CVPR 2016
Inception-v4, Inception-ResNet and the Impact of Residual Connections on Learning

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논문 리뷰

배성훈

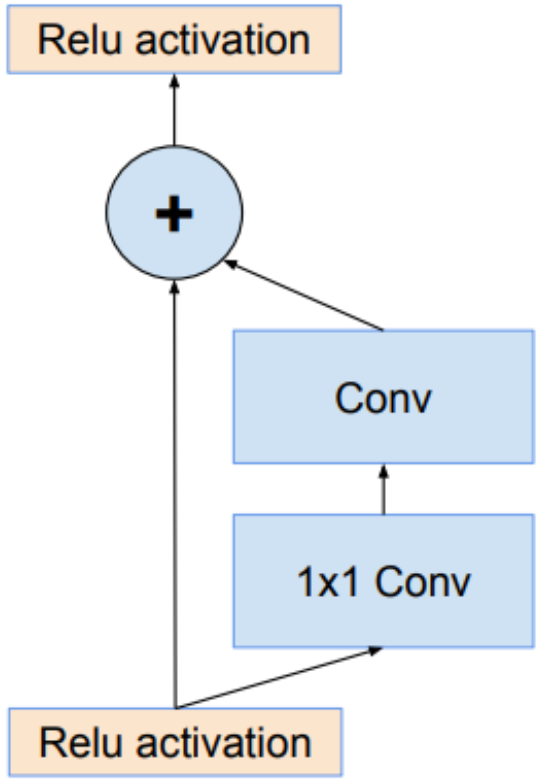
Inception-v4, Inception-ResNet and the Impact of Residual Connections on Learning (CVPR 2016)

- **Research Background:**
  - Residual connection과 Inception architecture를 합치면 어떤 **<u>이점</u>**이 있을까?
  - **<u>Network Depth와 Width를 증가</u>**시켜 성능을 향상시키는 대표적인 방법들을 조합해 성능 향상

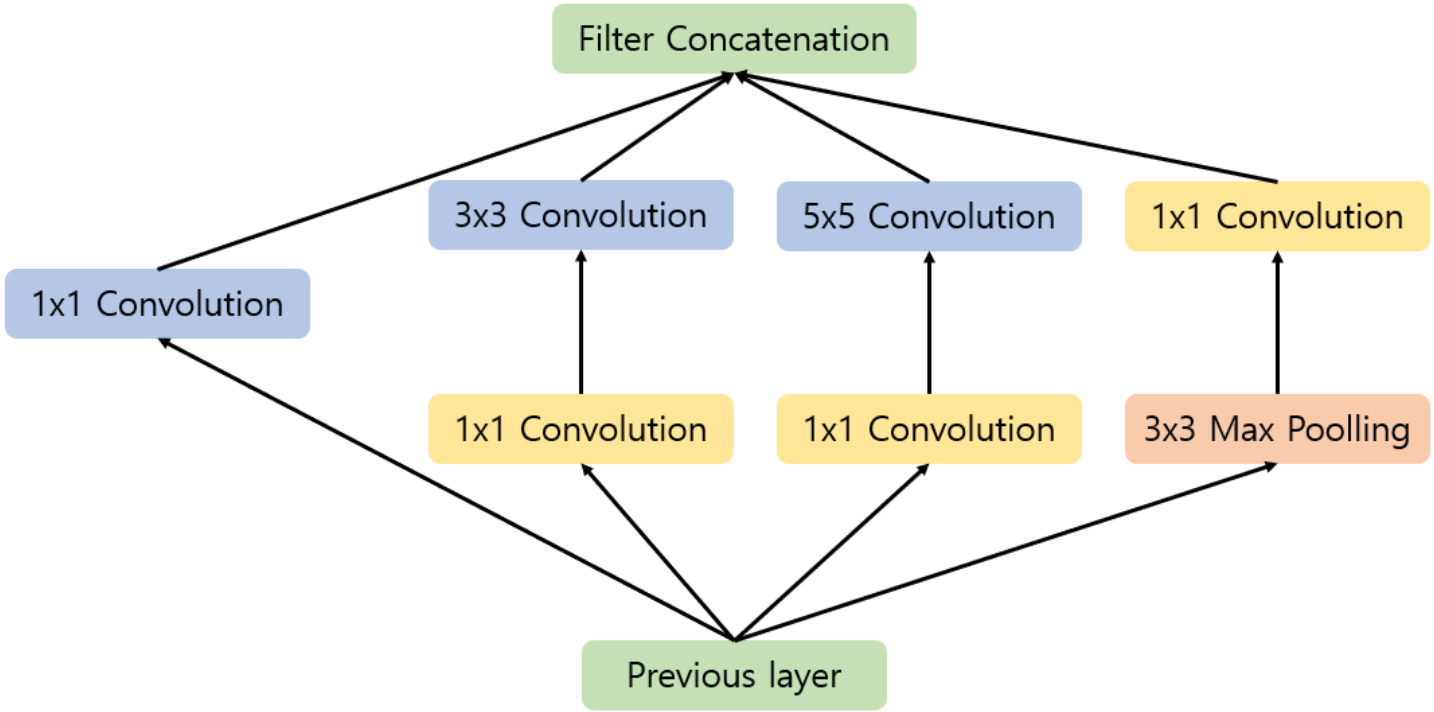
*__이점__: Inception의 계산 효율성 유지 + residual block 이점

*__Network Depth와 Width 증가__: 신경망 구조에서 Layer를 깊게 쌓고, filter 또는 channel의 수를 증가

Residual Block



Inception module



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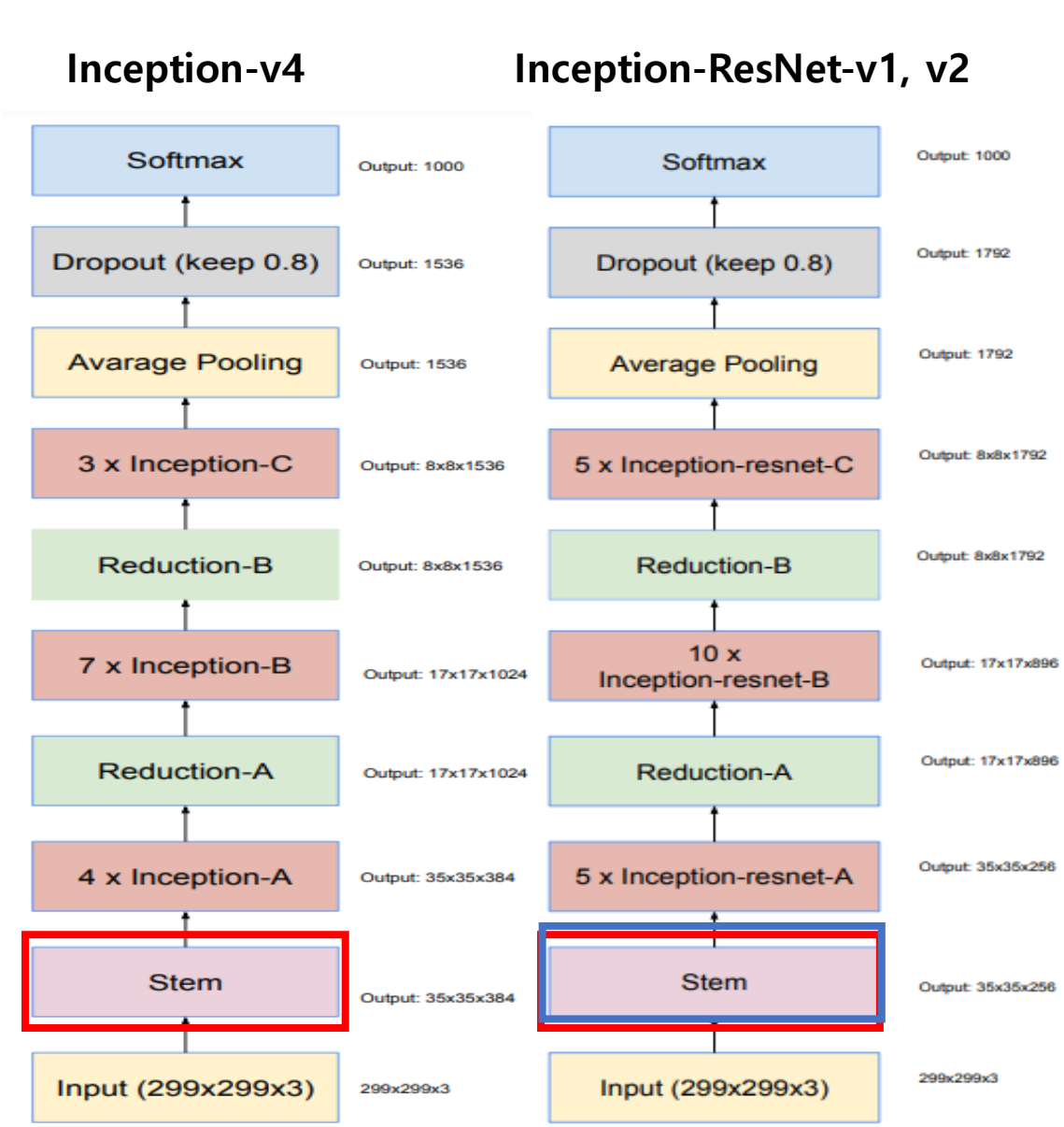
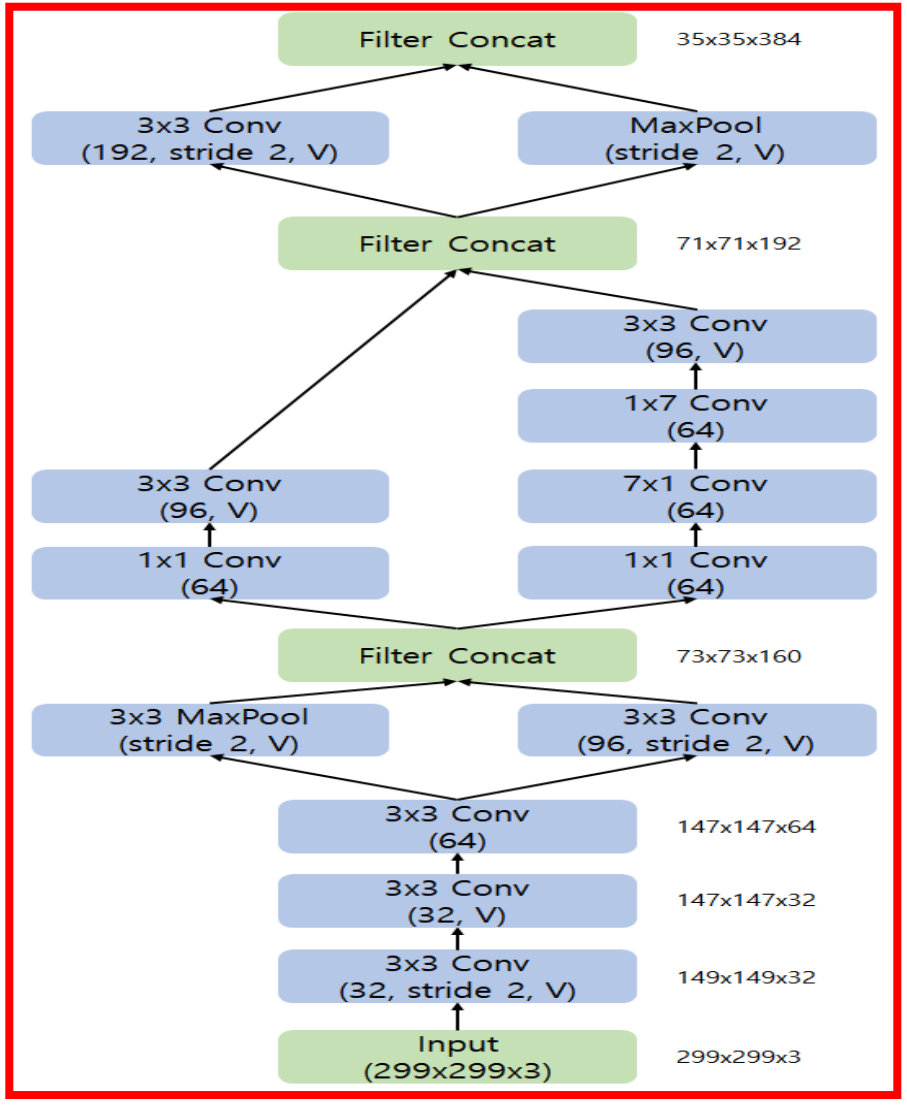
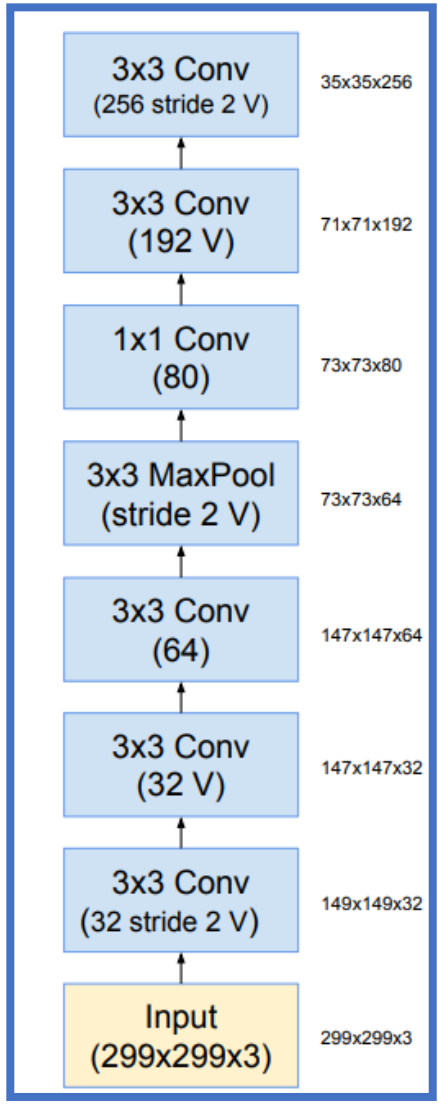
- **Method:** Residual Inception model vs Non-Residual Inception model







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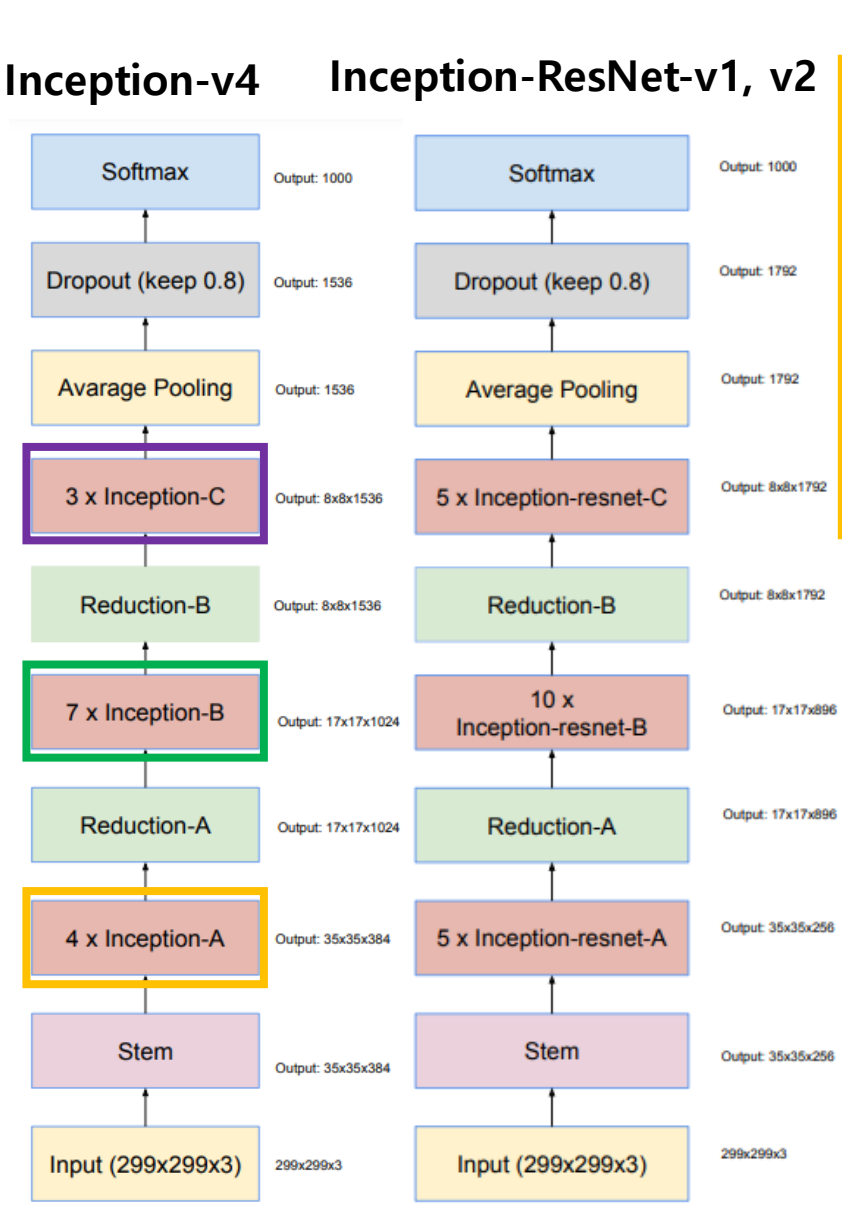

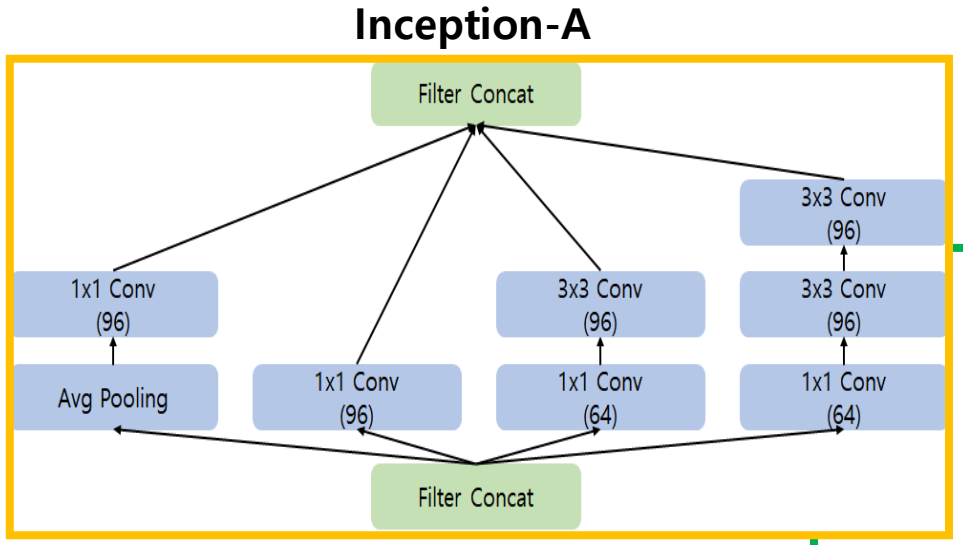

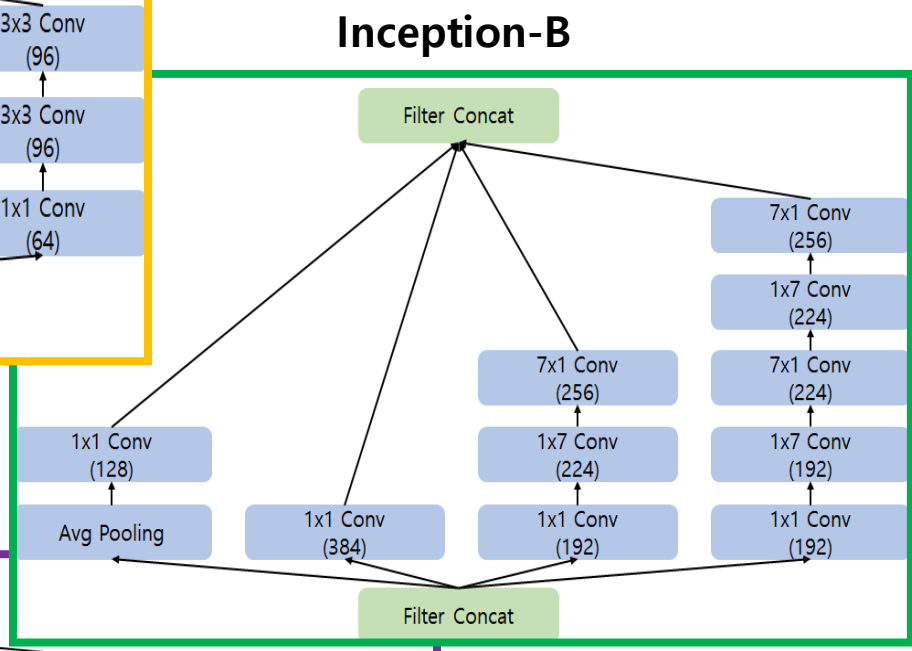

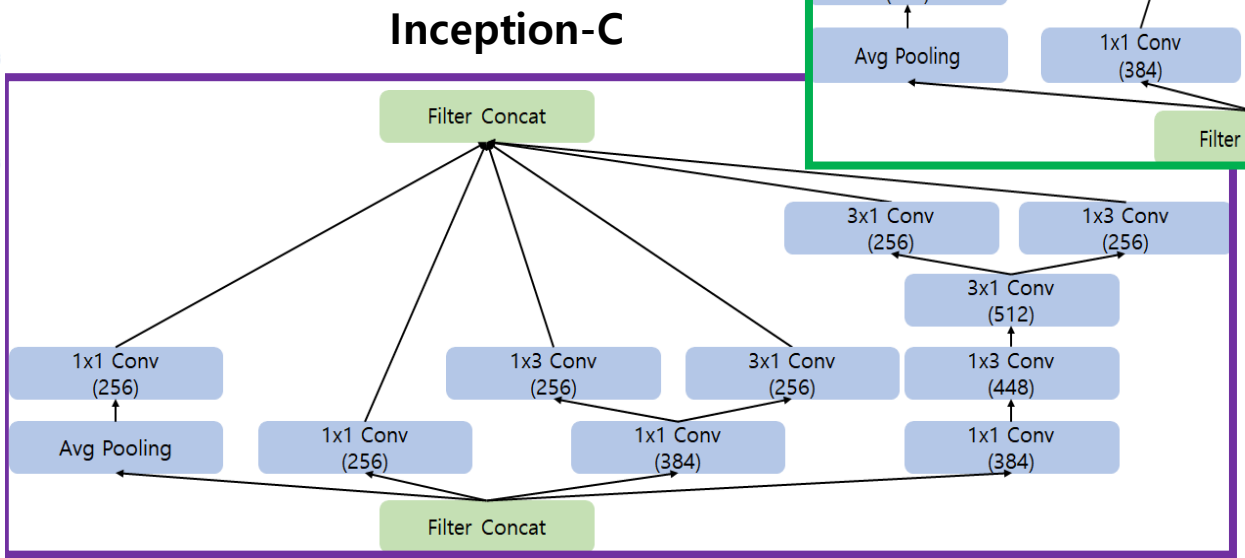

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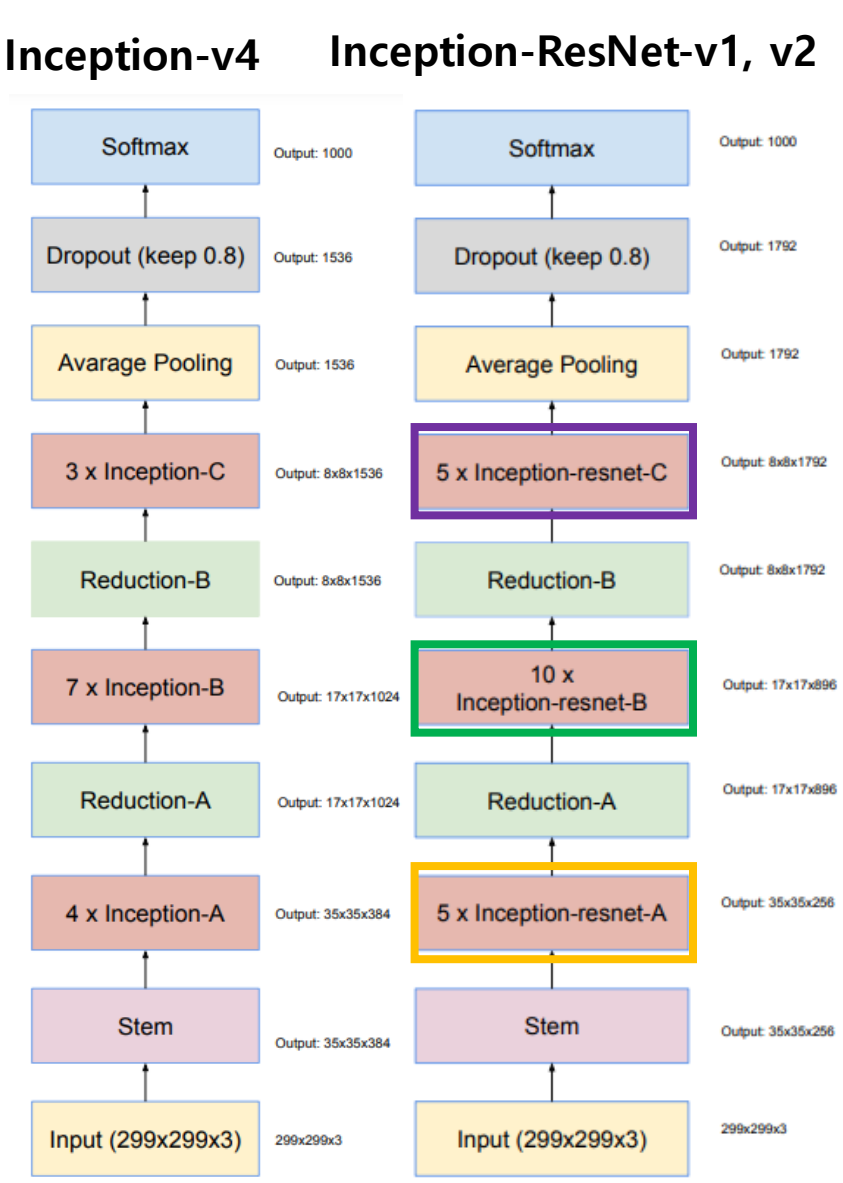

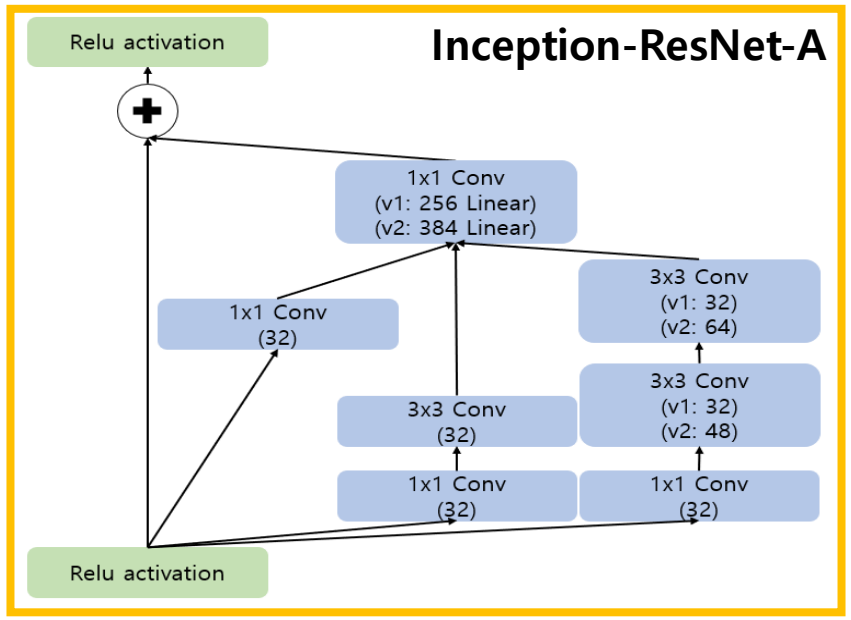

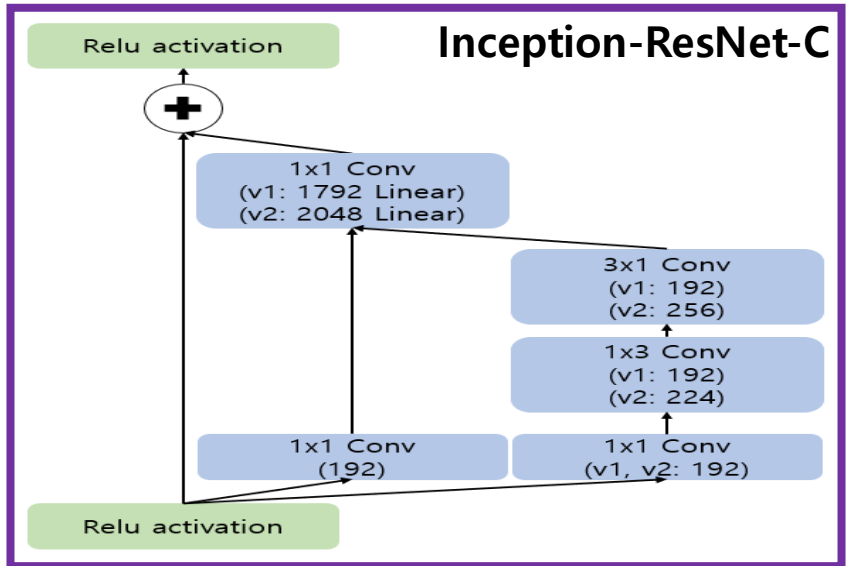

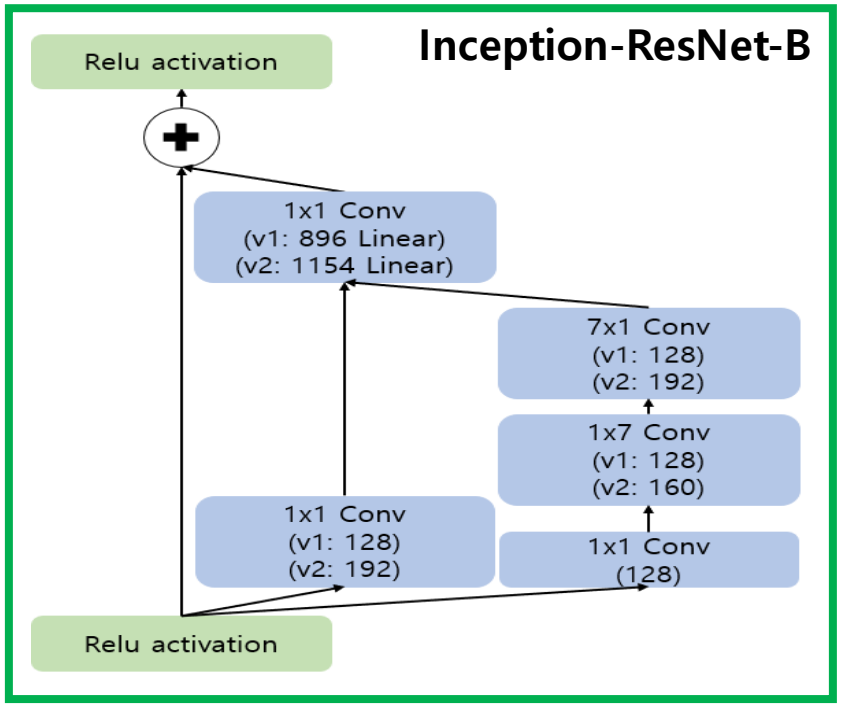

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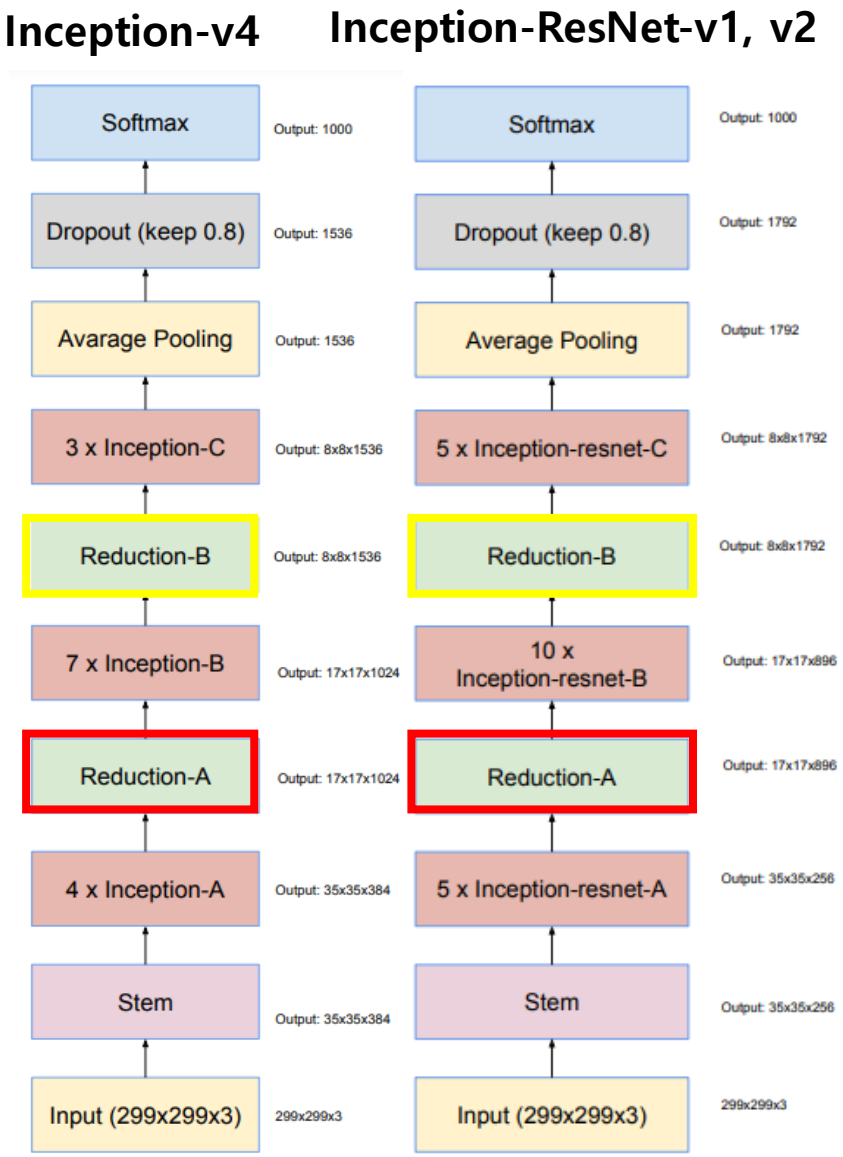
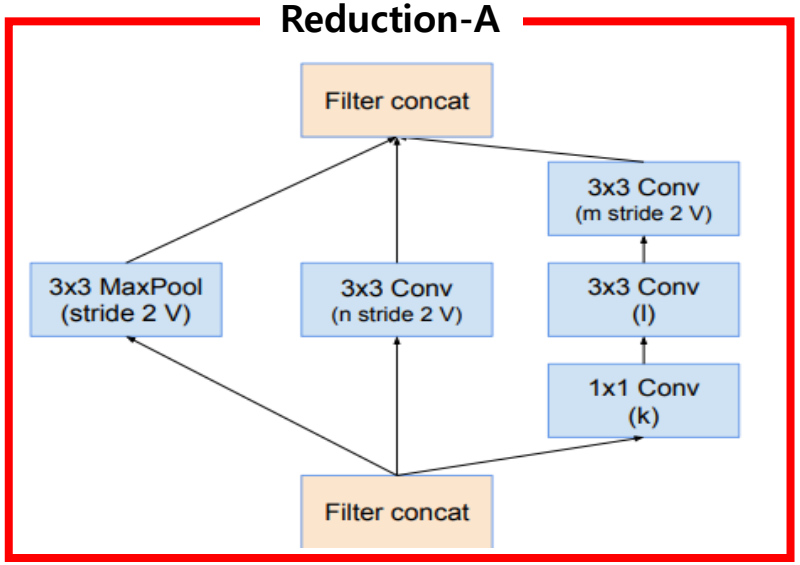
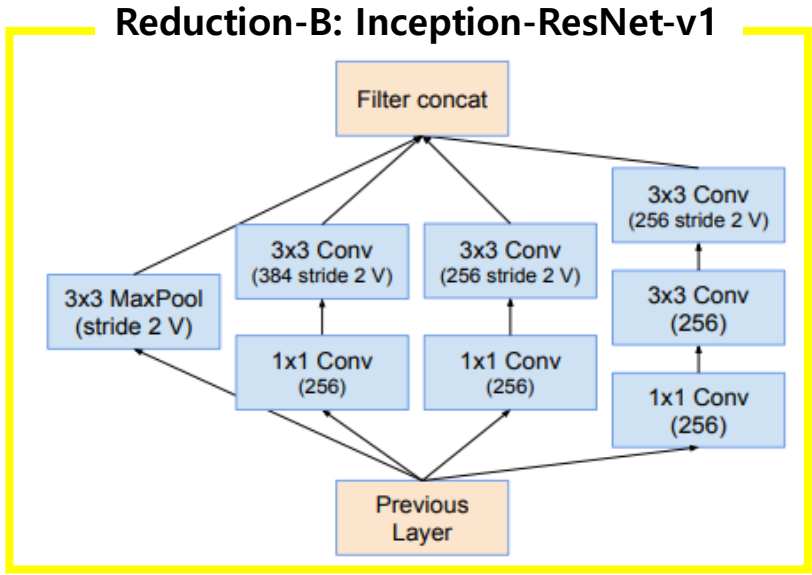
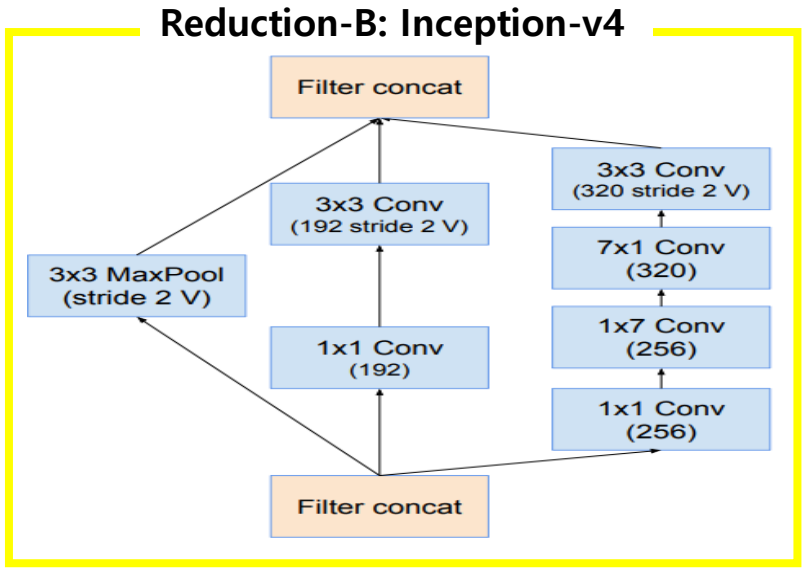
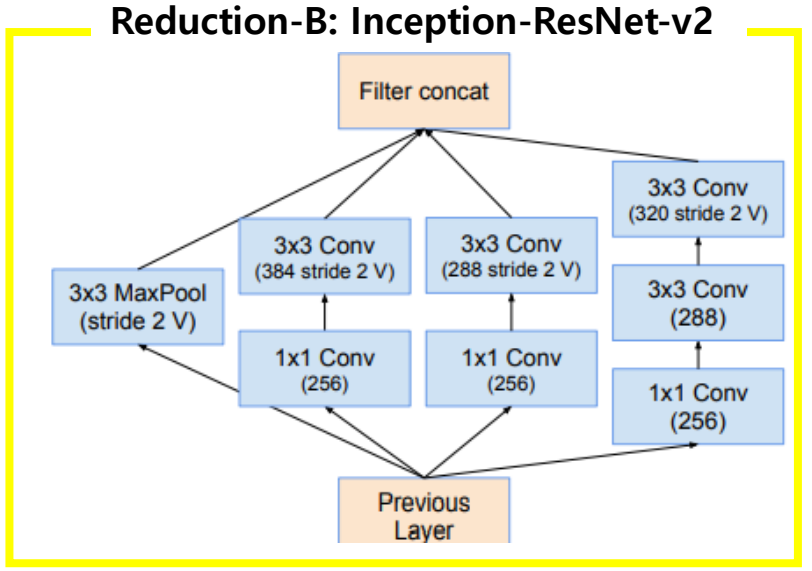










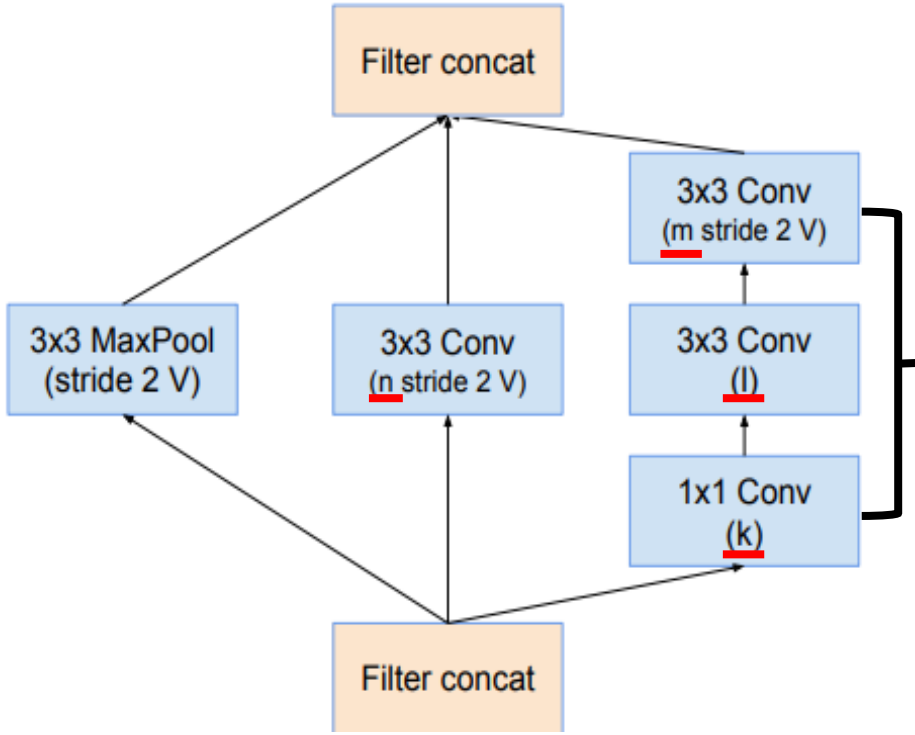
Inception-v4, Inception-ResNet and the Impact of Residual Connections on Learning (CVPR 2016)

- **Method:**
  - **Inception-ResNet-v1**: Inception-v3와 유사한 계산비용을 가진 하이브리드 버전
  - **Inception-ResNet-v2**: Recognition 성능이 크게 향상된 계산 비용이 많이 드는 하이브리드 버전
  - **Inception-v4**: Inception-ResNet-v2와 동일한 recognition 성능을 가진 Non-residual, pure Inception 버전

  *Residual Inception Blocks: 연산할 **파라미터 수를 줄이기** 위해 1x1 Conv를 먼저 진행해 입력 차원 수를 줄임

  *Activation Scaling: 잔차(Residual)를 Scaling해 **학습의 안정성을 높임**

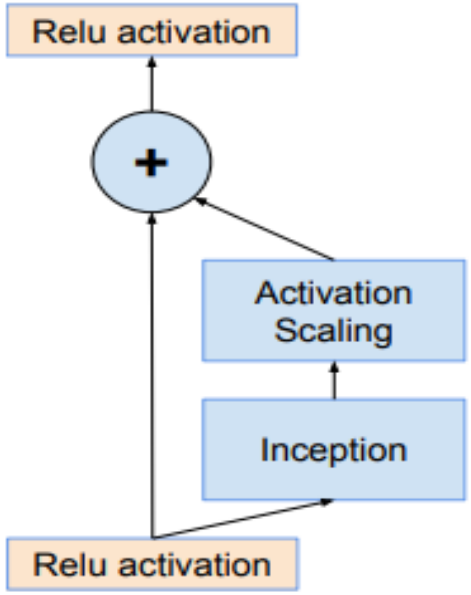
Reduction-A



Number of filters of the Reduction-A

Network	k	l	m	n
Inception-v4	192	224	256	384
Inception-ResNet-v1	192	192	256	384
Inception-ResNet-v2	256	256	384	384

Activation Scaling



Scaling Factor: 0.1 ~ 0.3
General Scaling Factor: 0.1

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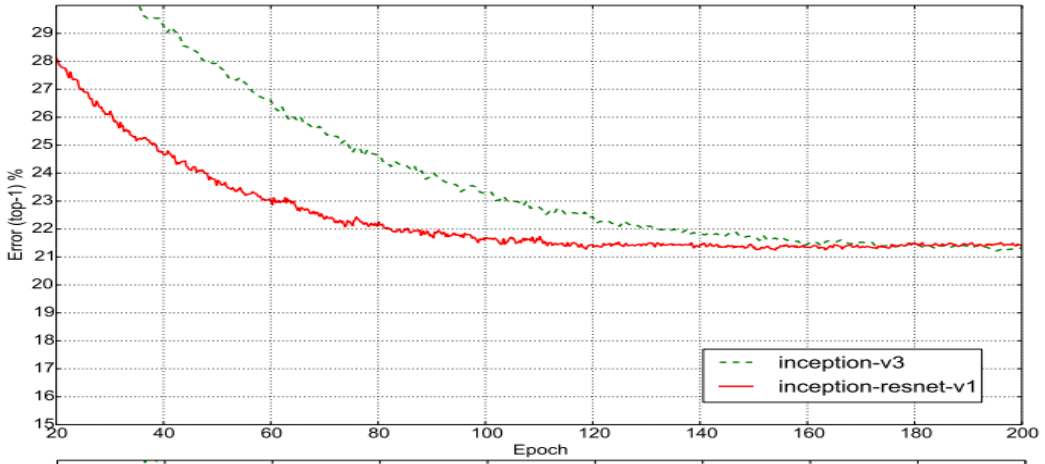
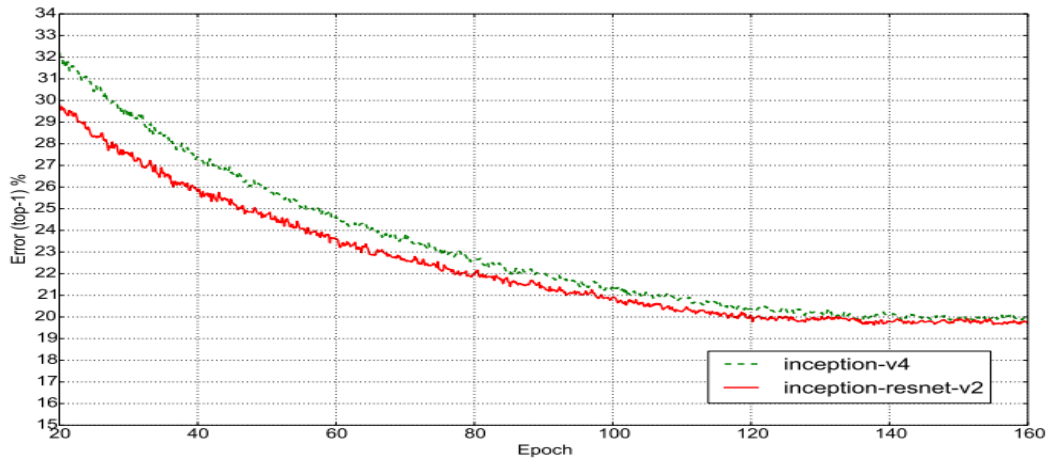
- **Experiment:**
  Residual connection의 도입으로 Inception 구조의 **학습속도가 향상**되고, 기존의 **성능을 능가**
  (계산 효율성 유지 + 학습 속도 향상)

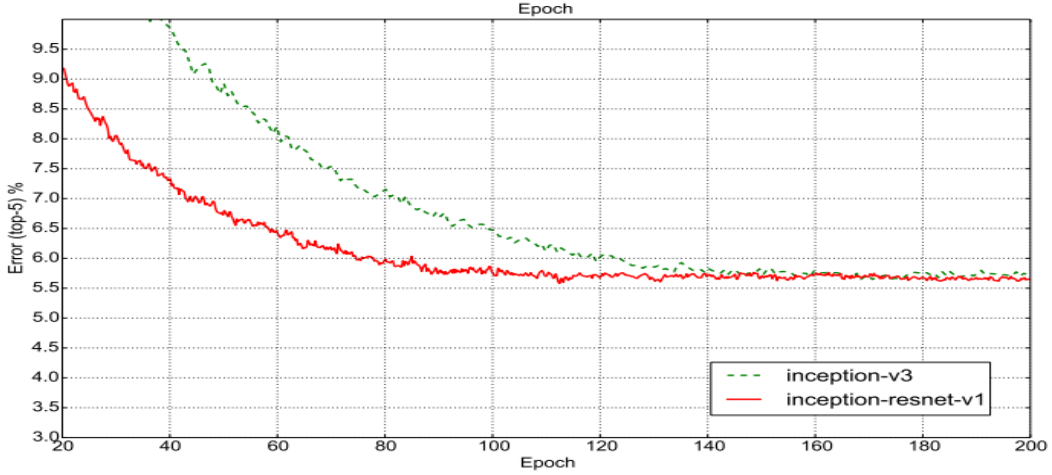
Top-1, -5 error measured on a single crop on the non-blacklist images of the ILSVRC-2012 validation set (Inception-v3 vs Inception-ResNet-v1), (Inception-v4 vs Inception-ResNet-v2)

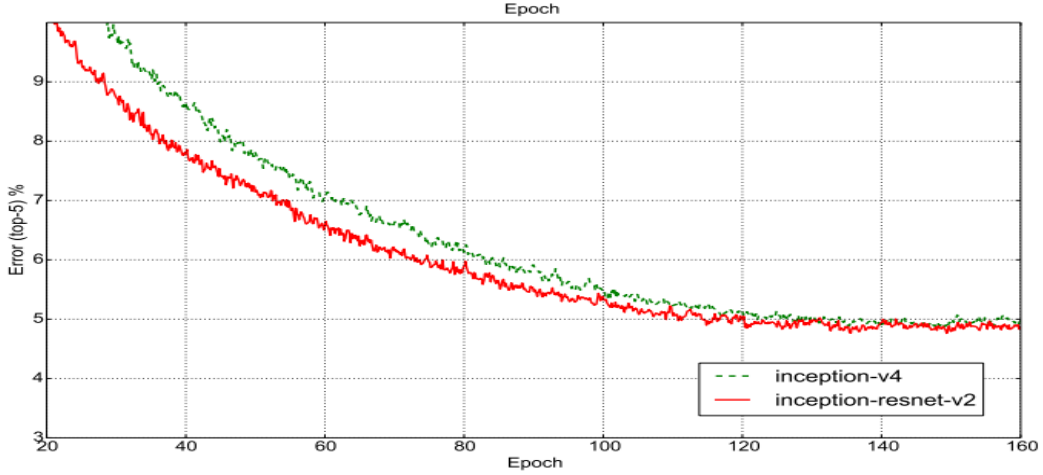
Top-1





Top-5





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  (계산 효율성 유지 + 학습 속도 향상)

Top-1, -5 error on the non-blacklisted subset of the validation set of ILSVRC 2012.

Network	Top-1 Error	Top-5 Error
BN-Inception [6]	25.2%	7.8%
Inception-v3 [15]	21.2%	5.6%
Inception-ResNet-v1	21.3%	5.5%
Inception-v4	20.0%	5.0%
Inception-ResNet-v2	19.9%	4.9%

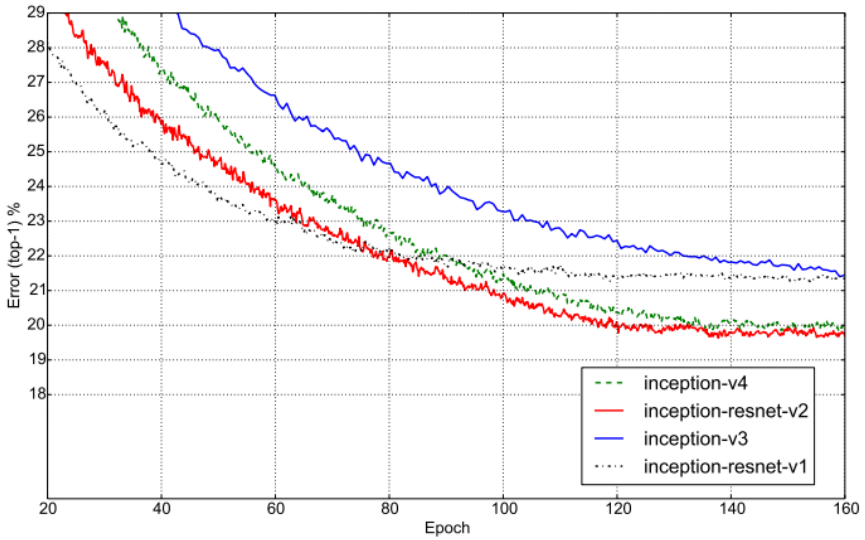
Best Performance

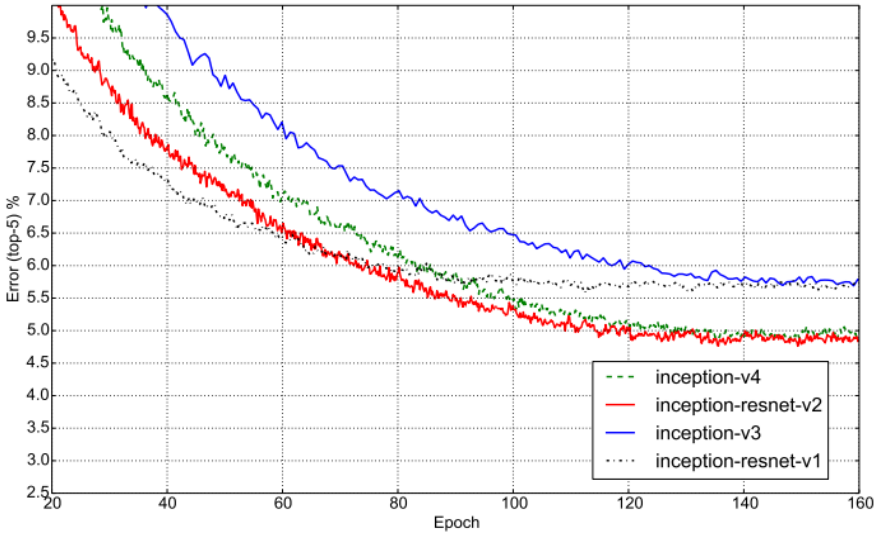
Ensemble results on all 50000 images of the validation set of ILSVRC 2012

Network	Models	Top-1 Error	Top-5 Error
ResNet-151 [5]	6	–	3.6%
Inception-v3 [15]	4	17.3%	3.6%
Inception-v4 + 3× Inception-ResNet-v2	4	16.5%	3.1%

Best Performance

Top-1, -5 error evolution of all four models (Single model, crop)





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- **Experiment:**
  Residual connection의 유무에 상관없이 모든 이전 네트워크 성능을 능가하는 모습을 보임 (**Inception-v4**)

Evaluation of various number of crop on all 50000 images of the validation set of ILSVRC 2012

Network	Crops	Top-1 Error	Top-5 Error
ResNet-151 [5]	10	21.4%	5.7%
Inception-v3 [15]	12	19.8%	4.6%
Inception-ResNet-v1	12	19.8%	4.6%
Inception-v4	12	18.7%	4.2%
Inception-ResNet-v2	12	18.7%	4.1%

Network	Crops	Top-1 Error	Top-5 Error
ResNet-151 [5]	dense	19.4%	4.5%
Inception-v3 [15]	144	18.9%	4.3%
Inception-ResNet-v1	144	18.8%	4.3%
Inception-v4	144	17.7%	3.8%
Inception-ResNet-v2	144	17.8%	3.7%

한줄평: ResNet의 이점과 Inception의 이점을 합쳐 성능이 향상하는지 확인하는 논문으로, Residual connection의 도입으로 **model의 수렴이 더 빠른 결과**를 보이지만, 성능 평가 결과 그렇게 **필수적이지 않다**는 모습을 보임