Layered Analysis of Irregular Facades via Symmetry Maximization

Submission ID: 0084

Supplemental Material

Details on the Normalized Global Symmetry (NGS) and the Graph-Cut Segmentation (GCS) on box patterns

Outline

- Part I: Normalized Global Symmetry (NGS)

- Part II: Graph-Cut Segmentation (GCS)

Part I: Normalized Global Symmetry (NGS)

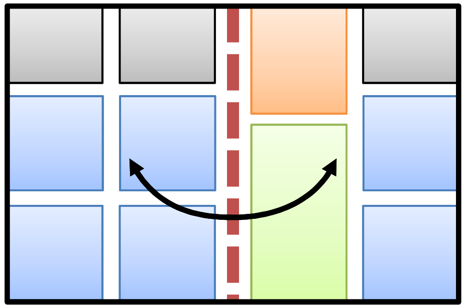
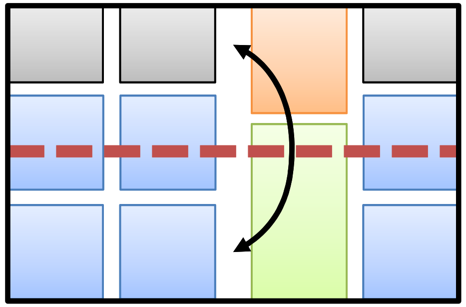
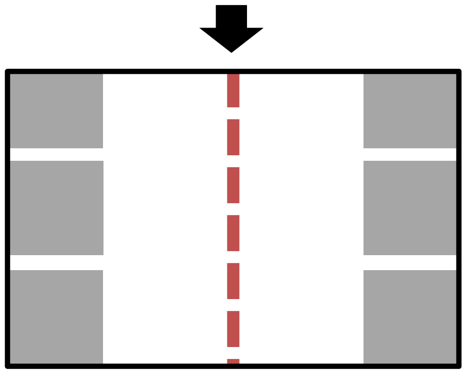
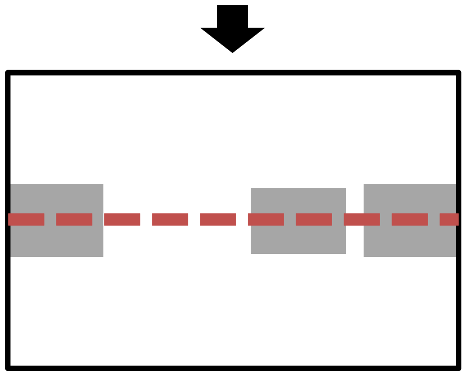
- Definition of global symmetry (GS) measure for a box pattern

- Definition of normalized global symmetry (NGS) for a split of a box pattern

Global (reflectional) symmetry (GS)

- Definition:
  - Given a box pattern S, the global reflectional symmetry (GS) of S is measured as the area overlap between S and its reflection about the center line, horizontal or vertical.

GS example

Direction	Horizontal	Vertical
Input		
Overlap regions		

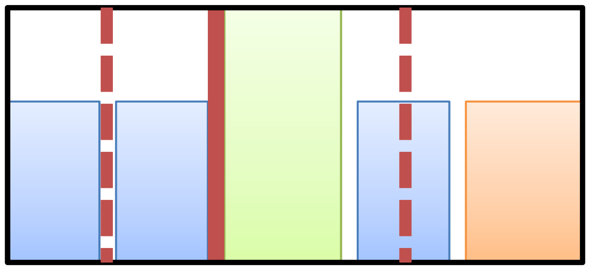
* GS (along each direction) is the sum of the area of the grey regions.
* The final GS takes the maximum of the two directions.
* NOTE: Only the overlap between repeated boxes (same color) is considered.

Normalized Global Symmetry (NGS)

- For a given split, the NGS is defined similar to NIS for split (see Eq. 3 in paper), only substituting the IS by GS:

$$N_G(S_1, S_2) = \frac{1}{2}\left(\frac{G(S_1)}{G(\beta(S_1))} + \frac{G(S_2)}{G(\beta(S_2))}\right)$$

where $G(S_1)$ and $G(S_2)$ are GS of the two substructures obtained by the split. $\beta(S)$ is the tight bounding box of S.



$G(S_1)$ $G(S_2)$

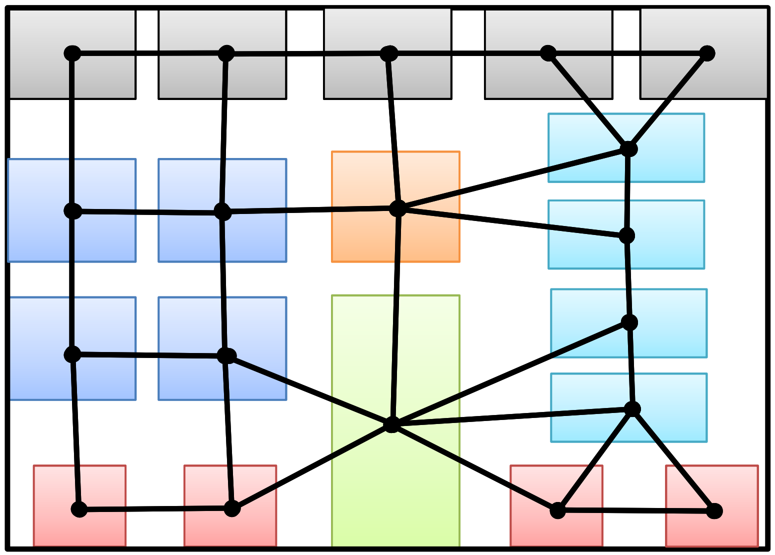
* NOTE: When computing NGS, we only consider GS along the split direction.

Part II: Graph-Cut Segmentation (GCS)

- Formulation of graph-cut segmentation (GCS) for box patterns
- Definition of box element adjacency

Formulation of GCS

- Given a box pattern, we first construct a graph where the nodes are the boxes and the edges are induced by box adjacency (defined later).



Formulation of GCS

- The problem of GCS for box pattern is formulated as finding a split or layering decomposition D which minimizes the cut cost:

$$C_g(D) = \sum_{e \in C_D} \delta_C(e) + \sum_{e \in I_D} \delta_I(e)$$

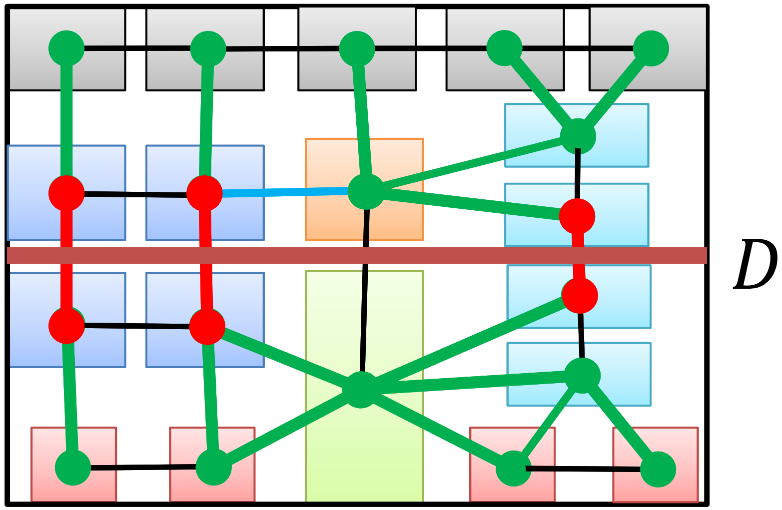
where C_D is the set of edges cut by D, I_D is the set of internal edges within each substructures, and

$$\delta_C(e) = \begin{cases} 1, & \text{if } e \text{ connects two } \textbf{same} \text{ color boxes} \\ 0, & \text{otherwise} \end{cases}$$

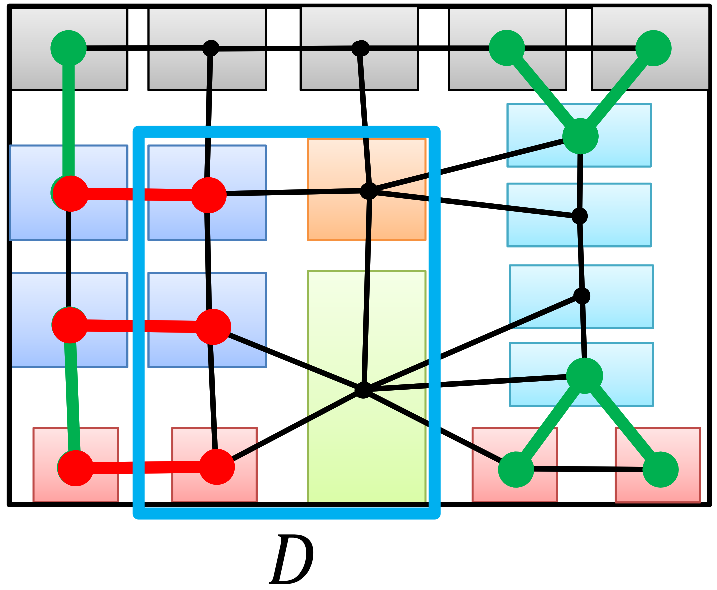
$$\delta_I(e) = \begin{cases} 1, & \text{if } e \text{ connects two } \textbf{different} \text{ color boxes} \\ 0, & \text{otherwise} \end{cases}$$

Formulation of GCS

GCS of a split



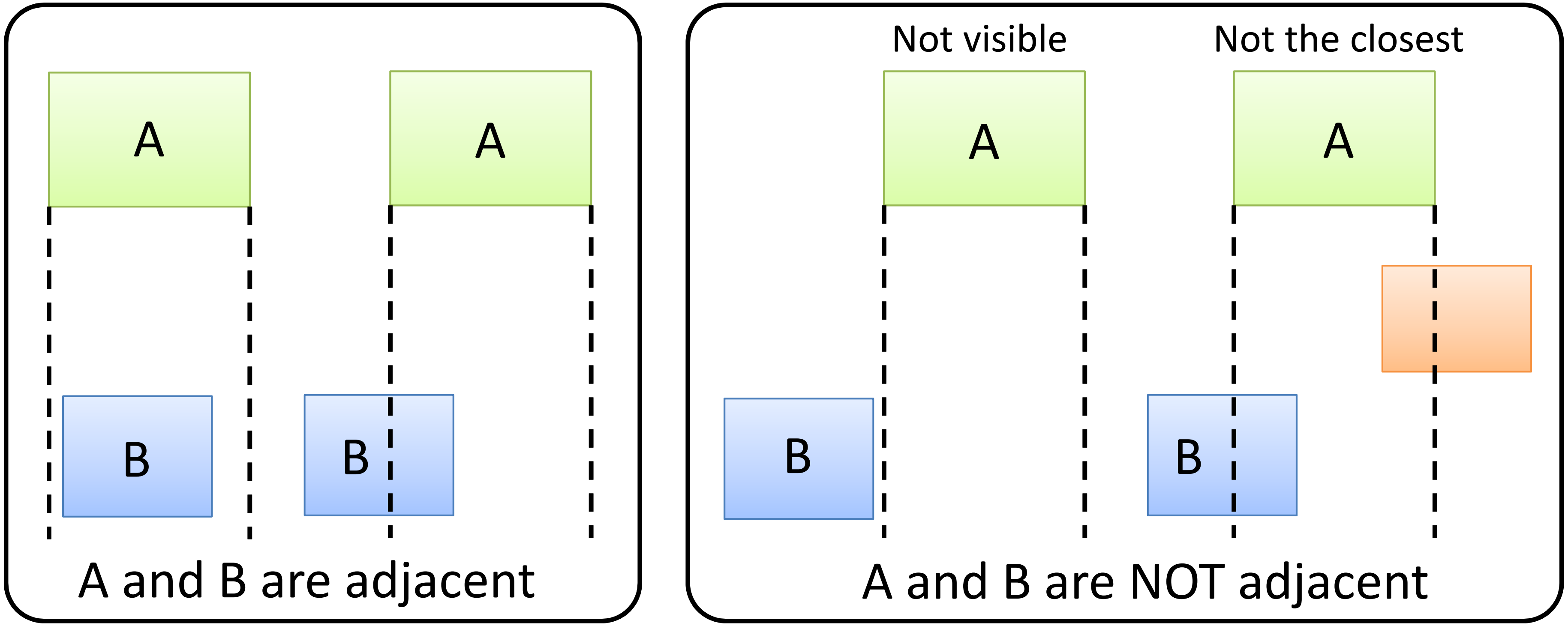
GCS of a layering



$$C_g(D) = \sum(\text{red edges}) + \sum(\text{green edges})$$

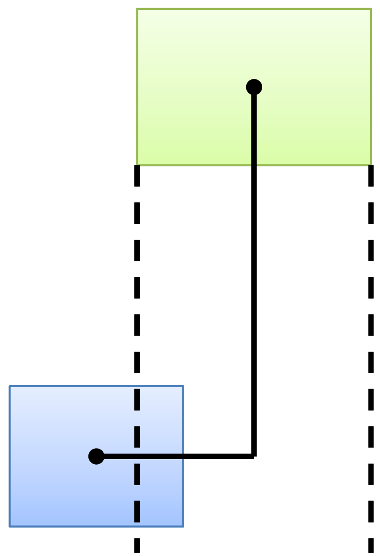
Box adjacency

- The adjacency between two boxes is defined based on axis-aligned visibility between two boxes.
- Given a box A, if B is the closest visible box to A, along one of the four directions (X, -X, Y, and -Y), they are adjacent.



Method of ox adjacency

- With the adjacency, we can define the distance between two adjacent boxes, i.e., the Manhattan distance between their centers of mass.



Smoothed graph-cut cost

- We develop a smoothed graph cut cost by performing Gaussian filtering over the distance between two adjacent boxes:

$$C_g(D) = \sum_{e \in C_D} \delta_C(e) e^{-(d_e/\sigma d_{\max})^2} + \sum_{e \in I_D} \delta_I(e) e^{-(d_e/\sigma d_{\max})^2}$$

where d_e is the distance between the two boxes connected by e, $d_{\max} = h_B + w_B$ (h_B and w_B are the height and width of the tight bounding box of the entire box pattern), and $\sigma = 0.2$.