Constrained counting and sampling are two fundamental problems in Computer Science with numerous applications, including network reliability, privacy, probabilistic reasoning, and constrained-random verification. In constrained counting, the task is to compute the total weight, subject to a given weighting function, of the set of solutions of the given constraints. In constrained sampling, the task is to sample randomly, subject to a given weighting function, from the set of solutions to a set of given constraints.

In this talk, I will introduce a novel algorithmic framework for constrained sampling and counting that combines the classical algorithmic technique of universal hashing with the dramatic progress made in Boolean reasoning over the past two decades. This has allowed us to obtain breakthrough results in constrained sampling and counting, providing a new algorithmic toolbox in machine learning, probabilistic reasoning, privacy, and design verification. I will demonstrate the utility of the above techniques on various real applications including probabilistic inference, design verification and our ongoing collaboration in estimating the reliability of critical infrastructure networks during natural disasters.

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