生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	果蠅是如何跟著香氣走的 (How Fruit Flies Follow a Scent)
生物系統 LIVING SYSTEM	果蠅 Common fruit fly (*Drosophila melanogaster*)
功能類別 FUNCTIONS	#應付亂流 (Manage turbulence) #感應氣味 (Sense odor) #化學性分解聚合物 (Chemically break down polymers)
作用機制標題	果蠅必須在眾多氣味中定位食物的香氣，並且應付亂流來找到食物的位置。 Fruit flies have to locate the scent of food in several odors and manage turbulence to find out the location of food.
生物系統/作用機制示意圖 (確認版權、註明出處；畫質)	 出處：https://blog.jeken.com.tw/2020/08/08/fruit-fly

作用機制摘要說明 (SUMMARY OF FUNCTIONING MECHANISMS)

現在你的家中可能有一種令航空工程師和計算機科學家都驚嘆和羨慕的生物。將藍莓放在廚房的任何地方，您可能很快就會發現在附近盤旋的小型果蠅（*Drosophila melanogaster*）。移動藍莓並打開旋轉的室內風扇，或在刮風的日子嘗試戶外實驗。蒼蠅仍然會找到寶藏。這些昆蟲如何在復雜多變的環境中追踪氣味的來源？

氣流和湍流將羽流 (plume) 分解成更小、壽命更短的細絲。果蠅必須在許多其他不相關氣味的背景下推斷食物來源位置。在第一次檢測到氣味細絲的時候，它們會轉向並逆風移動，朝向源頭。當氣味細絲結束時，它們開始橫向移動，越過風流方向。一旦檢測到另一條氣味細絲，它們就會再次逆風移動。通過這種方式，他們利用累積的小經驗來確定食物來源。

使用不完整的信息是現實世界中的常態。創建有效模擬昆蟲導航的計算程序可能在旨在在類似受限情況下導航的人類技術中具有廣泛的應用。例如，這可能有助於救援行動，或在信息不完整且時間緊迫的情況下尋找污染源。

There may be in your home right now a creature that is the marvel and envy of aeronautical engineers and computer scientists alike. Place a blueberry anywhere in your kitchen, and you will likely soon find the diminutive and intrepid fruit fly (*Drosophila melanogaster*) hovering nearby. Move the blueberry and turn on a rotating room fan, or try the experiment outside on a windy day. The fly will still find the treasure. How do these insects track odors to their source in a complicated and ever-changing environment?

Air currents and turbulence break up the plume into smaller, more short-lived filaments. Fruit flies must infer the food source location amidst a background of many other unrelated smells. Upon first detecting a filament of odor, they turn and move upwind, toward the source. When the odor filament ends, they begin moving laterally, across the direction of wind flow. Once they detect another filament, they move upwind again. In this way, they use an accumulation of small experiences to build towards an ultimate determination of the food source.

Working with incomplete information is the norm in the real world. Creating computational programs that effectively model navigation by insects could have far-ranging applications in human technologies that aim to navigate in similarly-constrained situations. For example, this could be helpful in rescue operations, or searching for sources of pollution, where information is incomplete and time is critical.

文獻引用 (REFERENCES)

「覓食是生物體的一項重要行為任務……我們專注於飛蟲在急湍的氣味羽流中覓食時所採用的投擲 (cast) 和浪湧 (surge) 策略。使用脈衝時序依賴可塑性，該模型快速學會將個體嗅覺感覺線索 (olfactory sensory) 與經典條件範式 (a classical conditioning paradigm) 中的食物做配對……我們的工作成功地將生物計算原理與脈衝機器學習相結合。它展示了如何通過覓食昆蟲來實現從靜態到任意複雜動態條件的知識轉移，並可以作為以個體為本的機器學習靈感。」(Rapp and Nawrot 2020: 28412)

"Foraging is a vital behavioral task for living organisms… We focus on cast and surge strategies employed by flying insects when foraging within turbulent odor plumes. Using a spike-based plasticity rule, the model rapidly learns to associate individual olfactory sensory cues paired with food in a classical conditioning paradigm… Our work successfully combines biological computational principles with spike-based machine learning. It shows how knowledge transfer from static to arbitrary complex dynamic conditions can be achieved by foraging insects and may serve as inspiration for agent-based machine learning." (Rapp and Nawrot 2020: 28412)

參考文獻清單與連結 (REFERENCE LIST) **Harvard 或 APA 格式**

Rapp, H. and Nawrot, M.P.A (2020).spiking neural program for sensorimotor control during foraging in flying insects.PNAS (https://www.pnas.org/doi/10.1073/pnas.2009821117)

延伸閱讀: Harvard 或 APA 格式（取自 AskNature 原文；若為翻譯者補充，請註明）
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撰寫/翻譯/編修者與日期
吳昌翰翻譯 (2022/4/2)；許秋容編修 (2022/06/18)
AskNature 原文連結
https://asknature.org/strategy/how-fruit-flies-find-fruit/

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