Autonomy in Spatial Computing

Jacob Beal (& Jonathan Bachrach) MIT CSAIL

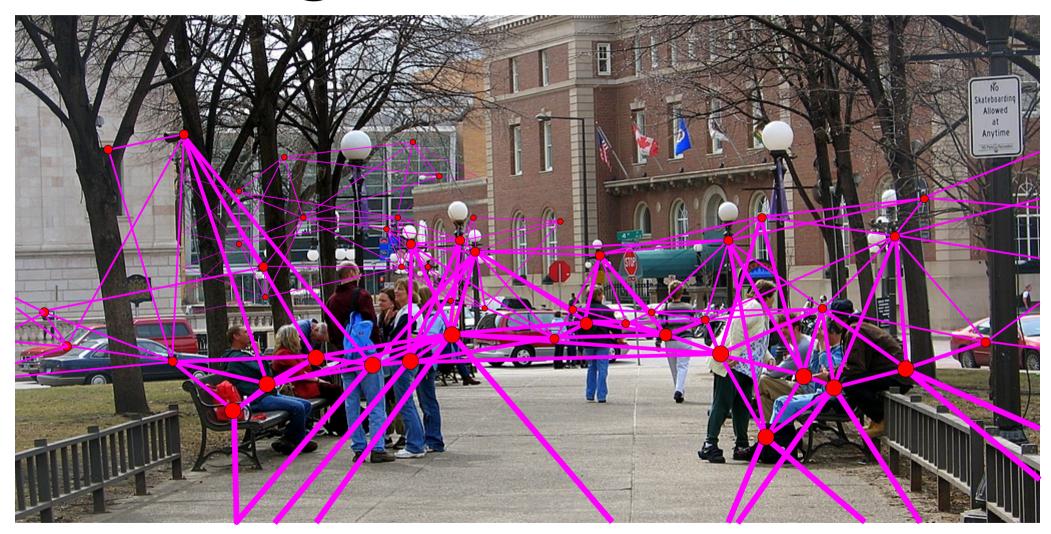
Networked devices are **filling** our environment...



Networked devices are **filling** our environment...

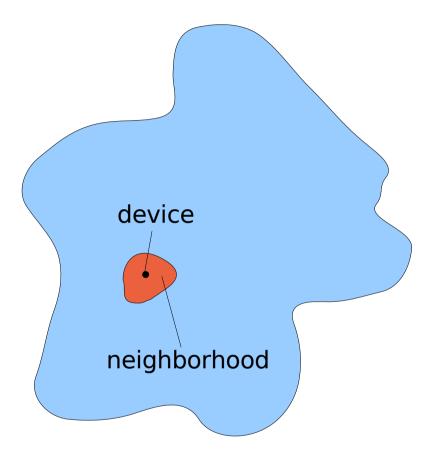


Networked devices are **filling** our environment...

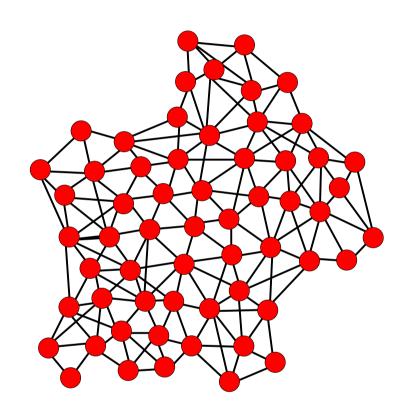


How do we program aggregates robustly? 4

Amorphous Medium



- Continuous space & time
- •Infinite number of devices
- See neighbors' past state

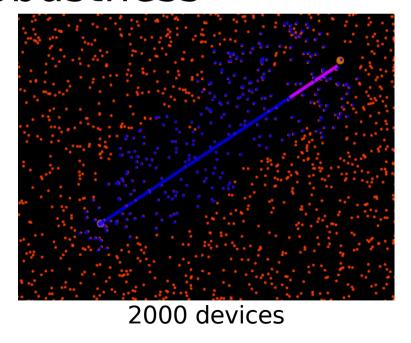


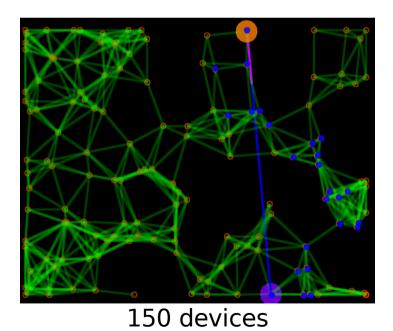
Approximate with:

- Discrete network of devices
- Signals transmit state

Why use continuous space?

- Simplicity
- Scaling & Portability
- Robustness





Proto

```
Global
(def gradient (src) ...)
(def distance (src dst) ...)
(def dilate (src n)
                                  evaluation
 (<= (gradient src) n))</pre>
(def channel (src dst width)
  (let* ((d (distance src dst))
         (trail (<= (+ (gradient src))</pre>
                        (gradient dst))
                                         global to local
                    d)))
                                           compilation
    (dilate trail width)))
                                                                                         Local
                             platform
                                                                            device
                          specificity &
                          optimization
                                                                          neighborhood
                                                                                         Discrete
                                            discrete
                                        approximation '
                                                        Device
                                                        Kernel
```

Key Ideas

- Many networks are spatial computers
- Continuous-space geometric programs are simple, scalable, and robust
- Proto compiles global descriptions into approximate local implementations
- Emergent behaviors can be engineered with by modulating regions