Domain Adaptation

Making Machine Learning Models work Across Datasets

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Outline

Motivation

Domain Shift and Domain Adaptation

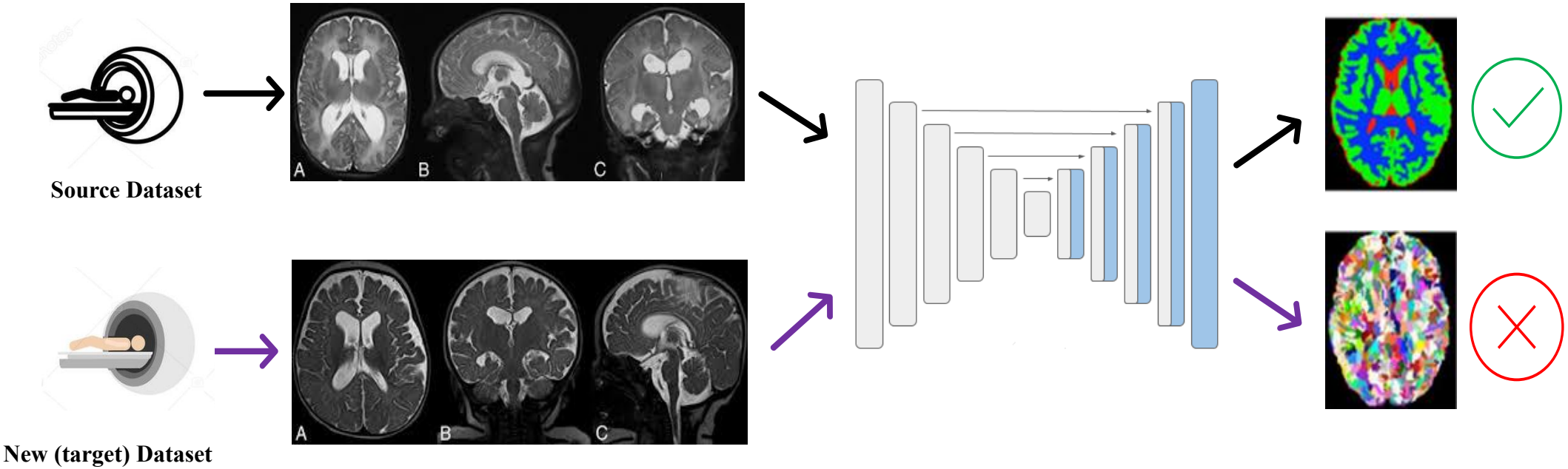
Domain Adaptation Techniques

Summary

Learning Goals

- Learn the basic domain adaptation concepts
- Expose you to different domain adaptation problems
- Get an overview of different domain adaptation approaches

Motivation



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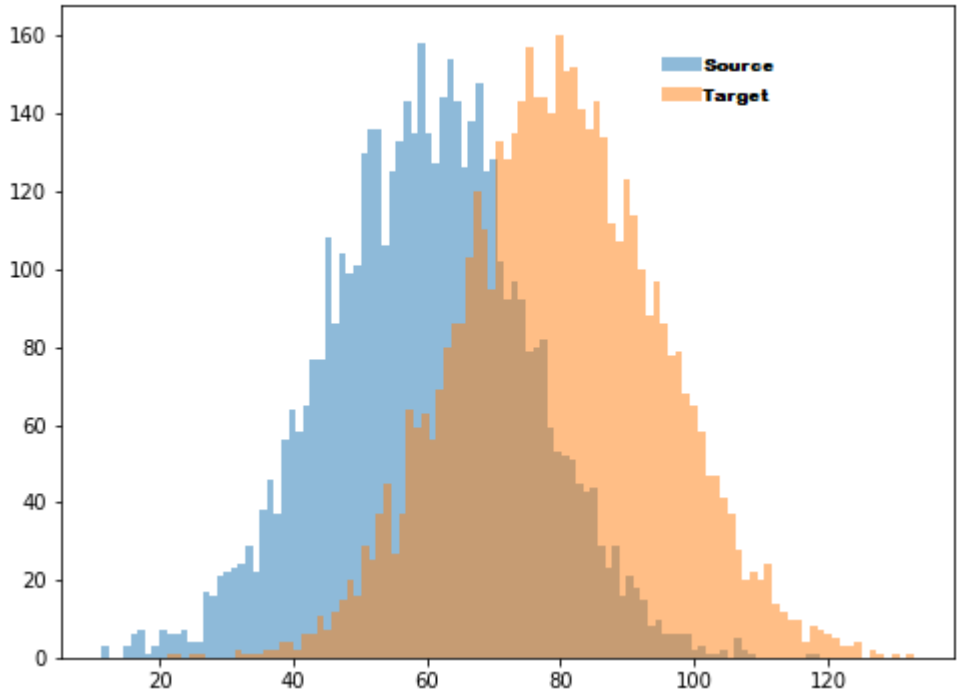
Domain Shift

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

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



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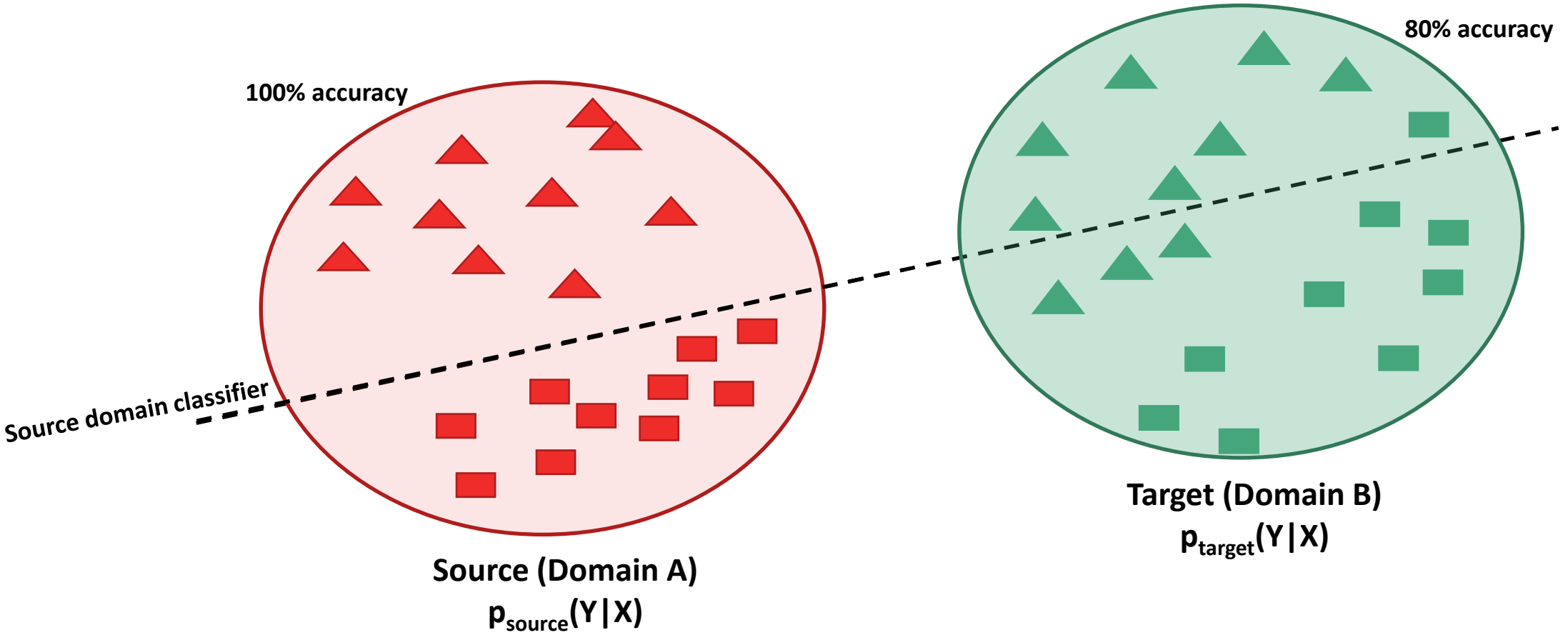
Domain Shift Problem



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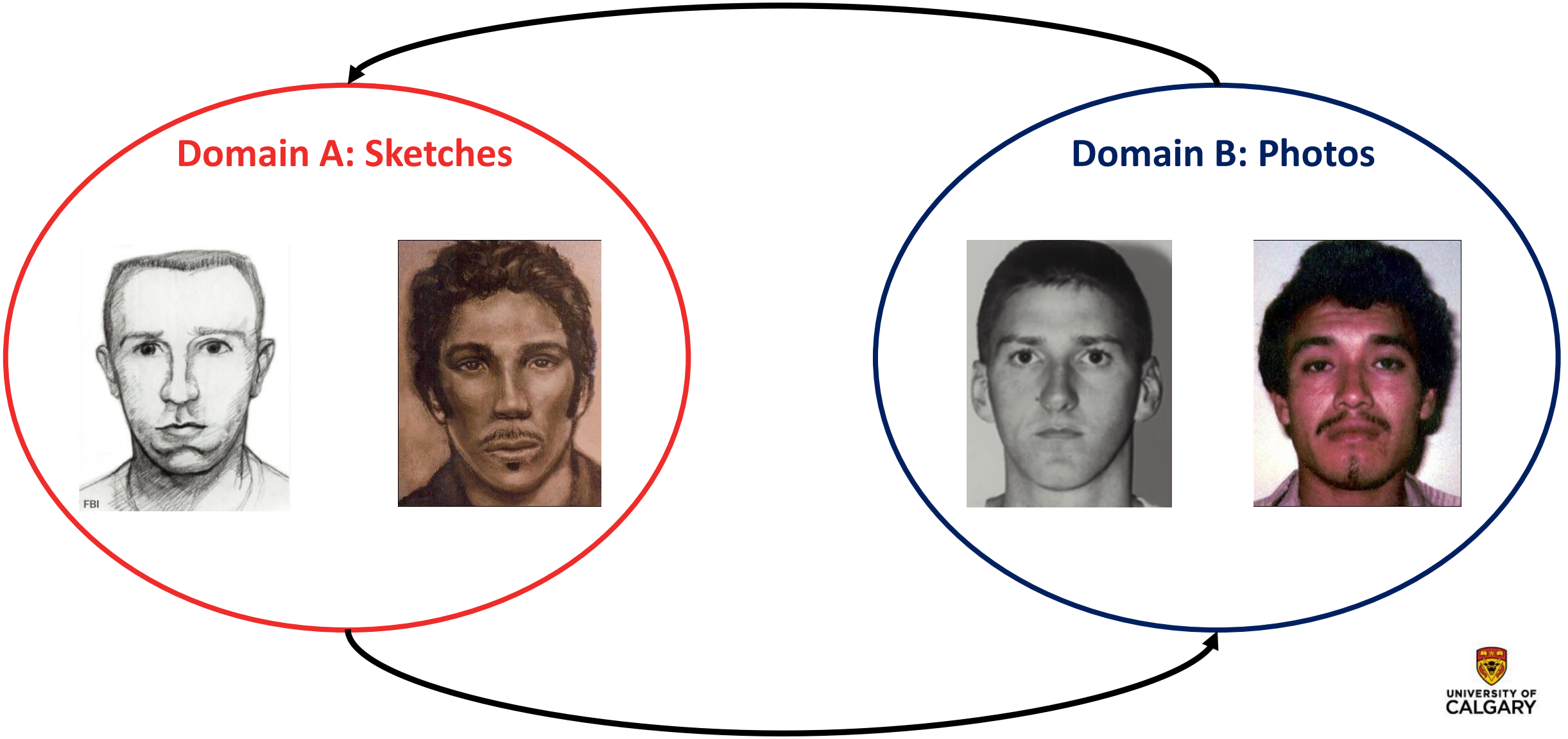
Different Types of Images

Domain A

Domain B

Different Types of Images: Sketches and Photos



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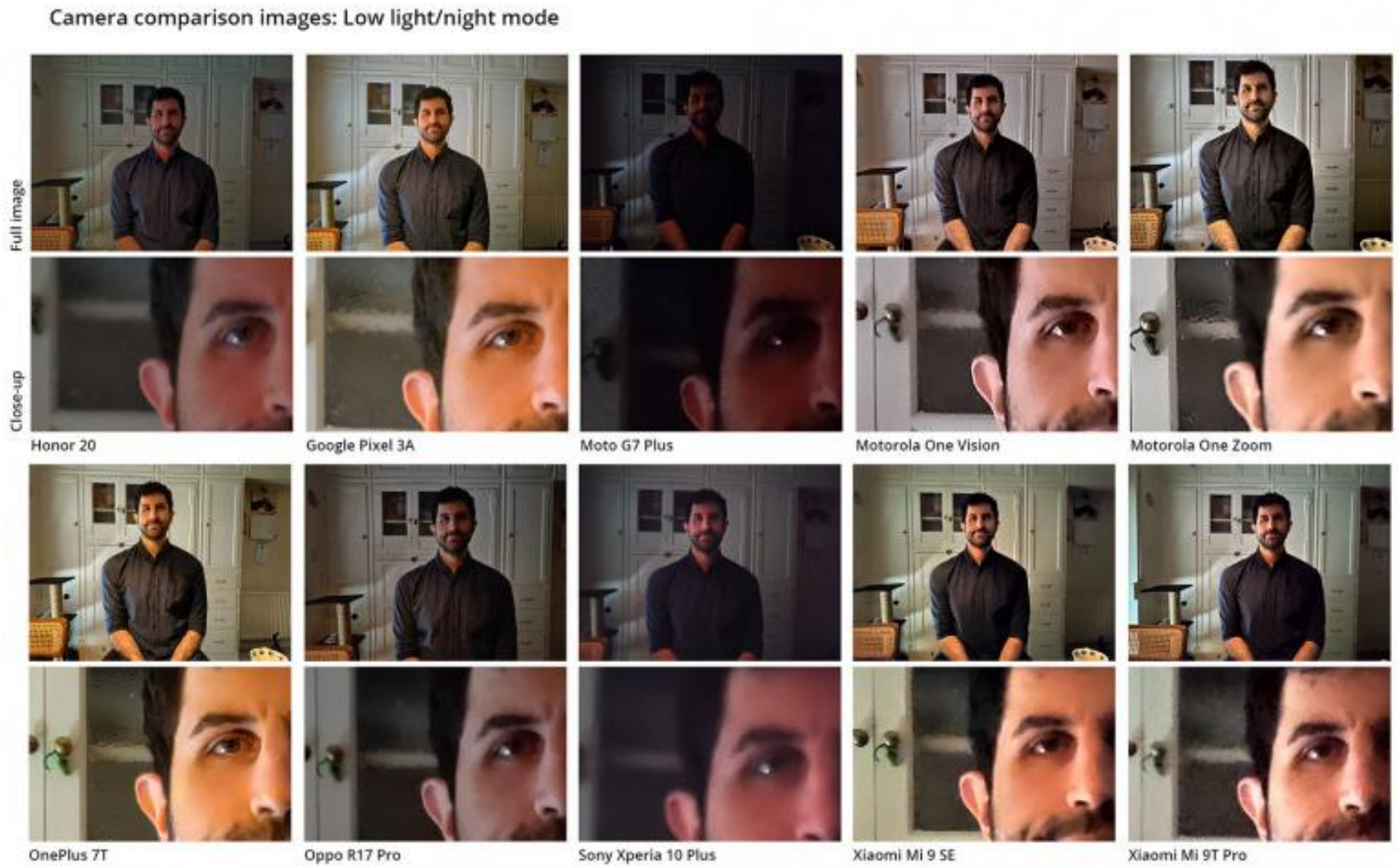
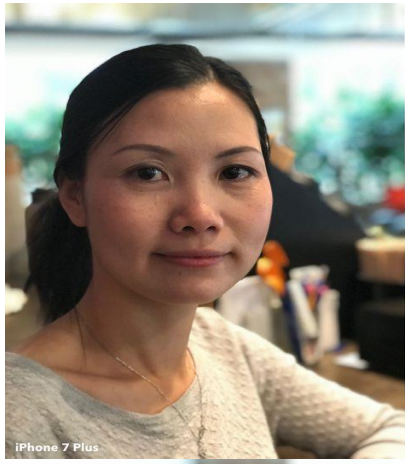
Technology Differences and Evolution





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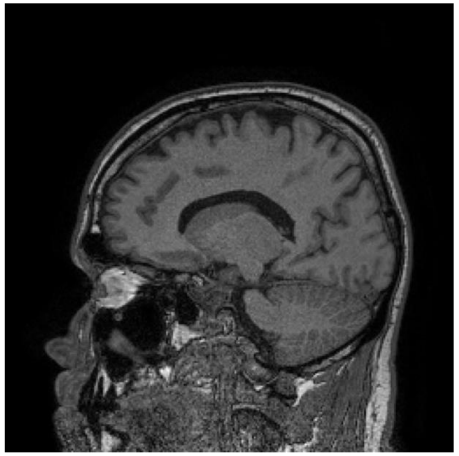
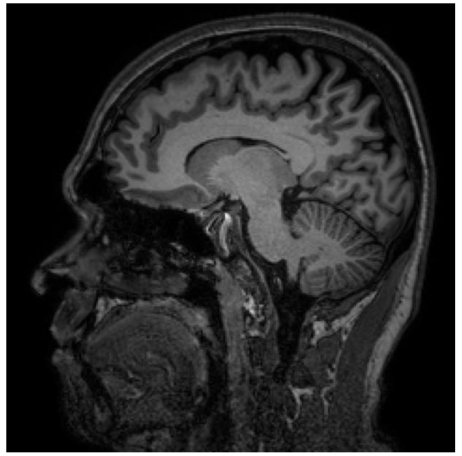
Hardware and Software Differences

philips_15



philips_3



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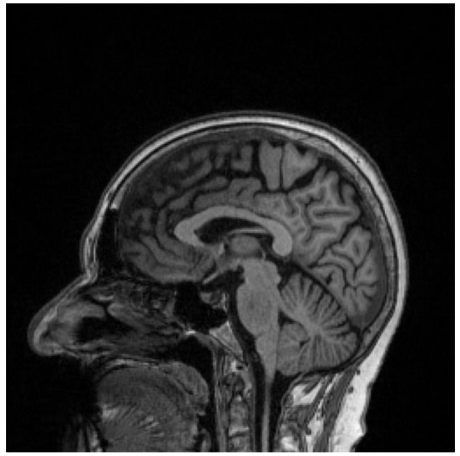

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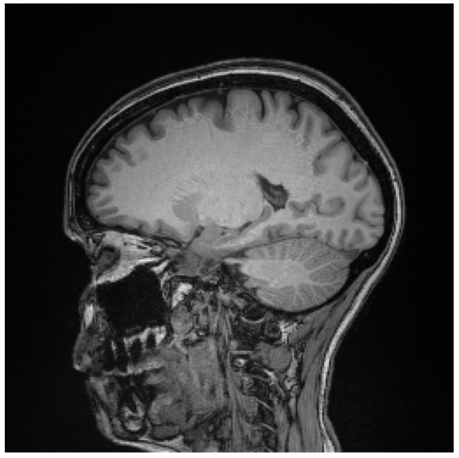

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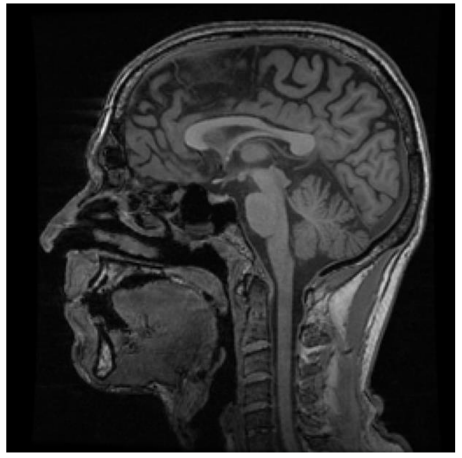

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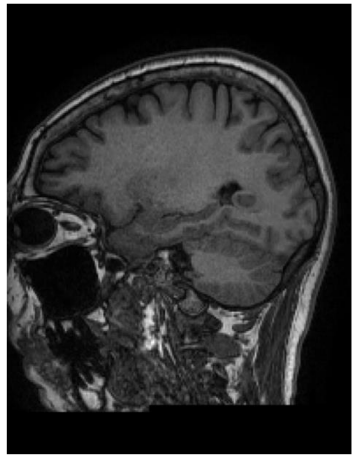

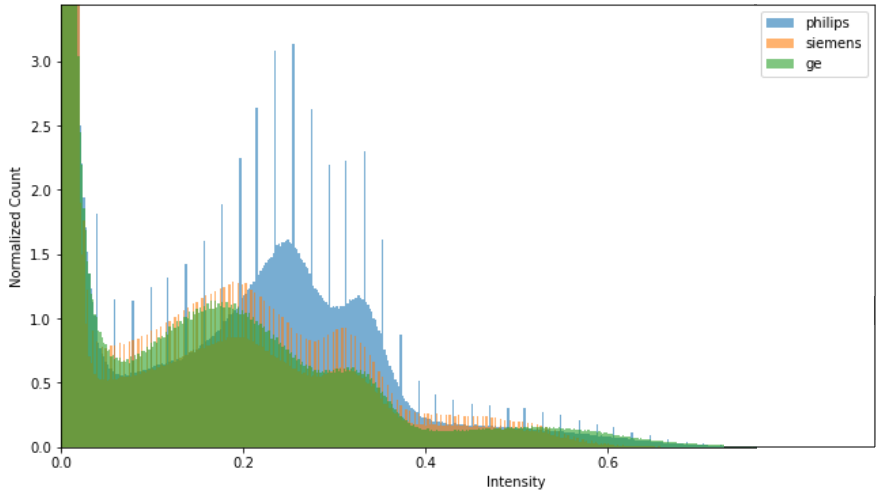

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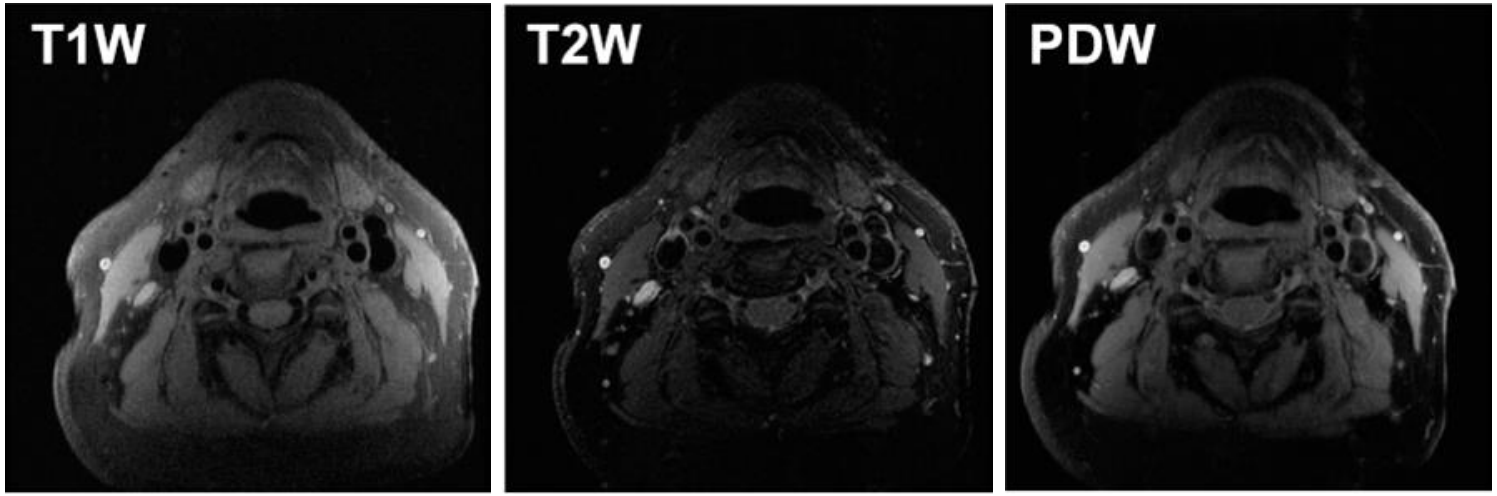
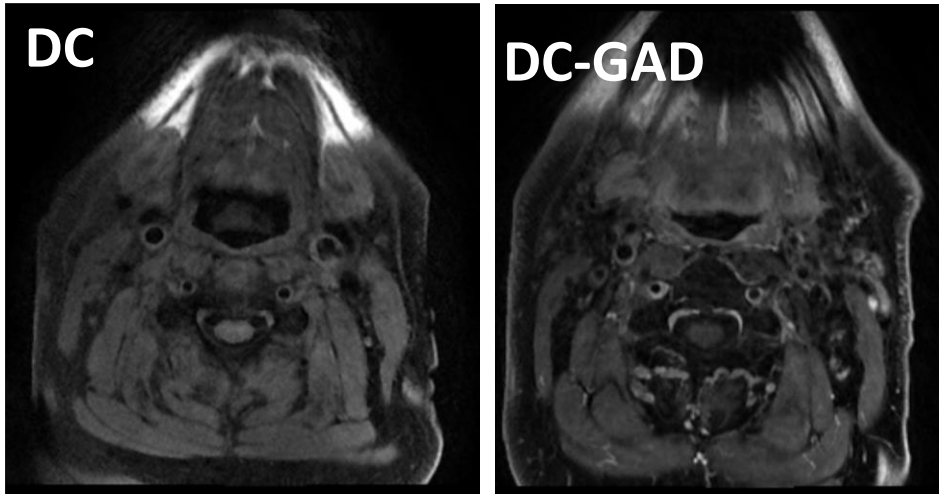
Hardware and Software Differences

AIM-HIGH Study



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

CARDIS Study



- Leverage AIM-HIGH annotated data to create a segmentation model for the data being collected at CARDIS study

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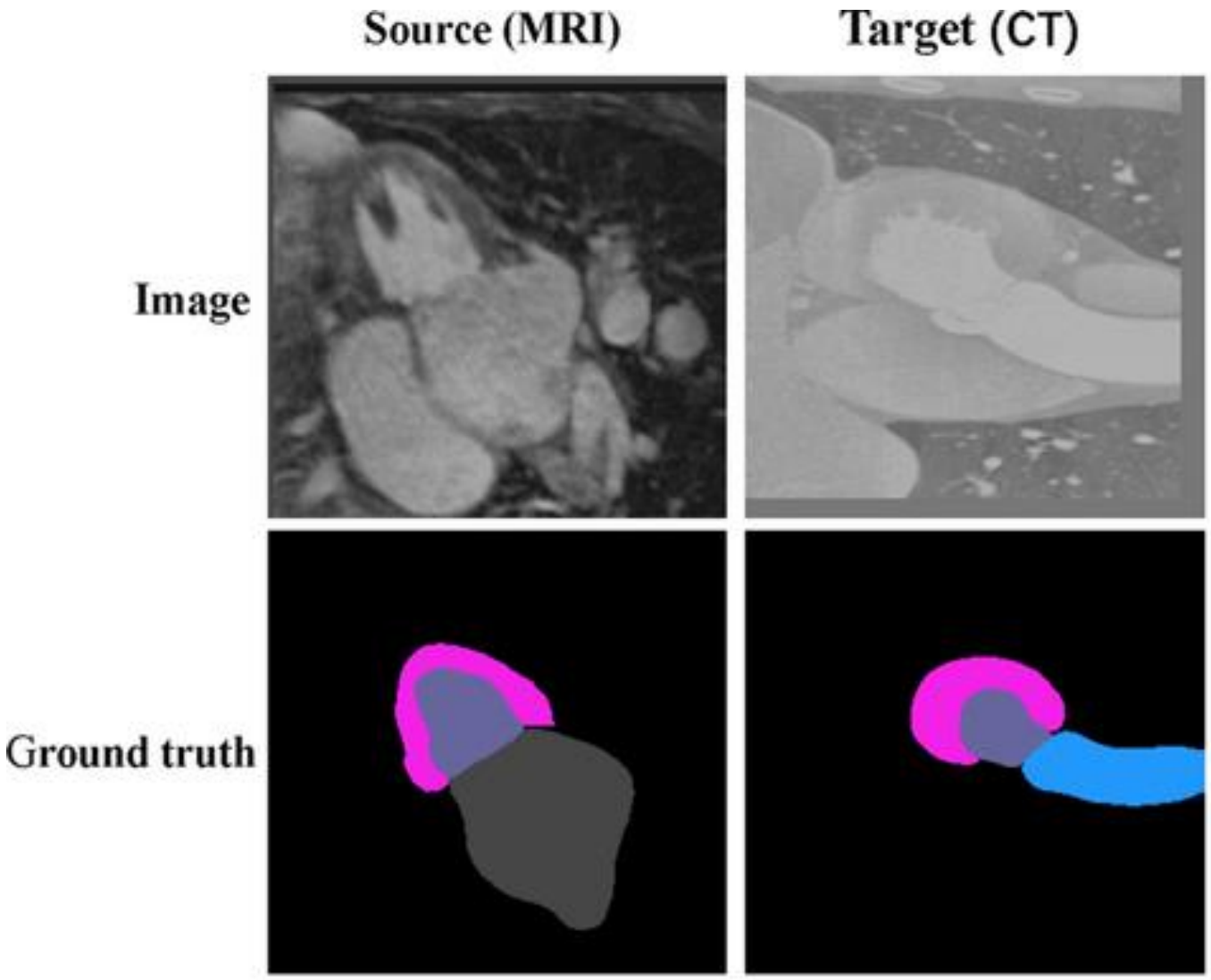
Different Technologies



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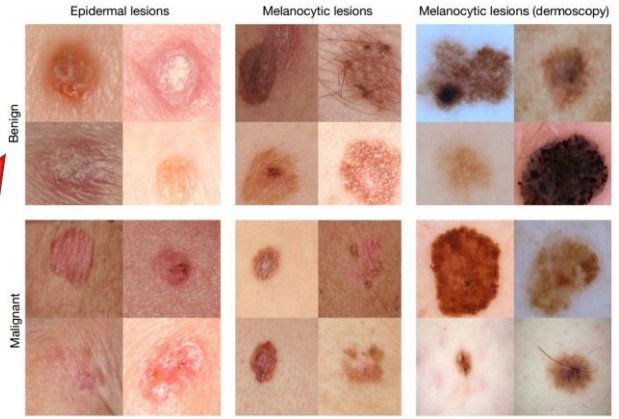
Degree of Domain Shift

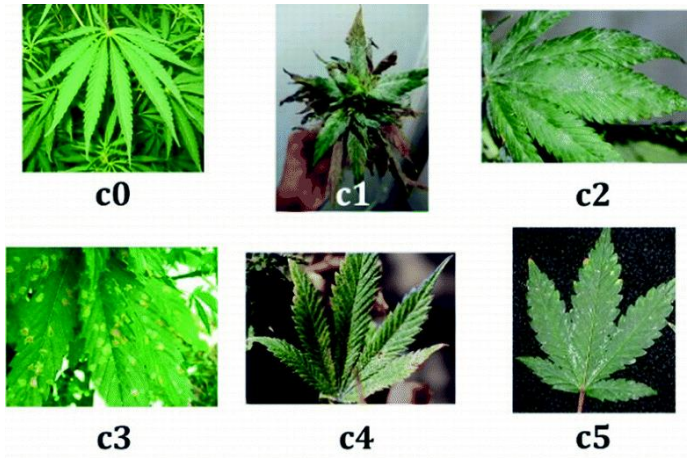
- **Degree of domain shift** is a measure of how much the distributions of the source and target domains are different

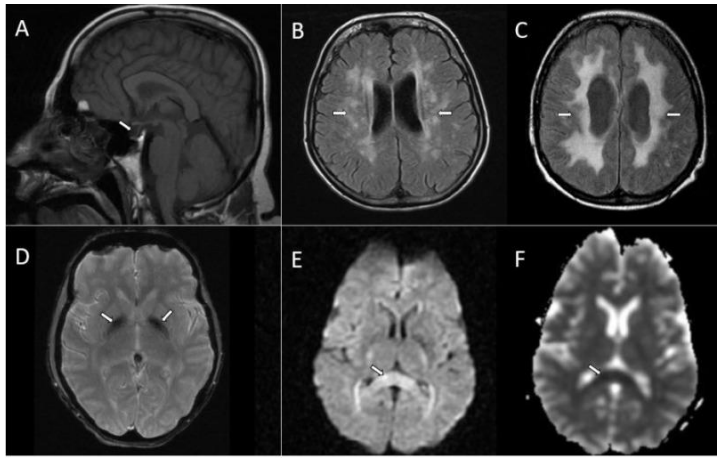
- Previous studies have revealed that the test error generally increases in proportion to the degree of domain shift.

Degree of Domain Shift

Small or large shift?

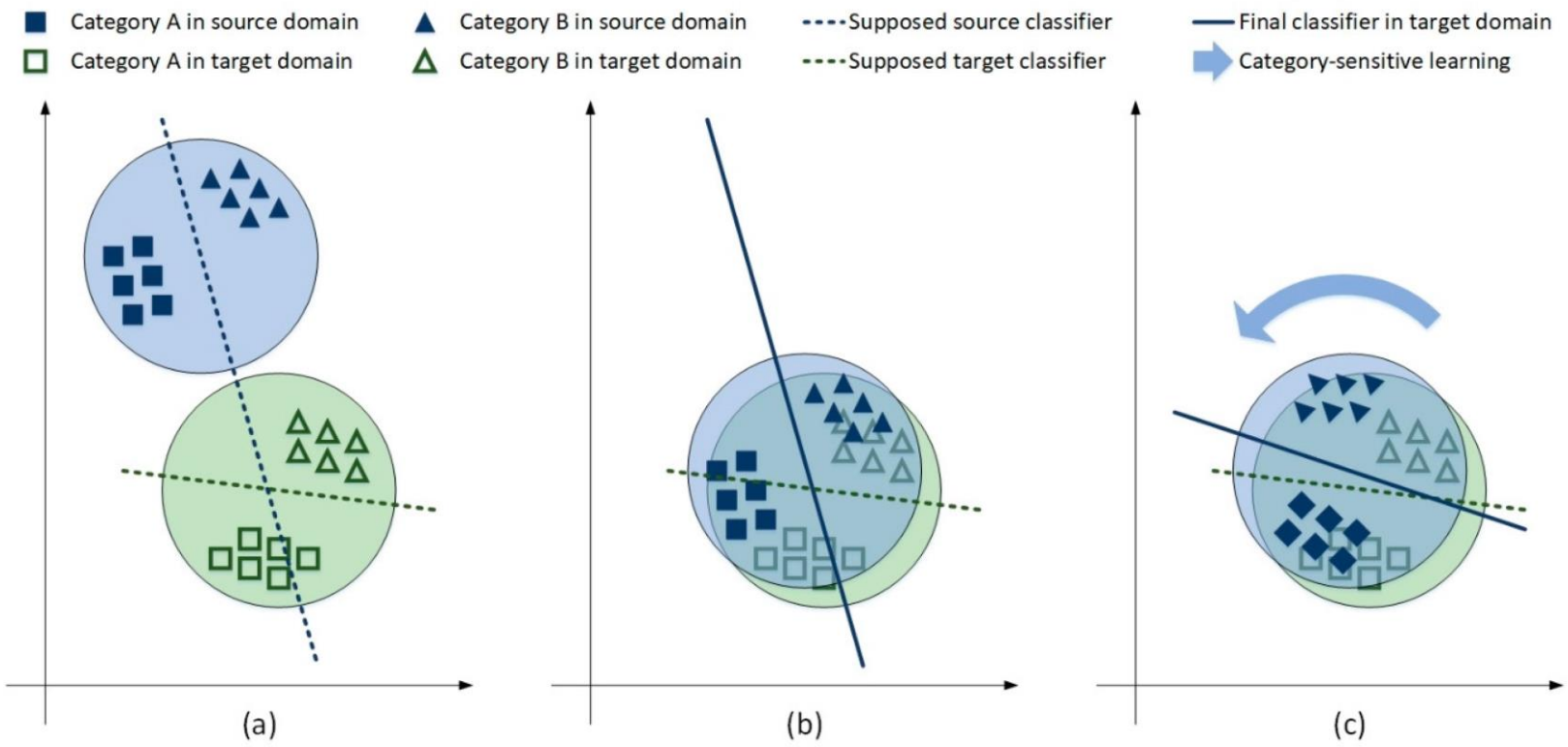






Domain Adaptation

- **Domain adaptation**: domain adaptation refers to adapting a model trained in one or more source domains to a different one or more target domains.



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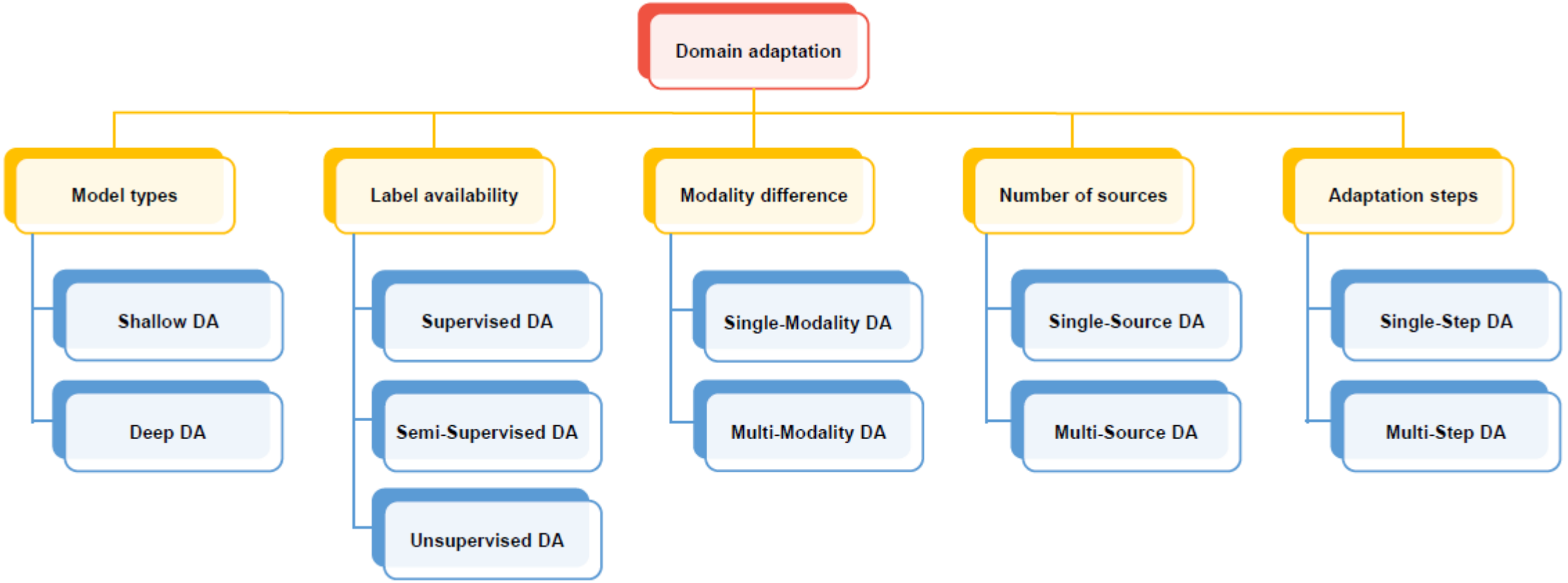
What is the difference between domain adaptation and transfer learning?

What is the difference between domain adaptation and transfer learning?

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

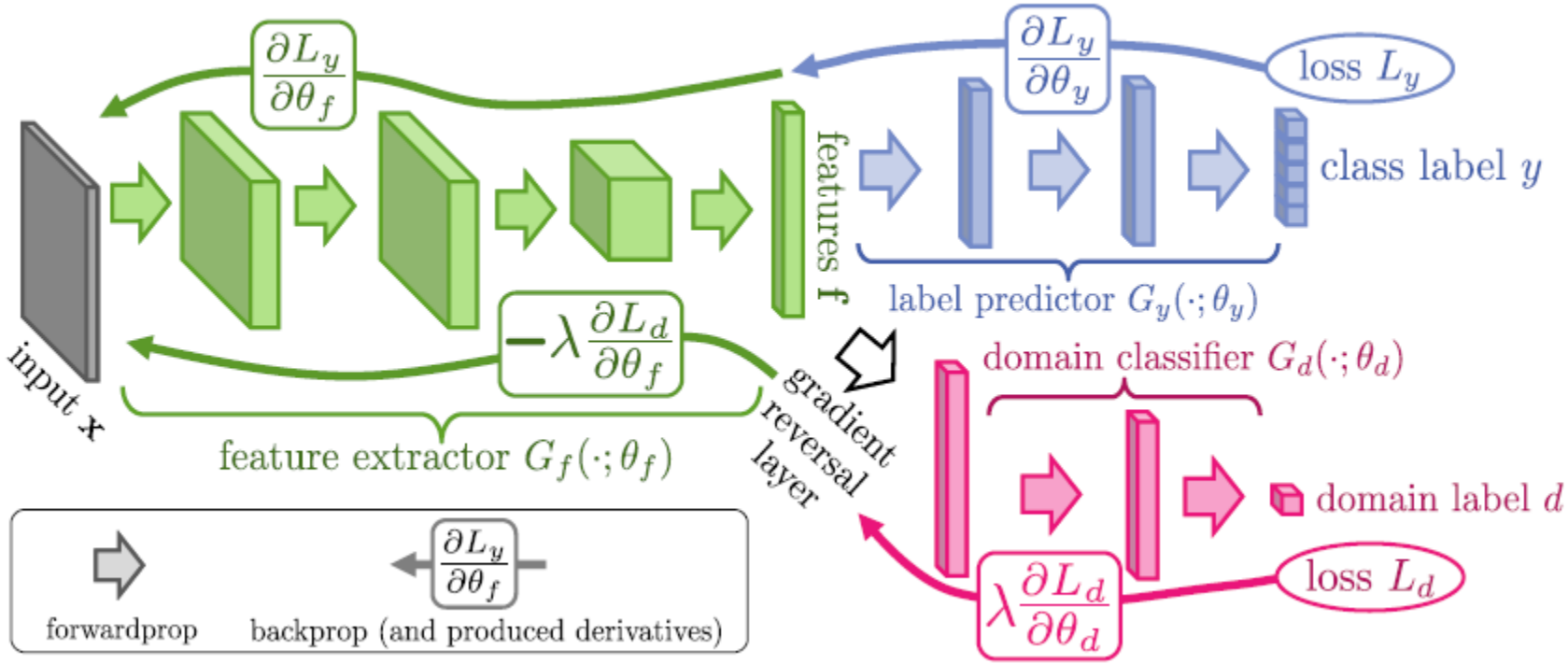
Domain Adaptation Categories



Supervised Domain Adaptation

- Essentially transfer learning
  - Fine-tune all layers
  - Fine-tune initial layers
  - Fine-tune final layers

Domain-Adversarial Training of Neural Networks (Unsupervised)



*Ganin et al., JMLR, 2016

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

To be continued…

Thank you!

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