Multiple-Kernel Local-Patch Descriptor

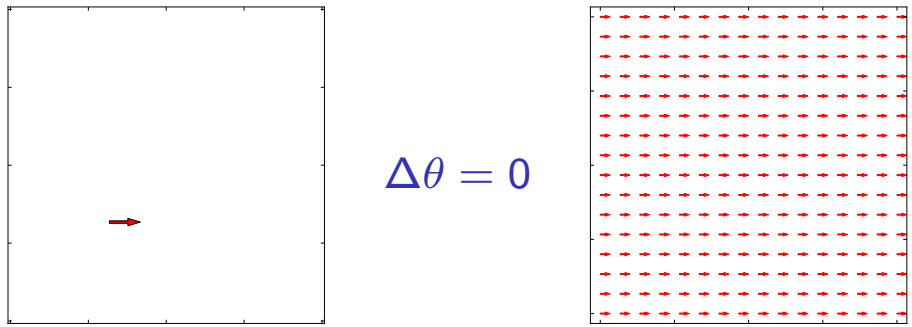
Supplementary material

May 13, 2017

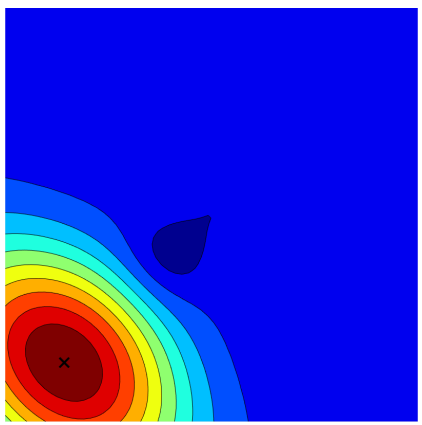
Patch maps

Compute the similarity of a single pixel $p \in \mathcal{P}$ with all pixels $q \in \mathcal{Q}$
$\rightarrow$ construct a *patch map* as a 2D similarity map on $\mathcal{Q}$.

$p_\theta = 0,\ p \in \mathcal{P}$ $\qquad$ $q_\theta = 0\ \forall q \in \mathcal{Q}$



Gradient angle is depicted with arrows



Patch map

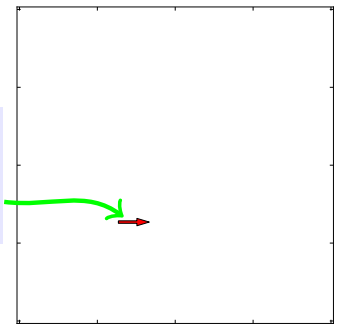
Red (blue) color is maximum (minimum) similarity. We show 10 isocontours in a uniform way. The absolute similarity value is not shown, it is the shape of the isocontours that matters.

Patch maps

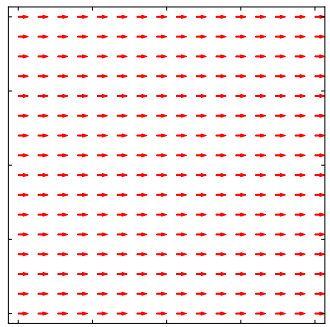
Compute the similarity of a single pixel $p \in \mathcal{P}$ with all pixels $q \in \mathcal{Q}$
$\rightarrow$ construct a *patch map* as a 2D similarity map on $\mathcal{Q}$.

$p_\theta = 0,\ p \in \mathcal{P}$ $\qquad$ $q_\theta = 0\ \forall q \in \mathcal{Q}$

Position and gradient orientation of pixel p

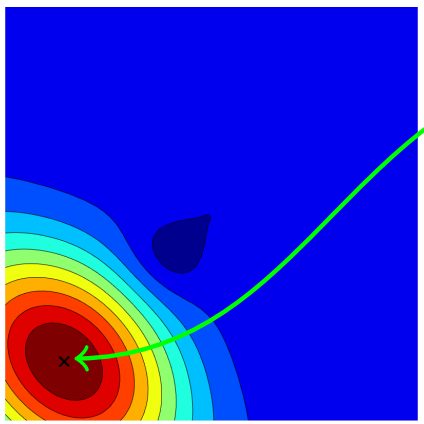


$\Delta\theta = 0$



Fixed gradient orientation for all pixels of $\mathcal{Q}$

Gradient angle is depicted with arrows



Position of pixel p

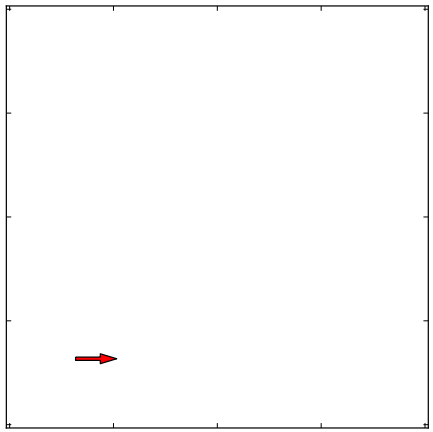
Red (blue) color is maximum (minimum) similarity. We show 10 isocontours in a uniform way. The absolute similarity value is not shown, it is the shape of the isocontours that matters.

Patch map

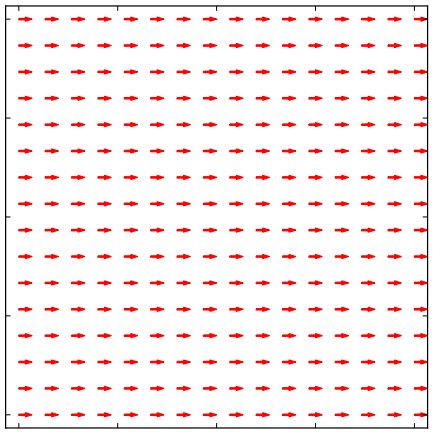
Patch maps for different parametrizations

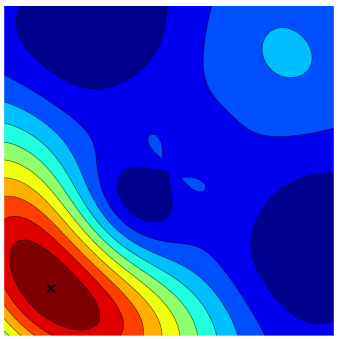
$p_\theta = 0,\ p \in \mathcal{P}$

$q_\theta = 0\ \forall q \in \mathcal{Q}$

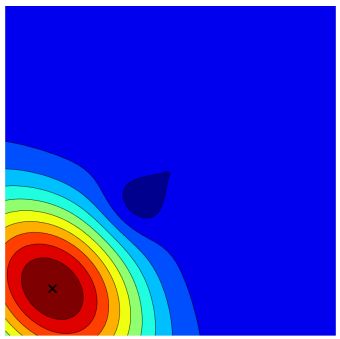


$\Delta\theta = 0$

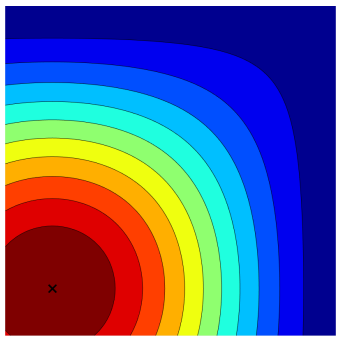




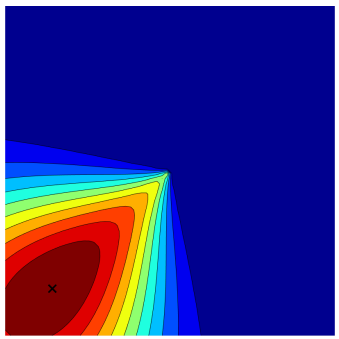
$k_\phi k_\rho k_\theta$



$k_\phi k_\rho k_{\tilde{\theta}}$



$k_x k_y k_\theta$



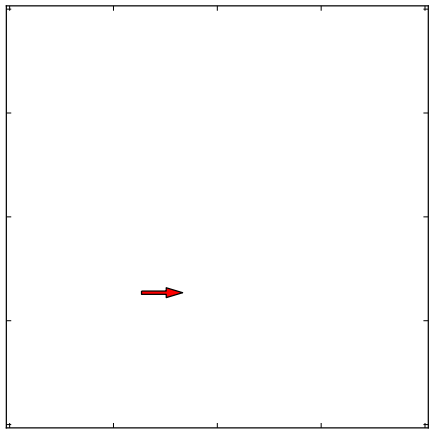
$k_x k_y k_{\tilde{\theta}}$

Different parametrization results in different similarity
Observe the effect of the relative angle $\tilde{\theta}$

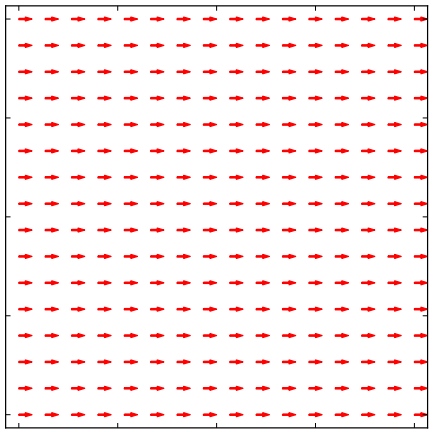
Patch maps for different parametrizations

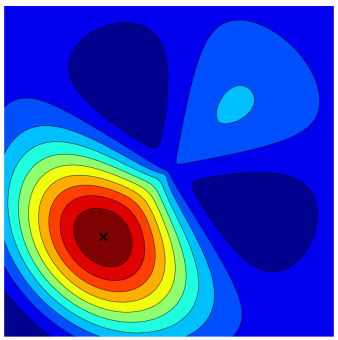
$p_\theta = 0,\ p \in \mathcal{P}$

$q_\theta = 0\ \forall q \in \mathcal{Q}$

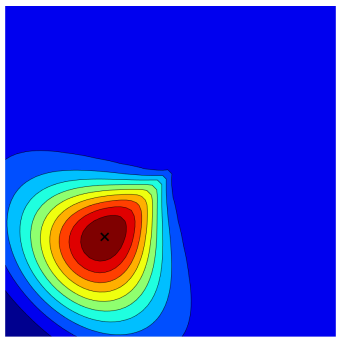


$\Delta\theta = 0$

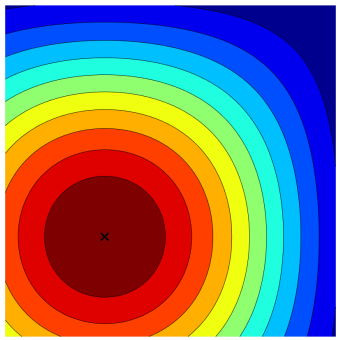




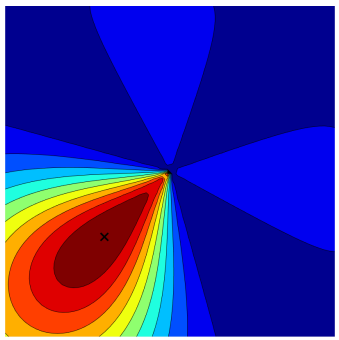
$k_\phi k_\rho k_\theta$



$k_\phi k_\rho k_{\tilde{\theta}}$



$k_x k_y k_\theta$

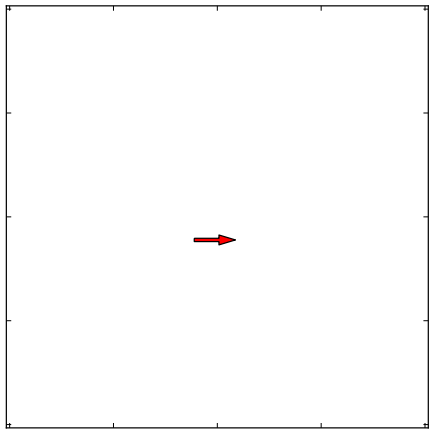


$k_x k_y k_{\tilde{\theta}}$

Different parametrization results in different similarity
Observe the effect of the relative angle $\tilde{\theta}$

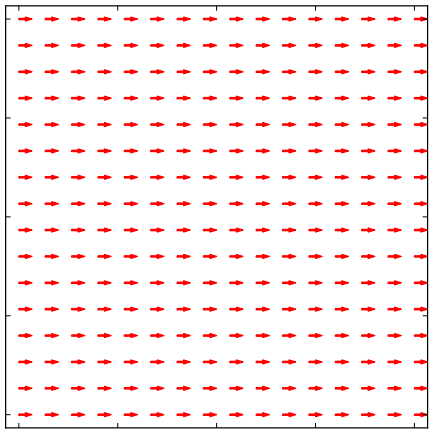
Patch maps for different parametrizations

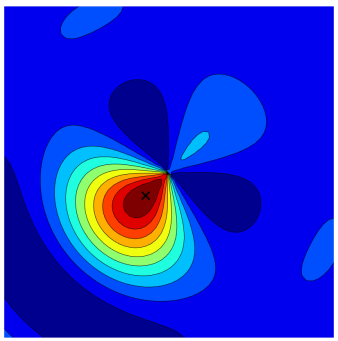
$p_\theta = 0,\ p \in \mathcal{P}$



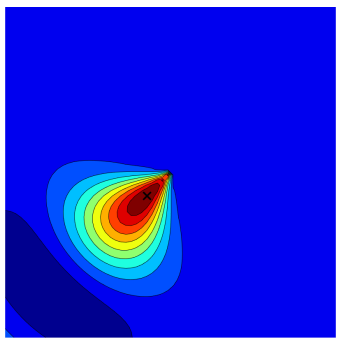
$\Delta\theta = 0$

$q_\theta = 0\ \forall q \in \mathcal{Q}$

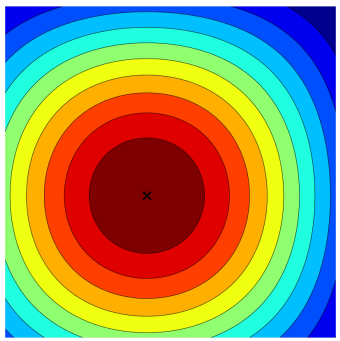




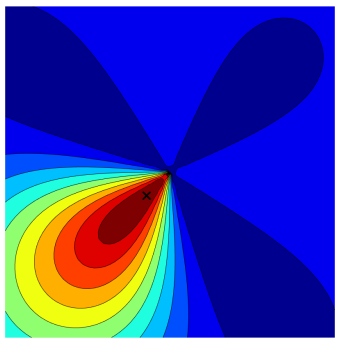
$k_\phi k_\rho k_\theta$



$k_\phi k_\rho k_{\tilde{\theta}}$



$k_x k_y k_\theta$

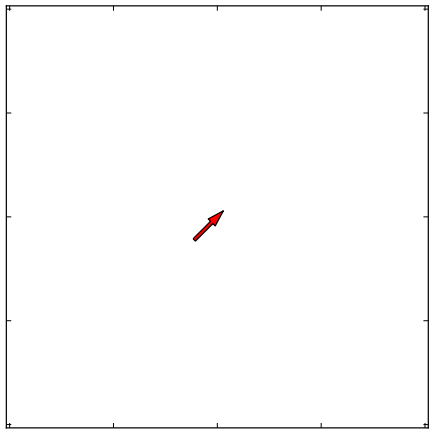


$k_x k_y k_{\tilde{\theta}}$

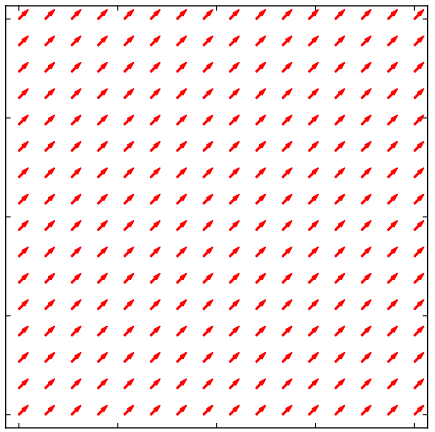
Different parametrization results in different similarity
Observe the effect of the relative angle $\tilde{\theta}$

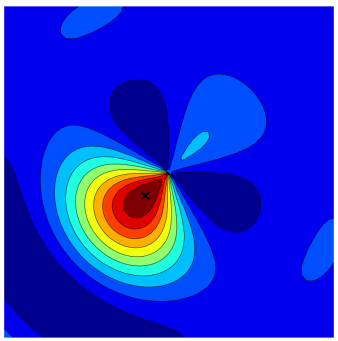
Shift invariant kernels

$p_\theta = \pi/4,\ p \in \mathcal{P}$ $\quad$ $q_\theta = \pi/4\ \forall q \in \mathcal{Q}$

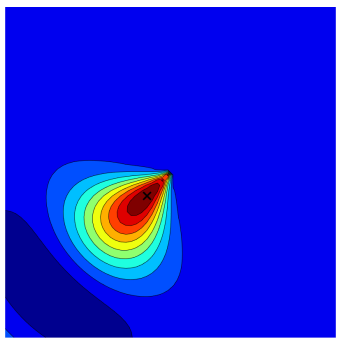


$\Delta\theta = 0$

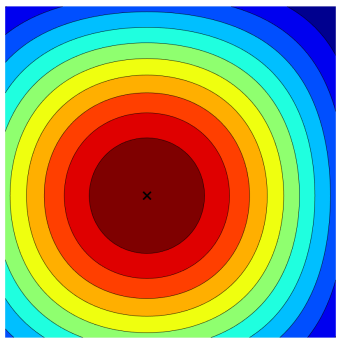




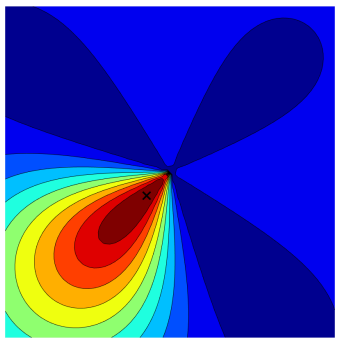
$k_\phi k_\rho k_\theta$



$k_\phi k_\rho k_{\tilde{\theta}}$



$k_x k_y k_\theta$



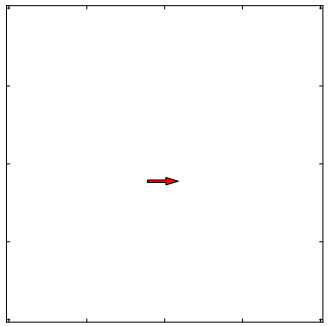
$k_x k_y k_{\tilde{\theta}}$

Shift invariant kernels $\Rightarrow$ Only the difference matters

Compare with previous slide: same $\Delta\theta$ but different p_θ and q_θ

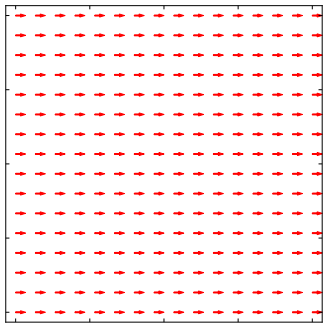
Combining kernels

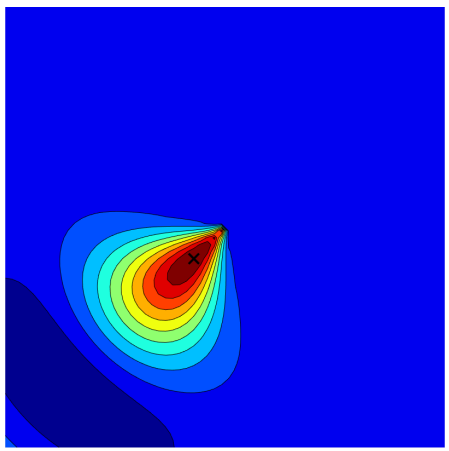
$p_\theta = 0,\ p \in \mathcal{P}$



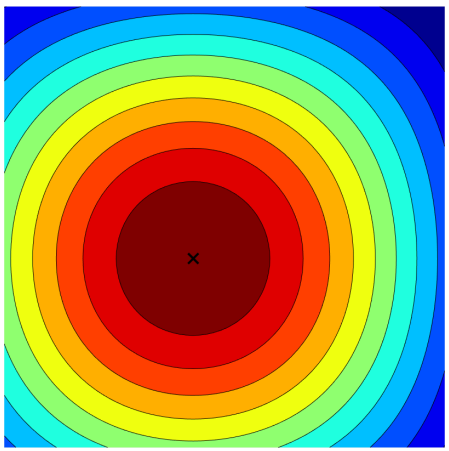
$\Delta\theta = 0$

$q_\theta = 0\ \forall q \in \mathcal{Q}$

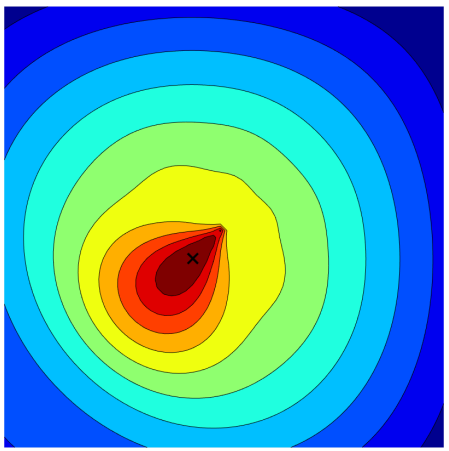




$k_\phi k_\rho k_{\tilde{\theta}}$



$k_x k_y k_\theta$

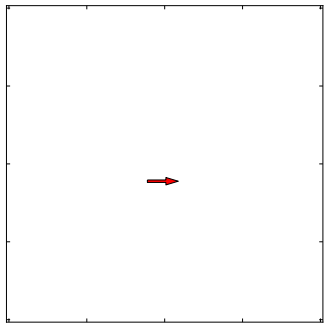


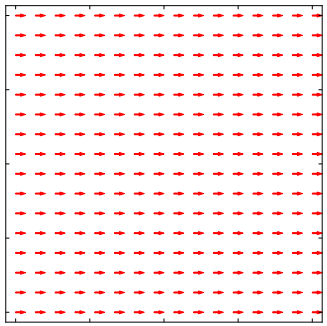
$k_\phi k_\rho k_{\tilde{\theta}} + k_x k_y k_\theta$

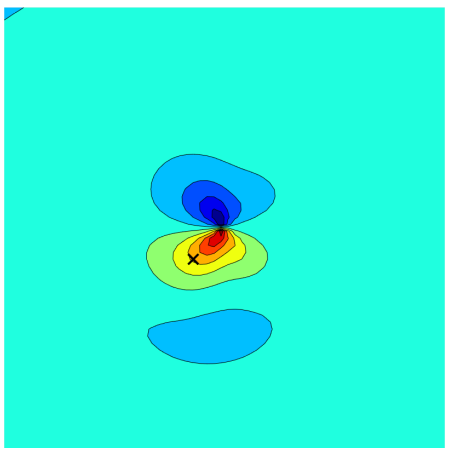
Combined parametrization: The discontinuity of the polar (left) is improved.

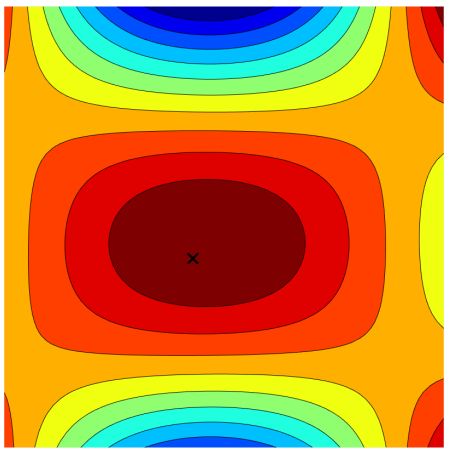
Combining kernels - effect of whitening

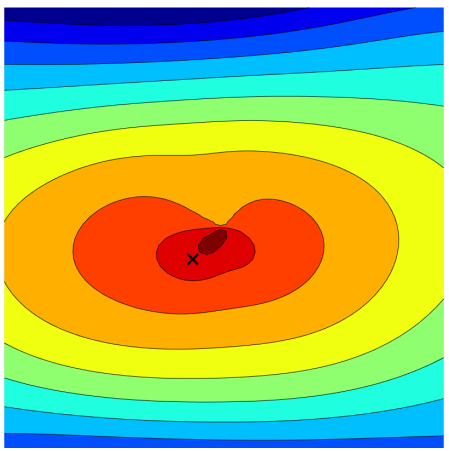
$p_\theta = 0,\ p \in \mathcal{P}$ $\qquad$ $\Delta\theta = 0$ $\qquad$ $q_\theta = 0\ \forall q \in \mathcal{Q}$









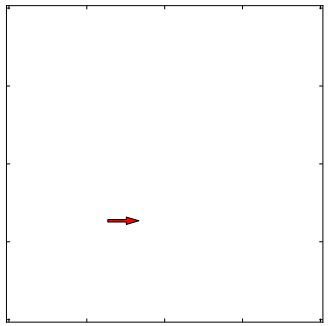


$k_\phi k_\rho k_{\tilde{\theta}}$ (LW) $\qquad$ $k_x k_y k_\theta$ (LW) $\qquad$ $k_\phi k_\rho k_{\tilde{\theta}} + k_x k_y k_\theta$ (LW)

Patch map showing the effect of whitening (compare with previous slide)

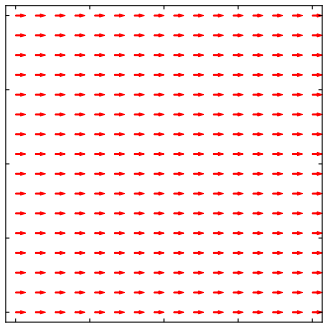
Combining kernels (another pixel)

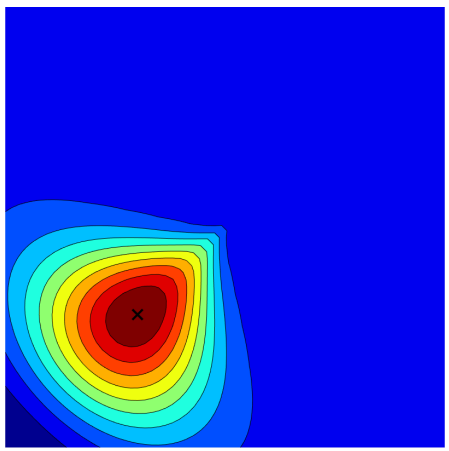
$p_\theta = 0,\ p \in \mathcal{P}$



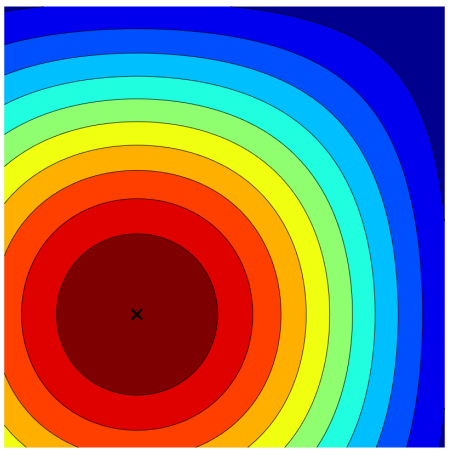
$\Delta\theta = 0$

$q_\theta = 0\ \forall q \in \mathcal{Q}$

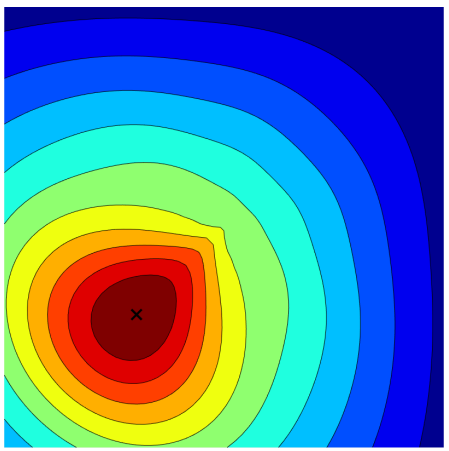




$k_\phi k_\rho k_{\tilde{\theta}}$



$k_x k_y k_\theta$

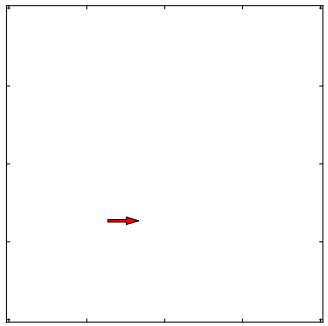


$k_\phi k_\rho k_{\tilde{\theta}} + k_x k_y k_\theta$

Combined parametrization: Patch map for different pixel p (different position)

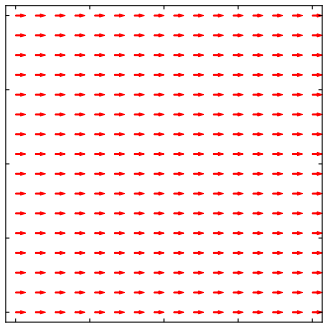
Combining kernels (another pixel) - effect of whitening

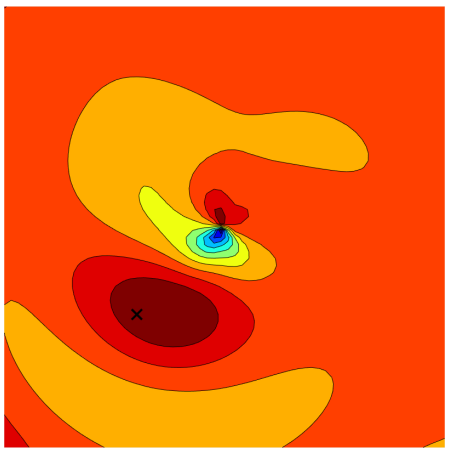
$p_\theta = 0,\ p \in \mathcal{P}$



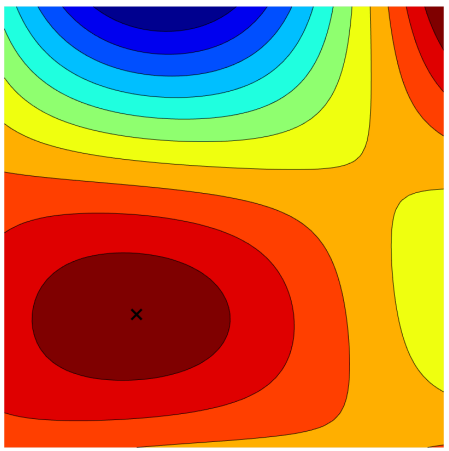
$\Delta\theta = 0$

$q_\theta = 0\ \forall q \in \mathcal{Q}$

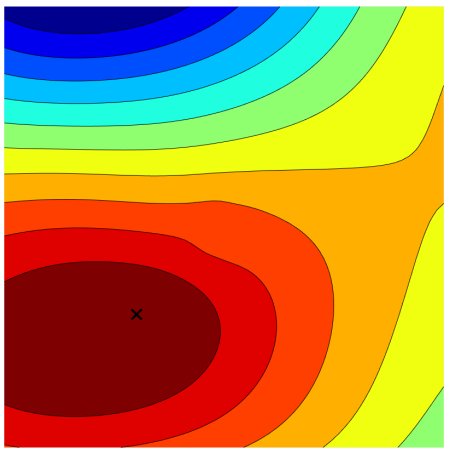




$k_\phi k_\rho k_{\tilde{\theta}}$ (LW)



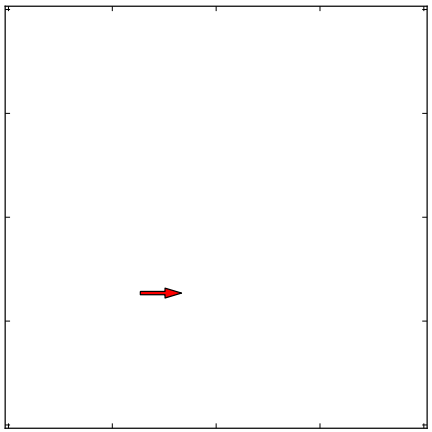
$k_x k_y k_\theta$ (LW)



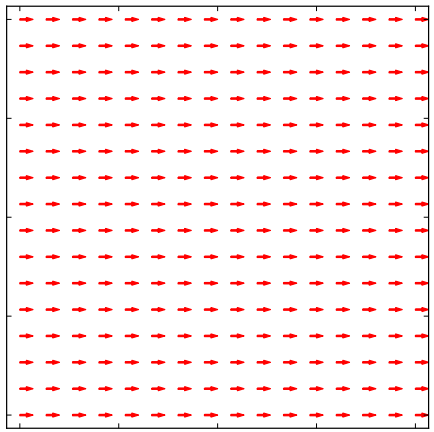
$k_\phi k_\rho k_{\tilde{\theta}} + k_x k_y k_\theta$ (LW)

Patch map showing the effect of whitening (compare with previous slide)

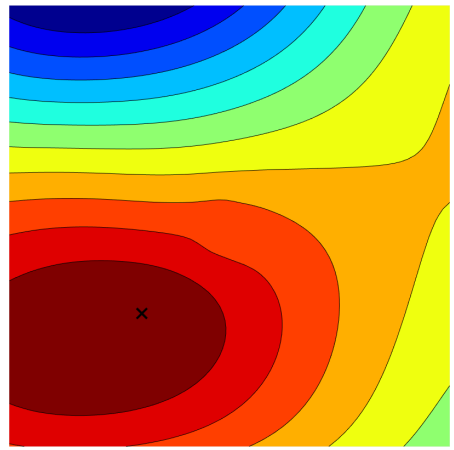
Combined kernels - The effect of whitening



$p_\theta = 0,\ p \in \mathcal{P}$



$q_\theta = 0\ \forall q \in \mathcal{Q}$

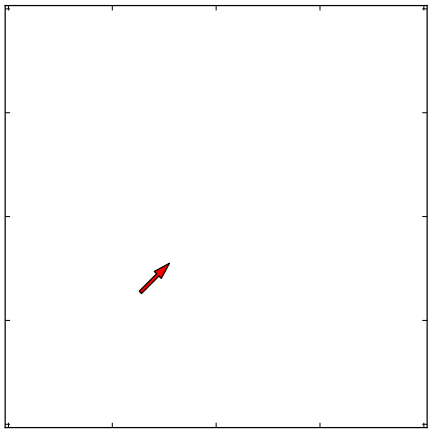


$k_\phi k_\rho k_{\tilde{\theta}} + k_x k_y k_\theta$ (LW)

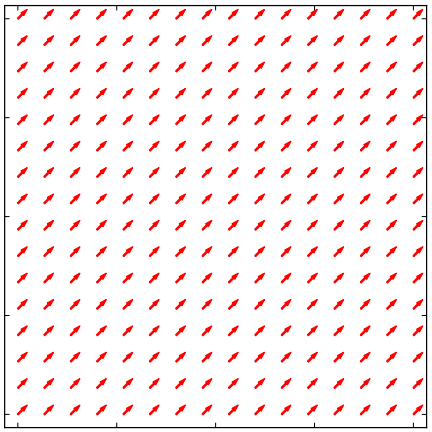
After whitening the similarity is not shift invariant

Compare with the following slides

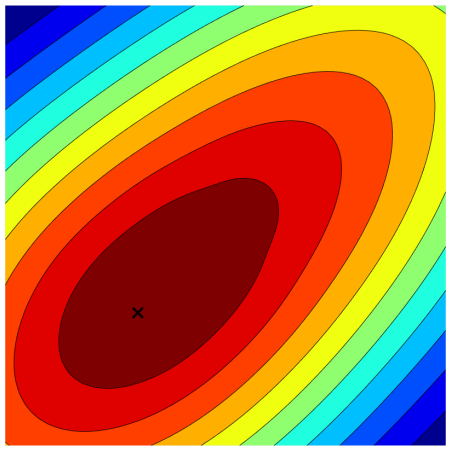
Combined kernels - The effect of whitening



$p_\theta = \pi/4,\ p \in \mathcal{P}$



$q_\theta = \pi/4\ \forall q \in \mathcal{Q}$

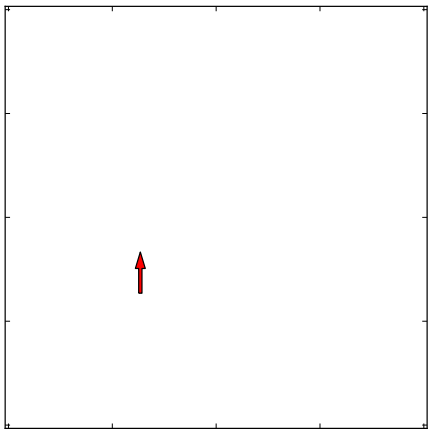


$k_\phi k_\rho k_{\tilde{\theta}} + k_x k_y k_\theta$ (LW)

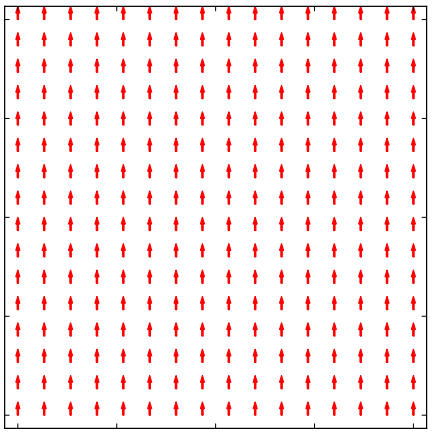
Difference $\Delta\theta$ is the same (equal to 0) but p_θ and q_θ change

Also the patch map changes

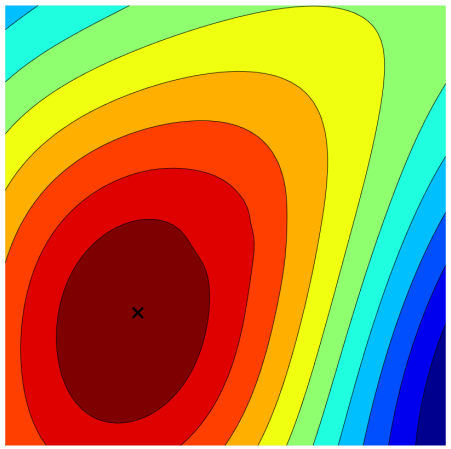
Combined kernels - The effect of whitening



$p_\theta = \pi/2,\ p \in \mathcal{P}$



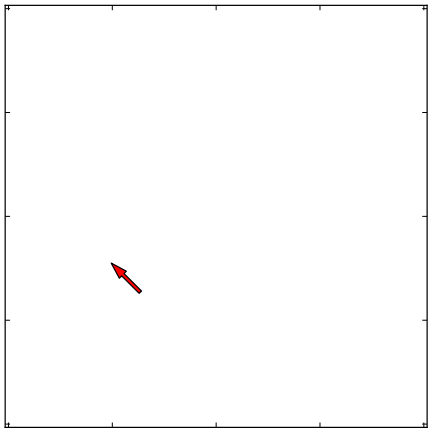
$q_\theta = \pi/2\ \forall q \in \mathcal{Q}$



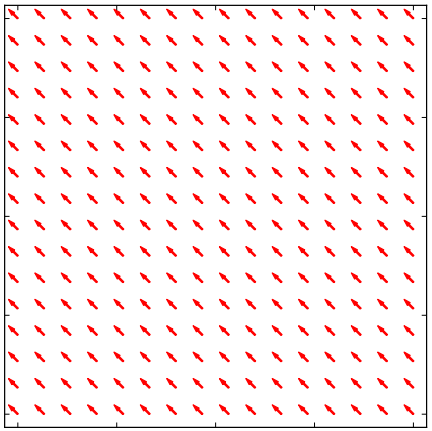
$k_\phi k_\rho k_{\tilde{\theta}} + k_x k_y k_\theta$ (LW)

The shape of similarity rotates according to the gradient angle!
Decreases the effect over-counting across the edge (perpendicular to the gradient)

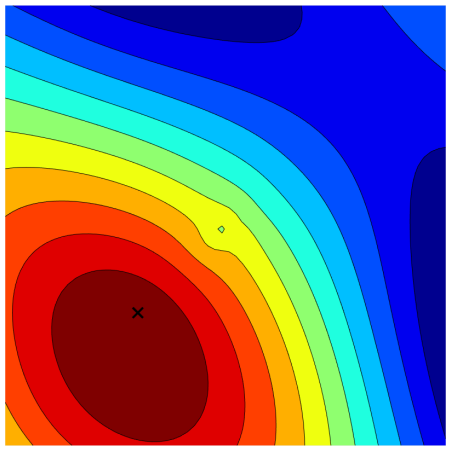
Combined kernels - The effect of whitening



$p_\theta = {}^{3\pi}/_{4},\ p \in \mathcal{P}$



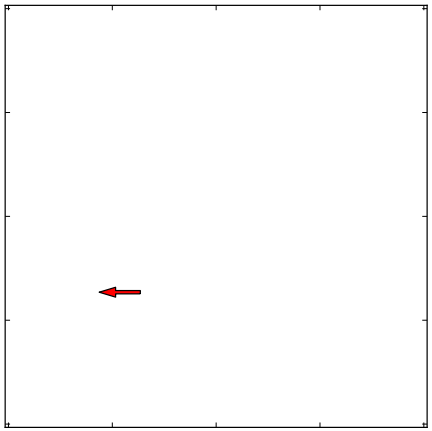
$q_\theta = {}^{3\pi}/_{4}\ \forall q \in \mathcal{Q}$



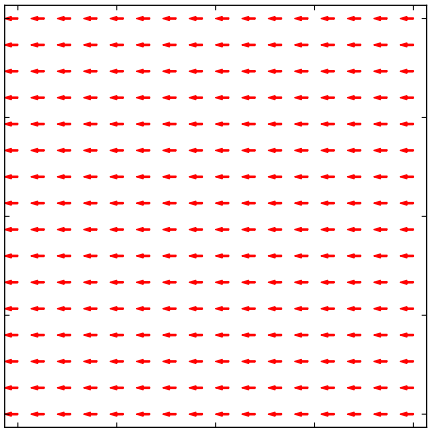
$k_\phi k_\rho k_{\tilde{\theta}} + k_x k_y k_\theta$ (LW)

The shape of similarity rotates according to the gradient angle!
Decreases the effect over-counting across the edge (perpendicular to the gradient)

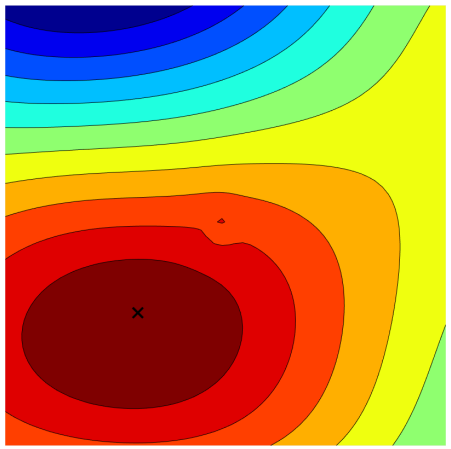
Combined kernels - The effect of whitening



$p_\theta = \pi,\ p \in \mathcal{P}$



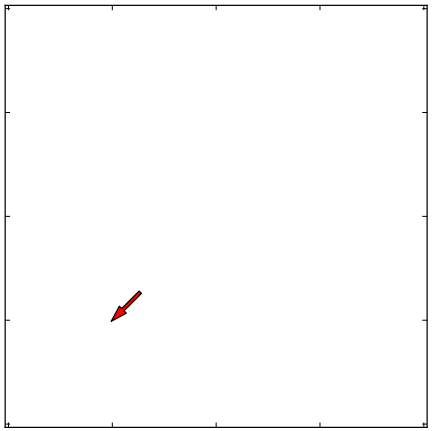
$q_\theta = \pi\ \forall q \in \mathcal{Q}$



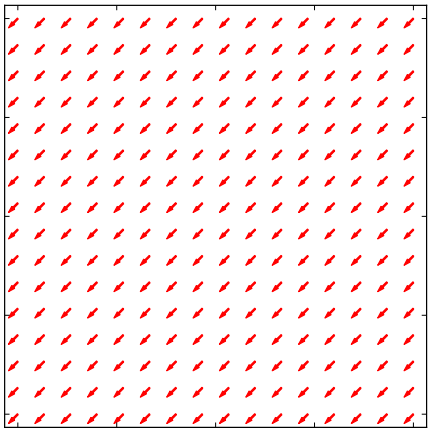
$k_\phi k_\rho k_{\tilde{\theta}} + k_x k_y k_\theta$ (LW)

The shape of similarity rotates according to the gradient angle!
Decreases the effect over-counting across the edge (perpendicular to the gradient)

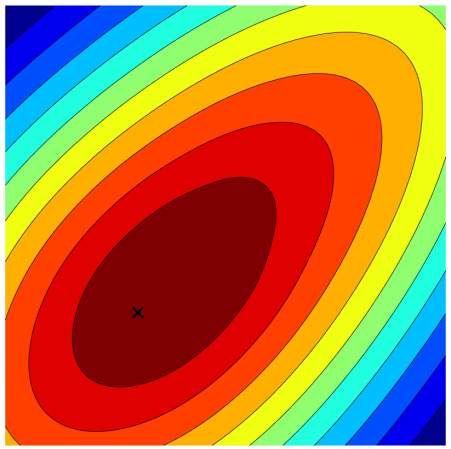
Combined kernels - The effect of whitening



$p_\theta = 5\pi/4,\ p \in \mathcal{P}$



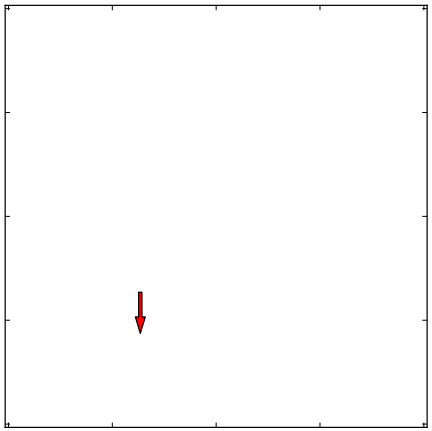
$q_\theta = 5\pi/4\ \forall q \in \mathcal{Q}$



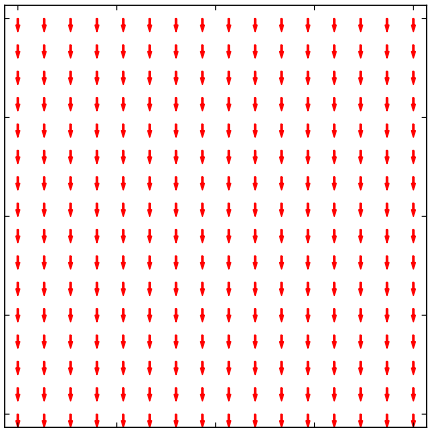
$k_\phi k_\rho k_{\tilde{\theta}} + k_x k_y k_\theta$ (LW)

The shape of similarity rotates according to the gradient angle!
Decreases the effect over-counting across the edge (perpendicular to the gradient)

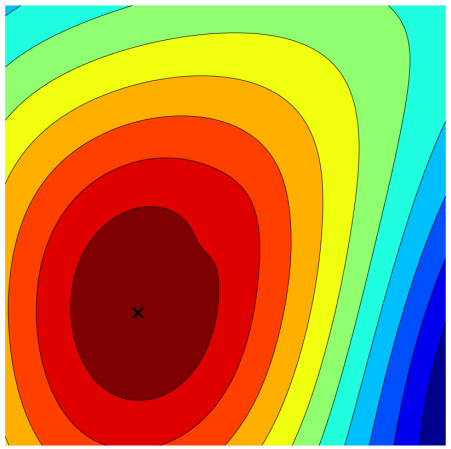
Combined kernels - The effect of whitening



$p_\theta = 3\pi/2,\ p \in \mathcal{P}$



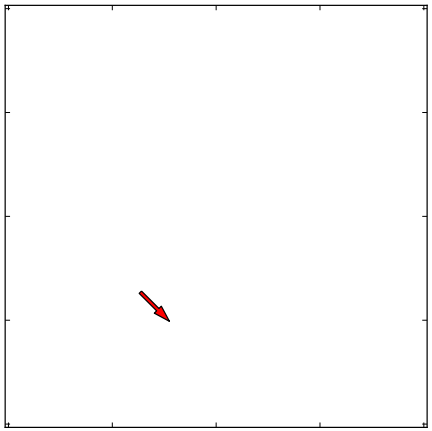
$q_\theta = 3\pi/2\ \forall q \in \mathcal{Q}$



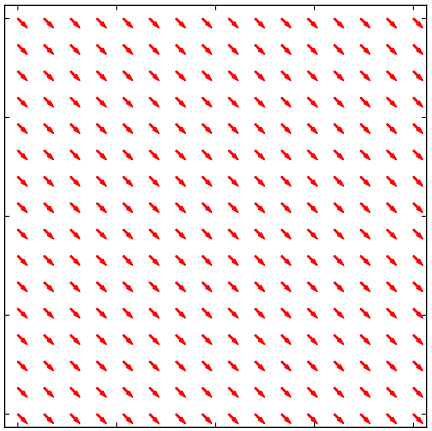
$k_\phi k_\rho k_{\tilde{\theta}} + k_x k_y k_\theta$ (LW)

The shape of similarity rotates according to the gradient angle!
Decreases the effect over-counting across the edge (perpendicular to the gradient)

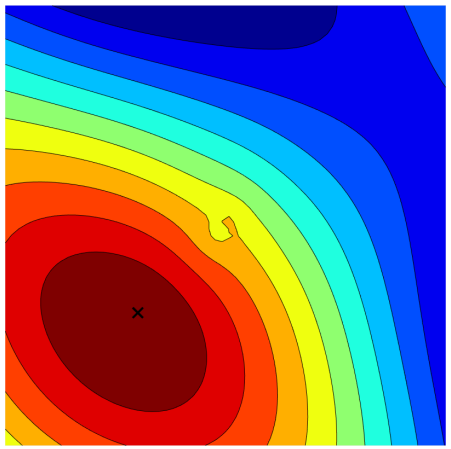
Combined kernels - The effect of whitening



$p_\theta = {}^{7\pi}/_{4},\ p \in \mathcal{P}$



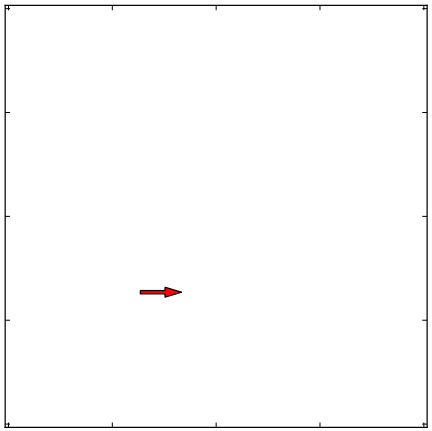
$q_\theta = {}^{7\pi}/_{4}\ \forall q \in \mathcal{Q}$



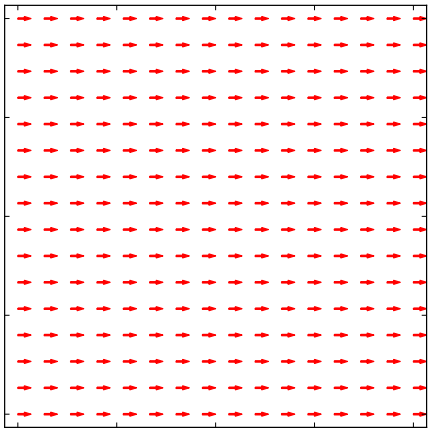
$k_\phi k_\rho k_{\tilde{\theta}} + k_x k_y k_\theta$ (LW)

The shape of similarity rotates according to the gradient angle!
Decreases the effect over-counting across the edge (perpendicular to the gradient)

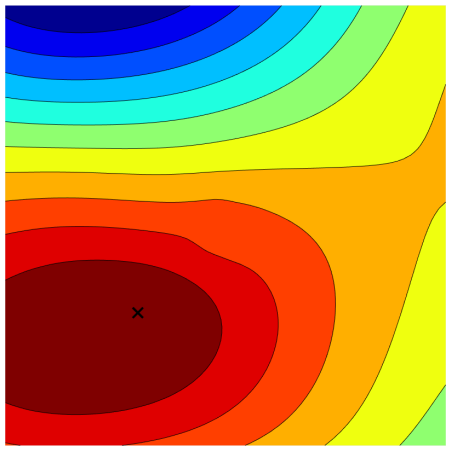
Combined kernels - The effect of whitening



$p_\theta = 2\pi,\ p \in \mathcal{P}$



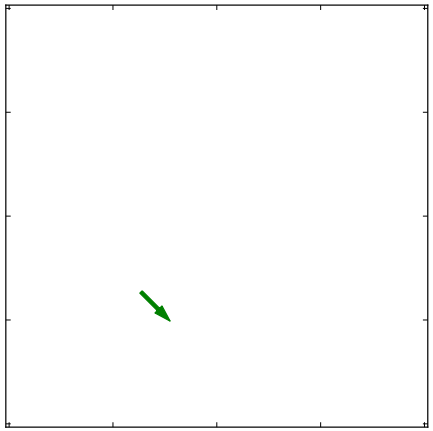
$q_\theta = 2\pi\ \forall q \in \mathcal{Q}$



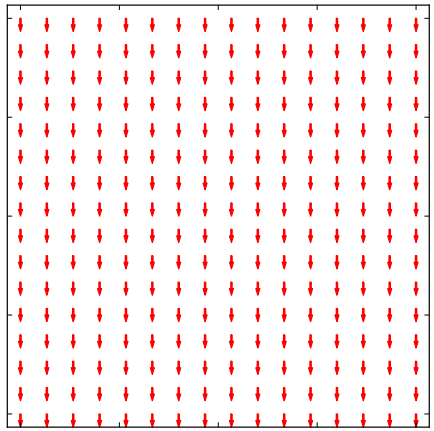
$k_\phi k_\rho k_{\tilde{\theta}} + k_x k_y k_\theta$ (LW)

The shape of similarity rotates according to the gradient angle!
Decreases the effect over-counting across the edge (perpendicular to the gradient)

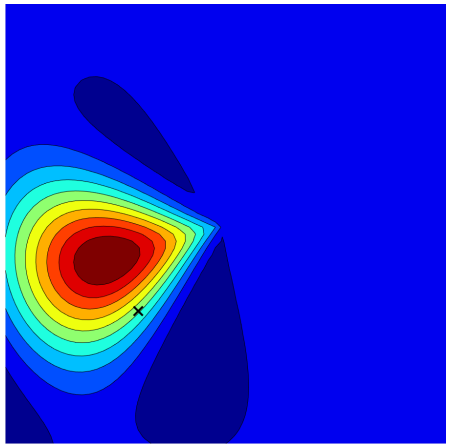
Insensitivity to small patch rotations



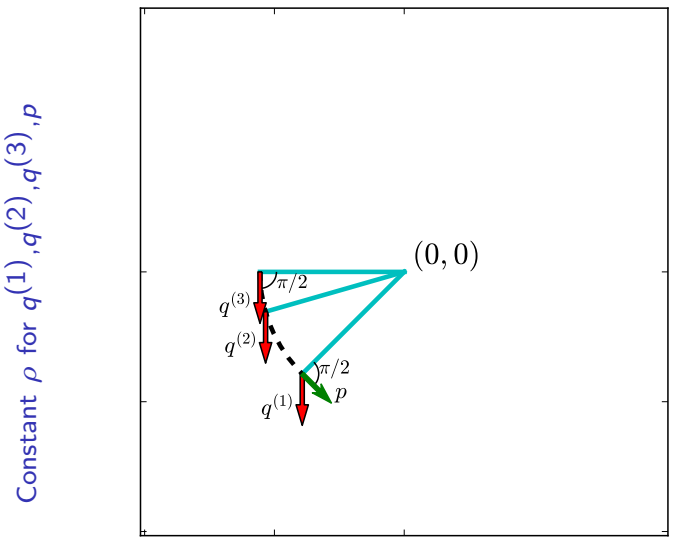
$p_\theta = 7\pi/4,\ p \in \mathcal{P}$

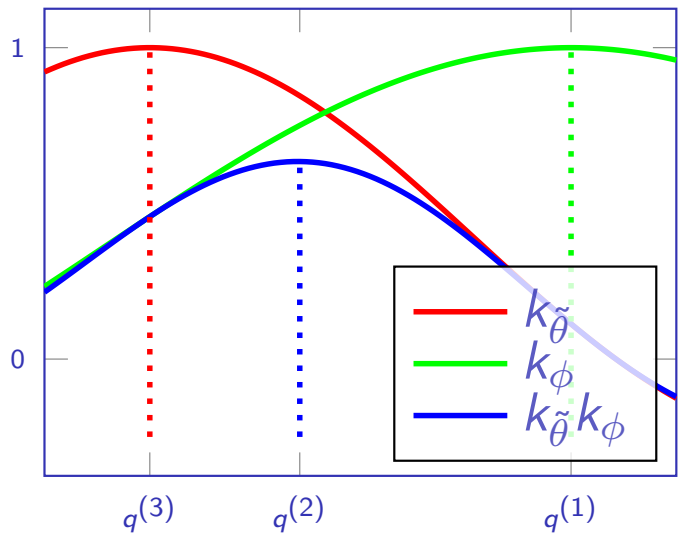


$q_\theta = 3\pi/2\ \forall q \in \mathcal{Q}$



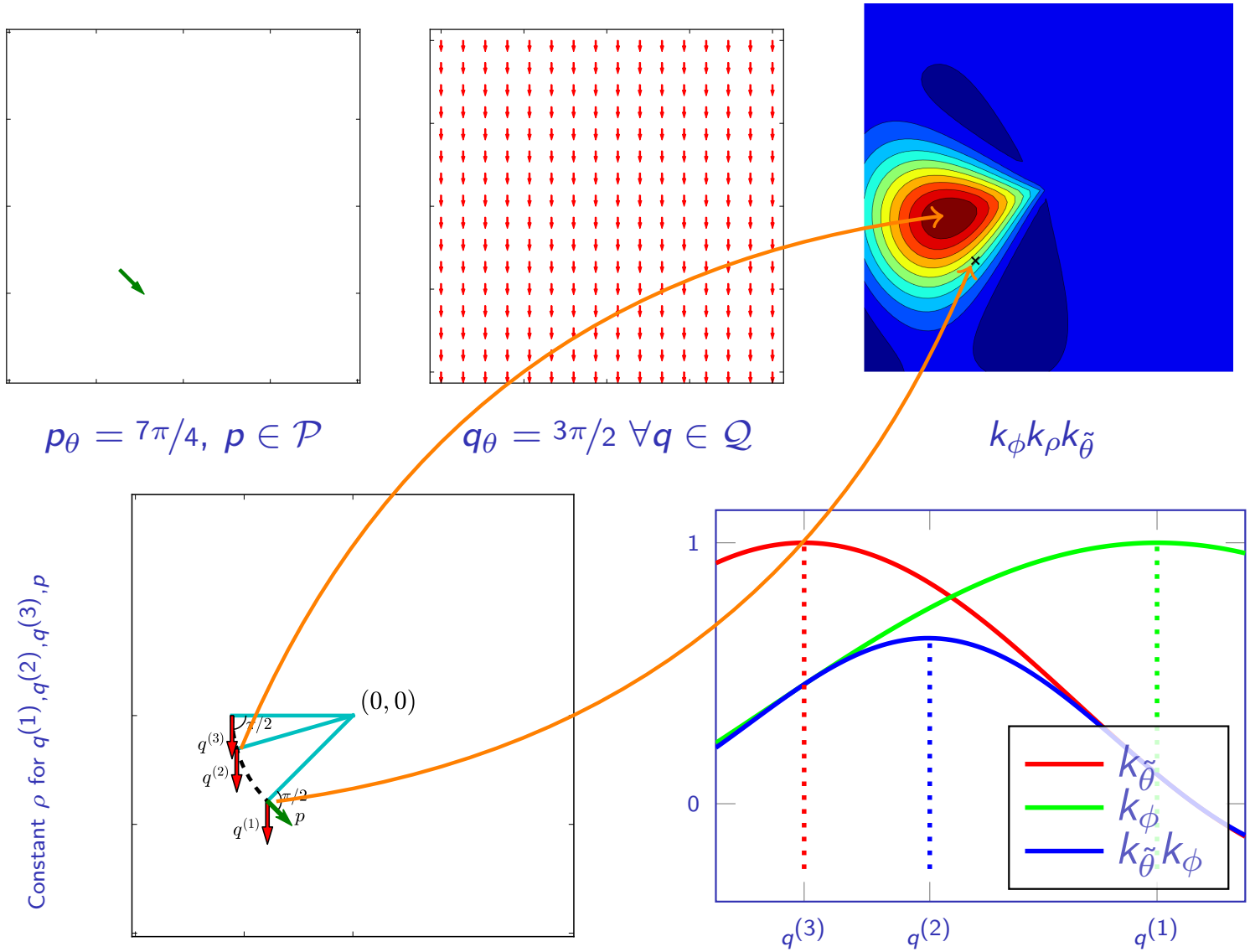
$k_\phi k_\rho k_{\tilde{\theta}}$





Related to the discussion in Section 4, lines 194-195, and Figure 2.

Insensitivity to small patch rotations



Related to the discussion in Section 4, lines 194-195, and Figure 2.