


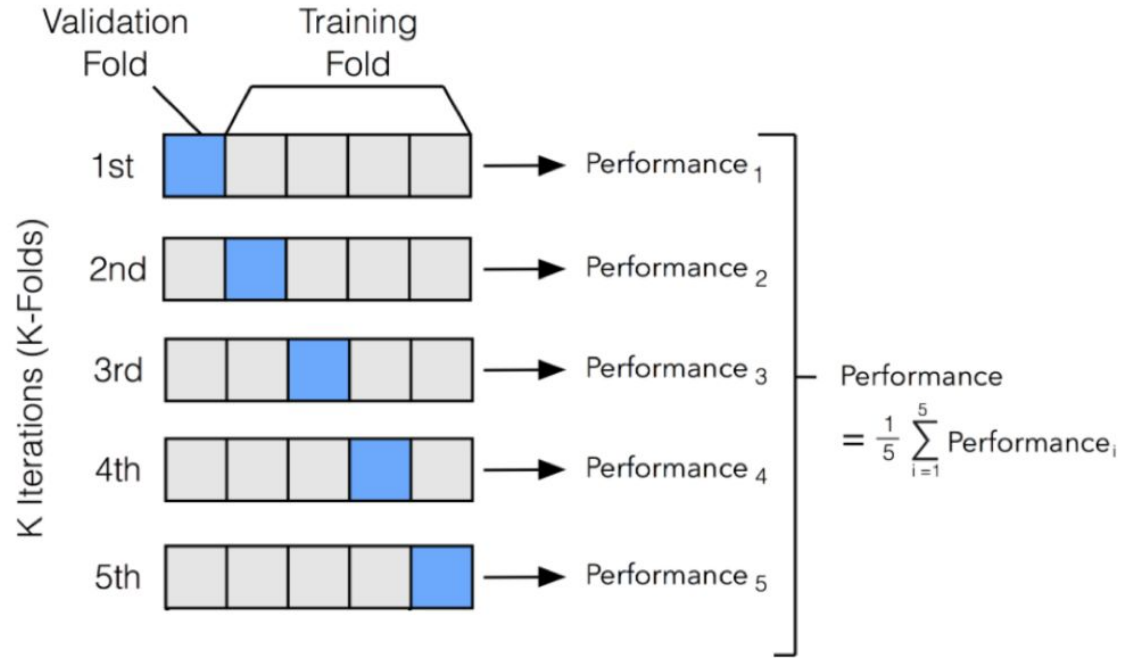
Machine Learning - CNN



Cross Validation

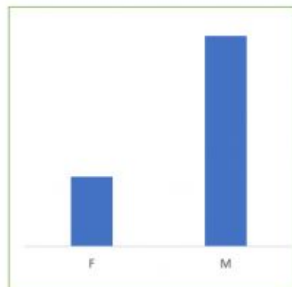
- K-Fold Cross Validation
- Stratified
- Leave One Out Cross Validation(LOOCV)
- Repeated
- Nested or Double Cross Validation

K-Fold Cross Validation

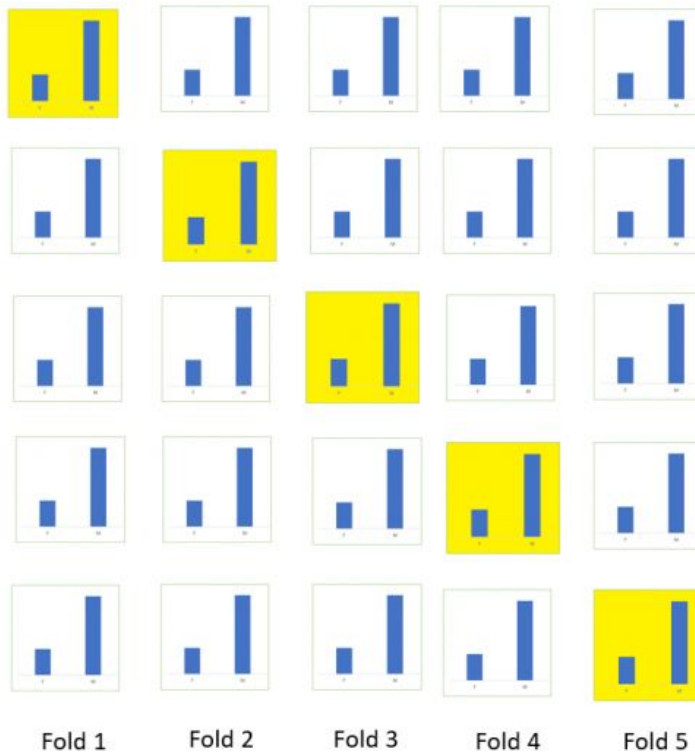


Stratified K-Fold Cross-Validation

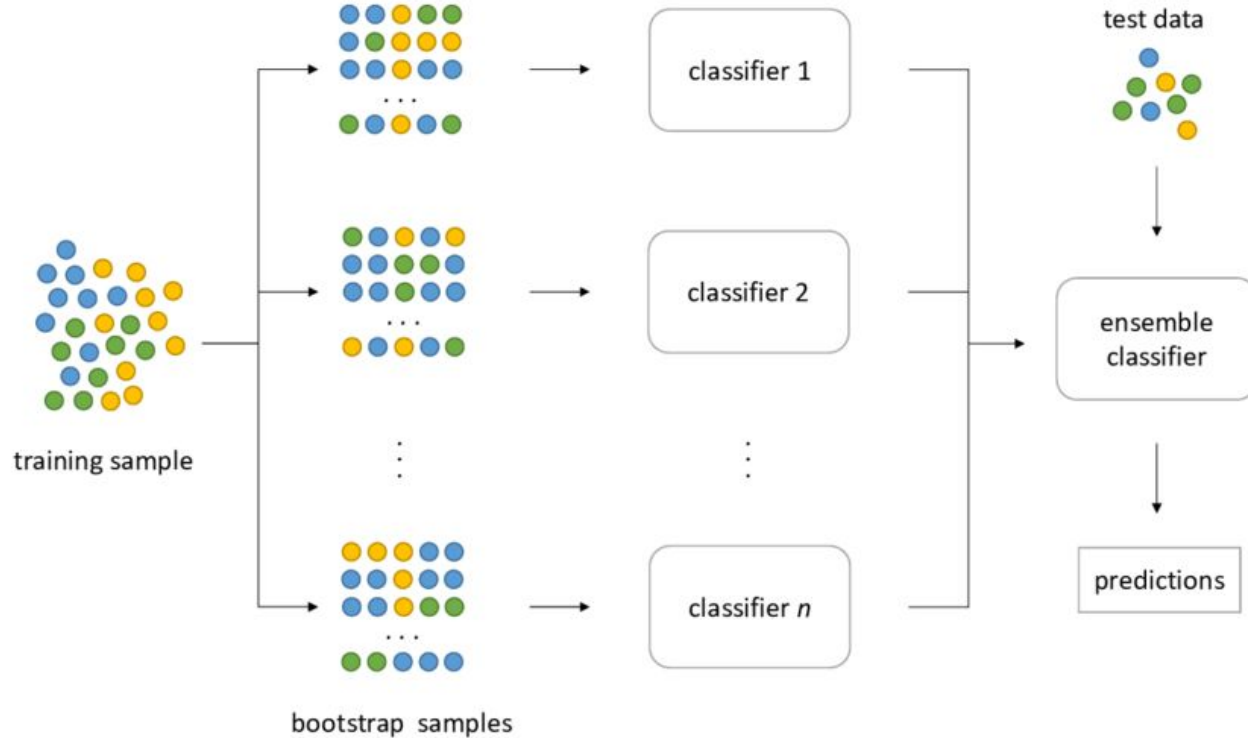
Stratified K-Fold
Cross Validation
(K=5)



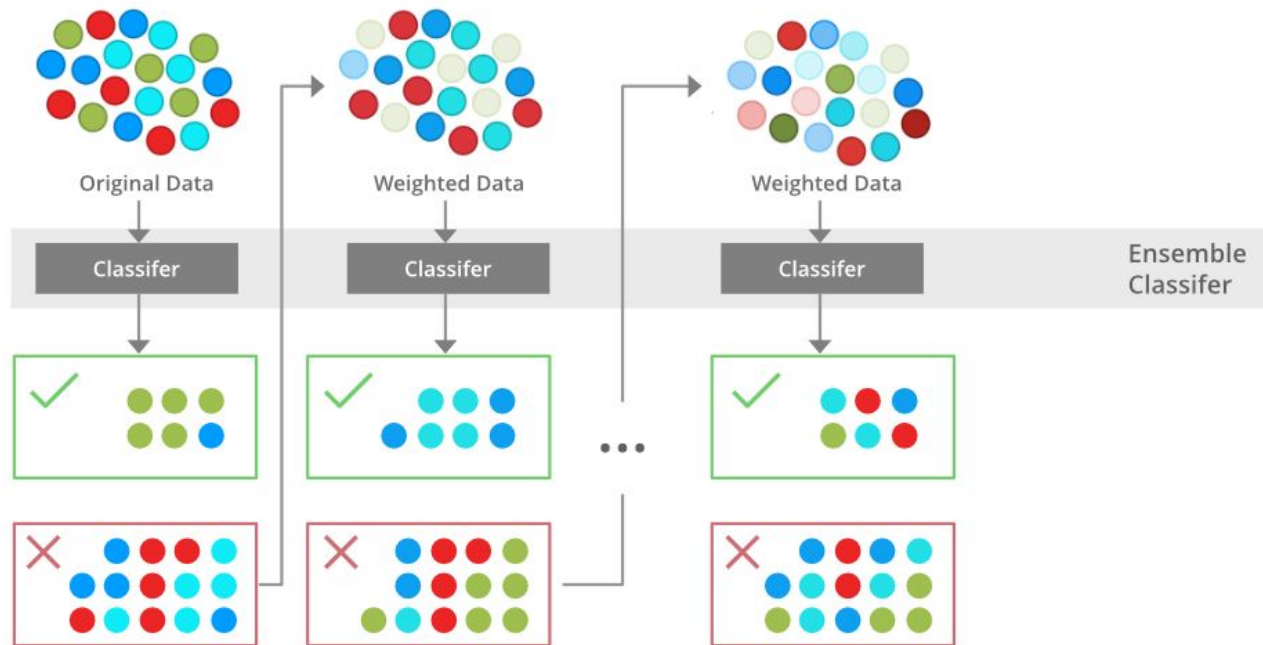
Class Distributions



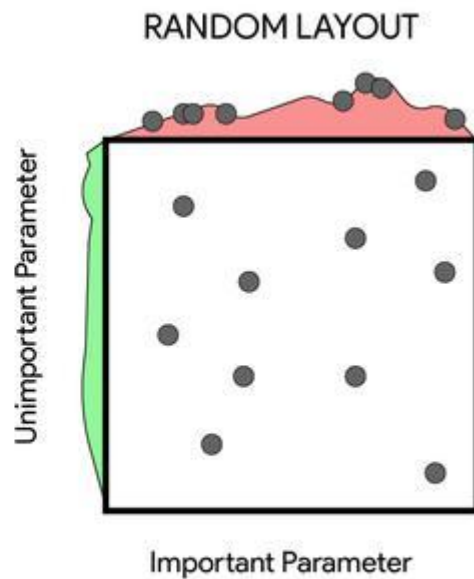
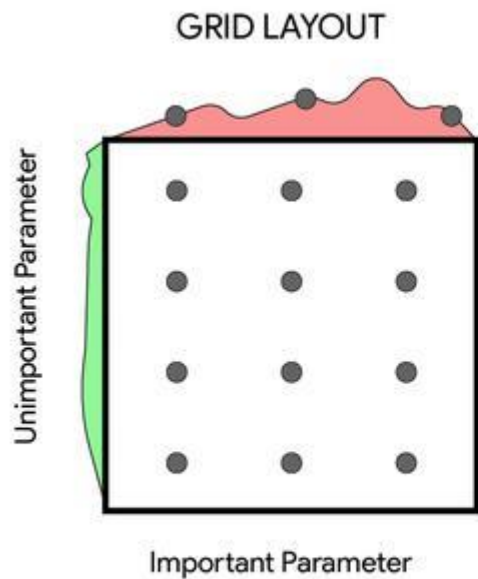
Ensemble Learning: Bagging(Bootstrap Aggregation)



Ensemble Learning: Boosting



Hyperparameter Optimization



What is Convolutional Filter

Input

4	9	2	5	8	3
3	6	2	4	0	3
2	4	5	4	5	2
5	6	5	4	7	8
5	7	7	9	2	1
5	8	5	3	8	4

Dimension: 6 x 6

*

Filter

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

Parameters:

Size: $f = 3$

Stride: $s = 2$

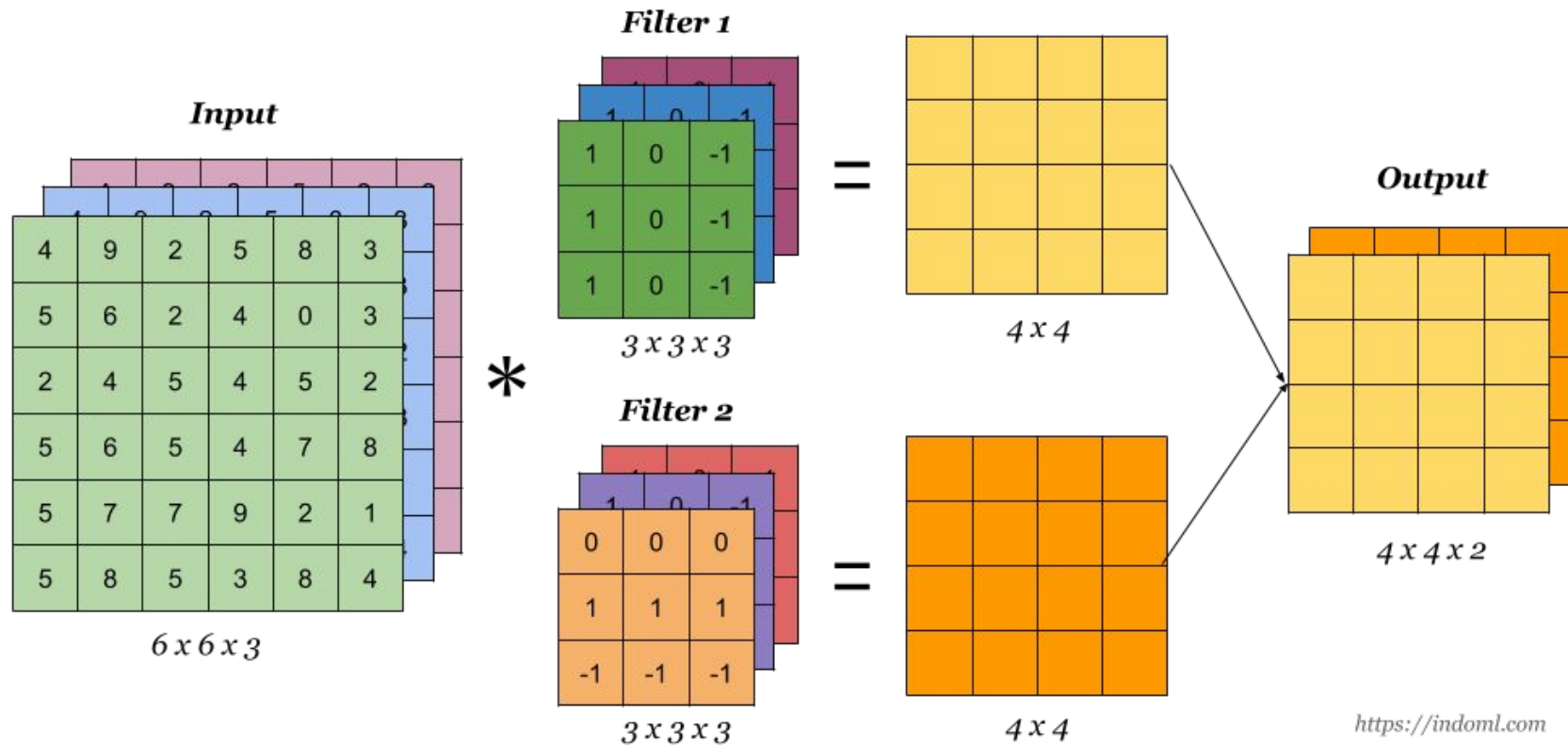
Padding: $p = 0$

$$\begin{aligned}(4) \times (1) + (9) \times (0) + (2) \times (-1) &= 2 \\(3) \times (1) + (6) \times (0) + (2) \times (-1) &= 1 \\(2) \times (1) + (4) \times (0) + (5) \times (-1) &= -3 \\2 + 1 - 3 &= 0\end{aligned}$$

=

0	-4
-5	3

Convolutional Filters



Convolutional Filters

0	0	0	0	0	0	...
0	156	155	156	158	158	...
0	153	154	157	159	159	...
0	149	151	155	158	159	...
0	146	146	149	153	158	...
0	145	143	143	148	158	...
...

Input Channel #1 (Red)

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

Kernel Channel #1



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0	0	0	0	0	0	...
0	167	166	167	169	169	...
0	164	165	168	170	170	...
0	160	162	166	169	170	...
0	156	156	159	163	168	...
0	155	153	153	158	168	...
...

Input Channel #2 (Green)

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

Kernel Channel #2



-498

0	0	0	0	0	0	...
0	163	162	163	165	165	...
0	160	161	164	166	166	...
0	156	158	162	165	166	...
0	155	155	158	162	167	...
0	154	152	152	157	167	...
...

Input Channel #3 (Blue)

0	1	1
0	1	0
1	-1	1

Kernel Channel #3



164

+ 1 = -25

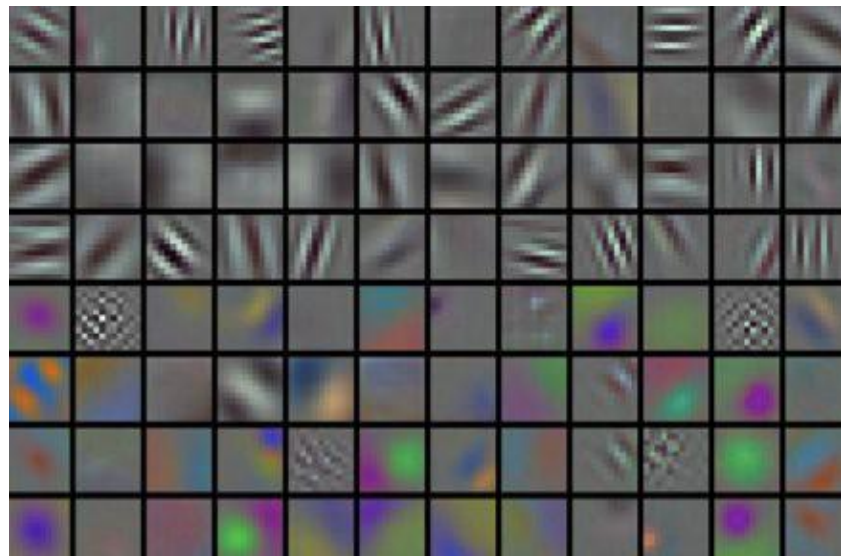
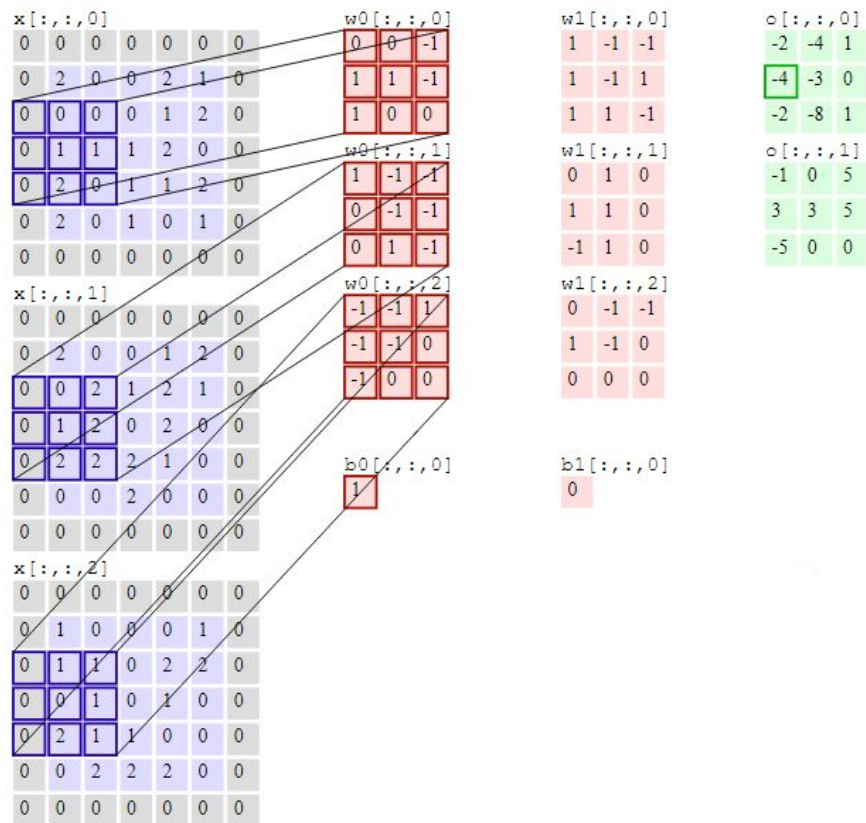


Bias = 1

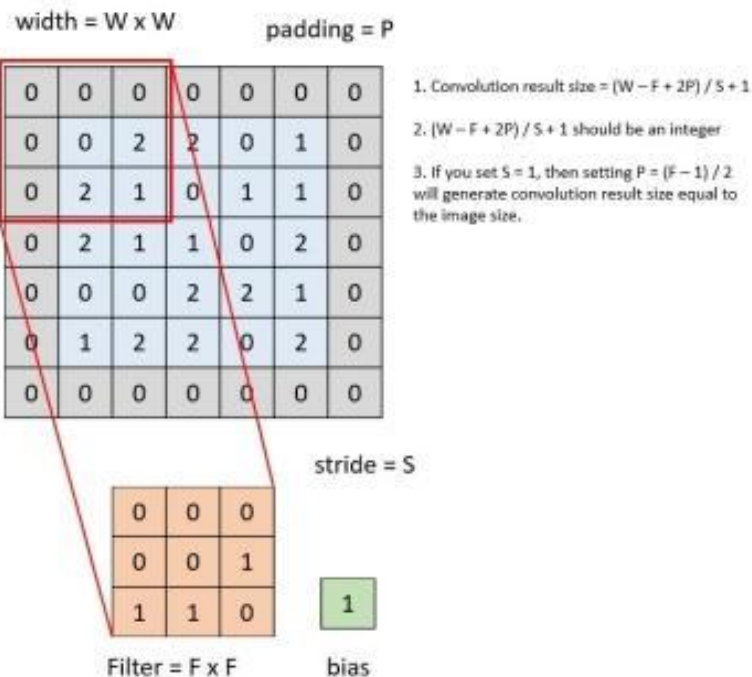
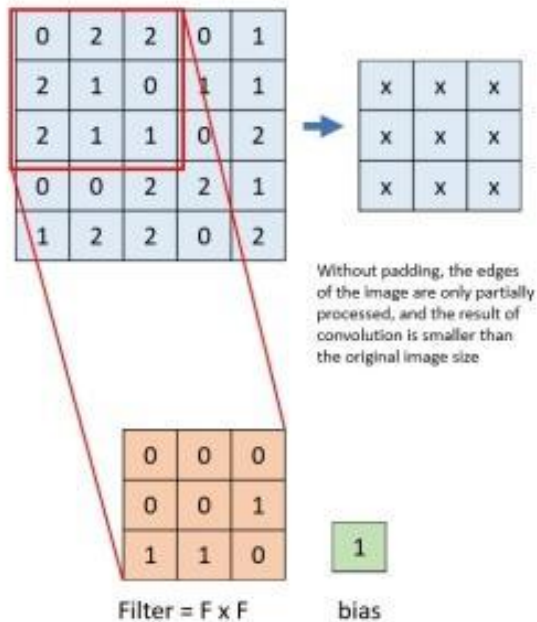
Output

-25				...
				...
				...
				...
...

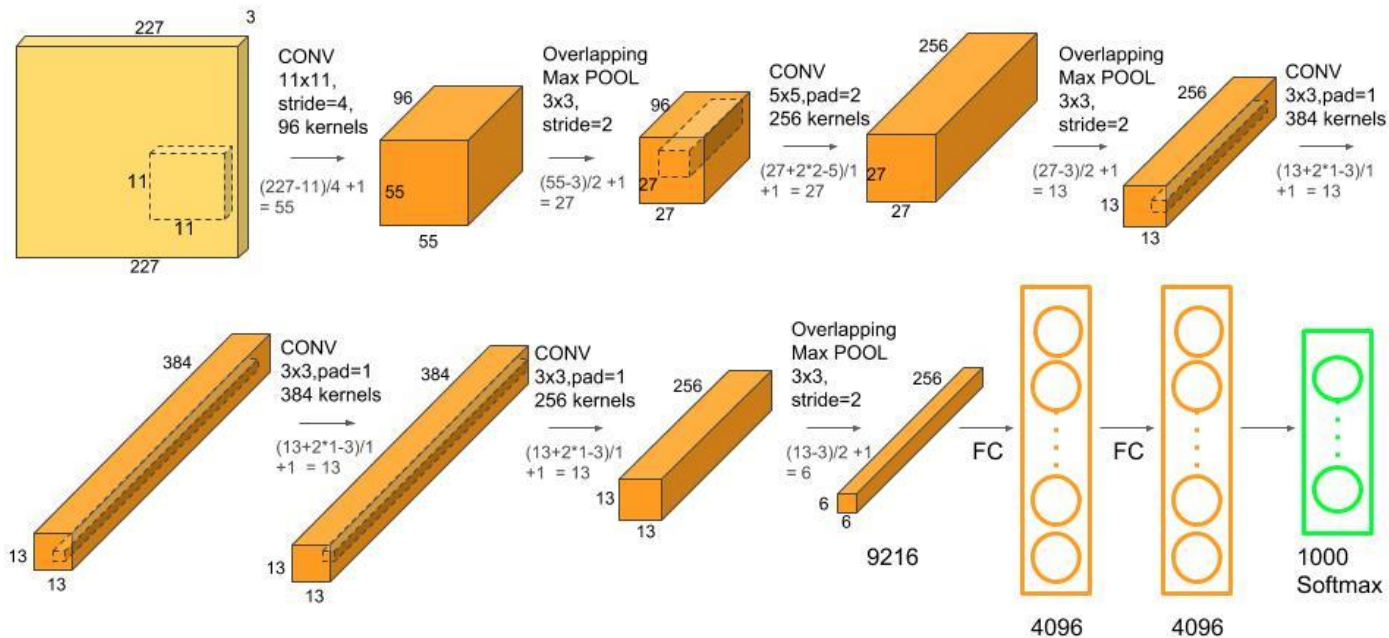
Convolutional Filters



Output of Filter



Alexnet



Pooling

Max Pooling

29	15	28	184
0	100	70	38
12	12	7	2
12	12	45	6

2 x 2
pool size

100	184
12	45

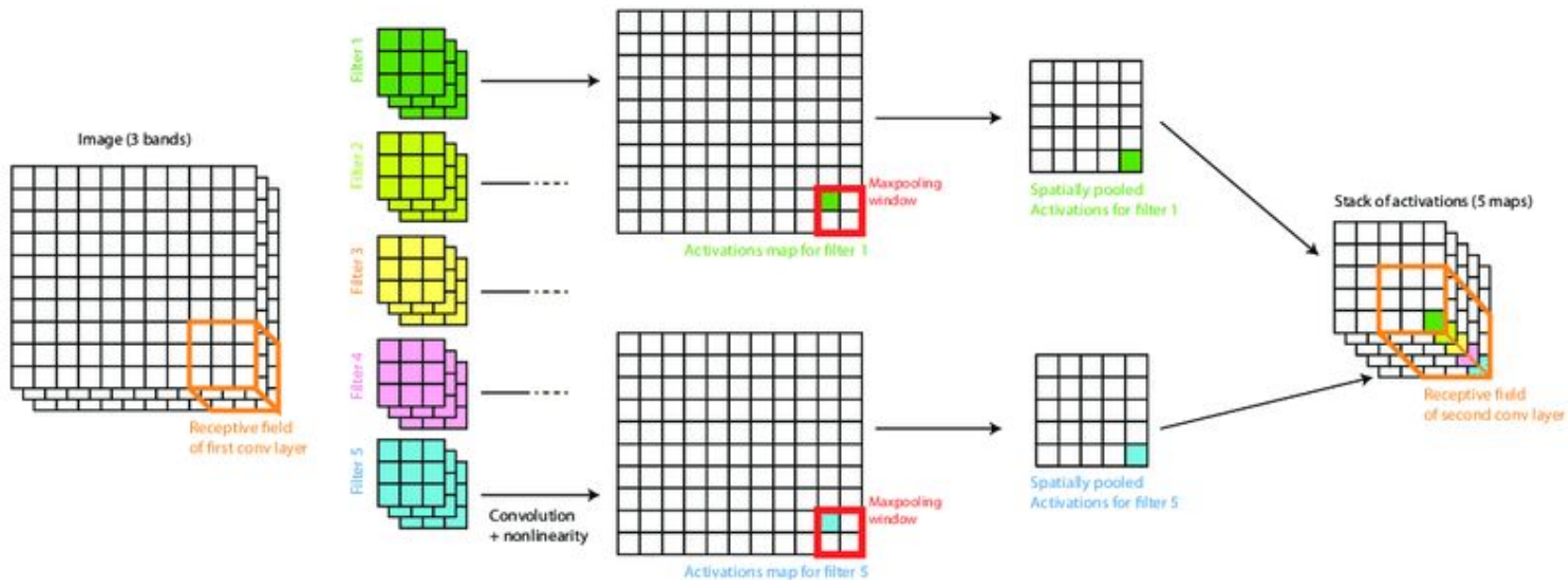
Average Pooling

31	15	28	184
0	100	70	38
12	12	7	2
12	12	45	6

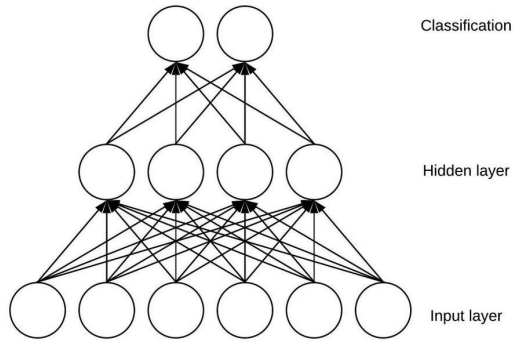
2 x 2
pool size

36	80
12	15

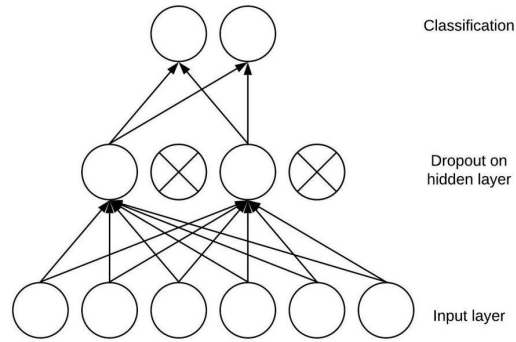
Pooling



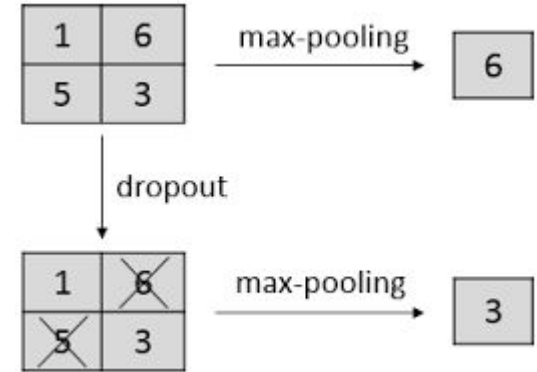
Dropout



Without Dropout



With Dropout



Resnet-18

