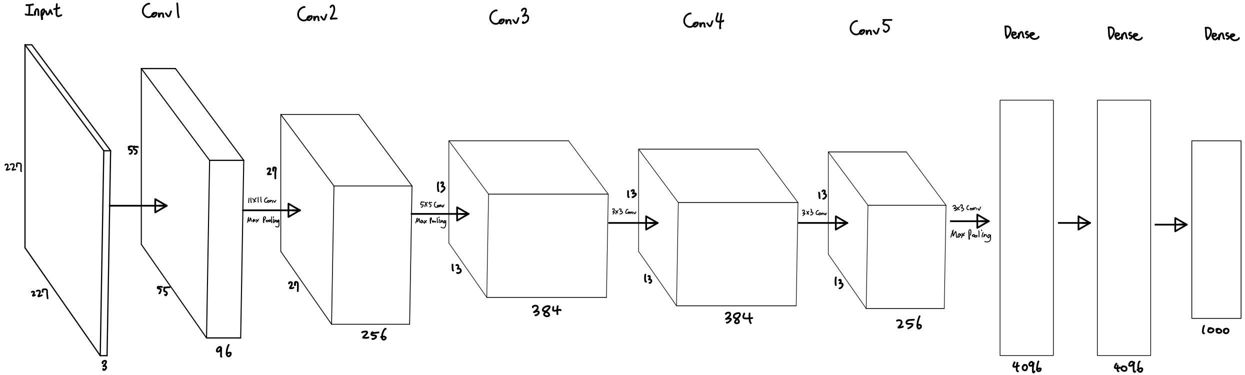

Input
Conv1
Conv2
Conv3
Conv4
Conv5
Dense
Dense
Dense
227
227
3
55
55
96
11X11 Conv
Max Pooling
27
27
256
5X5 Conv
Max Pooling
13
13
384
3x3 Conv
13
13
384
3x3 Conv
13
13
256
3x3 Conv
Max Pooling
4096
4096
1000

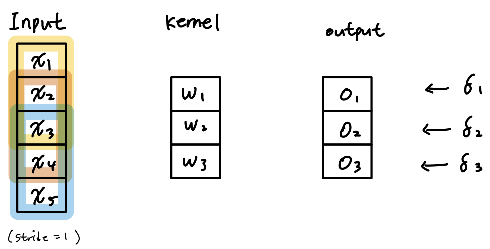
CNN 역전파

∵ 커널이 모든 입력데이터에 적용되므로 역전파 계산에도 Convolution 연산이 사용됨.

* 수식

$$\frac{\delta}{\delta x} = \frac{\delta}{\delta x}\int_{\mathbb{R}^d} f(y)g(x-y)\,dy$$
$$= \int_{\mathbb{R}^d} f(y)\frac{\delta g}{\delta x}(x-y)\,dy$$
$$= [f \cdot g'](x)$$

* 예시



$$\left.\begin{aligned} o_1 &= w_1x_1 + w_2x_2 + w_3x_3 \\ o_2 &= w_1x_2 + w_2x_3 + w_3x_4 \\ o_3 &= w_1x_3 + w_2x_4 + w_3x_5 \end{aligned}\right\} \longrightarrow o_i = \sum_{j=1} w_j \cdot x_{i+j-1}$$

- 편미분값 : $\delta_1, \delta_2, \delta_3$
- Convolution의 최종 출력값 : L

$$\delta_1 = \frac{\partial L}{\partial o_1}, \quad \delta_2 = \frac{\partial L}{\partial o_2}, \quad \delta_3 = \frac{\partial L}{\partial o_3}$$

$$\frac{\partial L}{\partial w_1} = \delta_1\frac{\partial o_1}{\partial w_1} + \delta_2\frac{\partial o_1}{\partial w_2} + \delta_3\frac{\partial o_1}{\partial w_3}$$
$$= \delta_1 x_1 + \delta_2 x_2 + \delta_3 x_3$$
$$\frac{\partial L}{\partial w_2} = \delta_1 x_2 + \delta_2 x_3 + \delta_3 x_4$$
$$\frac{\partial L}{\partial w_3} = \delta_1 x_3 + \delta_2 x_4 + \delta_3 x_5$$

$$\therefore \frac{\partial L}{\partial w_i} = \sum_{j=1} \delta_j x_{i+j-1}$$