

## PROJECTS FOR MAT2000

TUYEN TRUNG TRUONG

2 projects are offered:

### 1. PROJECT 1: STUDY THE CONVERGENT BEHAVIOUR OF GRADIENT DESCENT

Gradient Descent is a simple but effective optimization method. It, and variants, is particularly useful in Large scale examples, including Deep Neural Networks (the machine behind AI).

This project will study both theoretically and experimentally on the question whether Gradient Descent (and its variants) can find local minima of a function. This project will reveal how useful mathematical subjects as Linear algebra, Calculus and Dynamical Systems are useful to Optimization.

Reference: (More will be given later)

Jason D. Lee, Max Simchowitz, Michael I. Jordan and Benjamin Recht, Gradient descent only converges to minimizers, JMLR: Workshop and conference Proceedings vol 49: 1-12, 2016.

### 2. PROJECT 2: NUMERICAL CALCULATIONS RELATED TO THE RIEMANN HYPOTHESIS

The Riemann hypothesis asserts that all non-trivial roots of the Riemann zeta function have real part  $1/2$ . It is regarded as the most difficult and very useful open question in mathematics.

One may first try to find some of the non-trivial roots of the Riemann zeta function and check if the Riemann hypothesis holds for them. But how can we proceed, given that the Riemann zeta function is transcendental while computers can only work with rational numbers?

This project will research on both theoretical and practical issues to successfully put a hand on roots of the Riemann zeta function.

References: (More will be given later)

J. Arias de Reyna, High precision computation of Riemann's zeta function by the Riemann-Siegel formula, I, Mathematics of Computation, vol 80, number 274, 995–1009, 2011.

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