FISHNET VISION: IMPROVING BIODIVERSITY THROUGH AI

NTT DATA Portugal

12th NTT Sustainability Conference

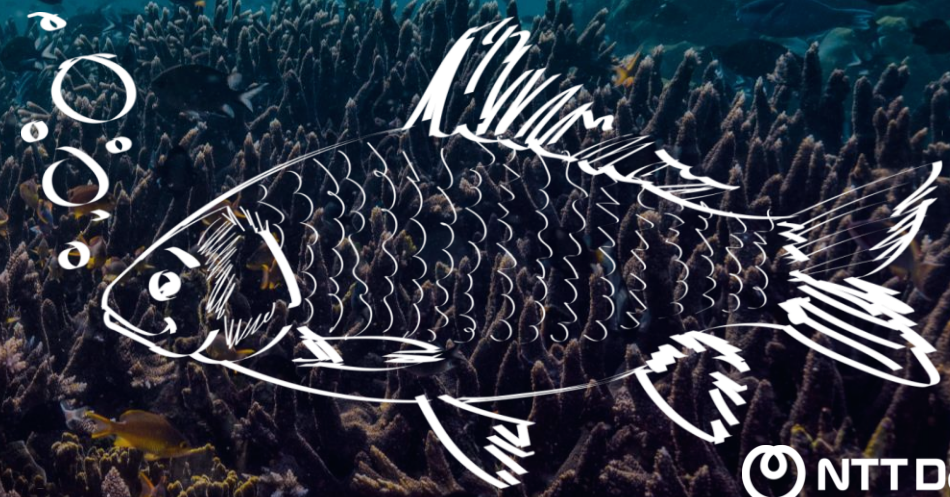
On a leading utilities company in Iberia, sustainability matters…

Fishways are crucial because they

- Promote genetic diversity by connecting fish populations
- Allow fish to reach their natural spawning grounds

Counting fish in fishways is useful and required by law

- Legal and regulatory compliance
- Fish population monitoring for conservation efforts
- Scientific research on biodiversity & food web dynamics



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But there are challenges…

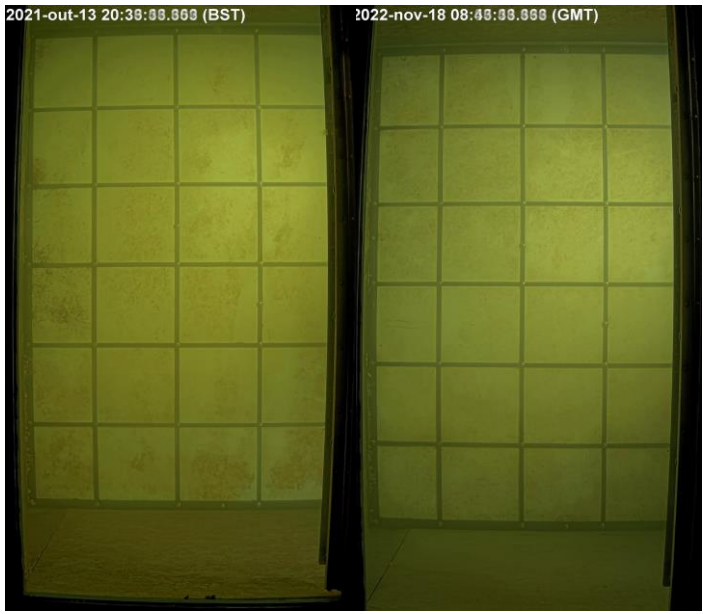
It’s challenging to count fish for both humans and AI models

- Unhelpful algae on windows and background
- Uneven illuminator positioning and coverage
- Water varies from clear to very murky

And more challenges…

Dam 1

Dam 2



The dams are quite different

- Different typical color of the water
- Different camera settings
- Different illumination
- Different fish shadows
- Different fish behavior
  - Bottom swimming vs hunting
- Different species distributions
- Different rare fish

Looks don’t matter…

Intra class dissimilarity (same species can look different)

- Fish profile varies with the swimming direction
- Fish characteristics vary with age
- Fish can be obscured by other fish, algae and shadows

…but classes do!

Inter class similarity (different species can look similar)

- Different life stages, abnormal sizes
- Fins occluded by murky water or shadows
- Swimming direction, orientation and profile

The solution starts with the right team

+10

Consultants

From multidisciplinary backgrounds and experience in different areas of expertise.

THE PROFILES

- Computer Vision Specialists
- Deep Learning Specialists
- Cloud and Data Engineers
- Utilities Experts

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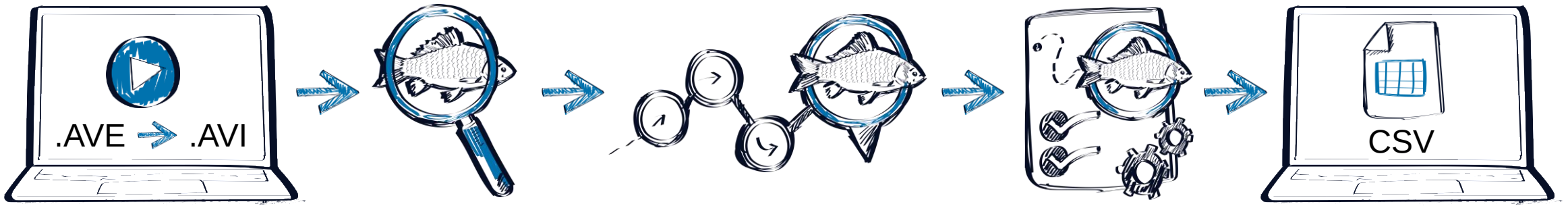
Solution Overview



Pre-processing → Detection → Tracking → Heuristics and Validation → Report

Development Process Overview

CONVERSION RPA

Convert from proprietary vídeo format **AVE** to **AVI**

PREPARATION

Transform videos to usable dataset for the model.

MODEL TRAINING

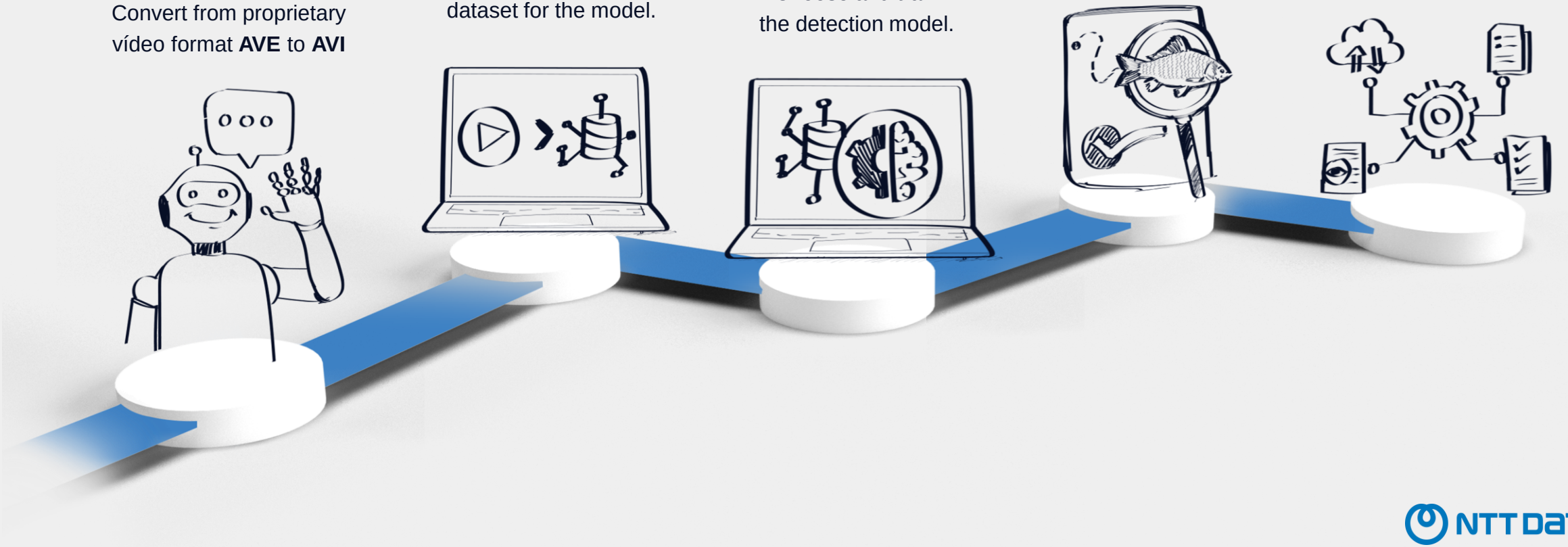
Choose and train the detection model.

IMPLEMENTATION

Implement tracking and heuristics, test and optimize

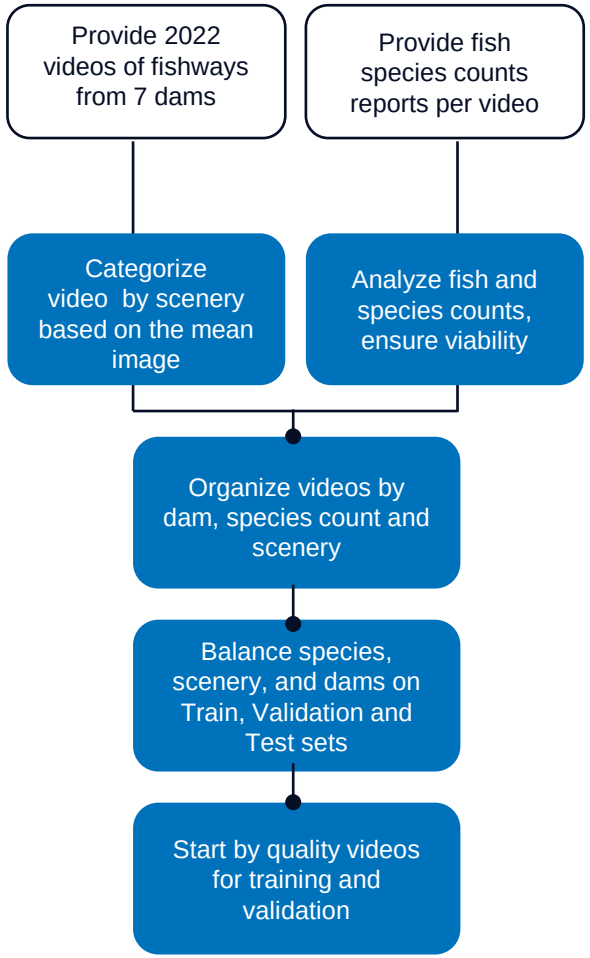
PRODUCTION

Cloud setup, test, monitor, document and deliver

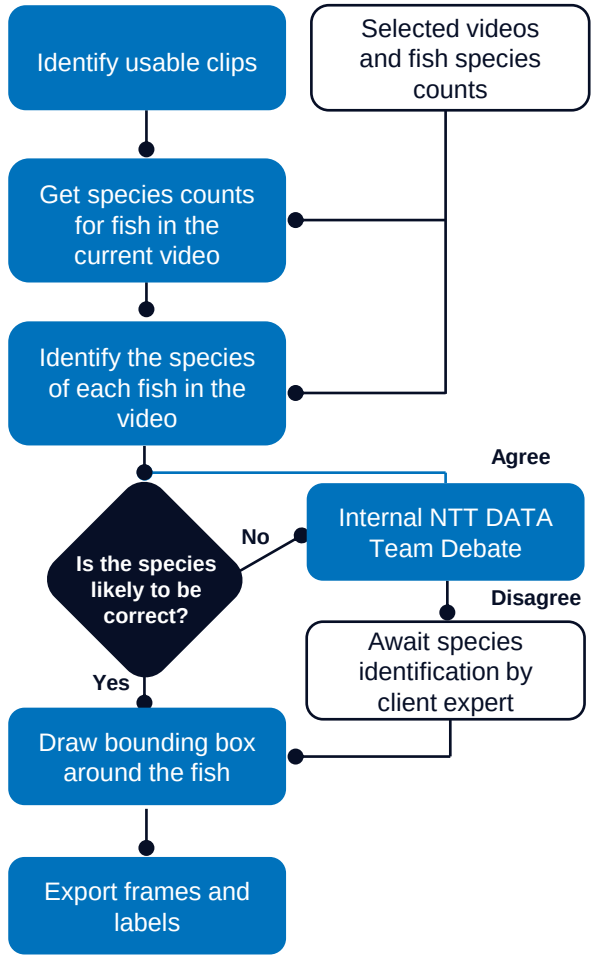


Preparation Overview

DATASET



LABELING



Pre-Processing has 2 steps:

- **Dataset**: prioritize videos for effective training
- **Labeling**: class and bounding box per fish

NTT Data tasks

Client tasks

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Preparation Numbers

Manualy reviewed frames and minutes of video

Aprox **1 200 000** frames

5 040 min

Number of datasets (training rounds)

5

Aprox **51 000** frames

43,5 min

Training frames and minutes of video

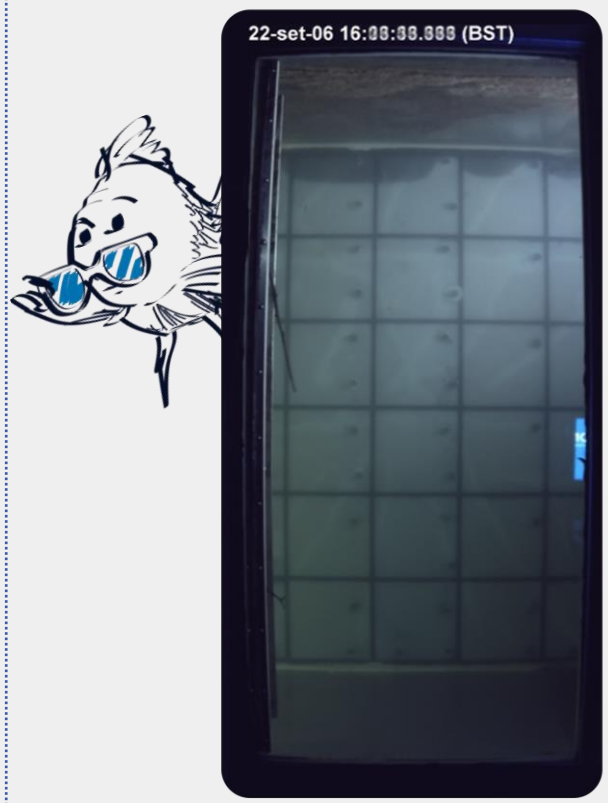
51 984

Unique fish labels (species and b.b.)

Preparation Sceneries

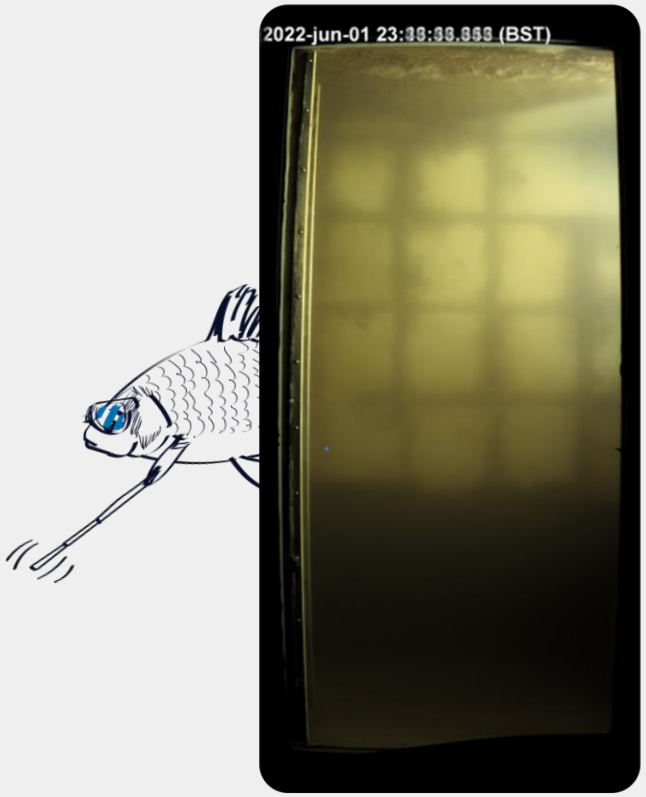
Easy

Clear water, no algae, homogenous illumination



Usable

Everything in between, including presence of reflections in the window



Hard

Hard for humans due to algae murkiness and uneven illumination

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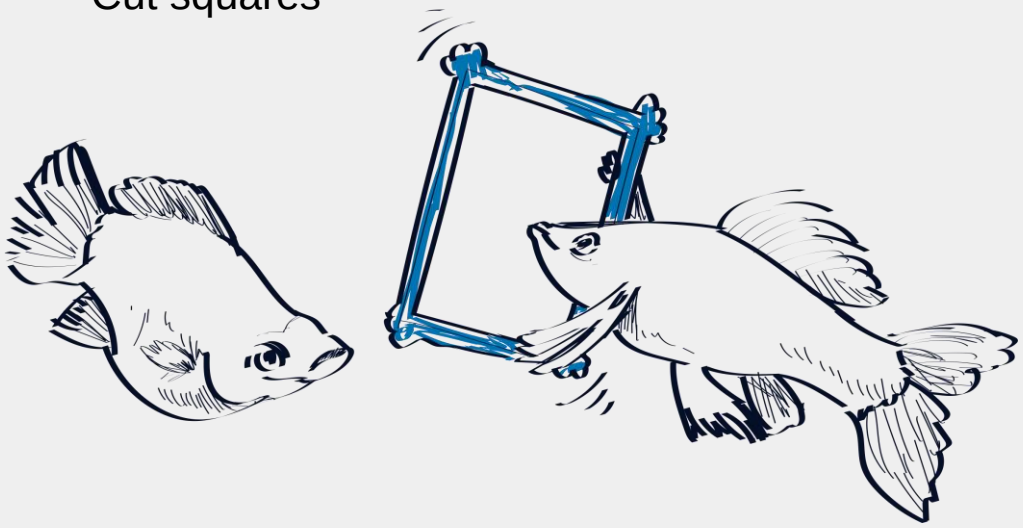
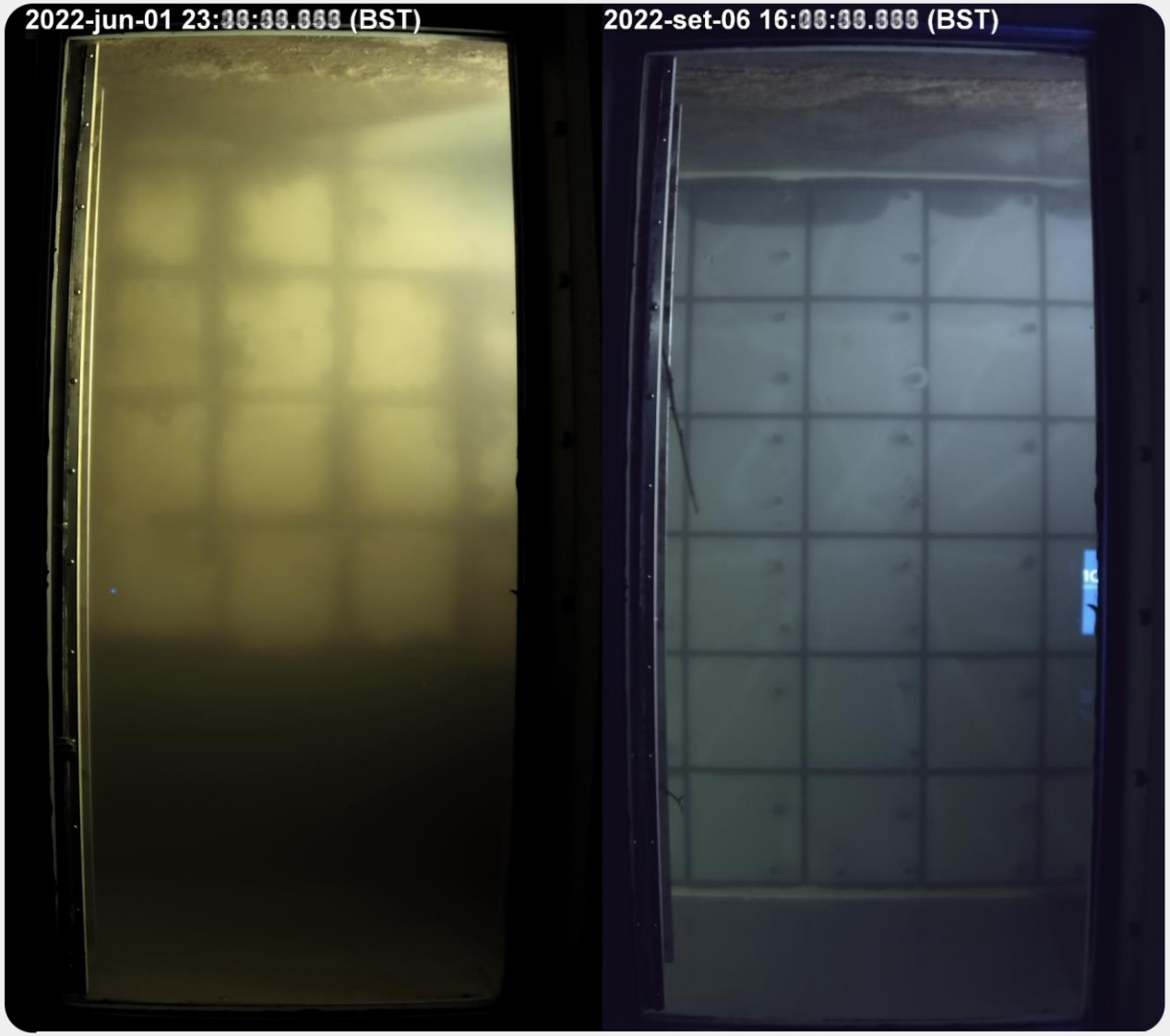
Preparation Frames

Non-square aspect ratios

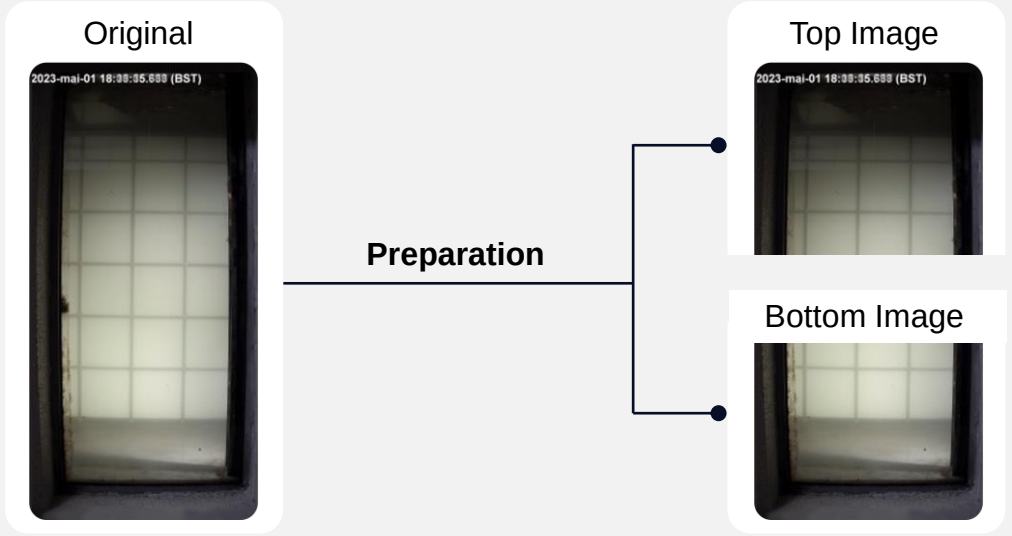
Pre-trained nets have square inputs…

- Train from scratch
- Combine two images
- Cut squares





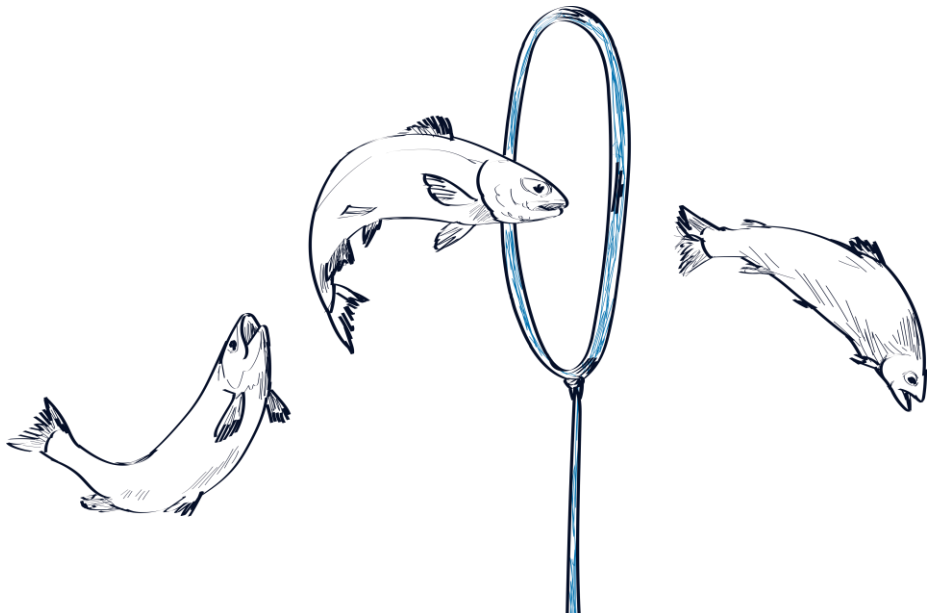
Preparation Easy Labelling Assistant



Model Training Overview

Model training loop:

- **Fine-tuning** the previous model
- **Use model** for pre-labeling future videos
- **Prioritize labeling** where is performance is worst



Tips for choosing models:

- **Balance**: Cost vs Performance
- **Yolo (v8)** – Too unreliable
- **RT-DETR** – Ok performance and tolerable cost

Most effective data augmentation strategies:

- Horizontal and Vertical Flips
- Small rotations (<10 degrees)
- HSV transformations

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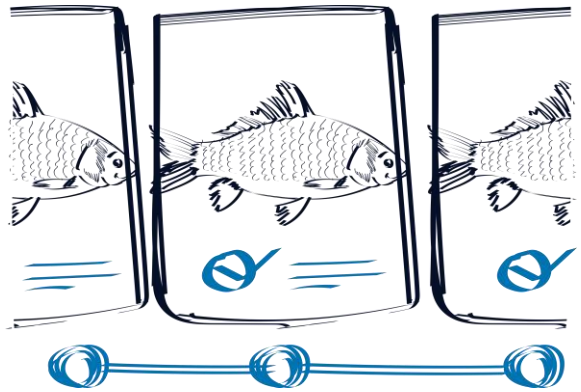
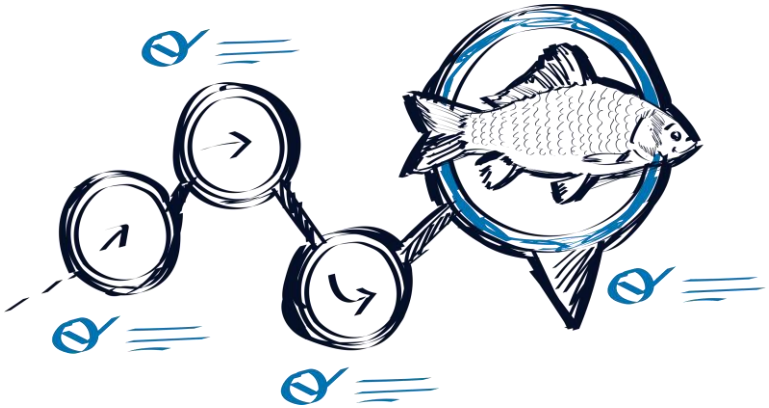
Solution Overview



Class Heuristics

Set of rules to improve class assignments across frames



Track Heuristics

Set of rules to help categorize fish movement across the fishway

Great results!

The goal of this project was to count how many fish of each species cross the fishway in each direction by attaining increasingly difficult and valuable use cases.

Taking into consideration the very aggressive schedule, the unforeseen complications and data quality issues, these were great results!

- **Use Case 1**: Identify if the video has fish in it. **95%** correct
- **Use Case 2**: Correctly distinguish fish, eels and other moving objects. **80%** correct
- **Use Case 3**: Correctly identify 9 fish species and count their direction of fishway traversals. **79%** correct

Key take-aways

APPROACH

- Don’t underestimate the complexity of the real world
- **Real world labelling will take even longer than you expect**
- Optimize the communication in the labelling team

MODEL

- There is no 100% accurate and consistent object detector
- **Object detector training requires lots of consistent data**
- Don’t waste too much time fine tunning hyperparameters

LABELLING

- Ensure everyone follow detailed and comprehensive rules
- **Label only what you are sure of, better no label than wrong label**
- Always review every label

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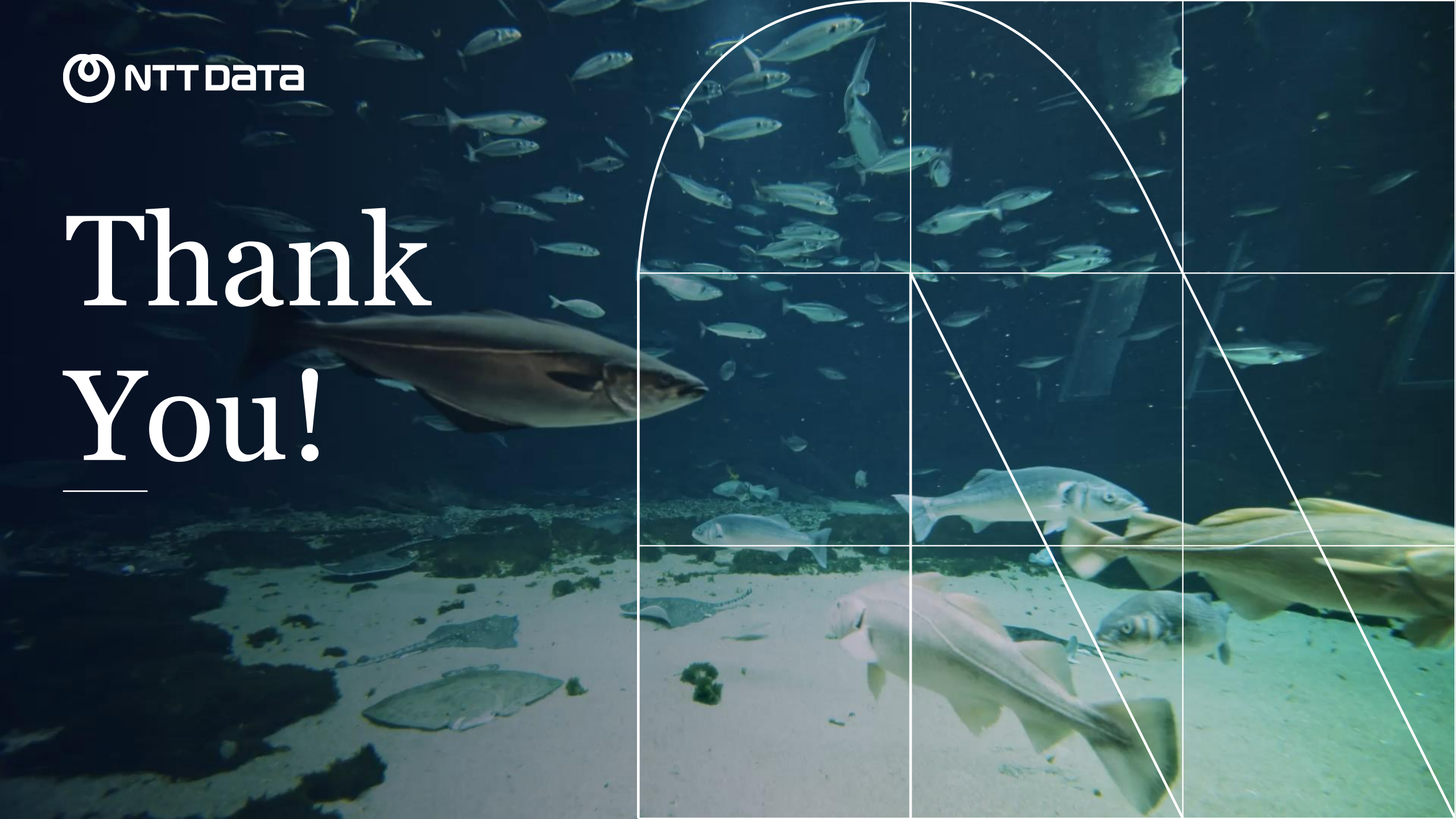
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Thank
You!