Contribution ID: **105** Type: **not specified**

Space-Efficient Interior Point Method, with applications to Linear Programming and Maximum Weight Bipartite Matching

Thursday, July 13, 2023 4:00 PM (20 minutes)

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Abstract: We study the problem of solving linear program in the streaming model. Given a constraint matrix $A \in \mathbb{R}^{m \times n}$ and vectors $b \in \mathbb{R}^m, c \in \mathbb{R}^n$, we develop a space-efficient interior point method that optimizes solely on the dual program. To this end, we obtain efficient algorithms for various different problems:

- For general linear programs, we can solve them in $\widetilde{O}(\sqrt{n}\log(1/\epsilon))$ passes and $\widetilde{O}(n^2)$ space for an ϵ-approximate solution. To the best of our knowledge, this is the first LP solver in streaming that has no space and pass dependence on m.
- For bipartite graphs, we can solve the minimum vertex cover and maximum weight matching problem in $\widetilde{O}(\sqrt{m})$ passes and $\widetilde{O}(n)$ space.

In addition to our space-efficient IPM, we also give algorithms for solving SDD systems and isolation lemma in $\widetilde{O}(n)$ spaces, which are the cornerstones for our graph results.

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Session Classification: Track A-2