

BE530 – Medical Deep Learning

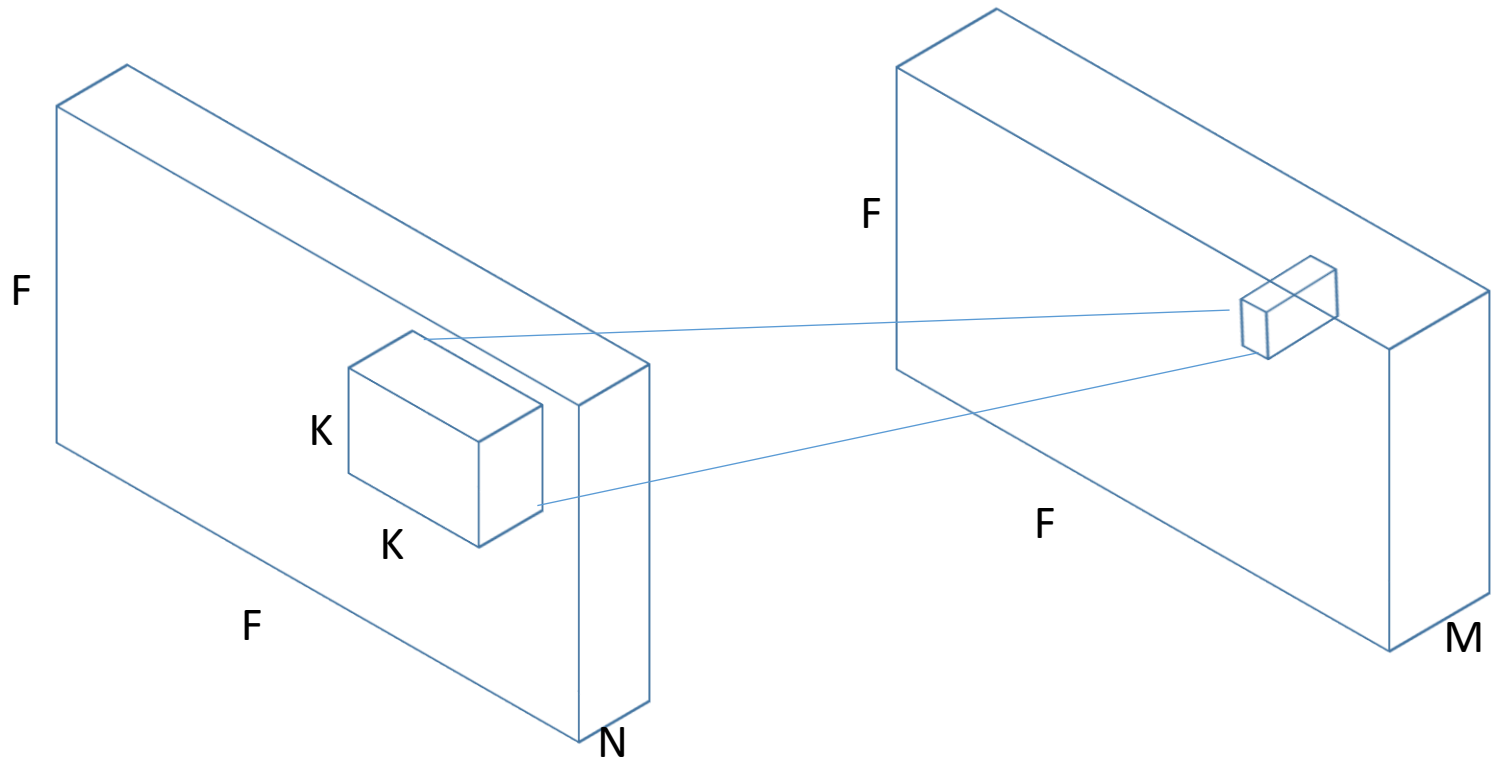
– Convolution Operations –

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Conventional Convolutions



■ CNN 계산량

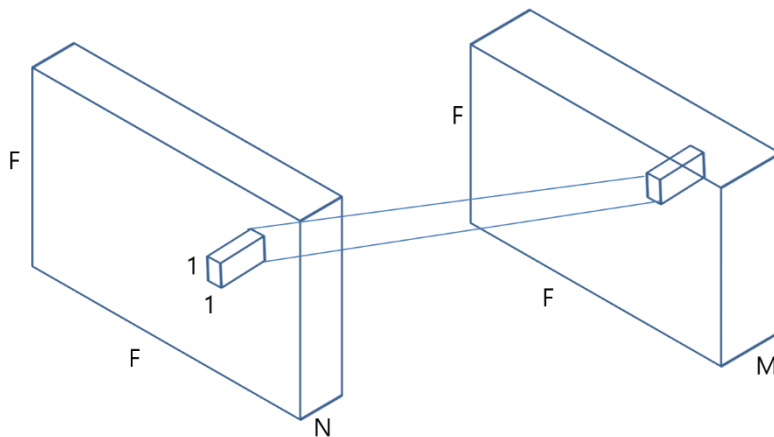
- $(K \times K \times N) \times M \times F \times F = K^2 \times F^2 \times N \times M$

■ Parameter 수

- $(K \times K \times N) \times M = K^2 \times N \times M$

Pointwise Convolution

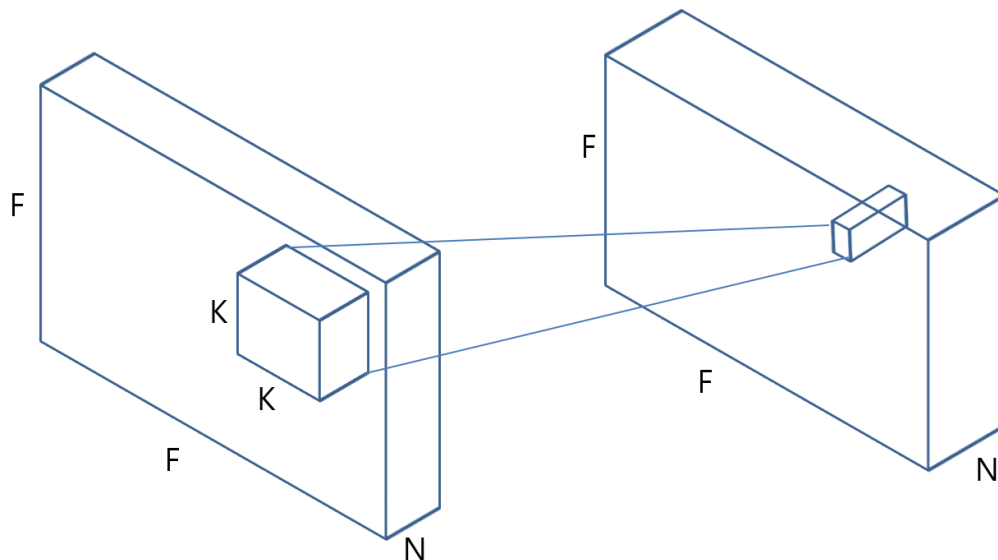
- 공간 방향의 Convolution은 수행하지 않으며, 채널 방향으로만 1×1 Convolution 수행
 - Feature map의 차원 축소 또는 증가 시 사용



- CNN 계산량
 - $(1 \times 1 \times N) \times M \times F \times F = F^2 \times N \times M$
- Parameter 수
 - $(1 \times 1 \times N) \times M = N \times M$

Depthwise Convolution

- Feature map의 각 채널마다 공간 방향의 Convolution 수행



- CNN 계산량

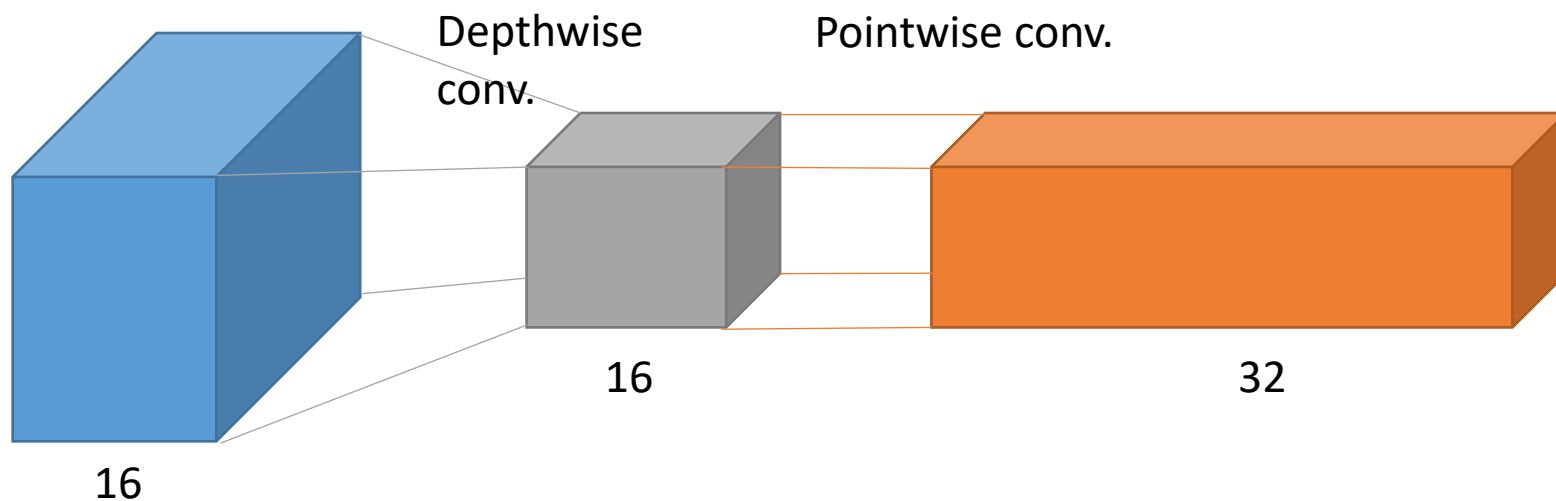
- $(K \times K \times 1) \times N \times F \times F = K^2 \times F^2 \times N$

- Parameter 수

- $(K \times K \times N) = K^2 \times N$

Depthwise Separable convolution

- 일반적인 Convolution 동작은 feature map의 공간 방향과 채널 방향으로 동시에 convolution을 수행하는 반면, 채널 방향 (pointwise convolution)과 공간 방향(depthwise convolution)을 독립적으로 수행 후 적용

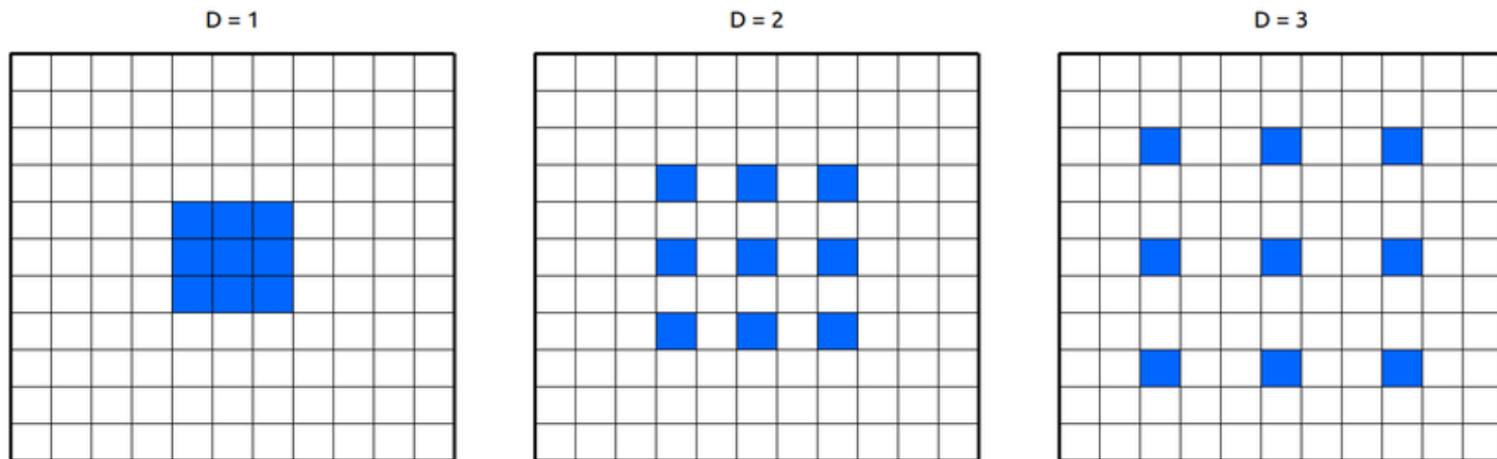


■ CNN 계산량

- $(F^2 \times N \times M) + (K^2 \times F^2 \times N)$
- $((F^2 \times N \times M) + (K^2 \times F^2 \times N)) / (K^2 \times F^2 \times N \times M) = 1/K^2 + 1/M$
 - 일반적으로 $M \gg K^2$ (e.g, $K=3, M \geq 32$)이므로, 계산량은 $1/9$ 로 감소

Dilated Convolution

- 기존 컨볼루션 필터가 수용하는 픽셀 사이에 간격을 둔 형태
 - Dilation Rate (D) – 커널 사이의 간격
- 적은 계산 비용으로 Receptive Field를 늘이는 방법
 - 필터 내부에 zero padding을 추가하여 강제로 Receptive Field를 늘임

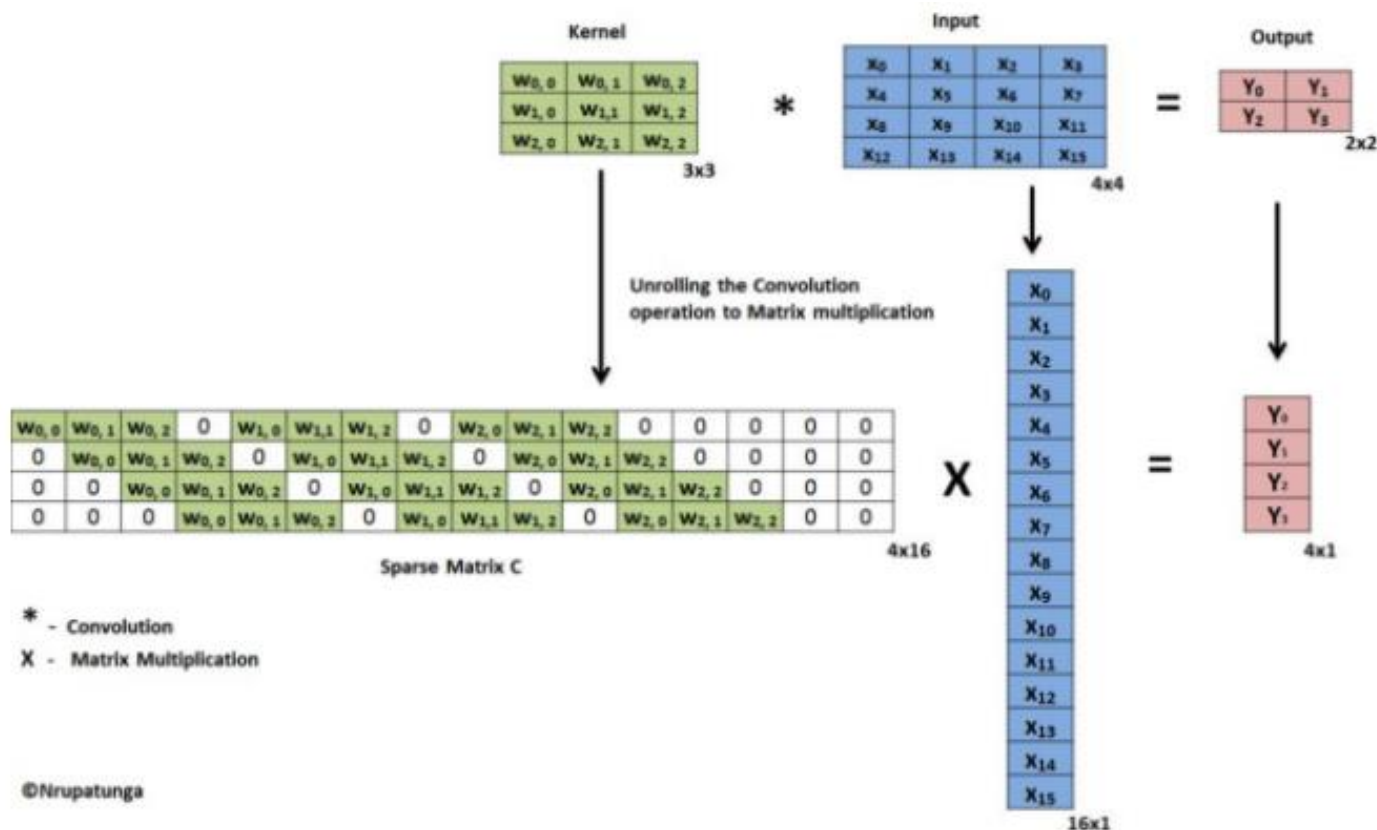


Transposed Convolution

■ 이미지 크기 복원 시

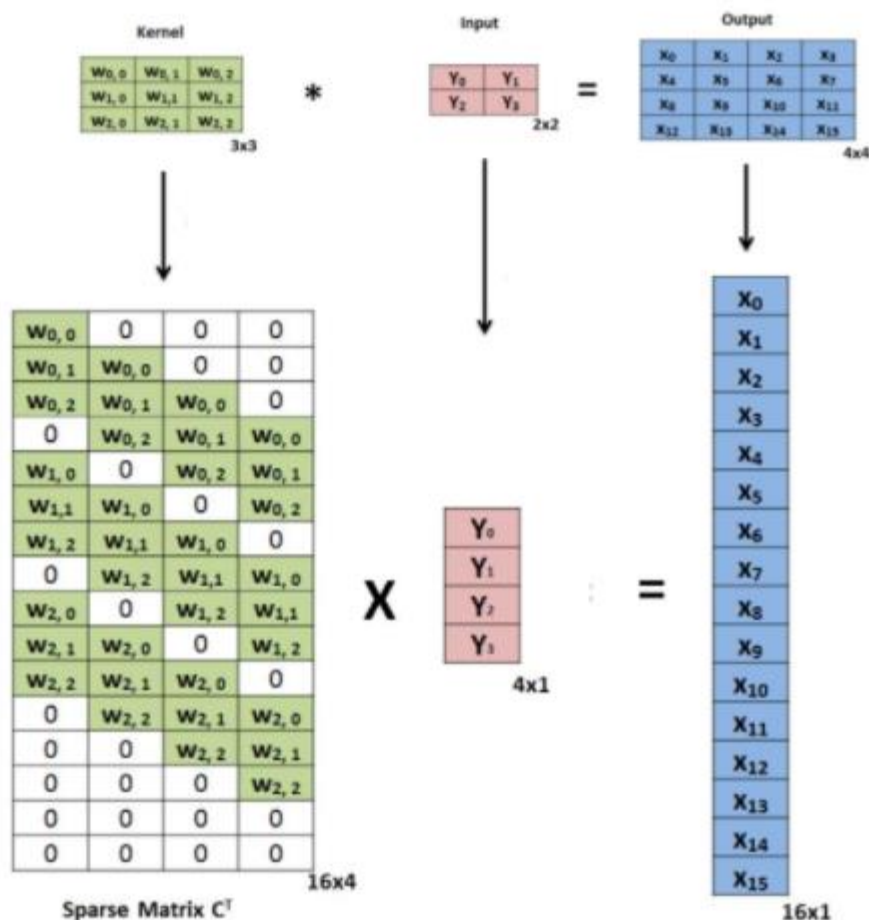
- Transposed convolution, bilinear up-sampling, ...

■ 2D Convolution 연산 과정



Transposed Convolution (cont.)

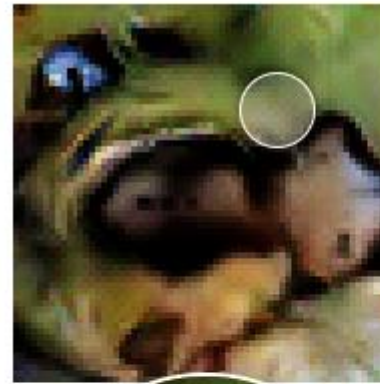
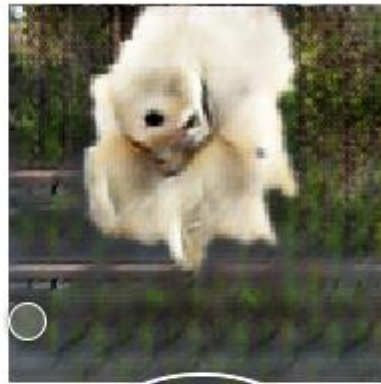
■ 2D Transposed Convolution 연산 과정



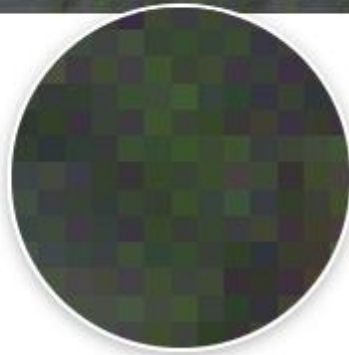
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Transposed Convolution (cont.)

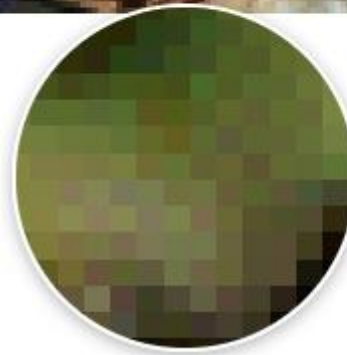
■ Checkboard artifact



Radford, et al., 2015 [1]



Salimans et al., 2016 [2]



Donahue, et al., 2016 [3]



Dumoulin, et al., 2016 [4]

**ANY
QUESTIONS?**