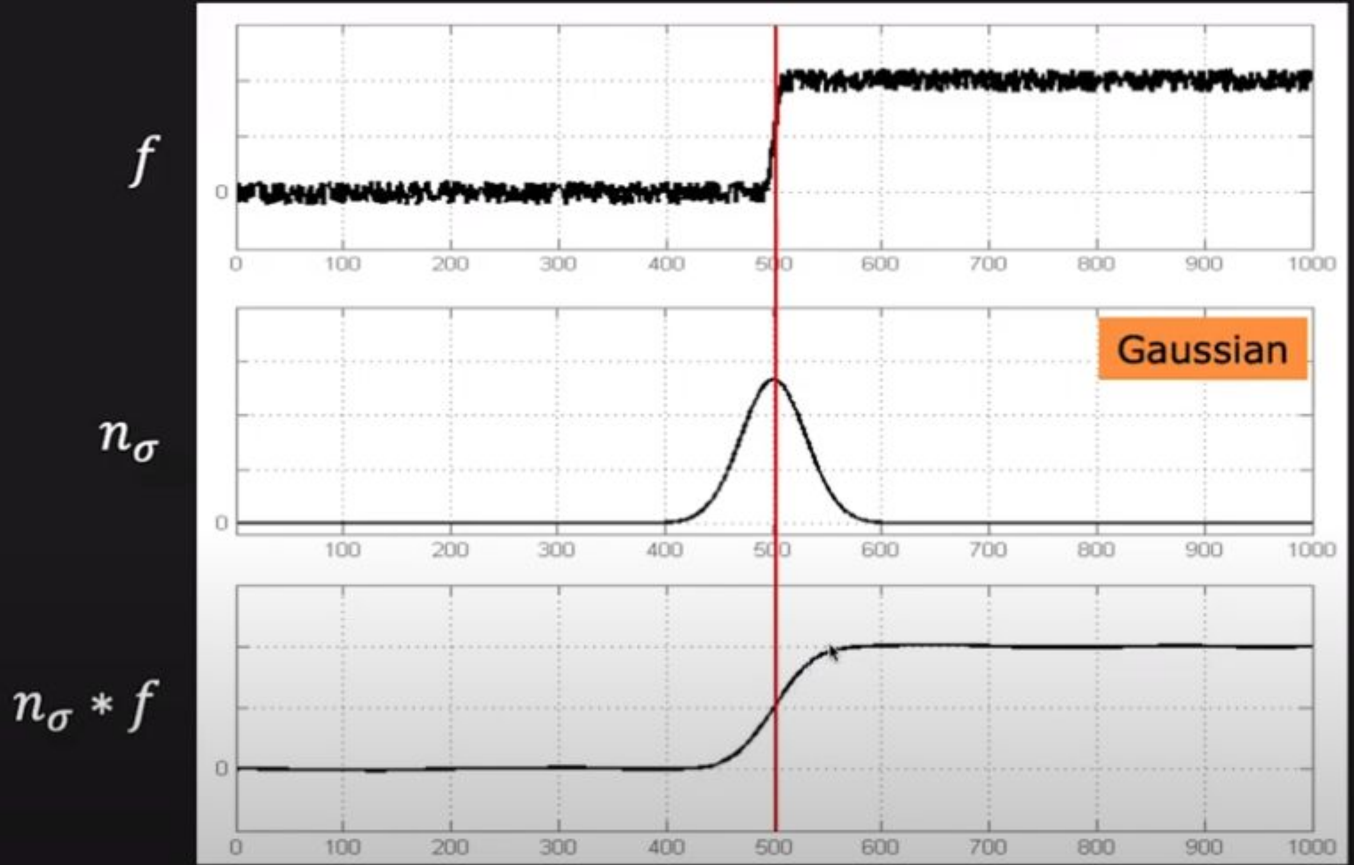
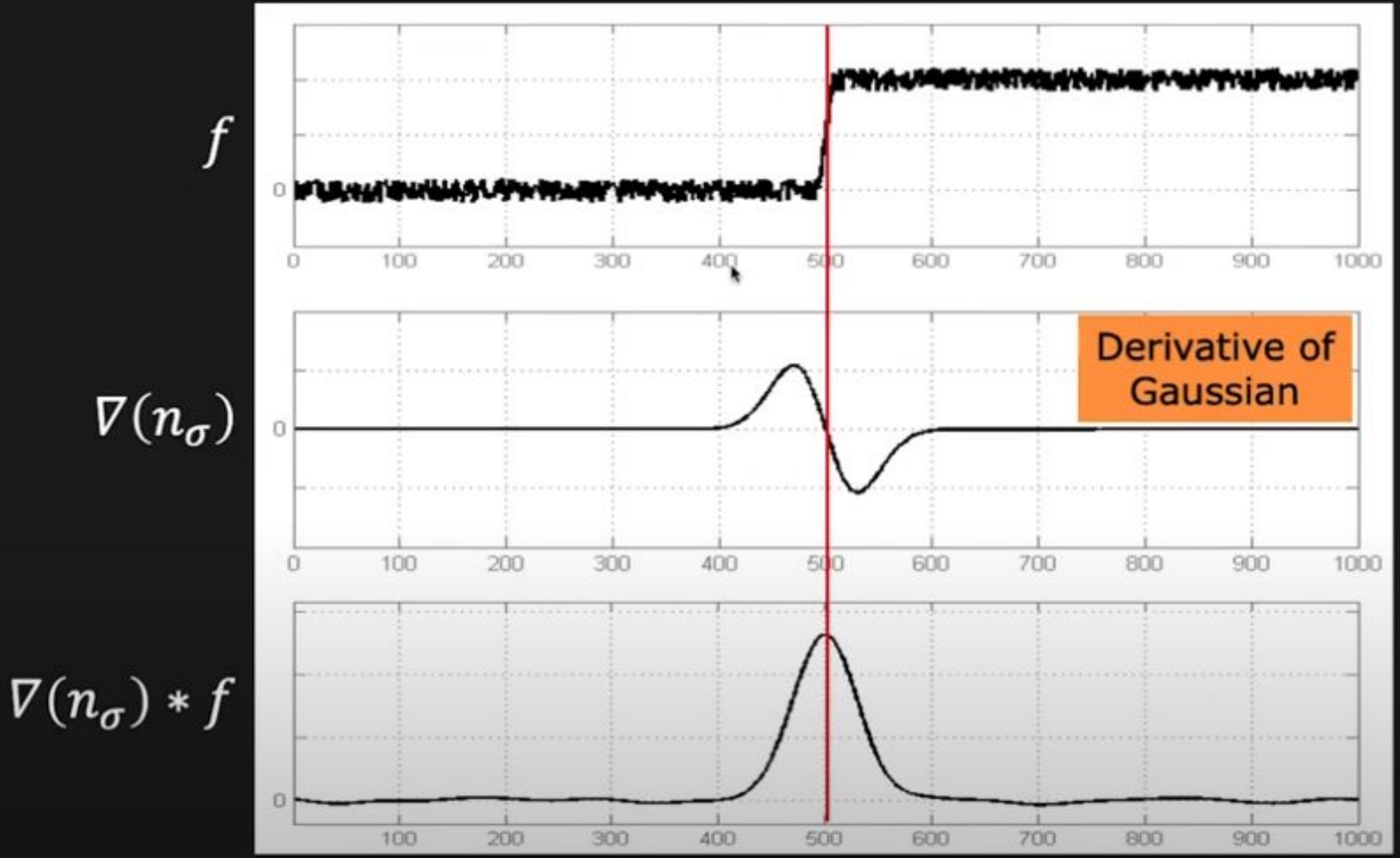
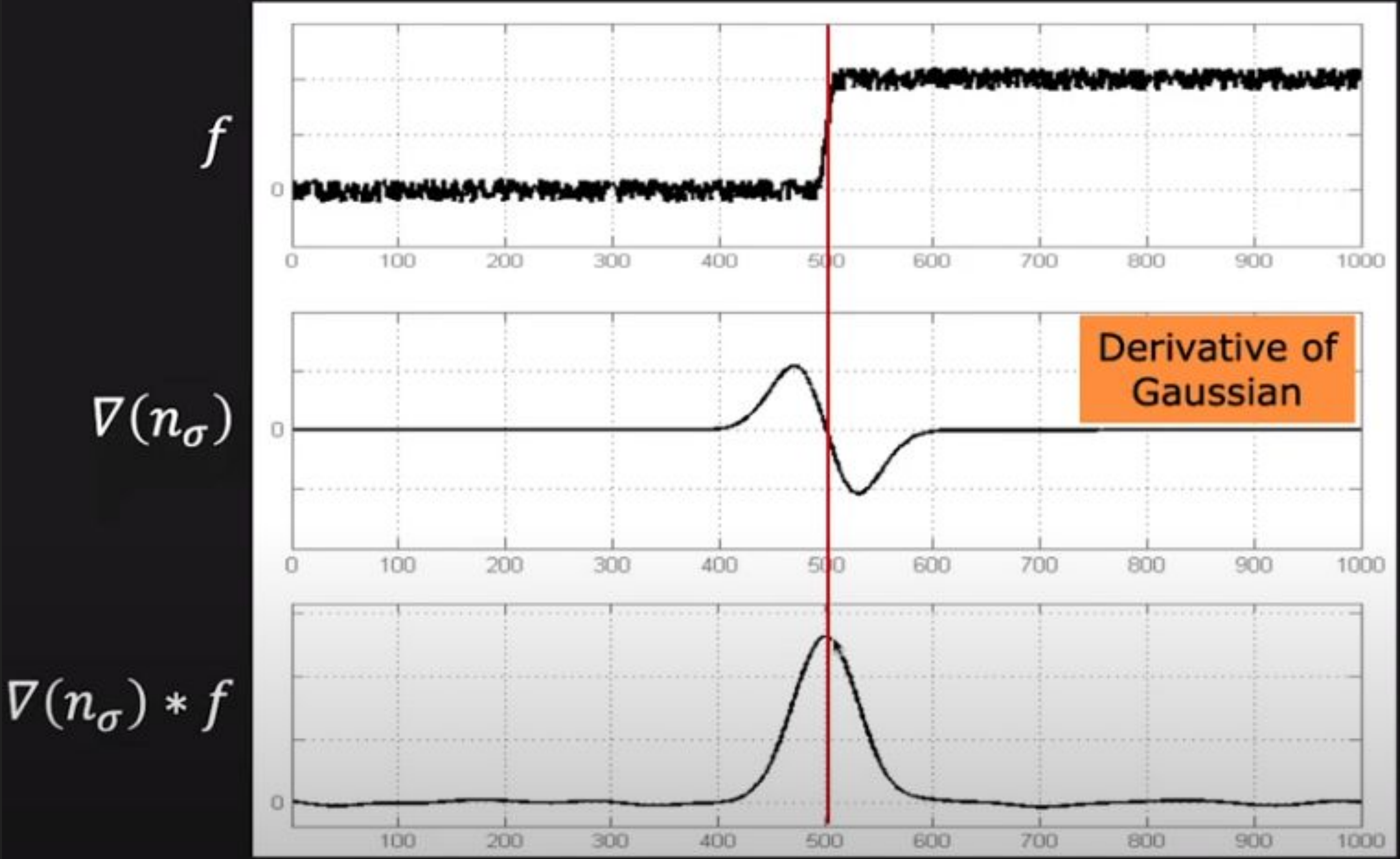
Review: Gaussian Filter



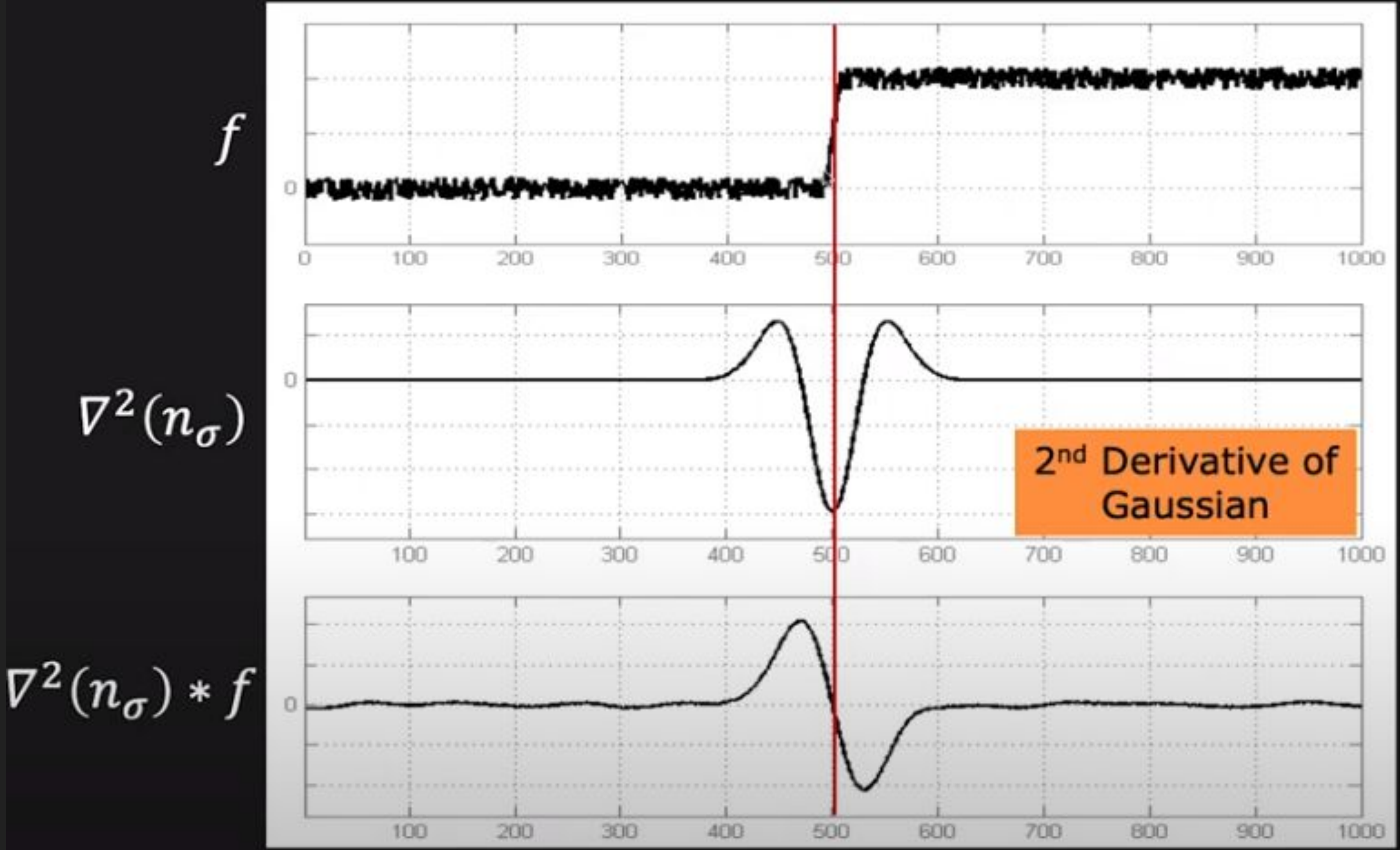
Review: Derivative of Gaussian



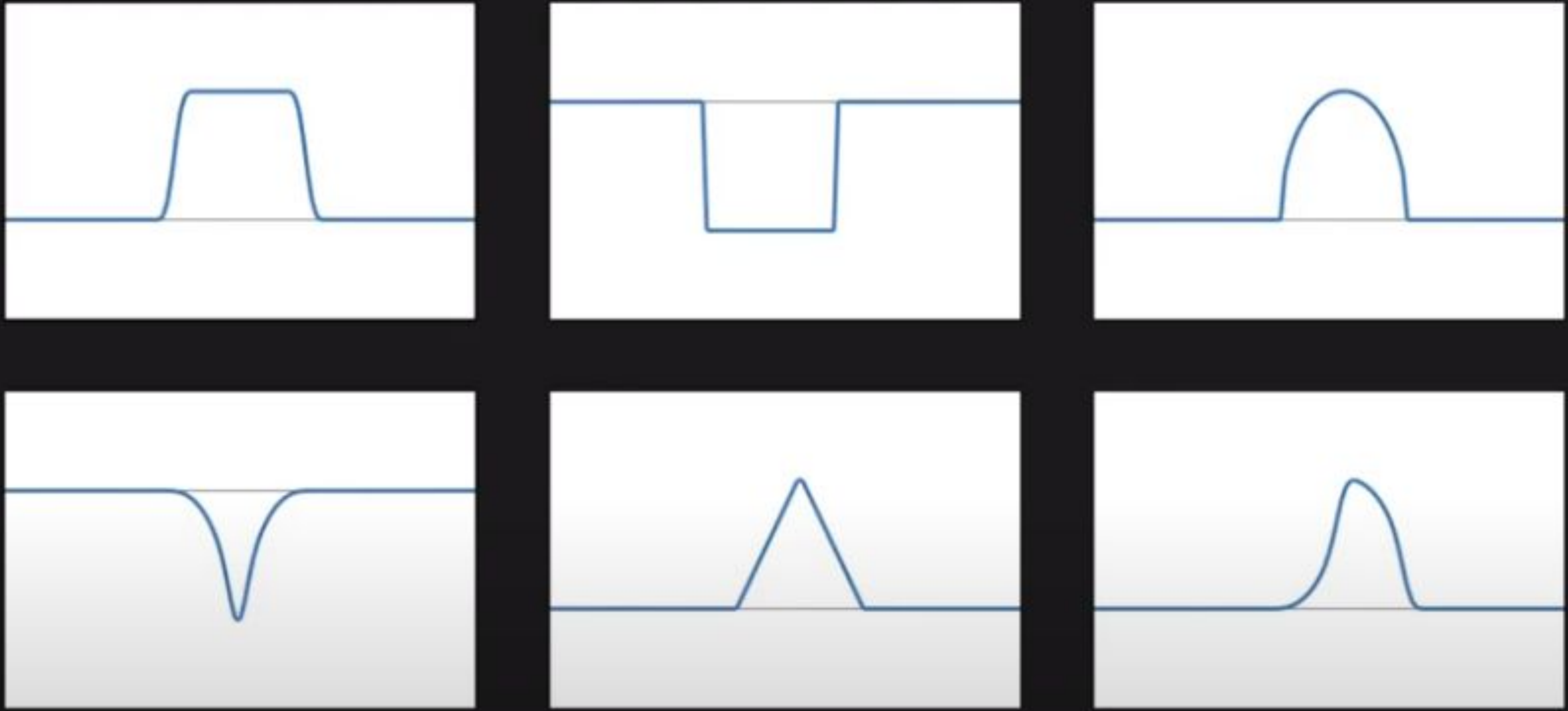
Review: Derivative of Gaussian



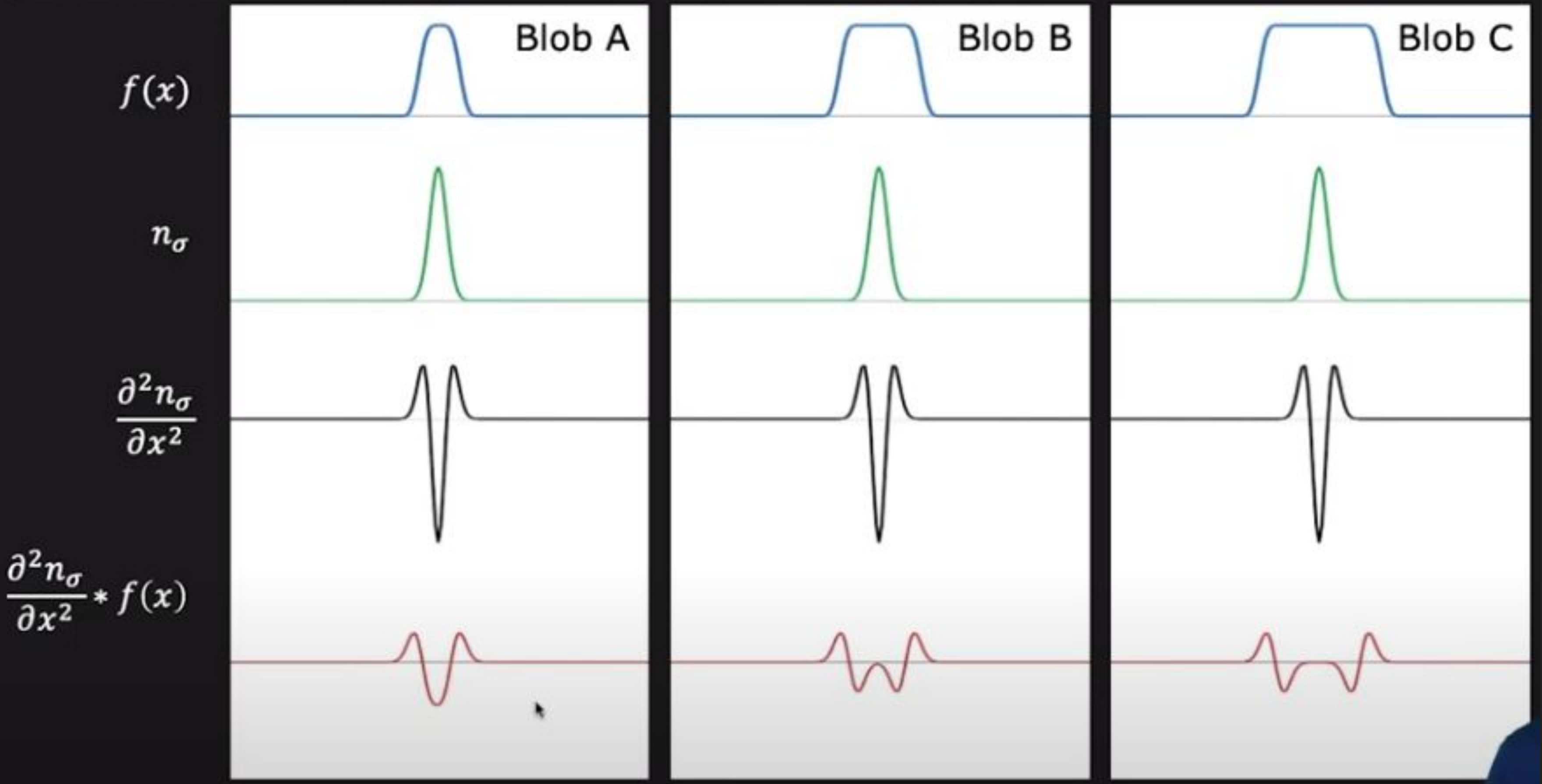
Review: 2nd Derivative of Gaussian



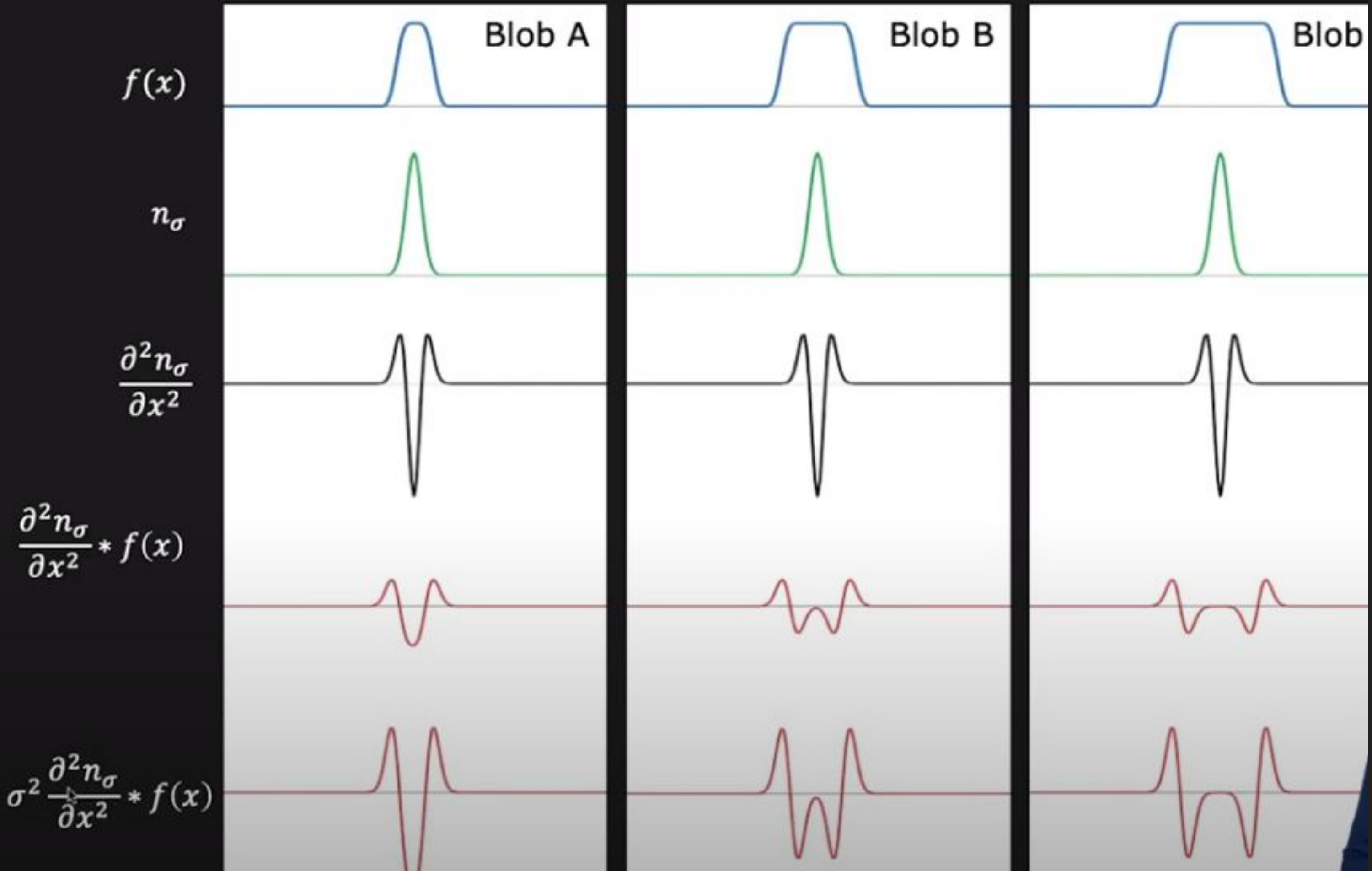
1D Blobs



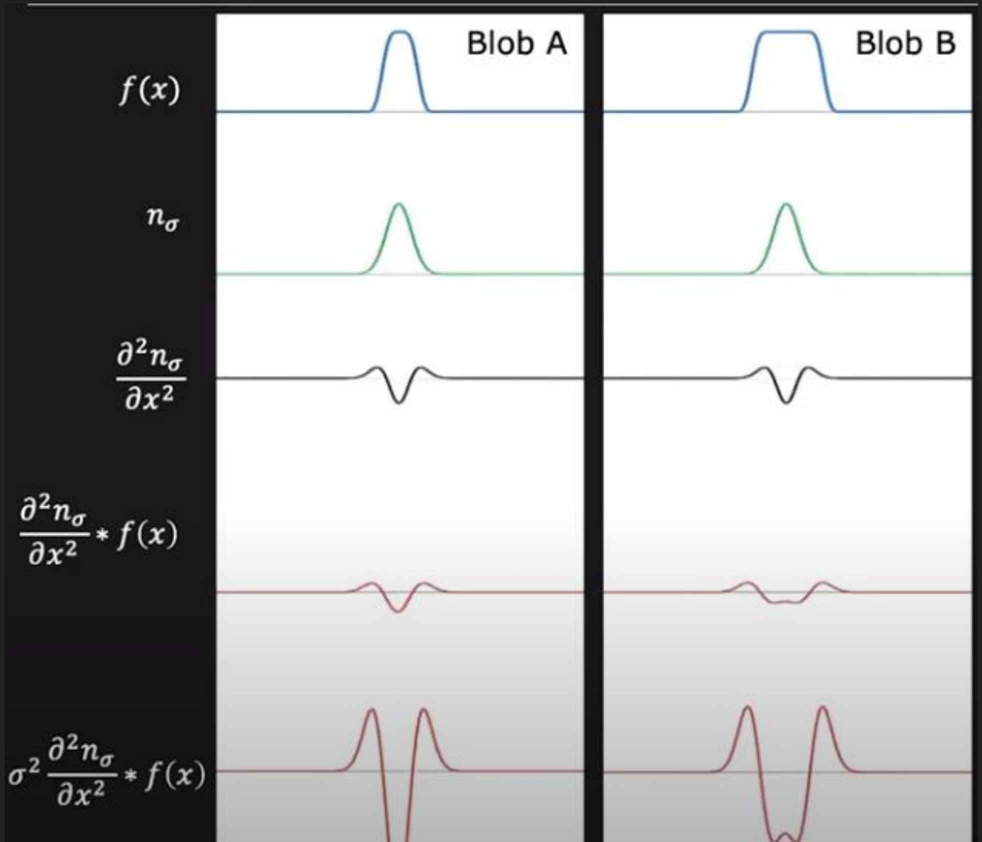
1D Blob and 2nd Derivative of Gaussian



1D Blob and 2nd Derivative of Gaussian



Increasing the sigma



1D Blob Detection Summary

Given: 1D signal $f(x)$

Compute: $\sigma^2 \frac{\partial^2 n_\sigma}{\partial x^2} * f(x)$ at many scales $(\sigma_0, \sigma_1, \sigma_2, \dots, \sigma_k)$.

Find: $$\boxed{(x^*, \sigma^*) = \underset{(x,\sigma)}{\arg\max} \left| \sigma^2 \frac{\partial^2 n_\sigma}{\partial x^2} * f(x) \right|}$$

x^*: Blob Position

σ^*: Characteristic Scale (Blob Size)

2D Blob Detector

Normalized Laplacian of Gaussian (NLoG) is used as the 2D equivalent for Blob Detection.

Laplacian

$$\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}$$

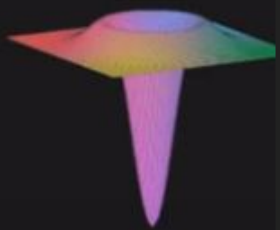
Gaussian

n_σ

LoG

$\nabla^2 n_\sigma$

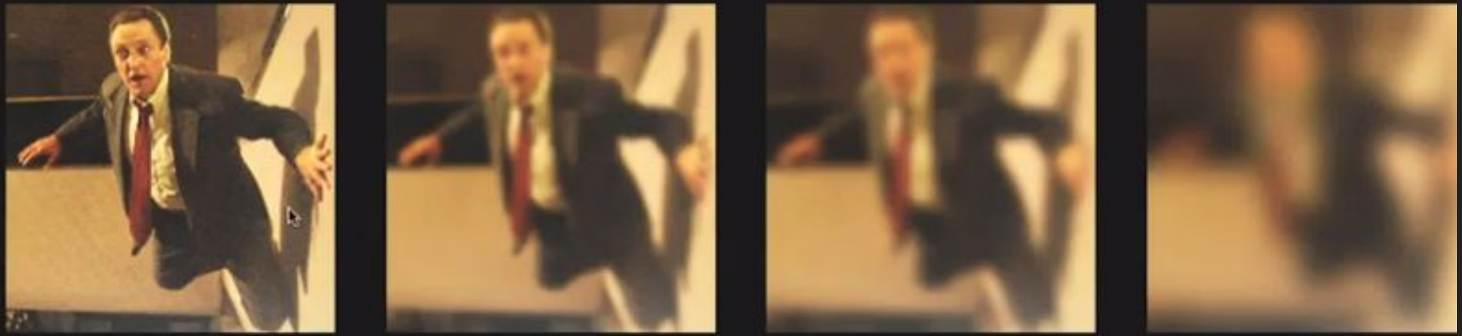
NLoG



$\sigma^2 \nabla^2 n_\sigma$

Location of Blobs given by Local Extrema after applying Normalized Laplacian of Gaussian at many scales.

Scale-Space



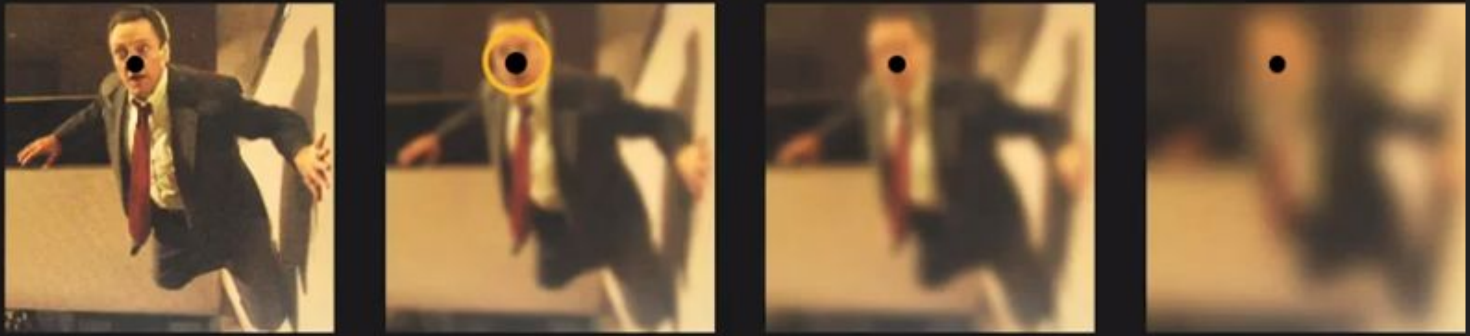
$S(x, y, \sigma_0)$ $S(x, y, \sigma_1)$ $S(x, y, \sigma_2)$ $S(x, y, \sigma_3)$

Increasing σ, Higher Scale, Lower Resolution

Scale Space: Stack created by filtering an image with Gaussians of different sigma (σ)

$$\boxed{S(x, y, \sigma) = n(x, y, \sigma) * I(x, y)}$$

Blob Detection using Local Extrema

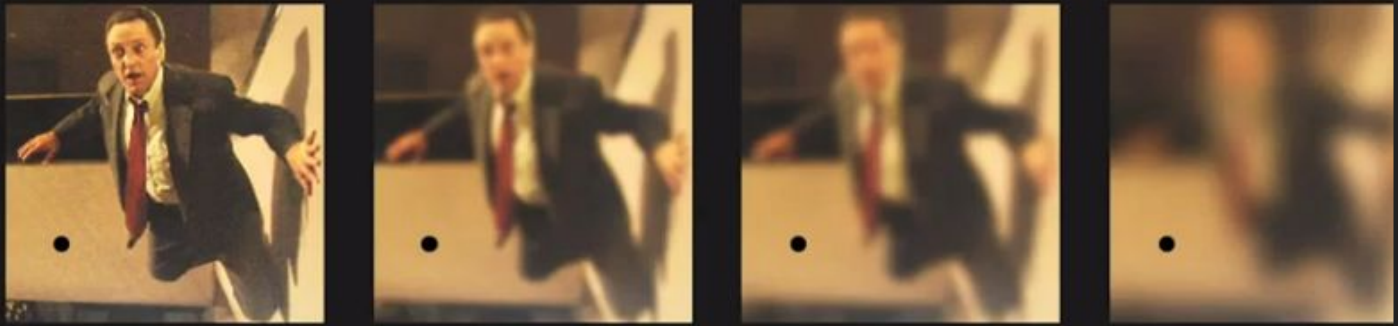


$S(x, y, \sigma_0)$ $S(x, y, \sigma_1)$ $S(x, y, \sigma_2)$ $S(x, y, \sigma_3)$

$\sigma^2 \nabla^2 S(x, y, \sigma)$

$(NLoG * I(x, y))$

Blob Detection using Local Extrema



$S(x,y,\sigma_0)$ $S(x,y,\sigma_1)$ $S(x,y,\sigma_2)$ $S(x,y,\sigma_3)$

$\sigma^2\nabla^2 S(x,y,\sigma)$
$(NLoG * I(x,y))$

σ_0 σ_1 σ_2 σ_3

2D Blob Detection Summary

Given an image $I(x,y)$

Convolve the image using NLoG at many scales σ

Find:

$$\boxed{(x^*, y^*, \sigma^*) = \underset{(x,y,\sigma)}{\arg\max} \, |\sigma^2 \nabla^2 n_\sigma * I(x,y)|}$$

(x^*, y^*): Position of the blob

σ^*: Size of the blob