**Title:** Verification of the Equivalence Property for Neural Networks using Geometric Path Enumeration

Topic:

Neural networks have become popular methods for tackling various machine learning tasks and are increasingly applied in safety-critical systems. This necessitates verified statements about their behaviour and properties. One of these properties is the equivalence of two neural networks, which is important, e.g., when neural networks shall be reduced to smaller ones that fit space and memory constraints of embedded or mobile systems.

The geometric path enumeration approach is increasingly applied to verify properties of larger neural networks. Regarded properties are mostly restricted to adversarial robustness or other linear constraints on input-output relations. In this project, the geometric path enumeration approach will be adjusted and applied to the equivalence property. The challenge of adjusting the approach includes, among other things, a definition of the term equivalence for two neural networks. Furthermore, there are many other optimization possibilities for scaling the approach, for example, over approximations of the networks can be applied and then systematically refined.

General Overview:
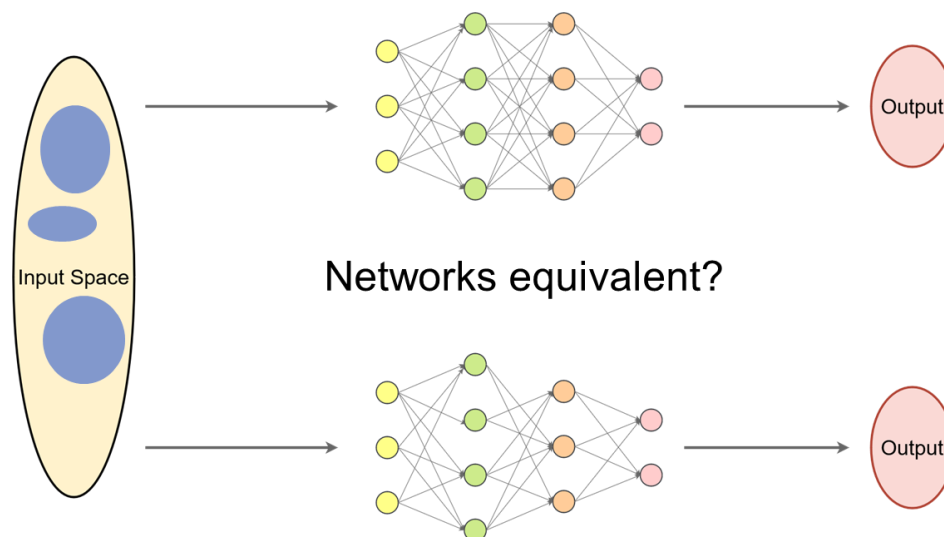
Possible Task Description:

- Definition of problem statement: neural network type, classification vs regression learning, etc.
- Design and implementation of geometric path enumeration approach for equivalence of two neural networks
- Evaluation of approach on smaller neural networks (potentially hand-written-digit recognition)
- Optimization of approach (over-approximation and refinement, parallelization on GPU, etc.)
- Final evaluation of approach on smaller and larger neural network benchmarks

Names of Supervisors:

Marko Kleine Büning, marko.kleinebuening@kit.edu, 50.34, Room 017
Prof. Carsten Sinz, carsten.sinz@kit.edu, 50.34, Room 028

Possible Number of Participants: 1 to 2 persons (if a group of more than two persons want to work on this project, the scope can be lifted with our consultation)