Presentation of Paper titled

“Self-organized Shortcuts in the Argentine Ant ”

Author: Goss, Simon et al.

Presented by

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As a CAP6675 course presentation

Motivation

The main motivation of this work is to establish a theoretical basis for a multi-agent interactive system that emerges with efficient pattern (like shortest path) in a “collective and self organizing”[1] manner.

Summary

- ‘Worker’ types in Argentine Ants have little to no individual capability of knowing the environment variables.
- But, collectively manages to find the shortest path between its nest and food source using pheromone trail.
- Author describes this phenomena with mathematical equations and logics.
- Simulations are done to establish the characteristics of this collective success.
- Validating the simulation data from real life experiments.
- Experiment to determine directional memory in Argentine ants.

Image: {http://en.wikipedia.org/wiki/Image:Argentine_ant.jpg}

Experimental Setup[1]

- 30 degree branching
- 5-10 minute taken to first find food source.
- Total experiment time is lower than the average evaporation time of pheromone (~30min)

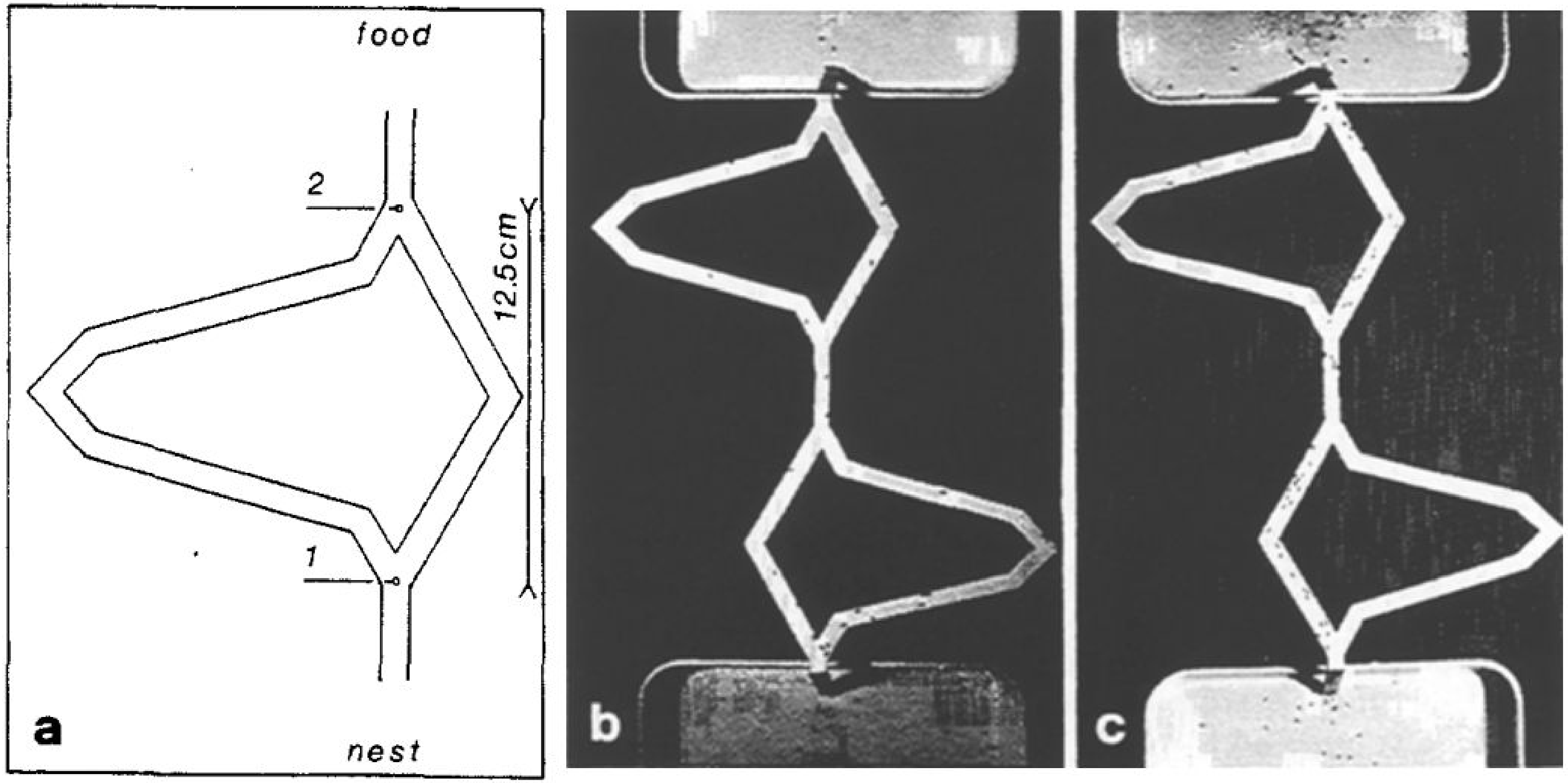


Fig. 1. A colony of *I. humilis* selecting the short branches on both modules of the bridge; a) one module of the bridge, b) and c): photos taken 4 and 8 min after placement of the bridge

[1]

Equation governing the system

- Worker Ants leave pheromone at points where a decision was made.

- Sj and Lj are amount of pheromone on short and long branch
- The probability of choosing a path ($p_{s,j}$) based on pheromone presence was experimentally determined. (in Eq 3)

$$\mathrm{d}S_j/\mathrm{d}t = \Phi p_{s,j'}(t-20) + \Phi p_{s,j}(t) \qquad (1)$$

$$(j = 1, j' = 2; j = 2, j' = 1)$$

$$\mathrm{d}L_j/\mathrm{d}t = \Phi p_{l,j'}(t-20r) + \Phi p_{l,j}(t) \qquad (2)$$

$$p_{s,j} = \frac{(20 + S_j)^2}{(20 + S_j)^2 + (20 + L_j)^2} \qquad (3)$$

$$(p_{s,j} + p_{l,j} = 1)$$

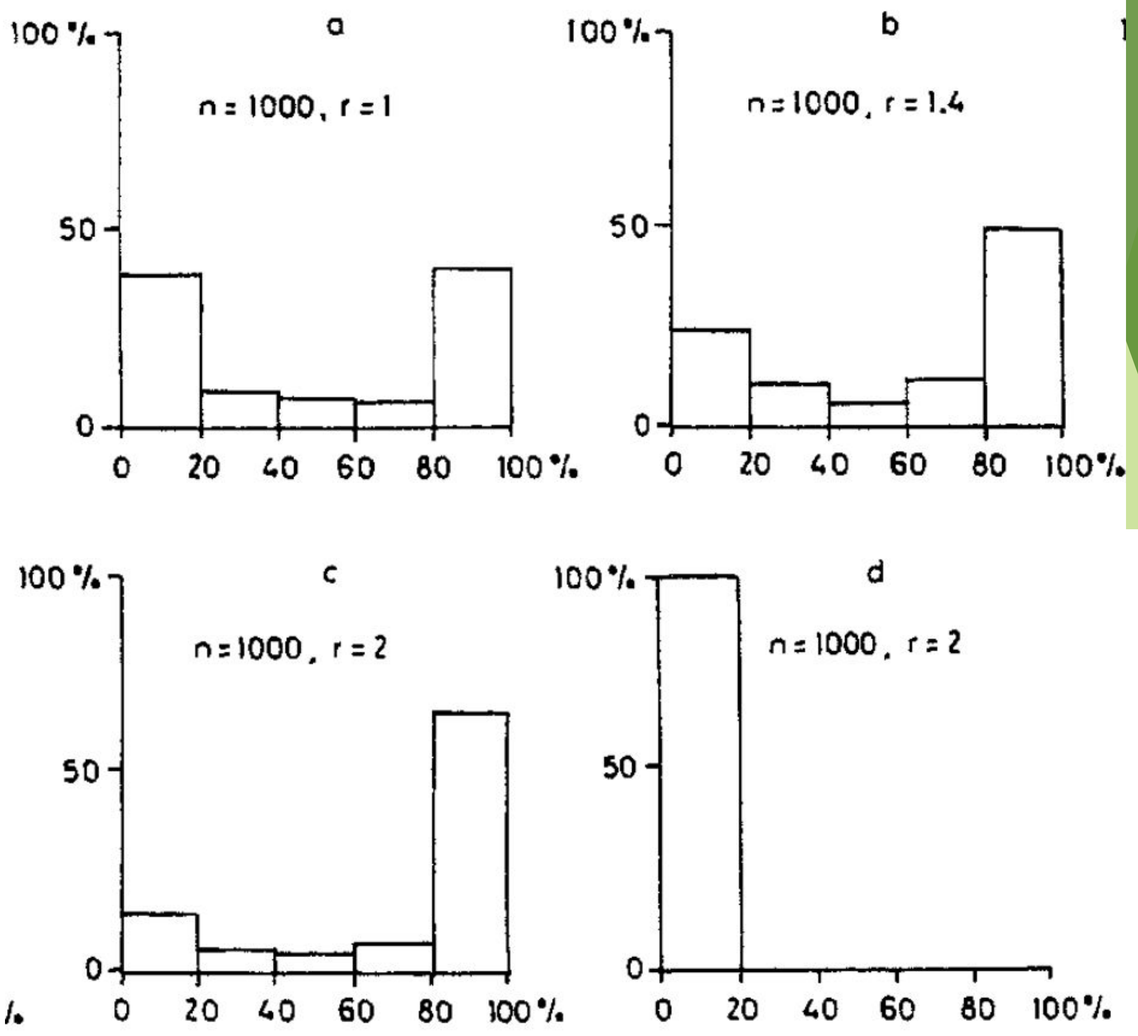
[1]

Monte Carlo Simulations

Graph shows distribution of ants choosing shorter path.

X axis : number of ants on shortest path
Y axis: number of simulation run with such result.

(a), (b), (c) has different distances for the longer branch. In (d) the shorter branch was added after 30 min



[1]

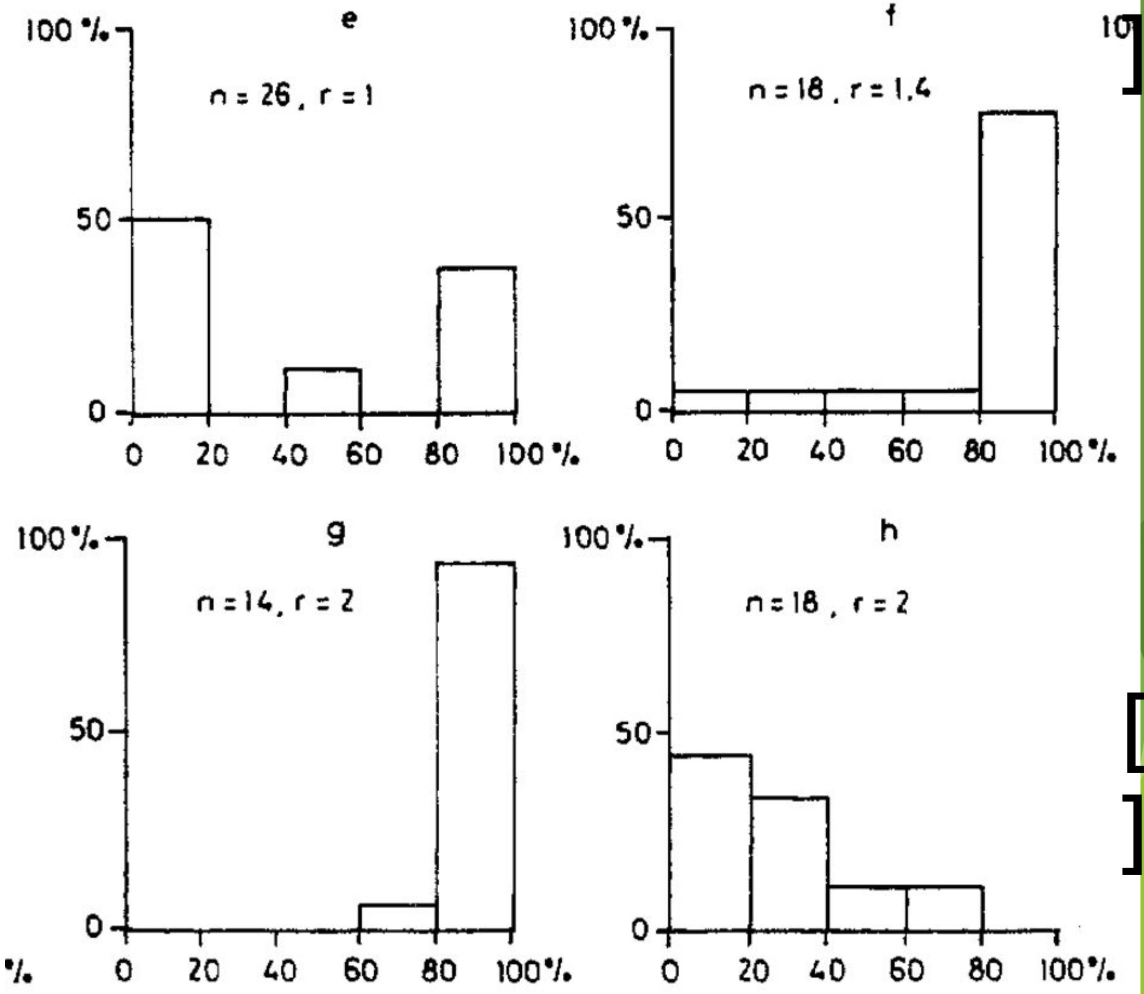
[1]

Experimental Validation

Corresponding to a,b,c and d this e,f,g and h shows more affinity to shorter path

Simulation Model gave three predictions:

1. the 'Selection' of shortest path depends on path difference in distance.
2. 'Selection' is one time phenomena (within experiment time
3. If there is no initial marking for short branch, the 'Selection' will not work as often as before.



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[1]

Memory Experiment

Visual Memory: Similar experiment performed under red light gave similar result, which implies there is no visual memory in effect.

Directional memory: Initially marked the shorter path ants with color, and then changing paths with newer one (without trail).
Marked ants followed both paths randomly.
Temporal Memory: repetition of the experiment on same nests did not change the distribution of outcomes.

Conclusion

- From Simple Agents emerges a large and efficient Network of communication.
- Interaction in-between agents is the source of complexity.

Strength

- Very well defined Research question.
- Claims are both experimentally and theoretically established.
- Not only describes the existence of a simple agent based complex communication network (in previous works), but also establishes how it becomes efficient.

Weakness

- The difference between simulated model and experimental result is not even slightly mentioned.
- In the memory portion, other environmental odors besides pheromone was not considered.
- No future work or application proposed (may be due to ongoing research work)

Extensions

- how the system would behave if the ants had a little memory? Will it be more efficient? Or loose efficiency.
- As the shortest route do not emerge immediately, what are the possible factors that contribute to this time lag.
- Influence of negative feedback on a positive feedback system.

And many more!!!

Referance

1. Goss, Simon, et al. "Self-organized shortcuts in the Argentine ant." *Naturwissenschaften* 76.12 (1989)

Q/A

THANKS FOR ATTENDING