Multilabel Random Walker Image Segmentation Using Prior Models

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Problem
An image with many objects requires seeding in each object

Main idea
Build intensity model, formulate as quadratic energy term:

\[ \lambda_i^s \]

\( x_i^s \) probability that node \( v_i \) belongs to label \( s \) (of \( k \) total labels/objects)
\( \lambda_i^s \) prior probability that the intensity at node \( v_i \) belongs to label \( s \)

In vector notation:

\[ \left( \sum_{q=1}^{k} \lambda_i^q \right) x_i = \lambda_i^s \]

Joint energy minimization with original random walker:

\[ E_{prior}^s(x^s) = \sum_{q=1, q \neq s}^{k} x^q \Lambda_c x^q + (x^s - 1)^T \Lambda_c (x^s - 1) \]

\[ E_{Total}^s = E_{random \ walker}^s + \gamma E_{prior}^s \]

Minimum achieved by solving a SPD system of linear equations

Graph interpretation
Equivalent to graph modification

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Equivalent to graph modification

Properties
Finds weak (missing) boundaries
For uniform or pure noise, finds central partition

Examples
Provides confidence of segmented pixel/voxel

Results
Finds weak (missing) boundaries
Provably robust to noise
Provides confidence of segmented pixel/voxel

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