Transform

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	Level	Completed
	Beginner	10
	Intermediate	4
	Advanced	2
	Expert	0

Goal
15

Total Completed
16

Transform

CSCI 5722: Computer Vision

Fall 2024

Dr. Tom Yeh

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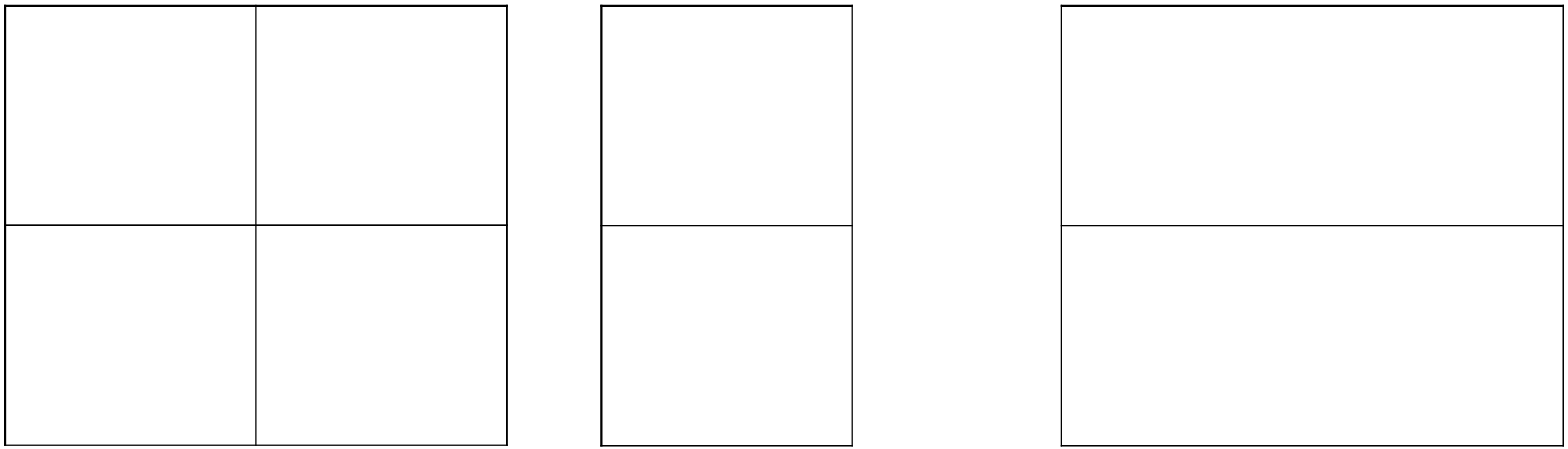
Linear Transform



2	7
3	5

1
-1

2	7
3	5

1	1	0	1
-1	0	1	1

1	1	0	1
-1	0	1	1

2	7
3	5

1	0	0	0
0	0	1	0
0	1	0	1
0	0	0	1
1	0	1	0

4	5	1
2	2	4
7	4	2
9	3	8

4	5	1
2	2	4
7	4	2
9	3	8

1	0	0	0
0	0	1	0
0	1	0	1
0	0	0	1
1	0	1	0

4	5	1
7	4	2
11	5	12
9	3	8
2	0	2

Linear Transform (i.e., Multiply Matrices)

a+b+c+d
=15

1	1	0	1
-1	0	1	1

4	2	2	b 4	2	d 6
5	1	a 4	5	c 1	6

Linear Transform (i.e., Multiply Matrices)

a+b+c+d
= 24

4	5	-1
-2	2	4
7	-4	2
9	3	8

1	0	0	0
0	0	1	0
0	1	0	1
0	0	0	1
1	0	1	0

4	b 5	-1
7	-4	c 2
7	5	12
a 9	3	d 8
11	8	7

What are the missing values?

a+b+c+d
=135

99	53	c 24
173	21	74
21	54	d 36

0	1	0
1	0	0
0	0	1

173	21	74
99	53	24
a 21	b 54	36

What are the values of A and B?

a+b = 4

3	7
2	8
1	-1

A	1	0
0	2	B

-1	1
9	11

a

A = _____-1___

b

B = _____5___

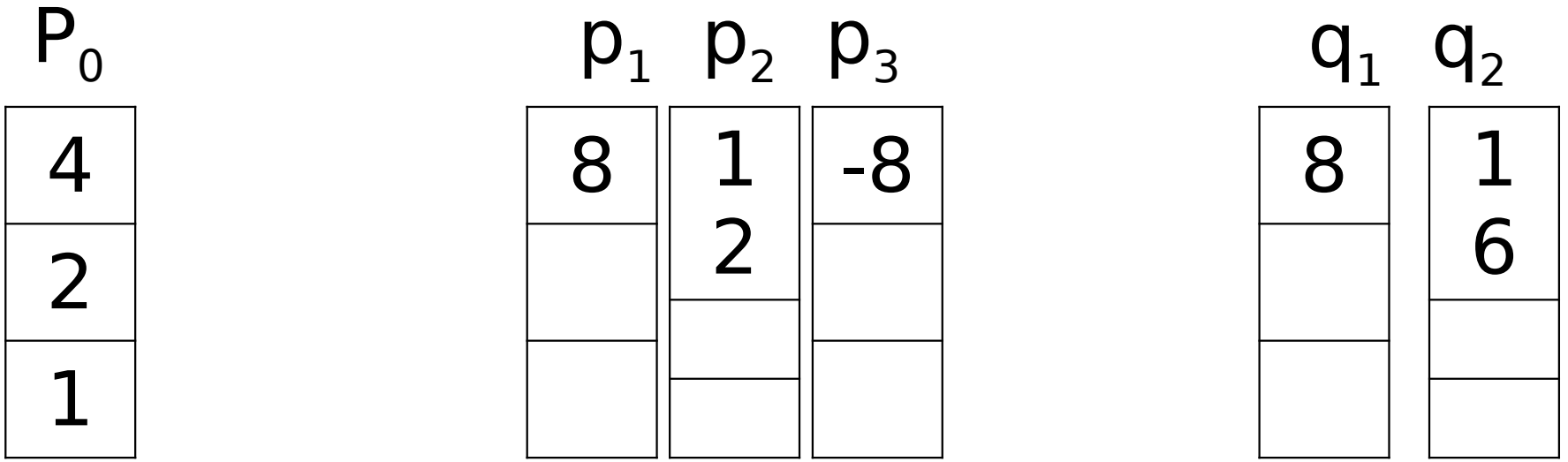
Homogeneous Coordinate

Convert to Homogeneous Coordinates

Convert to Homogeneous Coordinates

2	1	2	0
4	2	3	1

Equality in Homogeneous Coordinates



Which point is not equivalent to the rest in the homogenous coordinate? Cross it out!

A	B	C	D
3	9	-6	3
2	6	-4	2
1	3	-2	2

Which point is not equivalent to the rest in the homogenous coordinate? Cross it out!

A	B	C	D
2	2	-2	4
5	5	-5	10
1	2	-1	2

Suppose these points are all equivalent in the homogenous coordinates. Fill in the missing values.

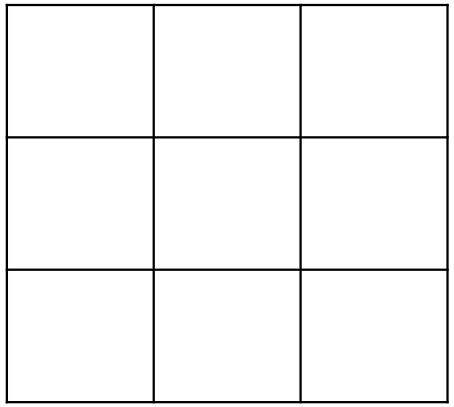
A	B	C	D
4	8	2	c 12
2	4	b 1	6
a 1	2	1/2	d 3

a+b+c+d = 17

Homogenous Transformation

Translation Matrix

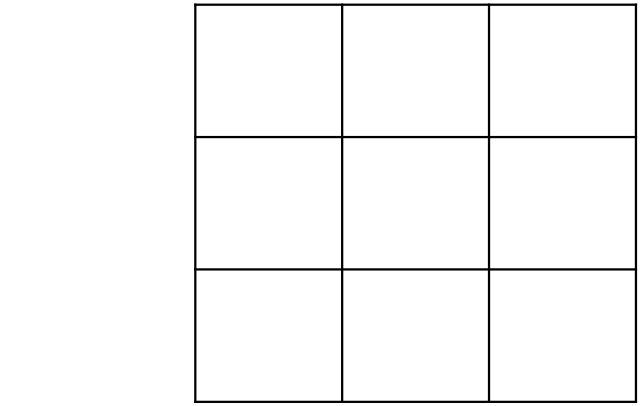
x
y



Translate by [-3, 2]

A	B
5	4
3	2

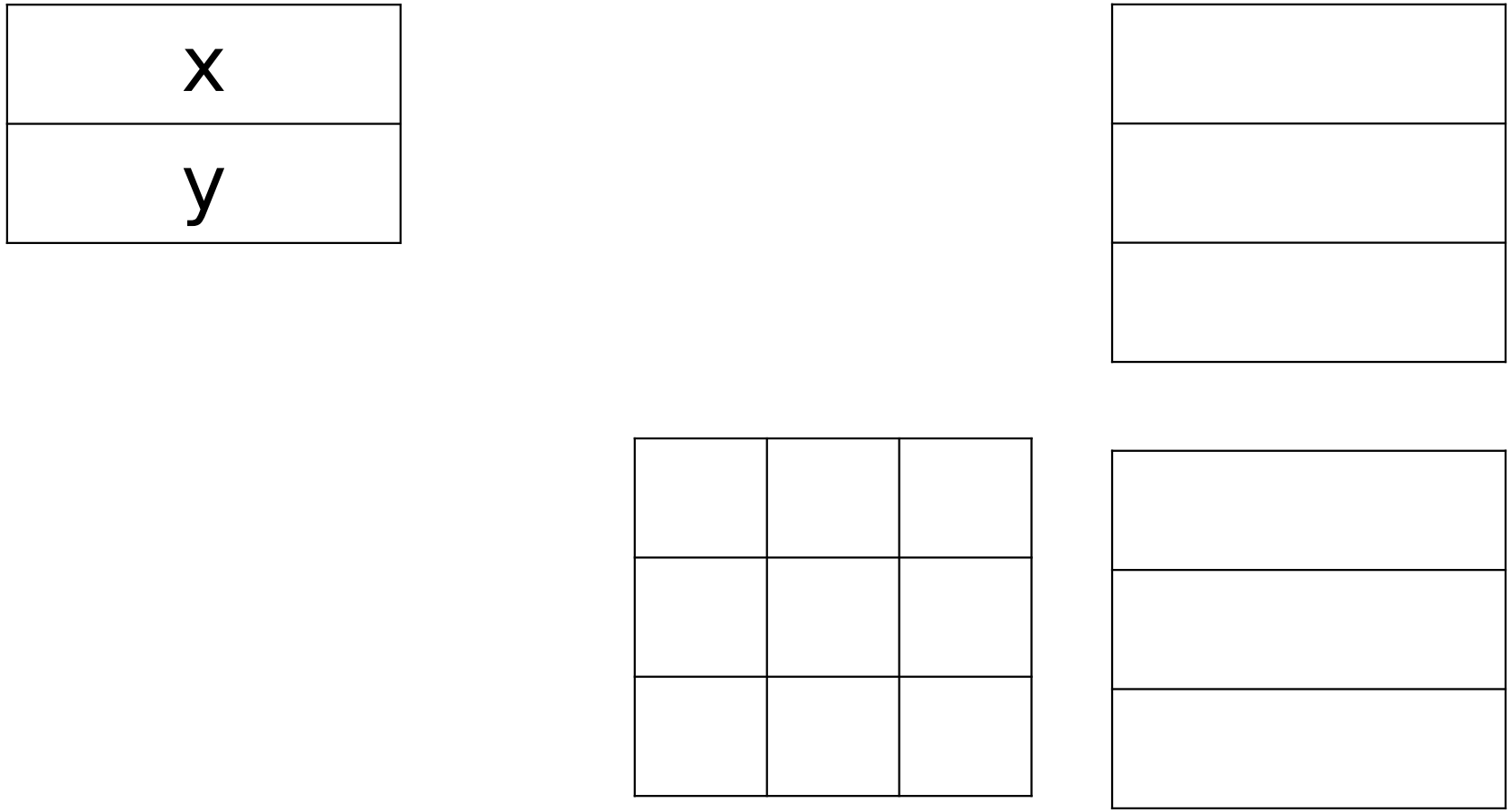
to H. C.



A^H	B^H

A’	B’
H	H

Scaling Matrix



Scale by [3, -2]

A	B
2	1
3	4

A^H	B^H

A’	B’
H	H

Translate by [2, 3]

A	B
4	-2
1	5

to H. C.

A^H	B^H
4	-2
1	c 5
1	1

a 1	0	2
0	1	b 3
0	0	1

A'^H	B'^H
6	0
4	d 8
1	1

a+b+c+d
= 17

Scale by [2, 3]

A	B
3	1
2	-1

to H. C.

A^H	B^H
3	1
2	c -1
1	1

a 2	0	0
0	3	b 0
0	0	1

A'^H	B'^H
6	2
6	d -3
1	1

a+b+c+d
= -2

Suppose P is translated to P’. What are the values of the transformation matrix M?

P

5
8
1

M

a 1	0	c -3
0	b 1	d 6
0	0	1

P’

2
1 4
1

a+b+c+d = 5

Suppose P is scaled to P’. What are the values of the transformation matrix M?

P

5
8
1

M

a 3	b 0	0
0	c -2	d 0
0	0	1

P’

15
-16
1

a+b+c+d = 1

Suppose a group of points are scaled by a common matrix M. Which point does not belong to this group? Cross it out!

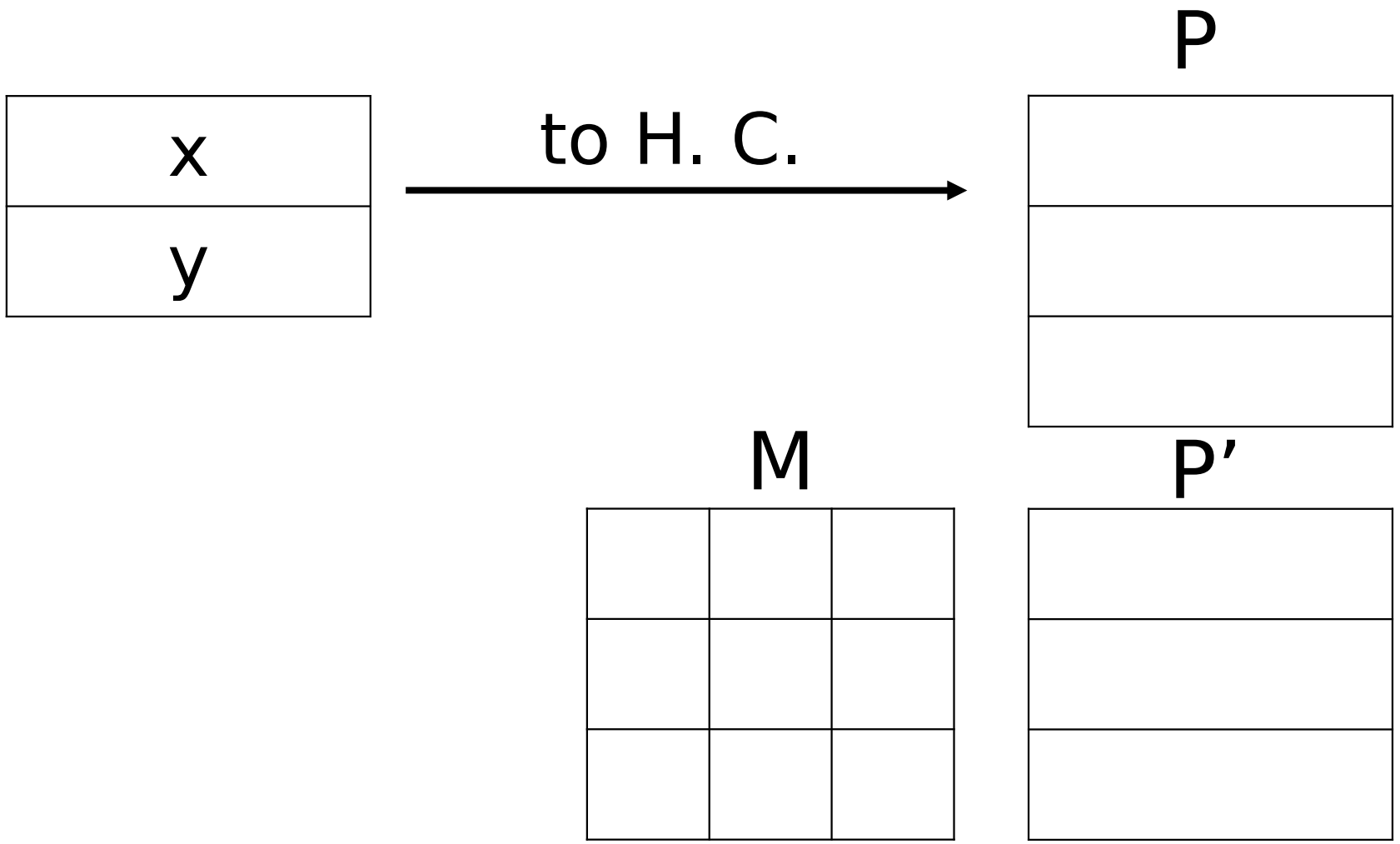
P1	P2	P3	P4
2	4	3	5
3	-1	2	-2
1	1	1	1

M

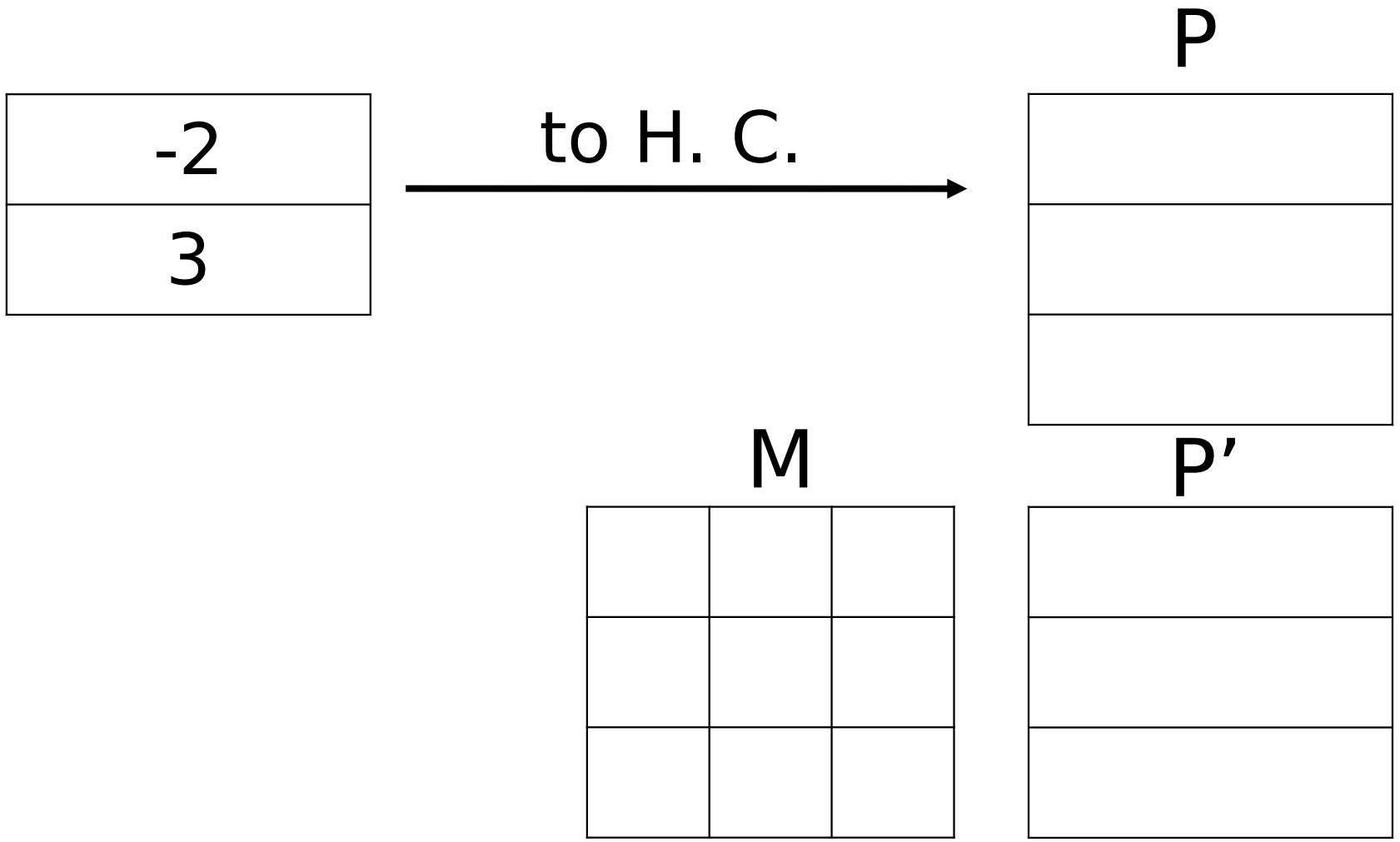
2	0	0
0	-2	0
0	0	1

4	8	6	10
-6	3	-4	4
1	1	1	1

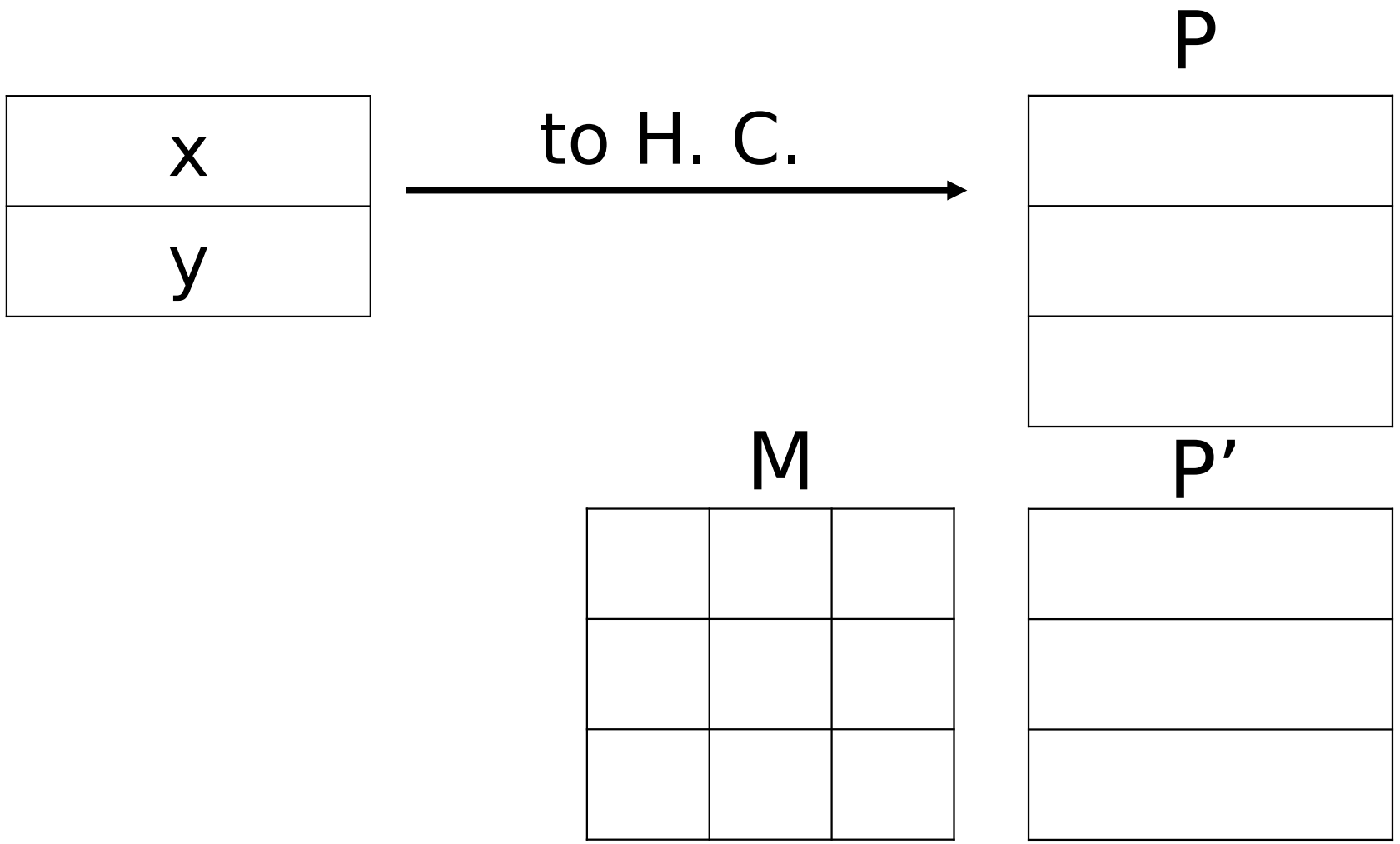
Scale by $[s_x, s_y]$ then Translate by $[t_x, t_y]$



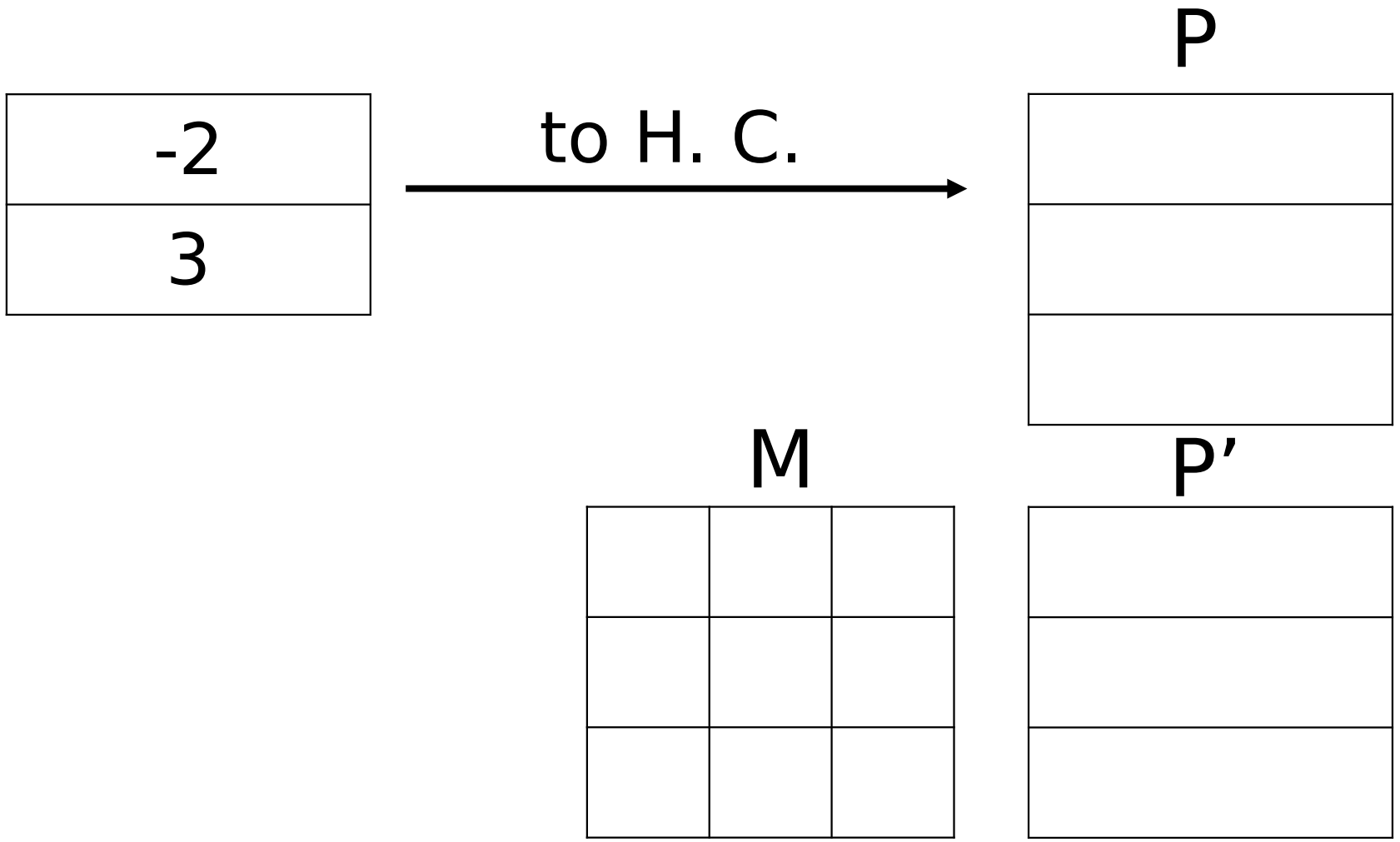
Scale by [2, 5] then Translate by [-3, 10]



Translate by $[t_x, t_y]$ then Scale by $[s_x, s_y]$



Translate by [-3, 10] then Scale by [2, 5]



Scale by [3, 2] then Translate by [4, -3]

4
-2

to H. C.

P

4
-2
1

M

a 3	0	4
0	b 2	c -3
0	0	1

P’

16
d -7
1

a+b+c+d = -5

Translate by [4, -3] then Scale by [3, 2]

4
-2

to H. C. →

P

4
-2
1

M

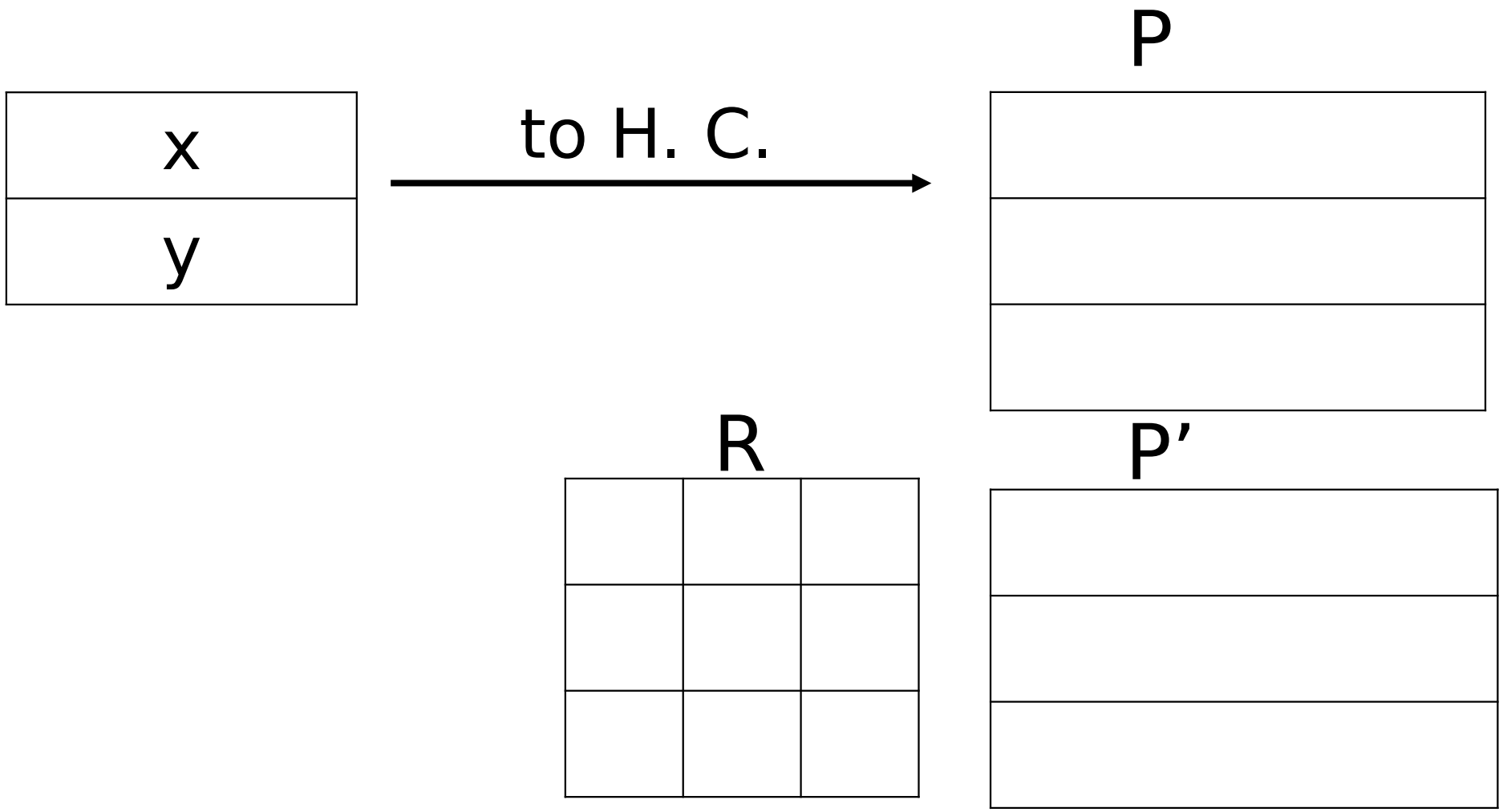
a 3	0	4
0	b 2	c -3
0	0	1

P’

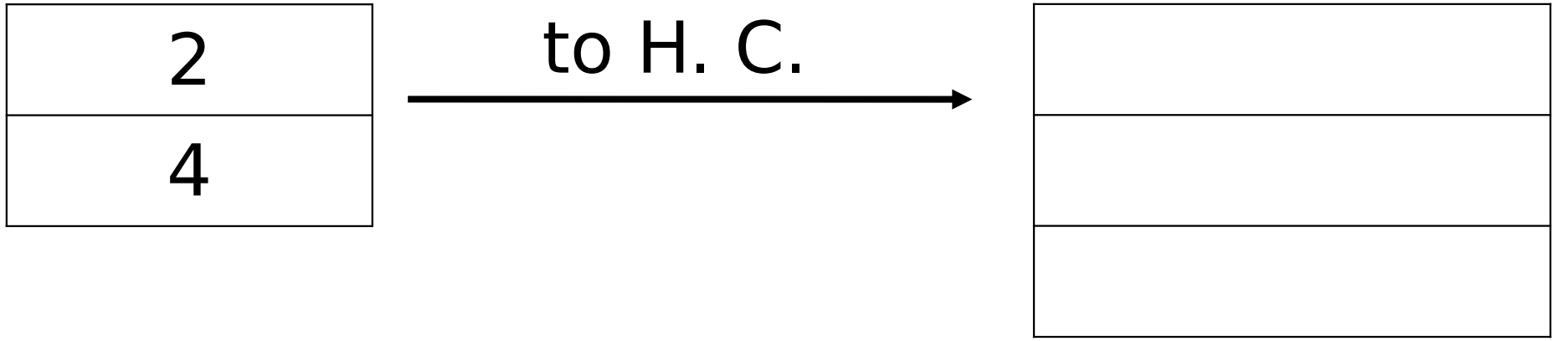
28
d -13
1

a+b+c+d
= -11

Rotation Matrix

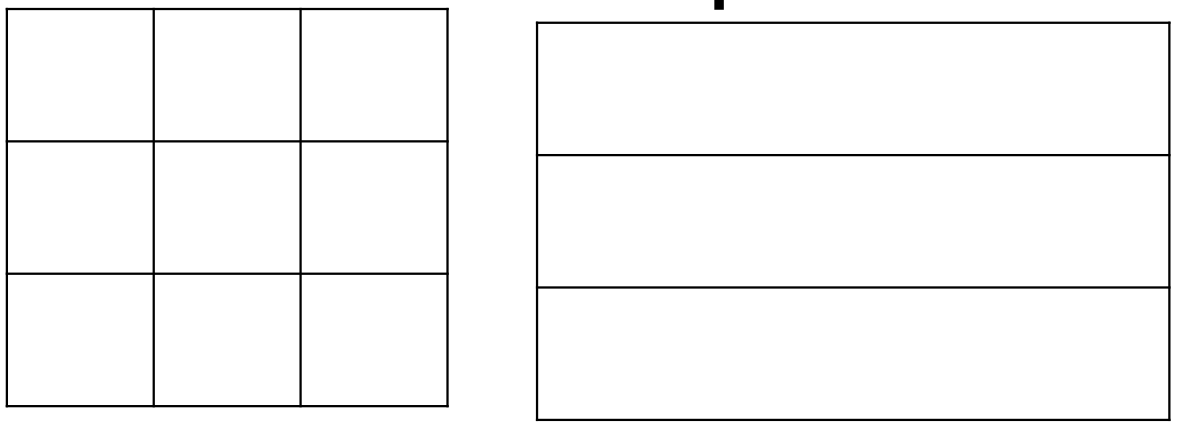


Rotate by 45° (CCW)



$\cos(45^\circ) =$ ____

$\sin(45^\circ) =$ ____



Rotate by 37° (CCW)

10
25

to H. C. →

P

10
25
1

$\cos(37^\circ) = 0.8$

$\sin(37^\circ) = 0.6$

R

0.8 a	-0.6 b	0 c
0.6	0.8	0 d
0	0	1

P’

-7
26
1

a+b+c+d = 20.4

Rotate by 90° (CCW)

8
5

to H. C. →

P

8
5
1

cos(90°) = _0___

sin(90°) = __1__

R

0	-1	0
a 1	b 0	0
0	0	1

a+b+c+d = 4

P’

c -5
d 8
1

Scale, Translate, Rotate

P = (3, 2)

Scale by [4, 2]

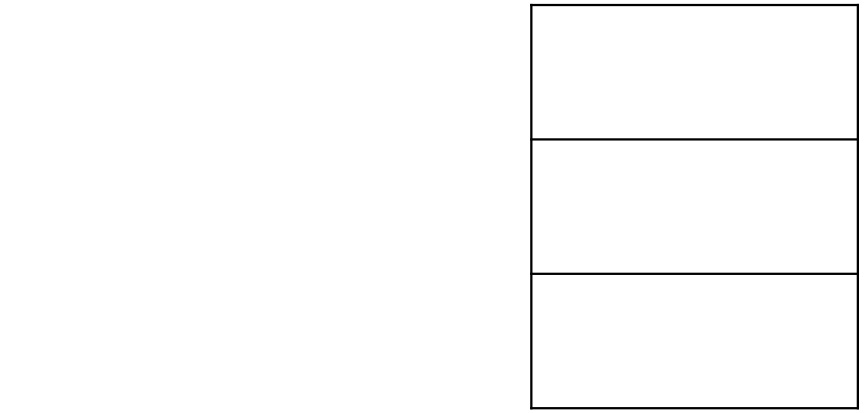
Translate by [3, 6]

Rotate CCW by 37°

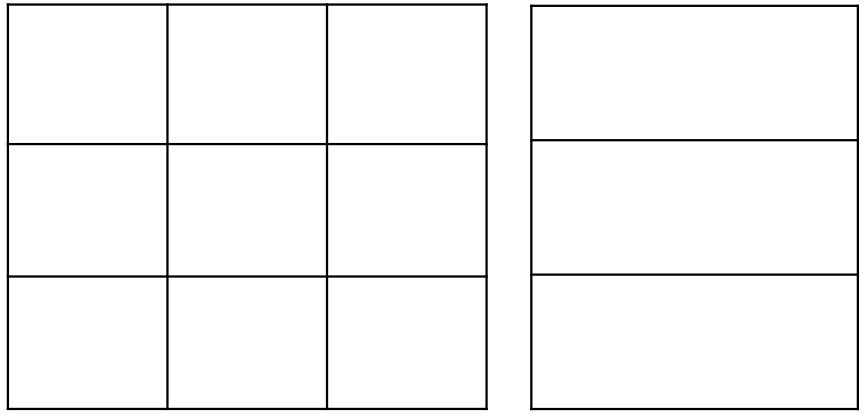
P’ = ?

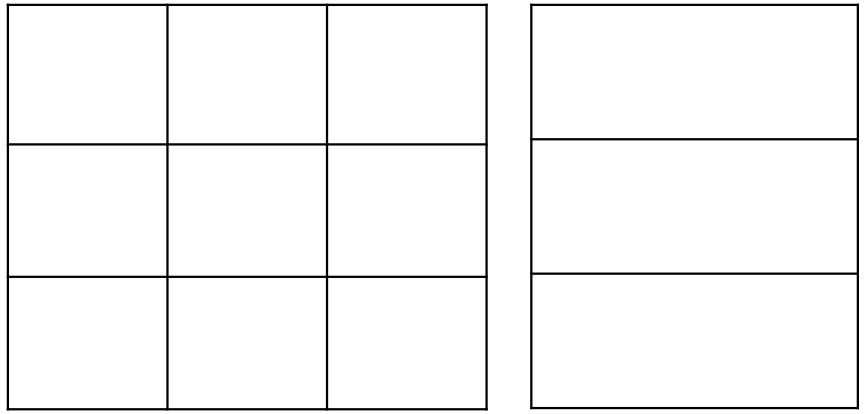
cos(37°) =

sin(37°) =



P





P’

Scale, Translate, Rotate

P = (2, 3)

Scale by [3, -4]

Translate by [-1, 2]

Rotate CCW by 53°

P’ = ?

cos(53°) = 0.6

sin(53°) = 0.8

a+b+c+d = 4

2
3
1

P

3	0	-1
0	-4	2
0	0	1

a 5
b -10
1

0.6	-0.8	0
0.8	0.6	0
0	0	1

c 11
d -2
1

P’