Superpixels and Polygons using Simple Non-Iterative Clustering

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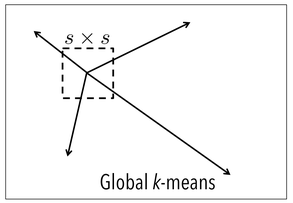
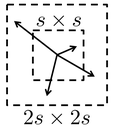
Simple Non-Iterative Clustering (SNIC) is an improved version of the Simple Linear Iterative Clustering* (SLIC) algorithm. SNIC is non-iterative, enforces connectivity from the start, requires less memory, is faster, and yet is a simpler algorithm. On segmentation benchmarks SNIC performs better than the state-of-the-art, including SLIC.

SLIC review

SLIC performs *k*-means clustering on the image plane with **centroids** chosen on a square grid in the image plane and **distance** *D* to be a weighted sum of the normalized spatial and color distances.



Global *k*-means



Local *k*-means (SLIC)

$$D = \frac{\|\mathbf{x}_j - \mathbf{x}_j\|_2^2}{s} + \frac{\|\mathbf{c}_j - \mathbf{c}_k\|_2^2}{m}$$

$$\mathbf{x} = [x, y]^T \qquad \mathbf{c} = [l, a, b]^T \qquad s = \sqrt{\frac{N}{K}} \qquad m = 10$$

Shortcomings of SLIC:

1. Several iterations
2. Repeat computations in overlapping local regions
3. Pixel connectivity enforced as a post-processing step

* SLIC Superpixels Compared to the State-of-the-art Superpixel Methods.
R. Achanta, S. Shaji, K. Smith, A. Lucchi, P. Fua. S. Süsstrunk (TPAMI 2012).

Simple Non-Iterative Clustering (SNIC)

SNIC makes two important modifications to SLIC :

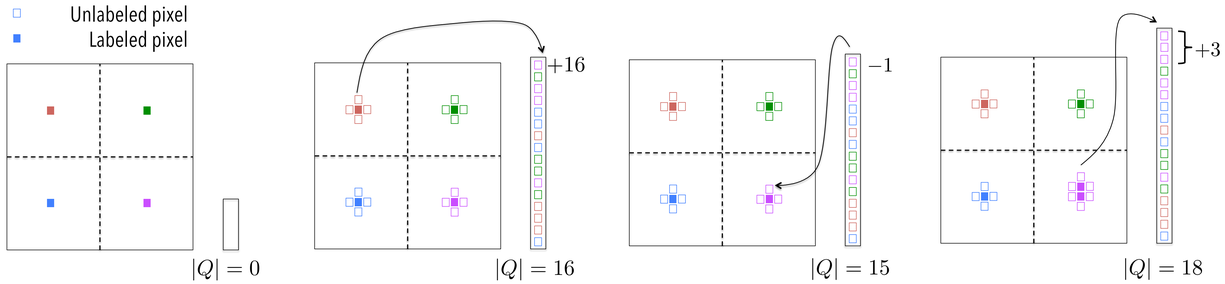
1. Centroids are evolved using **online averaging.**
2. Label assignment is achieved using a **priority queue**, which returns the element with the shortest distance D to a centroid.

Algorithm

1. Pick seeds on a regular square grid.
2. Initialize priority queue Q with immediate neighbors of seeds.

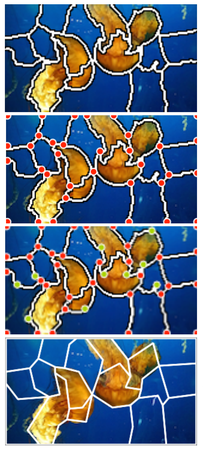
While Q is not empty:

3. Pop Q, and label the pixel P.
4. Update corresponding centroid.
5. For all unlabeled neighbors of P, compute D and push on Q.



1. Initial seeds with a unique label. Q is empty at this time.
2. For each seed compute distance D to unlabeled neighbors and push on Q.
3. Pop the top-most element on the queue and label the corresponding pixel.
4. Compute distance D to the nearest neighbors of this newly labeled pixel and push on Q. Continue until Q is empty.

Polygon Partitioning Algorithm



1. Segment image. Trace superpixel boundaries using a standard algorithm.
2. Assign initial vertices to be pixels that touch at least three different segments, at least two segments and the image borders, or are image corners.
3. New vertices are added using the Douglas-Peucker curve simplification algorithm.
4. Merge vertices that are too close and join remaining vertices to obtain polygons.

SNIC superpixels

SNIC polygons