**PETER CAINES**, McGill University

*Mean Field Games on Large Sparse and Dense Networks*

Mean Field Game (MFG) theory treats the existence of Nash equilibria for large population dynamical games by approximating them with infinite population games of negligible agents. The MFG equations consist of the Hamilton-Jacobi-Bellman equation for the control of a generic agent and the Fokker-Planck-Kolmogorov equation describing its state evolution; these are linked by the system's mean field, namely the state distribution of the generic agent.

Graphons are limits of node adjacency matrices (Lovasz, 2012). Graphon MFG (GMFG) systems (Caines and Huang, CDC 2018-19, SICON 2021) consist of MFGs where large nodal sub-populations interact over large dense graphs modelled in the limit by graphons. The solutions of the GMFG equations give a system's Nash equilibria and this permits an analysis of the optimality of the node dependent Nash values with respect to graphon index (Caines, Huang, Gao, Foguen-Tchuendom, CDC 2021,2022, MTNS 2022, IFAC 2023). This presentation of GMFG will use metric space embedded graph limits in the form of graphexons (Caines, CDC 2022). The formulation enables the modelling of limit networks situated in some compact space, M, by generalizing graphon functions on M x M to measures on M x M. This has the advantage of including both large sparse and dense networks; furthermore, the resulting set-up permits meaningful differentiation of variables with respect to network location which is not the case for graphon based formulations.

Work with Alex Dunyak, Rinel Foguen-Tchuendom, Shuang Gao, Minyi Huang; partially supported by NSERC (grant 2019-05336) and AFOSR (grant FA9550-23-1-0015).