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Department of Operations and Risk Management
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BUSINESS DISTINGUISHED SEMINAR SERIES

LIDS: LLM Summary Inference Under the Layered Lens

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Abstract: Large language models (LLMs) have gained significant attention by many researchers and practitioners in natural language processing (NLP) since the introduction of ChatGPT in 2022. One notable feature of ChatGPT is its ability to generate summaries based on prompts. Yet evaluating the quality of these summaries remains challenging due to the complexity of language. To this end, in this paper we suggest a new method of LLM summary inference with BERT-SVD-based direction metric and SOFARI (LIDS) that assesses the summary accuracy equipped with interpretable key words for layered themes. The LIDS uses a latent SVD-based direction metric to measure the similarity between the summaries and original text, leveraging the BERT embeddings and repeated prompts to quantify the statistical uncertainty. As a result, LIDS gives a natural embedding of each summary for large text reduction. We further exploit SOFARI to uncover important key words associated with each latent theme in the summary with controlled false discovery rate (FDR). Our theory establishes the perturbation rates for the empirical LIDS directions, consistency of the LIDS similarity measure and the number of selected latent SVD layers, stability of the induced summary embeddings, prompt-level uncertainty quantification from repeated summaries, high-probability benchmark separation, and SOFARI--BH FDR control and power guarantees for layered key word recovery. Comprehensive empirical studies demonstrate the practical utility and robustness of LIDS through human verification and comparisons to other similarity metrics, including a comparison of different LLMs. This is a joint work with Yingying Fan and Dylan Park.

Jinchi Lv is Kenneth King Stonier Chair in Business Administration, Department Chair, Professor in Data Sciences and Operations Department of the Marshall School of Business at the University of Southern California, and Professor in Department of Mathematics at USC. He received his Ph.D. in Mathematics from Princeton University in 2007. He was McAlister Associate Professor in Business Administration at USC from 2016-2019. His research interests include statistics, data science, artificial intelligence, machine learning, and business applications as well as large language models and blockchain. His papers have been published in journals in statistics, economics, business, computer science, information theory, neuroscience, and biology. He is the recipient of the International Congress of Basic Science (ICBS) Frontiers of Science Award and Lecture (2026), the 10th International Congress of Chinese Mathematicians (ICCM) 45 Minutes Invited Lecture (2026), the 10th International Congress of Chinese Mathematicians (ICCM) Best Paper Gold Award (2025), USC Fellow of Big Ten Academic Alliance Department Executive Officer (BTAA-DEO) Program (2025), Fellow of Asia-Pacific Artificial Intelligence Association (2024), Distinguished Scholar (2024, Lingnan University), NSF Grant (2023), NSF Emerging Frontiers (EF) Grant (2022), Fellow of American Statistical Association (2020), NSF Grant (2020), Kenneth King Stonier Chair in Business Administration (2019), Fellow of Institute of Mathematical Statistics (2019), Member of USC University Committee on Appointments, Promotions, and Tenure (UCAPT, 2019-2024), USC Marshall Dean's Award for Research Impact (2017), Adobe Data Science Research Award (2017), McAlister Associate Professor in Business Administration (2016), Simons Foundation Grant (2016), the Royal Statistical Society Guy Medal in Bronze (2015), NSF Faculty Early Career Development (CAREER) Award (2010), USC Marshall Dean's Award for Research Excellence (2009), Journal of the Royal Statistical Society Series B Discussion Paper (2008), NSF Grant (2008), and Zumberge Individual Award from USC's James H. Zumberge Faculty Research and Innovation Fund (2008). He has served as an associate editor of Operations Research (2024-present), Journal of the American Statistical Association (2023-present), Journal of Business & Economic Statistics (2018-2024), The Annals of Statistics (2013-2018), and Statistica Sinica (2008-2016).

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