

**Abstract:** Recent advances in matrix approximation have seen an emphasis on randomization techniques in which the goal is to create a sketch of an input matrix. This sketch, a random submatrix of an input matrix, having much fewer rows and columns than the original matrix, still preserves its relevant features. In one of such techniques random projections approximate the range of an input matrix. Dimension reduction transforms are obtained by means of multiplication of an input matrix by one or more matrices which can be orthogonal, random, and allowing fast multiplication by a vector.

The Subsampled Randomized Hadamard Transform (SRHT) is the most popular among transforms. An  $m \times n$  matrix can be multiplied by an  $n \times l$  SRHT matrix in  $O(mn \log l)$  arithmetic operations where typically  $l \ll \min(m, n)$ . We introduce an alternative, which we call the Subsampled Randomized Approximate Hadamard Transform (SRAHT), and which reduces complexity of multiplication by an input matrix to  $O((2n + l \log n) m)$  operations.

We also prove that our sublinear cost variants of a popular subspace sampling algorithm output accurate low rank approximation (hereafter LRA) of a large class of input. Finally, we introduce new sublinear algorithms for the CUR LRA matrix factorization which consists of a column subset  $C$  and a row subset  $R$  of an input matrix and a connector matrix  $U$ . We prove that these CUR algorithms provide close LRA with high probability on a random input matrix admitting LRA.

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