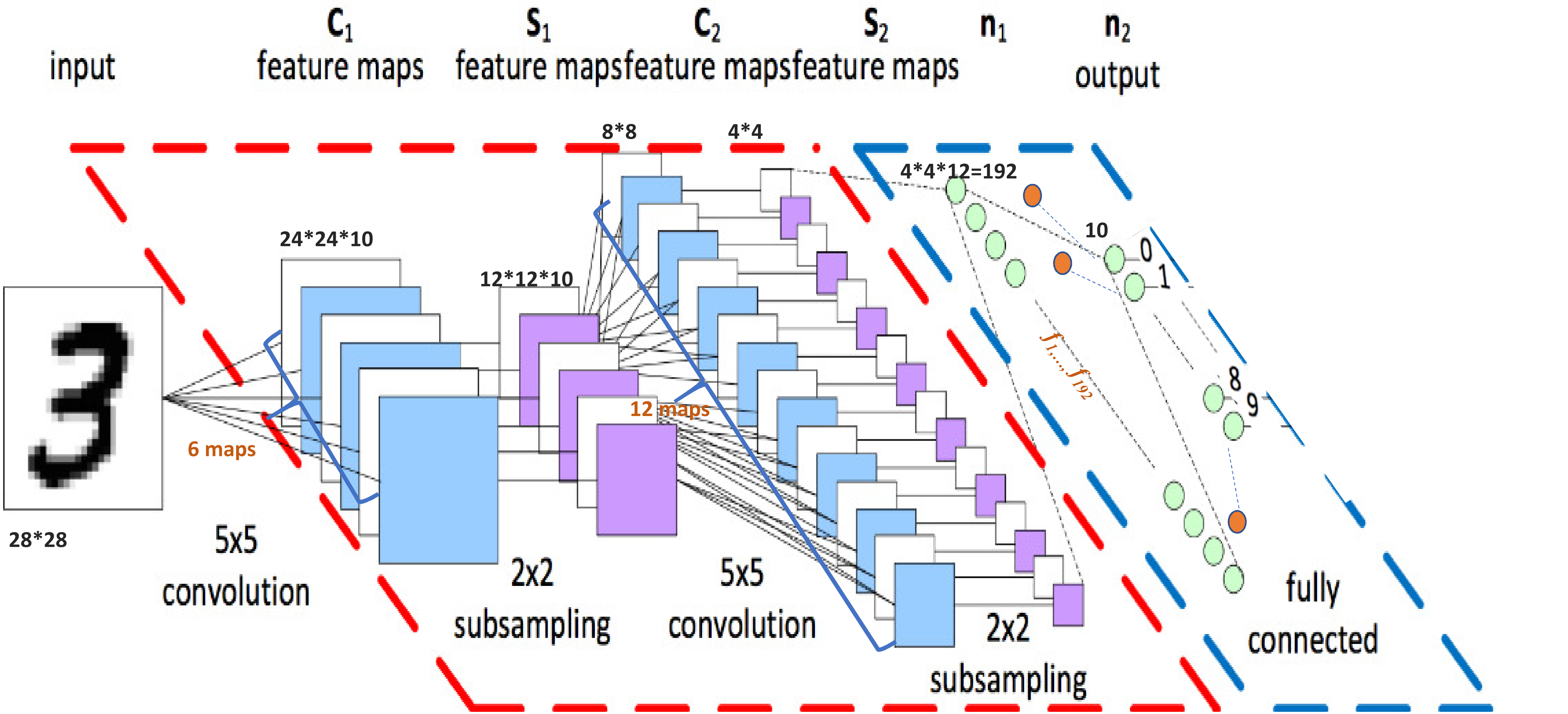
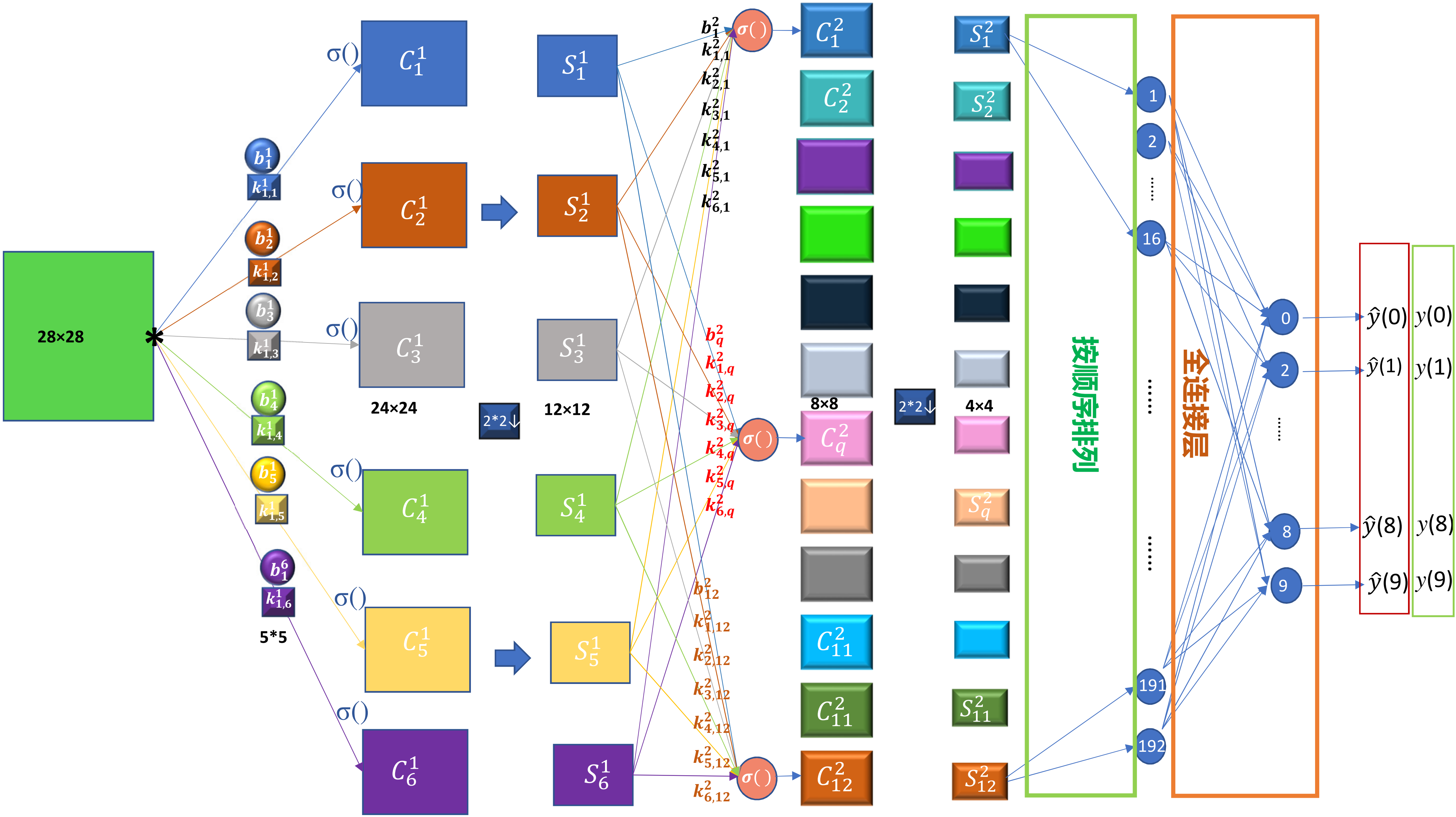
$$\Delta b(i) = \frac{\partial L}{\partial b(i)} = (\hat{y}(i) - y(i)) \cdot \hat{y}(i)(1 - \hat{y}(i))$$

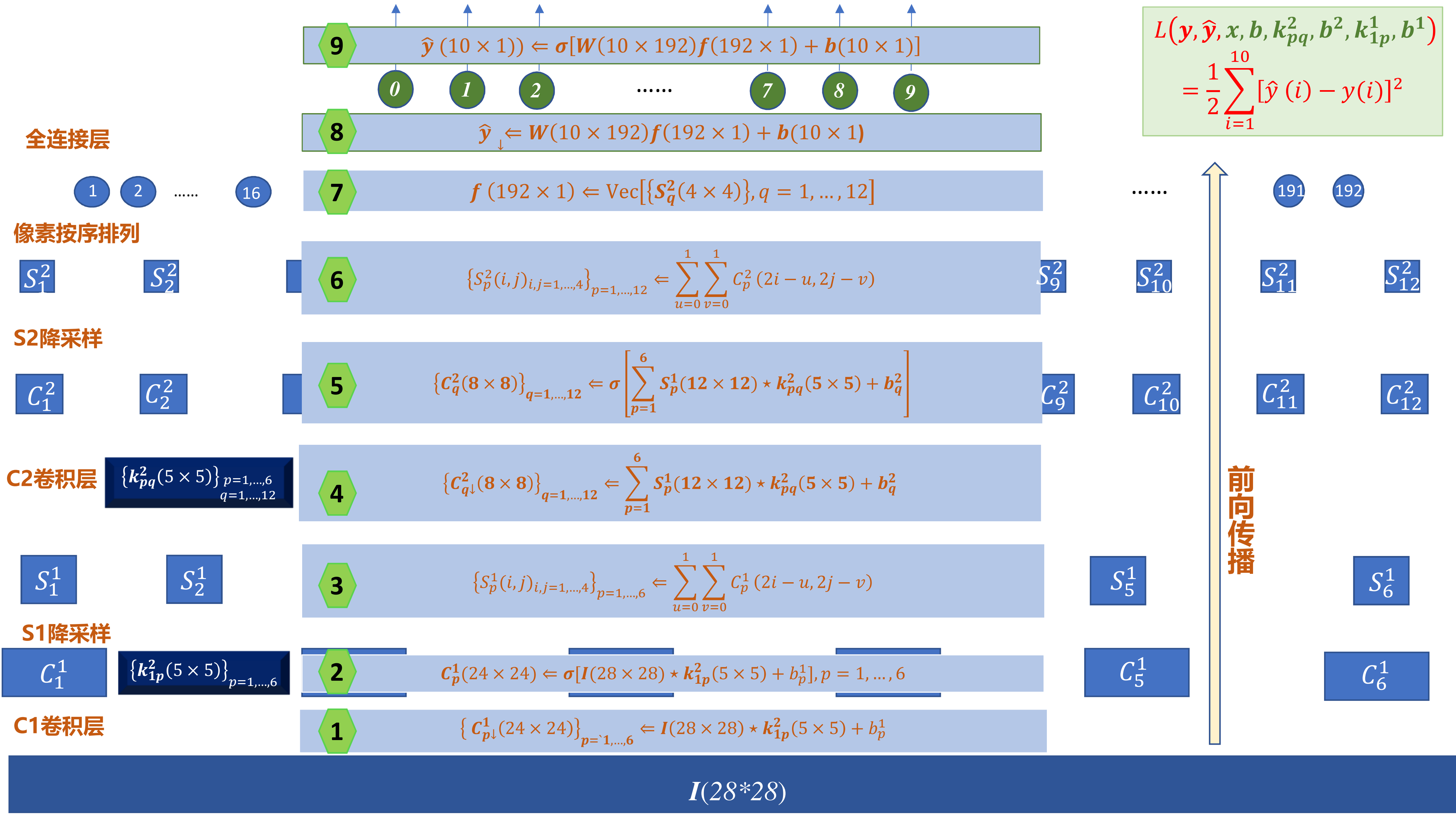
$$\Delta \hat{y}(i) = (\hat{y}(i) - y(i)) \cdot \hat{y}(i)(1 - \hat{y}(i))$$

$$\Delta C_q^2(i,j) = \frac{1}{4} \Delta S_q^2 \left(\lceil i/2 \rceil, \lceil j/2 \rceil \right), \; i,j = 1,2,\cdots,8$$

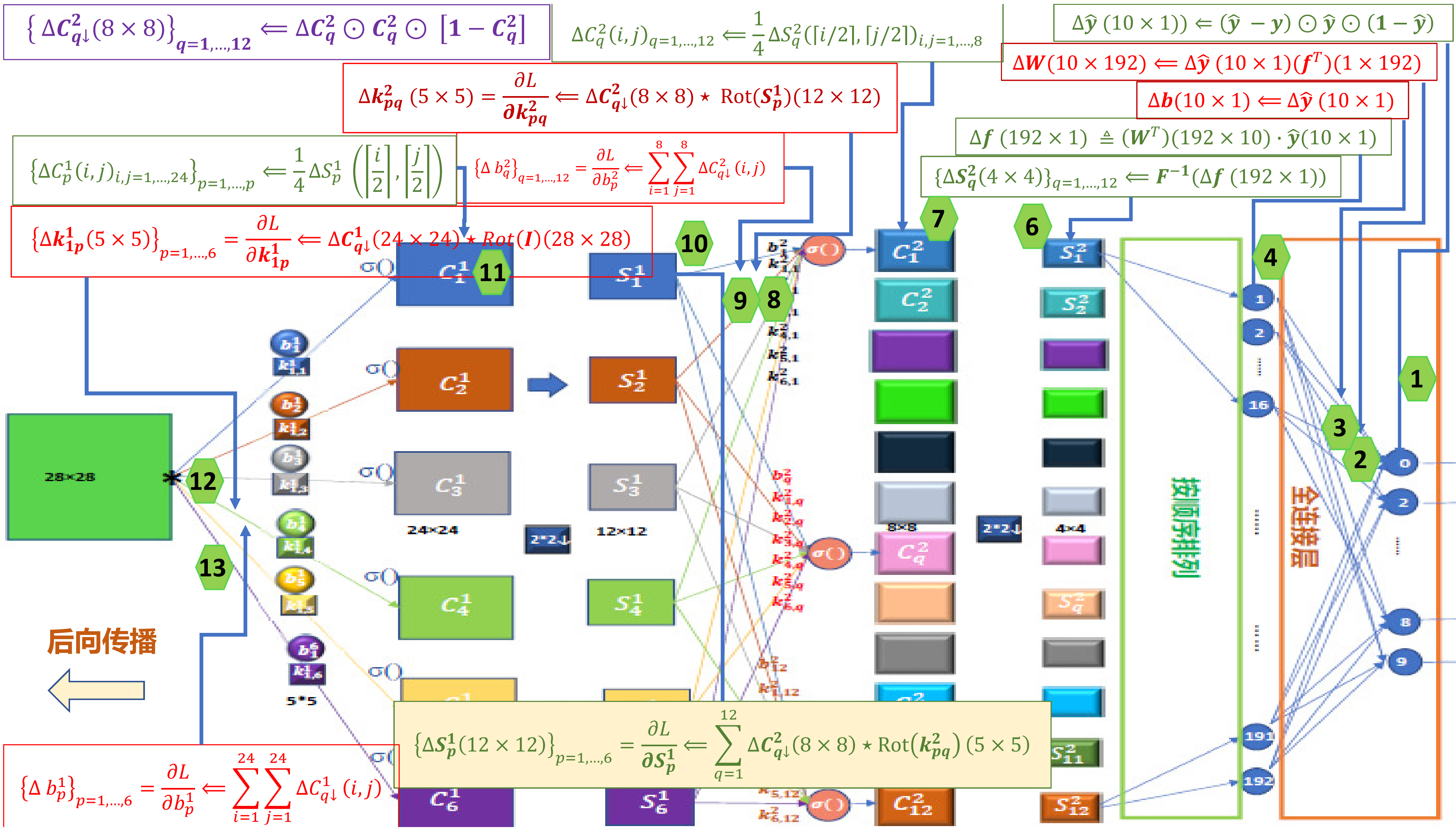
$$\Delta f(j) = \frac{\partial L}{\partial f} = \sum_{i=1}^{10} \Delta \hat{y}(i) \cdot W(i,j)$$




28×28
5*5
24×24
12×12
2*2↓
8×8
4×4
2*2↓
σ()
C_1^1
C_2^1
C_3^1
C_4^1
C_5^1
C_6^1
S_1^1
S_2^1
S_3^1
S_4^1
S_5^1
S_6^1
C_1^2
C_2^2
C_q^2
C_{11}^2
C_{12}^2
S_1^2
S_2^2
S_q^2
S_{11}^2
S_{12}^2
按顺序排列
全连接层
1
2
16
191
192
0
2
8
9
$\hat{y}(0)$ $y(0)$
$\hat{y}(1)$ $y(1)$
$\hat{y}(8)$ $y(8)$
$\hat{y}(9)$ $y(9)$



$L(\boldsymbol{y}, \hat{\boldsymbol{y}}, \boldsymbol{x}, \boldsymbol{b}, \boldsymbol{k}_{pq}^2, \boldsymbol{b}^2, \boldsymbol{k}_{1p}^1, \boldsymbol{b}^1) = \frac{1}{2}\sum_{i=1}^{10}[\hat{y}(i) - y(i)]^2$
9
$\hat{\boldsymbol{y}}(10 \times 1)) \Leftarrow \boldsymbol{\sigma}[\boldsymbol{W}(10 \times 192)\boldsymbol{f}(192 \times 1) + \boldsymbol{b}(10 \times 1)]$
0 1 2 …… 7 8 9
全连接层
8
$\hat{\boldsymbol{y}}_{\downarrow} \Leftarrow \boldsymbol{W}(10 \times 192)\boldsymbol{f}(192 \times 1) + \boldsymbol{b}(10 \times 1)$
1 2 …… 16
7
$\boldsymbol{f}(192 \times 1) \Leftarrow \mathrm{Vec}[\{\boldsymbol{S}_q^2(4 \times 4)\}, q = 1, \ldots, 12]$
…… 191 192
像素按序排列
S_1^2 S_2^2
6
$\{S_p^2(i,j)_{i,j=1,\ldots,4}\}_{p=1,\ldots,12} \Leftarrow \sum_{u=0}^{1}\sum_{v=0}^{1} C_p^2(2i-u, 2j-v)$
S_9^2 S_{10}^2 S_{11}^2 S_{12}^2
S2降采样
C_1^2 C_2^2
5
$\{\boldsymbol{C}_q^2(8 \times 8)\}_{q=1,\ldots,12} \Leftarrow \boldsymbol{\sigma}\left[\sum_{p=1}^{6} \boldsymbol{S}_p^1(12 \times 12) \star \boldsymbol{k}_{pq}^2(5 \times 5) + \boldsymbol{b}_q^2\right]$
C_9^2 C_{10}^2 C_{11}^2 C_{12}^2
C2卷积层
$\{\boldsymbol{k}_{pq}^2(5 \times 5)\}_{p=1,\ldots,6;\ q=1,\ldots,12}$
4
$\{\boldsymbol{C}_{q\downarrow}^2(8 \times 8)\}_{q=1,\ldots,12} \Leftarrow \sum_{p=1}^{6} \boldsymbol{S}_p^1(12 \times 12) \star \boldsymbol{k}_{pq}^2(5 \times 5) + \boldsymbol{b}_q^2$
前向传播
S_1^1 S_2^1
3
$\{S_p^1(i,j)_{i,j=1,\ldots,4}\}_{p=1,\ldots,6} \Leftarrow \sum_{u=0}^{1}\sum_{v=0}^{1} C_p^1(2i-u, 2j-v)$
S_5^1 S_6^1
S1降采样
C_1^1
$\{\boldsymbol{k}_{1p}^2(5 \times 5)\}_{p=1,\ldots,6}$
2
$\boldsymbol{C}_p^1(24 \times 24) \Leftarrow \boldsymbol{\sigma}[\boldsymbol{I}(28 \times 28) \star \boldsymbol{k}_{1p}^2(5 \times 5) + b_p^1], p = 1, \ldots, 6$
C_5^1 C_6^1
C1卷积层
1
$\{\boldsymbol{C}_{p\downarrow}^1(24 \times 24)\}_{p=`1,\ldots,6} \Leftarrow \boldsymbol{I}(28 \times 28) \star \boldsymbol{k}_{1p}^2(5 \times 5) + b_p^1$
$\boldsymbol{I}(28*28)$



$\{\Delta C^2_{q\downarrow}(8\times 8)\}_{q=1,\dots,12} \Leftarrow \Delta C^2_q \odot C^2_q \odot [1-C^2_q]$
$\Delta C^2_q(i,j)_{q=1,\dots,12} \Leftarrow \frac{1}{4}\Delta S^2_q(\lceil i/2\rceil,\lceil j/2\rceil)_{i,j=1,\dots,8}$
$\Delta\hat{y}\ (10\times 1)) \Leftarrow (\hat{y}-y)\odot\hat{y}\odot(1-\hat{y})$
$\Delta W(10\times 192) \Leftarrow \Delta\hat{y}\ (10\times 1)(f^T)(1\times 192)$
$\Delta k^2_{pq}\ (5\times 5) = \frac{\partial L}{\partial k^2_{pq}} \Leftarrow \Delta C^2_{q\downarrow}(8\times 8) \star \mathrm{Rot}(S^1_p)(12\times 12)$
$\Delta b(10\times 1) \Leftarrow \Delta\hat{y}\ (10\times 1)$
$\Delta f\ (192\times 1) \triangleq (W^T)(192\times 10)\cdot\hat{y}(10\times 1)$
$\{\Delta C^1_p(i,j)_{i,j=1,\dots,24}\}_{p=1,\dots,p} \Leftarrow \frac{1}{4}\Delta S^1_p\left(\left\lceil\frac{i}{2}\right\rceil,\left\lceil\frac{j}{2}\right\rceil\right)$
$\{\Delta\, b^2_q\}_{q=1,\dots,12} = \frac{\partial L}{\partial b^2_p} \Leftarrow \sum_{i=1}^{8}\sum_{j=1}^{8}\Delta C^2_{q\downarrow}(i,j)$
$\{\Delta S^2_q(4\times 4)\}_{q=1,\dots,12} \Leftarrow F^{-1}(\Delta f\ (192\times 1))$
$\{\Delta k^1_{1p}(5\times 5)\}_{p=1,\dots,6} = \frac{\partial L}{\partial k^1_{1p}} \Leftarrow \Delta C^1_{q\downarrow}(24\times 24) \star Rot(I)(28\times 28)$
28×28
24×24
12×12
8×8
4×4
2*2↓
5*5
按顺序排列
全连接层
后向传播
$\{\Delta S^1_p(12\times 12)\}_{p=1,\dots,6} = \frac{\partial L}{\partial S^1_p} \Leftarrow \sum_{q=1}^{12}\Delta C^2_{q\downarrow}(8\times 8) \star \mathrm{Rot}(k^2_{pq})\ (5\times 5)$
$\{\Delta\, b^1_p\}_{p=1,\dots,6} = \frac{\partial L}{\partial b^1_p} \Leftarrow \sum_{i=1}^{24}\sum_{j=1}^{24}\Delta C^1_{q\downarrow}(i,j)$

$$\Delta\,\hat{y}(i) \triangleq \big(\hat{y}(i) - y(i)\big)\hat{y}(i)\big(1 - \hat{y}(i)\big), i = 1, \dots, 10$$

$$\Delta b(i) = \frac{\partial L}{\partial b(i)} = (\hat{y}(i) - y(i))\hat{y}(i)(1 - \hat{y}(i)) = \Delta\,\hat{y}(i), i = 1, \dots, 10.$$

$$\Delta W(i,j) = \frac{\partial L}{\partial W(i,j)} = \Delta\,\hat{y}(i) f(j), i = 1, \dots, 10; j = 1, \dots, 192$$

$$\Delta f(i) = \frac{\partial L}{\partial f(i)} \Leftarrow \sum_{i=1}^{8} \Delta\,\hat{y}(i)\, W(i,j), i = 1, \dots, 192$$

$$\{\Delta S_q^2(i,j)\}_{q=1,\dots,12}, i,j = 1, \dots, 4 \Leftarrow F^{-1}(\Delta f(k), k = 1, \dots, 192)$$

$$\Delta C_q^2(i,j)_{q=1,\dots,12} \Leftarrow \frac{1}{4}\Delta S_q^2(\lceil i \rceil, \lceil j \rceil)_{i,j=1,\dots,8}$$

$$\{\Delta\, b_q^2\}_{q=1,\dots,12} = \frac{\partial L}{\partial b_q^2}$$

$$\Leftarrow \sum_{i=1}^{8}\sum_{j=1}^{8} \Delta C_q^2\,(i,j) C_q^2(i,j)\big[1 - C_q^2(i,j)\big] = \sum_{i=1}^{8}\sum_{j=1}^{8} \Delta C_{q\downarrow}^2\,(i,j)$$

$$\Delta k_{pq}^2(u,v)_{u,v=1,\dots,5} = \frac{\partial L}{\partial k_{pq}^2(u,v)} \Leftarrow \sum_{i=1}^{8}\sum_{j=1}^{8} \Delta C_{q\downarrow}^2\,(i,j)\, S_p^1(i-u, j-v)$$

$$= \sum_{i=1}^{8}\sum_{j=1}^{8} \Delta C_{q\downarrow}^2\,(i,j)\, Rot\big(S_p^1\big)(u-i, v-j) = \Delta C_{q\downarrow}^2 * Rot\big(S_p^1\big)(u,v)$$

$$C_{q\downarrow}^2(i,j) = \sum_{p=1}^{6}\sum_{u=-2}^{2}\sum_{v=-2}^{2} S_p^1\,(i-u, j-v)\, k_{pq}^2(u,v) + b_q^2,\ i,j = 1, \dots, 12$$

$$\Delta C_{q\downarrow}^2(i,j) \Leftarrow \Delta C_q^2(i,j) C_q^2(i,j)\,\big[1 - C_q^2(i,j)\big], i,j = 1, \dots, 12$$

$$C_{q\downarrow}^2(i,j) = \sum_{p=1}^{6} \boldsymbol{S_p^1} \star \boldsymbol{k_{pq}^2}(i,j) + b_q^2,\ i,j = 1, \dots, 12$$

$$\Delta\widehat{\boldsymbol{y}}\ (10\times 1))\Leftarrow(\widehat{\boldsymbol{y}}\ -\boldsymbol{y})\odot\widehat{\boldsymbol{y}}\odot(\mathbf{1}-\widehat{\boldsymbol{y}})$$

$$\Delta\boldsymbol{b}(10\times 1)\Longleftarrow\Delta\widehat{\boldsymbol{y}}\ (10\times 1)$$

$$\Delta\boldsymbol{W}(10\times 192)\Longleftarrow\Delta\widehat{\boldsymbol{y}}\ (10\times 1)(\boldsymbol{f}^{T})(1\times 192)$$

$$\Delta\boldsymbol{f}\ (192\times 1)\ \triangleq(\boldsymbol{W}^{T})(192\times 10)\cdot\widehat{\boldsymbol{y}}(10\times 1)$$

$$\{\Delta\boldsymbol{S}_{\boldsymbol{q}}^{\mathbf{2}}(4\times 4)\}_{q=1,\dots,12}\Longleftarrow\boldsymbol{F}^{-\mathbf{1}}(\Delta\boldsymbol{f}\ (192\times 1))$$

$$\Delta C_q^2(i,j)_{q=1,\dots,12}\Longleftarrow\frac{1}{4}\Delta S_q^2(\lceil i/2\rceil,\lceil j/2\rceil)_{i,j=1,\dots,8}$$

$$\begin{array}{ccccccc}
\boxed{\begin{array}{ll}\Delta C_q^2(1,1); & \Delta C_q^2(1,2)\\ \Delta C_q^2(2,1); & \Delta C_q^2(2,2)\end{array}} & =\frac{1}{4}\Delta S_q^2(1,1) & \cdots & \boxed{\begin{array}{ll}\Delta C_q^2(1,7); & \Delta C_q^2(1,8)\\ \Delta C_q^2(2,7); & \Delta C_q^2(2,8)\end{array}} & =\frac{1}{4}\Delta S_q^2(1,4)\\
\vdots & & & \vdots & \\
\boxed{\begin{array}{ll}\Delta C_q^2(7,1); & \Delta C_q^2(7,2)\\ \Delta C_q^2(8,1); & \Delta C_q^2(8,2)\end{array}} & =\frac{1}{4}\Delta S_q^2(4,1) & \cdots & \boxed{\begin{array}{ll}\Delta C_q^2(7,7); & \Delta C_q^2(7,8)\\ \Delta C_q^2(8,7); & \Delta C_q^2(8,8)\end{array}} & =\frac{1}{4}\Delta S_q^2(4,4)
\end{array}$$

$$\{\Delta\ b_q^2\}_{q=1,\dots,12}=\frac{\partial L}{\partial b_p^2}\Leftarrow\sum_{i=1}^{8}\sum_{j=1}^{8}\Delta C_{q\downarrow}^2\ (i,j)$$

$$\Delta\boldsymbol{k}_{\boldsymbol{pq}}^{\mathbf{2}}\ (5\times 5)=\frac{\partial L}{\boldsymbol{\partial k}_{\boldsymbol{pq}}^{\mathbf{2}}}\Longleftarrow\Delta\boldsymbol{C}_{\boldsymbol{q}\downarrow}^{\mathbf{2}}(8\times 8)\star\ \mathrm{Rot}(\boldsymbol{S}_{\boldsymbol{p}}^{\mathbf{1}})(12\times 12)$$

$$\left\{\Delta\boldsymbol{C}_{\boldsymbol{q}\downarrow}^{\mathbf{2}}(8\times 8)\right\}_{\boldsymbol{q}=\mathbf{1},\dots,\mathbf{12}}\Longleftarrow\Delta\boldsymbol{C}_{\boldsymbol{q}}^{\mathbf{2}}\odot\boldsymbol{C}_{\boldsymbol{q}}^{\mathbf{2}}\odot\ \left[\mathbf{1}-\boldsymbol{C}_{\boldsymbol{q}}^{\mathbf{2}}\right]$$

$$\left\{\boldsymbol{C}_{\boldsymbol{q}\downarrow}^{\mathbf{2}}(8\times 8)\right\}_{q=1,\dots,12}=\sum_{p=1}^{6}\boldsymbol{S}_{\boldsymbol{p}}^{\mathbf{1}}(\mathbf{12}\times\mathbf{12})\star\boldsymbol{k}_{\boldsymbol{pq}}^{\mathbf{2}}(5\times 5)+b_q^2$$

$$C_{q\downarrow}^2(i,j)=\sum_{p=1}^{6}\boldsymbol{S}_{\boldsymbol{p}}^{\mathbf{1}}\star\boldsymbol{k}_{\boldsymbol{pq}}^{\mathbf{2}}(i,j)+b_q^2,\ i,j=1,\dots,12$$

$$\left\{\Delta\boldsymbol{S}_{\boldsymbol{p}}^{\mathbf{1}}(12\times 12)\right\}_{p=1,\dots,6}=\frac{\partial L}{\boldsymbol{\partial S}_{\boldsymbol{p}}^{\mathbf{1}}}\Leftarrow\sum_{q=1}^{12}\Delta\boldsymbol{C}_{\boldsymbol{q}\downarrow}^{\mathbf{2}}(8\times 8)\star\mathrm{Rot}\left(\boldsymbol{k}_{\boldsymbol{pq}}^{\mathbf{2}}\right)(5\times 5)$$

$$\left\{\Delta \boldsymbol{S}_p^{\mathbf{1}}(12\times 12)\right\}_{p=1,\ldots,6} = \frac{\partial L}{\boldsymbol{\partial S}_p^{\mathbf{1}}} \Leftarrow \sum_{q=1}^{12} \Delta \boldsymbol{C}_{q\downarrow}^{\mathbf{2}}(8\times 8) \star \mathrm{Rot}\left(\boldsymbol{k}_{pq}^{\mathbf{2}}\right)(5\times 5)$$

$$\left\{\Delta C_p^1(i,j)_{i,j=1,\ldots,24}\right\}_{p=1,\ldots,p} \Leftarrow \frac{1}{4}\Delta S_p^1\left(\left\lceil\frac{i}{2}\right\rceil,\left\lceil\frac{j}{2}\right\rceil\right)$$

$$\left\{\Delta\, b_p^1\right\}_{p=1,\ldots,6} = \frac{\partial L}{\partial b_p^1} \Leftarrow \sum_{i=1}^{24}\sum_{j=1}^{24} \Delta C_{q\downarrow}^1\,(i,j)$$

$$\left\{\Delta \boldsymbol{k}_{\mathbf{1}\boldsymbol{p}}^{\mathbf{1}}(5\times 5)\right\}_{p=1,\ldots,6} = \frac{\partial L}{\partial \boldsymbol{k}_{\mathbf{1}\boldsymbol{p}}^{\mathbf{1}}} \Leftarrow \Delta \boldsymbol{C}_{\boldsymbol{q}\downarrow}^{\mathbf{1}}(24\times 24) \star Rot(\boldsymbol{I})(28\times 28)$$

$$\left\{\Delta \boldsymbol{C}_{\boldsymbol{p}\downarrow}^{\mathbf{1}}\right\}_{\boldsymbol{p}=\mathbf{1},\ldots,\mathbf{6}} \Leftarrow \Delta \boldsymbol{C}_{\boldsymbol{p}}^{\mathbf{1}} \odot \boldsymbol{C}_{\boldsymbol{p}}^{\mathbf{1}} \odot \left[\mathbf{1} - \boldsymbol{C}_{\boldsymbol{p}}^{\mathbf{1}}\right]$$

$$\left\{\boldsymbol{C}_{\boldsymbol{p}\downarrow}^{\mathbf{1}}(24\times 24)\right\}_{p=1,\ldots,6} = \boldsymbol{I}(28\times 28) \star \boldsymbol{k}_{\mathbf{1}\boldsymbol{p}}^{\mathbf{2}}(5\times 5) + b_p^1$$

$$\Delta\,\hat{y}(i) \triangleq \big(\hat{y}(i) - y(i)\big)\hat{y}(i)\big(1-\hat{y}(i)\big), i = 1, \ldots, 10$$

$$\Delta b(i) = \frac{\partial L}{\partial b(i)} = (\hat{y}(i) - y(i))\hat{y}(i)(1-\hat{y}(i)) = \Delta\,\hat{y}(i), i = 1, \ldots, 10.$$

$$\Delta W(i,j) = \frac{\partial L}{\partial W(i,j)} = \Delta\,\hat{y}(i) f(j), i = 1, \ldots, 10; j = 1, \ldots, 192$$

$$\Delta f(i) = \frac{\partial L}{\partial f(i)} \Leftarrow \sum_{i=1}^{8} \Delta\,\hat{y}(i)\,W(i,j), i = 1, \ldots, 192$$

$$\{\Delta S_q^2(i,j)\}_{q=1,\ldots,12}, i,j = 1, \ldots, 4 \Leftarrow F^{-1}(\Delta f(k), k = 1, \ldots, 192)$$

$$\Delta C_q^2(i,j)_{q=1,\ldots,12} \Leftarrow \frac{1}{4}\Delta S_q^2(\lceil i\rceil, \lceil j\rceil)_{i,j=1,\ldots,8}$$

$$\{\Delta\, b_q^2\}_{q=1,\ldots,12} = \frac{\partial L}{\partial b_q^2}$$
$$\Leftarrow \sum_{i=1}^{8}\sum_{j=1}^{8} \Delta C_q^2\,(i,j) C_q^2(i,j)\big[1 - C_q^2(i,j)\big] = \sum_{i=1}^{8}\sum_{j=1}^{8} \Delta C_{q\downarrow}^2\,(i,j)$$

$$\Delta k_{pq}^2(u,v)_{u,v=1,\ldots,5} = \frac{\partial L}{\partial k_{pq}^2(u,v)} \Leftarrow \sum_{i=1}^{8}\sum_{j=1}^{8} \Delta C_{q\downarrow}^2\,(i,j)\, S_p^1(i-u, j-v)$$
$$= \sum_{i=1}^{8}\sum_{j=1}^{8} \Delta C_{q\downarrow}^2\,(i,j)\, Rot\big(S_p^1\big)(u-i, v-j) = \Delta C_{q\downarrow}^2 * Rot\big(S_p^1\big)(u,v)$$

$$C_{q\downarrow}^2(i,j) = \sum_{p=1}^{6}\sum_{u=-2}^{2}\sum_{v=-2}^{2} S_p^1\,(i-u, j-v)\, k_{pq}^2(u,v) + b_q^2,\ i,j$$
$$= 1, \ldots, 12$$

$$\Delta C_{q\downarrow}^2(i,j) \ \Leftarrow \Delta C_q^2(i,j) C_q^2(i,j)\,\big[1 - C_q^2(i,j)\big], i,j = 1, \ldots, 12$$

$$C_{q\downarrow}^2(i,j) = \sum_{p=1}^{6} \boldsymbol{S_p^1} \star \boldsymbol{k_{pq}^2}(i,j) + b_q^2,\ i,j = 1, \ldots, 12$$

$$\Delta S_p^1(i,j)_{i,j=1,\dots,12} = \frac{\partial L}{\partial S_p^1(i,j)} \Leftarrow \sum_{q=1}^{12}\sum_{u=-2}^{2}\sum_{v=-2}^{2} \Delta C_{q\downarrow}^2\,(i+u, j+v)\, k_{pq}^2(u,v) = \sum_{q=1}^{12}\sum_{u=-2}^{2}\sum_{v=-2}^{2} \Delta C_{q\downarrow}^2\,(i+u, j+v)\,\mathrm{Rot}(k_{pq}^2)(-u,-v)$$

$$= \sum_{q=1}^{12}\sum_{u=-2}^{2}\sum_{v=-2}^{2} \Delta C_{q\downarrow}^2\,(i-(-u), j-(-v))\,\mathrm{Rot}(k_{pq}^2)(-u,-v) = \sum_{q=1}^{12} \Delta C_{q\downarrow}^2 * \mathrm{Rot}\big(k_{pq}^2\big)(i,j)$$

$$\Delta C_p^1(i,j)_{p=1,\dots,6} \Leftarrow \frac{1}{4}\Delta S_p^1\left(\left\lceil\frac{i}{2}\right\rceil, \left\lceil\frac{j}{2}\right\rceil\right), i,j = 1,\dots,24$$

$$\{\Delta\, b_p^1\}_{p=1,\dots,6} = \frac{\partial L}{\partial b_p^1}$$

$$\Leftarrow \sum_{i=1}^{8}\sum_{j=1}^{8} \Delta C_q^1\,(i,j) C_q^1(i,j)\big[1 - C_q^1(i,j)\big] = \sum_{i=1}^{24}\sum_{j=1}^{24} \Delta C_{q\downarrow}^1\,(i,j)$$

$$\Delta k_{1p}^1(u,v)_{u,v=1,\dots,5} = \frac{\partial L}{\partial k_{1p}^1(u,v)} \Leftarrow \sum_{i=1}^{24}\sum_{j=1}^{24} \Delta C_{q\downarrow}^1\,(i,j)\, I(i-u, j-v)$$

$$= \sum_{i=1}^{24}\sum_{j=1}^{24} \Delta C_{q\downarrow}^1\,(i,j)\, Rot(I)(u-i, v-j) = \Delta C_{q\downarrow}^1 * Rot(I)(u,v)$$

$$\Delta C_{p\downarrow}^1(i,j) \Leftarrow \Delta C_p^1(i,j) C_p^1(i,j)\,\big[1 - C_p^1(i,j)\big], i,j = 1,\dots,24,\ p=1,\dots,6$$

$$C_{p\downarrow}^1(i,j) = \boldsymbol{I} \star \boldsymbol{k_{1p}^2}(i,j) + b_p^1, \qquad i,j = 1,\dots,24,\ p=1,\dots,6$$

$$\begin{matrix} \Delta C_q^2(1,1); & \Delta C_q^2(1,2) \\ \Delta C_q^2(2,1); & \Delta C_q^2(2,2) \end{matrix} = \frac{1}{4}\Delta S_q^2(1,1) \quad \cdots \quad \begin{matrix} \Delta C_q^2(1,7); & \Delta C_q^2(1,8) \\ \Delta C_q^2(2,7); & \Delta C_q^2(2,8) \end{matrix} = \frac{1}{4}\Delta S_q^2(1,4)$$

$$\vdots \qquad\qquad \vdots$$

$$\begin{matrix} \Delta C_q^2(7,1); & \Delta C_q^2(7,2) \\ \Delta C_q^2(8,1); & \Delta C_q^2(8,2) \end{matrix} = \frac{1}{4}\Delta S_q^2(4,1) \quad \cdots \quad \begin{matrix} \Delta C_q^2(7,7); & \Delta C_q^2(7,8) \\ \Delta C_q^2(8,7); & \Delta C_q^2(8,8) \end{matrix} = \frac{1}{4}\Delta S_q^2(4,4)$$

$$\begin{matrix} \Delta C_q^2(1,3); & \Delta C_q^2(1,4) \\ \Delta C_q^2(2,3); & \Delta C_q^2(2,4) \end{matrix} = \frac{1}{4}\Delta S_q^2(1,2) \qquad \begin{matrix} \Delta C_q^2(1,5); & \Delta C_q^2(1,6) \\ \Delta C_q^2(2,5); & \Delta C_q^2(2,6) \end{matrix} = \frac{1}{4}\Delta S_q^2(1,3)$$

$$\begin{matrix} \Delta C_q^2(3,1); & \Delta C_q^2(3,2) \\ \Delta C_q^2(4,1); & \Delta C_q^2(4,2) \end{matrix} = \frac{1}{4}\Delta S_q^2(2,1) \qquad \begin{matrix} \Delta C_q^2(3,3); & \Delta C_q^2(3,4) \\ \Delta C_q^2(4,3); & \Delta C_q^2(4,4) \end{matrix} = \frac{1}{4}\Delta S_q^2(2,2) \qquad \begin{matrix} \Delta C_q^2(3,5); & \Delta C_q^2(1,6) \\ \Delta C_q^2(4,5); & \Delta C_q^2(2,6) \end{matrix} = \frac{1}{4}\Delta S_q^2(2,3) \qquad \begin{matrix} \Delta C_q^2(3,7); & \Delta C_q^2(3,8) \\ \Delta C_q^2(4,7); & \Delta C_q^2(4,8) \end{matrix} = \frac{1}{4}\Delta S_q^2(2,4)$$

$$\begin{matrix} \Delta C_q^2(5,1); & \Delta C_q^2(5,2) \\ \Delta C_q^2(6,1); & \Delta C_q^2(6,2) \end{matrix} = \frac{1}{4}\Delta S_q^2(3,1) \qquad \begin{matrix} \Delta C_q^2(5,3); & \Delta C_q^2(5,4) \\ \Delta C_q^2(6,3); & \Delta C_q^2(6,4) \end{matrix} = \frac{1}{4}\Delta S_q^2(3,2) \qquad \begin{matrix} \Delta C_q^2(5,5); & \Delta C_q^2(5,6) \\ \Delta C_q^2(6,5); & \Delta C_q^2(6,6) \end{matrix} = \frac{1}{4}\Delta S_q^2(3,3) \qquad \begin{matrix} \Delta C_q^2(5,7); & \Delta C_q^2(5,8) \\ \Delta C_q^2(6,7); & \Delta C_q^2(6,8) \end{matrix} = \frac{1}{4}\Delta S_q^2(3,4)$$

$$\begin{matrix} \Delta C_q^2(7,3); & \Delta C_q^2(7,4) \\ \Delta C_q^2(8,3); & \Delta C_q^2(8,4) \end{matrix} = \frac{1}{4}\Delta S_q^2(4,2) \qquad \begin{matrix} \Delta C_q^2(7,5); & \Delta C_q^2(7,6) \\ \Delta C_q^2(8,5); & \Delta C_q^2(8,6) \end{matrix} = \frac{1}{4}\Delta S_q^2(4,3)$$