My name is **Bahman Gharesifard** and I am a Professor in the Department of Mathematics and Statistics at Queen's University.

I am interested in a wide range of topics, using tools from geometry, algebra, and stochastic analysis. My recent research focuses systems and control, optimization theory, game theory, machine learning, reinforcement learning, universal approximation theory for neural networks, and optimal transport theory.

I have listed a few specific problems below, but the best way to learn about my work it to check my webpage.

Intersections of non-convex optimization, machine learning, and control theory: Stochastic gradient methods are at the heart of recent advances in optimization and machine learning. Besides neural networks, these include policy gradient methods, temporal difference learning, and actor-critic dynamics in reinforcement learning. These advancements have had profound impacts on model-free control, where decisions are made based on data. The theoretical problems in this area combine ideas from stochastic analysis, dynamical systems, and geometric methods.

Universal approximation theory in machine learning: Neural networks possess inherent universal approximation power, which means they can effectively approximate functions given enough nodes and layers. Universal approximation is a classical topic; however, we have only recently been able to theoretically characterize it for settings with bounded width. Techniques from control theory, particularly geometric and optimal control, have been shown to be key, with much still to discover for modern architectures and networks not studied in isolation. There is also an interesting intersection of this topic with optimal transport theory.

Structural frameworks for control of ensemble systems: In many real-world scenarios, some system parameters are only probabilistically known. Classical control notions, such as controllability and stabilizability, often rely on the deterministic knowledge of these parameters. Ensemble control theory provides the foundation for studying such systems, with fascinating intersections with optimal transport theory, identification theory, model-free control, and partial differential equations. Research in this area intersects with functional analysis, graph theory, differential geometry, and Lie theory.

If you find any of these problems interesting or would like to hear more about my research, do not hesitate to contact me at bahman.gharesifard@queensu.ca.