













$$M_i(0)=1$$

$$M_i(0)=0$$

$$M_i(1)=1$$

$$M_i(1)=0$$

always stop	stop if black
stop if white	never stop

$M_i(0)=1$

$M_i(0)=0$

$M_i(1)=1$

always stop
(violent crime)

stop if black

$M_i(1)=0$

stop if white

never stop

$$M_i(0)=1$$

$$M_i(0)=0$$

$$M_i(1)=1$$

always stop
(violent crime)

stop if black

$$M_i(1)=0$$

stop if white

never stop
(ask directions)

$M_i(0)=1$

$M_i(0)=0$

$M_i(1)=1$

always stop
(violent crime)

stop if black
(jaywalking)

$M_i(1)=0$

stop if white

never stop
(ask directions)

$M_i(0)=1$

$M_i(0)=0$

$M_i(1)=1$

always stop
(violent crime)

stop if black
(jaywalking)

$M_i(1)=0$

stop if white
(?)

never stop
(ask directions)

$M_i(0)=1$

$M_i(0)=0$

$M_i(1)=1$

always stop
(violent crime)

stop if black
(jaywalking)

$M_i(1)=0$

stop if white
(assume none)

never stop
(ask directions)

$$E[Y_i(1, 1) \mid \dots]$$

$$M_i(0)=1 \quad M_i(0)=0$$

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

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

$$E[Y_i(0, 1) \mid \dots]$$

$$M_i(0)=1 \quad M_i(0)=0$$

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

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

$$E[Y_i(1, 0) \mid \dots]$$

$$M_i(0)=1 \quad M_i(0)=0$$

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

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

$$E[Y_i(0, 0) \mid \dots]$$

$$M_i(0)=1 \quad M_i(0)=0$$

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

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

$$E[Y_i(1, 1) \mid \dots]$$

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

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

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

$$E[Y_i(0, 1) \mid \dots]$$

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

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

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

$$E[Y_i(1, 0) \mid \dots]$$

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

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

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

$$E[Y_i(0, 0) \mid \dots]$$

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

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

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

$$E[Y_i(1, 1) \mid \dots]$$

		$M_i(o)=1$	$M_i(o)=0$
$D_i=1$	$M_i(1)=1$		
	$M_i(1)=0$		
$D_i=0$	$M_i(1)=1$		
	$M_i(1)=0$		

$$E[Y_i(o, 1) \mid \dots]$$

		$M_i(o)=1$	$M_i(o)=0$
$D_i=1$	$M_i(1)=1$		
	$M_i(1)=0$		
$D_i=0$	$M_i(1)=1$		
	$M_i(1)=0$		

$$E[Y_i(1, o) \mid \dots]$$

		$M_i(o)=1$	$M_i(o)=0$
$D_i=1$	$M_i(1)=1$		
	$M_i(1)=0$		
$D_i=0$	$M_i(1)=1$		
	$M_i(1)=0$		

$$E[Y_i(o, o) \mid \dots]$$

		$M_i(o)=1$	$M_i(o)=0$
$D_i=1$	$M_i(1)=1$		
	$M_i(1)=0$		
$D_i=0$	$M_i(1)=1$		
	$M_i(1)=0$		

$$E[Y_i(1, 1) \mid \dots]$$

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

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

$$E[Y_i(0, 1) \mid \dots]$$

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

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

$$E[Y_i(1, 0) \mid \dots]$$

		$M_i(0)=1$	$M_i(0)=0$
$D_i=1$	$M_i(1)=1$	○	○
	$M_i(1)=0$		○

$D_i=0$	$M_i(1)=1$	○	○
	$M_i(1)=0$		○

$$E[Y_i(0, 0) \mid \dots]$$

		$M_i(0)=1$	$M_i(0)=0$
$D_i=1$	$M_i(1)=1$	○	○
	$M_i(1)=0$		○

$D_i=0$	$M_i(1)=1$	○	○
	$M_i(1)=0$		○

$$E[Y_i(1, 1) \mid \dots]$$

		$M_i(o)=1$	$M_i(o)=0$
$D_i=1$	$M_i(1)=1$	—obs—	
	$M_i(1)=0$?

		$M_i(o)=1$	$M_i(o)=0$
$D_i=0$	$M_i(1)=1$		
	$M_i(1)=0$?

$$E[Y_i(o, 1) \mid \dots]$$

		$M_i(o)=1$	$M_i(o)=0$
$D_i=1$	$M_i(1)=1$?
	$M_i(1)=0$?

		$M_i(o)=1$	$M_i(o)=0$
$D_i=0$	$M_i(1)=1$	obs	?
	$M_i(1)=0$?

$$E[Y_i(1, o) \mid \dots]$$

		$M_i(o)=1$	$M_i(o)=0$
$D_i=1$	$M_i(1)=1$?	?
	$M_i(1)=0$		o

		$M_i(o)=1$	$M_i(o)=0$
$D_i=0$	$M_i(1)=1$?	?
	$M_i(1)=0$		o

$$E[Y_i(o, o) \mid \dots]$$

		$M_i(o)=1$	$M_i(o)=0$
$D_i=1$	$M_i(1)=1$?	o
	$M_i(1)=0$		o

		$M_i(o)=1$	$M_i(o)=0$
$D_i=0$	$M_i(1)=1$?	o
	$M_i(1)=0$		o

$$E[Y_i(1, 1) \mid \dots]$$

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

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

$$E[Y_i(0, 1) \mid \dots]$$

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

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

drop this

$$E[Y_i(1, 0) \mid \dots]$$

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

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

$$E[Y_i(0, 0) \mid \dots]$$

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

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

$$E[Y_i(1, 1) \mid \dots]$$

		$M_i(0)=1$	$M_i(0)=0$
$D_i=1$	$M_i(1)=1$	—obs—	
	$M_i(1)=0$?

$D_i=0$	$M_i(1)=1$		
	$M_i(1)=0$?

drop this

$$E[Y_i(0, 1) \mid \dots]$$

		$M_i(0)=1$	$M_i(0)=0$
$D_i=1$	$M_i(1)=1$?
	$M_i(1)=0$?

$D_i=0$	$M_i(1)=1$	obs	?
	$M_i(1)=0$?

$$E[Y_i(1, 0) \mid \dots]$$

		$M_i(0)=1$	$M_i(0)=0$
$D_i=1$	$M_i(1)=1$?	?
	$M_i(1)=0$		

$D_i=0$	$M_i(1)=1$?	?
	$M_i(1)=0$		

$$E[Y_i(0, 0) \mid \dots]$$

		$M_i(0)=1$	$M_i(0)=0$
$D_i=1$	$M_i(1)=1$?	
	$M_i(1)=0$		

$D_i=0$	$M_i(1)=1$?	
	$M_i(1)=0$		

ate

$$E[Y_i(1, M_i(1)) \mid \dots]$$

—

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

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

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

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

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

$$E[Y_i(1, M_i(1)) \mid \dots]$$

—

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

		$M_i(0)=1$	$M_i(0)=0$
$D_i=1$	$M_i(1)=1$	$Y_i(1, 1)$	$Y_i(1, 1)$
	$M_i(1)=0$	$Y_i(1, 0)$	$Y_i(1, 0)$

		$M_i(0)=1$	$M_i(0)=0$
$D_i=1$	$M_i(1)=1$	$Y_i(0, 1)$	$Y_i(0, 0)$
	$M_i(1)=0$	$Y_i(0, 1)$	$Y_i(0, 0)$

		$M_i(1)=1$	$M_i(1)=0$
$D_i=0$	$M_i(1)=1$	$Y_i(1, 1)$	$Y_i(1, 1)$
	$M_i(1)=0$	$Y_i(1, 0)$	$Y_i(1, 0)$

		$M_i(1)=1$	$M_i(1)=0$
$D_i=0$	$M_i(1)=1$	$Y_i(0, 1)$	$Y_i(0, 0)$
	$M_i(1)=0$	$Y_i(0, 1)$	$Y_i(0, 0)$

$$E[Y_i(1, M_i(1)) \mid \dots]$$

—

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

		$M_i(0)=1$	$M_i(0)=0$
$D_i=1$	$M_i(1)=1$	$Y_i(1, 1)$	$Y_i(1, 1)$
	$M_i(1)=0$		$Y_i(1, 0)$

		$M_i(0)=1$	$M_i(0)=0$
$D_i=1$	$M_i(1)=1$	$Y_i(0, 1)$	$Y_i(0, 0)$
	$M_i(1)=0$		$Y_i(0, 0)$

		$M_i(0)=1$	$M_i(0)=0$
$D_i=0$	$M_i(1)=1$	$Y_i(1, 1)$	$Y_i(1, 1)$
	$M_i(1)=0$		$Y_i(1, 0)$

		$M_i(0)=1$	$M_i(0)=0$
$D_i=0$	$M_i(1)=1$	$Y_i(0, 1)$	$Y_i(0, 0)$
	$M_i(1)=0$		$Y_i(0, 0)$

$$E[Y_i(1, M_i(1)) \mid \dots]$$

—

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

$D_i=1$ {

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

$D_i=1$ {

	$M_i(0)=1$	$M_i(0)=0$
$M_i(1)=1$	$Y_i(0, 1)$	0
$M_i(1)=0$		0

$D_i=0$ {

	$M_i(0)=1$	$M_i(0)=0$
$M_i(1)=1$	$Y_i(1, 1)$	$Y_i(1, 1)$
$M_i(1)=0$		0

$D_i=0$ {

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

ates

$$E[Y_i(1, M_i(1)) \mid \dots]$$

—

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

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

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

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

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

$$E[Y_i(1, M_i(1)) \mid \dots]$$

—

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

		$M_i(0)=1$	$M_i(0)=0$
$D_i=1$	$M_i(1)=1$	$Y_i(1, 1)$	$Y_i(1, 1)$
	$M_i(1)=0$		

		$M_i(0)=1$	$M_i(0)=0$
$D_i=1$	$M_i(1)=1$	$Y_i(0, 1)$	$Y_i(0, 0)$
	$M_i(1)=0$		

		$M_i(0)=1$	$M_i(0)=0$
$D_i=0$	$M_i(1)=1$	$Y_i(1, 1)$	
	$M_i(1)=0$	$Y_i(1, 0)$	

		$M_i(0)=1$	$M_i(0)=0$
$D_i=0$	$M_i(1)=1$	$Y_i(0, 1)$	
	$M_i(1)=0$	$Y_i(0, 1)$	

$$E[Y_i(1, M_i(1)) \mid \dots]$$

—

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

		$M_i(0)=1$	$M_i(0)=0$
$D_i=1$	$M_i(1)=1$	$Y_i(1, 1)$	$Y_i(1, 1)$
	$M_i(1)=0$		

		$M_i(0)=1$	$M_i(0)=0$
$D_i=1$	$M_i(1)=1$	$Y_i(0, 1)$	$Y_i(0, 0)$
	$M_i(1)=0$		

		$M_i(0)=1$	$M_i(0)=0$
$D_i=0$	$M_i(1)=1$	$Y_i(1, 1)$	
	$M_i(1)=0$		

		$M_i(0)=1$	$M_i(0)=0$
$D_i=0$	$M_i(1)=1$	$Y_i(0, 1)$	
	$M_i(1)=0$		

$$E[Y_i(1, M_i(1)) \mid \dots]$$

—

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

		$M_i(0)=1$	$M_i(0)=0$
$D_i=1$	$M_i(1)=1$	$Y_i(1, 1)$	$Y_i(1, 1)$
	$M_i(1)=0$		

		$M_i(0)=1$	$M_i(0)=0$
$D_i=1$	$M_i(1)=1$	$Y_i(0, 1)$	0
	$M_i(1)=0$		

		$M_i(0)=1$	$M_i(0)=0$
$D_i=0$	$M_i(1)=1$	$Y_i(1, 1)$	
	$M_i(1)=0$		

		$M_i(0)=1$	$M_i(0)=0$
$D_i=0$	$M_i(1)=1$	$Y_i(0, 1)$	
	$M_i(1)=0$		

cdes

$$E[Y_i(1, 1) \mid \dots]$$

—

$$E[Y_i(0, 1) \mid \dots]$$

		$M_i(0)=1$	$M_i(0)=0$
$D_i=1$	$M_i(1)=1$	$Y_i(1, 1)$	$Y_i(1, 1)$
	$M_i(1)=0$		

		$M_i(0)=1$	$M_i(0)=0$
$D_i=1$	$M_i(1)=1$	$Y_i(0, 1)$	$Y_i(0, 1)$
	$M_i(1)=0$		

		$M_i(0)=1$	$M_i(0)=0$
$D_i=0$	$M_i(1)=1$	$Y_i(1, 1)$	
	$M_i(1)=0$	$Y_i(1, 1)$	

		$M_i(0)=1$	$M_i(0)=0$
$D_i=0$	$M_i(1)=1$	$Y_i(0, 1)$	
	$M_i(1)=0$	$Y_i(0, 1)$	

$$E[Y_i(1, 1) \mid \dots]$$

—

$$E[Y_i(0, 1) \mid \dots]$$

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

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

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

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

naive estimator

$$E[Y_i(1, 1) \mid \dots]$$

—

$$E[Y_i(0, 1) \mid \dots]$$

		$M_i(0)=1$	$M_i(0)=0$
$D_i=1$	$M_i(1)=1$	$Y_i(1, 1)$	$Y_i(1, 1)$
	$M_i(1)=0$		

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

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

		$M_i(0)=1$	$M_i(0)=0$
$D_i=0$	$M_i(1)=1$	$Y_i(0, 1)$	
	$M_i(1)=0$	$Y_i(0, 1)$	

$$E[Y_i(1, 1) \mid \dots]$$

—

$$E[Y_i(0, 1) \mid \dots]$$

		$M_i(0)=1$	$M_i(0)=0$
$D_i=1$	$M_i(1)=1$	$Y_i(1, 1)$	$Y_i(1, 1)$
	$M_i(1)=0$		

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

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

		$M_i(0)=1$	$M_i(0)=0$
$D_i=0$	$M_i(1)=1$	$Y_i(0, 1)$	
	$M_i(1)=0$		