

CAM-family Methods: Evolution of Class Activation Mapping

Evolution: CAM → Grad-CAM → Grad-CAM++ → Score-CAM → Layer-CAM



CAM

2016
Global average pooling
required



Grad-CAM

2017
Any CNN architecture



Grad-CAM++

2018
Better localization



Score-CAM

2020
Gradient-free



Layer-CAM

2021
Layer-wise mapping

Key Methods



CAM

Global average pooling + linear layer weights

$$L_{CAM} = \sum w_k \cdot A_k$$



Grad-CAM

Gradient-weighted class activation

$$L = \text{ReLU}(\sum \alpha_k \cdot A_k), \alpha_k = 1/Z \sum_i \sum_j \partial y^c / \partial A_k^{ij}$$



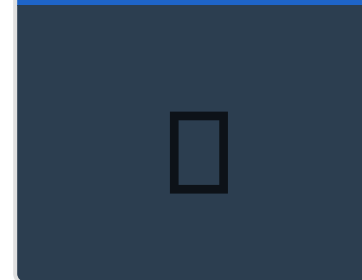
Score-CAM

Ablation-based, no gradients needed

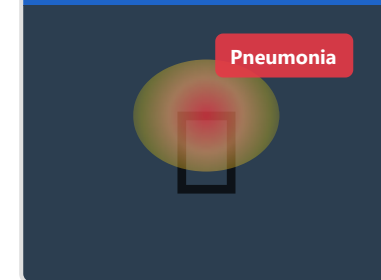
$$L = \text{ReLU}(\sum w_k \cdot A_k), w_k \text{ from forward pass}$$

Application: Medical X-ray

Original X-ray



Grad-CAM Heatmap



Key Applications

- ▶ **Medical Imaging:** Pathology localization
- ▶ **Object Detection:** Region proposals
- ▶ **Segmentation:** Boundary refinement
- ▶ **Quality Control:** Defect detection

Best for:	CNNs, visual tasks
Advantage:	Fast computation
Limitation:	CNN-specific