My name is Abdol-Reza Mansouri and I am a Professor of Mathematics here at Queen's.

My research interests are primarily in sub-Riemannian geometry and stochastic analysis, but extend to other areas such as the study of topological obstructions and inverse partial differential equation problems.

Here are some of the problems I would like to attack in the very near future, each forming the core of a suitable Master's or PhD research problem.

Problem 1 A fundamental problem in sub-Riemannian geometry is that of the regularity of length-minimizing curves, the study of which is made challenging by the possible existence of "abnormal" extremals. It has been shown recently that sub-Riemannian length-minimizing curves cannot have corner-type singularities. The aim of this research is to identify additional types of singularities that sub-Riemannian length-minimizing curves cannot exhibit.

Problem 2 It is known that a suitably defined random walk on a sub-Riemannian manifold converges in law to a "horizontal" Brownian motion, directly tied to the sub-Laplacian of the underlying geometry. The aim of this research is to identify the geometric information that can be recovered from the properties of such processes, in particular, the structure of the cut and conjugate loci.

Problem 3 The KLS conjecture states that for any log-concave distribution in $\mathbb{R}^d$, the Cheeger isoperimetric coefficient is equal to that achieved by half-spaces up to a universal constant factor. Recent approaches based on stochastic analysis tools, and, in particular, Eldan's stochastic localization, have led to lower bounds on the Cheeger isoperimetric coefficient approaching the conjectured lower bound. The aim of this research is to investigate possible extensions to the stochastic localization method that would help improve those bounds.

If you find any of these problems interesting or would like to learn more about them, do not hesitate to contact me at mansouri@queensu.ca