9.1

$f(x,y)$ derivative

$$\frac{\partial f}{\partial x} = \lim_{\delta x \to 0} \frac{f(x+\delta x, y) - f(x,y)}{\delta x}$$

continuous $f(x,y)$

numerical

$$\frac{\partial f}{\partial x} \simeq \frac{f(x+1,y) - f(x,y)}{\Delta x = 1}$$

correlation kernel $[-1 \;\; 1]$

$f(x,y) * [-1 \;\; 1] \simeq \frac{\partial f}{\partial x}$

centred $[-1 \; 0 \; 1]$ ← no shift

$[-1 \;\; 1]$ or $\begin{bmatrix} 1 \\ -1 \end{bmatrix}$

9.2

I

| | | | | | |
|---|---|---|---|---|---|
| 1 | 1 | 0.6 | 0.3 | 0 | 0 |
| 1 | 1 | 0.6 | 0.3 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |

$\frac{\partial I}{\partial x}$ $[-1 \;\; 1]$

| | | | | |
|---|---|---|---|---|
| 0 | -0.4 | -0.3 | -0.3 | 0 |
| 0 | -0.4 | -0.3 | -0.3 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |

$\frac{\partial I}{\partial y}$ $\begin{bmatrix} 1 \\ -1 \end{bmatrix}$

| | | | | | |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0.6 | 0.3 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |

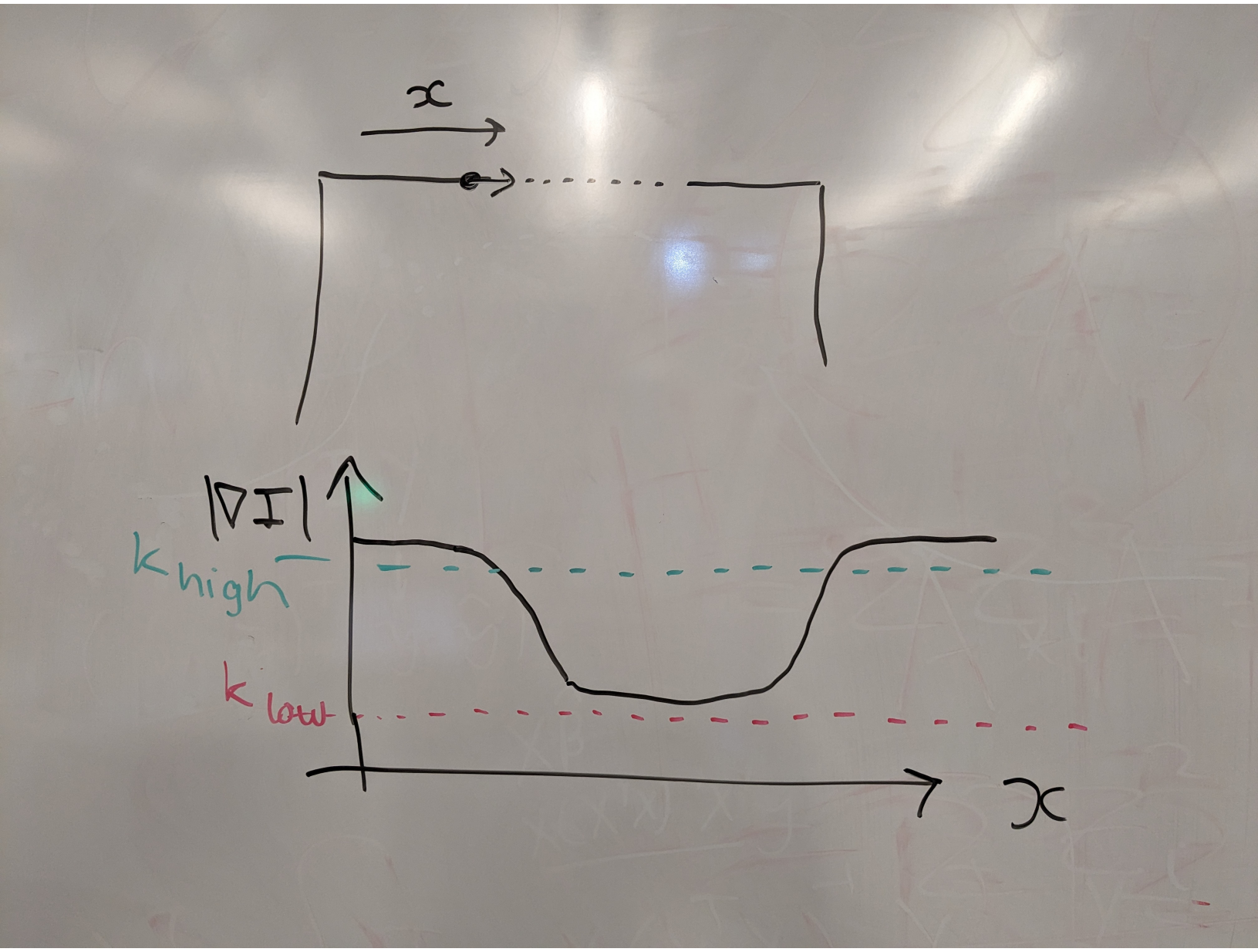
Forward diff $f(x+1, y) - f(x, y)$ $[-1 \quad 1]$

Backward diff $f(x, y) - f(x-1, y)$ $[-1 \quad 1]$

centred diff $\frac{1}{2}(f(x+1, y) - f(x-1, y))$ $[-1 \quad 0 \quad 1]\ \frac{1}{2}$

$\Delta x = 2$

Sobel $\begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix} [-1 \quad 0 \quad 1]$


x
|∇I|
k high
k low
x