What to learn from the impossible?

Formal and philosophical topics of impossibility theorems.

Hauptseminar, University of Tübingen, Summer 2025

Instructors

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[Alma | Moodle]

Office hours: by appointment. Please reach out if you have any questions.

Seminar Times and Location

1) **Introduction:**
   Tuesday, 15.04., 14-16h c.t., Hörsaal TTR2, AI Research Building.
2) **Gödels Incompleteness Theorem:**
   Friday, 02.05., 09-14h s.t.
3) **The problem of Induction and the NFL:**
   Friday, 16.05., 09-14h s.t.
4) **Fairness Impossibility Results:**
   Friday, 23.05., 09-14h s.t.
5) **Student Presentations:**
   Friday, 20.06., 09-17h s.t.

Except for the first one, all seminar sessions will take place in lecture hall 1.3 of the Forum Scientarium, Doblerstraße 33, Tübingen.

Course Description

At the core of mathematics, computer science, and machine learning lie formal results that show that certain things do not exist. For example,

- Gödels incompleteness theorem shows that in any effective axiomatization of arithmetics, true statements exist that cannot be proven from the axioms.
- The no-free lunch theorems show that no single learning algorithm is superior to all others across all possible environments.

- The fairness impossibility theorems show that certain notions of formal fairness in predictions are generally incompatible, e.g. equalized odds and predictive parity.

These results are often thought to have profound philosophical and practical implications. But what exactly are these implications? How do they affect real-world applications, and might there be ways to navigate or mitigate the dilemmas they present?

In this seminar, we will try to get to the bottom of these questions. The seminar is divided into two blocks. In the first block, we (the instructors) will introduce you to the three impossibility results mentioned above. We will discuss their philosophical origins and provide accessible proofs to them. In the second block, you (the students) will present and discuss both the philosophical and practical implications of these theorems based on recent research articles.

This seminar is open to students from a wide range of disciplines, including philosophy, machine learning, computer science, and cognitive science. An openness to interdisciplinary collaboration, a willingness to engage with mathematical reasoning, and an interest in philosophical inquiry will enrich your experience in this course.

The seminar will be held in English.

Course Requirements

Passing this course requires (A) your active participation and (B) writing an individual seminar paper.

(A) Active participation includes your attendance, reading the material for each of the sessions in preparation, and active participation in a student presentation.

In the presentation, each group will present the core argument of a paper we provide. The format is 20’ presentation and 25’ discussion. For each of the three topics, we will provide about 3 papers to be presented. Groups and topics will be allocated after the third session of the seminar.

Important: Each group must discuss their presentation with one of us no later than June 06.

(B) The length of the seminar paper depends on the credit points you want to earn:

- 3 CP: 1,500 words (both graded and not graded).
- 6 CP: 3,000 words.
- 9 CP: 4,000 words.
- 12 CP: 5,000 words.

We will provide a list of ’pre-approved’ topics. You’re also welcome to develop your own topic, which has to be approved by one of us. The seminar papers will be written in English.

The seminar papers must be submitted by **15.09.2025** via moodle.

Missing class and late assignments

We recognize that occasional problems associated with illness, family emergencies, job interviews, other professors, etc. will inevitably lead to legitimate conflicts over your time. If you expect that you will be unable to turn in an assignment on time, or must be absent from a class meeting, please notify us via email in advance and we can agree on a reasonable accommodation.

Academic Integrity

Each student is responsible for being aware of the university policies on academic integrity, including the policies on cheating and plagiarism. In this course, you are **not** allowed to use AI assistance for more than copy-editing your written assignment.

In case we have reasonable doubt about this, we will invite you to a follow-up discussion with one of the instructors to determine whether you have written the seminar paper independently. The follow-up discussion has no influence on the grade.