Livestock Breeding and Genomics

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Content

- Course administration
- Linear Algebra
- R/RStudio
- Introduction to Livestock Breeding and Genomics

Information

- Website: https://charlotte-ngs.github.io/lbgfs2024
- Moodle:
  https://moodle-app2.let.ethz.ch/course/view.php?id=23928
- Credit points: Written exam on 20.12.2024

Your Input

- ... is always welcome
- due to special status of course, instant input
- course evaluation might not be helpful
- other information you want to tell us
  - Your name
  - Study Major
  - Why this course
  - Previous experiences in animal breeding / R / statistics / ...
  - Your expectation

Goals

- Official goals from Vorlesungsverzeichnis
- Understanding basic concepts such as
  - selection
  - breeding value
  - selection response
  - difference between production and breeding
- Be able to explain certain phenomena
- Better understanding of statistics
- Exercises in R

Course program

Week	Date	Topic
1	20.09	Introduction to Livestock Breeding and Genomics
2	27.09	Review of Quantitative Genetics/Single Locus
3	04.10	Genetic Evaluation with Different Sources of Information
4	11.10	Genetic Covariance Between Relatives
5	18.10	Best Linear Unbiased Prediction (BLUP) - Univariate Analysis
6	25.10	BLUP - Additional Aspects
7	01.11	BLUP - Multiple Traits
8	08.11	Variance and Inbreeding
9	15.11	Variance Components Estimation
10	22.11	Genomic Selection
11	29.11	Genom-Wide Association Studies
12	06.12	Review on Selection Index Theory
13	13.12	Test-Exam and Questions
14	20.12	Exam

Exercises

- Topics of each lecture are repeated in exercise
- Exercise hours can be used to work on problems
- Solutions are presented one week later
- Exercise platform: (next slide)

Exercise Platform

Three different options are available (see course website)

1. Webr: https://webr.r-wasm.org/latest
2. Posit cloud: https://posit.cloud
3. Run your own platform: Follow steps on https://posit.co/download/rstudio-desktop

Prerequisites

- None
- all concepts will be explained
- Helpful are
  - quantitative genetics
  - statistics
  - linear algebra
  - R

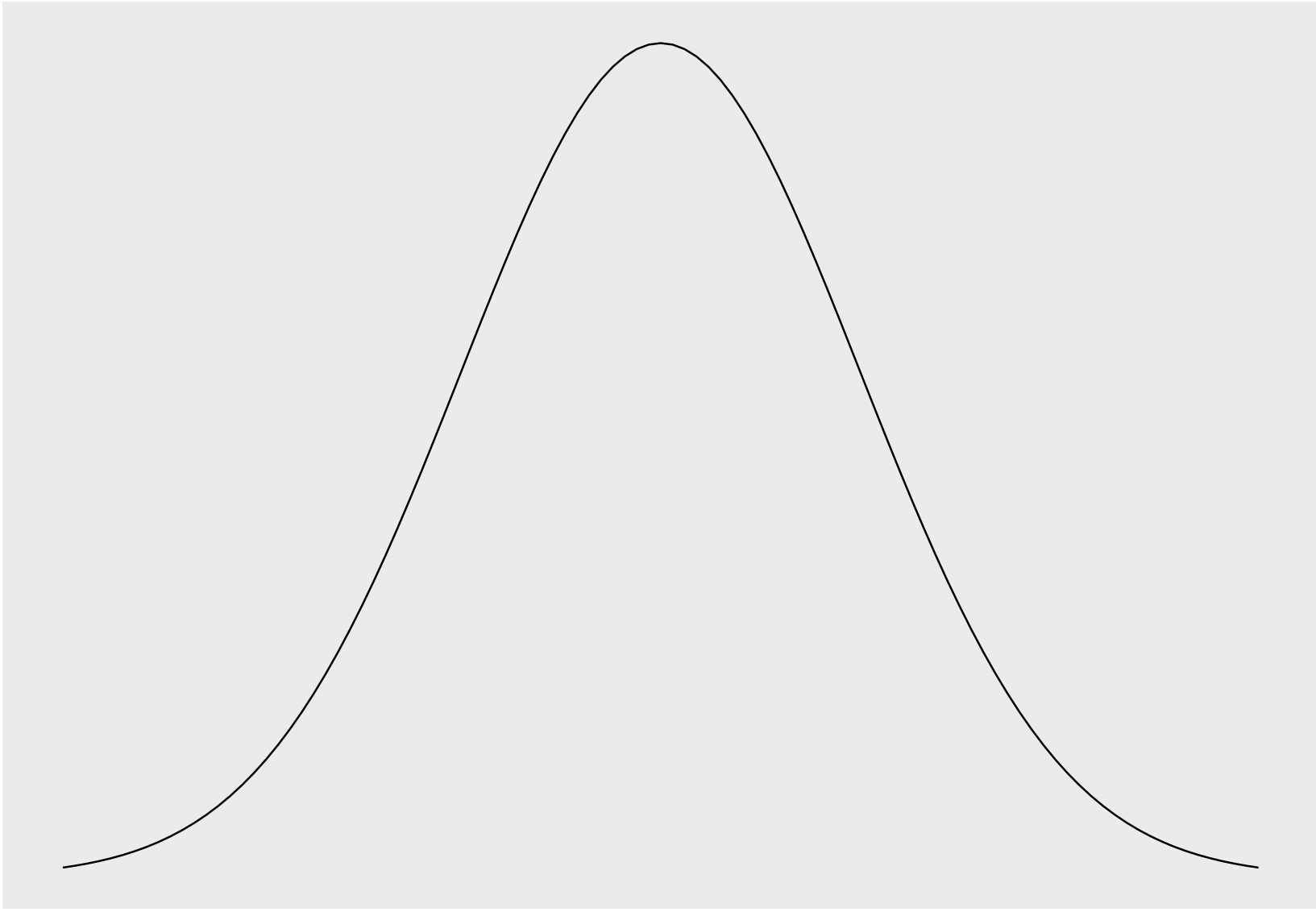
Introduction to Livestock Breeding

- Terminology
  - Livestock breeding
  - Animal breeding
  - Ambiguous use
- History
  - Traditional breeding
  - Genomics

What happens if . . .

- . . . selection is based on phenotypic observations of only a few traits
- how is selection response affected by such a strategy
- not phenotypes are passed from parents to offspring
- double role of genotype/genetic background of animals

Distribution of Phenotypes



Selection Response

- Selection response R is given by the breeders equation

$$R = i * r * \sigma_g$$

with $i = z/p$, in R: `dnorm(qnorm(1-p)) / p`

- Selection response per year: R/L where L is the generation interval

Fundamental Questions

- What is the best animal?
- How to find it?

Phenotypes and Genotypes

$$Y = V + E$$

where Y is observed and E can partially be observed and V is unknown

Improving Animal Populations

- Improvement via breeding $\rightarrow$ long-term
- Two tools

1. selection
   - process to determine parents of next generation
   - natural selection in wildlife and livestock
   - artificial selection in livestock: fix a goal and rank
2. mating
   - which animal is bred to which
   - extreme
   - complementary
   - heterosis - crossbreeding

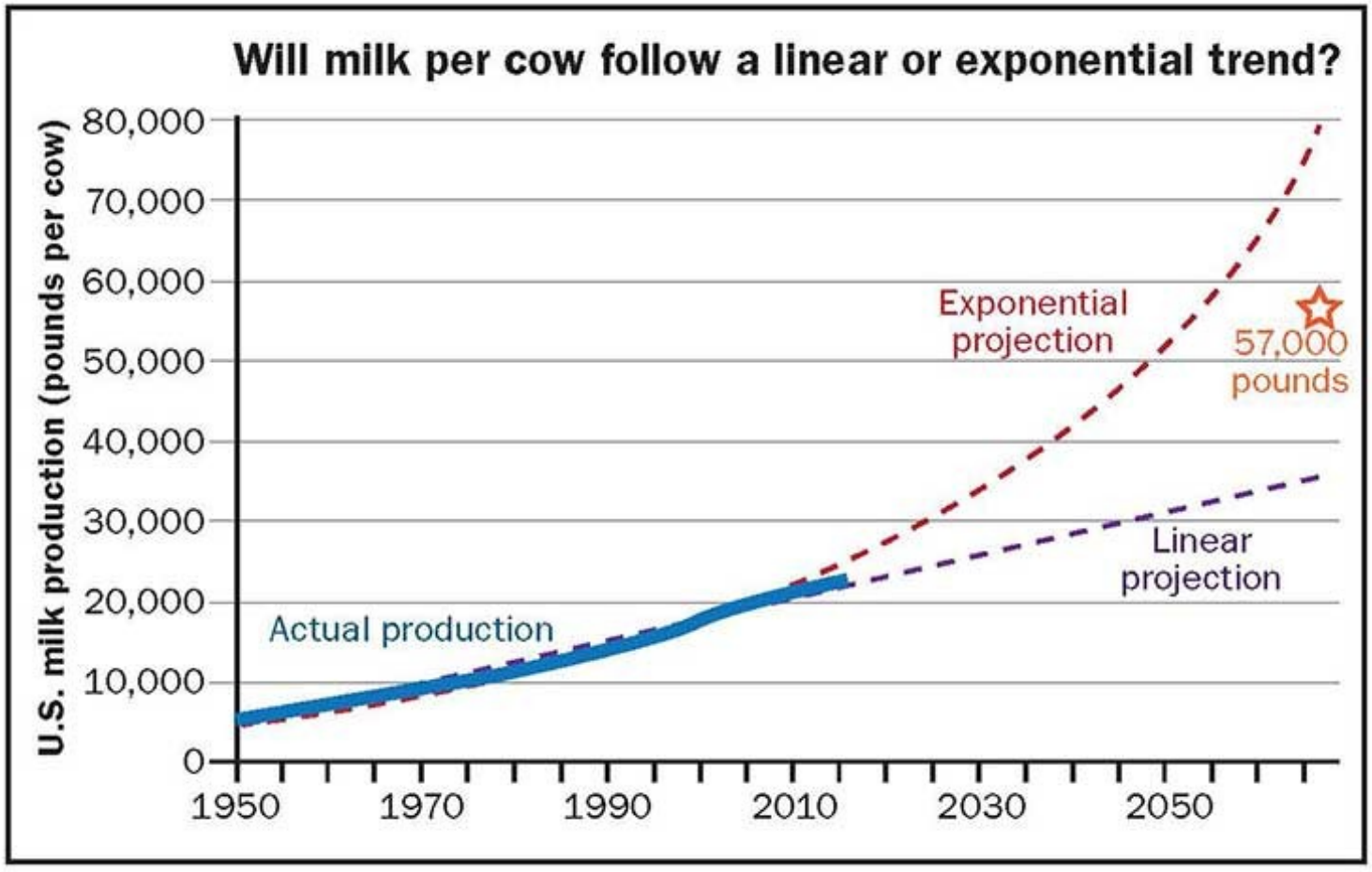
Statistics

- BLUP
- Bayesian methods

Computer Science

- Methods have been developed in 1940's - 1950's
- Progress occured later
- Development of cheap computing power

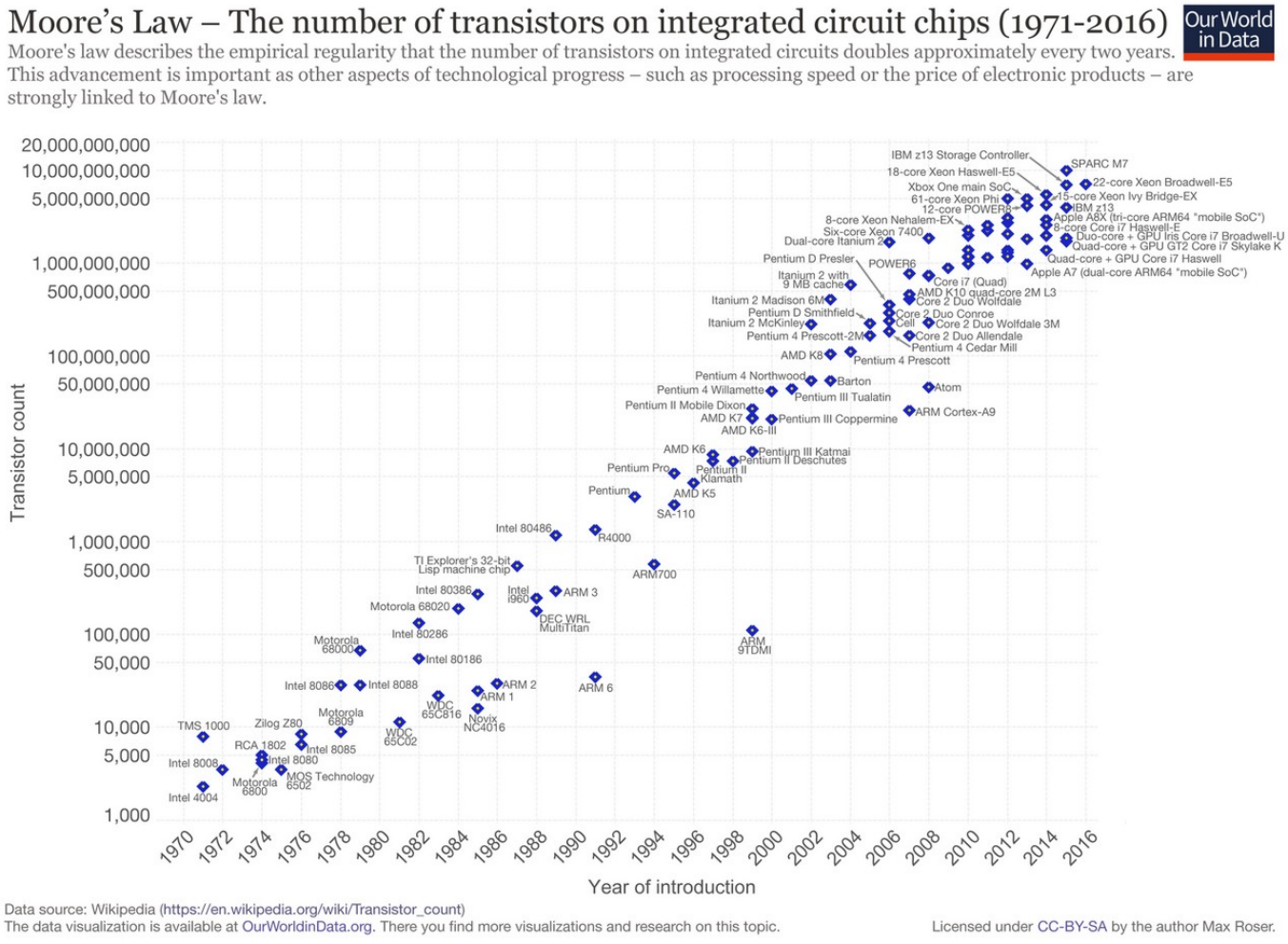
Milk Yield



Milk Performance per Cow
(Source: https://hoards.com/article-20808-what-will-dairy-cows-and-farms-look-like-in-50-years.html)

Figure 1: Yearly Milk Yield per Cow in the USA

Computer Performance



Source: https://en.wikipedia.org/wiki/Moore%27s_law

Figure 2: Computing Performance According To Moore's Law