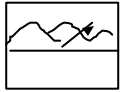


Do insects use visual recognition for navigation?

Two possible strategies:

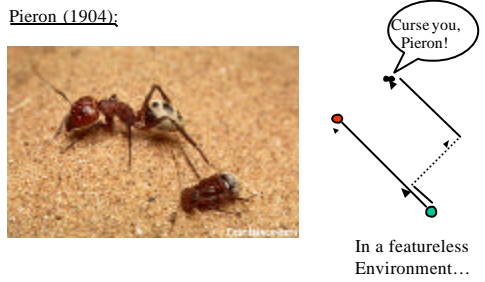
- Dead-reckoning
(keeping a running tally of directions and distances)
- Scene-based navigation
(attaching vectors to observed scenes)



What is the benefit of one strategy over the other?

Evidence for dead-reckoning

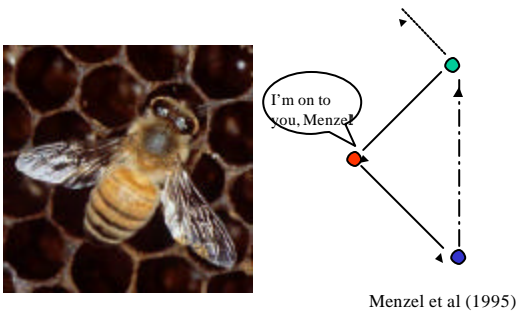
Pieron (1904):



Curse you, Pieron!

In a featureless Environment...

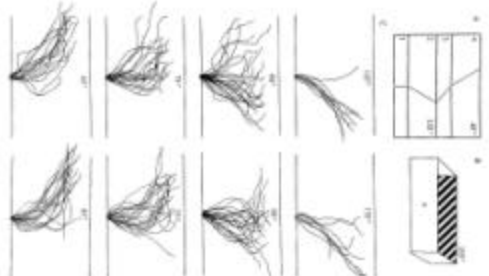
Evidence for scene-based navigation



I'm on to you, Menzel!

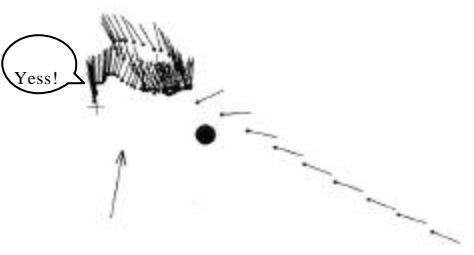
Menzel et al (1995)

Evidence for scene-based navigation (contd.)



(Collett and Baron, 1995)

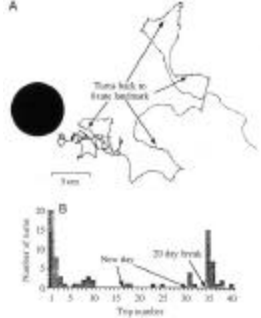
Evidence for object-based navigation



Yess!

(Collett and Baron, 1994)

Evidence for object-based navigation

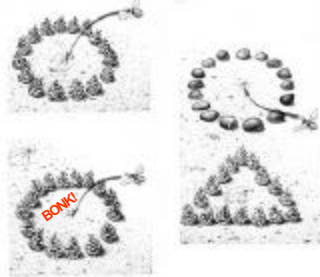


There's that, it's home landmark

20 day break

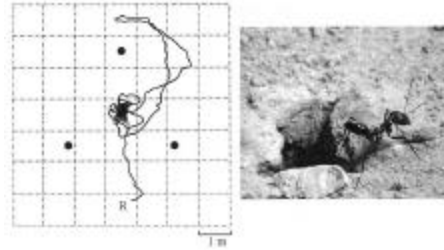
Evidence for use of landmarks to pinpoint places

Tinbergen (1932)



Evidence for use of landmarks to pinpoint places

Wehner et al. (1996)

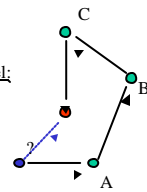


Can insects organize landmarks into 'cognitive maps'?

Basic 'snapshot' model:

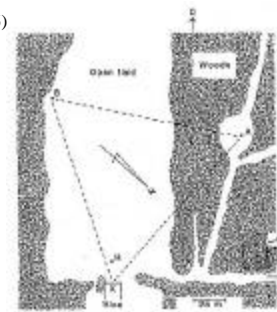
- Landmark A : move NNE
- Landmark B : move NW
- Landmark C : move S
- ...

Cognitive map model:



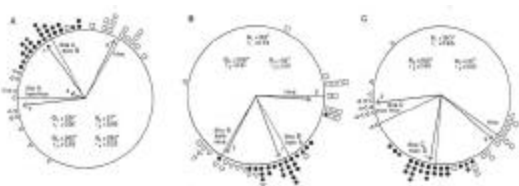
Can insects organize landmarks into 'cognitive maps'?

(Gould, 1986)



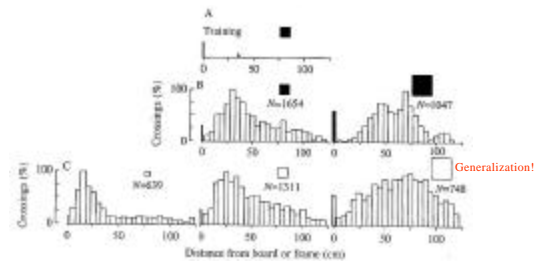
Can insects organize landmarks into 'cognitive maps'?

Yes!



How do insects represent and match patterns?

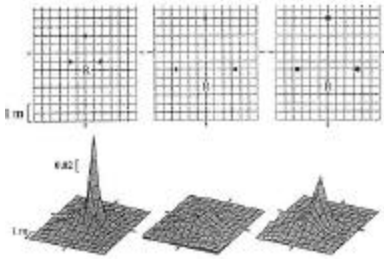
It seems that they use retinotopic matching.



(Cartwright and Collett, 1983)

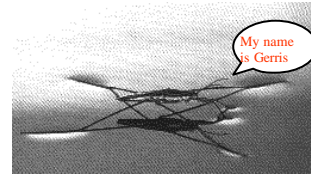
How do insects represent and match patterns?

Retinotopic matching in the desert ant
(Wehner et al, 1996)

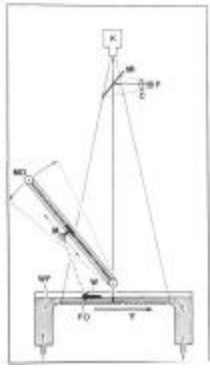


How do insects represent and match patterns?

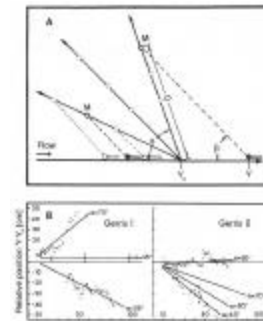
Retinotopic matching in the waterstrider
(Junger, 1991)



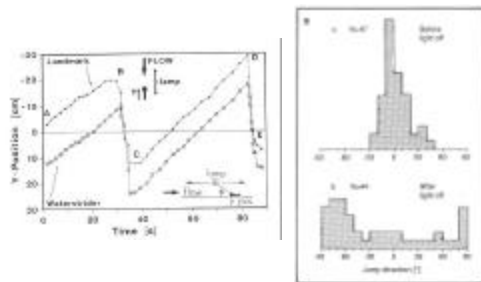
Retinotopic matching in the waterstrider



Retinotopic matching in the waterstrider



Retinotopic matching in the waterstrider

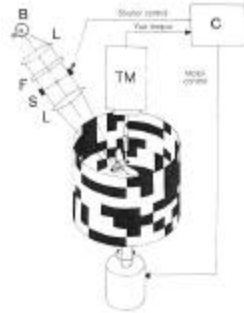


How do insects represent and match patterns?

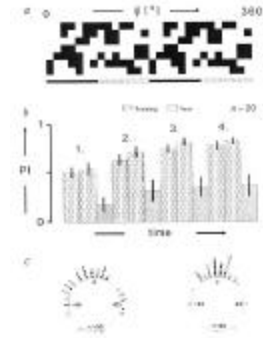
Retinotopic matching in Drosophila
(Dill et al, Nature, 1993)



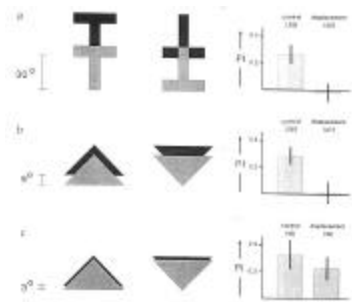
Retinotopic matching in Drosophila



Retinotopic matching in Drosophila



Retinotopic matching in Drosophila



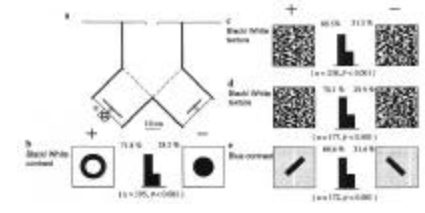
Inference: Images are stored retinotopically

But,

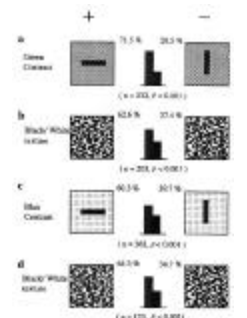
What about an image is stored?

Is it an exact copy of the image?

No. Bees can learn to recognize shapes defined by any of a number of cues [Zhang et al., 1995]



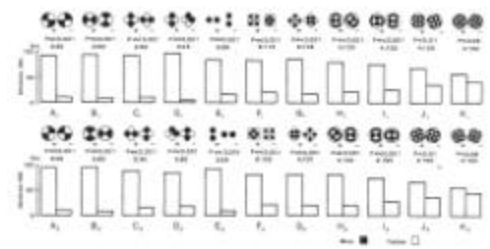
Bees can learn to recognize shapes defined by any of a number of cues

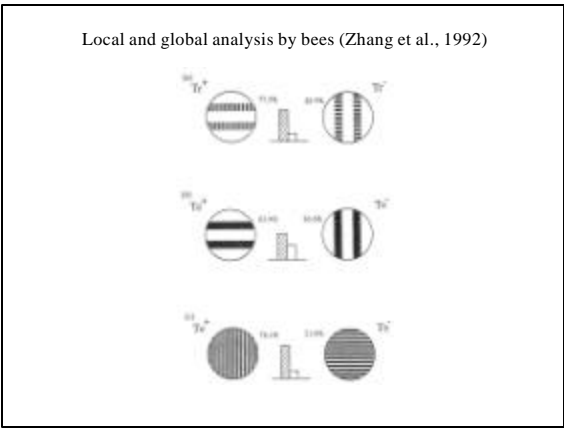
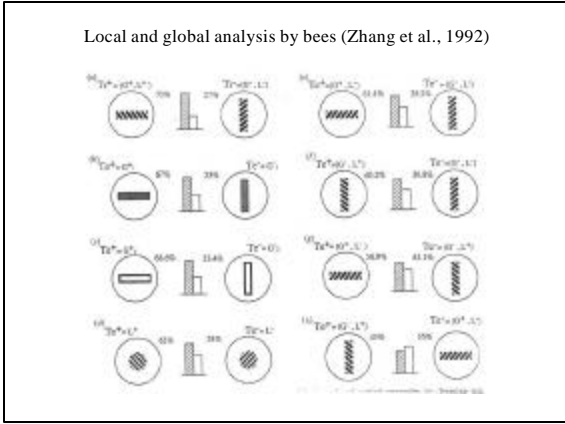
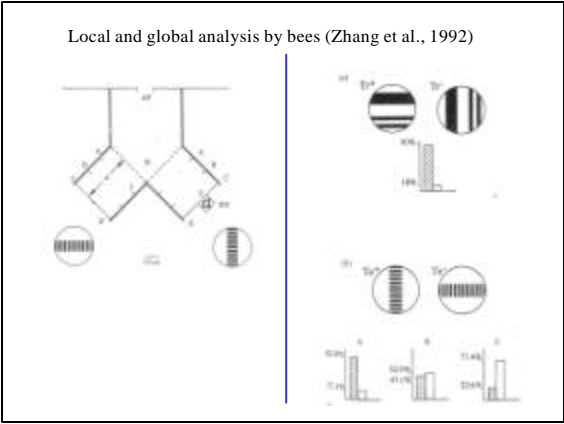


What about an image is stored?

Is it just the local features in the image?

No. Bees can perform pattern discrimination on the basis of local or global characteristics. (Gould, 1985)

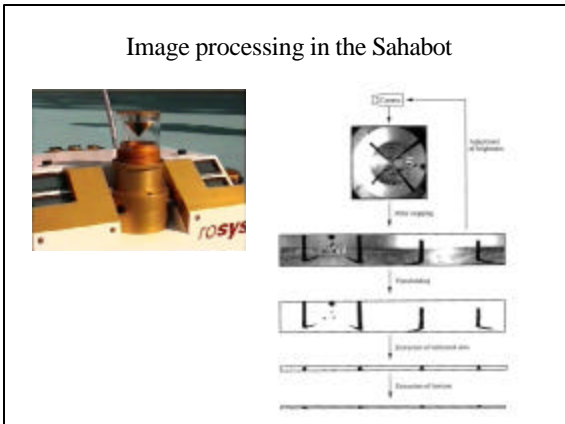
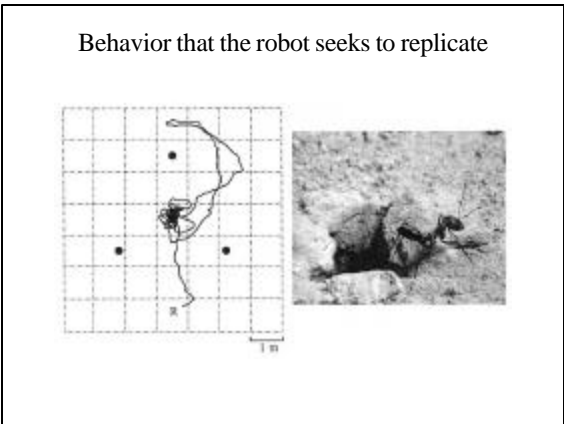




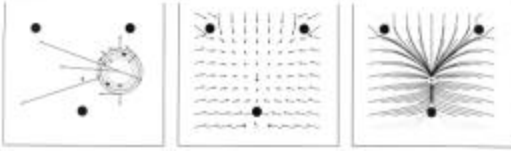
Mobile robots based on insect navigation strategies

Max-Planck Institute for Psychological Research, Munich

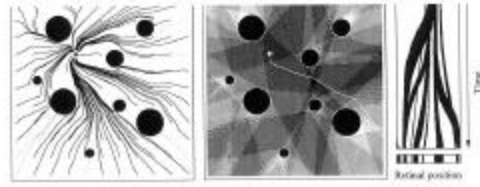
The left image shows two ants on a sandy surface. The right image shows a small, four-wheeled mobile robot with a camera and other sensors mounted on top.



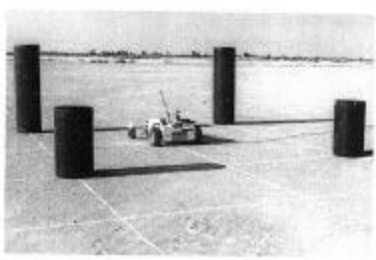
Basic snapshot algorithm of the Sahabot



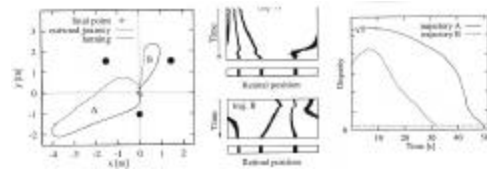
A simulation of the snapshot algorithm



Showtime for Sahabot



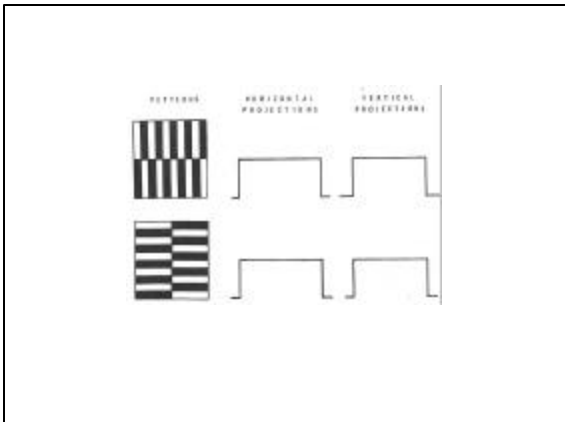
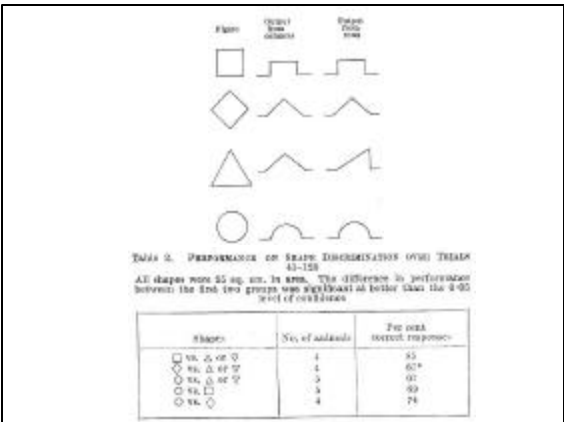
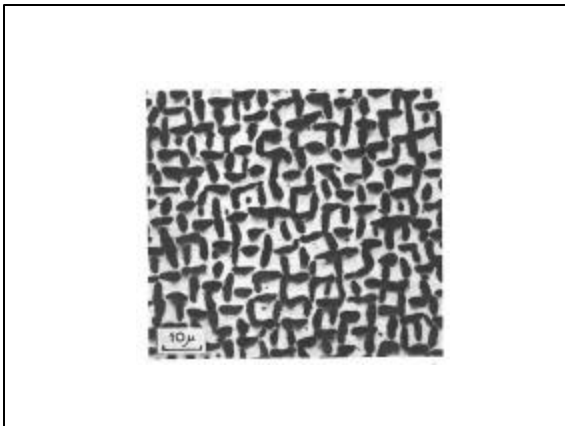
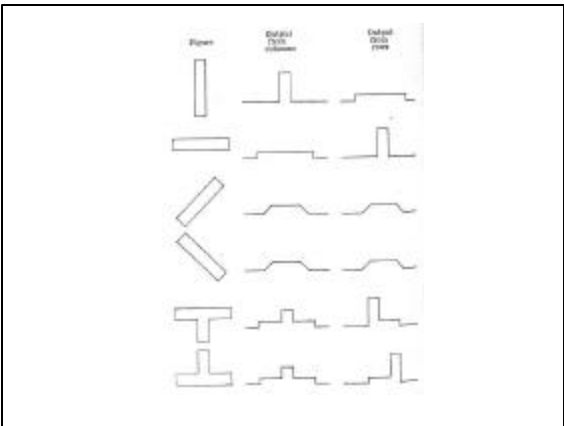
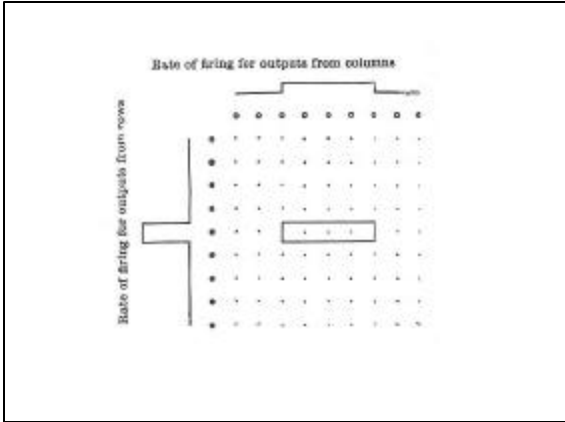
A sample Sahabot run

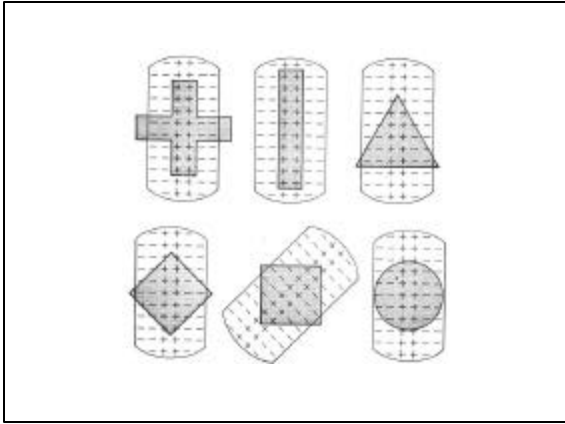
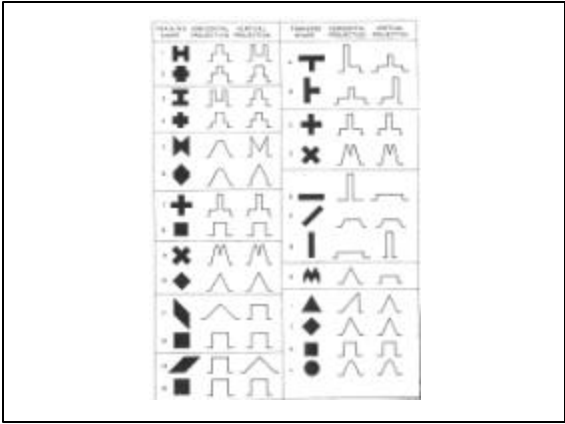


Pattern recognition by Octopuses



Shapes	Dimensions	No. of animals	Per cent correct responses
1 vs. —	10 cm. x 2 cm.	6	81
1 vs. / or \	"	8	71*
— vs. / or \	"	8	65.5
7 vs. 1	Long stroke, 10 cm. x 2 cm.	9	55*
4 vs. 4	Tall, 4 cm. x 2 cm.	7	56
/ vs. \	10 cm. x 2 cm.	6	50*





Is an octopus a CAT Scanner in reverse?



Can we use a tomographic representation for Real-world image-classification tasks?