TECHNISCHE UNIVERSITÄT DARMSTADT

Fachbereich 18
Elektrotechnik und Informationstechnik
Bioinspirierte Kommunikationssysteme

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Electrical Engineering and Information Technology
Bioinspired Communication Systems

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Thesis Topic (B.Sc. / M.Sc.)
Mean Field Control and Mean Field Games

The framework of mean field games (MFG) was introduced in the continuous setting of stochastic differential games (Huang et al. [2006]). Meanwhile, it has sparked interest both in mathematical communities and in applied research communities as a framework for tractably solving large-scale multi-agent problems. Applications for such mean field models are diverse and include e.g. finance, wireless communication, power control problems or public health models. See also Djehiche et al. [2017] for a survey on applications.

At its core lies the reduction of the classical multi-agent solution concept of Nash equilibria to the interaction between one representative agent and the 'mass' of infinite other agents – the mean field. The solution – a mean field equilibrium (MFE) – is characterized by a forward evolution equation for the mean field, and a backward optimality equation of representative agent optimality. Importantly, the MFE constitutes an approximate Nash equilibrium in the corresponding finite agent game of sufficiently many agents (Saldi et al. [2018]), which would otherwise be intractable to compute.

Nonetheless, computing an MFE remains difficult in the general case. At BCS Lab, you will have the opportunity to work on cutting-edge topics in Mean Field Games and Mean Field Control, investigating how to fuse modern machine learning with mean field models or extending existing mean field formulations both in theory and in practice.

Some of the following may help depending on the specific topic:

- Some understanding of probability theory
- Some experience in reinforcement learning / optimal control

For further information, please contact Kai Cui.

References

Boualem Djehiche, Alain Tcheukam, and Hamidou Tembine. Mean-field-type games in engineering [j]. *AIMS Electronics and Electrical Engineering*, 1(1): 18–73, 2017.

Minyi Huang, Roland P Malhamé, Peter E Caines, et al. Large population stochastic dynamic games: closed-loop mckean-vlasov systems and the nash certainty equivalence principle. *Communications in Information & Systems*, 6 (3):221–252, 2006.

Naci Saldi, Tamer Basar, and Maxim Raginsky. Markov–nash equilibria in mean-field games with discounted cost. *SIAM Journal on Control and Optimization*, 56(6):4256–4287, 2018.