MRI muscle segmentation and muscle disease diagnosis with deep learning

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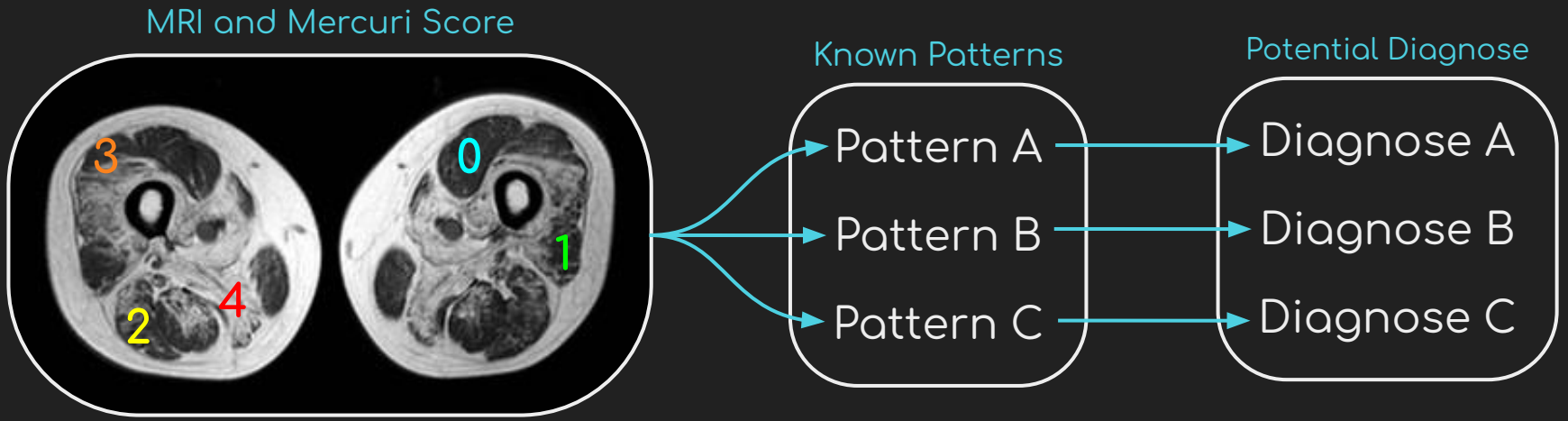
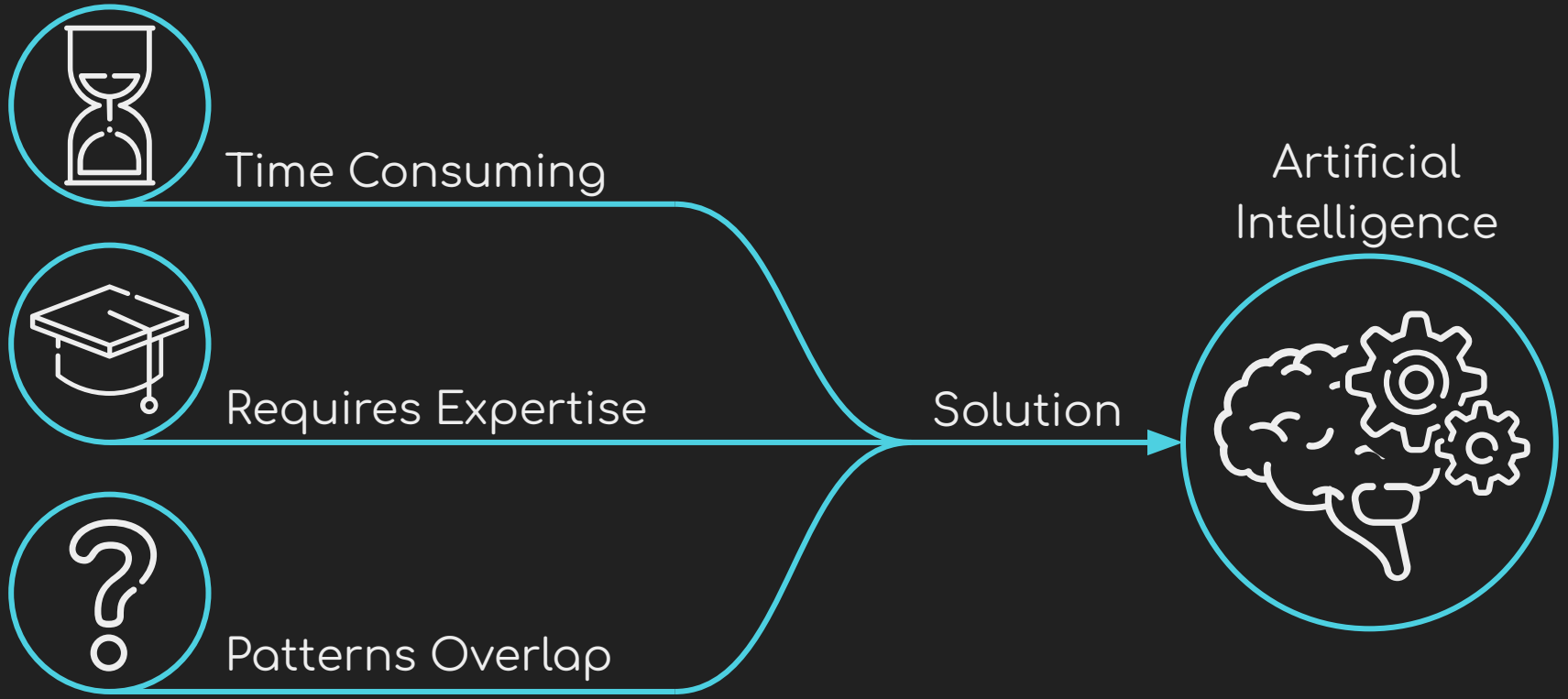
Muscle disease and quantitative MRI

- Genetic Muscle Diseases → Fat Replacement in Muscles
- Muscle MRI → Differentiate Muscle from Fatty Tissue
- Lamminen-Mercuri Scale → Quantify Fat Replacement
- Pattern of Fat Replacement → Guide the Muscle Disease Diagnosis

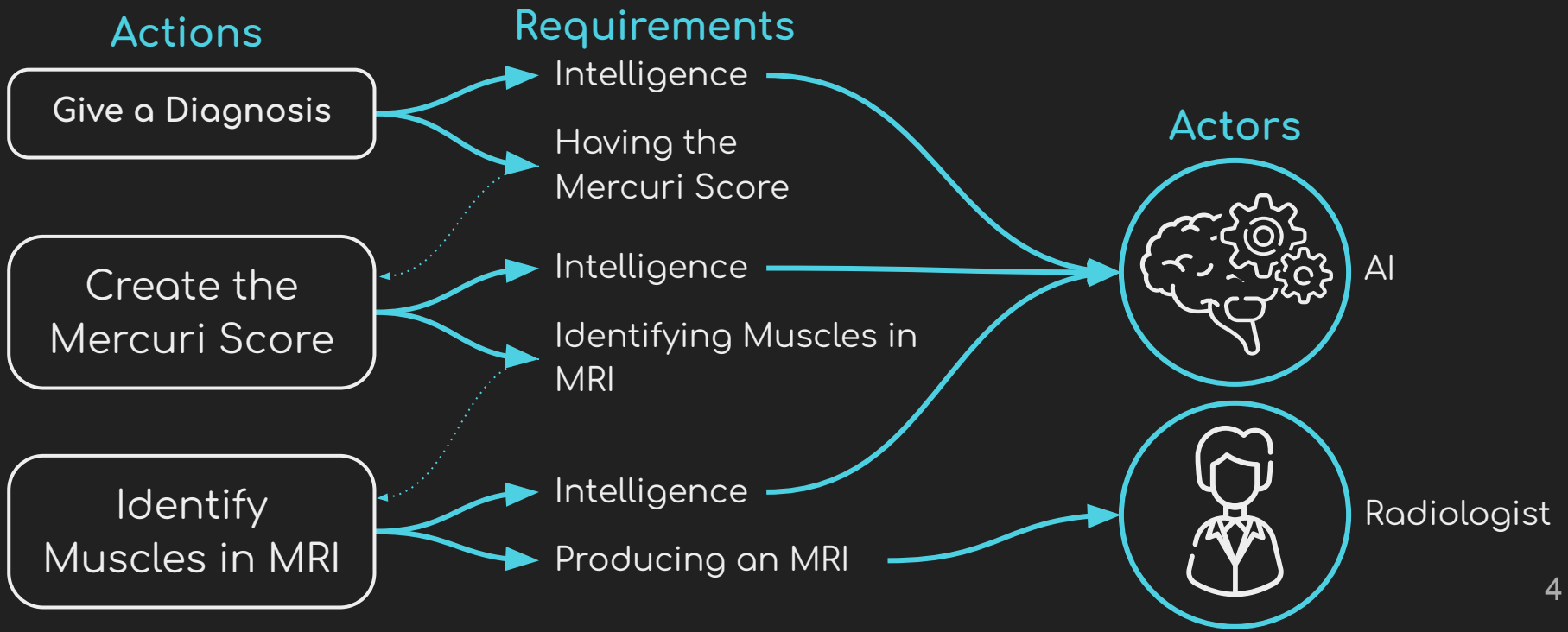


Limitations



Artificial Intelligence: How?

Deconstructing the Problem:



Artificial Intelligence: How?

Give a Diagnosis

Accuracy of a machine learning muscle MRI-based tool for the diagnosis of muscular dystrophies

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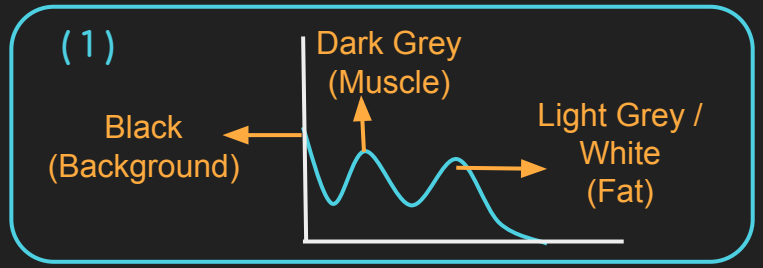
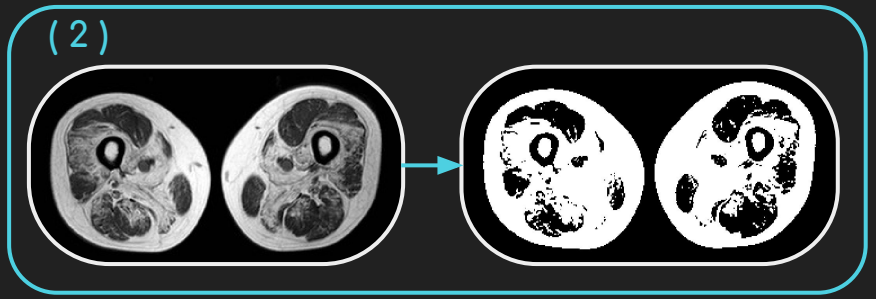
- Already done!
  - Random Forest Machine Learning model → MYO-Guide
  - Presented in the paper above
  - 976 MRI from 10 different Muscular Dystrophies (MDs)
  - 95.7% accuracy
- Improvements:
  - Include more MRI
  - Include more MDs

Artificial Intelligence: How?

Create the Mercuri Score

- **Simple Image Processing solution**
  - Find Muscle Pixel Intensity (1)
  - Find Fat Pixel Intensity (1)
  - Binarize image (2)
  - Find Fat Fraction (FF) (3)
  - Assign a Mercuri Score (4)





(3)

Muscle A:	5%
Muscle B:	42%
Muscle C:	86%

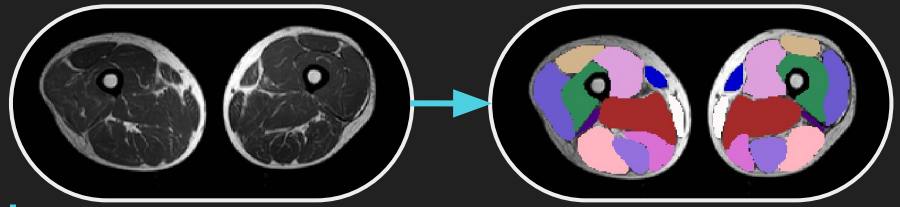
(4)

FF range	Mercuri Score
0% - 10%	0
10% - 30%	1
30% - 50%	2
50% - 70%	3
70% - 100%	4

* Example Ranges

Artificial Intelligence: How?

Identify Muscles in MRI

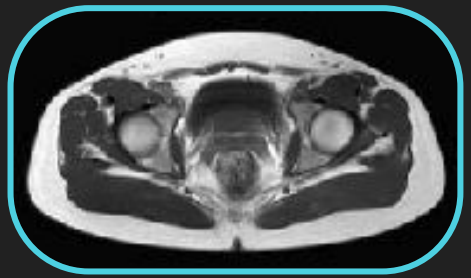


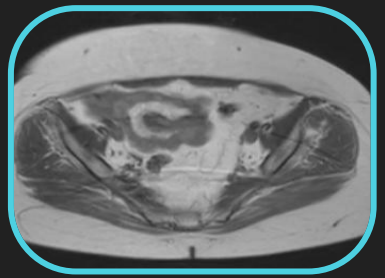
- Difficult problem:
  - Diverse Muscle Morphology
  - Highly Replaced Muscles are Hard to Segment
  - Training Data is Hard to Generate

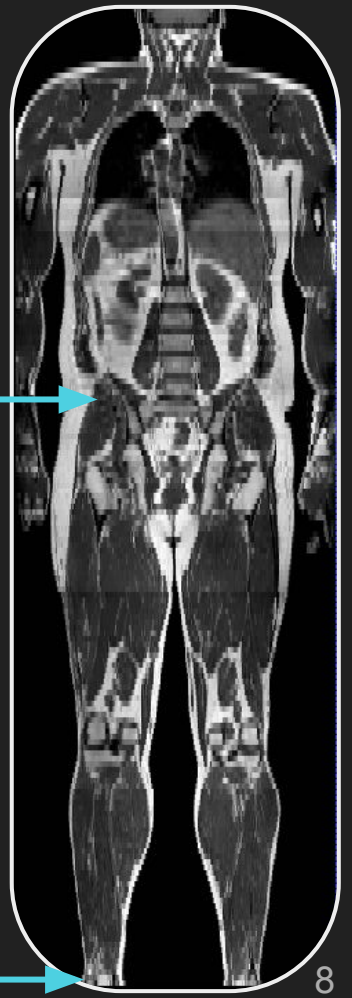
- Current Methodologies have Some Limitations:
  - Only Segment a Range of Slices
  - Trained and Tested Only with MRI from One Source
  - Don’t Work with Highly Replaced Muscles

Segmentation Objectives

- Segment any Slice Under Pelvis and Over Ankle
- Segment MRI from any source
  - Different image quality
  - Different image resolution
  - Different image contrast

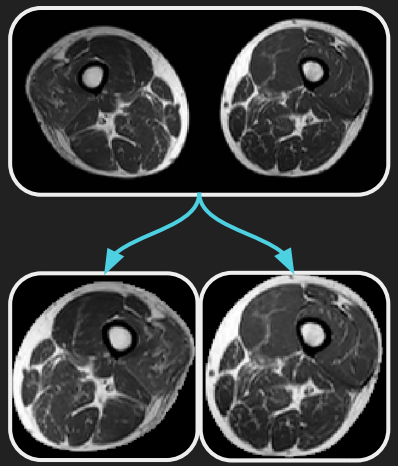


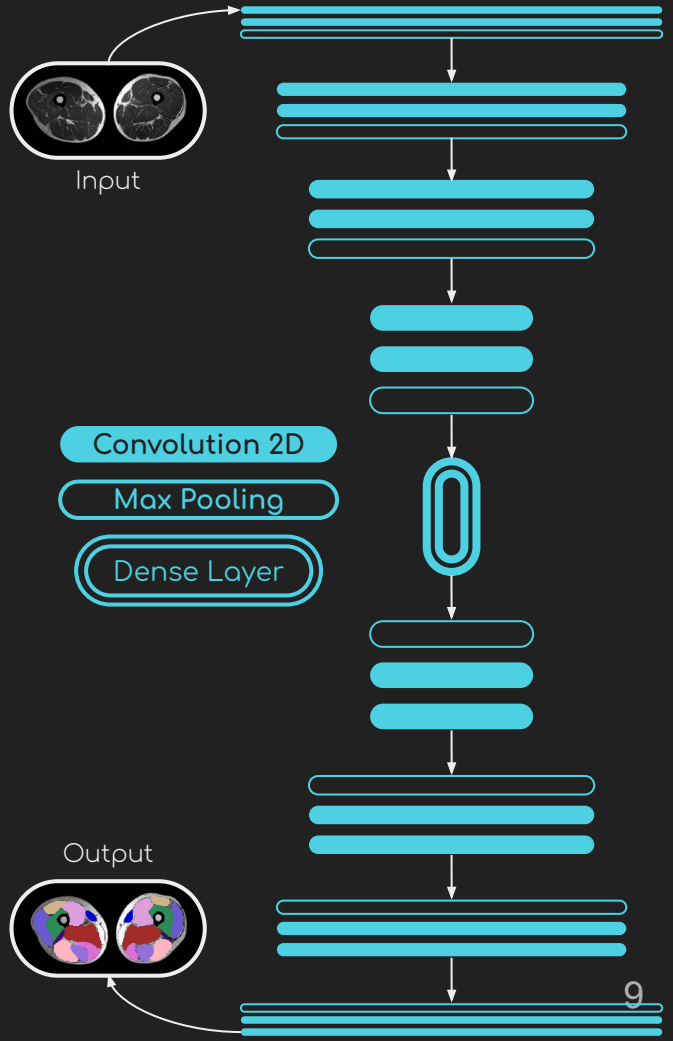




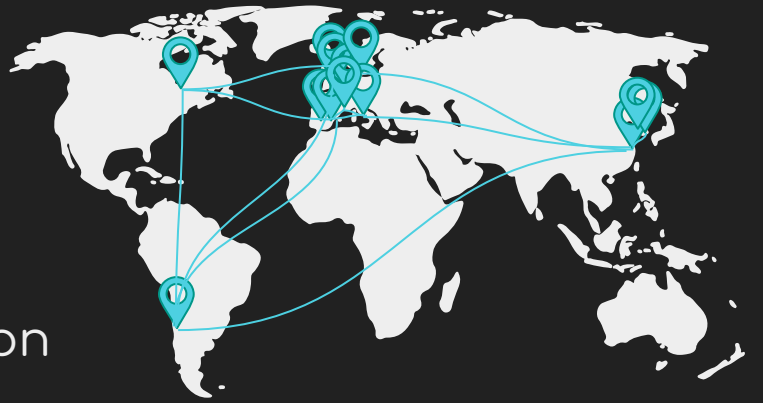
Methodology

- V-Net based Convolutional Neural Network
- Semiautomatic Algorithm to Split Legs
  - Double the Amount of Data
  - Lower the Segmentation Complexity
- Data Augmentation
- Transfer Learning using Pre-Trained Weights on ImageNet





Collaboration



- Currently 16 collaborating centres
- Currently 187 MRI collected → Segmentation
- Currently 1249 (+187) Mercuri Scores → Diagnosis

- Integrate all AI Tools into MYO-Share
- Open Portal with the Aim of:
  - Collecting and Sharing MRI
  - Offering Tools for Segmenting MRI
  - Offering Tools for Diagnosing Muscle Diseases

MYO-SHARE