Predicting Estrus Onset from High-Resolution Locomotor Activity and Core-Body Temperature in Female Mice

Team Members: Parth Shinde

Dataset Description

Dataset: Mouse Estrus Data
URL: https://tinyurl.com/mwmymhxk
Minute-by-minute recordings of locomotor activity and core-body temperature for male and female mice over 14 consecutive days under a 12 h light/12 h dark cycle. Estrus days for each female are known (every 4th day, starting on day 2), and lights-off switches at t = 0 min and every 720 min thereafter.

Research Question & Aims

Primary Question: Can we predict the exact onset of estrus in female mice using only their second-by-second activity and temperature rhythms?

Aims:

1. Characterize baseline circadian patterns in both sexes.
2. Identify the key changes in activity and temperature that precede estrus.
3. Build and interpret a predictive classifier for estrus onset.

Brief Writeup

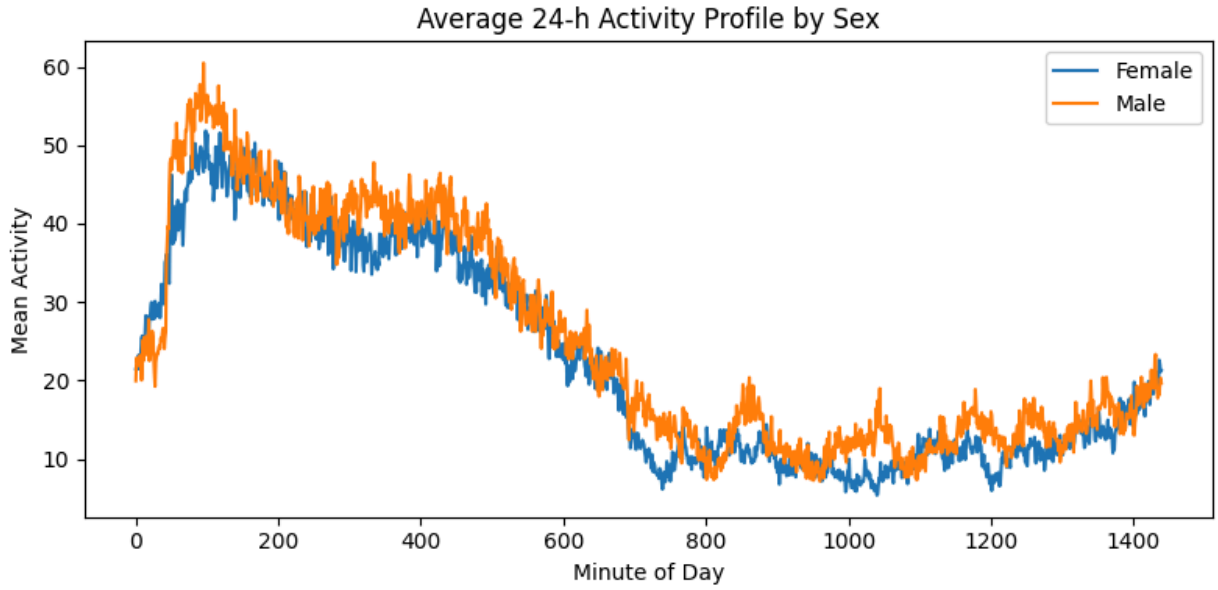
I will develop and evaluate a predictive model that identifies the transition into estrus in female mice using only their minute-level activity and temperature signals. Specifically, I am going to:

1. Align and segment each female's time series into sliding windows leading up to estrus onsets.
2. Extract temporal features (e.g., rolling means, variance, peak counts) from both activity and temperature channels.
3. Train a classification algorithm (e.g., logistic regression, random forest) to distinguish "pre-estrus" vs. "non-estrus" windows.
4. Assess model performance with cross-validation and evaluate feature importance to pinpoint key physiological indicators.
5. Visualize decision boundaries and time-aligned probability scores to interpret how rhythmic changes herald estrus.

6. Discuss implications for non-invasive monitoring of reproductive state and potential extensions to other circadian studies.

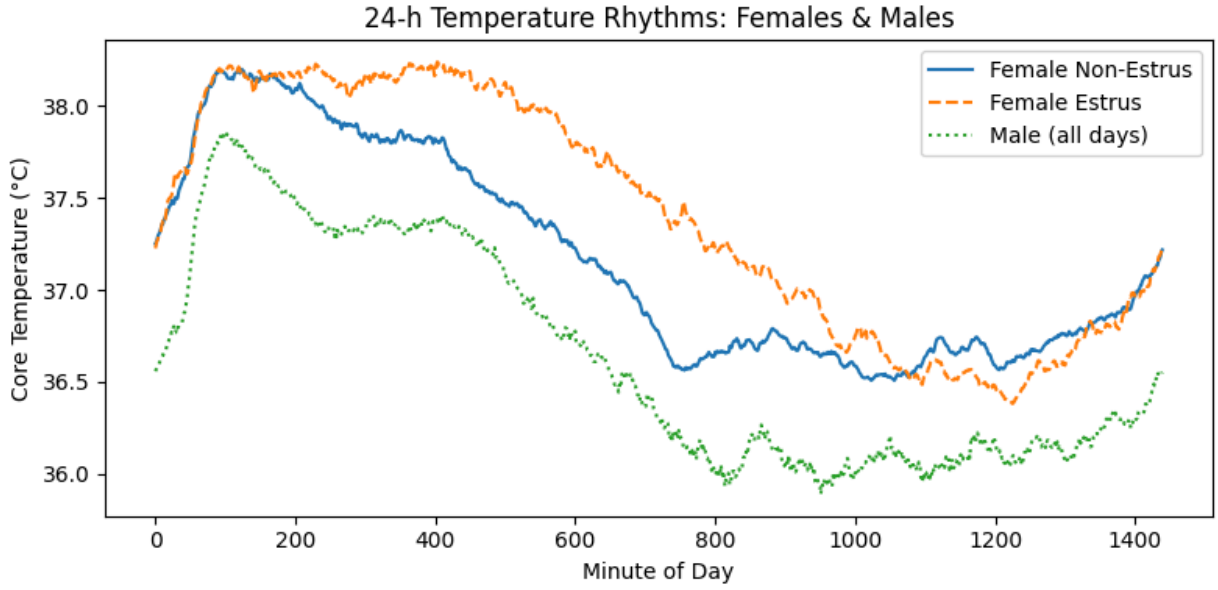
Static Visualizations

Figure 1. Average 24 h Activity Profile by Sex



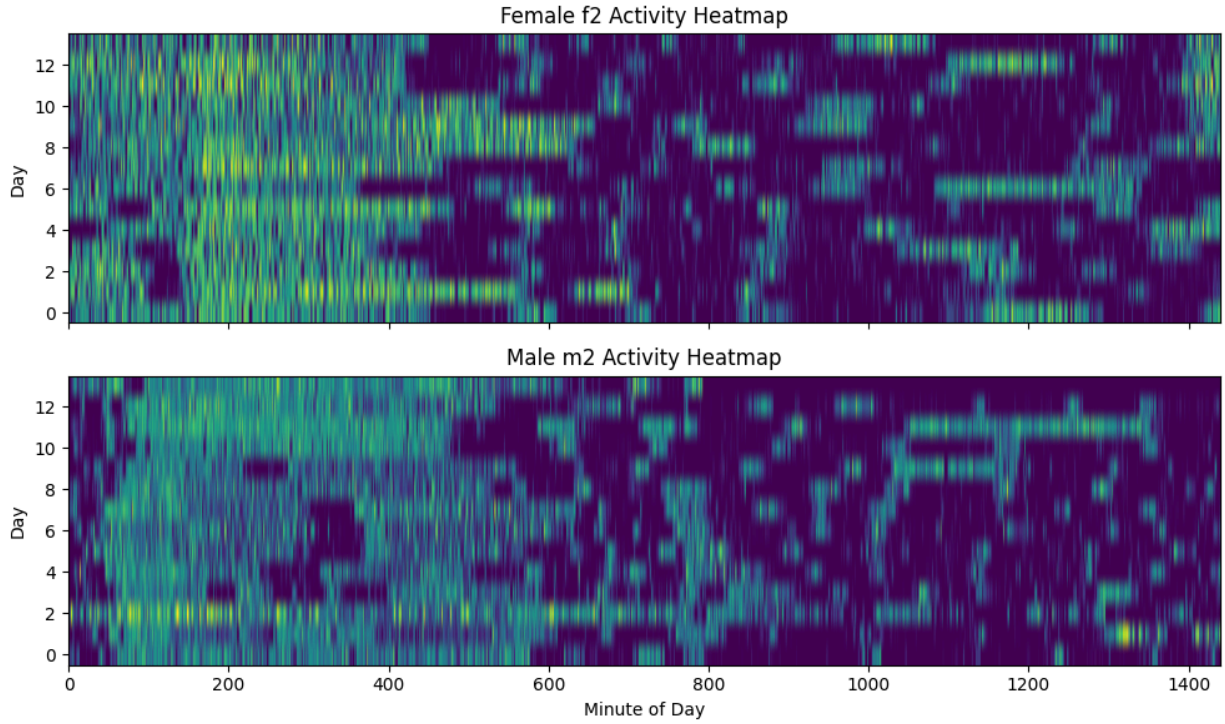
Over a 24 h cycle, females and males differ in overall activity levels and timing. This establishes a sex‑specific baseline against which estrus changes can be compared.

Figure 2. 24 h Core-Body Temperature Rhythms



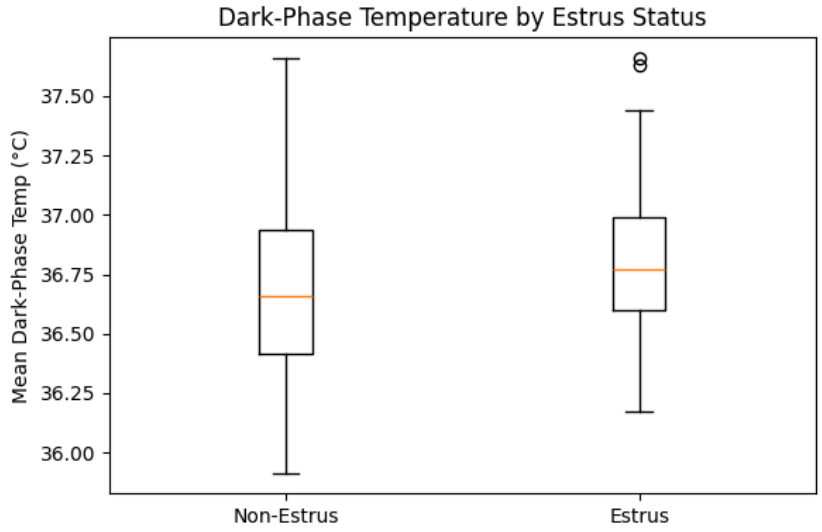
Female temperature curves on estrus (dashed) vs. non-estrus (solid) days, overlaid with the male average (dotted). Highlights the “hotter” active period around estrus.

Figure 3. Activity Heatmaps over 14 Days



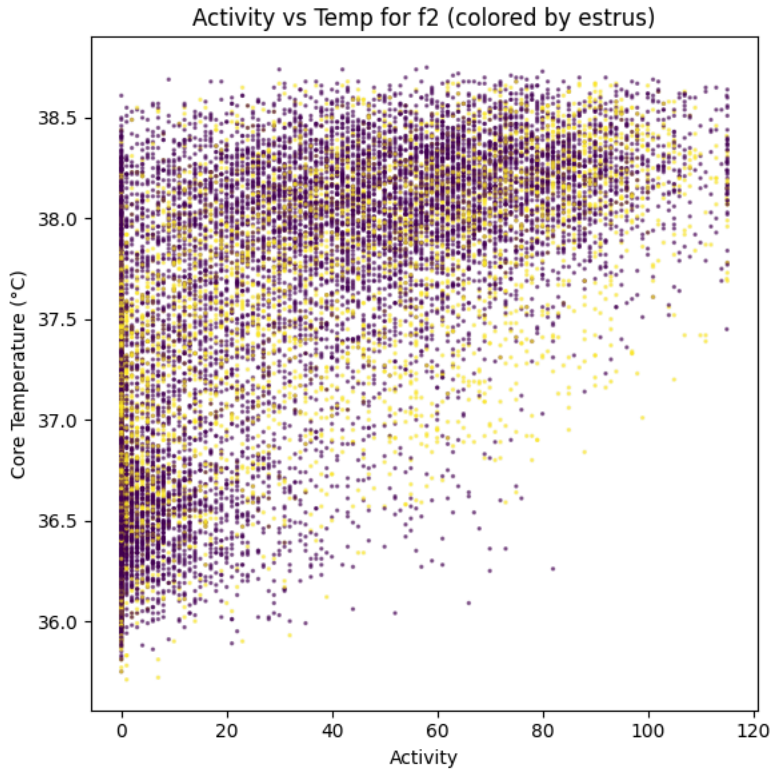
Minute-by-minute activity for one representative female and one male mouse, across all 14 days. You can visually see the repeating 4-day estrus peaks in the female heatmap.

Figure 4. Dark-Phase Temperature: Estrus vs. Non-Estrus



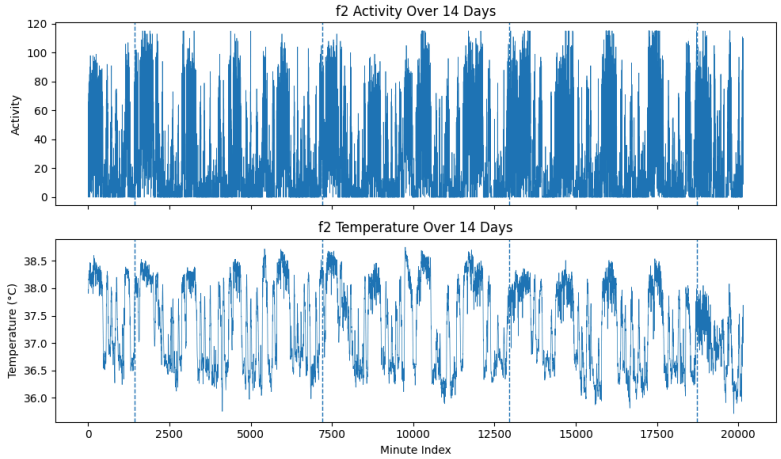
Boxplots of mean core-body temperature during the dark phase on estrus days vs. all other days for females. This quantifies the magnitude of the temperature rise.

Figure 5. Activity vs. Temperature (Colored by Estrus)



A scatter of minute-level activity vs. temperature for one female, with points colored by estrus status. Reveals how the joint distribution shifts as estrus approaches.

Figure 6. Full 14-Day Time Series (Activity & Temperature)



Continuous 14-day traces of activity (top) and temperature (bottom) for one female, with vertical lines marking each estrus onset - illustrating the real-time signature your model will try to detect.