

GoogLeNet详解

GoogLeNet在2014年由Google团队提出，斩获当年ImageNet竞赛中Classification Task (分类任务) 第一名。

Going deeper with convolutions

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网络中的亮点：

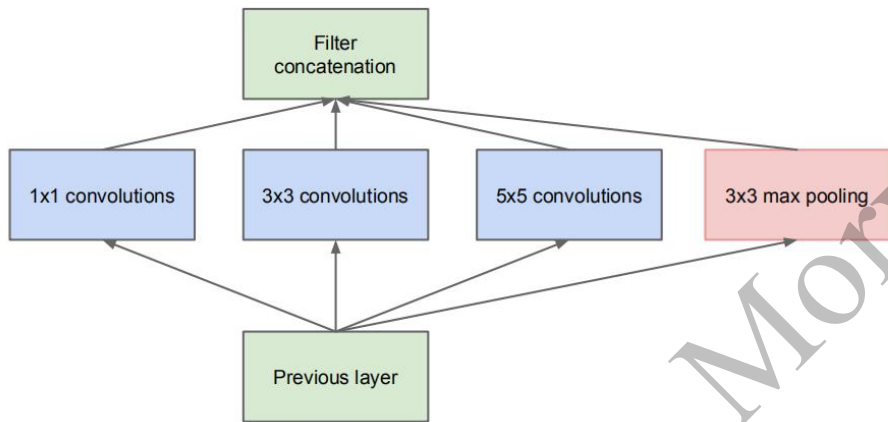
- 引入了Inception结构（融合不同尺度的特征信息）
- 使用 1×1 的卷积核进行降维以及映射处理
- 添加两个辅助分类器帮助训练
- 丢弃全连接层，使用平均池化层（大大减少模型参数）

GoogLeNet详解

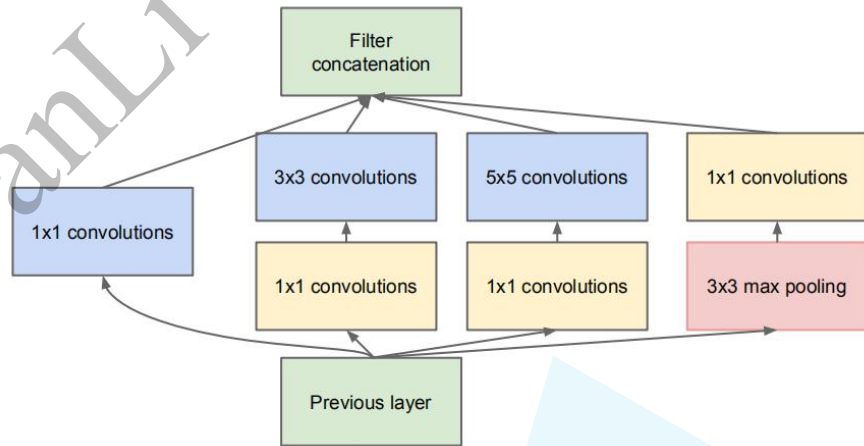
type	patch size/ stride	output size	depth	#1×1	#3×3 reduce	#3×3	#5×5 reduce	#5×5	pool proj	params	ops
convolution	7×7/2	112×112×64	1							2.7K	34M
max pool	3×3/2	56×56×64	0								
convolution	3×3/1	56×56×192	2		64	192				112K	360M
max pool	3×3/2	28×28×192	0								
inception (3a)		28×28×256	2	64	96	128	16	32	32	159K	128M
inception (3b)		28×28×480	2	128	128	192	32	96	64	380K	304M
max pool	3×3/2	14×14×480	0								
inception (4a)		14×14×512	2	192	96	208	16	48	64	364K	73M
inception (4b)		14×14×512	2	160	112	224	24	64	64	437K	88M
inception (4c)		14×14×512	2	128	128	256	24	64	64	463K	100M
inception (4d)		14×14×528	2	112	144	288	32	64	64	580K	119M
inception (4e)		14×14×832	2	256	160	320	32	128	128	840K	170M
max pool	3×3/2	7×7×832	0								
inception (5a)		7×7×832	2	256	160	320	32	128	128	1072K	54M
inception (5b)		7×7×1024	2	384	192	384	48	128	128	1388K	71M
avg pool	7×7/1	1×1×1024	0								
dropout (40%)		1×1×1024	0								
linear		1×1×1000	1							1000K	1M
softmax		1×1×1000	0								

GoogLeNet详解

Inception结构



(a) Inception module, naïve version

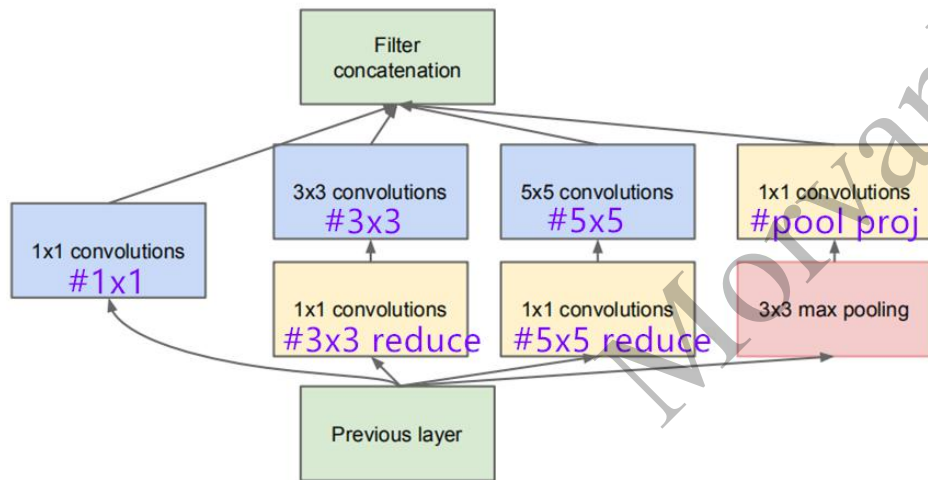


(b) Inception module with dimension reductions

注意：每个分支所得的特征矩阵高和宽必须相同

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Inception结构

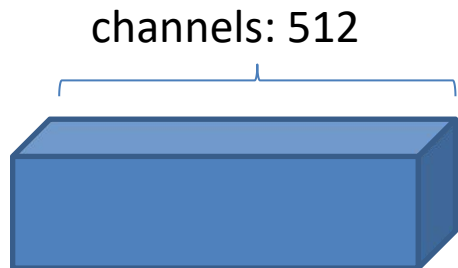


(b) Inception module with dimension reductions

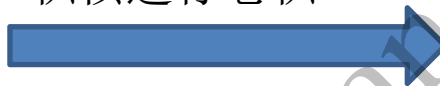
注意：每个分支所得的特征矩阵高和宽必须相同

GoogLeNet详解

不使用1x1卷积核降维



使用64个5x5的卷积核进行卷积



$$5 \times 5 \times 512 \times 64 = 819\,200$$

channels: 512



使用24个1x1的卷积核进行卷积



channels: 24



使用64个5x5的卷积核进行卷积



$$1 \times 1 \times 512 \times 24 = 12\,288$$

$$5 \times 5 \times 24 \times 64 = 38\,400$$

$$12\,288 + 38\,400 = 50\,688$$

使用1x1卷积核降维

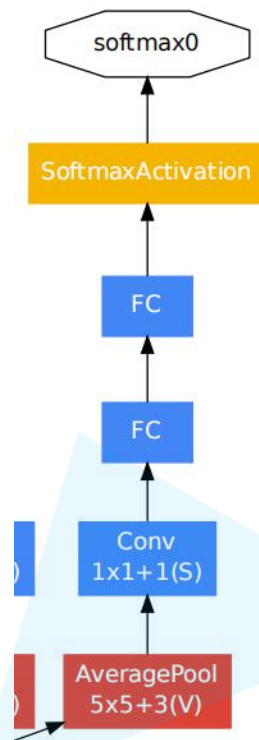
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辅助分类器 (Auxiliary Classifier)

The exact structure of the extra network on the side, including the auxiliary classifier, is as follows:

- An average pooling layer with 5×5 filter size and stride 3, resulting in an $4 \times 4 \times 512$ output for the (4a), and $4 \times 4 \times 528$ for the (4d) stage.
- A 1×1 convolution with 128 filters for dimension reduction and rectified linear activation.
- A fully connected layer with 1024 units and rectified linear activation.
- A dropout layer with 70% ratio of dropped outputs.
- A linear layer with softmax loss as the classifier (predicting the same 1000 classes as the main classifier, but removed at inference time).

$$out_{size} = (in_{size} - F_{size} + 2P) / S + 1$$



GoogLeNet详解

GoogLeNet模型参数 (不包含辅助分类器)

```
Total params: 6,994,392  
Trainable params: 6,994,392  
Non-trainable params: 0
```

$$\frac{6\,994\,392}{138\,357\,544} \approx \frac{1}{20}$$

VGGNet模型参数

```
Total params: 138,357,544  
Trainable params: 138,357,544  
Non-trainable params: 0
```