

Dual Path Network and Its Applications

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Thank Min Lin, Qiang Chen from Qihoo 360 for the extensive discussions.
Thank Xiaoli Liu, Ying Liu from Qihoo 360 for helping collect and annotate "external" data.

Results Overview

- **Object Localization**

- a) with "provided" data: **1st place** (Loc Error: 6.23%)
- b) with "external" data: **1st place** (Loc Error: 6.19%)

- **Object Detection**

- a) with "provided" data: **2nd place** (by mAP: 65.8%)
- b) with "external" data: **2nd place** (by mAP: 65.8%)

- **Object Detection from video (VID)**

- a) with "provided" data: **2nd place** (by mAP: 75.8%)
- b) with "external" data: **2nd place** (by mAP: 76.0%)



Dual Path Networks (DPN)



arXiv Preprint

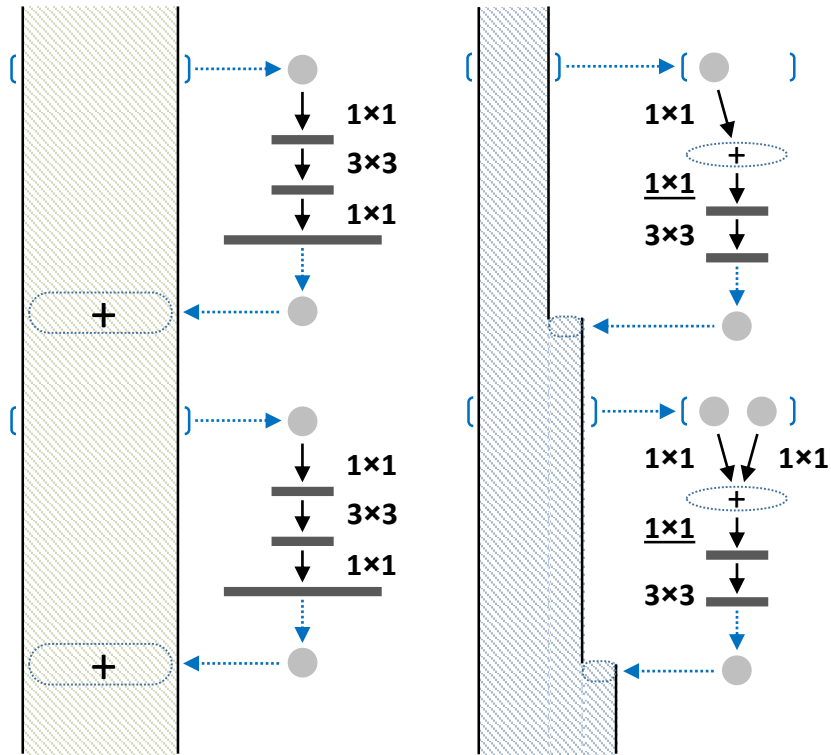
<https://arxiv.org/abs/1707.01629>



Code & Trained Models

<https://github.com/cypw/DPNs>

Motivation

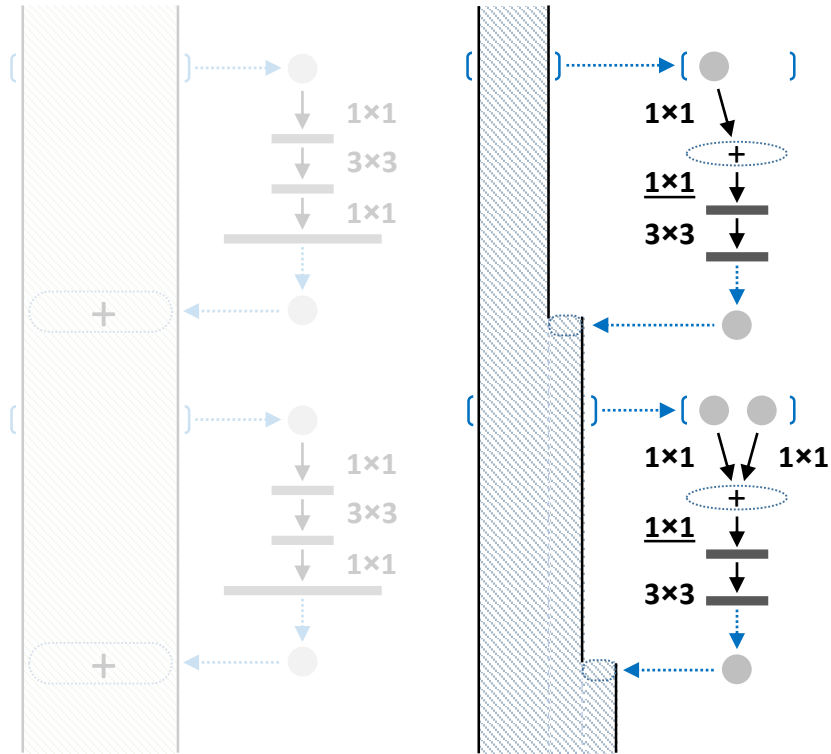


(a) Residual Network

(b) Densely Connected Network [1]

* Here, a 1×1 convolutional layer (underlined) is added for consistency with the micro-block design in (a).

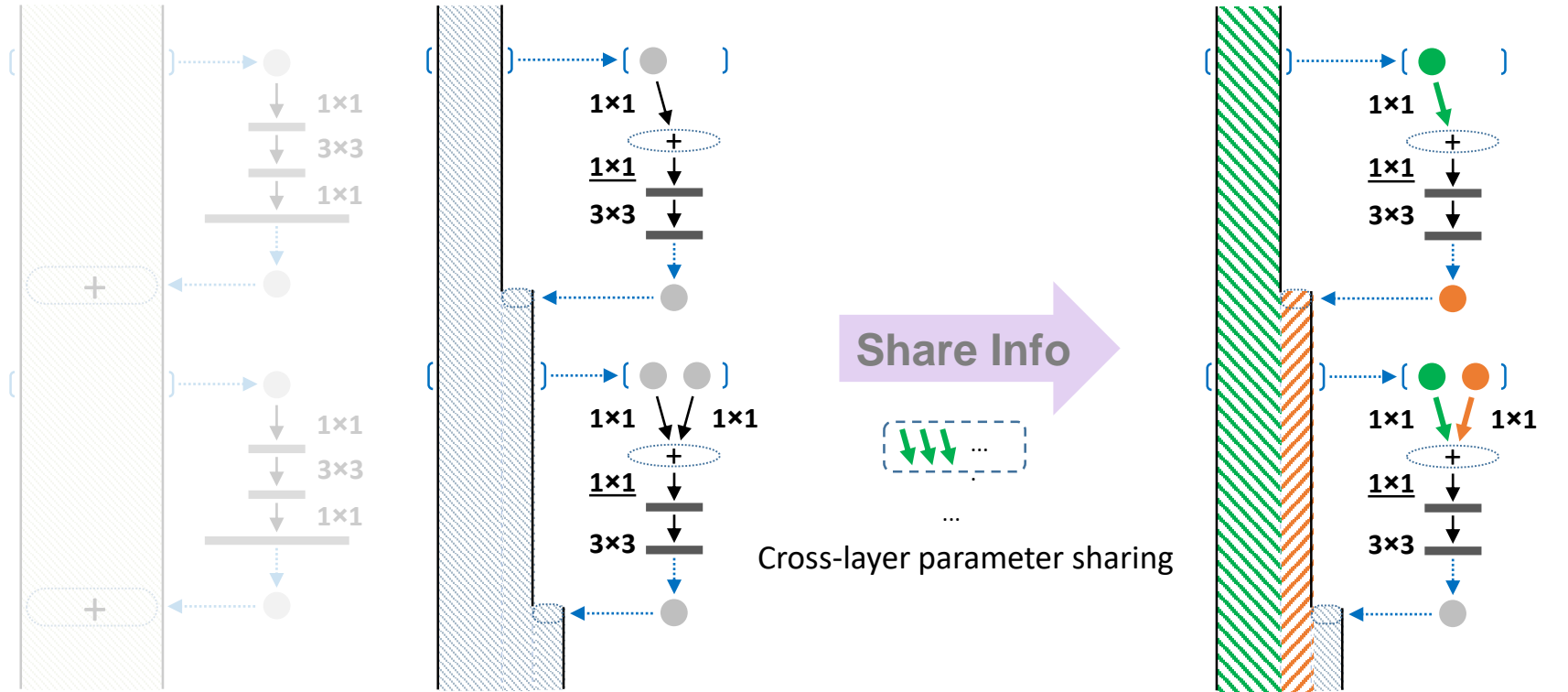
Motivation



(a) Residual Network

(b) Densely Connected Network [1]

Analysis



(a) Residual Network

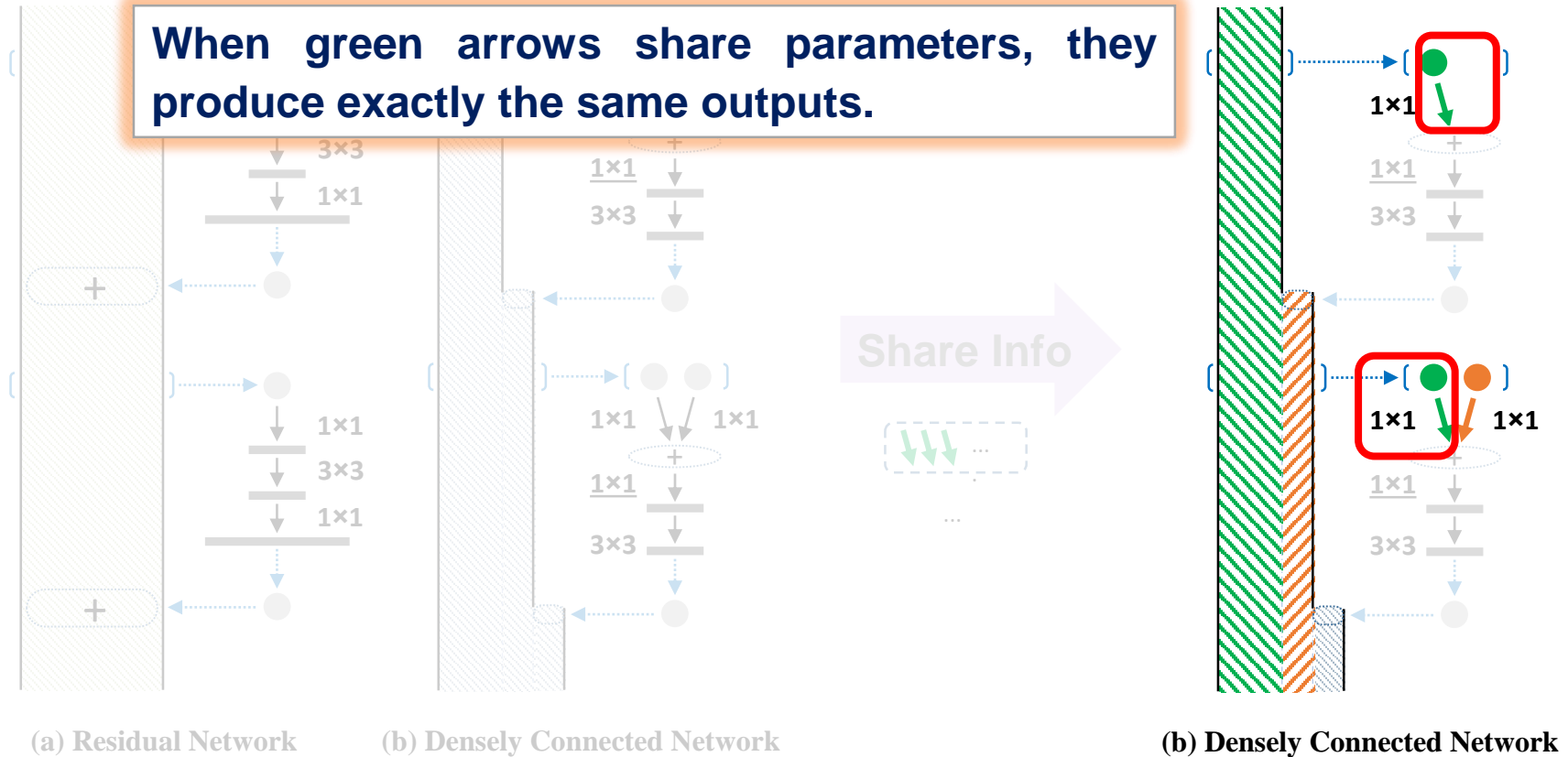
(b) Densely Connected Network

(b) Densely Connected Network



Analysis

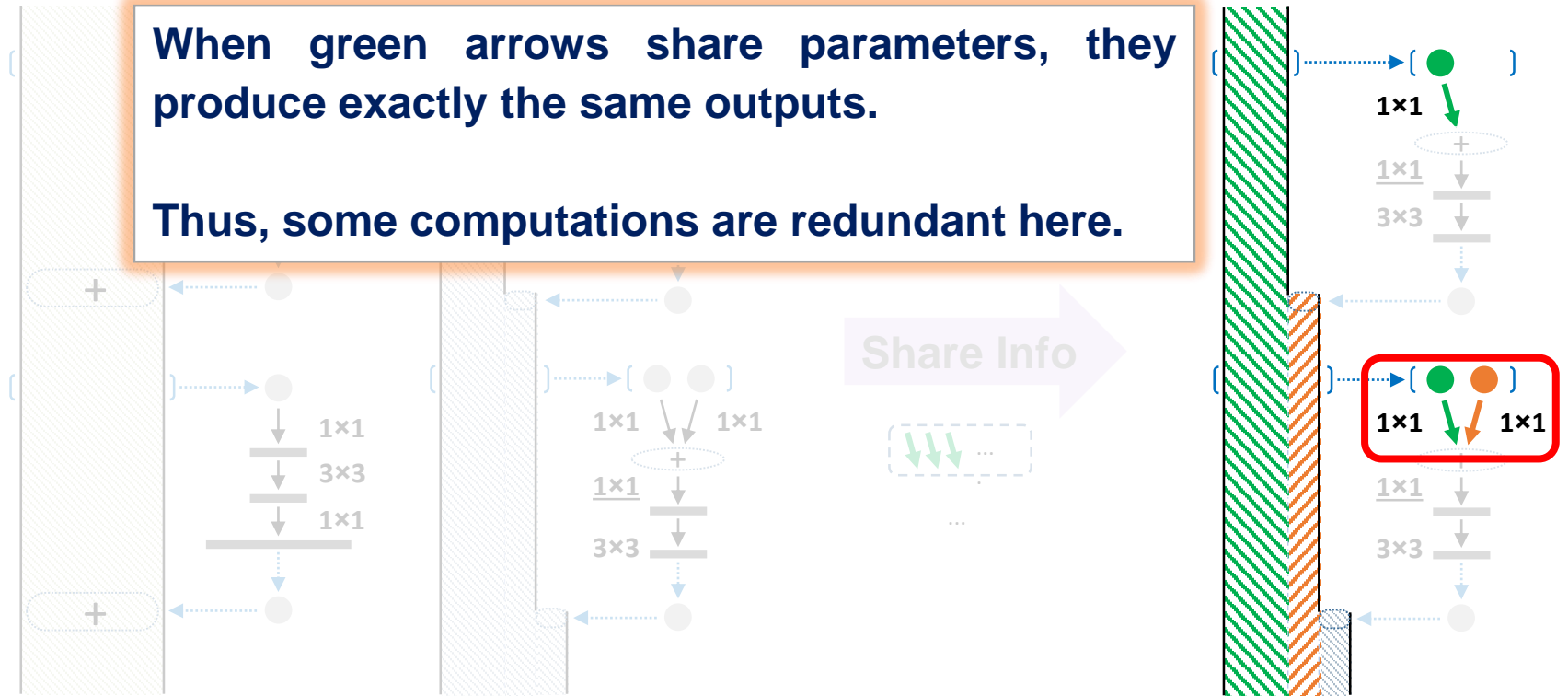
When green arrows share parameters, they produce exactly the same outputs.



Analysis

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Thus, some computations are redundant here.



(a) Residual Network

(b) Densely Connected Network

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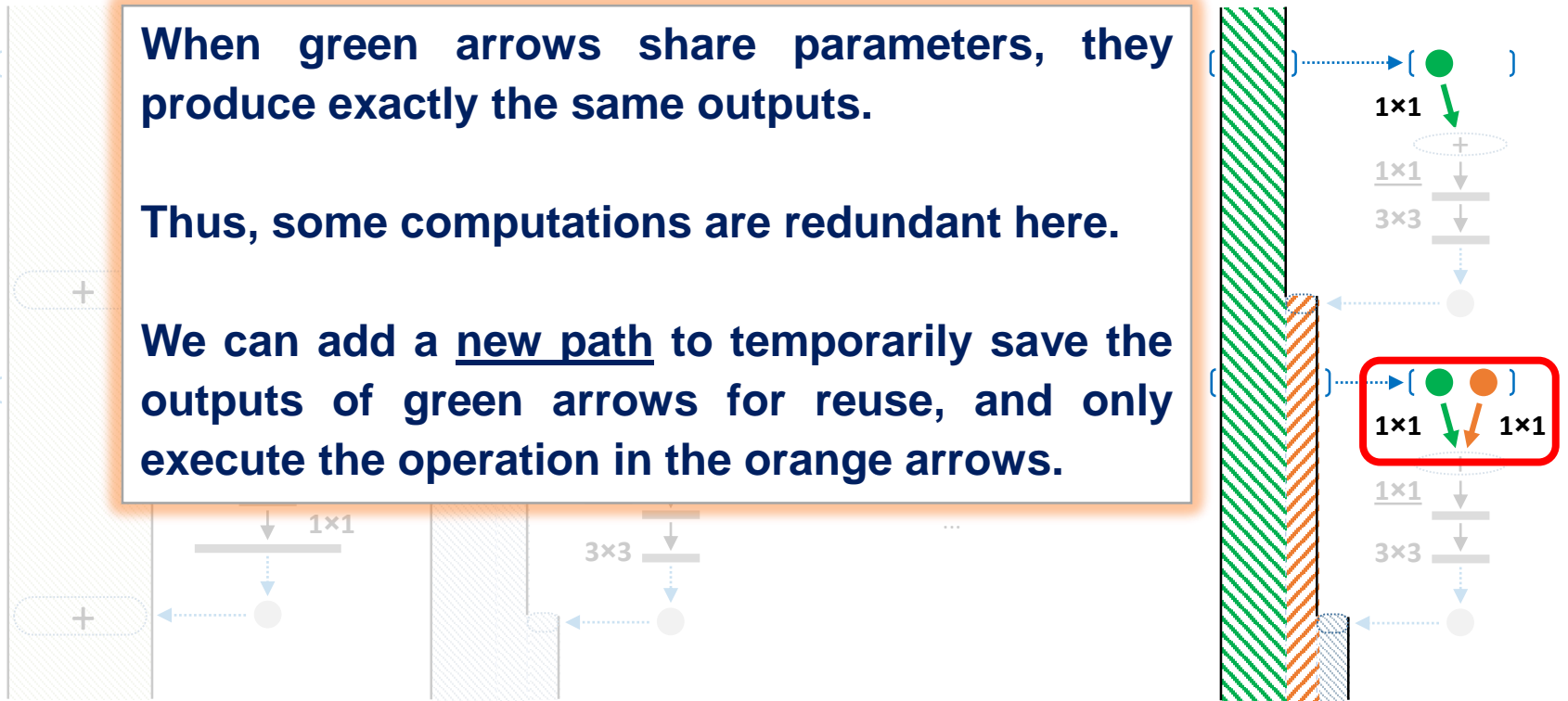


Analysis

When green arrows share parameters, they produce exactly the same outputs.

Thus, some computations are redundant here.

We can add a new path to temporarily save the outputs of green arrows for reuse, and only execute the operation in the orange arrows.



(a) Residual Network

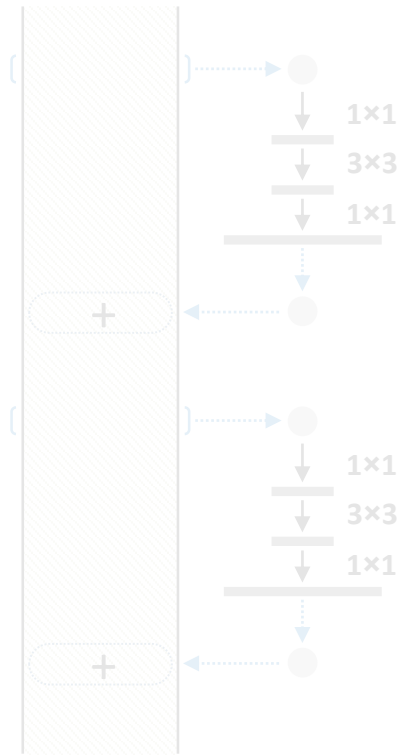
(b) Densely Connected Network

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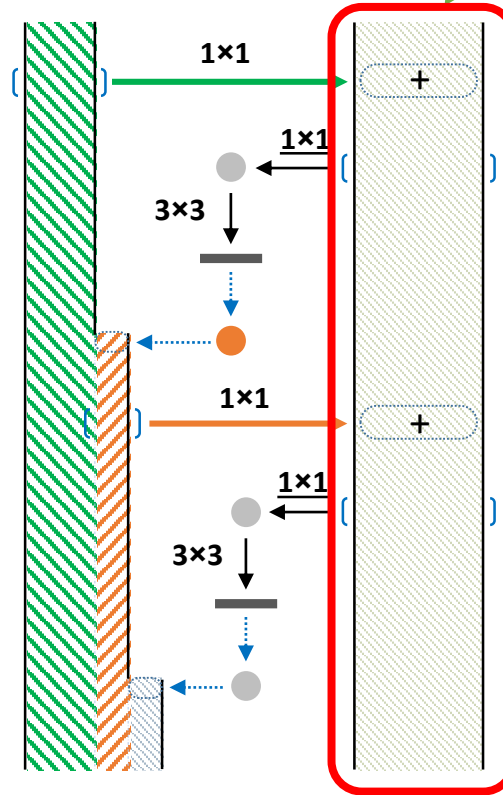


Analysis

A new path to temporarily save the outputs from the green arrows for reuse.

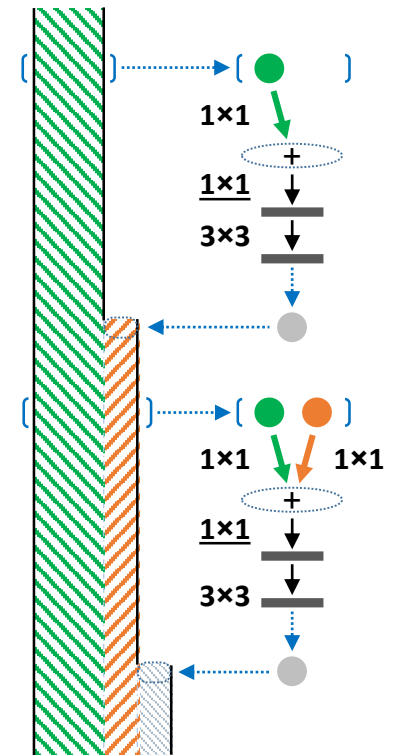


(a) Residual Network



(c) Densely Connected Network
(with shared connections)

Simplify

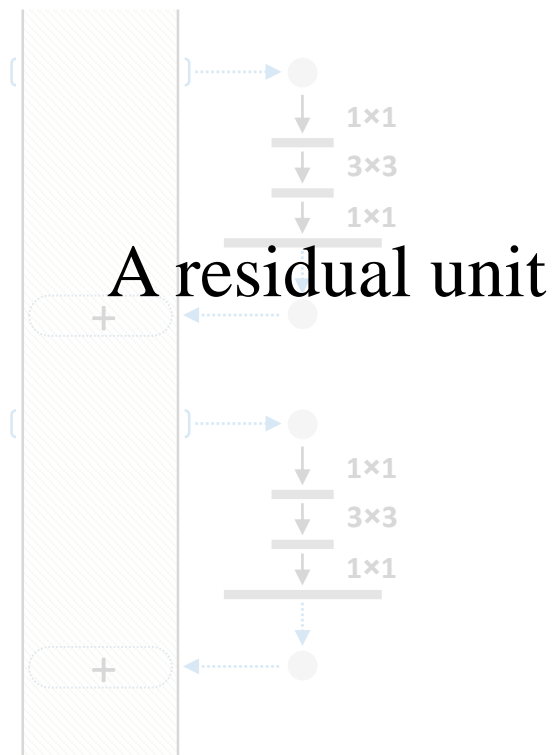


(b) Densely Connected Network

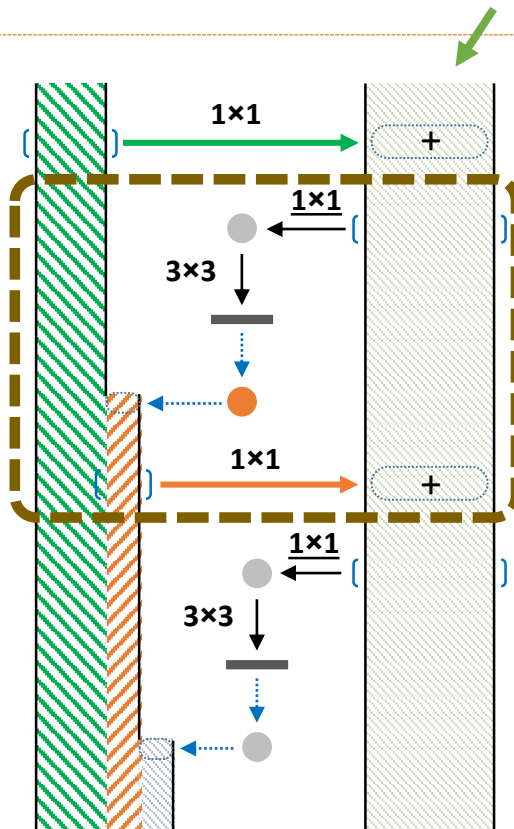


Analysis

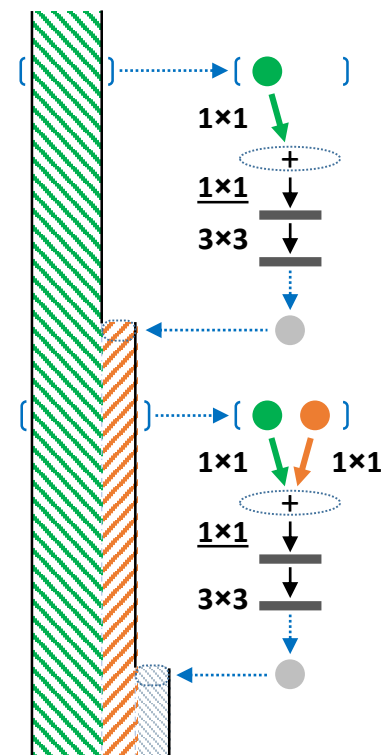
A new path to temporarily save the outputs from the green arrows for reuse.



(a) Residual Network



(c) Densely Connected Network
(with shared connections)

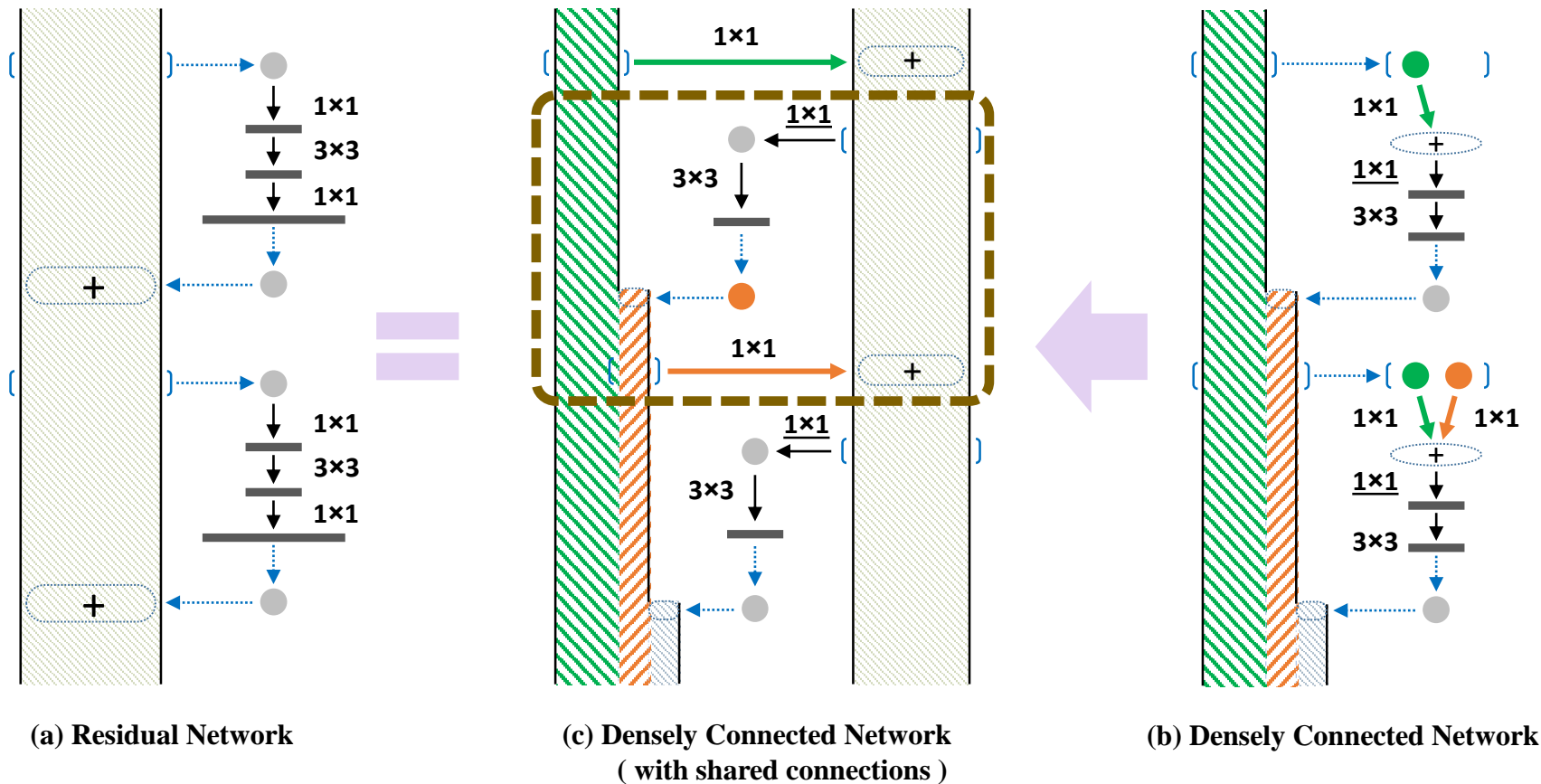


(b) Densely Connected Network

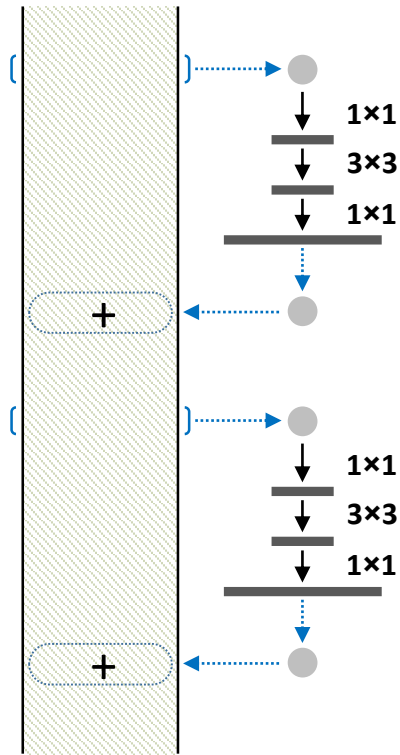


Analysis

A new path to temporarily save the outputs from the green arrows for reuse. (Residual Path)

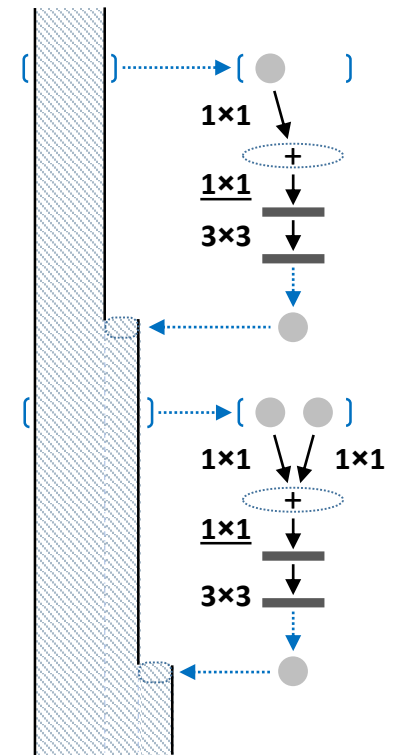


Analysis



(a) Residual Network

Cross-layer parameter sharing

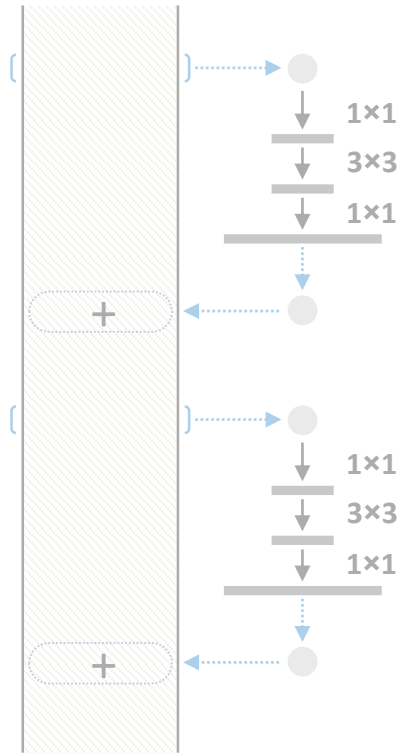
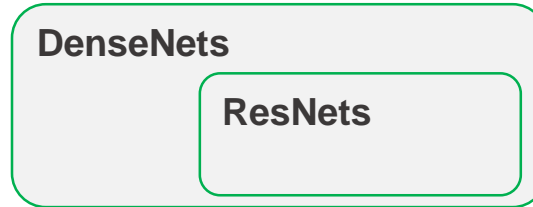


(b) Densely Connected Network

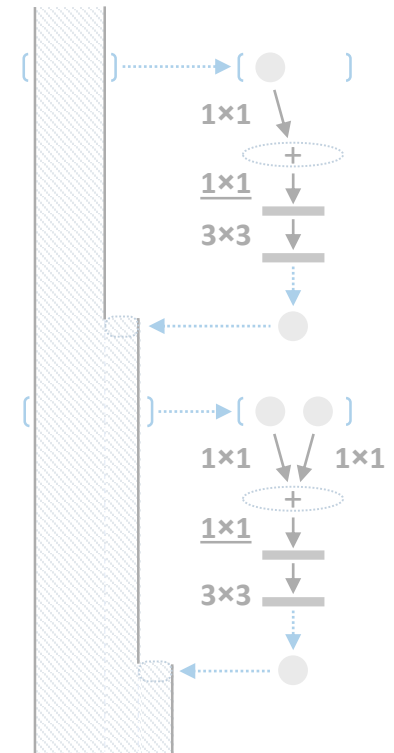


Analysis

- Residual Networks are essentially Densely Connected Networks but with shared connections.

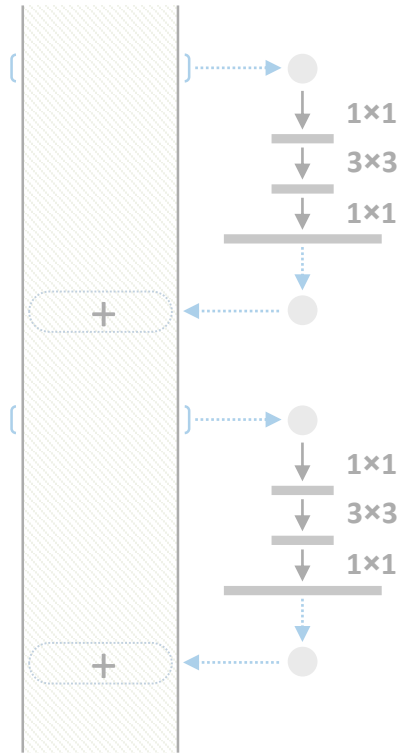


(a) Residual Network



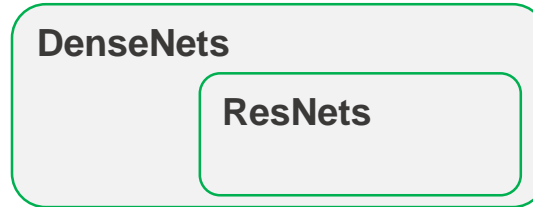
(b) Densely Connected Network

Analysis

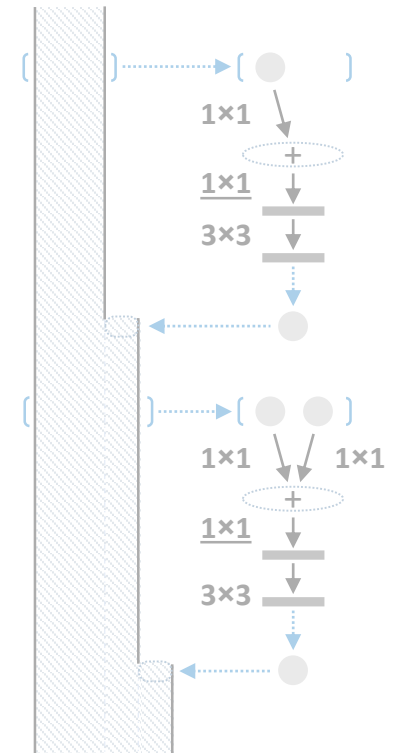


(a) Residual Network

- Residual Networks are essentially Densely Connected Networks but with shared connections.



- Advantage:
 - ResNet: features refinement (reuse feature)
 - DenseNet: keep exploring new features

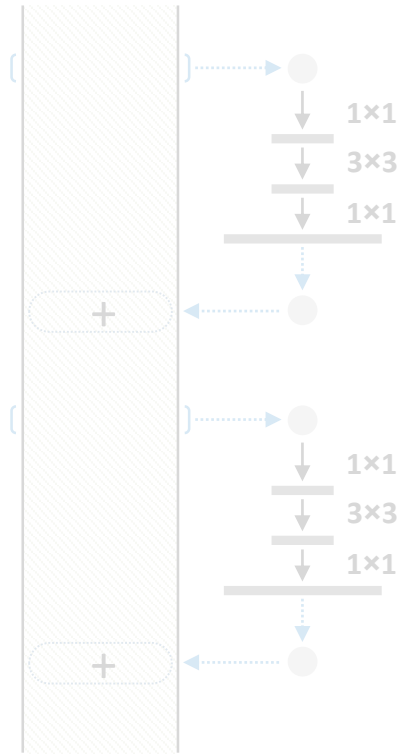


(b) Densely Connected Network

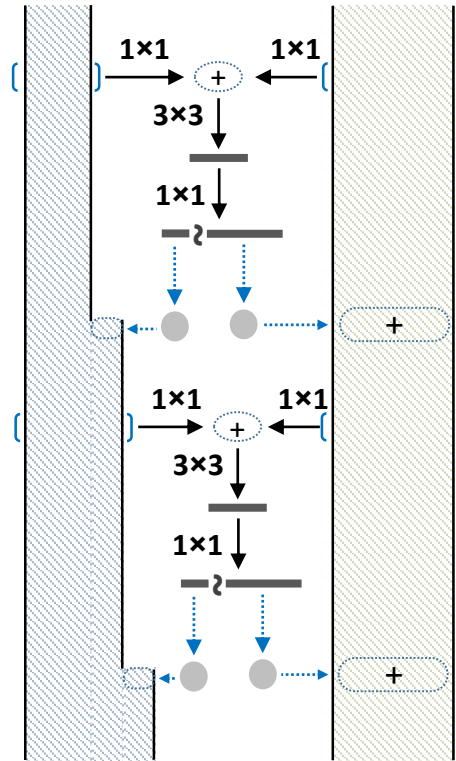
Dual Path Architecture



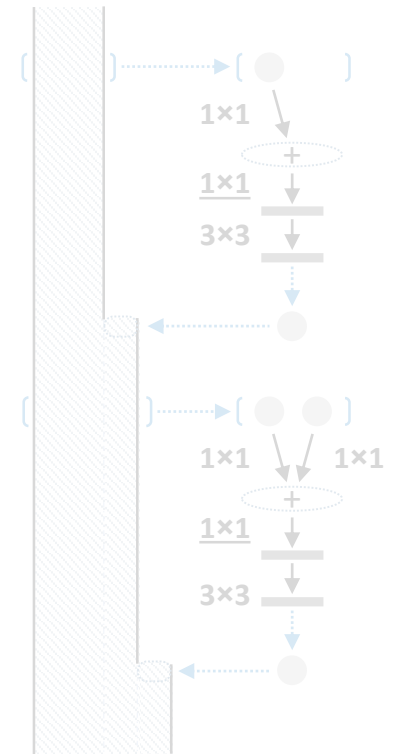
Dual Path Architecture



(a) Residual Network



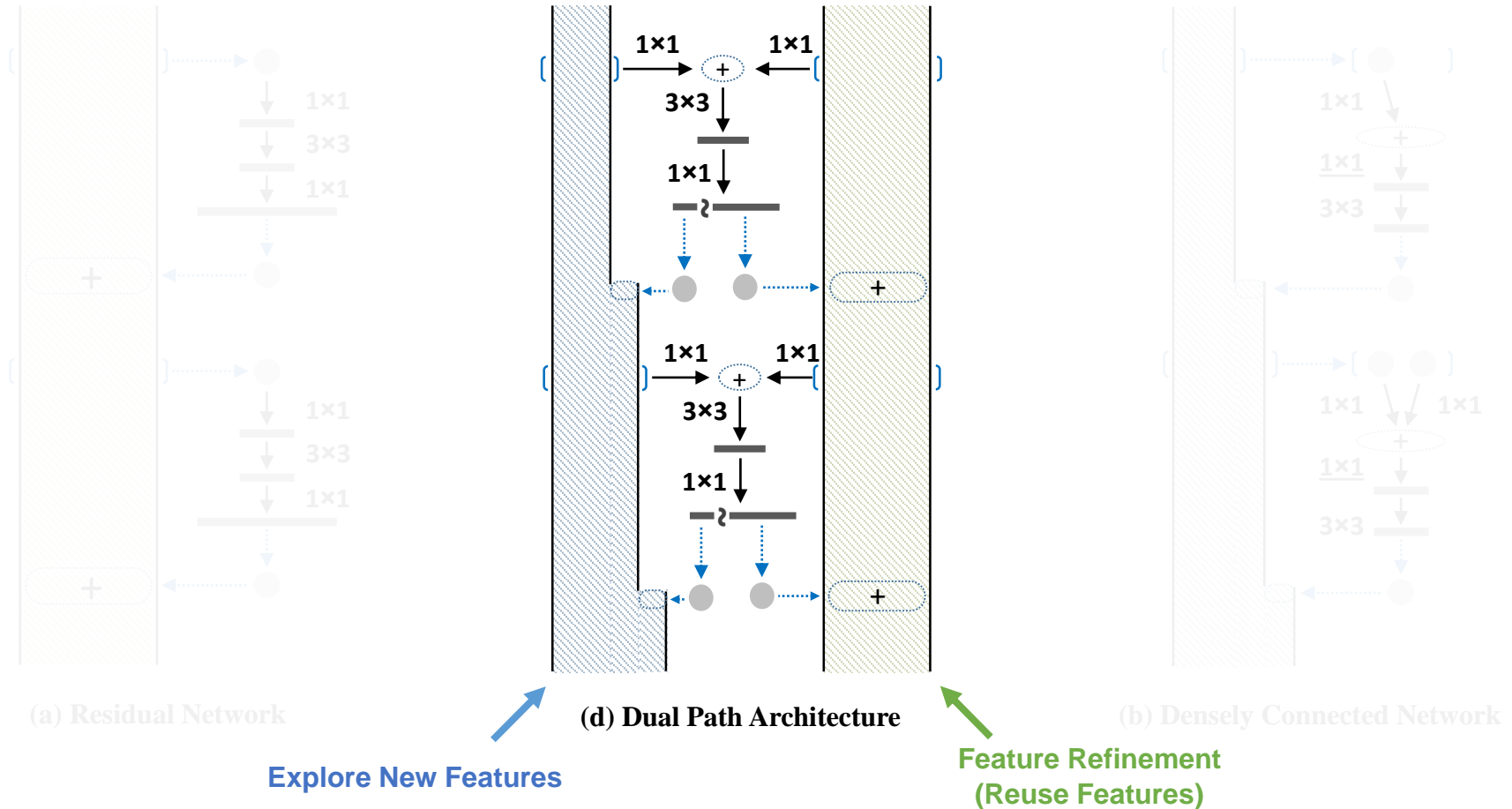
(d) Dual Path Architecture



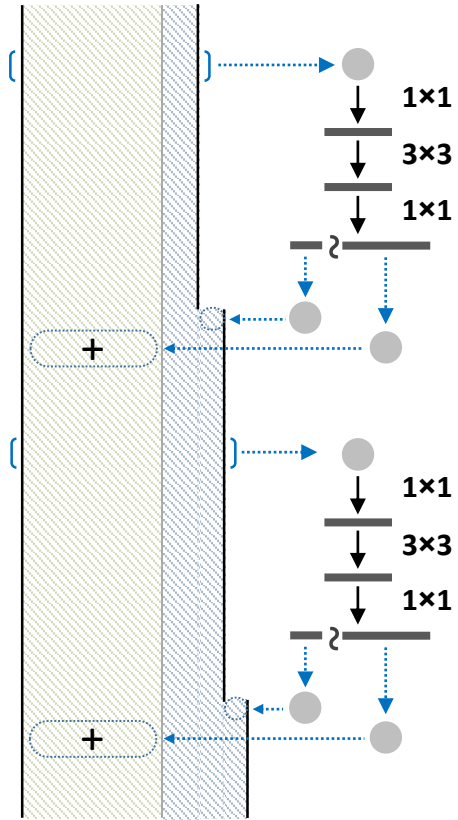
(b) Densely Connected Network



Dual Path Architecture



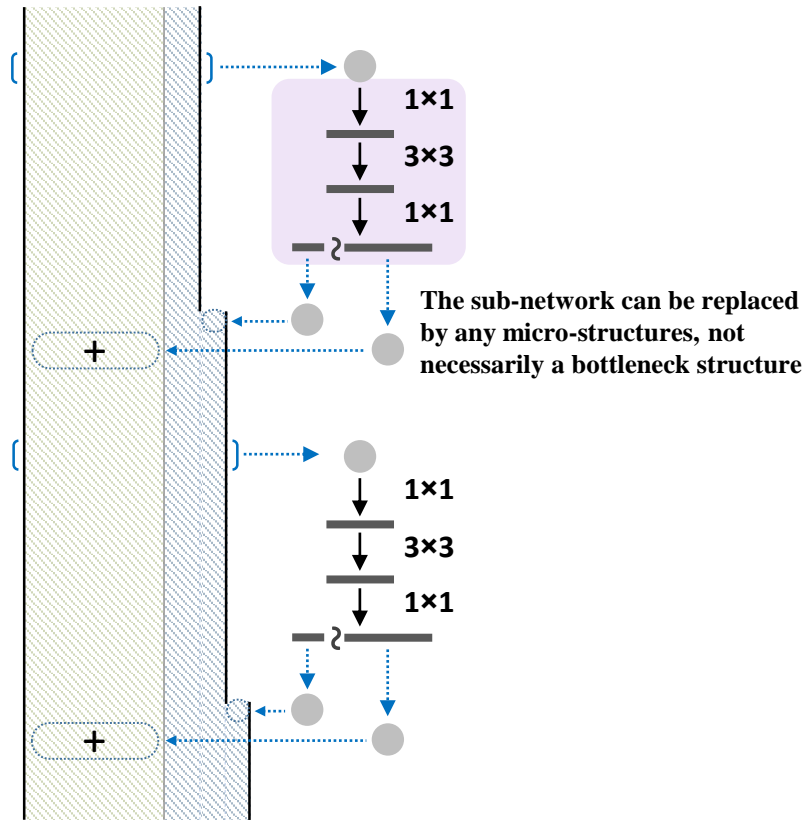
Dual Path Networks



(e) DPN



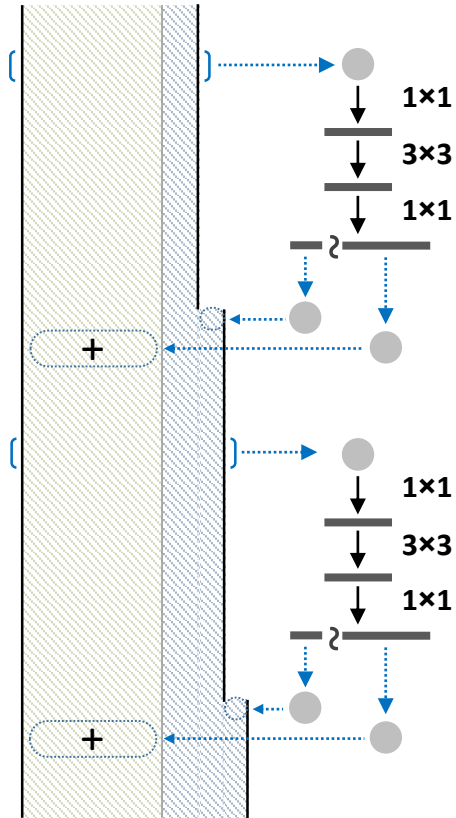
Dual Path Networks



(e) DPN

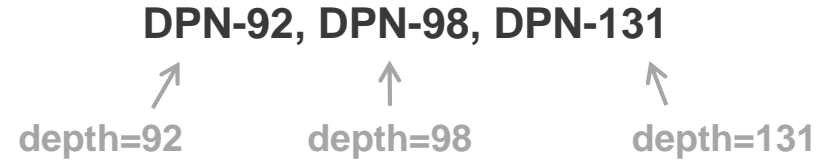


Dual Path Networks

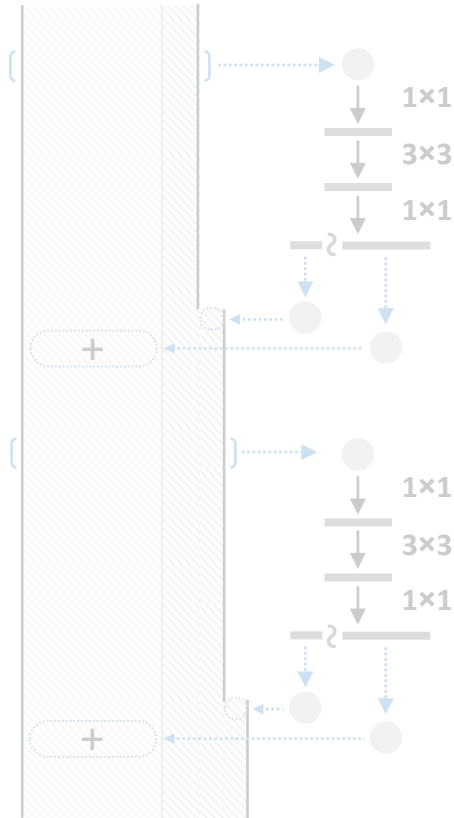


(e) DPN

- Three DPNs are designed:



Dual Path Networks



(e) DPN

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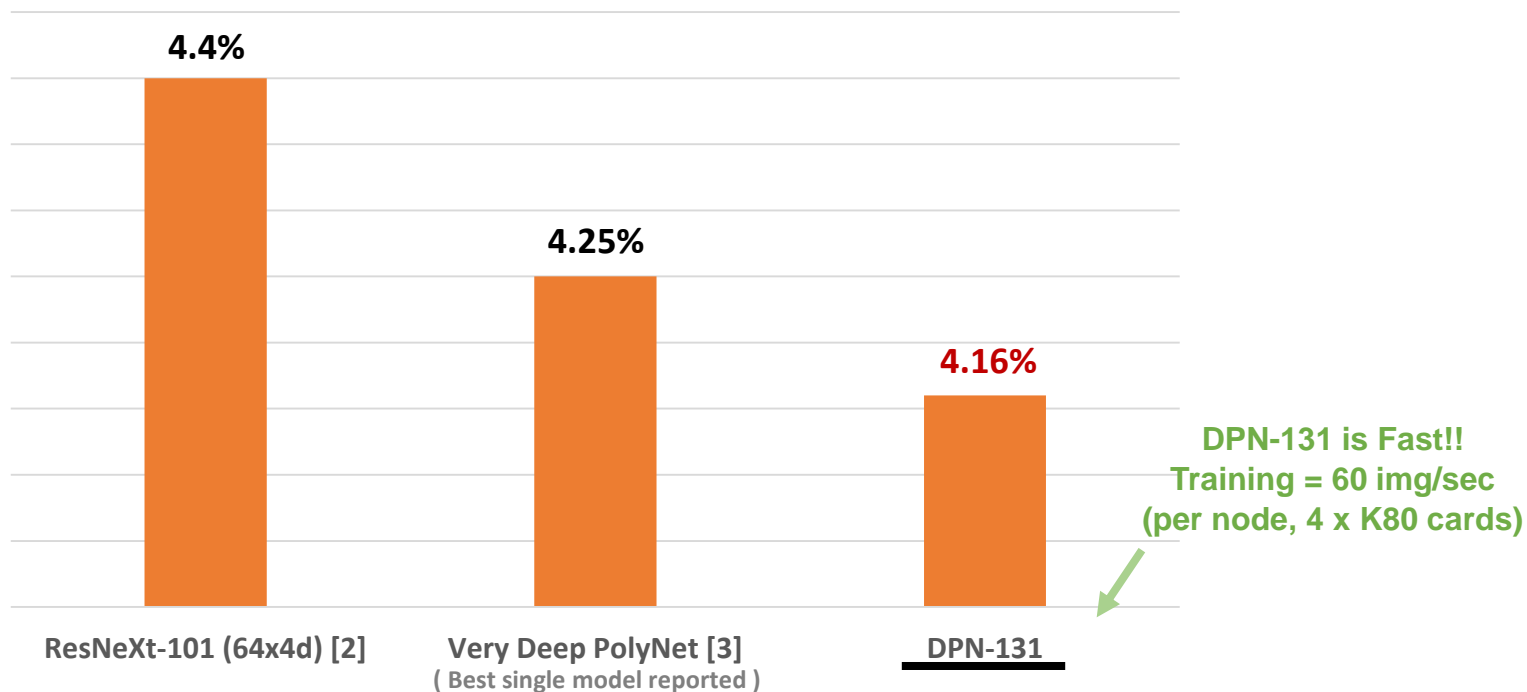
DPN-92, DPN-98, DPN-131
 ↗ depth=92 ↗ depth=98 ↗ depth=131

ResNeXt-101 (64x4d) [2]		DPN-98	
320 MB	Model Size	236 MB	- 26%
15.5	GFLOPs	11.7	- 25%
12.1 GB	GPU Memory	11.1 GB	- 8%
20.4 / 5.3	Top 1 / Top 5 Error.	20.2 / 5.2	

* Testing scale: x224 / Batch Size: 32 per GPU

Performance

Single model, Single center-crop, Top-5 val error rate

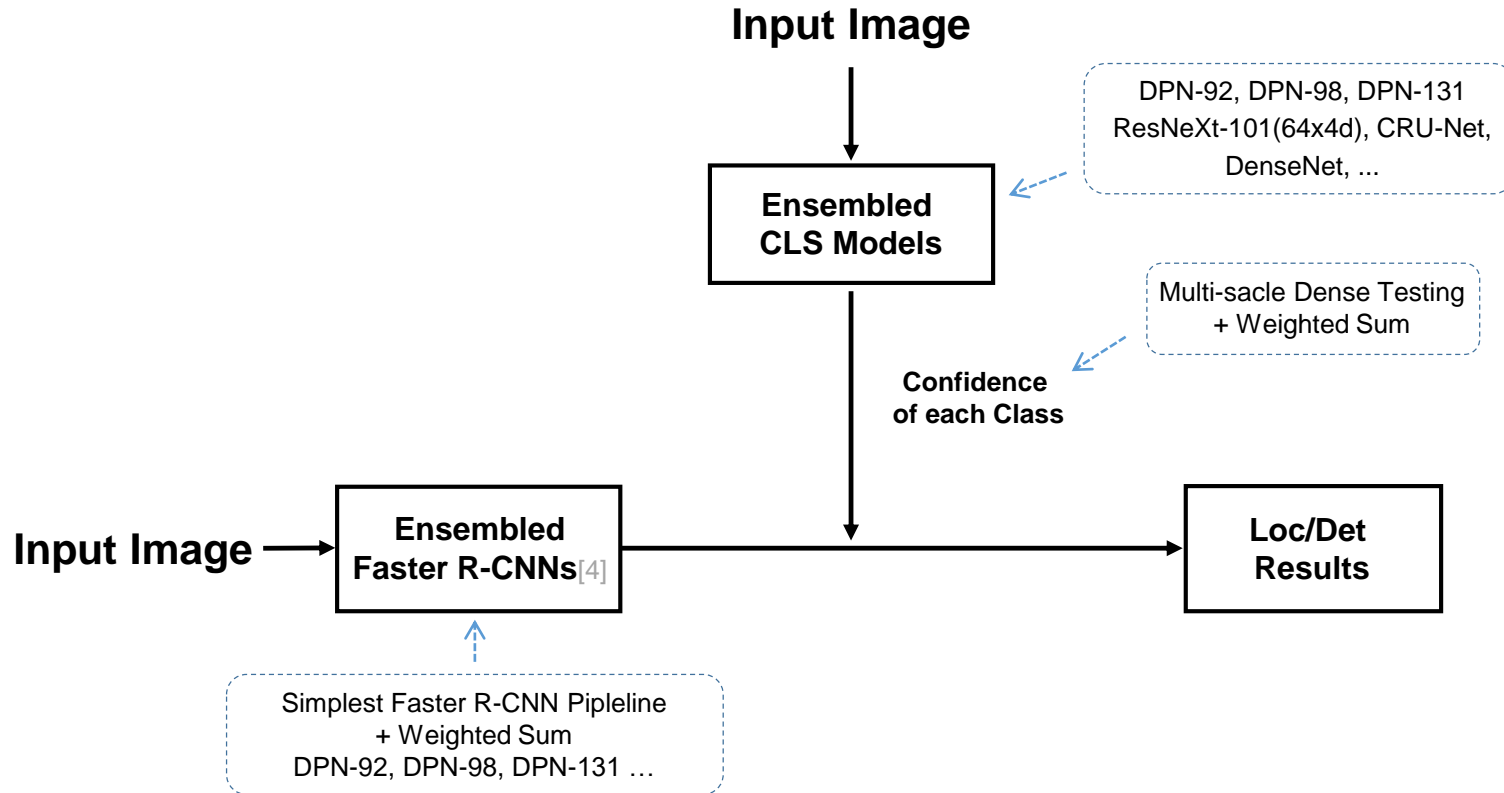


*Testing scale: x299 / x320

ILSVRC 2017

ILSVRC 2017: Object Localization & Detection

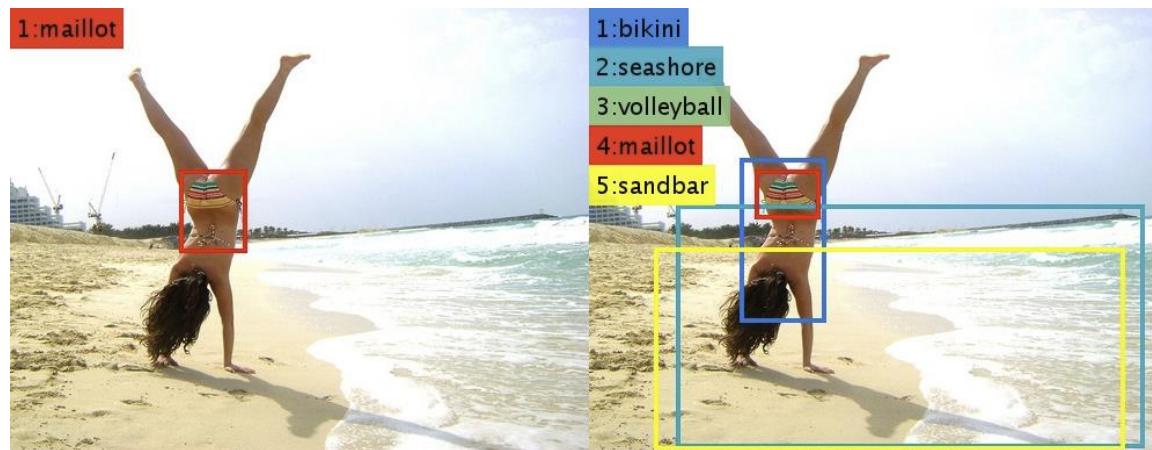
- **Main Framework:**



[4] S Ren, et al. "Faster R-CNN: Towards real-time object detection with region proposal networks." NIPS. 2015

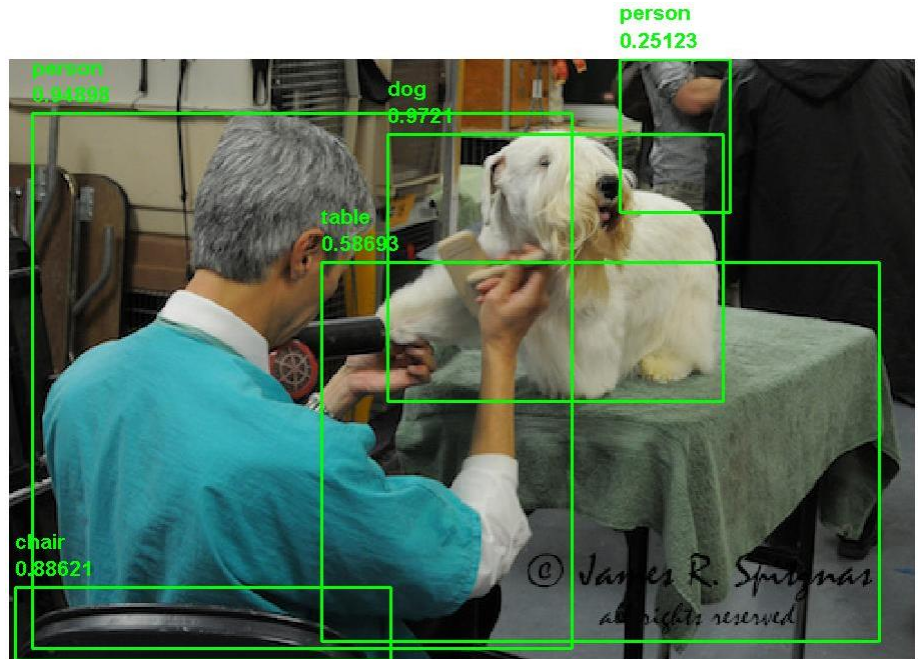
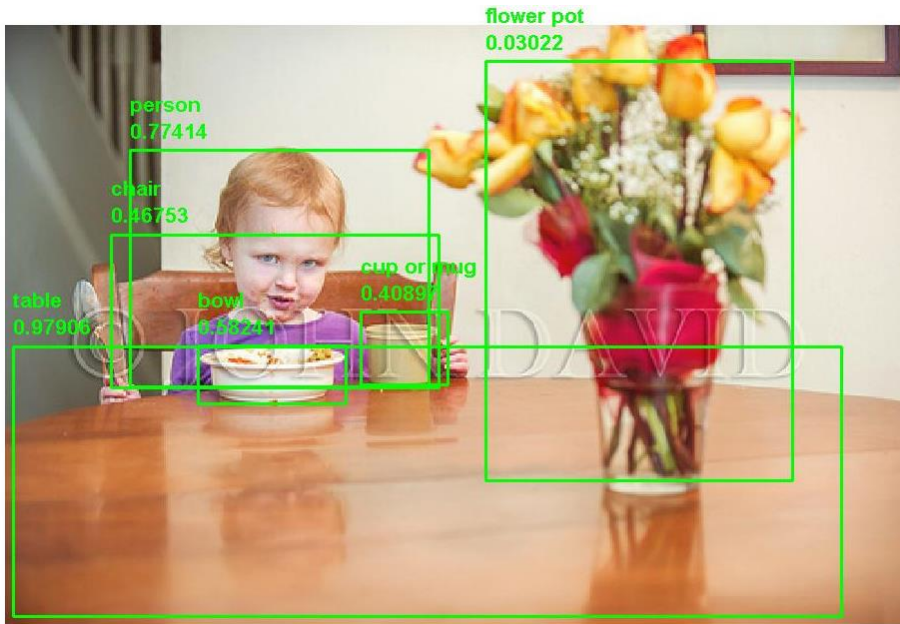
ILSVRC 2017: Object Localization

- Visualization:



ILSVRC 2017: Object Detection

- Visualization:



Thank You!

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Q & A