Our understanding of Cosmology, the theory of the Universe, has improved dramatically in the past two decades, thanks to the advances in Observational techniques. Modern galaxy surveys contain millions of galaxies, and the amount of data is going to continue increasing exponentially with next generations surveys. Traditional analysis methods reduce the data to its statistical properties, such as the two-point function, which is then used to constrain cosmological models and parameters. We propose a new method which aims at reconstructing the full initial density distribution of the Universe from the observational data. This is a computationally very difficult problem, since the dimensionality of the parameter space is very large (millions to billions of degrees of freedom). In addition, the problem is highly nonlinear, involving gravitational collapse to form the structure in the Universe (stars, galaxies, clusters of galaxies). We present a new efficient method for reconstructing the initial conditions of the Universe from the observations, which combines the L-BFGS optimization algorithm and our fast code for nonlinear structure formation. Our methodology also allows to estimate the full initial power spectrum and the Fisher matrix (which can be used to estimate error bars, for example).