Spatial Range Operation Example: Sum a Window

$$f \doteq \mathrm{sum}(I, W) = \sum_{(s,t) \in W} I(s,t)$$

5	8	10	10	12
4	6	8	10	20
4	4	5	5	7
7	8	10	11	11
10	10	8	8	7

Spatial Range Operation Example: Sum a Window

5	8	10	10	12
4	6	8	10	20
4	4	5	5	7
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Spatial Range Operation Example: Sum a Window

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7	8	10	11	11
10	10	8	8	7

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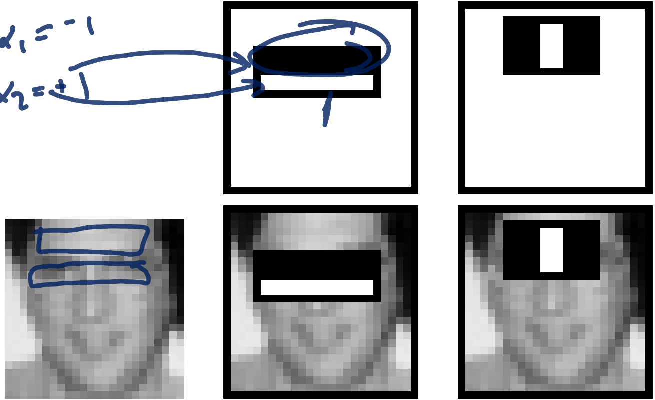
Haar Operator-based Features for Face Detection

$W_1, \alpha_1 = -1$
$W_2, \alpha_2 = +1$

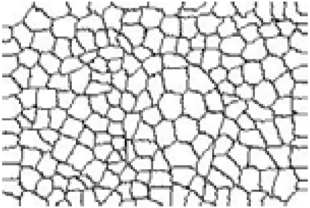


Proposed by Viola and Jones CVPR 2001.

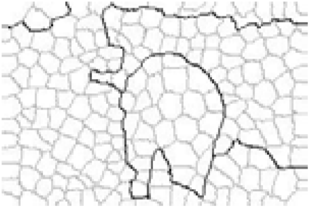
Superpixel Example – Arbitrarily-shaped Windows

The Image

A Human Segmentation



Superpixel Map

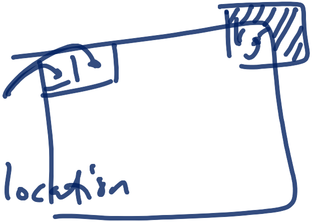


Reconstruction of Human Segmentation with Superpixels

Oversegmentation as a preprocessing step was codified by X. Ren and J. Malik. *Learning a classification model for segmentation.* ICCV 2003.

Generic Range Map Operator Pseudo-Code

procedure GENERIC RANGE MAP OPERATOR
  for each pixel $\mathbf{s} \in \Lambda_{\mathbf{J}}$ **do**
    let $W_{\mathbf{s}}$ be the window into Λ at centered at $\mathbf{s}$
    $\mathbf{J}(\mathbf{s}) = f(\mathbf{I}, W_{\mathbf{s}}))$
  end for
end procedure

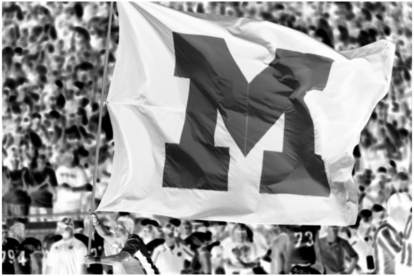


Worry about valid windows for each location

Single Pixel Range Map: Negative Image

Intensity Transformations operate on single pixels

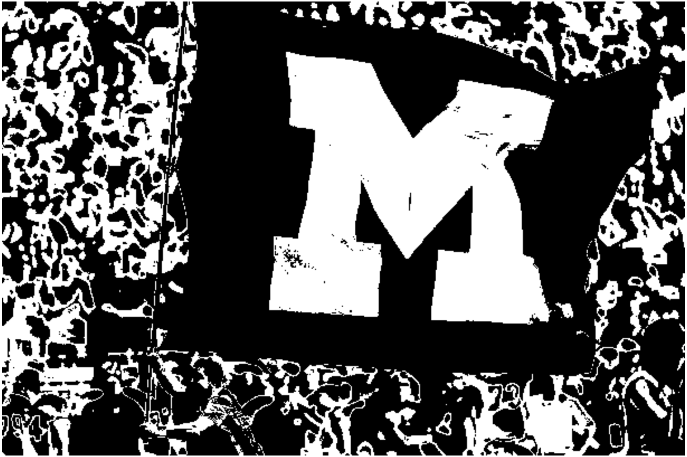
Input Image



Negative Image

$$J(s) = -I(s) \quad \forall s \in \Omega$$

Range Map of Binary Functions: Thresholding Example



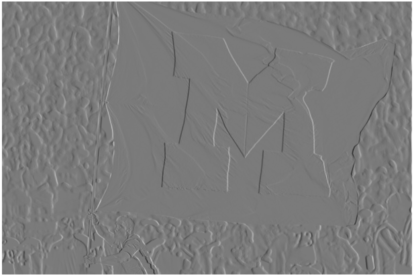
$$f_b(\mathbf{I}[W]; 128, 230) = \begin{cases} 1 & 128 \leq \mathbf{I}[W] \leq 230 \\ 0 & \text{otherwise} \end{cases}$$

Windowed Spatial Range Map: Smoothing an Image

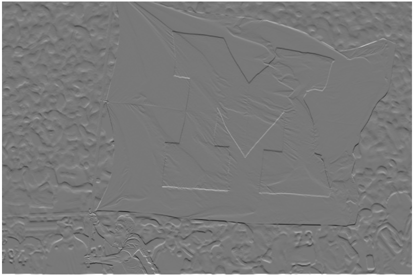
Input Image

Smoothed Image 15×15

Discrete Image Derivative Example



$\nabla_x \mathbf{I}$



$\nabla_y \mathbf{I}$

Approximating an Image Laplacian

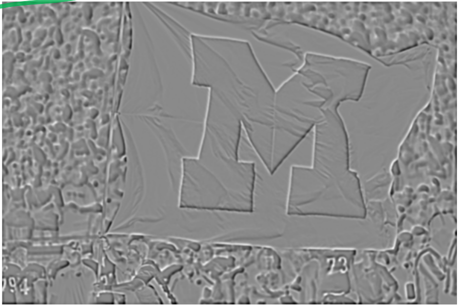
Gaussian ($\sigma = 2$)

minus

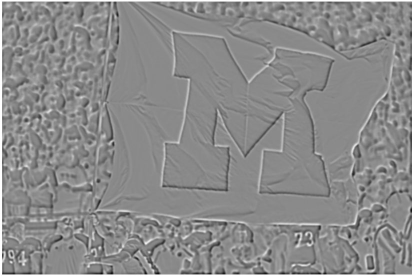
Gaussian ($\sigma = 1$)

$=$

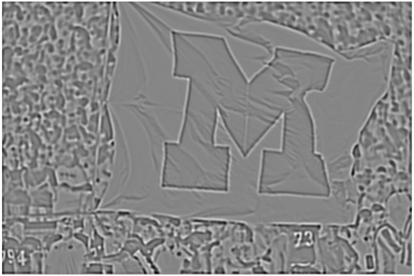
equals



Approximating an Image Laplacian



$\mathbf{G}_2 - \mathbf{G}_1$



$\nabla^2 \mathbf{I}$

Not exactly: $\nabla^2 \boldsymbol{\kappa}_1 \mathbf{I}$