An Agent Framework for Agent Societies

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Proto’s Continuous Model

- Continuous space-time
- Infinite number of devices
- Neighbors’ past state

**Benefits**: simple, scalable, robust, adaptive

- Approximate with discrete network of devices
- Signals transmit state
(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)))
Proto’s Families of Primitives

Pointwise

Restriction

Feedback

Neighborhood

ASRM defines seven *functional concepts* for agent systems:

- Agent Administration
- Directory Services
- Security and Survivability
- Messaging
- Mobility
- Conflict Management
- Logging

ASRA defines *architectural paradigms* for each functional concept.
Current Progress on Functional Concepts

- Agent Administration
- Directory Services
- Security and Survivability
- Messaging
- Mobility
- Conflict Management
- Logging
Framework Implementations
Contributions

Analysis of Proto’s support for agent framework functional concepts.

Open Research Challenges:
- Conflict Management, Voting
- Security, Non-cooperative Agents
- Logging

http://proto.bbn.com
Thanks

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BACKUP
(def quadratic (a b c)
  (/ (- (neg b)
       (sqrt (- (pow b 2)
               (* 4 a c)))))
  (* 2 a)))
Agent Framework Bullseye

Required components:
- Sensor
- Service Discovery
- Localization
- Communication

Back to Problem
(def bullseye (src)
  (let ((d (distance-to src)))
    (if (< d 15) (red 1)
      (if (< d 30) (green 1)
        (if (< d 45) (blue 1)
          0)))))
(bullseye (sense 1))

proto -s 0.1 -r 8 -n 1000 -m -l "(mov (all (bullseye (sense 1)) (brownian)))"

Back to Problem
Agent Administration

Includes:
- Instantiating agents
- Terminating agents
- Inspecting agent state

Example: Cellular-level scaling via replication
Directory Services

Enables locating and accessing shared resources (i.e., UDDI).

(Note)

(distance-to (sense 1))

Note

(sense 1) is an operator that returns the location of a test sensor shown in orange.
Example: Connecting data sources to data sinks

(connect (sense 1) (sense 2))
“Remain useful/dependable in the face of malice, error, or accident.”

Example: Self-repairing shortest-path
(def shortest-path (source destination)
  (letfed
    ;; di is the total distance from source and dest to executing node
    ((di (+ (distance-to source)
            (distance-to destination)))
     ;; min-di is the shortest path distance
     (min-di (min-hood (broadcast destination di))))
    ;; if executing node is on the shortest path (and not infinity)
    (if (and (not (= min-di (inf)))
              (= min-di di))
      (blue 1) ;; turn on blue LED
      (blue 0)))) ;; else, turn off blue LED
Messaging

\[(\textit{mov}) \rightarrow \langle \textit{move the device} \rangle\]

\[\langle \textit{normalize} \rangle \rightarrow \langle \textit{normalize the vector} \rangle\]

\[\langle \textit{int-hood} \rangle \rightarrow \langle \textit{integrate over each neighbor's vector} \rangle\]

\[\langle \textit{nbr-vec} \rangle \rightarrow \langle \textit{return distance-vector to each neighbor} \rangle\]
Mobility

Back to Restriction
Conflict Management

“Facilitates and enables the management of interdependencies between agents activities and decisions.”

Example: the elect operator is a self-stabilizing symmetry-breaking function that selects leaders in a cooperative society.
“Enables information about events that occur during agent system execution to be retained for subsequent inspection.”

Future work for Proto includes implementing logging. Idea: similar to queries on distributed DB.