A comparative study of shape optimization methods.

**Background**
Laminar channel flows are one of the simplest canonical flow configurations in fluid mechanics. However, under the diffusion-dominated laminar flow regime in channels, it is difficult to enhance mixing and hence improve heat transfer. Thus searching for a channel shape that maximizes heat transfer while minimizing momentum loss is a non-trivial task. For this, we will make use of zero-order/gradientless methods instead of computationally expensive and mathematically rigorous gradient-based methods.

**Content of the Thesis**
The aim of the thesis will be to use gradientless optimization methods to search for channel flow configurations with arbitrary wall structuring that increase Stanton number $St$ (non-dimensional heat transfer). And this has to be achieved with the least possible drag coefficient $C_D$ (non-dimensional momentum transfer) possible. This is difficult to achieve due to the similarity in the transport mechanism of heat and momentum transfer - known as the Reynolds analogy.

In the first phase, Particle Swarm Optimization (PSO) will be used to explore the high-dimensional parameter space marked by the discretized grid. To predict $C_D$ and $St$, for the channel with arbitrary wall structuring, we will make use of a surrogate machine learning (ML) model instead of using numerical simulations. A ready-to-use trained ML model is available for this purpose. The final goal is to compare and contrast the impact of different gradientless techniques on shape optimization. For this purpose, we will make use of other well-known gradientless techniques, namely Random Walk, Genetic Algorithm, and Firefly Algorithm.

**Requirements**
- Basic knowledge of fluid mechanics

**Beneficial Skills**
- Optimisation techniques
- Numerical programming
- Python

**Start:** immediately

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