Livestock Breeding and Genomics

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Content

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

Who Is Who

- Your name
- Study Major
- Why this course
- Previous experiences in animal breeding / R / statistics / ...

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 (see next slide)
- Better understanding of statistics
- Exercises in R

Information

- Website: https://charlotte-ngs.github.io/lbgfs2023
- Moodle:
  https://moodle-app2.let.ethz.ch/course/view.php?id=20077
- Credit points: Written exam on 22.12.2023

Lecture plan

- Type G
- Plan from next week on: mix lecture and exercises

Course program

Week	Date	Topic
1	22.09	Introduction to Livestock Breeding and Genomics
2	29.09	Review of Quantitative Genetics/Single Locus
3	06.10	Genetic Evaluation with Different Sources of Information
4	13.10	Genetic Covariance Between Relatives
5	20.10	Best Linear Unbiased Prediction (BLUP) - Univariate Analysis
6	27.10	BLUP - Additional Aspects
7	03.11	BLUP - Multiple Traits
8	10.11	Variance and Inbreeding
9	17.11	Variance Components Estimation
10	24.11	Genomic Selection
11	01.12	Genom-Wide Association Studies
12	08.12	Review on Selection Index Theory
13	15.12	Test-Exam and Questions
14	22.12	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: (will be available soon)

Your experiences

- . . . in quantitative genetics, statistics, linear algebra
- Do you know any programming languages, if yes which one?
- What tools are you using when you work with data (projects, BSc thesis, MSc thesis)
- Were there any lectures in which you got in contact with programming languages, which ones?
- Are you interested in learning how to program?

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

Comments from farmers

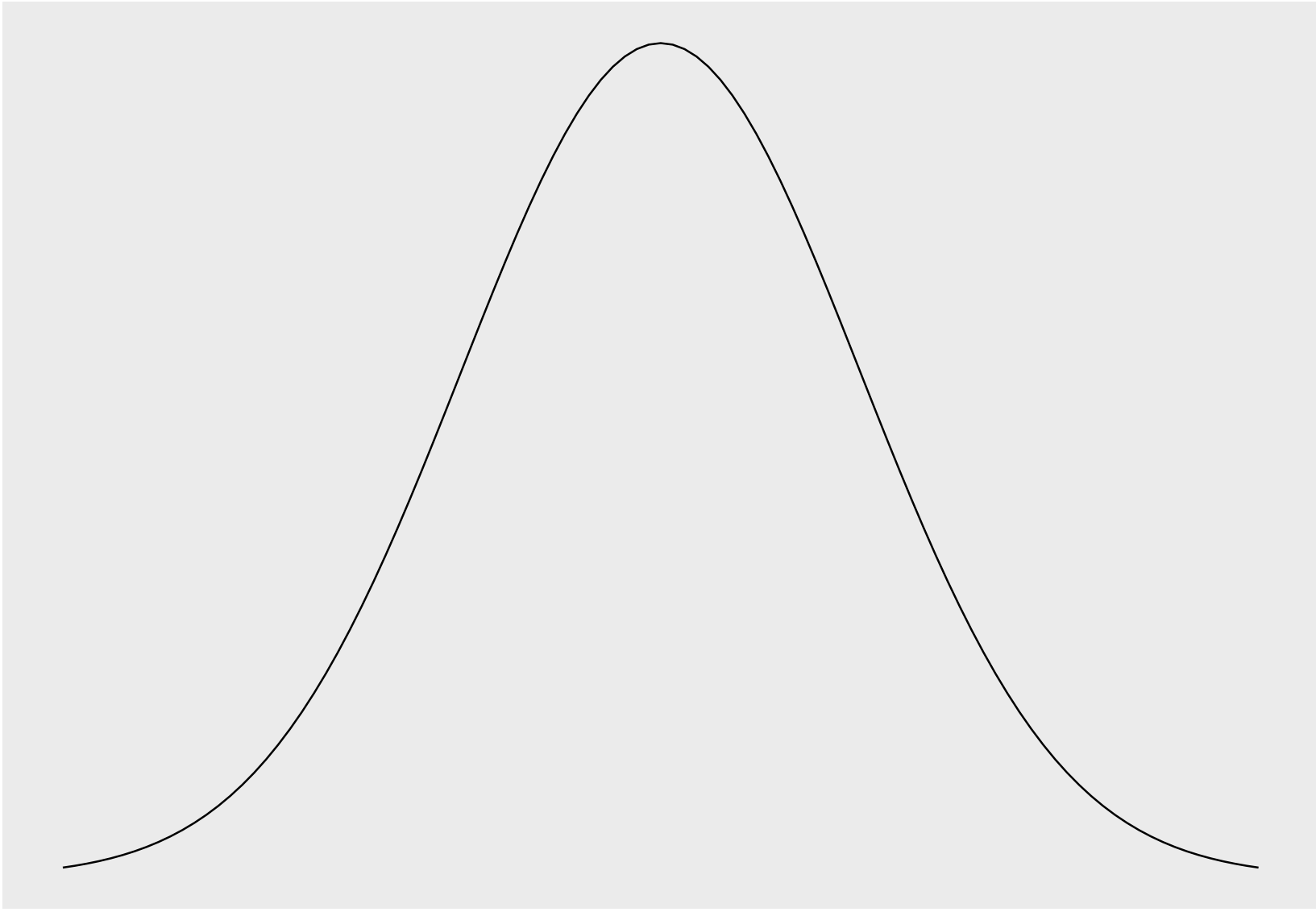
- "Deep cow families" (Schweizer Bauer - https://www.schweizerbauer.ch/tiere/milchvieh/eine-komplette-kuh-zuechten-17854.html)
- "I have not met anybody who can explain the concept of a breeding value. My cow has a breeding value of -900 and still gives milk." (Leserbrief im Schweizer Bauer)
- "Cows must give a lot of milk, and have good conformation scores"

$\rightarrow$ Aim: Know how to deal with different opinions

What happens if . . .

- . . . selection is based on phenotypic observations of only a few traits
- how is selection response affected by such a strategy

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

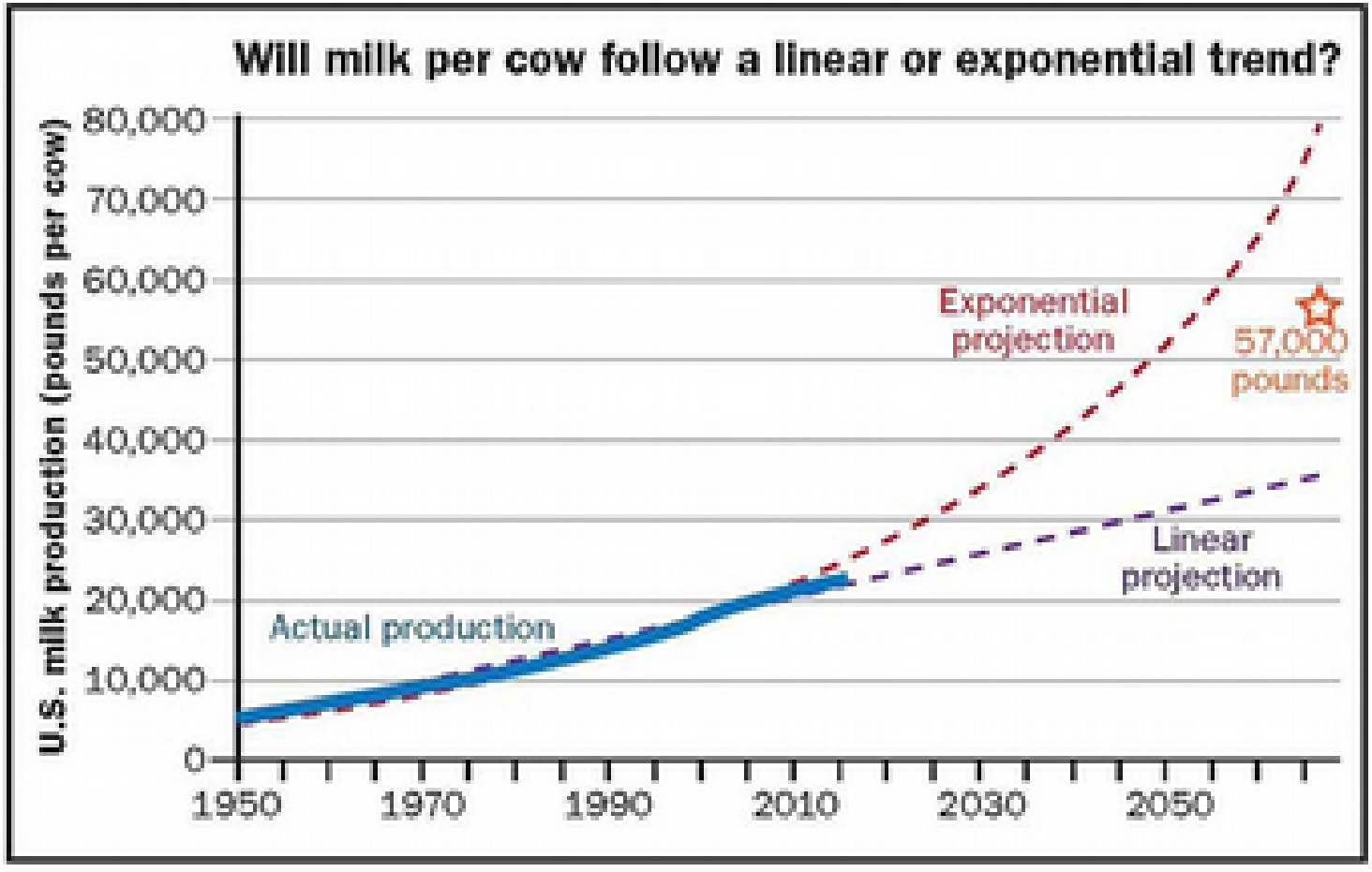
Statistics

- BLUP
- Bayesian methods

Computer Science

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

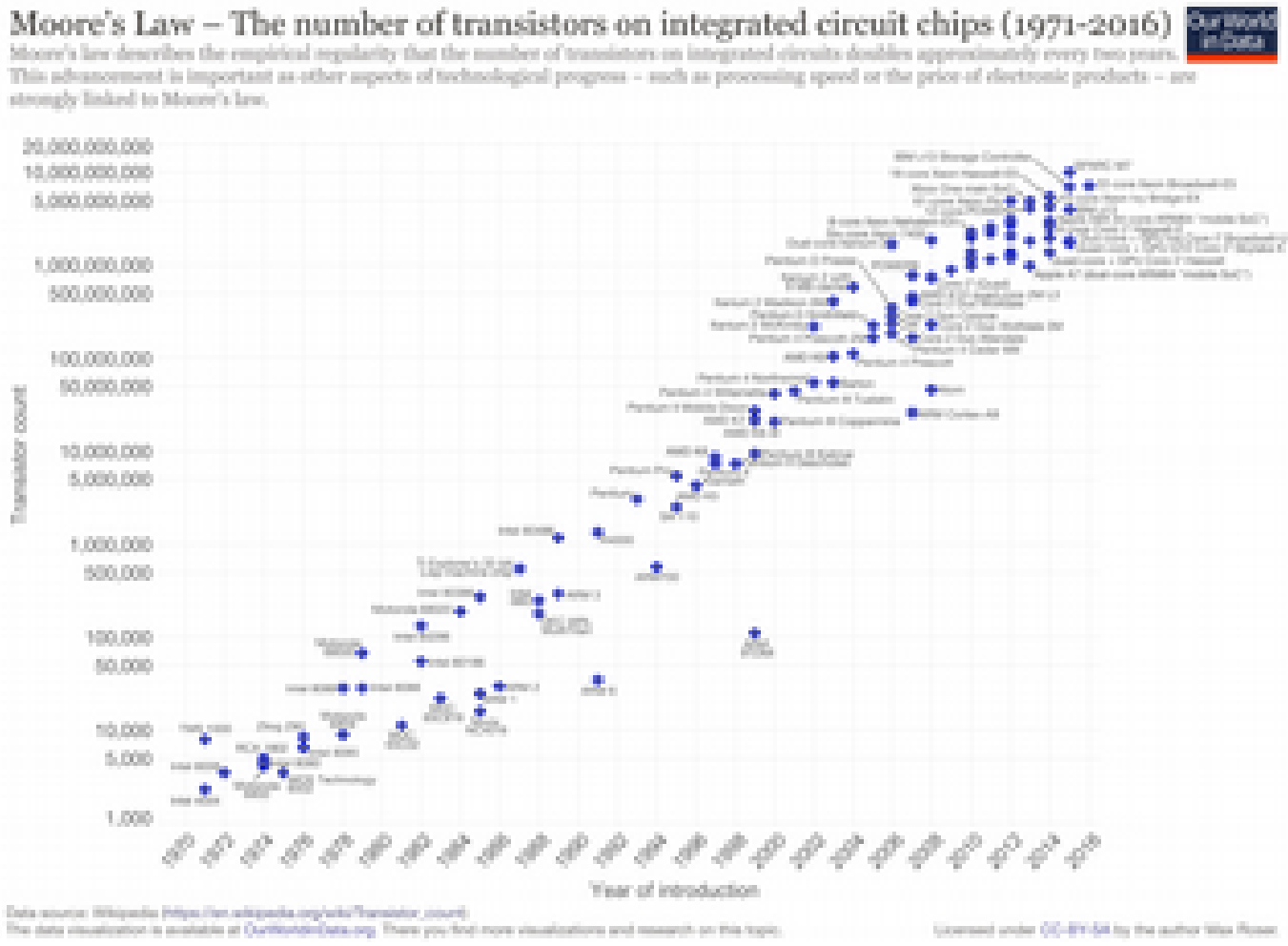
Milk Yield



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