

SC201

Lecture 14

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$$\begin{bmatrix} 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \end{bmatrix}$$

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$$\begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

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$$\begin{bmatrix} 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \end{bmatrix}$$

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$$\begin{bmatrix} & \\ & \end{bmatrix}$$

0	-30	-30	0
0	-30	-30	0
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-1	0	1
-1	0	1
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$$\begin{bmatrix} 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \end{bmatrix}$$

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$$\begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

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$$\begin{bmatrix} -90 \\ \end{bmatrix}$$

$$\begin{bmatrix} 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \end{bmatrix}$$

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$$\begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

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$$\begin{bmatrix} -90 \\ \vdots \\ \vdots \end{bmatrix}$$

$$\begin{bmatrix} 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \end{bmatrix}$$

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$$\begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

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$$\begin{bmatrix} -90 & 90 \\ \quad & \quad \end{bmatrix}$$

$$\begin{bmatrix} 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \end{bmatrix}$$

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$$\begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

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$$\begin{bmatrix} -90 & 90 \\ \quad & \quad \end{bmatrix}$$

$$\begin{bmatrix} 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \end{bmatrix}$$

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$$\begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

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$$\begin{bmatrix} -90 & 90 \\ -90 & \end{bmatrix}$$

$$\begin{bmatrix} 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \end{bmatrix}$$

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$$\begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

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$$\begin{bmatrix} 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \end{bmatrix}$$

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$$\begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

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$$\begin{bmatrix} -90 & 90 \\ -90 & 90 \end{bmatrix}$$

$$\begin{bmatrix} 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \end{bmatrix}$$

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$$\begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

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$$\begin{bmatrix} -90 & 90 \\ -90 & 90 \end{bmatrix}$$

$$\begin{bmatrix} 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \end{bmatrix}$$

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$$\begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

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$$\begin{bmatrix} -90 & 90 \\ -90 & 90 \end{bmatrix}$$

$$\begin{bmatrix} 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \end{bmatrix}$$

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$$\begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

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$$\begin{bmatrix} -90 & 90 \\ -90 & 90 \end{bmatrix}$$

10	10	10	0	0	0
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-1	0	1
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0	-30	-30	0
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0	-30	-30	0
0	-30	-30	0
0	-30	-30	0
0	-30	-30	0

-90	90
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Effective Receptive Field

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10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0

0	-30	-30	0
0	-30	-30	0
0	-30	-30	0
0	-30	-30	0

-90	90
-90	90

10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0
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-1	0	1
-1	0	1
-1	0	1

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0	-30	-30	0
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0	-30	-30	0

$$\begin{bmatrix} 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \\ 0 & -30 & -30 & 0 \end{bmatrix}$$

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$$\begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

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$$\begin{bmatrix} -90 & 90 \\ -90 & 90 \end{bmatrix}$$

-90	90
-90	90

-90	90
-90	90



-90	90
-90	90

Flatten()



-90	90
-90	90

Flatten()

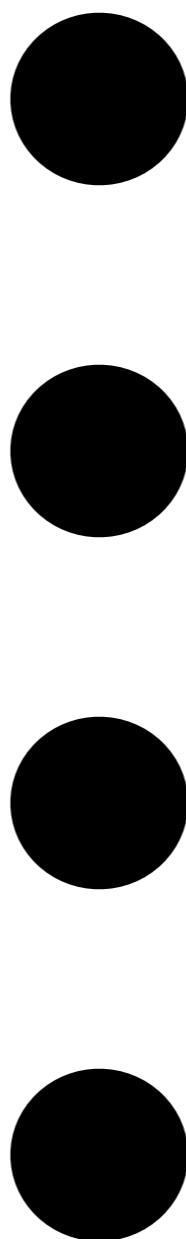


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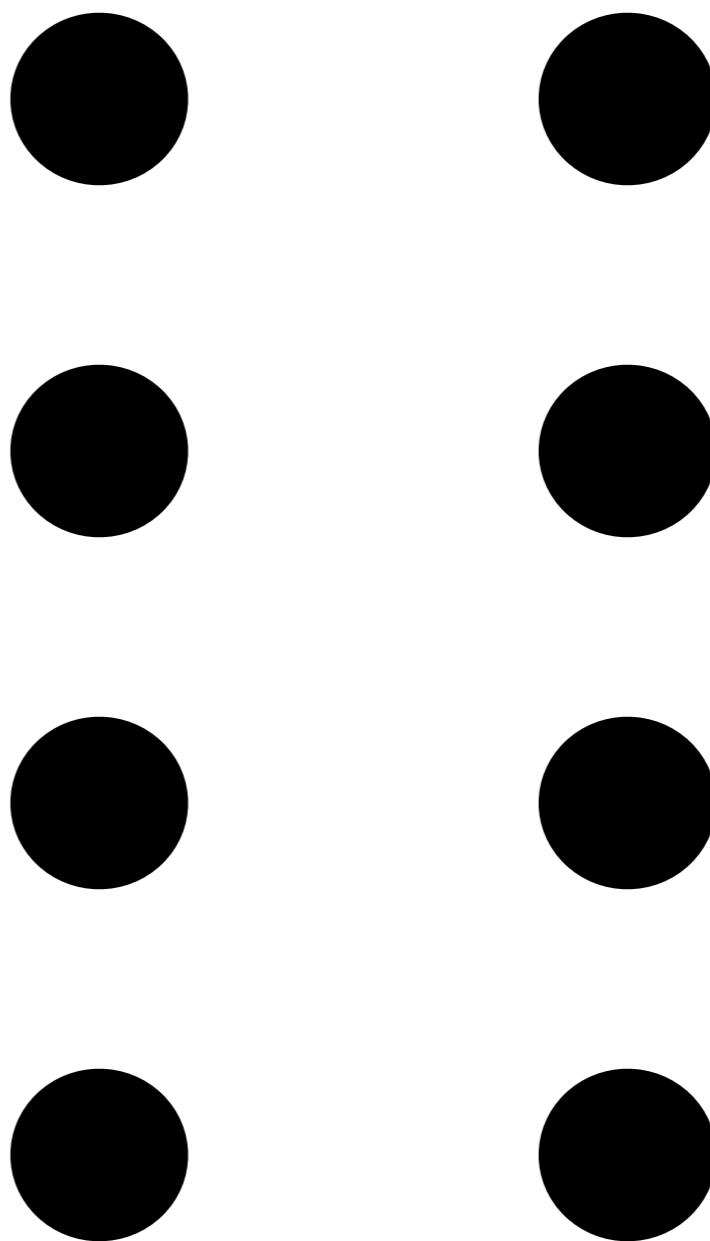
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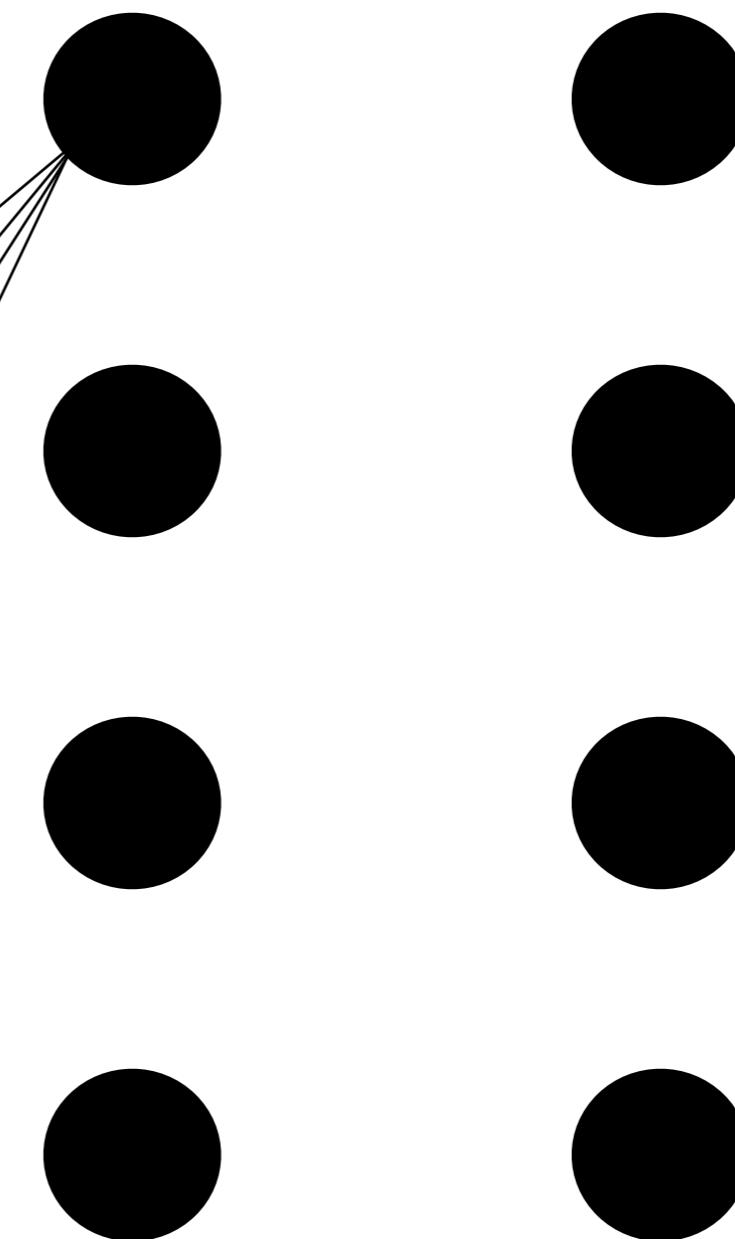
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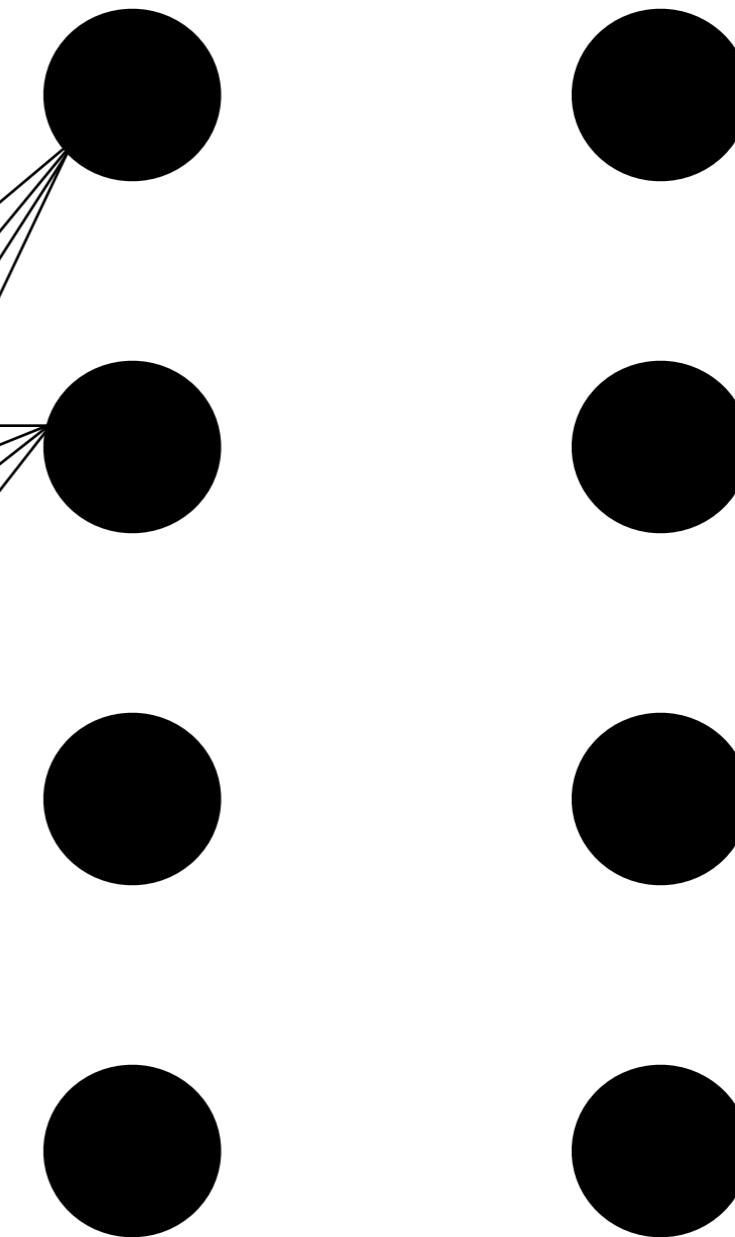
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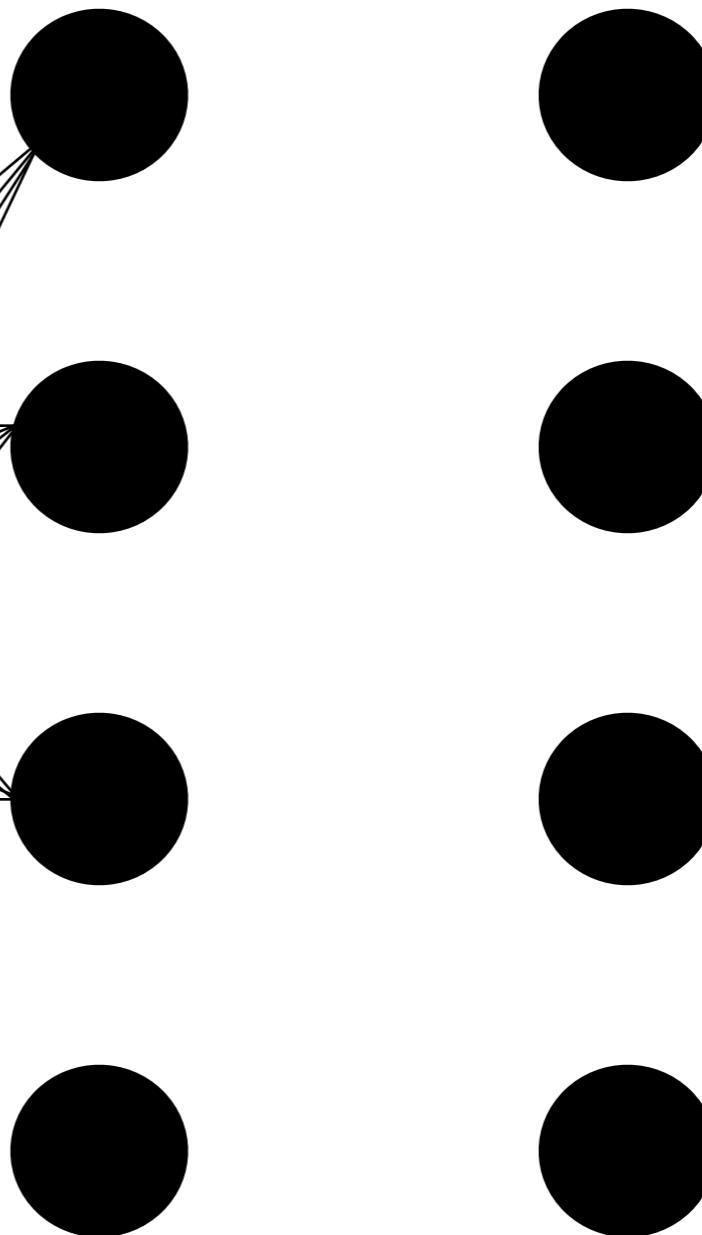
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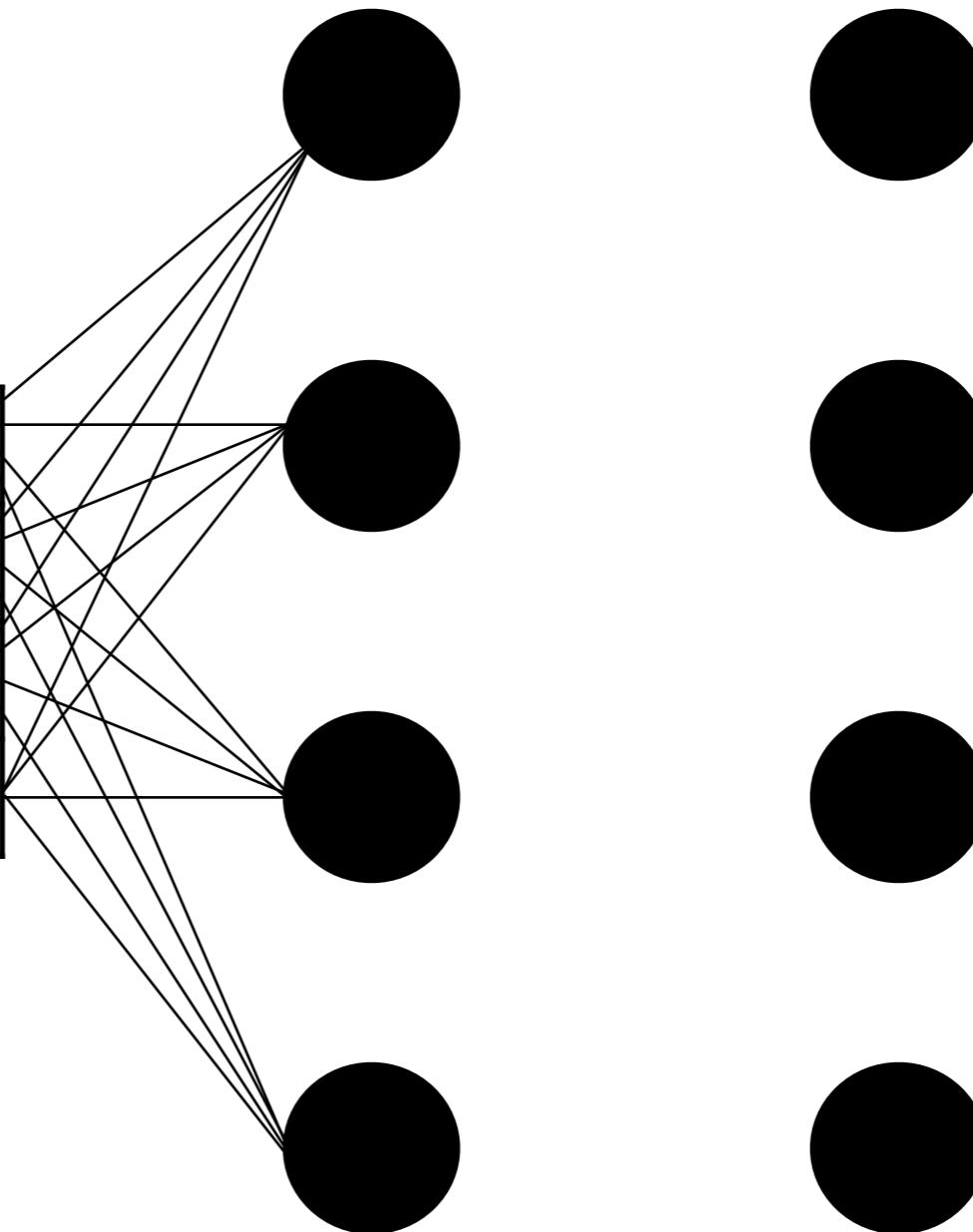
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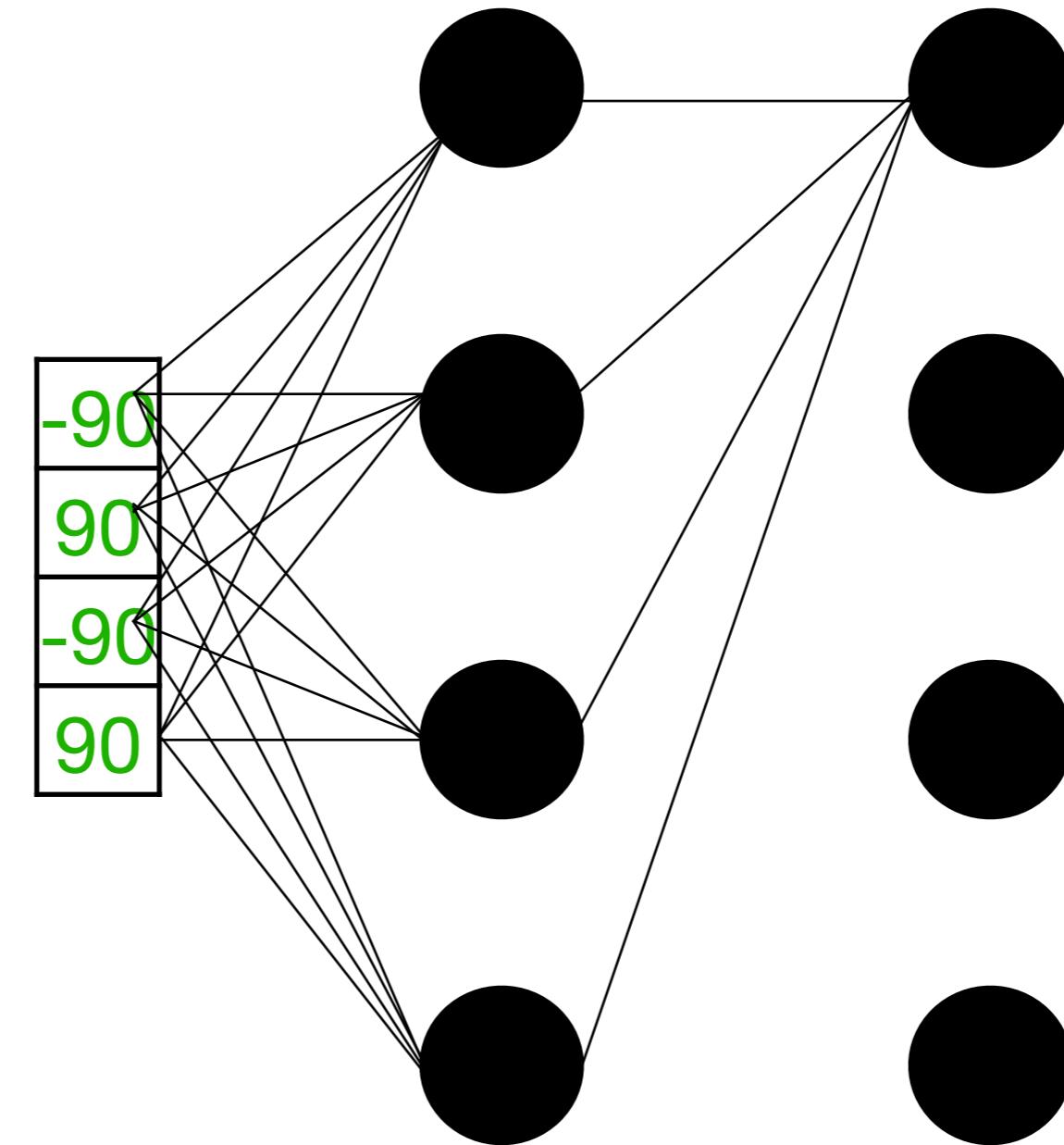
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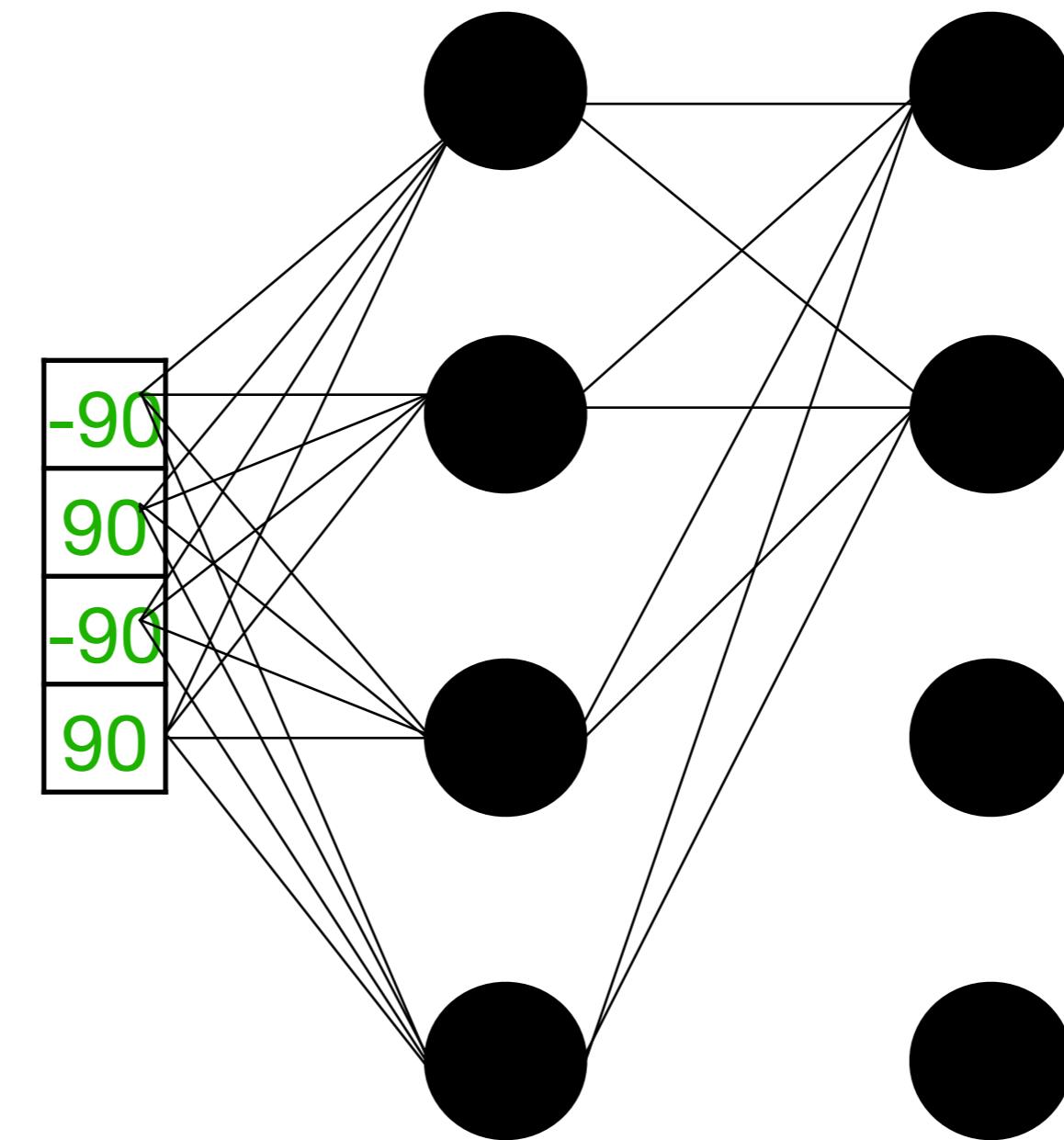
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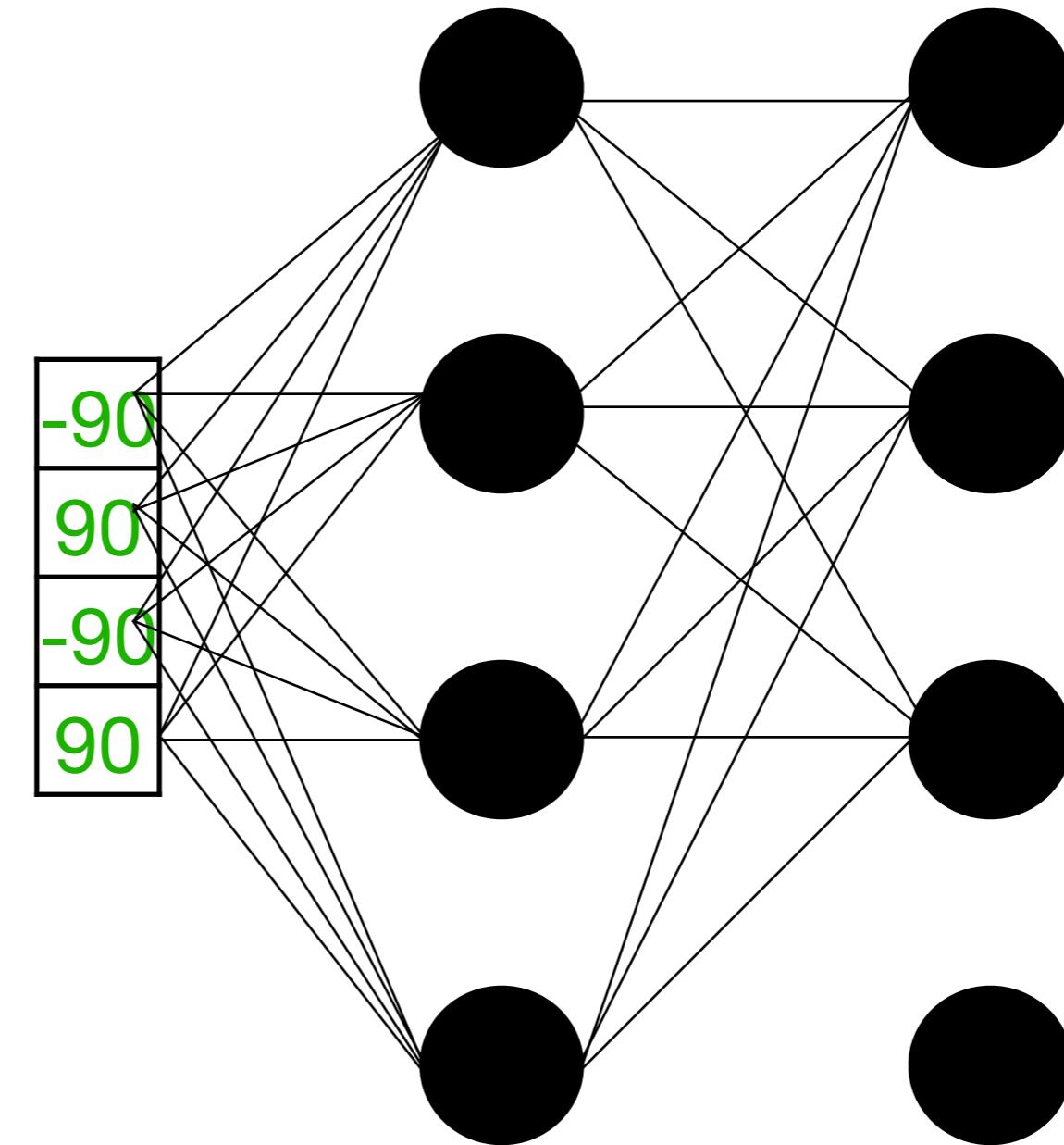
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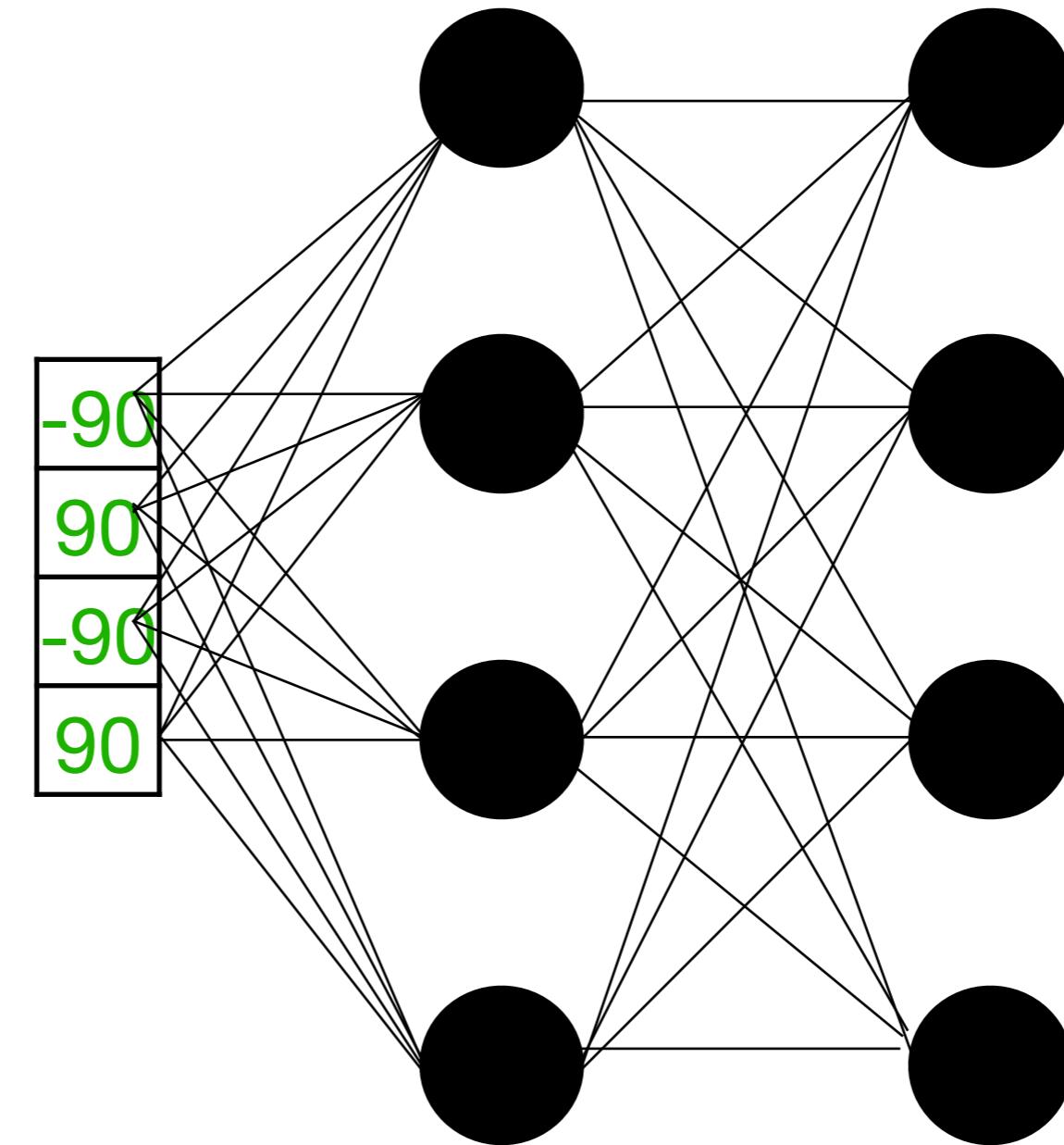
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Convolutional Neural Network

Zero Padding

10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0

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-1	0	1
-1	0	1
-1	0	1

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10	10	10	0	0	0	
10	10	10	0	0	0	
10	10	10	0	0	0	
10	10	10	0	0	0	
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-1	0	1
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0	0	0	0	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
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0	10	10	10	0	0	0	0
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0	10	10	10	0	0	0	0
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0	0	0	0	0	0	0	0
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[REDACTED]

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0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
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20	0	-20		

0	0	0	0	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
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0	10	10	10	0	0	0	0
0	0	0	0	0	0	0	0

-1	0	1
-1	0	1
-1	0	1

Page 1

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0	10	10	10	0	0	0	0
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0	10	10	10	0	0	0	0
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-1	0	1
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-1	0	1

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20	0	-20	-20	0	

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0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	0	0	0	0	0	0	0

*

-1	0	1
-1	0	1
-1	0	1

=

20	0	-20	-20	0	0

Stride=1

0	0	0	0	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	0	0	0	0	0	0	0

*

-1	0	1
-1	0	1
-1	0	1

=

20	0	-20	-20	0	0

0	0	0	0	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	0	0	0	0	0	0	0

*

-1	0	1
-1	0	1
-1	0	1

=

20	0	-20	-20	0	0
20	0	-30	-30	0	0
.....
.....
.....	0

0	0	0	0	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	0	0	0	0	0	0	0

*

=

20	0	-20	-20	0	0
20	0	-30	-30	0	0
.....
.....
.....	0

0	0	0	0	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	0	0	0	0	0	0	0

-1	-1	-1
0	0	0
1	1	1

	20	0	-20	-20	0	0
=						0
=						...
=						...
=						0
=						
=						
=						

0	0	0	0	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	0	0	0	0	0	0	0

*

-1	-1	-1
0	0	0
1	1	1

20	0	-20	-20	0	0
20					0
					...
					...
					0

0	0	0	0	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	0	0	0	0	0	0	0

*

-1	-1	-1
0	0	0
1	1	1

20	0	-20	-20	0	0
20	30				0
					...
					0

0	0	0	0	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	0	0	0	0	0	0	0

*

-1	-1	-1
0	0	0
1	1	1

20	0	-20	-20	0	0
20	30	20	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0

0	0	0	0	0	0	0	0
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0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	0	0	0	0	0	0	0

*

-1	-1	-1
0	0	0
1	1	1

20	0	-20	-20	0	0
20	30	20	10	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0

0	0	0	0	0	0	0	0
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0	10	10	10	0	0	0	0
0	0	0	0	0	0	0	0

*

-1	-1	-1
0	0	0
1	1	1

20	0	-20	-20	0	0
20	30	20	10	0	0
...					
...					
0					

0	0	0	0	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
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0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	0	0	0	0	0	0	0

*

-1	-1	-1
0	0	0
1	1	1

20	0	-20	-20	0	0
20	30	20	10	0	0
...					
...					
0					

0	0	0	0	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	0	0	0	0	0	0	0

-1	-1	-1
0	0	0
1	1	1

0	0	0	0	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	0	0	0	0	0	0	0

*

-1	-1	-1
0	0	0
1	1	1

=

20	0	-20	-20	0	0
20	30	20	10	0	0
0	0				
					0

0	0	0	0	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	0	0	0	0	0	0	0

*

-1	-1	-1
0	0	0
1	1	1

20	0	-20	-20	0	0
20	30	20	10	0	0
0	0	0	0	0	0
...
...
...	0
...	0

0	0	0	0	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	10	10	10	0	0	0	0
0	0	0	0	0	0	0	0

*

-1	-1	-1
0	0	0
1	1	1

20	0	-20	-20	0	0
20	30	20	10	0	0
0	0	0	0	0	0
...
...
...	0
...	0

20	0	-20	-20	0	0
20	30	20	10	0	0
0	0	0	0	0	0
...
...
...
...	0

20	0	-20	-20	0	0
20	30	20	10	0	0
0	0	0	0	0	0
...
...	0
...	0
...	0

*

20	0	-20	-20	0	0
20	30	20	10	0	0
0	0	0	0	0	0
...
...	0
...	0
...	0

*

-1	0	1
-1	-1	-1
0	0	0
1	1	1

20	0	-20	-20	0	0
20	30	20	10	0	0
0	0	0	0	0	0
...	0
...	0
...	0

*

-1	0	1
-1	-1	-1
0	0	0
1	1	1

=

20	0	-20	-20	0	0
20	30	20	10	0	0
0	0	0	0	0	0
...	0
...	0
...	0

*

-1	0	1
-1	-1	-1
0	0	0
1	1	1

=

-110			

	20	0	-20	-20	0	0
	20	30	20	10	0	0
	0	0	0	0	0	0
...
...
...	0
...	0

*

-1	0	1
-1	-1	-1
0	0	0
1	1	1

[REDACTED]

-110	-30		

20	0	-20	-20	0	0
20	30	20	10	0	0
0	0	0	0	0	0
...
...
...
0	0	0	0	0	0
...
0	0	0	0	0	0

*

-1	0	1	
-1	-1	-1	1
0	0	0	1
1	1	1	

1

-110	-30	-10	

20	0	-20	20	0	0
20	30	20	10	0	0
0	0	0	0	0	0
...
...	0
...	0
...	0

*

-1	0	1
-1	-1	-1
0	0	0
1	1	1

=

-110	-30	-10	10

20	0	-20	-20	0	0	
20	30	20	10	0	0	0
0	0	0	0	0	0	...
...
...	0
...	0
...	0

*

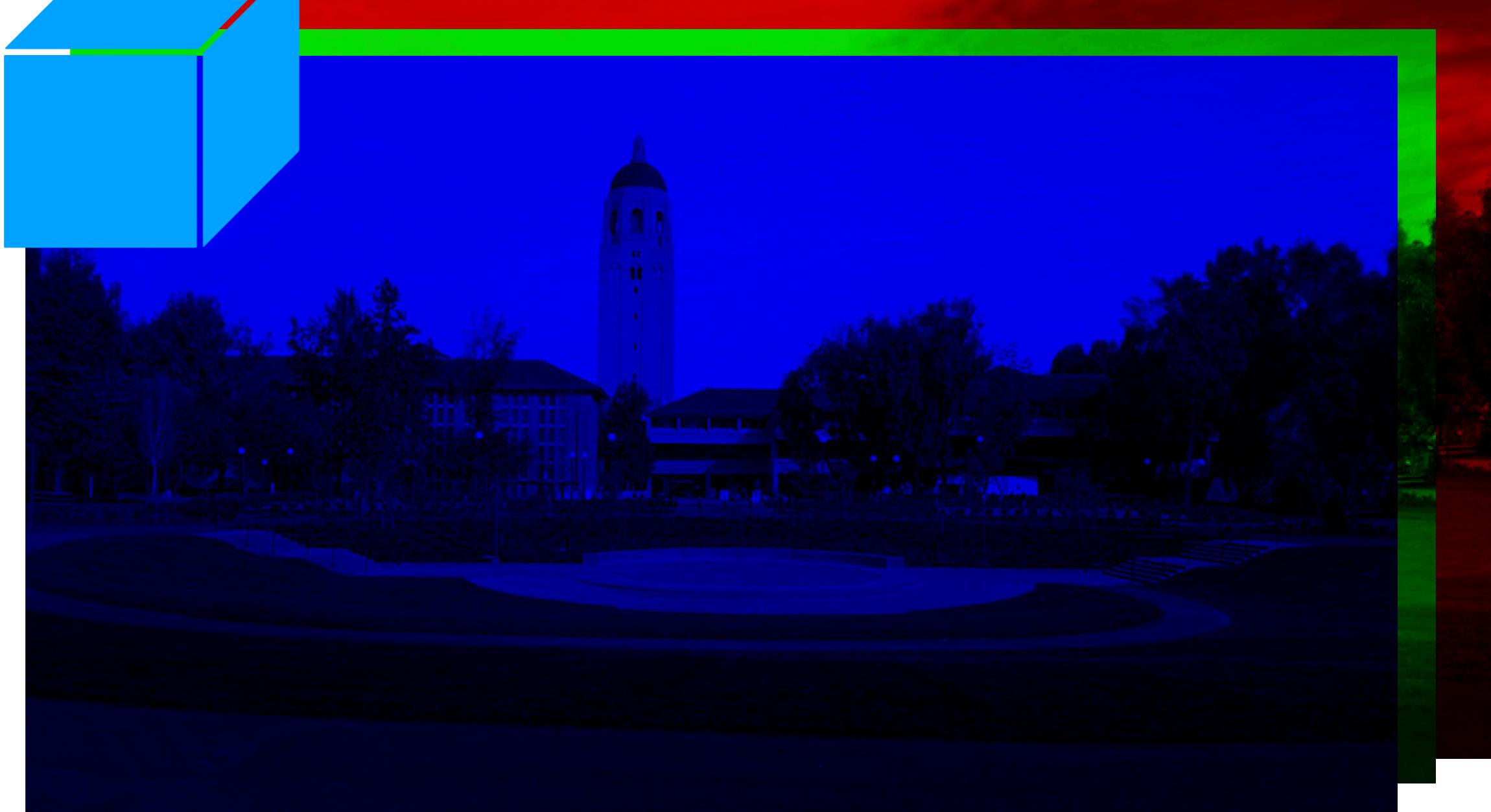
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-1	-1	-1
0	0	0
1	1	1

=

-110	-30	-10	10

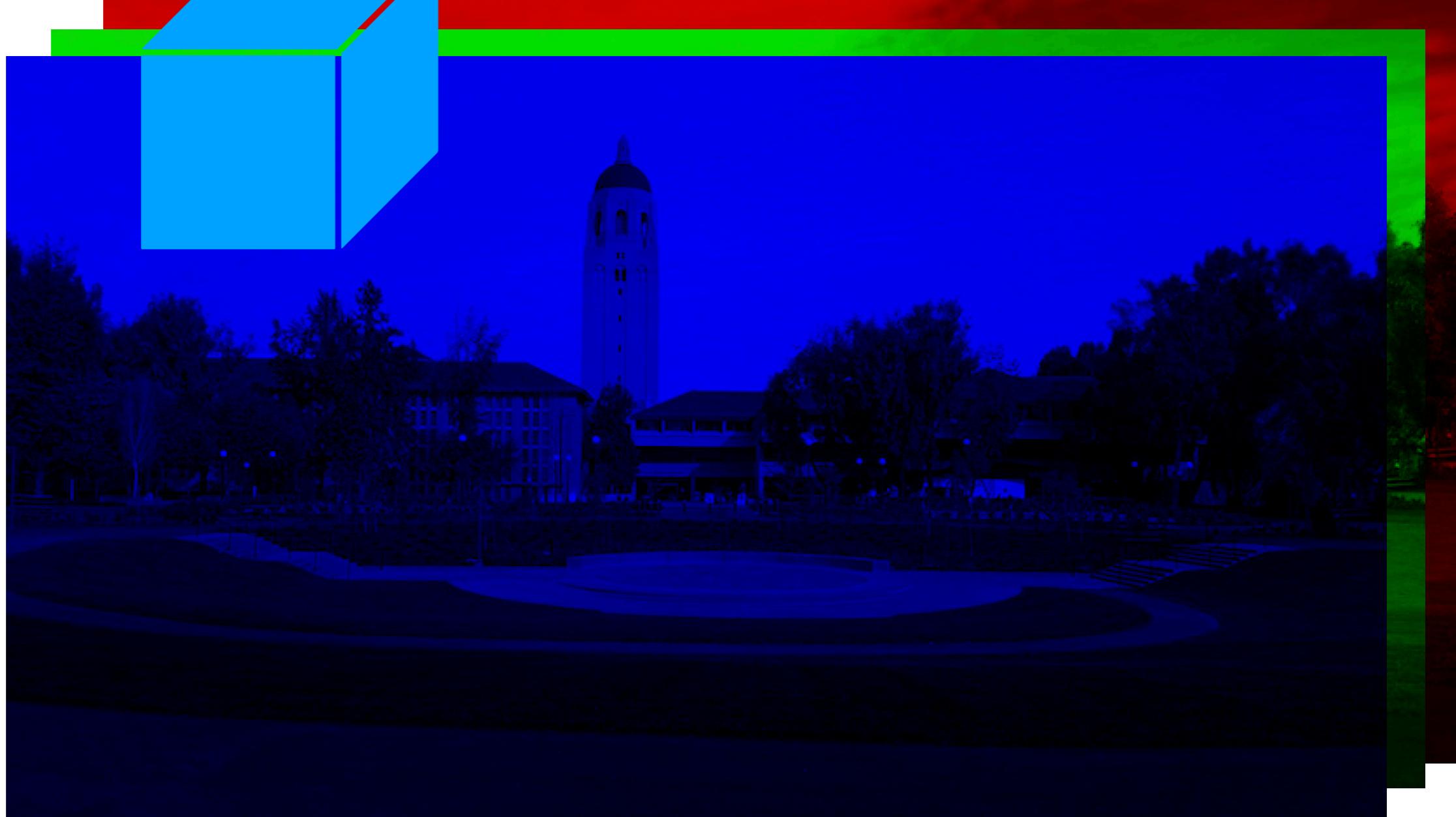




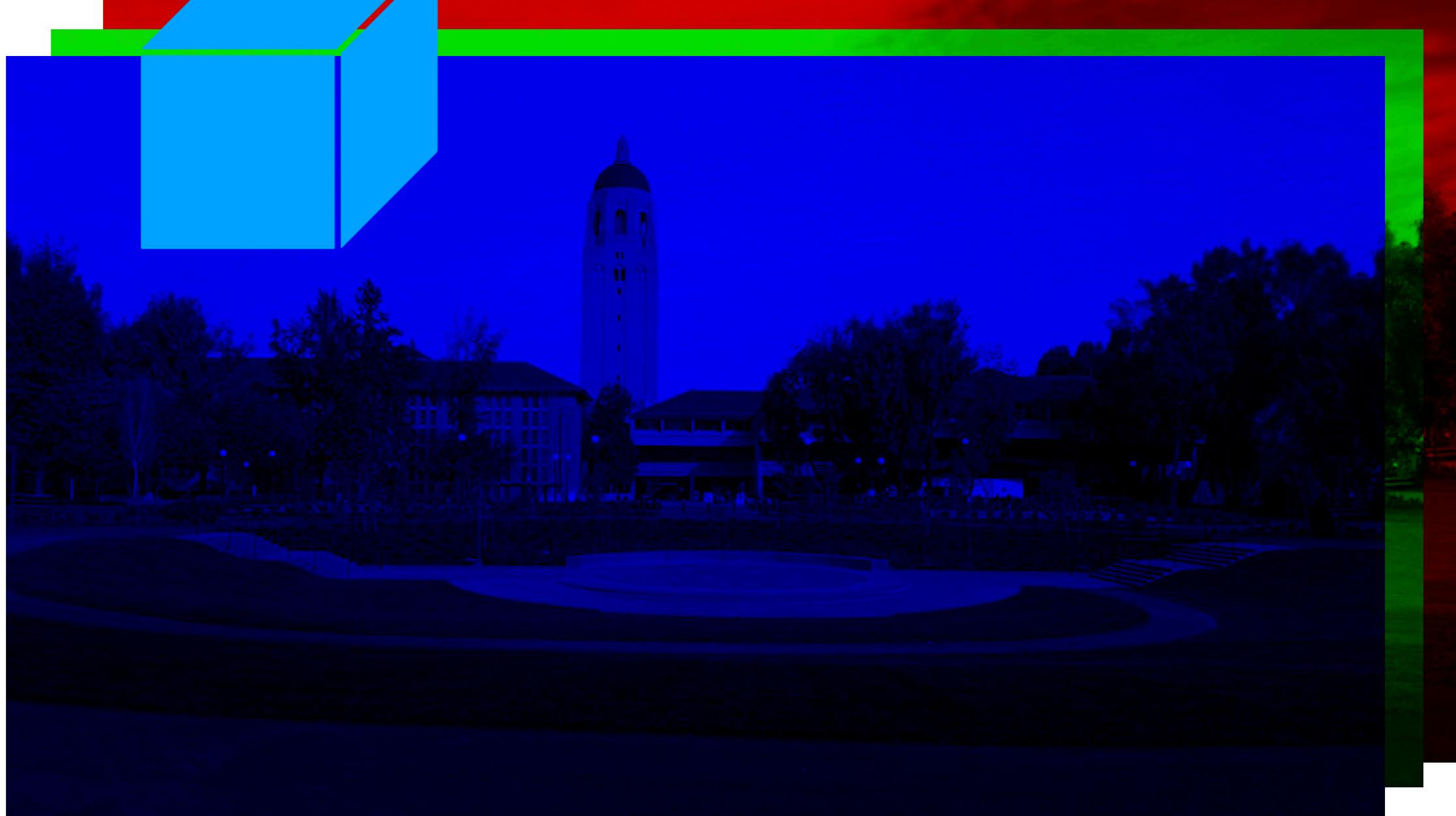


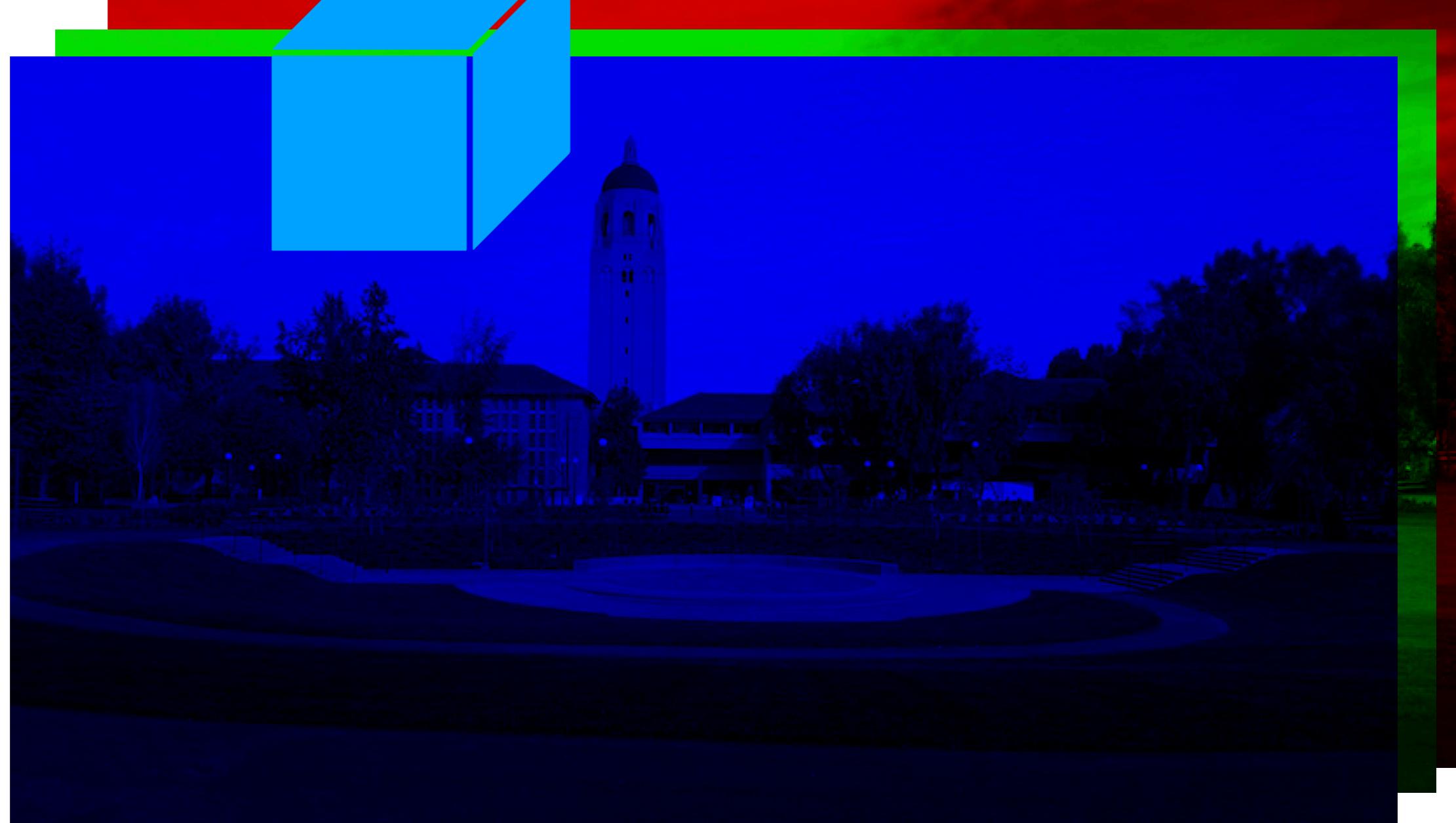


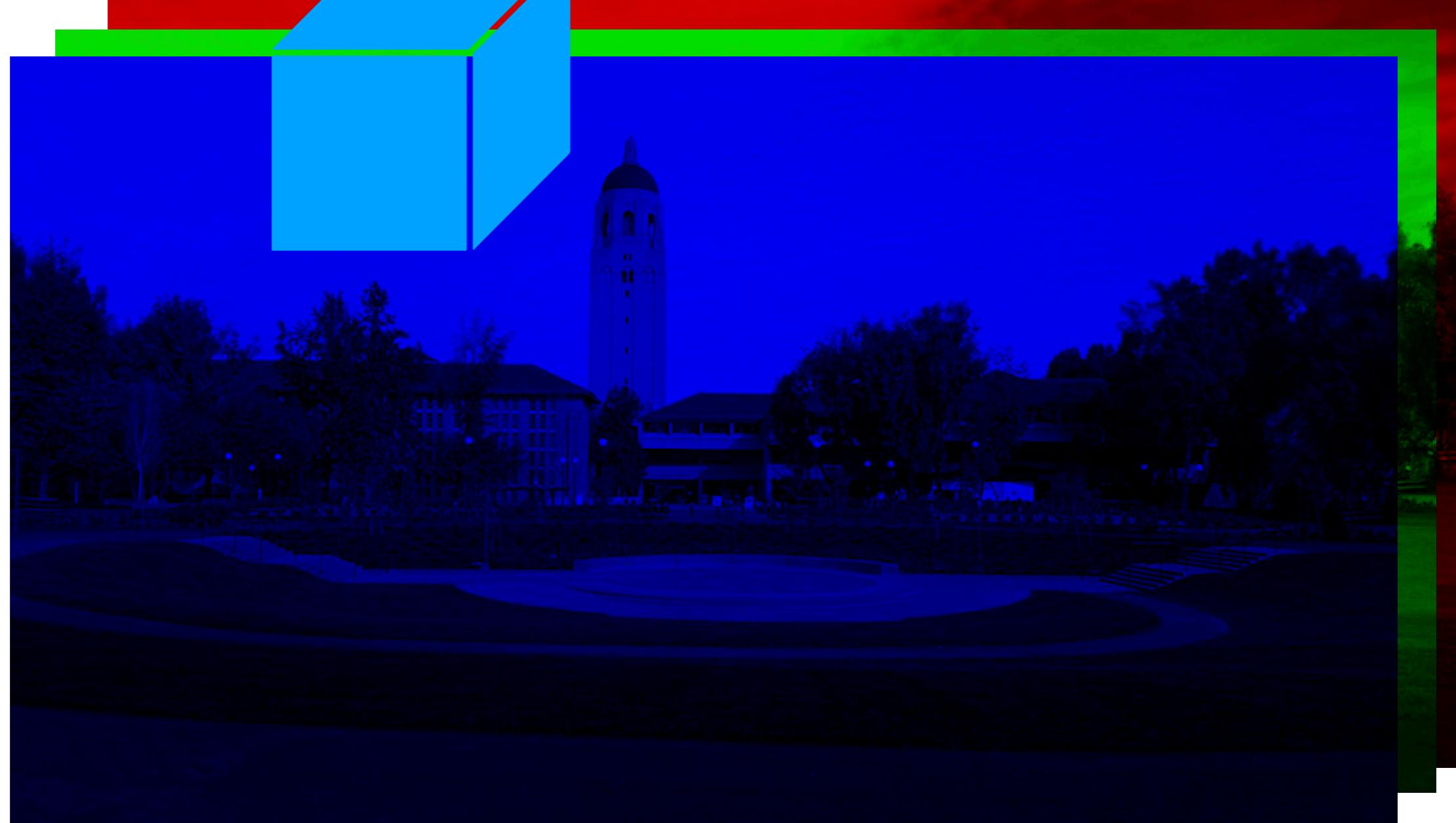
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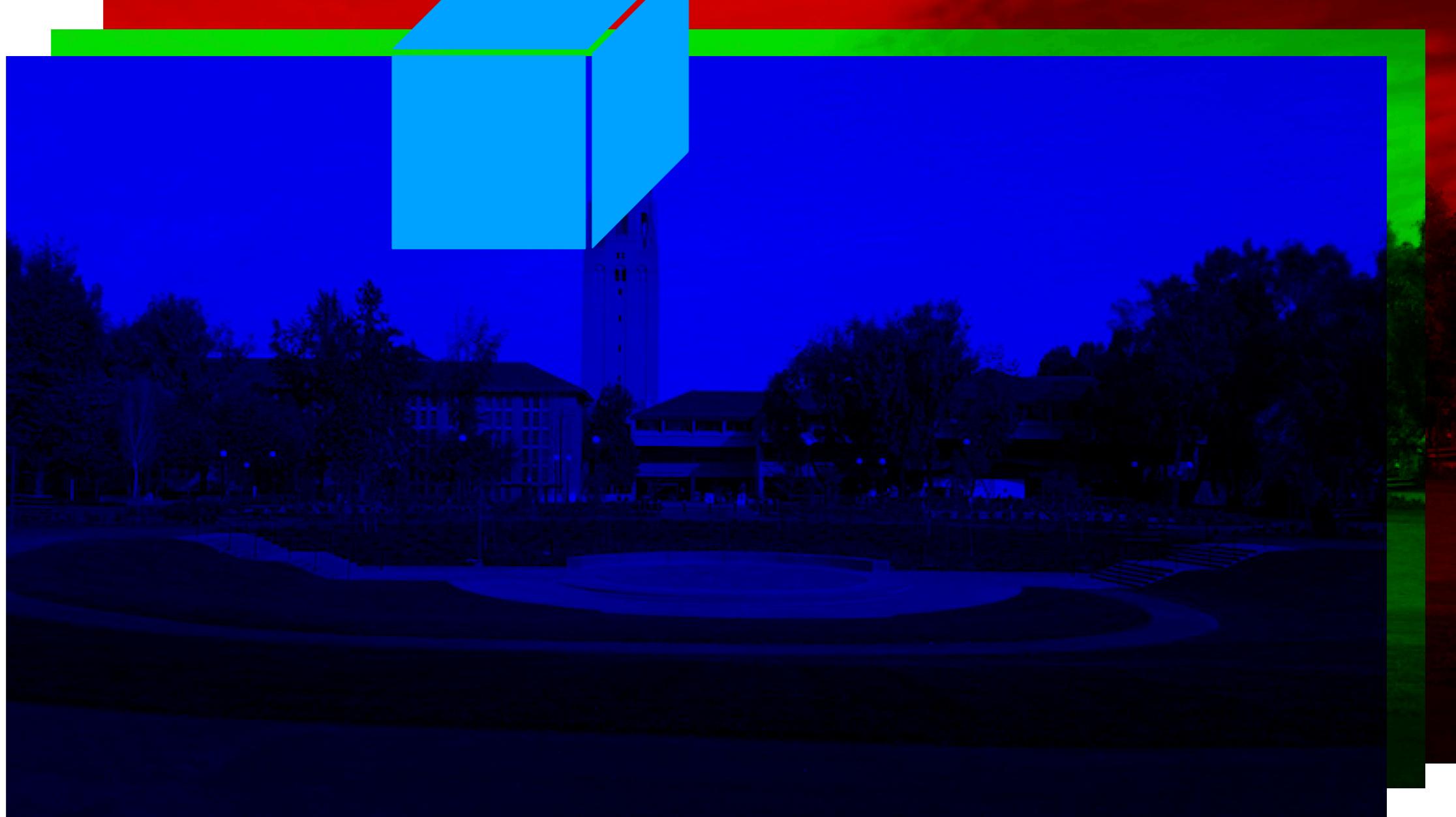


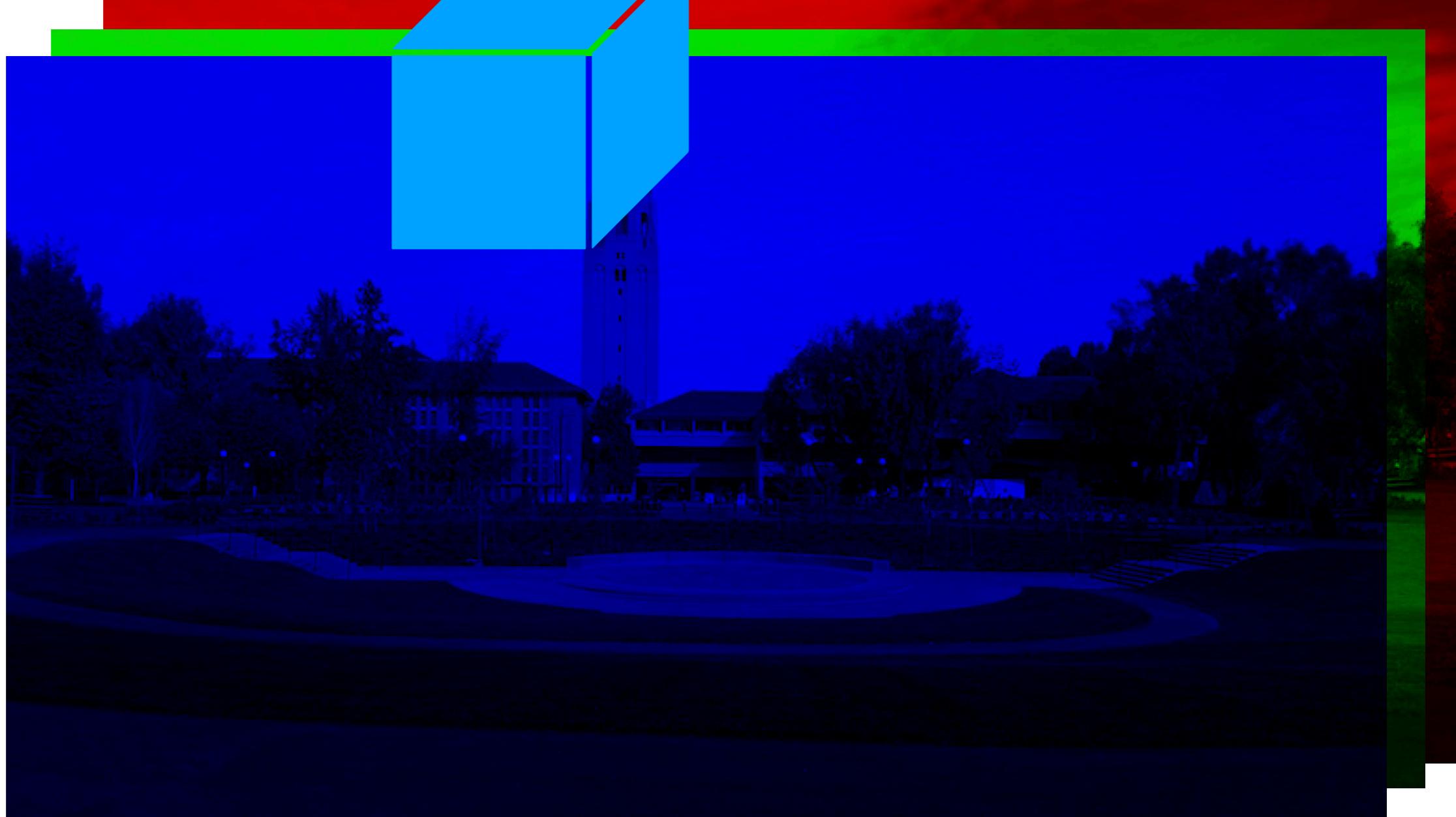
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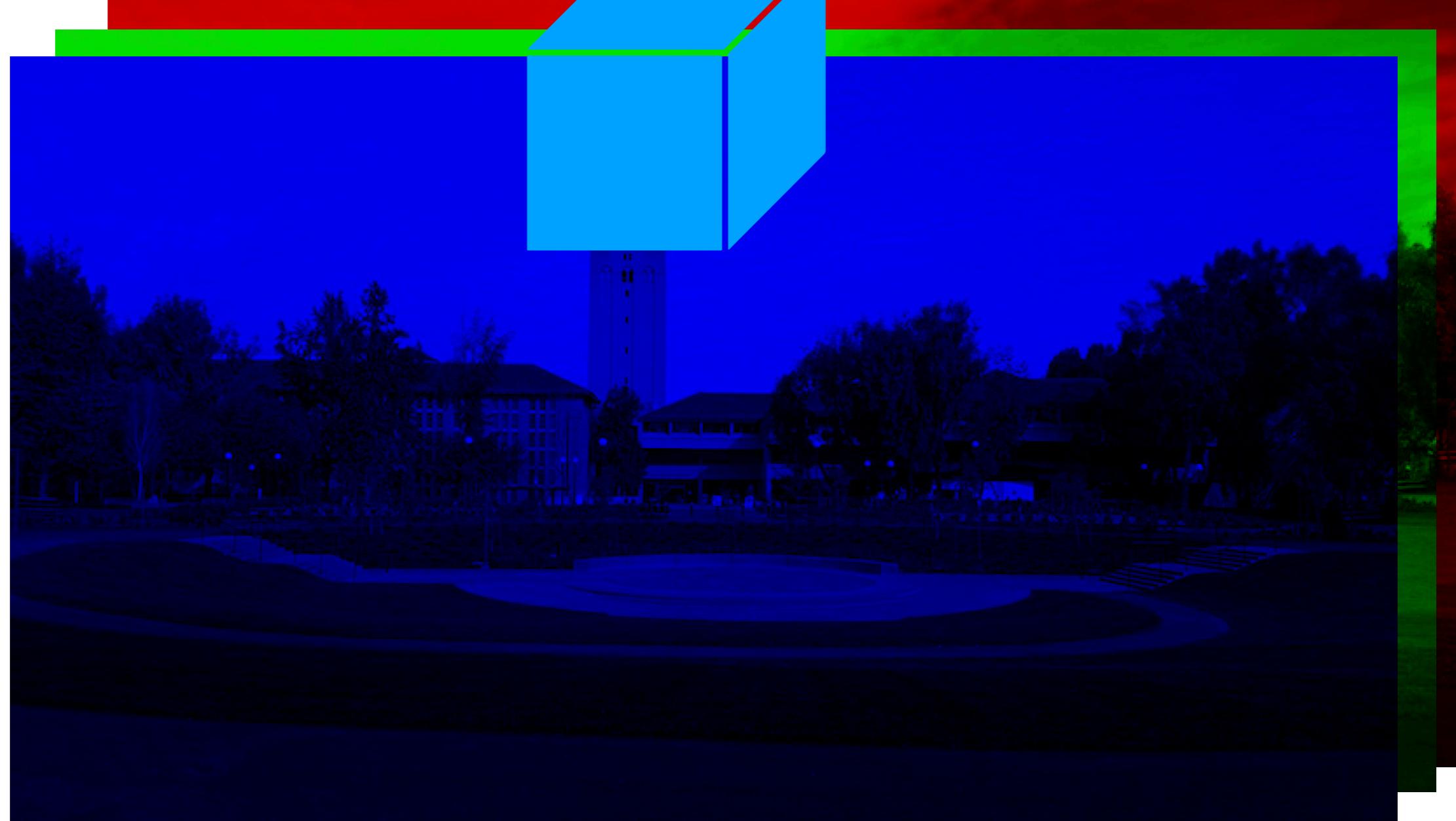


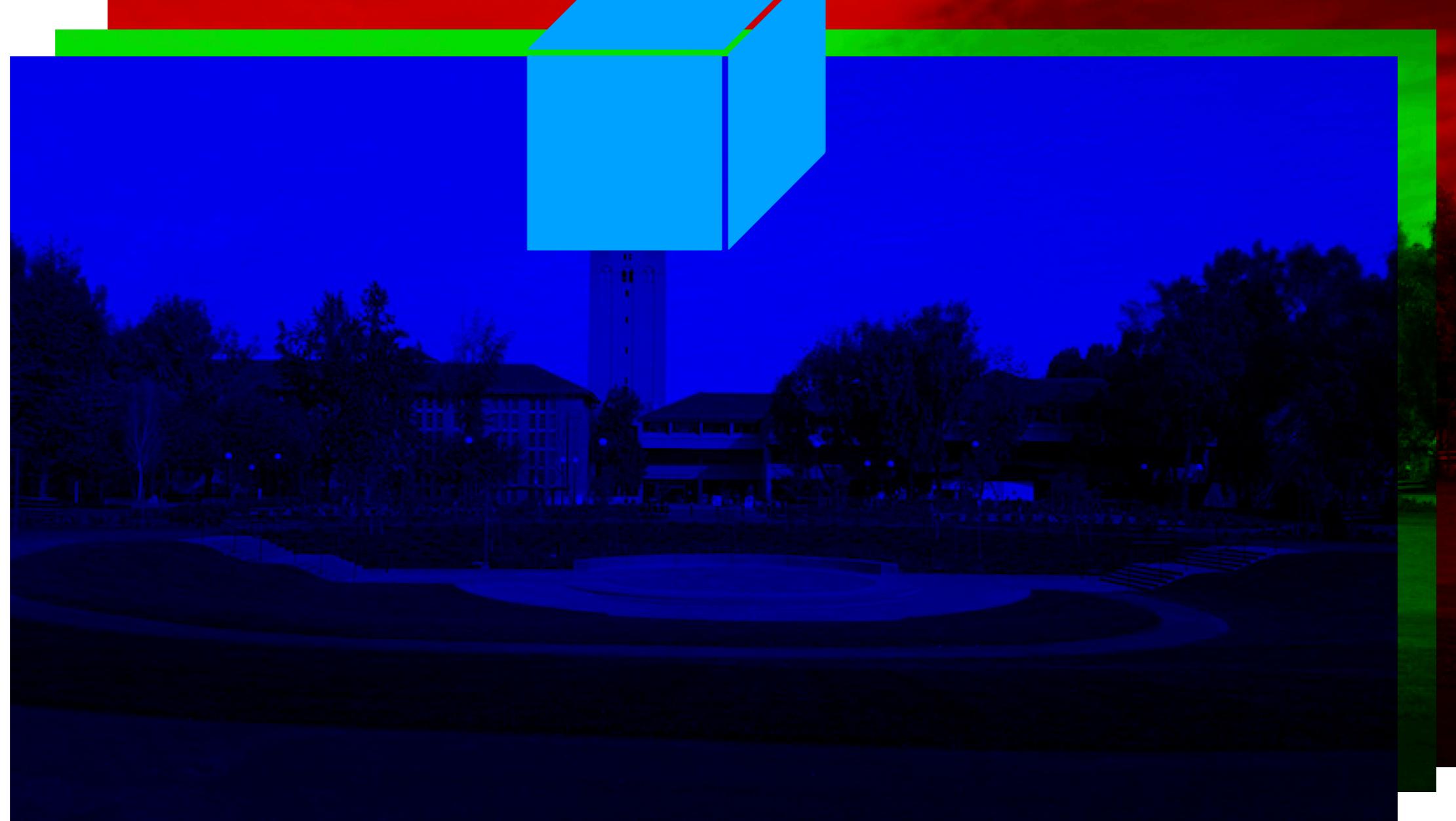


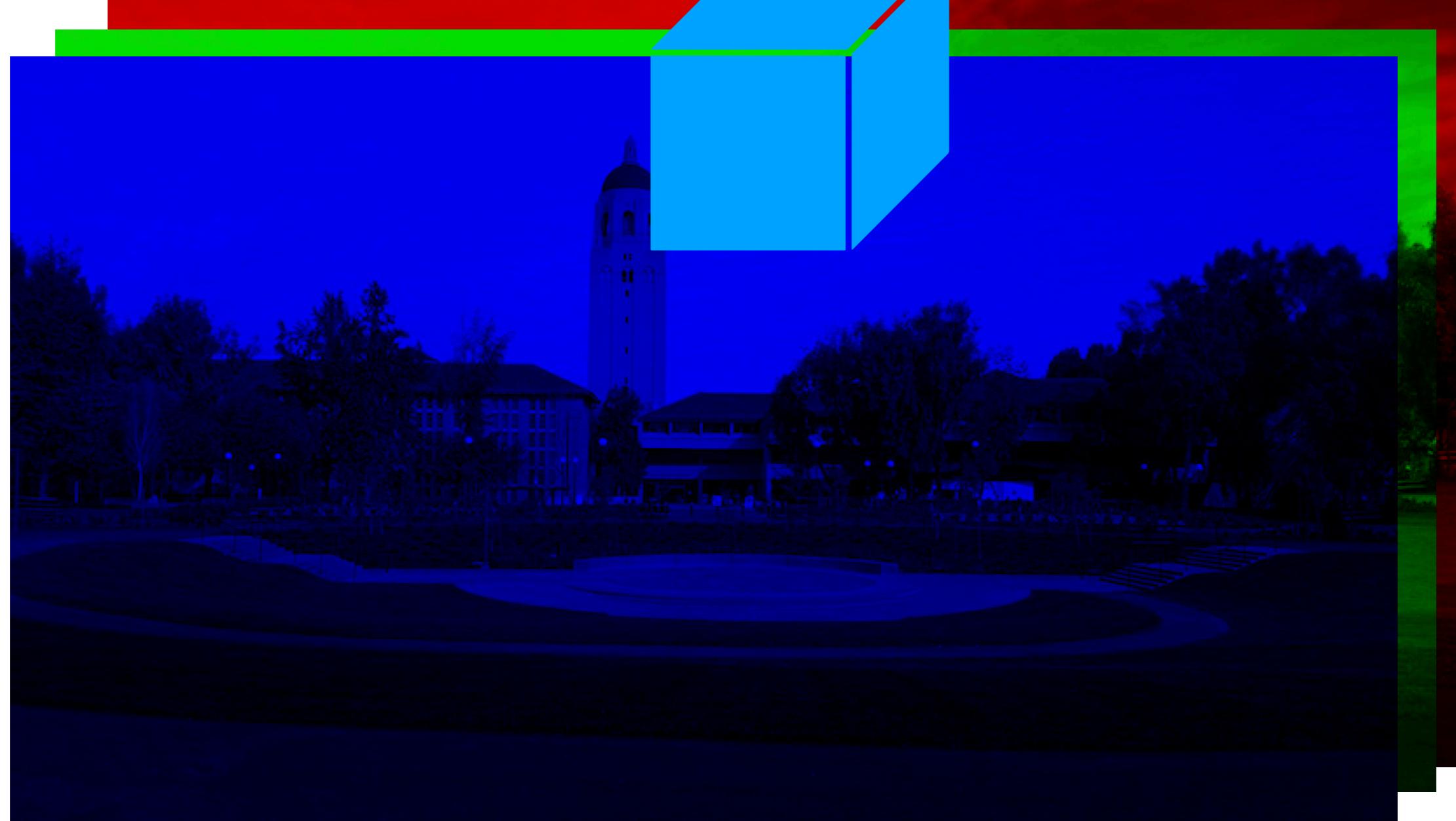


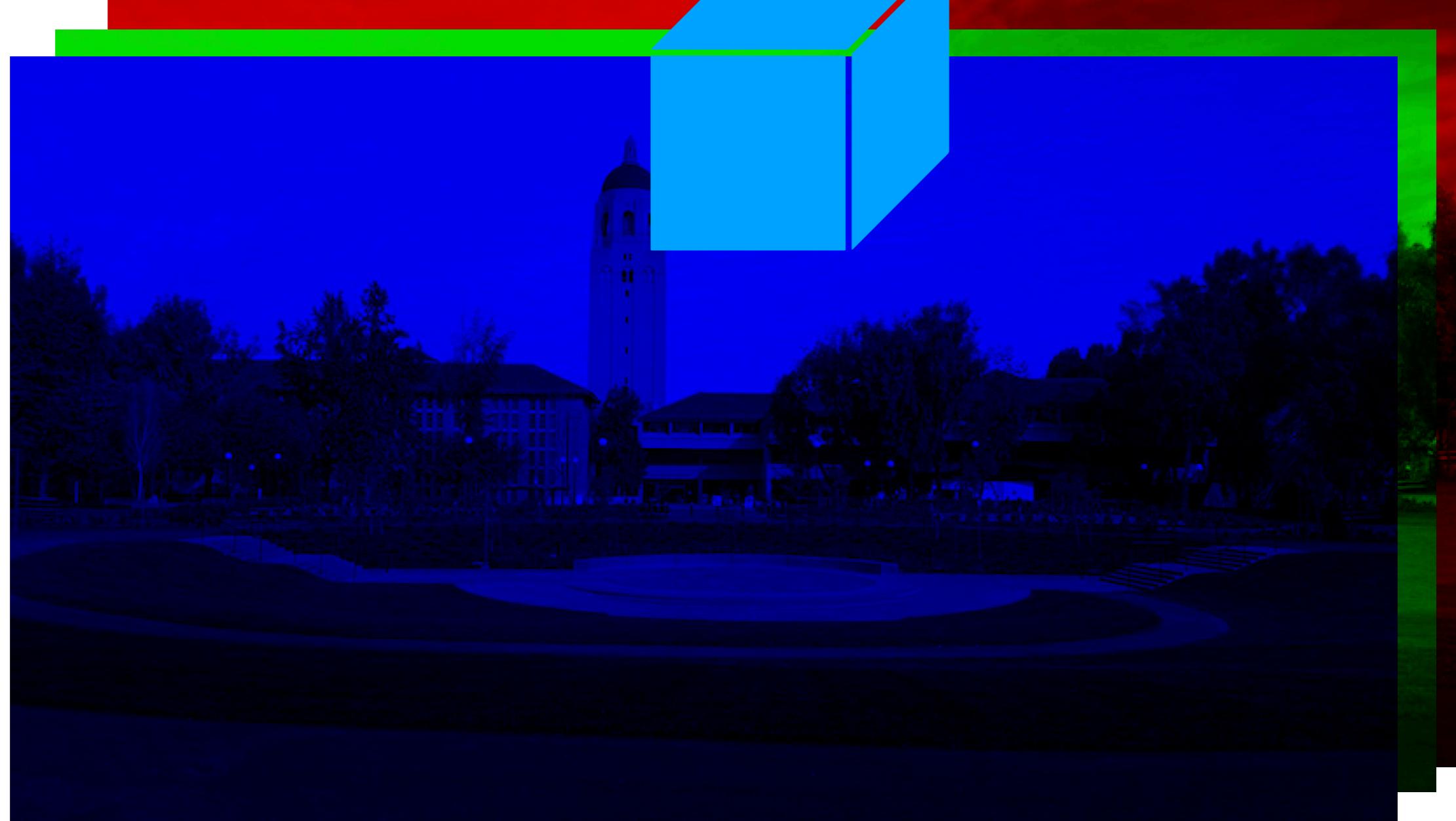










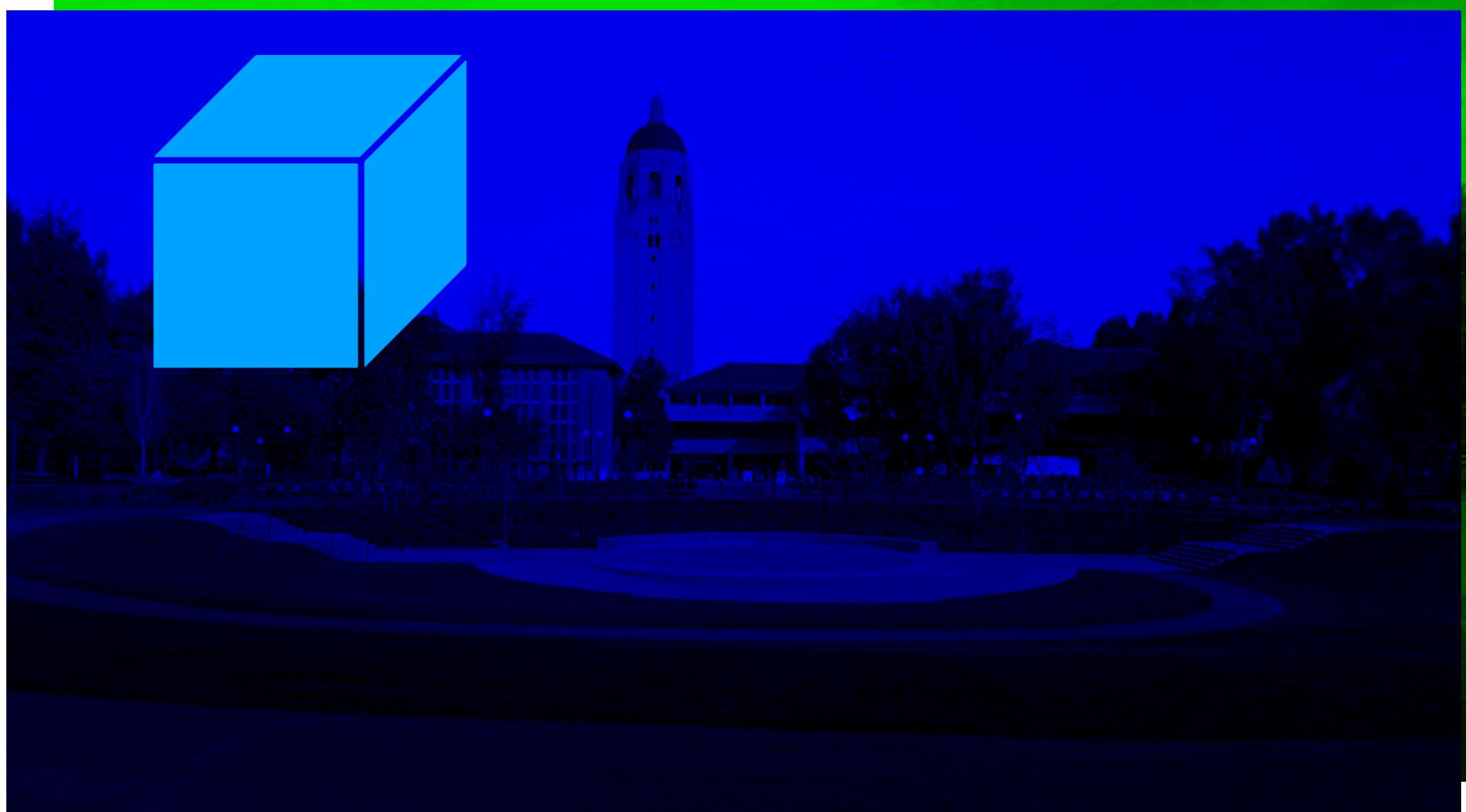


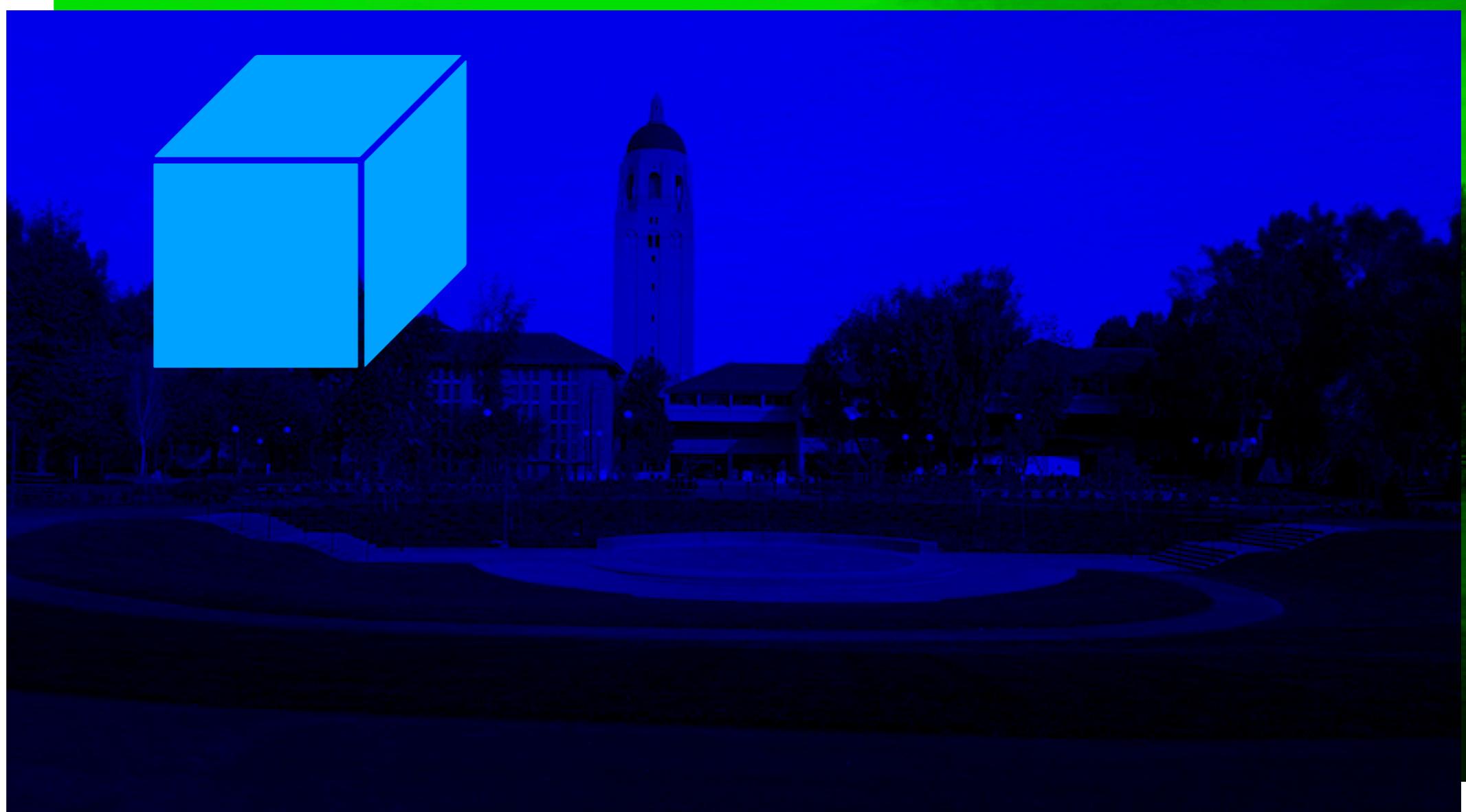


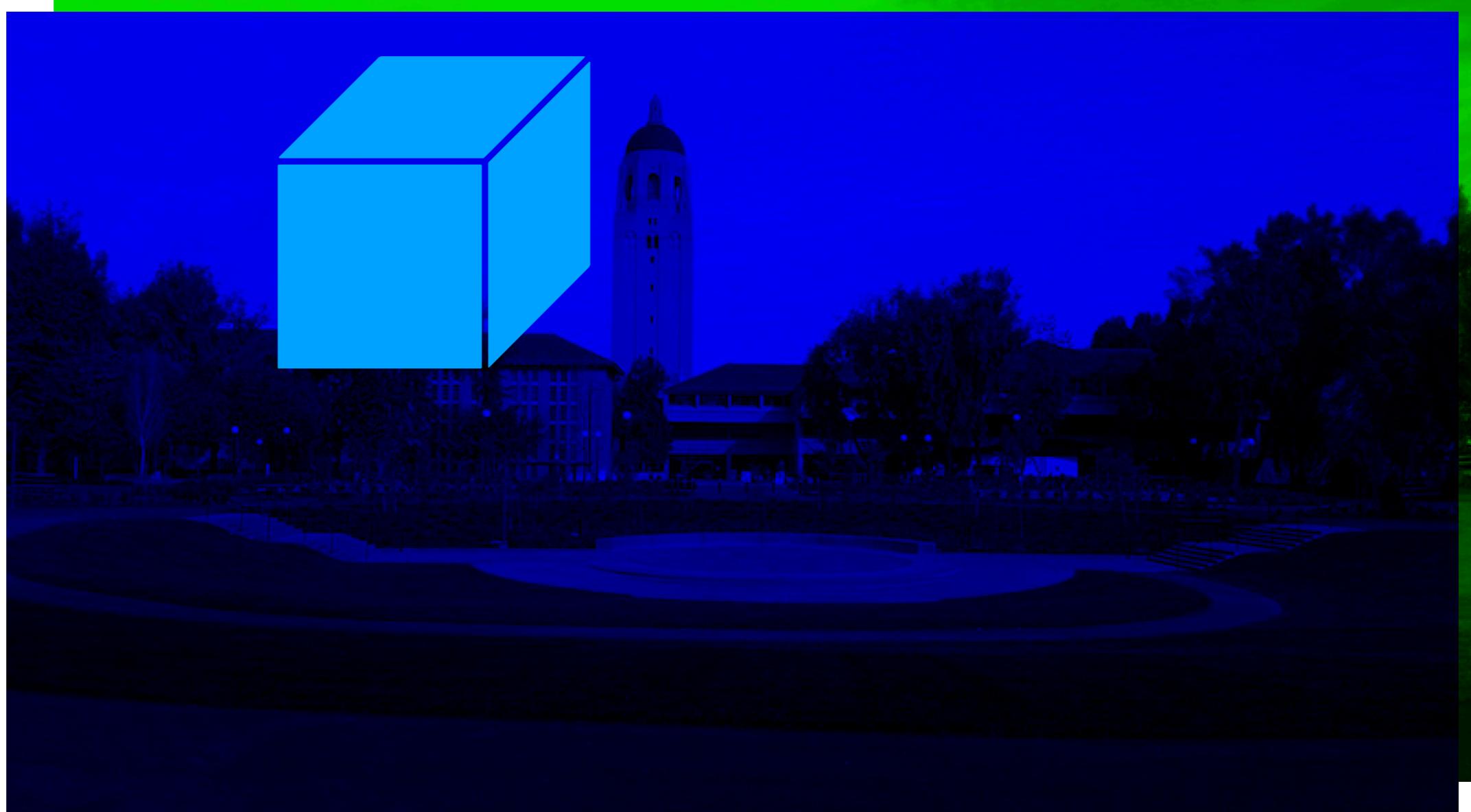


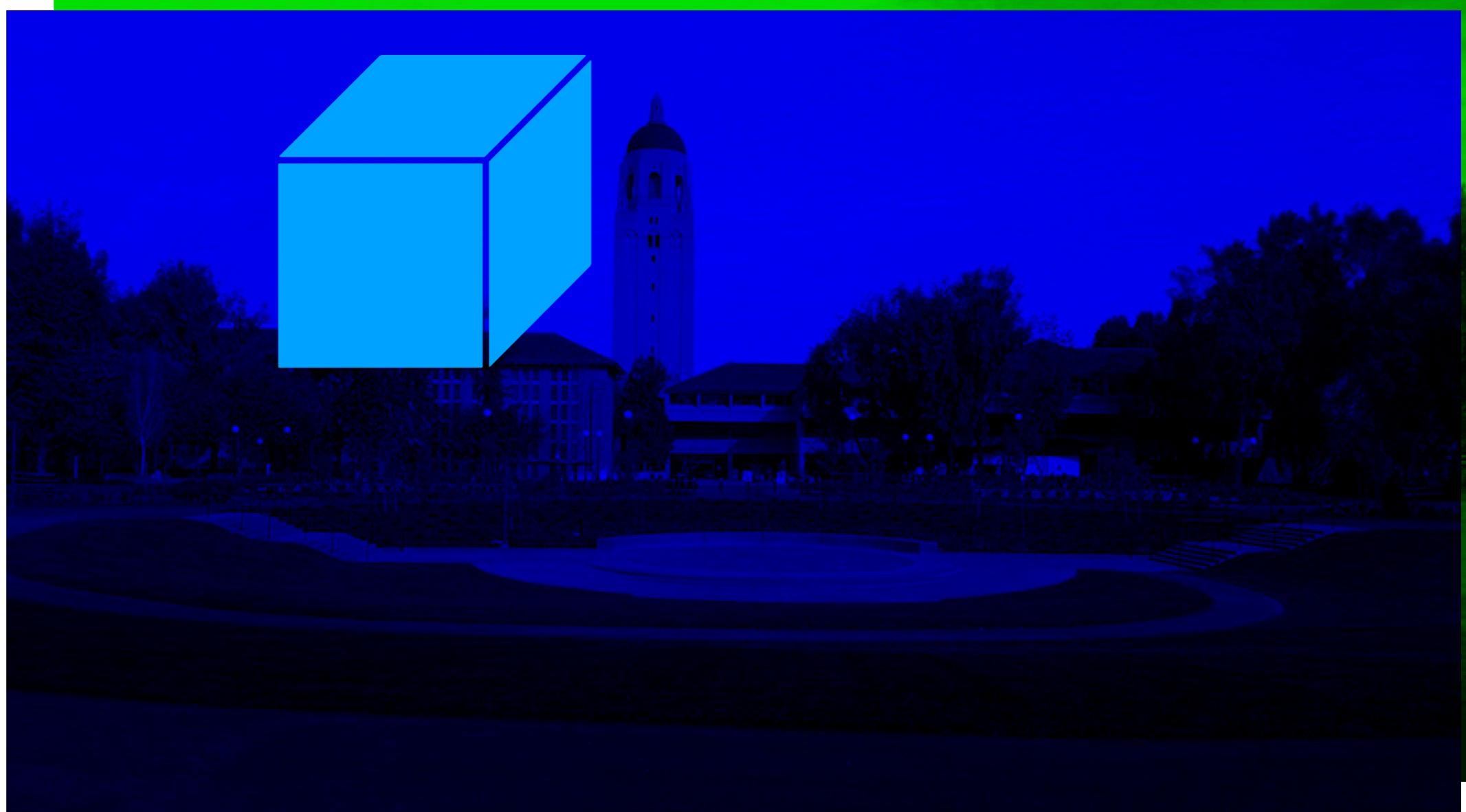


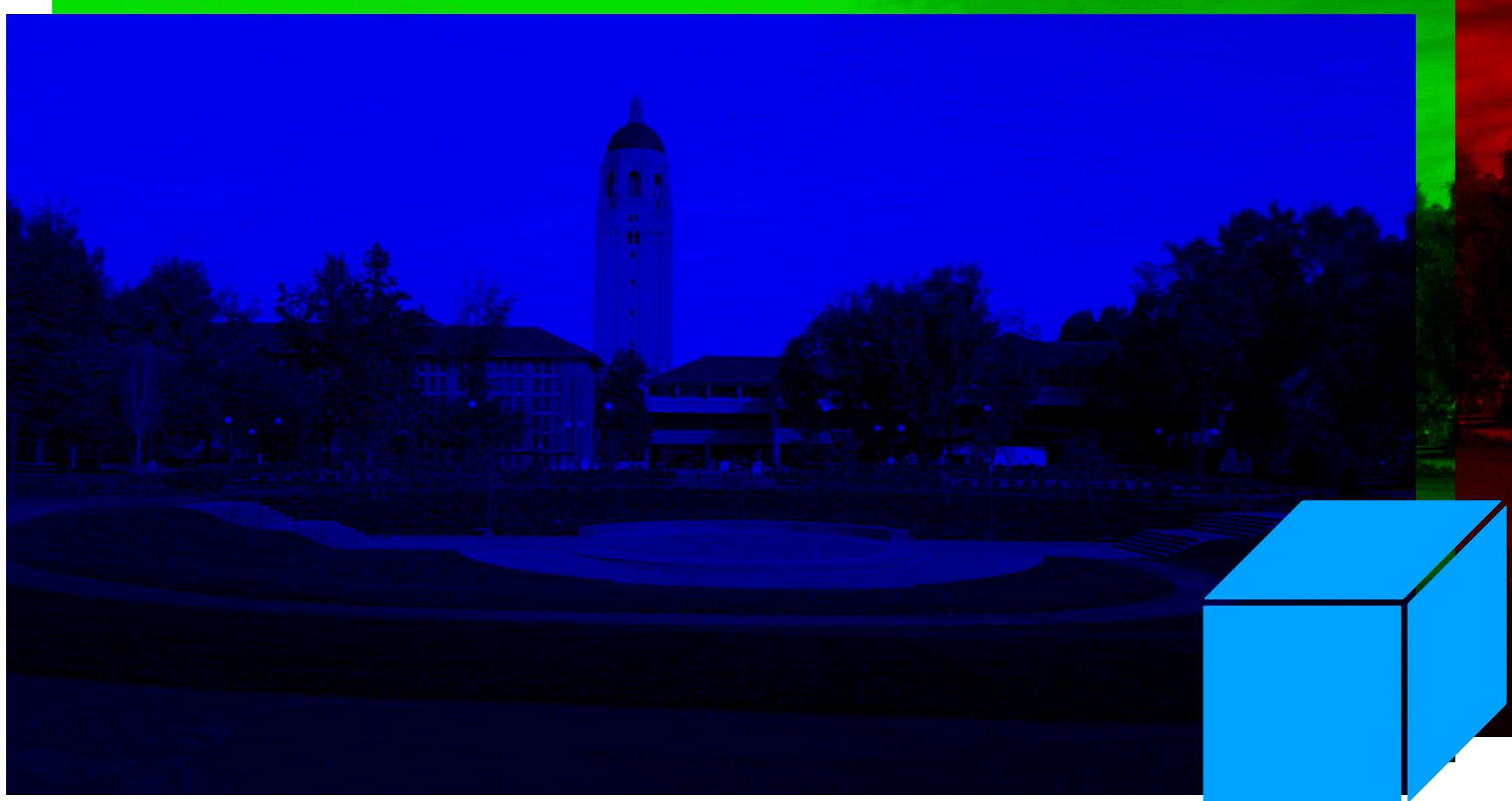


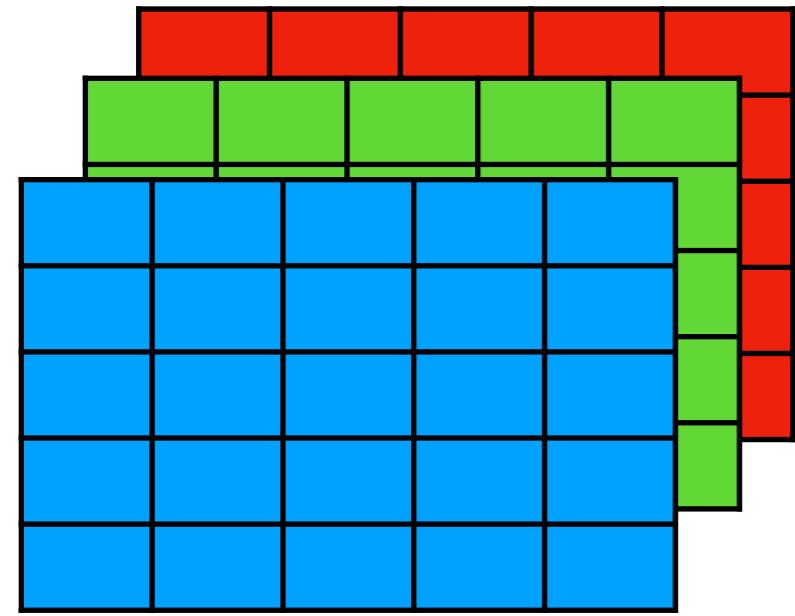


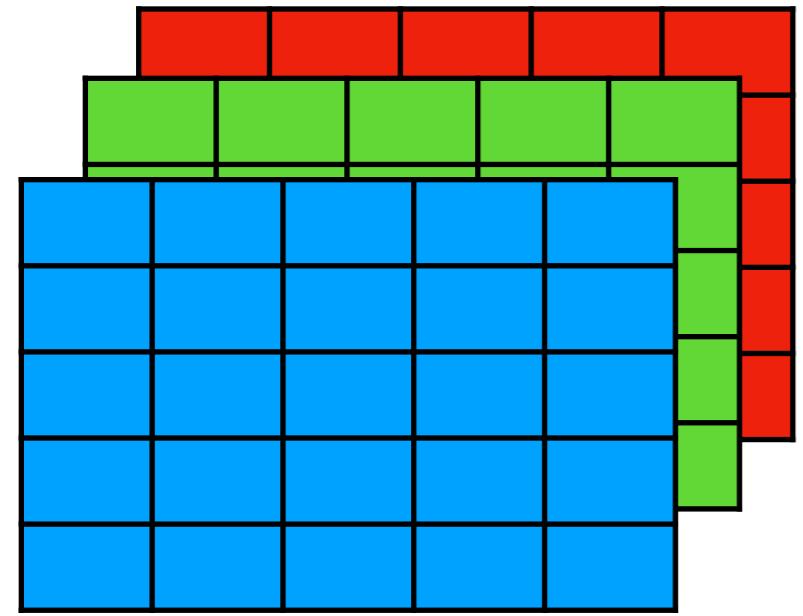




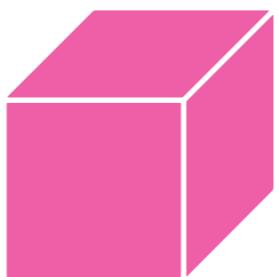




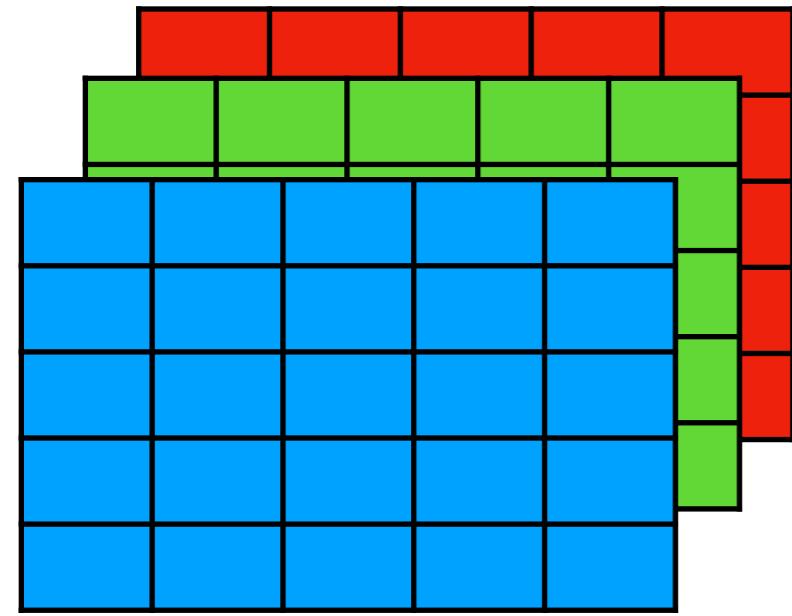




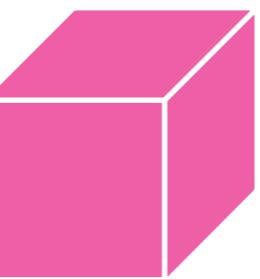
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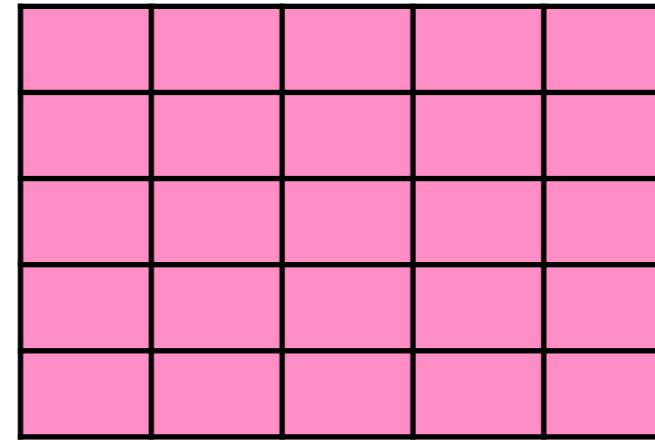
$$\begin{array}{c} \text{A 5x5 matrix of blue squares. A 2x3 submatrix of green and red squares is highlighted in the top-right corner.} \\ \times \quad \text{A 3x3 cube composed of 9 pink squares.} \\ = \quad \text{A 5x5 matrix of pink squares.} \end{array}$$



*

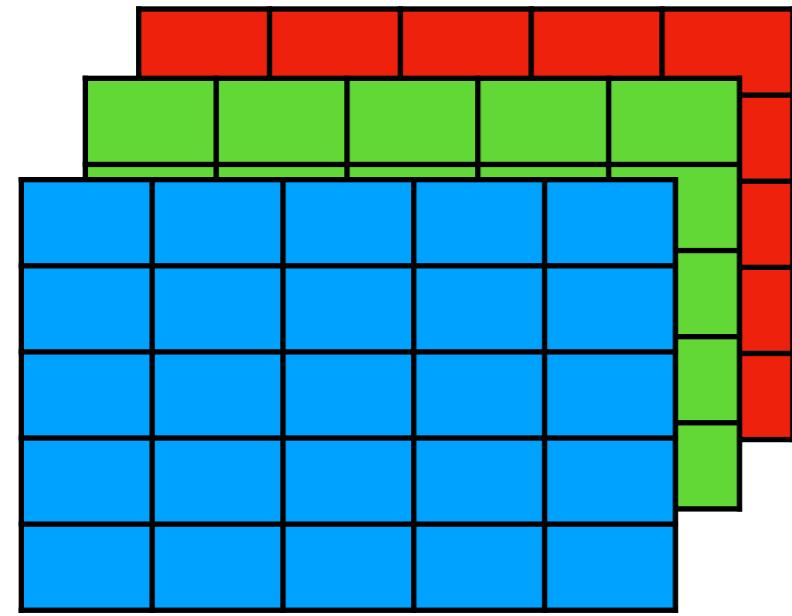


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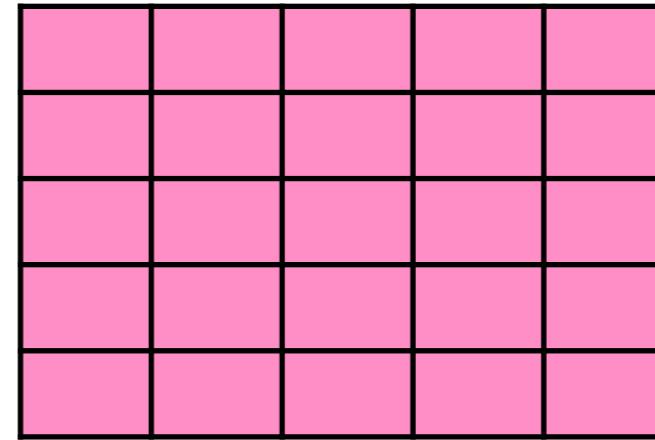


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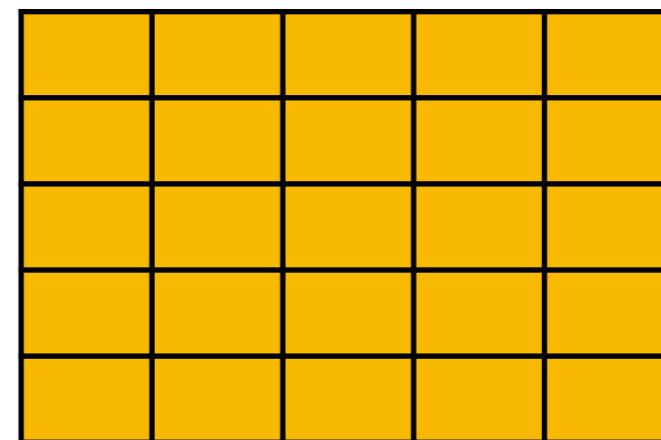


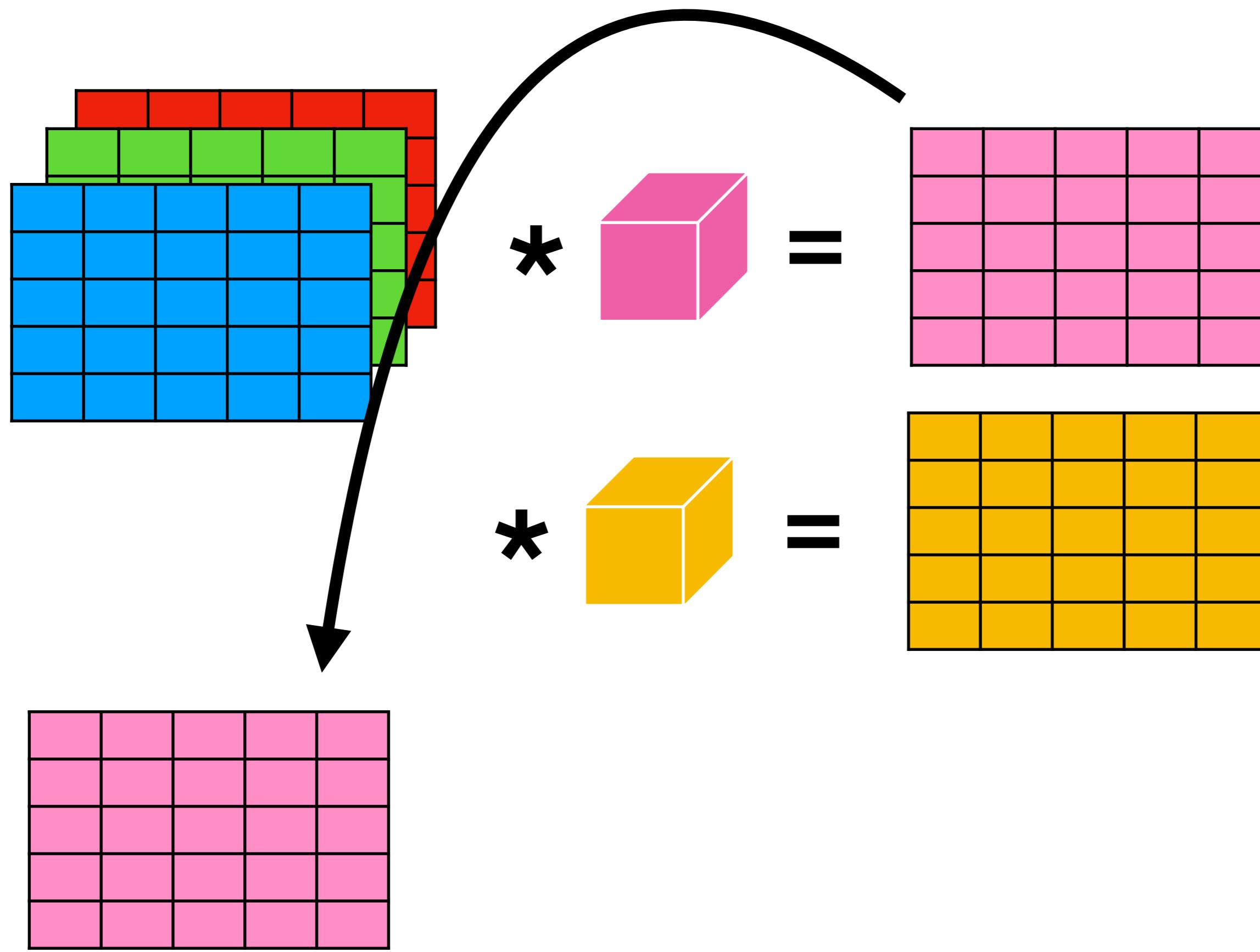


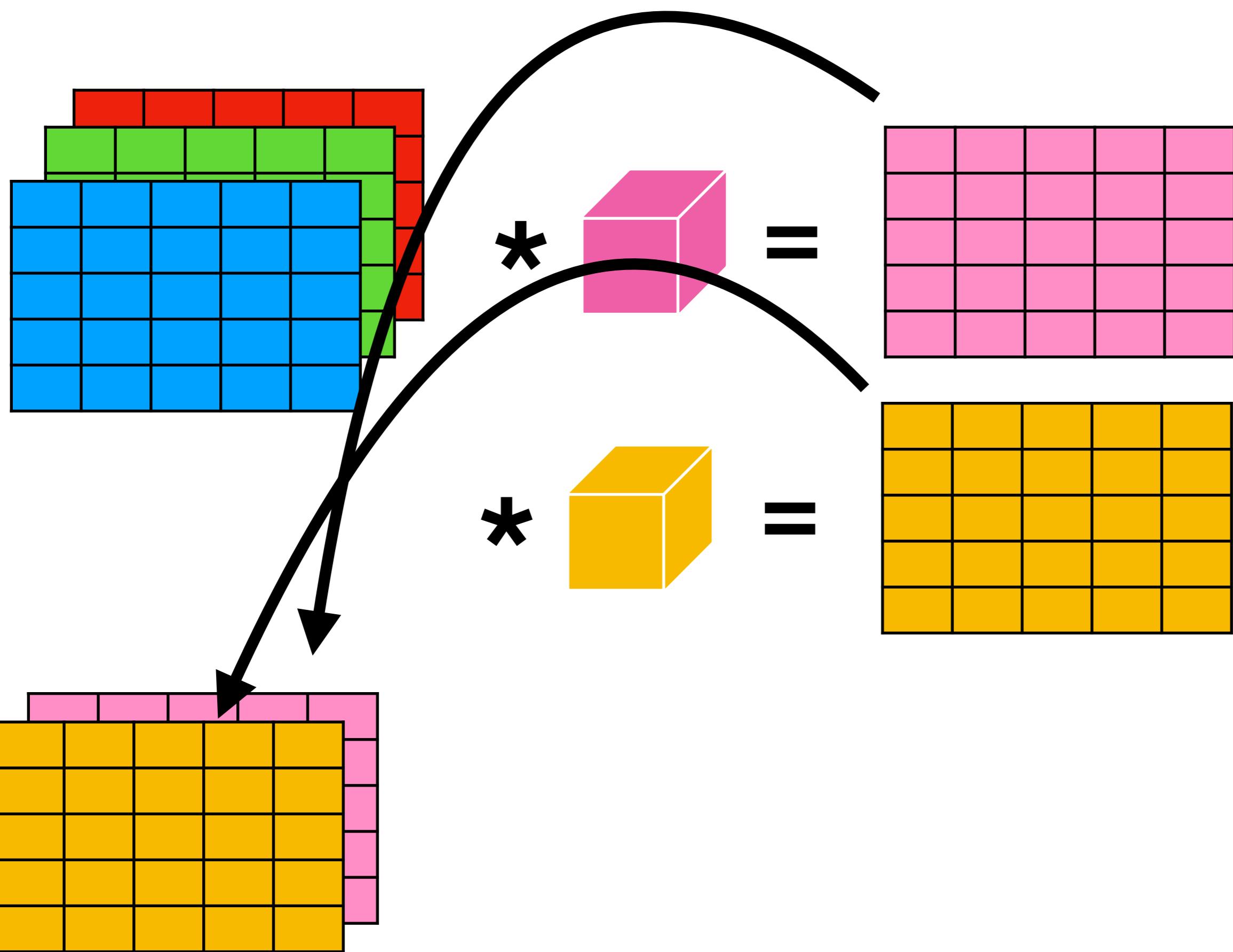
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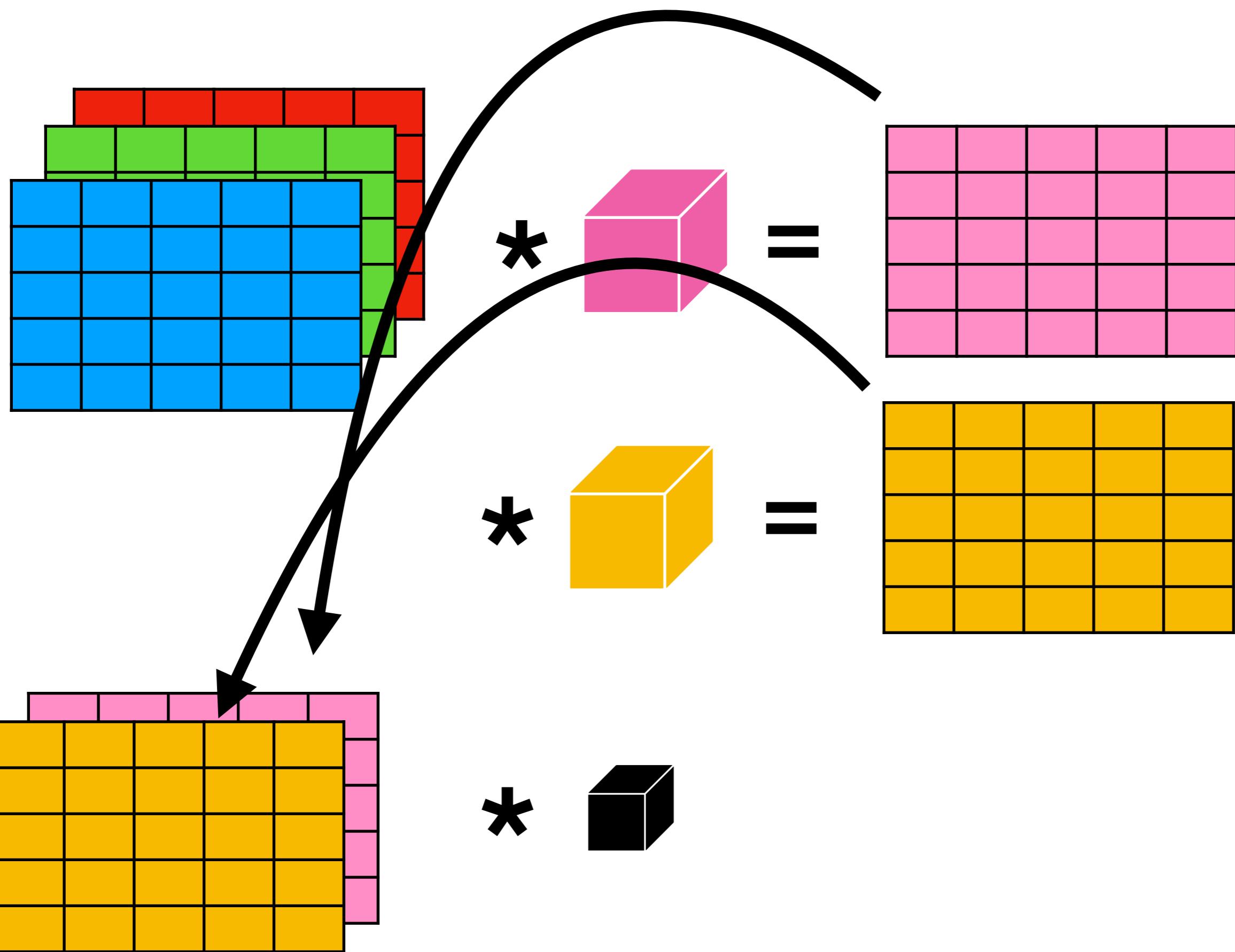


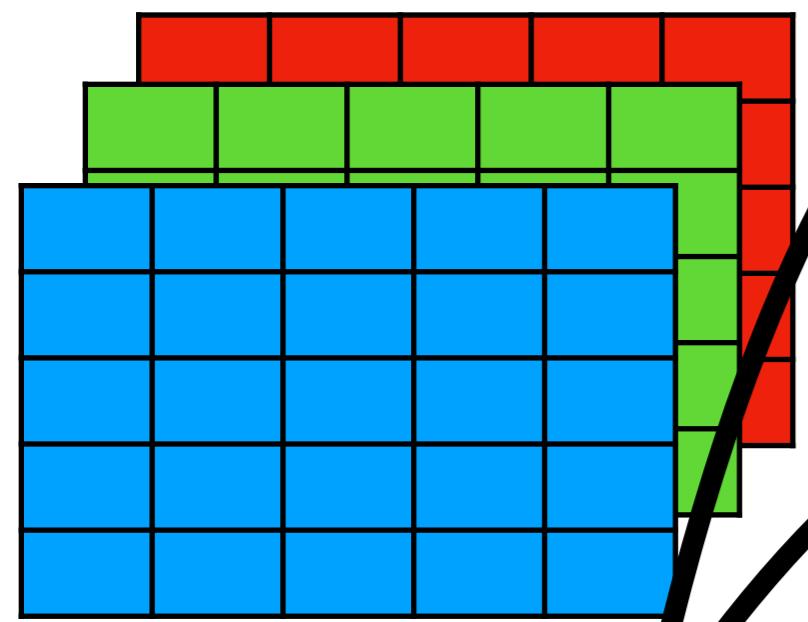
* =



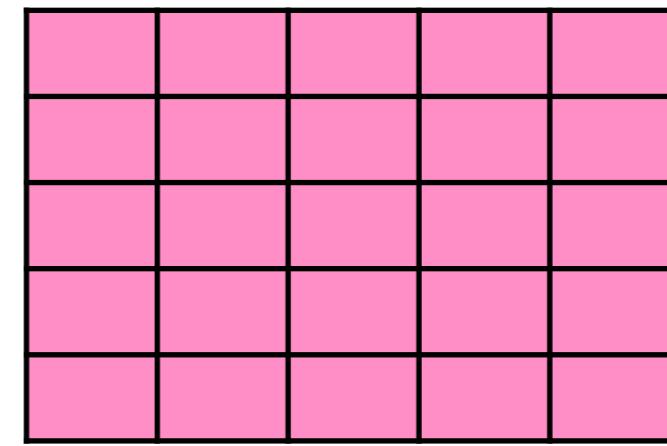




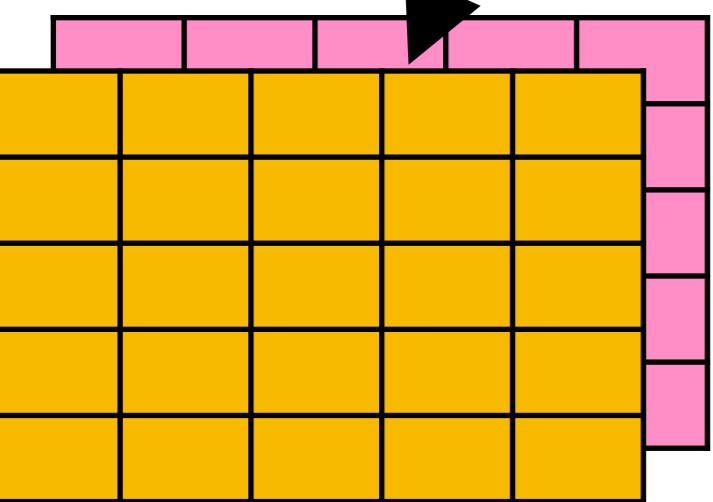




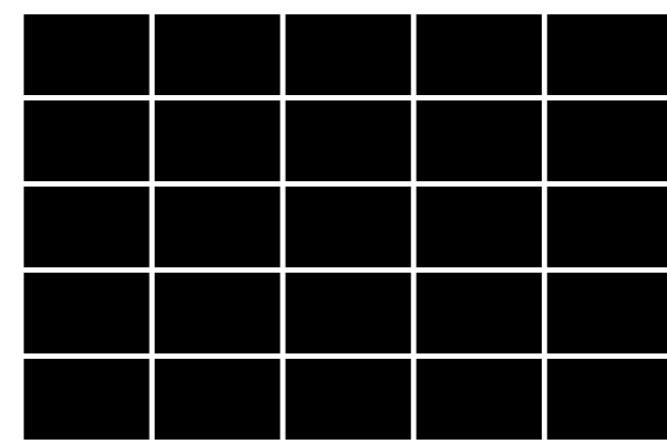
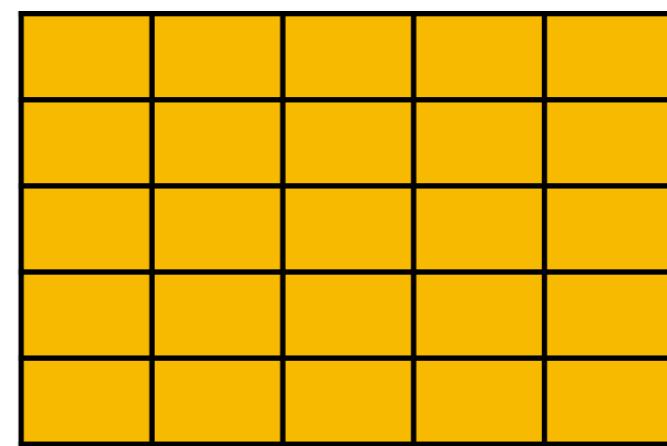
$$\begin{matrix} * & \text{pink cube} & = \end{matrix}$$



$$\begin{matrix} * & \text{yellow cube} & = \end{matrix}$$

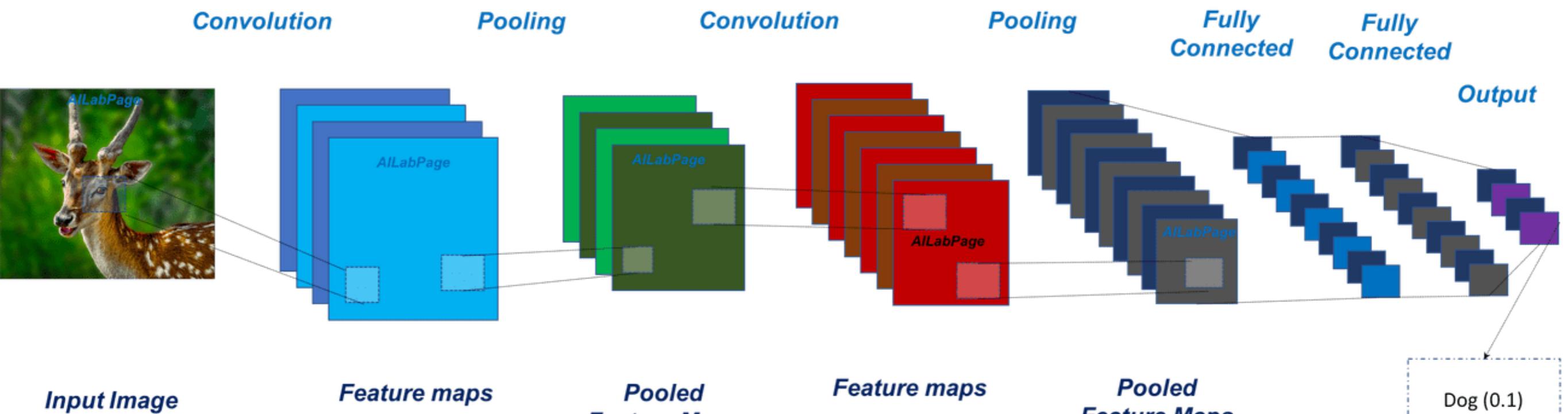


$$\begin{matrix} * & \text{black cube} & = \end{matrix}$$



Convolutional Neural Network

Convolution Neural Network



Input Image

Feature maps

Pooled Feature Maps

Feature maps

Pooled Feature Maps

Dog (0.1)
Cat(0.4)
Deer(0.94)
Lion(0.2)

AI Lab Page

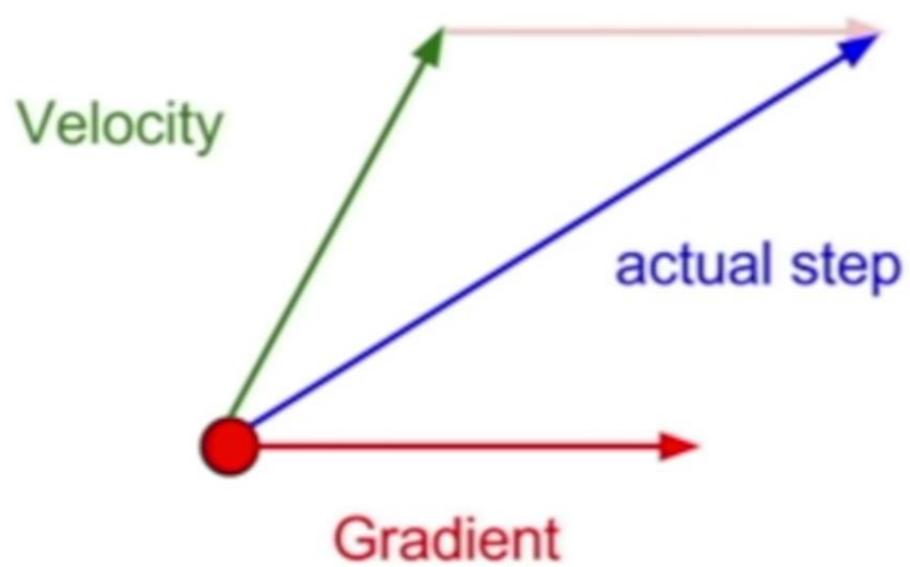
Data Source - Open Internet various sources

Image Source - <https://vinodsblog.com>

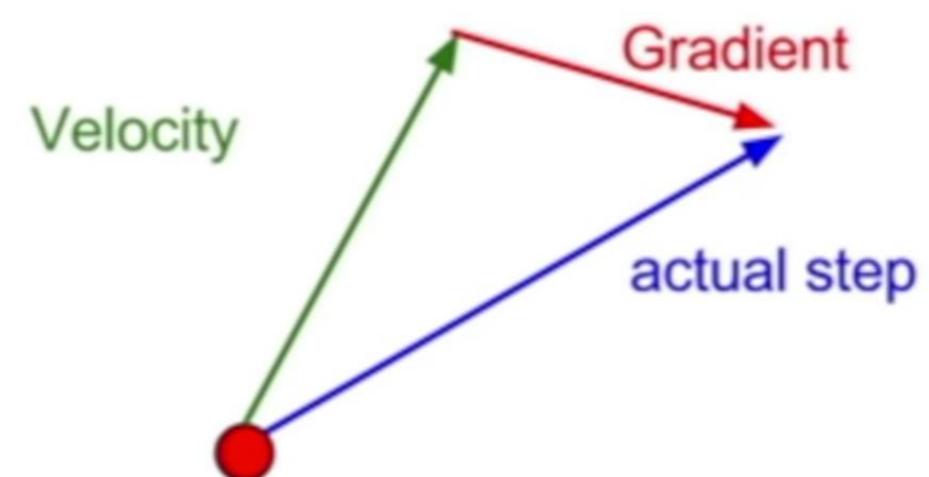
via @vinod1975

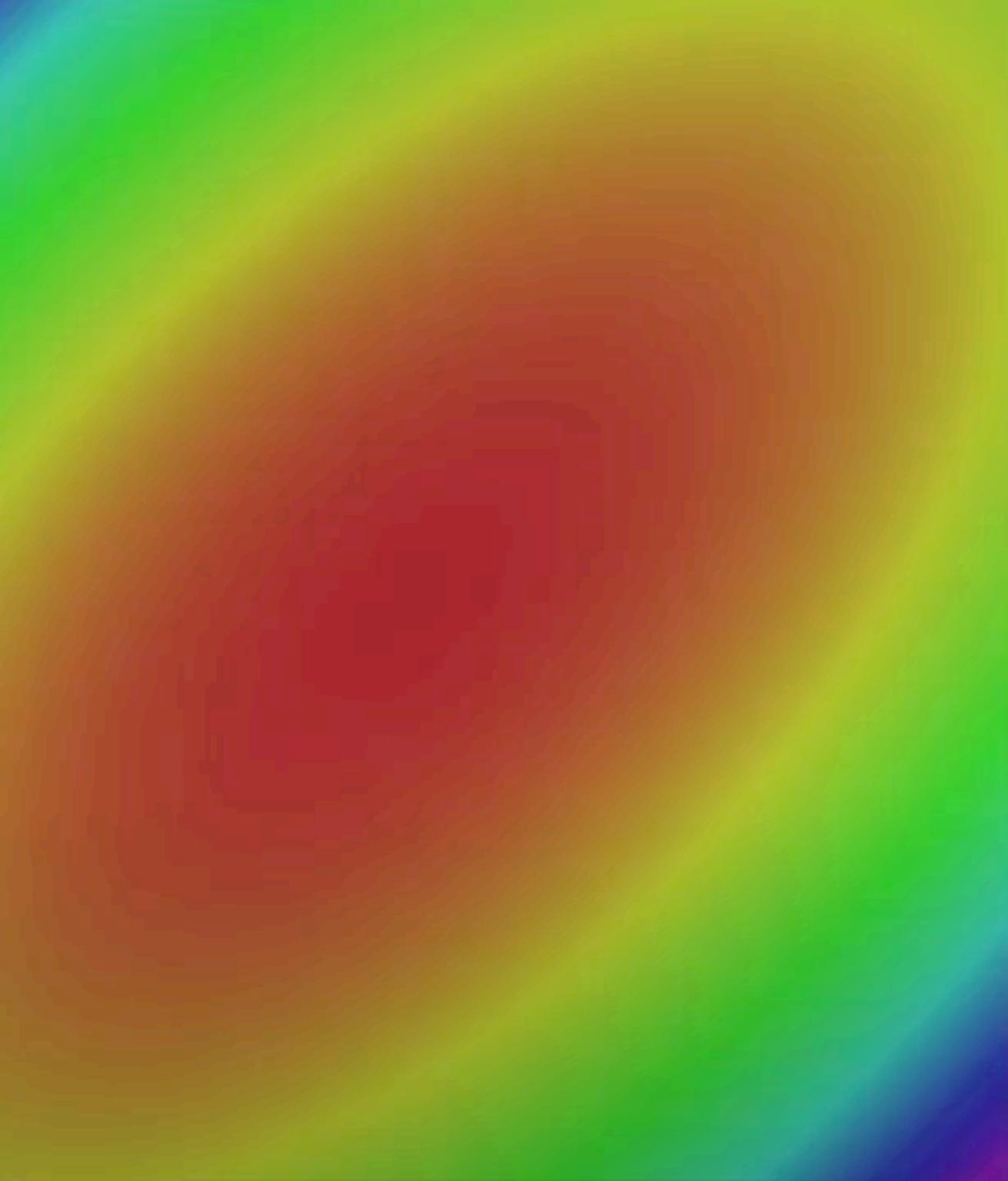


Momentum update:



Nesterov Momentum





- SGD
- SGD+Momentum
- RMSProp
- Adam

10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0

*

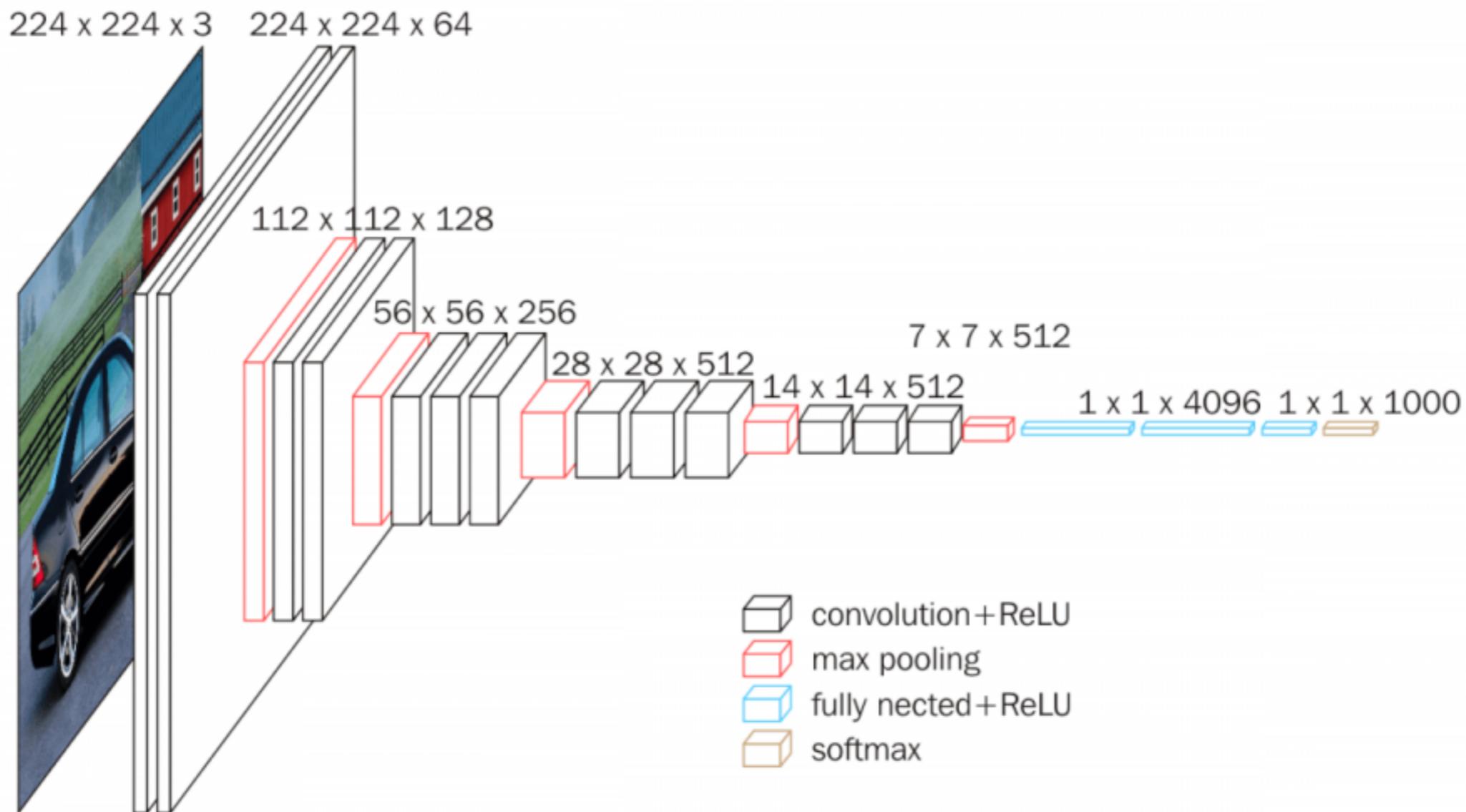
w1	w2	w3
w4	w5	w6
w7	w8	w9

=



Learn these!!

VGGNet



HOW DOES MACHINE LEARNING WORK?

