



# Automatic Rank Determination for Low-Rank Adaptation via Submodular Function Maximization

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**TIME** 10:30 AM - 11:30 AM

**VENUE** CS Seminar Room, Y6405, 6th Floor,  
Yellow Zone, Yeung Kin Man Academic  
Building, City University of Hong Kong, 83  
Tat Chee Avenue, Kowloon Tong

## ABSTRACT

In this talk, we will introduce SubLoRA, a rank determination method for Low-Rank Adaptation (LoRA) based on submodular function maximization. In contrast to prior approaches, such as AdaLoRA, that rely on first-order (linearized) approximations of the loss function, SubLoRA utilizes second-order information to capture the potentially complex loss landscape by incorporating the Hessian matrix. We show that the linearization becomes inaccurate and ill-conditioned when the LoRA parameters have been well optimized, motivating the need for a more reliable and nuanced second-order formulation. To this end, we reformulate the rank determination problem as a combinatorial optimization problem with a quadratic objective. However, solving this problem exactly is NP-hard in general. To overcome the computational challenge, we introduce a submodular function maximization framework and devise a greedy algorithm with approximation guarantees. We derive a sufficient and necessary condition under which the rank-determination objective becomes submodular, and construct a closed-form projection of the Hessian matrix that satisfies this condition while maintaining computational efficiency. Our method combines solid theoretical foundations, second-order accuracy, and practical computational efficiency. We further extend SubLoRA to a joint optimization setting, alternating between LoRA parameter updates and rank determination under a rank budget constraint. Extensive experiments on fine-tuning physics-informed neural networks (PINNs) for solving partial differential equations (PDEs) demonstrate the effectiveness of our approach. Results show that SubLoRA outperforms existing methods in both rank determination and joint training performance.

## BIOGRAPHY

GAO Yihang is currently a departmental Research Fellow in the Department of Mathematics at the National University of Singapore (NUS), Singapore. He received the B.S. degree in Mathematics and Applied Mathematics from Zhejiang University, China, in 2020, and the Ph.D. degree in Mathematics from the University of Hong Kong (HKU), Hong Kong SAR, in 2024. His research interests include mathematical machine learning, optimization, and scientific computing.

**All are welcome!**



In case of questions, please contact Prof. SONG Linqi at [linqi.song@cityu.edu.hk](mailto:linqi.song@cityu.edu.hk), or visit the CS Departmental Seminar Web at <https://www.cs.cityu.edu.hk/events/cs-seminars/recent-cs-colloquiums>.