COMPORTAMIENTO COLECTIVO NO TRIVIAL EN SISTEMAS COMPLEJOS CON MINI-ROBOTS

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COLABORACIÓN EN MÉXICO

Estephania Molina Delgado

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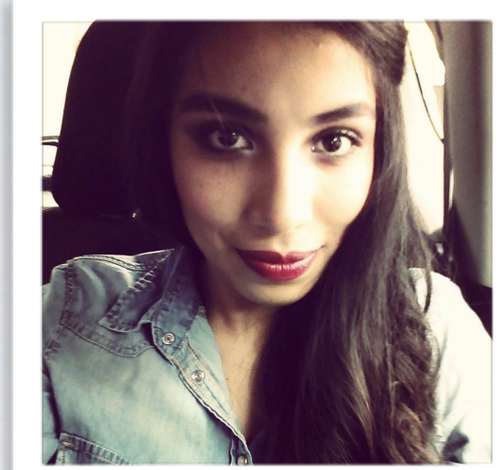


Rosa Graciela Chávez Barrera

COLABORACIÓN EN INGLATERRA

Andrew Adamatzky

Jeff Jones

RESUMEN / INTRO

Se discutirá el problema del fenómeno ***comportamiento colectivo no trivial***, frecuentemente referido como ***auto-organización***, en sistemas complejos analizado a través de mini-robots. Durante la conferencia se presentarán algunos prototipos desarrollados en la Escuela Superior de Cómputo del Instituto Politécnico Nacional en conjunto con la University of the West of England en el Reino Unido. Además se presentará el proyecto de investigación swarm-robotics, que actualmente se está impulsado en ESCOM.

NON-TRIVIAL COLLECTIVE BEHAVIOUR

videos source: *youtube*

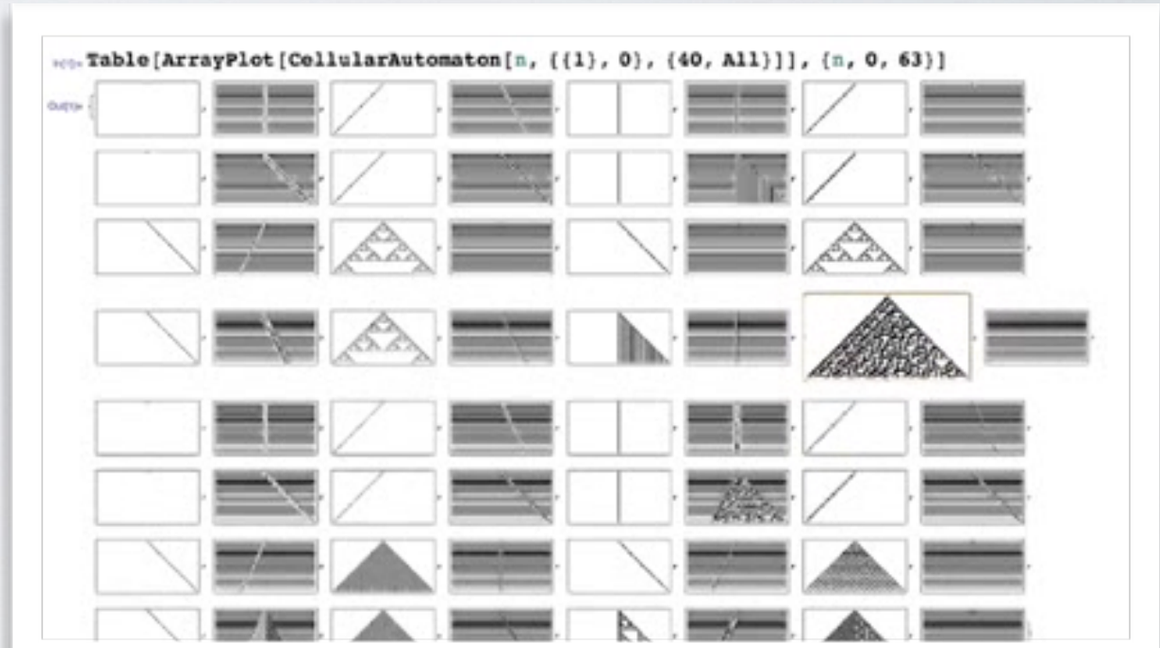
NON-TRIVIAL COLLECTIVE BEHAVIOUR

videos source: *youtube*

CLASSES IN CELLULAR AUTOMATA

Stephen Wolfram defines his classification in simple rules (1986), known as *elementary cellular automata*. Also, this classification is extended to any dimension.

- A CA is **class I**, if there is a stable state $x_i \in \Sigma$, such that all finite configurations evolve to the homogeneous configuration.
- A CA is **class II,** if there is a stable state $x_i \in \Sigma$, such that any finite configuration become periodic.
- A CA is **class III**, if there is a stable state, such that for some pair of finite configurations c_i and c_j with the stable state, is decidable if c_i evolve to c_j, such that any configuration become chaotic.
- Class **IV** includes all previous CA, also called complex. [Culik II & Yu, 1988]



video source: *youtube*

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Harold V. McIntosh, ***One Dimensional Cellular Automata***, Luniver Press, United Kingdom, 2009.
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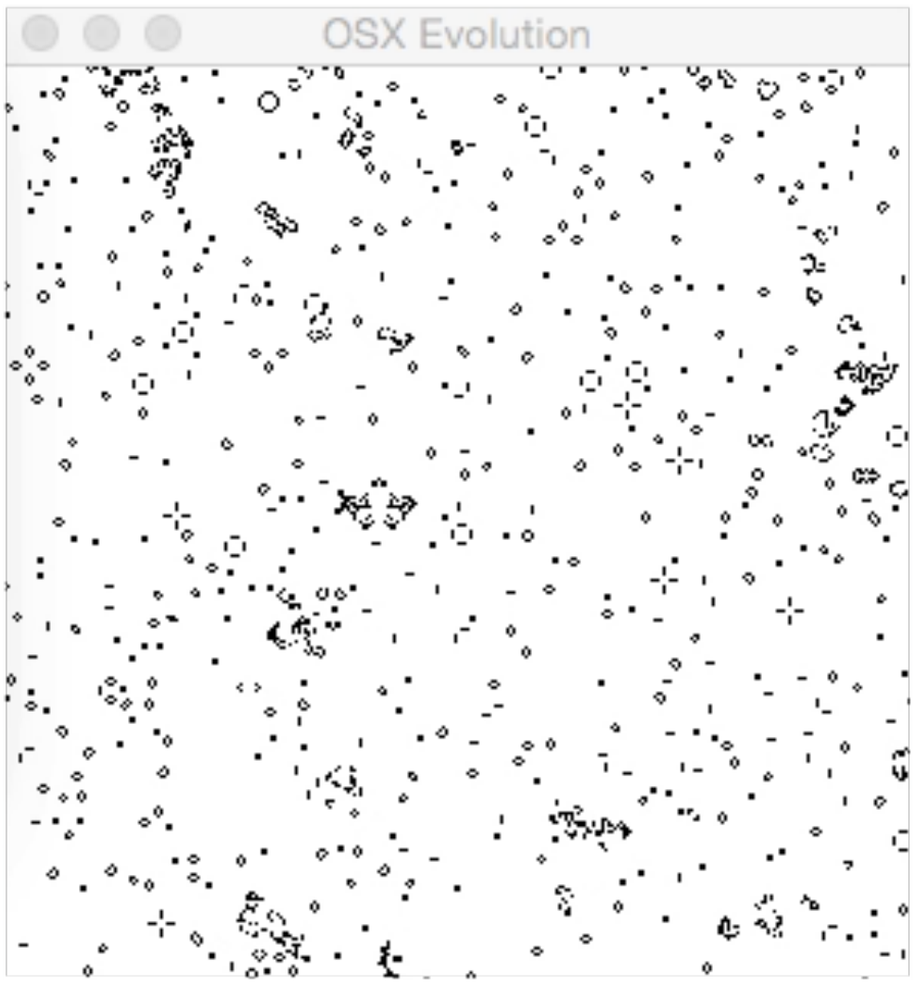
COMPLEXITY, CHAOS, PATTERNS, AND BEYOND …



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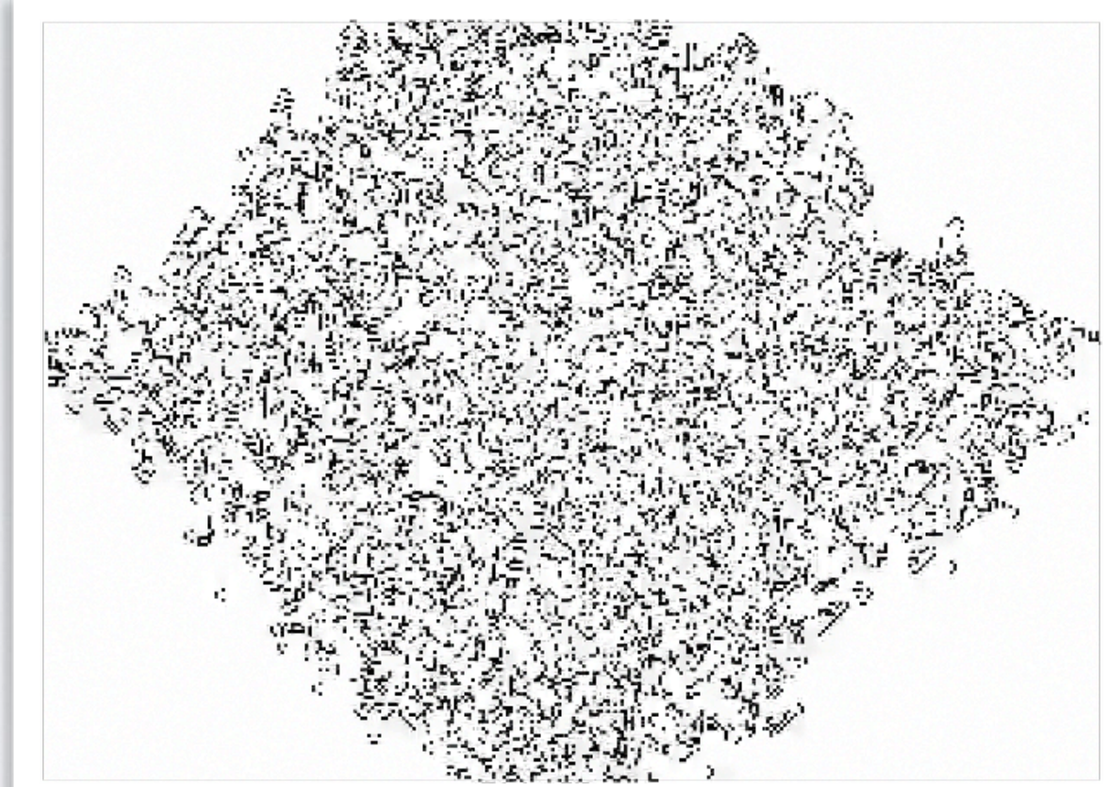

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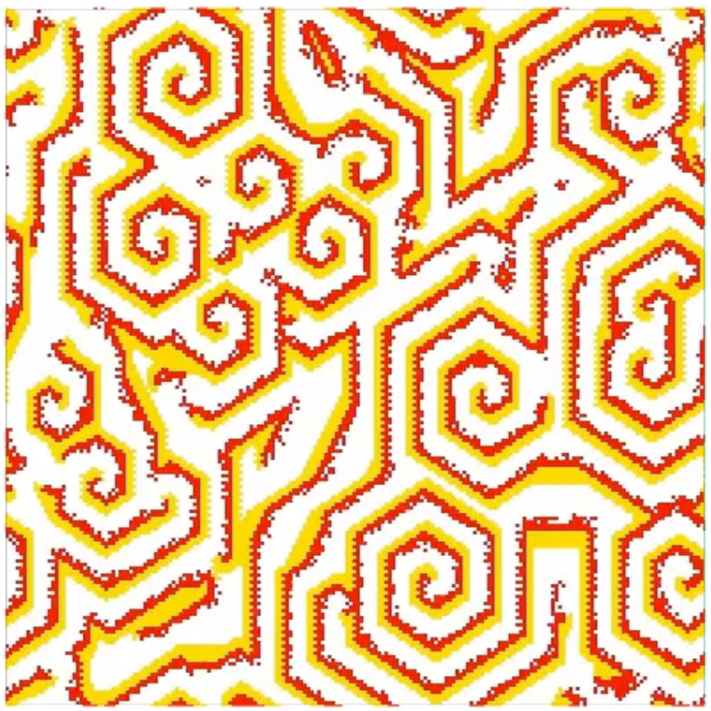

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COLLECTIVE BEHAVIOUR IN SPATIALLY EXTENDED SYSTEMS

Spatially extended systems with local interactions and synchronous updating are of fundamental importance in trying to understand the nature of the complexity exhibited by such phenomena as developed turbulence and neural dynamics.

Mean field approximation

$$c^t = \Pr\{A_i{}^t = 1\} = 1 - \Pr\{A_i{}^t = 0\} .$$

And since the rules are totalistic,

$$\Pr\{A_i{}^{t+1} = 1\} = \sum_{S=0}^{\mathcal{N}} p_S \Pr\{\mathcal{S}(\mathcal{V}_i{}^t) = S\} .$$

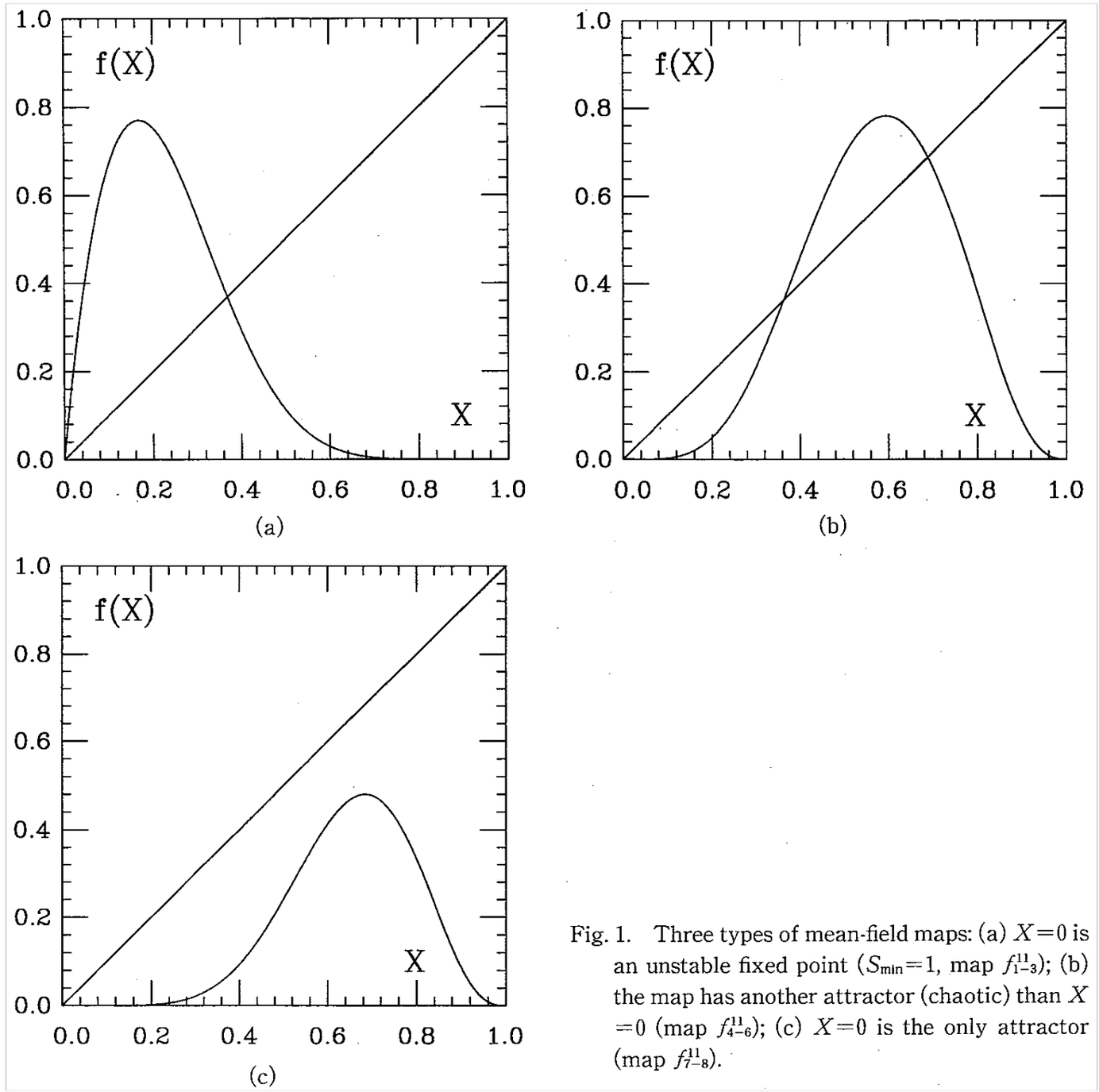
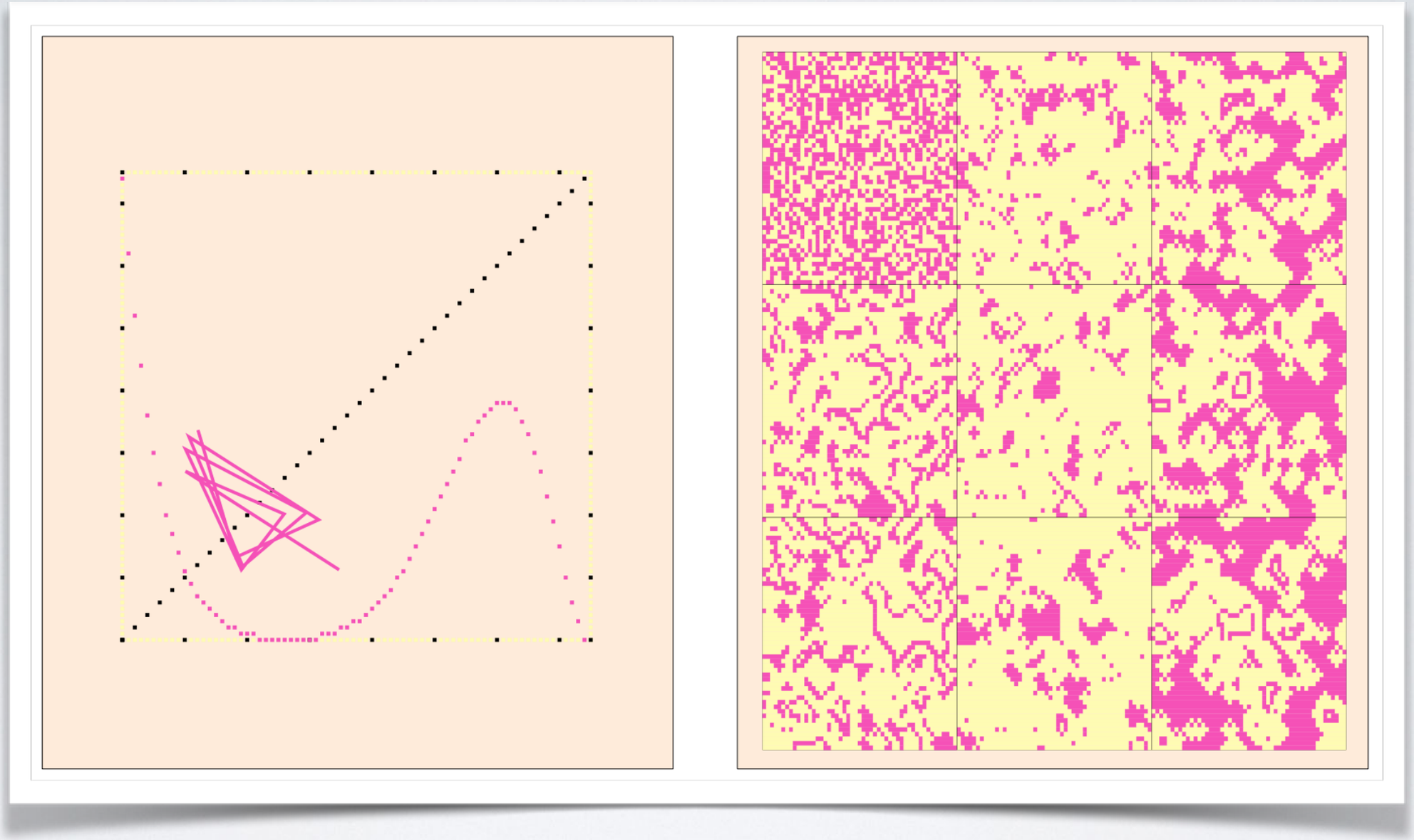


Fig. 1. Three types of mean-field maps: (a) $X=0$ is an unstable fixed point ($S_{\min}=1$, map $f_{1\text{–}3}^{11}$); (b) the map has another attractor (chaotic) than $X=0$ (map $f_{4\text{–}6}^{11}$); (c) $X=0$ is the only attractor (map $f_{7\text{–}8}^{11}$).

Hugues Chaté and Paul Manneville, **Collective Behaviours in Spatially Extended Systems with Local Interactions and Synchronous Updating**, *Progress of Theoretical Physics*, Vol. 87, No. 1, 1992.

NON-TRIVIAL COLLECTIVE BEHAVIOUR IN CELLULAR AUTOMATA

Non-trivial collective behaviour in 2D cellular automata (von Neumann function)



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KILOBOT PROJECT, HARVARD UNIVERSITY, USA

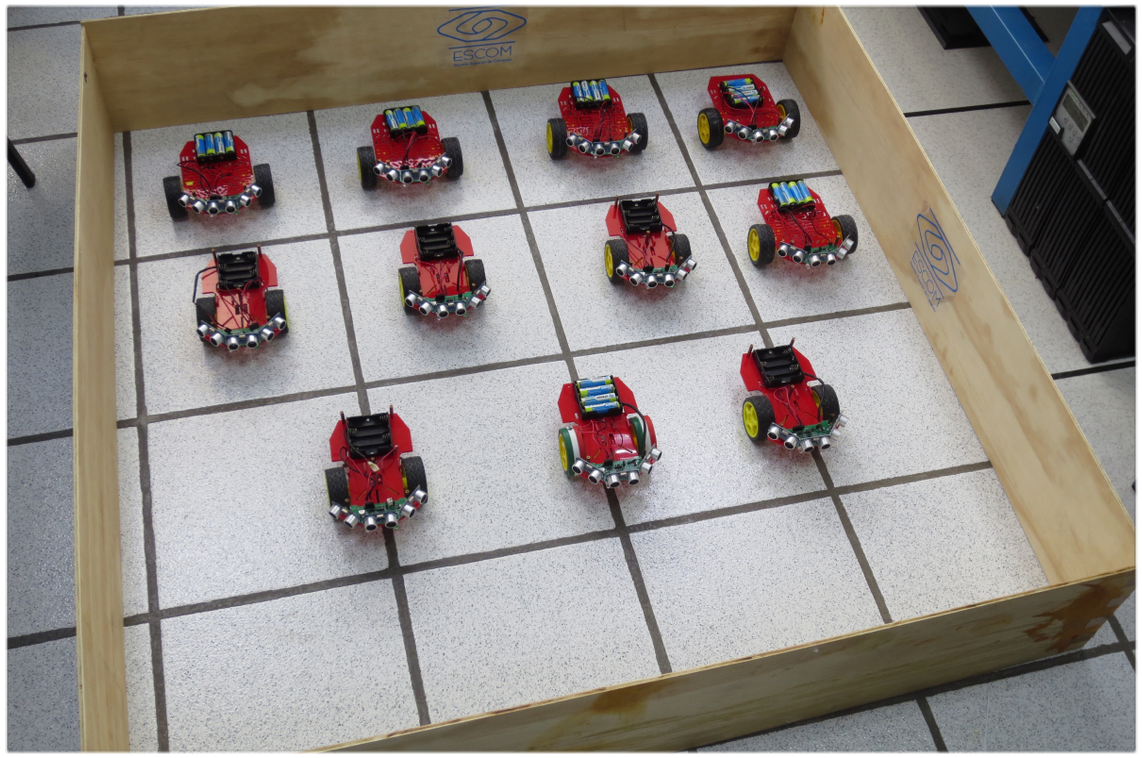
video source: Harvard University and youtube.

SWARM ROBOTICS PROJECT, ESCOM-MEXICO, UWE-UK

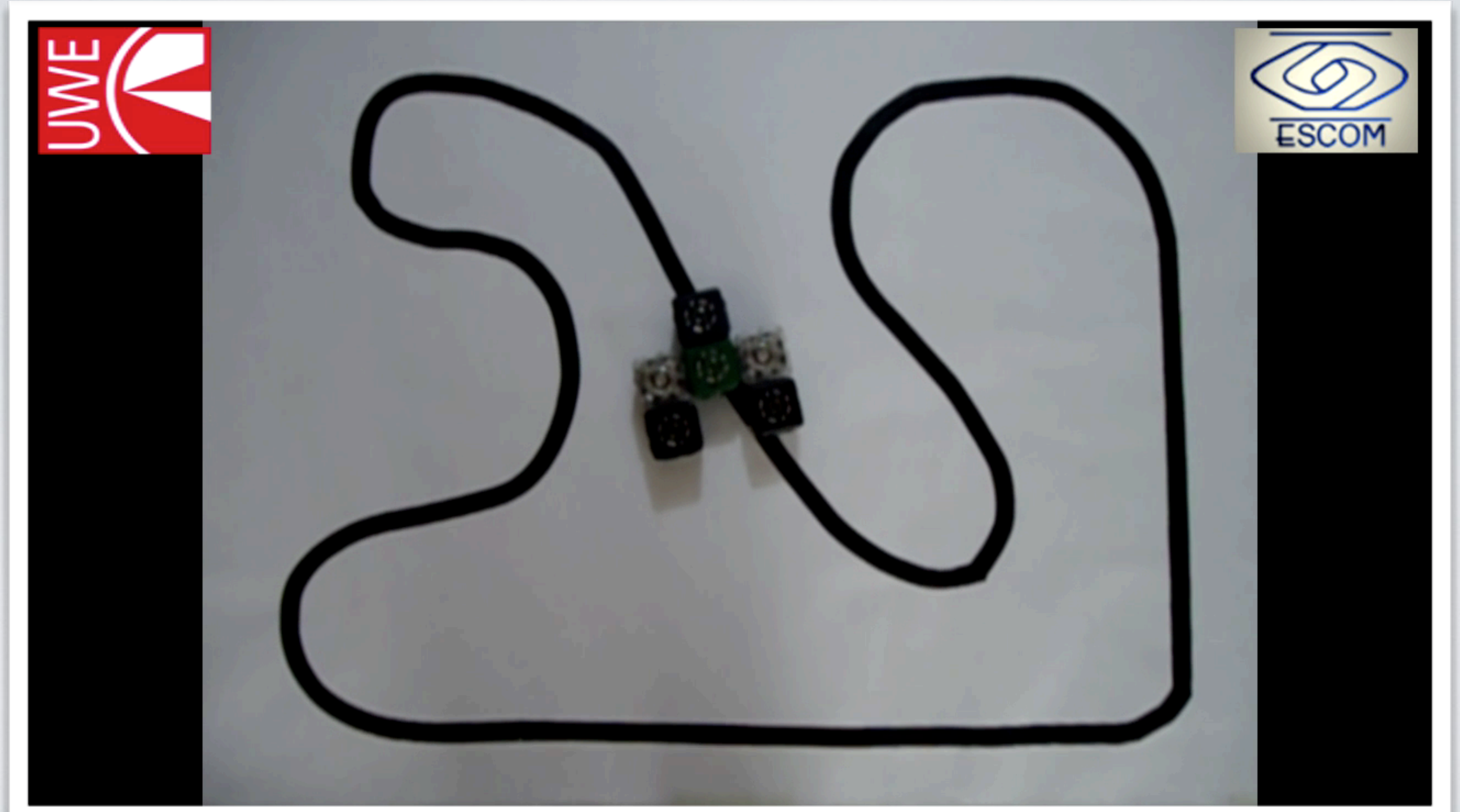
Spatially extended systems with local interactions and synchronous updating are of fundamental importance in trying to understand the nature of the complexity exhibited by such phenomena as developed turbulence and neural dynamics.

Cubelets reprogramming

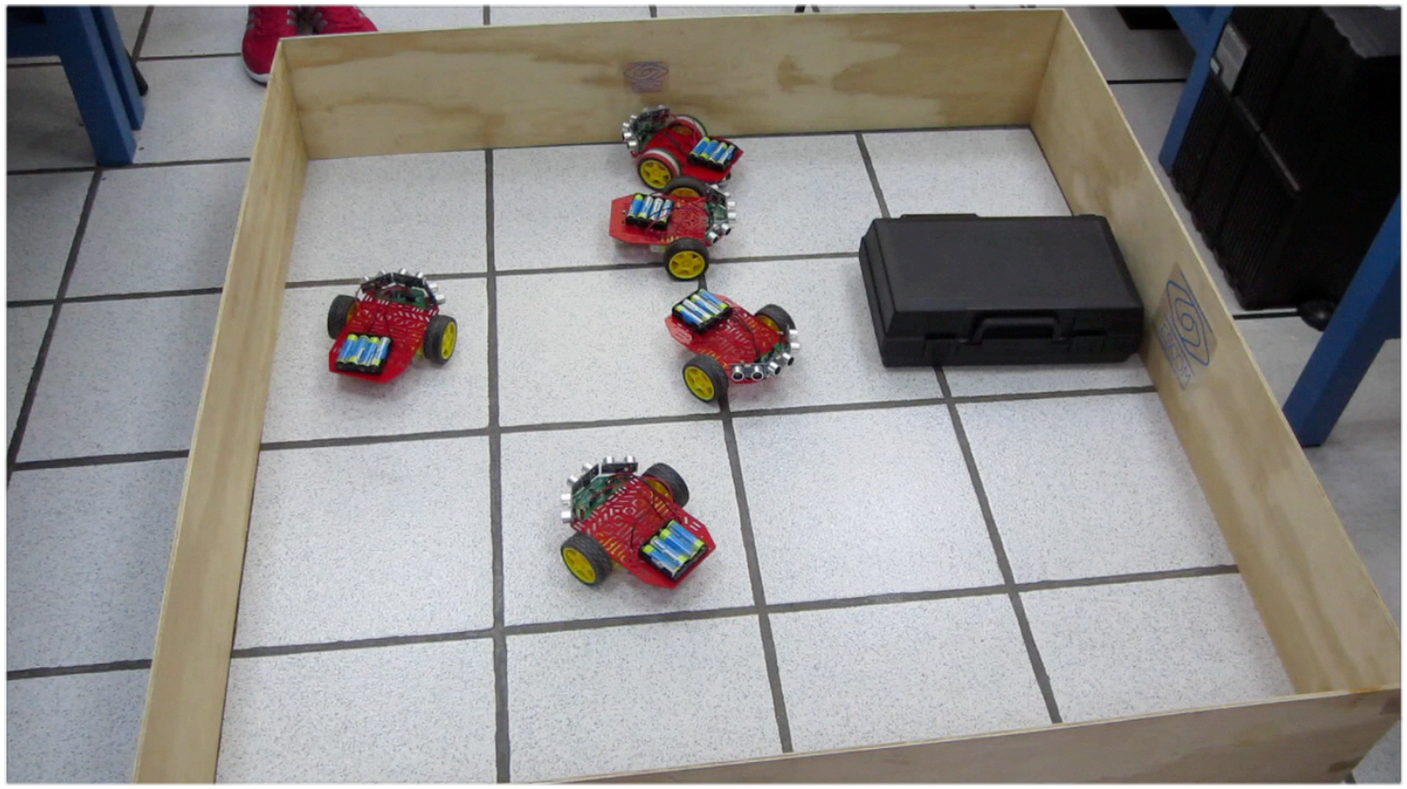
Low cost mini robots



SWARM ROBOTICS PROJECT, ESCOM-MEXICO, UWE-UK



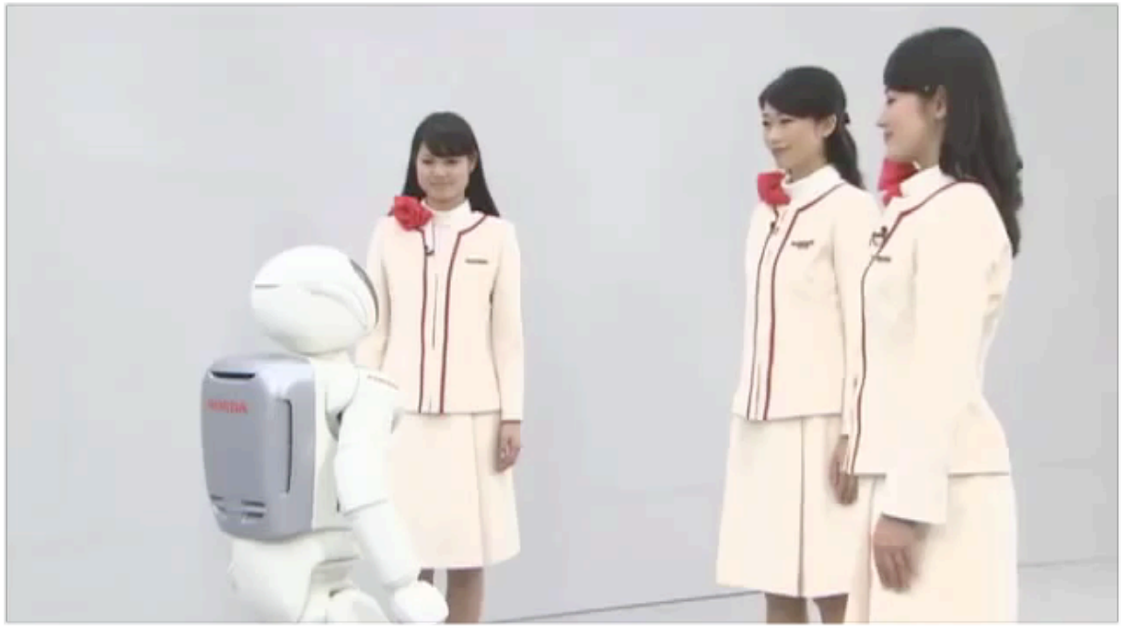
SWARM ROBOTICS PROJECT, ESCOM-MEXICO, UWE-UK



CONCLUSIONES Y DEMOSTRACIÓN

Proyectos e investigación en progreso:

- **Implementación de nuevos algoritmos.**
- **Experimentación para seguimiento autómatico con slime mould.**
- **Implementación de un sistema de seguridad para ESCOM …**



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Jeff Jones, ***From Pattern Formation to Material Computation***, Springer 2015.

FIN

Gracias por su atención!

Computer Science Laboratory (LCCOMP)
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