Fundamentals vs. Applications

Big picture context

Theory

Applications

- Describe something about the world
- Collect data
- Analyze it

Describe something about the world

- “Holy cow, that’s crazy”
  - https://www.bbc.com/travel/article/20210915-a-british-beast-rarer-than-the-panda

- What’s their inbreeding coefficient?

Big picture context

Theory

- What's an inbreeding coefficient??
- Need a framework
  - Assumptions
  - Definition of terms
  - Not subjective/open to interpretation.
- **Model**

Applications

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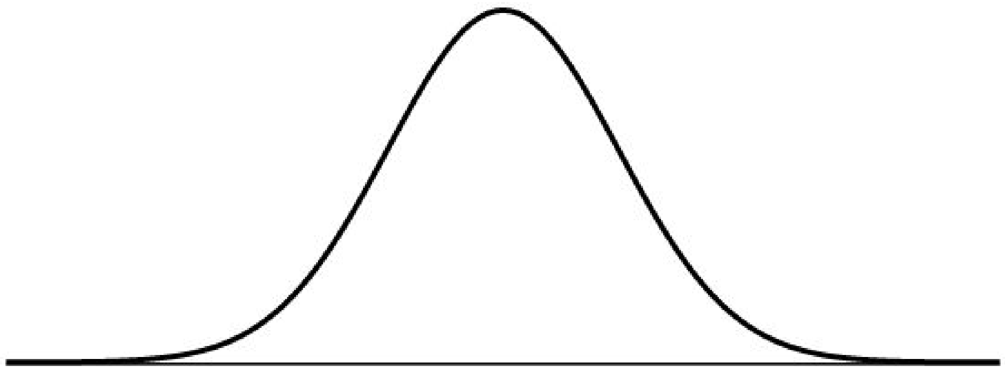
Models

- Mathematical representations of real life processes.
  - Simplifications – do not try to capture all the complexities/nuances of real life.
- Provide a way to predict/understand behavior.
  - can describe current behavior,
  - or predict future behavior.
- A good model can do this even if it's a simplification of the real life process.

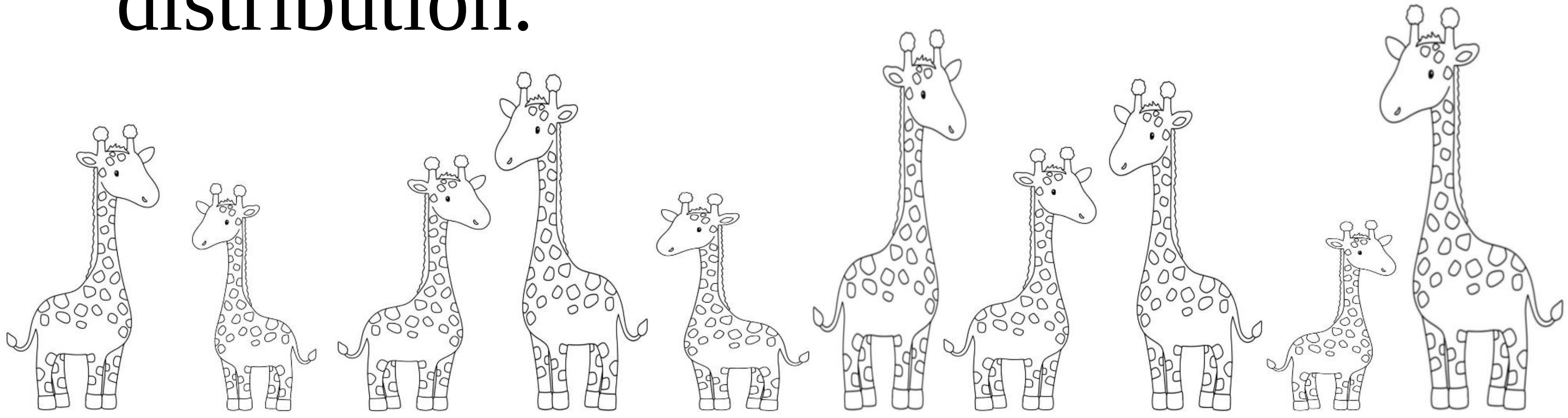
Models

- Many ways models can be created.

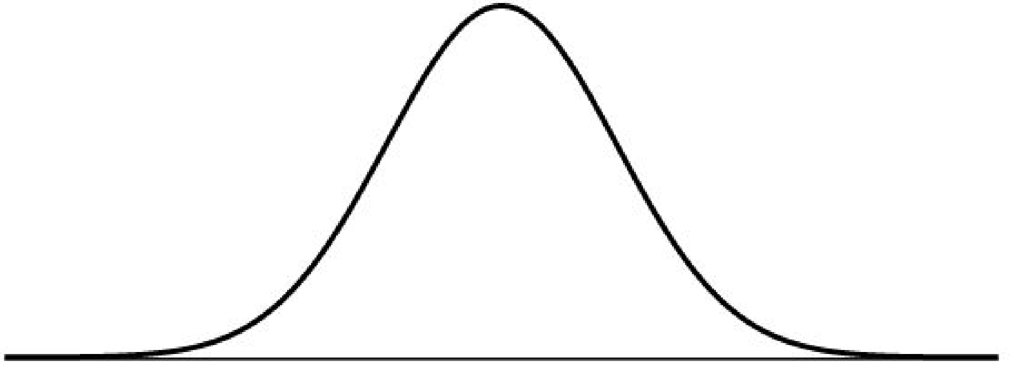
Example: Normal Distribution



- Height is often modeled using a normal distribution.



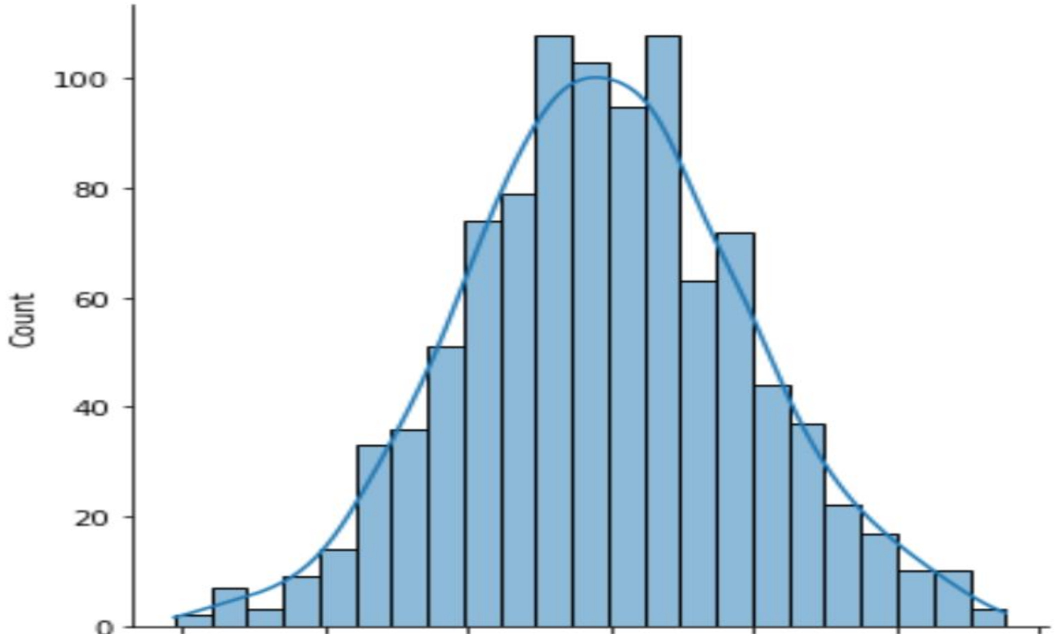
Normal distribution

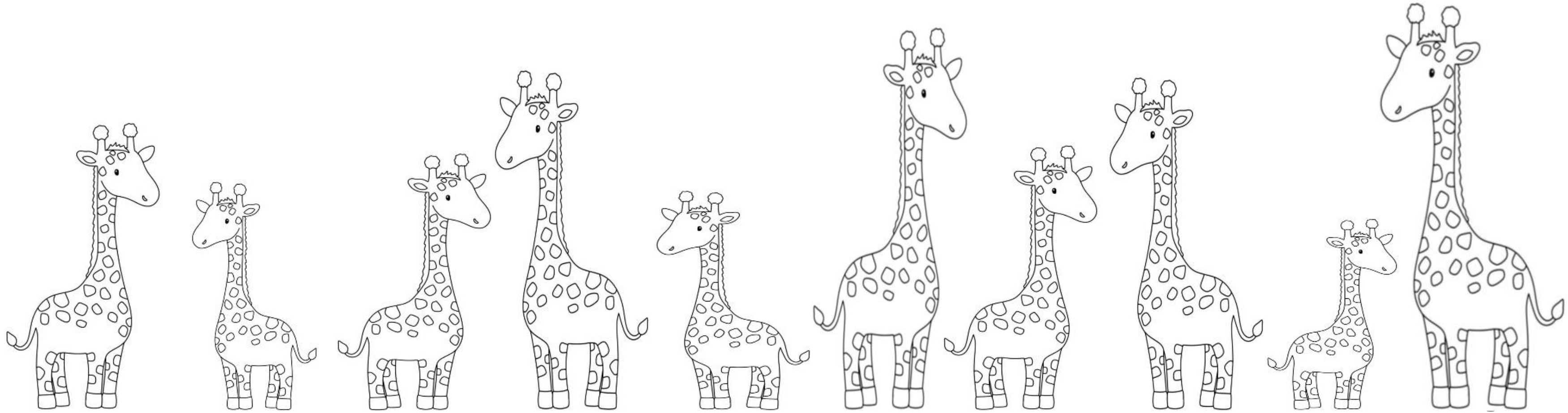


- Defined with an equation:

$$f(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{\frac{-(x-\mu)^2}{2\sigma^2}}$$

Height data tends to look Normal





Height data tends to look Normal

- Of course, height isn't actually generated by the equation …

$$f(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{\frac{-(x-\mu)^2}{2\sigma^2}}$$

- The normal distribution just tends to capture the data well.

Population Genetics Models

- Often defined by a list of assumptions.
  - We'll see a lot of these coming up.

- The assumptions dictate the dynamics of alleles over time.
  - Simplifications of real life.
  - Allow us to predict behavior using mathematical equations.

Reminder: big picture context

Theory

- **Model**
- A framework
  - Not subjective/open to interpretation.
  - Assumptions
  - Definition of terms

What's an inbreeding coefficient??

Applications

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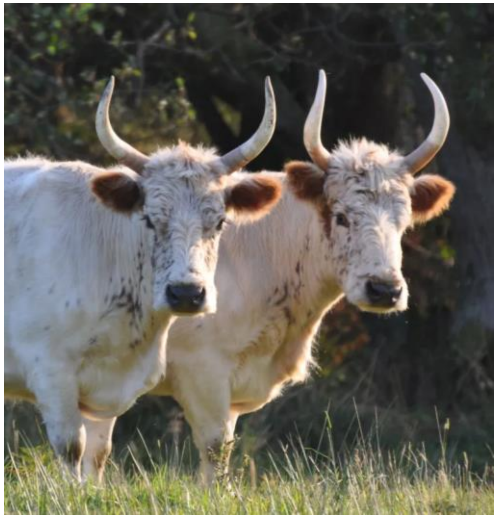

Parameters

- Mathematical constructs
- Can be used to define a model
- Can be defined by the model

- Normal distribution:

$$f(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{\frac{-(x-\mu)^2}{2\sigma^2}}$$

μ and σ^2 are parameters

Parameters

- Defined by equations
- Can be functions of other parameters
  - $\mu = E[X]$
  - $\sigma^2 = E[(X- \mu)^2]$

- The inbreeding coefficient is a parameter, defined by an equation
  - we'll see it later on in the class.

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Applications

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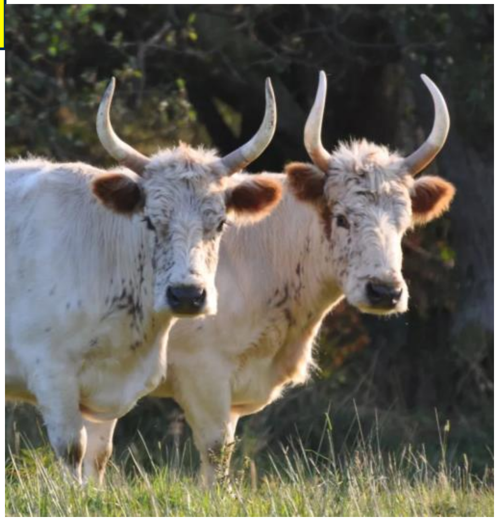

The inbreeding coefficient is a parameter.

- Parameters are defined using an equation … do not involve data.

- What do we do with data?
- Need **an estimator**.
  - Also an equation (one for data).
- Can have many different estimators of the same parameter.
  - each with different equations.

Estimators

- Equations:
  - functions of the data.

- These equations often look nothing like the equation that defines the parameter.

Why do we have models?

- Why not just use estimators since they’re what’s important for summarizing the data?

Models provide a context

- Inbreeding coefficient: parameter
  - defined via an equation

- Estimator for the inbreeding coefficient
  - can be many different versions
    - e.g. via Anova; via Bayesian approach
    - each with different properties
- The definition of the parameter stays the same

Reminder: big picture context

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An inbreeding coefficient is a parameter, defined by an equation.

Applications

- Describe something about the world
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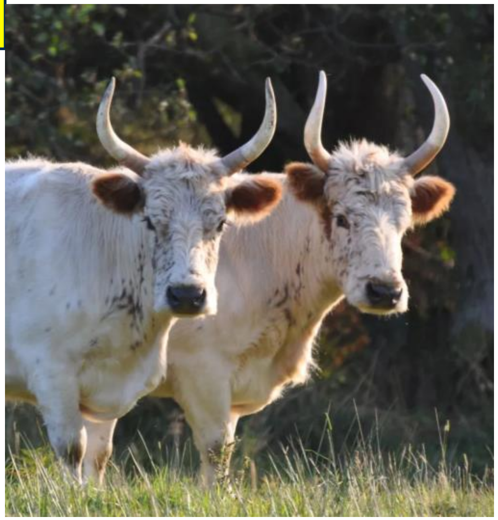
The estimator for the inbreeding coefficient is defined by its own equation.



The model provides a context

- A context for evaluating estimators/ estimates
  - comparing results from different approaches
- If you don’t understand the model assumptions and the definitions, it’s much harder to evaluate your results.

This class is focused on models

- What they are
  - Their assumptions
  - The consequences of these assumptions
  - What happens when you modify the assumptions
- How terms are defined
  - Parameters, not estimators
    - (some exceptions)
- Understanding the fundamentals puts you in a better position for learning the applications.