HRNET SWIMMING ANALYZER

Mark Shperkin, Lead ML Engineer

Travis Shuler II, ML Research Scientist

Problem Statement

Problem: Underwater pose estimation is challenging due to occlusions from turbulence and bubbles and dynamic aquatic conditions.

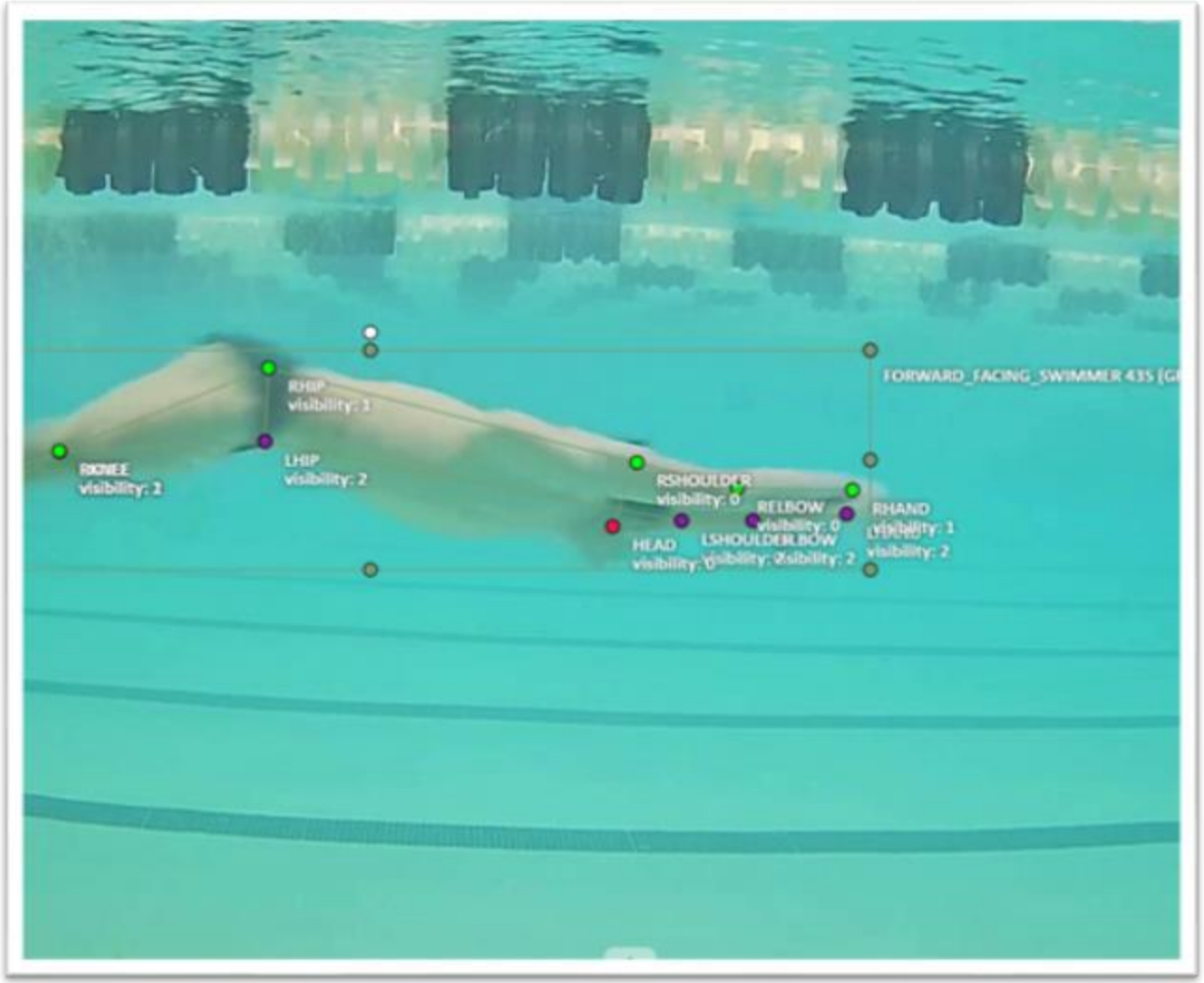
Motivation: Can enhance swimming performance and aid in biomechanical studies and injury prevention.

Inputs: Underwater Video Frames of Swimmers

Outputs: 13 key points that define the swimmer's pose.

Key Technical Challenges

- Developing the entire ML System
- Outdated online HRNET resources
- Limited Labeled Data



Related Work

EXISTING SOLUTIONS OR PREVIOUS WORK

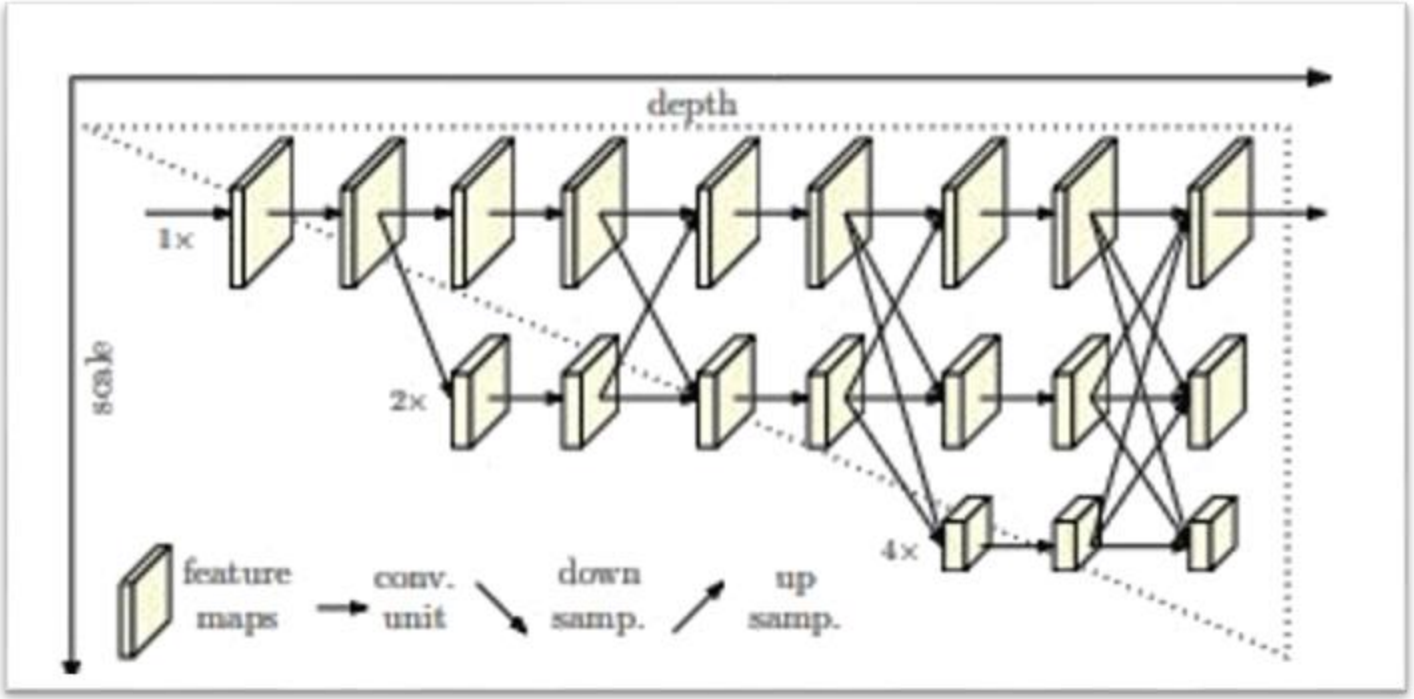
- Traditional Pose Estimation Approaches
- Other Deep Learning Architectures:
  - Hourglass Networks
  - SimpleBaseline
  - Cascaded Pyramid Networks (CPN's)
- HRNET for terrestrial or above-water
  - **Validated** on **terrestrial datasets** like COCO and MPII

HRNET UNDERWATER SWIMMING ANALYZER

- Retains High-Resolution Features Throughout HRNET Model.
- Exclusively Training on **Custom Underwater Dataset**.
- Incorporates **Visibility Annotations** for Occluded Key Points.
- Robust Generalization for Underwater Swimming Poses.

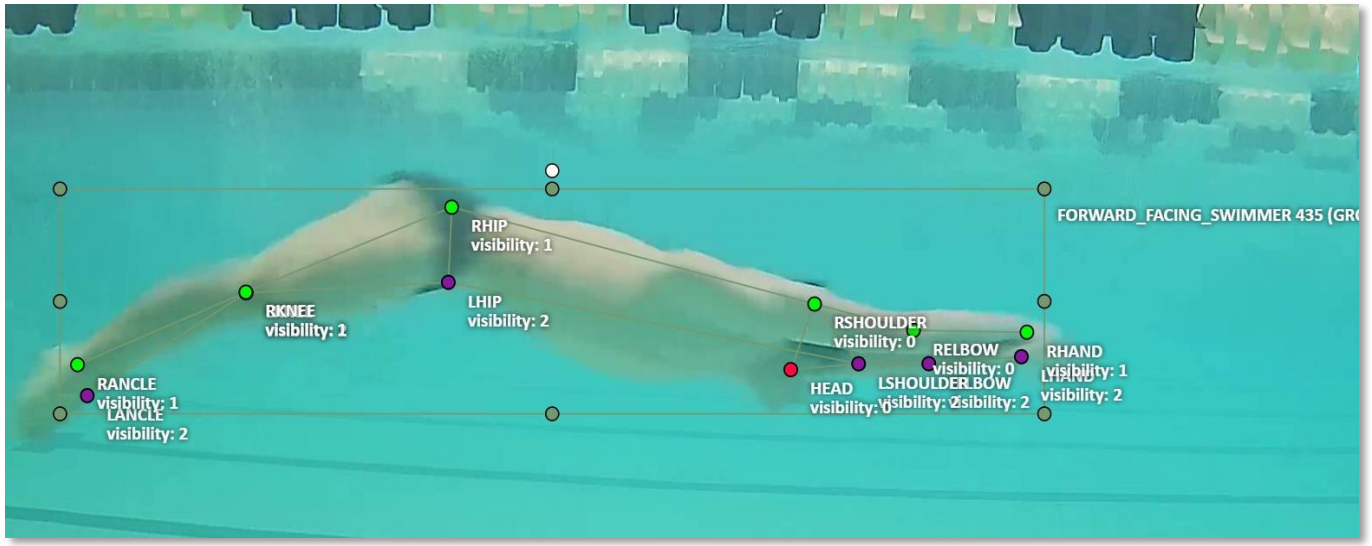
Approach using HRNET

- Leveraged HRNet-W32, a high-resolution network designed to retain spatial precision.

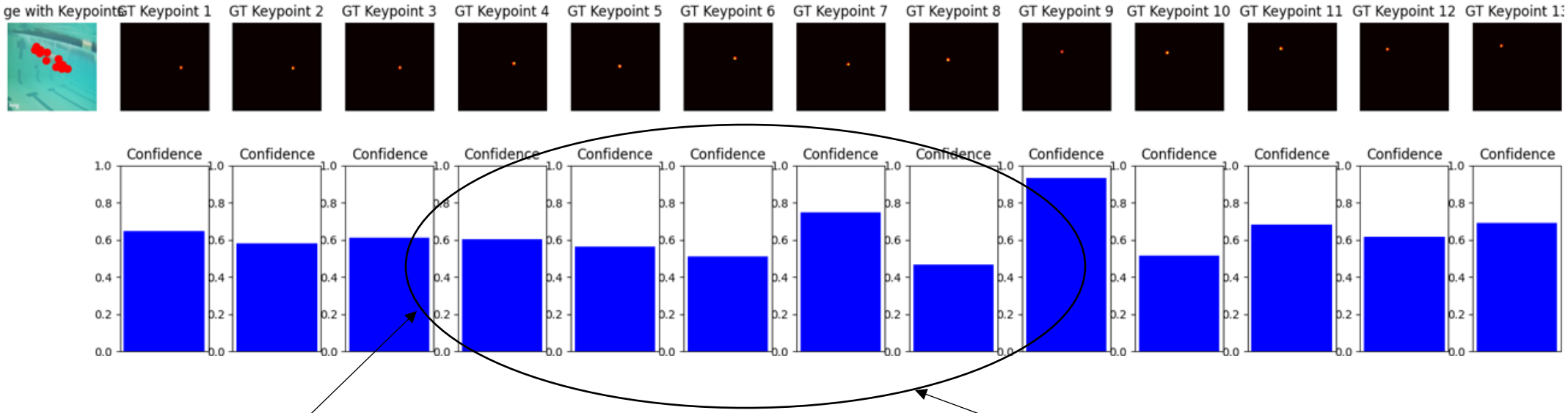


Our Innovations

- Domain Specific Dataset
- Underwater-Specific Enhancements
- Visibility Annotations



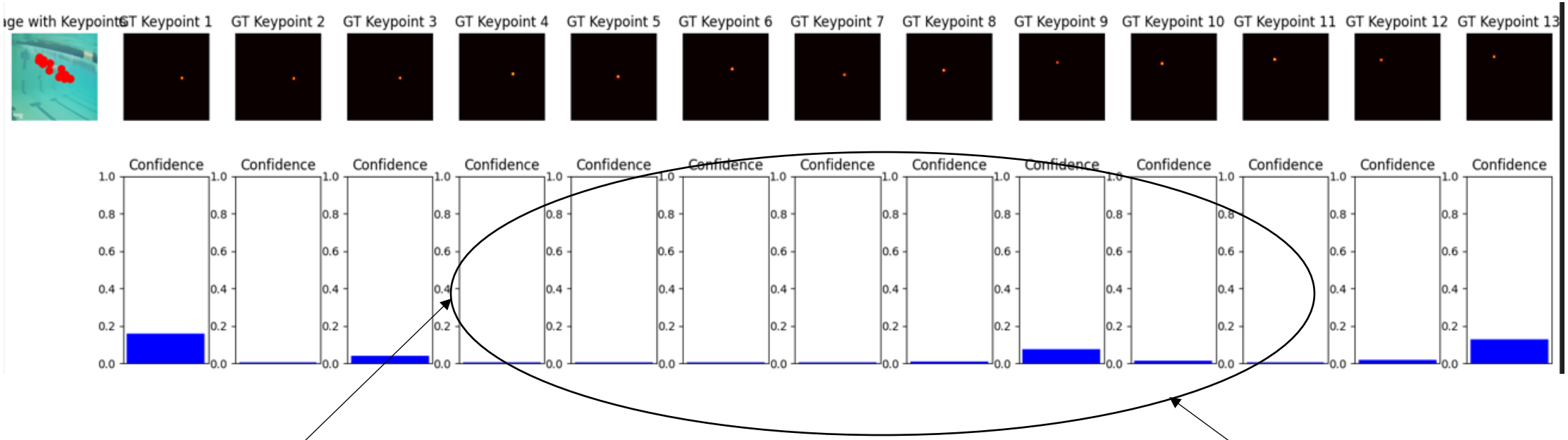
Confidence Results for 411-Frames Model



If the confidence is above 0.3 the prediction is sufficiently accurate to be displayed.

Metric: Confidence

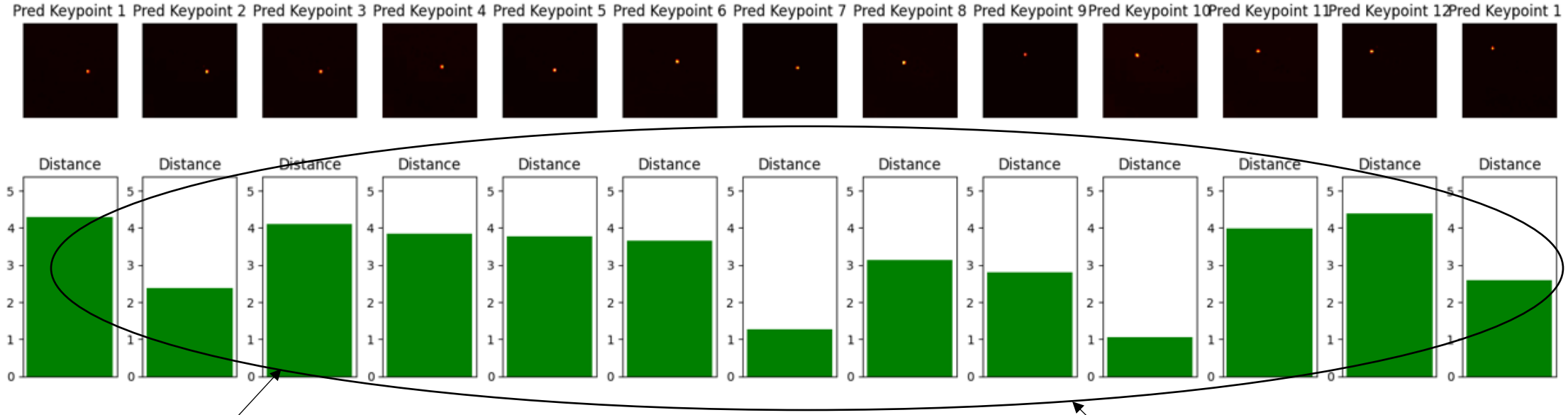
Confidence Results for 84-Frames Model



If the confidence is above 0.3 the prediction is sufficiently accurate to be displayed.

Metric: Confidence

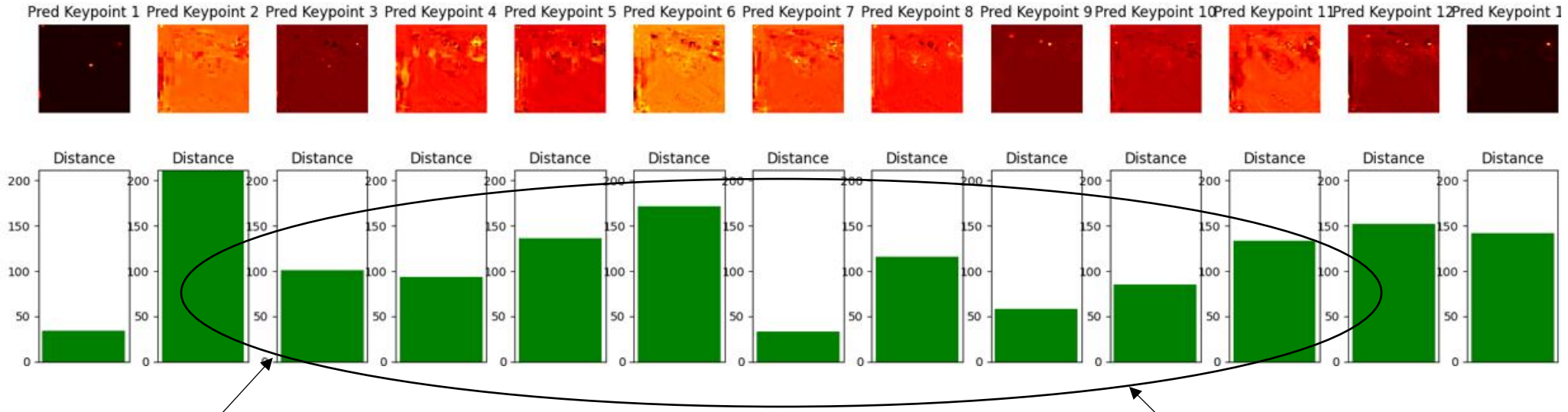
Distance Results for 411-Frames Model



Distance from the target key point to the predicted key point.

Metric: Hamiltonian Distances

Distance Results for 84-Frames Model



Distance from the target key point to the predicted key point.

Metric: Hamiltonian Distances

Broader Impact

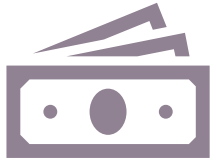
How Others Can Use Our Findings:

Swimming Performance Analysis

Biomechanics Research

Sports Injury Prevention

Adapting HRNET to Other Underwater Domains



Limitations of Our Approach

Data Size and Diversity

Computational Cost

Future Improvements

Expanding the Dataset

Multi-View Intergration

Validation Framework