What am I programming?

Amorphous computer:

Extremely large network, scattered through space, communicating only between nearby neighbors, and made of unreliable parts.

Amorphous medium:

The space approximated by an amorphous computer.

Key idea: Make networking entirely implicit!
What sort of programs?

Traffic Control

Habitat Monitoring

Agricultural Management
A geographically distributed network...
... approximates a region of space ...
... but it's the space I want to program!
Amorphous Design Space

$n > 10^6$ nodes

Plentiful energy, memory and processing

No naming, time or coordinate service

Cost constraints:

- Communication density $O(\lg n)$
- Time (stabilization, update, etc.) $O(d \lg d)$
- Locality of execution
Challenges to Robustness

Point failure & rejoin
  Node, edge, or micropartition
  Continuously occurring
Region failure & rejoin

Cut and paste too?
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**Region** failure & rejoin

*Cut and paste too?*
Process = Region

Behavior is specified for a generic point in the region.

(defprocess wheat-manager ...)
(defprocess corn-manager ...)
(defprocess soy-manager ...)
(defprocess water-manager ...)
(defprocess farm-manager ...
  (p-assert
    (h (local harvesters))
    (subprocess (harvester h) :gradient 2))
  ...)

Executing Processes Can Move
Executing Processes Can Move

(defprocess farm-manager ...
  (p-assert
   (h (local harvesters))
   (subprocess (harvester h) :gradient 2))
  ...)

FARM-MANAGER

HARVESTER 3

HARVESTER 6
(defprocess corn-manager ...  
 (constraint ; ensure mature ears are picked  
   (or (not (local ears)) ; invariant  
     (not (maturep (local ears)))))  
 (assert request-picking 'corn) ; repair  
 ...)
Process Variables Have Aggregate Values

Local: doesn't spread
Gossip: free aggregation
Fold: no point counted twice
Atomic: serializable

(defprocess water-manager ...
  (variable needs-water :gossip :fold push)
  (p-constraint
    (c (local crops))
    (> (local dampness) (damp-pref c))
    (assert needs-water c)))
(defprocess water-manager ...
  (constraint
    (not needs-water)
    (subprocess (water) :node 2
      :move (attract-to (source-of needs-water)))
  ..)
Contributions

Network is a discrete sampling of space

Toward a high-level spatial language:

- Amorphous computing primitives
- Process = Region
- Invariant & Repair