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PixMin Added Value Potential Determination: a whale detection use-case

We, at Brainlike Inc., deliver PixMin automatic event detection solutions that add significant value to simpler alternatives. PixMin solutions may not be worthwhile for detecting events such as room temperature and irrigation control cutoff values, where thermostats and timers can be manually set to satisfactory cutoff values. PixMin solutions may be worthwhile in many other applications where cutoff points must be controlled automatically as sensing conditions change. We have designed PixMin solutions based on edge machine learning (EML) to be more affordable and effective than alternatives based on cloud machine learning (CML). Even so, delivering PixMin solutions can take time and cost money. Before investing that time and money, we recommend determining solution delivery requirements as well as potential benefits beforehand. Doing so will result in deciding if and how to deliver valuable PixMin solutions This report describes how we made one such added value potential determination.

We delivered a solution to Shell Oil that automatically detects endangered marine mammals from aircraft imagery. Before offering that solution, we worked with Shell to:

A. Specify operational needs and targeted benefits.
B. Specify a plan for configuring PixMin to meet the specified needs.
C. Specify a plan for operationally evaluating PixMin performance.
D. Complete a definitive operational evaluation.

During initial discussions with Shell, we were told that their analysts were taking 20 minutes to determine endangered bowhead whale presence or absence *per image*, within 12,000 image files captured during each survey flight. That amounted to 4,000 analyst hours spent after each flight—far longer than affordable, in terms of a) analyst time and cost, but especially b) analyst time it would take to make next-day whale mitigation decisions. We and Shell concluded that if we could deliver an automatic detection process that met the requirements listed below, then key benefits listed further below would result.

These were the requirements.

1) PixMin would be expected to detect over 80% of whales within survey flight imagery.
2) PixMin would be configured to produce only one detection per image.
3) PixMin would produce and display output “alert maps” and target sub-images (“chips”) in a form that would enable analysts to visually validate detections at the rate of one image per second.
4) PixMin would deliver output to analysts from over 12,000 images, starting immediately after they were downloaded from a survey flight and ending in less than four hours.

These were the benefits.

- Thousands of analyst hours and staffing dollars would be saved.
- Analysts could determine the amount of whale activity within a survey region from one flight soon enough after the flight to decide on next-day drilling operations.
- Whale protection regulators would agree that the process sufficiently mitigates potential whale harm to authorize drilling operations.

Details

To evaluate our system, we obtained survey flight imagery from Shell in a configuration (CONFIG) dataset, representatively sampled from previous survey flights. The CONFIG dataset imagery reflected representative whale presence in the survey region as well as representative clutter within survey images. Shell and we agreed that we would first build our process using only the CONFIG sample. We would then deliver our built process so that Shell could evaluate the process on their own TEST dataset that they had not supplied to us.

When we built our process and completed preliminary testing with the CONFIG sample, our results met the above requirements. When Shell independently evaluated our built process with their TEST dataset, their results also met the above requirements. Shell and we were satisfied that our process had produced all intended benefits.

Here's how we built our whale detection system. First, we found 36 images in our CONFIG dataset that contained target whales. Next, we separated the 36 images into 18 pairs, with each pair matched as closely as possible for whale clarity and background clutter. We then randomly split each pair, resulting in two target samples a) and b) containing 18 whales each. Next, for each whale whale image, we then made a time series snippet. Each snippet was a sequence of consecutive images with the target whale image in the middle, preceded by target-free images captured just before the target image, and followed by target-free images captured just after the target image. We then used (an early version of) the PixMin ADK to find a promising configuration based on sample a). That configuration detected all 18 whales within the subsample while minimizing false alerts in the entire subsample. We then ran PixMin with sample b) to verify that it would meet the above precision requirements 1) and 2).

Outcome

We met requirement 3) by delivering output alert maps and detection chips to analysts such that they could scan them and evaluate whale sightings at a rate of one image per second. Along the way, we also made our system run sufficiently fast to meet requirement 4). Among other speed enhancement features, we processed raw imagery instead of three-color imagery, resulting in a speed improvement by a factor of 4. We also assigned each imagery detection instance to a separate core process in a multi-core server processor. These, among other internal PixMin enhancement features, produced the required processing speed. We delivered a resulting operational product to Shell that they could use effectively, and on their own, to meet their pre-determined operational needs and reap their pre-determined operational benefits.

Conclusion

We delivered a valuable PixMin solution to Shell Oil for detecting endangered whales, only after first determining key solution requirements and potential solution benefits. More generally, we have found that deciding if and how to deliver PixMin value requires determining key requirements and benefits beforehand.