$$p_k(x) = \frac{c_k}{Nh^D} \sum_{i=1}^{N} k\left(\left\| \frac{x-x_i}{h} \right\|^2\right)$$

c_k is a normalization constant

$k\left(\left\| \frac{x-x_i}{h} \right\|^2\right)$ is a kernel

computing the gradient,

$$\nabla p_k(x) = \frac{2c_k}{Nh^{D+2}} \sum_{i=1}^{N} (x - x_i) k'\left(\left\| \frac{x-x_i}{h} \right\|^2\right)$$

$$= \frac{-2c_k}{Nh^{D+2}} \left[\sum_{i=1}^{N} x_i k'\left(\left\| \frac{x-x_i}{h} \right\|^2\right) - x \sum_{i=1}^{N} k'\left(\left\| \frac{x-x_i}{h} \right\|^2\right) \right]$$

mean shift vector $m_{k'}(x)$

$$= \frac{-2c_k}{Nh^{D+2}} \sum_{i=1}^{N} k'\left(\left\| \frac{x-x_i}{h} \right\|^2\right) \left[\frac{\sum_{i=1}^{N} x_i k'\left(\left\| \frac{x-x_i}{h} \right\|^2\right)}{\sum_{i=1}^{N} k'\left(\left\| \frac{x-x_i}{h} \right\|^2\right)} - x \right]$$

$p_{k'}(x)$

$$= \frac{-2c_k c_{k'}}{c_{k'} h^2 N h^D} \sum_{i=1}^{N} k'\left(\left\| \frac{x-x_i}{h} \right\|^2\right) m_{k'}(x)$$

$$= \frac{2c}{h^2} p_{k'}(x) m_{k'}(x)$$

$$m_{k'}(x) = \frac{h^2}{2c} \frac{\nabla p_k}{p_{k'}(x)}$$

mean shift vector $m_{k'}(x)$ always points in direction of maximum increase in density