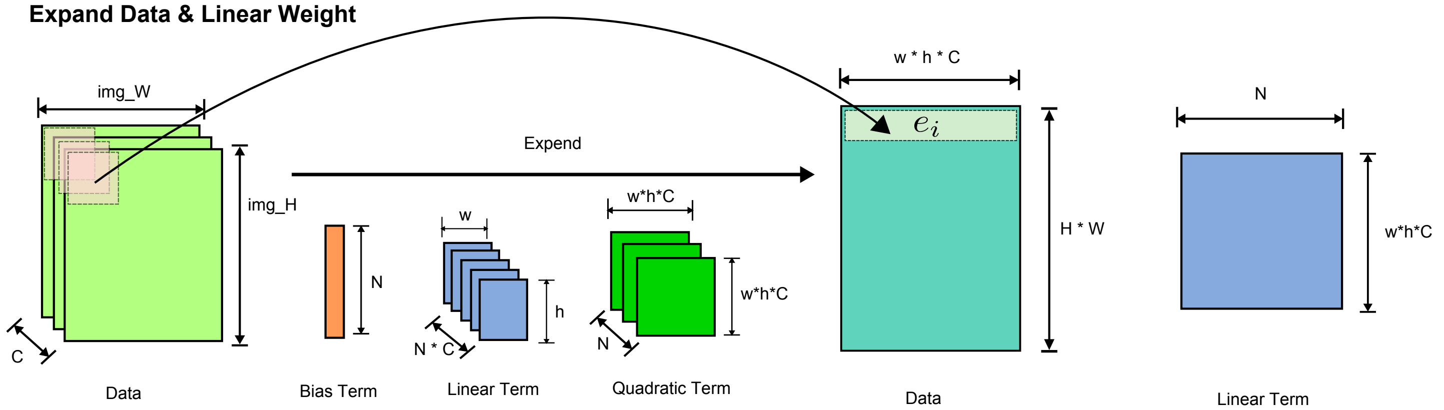
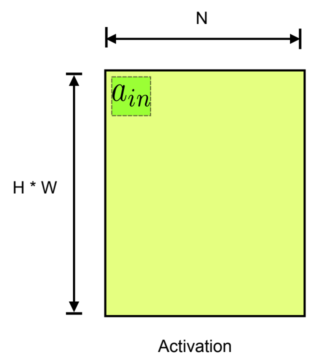
Colinear Convolution

Expand Data & Linear Weight

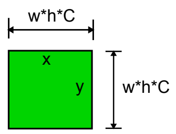


Forward Propagation

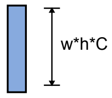


For one w*h*C filter n in [1..N] :

Quadratic Term F_n



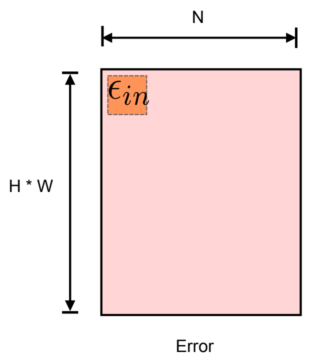
Linear Term S_n



Bias Term b_n

$$a_{in} = e_i F_n e_i^T + S_n e_i^T + b_n$$
$$= \sum_x \sum_y e_{ix} f_{xyn} e_{iy} + \sum_x s_{xn} e_{ix} + b_n$$

Backward Propagation



For one w*h*C filter n in [1..N] :

$$\frac{\partial E}{\partial a_{in}} = \epsilon_{in}$$

Update Parameters :

$$\frac{\partial E}{\partial f_{xyn}} = \sum_i \frac{\partial E}{\partial a_{in}} \cdot \frac{\partial a_{in}}{\partial f_{xyn}} = \sum_i \epsilon_{in} e_{ix} e_{iy}$$

$$\frac{\partial E}{\partial s_{xn}} = \sum_i \frac{\partial E}{\partial a_{in}} \cdot \frac{\partial a_{in}}{\partial s_{xn}} = \sum_i \epsilon_{in} e_{ix}$$

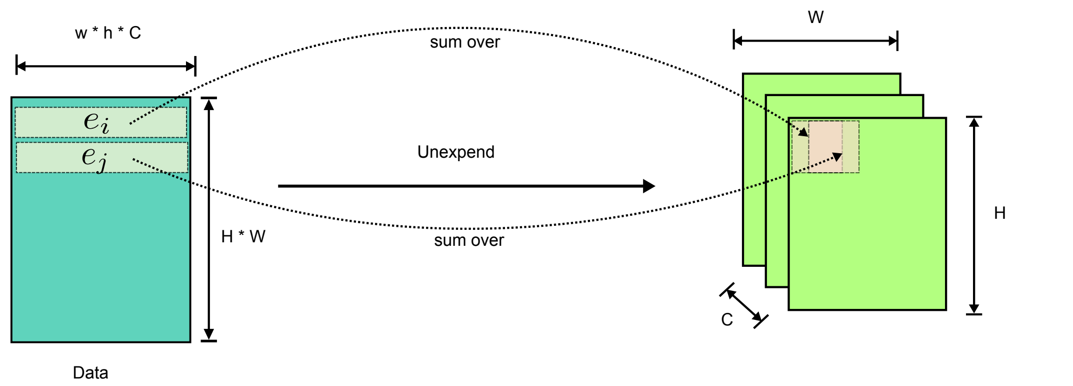
$$\frac{\partial E}{\partial b_n} = \sum_i \frac{\partial E}{\partial a_{in}} \cdot \frac{\partial a_{in}}{\partial b_n} = \sum_i \epsilon_{in}$$

Propagate Errors :

F - **Asymmetric Matrix** $$\frac{\partial E}{\partial e_{ix}} = \sum_n \frac{\partial E}{\partial a_{in}} \cdot \frac{\partial a_{in}}{\partial e_{ix}} = \sum_n \epsilon_{in}\left(\left(\sum_y (f_{xyn} + f_{yxn}) e_{iy}\right) + s_{xn}\right)$$

F - **Symmetric Matrix** $$\frac{\partial E}{\partial e_{ix}} = \sum_n \frac{\partial E}{\partial a_{in}} \cdot \frac{\partial a_{in}}{\partial e_{ix}} = \sum_n \epsilon_{in}\left(\left(2\sum_y f_{xyn} e_{iy}\right) + s_{xn}\right)$$

Unexpand Data



Edit by Pang Liang