

The College of Arts & Sciences  
Department of Mathematical Sciences

Candidate Colloquium

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University of Houston

Monday, January 22, 2024

Edwards Center 1, Room 6134

4:00 – 5:00 pm

## *First passage time problems in biology*

First passage time (FPT) measures when a stochastic process first exceeds a threshold or reaches a target. FPT problems arise in various biological systems, including cell signaling, animals collecting resources, and decision-making processes. In this talk, we will discuss two examples of (i) how FPT models are applied to address biological questions and (ii) how FPT approximation formulas provide a simple and general measure for many biological systems. For the first example, we explore the detection mechanism in zebrafish development, necessitated to be completed within a finite time due to physical constraints. Despite the seemingly unnecessary involvement of macrophages by introducing uncertainty, we demonstrate that this “unnecessary” mechanism is pivotal for enhancing detection probability through stochasticity. We validate our hypothesis by comparing it with live image data. Secondly, we delve into cover times, a special type of FPT, which measure the time it takes a random searcher to explore an entire spatial region. Although the cover times of many searchers can provide a measure for search efficiency in many biological systems, most prior studies have been focused on the cover times of a single searcher. We estimate cover times in continuum space and networks in the limit of many searchers. We show that the formula depends only on the searcher’s characteristics and a certain geodesic distance between the searcher's starting location and the farthest point in the target. This general formula opens avenues for collaboration with experimentalists, providing valuable insights into the applicable systems.

**Refreshments will be served 3:15 – 3:45 pm in the Faculty Lounge  
4118 French Hall West**