Richardson–Lucy deconvolution

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The **Richardson–Lucy algorithm**, also known as **Richardson–Lucy deconvolution**, is an iterative procedure for recovering a latent image that has been blurred by a known point spread function.[1][2]

Pixels in the observed image can be represented in terms of the point spread function and the latent image as

$$c_i = \sum_j p_{ij} u_j$$

where p_{ij} is the point spread function (the fraction of light coming from true location j that is observed at position i), u_j is the pixel value at location j in the latent image, and c_i is the observed value at pixel location i. The statistics are performed under the assumption that u_j are Poisson distributed, which is appropriate for photon noise in the data.

The basic idea is to calculate the most likely u_j given the observed c_i and known p_{ij}. This leads to an equation for u_j which can be solved iteratively according to

$$\mathbf{u}_j^{(t+1)} = \mathbf{u}_j^{(t)} \sum_i \frac{c_i}{\mathbf{c}_i} p_{ij}$$

where

$$\mathbf{c}_i = \sum_j \mathbf{u}_j^{(t)} p_{ij}.$$

It has been shown empirically that if this iteration converges, it converges to the maximum likelihood solution for u_j.[3]

In problems where the point spread function p_{ij} is dependent on one or more unknown parameters, the Richardson–Lucy algorithm can not be used. A later and more general class of algorithms, the expectation-maximization algorithms,[4] have been applied to this type of problem with great success.[5]

References

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