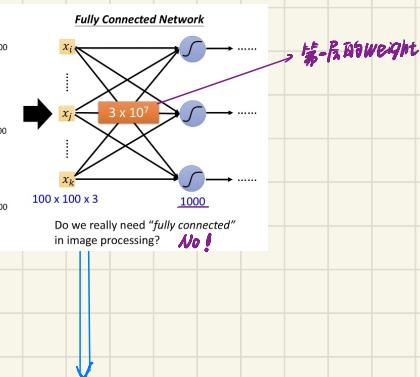
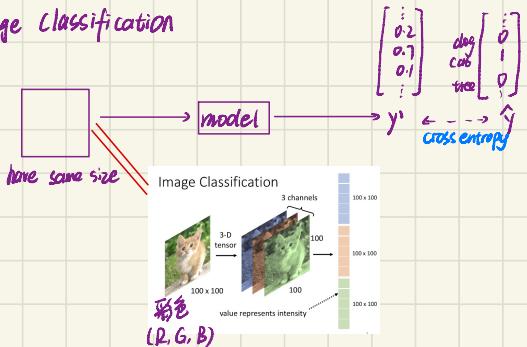


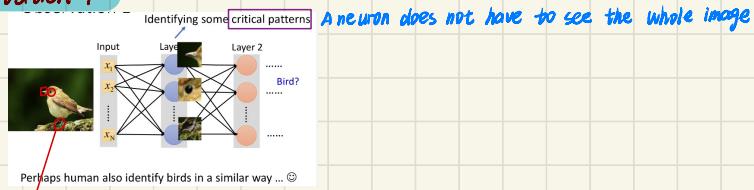


Convolutional Neural Network (CNN)

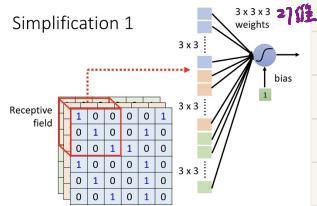
Image Classification



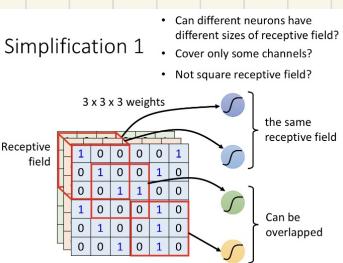
observation 1



Simplification 1 (后续)

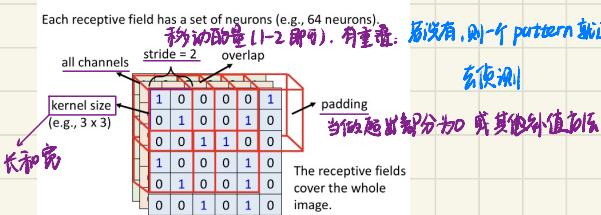


Simplification 1



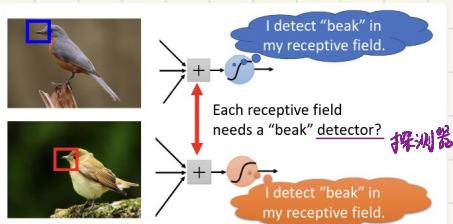
- Can different neurons have different sizes of receptive field?
- Cover only some channels?
- Not square receptive field?

Simplification 1 — Typical Setting

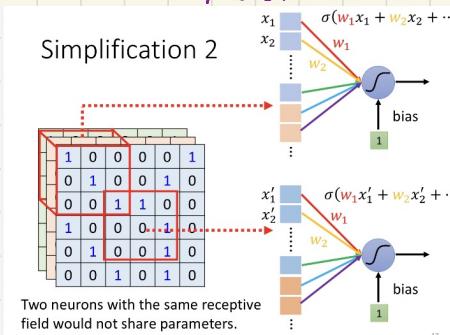


Observation 2

- The same patterns appear in different regions

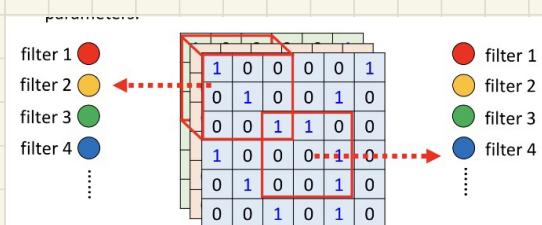


Simplification 2 共享参数



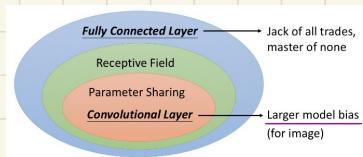
weight 完全一样

Simplification 2 — Typical Setting



Each receptive field has a set of neurons
Each receptive field has the neurons with the same set of parameters.

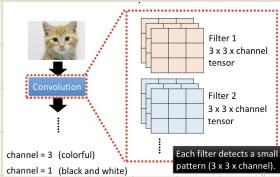
Benefit of Convolutional Layer



if having small bias, may overfitting

- Some patterns are much smaller than the whole image.
- The same patterns appear in different regions.

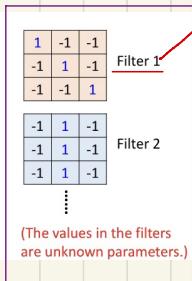
Convolutional Layer



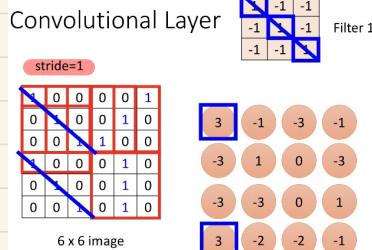
Consider channel = 1

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

6 x 6 image

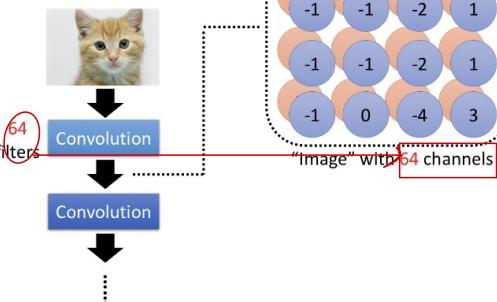


黑白照 channel = 1, 所以 Filter 的高度为 1

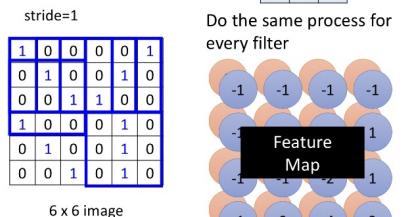


↓ it's all

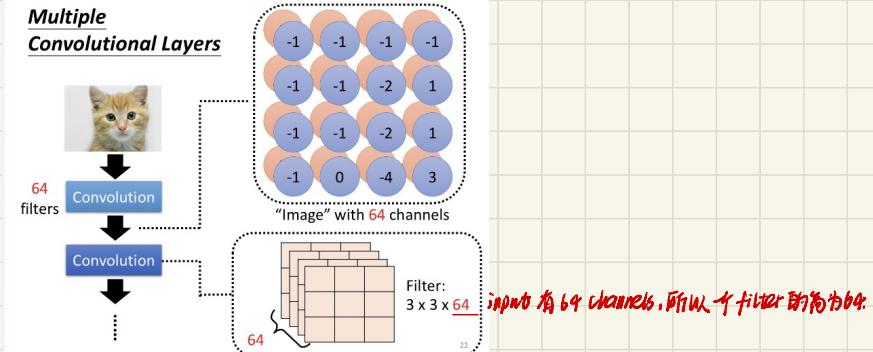
Convolutional Layer



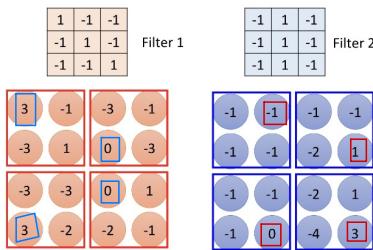
Convolutional Layer



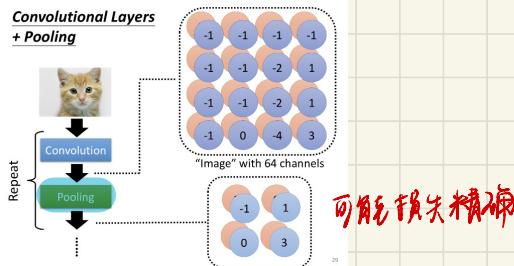
Multiple Convolutional Layers



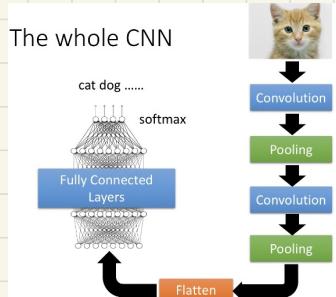
Pooling - Max Pooling



use convolutional layers + Pooling



The whole CNN:



Alpha Go = Playing Go

Alpha Go does not use pooling...

CNN is not invariant to scaling and rotation. \Rightarrow 解决方法: Spatial Transformer