Long range interactions in Image segmentation

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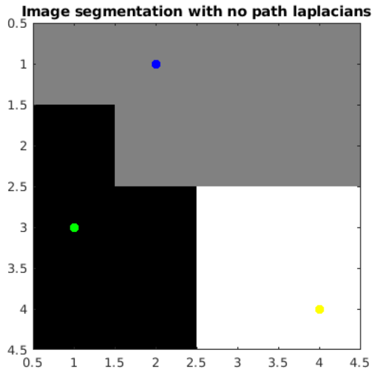
Here we compare image segmentation on a toy example of a lattice using various transforms of k-path Laplacian.

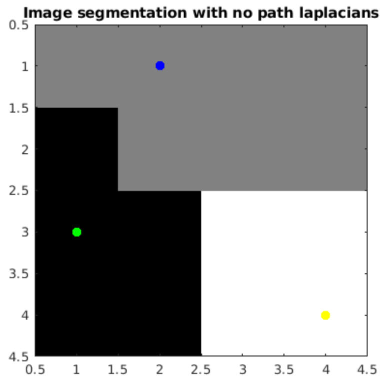
1 Mellin transform of k-path Laplacian

First we consider Mellin transform given by

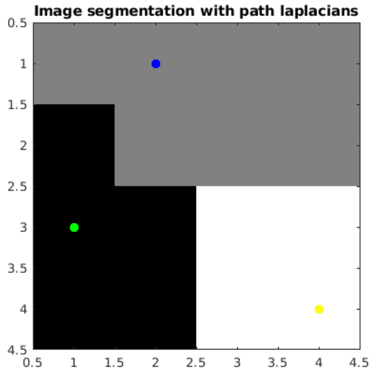
$$\mathcal{L}_{M,s} = \sum_{k=1}^{\infty} \frac{1}{k^s} L_k$$



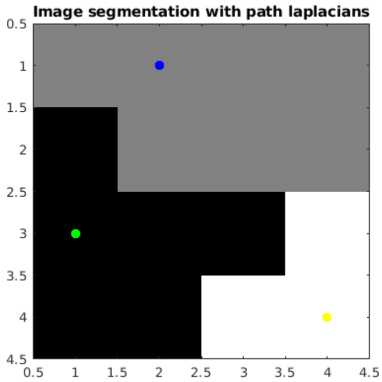
(a) k=1



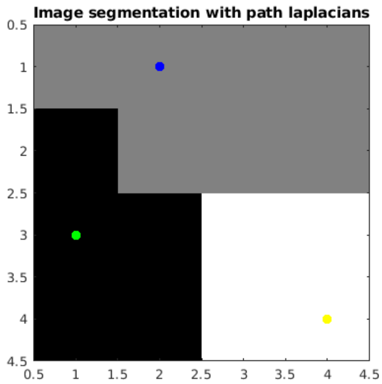
(b) k up to 2



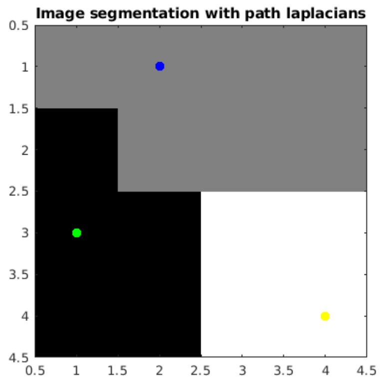
(c) k up to 3



(d) k up to 6(diameter)



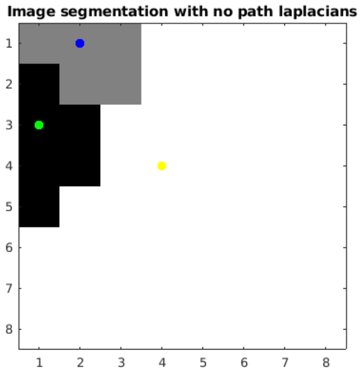
(e) k up to 3



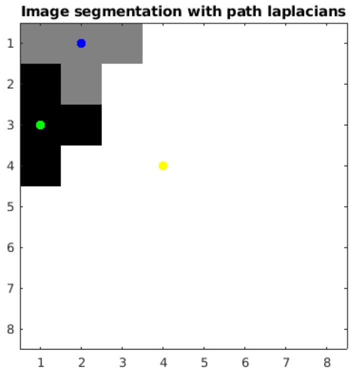
(f) k up to 6(diameter)

Figure 1: A 4×4 lattice representing pixels of an image each of intensity 1. We carry out image segmentation by assigning each pixels to the label(either blue, yellow or green) for which the probability of a random walker starting at any pixel p first reaches the label is highest.We use Mellin transforms with $s = 2$, for the first and second law. The third row corresponds to $s = 4$

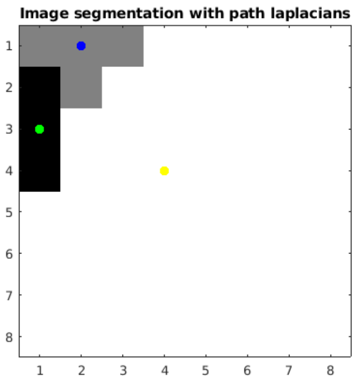
Here we investigate how the segmentation happens on an 8×8 lattice.



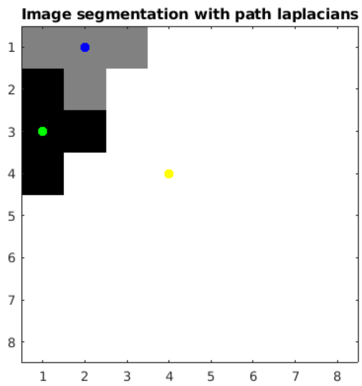
(a) k=1



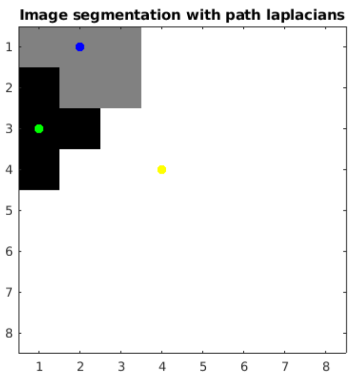
(b) k up to 3



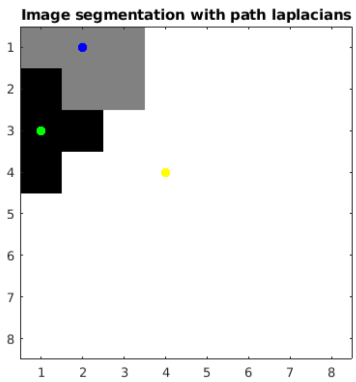
(c) k up to 6



(d) k up to 14



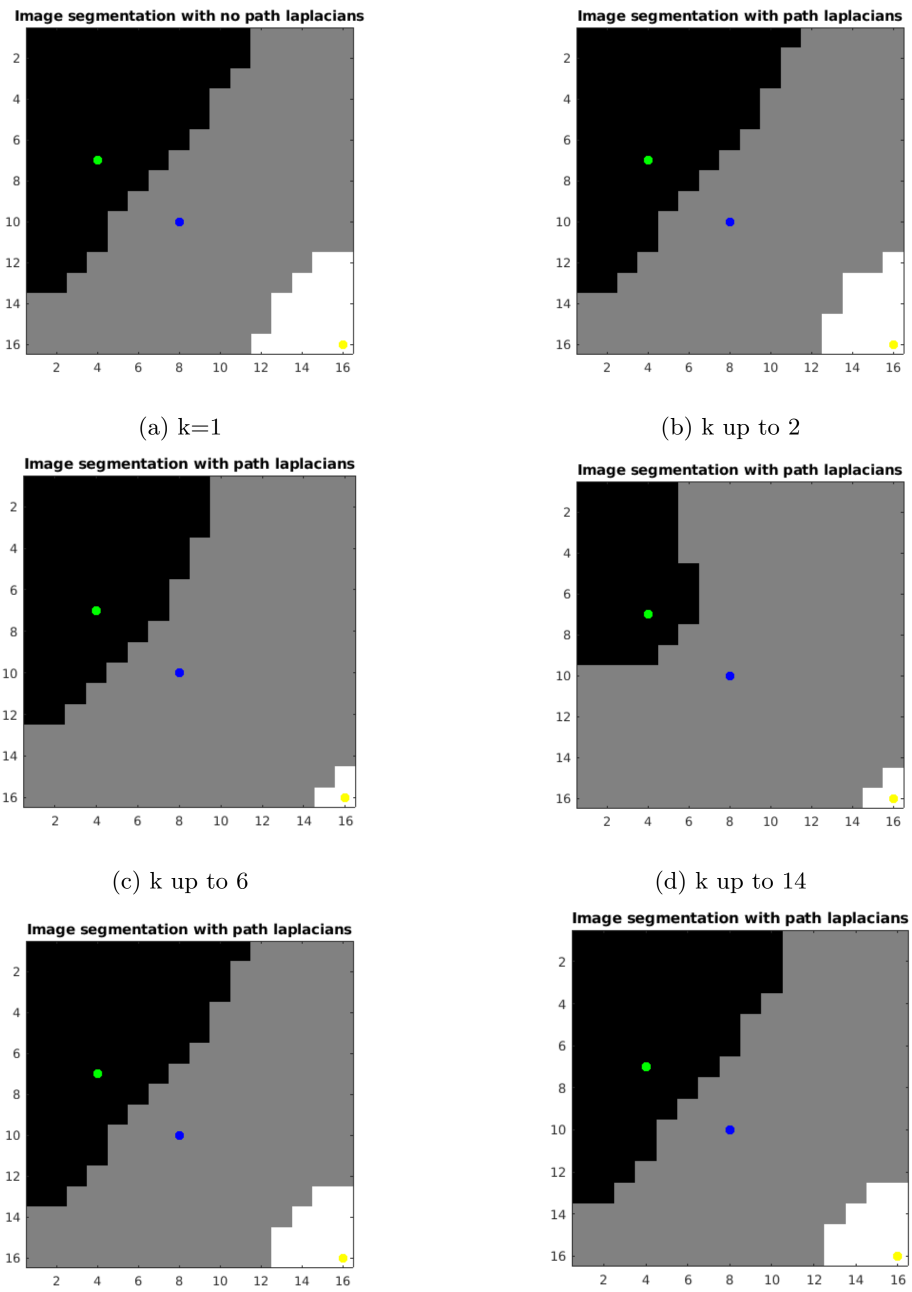
(e) k up to 6



(f) k up to 14 (diameter)

Figure 2: Illustration of segmentation, figure (a) corresponds to results by the Laplacian matrix,L while figures(b),(c), and (d) follows from k-path Laplacians of the Mellin transform with $s = 2$. On the otherhand, figures(b),(c), and (d) follows from k-path Laplacians of the Mellin transform with $s = 4$

For a 16×16 matrix, we have the following illustrations.



(a) k=1

(b) k up to 2

(c) k up to 6

(d) k up to 14

(e) k up to 6

(f) k up to 14

Figure 3: A 16×16 lattice representing pixels of an image each of intensity 1. We carry out image segmentation by assigning each pixels to the label(either blue, yellow or green) for which the probability of a random walker starting at any pixel p first reaches the label is highest.We use Mellin transforms with $s = 2$, for the first and second law. The third row corresponds to $s = 4$

2 Laplace transform of k-path Laplacian

When we consider Laplace transformed k-path Laplacian given by

$$\mathcal{L}_{L,\lambda} = \sum_{k=1}^{\infty} e^{-\lambda k} L_k$$