

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

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

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| M <sub>i</sub> (1)=1 | always stop<br>(violent crime) | stop if black                  |
|----------------------|--------------------------------|--------------------------------|
| M <sub>i</sub> (1)=0 | stop if white                  | never stop<br>(ask directions) |

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

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

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

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

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

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

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

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

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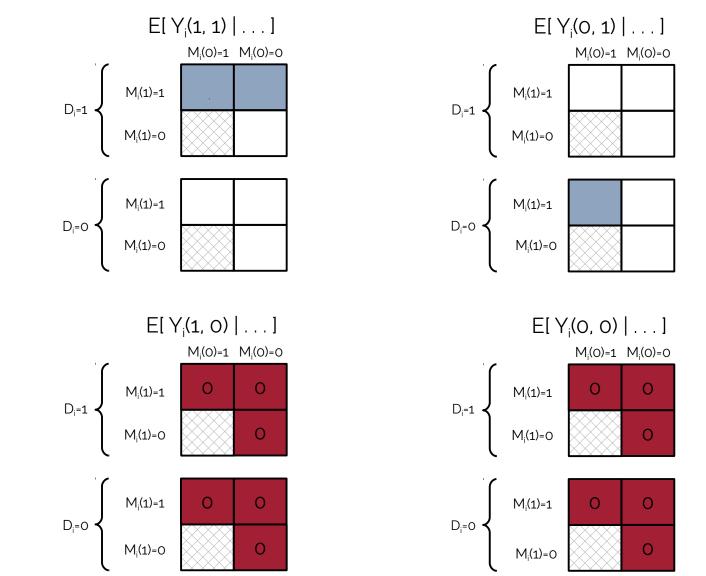
$$D_{j-1} \begin{cases} M_{j}(1) - 1 & M_{j}(0) - 0 \\ M_{j}(1) - 0 & D_{j-1} \end{cases}$$

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

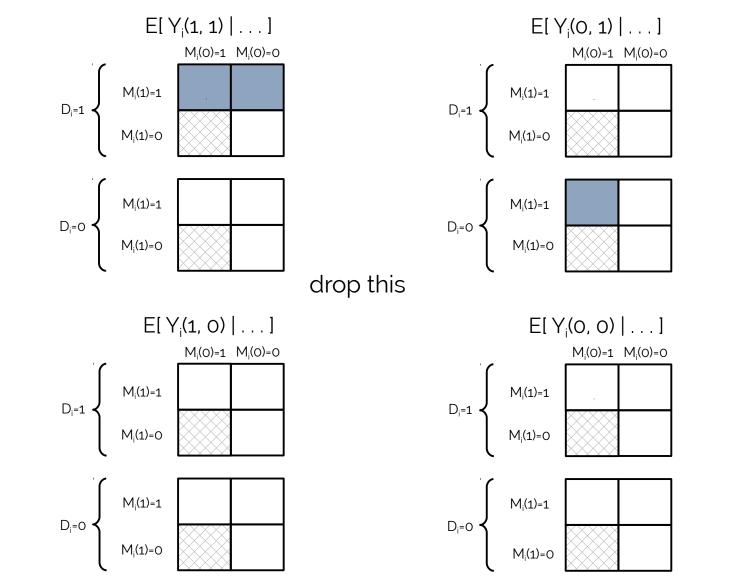
$$M_{i}(0)-1 \quad M_{i}(0)-0$$

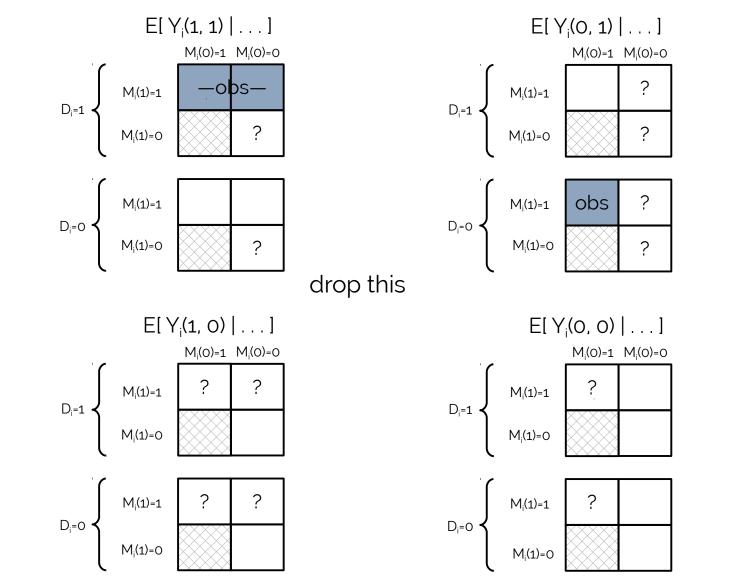
$$D_{i}-1 \begin{cases} M_{i}(1)-1 & \dots \\ M_{i}(1)-0 & \dots \\ M_{i}(1)-1 & \dots \\ M_{i}(1)-0 & \dots \\ M_{i}(1)-1 & \dots$$

$$E[Y_{i}(1,1) | \dots] \\ M_{i}(0)=0 \\ D_{i}=1 \begin{cases} M_{i}(1)=1 \\ M_{i}(1)=0 \\ M_{i}(1)=0 \end{cases} D_{i}=1 \begin{cases} M_{i}(1)=1 \\ M_{i}(1)=0 \\ M_{i}(1)=0 \\ M_{i}(1)=0 \end{cases} D_{i}=1 \begin{cases} M_{i}(1)=1 \\ M_{i}(1)=0 \\ M_{i}(1)=0 \\ M_{i}(1)=0 \end{cases} D_{i}=1 \begin{cases} M_{i}(1)=1 \\ M_{i}(1)=0 \\ M_{i}(1)=0 \\ M_{i}(1)=0 \end{cases} D_{i}=1 \begin{cases} M_{i}(1)=1 \\ M_{i}(1)=0 \\ M_{i}(1)=0 \\ M_{i}(1)=0 \end{cases} D_{i}=1 \begin{cases} M_{i}(1)=1 \\ M_{i}(1)=0 \\ M_{i}(1)=0 \\ M_{i}(1)=0 \end{cases} D_{i}=1 \begin{cases} M_{i}(1)=1 \\ M_{i}(1)=0 \\ M_{i}(1)=0 \\ M_{i}(1)=0 \end{cases} D_{i}=0 \end{cases} D_{i}=0 \begin{cases} M_{i}(1)=1 \\ M_{i}(1)=0 \\ M_{i}(1)=0 \\ M_{i}(1)=0 \\ M_{i}(1)=0 \end{cases} D_{i}=0 \rbrace D_{i}=0 \end{cases} D_{i}=0 \end{cases} D_{i}=0 \rbrace D_{i}$$



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





## ate

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

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

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

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

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

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

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

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

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

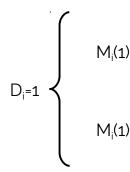
 $E[Y_i(0, M_i(0)) | \dots]$ 

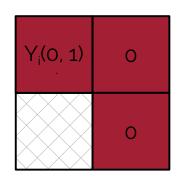
 $M_i(0)=1$   $M_i(0)=0$ 

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

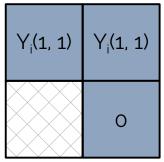
|                     | M <sub>i</sub> (1)=1 |  |
|---------------------|----------------------|--|
| D <sub>i</sub> =1 ≺ | M <sub>i</sub> (1)=0 |  |

| obs | obs |
|-----|-----|
|     | 0   |

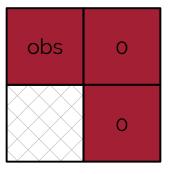




$$D_{i}=0 \begin{cases} M_{i}(1)=1 \\ M_{i}(1)=0 \end{cases}$$



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



## ates

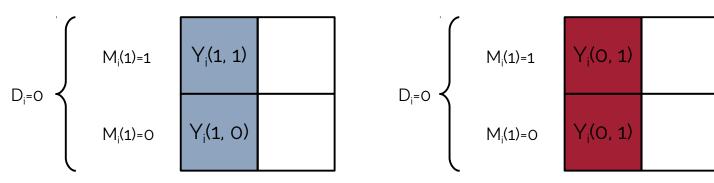
$$E[Y_i(1, M_i(1)) | ...]$$

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

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

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

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

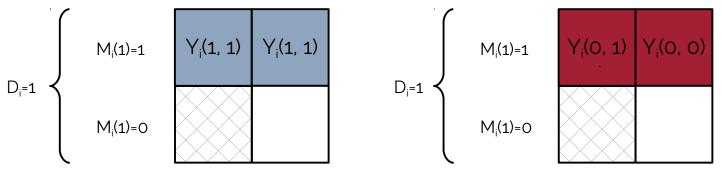


$$D_{i}=O \begin{cases} M_{i}(1)=1 & Y_{i}(0, 1) \\ M_{i}(1)=0 & Y_{i}(0, 1) \end{cases}$$

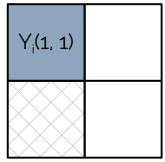
$$E[Y_i(1, M_i(1)) | ...]$$

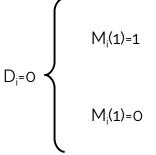
 $M_{i}(0)=1$  $M_i(0)=0$   $M_{i}(0)=1$  $M_i(0)=0$ 

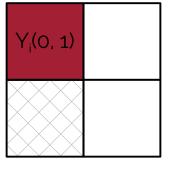
$$D_{i}=1$$
  $M_{i}(1)=1$ 



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







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

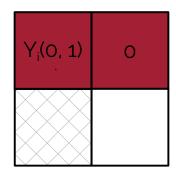
E[ Y<sub>i</sub>(o, M<sub>i</sub>(o)) | . . . ]

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

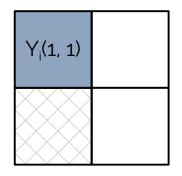
 $M_i(0)=1$   $M_i(0)=0$ 

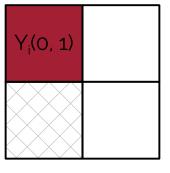
 $D_{i}=1 \quad \begin{cases} M_{i}(1)=1 \end{cases}$ 

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



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





## cdes

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

- E[ Y<sub>i</sub>(0, 1) | . . . ]

|                   |                      | M <sub>i</sub> (0)=1  | M <sub>i</sub> (0)=0  |                            |                      | M <sub>i</sub> (0)=1  | $M_i(O)=O$            |
|-------------------|----------------------|-----------------------|-----------------------|----------------------------|----------------------|-----------------------|-----------------------|
| D <sub>i</sub> =1 | M;(1)=1              | Y <sub>i</sub> (1, 1) | Y <sub>i</sub> (1, 1) | D <sub>i</sub> =1          | M <sub>i</sub> (1)=1 | Y <sub>i</sub> (O, 1) | Y <sub>i</sub> (O, 1) |
|                   | M;(1)=0              |                       |                       |                            | M <sub>i</sub> (1)=0 |                       |                       |
|                   |                      |                       |                       | ,                          |                      |                       |                       |
|                   | M;(1)=1              | Y <sub>i</sub> (1, 1) |                       |                            | M <sub>i</sub> (1)=1 | Y <sub>i</sub> (0, 1) |                       |
| D <sub>i</sub> =0 | M <sub>i</sub> (1)=0 | Y <sub>i</sub> (1, 0) |                       | D <sub>i</sub> =0 <b>〈</b> | M <sub>i</sub> (1)=0 | Y <sub>i</sub> (O, 1) |                       |

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

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

 $M_i(0)=0$ 

## naive estimator

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

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

|                   |                      | 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;(1)=1              |                      |         | $M_i(1)$                                     | )=1                  |                      |
|                   | M;(1)=0              |                      |         | $D_{i}=1 \begin{cases} M_{i}(1) \end{cases}$ | r=O                  |                      |
| '(                |                      |                      |         |  |                      |                      |
| D <sub>i</sub> =0 | M <sub>i</sub> (1)=1 |                      |         | M <sub>i</sub> (1)                           | ·=1                  |                      |
|                   | M;(1)=0              |                      |         | $D_{i}=0 \begin{cases} M_{i}(1) \end{cases}$ | t=O                  |                      |

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

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

|                   |                      | M;(0)=1 | M;(0)=0 |                     |                      | M <sub>i</sub> (0)=1 | M <sub>i</sub> (0)=0 |
|-------------------|----------------------|---------|---------|---------------------|----------------------|----------------------|----------------------|
| D-1               | M <sub>i</sub> (1)=1 | ,       |         | D-1 \               | M <sub>i</sub> (1)=1 | ,                    |                      |
| D <sub>i</sub> =1 | M <sub>i</sub> (1)=0 |         |         | D <sub>i</sub> =1 { | M <sub>i</sub> (1)=0 |                      |                      |
| . (               |                      |         |         | 1 '.                |                      |                      |                      |
|                   | M <sub>i</sub> (1)=1 |         |         |                     | M;(1)=1              |                      |                      |
| D <sub>i</sub> =0 | M <sub>i</sub> (1)=0 |         |         | D <sub>i</sub> =0 ≺ | M <sub>i</sub> (1)=0 |                      |                      |