

$$M_i(O)=1$$
  $M_i(O)=0$ 

M <sub>i</sub> (1)=1	always stop	stop if black
M <sub>i</sub> (1)=0	stop if white	never stop

$$M_{i}(O)=1$$
  $M_{i}(O)=0$ 

M <sub>i</sub> (1)=1	always stop (violent crime)	stop if black
M <sub>i</sub> (1)=0	stop if white	never stop

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 always stop (violent crime) stop if black (jaywalking) 
$$M_i(1)=0$$
 stop if white never stop (ask directions)

$$M_{i}(0)=1$$
  $M_{i}(0)=0$ 

M <sub>i</sub> (1)=1	always stop (violent crime)	stop if black (jaywalking)
M <sub>i</sub> (1)=0	stop if white (assume none)	never stop (ask directions)

$$E[Y_{j}(1, 1) | \dots]$$

$$D_{j-1} \begin{cases} M_{j}(1) - 1 & E[Y_{j}(0, 1) | \dots] \\ M_{j}(0) - 1 & M_{j}(0) - 0 \\ M_{j}(1) - 0 & D_{j-1} \end{cases}$$

$$D_{j-1} \begin{cases} M_{j}(1) - 1 & M_{j}(1) - 0 \\ M_{j}(1) - 0 & D_{j-1} \end{cases}$$

$$E[Y_{j}(1, 0) | \dots]$$

$$E[Y_{j}(1, 0) | \dots]$$

$$D_{j-1} \begin{cases} M_{j}(1) - 1 & M_{j}(0) - 0 \\ M_{j}(1) - 0 & D_{j-1} \end{cases}$$

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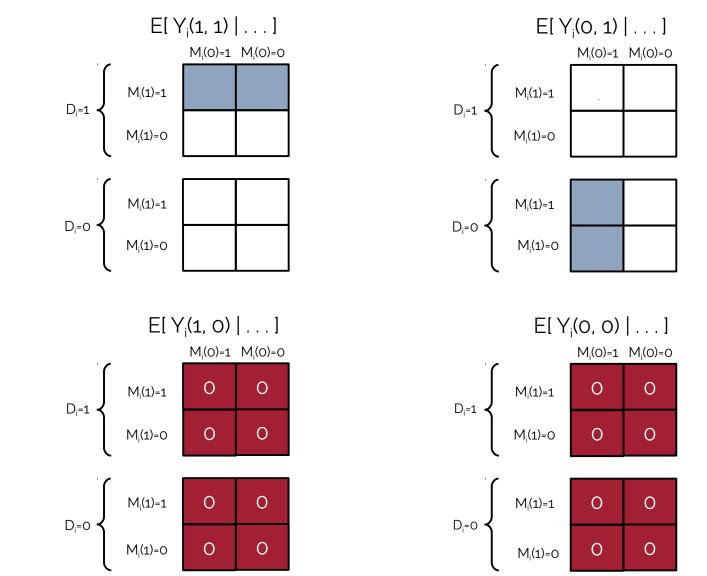
$$D_{j-1} \begin{cases} M_{j}(1) - 1 & M_{j}(0) - 0 \\ M_{j}(1) - 0 & D_{j-1} \end{cases}$$

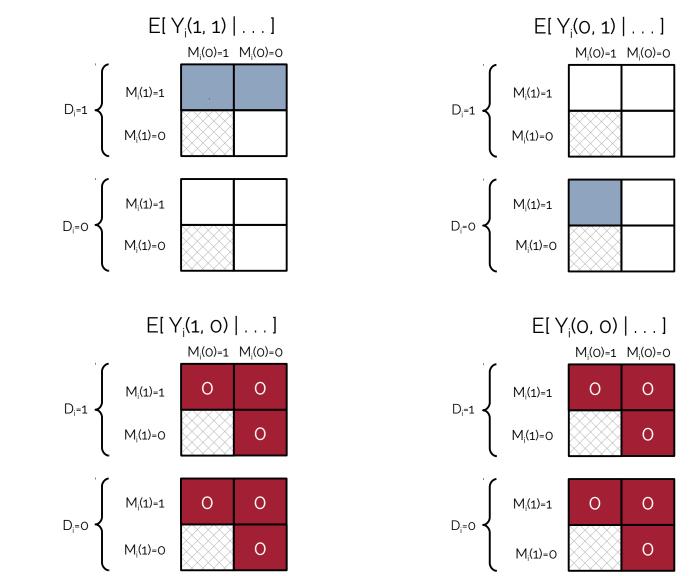
$$D_{j-1} \begin{cases} M_{j}(1) - 1 & M_{j}(0) - 0 \\ M_{j}(1) - 0 & D_{j-1} \end{cases}$$

$$E[Y_{i}(1, 1) | \dots]$$

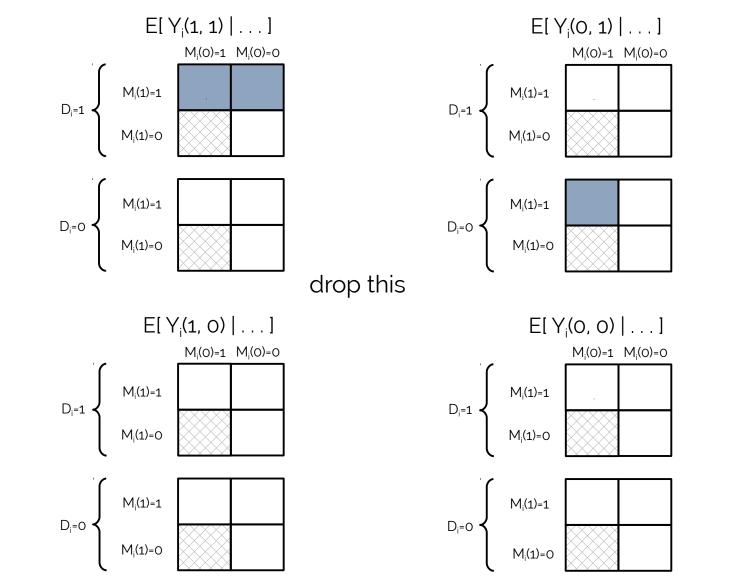
$$M_{i}(0)-1 \quad M_{i}(0)-0$$

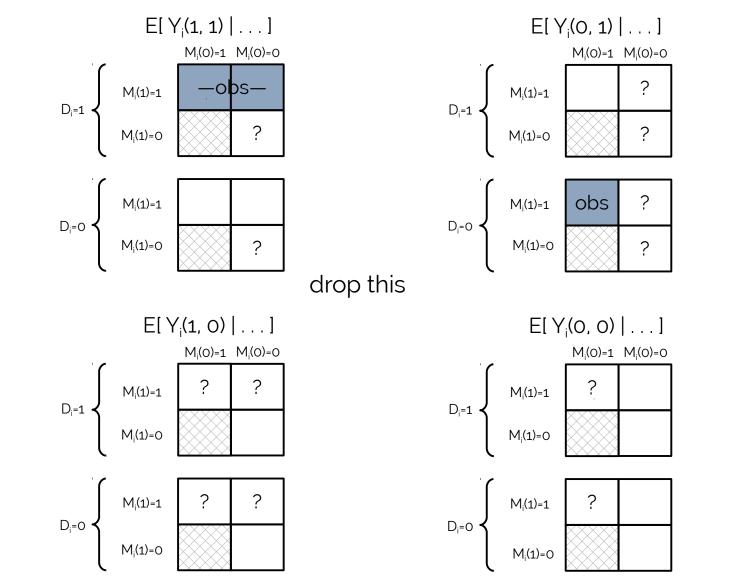
$$D_{i}-1 \begin{cases} M_{i}(1)-1 & \dots \\ M_{i}(1)-0 & \dots \\ M_{i}(1)-1 & \dots \\ M_{i}(1)-0 & \dots \\ M_{i}(1)-1 & \dots$$





$$E[Y_{i}(1,1) | \dots] \\ M_{i}(0)=1 & M_{i}(0)=0 \\ M_{i}(1)=1 & P_{i}(1,0) & P_{i}(1,0)=0 \\ M_{i}(1)=0 & P_{i}(1,0) & P_{i}(1,0)=0 \\ M_{i}(1)=1 & P_{i}(1,0) & P_{i}(1,0)=0 \\ M_{i}(1,0)=1 & P_{i}(1,0)=1 \\ M_{i}(1,0)=1 & P_{i}(1,0)=1 \\ M_{i}(1,0)=1 & P_{i}(1,0)=1 \\ M_{i}(1,0)=1 & P_{i}(1$$





## ate

$$E[Y_i(1, M_i(1)) | ...]$$

 $E[Y_i(0, M_i(0)) | ...]$ 

 $M_i(0)=1$  $M_i(0)=0$   $M_i(0)=1$   $M_i(0)=0$ 

 $D_{i}=1 \begin{cases} M_{i}(1)=1 & Y_{i}(1, 1) & Y_{i}(1, 1) \\ M_{i}(1)=0 & Y_{i}(1, 0) & Y_{i}(1, 0) \end{cases}$   $D_{i}=1 \begin{cases} M_{i}(1)=1 & Y_{i}(0, 1) & Y_{i}(0, 0) \\ M_{i}(1)=0 & Y_{i}(0, 1) & Y_{i}(0, 0) \end{cases}$ 

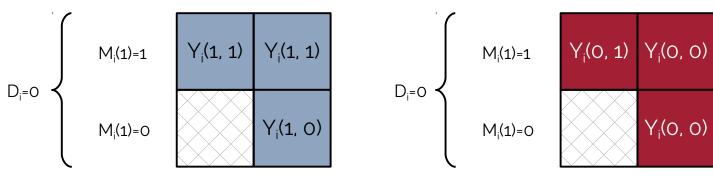
$$E[Y_i(1, M_i(1)) | ...]$$

 $E[Y_i(0, M_i(0)) | ...]$ 

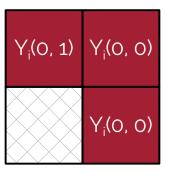
 $M_{i}(0)=1$  $M_i(0)=0$ 

$$D_{i}=1 \begin{cases} M_{i}(1)=1 \\ M_{i}(1)=0 \end{cases}$$

$$D_{i}=0 \quad \begin{cases} & M_{i}(1)=1 \\ & M_{i}(1)=0 \end{cases}$$



$$D_{i}=0 \begin{cases} M_{i}(1) \\ M_{i}(1) \end{cases}$$



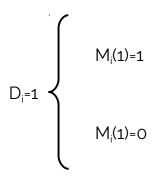
$$\mathsf{E}[\;Y_i(1,\;M_i(1))\;|\;\dots\;]$$

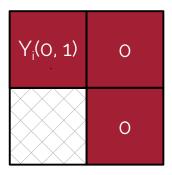
 $E[Y_i(0, M_i(0)) | \dots]$ 

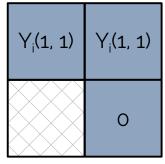
 $M_{i}(0)=1$  $M_i(0)=0$ 

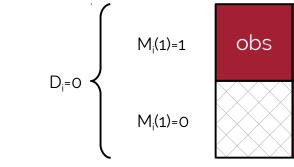
	M <sub>i</sub> (1)=1	obs	ob	
D <sub>i</sub> =1		M <sub>i</sub> (1)=0		0

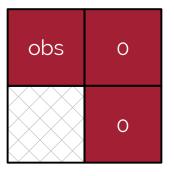
obs	obs
	0











## ates

$$E[Y_i(1, M_i(1)) | ...]$$

 $E[Y_i(0, M_i(0)) | ...]$ 

$$M_i(0)=1$$
  $M_i(0)=0$ 

	M <sub>i</sub> (1)=1	Y <sub>i</sub> (1, 1)	Y <sub>i</sub> (1, 1)
D <sub>i</sub> =1	M <sub>i</sub> (1)=0		

$$D_{i}=1 \begin{cases} M_{i}(1)=1 & Y_{i}(0, 1) & Y_{i}(0, 0) \\ M_{i}(1)=0 & M_{i}(1)=0 \end{cases}$$

$$D_{i}=0 \ \begin{cases} M_{i}(1)=1 & Y_{i}(1, 1) \\ M_{i}(1)=0 & Y_{i}(1, 0) \end{cases} \qquad D_{i}=0 \ \begin{cases} M_{i}(1)=1 & Y_{i}(0, 1) \\ M_{i}(1)=0 & Y_{i}(0, 1) \end{cases}$$

$$D_{i}=0 \begin{cases} M_{i}(1)=1 & Y_{i}(0, 1) \\ M_{i}(1)=0 & Y_{i}(0, 1) \end{cases}$$

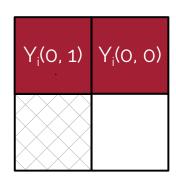
$$E[Y_i(1, M_i(1)) | ...]$$

 $E[Y_i(0, M_i(0)) | \dots]$ 

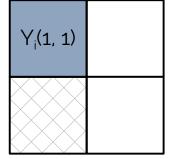
 $M_{i}(0)=1$   $M_{i}(0)=0$ 

$$D_{i}=1 \begin{cases} M_{i}(1)=1 & Y_{i}(1)=1 \\ M_{i}(1)=0 & Y_{i}(1)=1 \end{cases}$$

$$D_{i}=1 \begin{cases} M \\ M \end{cases}$$



$$D_{i}=0 \begin{cases} M_{i}(1)=1 & Y_{i}(1) \\ M_{i}(1)=0 & Y_{i}(1) \end{cases}$$



J-0 \$	M <sub>i</sub> (1)=1
J <sub>i</sub> =U \	M <sub>i</sub> (1)=0

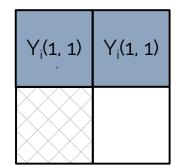
Y <sub>i</sub> (0, 1)	

$$E[Y_i(1, M_i(1)) | ...]$$

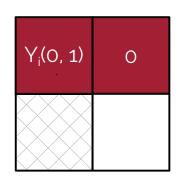
 $M_i(0)=1$   $M_i(0)=0$ 

 $M_i(0)=1$   $M_i(0)=0$ 

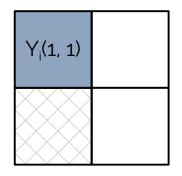
 $D_{i}=1$   $M_{i}(1)=1$ 



$$D_{i}=1 \begin{cases} M_{i}(1) \\ M_{i}(1) \end{cases}$$



 $D_{i}=0 \begin{cases} M_{i}(1)=1 \\ M_{i}(1)=0 \end{cases}$ 



$$D_{i}=0 \begin{cases} M_{i}(1)=1 \\ M_{i}(1)=0 \end{cases}$$

Y <sub>i</sub> (O, 1)	

## cdes

$$E[Y_i(1, 1) | ...]$$

 $E[Y_i(0, 1) | ...]$ 

$$M_i(0)=1$$
  $M_i(0)=0$ 

	M <sub>i</sub> (1)=1	Y <sub>i</sub> (1, 1)	Y <sub>i</sub> (1, 1)
O <sub>i</sub> =1 <b>≺</b>	M;(1)=0		

$$D_{i}=1 \begin{cases} M_{i}(1)=1 & Y_{i}(0, 1) & Y_{i}(0, 1) \\ M_{i}(1)=0 & M_{i}(1)=0 \end{cases}$$

$$D_{i}=0 \quad \begin{cases} M_{i}(1)=1 & Y_{i}(1, 1) \\ M_{i}(1)=0 & Y_{i}(1, 1) \end{cases} \qquad D_{i}=0 \quad \begin{cases} M_{i}(1)=1 & Y_{i}(0, 1) \\ M_{i}(1)=0 & Y_{i}(0, 1) \end{cases}$$

$$D_{i}=0 \begin{cases} M_{i}(1)=1 & Y_{i}(0, 1) \\ M_{i}(1)=0 & Y_{i}(0, 1) \end{cases}$$

$$E[Y_i(1, 1) | ...]$$

 $E[Y_i(0, 1) | ...]$ 

 $M_i(0)=0$ 

## naive estimator

$$\mathsf{E}[\;\mathsf{Y}_{\mathsf{i}}\!(\mathsf{1},\;\mathsf{1})\;|\;\dots\;]$$

\_\_\_

 $\mathsf{E}[\,Y_i(0,\,\mathbf{1})\,|\,\dots\,]$ 

		M <sub>i</sub> (0)=1	M;(0)=0			M <sub>i</sub> (0)=1	M <sub>i</sub> (0)=0
D <sub>i</sub> =1	M <sub>i</sub> (1)=1	Y <sub>i</sub> (1, 1)	Y;(1, 1)	D <sub>i</sub> =1	M;(1)=1		
	M <sub>i</sub> (1)=0				M <sub>i</sub> (1)=0		
D <sub>i</sub> =0	M <sub>i</sub> (1)=1				M <sub>i</sub> (1)=1	Y <sub>i</sub> (O, 1)	
	M;(1)=0			D <sub>i</sub> =O	M <sub>i</sub> (1)=0	Y <sub>i</sub> (O, 1)	

$$E[Y_i(1, 1) | ...]$$

 $E[Y_i(0, 1) | ...]$ 

$$M_i(O)=1$$
  $M_i(O)=0$ 

	M <sub>i</sub> (1)=1	Y <sub>i</sub> (1, 1)	Y <sub>i</sub> (1, 1)
D <sub>i</sub> =1 <b>〈</b>	M;(1)=0		

-	,	

D <sub>i</sub> =0 <b>≺</b>	M;(1)=1	
	M <sub>i</sub> (1)=0	

$$D_{i}=0 \begin{cases} M_{i}(1)=1 & Y_{i}(0, 1) \\ M_{i}(1)=0 & M_{i}(1)=0 \end{cases}$$

