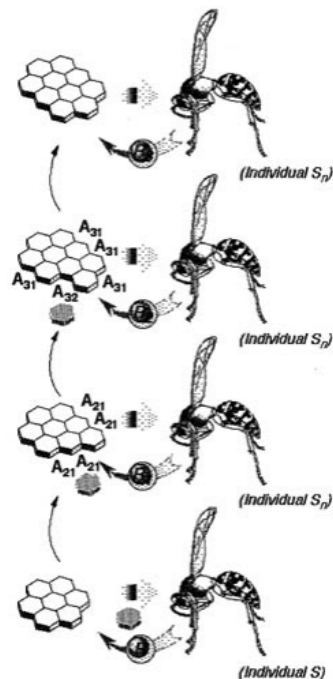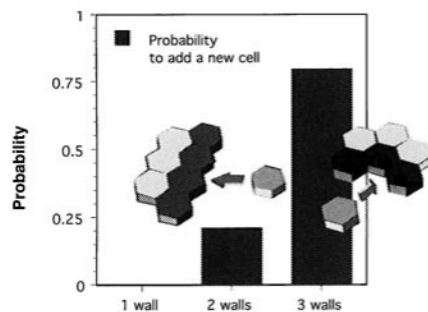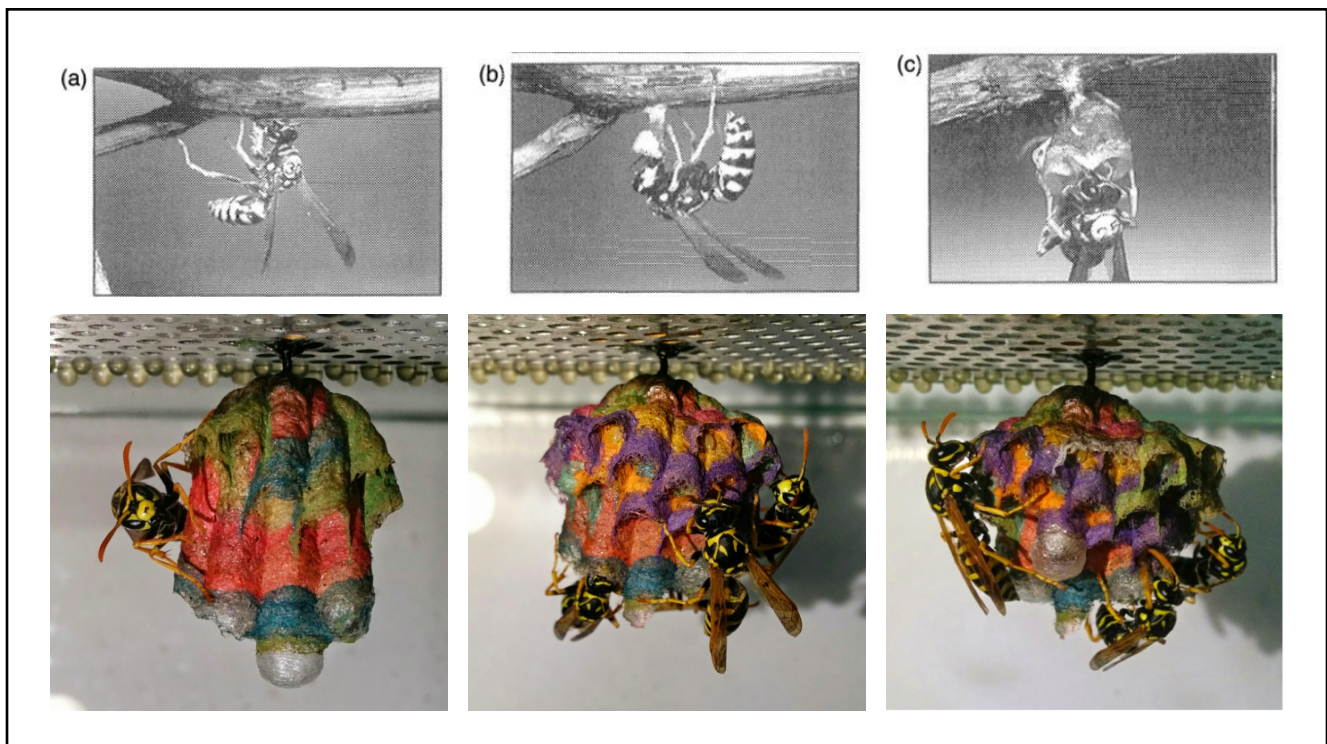# Nest Building in Social Insects

Helen Wang and Julian Fiorito

Discrete Stigmergy

- Discrete stigmergy in insects is based on a discrete set of stimulus types

- A stimulus is transformed into another, qualitatively different, stimulus under the action of an insect
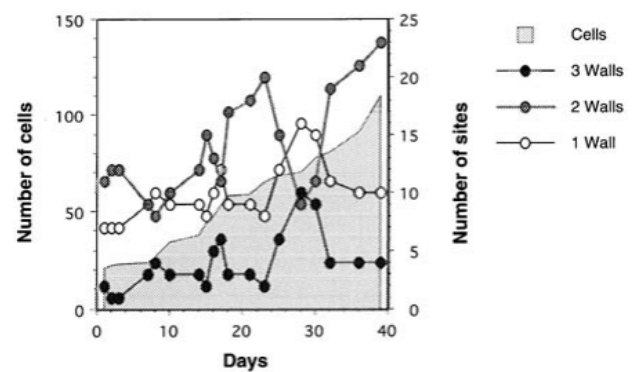
Nest Complexity and Size

The larger the nest, the more possible sites to add new cells

Complex nest structure stimulate complex behaviors to form more complex structure

Paper Wasp Nest Activity

Video of a Hornet Building its Nest

Structure of a Paper Wasp Nest

Multiple layers of cells connected by pedicels

Protective/insulating shell

Modeling Nest Building Behavior

Theraulaz and Bonabeau

Model of asynchronous automata in discrete cubic space

Agents place "bricks" that cannot be removed

Algorithm 6.3 High-level description of the construction algorithm

```
/* Initialization */
Construct lookup table /* identical for all agents */
Put one initial brick at predefined site /* top of grid */
For k = 1 to m do
    assign agent k a random unoccupied site /* distribute the m agents */
End For
/* Main loop */
For t = 1 to t_max do
    For k = 1 to m do
        Sense local configuration
        If (local configuration is in lookup table) then
            Deposit brick specified by lookup table
            Draw new brick
        Else
            Do not deposit brick
        End If
        Move to randomly selected, unoccupied, neighboring site
    End For
End For
/* Values of parameters used in simulations */
m = 10
```
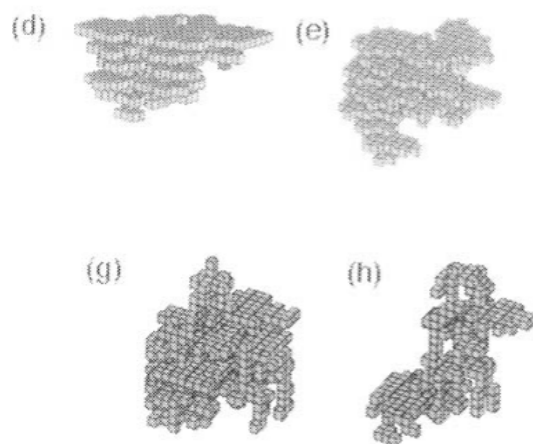
Structured VS Unstructured

Coordination algorithm: each stimuli map to one action
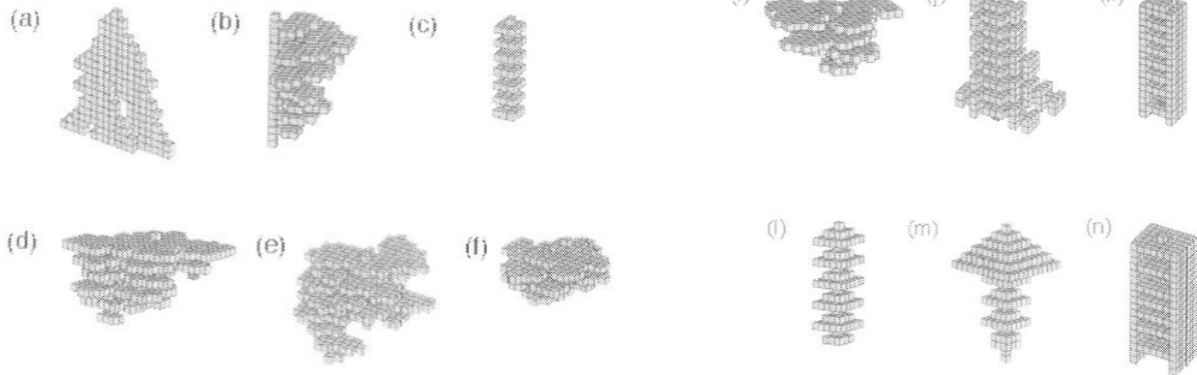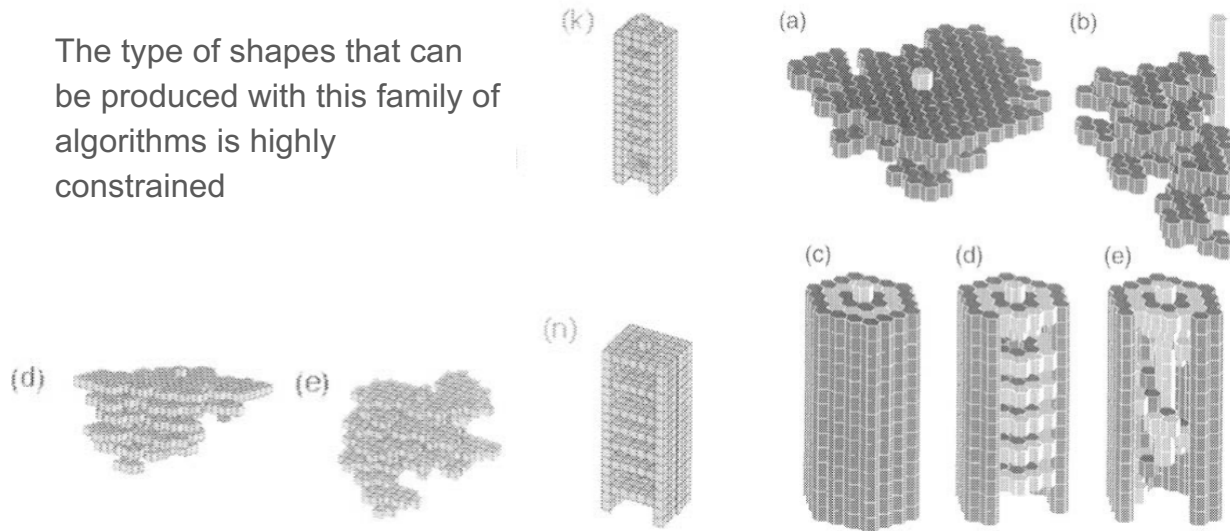

Coordinated VS Noncoordinated

Same coordinated algorithm leads to different global architectures in different simulations.

That is not the case for different simulations of the same Noncoordinated algorithm
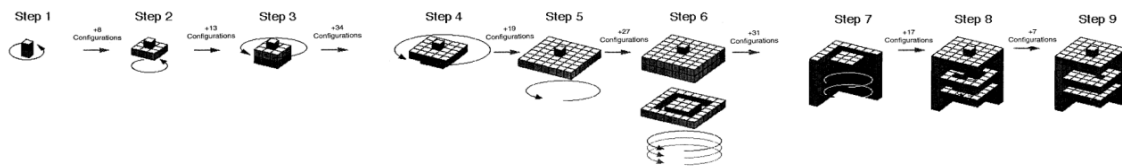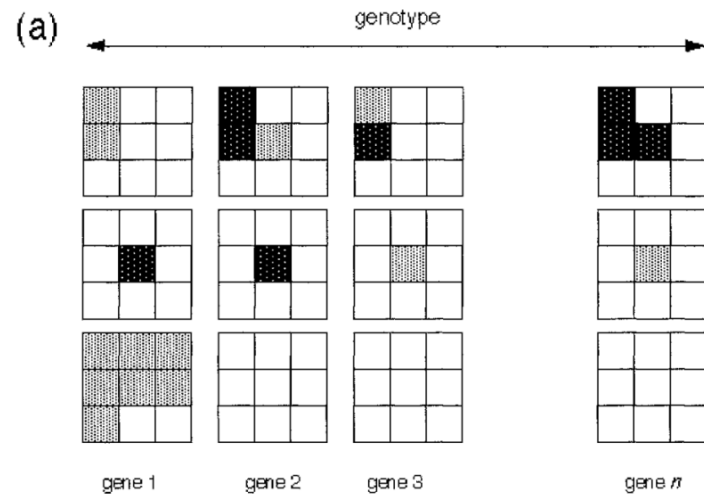
Square VS Hexagon

The type of shapes that can
be produced with this family of
algorithms is highly
constrained

Example of Emergent Steps and Structures

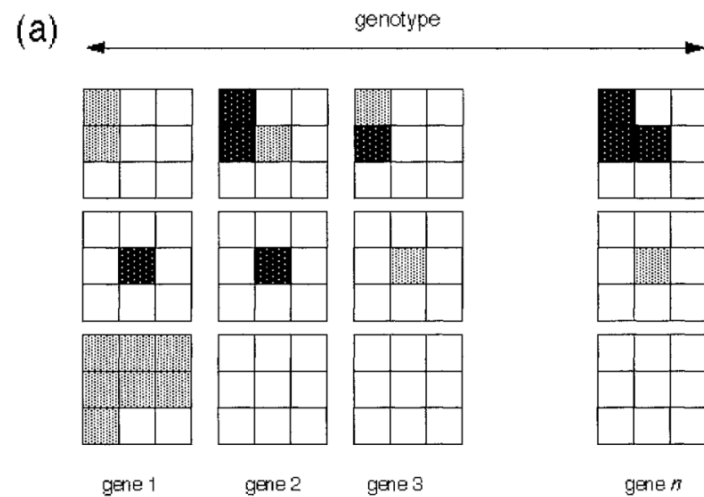# Genetic Algorithms and Nest Building
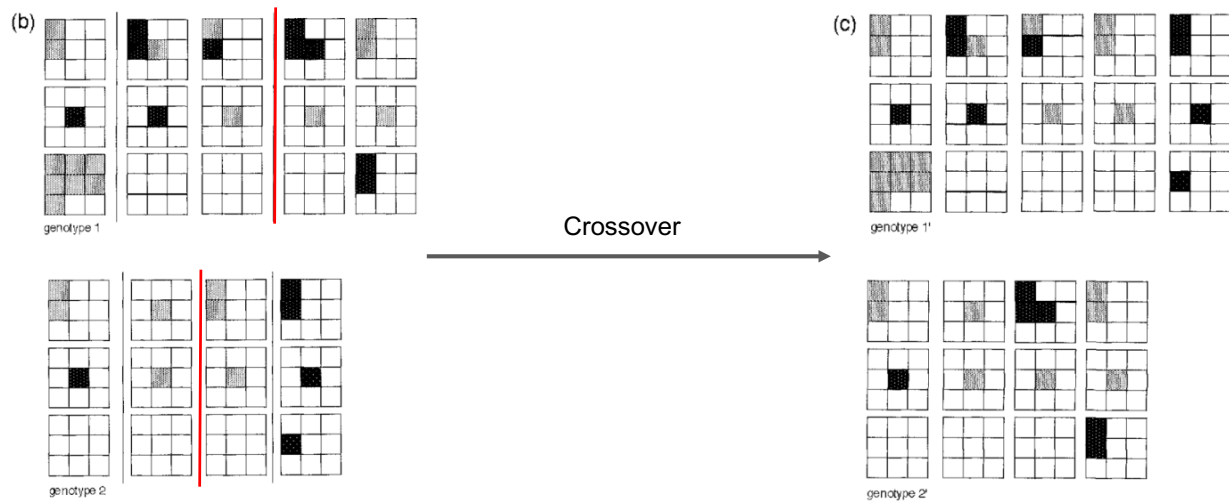

Genetic Algorithms and Nest Building

Rules are encoded in a genotype based on the surrounding 26 cells

In reproduction both mutation and crossover are possible
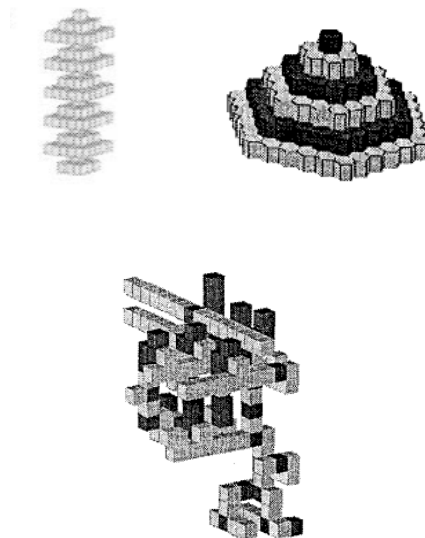
Fitness proportionate selection was used

4/4/23

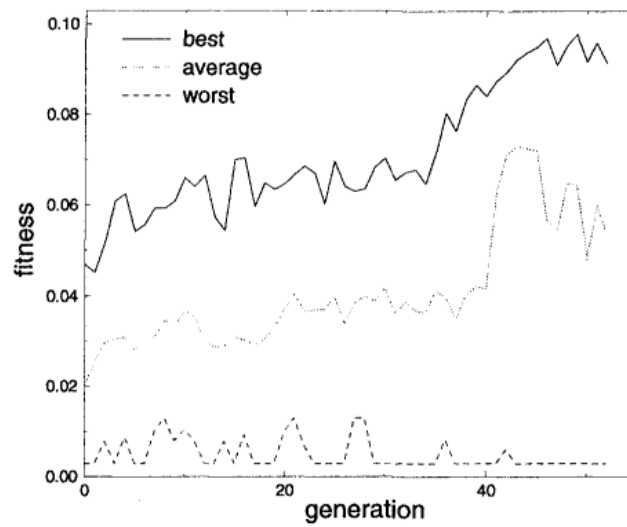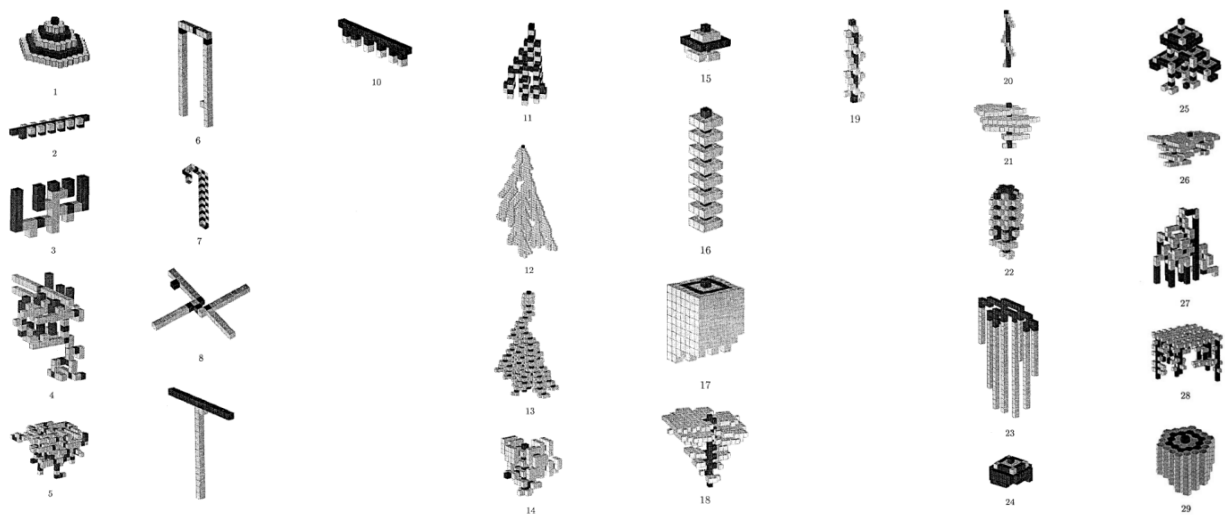## Crossover mutation in GA for nest building

Crossover

Fitness Function

1. The more number of microrules used the better

1. Bricks have adjacent faces with many of their neighbors

1. Large patterns that repeat themselves

8

Some interesting Designs found by the GA

Questions?