Colisweeper is an interactive, biological version of the Minesweeper™ computer game, based on Lux/LuxR signaling and chromogenic enzymatic reactions. The goal is to uncover non-mines in an agar “minefield” without detonating mines.

Signal origin
Sender cell (mine)

Pre-processing
Signal (AHL) diffusion

Processing
Promoter activation at different [AHL]

Optimization
Positive feedback loop

Playing
Player interaction

Output
Color response

How to play?
1. Choose a colony to play
2. Pipette substrate Flag or Play
3. Wait
4. Check color
5. Choose next colony

Important: Colors are only revealed after player interaction (adding substrate). The colors overlay and are all orthogonal.

Pre-processing

2D Spatiotemporal model
• 1 PDE (AHL reaction-diffusion)
• 4 coupled ODEs (intercellular reactions)
• 3 domains: agar plates, sender and receiver colonies
• 24 parameters (19 from literature, 3 from experiments, 1 estimated)
Simulated using finite element methods (COMSOL) with von Neumann boundary condition

Analytical approximation of AHL gradient
• Steady state solution of the AHL gradient generated by a single mine colony
• 2D and polar coordinates:

\[ [\text{AHL}]_r(r) = Q_1 \cdot r \cdot \int_0^r \frac{K_1(u)}{u^2} du \]

where \( r \) is the distance from the mine and \( K_1(u) \) is modified Bessel functions of the second kind.

Proof of Principle:

Spatiotemporal model

Experiment

Experimental evaluation

Orthogonal hydrolyses

Color output of 1 enzyme + 1 substrate reaction in liquid culture overexpressing the corresponding hydrolyase.

Orthogonality in A & B

Human practice

Gamification

Worldwide playing

Access

Remote Control

Global players

Education

References


The lab work, modeling, webapp, and gamification were done by our team members.

The lab work, modeling, webapp, and gamification were done by trainees for whom the following ETH Zurich groups were their support:

- The Sensory Laboratory
- Synthetic biology group
- Computational systems biology group
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