

## Machine Learning Reading Assignment - 2

The reference paper name :

**ResNet:** He et al., Deep Residual Learning for Image Recognition, CVPR 2016 (best paper)

### Summary:

- The paper addresses the degradation problem in very deep neural networks, where adding more layers can cause higher training error.
- It proposes a residual learning framework where instead of learning the underlying mapping  $H(x)$ , the stacked layers learn the residual mapping  $F(x) = H(x) - x$ .
- This is implemented using shortcut connections that add the identity mapping of the input  $x$  to the output  $F(x)$ .
- The residual formulation makes it easier to optimize very deep networks. Identity shortcuts don't add complexity.
- They achieve excellent results on ImageNet classification with 152-layer ResNet, surpassing prior state-of-the-art using VGG nets.
- Analysis shows ResNets have smaller response magnitudes than plain nets, and accuracy continues increasing with depth.
- ResNets generalize well to other tasks like object detection on PASCAL VOC and MS COCO.

### Pros:

- Simple yet effective way of enabling training of very deep networks by reformulating as residual learning.
- Identity shortcuts provide a clean way of implementing residual learning without extra parameters.
- Achieves state-of-the-art results on ImageNet with substantially increased depth yet lower complexity.
- Provides both empirical evidence and some theoretical analysis of residual learning.
- Generalizable approach that also achieves good gains on other vision tasks like object detection.

### Cons:

- Lacks more detailed analysis of why residual learning alleviates optimization difficulties.
- Main focus is on empirical evidence, less on new theoretical insights.
- Shortcut connections had been explored in prior works, but residual learning formulation is new.
- Issues training extremely deep 1000+ layer networks, suggesting scope for improvement.
- Limited investigation of other shortcut functions besides identity mapping.

