Domain Adaptation

Making Machine Learning Models work Across Datasets

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Outline

Motivation

Domain Shift and Domain Adaptation
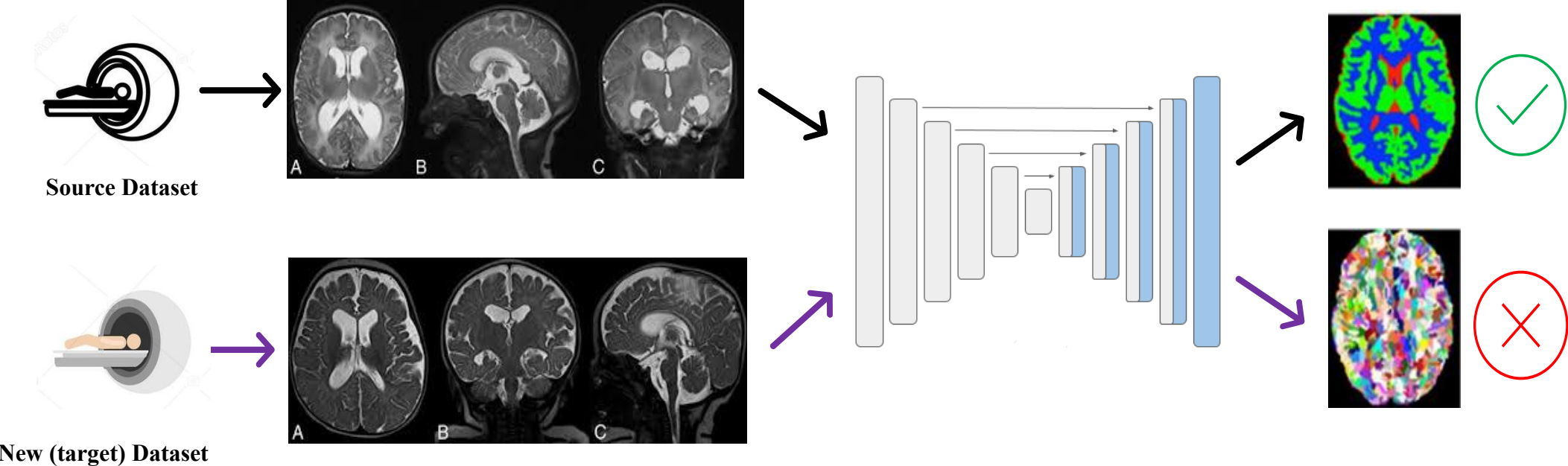
Domain Adaptation Techniques

Summary

Learning Goals

- Learn the basic domain adaptation concepts

- Expose you to different domain adaptation problems

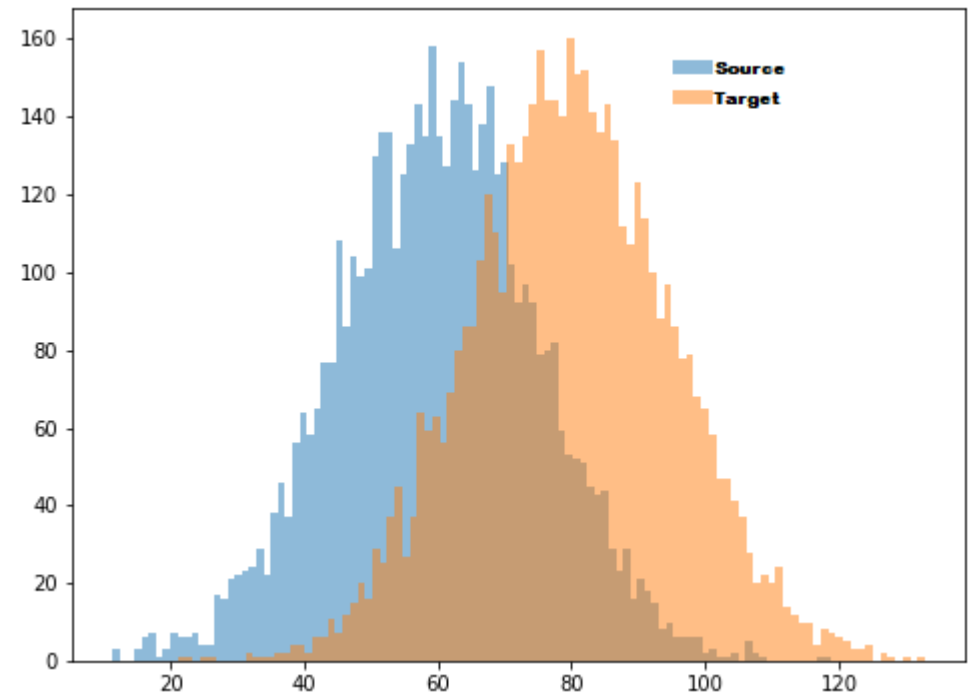- Get an overview of different domain adaptation approaches

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Motivation

Source Dataset
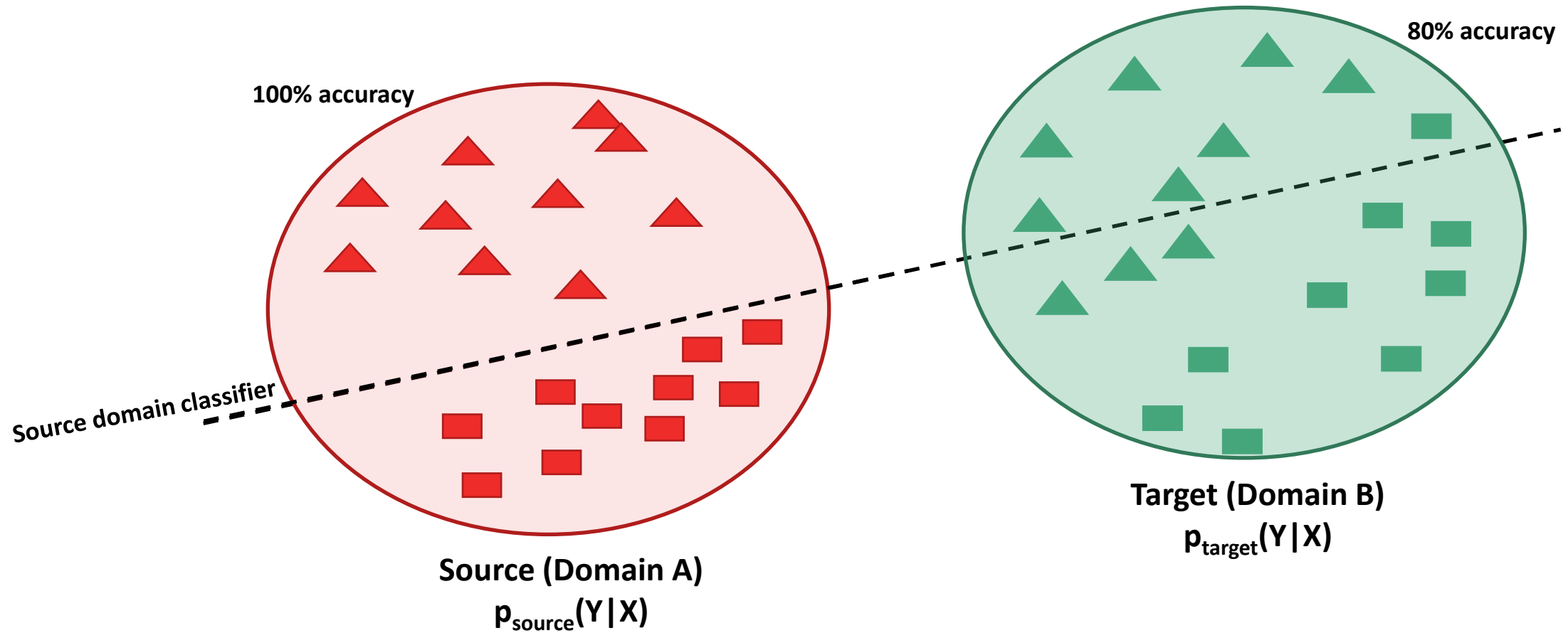
New (target) Dataset

Domain Shift

- **Domain shift**: refers to the change of data distribution between one dataset (source/reference domain) and another dataset (target domain).

$$p_{source}(Y|X) \neq p_{target}(Y|X)$$

Domain Shift Problem

100% accuracy
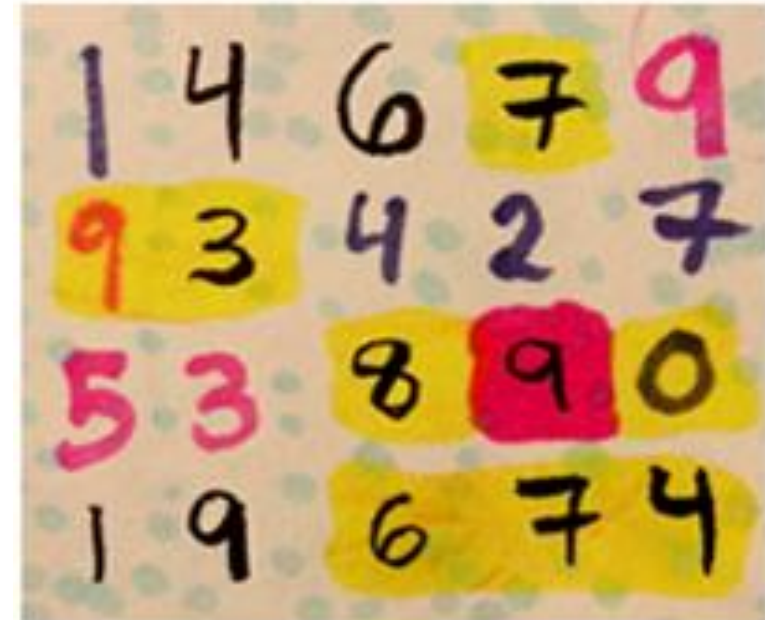
80% accuracy

Source domain classifier

Source (Domain A)
$p_{source}(Y|X)$

Target (Domain B)
$p_{target}(Y|X)$

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Different Types of Images

Domain A

Domain B

Different Types of Images: Sketches and Photos
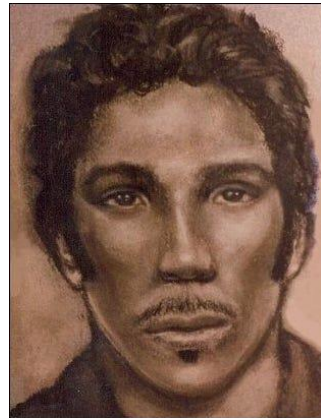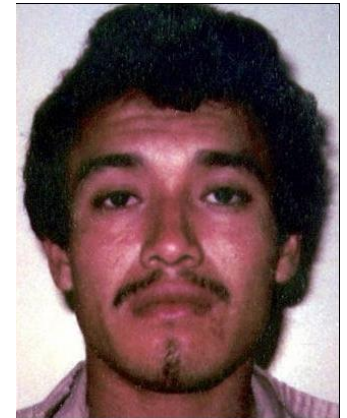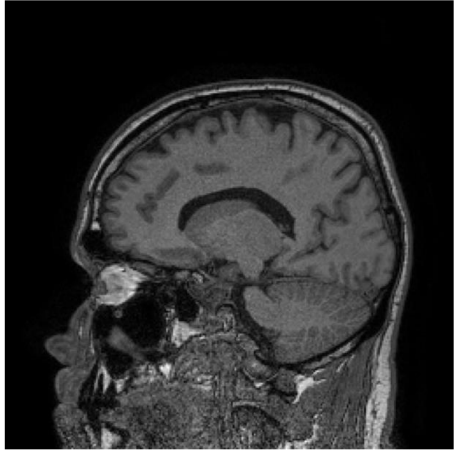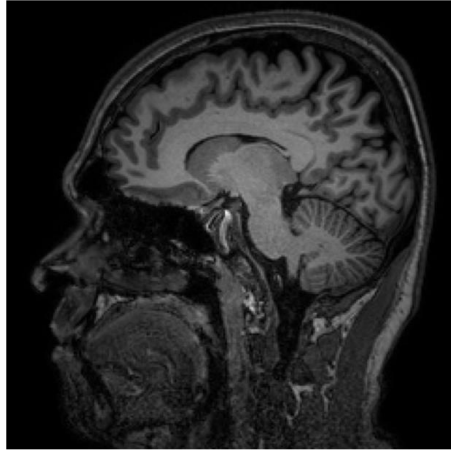
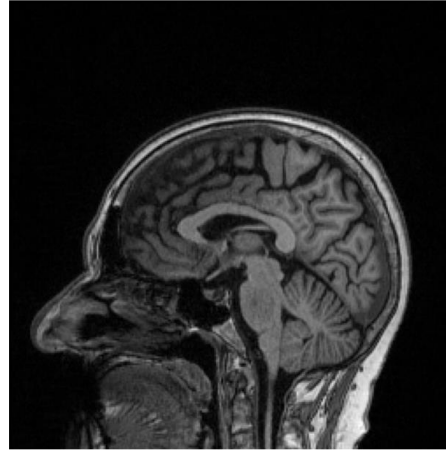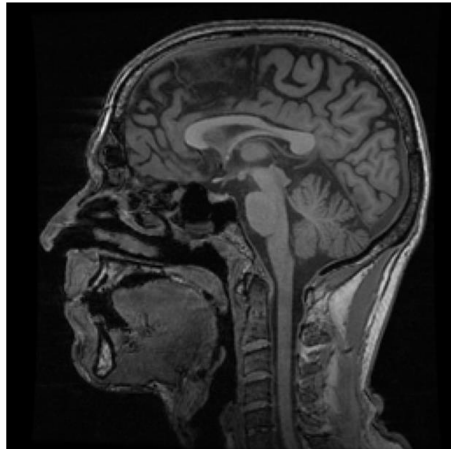Camera comparison images: Low light/night mode
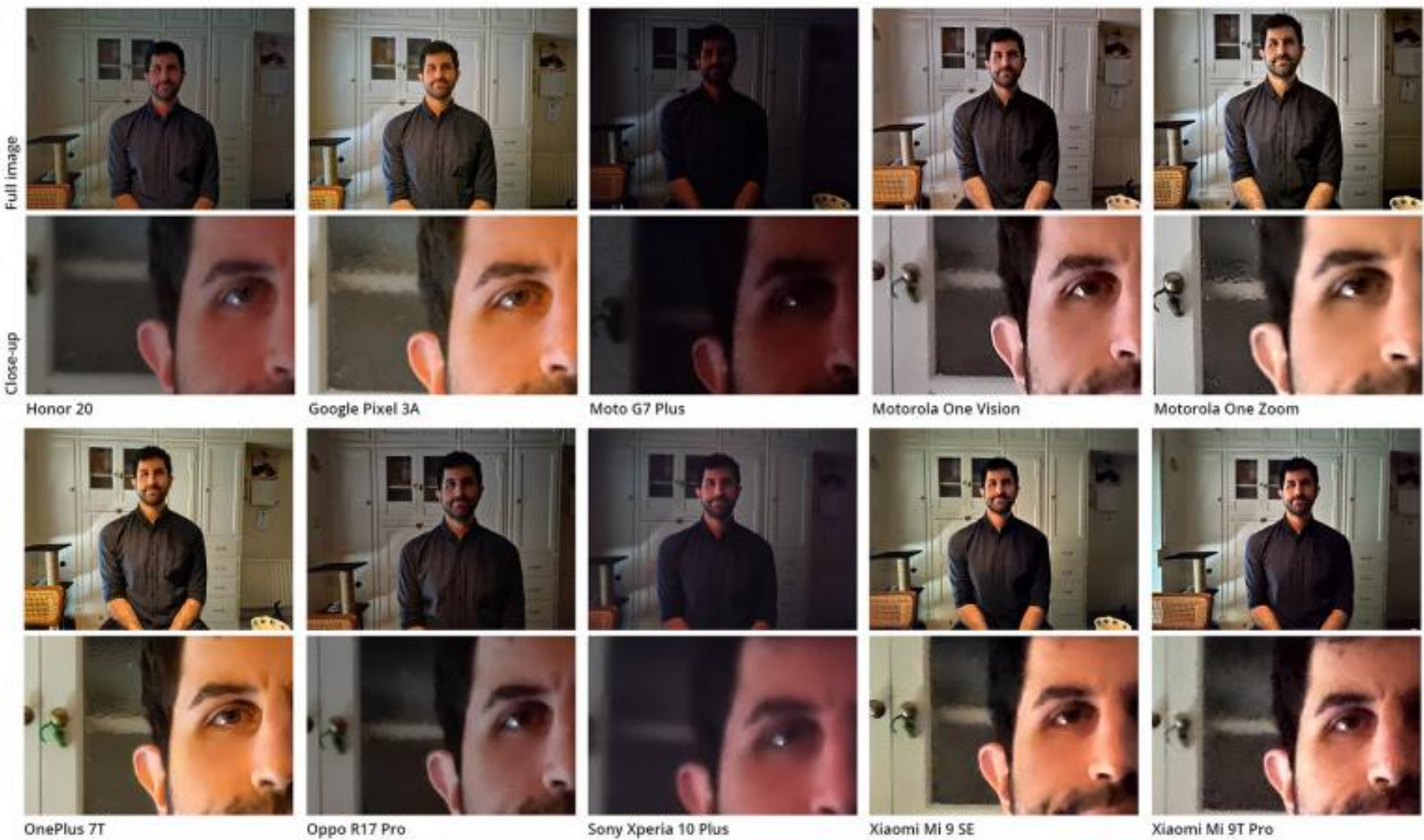
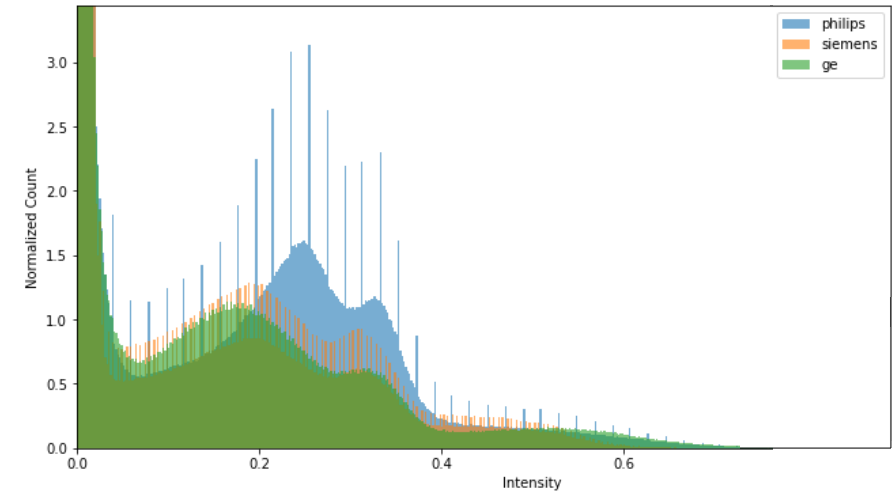# Hardware and Software Differences

philips_15

philips_3

siemens_15
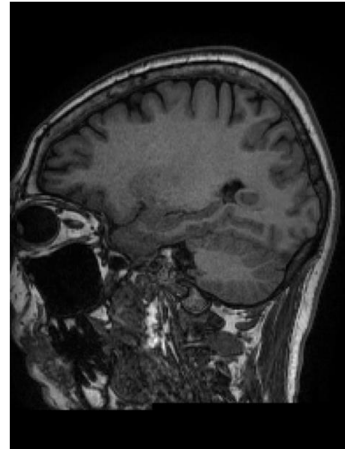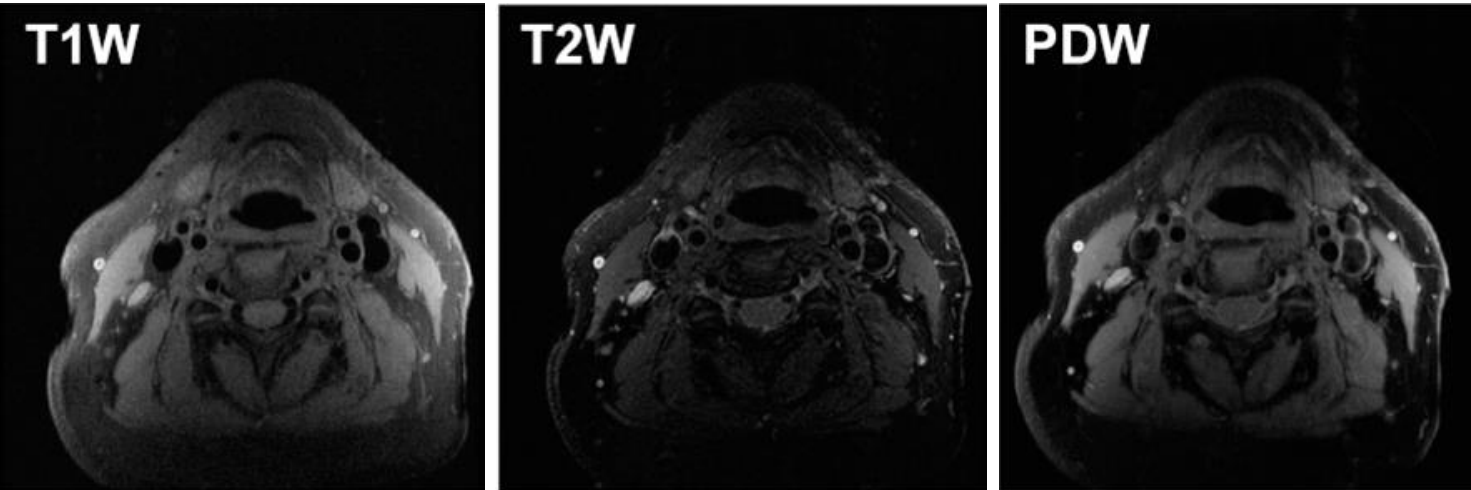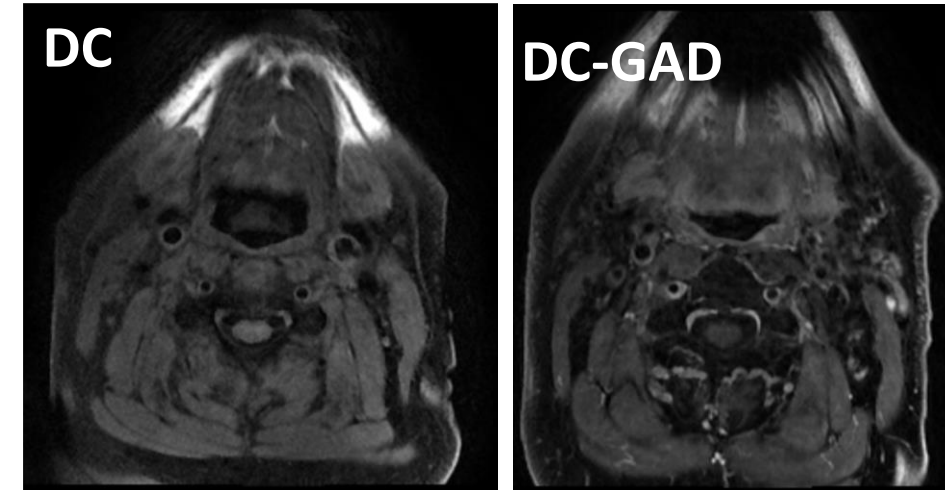
siemens_3

ge_3

ge_15

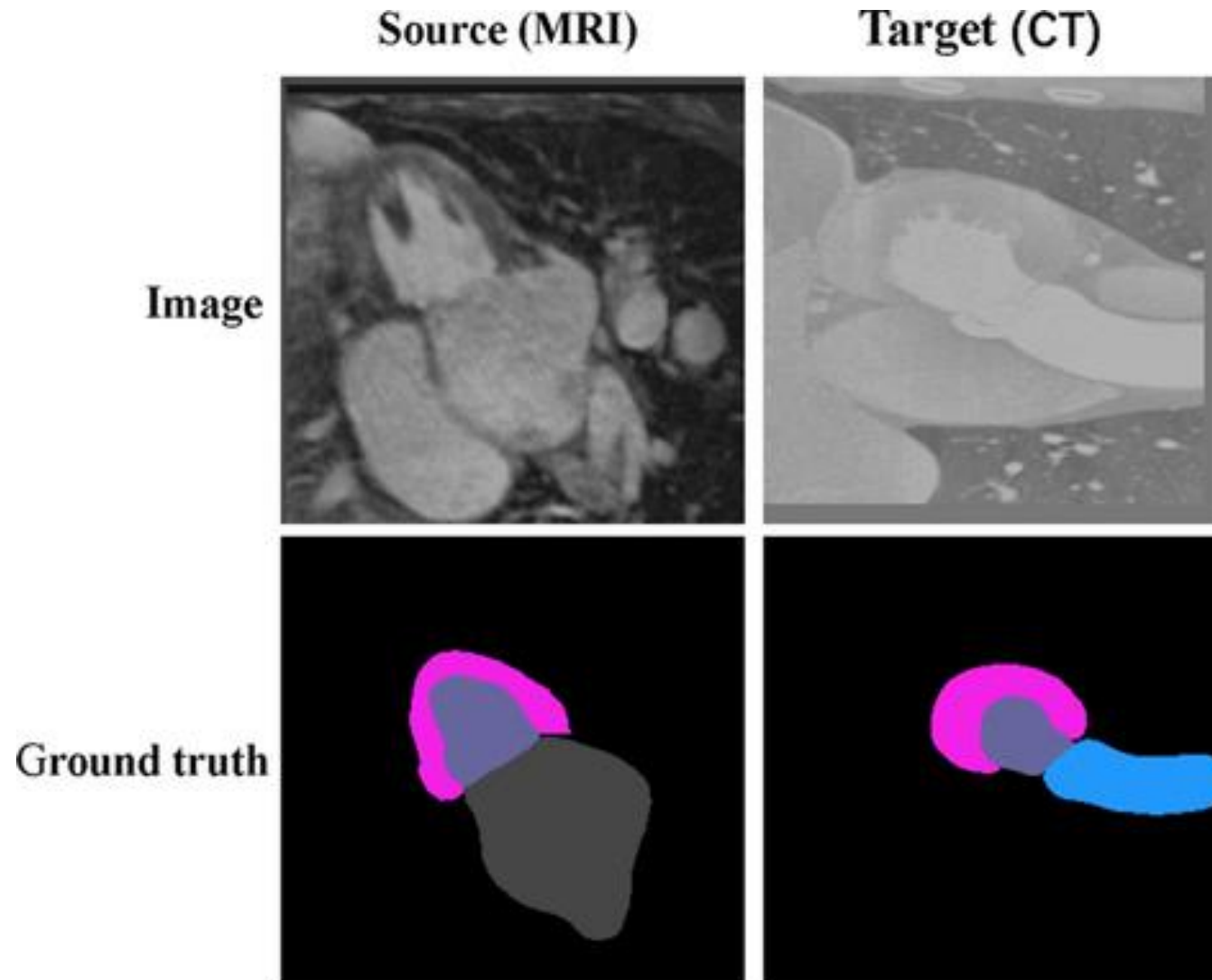# Hardware and Software Differences

AIM-HIGH Study

- The carotid arteries were manually annotated at the time of the study

CARDIS Study

- Leverage AIM-HIGH anno-tated data to create a segmentation model for the data being collected at CARDIS study
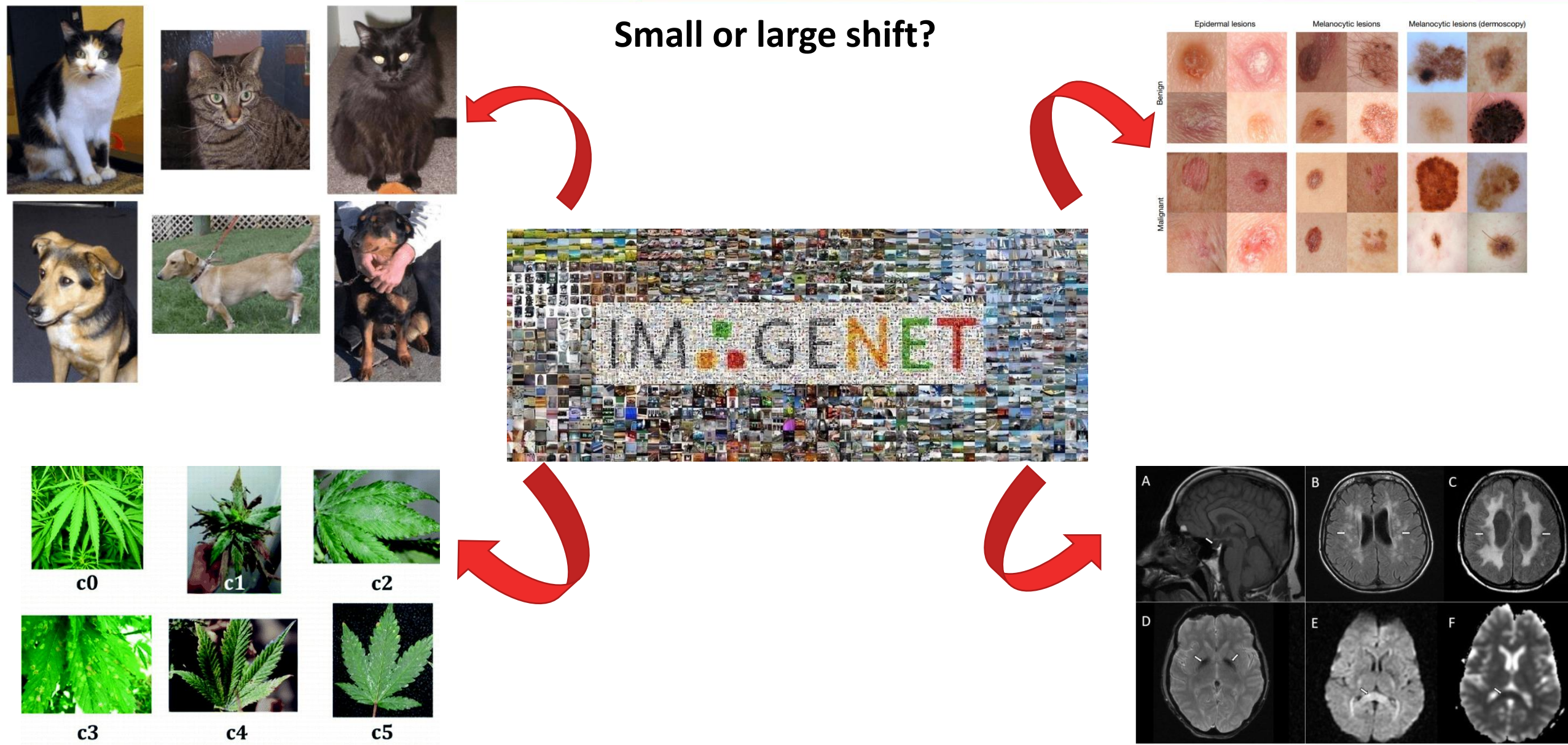
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Different Technologies

Degree of Domain Shift

- **Degree of domain shift** is a measure of how much the distributions of the source and target domains are different

- Previous studies have revealed that the test error generally increases in proportion to the degree of domain shift.
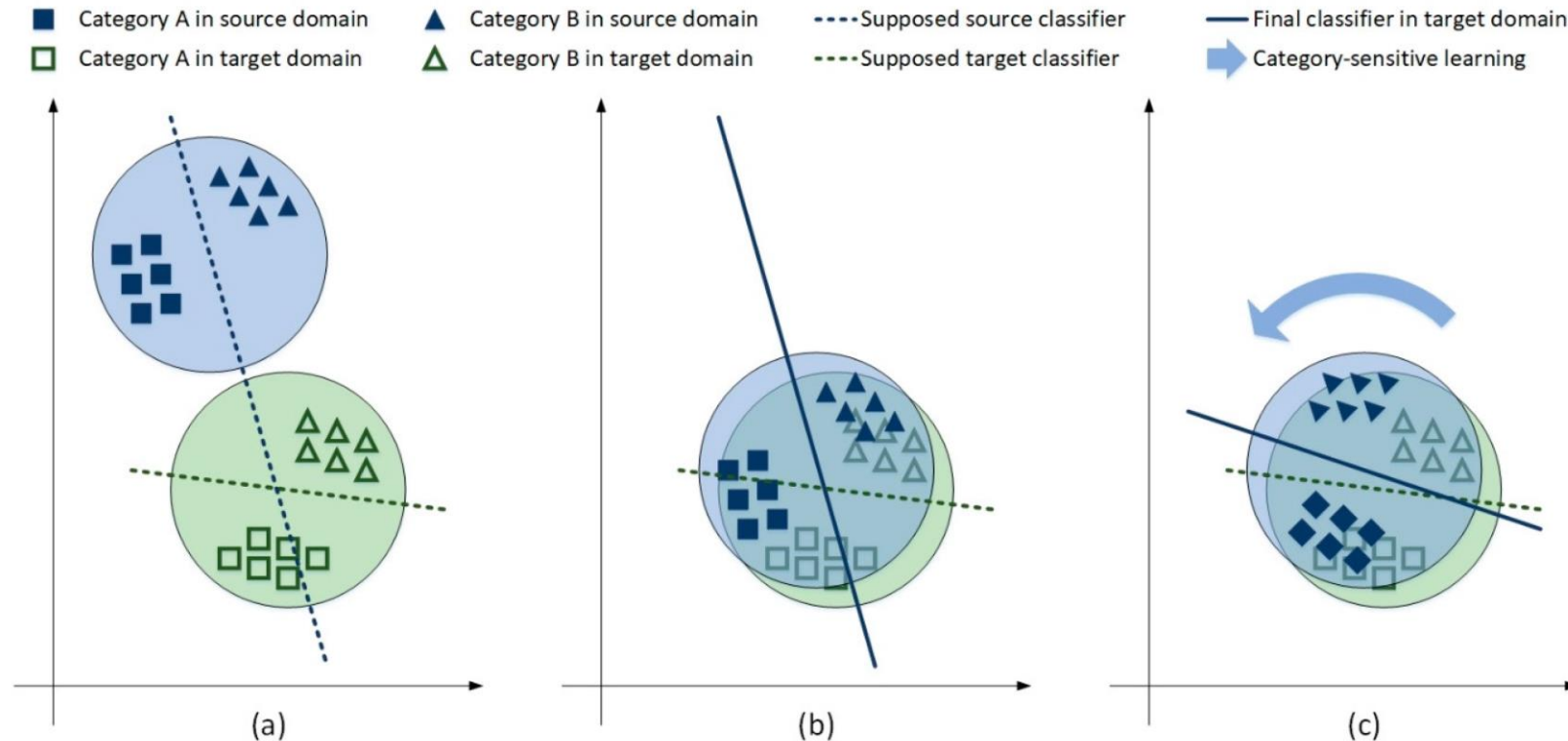
Degree of Domain Shift

Small or large shift?

Domain Adaptation

- **Domain adaptation**: domain adaptation refers to adapting a model trained in one or more source domains to a different one or more target domains.
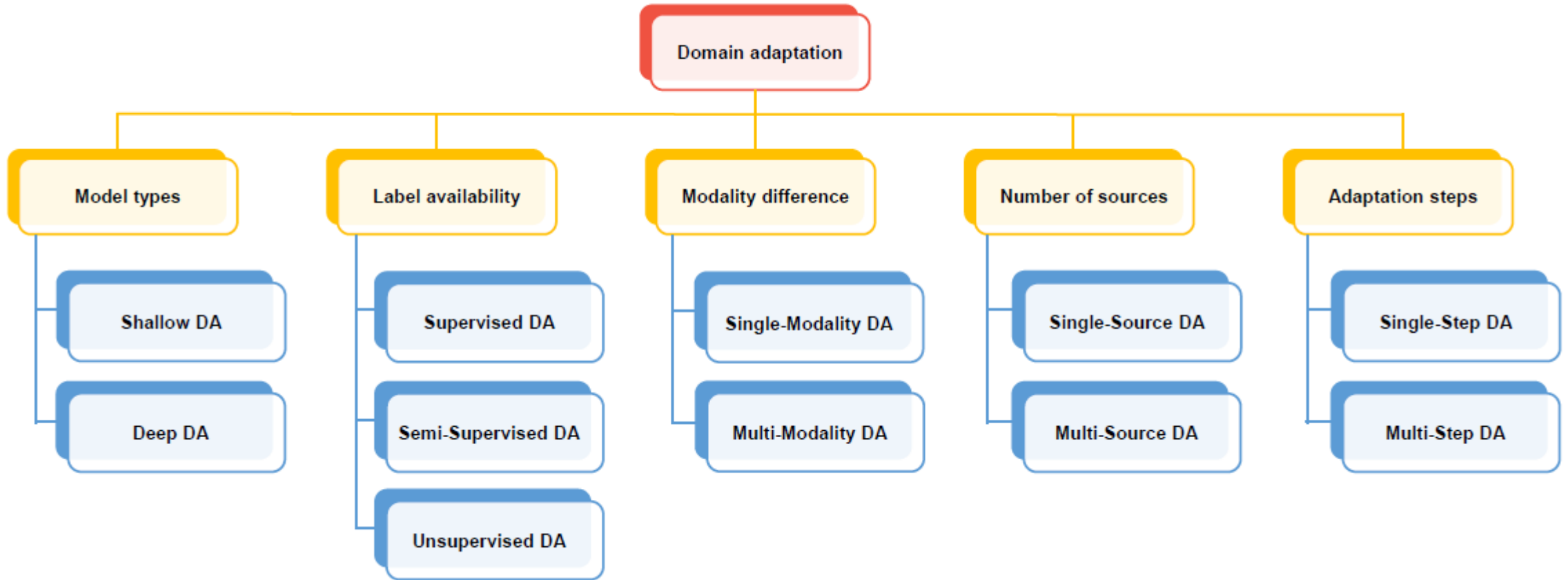
What is the difference between domain adaptation and transfer learning?

What is the difference between domain adaptation and transfer learning?

- In domain adaptation the task in the source and target domains are the same
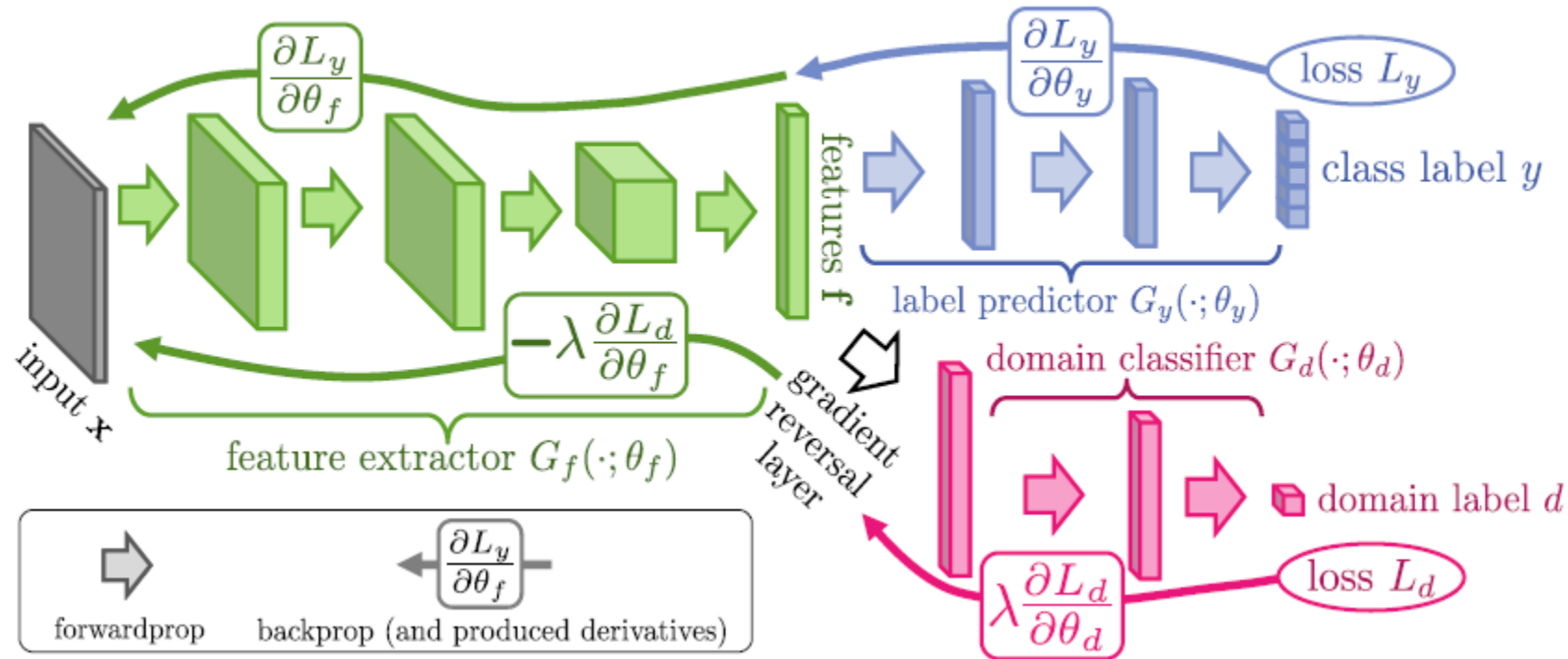
Domain Adaptation Categories

Supervised Domain Adaptation

- Essentially transfer learning
  - Fine-tune all layers

  - Fine-tune initial layers

  - Fine-tune final layers

*Ganin et al., JMLR, 2016

$$E(\theta_f, \theta_y, \theta_d) = \frac{1}{n} \sum_{i=1}^{n} \mathcal{L}_y^i(\theta_f, \theta_y) - \lambda \left(\frac{1}{n} \sum_{i=1}^{n} \mathcal{L}_d^i(\theta_f, \theta_d) + \frac{1}{n'} \sum_{i=n+1}^{N} \mathcal{L}_d^i(\theta_f, \theta_d) \right)$$

Thank you!