

Transfer Learning

Week 12 – Advanced Topic 4

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Overview

- What is transfer learning?
- Motivation
 - When/why can you use it?
 - Different strategies
- How does it work?
- Pre-process (Keypoints)
- Methodology
- Results
- Conclusion

What is Transfer Learning?

A technique that enables a previously trained machine learning model to be repurposed for a new and related task

The idea is to keep *parts* of the previously model to speed up training and accuracy of the new model

Why use transfer learning?

- Leverage an existing neural network architecture that works well on problems similar to your own.
- Leverage a working model which has **already learned** patterns on similar data to your own. Great results with **less custom data**.

Training from scratch or using transfer learning?

<https://arxiv.org/abs/2106.10270>

"We also perform an in-depth analysis of the transfer learning setting for Vision Transformers. We conclude that across a wide range of datasets, even if the downstream data of interest appears to only be weakly related to the data used for pre-training, transfer learning remains the best available option. Our analysis also suggests that among similarly performing pre-trained models, for transfer learning a model with more training data should likely be preferred over one with more data augmentation."

Why it is important?

- **Limited Data**

- Getting labeled data is tough and costly.
- Transfer learning uses pre-trained models to reduce the need for large datasets.

- **Enhanced Performance**

- Using pre-trained models leads to faster and more accurate results for new tasks.
- Ideal for applications that need high accuracy and efficiency.

- **Time and Cost Efficiency**

- Transfer learning reduces training time and saves resources by using existing models.

- **Adaptability**

- Models trained on one task can be adjusted for similar tasks.
- Useful for applications like image recognition and natural language processing.

Transfer learning strategies

- **Transductive Transfer Learning**

- Moves knowledge from one area to another similar area.
- Focuses on the new area with little labeled data.
- Quick at finding patterns because source and target data are alike.
- Example: Using a model trained on product reviews to analyze movie reviews.

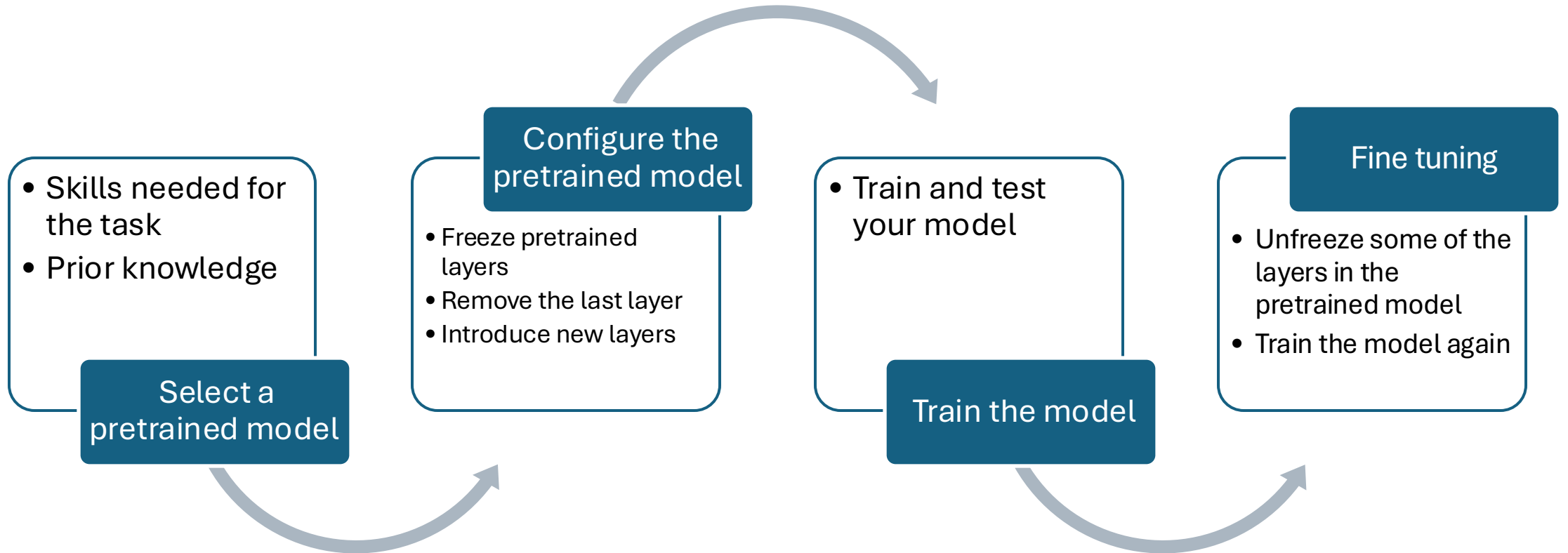
- **Inductive Transfer Learning**

- Works with the same data type but for different tasks.
- Pre-trained models learn new tasks faster.
- Example: A vision model trained on many images to recognize objects.

- **Unsupervised Transfer Learning**

- Uses unlabeled data in both areas.
- Learns common features to perform better in new tasks.
- Example: Training on unlabeled vehicle images to then identify motorcycle types in traffic.

Transfer Learning Process



Transfer learning code pipeline

PyTorch transfer learning tutorial:

https://www.learnpytorch.io/06_pytorch_transfer_learning/

Let's look at an example for an image classification task!

<https://github.com/maria-t/transfer-learning.git>

Keypoints

- Pretrained models receive as an input annotated images.
- Highlight regions/points of interest (annotation).
- Huge amount of data during training process.



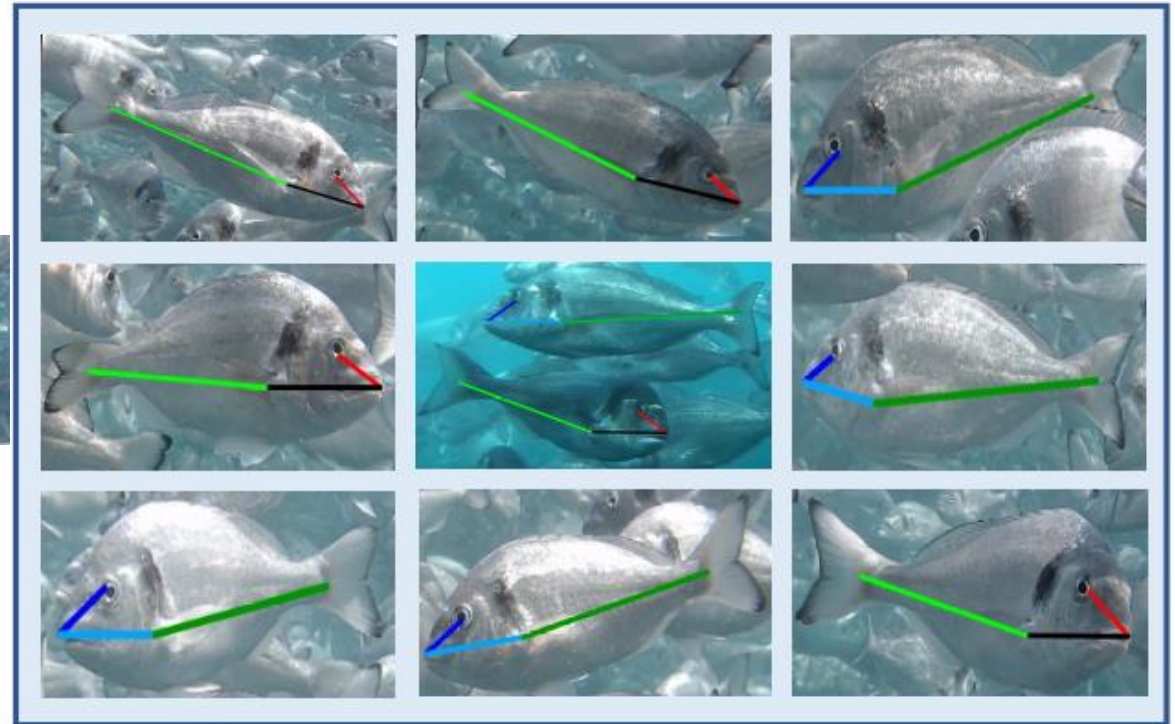
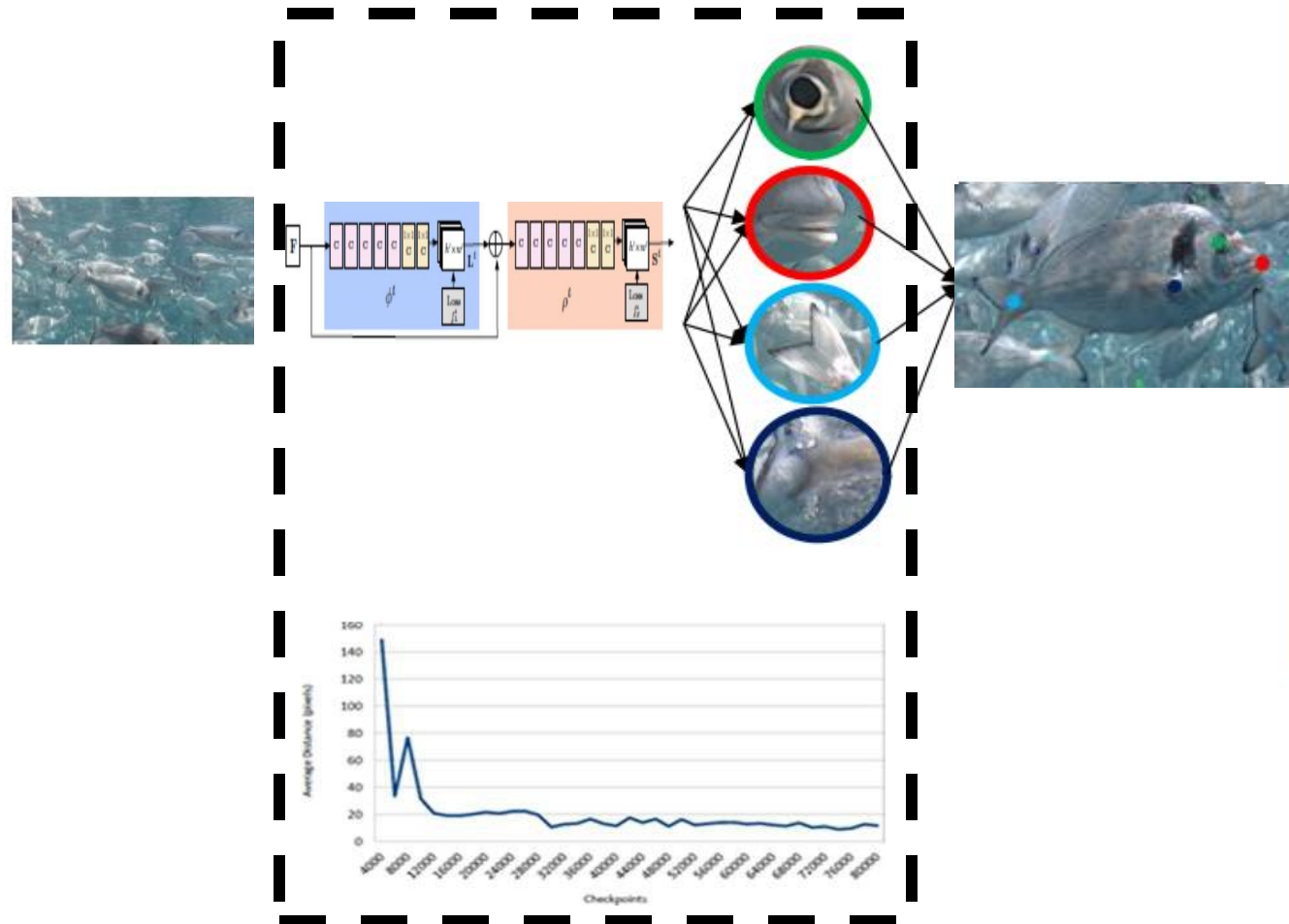
Example of an annotated image.

Method

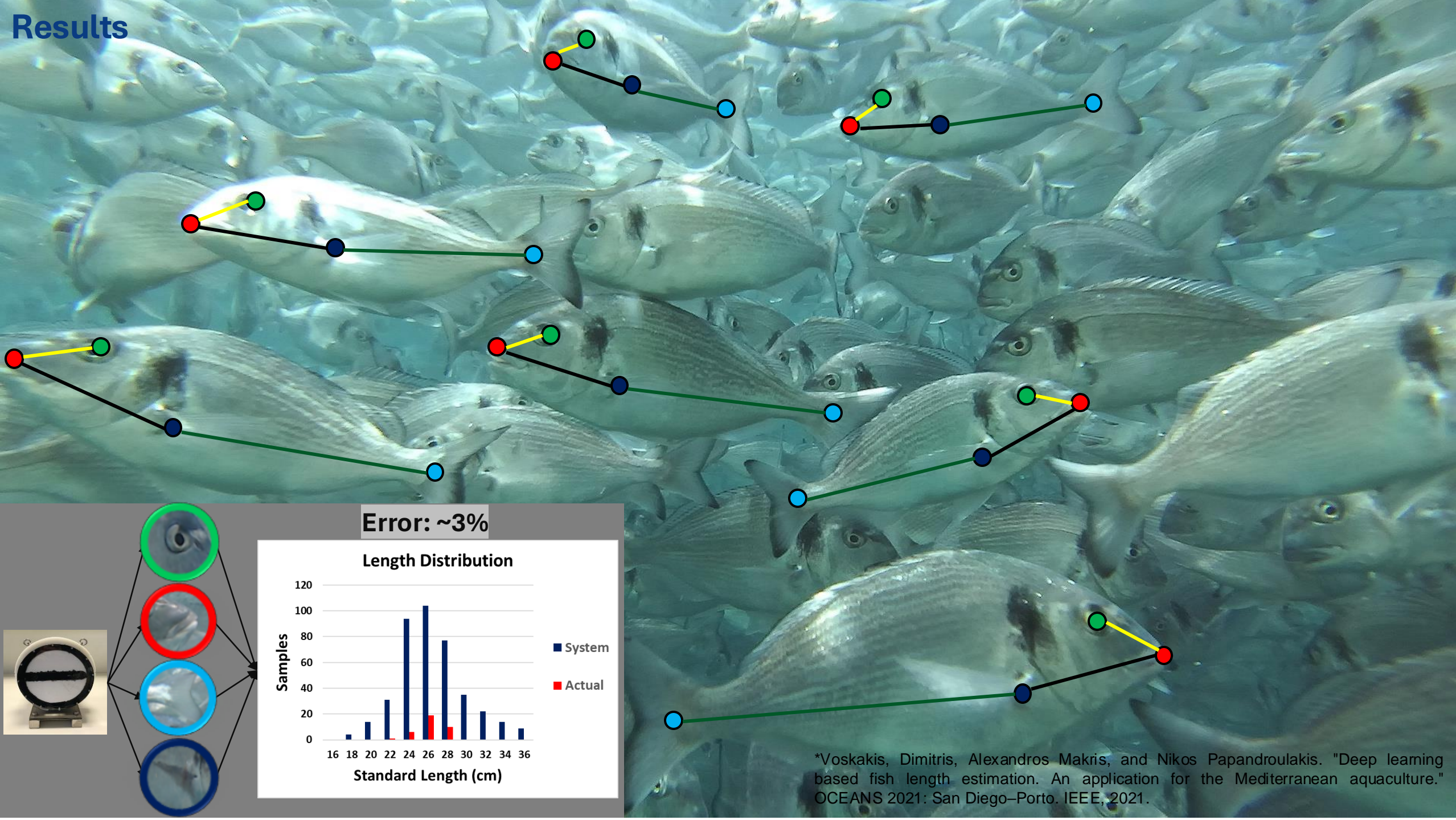
Rectified Images
(Input)

Keypoint extraction
(Process)

Predictions
(Output)



*Voskakis, Dimitris, Alexandros Makris, and Nikos Papandroulakis. "Deep learning based fish length estimation. An application for the Mediterranean aquaculture." OCEANS 2021: San Diego–Porto. IEEE, 2021.



Conclusions

Pros

- Faster training process
- Enhanced performance on new tasks
- Higher accuracy
- Lower computational resources

Cons

- Potential domain mismatch
- Extensive fine-tuning -> Overfitting
- Limited flexibility

Conclusions

- Transfer learning is used to improve model performance
- Performs well with less data & adapt quickly to new tasks
- Reduces computational costs
- Foundation for further advances (e.g. GPT)
- Scalability across tasks and industries (e.g. health care, autonomous driving, etc.)

MAIN BENEFITS OF TRANSFER LEARNING



<https://research.aimultiple.com/transfer-learning/>

Thank you!