

Spatial Computing

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SASO Grand Challenges
October, 2008

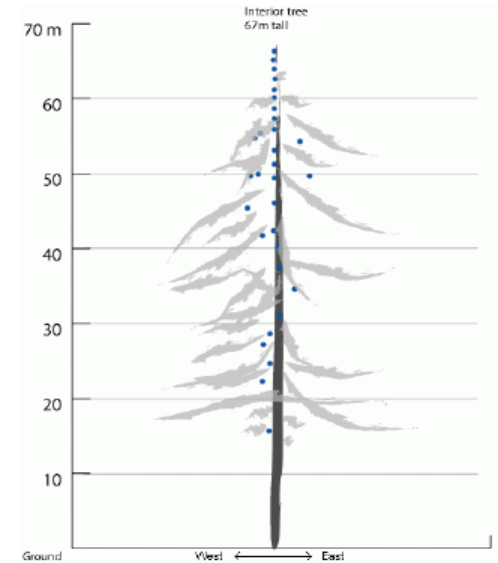
Spatial Computers



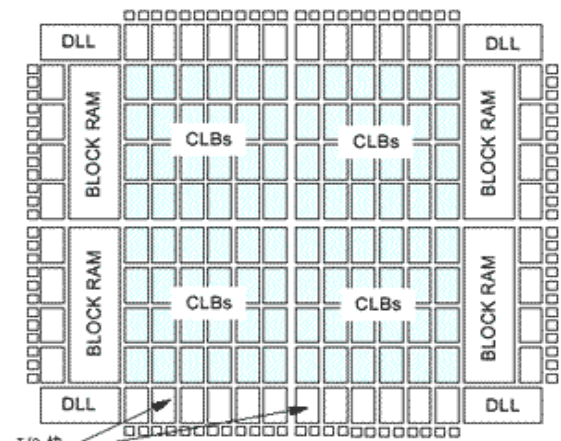
Robot Swarms



Biological Computing

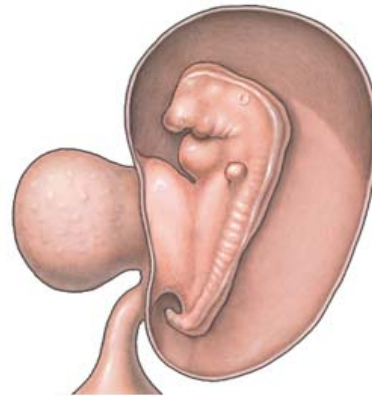


Sensor Networks



Reconfigurable Computing

3.5 weeks



Cells during Morphogenesis

ADAM.

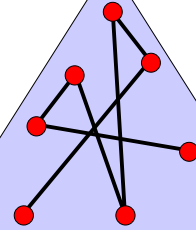


Modular Robotics

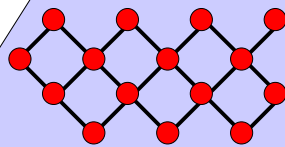
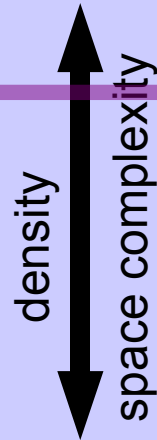
More formally...

- A spatial computer is a collection of computational devices distributed through a physical space in which:
 - the difficulty of moving information between any two devices is strongly dependent on the distance between them, and
 - the “functional goals” of the system are generally defined in terms of the system's spatial structure

Graphs

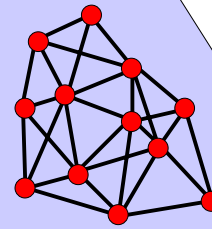


spatial computing



jitter

grain size



Crystalline
(e.g. CAs)

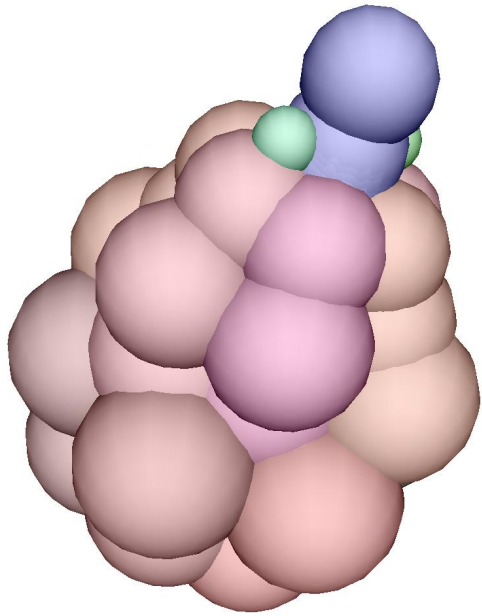
**Amorphous/
Continuous**

(w. Dan Yamins)

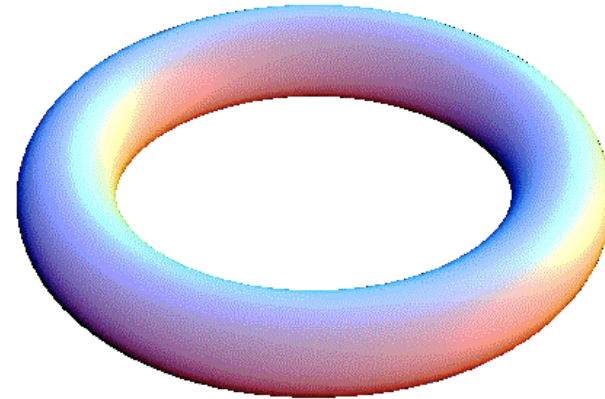
Why is this SASO?

- Local interaction, global behavior
- Many devices = constant change & failure
- Engineering control:
 - Predictable composition
 - Continuous/discrete

First steps: MGS



Meristem formation

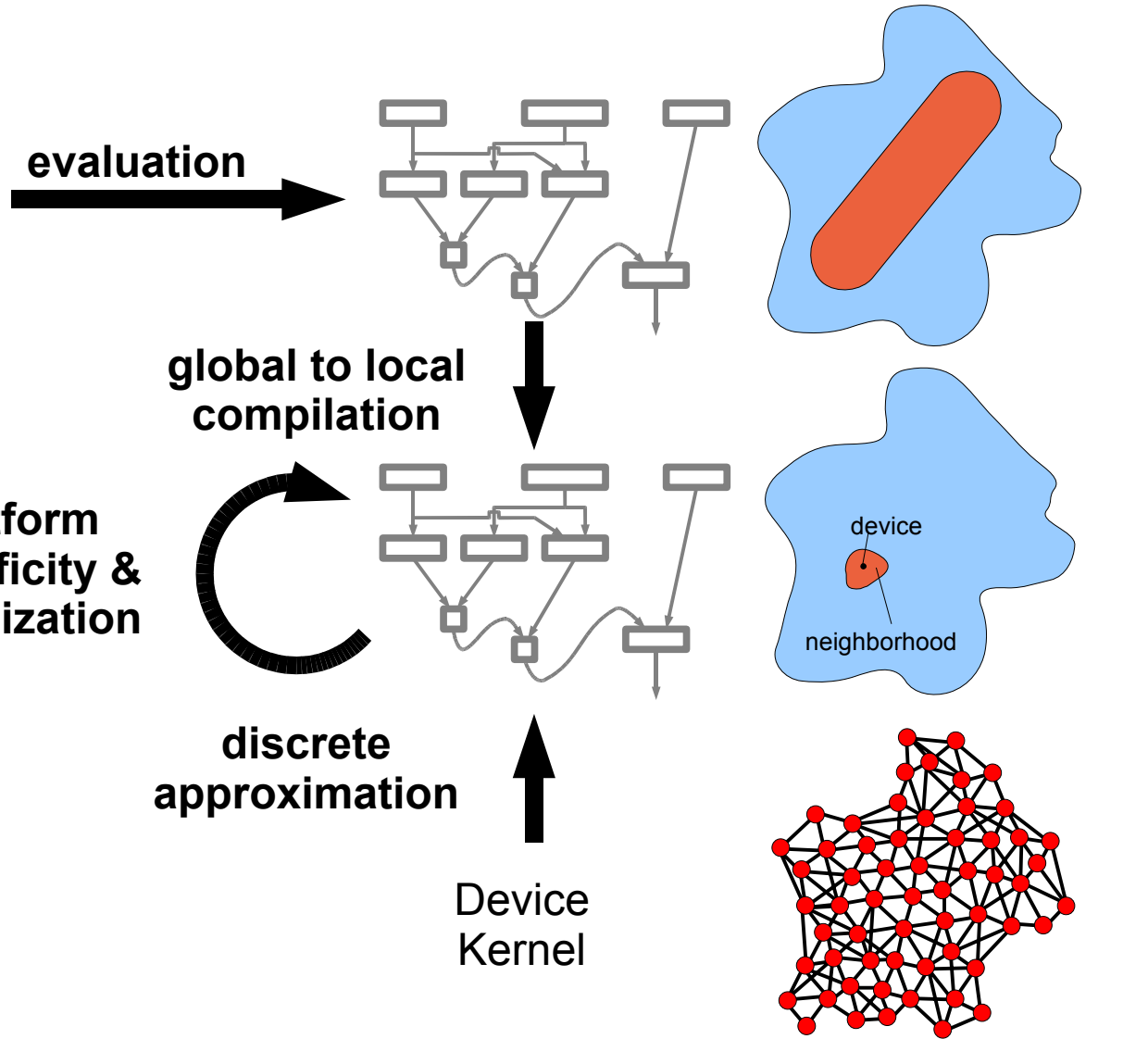
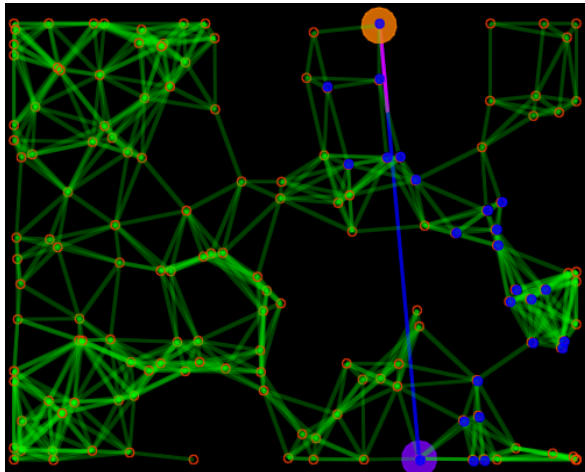


Turing pattern on torus

Michel, Giavitto, Spicher

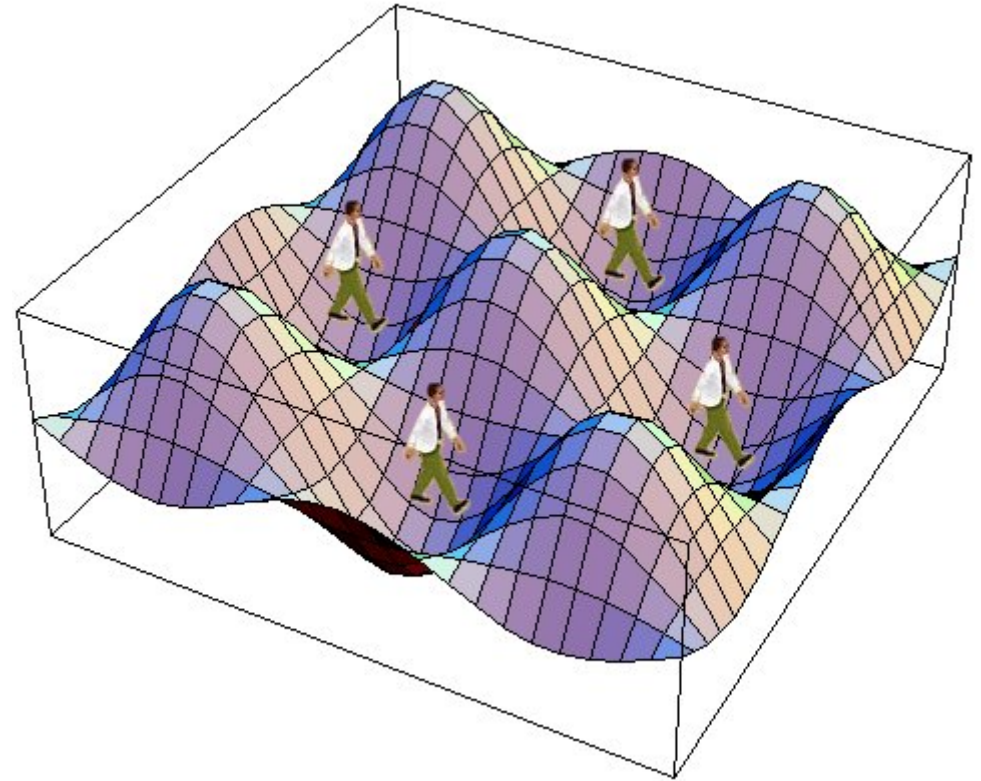
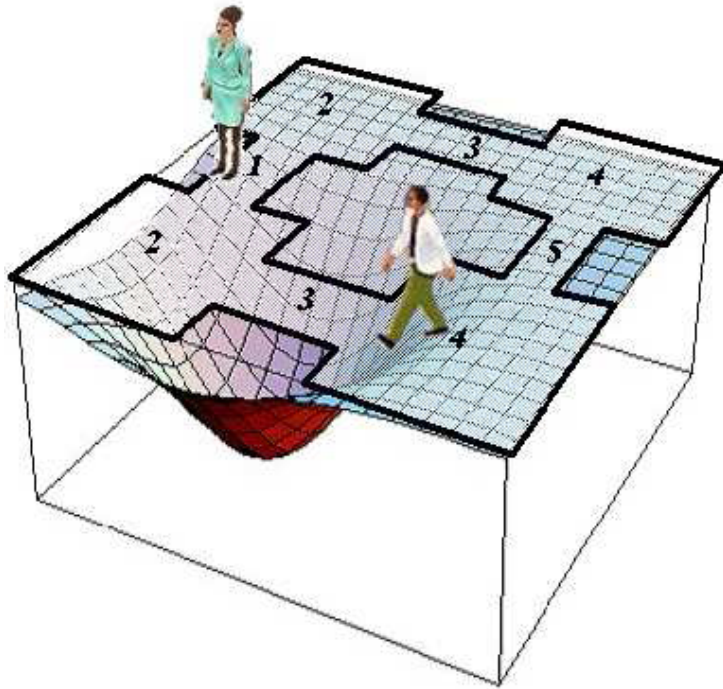
First steps: Proto

```
(def gradient (src) ...)  
(def distance (src dst) ...)  
(def dilate (src n)  
  (<= (gradient src) n))  
(def channel (src dst width)  
  (let* ((d (distance src dst))  
         (trail (<= (+ (gradient src)  
                       (gradient dst))  
                    d)))  
    (dilate trail width)))
```



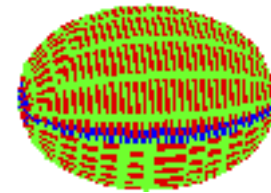
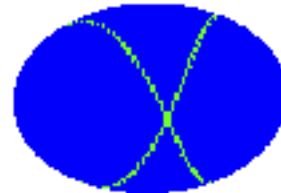
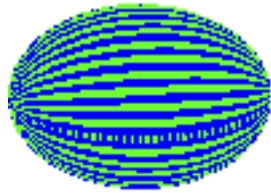
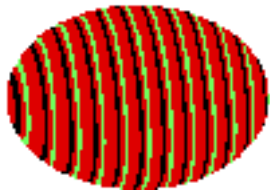
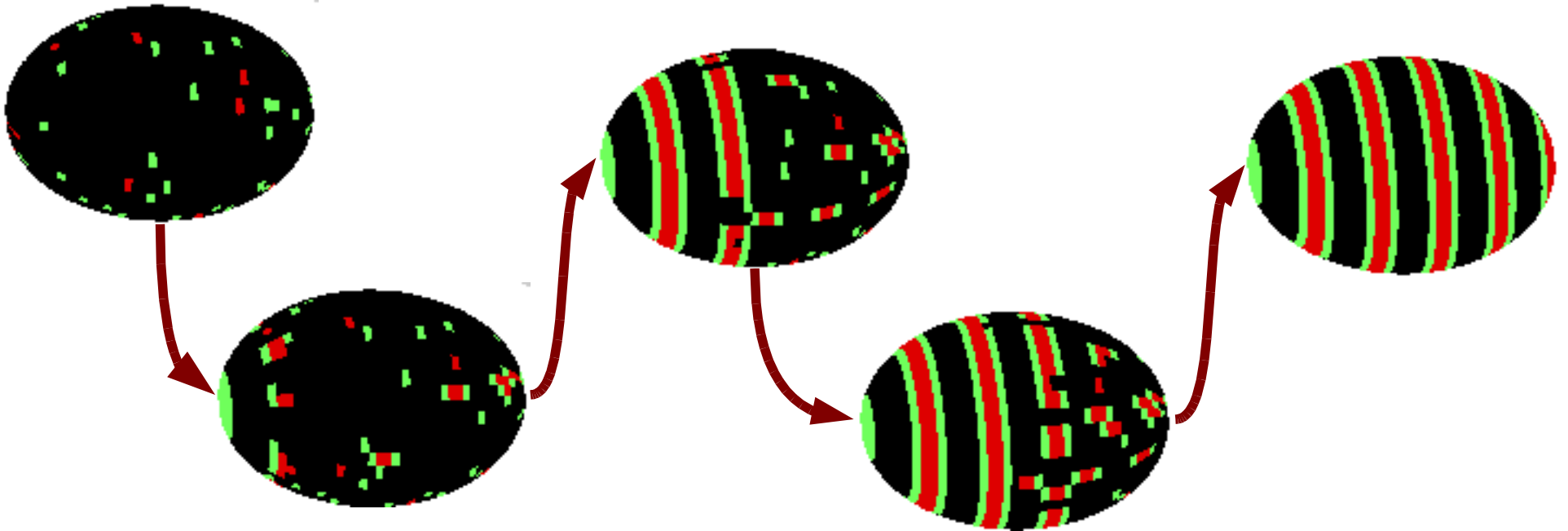
Beal & Bachrach

First steps: Co-Fields



Mamei & Zambonelli

First steps: Local Checkability



Yamins

Challenges

- How is computation across space special?
- How can we predict composition/discretization?
- What techniques transfer between domains?
- Are *your* problems or techniques spatial?