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Probably Anytime-Safe Stochastic Combinatorial Semi-Bandits

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Motivated by concerns about making online decisions that incur undue amount of risk at each time step, in this paper, we formulate the probably anytime-safe stochastic combinatorial semi-bandits problem. In this problem, the agent is given the option to select a subset of size at most K from a set of L ground items. Each item is associated with a certain mean reward as well as a variance that represents its risk. To mitigate the risk that the agent incurs, we require that with probability at least $1-\delta$, over the entire horizon of time T , each of the choices that the agent makes should contain items whose sum of variances does not exceed a certain variance budget. We call this probably anytime-safe constraint. Under this constraint, we design and analyze an algorithm PASCombUCB that minimizes the regret over the horizon of time T . By developing accompanying information-theoretic lower bounds, we show under both the problem-dependent and problem-independent paradigms, PASCombUCB is almost asymptotically optimal. Our problem setup, the proposed PASCombUCB algorithm, and novel analyses are applicable to domains such as recommendation systems and transportation in which an agent is allowed to choose multiple items at a single time step and wishes to control the risk over the whole time horizon.

Bio: Vincent Y. F. Tan (S'07-M'11-SM'15) was born in Singapore in 1981. He received the B.A. and M.Eng. degrees in electrical and information science from Cambridge University in 2005, and the Ph.D. degree in electrical engineering and computer science (EECS) from the Massachusetts Institute of Technology (MIT) in 2011. He is currently an Associate Professor with the Department of Mathematics and the Department of Electrical and Computer Engineering (ECE), National University of Singapore (NUS). His research interests include information theory, machine learning, and statistical signal processing. Dr. Tan is an elected member of the IEEE Information Theory Society Board of Governors. He was an IEEE Information Theory Society Distinguished Lecturer from 2018 to 2019. He received the MIT EECS Jin-Au Kong Outstanding Doctoral Thesis Prize in 2011, the NUS Young Investigator Award in 2014, the Singapore National Research Foundation (NRF) Fellowship (Class of 2018), the Engineering Young Researcher Award in 2018, and the NUS Young Researcher Award in 2019. A dedicated educator, he was awarded the Engineering Educator Award in 2020 and 2021 and the (university level) Annual Teaching Excellence Award in 2022. He is currently serving as a Senior Area Editor for the *IEEE Transactions on Signal Processing* and as an Associate Editor in Machine Learning and Statistics for the *IEEE Transactions on Information Theory*.

