Agent Based Modeling of Crowd Behavior

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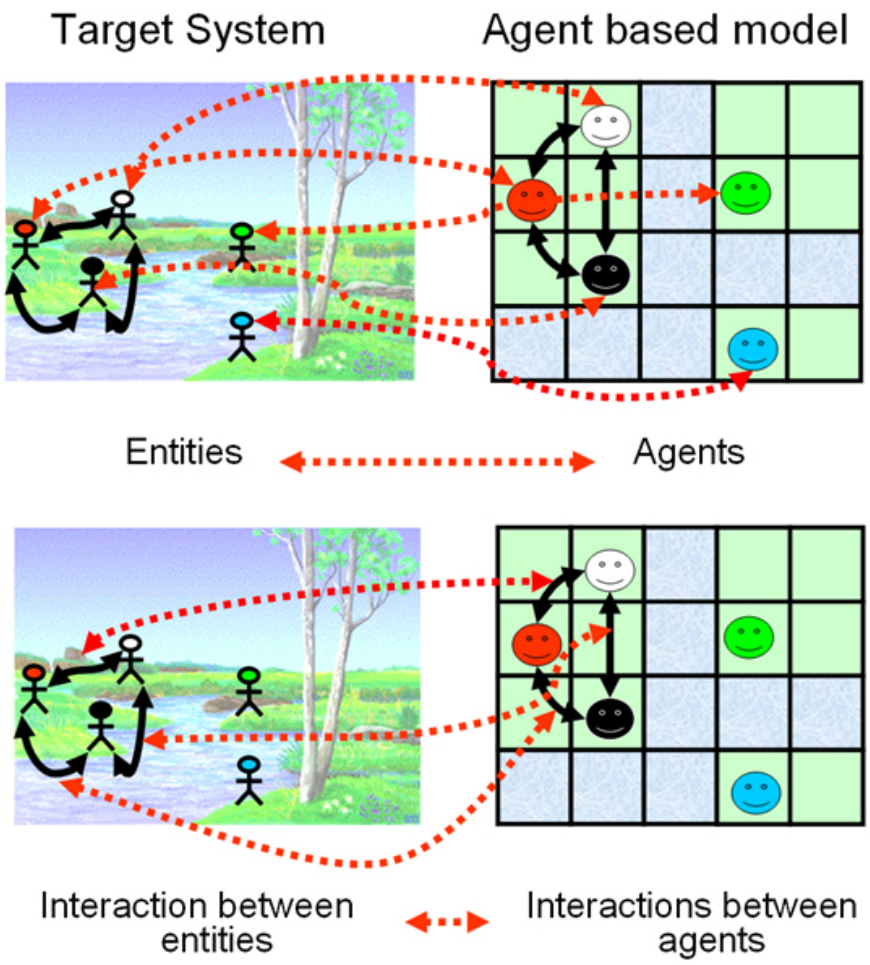
What is Agent Based Modeling (ABM)?

- Agents are autonomous entities
  - They have their own goals and decision making processes
  - React and interact with their environment and other agents
- ABM is a method for modeling and simulating the individual actions of autonomous agents
  - The goal is to observe the high level emergent complex behavior resulting from lower level interactions.
- Relevant to a large number of fields
  - Bio, Chem, Physics, CS, Math, Social Science
- Can be modeled and simulated using a number of programs including Netlogo

Agent Based Modeling



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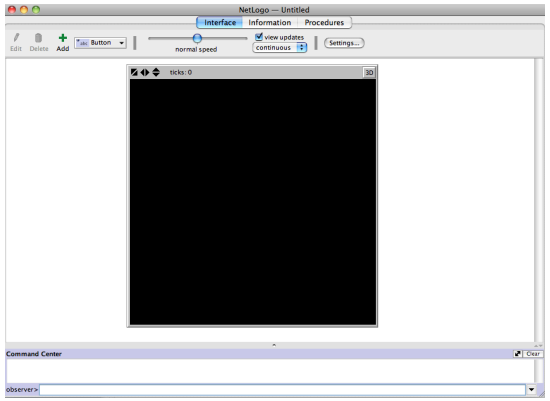
Alternatives to ABM

- Cellular automata
- Continuum dynamics using a dynamic potential field
- Fluid dynamics
- AI-based models
- Particle based models

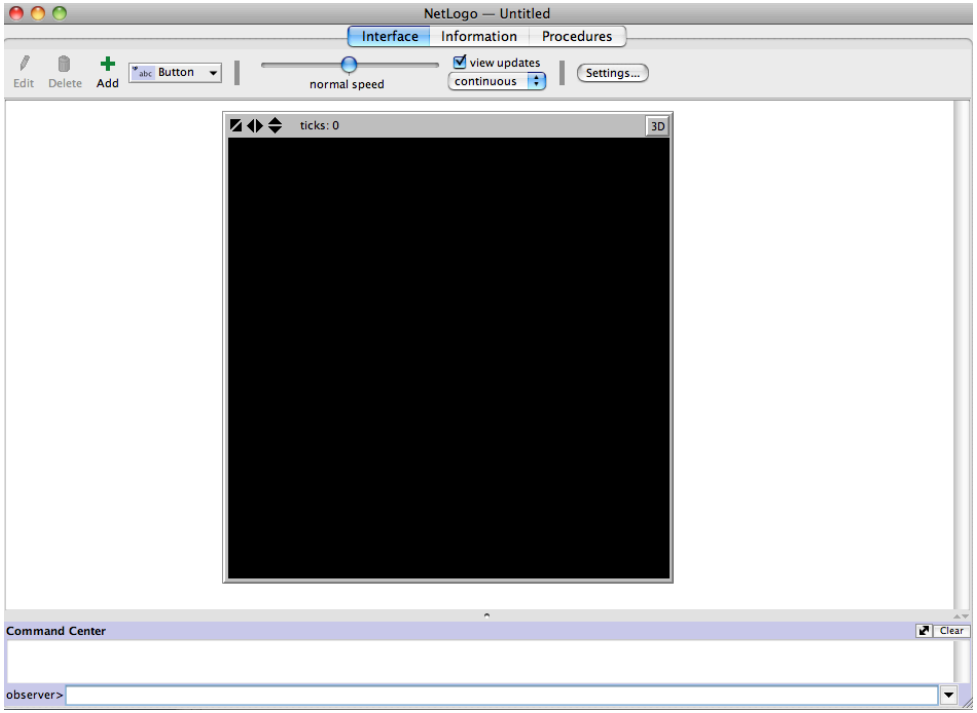
Introduction to Netlogo

- Environment for coding and simulating agent based systems
- Has both an interface for viewing simulations and a coding environment for writing simulations
  - Influenced by the Logo Programming Language
  - Qualitative and quantitative feedback
- Developed by Uri Wilensky
  - Director of Northwestern University's Center for Connected Learning and Computer Based Modeling



Netlogo

- Agents are called “Turtles”
- The environment is made up of a grid of “Patches”
- The user (“Observer”) can submit commands through a command prompt like interface



- Netlogo Simulations can be exported and run as a java applet
- Sample Netlogo Simulation
  - Wolf Sheep Predation

Motivation

- The study of crowd behavior is vital to:
  - Urban planning, crowd control, and emergency planning, etc.
- Human psychology important aspect
  - Modeling crowds at a large scale can be a difficult task
  - ABM however localizes all decision making
    - Takes into account small scale goals and other psychological influences
    - Crowd behavior that approximates aspects of realistic human behavior has been achieved
- My research focuses on evacuation of crowds due to emergency situations in closed spaces

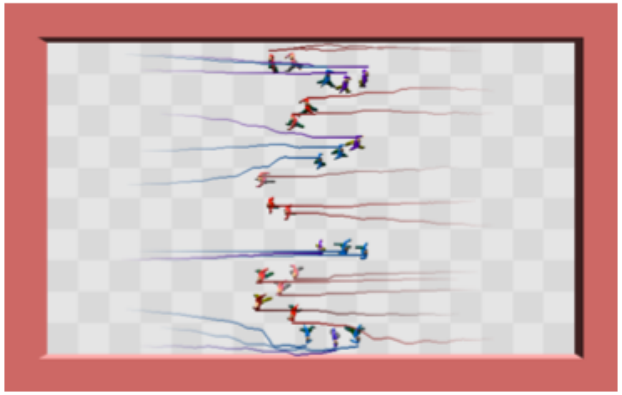
Overview of Crowd Behavior
Some Important Terms

- Emergence
  - Spontaneous new large scale behaviors resulting from interactions of many objects.
- Crowd
  - Many people in same area where the density is high enough such that there are continuous interactions between agents
- Panic
  - Breakdown of ordered behavior due to reactions to an event
- Social Comparison Theory
  - People compare their behavior with similar agents and then imitate them

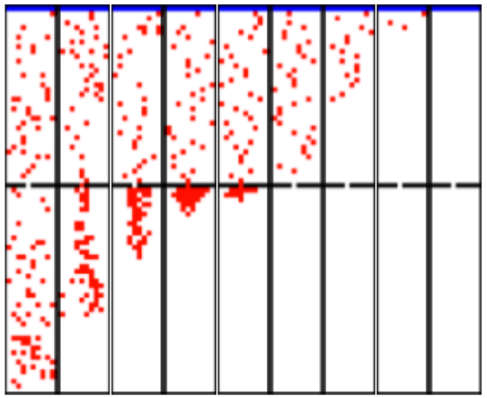
Typical Crowd Behavior

- Lane Formation
  - Oppositely moving pedestrians typically form lanes of uniform walking direction
- Grouping in similar pedestrians
  - Agents in the same “group” will congregate and move together
- Lack of orderly queuing
  - At a bottleneck like a doorway, orderly queuing may break down in the presence of a large crowd

Lane Formation (Treuille et. al)

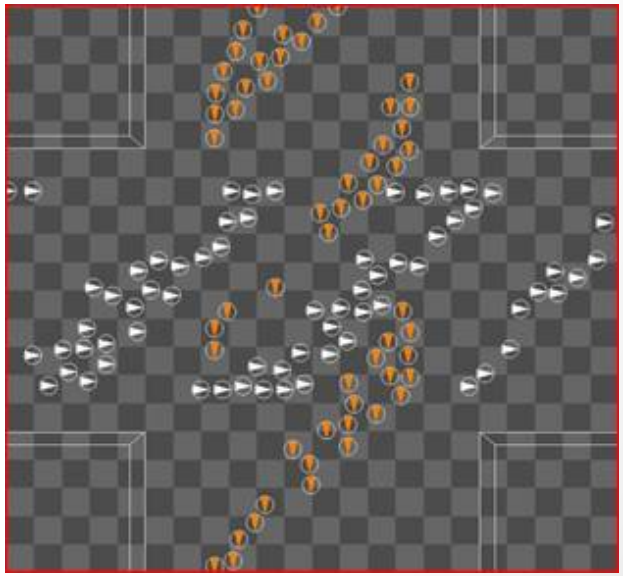


Disorderly Queuing (Lightfoot and Milne)



Project Goals

- To obtain and study a reasonably realistic model of crowd behavior in an emergency situation.
- I will focus in on the aspect of grouping within crowds
  - The model will be of an evacuation of a stadium
  - Groups will represent fans of different teams and families/parties within each fan group
    - Groups will interact in different ways



Outline

- 1) Model a simple built space in Netlogo
- 2) Model simple naïve agents to move within the space
- 3) Endow the agents with more complex abilities
  - Goals, groups, path planning, obstacle avoidance, etc.
- 4) Model a more complicated, realistic space
- 5) Study the development of emergent behavior over time

Resources Used

- Real-Time Crowd Simulation for Emergency Planning
  - Thirion and Basu
- Modeling Crowd Behavior Based on Social Comparison Theory: Extended Abstract
  - Fridman and Kaminka
- Pedestrian, Crowd and Evacuation Dynamics
  - Helbing and Johansson
- Modeling Emergent Crowd Behavior
  - Lightfoot and Milne
- Multi agent simulation of pedestrian behavior in closed spatial environments
  - Camillen et. al
- Continuum Crowds
  - Treuille et. al

The End