Session 01-01 - Welcome to the Programm

Section 01: Mathematical Foundations & Algebra

Dr. Nikolai Heinrichs & Dr. Tobias Vlćek

Introduction

Teaching Team

Figure 1: Dr. Tobias Vlcek

Figure 2: Dr. Nikolai Heinrichs

About me

- Field: Optimizing and simulating complex systems
- Languages: of choice: Julia, Python and Rust
- Interest: Modelling, Simulations, Machine Learning
- Teaching: OR, Algorithms, Programming & Mathematics
- Contact: vlcek@beyondsimulations.com

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> 💡 Tip
>
> Nikolai and I really appreciate active participation and interaction!

Teaching Styles

- Interactive Teaching: Presentation, discussion, and exercises
- Assignments: To be solved here and at home
- Mock Exams: We will hold mock exams to help you check your progress and understanding
- Difficulty of the Feststellungsprüfung: Strongly depends on your background and math experience!

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> 💡 Tip
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> No worries, we will help you out if you have any questions!

Participation & Materials

- Try actively participating in this course
- You will find it much (!) easier and more interesting
- Bring a laptop or tablet, a notebook and pen and a calculator
- Slides are [hosted online here](#)
- Some material will also be uploaded to Moodle due to copyright

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> 💡 Tip
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> If you find any good materials online, please share them with us and the group.

Our Plan for Today

- Introductions and course overview
- Assigments to asses your current level
- Anonymous self-assessment with a survey
- Group formation and contact exchange

Structure

Course Structure

This course consists of 8 sections with approximately 60 sessions total:

- Section 1-2: Mathematical foundations and basic functions (Basics)
- Section 3-4: Advanced functions and differential calculus (Exam Focus)
- Section 5: Integral calculus and financial applications (Advanced)
- Section 6: Probability theory (Exam Focus)
- Section 7: Statistics and linear algebra (Advanced)
- Section 8: Comprehensive exam preparation (Exam Focus)

Module Objectives

Upon completion, you will be able to:

- Master mathematical language and notation
- Solve algebraic equations and inequalities
- Analyze and interpret functions and their properties
- Use probability theory for risk assessment and decision-making
- Apply financial mathematics to investment and loan problems
- Successfully pass the Feststellungsprüfung and begin your Bachelor

> ⚠️ **Warning**
>
> Independent self-study is essential to achieve these objectives.

Sections 1-2

Foundations

- Mathematical language, set theory, number systems
- Algebraic manipulation, exponents, logarithms
- Linear and quadratic equations and inequalities
- Introduction to functions and graphical analysis
- Basic business applications

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> ℹ️ **Question**
>
> Are these topics you are familiar with?

Sections 3-4

Functions & Calculus

- Advanced functions: polynomial, rational, exponential, trigonometric
- Limits, continuity, and derivatives
- Function analysis: maxima, minima, inflection points
- Optimization problems with business applications
- Rates of change and tangent lines

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> ℹ️ **Question**
>
> What about these topics?

Sections 5-7

Integral Calculus & Probabilities

- Integration techniques and area calculations
- Financial mathematics: interest, present value, annuities
- Probability theory and random experiments
- Statistics, data analysis, and hypothesis testing
- Vectors, matrices, and linear algebra basics

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> **ℹ Question**
>
> How do you feel about these topics?

Section 8

Exam Preparation

- Comprehensive review and integration
- Mock Feststellungsprüfung sessions
- Advanced problem-solving strategies
- Final preparation and exam techniques

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> **💡 Tip**
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> After each of the previous sections we will also take 1-2 sessions to refresh past content to ensure you are really prepared for the Feststellungsprüfung.

Assessment

- No formal grading by KLU - we're here to help you succeed
- 75% attendance required due to KLU rules (will be tracked)
- Collaborative learning encouraged - work together in groups
- Self-directed - your responsibility to master the material
- Feststellungsprüfung will be written individually in English

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> **💡 Tip**
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> Please do not hesitate to contact us if you have any questions!

Assignments

- You won't have to hand in most assignments
- We will discuss the results together in class
- If you don't do the assignments, you won't be prepared!
- It is your responsibility to prepare yourself for the exam
- We are just here to help and guide you in the right direction

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> 💡 **Tip**
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> We are not grading or marking your work, so please do not worry about that! Ask us any question you have, no matter how stupid it may seem. If you are lost, even after we have explained something multiple times, ask us again! We want you to succeed and pass!

Keys to Success

- Practice regularly: Mathematics improves with daily problem-solving
- Participate actively: Ask questions and collaborate with peers
- Form study groups: Learn collectively and support each other
- Use mock exams: Use simulated exam conditions
- Monitor progress: Identify weak points early and address them

Artificial Intelligence

How to use AI

- We base our assessment on the KLU classification:
  - ‣ Level 1: Pause: Use of AI defined by the educator
- Feel free to use AI tools to support understanding
- A course chatbot is available on the learning website
- It is designed to guide your problem-solving process

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> ⚠ **Warning**
>
> Usage of AI is not allowed in the Feststellungsprüfung.

How to use the Chatbot

- Just click the chatbot bubble on the website
- The chat will open and you can ask your questions
- It is programmed by us and uses Mistral AI as backend
- Ask your question as specific as possible
- This ensures enough context for the model
- We can see aggregated logs, but cannot identify you
- Please don't provide personal information

LLMs and Mathematics

- Large language models (LLMs) are pattern-based
- They are not good at providing explicit solutions to mathematical tasks
- They are better suited to explain concepts

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> ⚠️ Always question the output of LLMs, especially for math!
>
> There are often better options as LLMs, such as Wolfram Alpha, which use symbolic computation rather than pattern matching, to solve math problems.

Assessment

What's the status quo?

- Lets find out how prepared you are currently
- You will have approximately 2 hours to solve some tasks
- These will cover all important topics
- If you can't answer a task, just shortly note why
- You can find all the tasks here

Instructions

- Work individually and quietly
- Pace: seven blocks of ~20 minutes each
- Mark your confidence (1–7) next to each problem
- If you are stuck, briefly note why and move on

Rules

- No AI tools or internet resources during the assignments
- Calculators: basic arithmetic use is fine; no CAS features
- You may ask clarifying questions about wording, not solutions
- This is diagnostic only; it is not graded

Quick Survey

Anonymous Self-Assessment

- In a moment we will do a short survey with you
- It is just an online form to fill out with a few questions
- In the coming months we will repeat this after each section
- Helps us to monitor progress and receive anonymous feedback
- You can find the survey here

Working Together

Learning Groups

Our idea

- We will form small groups of 3 students

- Groups will rotate after each section
- We will just randomly assing you each time
- Agree on a weekly study slot and communication channel

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> **ℹ Question**
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> Is this in your interest or do you prefer a different way?

That's it for today.

Any Questions?

References

References

- Interested in further literature to learn more about Mathematics?
- Take a look at the [reference list](#) of this course
- Here you can find recommended books and resources

> **💡 Tip**
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> Have you found anything worthwhile that might help your classmates or you? Please share it with us and we will update the references.