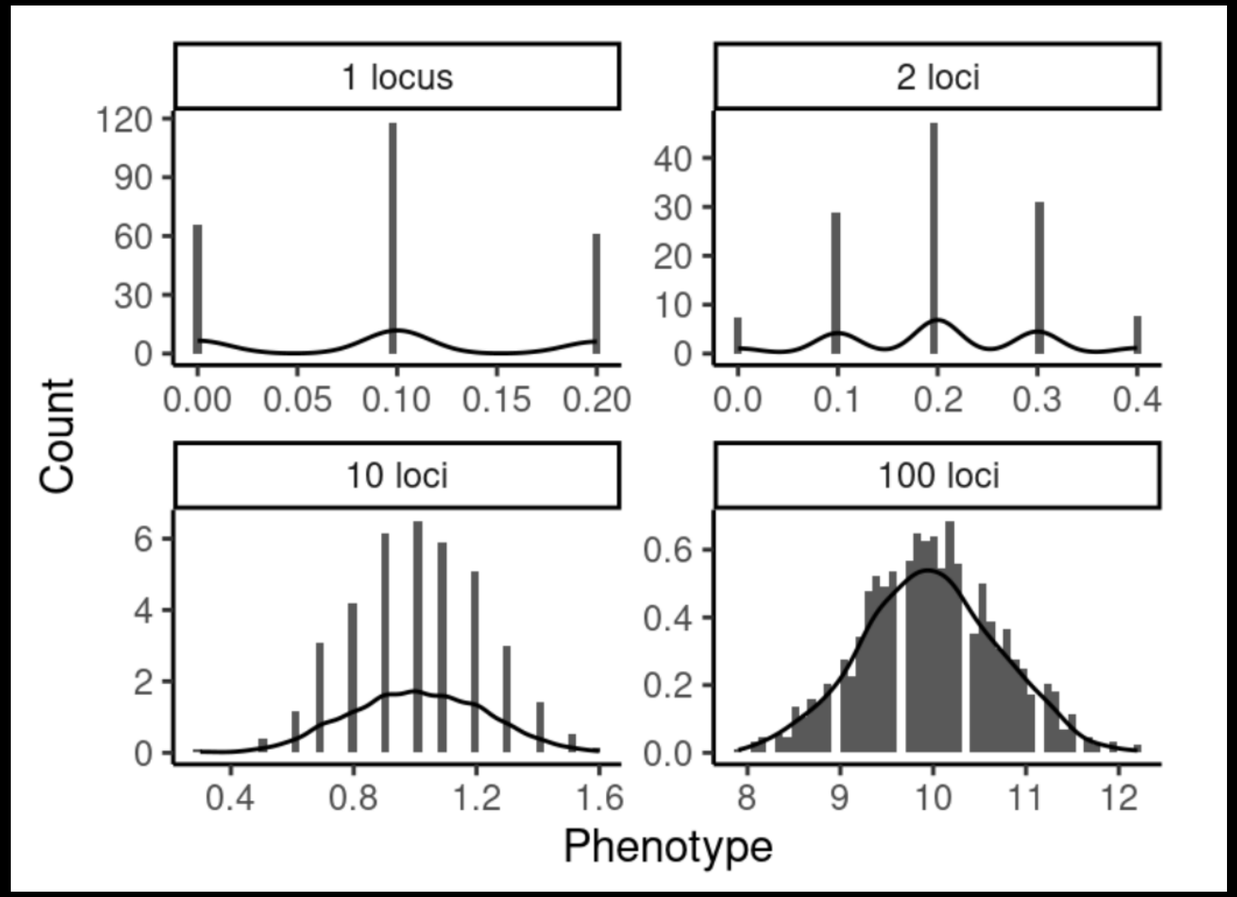
polygenic traits

Quantitative genetics



Normal distribution





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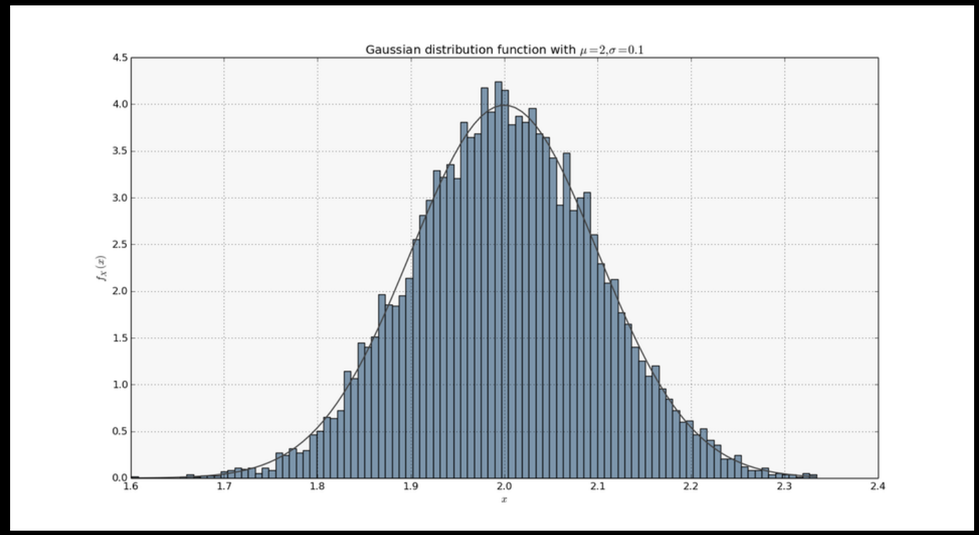

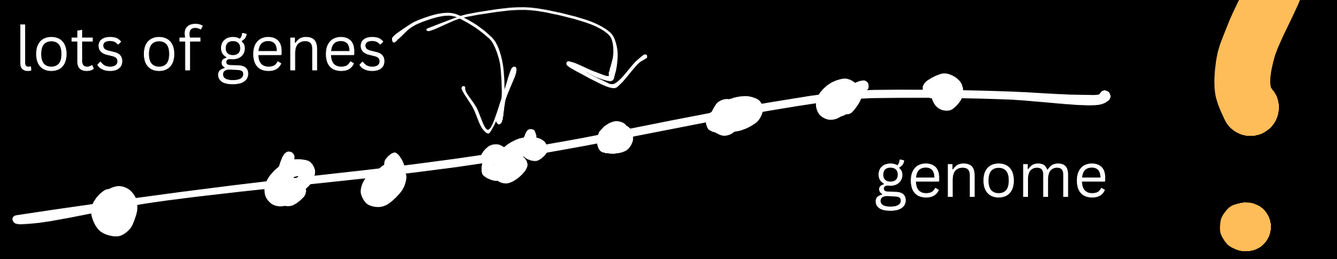

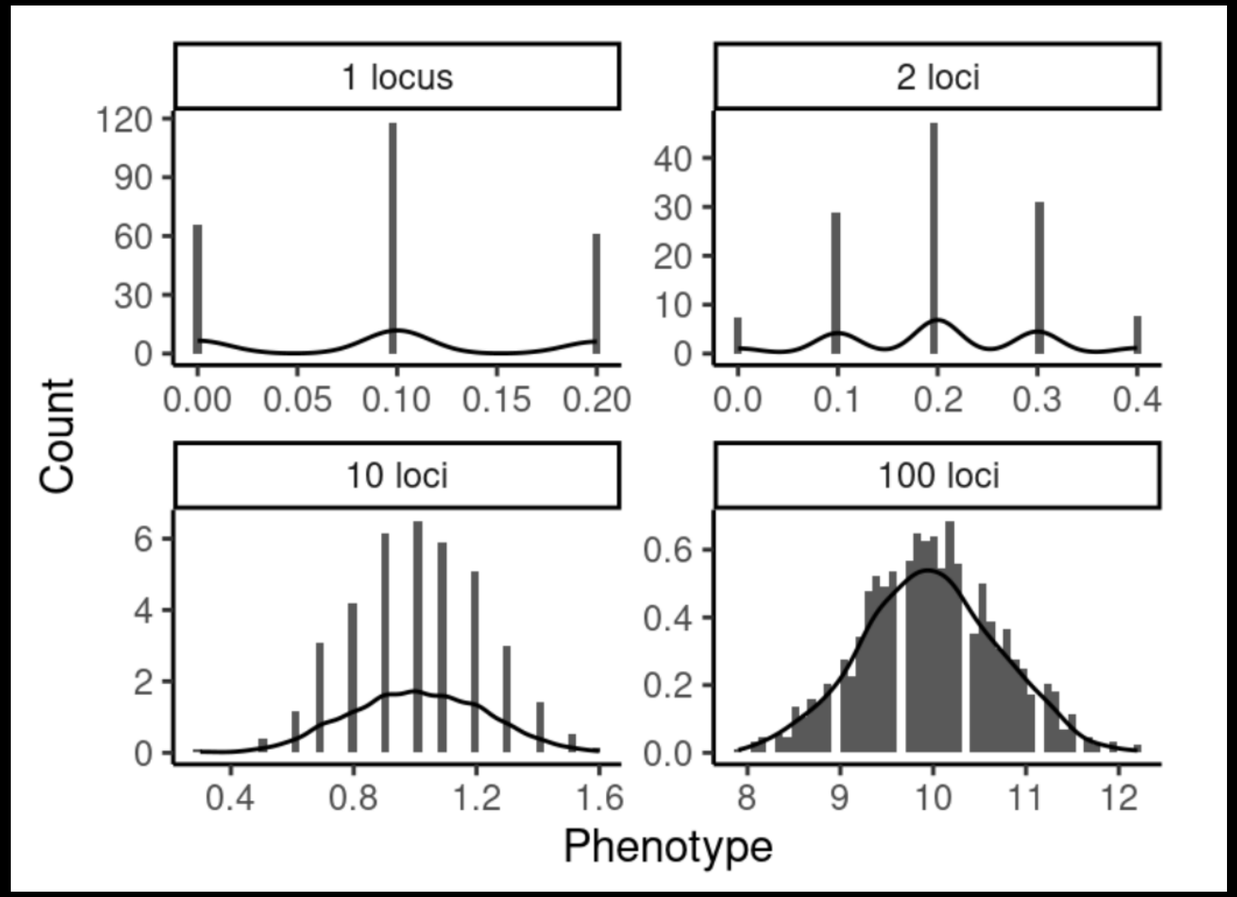

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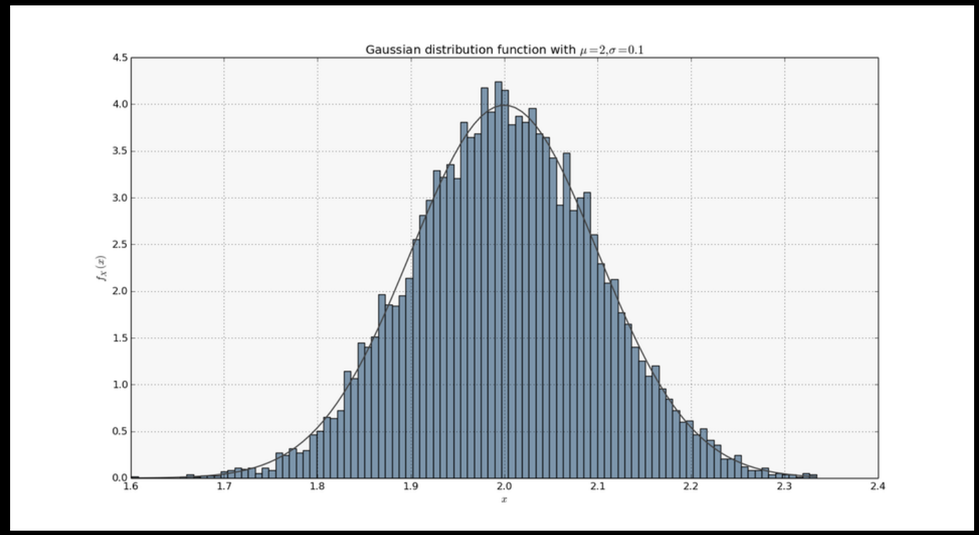
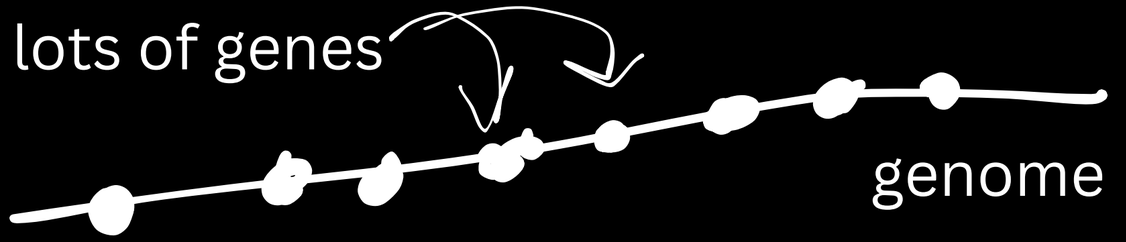
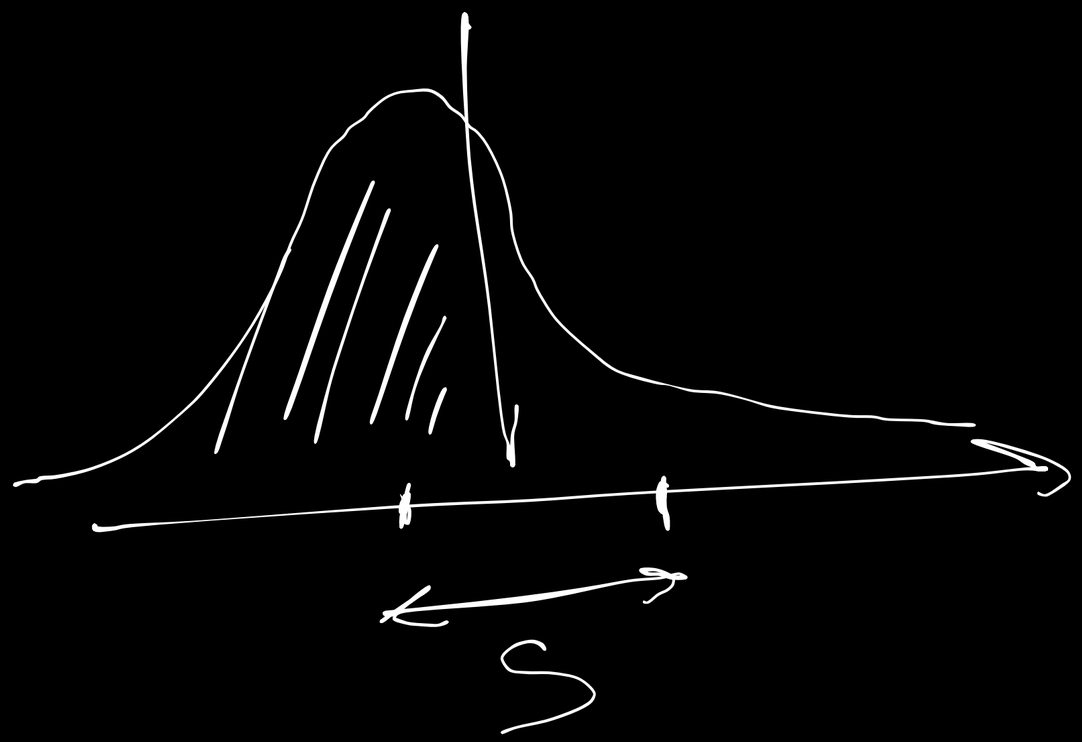


Central limit theorem



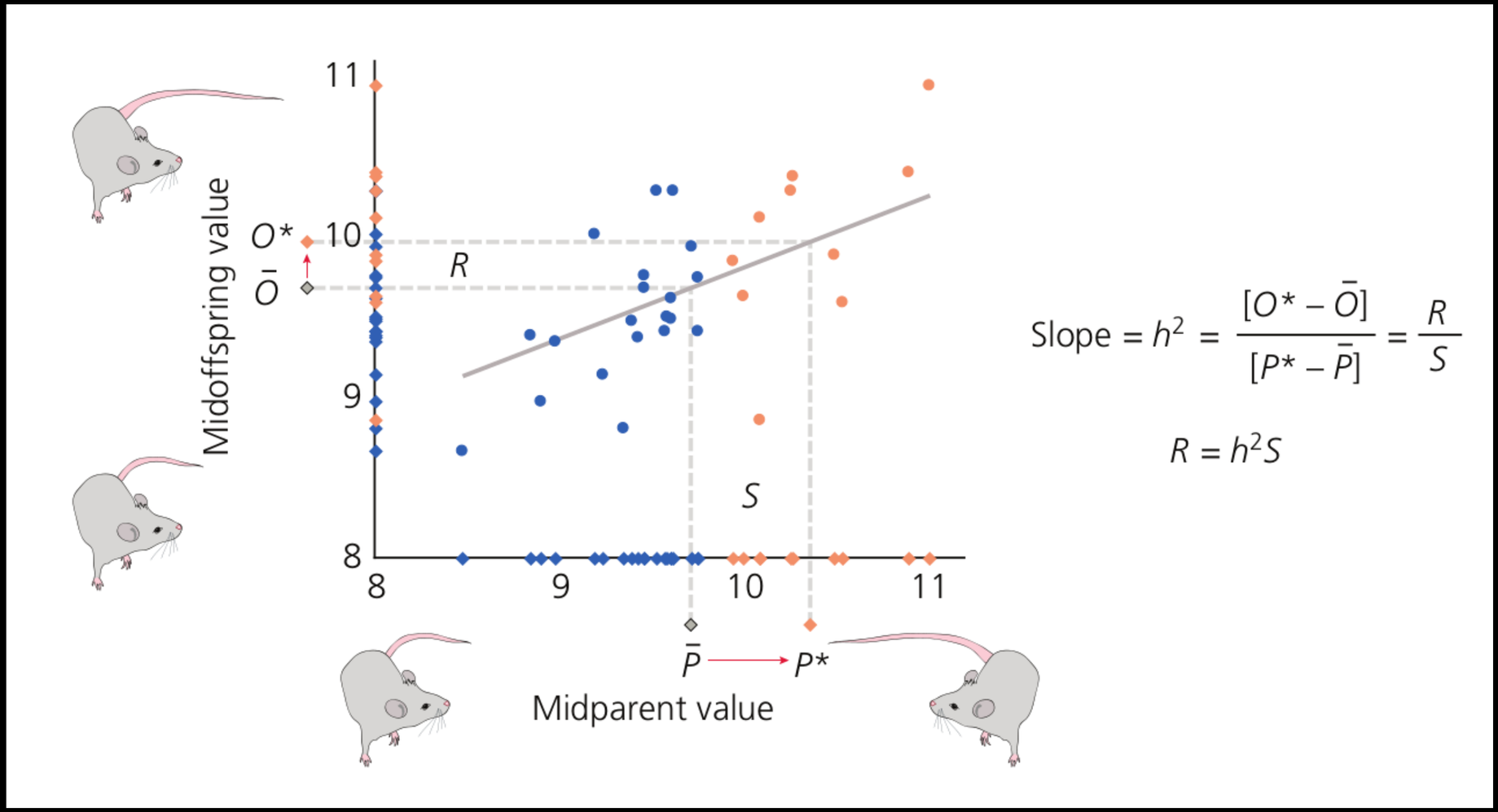
Breeder's equation



$$R = h^2 S$$

heritability

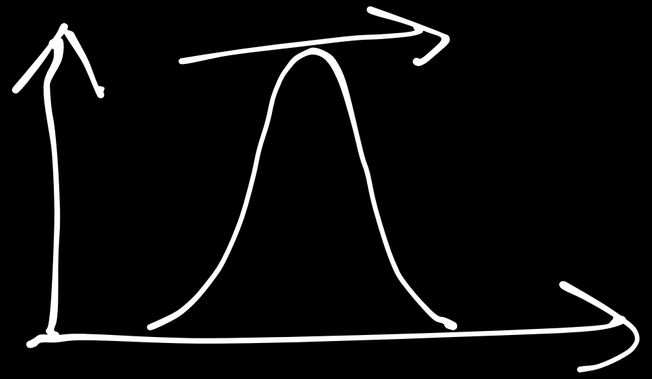
Measuring heritability



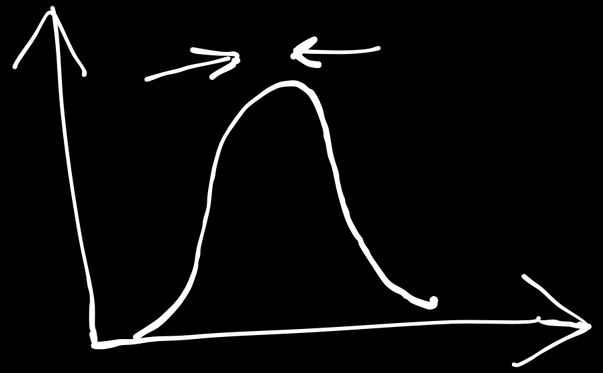
$$\text{Slope} = h^2 = \frac{[O^* - \bar{O}]}{[P^* - \bar{P}]} = \frac{R}{S}$$

$$R = h^2 S$$

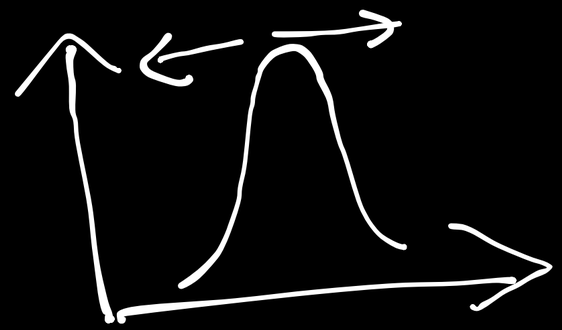
Forms of selection (on quantitative traits)



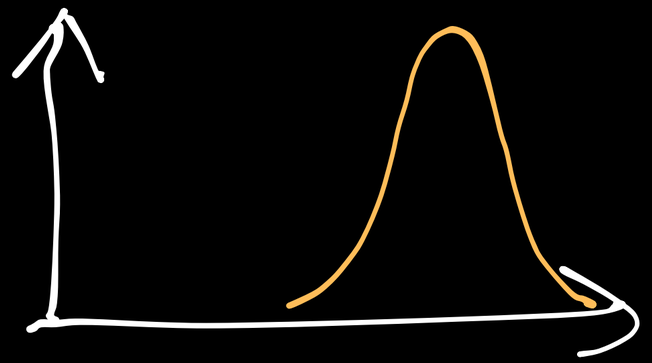
directional



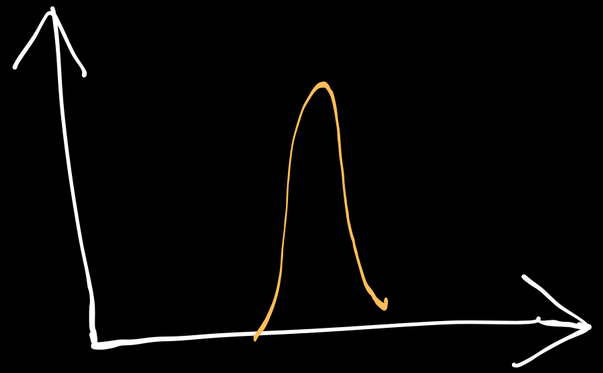
stabilizing

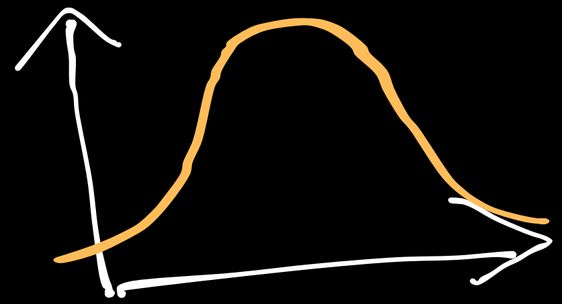


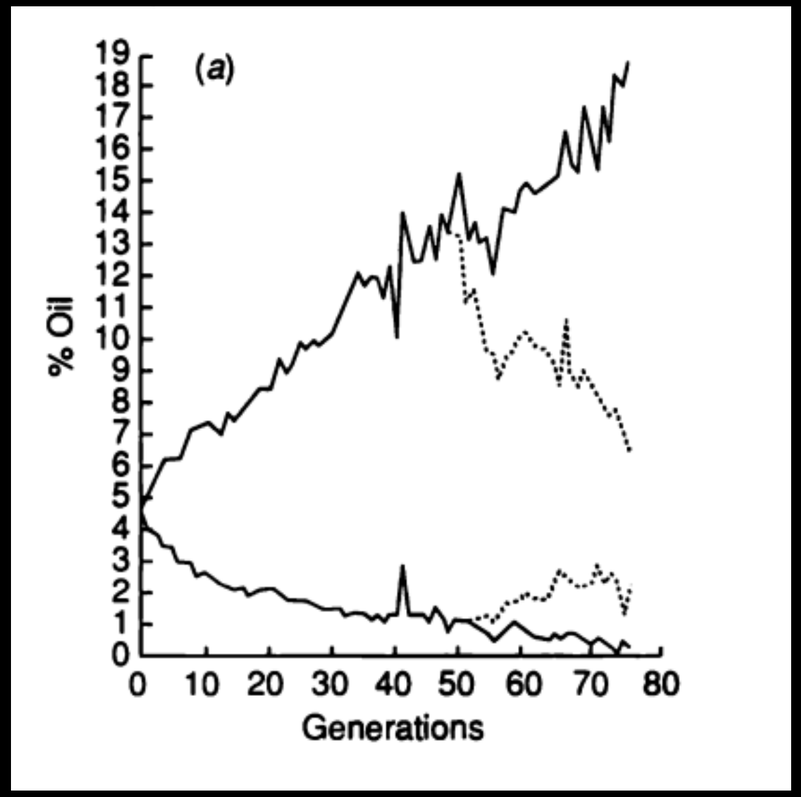
disruptive



trait

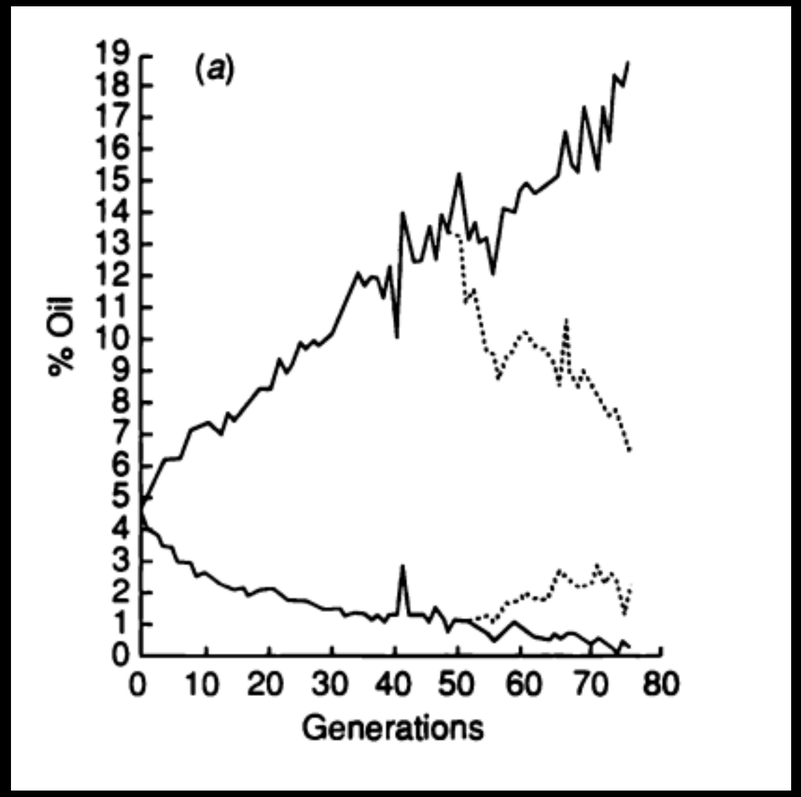






Falconer and McKay 1996

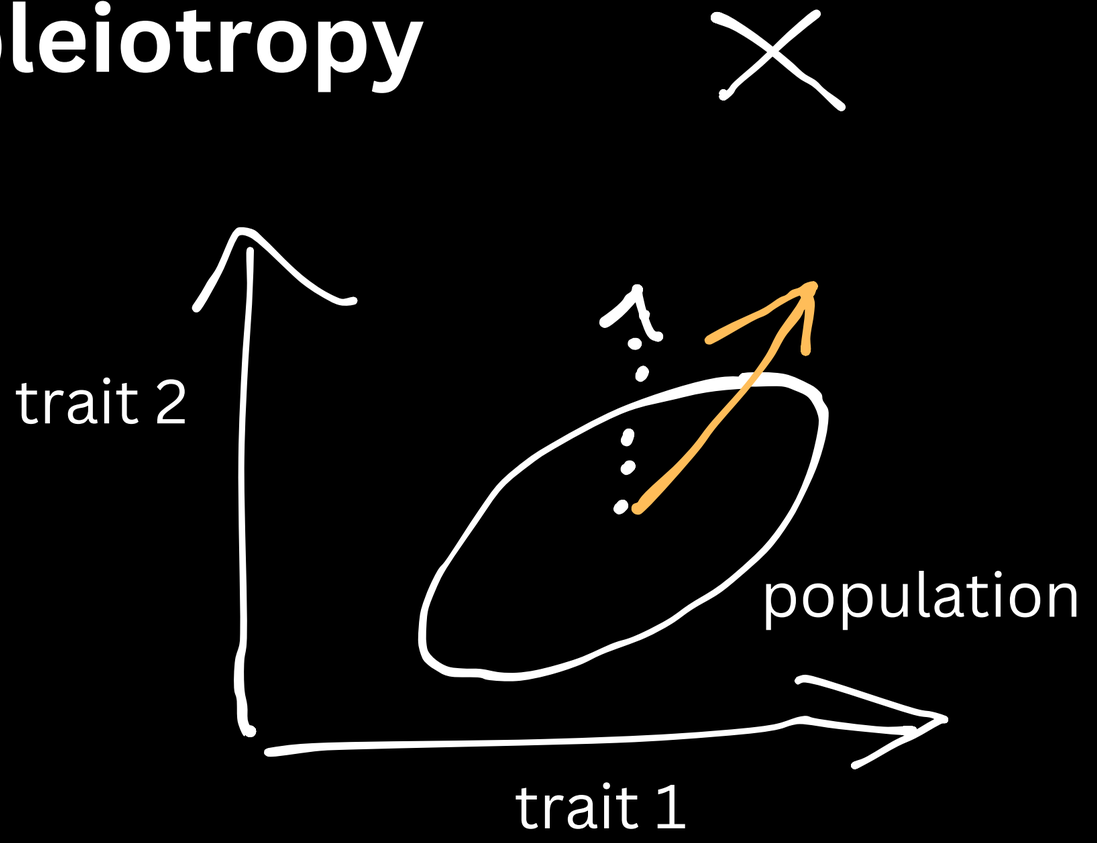
Limits of the breeder's equation



Falconer and McKay 1996

pleiotropy

fitness optimum



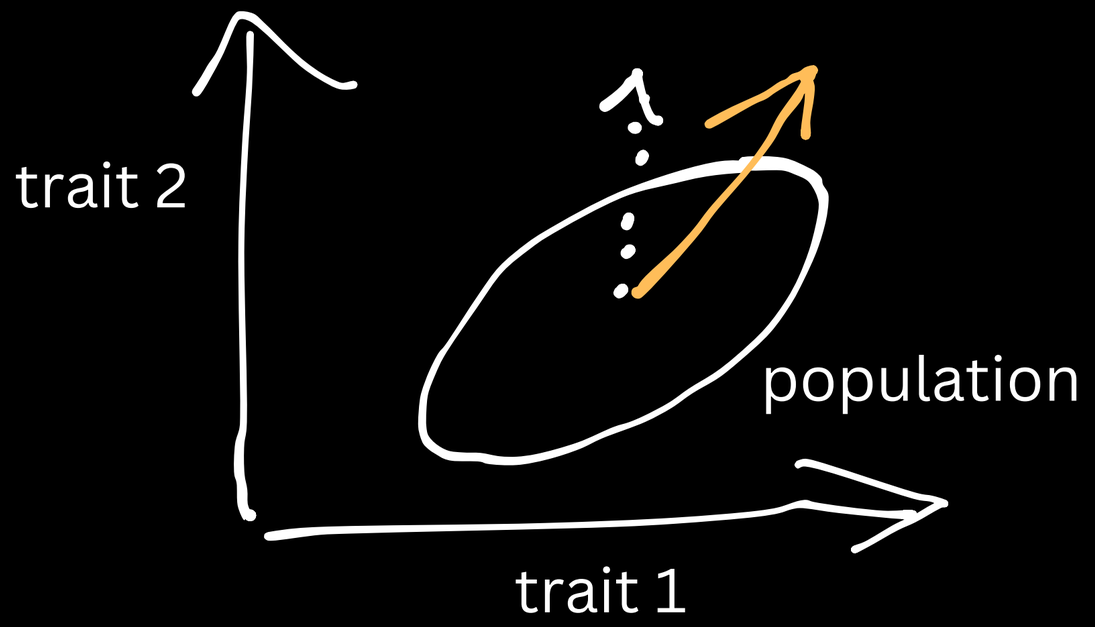
Multivariate breeder's equation

$$\Delta \bar{z} = G\beta$$

$$\begin{bmatrix} \\ \\ \end{bmatrix} = \begin{bmatrix} & \\ & \end{bmatrix} \cdot \begin{bmatrix} \\ \\ \end{bmatrix}$$

pleiotropy

fitness optimum



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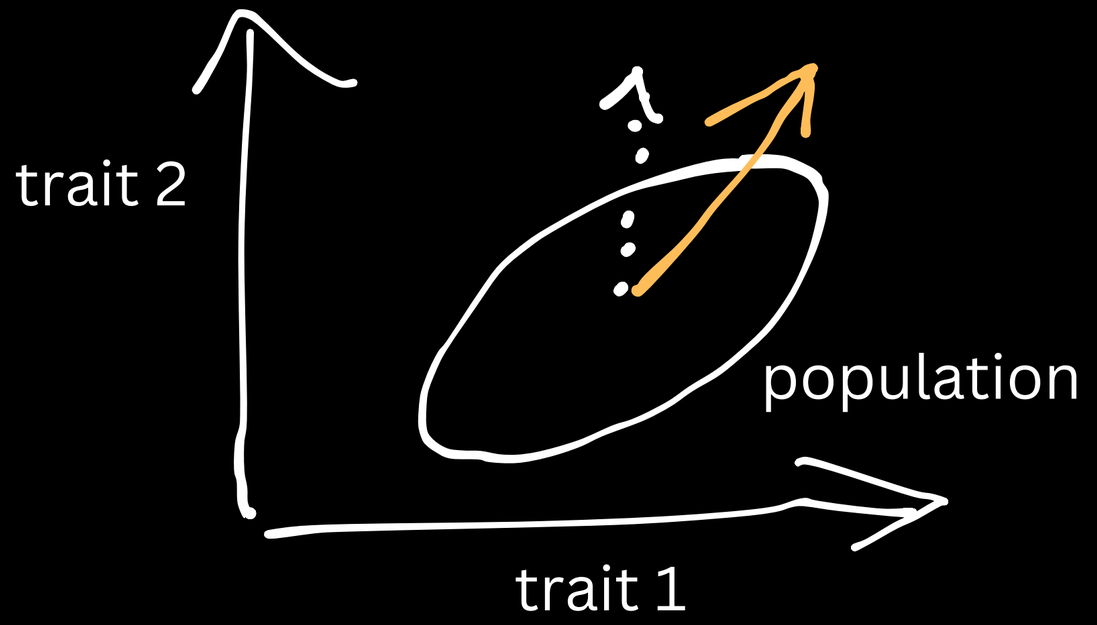
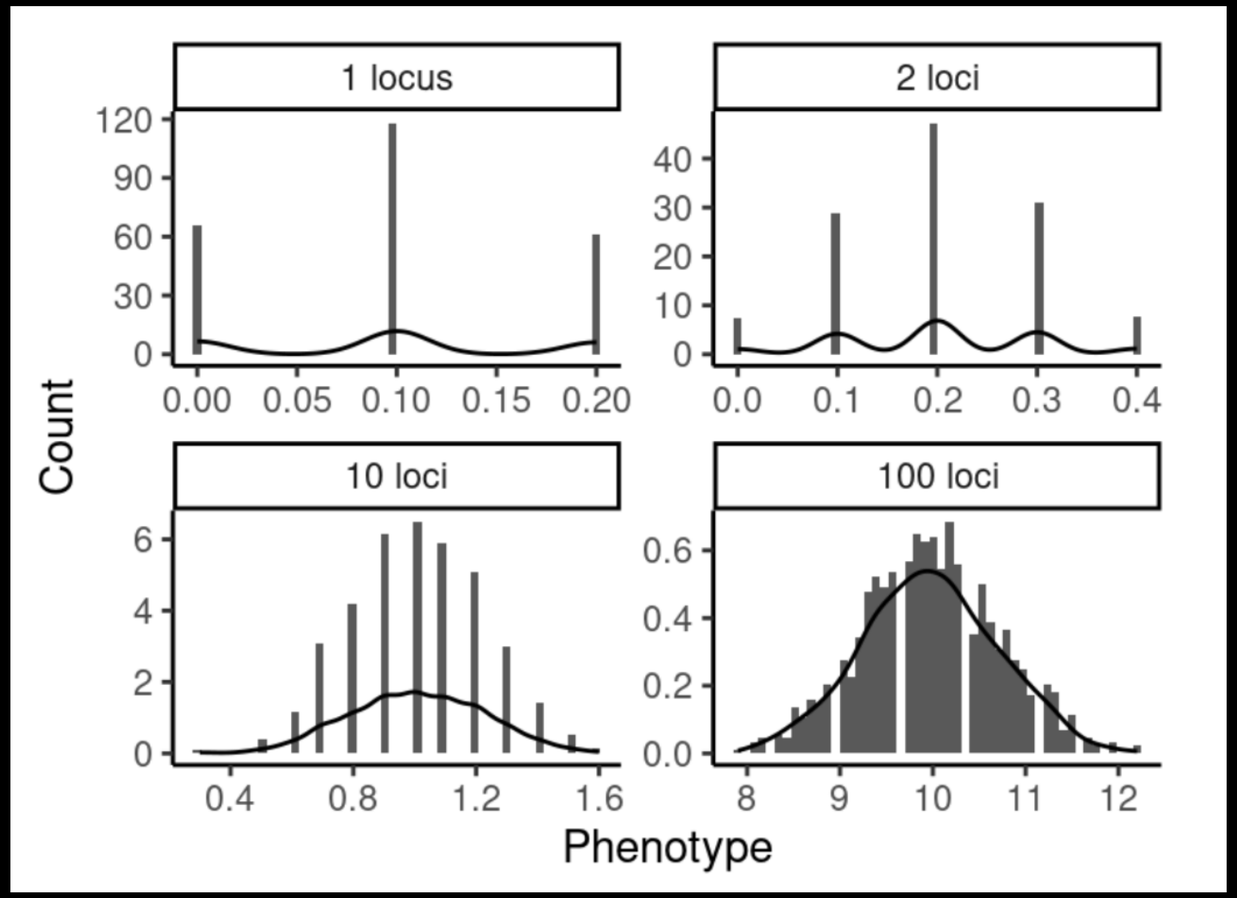
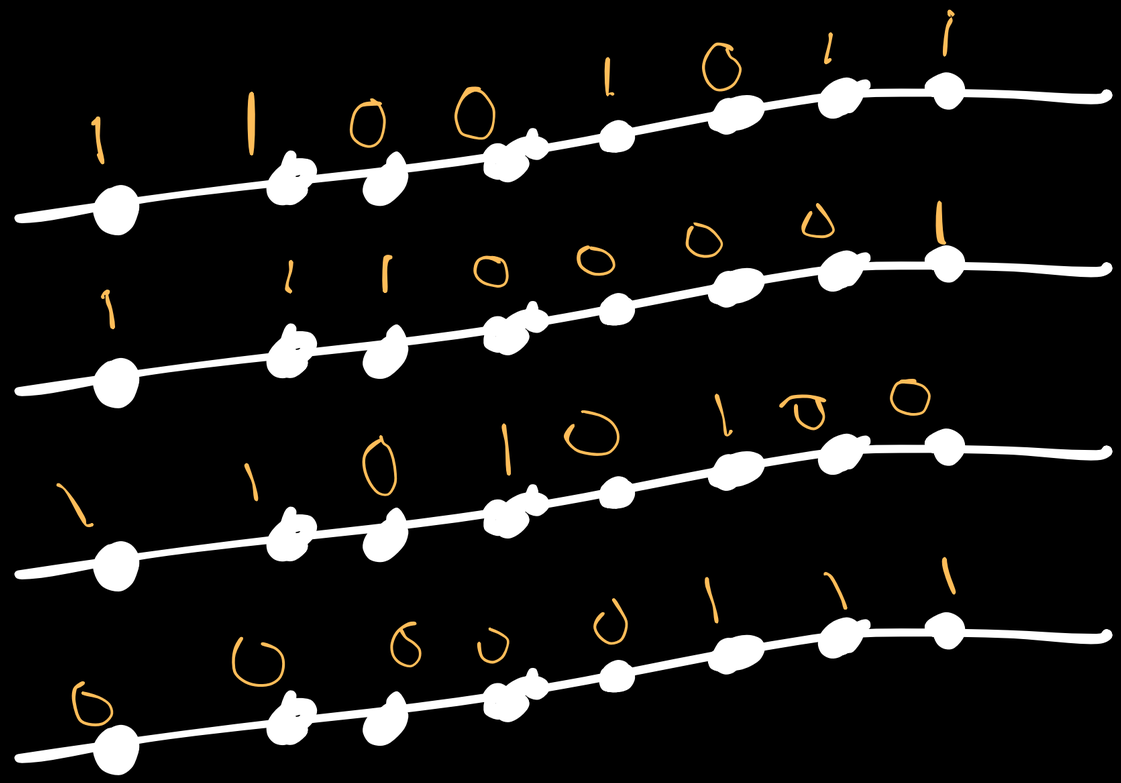


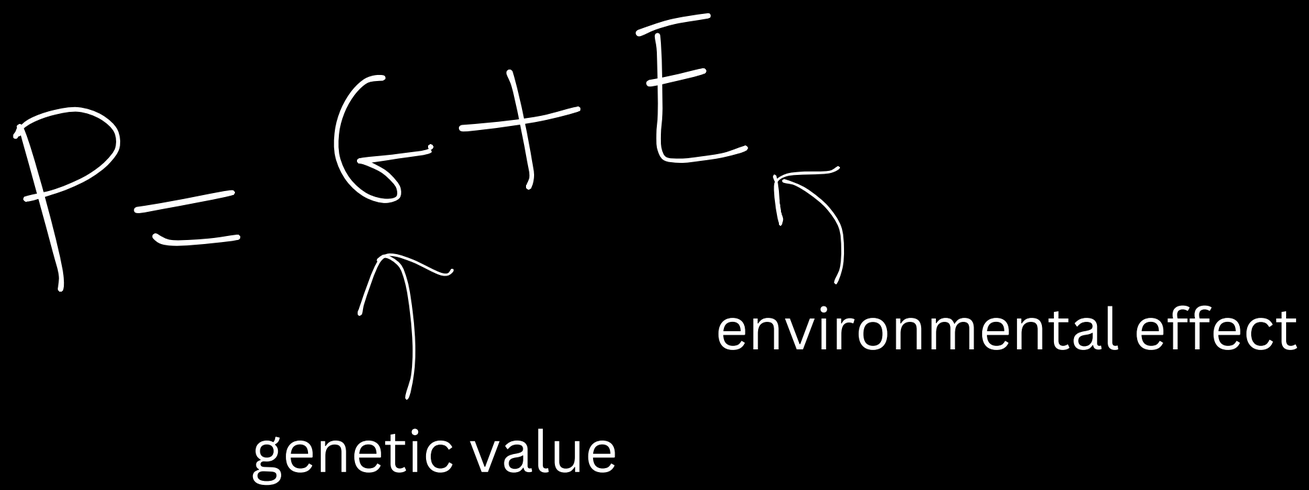
lines of least genetic resistance



Additive genetic effects



Phenotypic variance decomposition



Phenotypic variance decomposition

$$P = G + E$$

genetic value

environmental effect

$$V_P = V_G + V_E$$

Phenotypic variance decomposition

$$P = G + E$$

genetic value

environmental effect

$$V_P = V_G + V_E$$

$$V_G = V_A + V_D + V_I$$

additive

dominance

epistasis

Fundamental theorem of natural selection

Rate of increase in fitness

$$\mathcal{L}$$

Additive genetic variance for fitness

Fisher

additive

increases blood
pressure by 2%
no matter what

additive

increases blood pressure by 2% no matter what

dominance

increases blood pressure by 2% depending on which other allele is present

additive

increases blood pressure by 2% no matter what

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increases blood pressure by 2% depending on which other allele is present

epistasis

increases blood pressure by 2% depending on which alleles are present at other loci

additive

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dominance

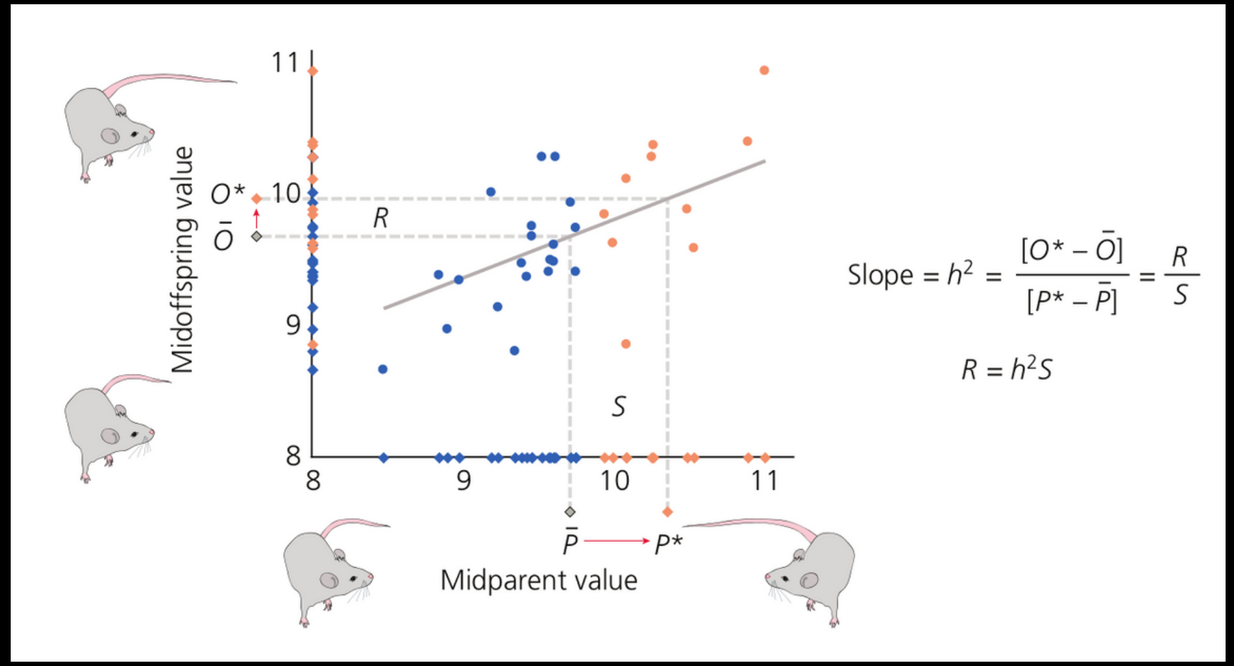
increases blood pressure by 2% depending on which other allele is present

epistasis

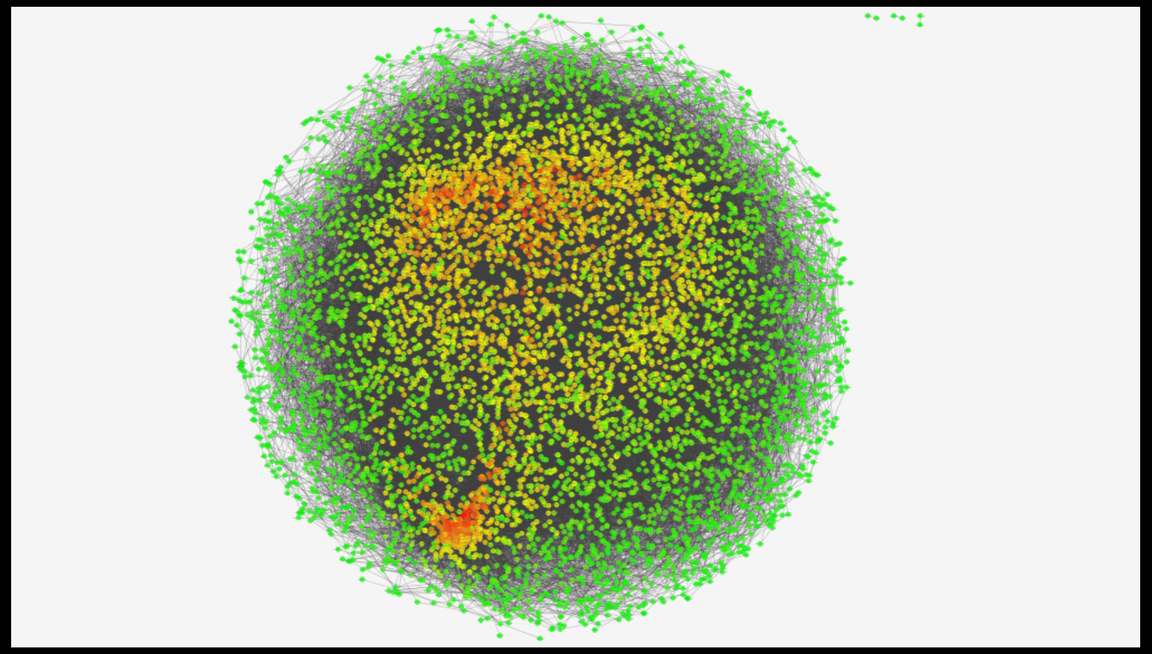
increases blood pressure by 2% depending on which alleles are present at other loci

Estimating additive variance

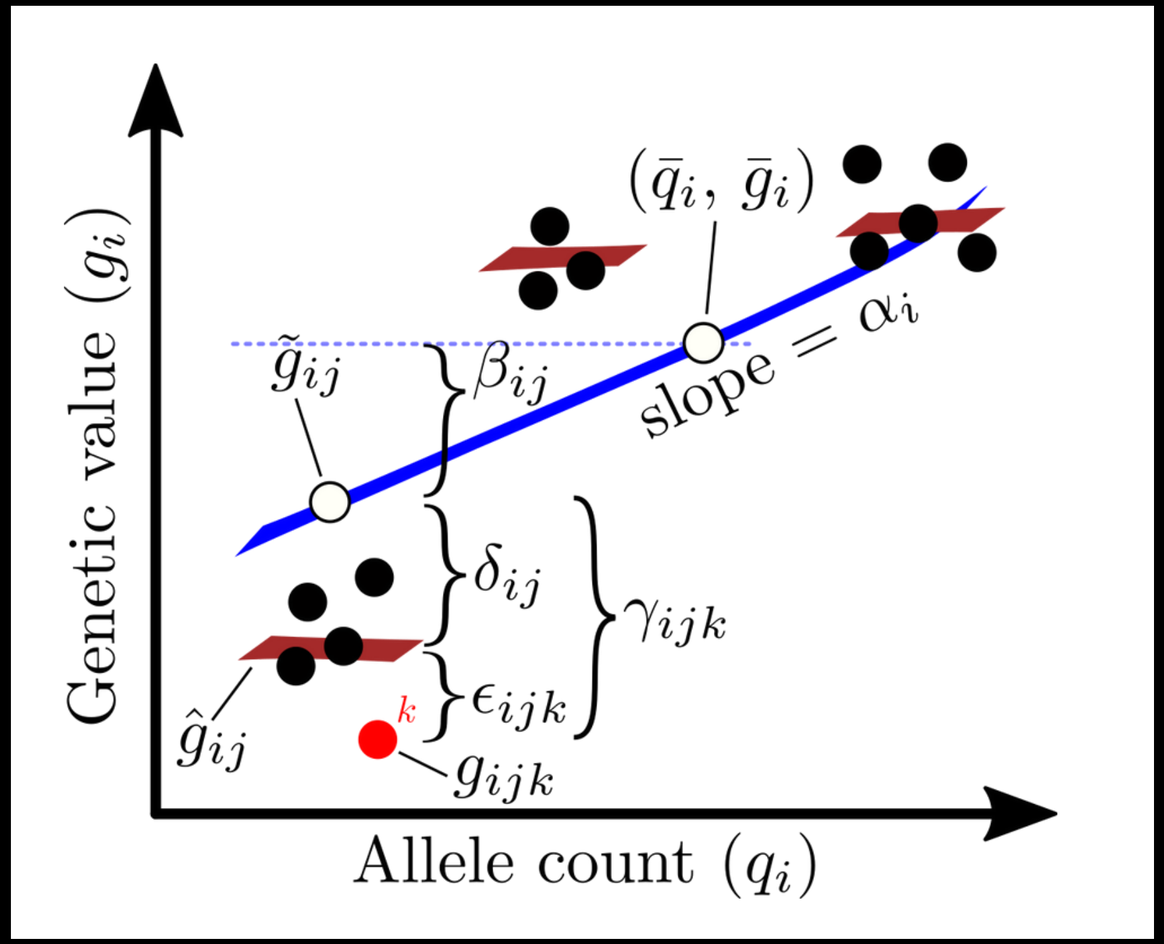
$$\frac{V_A}{V_P} = h^2$$

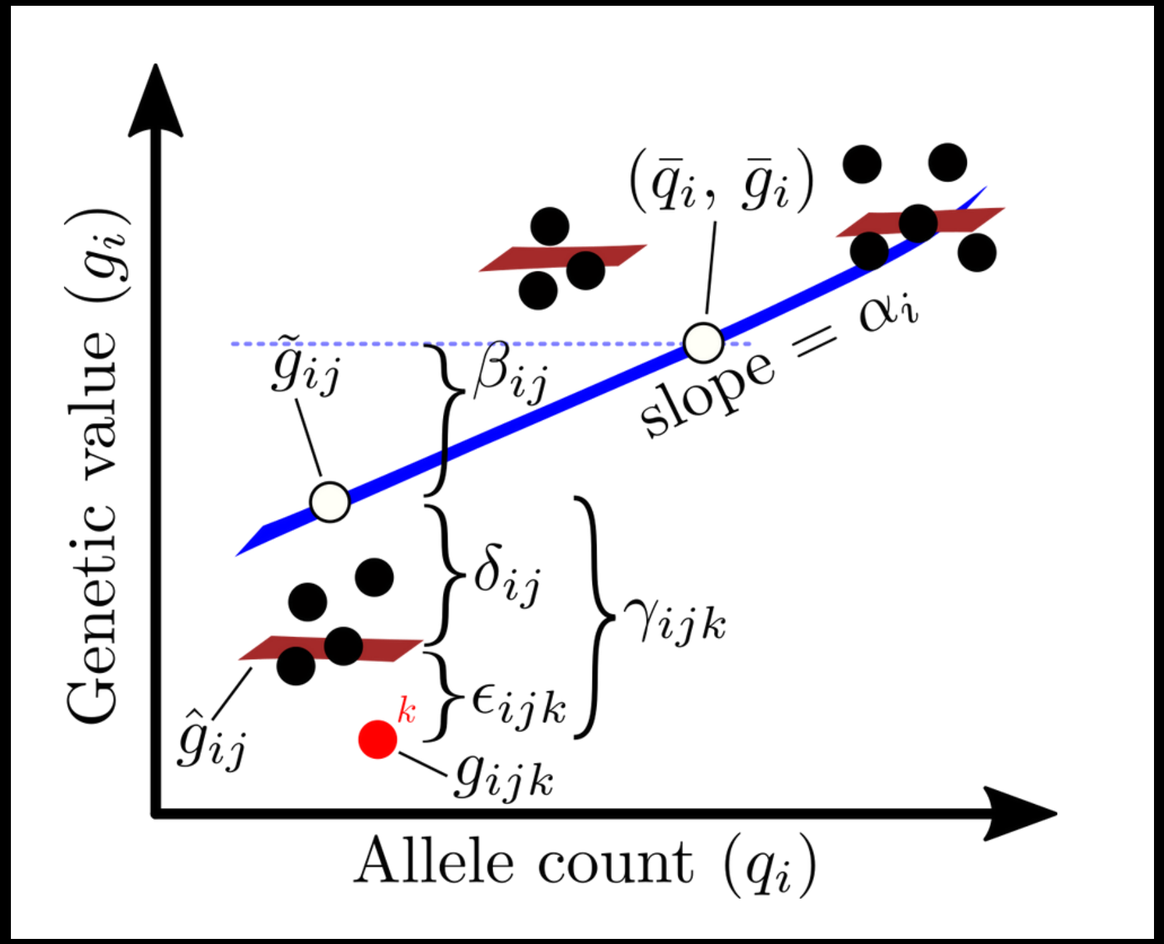


Genotype-phenotype map



gene network


Genetic value (g_i)
Allele count (q_i)
$(\bar{q}_i,\ \bar{g}_i)$
slope $= \alpha_i$
$\tilde{g}_{ij}$
β_{ij}
δ_{ij}
γ_{ijk}
ϵ_{ijk}
$\hat{g}_{ij}$
k
g_{ijk}

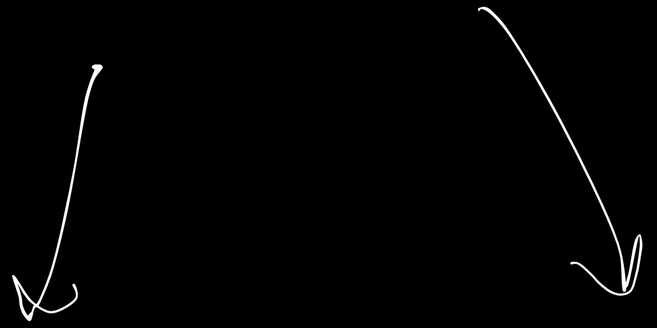


Additive variance

=

variance in breeding values

Functional epistasis



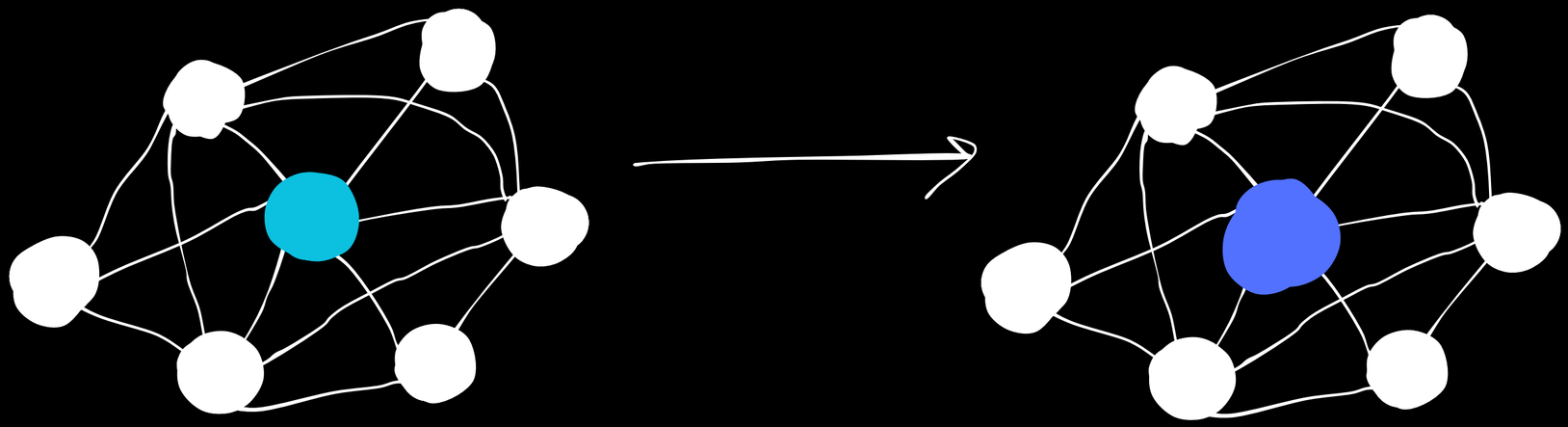
Statistical additivity

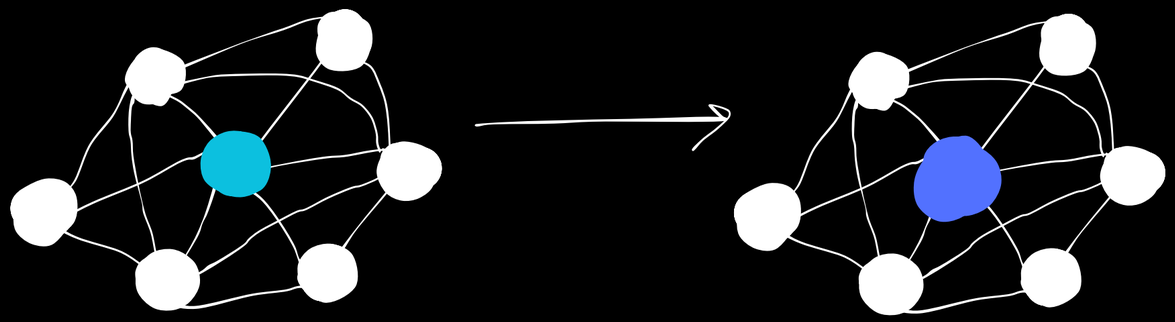
Statistical epistasis

Functional epistasis

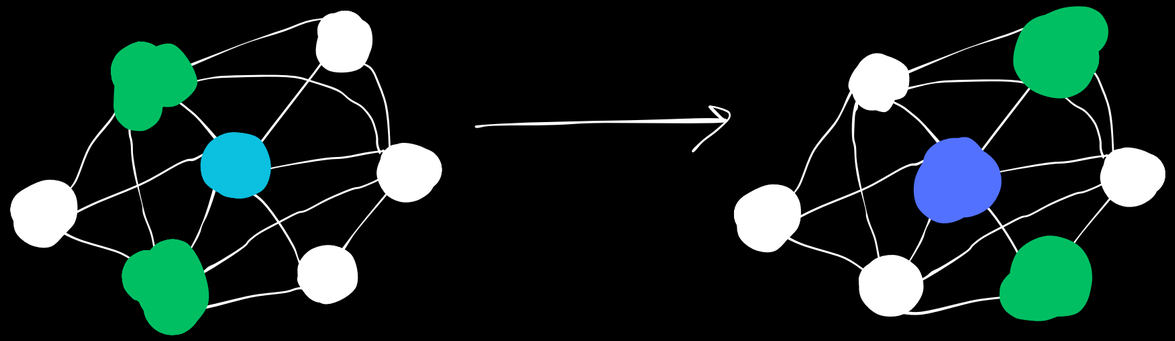
Statistical additivity

Statistical epistasis





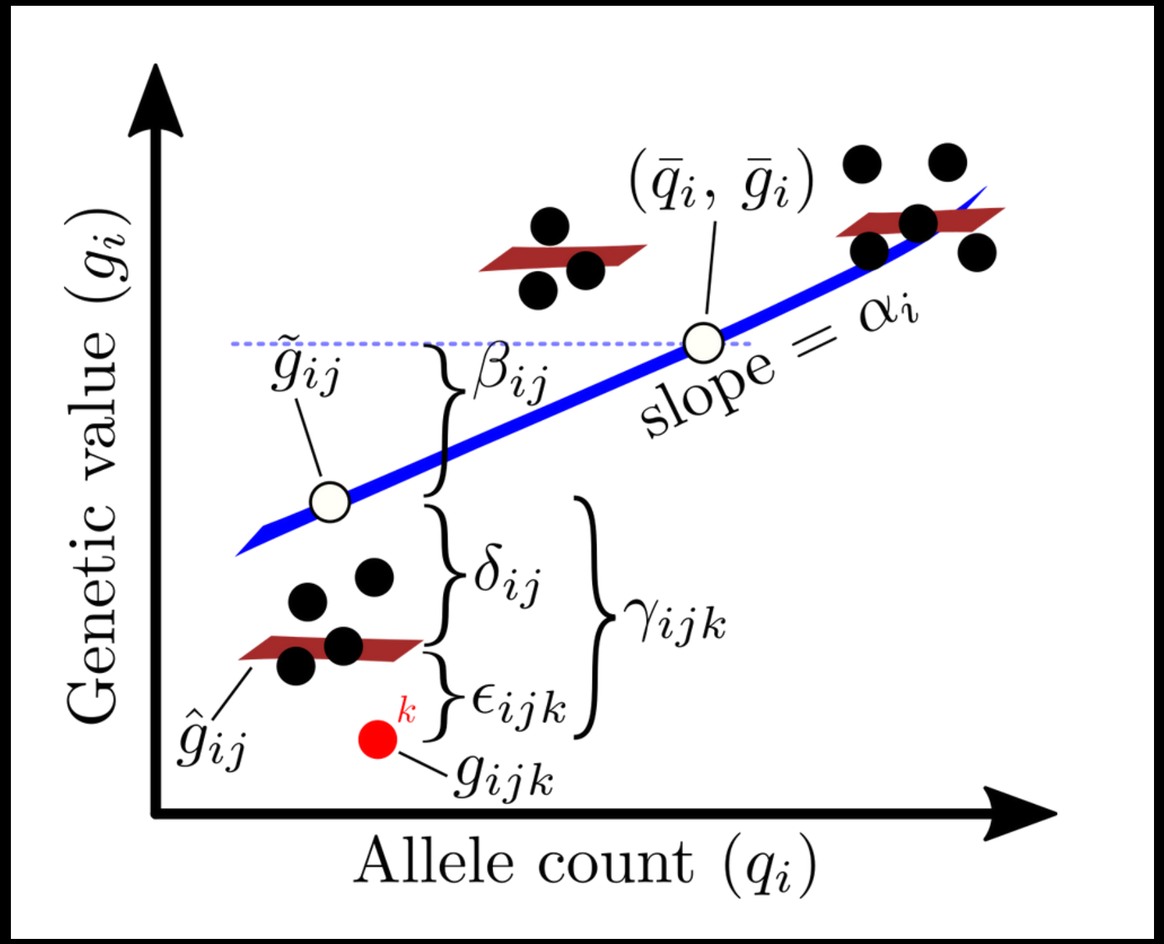
high heritability in a poor genetic background



low heritability in a diverse genetic background

Quantitative genetics predicts short-term evolution

because heritability is contextual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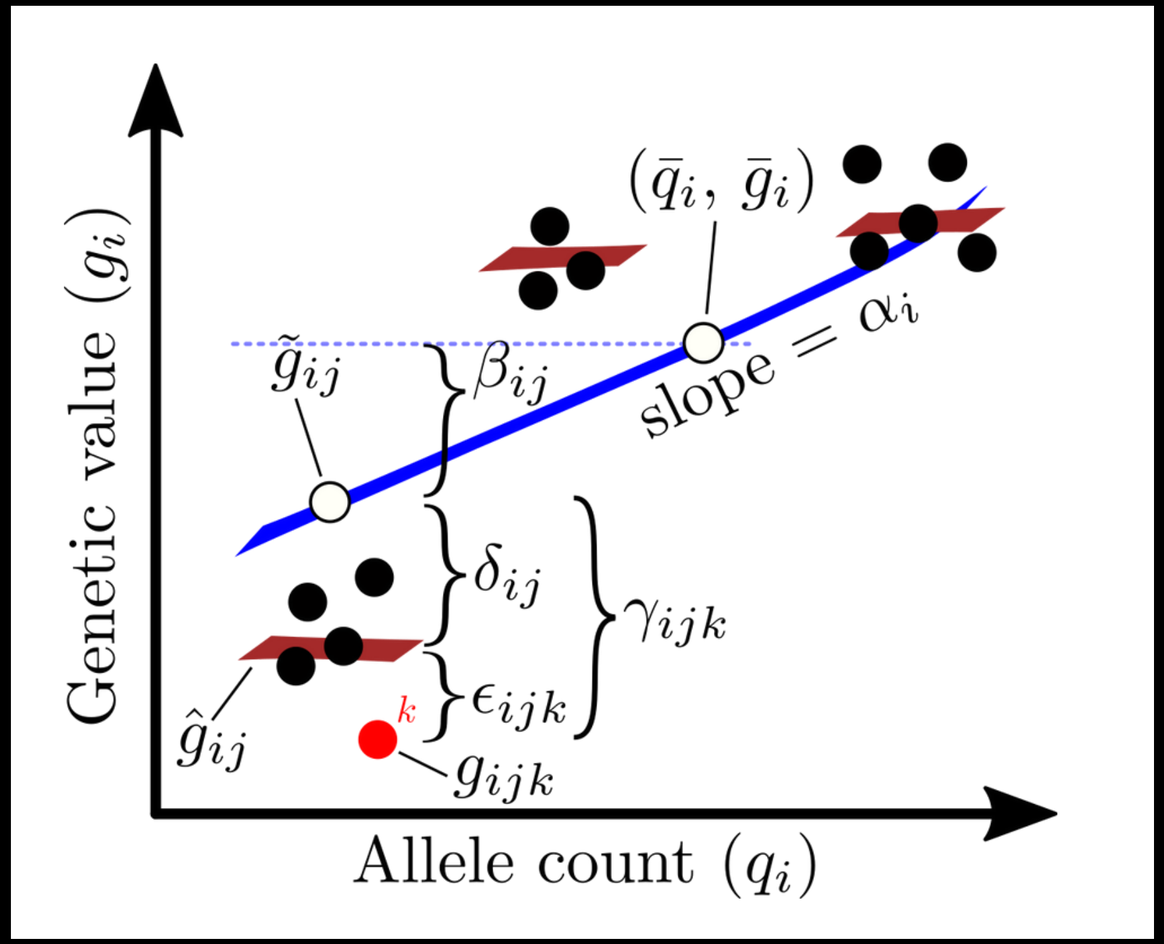
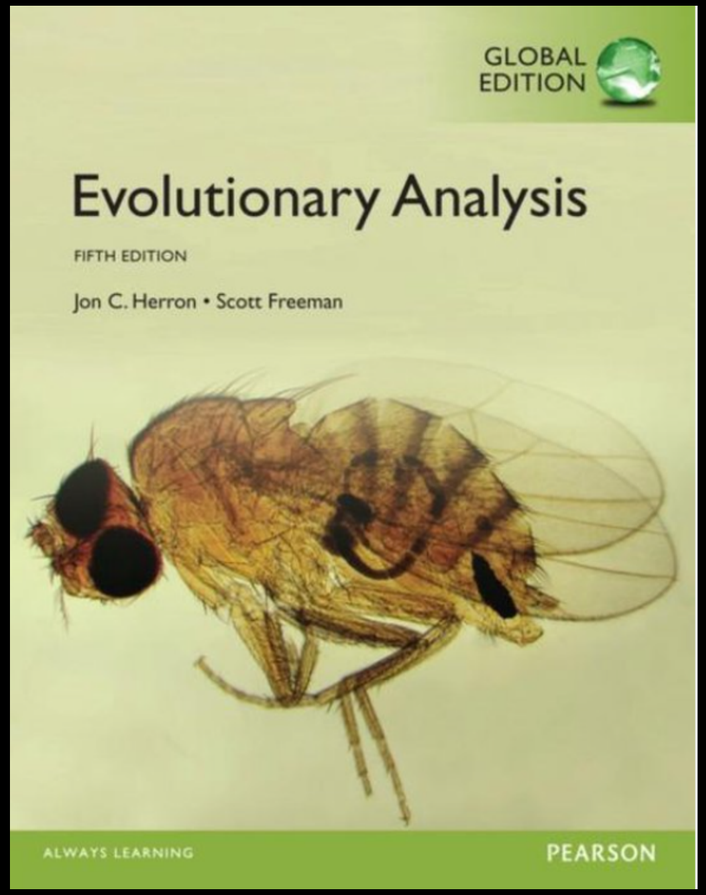
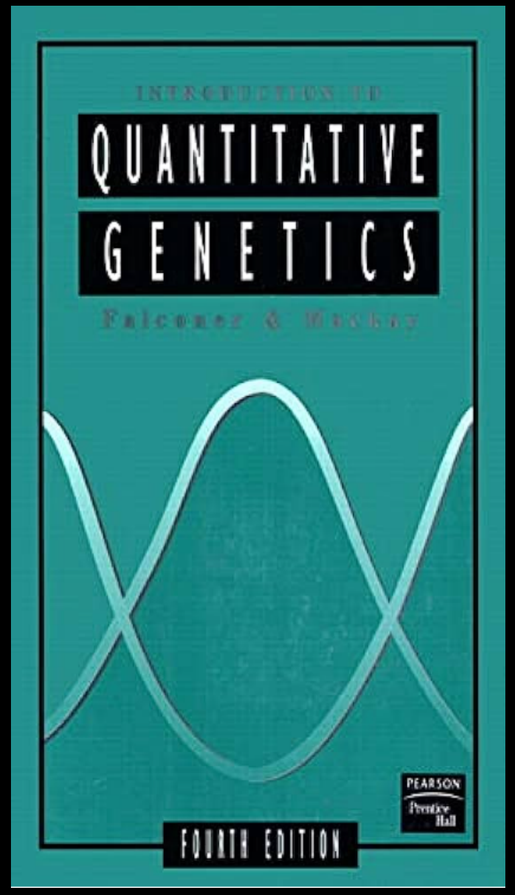


Quantitative trait locus (QTL) mapping

Genome-wide association studies (GWAS)





Falconer, D. S., & Mackay, T. (1996). Introduction to quantitative genetics (4. ed., [16. print.]). Pearson, Prentice Hall.

Herron, J. C., & Freeman, S. (2015). Evolutionary analysis (5. ed., Pearson global ed). Pearson.