1 Paper Details

Title Internet tomography

Venue IEEE Signal Processing Magazine

Year of Publication 2002

Paper Motivation The paper applies the great wealth of signal processing knowledge to a new field called Network Tomography following the principle of 'Tomography', i.e., reconstructing an object's internal structure from external measurements.

Problem Description Here, the external measurements correspond to the end-to-end nature of internet and the internal structure correspond to properties such as traffic flow, link-by-link loss, rates, connectivity, delay distributions and more.

These problem comes in two types both of which can be approximated by the equation $\boldsymbol{y} = \boldsymbol{A\theta} + \boldsymbol{\epsilon}$ where $\boldsymbol{A}$ is generally not full-rank

Link-Level Network Inference Estimation of link-level network parameters from path-level measurements.

Here $\boldsymbol{A}$ is the routing matrix (typically binary), $\boldsymbol{\theta}$ is a vector of packet parameters such as mean delays, logarithms of packet transmission probabilities over a link, $\boldsymbol{y}$ is a vector of measurements which can be end-to-end delays or packet counts for difference measurements and $\boldsymbol{\epsilon}$ is a noise term

Origin-Destination Tomography Estimation of path-level network parameters from measurements made on individual links.

Here $\boldsymbol{A}$ is the routing matrix (typically binary), $\boldsymbol{\theta}$ is a vector corresponding to the number of bytes originating from a specified origin node to a specified destination node, $\boldsymbol{y}$ corresponds to bytes sent from the origin node regardless of their destination $\boldsymbol{\epsilon}$ is a noise term generally taken as zero

Optimization Method If the noise $\boldsymbol{\epsilon}$ satisfies some conditions (Gaussian distributed with covariance independent of $\boldsymbol{A\theta}$) then a recursive linear least squares solution implemented using conjugate gradient or Gauss-Seidel iteration is used.

If the noise $\boldsymbol{\epsilon}$ is poisson, binomial, or multinomial distributed then reweighted nonlinear least squares, maximum likelihood via expectation-maximization (EM), and maximum a posteriori (MAP) via Monte Carlo Markov chain(MCMC) algorithms are used.