Blind Inversion Needs Distribution (BIND): General Notion and Case Studies

Lei Li

Abstract

A class of scientific measurement problems share a common feature which we refer to as "blind inversion." That is, we can regard a module of measurement instruments as a system with quantities to be measured as input and observations as output. In a blind inversion problem, both the effective system and the input are unknown to us. Due to either experimental design or the nature of scientific problem in question, very often the distributional knowledge of the input can be obtained. Given this piece of information, we apply a two-step scheme – abbreviated by BIND – to solve the blind inversion problem. First, we make use of the distributions of the input and output to estimate the system. Second, we reconstruct the value of each individual input using the system obtained in the first step. From this perspective, we have another look at two measurement problems that are part of Professor Speed's recent research in molecular biology. We also connect the idea with the long-standing predictive deconvolution method used in seismology and discuss assessment issues of BIND.

Keywords: blind inversion; color-correction; DNA sequencing; electrophoresis; microarray; seismology

1 Introduction

Scientific discoveries are based on accurate measurements. The innovation of measurement instruments and invention of conceptual models cross each other's track and lead each other's way throughout the history of science. As instrumental techniques advance and the collected information expands, new tools of data analysis emerge along the way. One such famous historical example is Gauss's use of least squares in astronomy and geodesy. Not only have ingenious algorithms been applied to the practice of data analysis, but probabilistic models such as regression models have also been proposed and widely accepted for the purpose of designing and evaluating measurement processes. Nowadays, it has become common sense that uncertainty is the nature of any measurement processes.

In the area of biology, human beings' understanding of life has experienced great breakthroughs at the molecular level since the last century. Based on new understandings, scientists have developed *in vitro* bio-techniques such as cloning and polymerase