Session 5: Lecture 6:

Agent-Based Urban Models

The Notting Hill Carnival Model

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Outline of the Talk

1. My Major Example: The Notting Hill Carnival
2. The Model: Flocking and Crowding: Swarms
3. Using such Models in Policy

Questions?

1. My Major Example: The Notting Hill Carnival

How to solve problems of packing many people into small spaces and not letting them crush each other to death, and developing a quality environment which minimises crime.

We will look at the nature of the problem and then at the data needed to observe and understand the problem – this is an issue in its own right as it is complicated by lack of preference data and crude data on how people flock and disperse and track to the event itself

Intelligent Space were contracted by the GLA Carnival review group for the project and CASA was involved in the modeling

Intelligent Space is a spin off company from the Bartlett School of Planning and CASA

DR JAKE DESYLLAS

Project Manager

ELSPETH DUXBURY

Management of Crowd Observation

ZACHARAY AU

Risk Assessment Consultant

a.What is the Notting Hill Carnival

A Two day Annual event based on a street parade and street concerts in inner London which is a celebration of West Indian ethnic culture. Started in 1964 as The Notting Hill Festival; attracting 150,000 people by 1974

It attracts up to 1 million visitors and spreads over an are of about 3.5 sq miles

Here are some pictures

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MyVillage NOTTING HILL

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personals
fashion & lifestyle
restaurants
health & beauty
message board

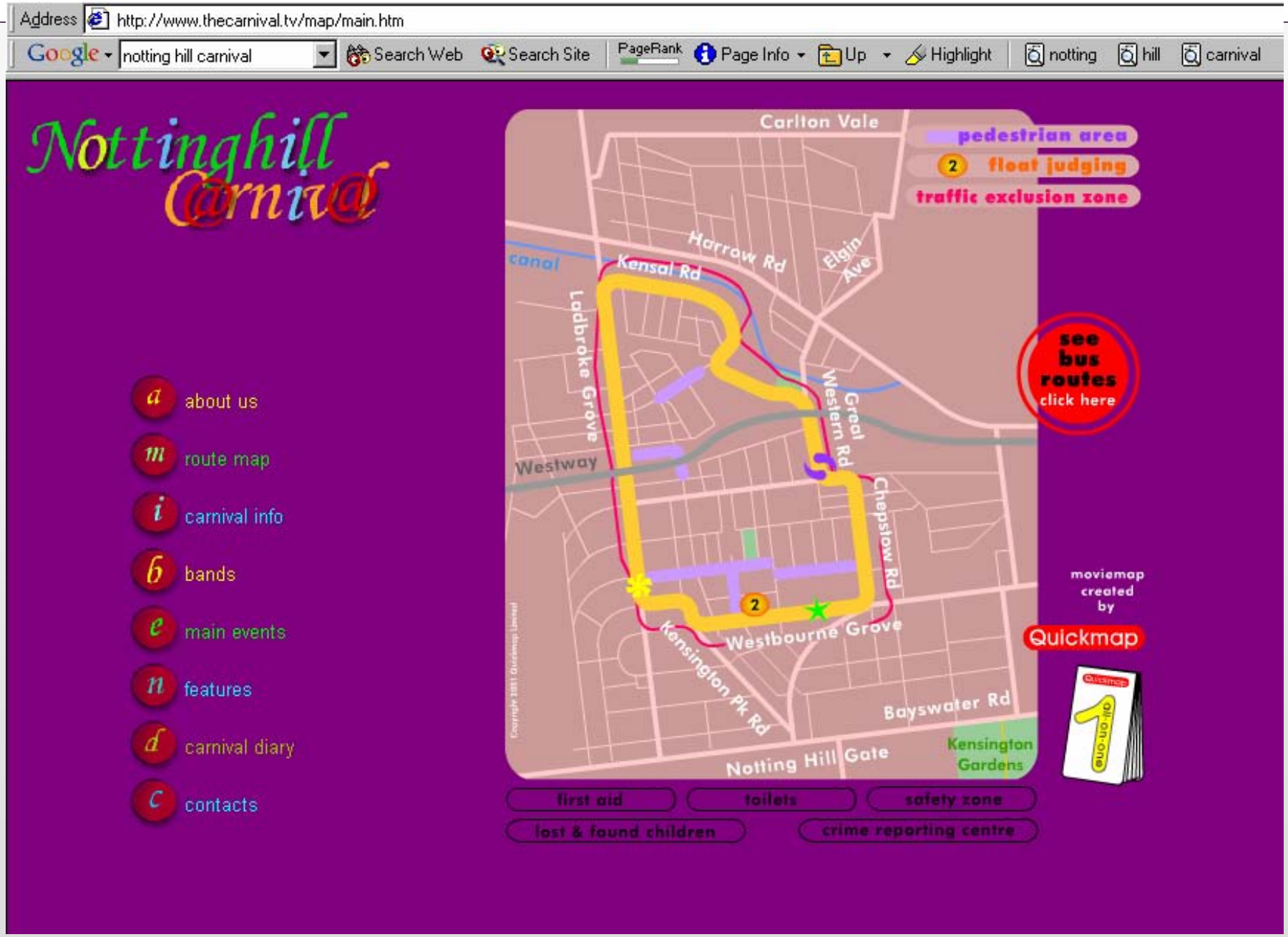
News & Community







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canal
Kensal Rd
Harrow Rd
Elgin Ave
Ladbroke Grove
Great Western Rd
Westway
Chepstow Rd
Westbourne Grove
Kensington Pk Rd
Bayswater Rd
Notting Hill Gate
Kensington Gardens
see bus routes click here
moviemap created by
Quickmap
first aid
toilets
safety zone
lost & found children
crime reporting centre

b.The Project: Public Safety

We have been involved in the problem of redesigning the route location for the parade which is judged to be ‘unsafe’ because of crowding and because of the crime and environmental hazards generated by concentration in a small area: for example crime has risen by about 15% annually for the last 10 years – 430 reported crimes committed last year. 3 murders in 2000.

- 710,000 visitors in 2001.
- continuous parade along a circular route of nearly 3 miles
- 90 floats and 60 support vehicles move from noon until dusk each day.
- 40 static sound systems
- 250 street stalls selling food.
- peak crowds occur on the second day between 4 and 5 pm
- 260,000 visitors in the area.
- 500 accidents,
- 100 requiring hospital treatment
- 30 percent related to wounding
- 430 crimes committed over the two days
- 130 arrests
- 3500 police and stewards each day.

c. Observing the Carnival: Data

We have used 4 different methods to determine the number of people at carnival 2001

1. Intelligent Space Flow Survey : 38 streets, 80 people days
2. Intelligent Space Crowd Density Survey : 1022 digital images, creating a composite image of carnival 2001
3. LUL Tube Exit and Entrance Survey

4. St Johns Ambulance Accident data


HELI-TELE I QUEENS HOTEL


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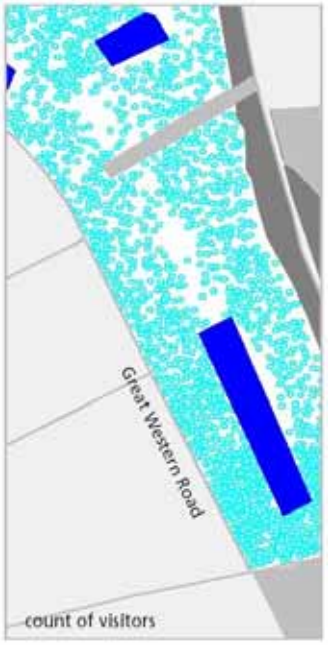
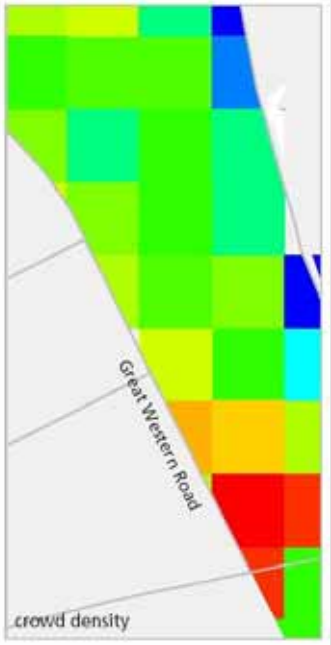
HELI-TELE I QUEENS HOTEL

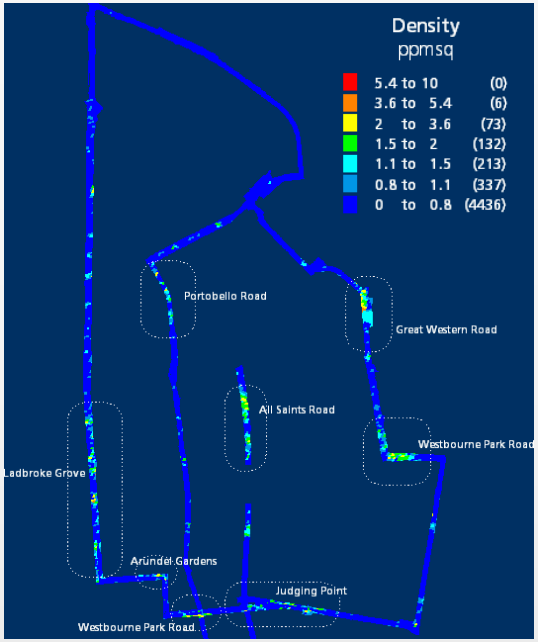

Great Western Road
helicopter footage

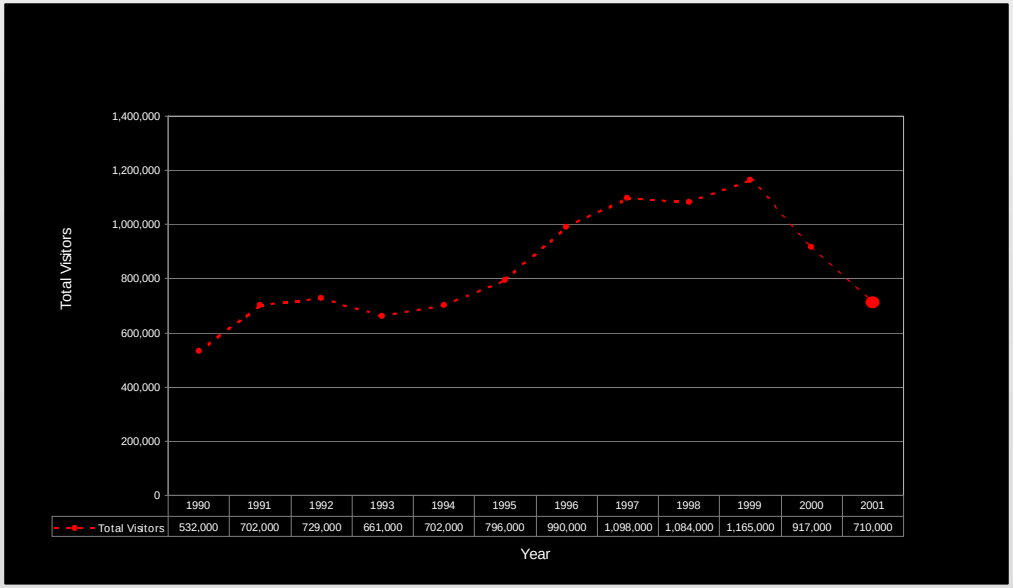

Great Western Road
count of visitors

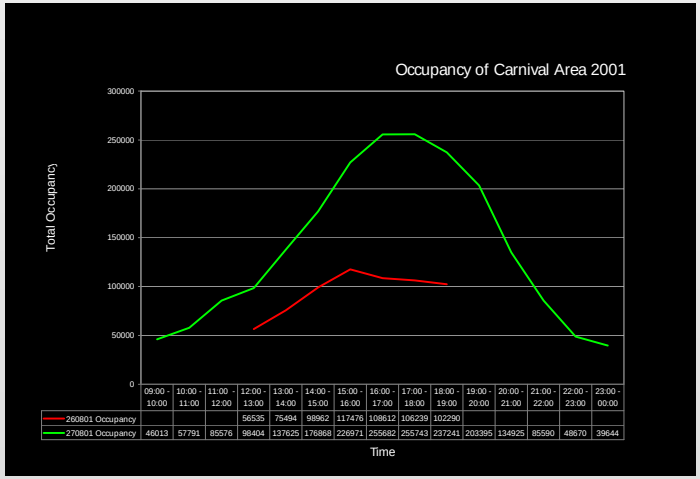

Great Western Road
crowd density

Visitors to Carnival 2001

Source	Sunday	Monday	Total
ISP survey	172,344	366,636	538,980
Extrapolated Counts	39,217	48,222	87,439
Westbourne Park Tube	13,726	25,810	39,536
Residents	44,353	44,353	44,353
Total	269,600	485,000	710,300

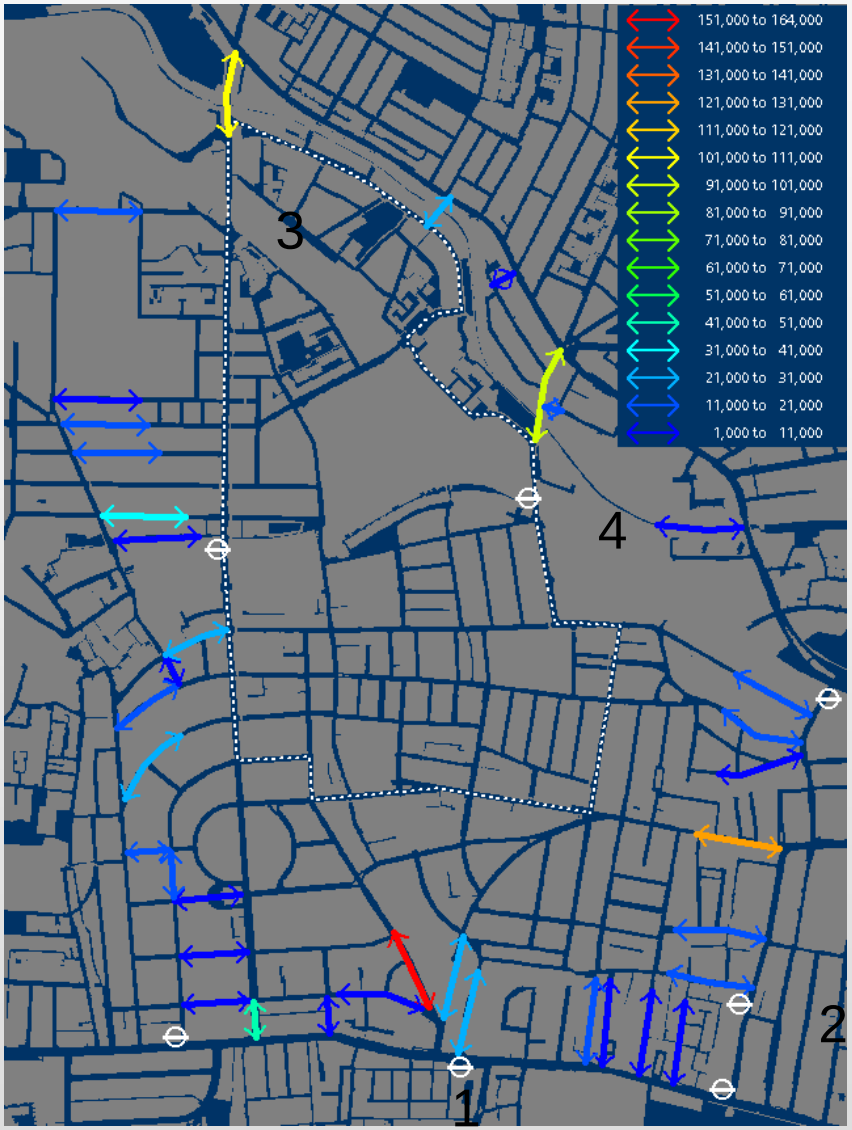






Access to Carnival is very unevenly distributed

Road Name	% of Total Flows In	% of Total Flows Out
1. Kensington Park Road	19%	14%
2. Westbourne Grove (East)	15%	10%
3. Ladbroke Grove (North)	10%	13%
4. Great Western Road	9%	12%
Sum Routes 1-4	54%	49%



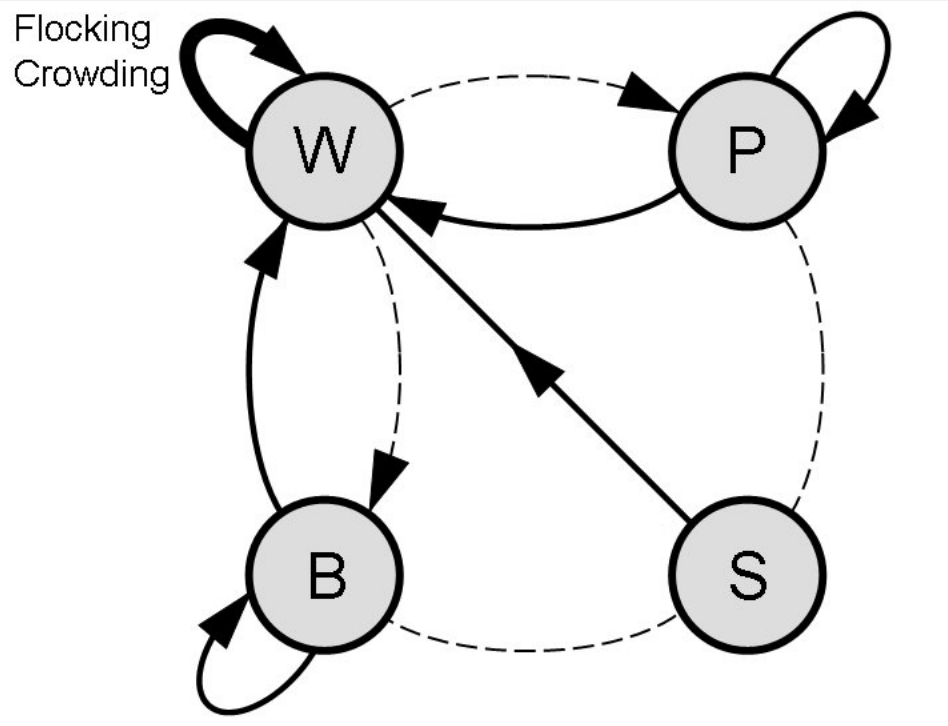
7. The Model: Flocking and Crowding: Swarms

We need to simulate how visitors to the carnival move form their entry points to the events that comprise the carnival – the locations of the bands and the line of the parade

The problem is complicated by

1. We do not know the actual (shortest) routes linking entry points to destinations
2. Detailed control of the event by the police etc. is intrinsic to the event – we need to introduce this control slowly to assess its effect

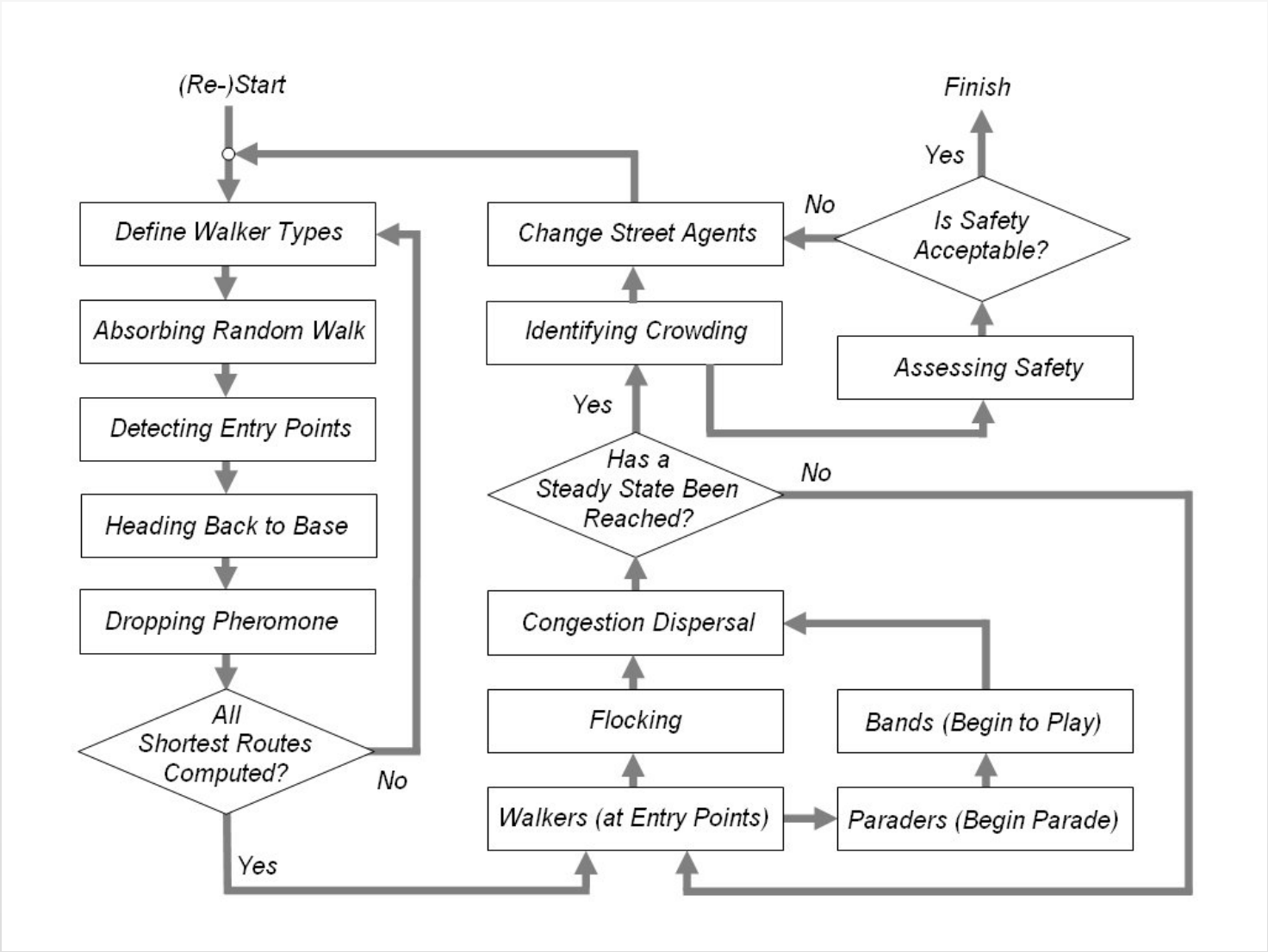
We define agents as walker/visitors (W) who move, the bands that can be moved (B), the paraders who move in a restricted sense (P), and the streets (S) that can be closed



We run the model in three stages, slowly introducing more control to reduce congestion

1. We first find the shortest routes from the ultimate destinations of the walkers to their entry points using a “SWARM” algorithm – this is our attraction surface
2. This gives us the way walkers move to the carnival and in the second stage we simulate this and assess congestion
3. We then reduce this congestion by closing streets etc and rerunning the model, repeating this stage, until a “safe” situation emerges

Here is a flow chart of how we structure the model



The First Stage: Computing the Attraction-Access Surface

We compute the access surface using the concept of swarm intelligence which essentially enables us to let agents search the space between origins and destinations to provide shortest routes, and these determine the access surface.

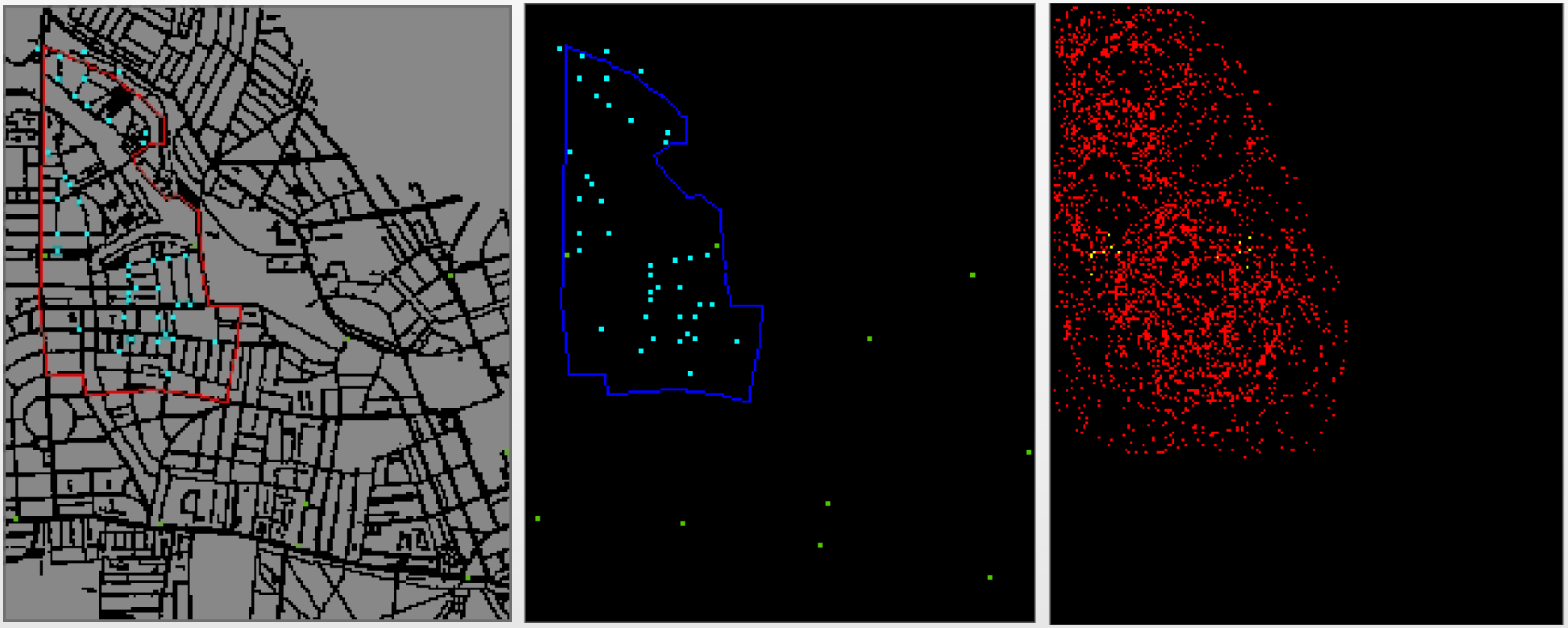
This is an increasingly popular method of finding routes in networks and it is based on the idea that if you launch enough agents and let them wander randomly through the network, they will find the objects in question

Let me show you how this works – we will load in the agents onto the parade routes and the sound systems, then let them wander randomly without imposing a street network, and they will find a selected set of entry points – the subway stations in this case. Then the pattern is built up this way

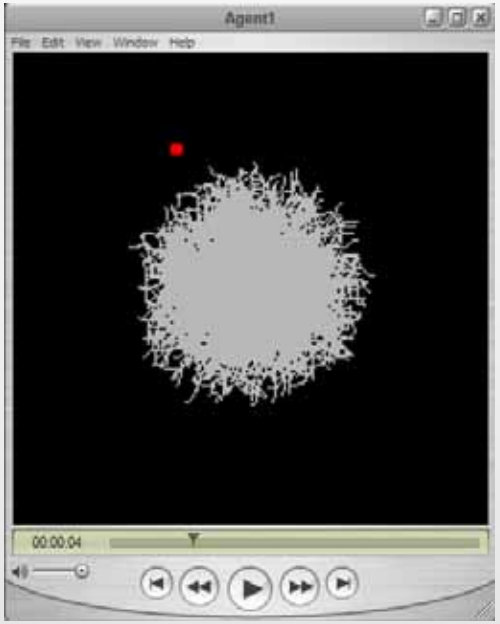
We show first the parade and the sound systems and the subway stations

Then the random access map

Then the shortest routes computed



Let me tell you how swarming works and show you some movies of this process.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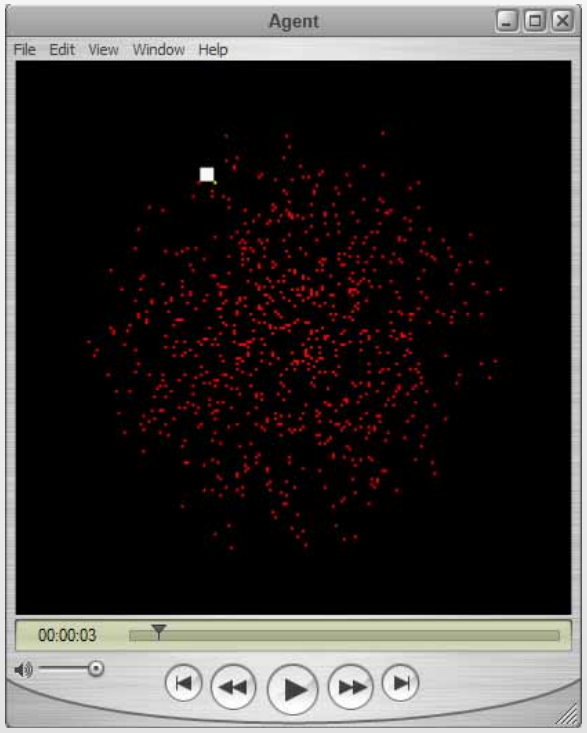
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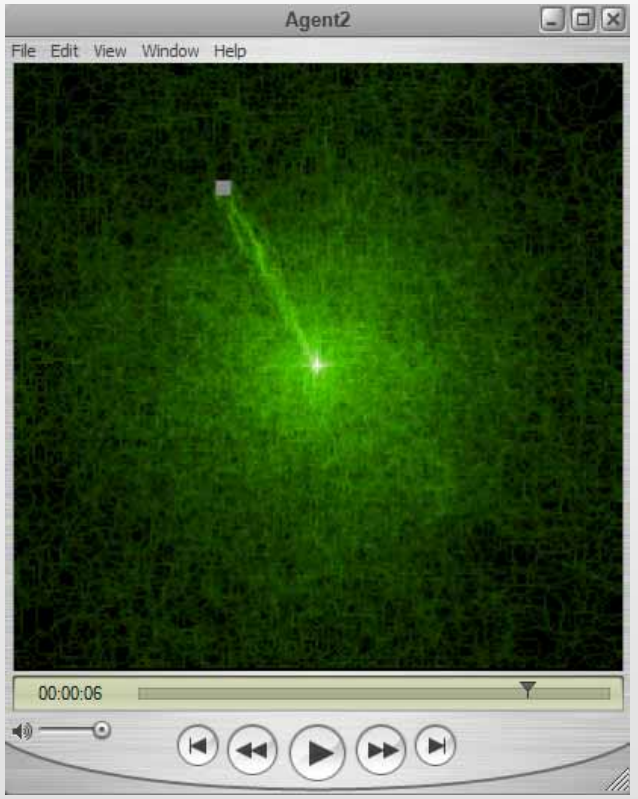
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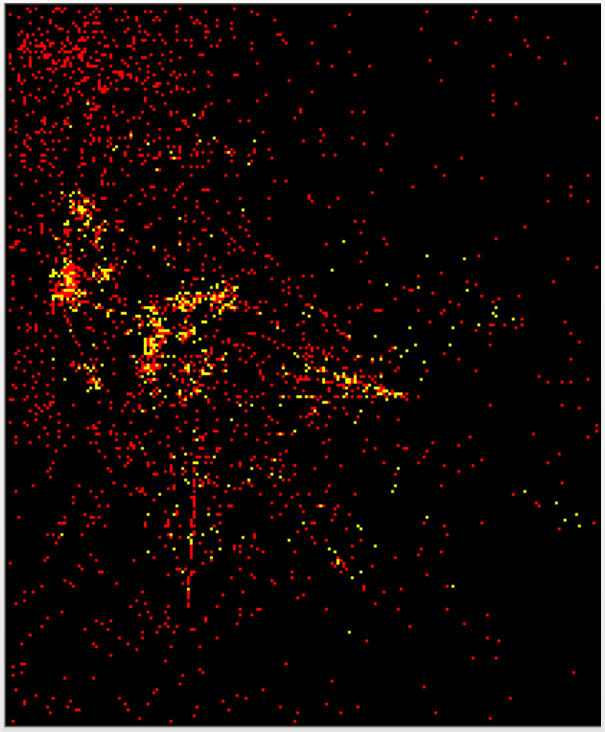
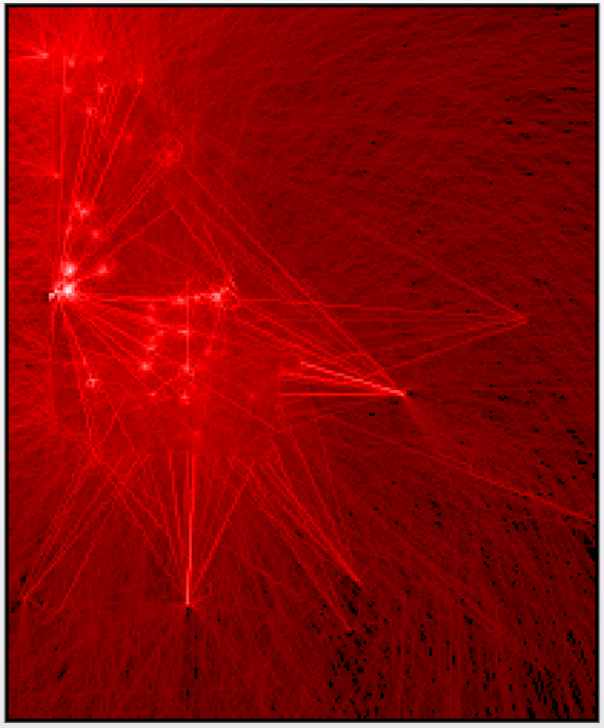
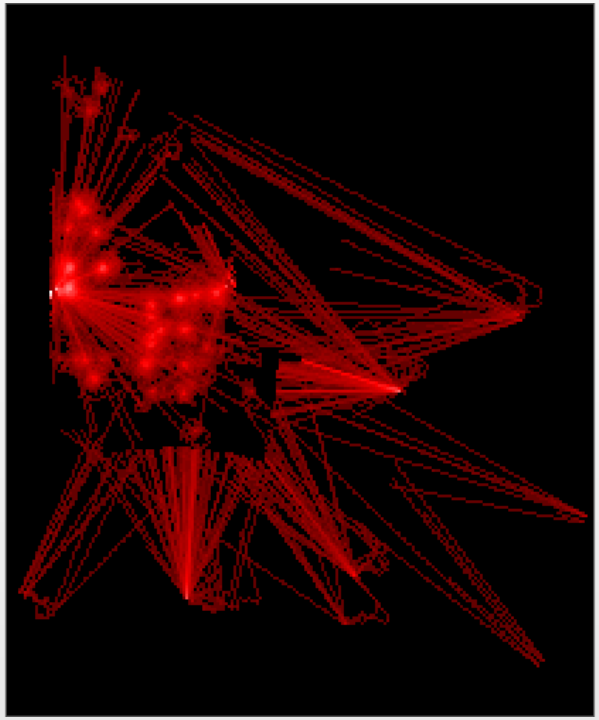
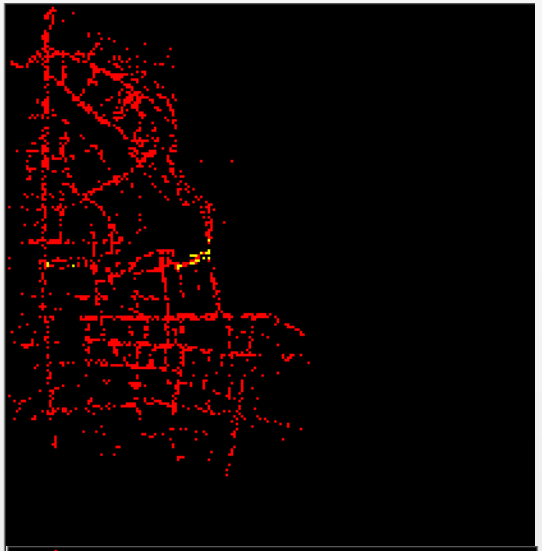
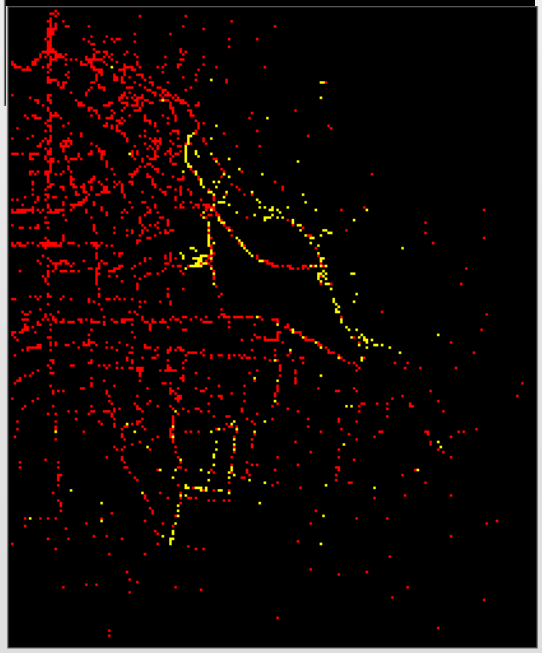




Let’s do this for the real street geometry and run the movie to see how this happens





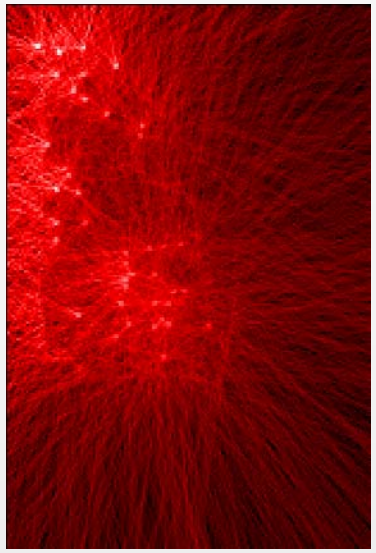
Let me run the First Stage Swarm Movie

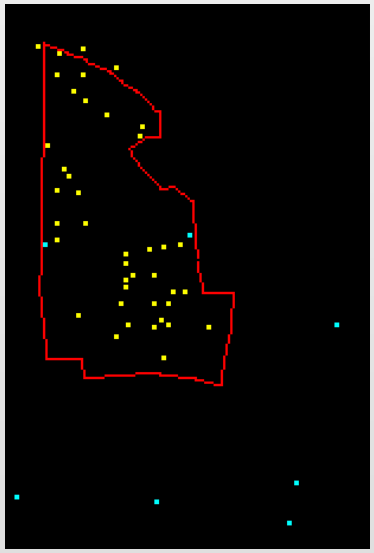
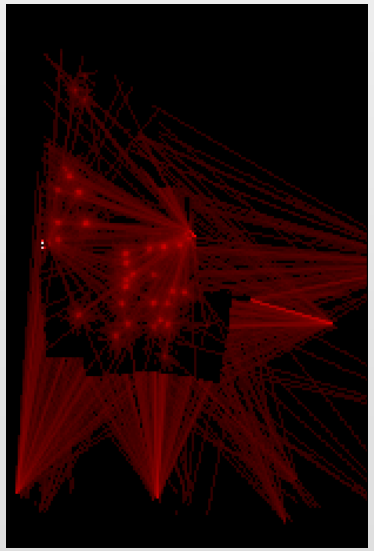
The Second and Subsequent Stages

In essence, once we have generated the access and shortest route surfaces, we use these or a combination of these – a linear/weighted combination – as the final surface and we then pass to a second stage.

We use a regression model to estimate entry point volumes and then let these walkers out at the entry points and then let them establish their steady state around the carnival – thus we run the model again

We generate a new density surface and this then enables us to pass to a third stage

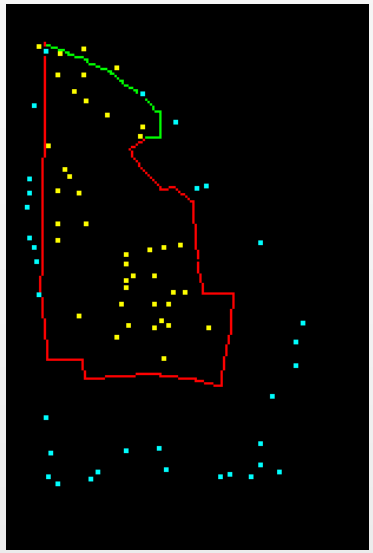




Let me run the Second Stage Unconstrained Simulation Movie

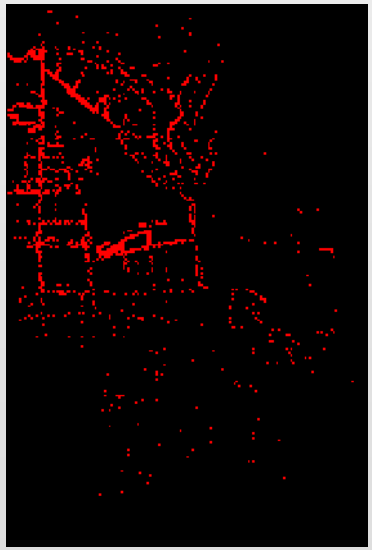
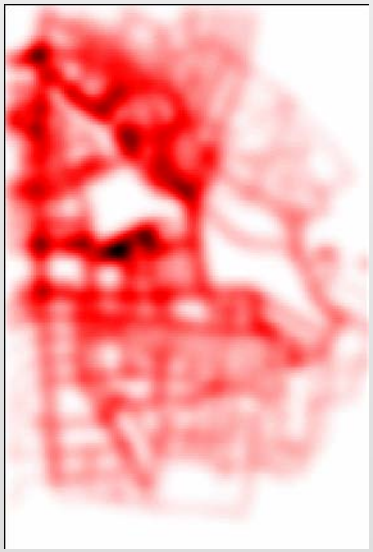
In the third stage, we figure out where the crowding is worst and then introduce simple controls – close streets etc

In fact in the existing simulation we already have several streets and subway stations controlled and we can test these alternatively

Thus in the existing simulation, we can figure out if the existing controls are optimal



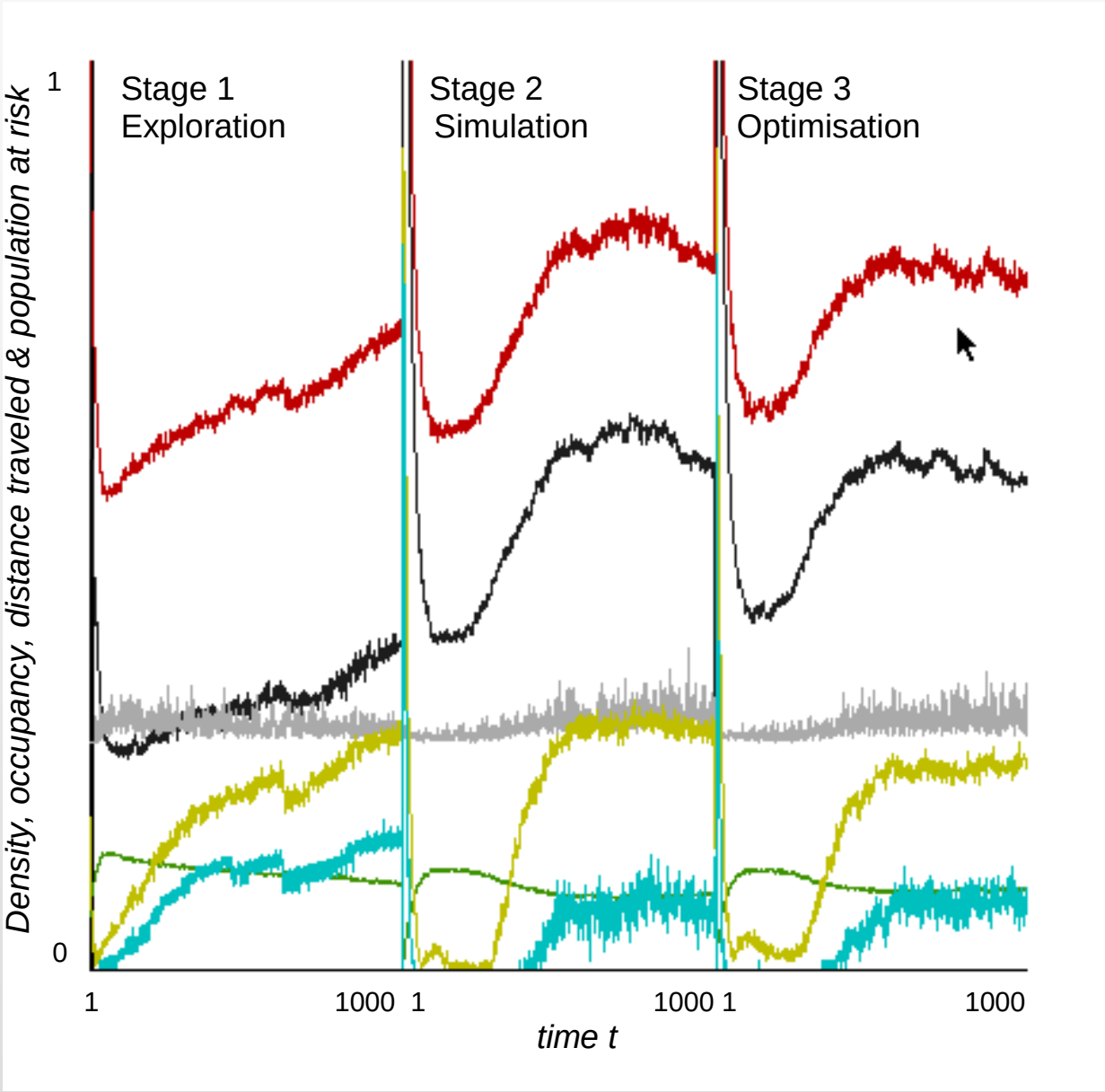


Crowd Analysis

There is a substantial amount of analysis possible from this model with numerous additional graphics such as peak density analysis etc

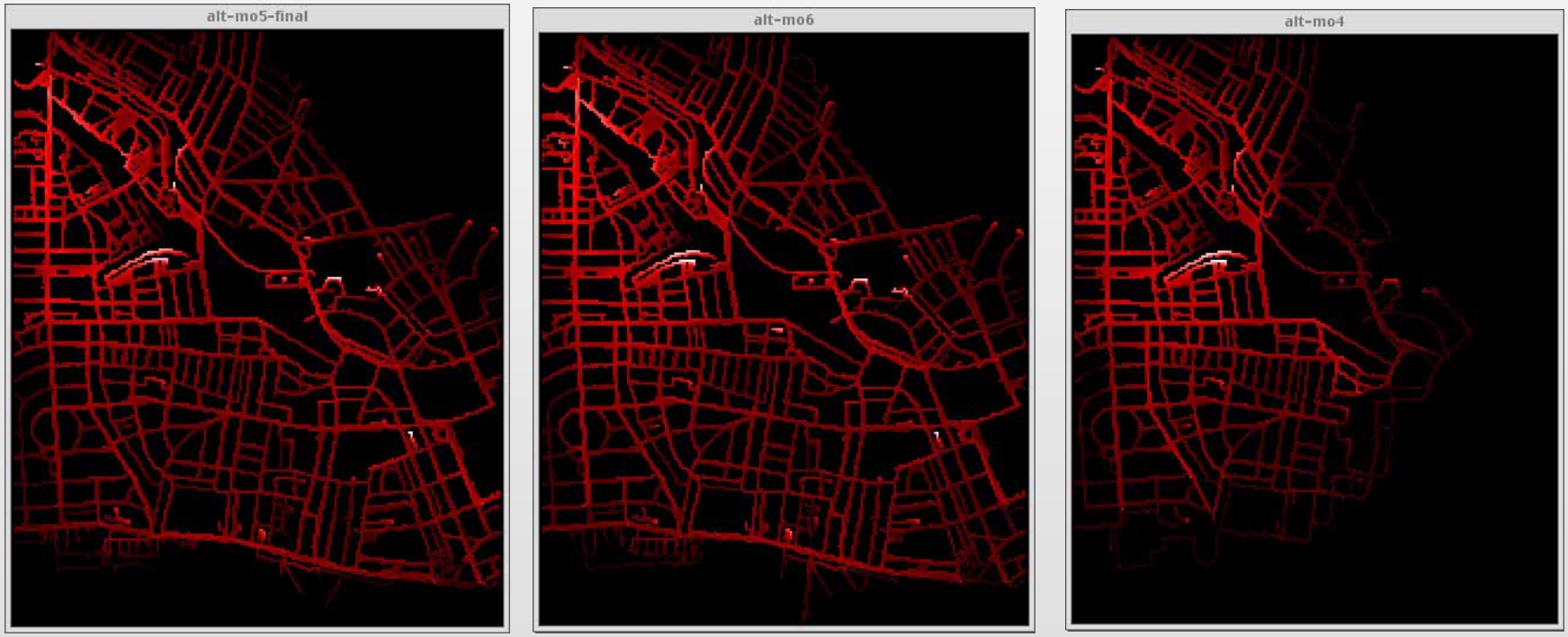
Basically we can compute densities for each pixel and groups of pixels at any cross section of time and over any time period. We can also deal with distance moved and all related derivatives in terms of velocity with respect to each agent and cluster of agents as well as locations. Here's a typical example

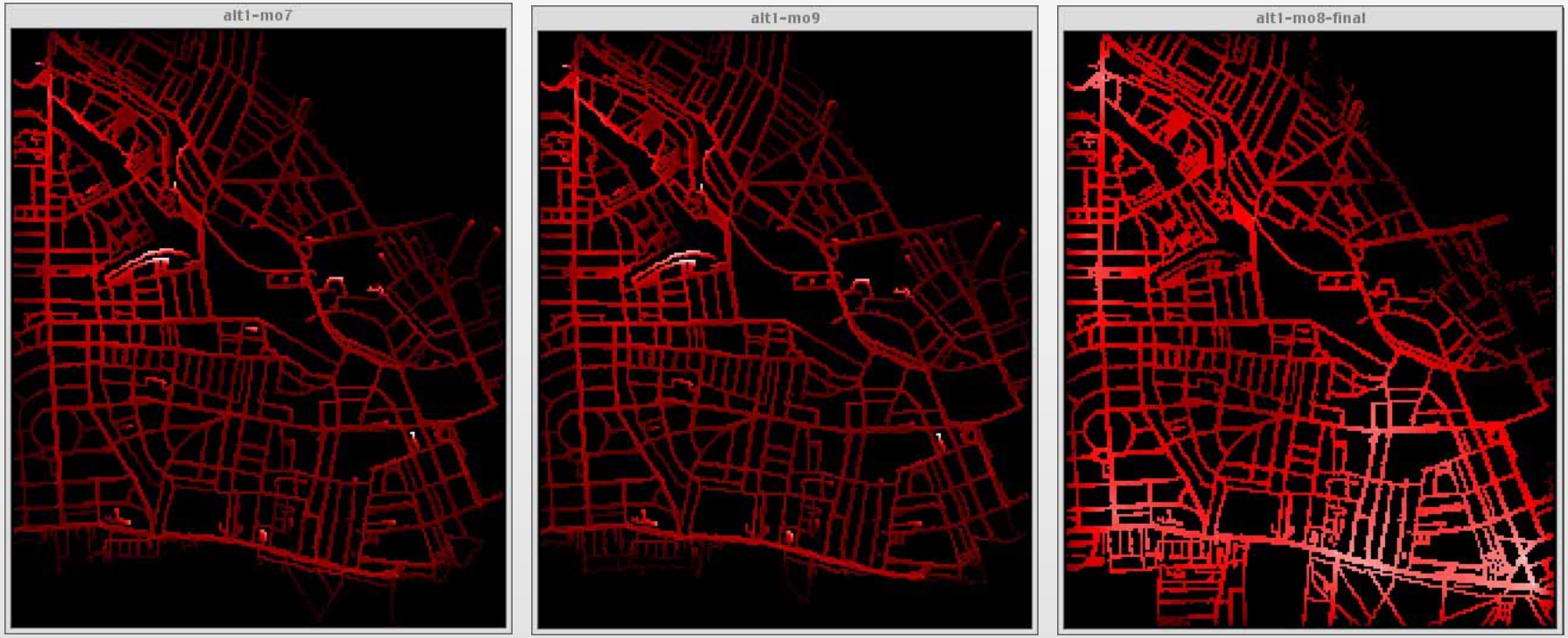

Stage 1
Exploration
Stage 2
Simulation
Stage 3
Optimisation
Density, occupancy, distance traveled & population at risk
1
0
1
1000
1
1000
1
1000
time t

3. Using such Models in Policy

There are six routes which were given to us by the GLA and Westminster – essentially we are engaged in ‘what if analysis’. The general principles is to break the loop of the carnival & reduce densities.

Here are the density maps for each scheme where the model has been run given new entry points and volumes from the regression model




alt1-mo7
alt1-mo9
alt1-mo8-final

Analysis of Crowding

Statistics	*Existing*	*Alt 1*	*Alt 2*	*Alt 3*	*Alt 4*	*Alt 5*	*Alt*
	Carnival	*MO8*	*MO5*	*MO7*	*MO6*	*MO4*	*MO9*
maximum density	116	47	64	75	77	88	50
max neighbor density	417	98	190	227	265	297	132
av density	2.5641	1.6402	2.05	2.331	2.2069	2.2099	2.2353
av distance in last iteration	1.0786	0.9999	1.0959	1.0916	1.0464	1.0578	1.0286
av distance from origin	74.3073	95.9656	71.9376	78.8635	77.5772	80.307	88.7344
		chair	W-E L	Park	E-W L	H	M-H

Questions?

You can get lots of info on all this in my book Cities and Complexity, various chapters