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An hybrid algorithm to simulate mice following residential walls

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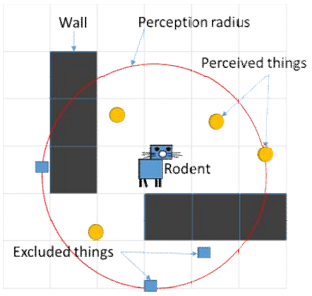
Keywords: Agent-Based Modelling, Commensal Rodent, Wall Following, Hybrid Architecture

- **Objective** : Provide simulation tools to help prevent epidemics spread.
- **Strategy** : We focus on the ability of rodents to forage using cognitive search behaviour to interact with items of interest, either attractive (*e.g.*, food, nests, relatives) or repulsive (*e.g.*, cats, humans) in their surroundings.
- **Approach** : Combine a cognitive architecture with an algorithm simulating rodents' moves following residential walls.
- **Expected result**: Realistic overall behaviour of mice wandering in habitations and avoiding obstacles in different configuration.

Method

Algorithm composed of three component parts.

a) Exclusion of unseen objects in perception radius



Rodent processing to perceive things in it surrounding.

b) Reaching the closest wall without entering in it

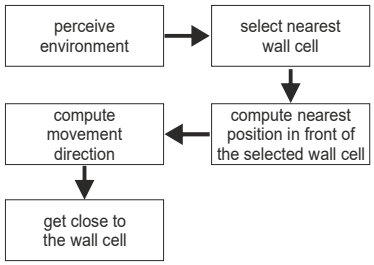
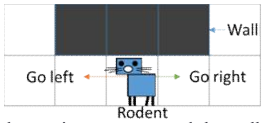


Fig 1: sub-models involved.

c) Circumventing walls



Rodent trying to get around the wall by choosing right or left aim.

- We use Pythagorean Theorem and vector product to obtain this equation system:

$$\begin{cases} RF^2 = OR^2 + OF^2 \\ \overrightarrow{OR}.\overrightarrow{OF} = ||\overrightarrow{OR}||.||\overrightarrow{OF}||.\cos(\widehat{\overrightarrow{OR},\overrightarrow{OF}}) \end{cases}$$

- Agent right and left direction are given by :

$$\begin{cases} xR = y0 \pm \frac{N2}{N1}(xF - x0) \\ yR = x0 \pm \frac{N2}{N1}(yF - y0) \end{cases}$$

Shape of rodent activity at each step

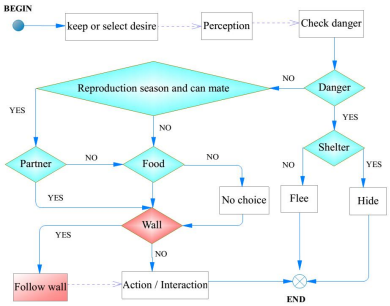


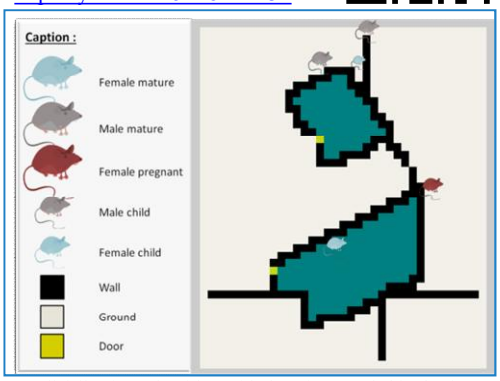
Fig 2: Rodent agent step in the hybrid model.

- Blue : general cognitive scheme.
- Red : obstacle avoiding.

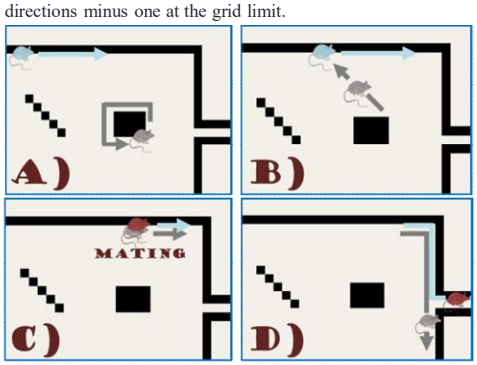
Testing

A dynamic representation of the simulation has been also uploaded on Youtube™ and is available at :

https://youtu.be/z5oS8elHD34



'Wall following' algorithm with domain extended in the four directions minus one at the grid limit.



Combination of cognitive behaviour and wall following algorithm. **A)** rodents follow walls, **B)** male perceived female, **C)** they mate and **D)** they switch back to wall following

Discussion

- Given its simplicity, the algorithm has to be overloaded with several patches to account for particular constraints :
  - ✓ Targeting free cells contiguous to wall to prevent agent from entering the walls;
  - ✓ Include conditional tests to account for the simulated grid limits;
  - ✓ Keep a direction of movement in the scheme to avoid infinite loops in the agent displacement;
  - ✓ Filter the unseen items beyond the walls.

Conclusion

- The algorithm proved efficient and could be plugged in a larger simulated context;
- Encapsulating this model into a more composite framework has been straightforward;
- Within a data poor environment, the simulation can be used to tackle the question of mice wanderings in actual households;
- This model is a significant added value to be included in a larger epidemiologic simulation context.

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