Gradients and Sobel Filters

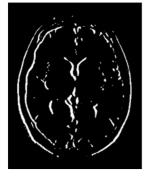
• Gradients are a measure of intensity change in an image, and they generally mark object boundaries and changing area of light and dark. If we think back to treating images as functions, F(x, y), we can think of the gradient as a derivative operation F'(x, y). Where the derivative is a measurement of intensity change.

Sobel filters

• The Sobel filter is very commonly used in edge detection and in finding patterns in intensity in an image. Applying a Sobel filter to an image is a way of **taking (an approximation) of the derivative of the image** in the x or y direction. The operators for *Sobelx* and *Sobely*, respectively, look like this:

$$S_X = \begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix}$$

$$S_{y} = \begin{pmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{pmatrix}$$



Sobel x



Sobel y

x vs. y

• In the above images, you can see that the gradients taken in both the x and the y directions detect the edges of the brain and pick up other edges. Taking the gradient in the x direction emphasizes edges closer to vertical. Alternatively, taking the gradient in the y direction emphasizes edges closer to horizontal.

• Magnitude:

- Sobel also detects which edges are *strongest*. This is encapsulated by the **magnitude** of the gradient; the greater the magnitude, the stronger the edge is. The magnitude, or absolute value, of the gradient is just the square root of the squares of the individual x and y gradients. For a gradient in both the x **and** y directions, the magnitude is the square root of the sum of the squares.
- abs_sobelx=\sqrt{(sobel_x)^2}
- abs_sobely=\sqrt{(sobel_y)^2}
- abs_sobelxy= \sqrt{(sobel_x)^2+(sobel_y)^2}

• Direction:

- In many cases, it will be useful to look for edges in a particular orientation. For example,
 we may want to find lines that only angle upwards or point left. By calculating the
 direction of the image gradient in the x and y directions separately, we can determine the
 direction of that gradient!
- The direction of the gradient is simply the inverse tangent (arctangent) of the y gradient divided by the x gradient:
- tan-1(sobel_y/sobel_x).