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A LINEAR SYSTEM OUTPUT TRANSFORMATION FOR SPARSE APPROXIMATION¹

Abstract. We propose an approach that provides a stable transformation of the output of a linear system into the output of a system with a desired basis. The matrix of basis functions of a linear system has a large condition number, and the series of its singular numbers gradually decreases to zero. Two types of methods for stable output transformation are developed using approximation of matrices based on the truncated Singular Value Decomposition and on the Random Projection with different types of random matrices. It is shown that the use of the output transformation as a preprocessing makes it possible to increase the accuracy of solving sparse approximation problems. An example of using the method in the problem of determining the activity of weak radiation sources is considered.

Keywords: sparse approximation, discrete ill-posed problem, random projection, singular value decomposition.

INTRODUCTION

In practical applications related to the recovery of signals from the results of indirect measurements, the following problem is often encountered. The signal emitted by the object of measurement is fed to the input of a linear measuring system. The result of measurements is a measurement vector (output). The matrix of a linear input “/” output transformation (a set of basis functions, which are non-orthogonal in the general case) is known. It describes the interaction of the measured signal with the environment, as well as the properties of the measuring means. The problem is to obtain the input vector given the output vector.

Here we consider a downstream problem using the recovered input vector. In particular, the set of basic functions of some measuring system may not meet user requirements or may be incompatible with downstream processing methods. However, if one knows a set of basis functions which would give the output of a measuring system with the required properties (resolution, accuracy), there appears a problem of transforming the output of a real system into the output of a system with

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