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Scent and Sensibility: Navigating a Chemical Trail

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Chemical sensing is the oldest evolutionary adaptation and is used by almost all motile species from bacteria to mammals. Bacteria and other simple organisms use chemical gradients to move toward a desired area (chemotaxis). Larger animals such as fruitflies trying to find some nice rotting fruit or dogs tracking a scent trail use olfactory (and other cues like wind direction) to locate the desired source. In this talk, I will present some recent work that we have been doing on chemotaxis and olfactory navigation. In the first part of the talk, we describe some new experiments on bacterial chemotaxis that show novel behavior. We use the classic Keller-Segel equations and then a very simplified mean-field approach to explain this behavior. In the second part of the talk, I will discuss the problem of trail following and odor location by single organisms. I will start with a very simplistic model based on the assumption of a smooth gradient and show that even this problem leads to some very interesting mathematics. I then show some examples of the real world of odor distribution and why this is a really hard problem. I will discuss several different approaches in this but the real work is just beginning.