Additional Parameters :—

① Padding :—

to prevent shrink.

Zero padding   pixel replication.
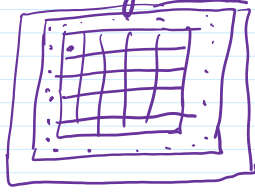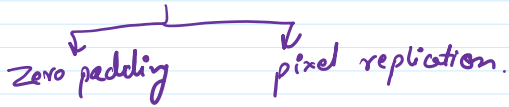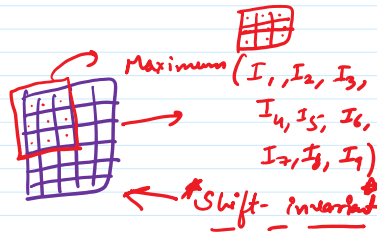
② Stride :—

stride = 1 (default)

strid = 2.

N.B.: Blue maps are inputs, and cyan maps are outputs.

outputs→

Input→

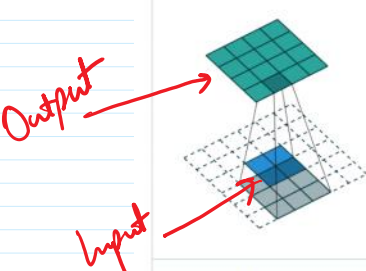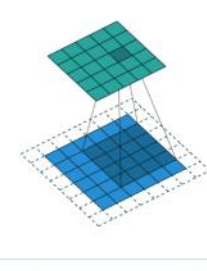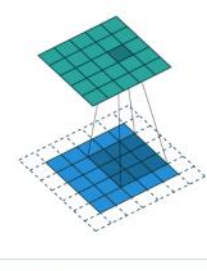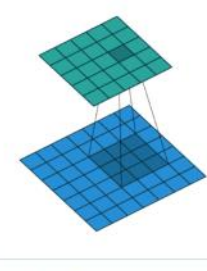| No padding, no strides | Arbitrary padding, no strides | Half padding, no strides | Full padding, no strides |
| No padding, strides | Padding, strides | Padding, strides (odd) | |

Pooling :—

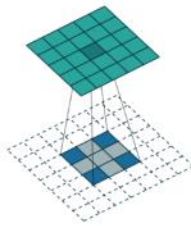Max Pooling →   Maximum $(I_1, I_2, I_3,$
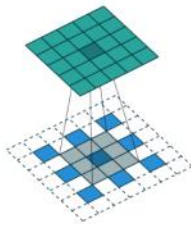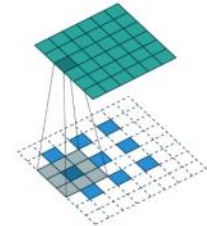$I_4, I_5, I_6,$
$I_7, I_8, I_9)$

←Shift- invariant

Average Pooling → Average Linear Filter.

Unpooling / Transposed Convolution :—

N.B.: Blue maps are inputs, and cyan maps are outputs.

Output →
Input →

No padding, no strides, transposed	Arbitrary padding, no strides, transposed	Half padding, no strides, transposed	Full padding, no strides, transposed
No padding, strides, transposed	Padding, strides, transposed	Padding, strides, transposed (odd)	

Downsampling :

Naïve image downsampling
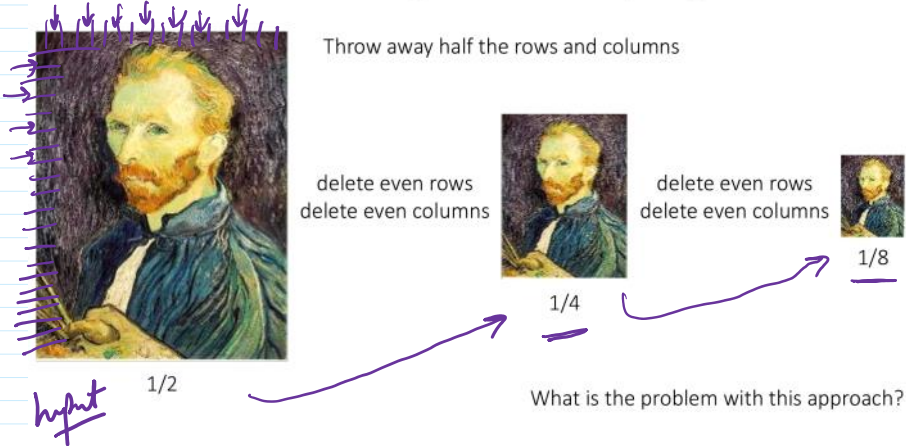
Throw away half the rows and columns

Input
1/2

delete even rows
delete even columns

1/4

delete even rows
delete even columns

1/8

What is the problem with this approach?

Naïve image downsampling

1/2   1/4 (2x zoom)   1/8 (4x zoom)

What is the 1/8 image so pixelated (and do you know what this effect is called)?

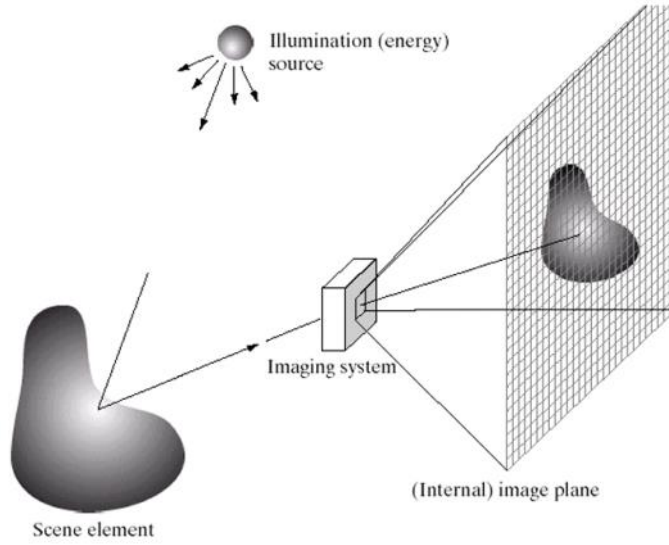What is the 1/8 image so pixelated (and do you know what this effect is called)?

Aliasing

Illumination (energy) source

Imaging system

(Internal) image plane

Scene element

Better image downsampling

Apply a smoothing filter first, then throw away half the rows and columns

1/2

Gaussian filter
delete even rows
delete even columns

1/4

Gaussian filter
delete even rows
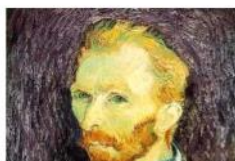delete even columns

1/8

Better image downsampling

1/2   1/4 (2x zoom)   1/8 (4x zoom)

Naïve image downsampling
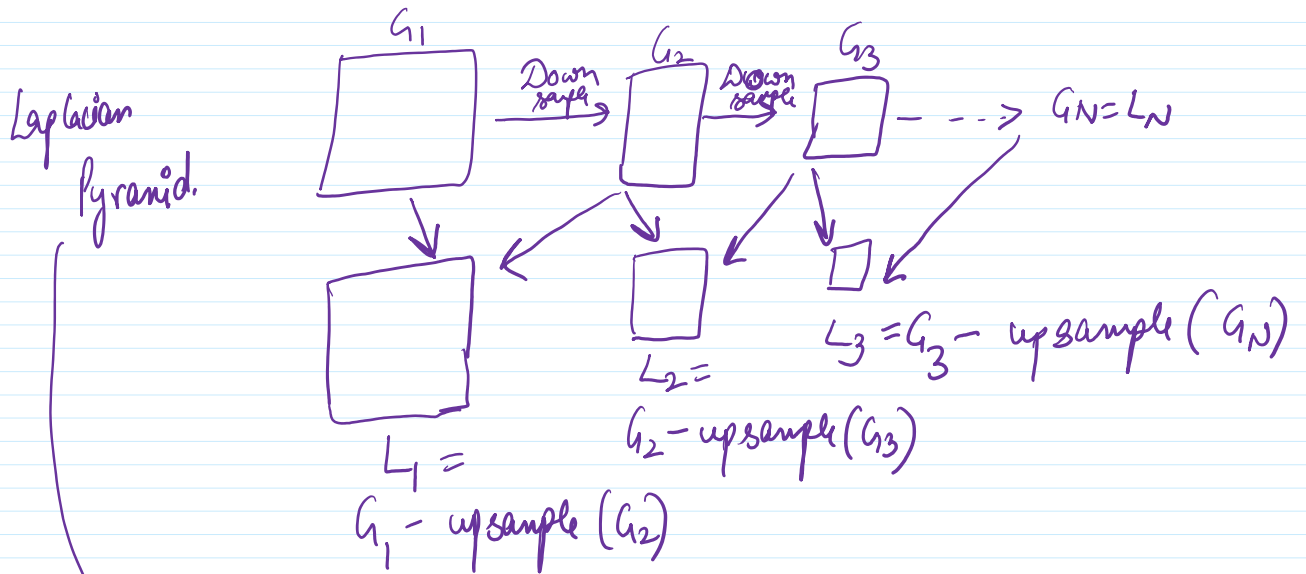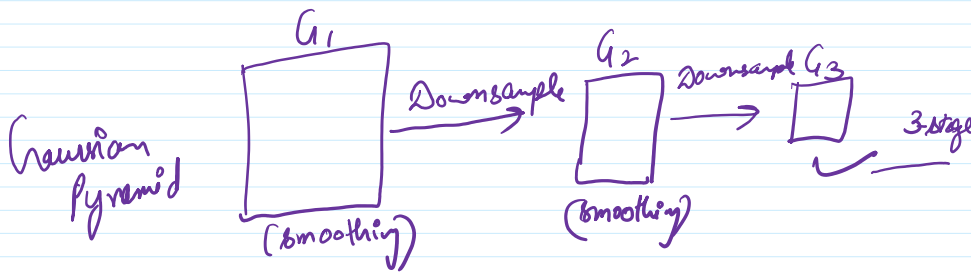
Naïve image downsampling

1/2   1/4 (2x zoom)   1/8 (4x zoom)

What is the 1/8 image so pixelated (and do you know what this effect is called)?

Image Pyramids :—

Gaussian Pyramid

G_1 $\xrightarrow{\text{Downsample}}$ G_2 $\xrightarrow{\text{Downsample}}$ G_3 $\quad$ 3 stage

(smoothing) $\qquad$ (smoothing)

Laplacian Pyramid.

$G_1 \xrightarrow[\text{sample}]{\text{Down}} G_2 \xrightarrow[\text{sample}]{\text{Down}} G_3 \quad - - \to G_N = L_N$

$L_1 = G_1 - \text{upsample}(G_2)$

$L_2 = G_2 - \text{upsample}(G_3)$

$L_3 = G_3 - \text{upsample}(G_N)$

Why?

Laplacian can be written as a difference of two Gaussians

0	1	0
1	-4	1
0	1	0

0	-1	0
-1	4	-1
0	-1	0

$$L = G_1 - G_2$$