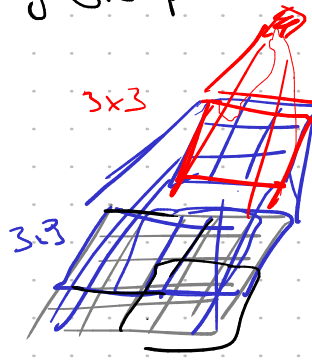
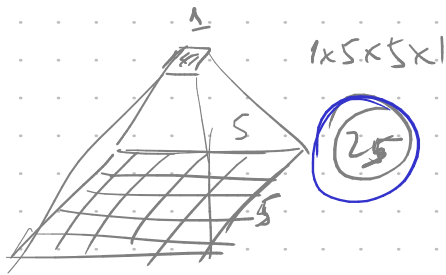


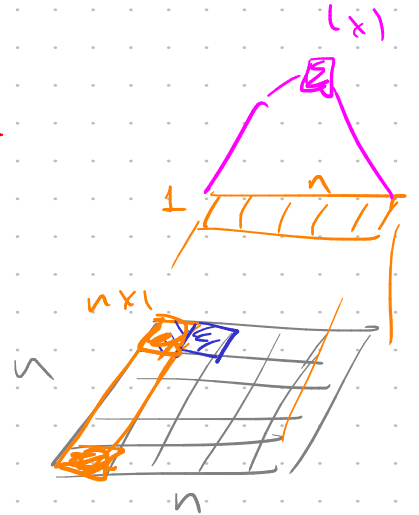
① VGG - Visual Geometry Group



$$9 + 9 + 9 = 27$$

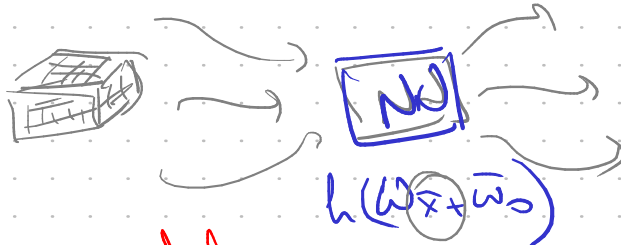
$$11 \times 11 \approx 3 \times 3 + 3 \times 3 + \dots + 3 \times 3$$

$$5 \times 9 = 45$$



$$n^2 \sim 2n$$

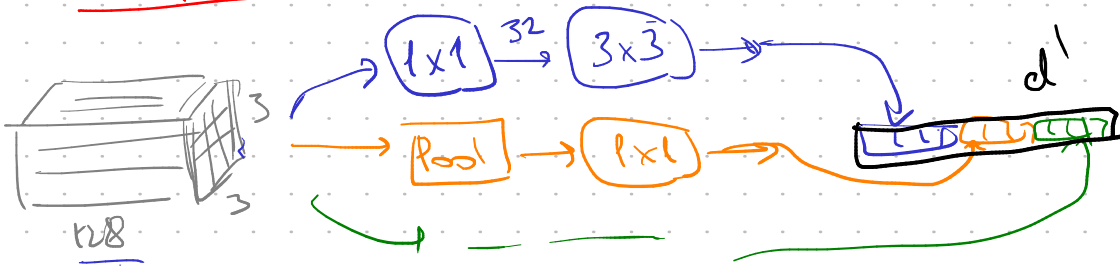
② Network in network



GoogleNet

$$\bar{x}' = h(W\bar{x} + \bar{w}_0)$$

Inception module



③ Auxiliary classifiers

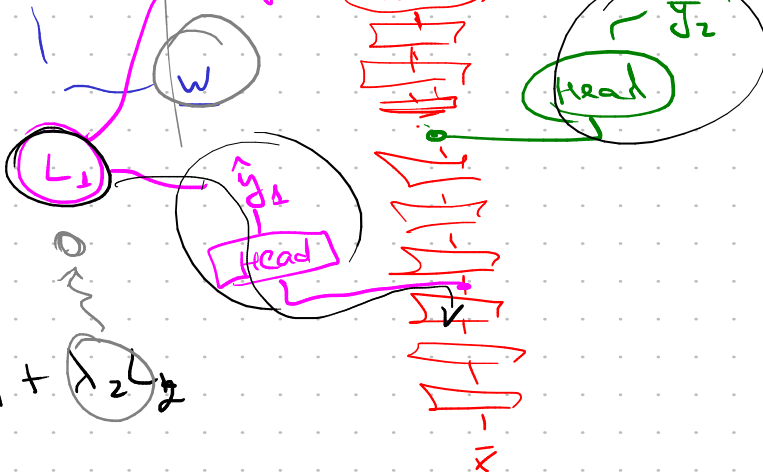


$$\bar{x}^{(k+1)}$$

$$\bar{x}^{(k)}$$

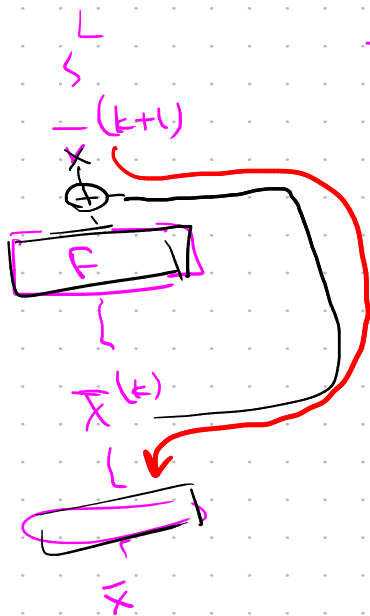
$$\frac{\partial L}{\partial \omega} = \frac{\partial L}{\partial \bar{x}^{(k+1)}} \frac{\partial \bar{x}^{(k+1)}}{\partial \bar{x}^{(k)}} \frac{\partial \bar{x}^{(k)}}{\partial \omega}$$

$$\frac{\partial \bar{x}^{(k+1)}}{\partial \bar{x}^{(k)}} \frac{\partial \bar{x}^{(k)}}{\partial \omega}$$



$$L = L + \lambda_1 L_1 + \lambda_2 L_2$$

4 Residual connections



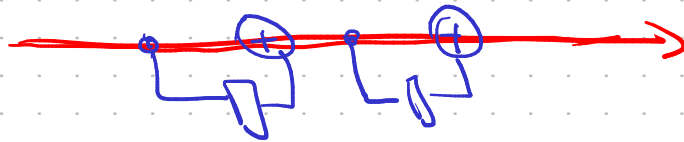
$$\bar{x}^{(k+1)} = F(\bar{x}^{(k)})$$

$$\bar{x}^{(k+1)} = F(\bar{x}^{(k)}) + \bar{x}^{(k)}$$

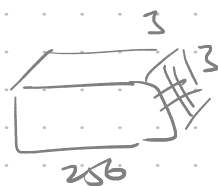
$$\frac{\partial \bar{x}^{(k+1)}}{\partial \bar{x}^{(k)}} = \frac{\partial F}{\partial \bar{x}^{(k)}} + \mathbf{I}$$

$$\frac{\partial F}{\partial \bar{x}^{(k)}} \rightarrow 0$$

$$F \sim x^{(k)} \mapsto x^{(k+1)}$$



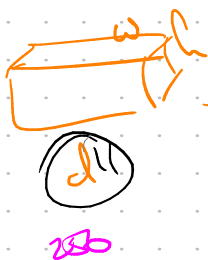
5 Bottlenecks



$$256 \times 3 \times 3 \times 256 = 256 \cdot ((256-9))$$

$$d \times w \times h \sim [d \times w \times h \times d'] \sim d'$$

$$256 \times d'$$



$$d \times 1 \times 1 \times d''$$



$$d'' \times w \times h \times d''$$

$$d'' \times 1 \times 1 \times d''$$

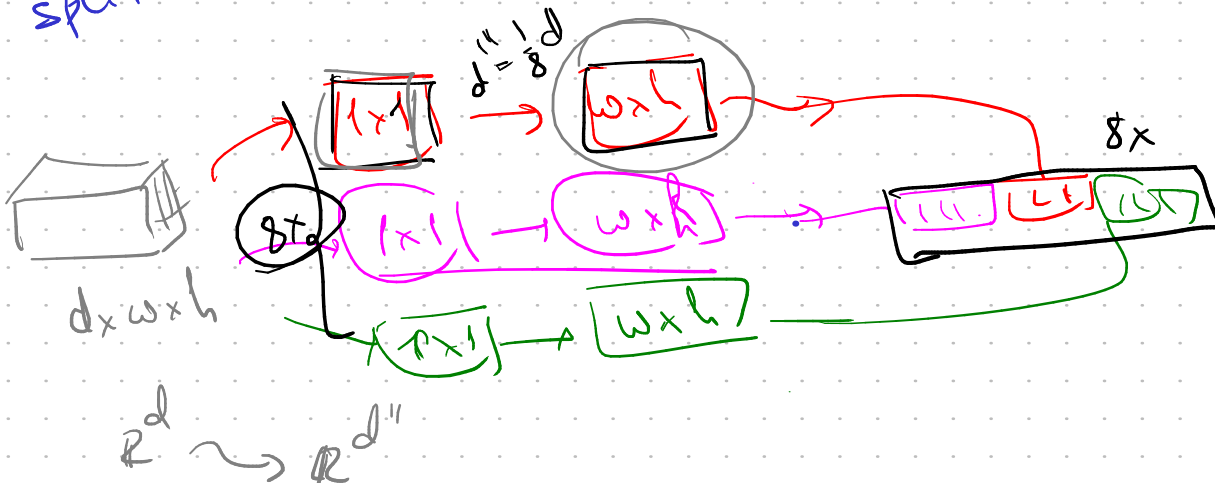
$$256 \cdot 32$$

$$+ 32 \cdot 9 \cdot 32$$

$$+ 32 \cdot 256 =$$

split-transform-merge

$$= 256(32 + 36 + 32) = 256 \cdot 100$$



⑥ Efficient Net

NAS - neural architecture search

- depth $\underline{d} = \alpha$
 - width $\underline{w} = \beta$
 - resolution $\underline{z} = \gamma$

layers d
 channels w^2
 input size z^2

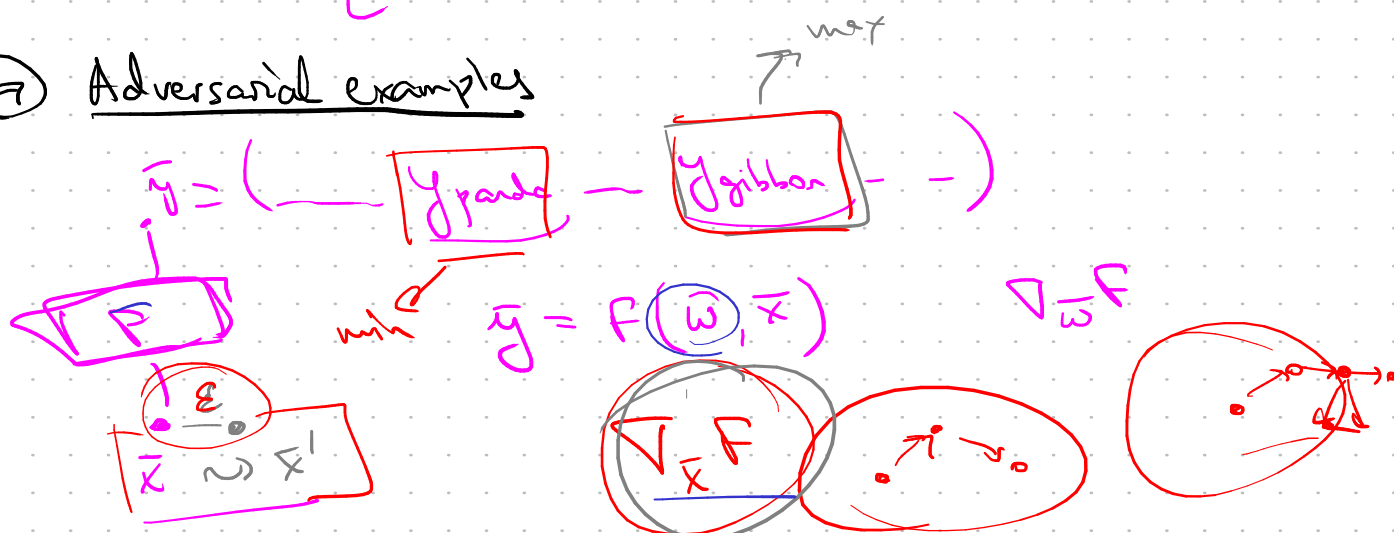
compound scaling

$$\boxed{\text{FLOPs}} \propto d \cdot w^2 \cdot z^2 = (d \cdot \beta^2 \cdot \gamma^2) = c \approx 2$$

$$\begin{cases} \alpha, \beta, \gamma \geq 1 \\ \alpha \beta^2 \gamma^2 = c \end{cases}$$

$$\alpha^*, \beta^*, \gamma^*$$

⑦ Adversarial examples



white-box: $F, \bar{w}$

grey-box: $F, \bar{x}$

black-box: $\bar{x}, \bar{x}'$

$$\nabla_{\bar{x}} (F_1 + F_2 + \dots + F_n)$$

