Livestock Breeding and Genomics

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Content

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

Notes:

- Good morning, welcome to the course of Livestock Breeding and Genomics
- Today, we want to cover the following four points

Who Is Who

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

Notes:

- Before getting into the material of this course, I want to present myself
- Then I would like to get to know you a little
- I am interested in the following points about you

Goals

- Official goals: http://www.vorlesungsverzeichnis.ethz.ch/Vorlesungsverzeichnis/lerneinheit.view?lang=en&lerneinheitId=131686&semkez=2019W&ansicht=KATALOGDATEN&
- Understanding basic concepts such as
  - selection
  - breeding value
  - selection response
- Be able to exlpain certain phenomena (see next slide)
- Better understanding of statistics
- Exercises in R

Notes:

- Official goals can be taken from the course website
- I want to have a few additional goals listed here.

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)

Notes:

- Depending on where you will get a job later, you might get in contact with farmers and they sometimes have special opions about different concepts in animal breeding
- After this course you will be able to explain the relevant concepts related to selection and breeding.
- If this is not the case, please come to me and let me know.

Information

- Website: https://charlotte-ngs.github.io/LBGFS2019/
- Credit points: Written exam on 20.12.2019

Notes:

- All important information is available from the website.
- All the material for the course consisting of course notes, exercises and solutions can be downloaded from the website
- The website is structured into different sections corresponding to the different types of material that will be available to you
- At the very end there is the section on additional material. There are two sections of course notes that explain some of the prerequisites. But we will come to that in a moment.
- For those of you who want to get credit points for this course, the only requirement is the written exam at the end of the semester.

Lecture plan

- Type G
- Plan from next week:
  - exercise hour: 9-10
  - lecture: 10-12

Notes:

- My plan is to do two hours of lecture per week
- The third hour is available for you to work on exercises.

Course program

Week	Date	Topic
1	20.09	Introduction to Livestock Breeding and Genomics
2	27.09	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 - Univariate Analysis
6	25.10	Best Linear Unbiased Prediction - Multivariate Analysis
7	01.11	Models with Random Environmental Effects
8	08.11	Analysis of Longitudinal Data
9	15.11	Variance Components Estimation
10	22.11	Linkage Disequilibrium
11	29.11	Genomic Selection
12	06.12	Genom-Wide Association Studies
13	13.12	Questions, Test Exam
14	20.12	Exam

Notes:

- This table shows the different topics that are planned to be presented to you. Usually, we cannot cover all of them.
- After the introduction, we start with a brief review of quantitative genetics where a single genetic locus influences a quantitative trait.
- With the topic of genetic evaluation, we start to look at multiple loci influencing a given trait.
- The most important topics will be Best Linear Unbiased Prediction (BLUP)
- Towards the end of the semester, variance components estimation and genomic selection are introduced
- The goal and the center of all these topics will always be how to predict the genetic potential of livestock animals in a given population

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)

Notes:

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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?

Notes:

- In previous years, students who have taken this course had different levels of experience
- To get a better idea, what you already know, I prepared a few questions which I would ask you to answer now.

Prerequisites

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

Notes:

- Hard pre-requisites for the course are none
- I explain all concepts from scratch such that also people without any prior knowledge are able to understand
- It is helpful, if you have heard something about the following topics that were already part of the questionnaire.
- These topics are
  - quantitative genetics. We will get to a short overview, either at the end of this week or at the beginning of next week
  - statistics
  - linear algebra
  - R
- If you were not able to answer the questions about these topics, I recommend that you got to the website and have look at the first two chapters of the course notes which are available under the last section called More Material.

Introduction to Livestock Breeding

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

Notes:

- In this course I use the terms animal breeding and livestock breeding interchangably, although, in principle the latter is more specific and applies only to farm animals which are kept for their performance to produce a product that is used for human consumption. Animal breeding might also apply for pet animals, but in pets the focus is not so much on performance and production, but mostly on avoiding diseases.
- The German language often does not differentiate well between rearing a young animal and breeding in a population. Furthermore, especially in cattle there is no clear separation between production and breeding. In the Swiss cattle industry, most farmers would call themselves as breeders, but most of their activity is really centered around livestock production.
- In this course, we are using a science based definition of livestock breeding. At the center of this definition is the breeding goal for a certain population.
- The breeding goal is formulated in terms of an aggregate genotype H. H contains all traits of economic interest.
- H is estimated using an index I which is a linear combination of

Fundamental Questions

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

Notes:

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Phenotypes and Genotypes

$$P = G + E$$

where P and E are observed and G is unknown

Notes:

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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

Notes:

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Statistics

- BLUP
- Bayesian methods

Notes:

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Computer Science

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

Notes:

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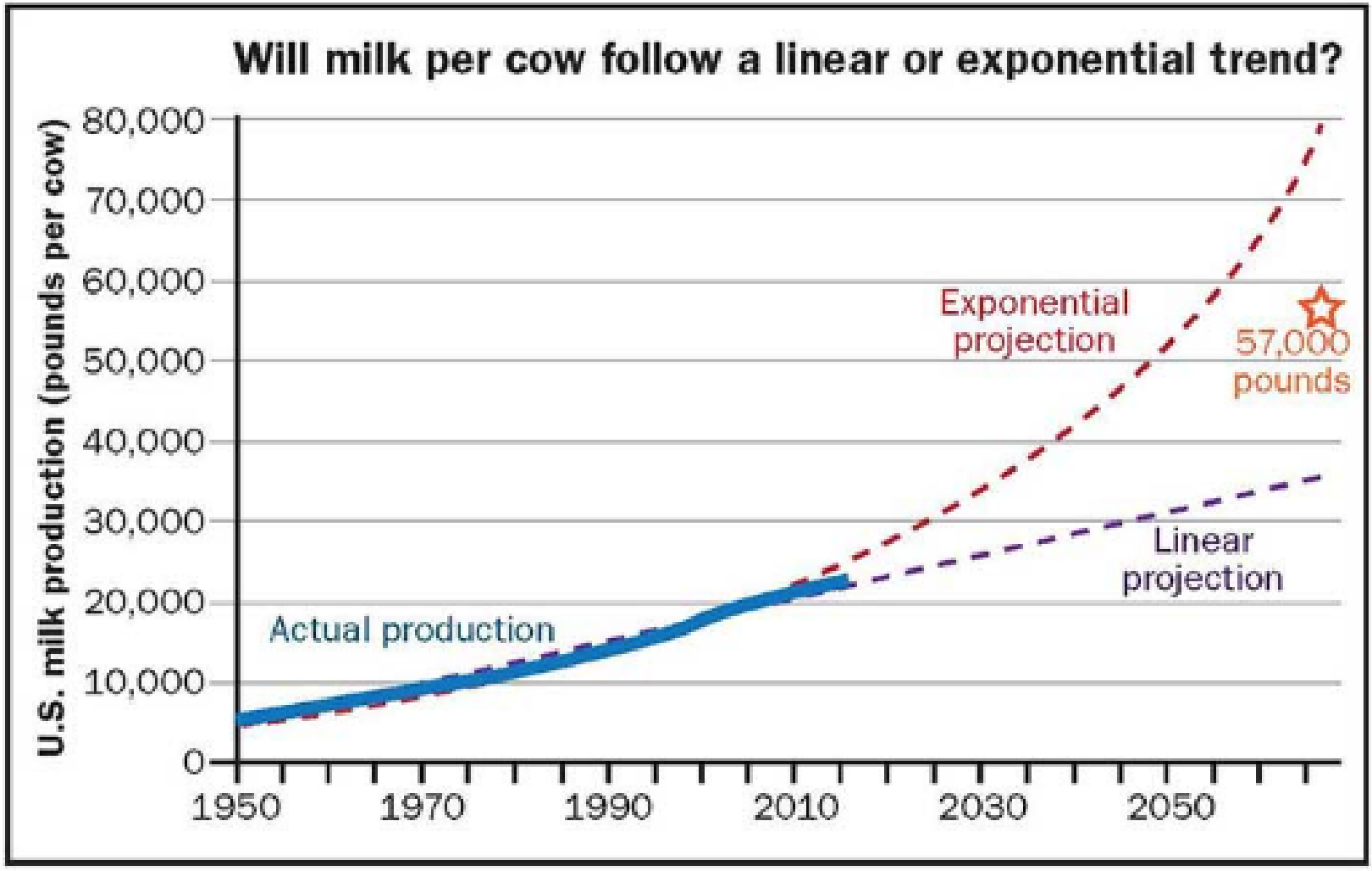
Milk Yield



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

Notes:

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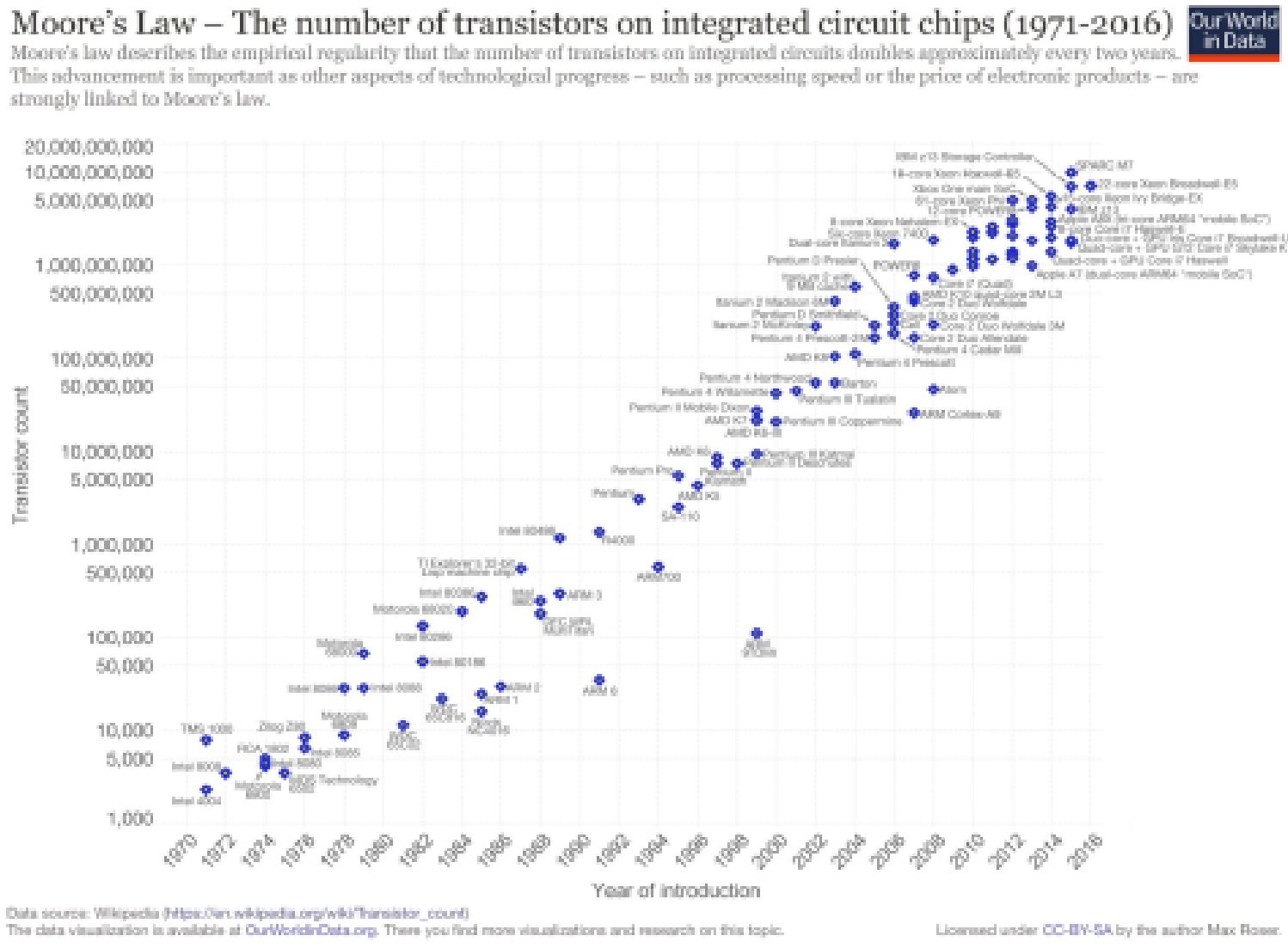
Computer Performance



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

Notes:

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