



Parallelizing SWE simulations with MPI and CUDA

MATH-454 Final Project

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Overview

1. MPI Parallelism

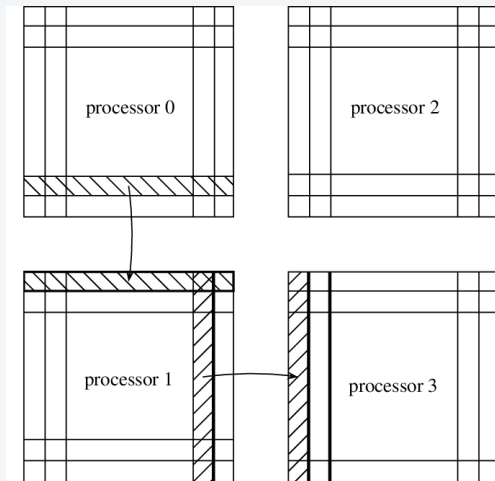
2. 2024 Data – Key Numbers

3. Takeaways

MPI Parallelism

Domain Decomposition

Halo exchange splits the domain into overlapping blocks so that each MPI task can update ghost cells locally



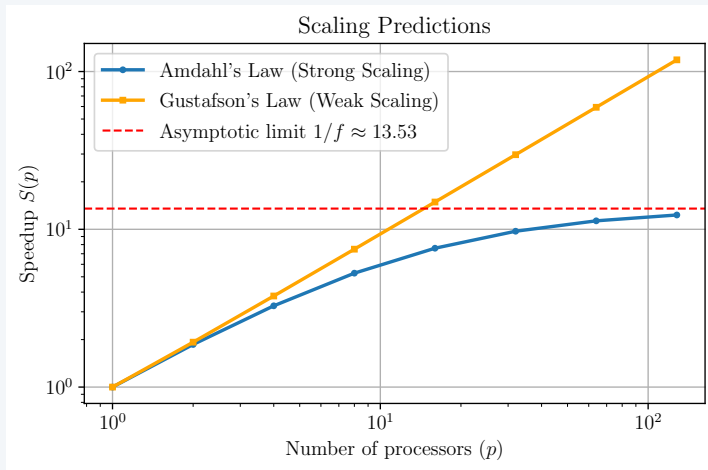
Theoretical Scaling

- **Amdahl's Law:**

$$T_p = \left[(1 - \alpha) + \frac{\alpha}{p} \right] T_1$$

- **Gustafson's Law:**

$$S(N, p) = 1 + (p - 1)\alpha(N)$$



Step 1 – Raw video parser

- Recurses through arbitrary directory trees (handles DCIM/, BCF/ ...).
- Groups clips into events when inactivity $>$ `event_time_period_s` (default 300 s).
- Writes tidy filenames and a single CSV with *site*, *camera*, *event*, metadata.

2024 improvement

Command-line flag for gap length, more robust to different structures.

Step 2 – MegaDetector V6 upgrade

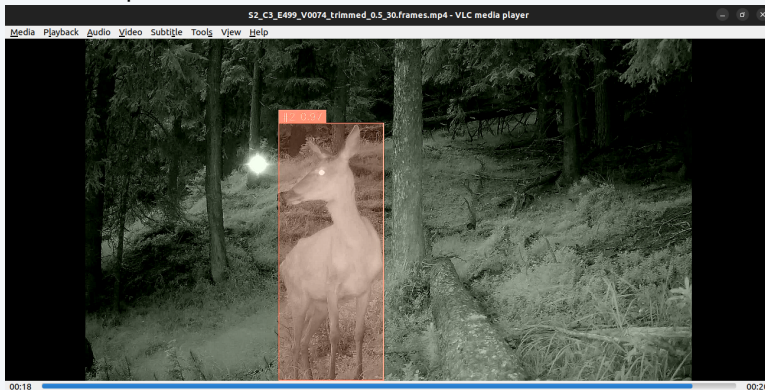
- Switched to **PyTorchWildlife** implementation (YOLOv9/v10 backbone).
- Script rewritten: new I/O, batch API, GPU batching.
- Converted V6 JSON back to legacy V5 schema → zero downstream code changes.

Steps 3 & 4 – Trim → ByteTrack

- **Trim** videos to animal spans (≥ 30 frames, MD confidence ≥ 0.5).
- Reduces 56 h \Rightarrow 11.1 h (80 %).
- Run MD on every frame, then ByteTrack: Kalman + IoU association at 30 fps.
- Fixed frame index bug \mapsto stable tracks, optional interpolation & smoothing.

Step 5 – Visualising tracks

- Auto¹²renders annotated MP4s for batch QA.
- Produces an Excel¹²ready CSV to flag *false positives*, *ID switches*, etc.
- Screenshot example ↓

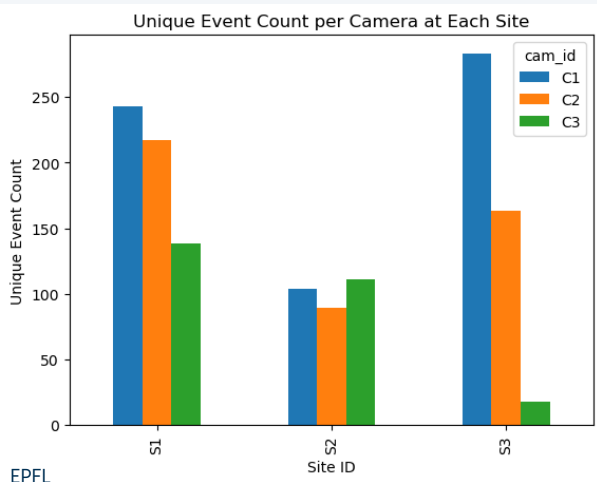


2024 Data – Key Numbers

Field campaign 2024

- 9 Bushnell cameras, 3 sites (alpine meadow, forest edge, scree field).
- 56 h raw footage (June–August 2024, day & IR night).
- **1,050 events** detected across sites.

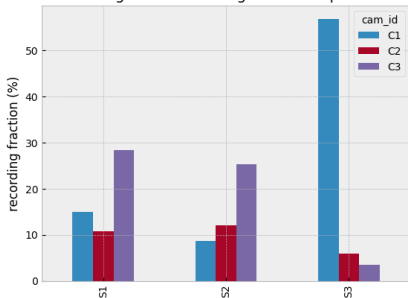
Event distribution



- Site 1 & 3 dominate – ~ 400 events each.
- Site 3/C3 malfunction \rightarrow only 15 events.

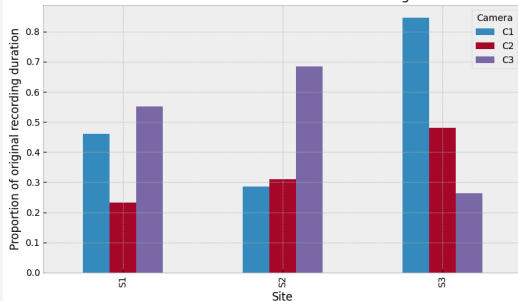
Animal presence & trimming impact

Fraction of recording time containing an animal per camera per site.



MegaDetector estimate per camera

Relative duration of trimmed recordings



Proportion retained after trimming

80 % of recording time discarded, yet ~11 h of real wildlife retained.

Takeaways

What worked, what's next

Highlights

- Full V6 integration with backward-compatible outputs.
- Modular scripts & CLI flags simplify future seasons.
- Pipeline feeds **MammAlps benchmarks** out of the box.

Open issues

- Automate quality checks (false triggers, exposure quirks).
- Complete behavior recognition and long-term event modules.

Conclusion

- 2024 run condensed **56 h** → **11 h** wildlife video, 1,050 events.
- Upgraded detection, trimming, tracking – ready for scalable ecology.
- Looking forward: richer labels & less human touch.

Questions?

Acknowledgments

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Thank you for your attention!

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