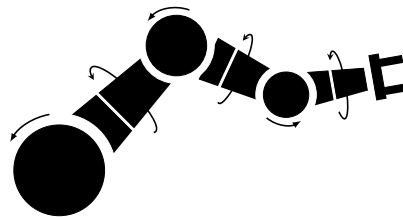


Winter Term 2026/2027

## Seminar on Differential Geometry and Robotics



### Contents:

The seminar shall provide an introduction to the mathematical modelling of robot motions. Specifically, differential-geometric and algebraic methods of Lie group and Lie algebra theory are used to describe the kinematics of robot arms. At the heart of our investigation lies the group of rigid-body motions in three-space  $SE(3)$ . This is the group of orientation-preserving motions that keep the Euclidean distance fixed. Besides its group structure, the motion group

$$SE(3) = SO(3) \ltimes \mathbb{R}^3$$

also has the structure of a differentiable manifold. Both structures are compatible, which makes  $SE(3)$  a Lie group. The aim of the seminar is to analyse the group  $SE(3)$  and discuss its applications in theoretical robotics. During the seminar, we will develop the necessary foundations from the areas of Lie groups, representation theory, quadrics, and Clifford algebras. In this sense, the discussed contents are also of interest to a larger mathematical audience outside of robotics.

**Preliminary Meeting:** Friday, 31 July 2026, at 13:00 in seminar room 3.069.

Please feel free to register for the preliminary meeting by sending a short email to Artem Nepechiy.

**Timeslot:** Thursdays, 09:45–11:15, in seminar room 3.069.

### Prerequisites:

The courses 'Analysis I,II,III', 'Linear Algebra I, II', 'Elementare Geometrie'. The seminar is suitable for advanced bachelor's and master's students. Basic notions of differential geometry are needed, but the seminar can also be taken concurrently with the differential geometry lecture.

### References:

Our main source will be J. M. Selig, *Geometric Fundamentals of Robotics*.

