Quantifying Cricket Social Behavior: A Mathematical Model for Analyzing Movement Patterns and Spatial Preference

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Animal behavioral research often grapples with identifying subtle movement patterns, integrating multiple behavioral metrics, and mitigating observer bias. My project presents a novel, accessible algorithm that utilizes trigonometric modeling to analyze 2D motion dynamics in crickets (Gryllidae), providing insights into social structures and offering a scalable methodology for behavioral analysis in other species. I conducted 150 five-minute trials in a custom-designed chamber, tracking individual cricket movement in the presence of a familiar and an unfamiliar conspecific. Using video analysis, vector calculus, and trigonometric modeling, I developed a Python-based algorithm to quantify spatial preferences, time allocation within defined zones, velocity, and angular orientation. The algorithm's adaptable framework enables detailed, automated analysis of animal movement across diverse behavioral studies. Crickets exhibited a statistically significant preference for the familiar conspecific, spending more time in its proximity (ANOVA, $p < 0.01$). Proximity increased over time, with angular orientation analysis revealing a tendency for parallel and antiparallel positioning. Heatmap data further indicated clustering near the familiar individual. This study highlights the social complexity of crickets, demonstrating that spatial preferences and movement patterns serve as reliable behavioral proxies. By integrating computational modeling with behavioral analysis, this research provides a powerful tool for minimizing observational bias and enhancing quantitative precision in ethology. The algorithm's flexibility allows for broader applications in studying social structures, movement coordination, and behavioral responses in various species.

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