A coarse behavior analysis of locomotion in acorn ants

Hailey Hutchison, Grace McKenzie-Smith, Wesleyan Department of Physics, QAC Summer Apprenticeship 2025

Introduction

- Ants (family Formicidae) are eusocial insects with multigenerational colonies, cooperative care of brood items, and division of labor
- Social selection and nonsocial selection, the mechanisms responsible for influencing an animal's fitness, produce evolutionary change through separate genetic pathways
- There is a general theory in biology predicting that social behaviors evolve more quickly than nonsocial behaviors
- We want to observe how the behavioral patterns of worker ants change when they are placed in a solo context versus a group context to give us more insight into how single-animal and multi-animal phenotypes emerge as well as the rate they evolve over time

Experimental design

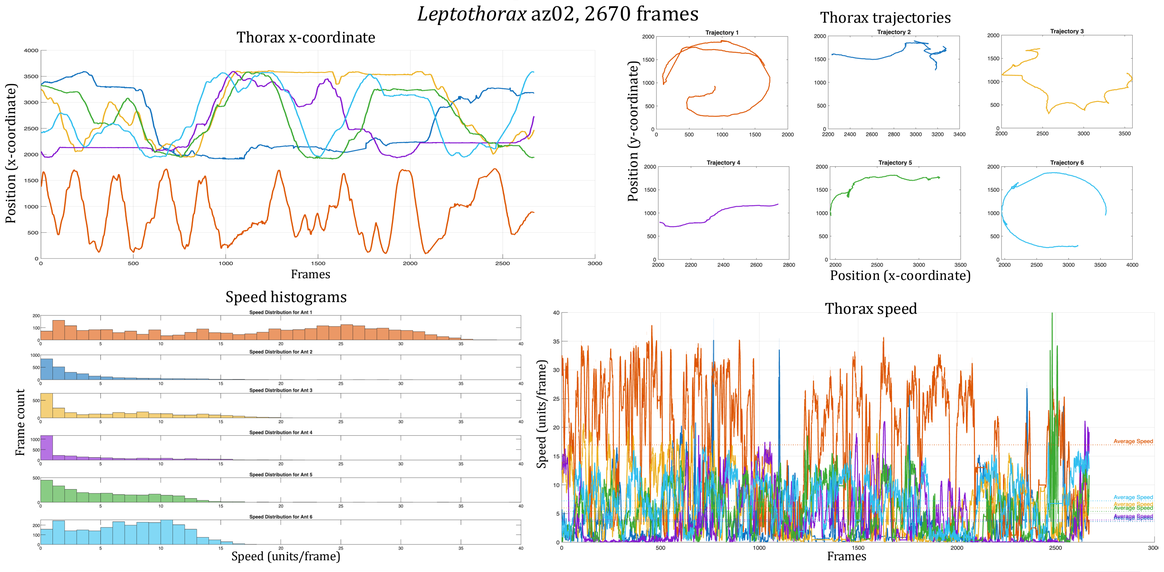
For our initial sample and analysis, we have a collection of multiple closely related species of ants in the genera *Leptothorax* and *Temnothorax.* Worker ants from each colony are then extracted and placed into a small arena, either by themselves or in a group of 5 ants that represent a solo context and a social context, respectively. Arenas are then videoed to collect postural data of each ant.

- The next steps of this project are to continue collecting data from a diverse sample of *Leptothorax* and *Temnothorax* ants to explore more specific interactions, develop an algorithm to stereotype behaviors, and compile ethograms

- Shown below are plots for the solo (orange) and social (multiple colors) ants showing the x-coordinate of their thorax position over time, their 2d locomotion trajectories over time, histograms of each ant's speed distribution, and a plot of thorax speed over time

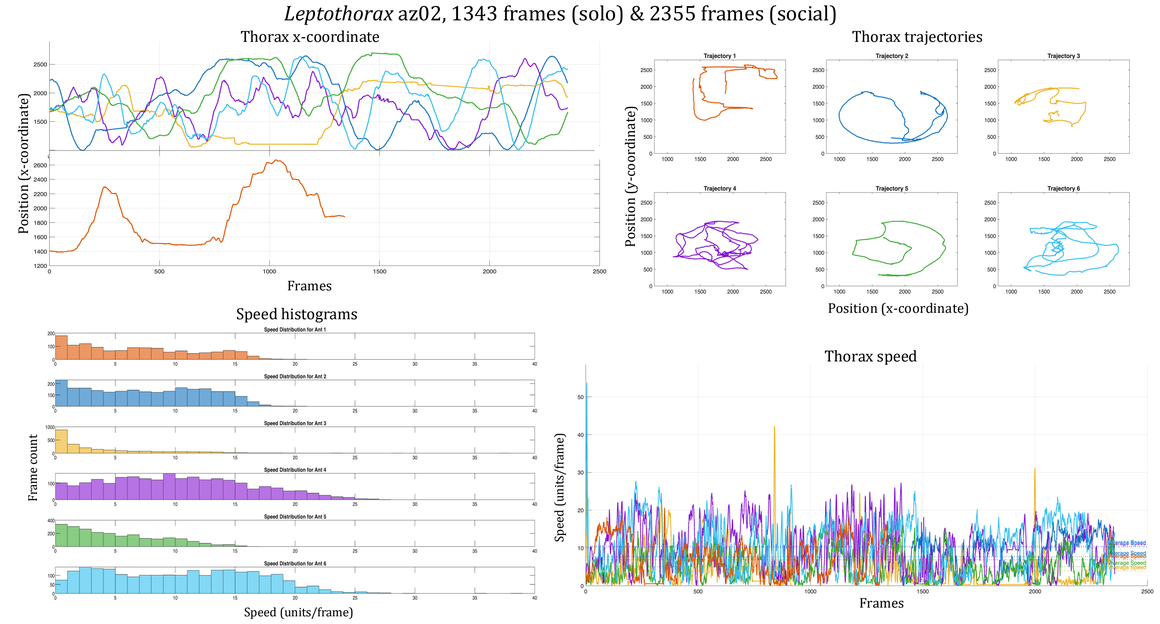
Experiment 1

Leptothorax az02, 2670 frames



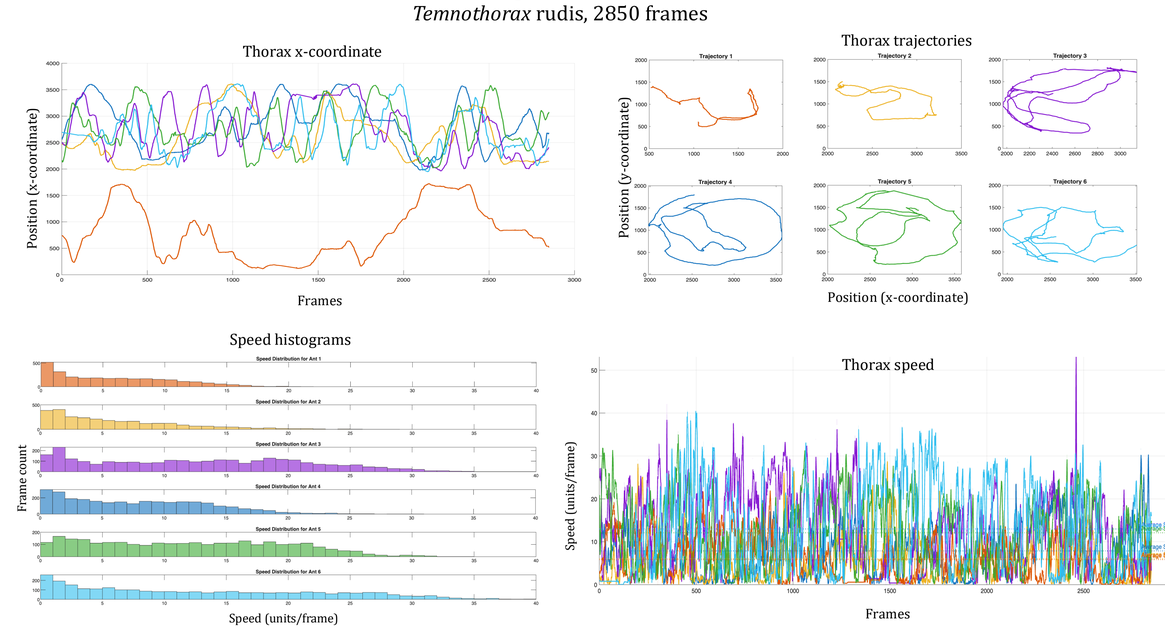
Experiment 2

Leptothorax az02, 1343 frames (solo) & 2355 frames (social)



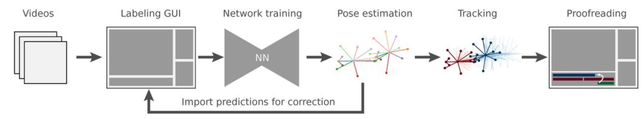
Experiment 3

Temnothorax rudis, 2850 frames



Social LEAP Estimates Animal Poses (SLEAP)

- SLEAP is a supervised deep learning model used to collect multi-animal postural data
- Models are trained to estimate and track the positions of multiple animals from videos



- SLEAP models train on user-labelled frames that assign a skeleton to each animal

Challenges

- Labelling and proofreading is a time-intensive process
- Estimates of position and identity can be inaccurate in early models

Discussion

- **Experiment 1** shows that the solo ant has a locomotive pattern different from any of the ants in the group arena and was more active on average than all ants in the group arena
- **Experiment 2** demonstrates no real difference between the patterns of position and speed in the solo ant versus the ants in the group arena
- **Experiment 3** shows that the solo ant has a locomotive pattern different from any ant in the group arena, similar to our first experiment, and has a slower average walking speed than most ants in the group arena
- In **Experiments 1 & 2** the trajectories of each ant take on a distinct shape and tend to occupy different parts of the arena. It will be interesting to look for this trend in future experiments
- Future analysis will look more at the shape of the ants' walking paths and explore any consistencies with results from a previous study proving that ants take a more linear walking path in settings with a low density of individuals (Gordon, 1995)

References

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