



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

$$\begin{array}{c} P \\ \hline \begin{matrix} 2 \\ 3 \\ 1 \end{matrix} \end{array}$$
$$2S_x = 8$$
$$S_x = 4$$
$$\begin{array}{c} M \\ \hline \begin{matrix} S_x & 0 & 0 \\ 0 & S_y & 0 \\ 0 & 0 & 1 \end{matrix} \end{array}$$
$$\begin{array}{c} P' \\ \hline \begin{matrix} 8 \\ -6 \\ 1 \end{matrix} \end{array}$$
$$3S_y = -6$$
$$S_y = -2$$



# Scale, Translate, Rotate

$$P = (3, -2)$$

Scale by [3, -4]

Translate by [1, 2]

Rotate CCW by  $37^\circ$

$$P' = ?$$

$$\cos(37^\circ) = \frac{4}{5}$$

$$\sin(37^\circ) = \frac{3}{5}$$

$$\begin{matrix} 8-6=2 \\ -6+8=2 \\ 1 \end{matrix}$$

3
-2
1

P

$$\begin{matrix} 6+8 \\ = 14 \end{matrix}$$

a	<table border="1"> <tr><td>3</td><td>0</td><td>1</td></tr> <tr><td>0</td><td>-4</td><td>2</td></tr> <tr><td>0</td><td>0</td><td>1</td></tr> </table>	3	0	1	0	-4	2	0	0	1	b	<table border="1"> <tr><td><math>9+1=10</math></td></tr> <tr><td><math>8+2=10</math></td></tr> <tr><td>1</td></tr> </table>	$9+1=10$	$8+2=10$	1
3	0	1													
0	-4	2													
0	0	1													
$9+1=10$															
$8+2=10$															
1															
	<table border="1"> <tr><td><math>\frac{4}{5}</math></td><td><math>-\frac{3}{5}</math></td><td>0</td></tr> <tr><td><math>+\frac{3}{5}</math></td><td><math>\frac{4}{5}</math></td><td>0</td></tr> <tr><td>0</td><td>0</td><td>1</td></tr> </table>	$\frac{4}{5}$	$-\frac{3}{5}$	0	$+\frac{3}{5}$	$\frac{4}{5}$	0	0	0	1	c	<table border="1"> <tr><td>2</td></tr> <tr><td>14</td></tr> <tr><td>1</td></tr> </table>	2	14	1
$\frac{4}{5}$	$-\frac{3}{5}$	0													
$+\frac{3}{5}$	$\frac{4}{5}$	0													
0	0	1													
2															
14															
1															

$$\begin{aligned} & -\frac{3}{5}x^{10} + \frac{4}{5}x^{10} \\ &= \frac{1}{5}x^{10} = 2 \\ & \frac{4}{5}x^{10} - \frac{3}{5}x^{10} \\ &= \frac{1}{5}x^{10} = 2 \end{aligned}$$



# Logic Operation

1.  $a = I > 5$
2.  $b = I < 3$
3.  $J = np.ones((3,3))$
4.  $J[a] = -5$
5.  $J[b] = -3$

I

1	2	3
6	5	4
9	8	7

J

J

-3	-3	1
-5	1	1
-5	-5	-5

a

b

F	F	F	T	T	F
T	F	F	F	F	F
T	T	T	F	F	F



$M_{2 \times 2}$

$B$

$I(x, y)$

$Y$

4			
3	1	1	
2	1	1	
1	1		
1	2	3	4

$X$

$i = 1$

	j = 0	j = 1	
i = 0	1	1	
1	1	1	
2	1	1	
3	1	1	
4	1	1	
	1	1	

$x^i y^j I(x, y)$

$j = 1$

4			
3	3	3	
2	2	2	
1	1	1	

	i = 1	i = 0	
1	2	3	
2	1	3	
3	2		
4	1		

4			
3	6	9	
2	2	6	
1	2		

$\sum_x \sum_y$

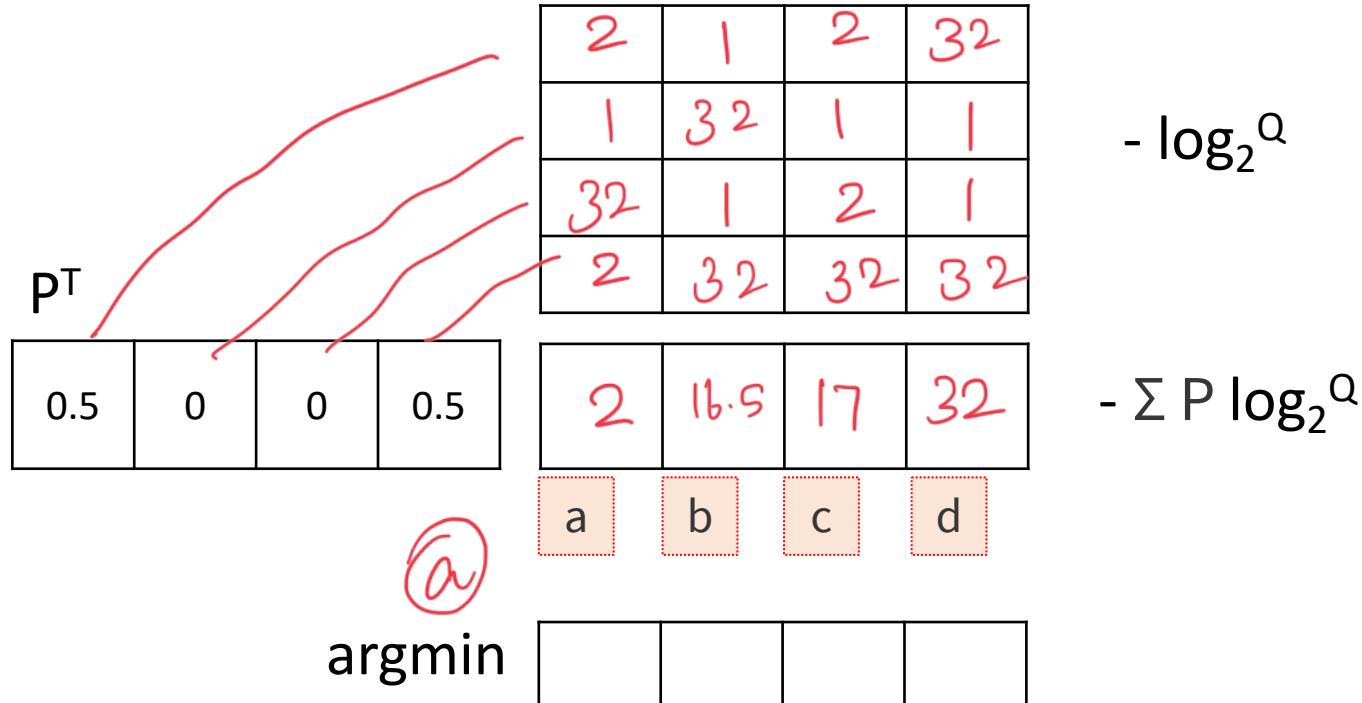
	j = 0	j = 1	
i = 0	5	11	
i = 1	11	25	
	a	b	
c			d

$M(B)$

□ □ Find Q most similar to P by Cross Entropy

X	$\log_2 X$
1	0
0.5	-1
0.25	-2
0.125	-3
$2^{-32}$	-32
0	NaN

$Q_1$	$Q_2$	$Q_3$	$Q_4$
0.25	0.5	0.25	$2^{-32}$
0.5	$2^{-32}$	0.5	0.5
$2^{-32}$	0.5	0.25	0.5
0.25	$2^{-32}$	$2^{-32}$	$2^{-32}$

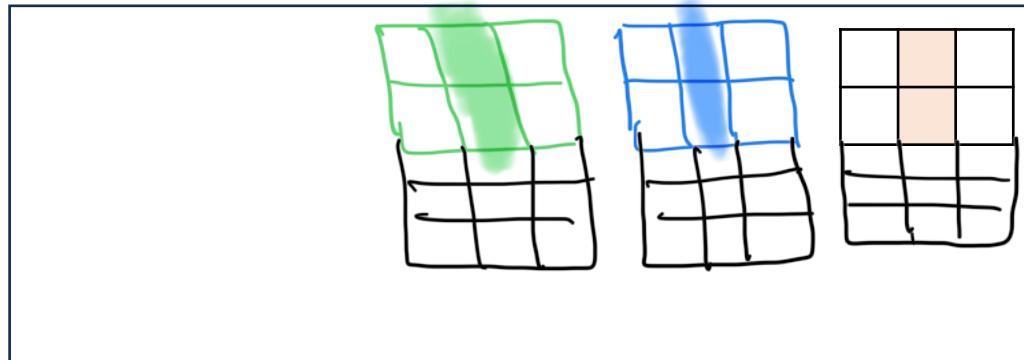




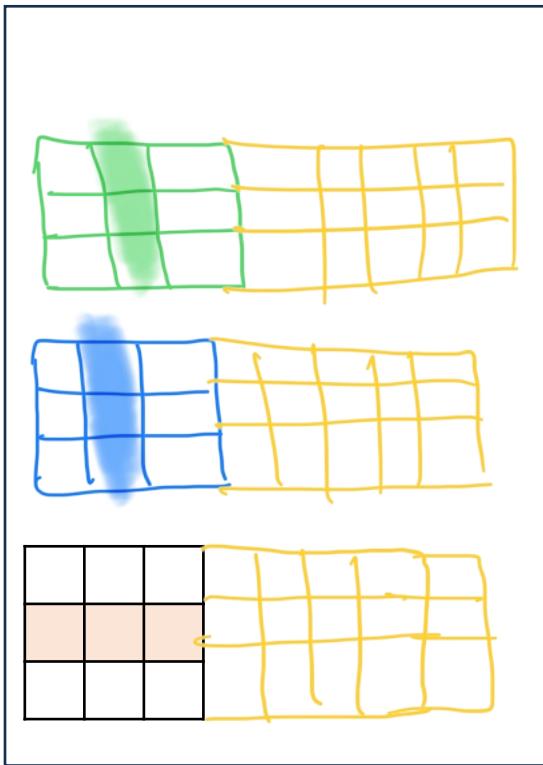
# Scale to 3 channels, 5 filters, 8 inputs

Copy, add rows and columns  
Show your work

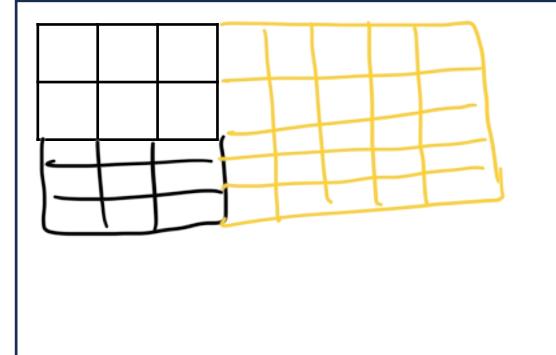
K



X



Z



$$\text{shape}(K) = (5, 9)$$

$$\text{shape}(X) = (9, 8)$$

$$\text{shape}(Z) = (5, 8)$$



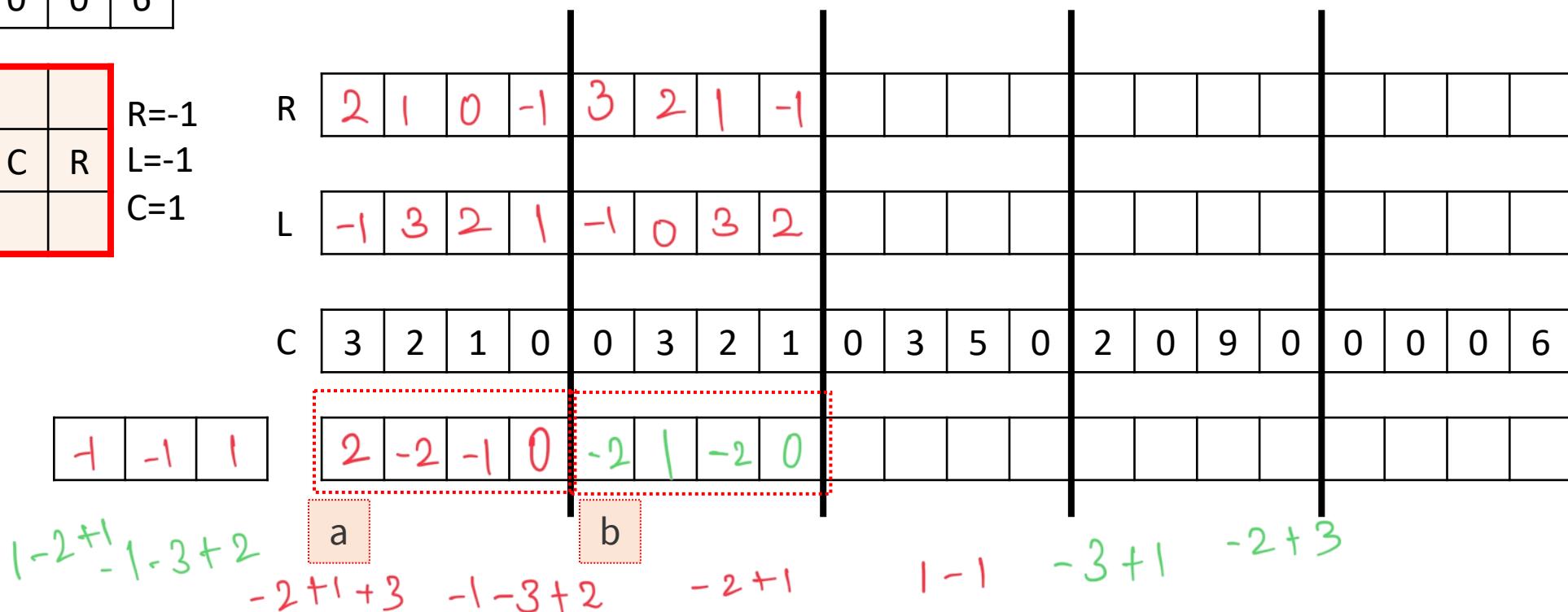
# Left/Right Neighbors

3	2	1	0
0	3	2	1
0	3	5	0
2	0	9	0
0	0	0	6

L	C	R

R=-1  
L=-1  
C=1

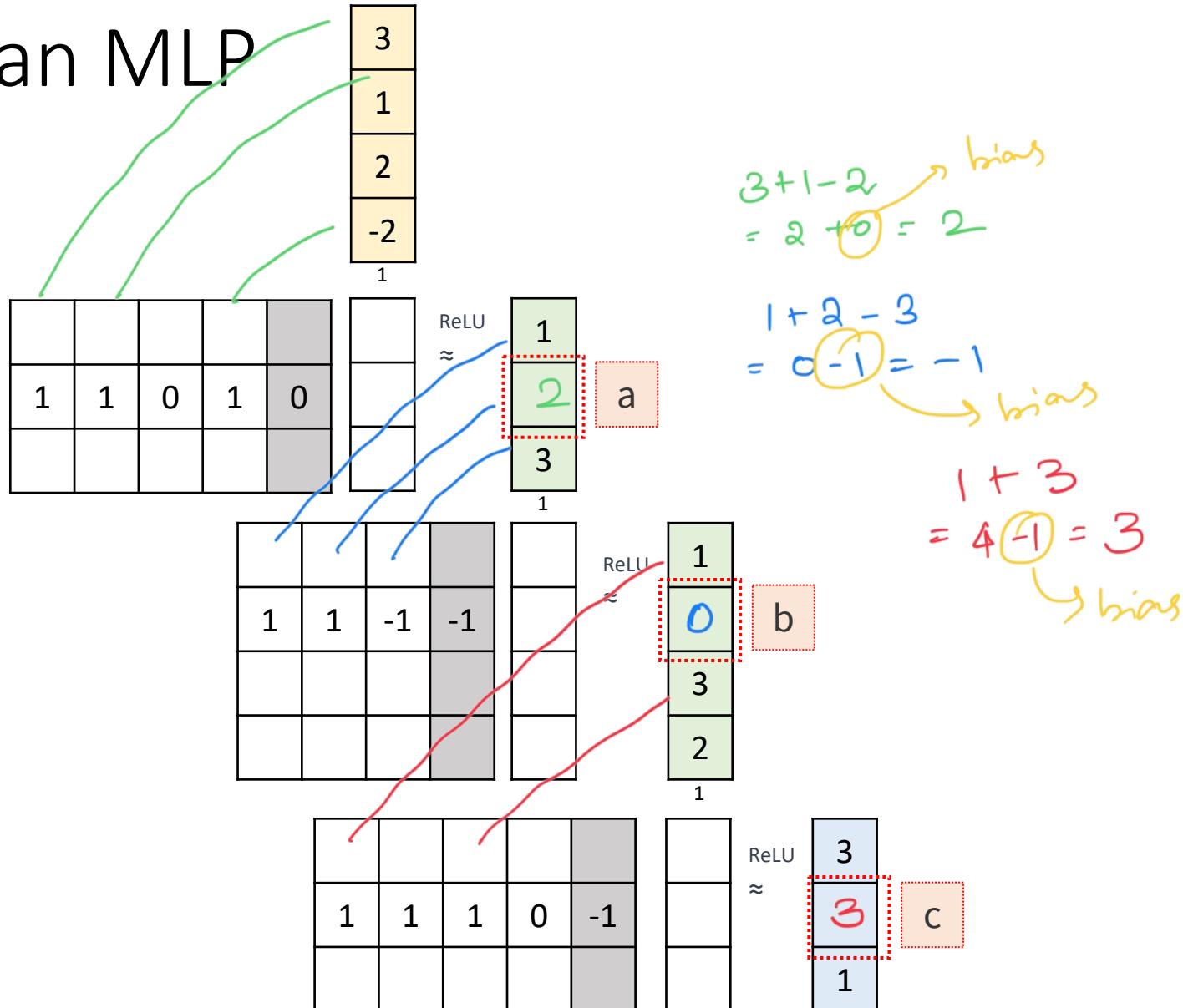
Calculate a, b. Pad with -1 instead of X.





# O Calculate an MLP

Calculate the second feature / node / row only.





## 2 Layers

ReLU:



1	-2	1	-2	0	-2	1	2	-1	0	2	-1
2	6	-1	4	1	0	4	1	-2	2	0	3
0	1	5	0	4	0	-1	0	3	0	-1	0

1 1 1 1 1 1 1 1 1 1 1 1

1	0	1	-2
1	1	0	-2
0	1	0	0
1	-1	0	0

$\begin{matrix} -2 \\ 0 \\ 0 \\ -2 \\ \vdots \\ 0 \\ -2 \\ -2 \\ -2+4 \\ 1-2 \\ 1-2 \\ 1-2 \\ 1-2-4 \\ 1=0 \end{matrix}$

1	1	1	1	0
1	0	-1	0	5

$4+0$     $2+0+1+0$   
 $0+0-4+5$

			0	2							
			0	0							
			4	1							
			0	0							
1	1	1	1	1	1	1	1	1	1	1	1

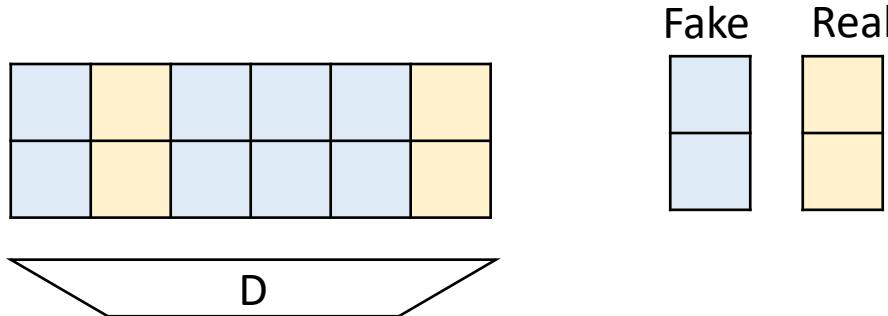
			a	4	3	c					
			b	1	6	d					

$2-1+5$



# Discriminator Loss

	F	R	F	F	F	R
P <sub>1</sub>	0	1	0	0	0	1
P <sub>2</sub>	1	0	1	1	1	0
P <sub>3</sub>	0	1	0	0	0	1
P <sub>4</sub>	1	0	1	1	1	0
P <sub>5</sub>	0	1	0	0	0	1
P <sub>6</sub>	1	0	1	1	1	0



$-\log(0) \approx 32$
$-\log(0.1) \approx 3$
$-\log(0.3) \approx 2$
$-\log(0.5) \approx 1$
$-\log(0.7) \approx 0.5$
$-\log(0.9) \approx 0.2$
$-\log(1) = 0$

	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	P <sub>4</sub>	P <sub>5</sub>	P <sub>6</sub>
real	0	1	0	0	0	1
!real	1	0	1	1	1	0

.7	.3	.3	.3	.3	.3	.7
.3	.7	.7	.7	.7	.7	.3

Y

1-Y

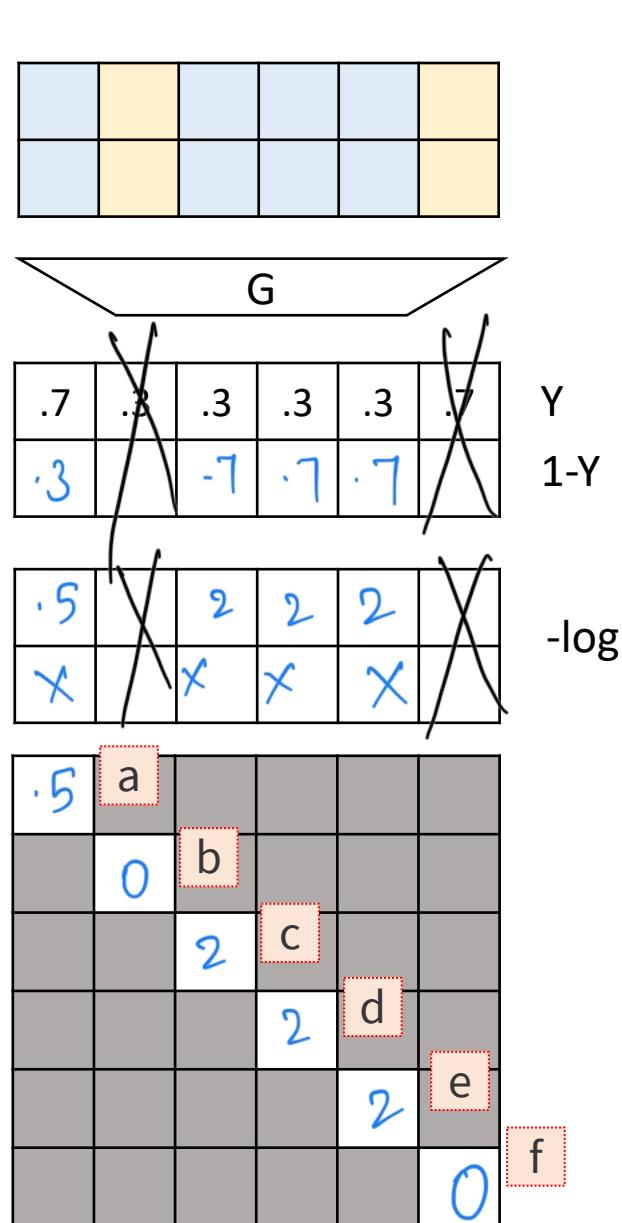
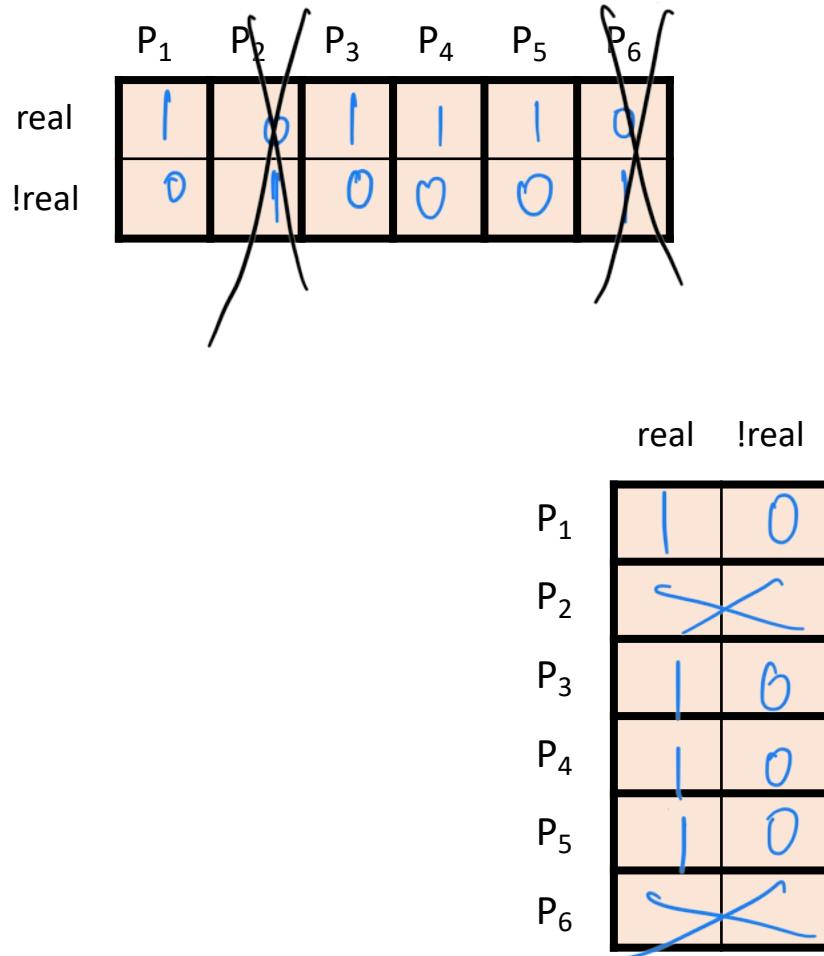
.5	2	2	2	2	.5
2	-5	5	5	5	2

-log

2	a					
	2	b				
		.5	c			
			.5	d		
				.5	e	
					.5	f



# Generator Loss



Calculate  $p(\text{sound?}, \text{angry?}, \text{home?})$

(Simplify the fractions)

!Home	!Angry 10	A. woof	4
		B. growl	4
		C. bark	2
Angry 10	Angry 10	A. woof	6
		B. growl	2
		C. bark	2



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Home	!Angry 20	A. woof	6
		B. growl	12
		C. bark	2
Angry 10	Angry 10	A. woof	2
		B. growl	3
		C. bark	5

a

$$p(\text{growl, angry, !home}) = \frac{2}{50}$$

b

$$p(\text{woof, angry, !home}) = \frac{6}{50}$$

c

$$p(\text{woof, angry, home}) = \frac{12}{50}$$

d

$$p(\text{bark, !angry, home}) = \frac{2}{50}$$



# Calculate $p(\text{sound?} \mid \text{angry?}, \text{home?})$

(Simplify the fractions)

!Home	!Angry	A. woof	4
		B. growl	4
Home	Angry	C. bark	2
		A. woof	6
		B. growl	2
		C. bark	2



50

Home	!Angry	A. woof	6
		B. growl	12
!Home	Angry	C. bark	2
		A. woof	2
		B. growl	3
		C. bark	5

a

$$p(\text{growl} \mid \text{angry}, \text{!home}) = \frac{2}{10}$$

b

$$p(\text{woof} \mid \text{angry}, \text{!home}) = \frac{6}{10}$$

c

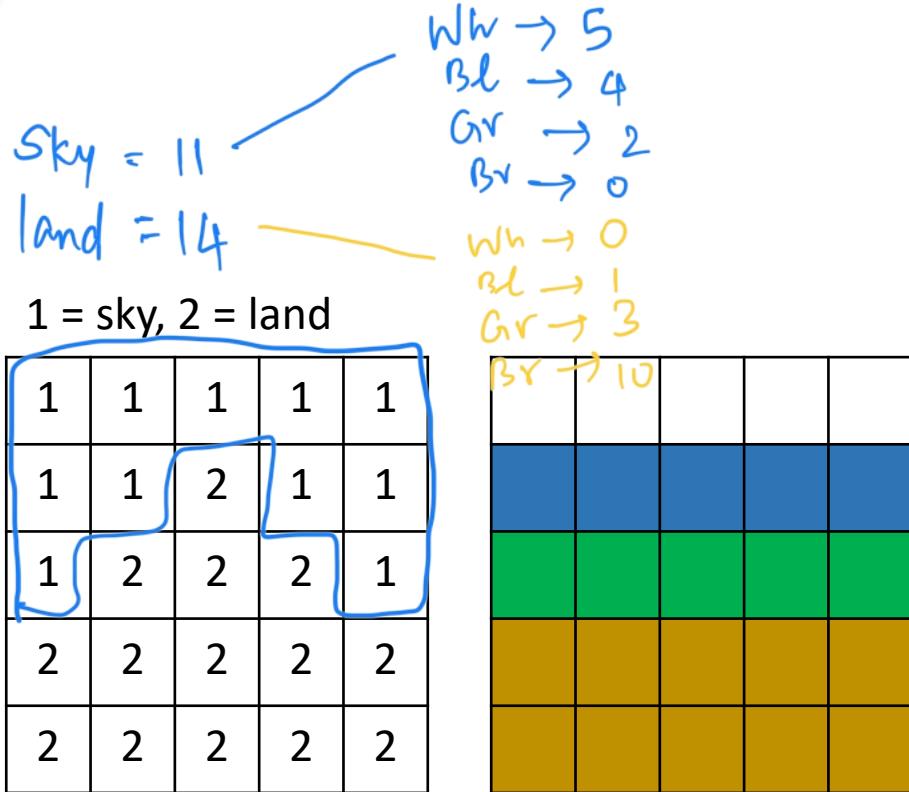
$$p(\text{woof} \mid \text{angry}, \text{home}) = \frac{2}{10}$$

d

$$p(\text{bark} \mid \text{!angry}, \text{home}) = \frac{2}{20}$$



# Conditional Probability Values



- a  $p(\text{color} = \text{blue} | \text{part} = \text{sky}) = \frac{4}{11}$
- b  $p(\text{color} = \text{blue} | \text{part} = \text{land}) = \frac{1}{14}$
- c  $p(\text{color} = \text{white} | \text{part} = \text{sky}) = \frac{5}{11}$
- d  $p(\text{color} = \text{green} | \text{part} = \text{land}) = \frac{3}{14}$



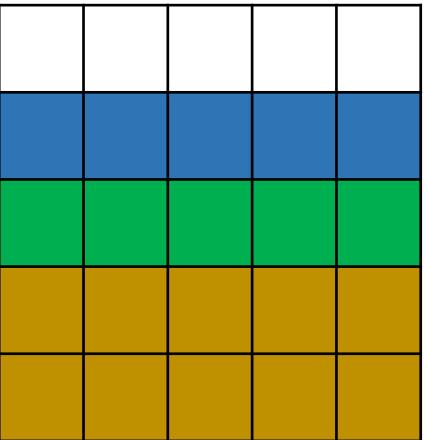
# Joint Probability Values

(Simplify the fractions)

$$\frac{5}{11} \cdot \frac{11}{25}$$

1 = sky, 2 = land

1	1	1	1	1
1	1	2	1	1
1	2	2	2	1
2	2	2	2	2
2	2	2	2	2



a

$$p(\text{color} = \text{blue}, \text{part} = \text{sky}) = \frac{4}{25}$$

b

$$p(\text{color} = \text{blue}, \text{part} = \text{land}) = \frac{1}{25}$$

c

$$p(\text{color} = \text{white}, \text{part} = \text{sky}) = \frac{8}{25}$$

d

$$p(\text{color} = \text{green}, \text{part} = \text{land}) = \frac{3}{25}$$