



**THE HONG KONG UNIVERSITY OF SCIENCE & TECHNOLOGY**

**Department of Mathematics**

**SEMINAR ON STATISTICS AND DATA SCIENCE**

**RankSEG-RMA: An Efficient Segmentation  
Algorithm via Reciprocal Moment Approximation**

**By**

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**Abstract**

Semantic segmentation labels each pixel in an image with its corresponding class, and is typically evaluated using the Intersection over Union (IoU) and Dice metrics to quantify the overlap between predicted and ground-truth segmentation masks. In the literature, most existing methods estimate pixel-wise class probabilities, then apply argmax or thresholding to obtain the final prediction. These methods have been shown to generally lead to inconsistent or suboptimal results, as they do not directly maximize segmentation metrics. To address this issue, a novel consistent segmentation framework, RankSEG, has been proposed, which includes RankDice and RankIoU specifically designed to optimize the Dice and IoU metrics, respectively. Although RankSEG almost guarantees improved performance, it suffers from two major drawbacks. First, it is its computational expense—RankDice has a complexity of  $O(d \log d)$  with a substantial constant factor (where  $d$  represents the number of pixels), while RankIoU exhibits even higher complexity  $O(d^2)$ , thus limiting its practical application. For instance, in LiTS, prediction with RankSEG takes 16.33 seconds compared to just 0.01 seconds with the argmax rule. Second, RankSEG is only applicable to overlapping segmentation settings, where multiple classes can occupy the same pixel, which contrasts with standard benchmarks that typically assume non-overlapping segmentation. In this paper, we overcome these two drawbacks via a reciprocal moment approximation (RMA) of RankSEG with the following contributions: (i) we improve RankSEG using RMA, namely RankSEG-RMA, reduces the complexity of both algorithms to  $O(d)$  while maintaining comparable performance; (ii) inspired by RMA, we develop a pixel-wise score function that allows efficient implementation for non-overlapping segmentation settings.

**Bio:** Dr. DAI Ben is an Assistant Professor in the Department of Statistics at The Chinese University of Hong Kong. His primary research interests include statistical consistency, theory-driven machine learning methods, theoretical foundation of machine learning, black-box significance testing, statistical computing and software development.

**Date** : 11 March 2026 (Wednesday)  
**Time** : 11:00a.m.-12:00noon  
**Venue** : Room 3598 (near Lift 27/28 )  
*All are welcome*