



AI+EM

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SEFSC Innovation Project

In Collaboration

**AFSC, University of Washington, NGO's and
the Fishing Industry**

AI?

BASED ON YOUR
INTERNET HISTORY,
YOU MIGHT BE DUMB
ENOUGH TO ENJOY
EXTREME SPORTS.



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CLICK HERE TO BUY A
TICKET TO BASE JUMP
FROM THE INTERNA-
TIONAL SPACE STATION.



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I THINK
THE INTER-
NET IS
TRYING TO
KILL ME.



WE
CALL IT
"MACHINE
LEARNING."



Proof of Concept

- 4 types of rockfish



Blackspotted



Rougheyeye



Shortraker



Thornyhead

Test on Rockfish Dataset

- Training (*used previous ~15,000 training dataset*)
 - Blackspotted (59), Rougheyeye (15), Shortraker (21), Thornyhead (9).
- Testing
 - Blackspotted (20), Rougheyeye (5), Shortraker (7), Thornyhead (4).
- Confusion Matrix (Accuracy=91.7%)

	Blackspotted	Rougheyeye	Shortraker	Thornyhead
Blackspotted	18	1	0	0
Rougheyeye	0	4	0	0
Shortraker	2	0	7	0
Thornyhead	0	0	0	4

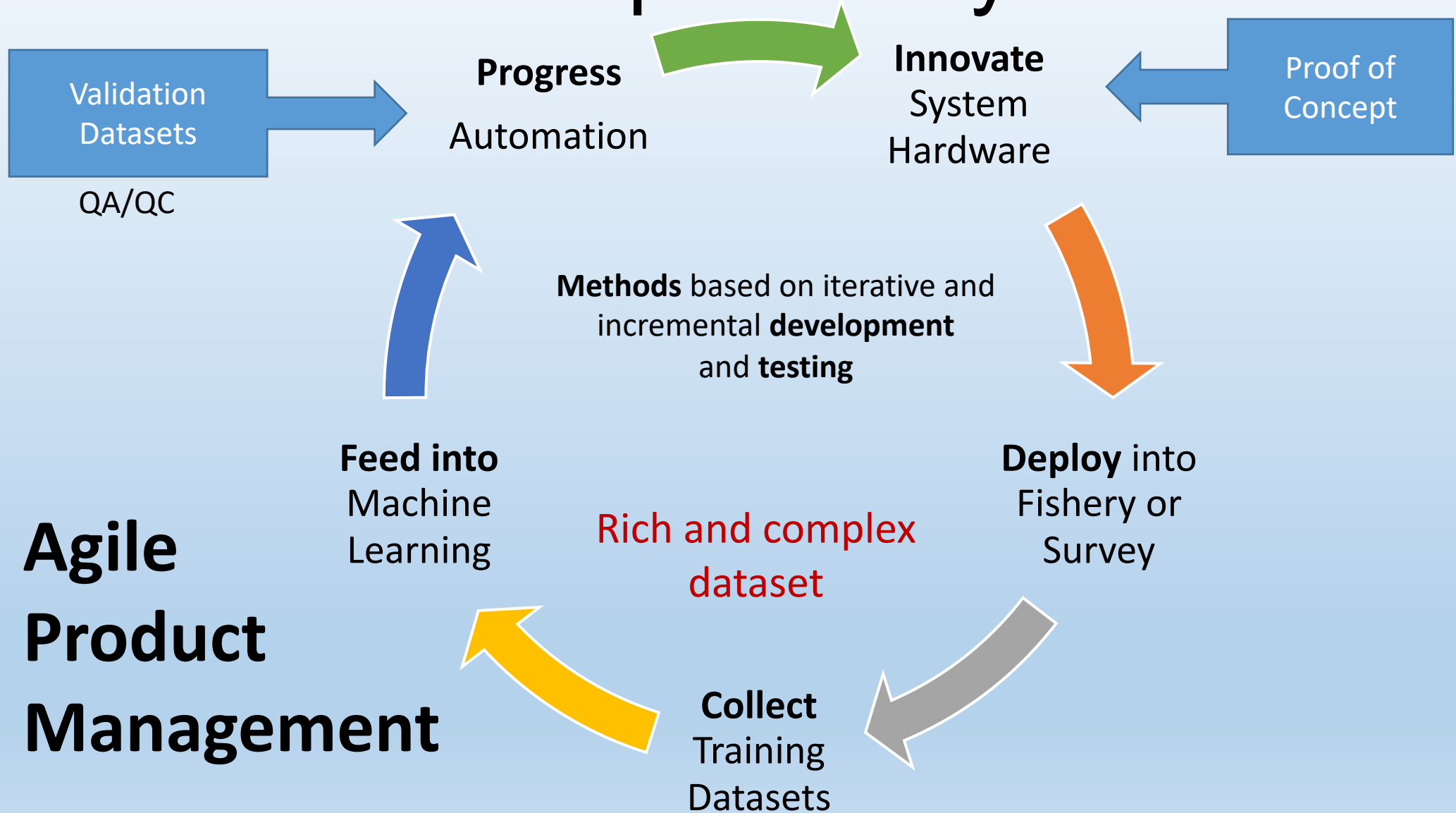
Machine Vision Systems (IMS)

- Remote monitoring systems that support the latest developments in **machine learning (AI)** to improve system functionality, reliability and timeliness of data.
- An automated system that can see, learn, process and transmit data

Cost Categories for Developing Machine Vision?

1. Collect Imagery (EM, Chute, Belt Systems, cameras)
2. Annotate imagery to create a rich training dataset.
3. Feed these data in ML algorithm(s).
4. Hardware development and implementation.

Iterative Development Cycle



Guidelines for Developing Automation

1. The scale of the data needs to reasonably capture the complexity of the problem.
2. Big data must be accurate.
3. At minimum you need an ML algorithm that captures the discriminating information.

Guidelines for Developing Automation

4. The more complex the algorithm the greater the processing power/time required.

5. There is a delicate balance in **dedicating resources** between Algorithm development and collecting more data.

6. Use multiple sources of information (human versus machine) to **validate your system**

UW Annotation Software

The screenshot displays the UW Annotation Software interface. On the left, a video frame shows a fish, with the word "halibut" overlaid in green. A blue arrow points from the "ID" label to the "268" field in the annotation table. Another blue arrow points from the "Species" label to the "Pacific Halibut" field. A third blue arrow points from the "Confidence" label to the "1" field. A fourth blue arrow points from the "Position in Excel File" label to the "D6-T148,Y=364,Width=297,Height=7/54" field. A fifth blue arrow points from the "Number of frames for the catch event and the position of the current frame in the event" label to the "7/54" field. A sixth blue arrow points from the "If a species is Occcluded" label to the "Occcluded" checkbox. The main table lists annotations with columns for ID, species, and a checkbox. The table is filtered to show only "Pacific Halibut" entries. The table has 5 columns: ID, species, a checkbox, and two empty columns. The table contains 10 rows of data. The first row is highlighted in blue. The second row is highlighted in light blue. The third row is highlighted in light blue. The fourth row is highlighted in light blue. The fifth row is highlighted in light blue. The sixth row is highlighted in light blue. The seventh row is highlighted in light blue. The eighth row is highlighted in light blue. The ninth row is highlighted in light blue. The tenth row is highlighted in light blue.

ID	species			
268	Pacific Halibut	1		

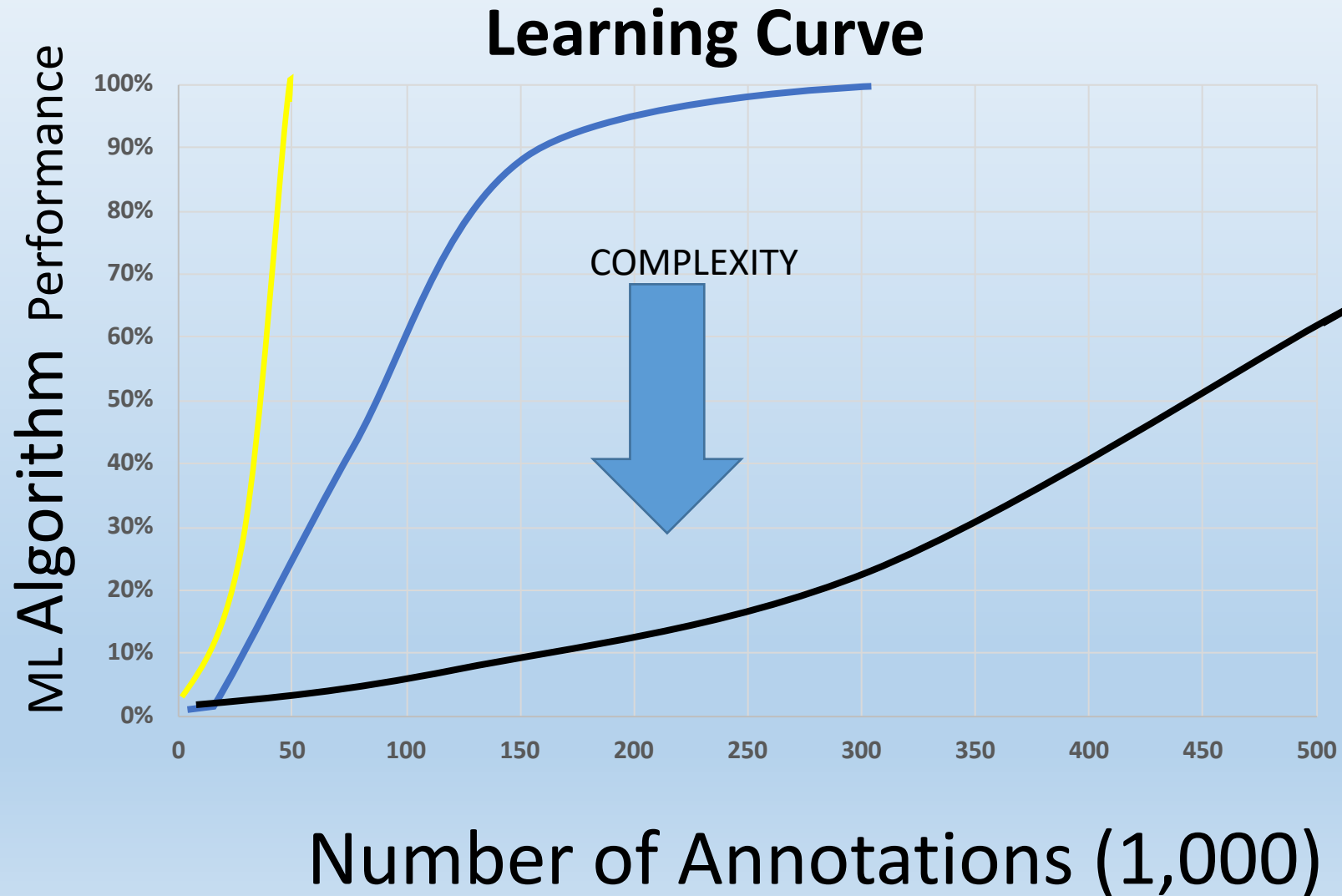
Annotations:

- ID: 268
- Species: Pacific Halibut
- Confidence: 1
- Position in Excel File: D6-T148,Y=364,Width=297,Height=7/54
- Number of frames for the catch event and the position of the current frame in the event: 7/54
- If a species is Occcluded: Occcluded

Table:

ID	species			
246	Spiny Dogfish Shark			
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How many annotations do I need for training?



Large Annotated Datasets Required: Longline Fisheries

- 35,300,000 # frames collected from 184 hauls
- 50,000 # frames processed per week
- 706 # of weeks to process
- 14 # of years to process

How do you annotate all those images?

Semi-automated annotation tools

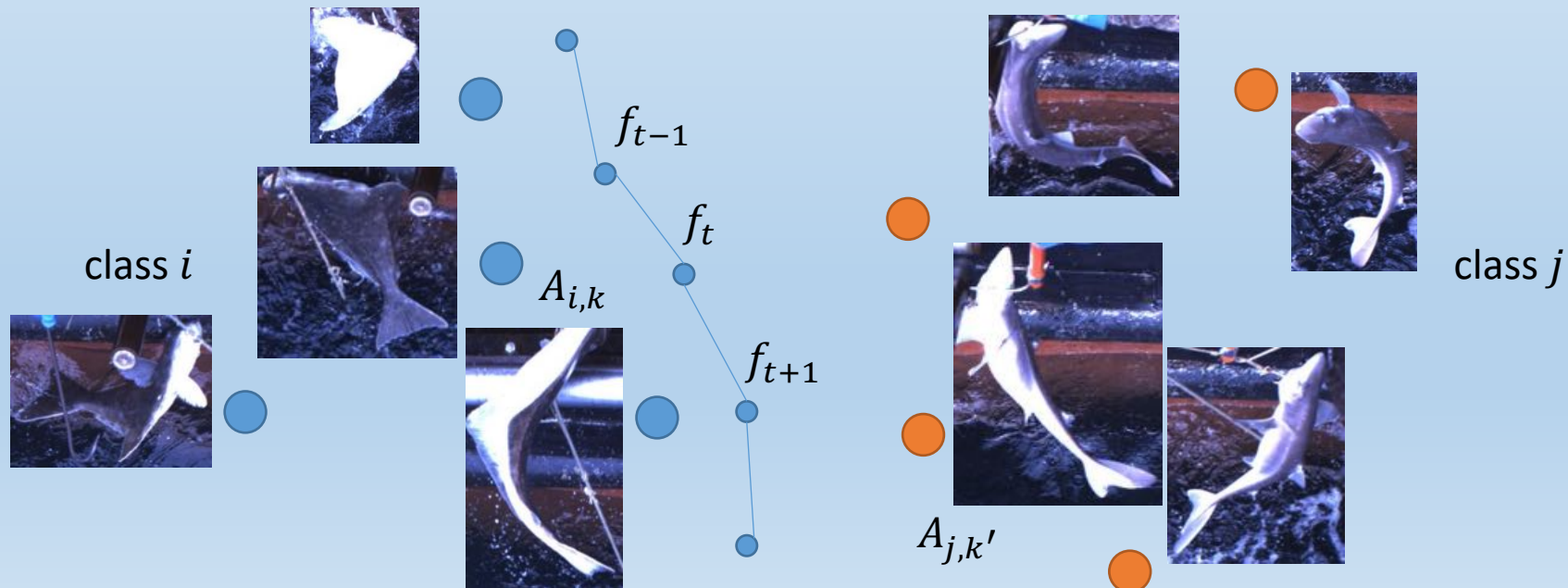
Strategic sub-sampling of data

Query Learning/Unsupervised Learning (DL)

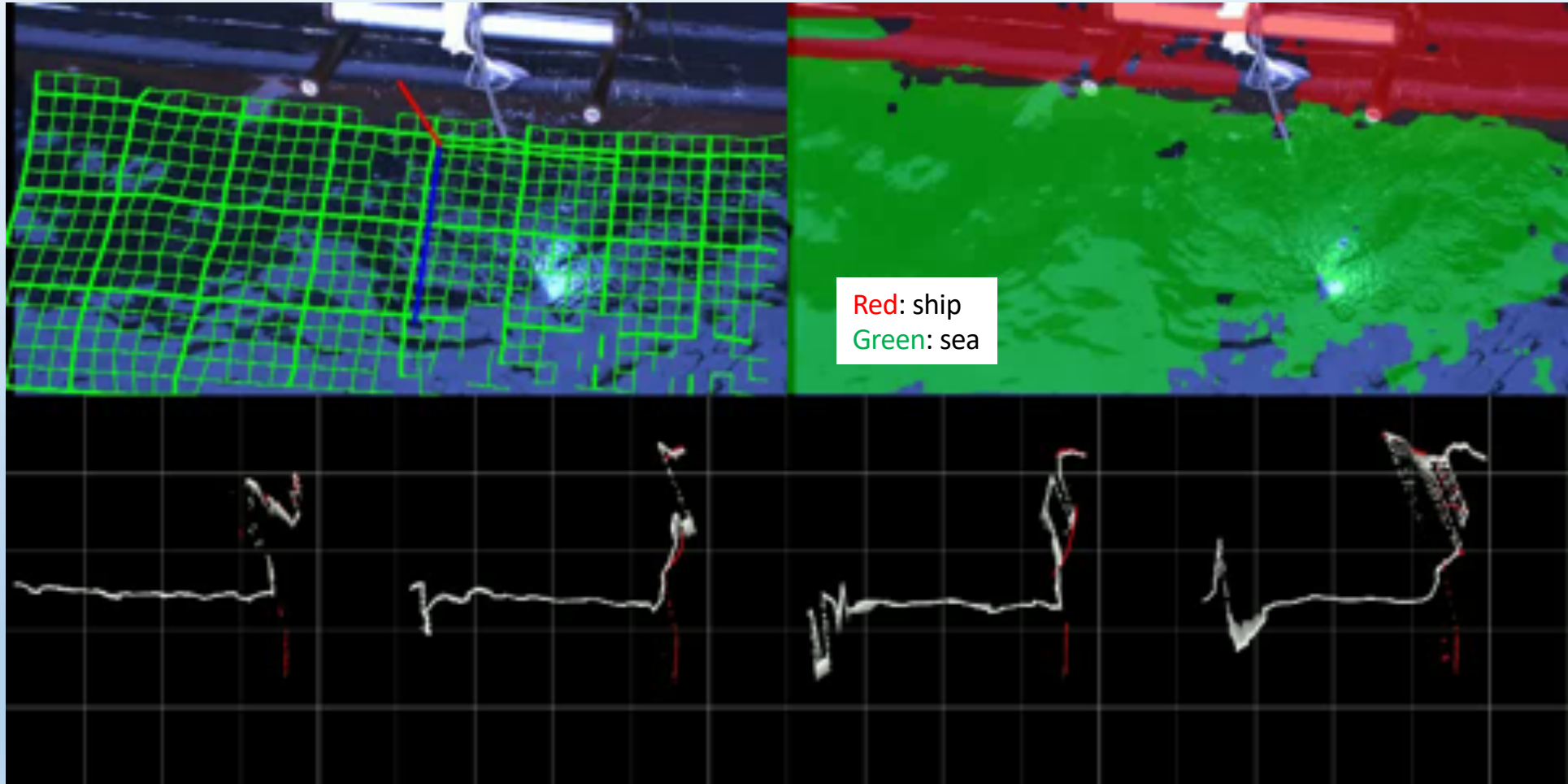
Metric Learning with Multiple Representative Features

- To deal with intra-class variance
- For class i , define K representative feature vectors $A_{i,k}$ for intra-class variance:

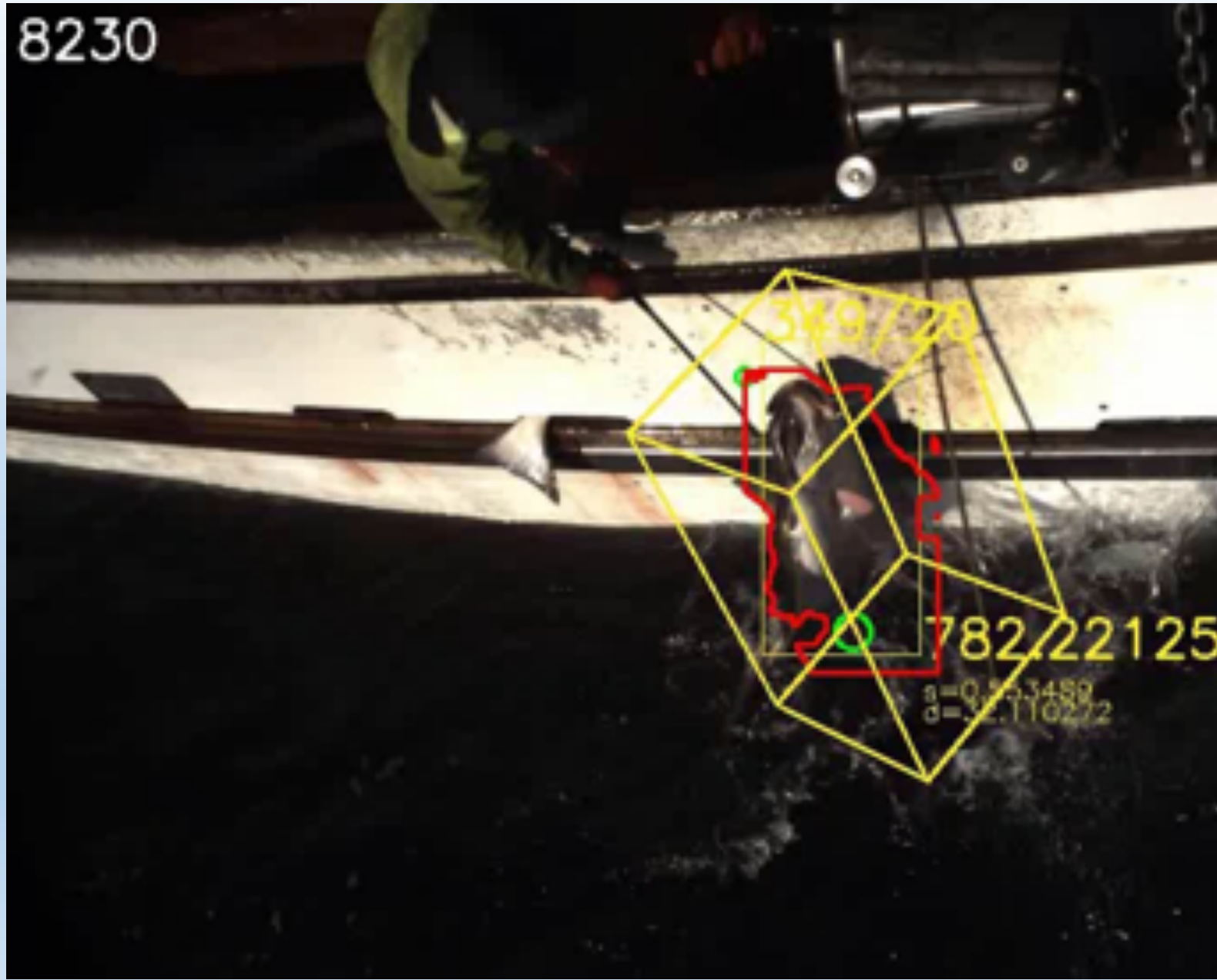
$$L_R(f_t) = \max\left(\min_k d(f_t - A_{i,k}) - \min_{j,k'} d(f_t - A_{j,k'}) + \beta, 0\right)$$



Identifying Catch Events



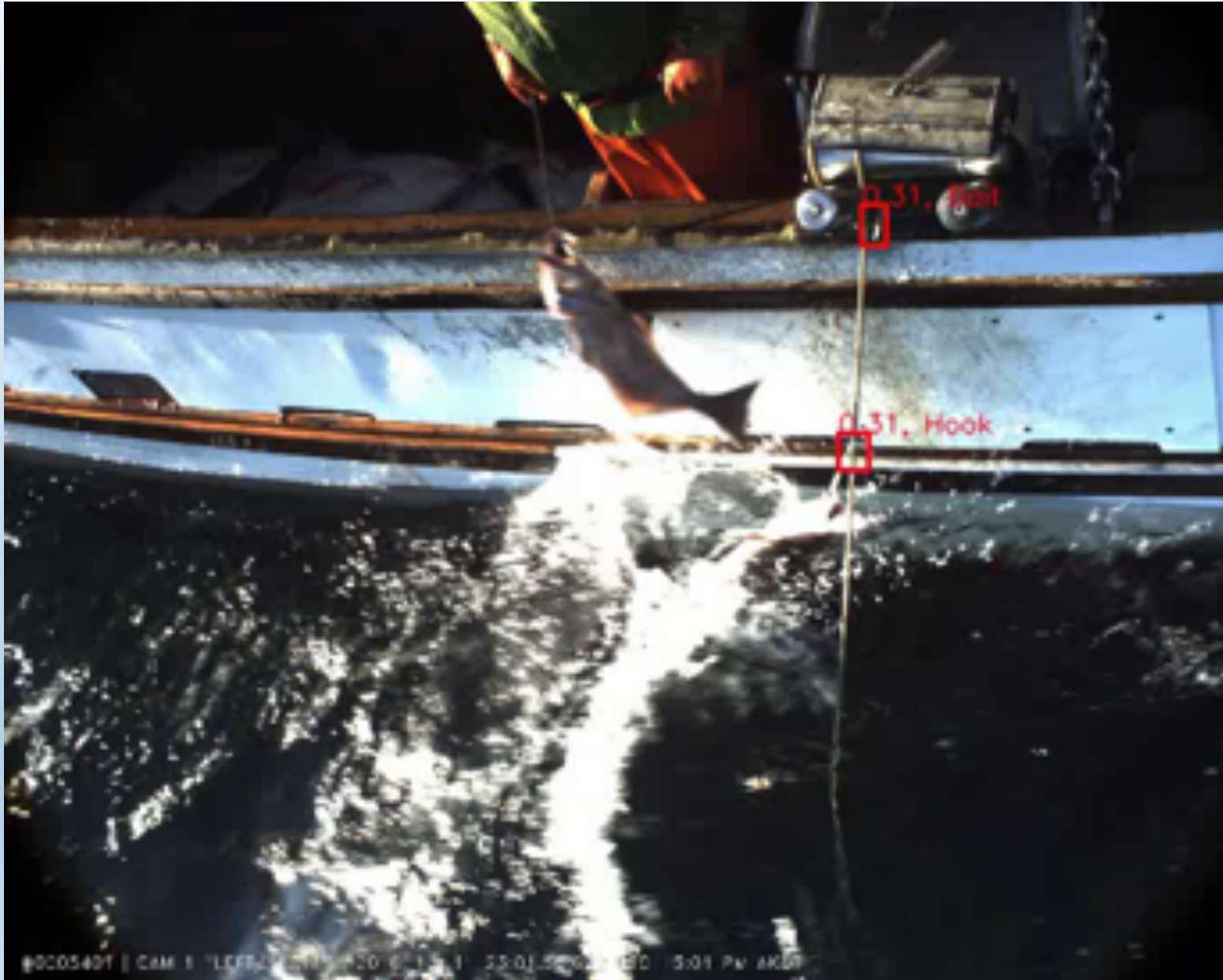
3D bounding box for size estimation

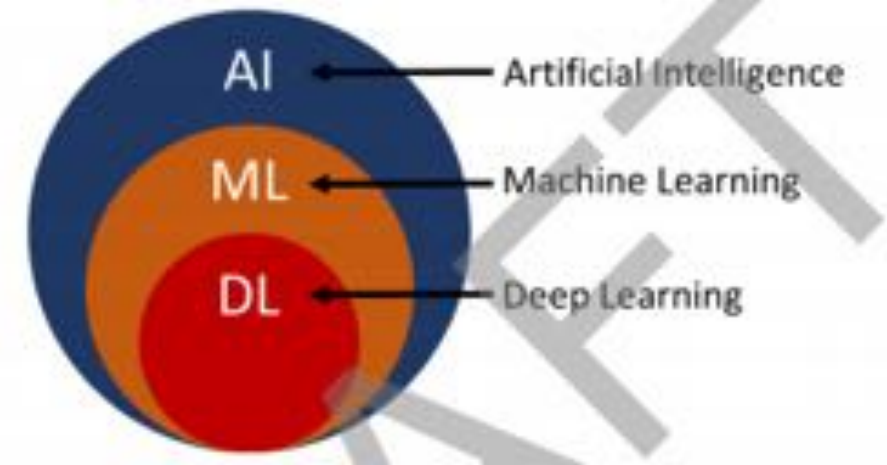


What's Next?

- Distribute the knowledge and design of systems that collect and analyze imagery.
- Provide access to open source Machine Learning algorithms to promote development of automation in other fisheries (VIAMI, GitHub)
- Provide Access to machine vision Stereo Camera systems to promote automation and development of 3D vision systems to estimate size and volume measurements.

Questions?





The NOAA AI Strategy will dramatically expand the application of artificial intelligence (AI) in every NOAA mission area by improving the efficiency, effectiveness and coordination of AI development and usage across the agency.

AI methods will provide transformative advancements in the quality and timeliness of NOAA science, products, and services: are already demonstrating significant improvements in performance and skill at vastly reduced costs and compute time.