Simple SIR Infection Model in FLAME

David Worth, Chris Greenough, Shawn Chin

Software Engineering Group
Computational Science & Engineering Department
Rutherford Appleton Laboratory

david.worth@stfc.ac.uk, christopher.greenough@stfc.ac.uk, shawn.chin@stfc.ac.uk
Background

- Transfer NetLogo infection model to FLAME
- Agents move randomly on torroidal domain
- One of 3 states
  - Susceptible
  - Infected
  - Removed (immune)
- Birth and death included
- Spread controlled by
  - Infectiousness, chance of recovery, duration of virus
One Iteration

- Agent moves
  - 1 unit in direction ±100º of current heading
- Infected agents post location
- Susceptible agents read locations
  - Look for messages within their 1x1 patch
  - Calculate chance of becoming infected
  - Based on infectiousness
- Infected agents calculate chance of recovery
  - Based on duration of virus & chance of recovery
- Non-sick agents have chance of reproducing
  - Up to carrying capacity
  - Based on agent lifespan & average number of offspring
Implementation

- One **Person** agent
  - Agent identification: **Id**
  - Position: $x, y$ (double) and **heading** (double)
  - State flags: **is_sick**, **isimmune**
  - Counters: **sick_count** (how long infected), **age** (how old)

- One **infected** message
  - Agent id: **Id**
  - Position: $x, y$ (double)

- Functions
  - **get_older** (Start $\Rightarrow$ 1)
  - **move** (1 $\Rightarrow$ 2) Output **infected** message
  - **infect** (2 $\Rightarrow$ 3) Input **infected** message
  - **recover** (3 $\Rightarrow$ 4) Depends on **infect** function
  - **Reproduce** (4 $\Rightarrow$ End) Depends on **recover** function
Agent Creation

- Required by `reproduce` function
- Need **unique ids**
- New agent created from existing one so use existing id as basis
  - Add on global number of agents * current iteration number
  - Increment global number of agents
- OK because agents only have one child per iteration
- Not complete solution
  - Global number of agents changed by other functions
Environment

- Fixed values defining: reproduction, disease, domain
  - Lifespan 100
  - Average offspring 4
  - Carrying capacity – scaled with initial number of agents
  - Infectiousness 65%
  - Chance of recovery 50%
  - Duration of disease 20
  - Domain height – scaled with initial number of agents
  - Domain width – scaled with initial number of agents
Input Data

- Initially same as NetLogo model
  - 150 agents
  - 10 infected (choose first 10)
  - 34x34 domain
  - Carrying capacity = 750
  - Position and heading random uniform distribution

- Other values on previous slide

- Generated with Python script
  - ./init_start_state.py <width> <height> <agent_count>
  - Scale domain with agent count to keep same density
  - Change carrying capacity in script!!
Verification

- Check with NetLogo

**NetLogo Results**

- Total
- Infected
- Immune
- Healthy

**FLAME Results**

- Total
- Infected
- Immune
- Healthy
Serial run 15000 agents

Flame Serial Run

Number of agents

0 10000 20000 30000 40000 50000 60000 70000 80000

1 6 11 16 21 26 31 36 41

Total  Infected  Immune  Healthy

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Carrying capacity of domain is **global data**
- Split capacity equally between nodes is only choice
- Try to keep agent number same on all nodes therefore...
- Do **round-robin** agent partitioning
- Does give “better” results

### Parallel - Round Robin

- **Total**
- **Infected**
- **Immune**
- **Healthy**

### Parallel - Geometric

- **Total**
- **Infected**
- **Immune**
- **Healthy**
Pretty Pictures

- Run on HECToR
- 500 cores
- 150000 initial agents
- 750000 carrying capacity

Iteration 10  Iteration 100  Iteration 200  Iteration 300
- HECToR
- 15,000 agents
- Completely unreliable!
Conclusions

- Improvements to FLAME
  - Global variables
    - Update frequency – every change, end of iteration, programmatic
    - Partition of values among nodes – e.g. carrying capacity
  - Geometric partitioning better for infection model if GVs available
    - Halo filters
  - Agent migration if using geometric partitioning

- NetLogo = bad model
  - Missing potential infection because of patches

Infection from this one → Why not this one?