**Neural Networks and Continuous Time**

Frieder Stolzenburg, Florian Ruh  
Hochschule Harz (FH), University of Applied Sciences,  
Department of Automation and Computer Sciences, D-38855 Wernigerode, Germany,  
{fstolzenburg,fruh}@hs-harz.de

**Goal**

simulate structure and functional aspects of biological networks, i.e. find computational model for technical, physical, and cognitive processes, which evolve continuously in time

**Scenario 1: deductive reasoning**

**Continuous Neural Networks**

**Neural Network Unit**

1. summation with *time delay*:
   \[ y_1(t) = \sum_{i=1}^{n} w_i \cdot x_i(t - \delta_i) \]

2. *integration* (average signal power):
   \[ y_2(t) = \sqrt{\frac{1}{T} \int_{t-T}^{t} y_1(u)^2 du} \]

3. *nonlinear activation*:
   \[ y_3(t) = \frac{\tanh(\alpha y_2(t))}{\alpha} \]

4. *oscillation* (amplitude modulation):
   \[ y_4(t) = y_3(t) \cdot \cos(\omega t) \]

**Summary**

CNNs can express deductive reasoning, robot behavior, and analysis of environment