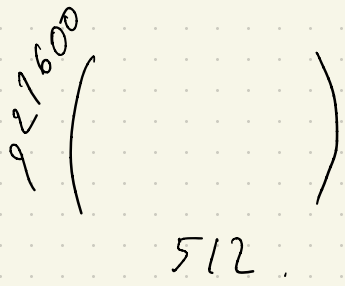
1) $640 \times 480 \times 3 = 921600$



2) пункты „не зависимы".

3) нет инвариантности по сдвигу.

$X \in \mathbb{R}^3$ $\quad \Theta_i \in \mathbb{R}^3 \times \mathbb{R}^3$

$h_1 = \Theta X$, S_L

$$\begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{pmatrix} \begin{pmatrix} x_0 \\ x_1 \\ x_2 \end{pmatrix} = (x_1, x_2, x_0)^T$$

S_L ; S_R.

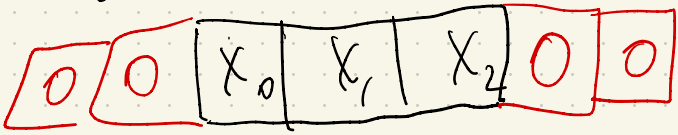
$\Theta(S X) = S (\Theta X)$.

$\Theta S = S \Theta$ циркулянт.

$$\Theta = \begin{pmatrix} k_0 & k_1 & k_2 \\ k_2 & k_0 & k_1 \\ k_1 & k_2 & k_0 \end{pmatrix}$$

$$(\tilde{\Theta} X)_i = \sum_{j=0}^{2} K_{(j-i) \bmod 3} \cdot X_j = \tilde{\Theta} * X$$

$$h_0^2 (\tilde{\Theta} X)_0 = \sum_{j=0}^{2} K_j X_j$$



0: $K_0\ K_1\ K_2$

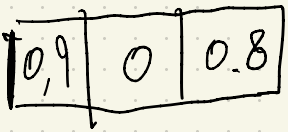
1: $K_2\ K_0\ K_1$

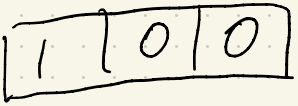
$$\tilde{\Theta} = \begin{pmatrix} K_0 & K_1 & K_2 \\ K_2 & K_0 & K_1 \\ K_1 & K_2 & K_0 \end{pmatrix}$$

$\tilde{\Theta}^T * X$

$\sqrt{\sigma(\theta)\ \sigma(x)}$

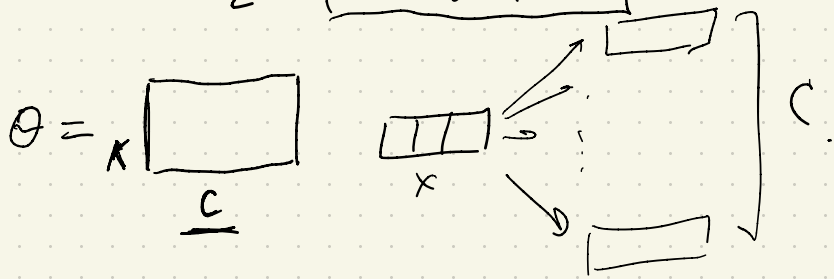
$X =$

$\tilde{\Theta}_0 =$ 

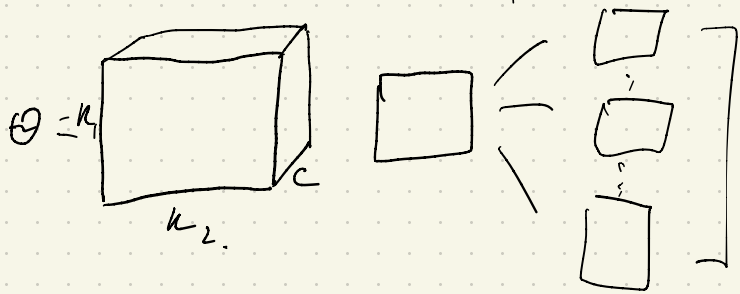
$\tilde{\Theta}_1 =$ 

$\theta_2 = \boxed{1\,0\,|\,0\,|\,0}$

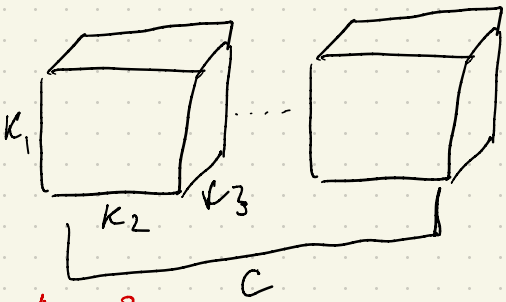
$x \in \mathbb{R}^n$

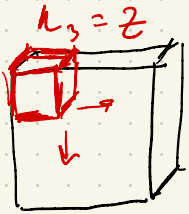


$x \in \mathbb{R}^n \times \mathbb{R}^m$



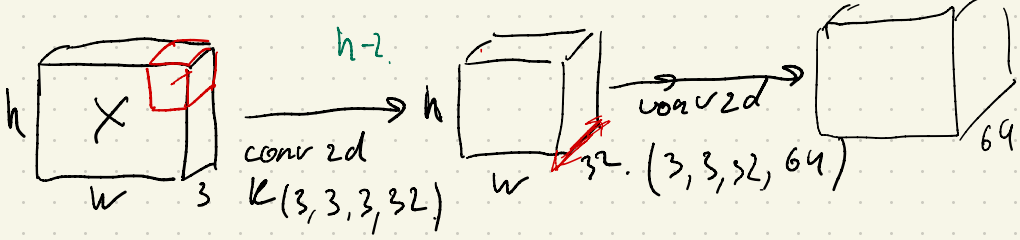
$x \in \mathbb{R}^n \times \mathbb{R}^m \times \mathbb{R}^z$





$\boxed{\text{conv 2D}}$

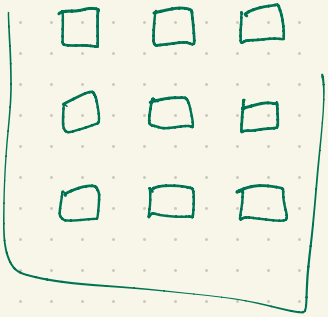
$\boxed{\text{Depth wise - conv.}}$



$w-2$

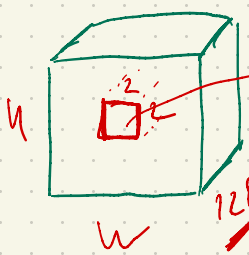
$K(5,5,3,32)$ $\quad w-4$

$$\boxed{w_1 = w - K_w + 1}$$



$$K = \begin{pmatrix} k_{11} & k_{12} & \cdots & k_{1n} \\ \vdots & & & \\ k_{n1} & \cdots & \cdots & k_{nn} \end{pmatrix}$$

h_1



[max pooling.
AVg pooling.]

1) Padding
2) Stride

$\boxed{w, h_1} = X$ $\quad \boxed{w', h'}$

$\boxed{K_w, K_{h_1}}$ $\quad K$

$$W' = \lfloor (W - K_w + 2p + 1) / S \rfloor$$ если pad.

$$W' = \lfloor (W - K_w + 1) / S \rfloor$$ если нет pad.

$W = 8.$ $K_w = 3$ $p = 0.$ $S = 1$

$\underbrace{W - K_3 + 1} = 6.$ $p = 1$

$\underbrace{8 - 3 + 2 + 1 = 8.}$ $p = \lfloor K_w / 2 \rfloor$

$s = 2.$

$(8 - 3 + 2 + 1)/2 = 4.$

$\boxed{n}$

$m \left(\quad \right) = \Theta$

z

$\boxed{m \cdot z = n.}$

$k = \underline{m}$