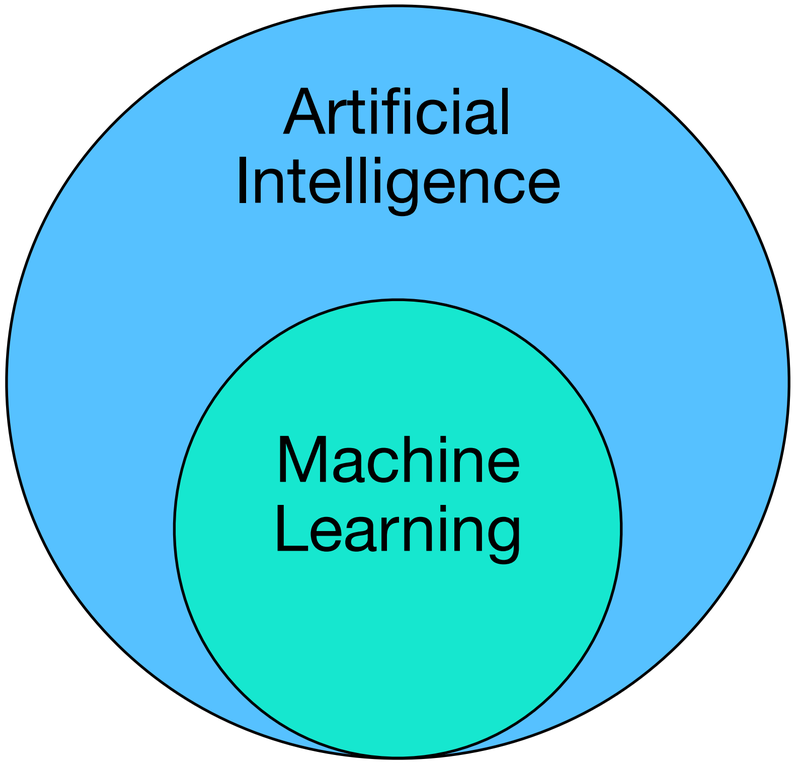
Data Augmentation for Segmentation

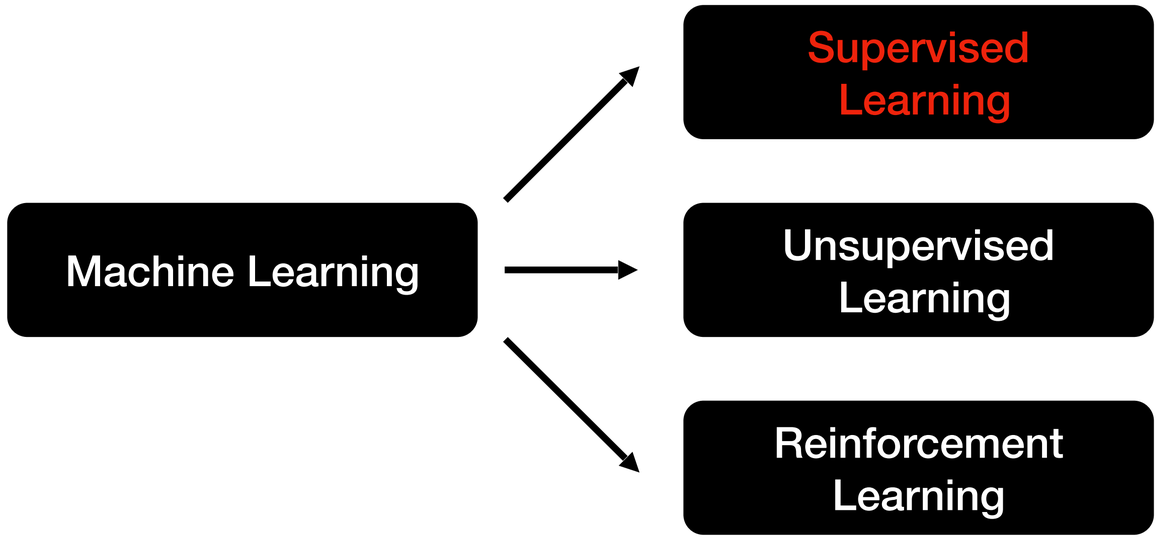
Research and Presentation Methods

Parsa Toopchinezhad - Dr. Torkashvand - Fall 2023

Table of Contents

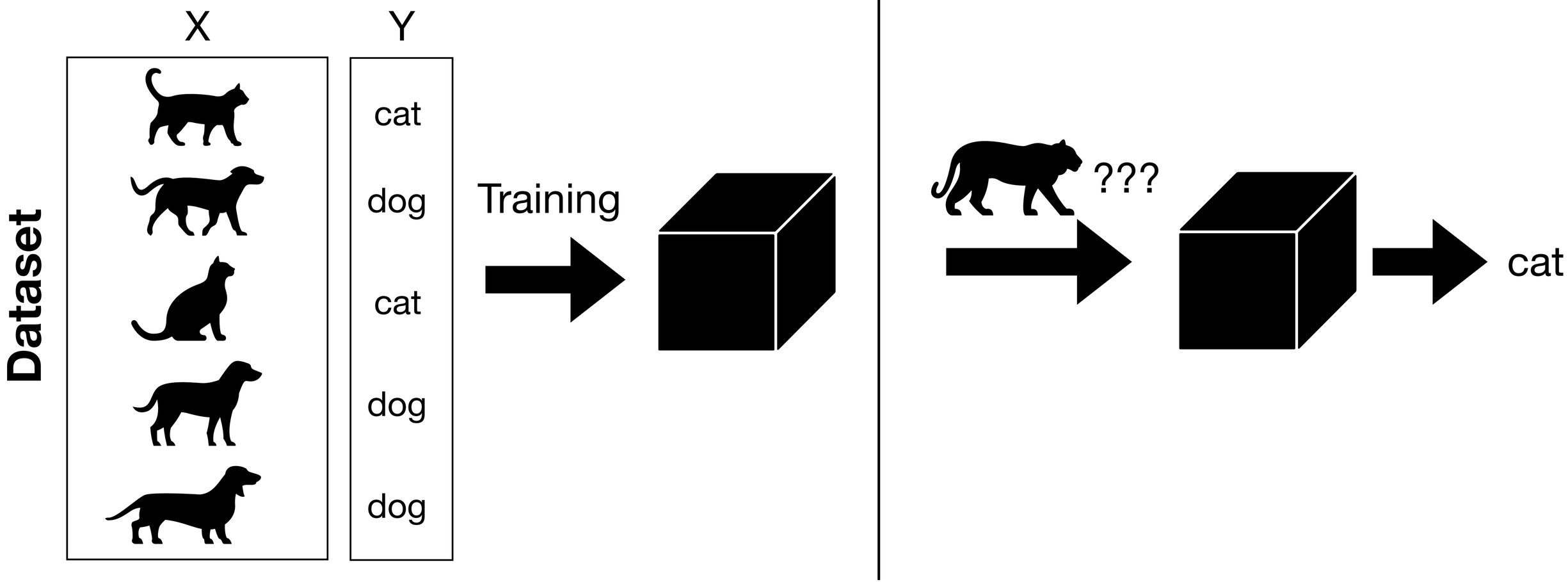
What is Machine Learning





The Supervised Learning Problem

The Most Used Subset in ML



Types of Data

Image Processing

- Tumor Detection
- Waste Classification
- Self Driving Cars

Images

Dataset Types

Natural Language Processing

- Question Answering
- Text Summarization
- Sentient Analysis

Text

Signal Processing

- Voice to Text
- Heartbeat
- EEG

Signals

Image Processing Tasks

Is this a dog?

Image classification

Classify object

Where are the animals in this image?

Object Detection

Bounding Box

Which pixels belong to which object?

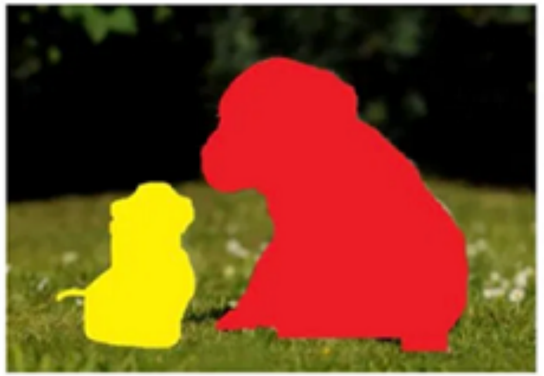
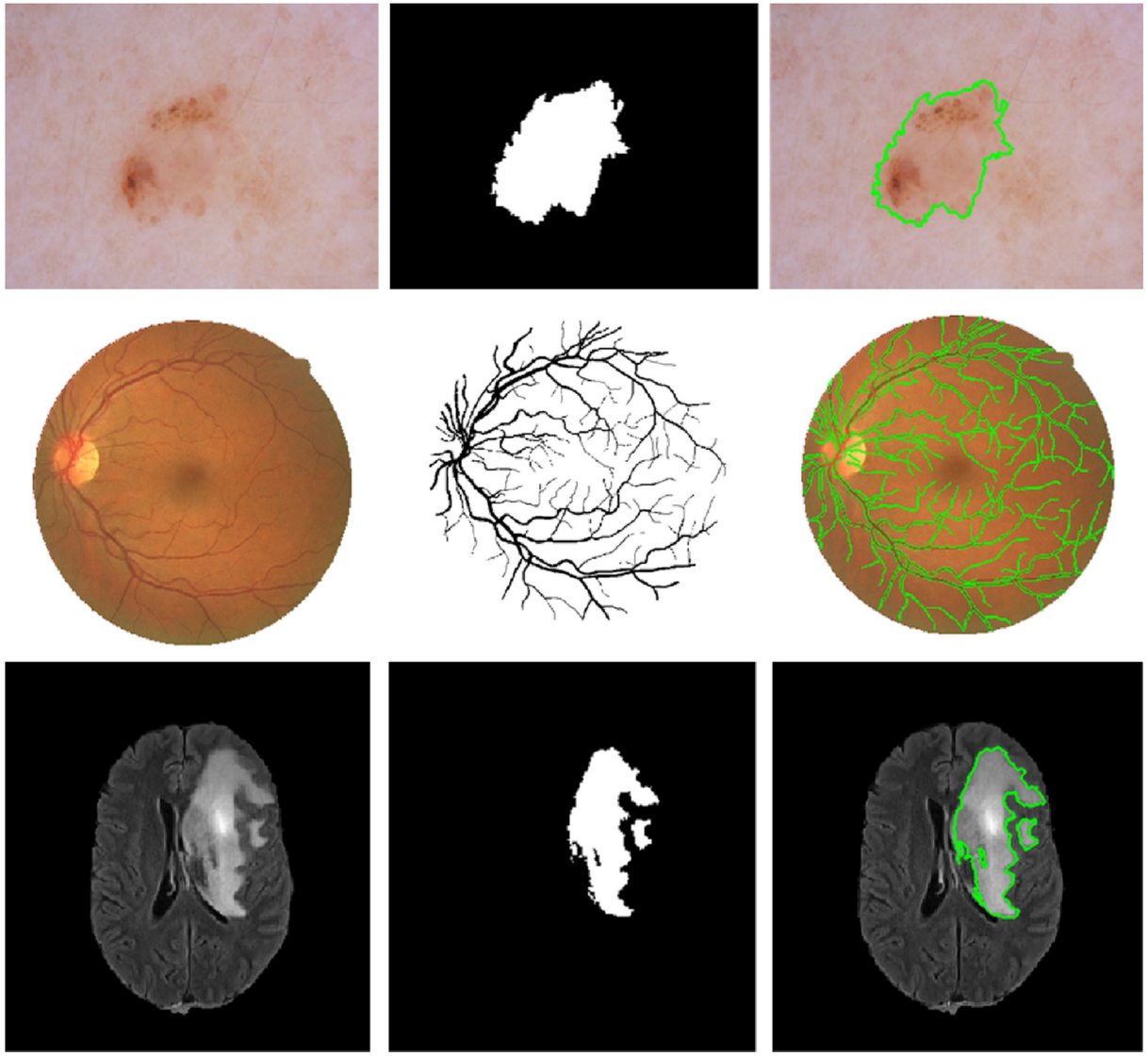


Image Segmentation

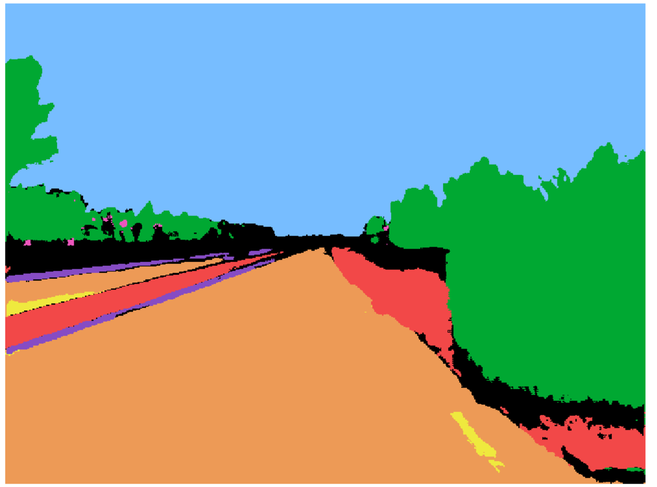
Outline of the object

Segmentation Applications



Input Image

Semantic Segmentation



The Problem of Data Scarcity

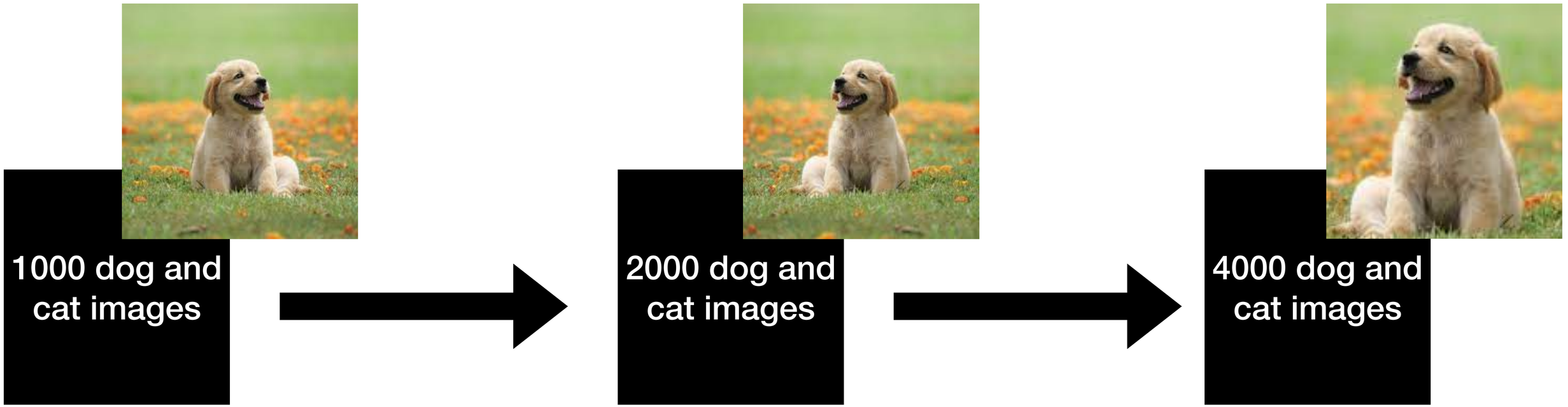
- Deep learning models require immense data (e.g 1k-100k)
- Manually labelling examples can take a long time
- Many applications require a professional to label data (extremely expensive)
- Some diseases might have a few examples (e.g 20)

Data Augmentation

A simple yet effective solution

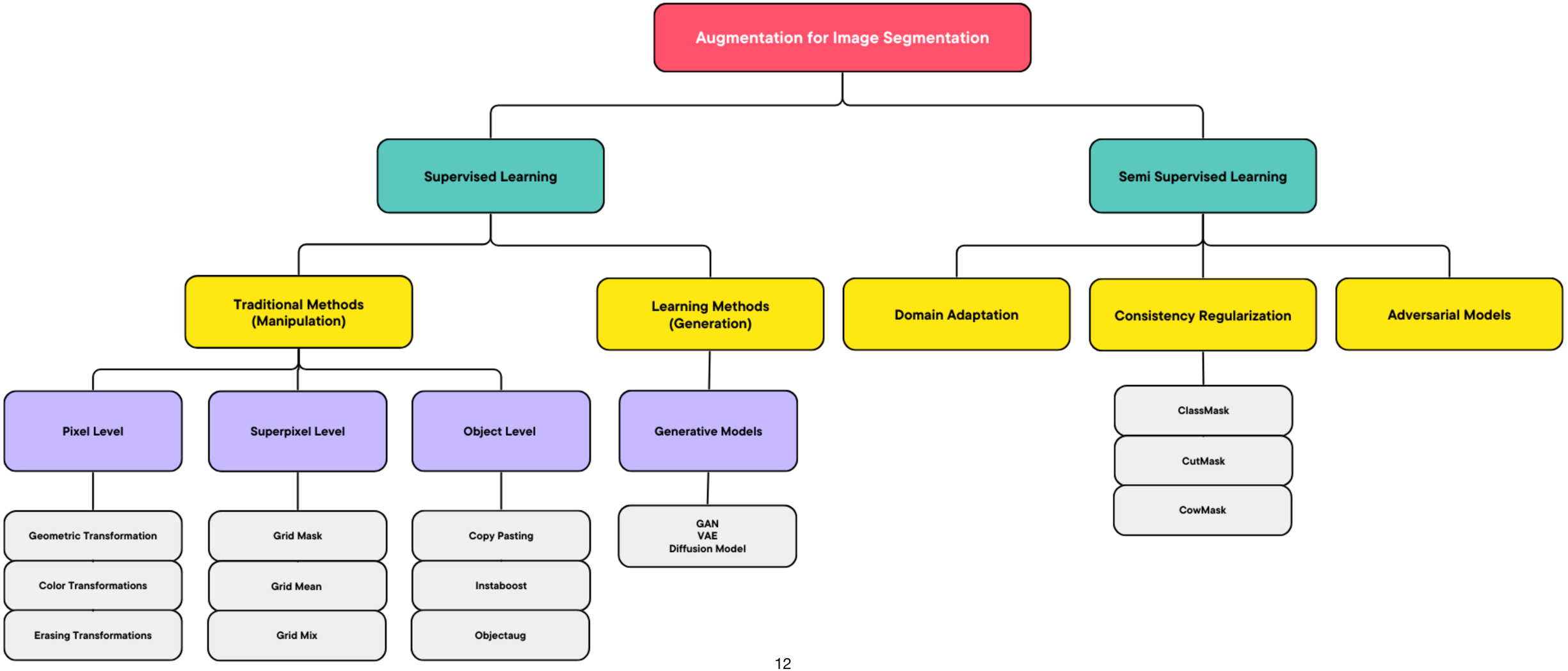
- Instead of gathering new data, artificially generate it
- Augmentations can be simple as geometric transformations
- Easily extends our dataset
- Proven to greatly increase model accuracy

Increasing Dataset Size via Augmentation

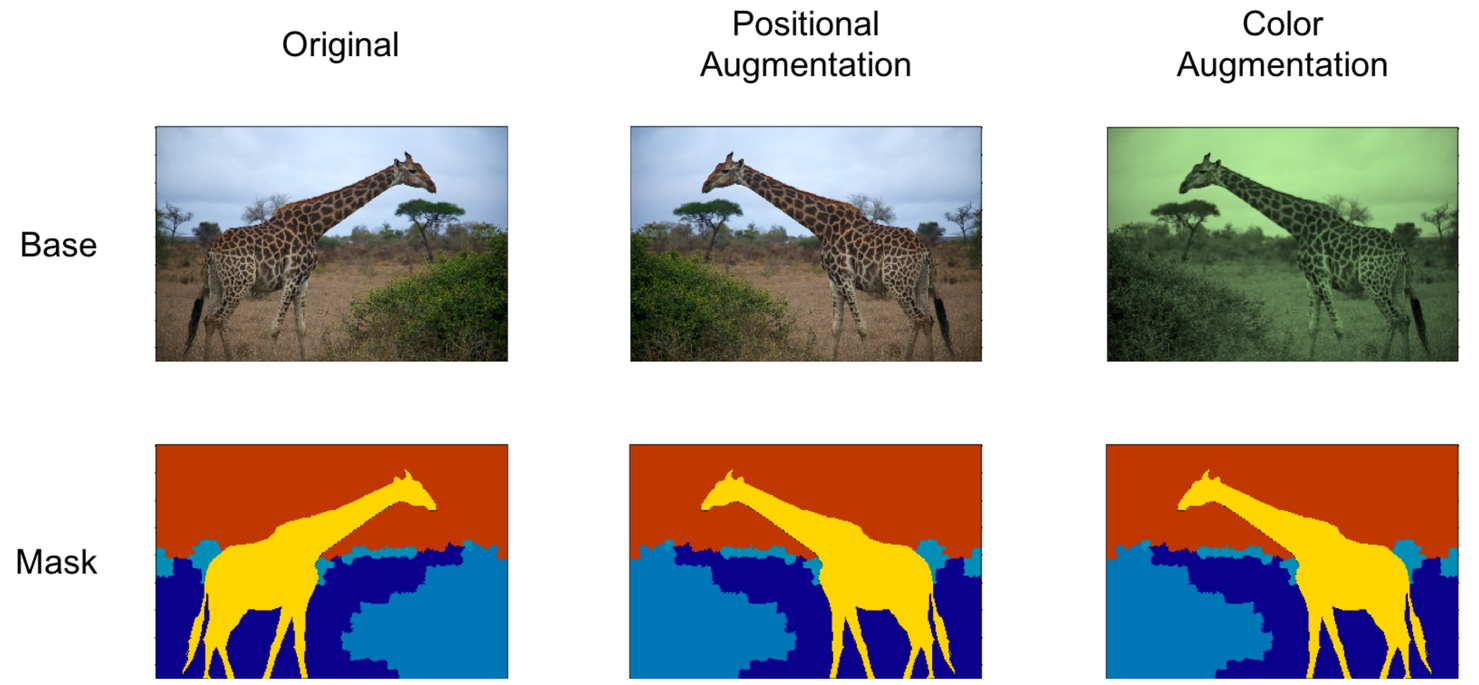


Data Augmentation for Segmentation

A novel taxonomy



Pixel Level

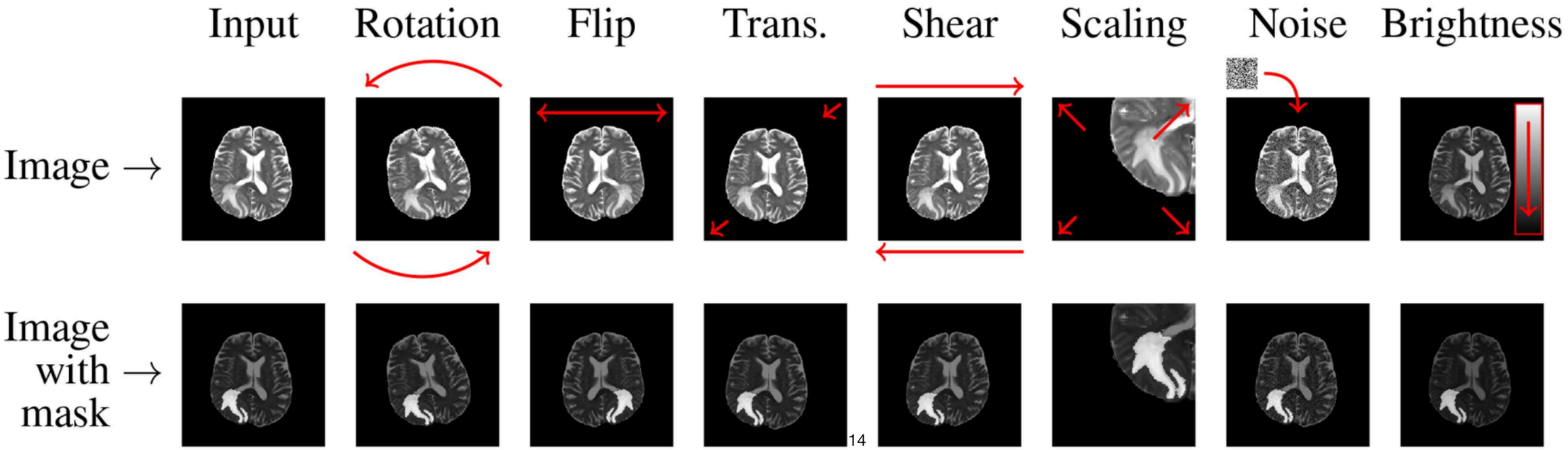

Original
Positional Augmentation
Color Augmentation
Base
Mask


Original
Rotation
Flip
Scaling
Brightness

Pixel Level

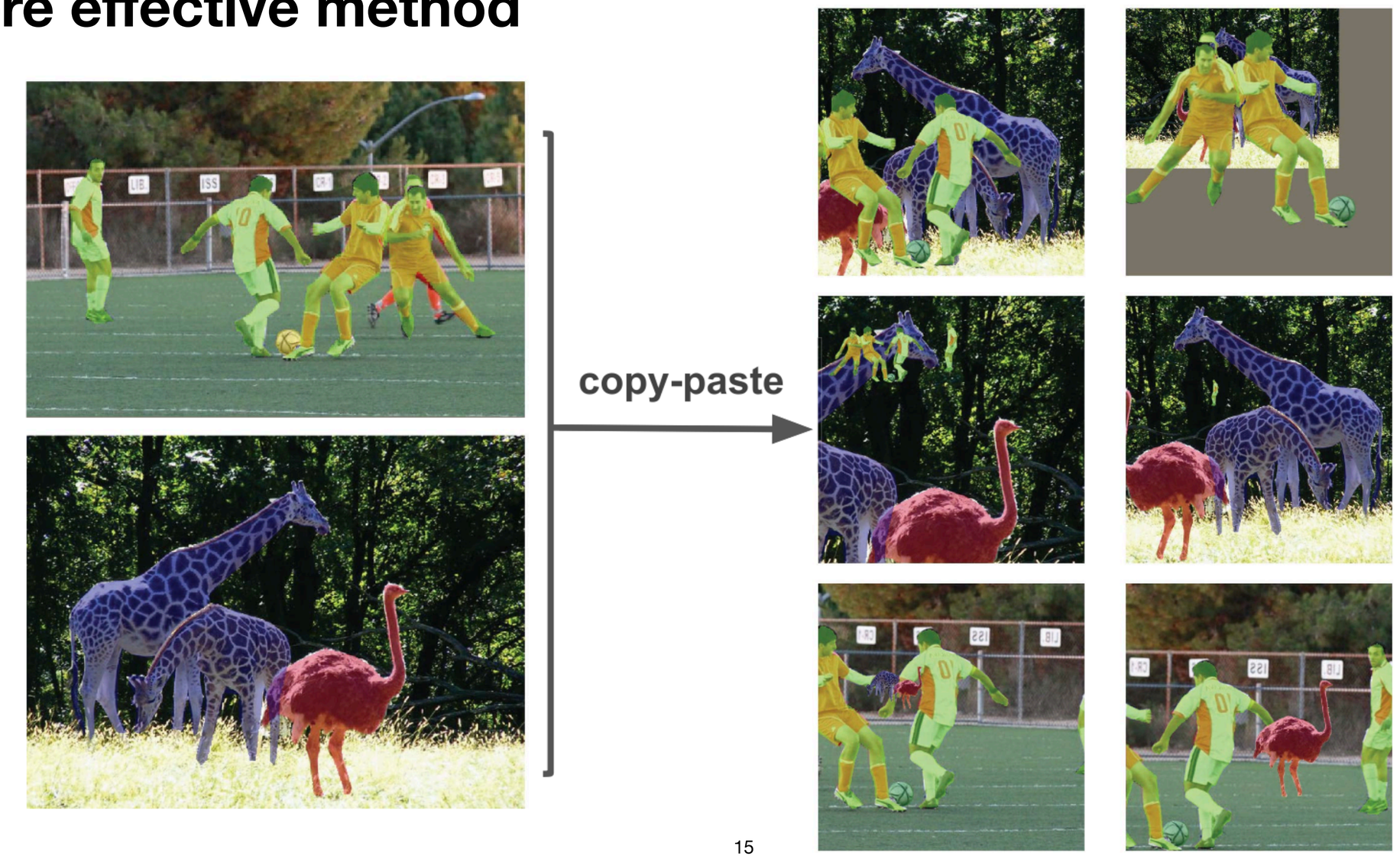
For brain tumour

	Augmentation	Test
(a)	Without	0.763
	Flip	0.785
	DIR	0.773
	DIR + Flip	**0.800**
(b)	Without	0.785
	Flip	0.797
	DIR	0.792
	DIR + Flip	**0.809**



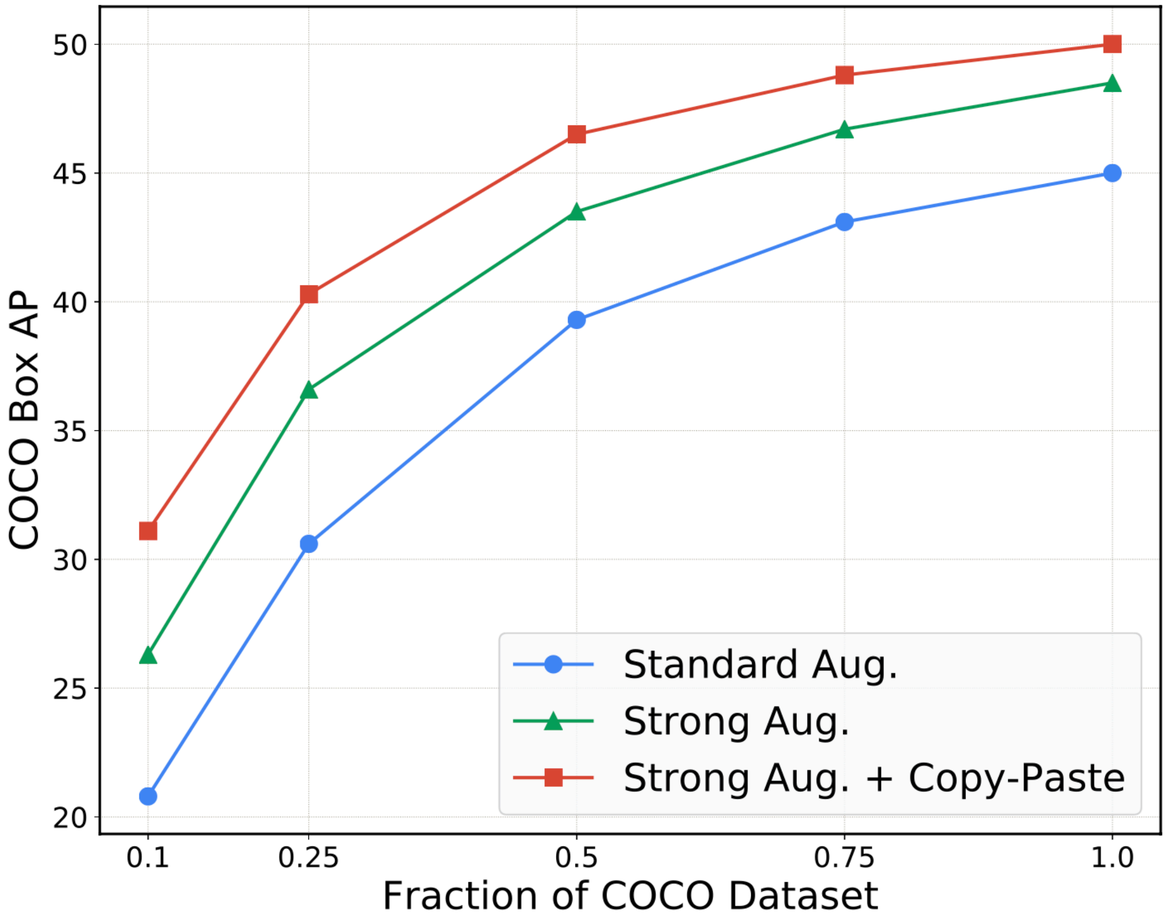
Simple Copy Pasting

A more effective method



Simple Copy Pasting

Results and comparisons



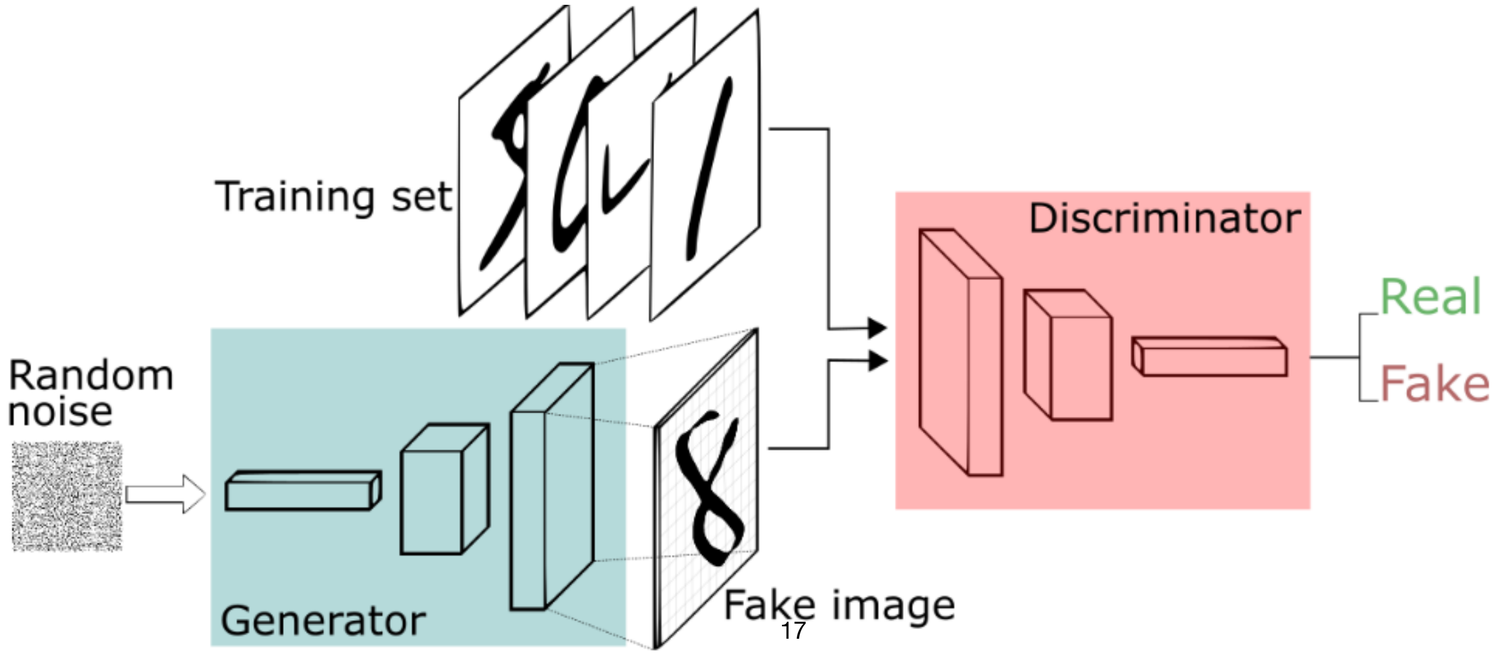
Model	Box AP
Res-50 FPN (1024)	47.2
w/ Copy-Paste	(+1.0) 48.2
Res-101 FPN (1024)	48.4
w/ Copy-Paste	(+1.4) 49.8
Res-101 FPN (1280)	49.1
w/ Copy-Paste	(+1.2) 50.3
Eff-B7 FPN (640)	48.5
w/ Copy-Paste	(+1.5) 50.0
Eff-B7 FPN (1024)	50.8
w/ Copy-Paste	(+1.1) 51.9
Eff-B7 FPN (1280)	51.1
w/ Copy-Paste	(+1.5) 52.6

Comparison of copy-paste method vs without augmentation

Generative Adversarial Networks

Addressing the problems of traditional augmentation

- Previous methods were limited to simple transformations
- No truly novel examples where made
- GANs (Generative Adversarial Networks) can be trained to create new data



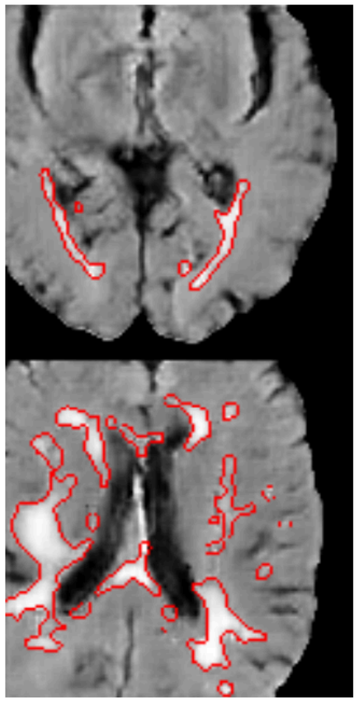
Generative Adversarial Networks

Creating believable new examples

Generative Adversarial Networks

Using GANs for augmentation

(c) Real MRI



(d) Synthetic MRI

Table 3: **CSF segmentation on CT:** UNet results with different proportions of the available training data and different augmentation techniques.

	Available data		
	100%	50%	10%
No augmentation	88.1 (0.32)	85.0 (0.58)	75.1 (0.60)
GAN augmentation	88.4 (0.41)	85.6 (1.33)	76.3 (1.77)
Rotation augmentation	**88.9** (0.51)	**86.0** (0.50)	**76.9** (0.58)
GAN + Rotation augmentation	**89.3** (0.39)	**86.9** (0.36)	**78.4** (0.99)

Conclusion

- Many different augmentation methods exists
- Easily Implemented
- They can increase performance on CV tasks
- Some augmentation methods do not work for specific datasets
- Always better to mix augmentation methods

References

- Creswell, A., White, T., Dumoulin, V., Arulkumaran, K., Sengupta, B., & Bharath, A. A. (2018). Generative adversarial networks: An overview. *IEEE signal processing magazine*, *35*(1), 53-65.

- Ghiasi, G., Cui, Y., Srinivas, A., Qian, R., Lin, T. Y., Cubuk, E. D., ... & Zoph, B. (2021). Simple copy-paste is a strong data augmentation method for instance segmentation. In *Proceedings of the IEEE/CVF conference on computer vision and pattern recognition* (pp. 2918-2928).

- Nalepa, J., Marcinkiewicz, M., & Kawulok, M. (2019). Data augmentation for brain-tumor segmentation: a review. *Frontiers in computational neuroscience*, *13*, 83.

Thank You