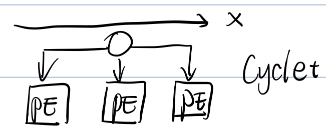
1.

(1) $A^A(c,k,oy) = (c,0,oy)$ $\quad A^B(c,k,oy) = (c,k,0,0)$ $\quad A^Y(c,k,oy) = (k,0,oy)$

(2) $T = \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 1 & 0 & 1 \end{pmatrix}$ $\quad T^{-1} = \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & -1 & 1 \end{pmatrix}$

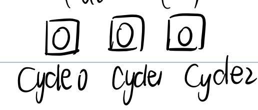
$A^A = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix}$ $\quad A^A T^{-1} = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 0 \\ 0 & -1 & 1 \end{pmatrix}$ $\quad A^A T^{-1}\begin{pmatrix} dx \\ dy \\ dt \end{pmatrix} = \begin{pmatrix} 0 \end{pmatrix} \Rightarrow (dx,dy,dt) = (1,0,0)$

张量A为Multicast，在x方向上多播



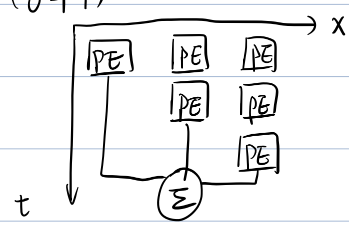
$A^B = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$ $\quad A^B T^{-1} = \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$ $\quad A^B T^{-1}\begin{pmatrix} dx \\ dy \\ dt \end{pmatrix} = \begin{pmatrix} 0 \end{pmatrix} \Rightarrow (dx,dy,dt) = (0,0,1)$

张量B为Stationary，在不同时间同一位置上reuse

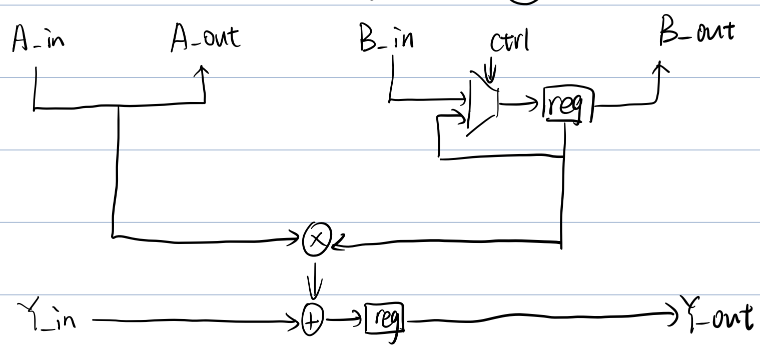


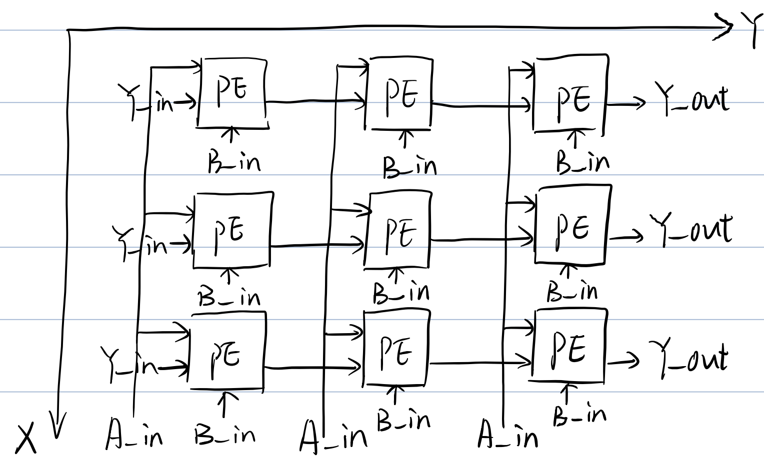
$A^Y = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix}$ $\quad A^Y T^{-1} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & -1 & 1 \end{pmatrix}$ $\quad A^Y T^{-1}\begin{pmatrix} dx \\ dy \\ dt \end{pmatrix} = \begin{pmatrix} 0 \end{pmatrix} \Rightarrow (dx,dy,dt) = (0,1,1)$

张量Y为Systolic，在y方向传递



(3)

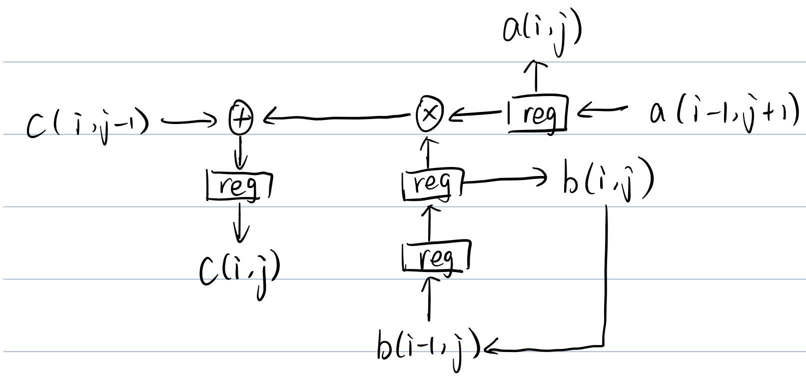


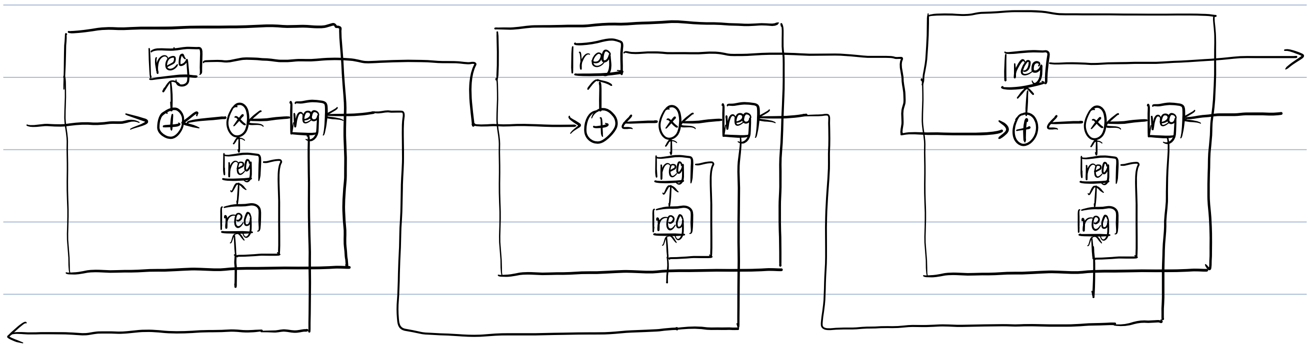


2.

(1) $d_C=(0,1)$ $d_A=(1,-1)$ $d_B=(1,0)$ $P=(0,1)$ $\lambda=(2,1)$

$P\times d_C=1$ $\lambda\cdot d_C=1$ $P\times d_A=-1$ $\lambda\cdot d_A=1$ $P\times d_B=0$ $\lambda\cdot d_B=2$





(2) $a(i,j)=A(i+j-1)$ $w=i+j-1$

$$\underset{v}{\begin{pmatrix} i \\ j \end{pmatrix}} = \underset{H}{\begin{pmatrix} \frac{1}{2} \\ \frac{1}{2} \end{pmatrix}}\cdot\underset{w}{(i+j-1)} + \underset{\lambda}{(i-j)}\underset{q}{\begin{pmatrix} \frac{1}{2} \\ -\frac{1}{2} \end{pmatrix}} + \underset{c}{\begin{pmatrix} \frac{1}{2} \\ \frac{1}{2} \end{pmatrix}}$$

$$\Delta z=(P\times H)\Delta w-\frac{\lambda\times H}{\lambda\cdot q}\Delta w\, P\times q$$

令 $\Delta w=1 \Rightarrow \Delta z=2$

$$\begin{pmatrix} i \\ j \end{pmatrix} = \begin{pmatrix} 0 \\ 1 \end{pmatrix}\cdot j + i\begin{pmatrix} 1 \\ 0 \end{pmatrix}$$

令 $\Delta w=1 \Rightarrow \Delta z=1$

取 $a(0,2)=A(1)$ $z_a=2$ $t_a=2$ 取 $b(0,1)=B(1)$ $z_b=1$ $t_b=1$

$C(1)=c(1,4)$ $z_c=4$ $t_c=6$ $C(2)=c(2,4)$ $z_c'=4$ $t_c'=8$

t \ PE	1	2	3	4
1	B_1(发用,在reg1里)		A_1	
2	B_1	B_2(- - -) A_1		A_2
3	B_1 A_1	B_2	B_3(- - -) A_2	
4	B_1	B_2 A_2	B_3	B_4(- - -) A_3

5	B_1 A_2	B_2	B_3 A_3	B_4	
6	B_1	B_2 A_3	B_3	B_4 A_4	$\to C_1: PE=4 \quad t=6$
7	B_1 A_3	B_2	B_3 A_4	B_4	
8	B_1	B_2 A_4	B_3	B_4 A_5	$\to C_2: PE=4 \quad t=8$
					$\to C_3: PE=4 \quad t=10$

3. $Y(i,j) \mathrel{+}= A(i,k) \times B(k,j)$ $\qquad T=\begin{pmatrix}0&1&0\\0&0&1\\1&1&1\end{pmatrix}$ $\quad T^{-1}=\begin{pmatrix}-1&-1&1\\1&0&0\\0&1&0\end{pmatrix}$

$A^A(i,j,k)=(i,k)$ $\quad A^A=\begin{pmatrix}1&0&0\\0&0&1\end{pmatrix}$ $\quad A^AT^{-1}=\begin{pmatrix}-1&-1&1\\0&1&0\end{pmatrix}$ $\quad A^AT^{-1}\begin{pmatrix}dx\\dy\\dt\end{pmatrix}=\begin{pmatrix}0\\0\end{pmatrix}\Rightarrow(1,0,1)$

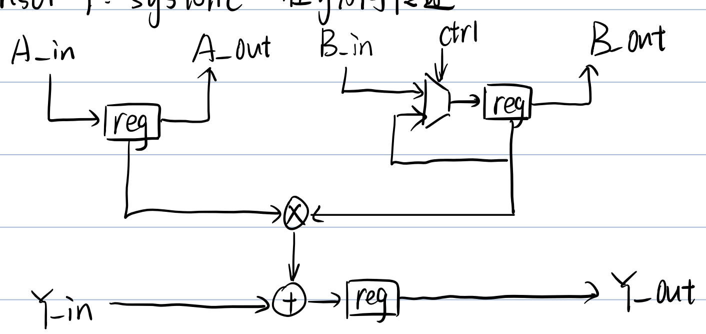
tensor A: systolic 在x方向传递

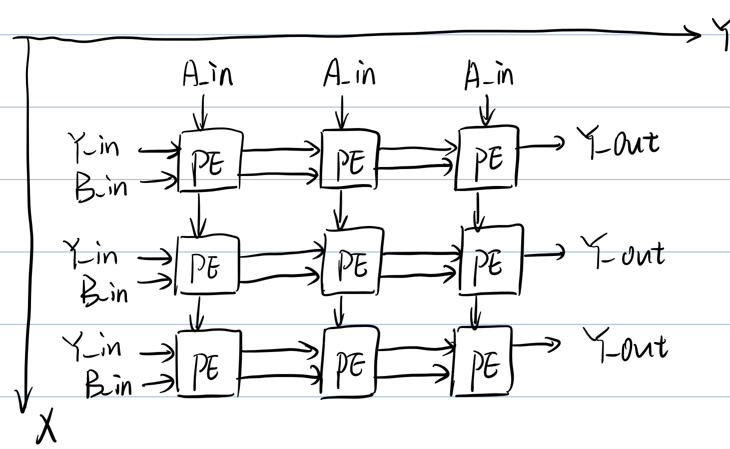
$A^B(i,j,k)=(k,j)$ $\quad A^B=\begin{pmatrix}0&0&1\\0&1&0\end{pmatrix}$ $\quad A^BT^{-1}=\begin{pmatrix}0&1&0\\1&0&0\end{pmatrix}$ $\quad A^BT^{-1}\begin{pmatrix}dx\\dy\\dt\end{pmatrix}=\begin{pmatrix}0\\0\end{pmatrix}\Rightarrow(0,0,1)$

tensor B: stationary

$A^Y(i,j,k)=(i,j)$ $\quad A^Y=\begin{pmatrix}1&0&0\\0&1&0\end{pmatrix}$ $\quad A^YT^{-1}=\begin{pmatrix}-1&-1&1\\1&0&0\end{pmatrix}$ $\quad A^YT^{-1}\begin{pmatrix}dx\\dy\\dt\end{pmatrix}=\begin{pmatrix}0\\0\end{pmatrix}\Rightarrow(0,1,1)$

tensor Y: systolic 在y方向传递





4. $Y(i,j) \mathrel{+}= A(i,k) \times B(k,j)$ $\quad T = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}$ $\quad T^{-1} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}$

$A^A(i,j,k) = (i,k)$ $\quad A^A = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix}$ $\quad A^A T^{-1} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \end{pmatrix}$ $\quad A^A T^{-1} \begin{pmatrix} dx \\ dy \\ dt \end{pmatrix} = (0) \Rightarrow (0,0,1)$

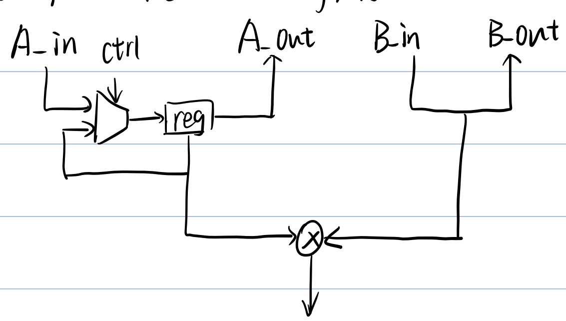
tensor A : stationary

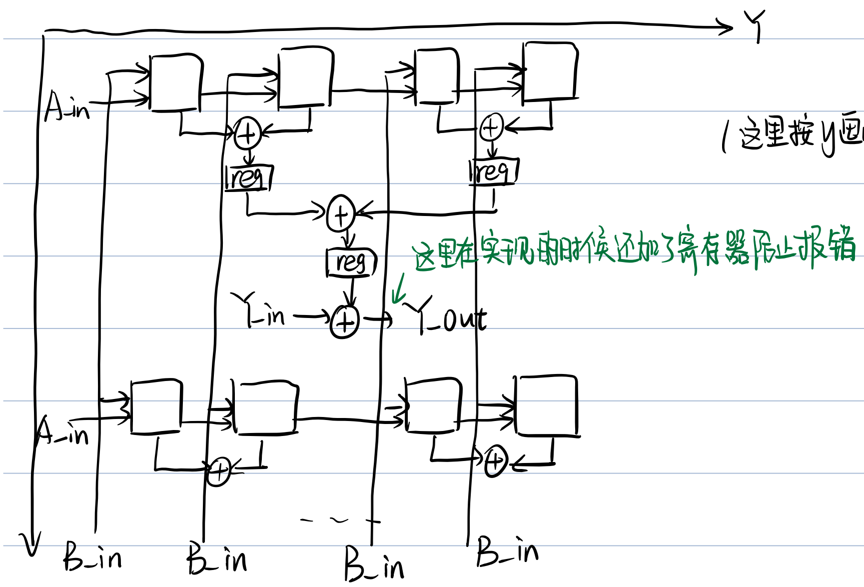
$A^B(i,j,k) = (k,j)$ $\quad A^B = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}$ $\quad A^B T^{-1} = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$ $\quad A^B T^{-1} \begin{pmatrix} dx \\ dy \\ dt \end{pmatrix} = (0) \Rightarrow (1,0,0)$

tensor B : multicast 在x方向上多波

$A^Y(i,j,k) = (i,j)$ $\quad A^Y = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \end{pmatrix}$ $\quad A^Y T^{-1} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix}$ $\quad A^Y T^{-1} \begin{pmatrix} dx \\ dy \\ dt \end{pmatrix} = (0) \Rightarrow (0,1,0)$

tensor Y : multicast 在y方向上多波





(这里按y画的，实现上A沿x传递)