Evacuation Bottleneck

Simulating a Panic on a Cruise Ship

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December 19, 2012

Outline

Our Research Object

- Costa Voyager
- Capacity: 836 passengers
- 8 Rescue Boats
- In distress at sea in 2005

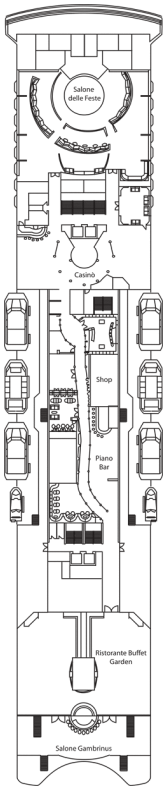
Source: http://www.shipspotting.com,
Picture taken by Roy Batty

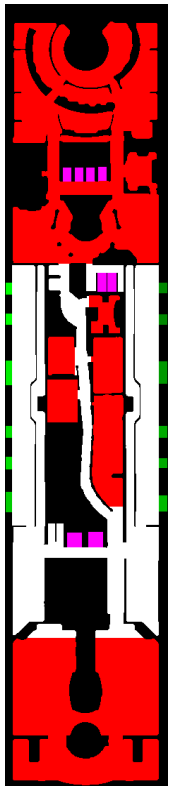
Program Structure

1. Load configuration
2. Loop over simulation steps
   - 2.1 Place new agents
   - 2.2 Handle filled exits
   - 2.3 Progress agents with calculated forces
   - 2.4 Remove exited agents
   - 2.5 Plot current state (optional)
3. Plot and save final data

The Deck Plan

- Colormap
  - Allows any number of zones
- Scaling
- Greatly simplyfied





Source: `http://www.kreuzfahrtberater.de`

Configuration File

- Simulation parameters initialized from a file:
  - Deck configuration
  - Plotting options
  - Physical and behavioral parameters
- Simple syntax makes automated generation easy

Placement of New Agents

- Spawning zones as entering areas for agents
- In each step, remaining agents are tried to be placed
- If spawning zones are too full, new agents can only appear in later steps
- Nice model for steady inflow of agents

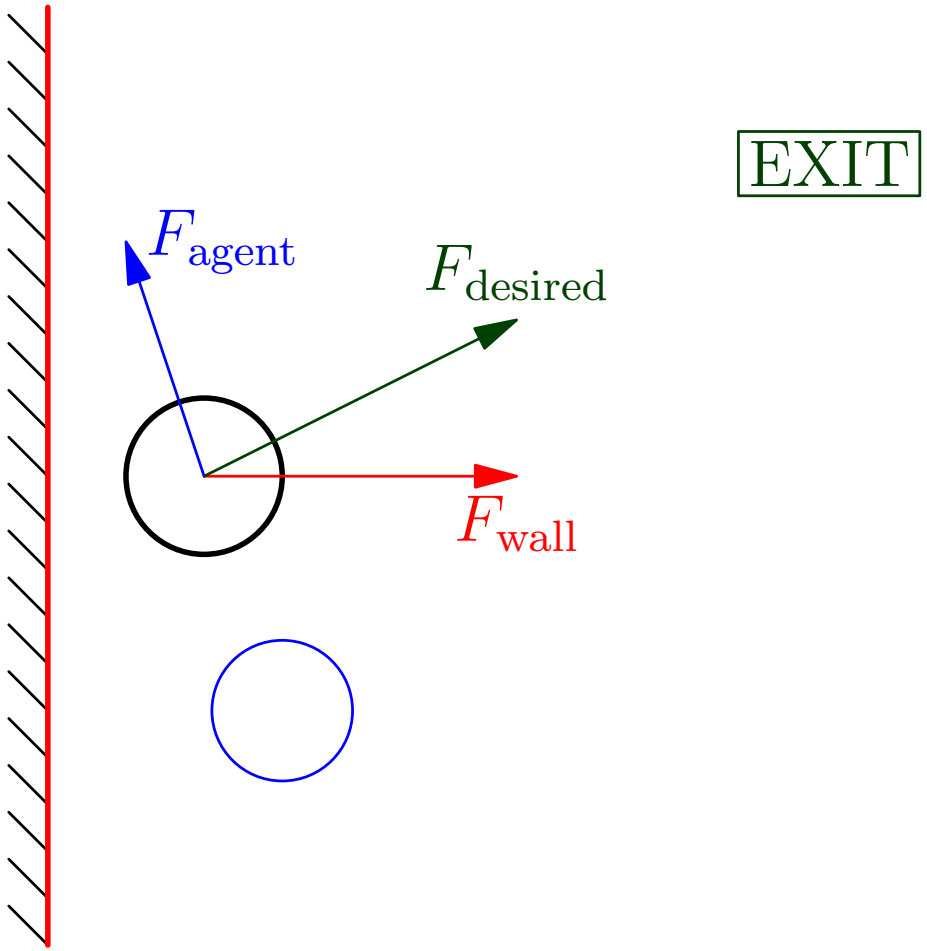
Filled Exits

- Rescue boats modeled with limited capacities
- If a boat gets full, agents need to be informed
- Two implementation approaches:
  - Instantaneous update
  - Gradual circle-shaped spreading of information

Forces

- As described in paper *"Simulating dynamical features of escape panic"* by Helbing, Farkas and Vicsek
- Three main forces act on agents:
  - Desired direction
  - Repulsion & friction between agents
  - Repulsion & friction from walls
- Motions calculated with Leap-Frog integration method

Forces: Sketch

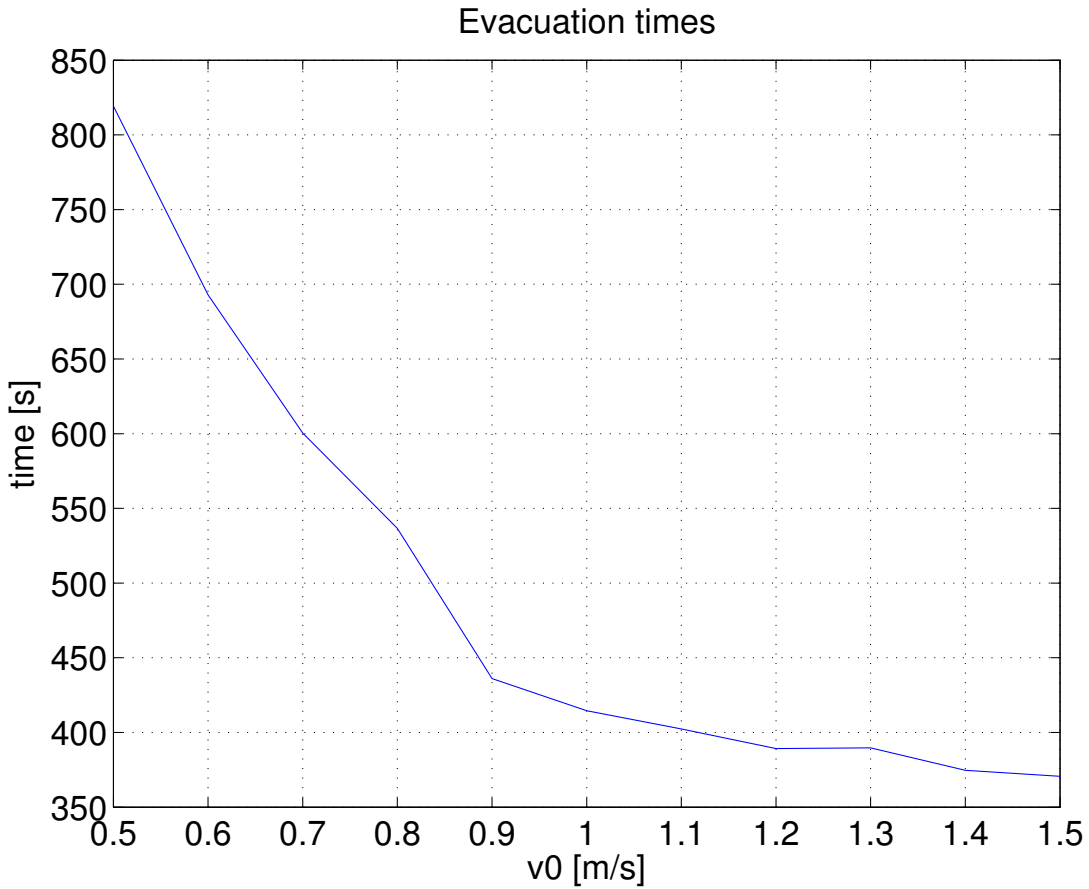


Distribution of the Agents to the Exits

- The distribution depends strongly on the geometry of the ship
- There was no case where the agents really spread over the exits
  - Weakness in the model
  - More realistic: Go for the shortest individual evacuation time
- Realistic update for propagation of information
- *Video*

Effect of Desired Speed on Total Evacuation Time

- We could reproduce the results from Helbing, Farkas and Vicsek for low panic levels
- High panic levels: Problem!



All the things you don't want to happen

- Agents were stuck in walls
  - Even the tiniest timesteps did not help
- MATLAB does not behave as expected in batch mode
  - Simulation works in foreground, crashes in background
  - No error message, just silently writing crashdumps to home
- No reproducability even with fixed random seed in our group
  - Different versions of MATLAB

Some points to take away

- The basic results could be reproduced
- The model is not very well suited for multiple exits
  - There should be a heuristic to decide for a direction
- Use the power of Open Source Software (OSS)!

References

- Simulating dynamical features of escape panic, Dirk Helbing, Illés Farkas, Tamás Vicsek Nature, December 28, 2000
- A Free Digital Society, Richard Stallman `https://www1.ethz.ch/foss/news/rms`

You ask – We answer

- Now it's your turn