

Infotaxis: searching without gradientsMassimo Vergassola^{1*}, B.I. Shraiman², E. Villermaux³¹ CNRS, Institut Pasteur, Paris² KITP, University California Santa Barbara³ IRPHE, Université Aix Marseille 1* Electronic Address: `massimo@pasteur.fr`

Chemotactic bacteria rely on local concentration gradients to guide them towards the source of a nutrient [1]. Such local cues pointing towards the location of the source are not always available at macroscopic scales because mixing in a flowing medium breaks up regions of high concentration into random and disconnected patches. Thus animals sensing odors in air or water detect them only intermittently as patches of odor sweep by, carried by winds and currents [2, 3, 4, 5, 6]. A macroscopic searcher must devise a strategy of movement based upon sporadic cues and partial information. Here we propose a search algorithm, which we call “infotaxis”, designed to work under such conditions. Any search process can be thought of as acquisition of information on source location and in infotaxis the latter will play a role similar to concentration in chemotaxis. The infotaxis strategy locally maximizes the expected rate of information gain. Its efficiency is demonstrated computationally using a model of odor plume propagation and using experimental data on mixing flows [7]. Infotactic trajectories feature zigzagging and casting paths similar to those observed in flights of moths [8]. The proposed search algorithm is relevant to the design of olfactory robots [9, 10, 11], but the general idea of infotaxis can be applied more broadly in the context of searching with sparse information.

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