

INTERFACING DATA FOR COMPLEX SYSTEMS RESEARCH

Marco Quaggiotto
Wouter Van den Broeck

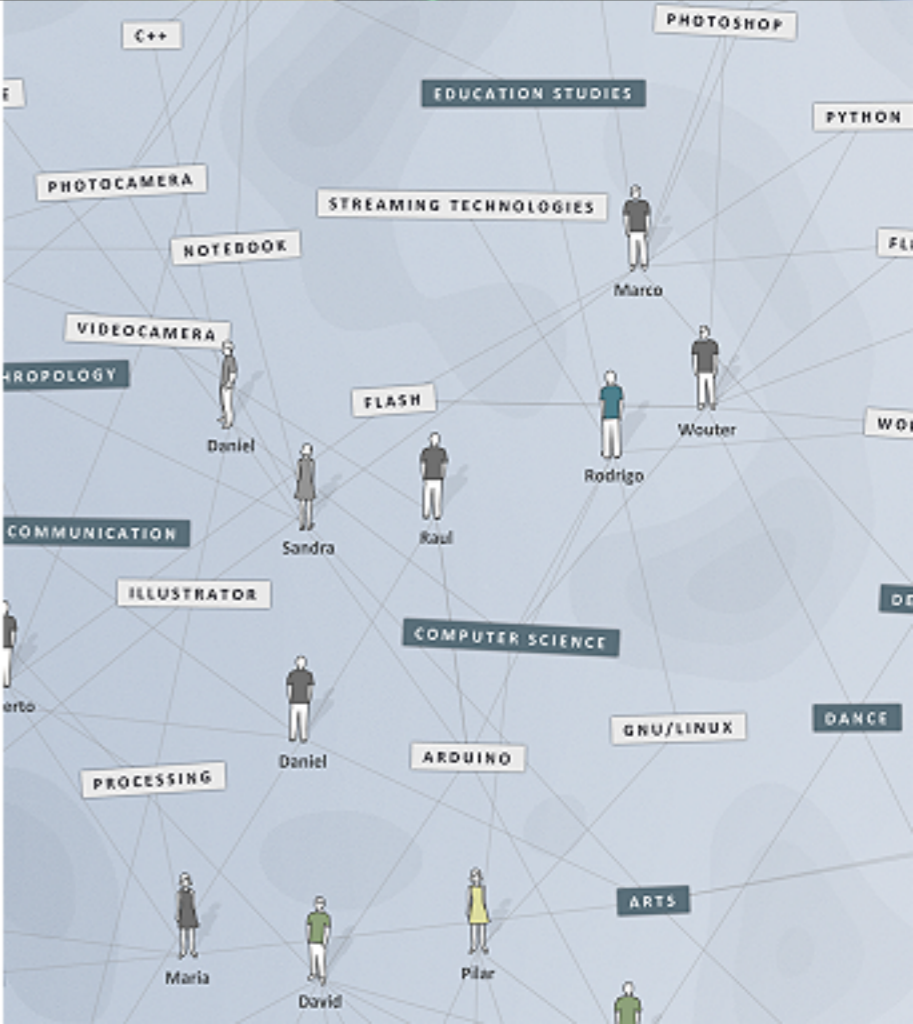
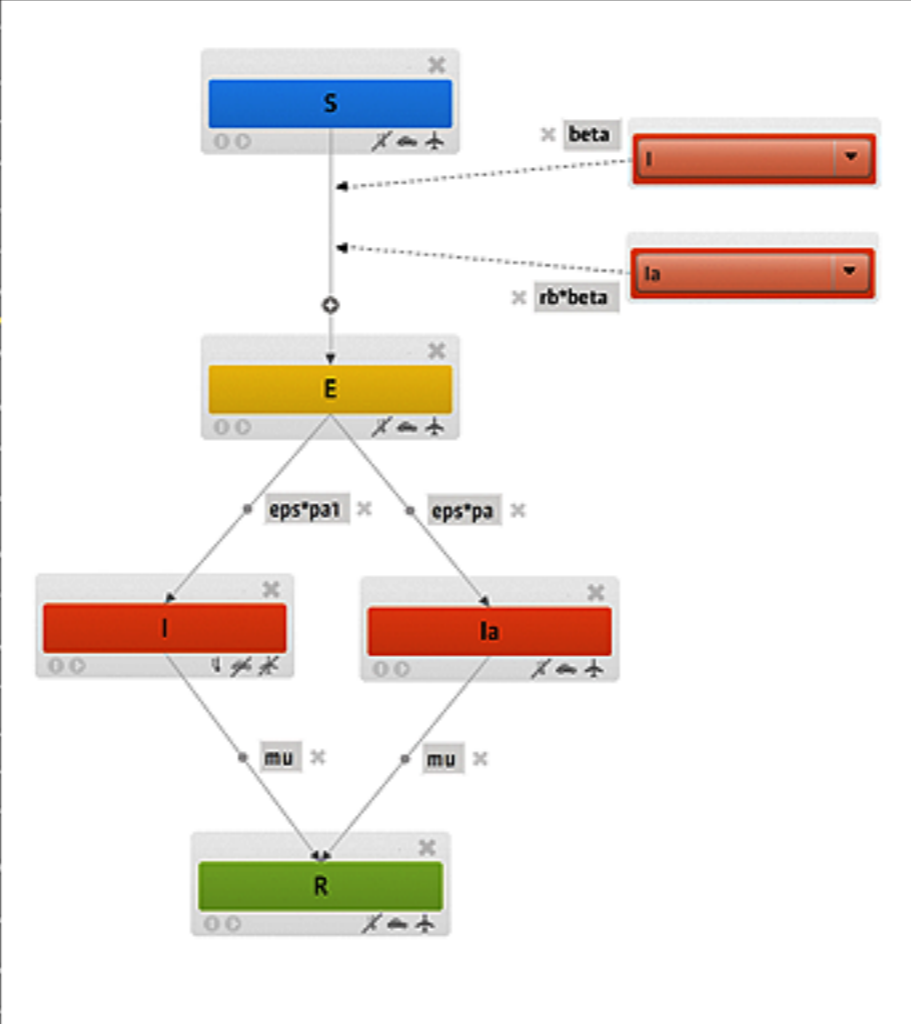
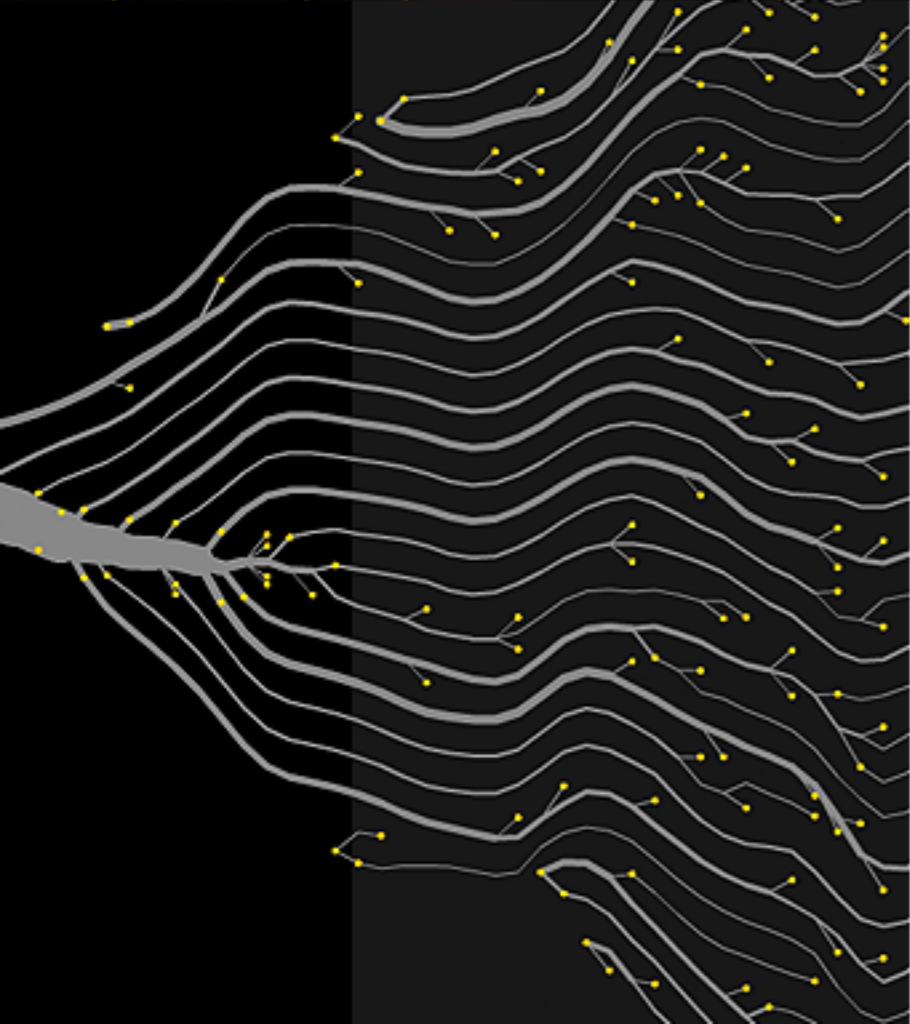
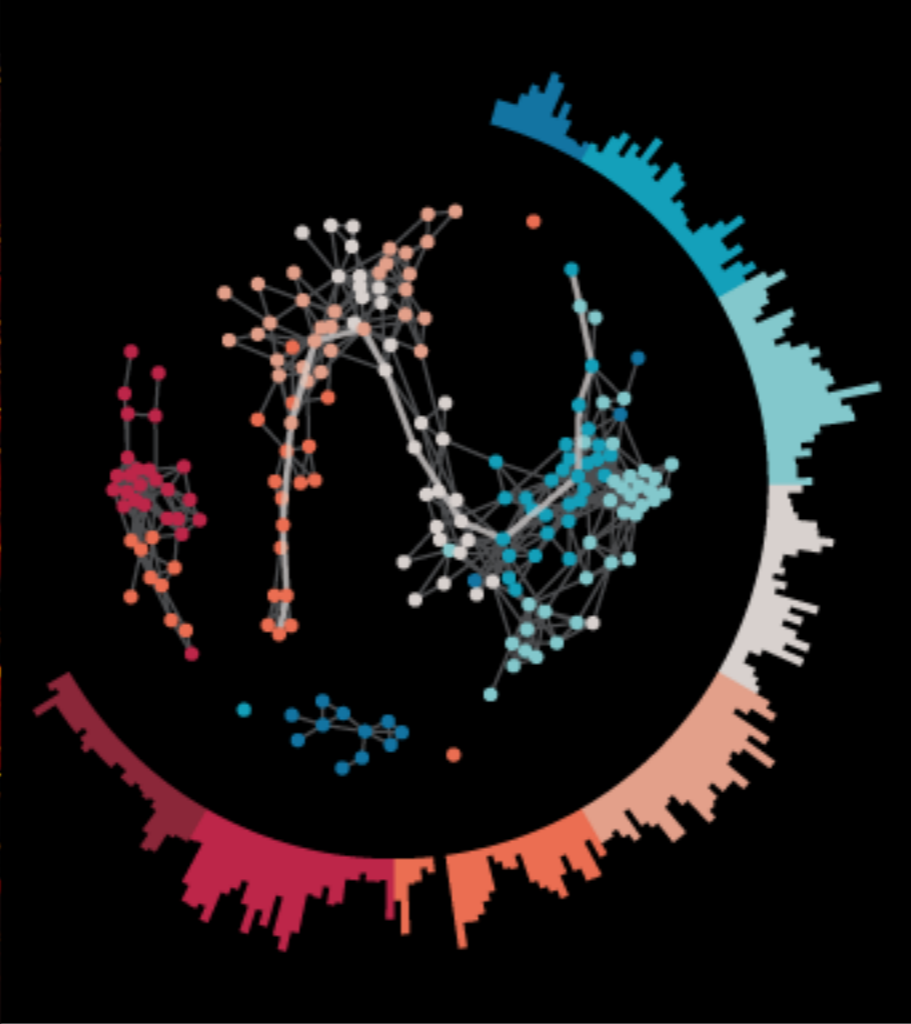
ISI FOUNDATION – TORINO

**INTERFACING DATA
FOR COMPLEX SYSTEMS
RESEARCH**

INTERFACING DATA FOR COMPLEX SYSTEMS RESEARCH

- » **Complex Networks and Systems Lagrange Laboratory**
- » **Computational Epidemiology Laboratory**
- » **Data Science Laboratory**

INTERFACING DATA
FOR COMPLEX SYSTEMS
RESEARCH



INTERFACING DATA

FOR COMPLEX SYSTEMS

RESEARCH

- » **COMMUNICATION**
- » **FACILITATING SCIENCE**
- » **FACILITATING POLICY & MANAGEMENT**

COMMUNICATION

- targeted highlighting of specific features or patterns in the data
- **DATA VISUALISATION**
- controlling parameters
 - » the effectiveness of the communication
 - representational language
 - focus and context
 - » the cost of producing the visualisation

FACILITATING SCIENCE

- serendipitous discovery of features or patterns in the data
- scientific instrument for open-ended exploration
- **VISUAL ANALYTICS**
- controlling parameters:
 - » flexibility with which it allows the scientists to explore the data → filters and perspectives
 - » nature of the data: data space, network, etc.

FACILITATING POLICY & MANAGEMENT

- focussed (domain specific) analysis and representation
 - » data analysis: detect patterns & correlations
 - » forecasting: showing consequences of certain "what if" scenarios
- integrated workflow:
 - » set-up of scenario
 - » execution of forecasting
 - » analysis & representation of results

FACILITATING POLICY & MANAGEMENT

- **controlling parameters:**
 - » **expectations and capabilities of target users → usability is key**
 - » **tradeoff between providing task-specific functionality and flexibility**

MULTI-DISCIPLINARY ACTIVITY

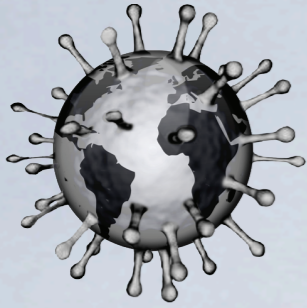
- **domain specific science**
- **computer science**
 - » **algorithms**
 - » **data management**
 - » **software development**
- **communication design**
 - » **graphic design**
 - » **interface design**

1. EPIDEMIC SPREADING

2008-2011

GLEAMVIZ.ORG – GLEAMVIZ SIMULATOR SYSTEM

FORECASTING EPIDEMIC SPREADING



GLEaMviz Simulator
GLEaMviz.org

Principal Investigators

Alessandro Vespignani (team coordinator)

Vittoria Colizza

Research and Development Team

Northeastern University: Fabio Ciulla, Bruno Goncalves, Nicola Perra, Luca Rossi, Qian Zhang

ISI Foundation: Paolo Bajardi, Duygu Balcan, Luca Cappa, Corrado Gioannini, Chiara Poletto, Marco Quaggiotto, Michele Tizzoni, Wouter Van den Broeck

Collaborating on influenza surveillance (influweb)

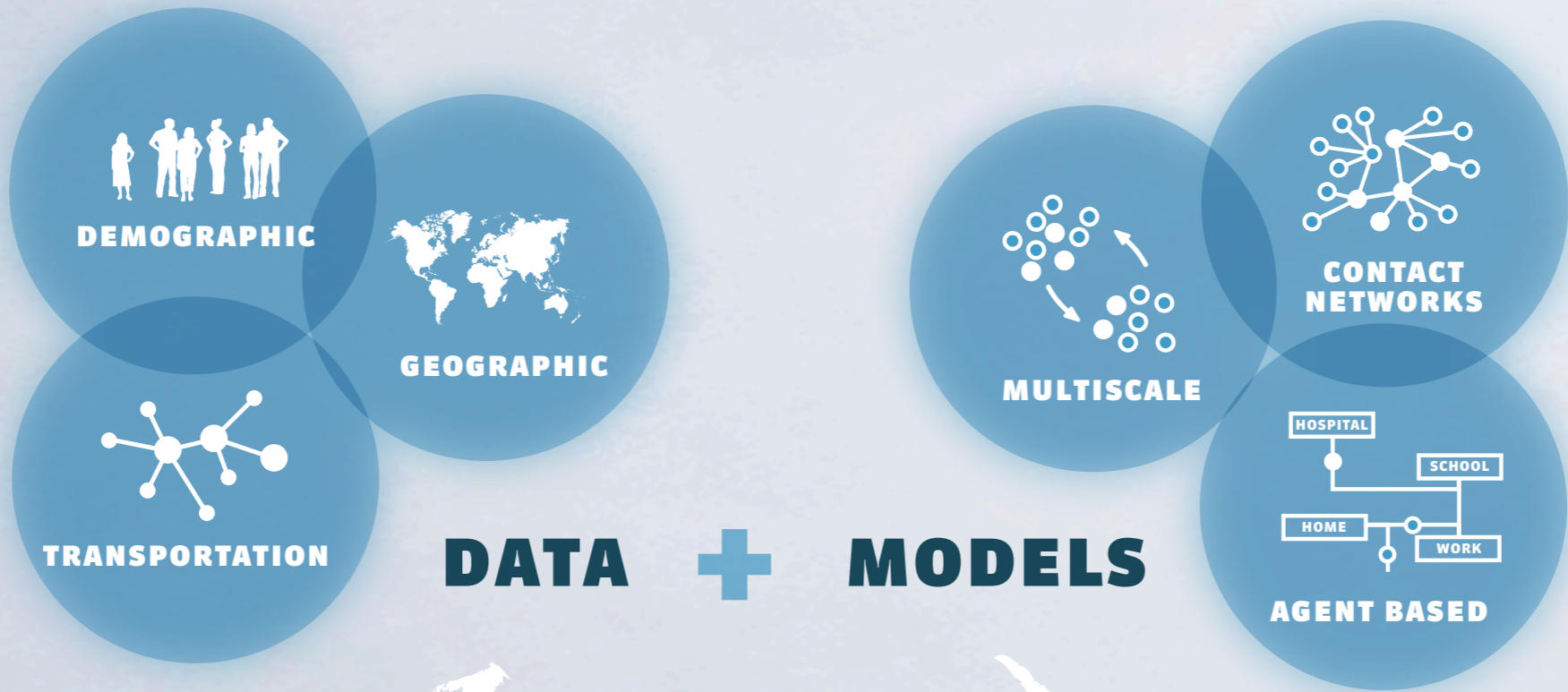
Daniela Paolotti

Former collaborators

Hao Hu, Jose J. Ramasco

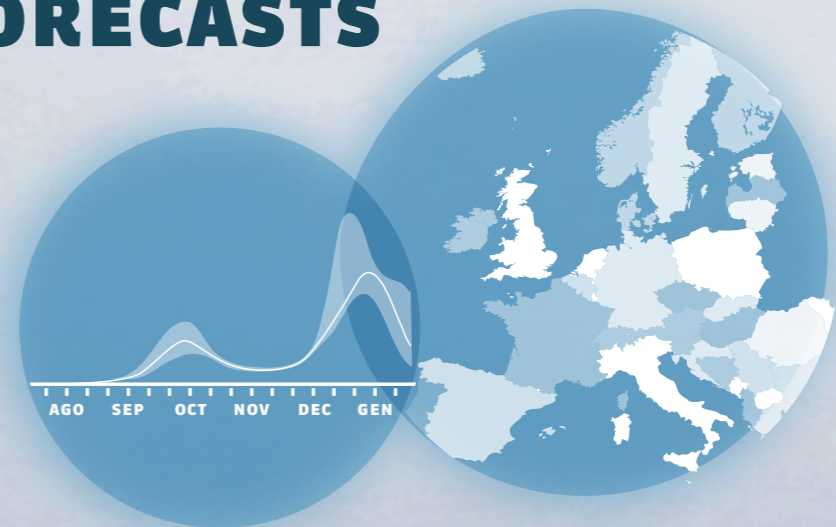
FORECASTING THE SPREADING OF AN EPIDEMIC, considering:

- » **SUBSTRATE**: population distribution, mobility, ...
- » **DISEASE**: infectiousness, latency, impact on mobility, ...
- » **INTERVENTIONS**: antivirals, vaccinations, mobility restrictions, ...



MONITORING

FORECASTS



DEMOGRAPHIC AND MOBILITY DATA

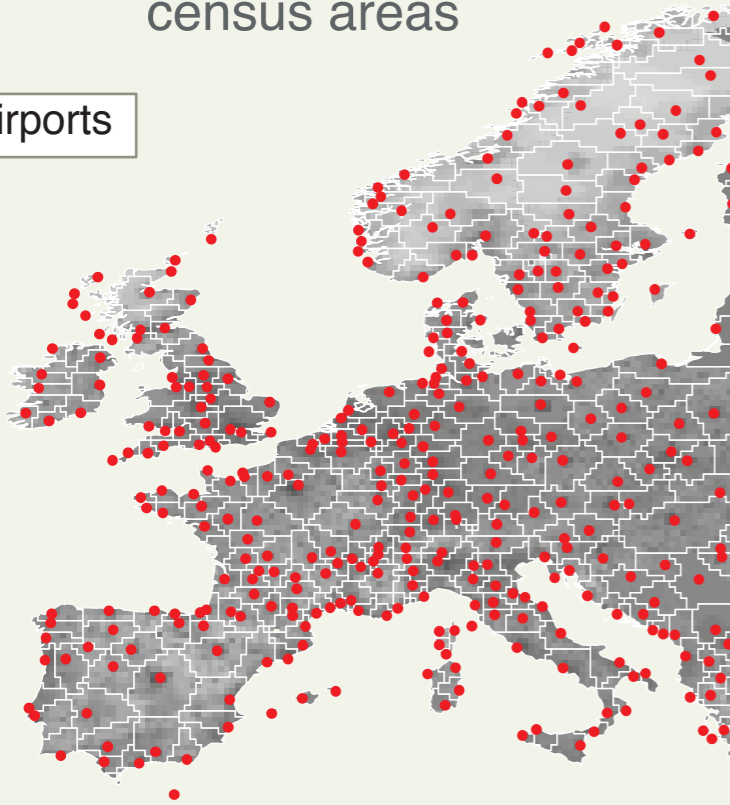
+

STOCHASTIC DISEASE MODEL

Population layer

census areas

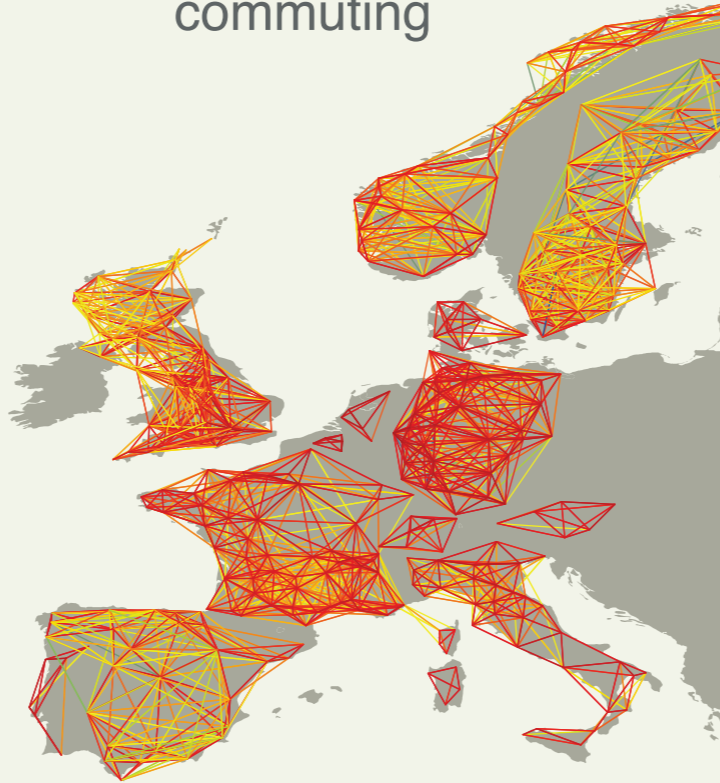
● airports



Short-range mobility layer

commuting

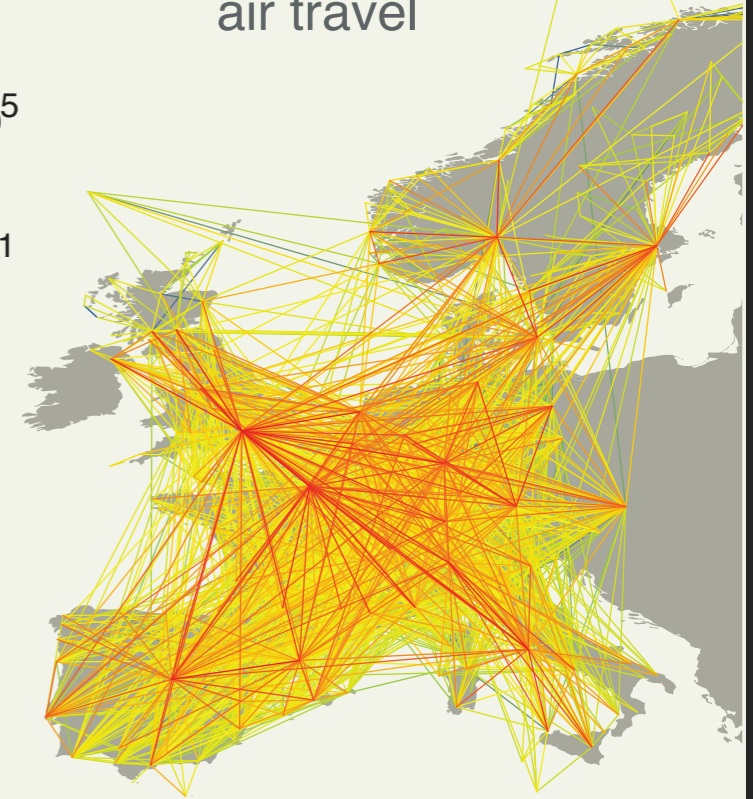
10^5
 10^1

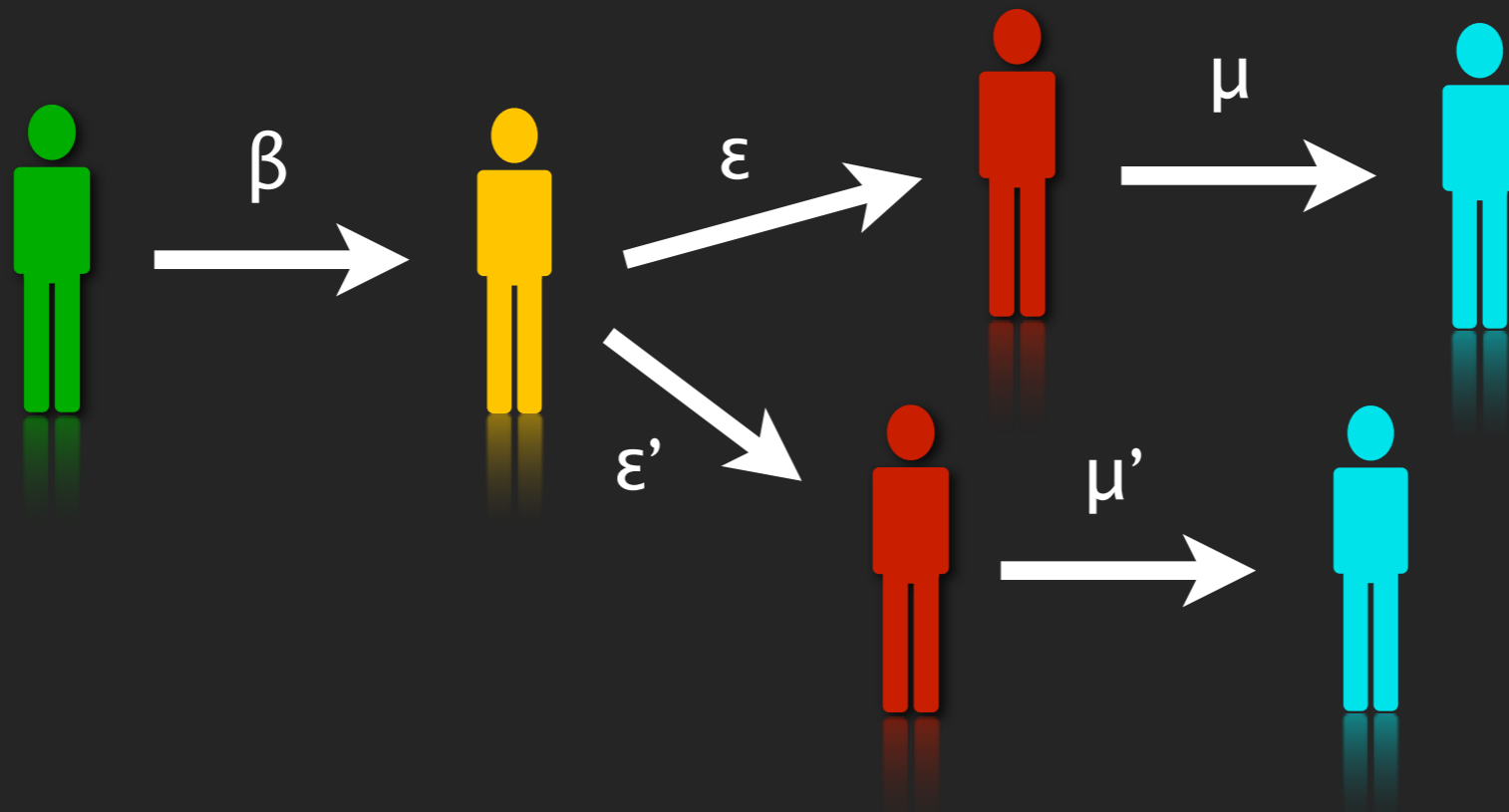
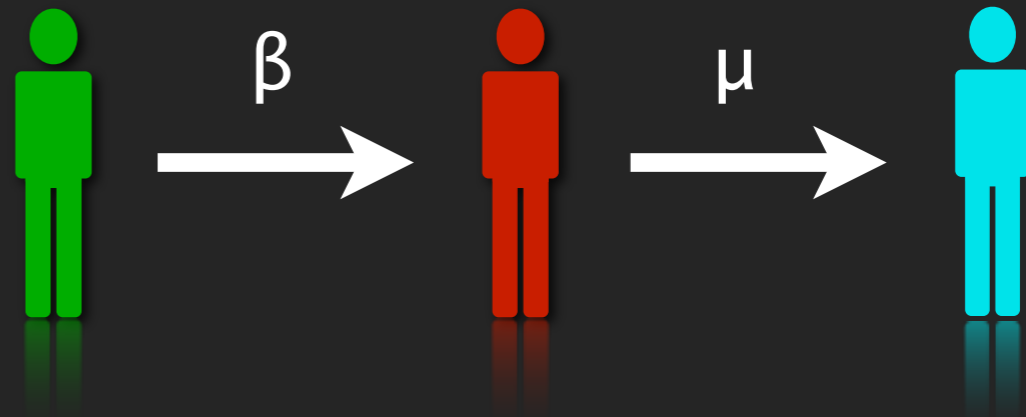
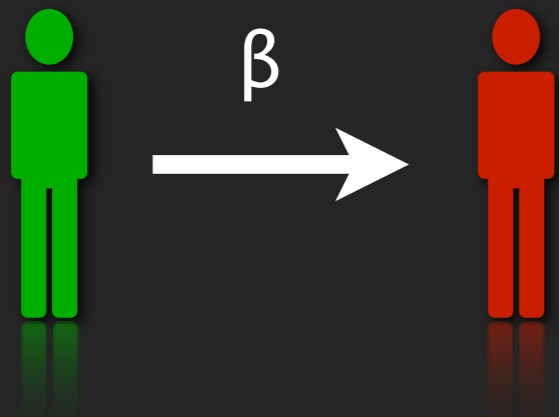


Long-range mobility layer

air travel

10^5
 10^1

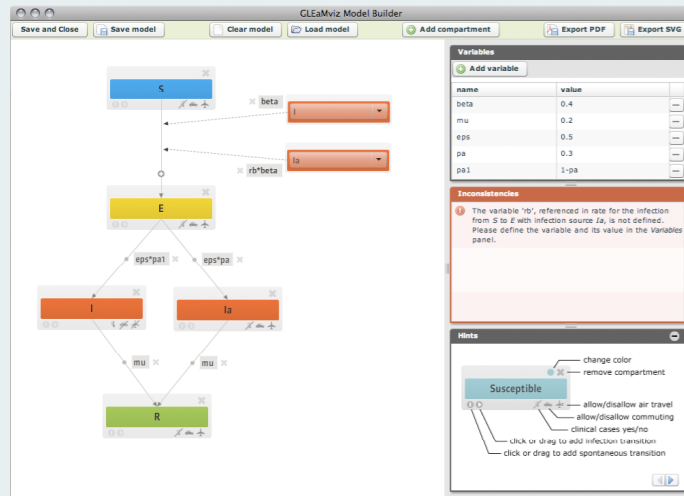




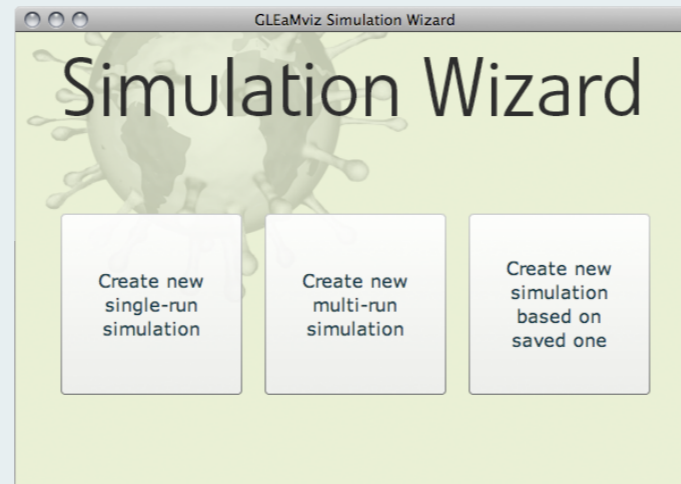
STOCHASTIC DISEASE MODEL

GLEaMviz Client

GLEaMviz Server

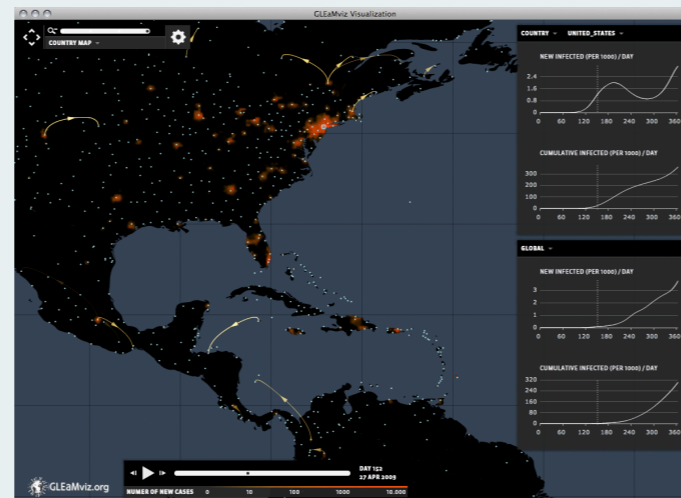
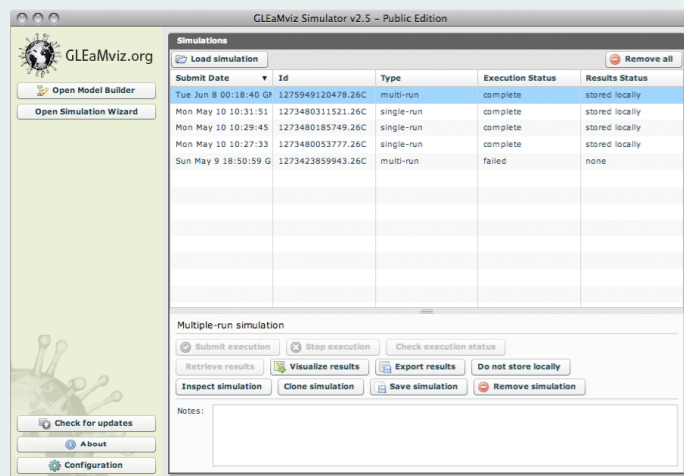
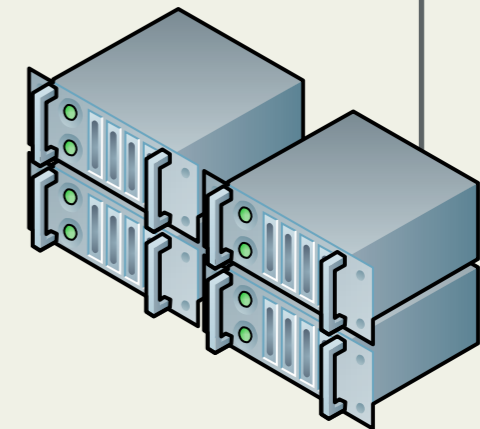


1 Design the compartmental model of the infectious disease in the **Model Builder**.



2 Configure the simulation of the world-wide epidemic spreading in the **Simulation Wizard**.

3 Submit the simulation for execution by the **Engine** on the server.



4 Inspect all simulations and retrieve results in the **Simulations History**.

5 Inspect the results of a simulation in the **interactive Visualization**.

Model

Variables

The screenshot shows the GLEaMviz Model Builder interface. The main workspace contains a compartmental model diagram with compartments S (Susceptible, blue), E (Exposed, yellow), I (Infected, orange), Ia (Infected asymptomatic, orange), and R (Recovered, green). Transitions are labeled with rates: S to E is βI and βI_a ; E to I is $\epsilon \cdot pa$ and $\epsilon \cdot pa$; I to R is μ and μ . The right sidebar contains three panels: 'Variables' with a table of parameters, 'Inconsistencies' with a warning about the undefined variable 'rb', and 'Hints' with a legend for compartment icons.

name	value
beta	0.4
mu	0.2
eps	0.5
pa	0.3
pa1	1-pa

Inconsistencies

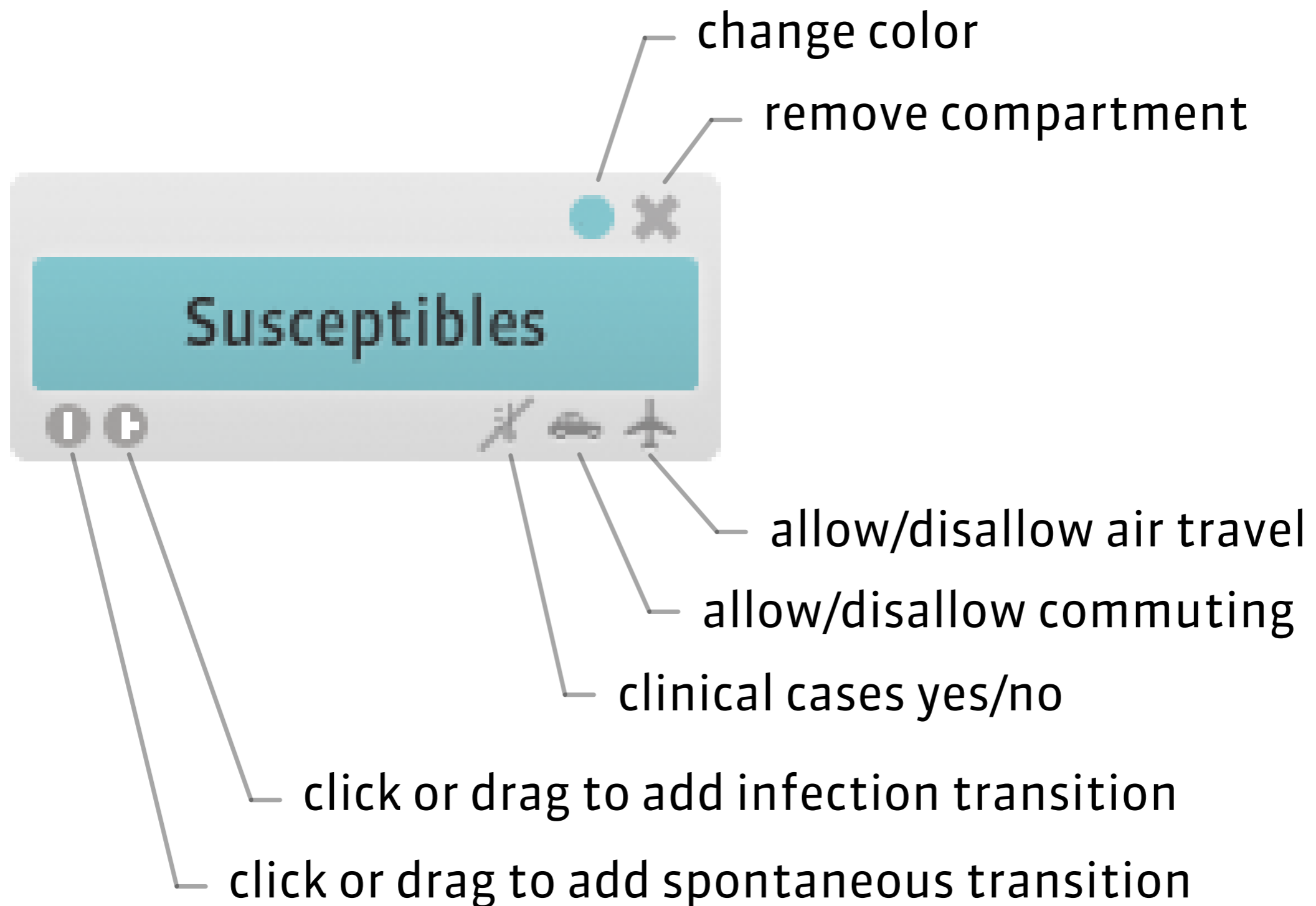
! The variable 'rb', referenced in rate for the infection from S to E with infection source Ia, is not defined. Please define the variable and its value in the Variables panel.

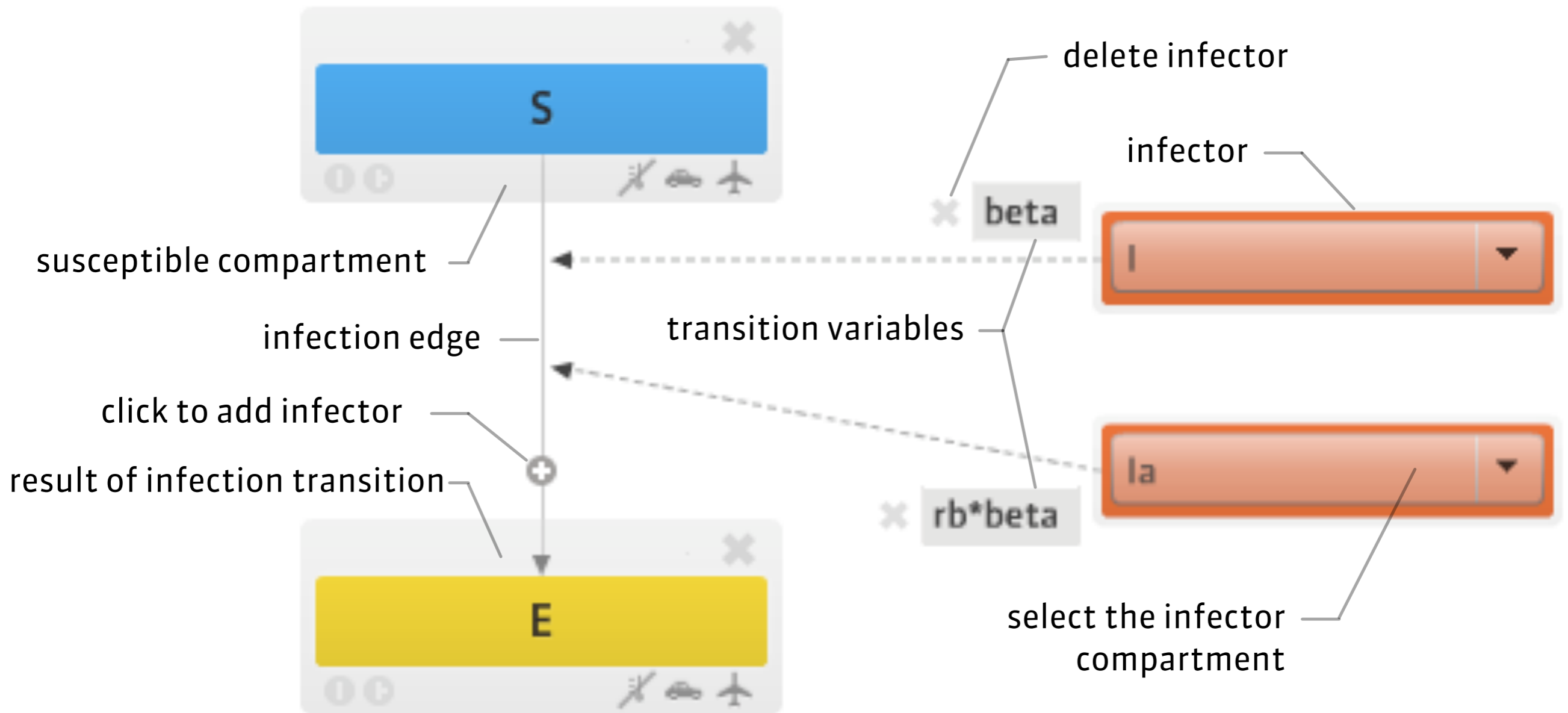
Hints

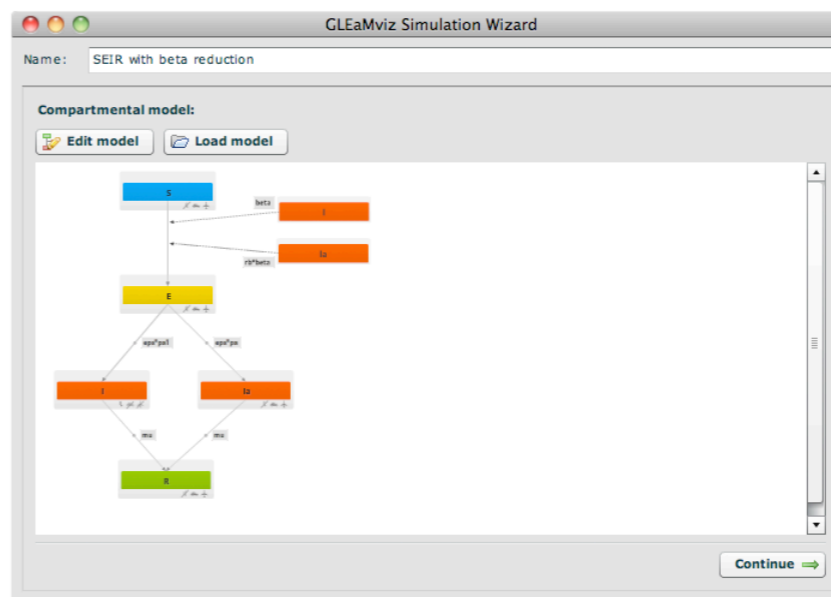
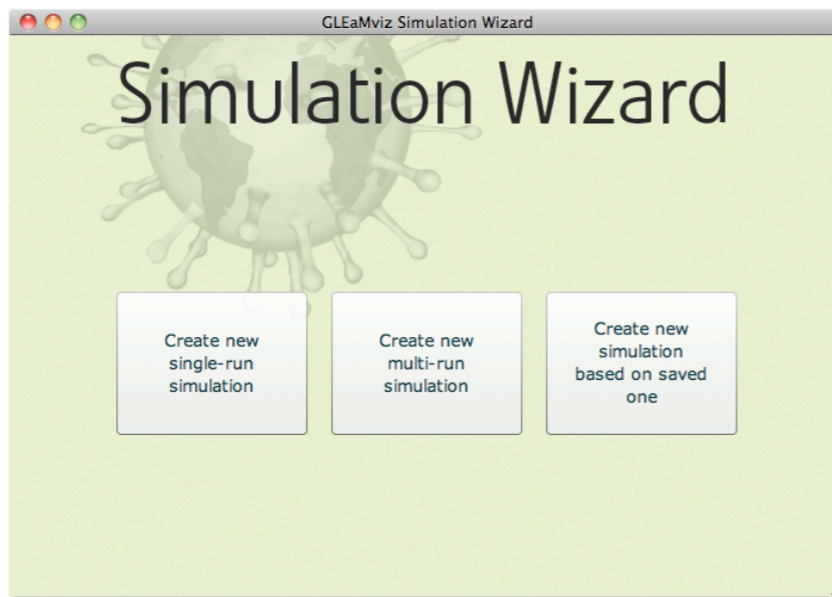
- change color
- remove compartment
- allow/disallow air travel
- allow/disallow commuting
- clinical cases yes/no
- click or drag to add infection transition
- click or drag to add spontaneous transition

Inconsistencies

Hints







Name: SEIR with beta reduction

Type: **multi-run**

Start date: 09/01/2009

Duration: 365 days

Number of runs: 10

Enable seasonality:

Minimal seasonality rescaling of the reproductive number: 0.55

Airplane occupancy rate: 75 %

Time spent at the commuting destination: 8 hours

The minimum number of clinical cases that need to occur in a country, for it to be considered infected: 1

Minimum number of infected countries for an occurrence to be an epidemic: 2

Back Continue

Name: SEIR with beta reduction

Time-dependent variable overrides:

Variable: beta

From: 01/01/2010 (day 93) From start

Up to and including: 01/10/2010 (day 102) Till end

Alternate value: 0.3

Variable: beta

From: 01/11/2010 (day 103) From start

Up to and including: 01/20/2010 (day 112) Till end

Alternate value: 0.2

Variable: beta

From: 01/21/2010 (day 113) From start

Up to and including: 09/30/2010 (day 365) Till end

Add variable override remove override Remove all View compartmental model

Back Continue

Name: Vaccination scenario

Initial global distribution of population in compartments:

Susceptible 70 %

Susceptible_Vaccine 30 %

Add compartment Remove compartment

Back Continue

Name: Vaccination scenario

Initial geographic location of the epidemic:

Country	City	Compartment	# Individuals	Fraction / 1000
Thailand	Bangkok [BKK]	Infected_Travel	5	0.0003
Myanmar	Monghsat [MOG]	Infected_Asymp	5	0.0134

Add seed Remove seed

Back Continue

Name: Sim TC8EC8270-EAE7-9D80-604F-712FEEC50E42

Result compartments:

S

E

I

R

Ia

Select one or more (at most 5) compartments to be considered when retrieving and visualising the results in this client. When the visualization window opens, it will show the results of the first compartment marked as clinical case.

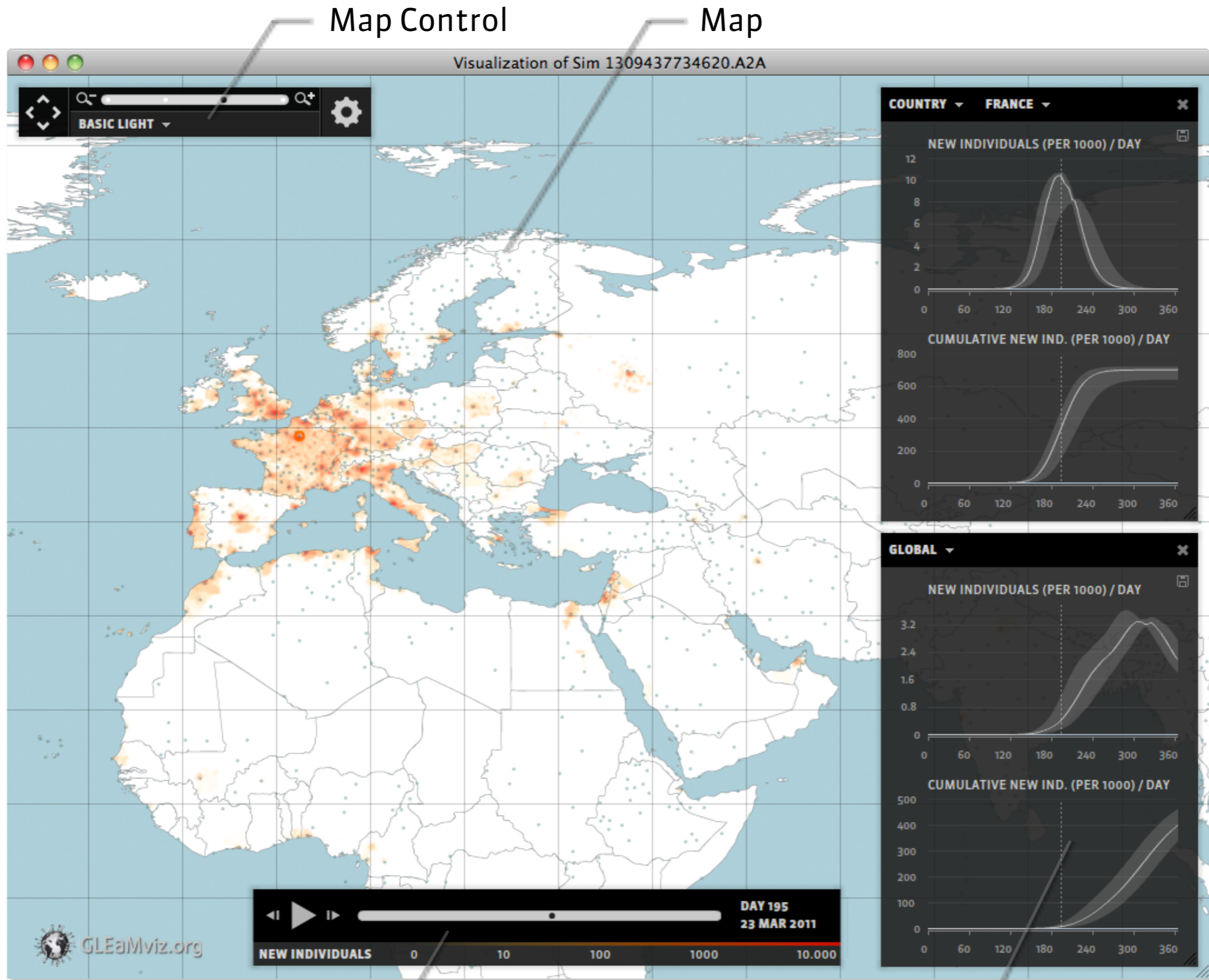
In the settings of the visualization window you will have the opportunity to change this, and visualize all or a subset of the compartments selected here.

The results will show the median of the sum of the amount of people entering the visualized compartments, as well as the cumulative numbers, and their respective confidence intervals.

Download and allow the visualization of the instantaneous number of individuals in each selected compartment. (This option is available only in the unlimited version of GLEaMviz, obtainable upon agreement with the development team.)

Back Save Simulation Submit

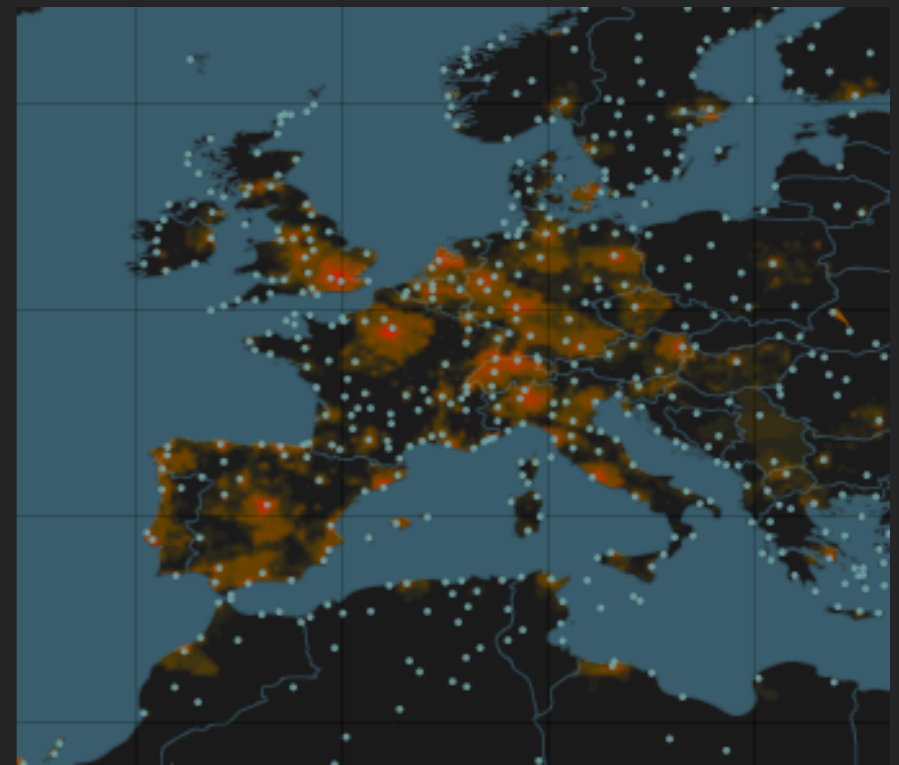
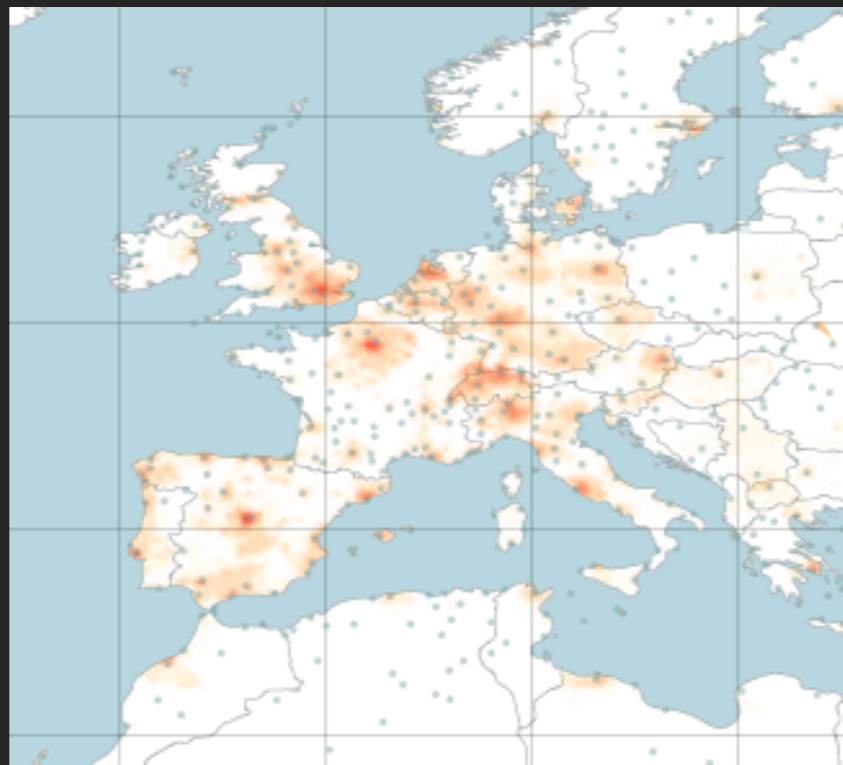
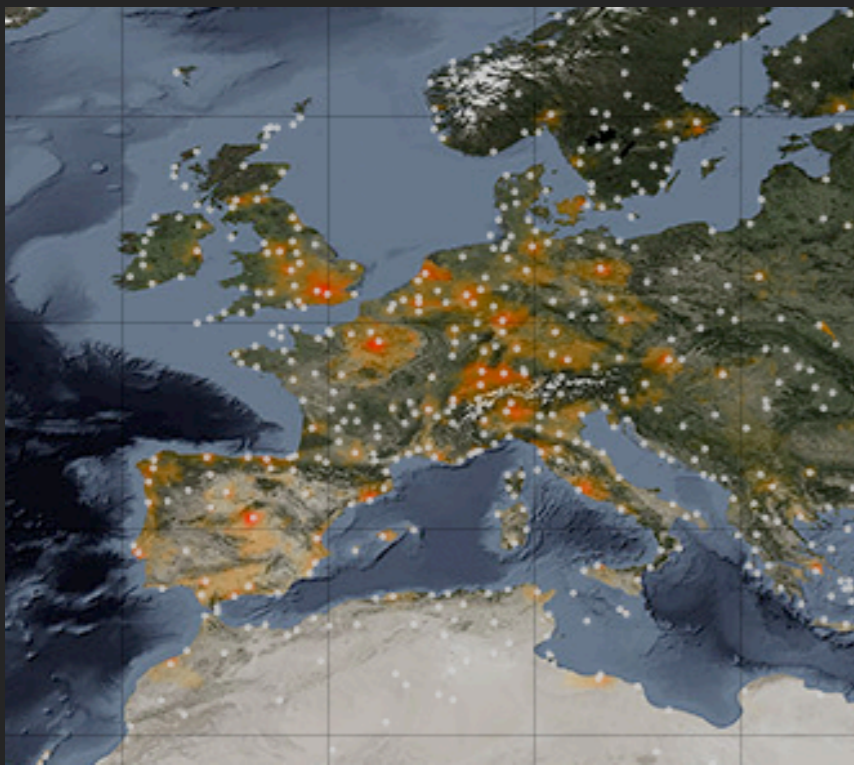
GLEAMVIZ: SIMULATION SET-UP WIZARD



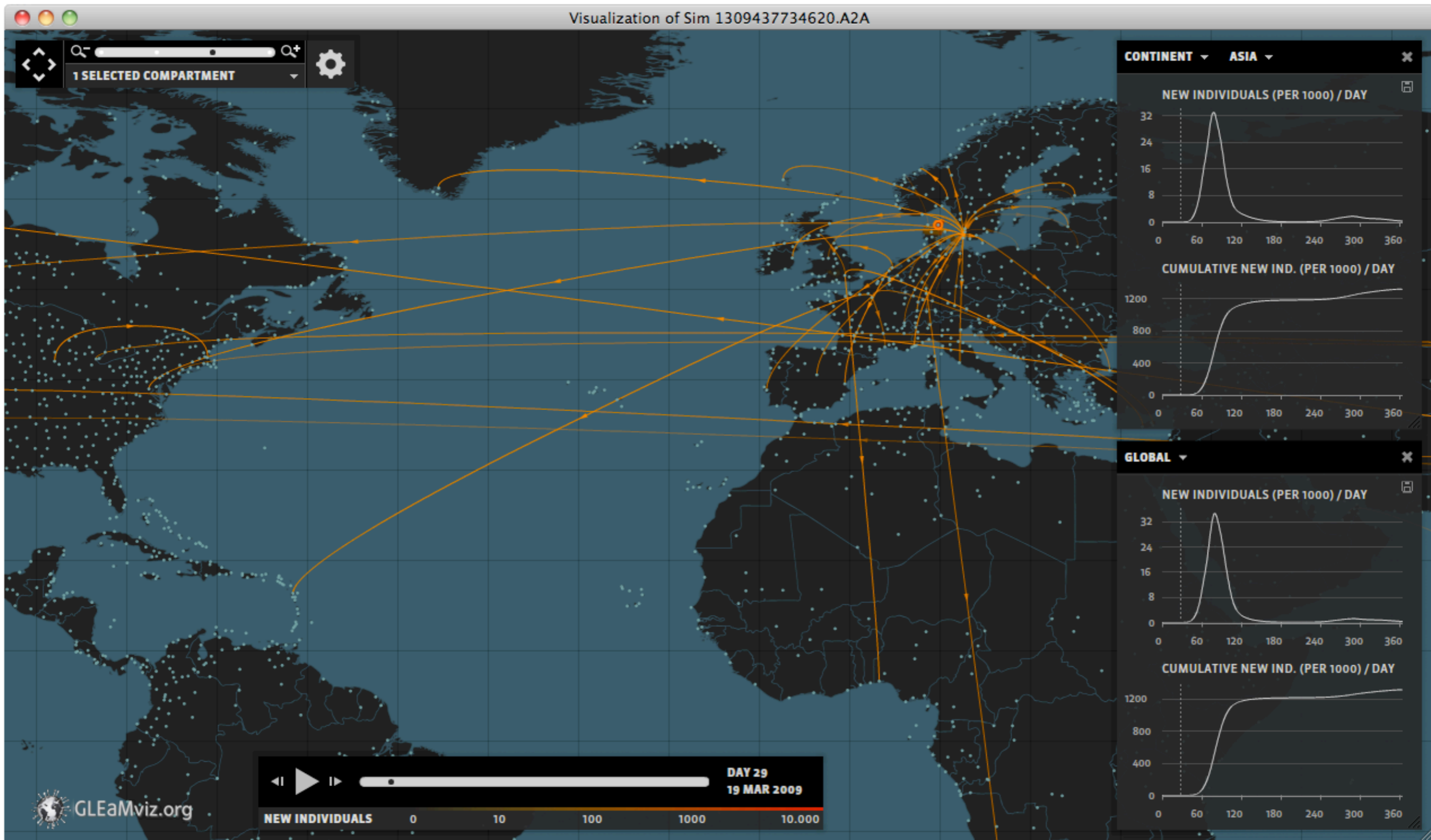
Play Control

Charts Panel

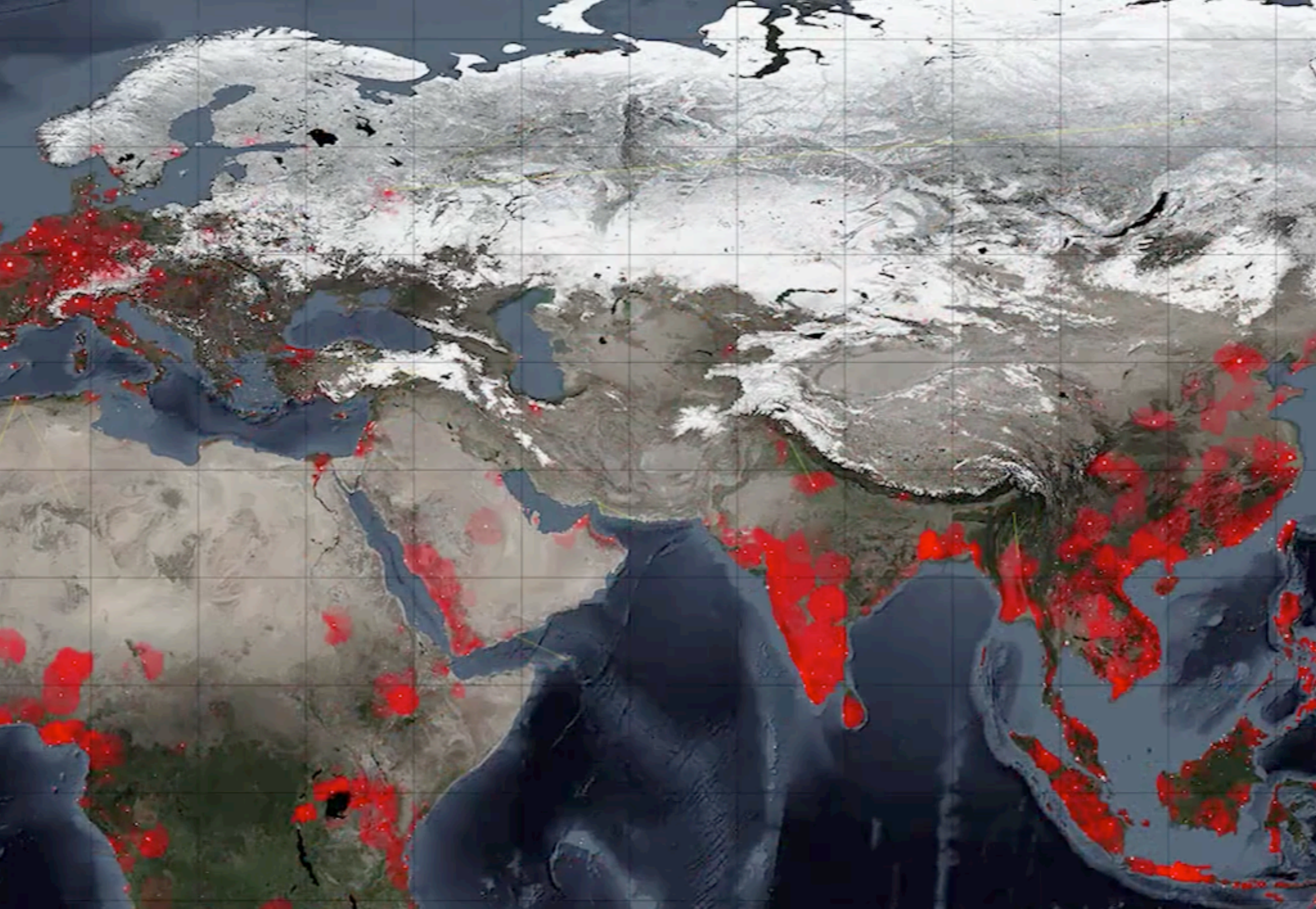
GLEAMVIZ: GEOGRAPHIC VISUALISATION



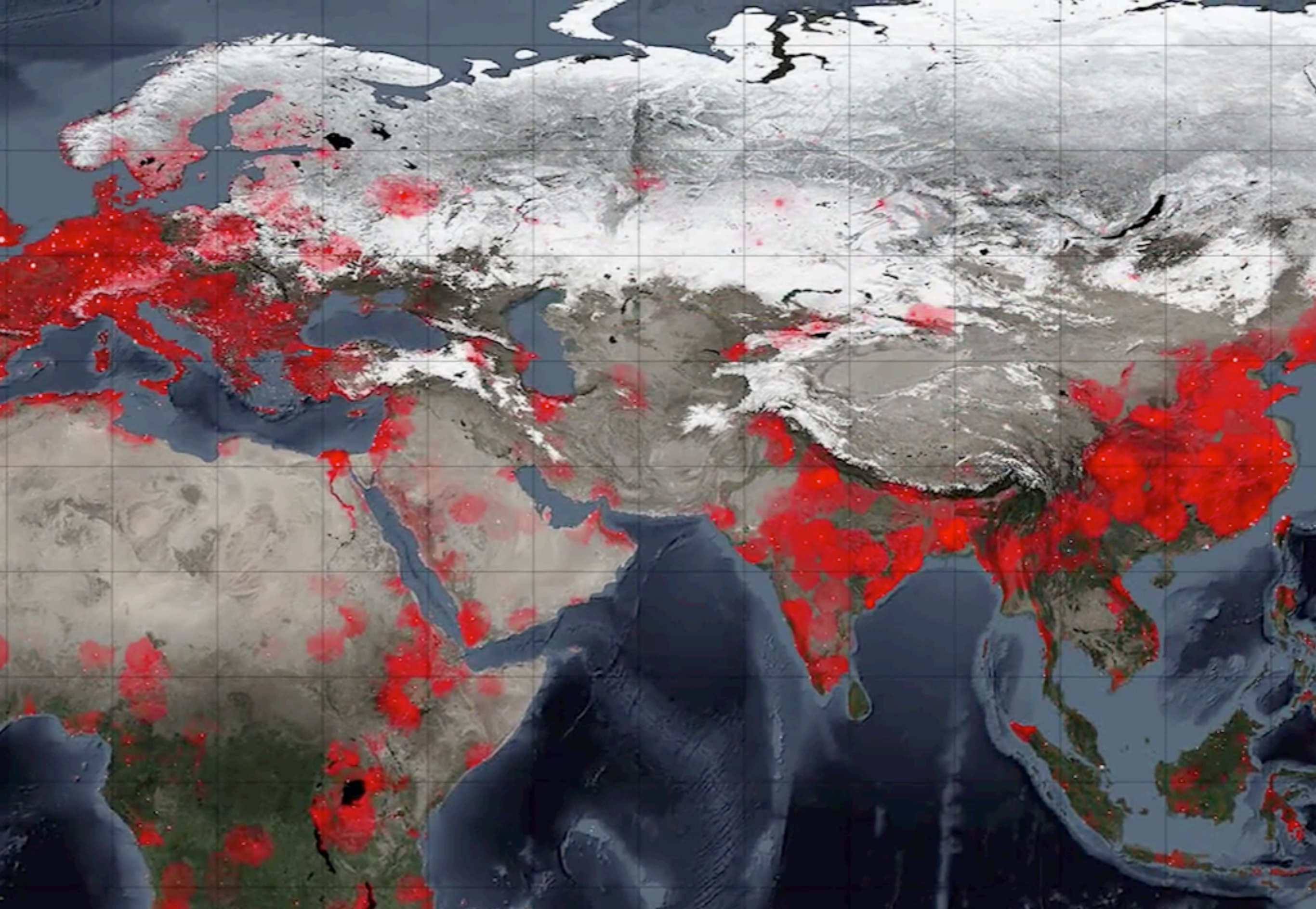
GLEAMVIZ: DIFFERENT MAP TYPES



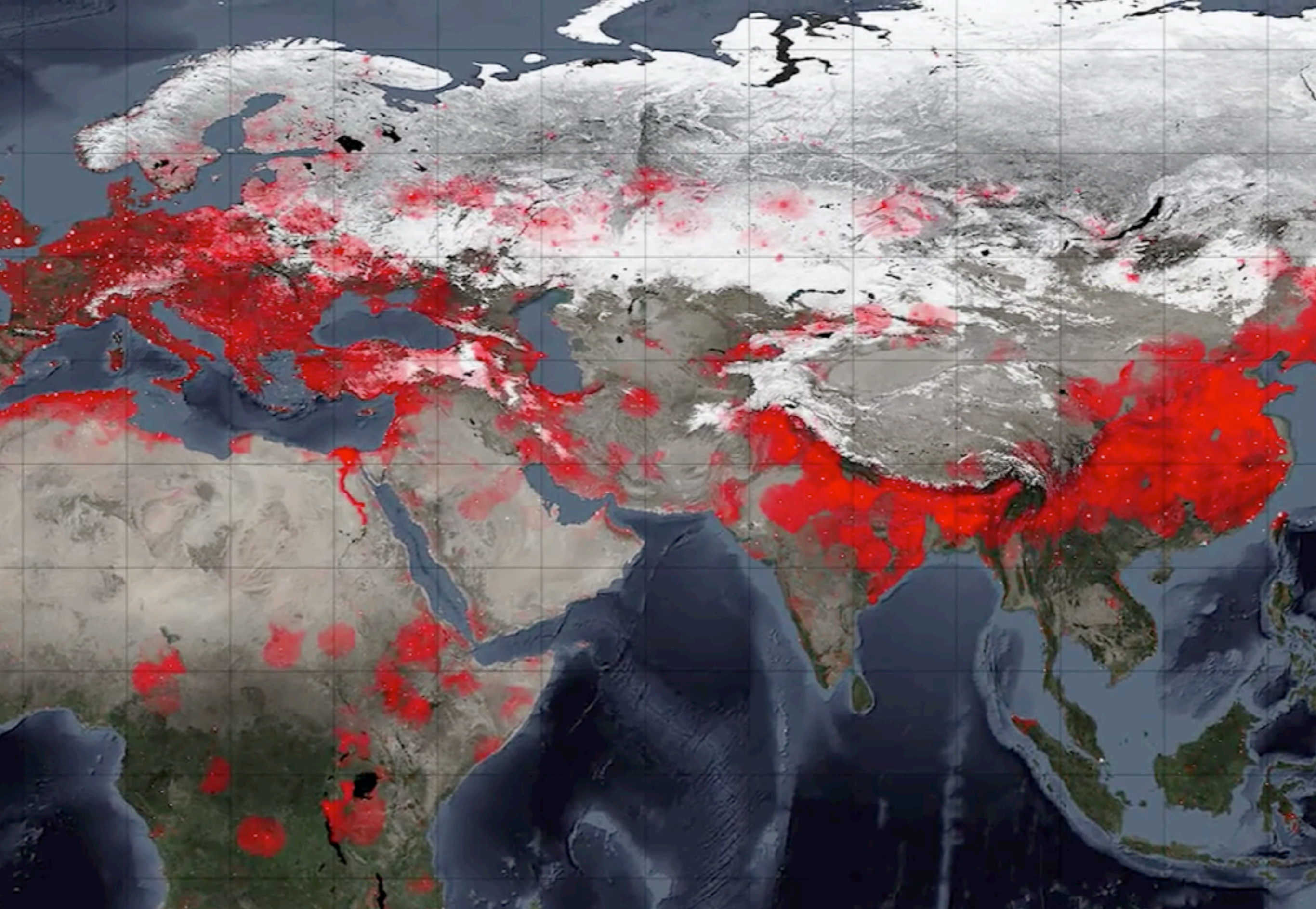
GLEAMVIZ: VISUALISING THE INITIAL INVASION VECTORS



GLEAMVIZ: VISUALISING THE SPREADING



GLEAMVIZ: VISUALISING THE SPREADING



GLEAMVIZ: VISUALISING THE SPREADING

1 SELECTED COMPARTMENT

MAP OPTIONS

CITY APPEARANCE

INFECTION APPEARANCE

COLORS

Min. color Opacity 0

Max. color Opacity 0.8

Cases smoothing

TRANSPORT

Show seeding

Color

Enable TCC

TCC Target Color

Type CURVED WITH ARRO...

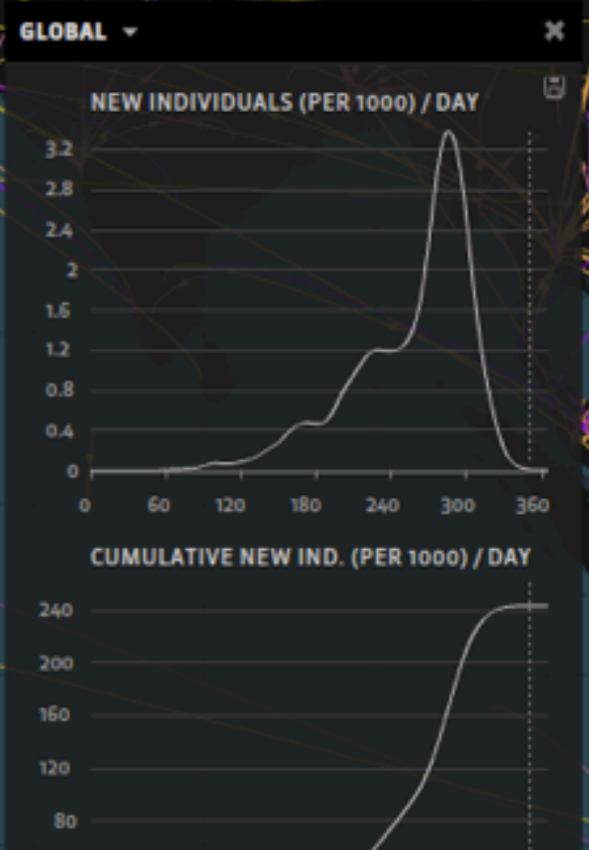
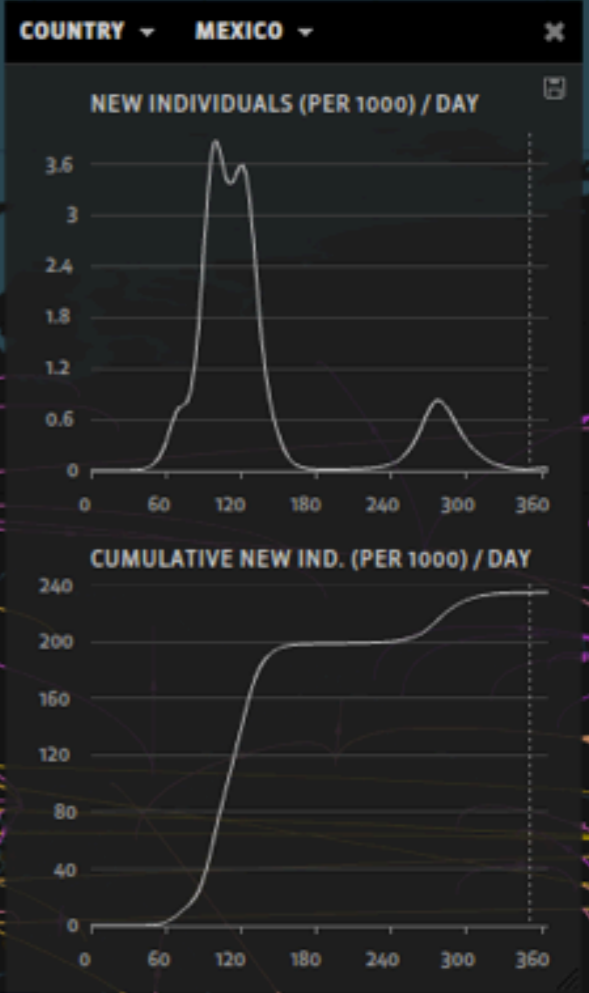
Alpha 1

Thickness 1

Arrow size 4

Fadeout 0

PANEL OPTIONS



GLEAMVIZ: EXTENSIVE CONTROL OVER APPEARANCE

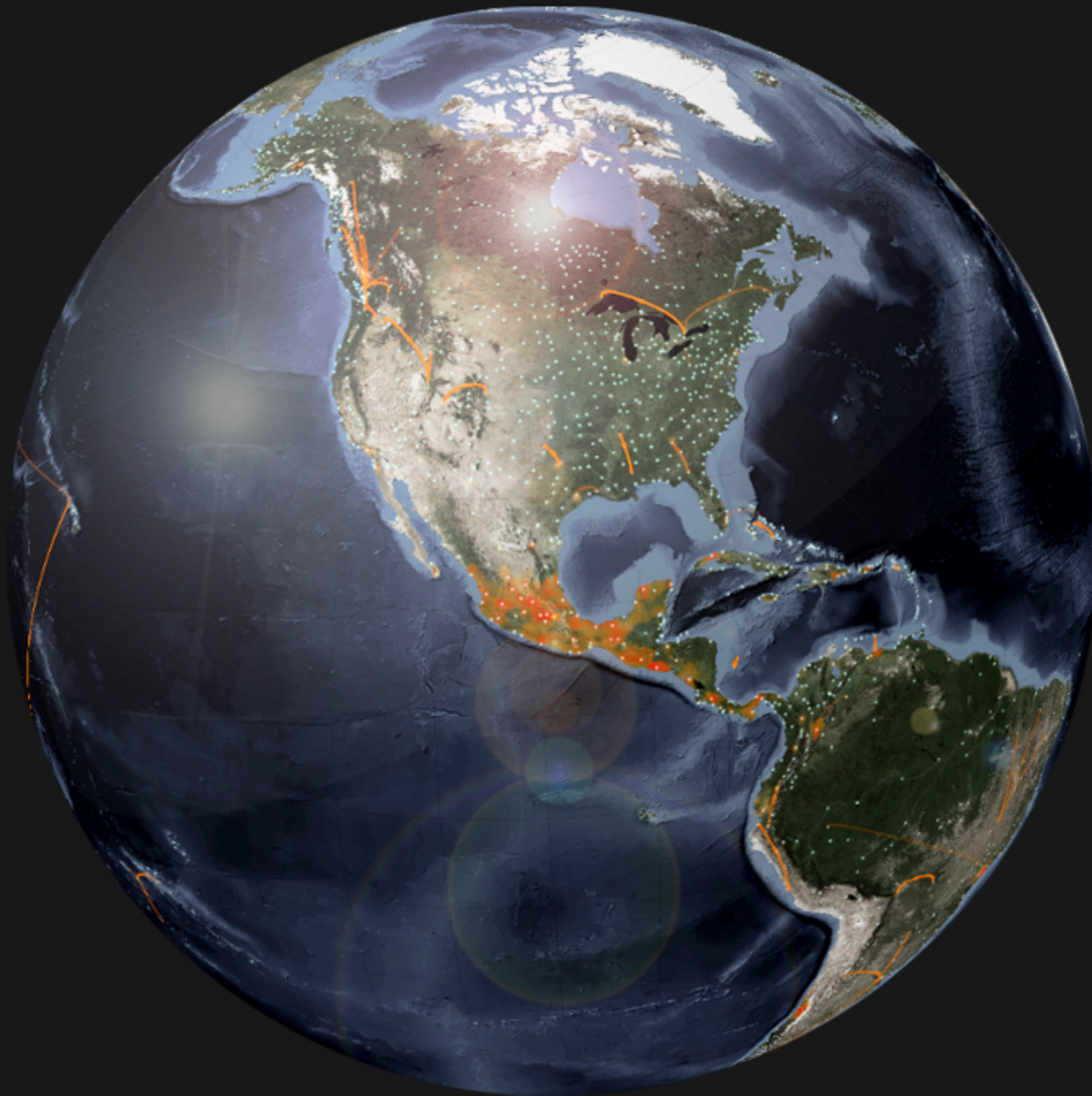
2008-2011

GLEAMVIZ.ORG – GLEAMVIZ & EPIDEMIC PLANET

DISSEMINATION & EXPERIMENTS



DETAIL OF SCENARIO VISUALISATION – WIRED IT





EPIDEMIC PLANET

**EXPLORE HOW H1N1 INFLUENZA TRAVELS AROUND THE GLOBE
AND HOW INTERVENTION MEASURES MAY HELP**



GENviz

Check and city

Check transmission control

Check information control

Selected scenario details

Scenario: ...

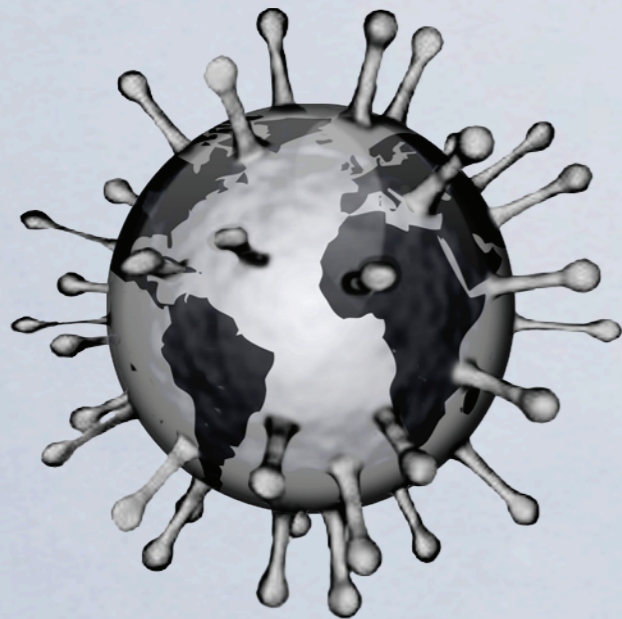
Transmission: ...

Information: ...

Epidemic Planet

... ..

EPIDEMIC PLANET - 2009, SCIENCE GALLERY, DUBLIN



GLEaMviz Simulator
GLEaMviz.org

2. SOCIAL NETWORKS

WHY IS IT IMPORTANT?

Understand and represent:

social dynamics on a interpersonal scale

processes on networks (epidemics...)

social interaction and use of space

Design:

control measures evaluation

social environment design

SOCIOPATTERNS

Core team:

Ciro Cattuto

Alain Barrat

Wouter Van den Broeck

Partners:

ISI Foundation (Turin)

Laboratoire de Physique de l'École Normale Supérieure de Lyon

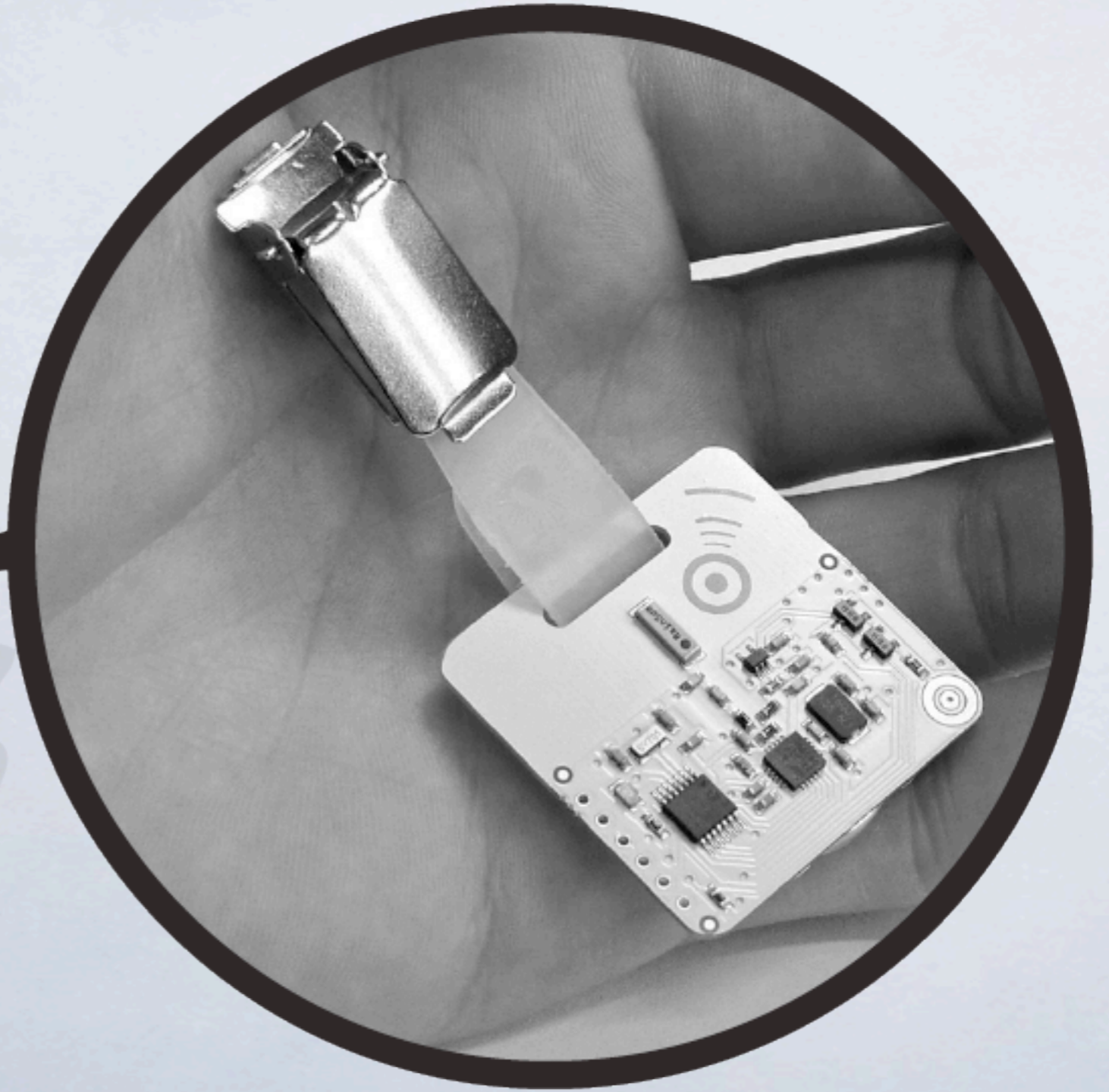
Centre de Physique Théorique (Marseille)

Bitmanufaktur (Berlin)

www.sociopatterns.org

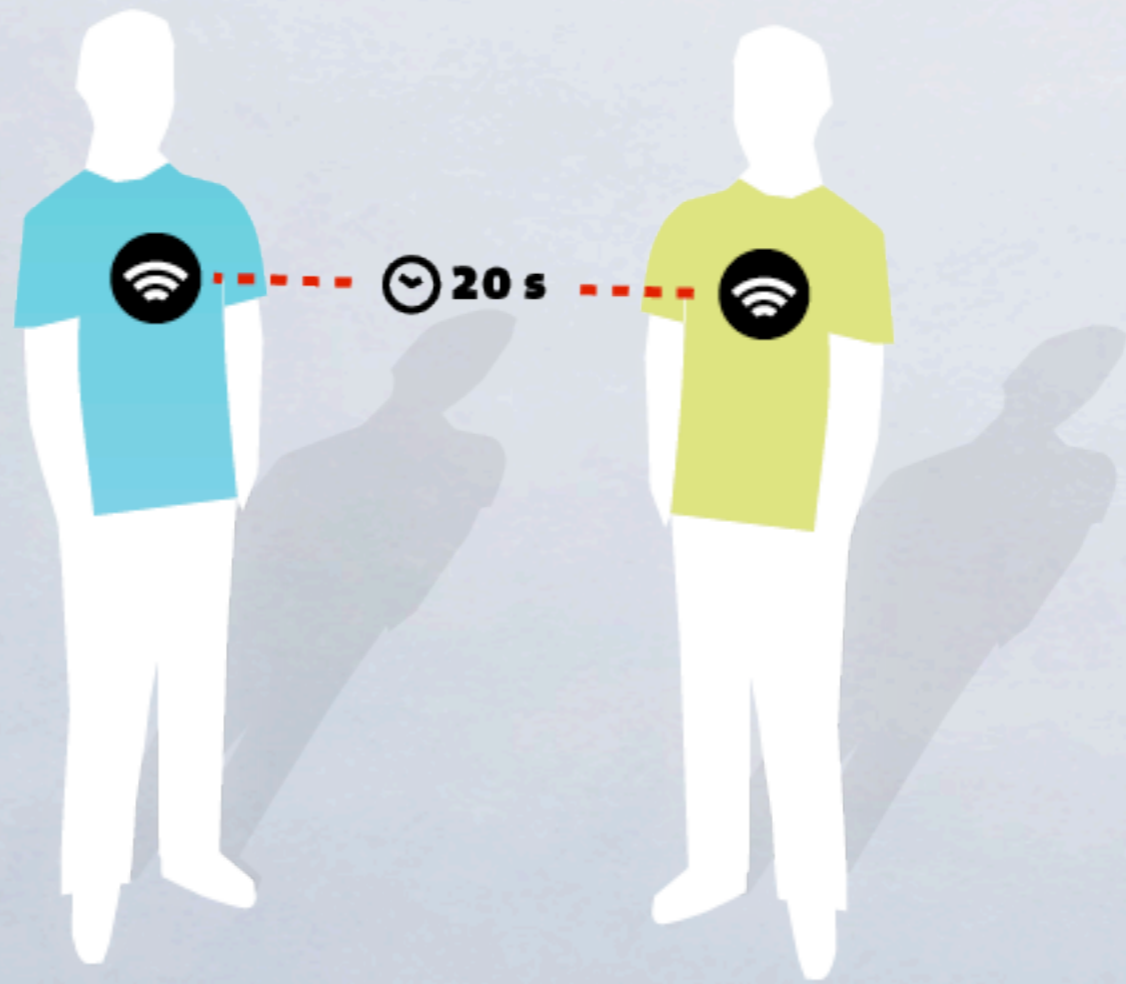


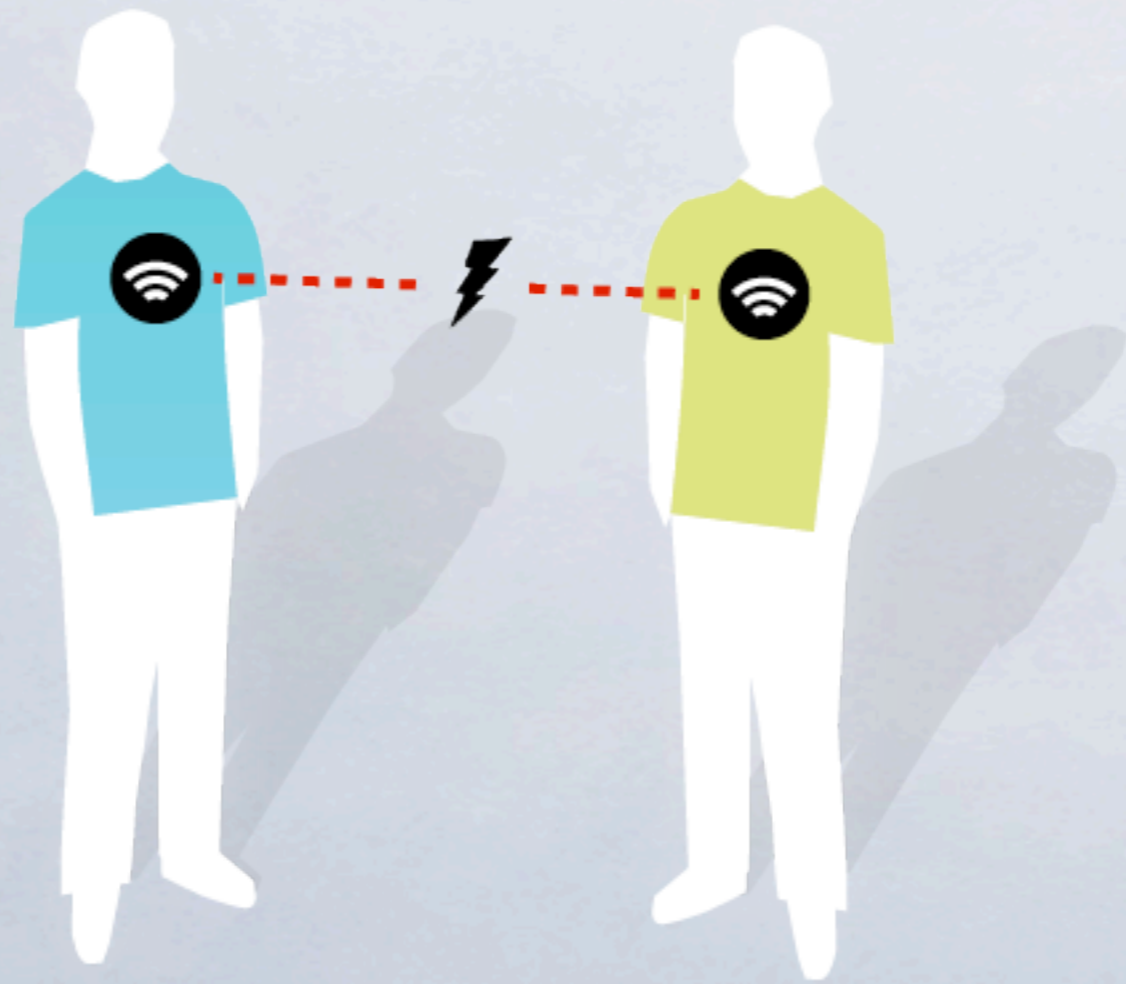


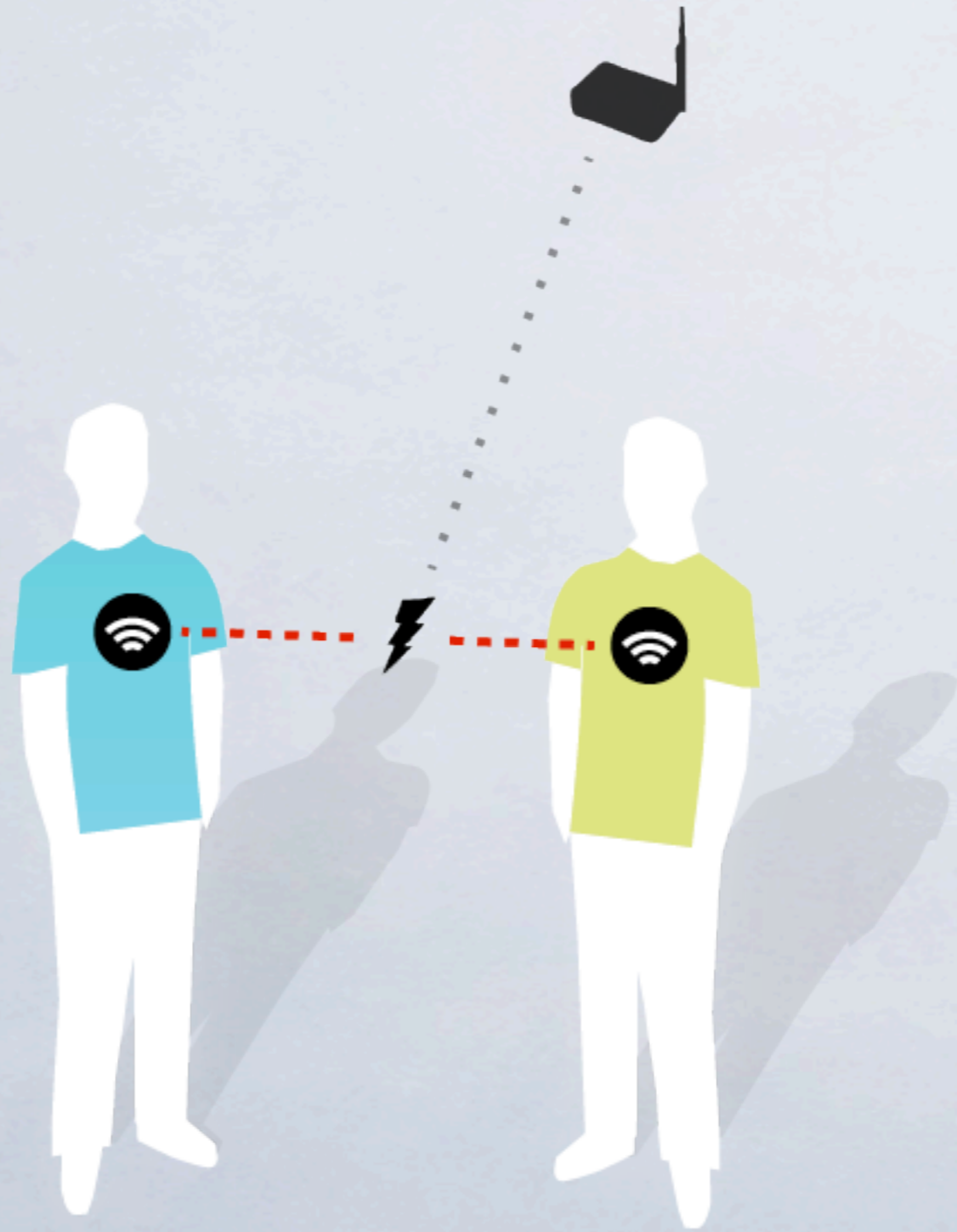


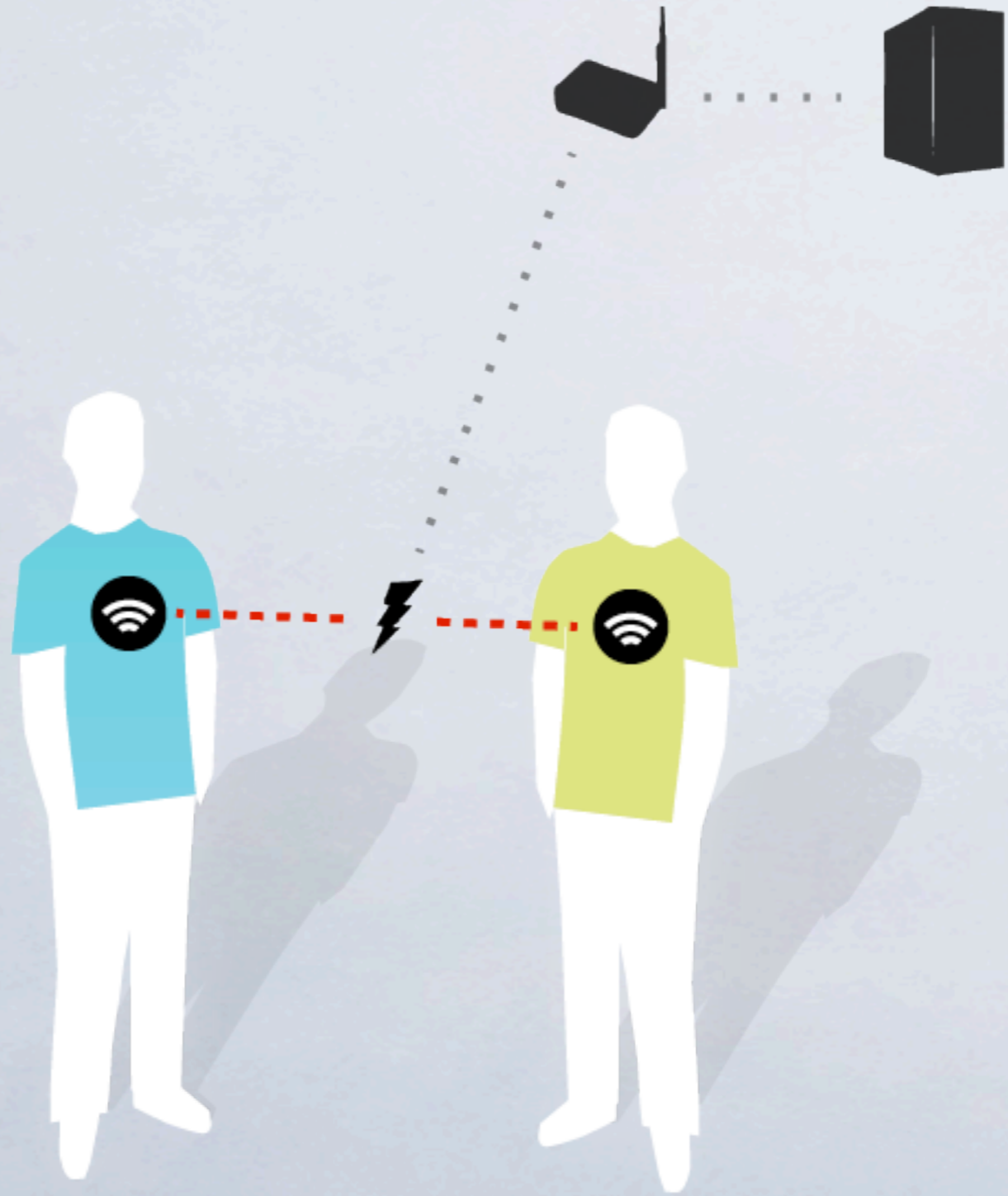














actor class: twisted.internet.selectreactor.SelectReactor.

isted.web.server.Site starting on 8080

starting factory <twisted.web.server.Site instance at 0x1015f8518>

builtin_.Receiver starting on 2342 2011-09-07 14:13:26+0200 [-] Starting protocol <_builtin_.Receiver ins

ltin_.Receiver (UDP)] S t=1315397606 ip=0x0afe00b5 id=513 boot_count=0 seq=0x00006981 strgth=0 flgs=0 last_

ltin_.Receiver (UDP)] S t=1315397607 ip=0x0afe00b5 id=513 boot_count=0 seq=0x000069a1 strgth=1 flgs=0 last_

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2008 - Workshop

Facing the Challenge
of Infectious Diseases

EXPOSE SOCIAL RELATIONS

Wed Oct 15 2008 10:35:11 AM

Cafeteria #1

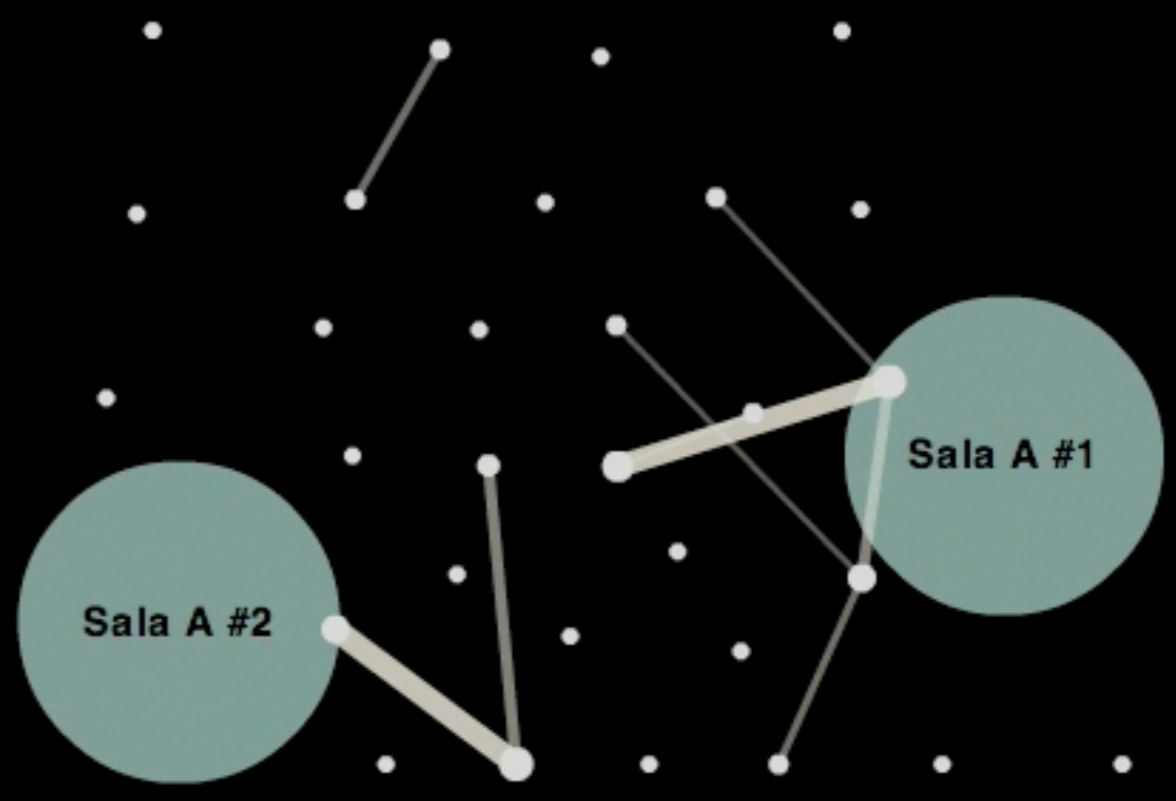
Bar #3

Cafeteria #2

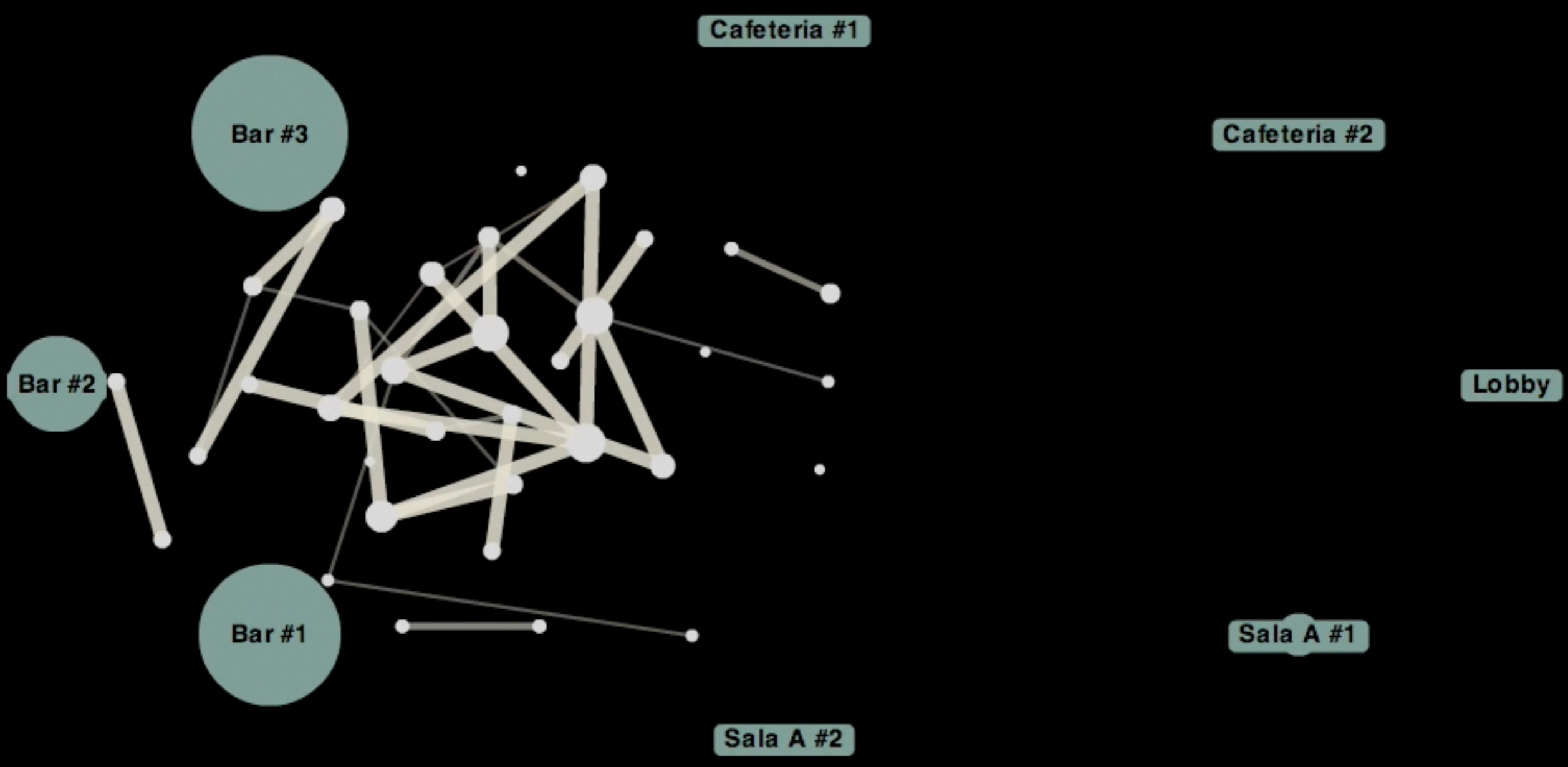
Bar #2

Lobby

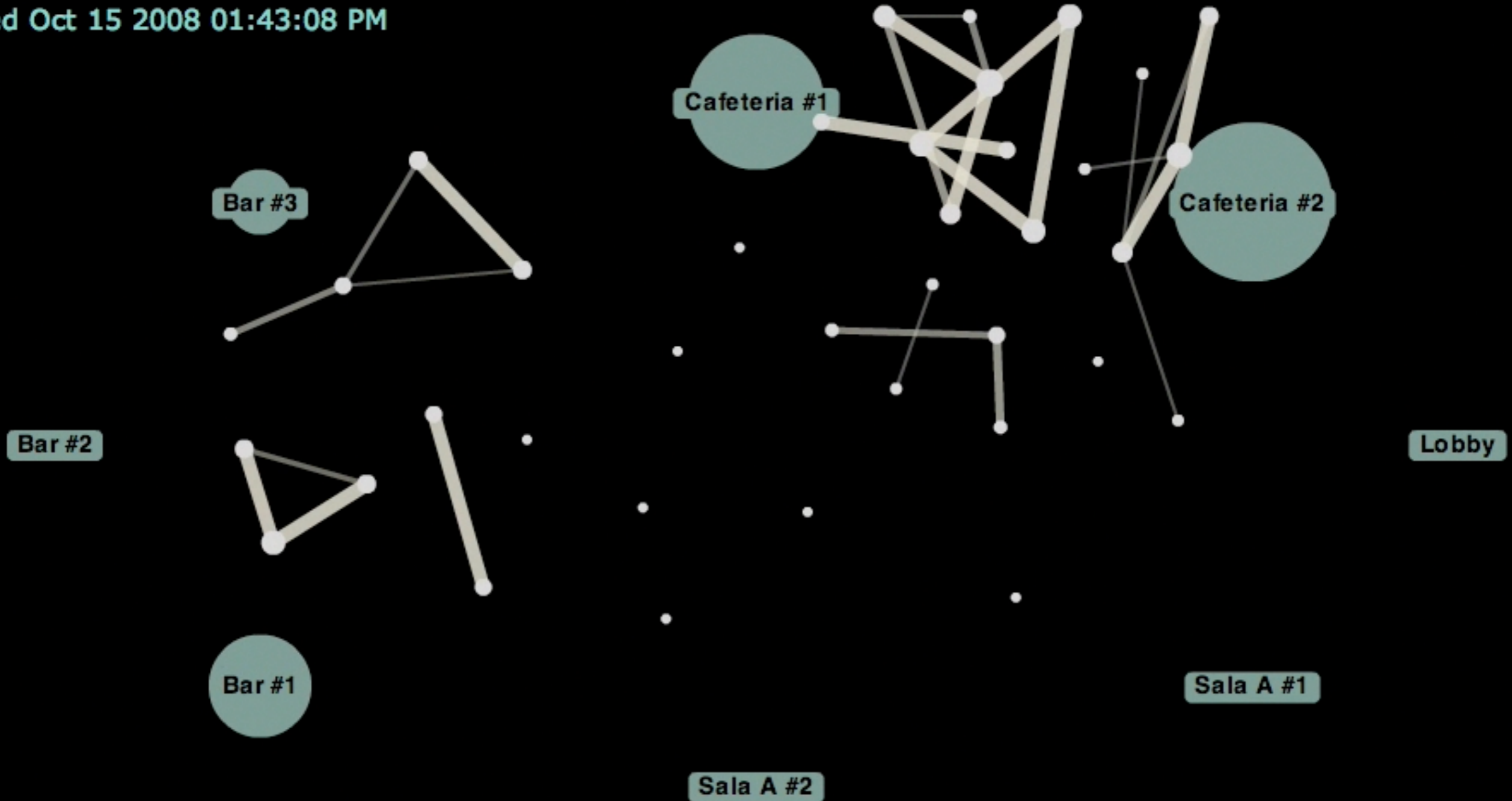
Bar #1



Wed Oct 15 2008 10:56:11 AM



Wed Oct 15 2008 01:43:08 PM





2010

Lyon School Experiment

EXPOSE MOVEMENT CLUSTERING

Playground (129)

Cafeteria (111)

Stairs 1 (114)

Stairs 2 (112)

Cpa, room 20 (101)

Cpb, room 22 (102)

Ce1a, room 24 (103)

Ce1b, room 26 (104)

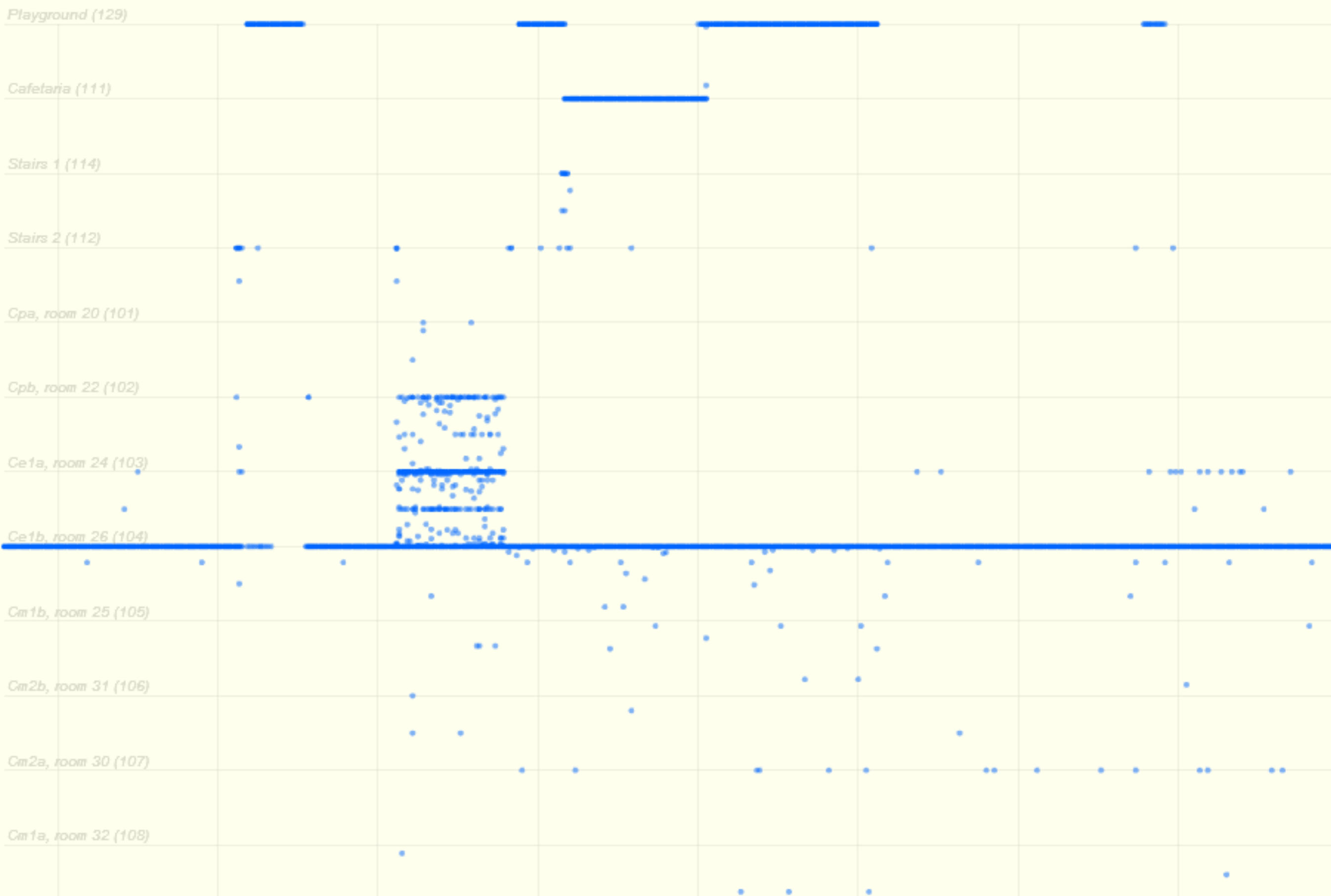
Cm1b, room 25 (105)

Cm2b, room 31 (106)

Cm2a, room 30 (107)

Cm1a, room 32 (108)

POSITIONS



Playground (129)

Cafeteria (111)

Stairs 1 (114)

Stairs 2 (112)

Cpa, room 20 (101)

Cpb, room 22 (102)

Ce1a, room 24 (103)

Ce1b, room 26 (104)

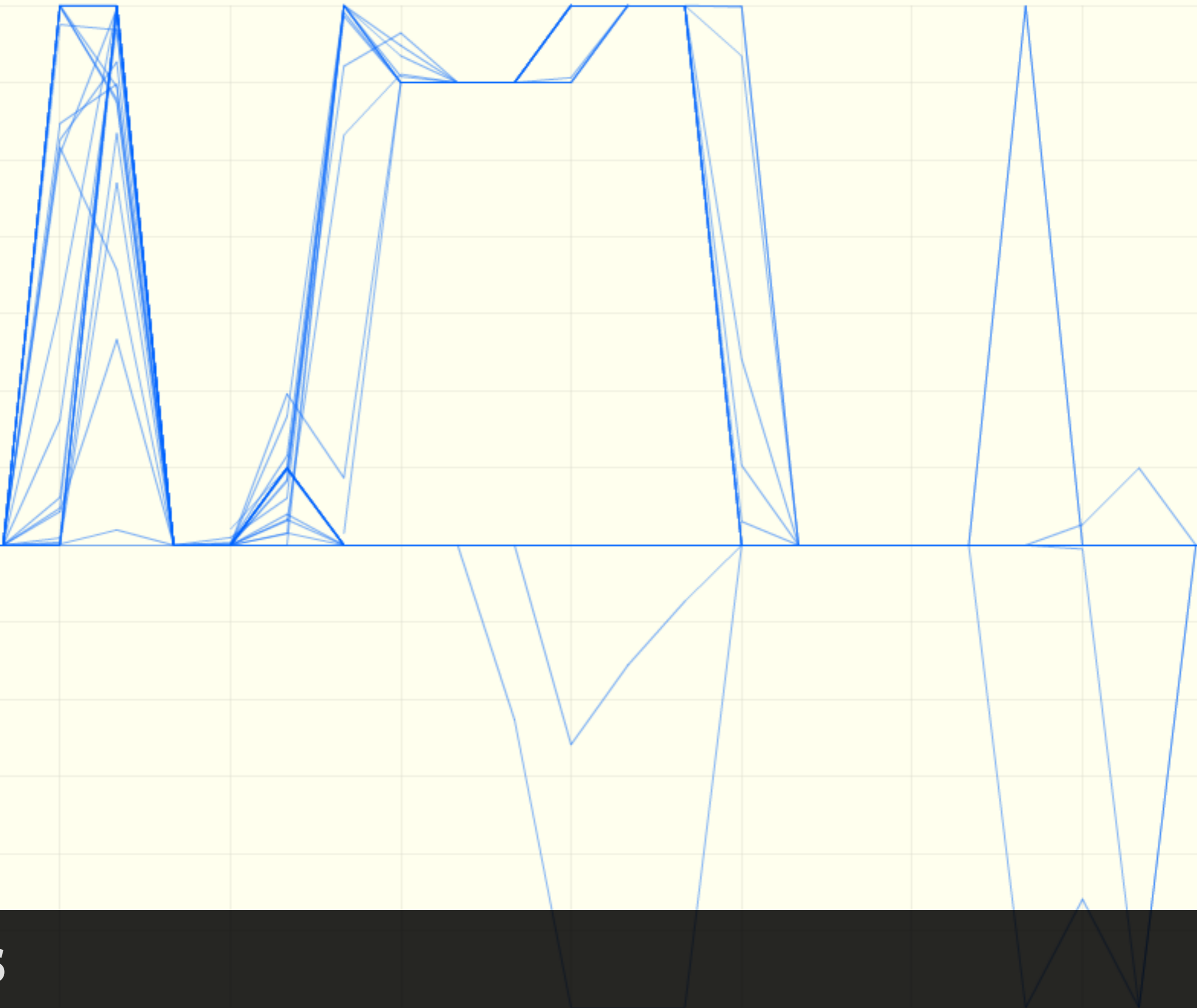
Cm1b, room 25 (105)

Cm2b, room 31 (106)

Cm2a, room 30 (107)

Cm1a, room 32 (108)

PATHS



Playground (129)

Cafeteria (111)

Stairs 1 (114)

Stairs 2 (112)

Cpa, room 20 (101)

Cpb, room 22 (102)

Ce1a, room 24 (103)

Ce1b, room 26 (104)

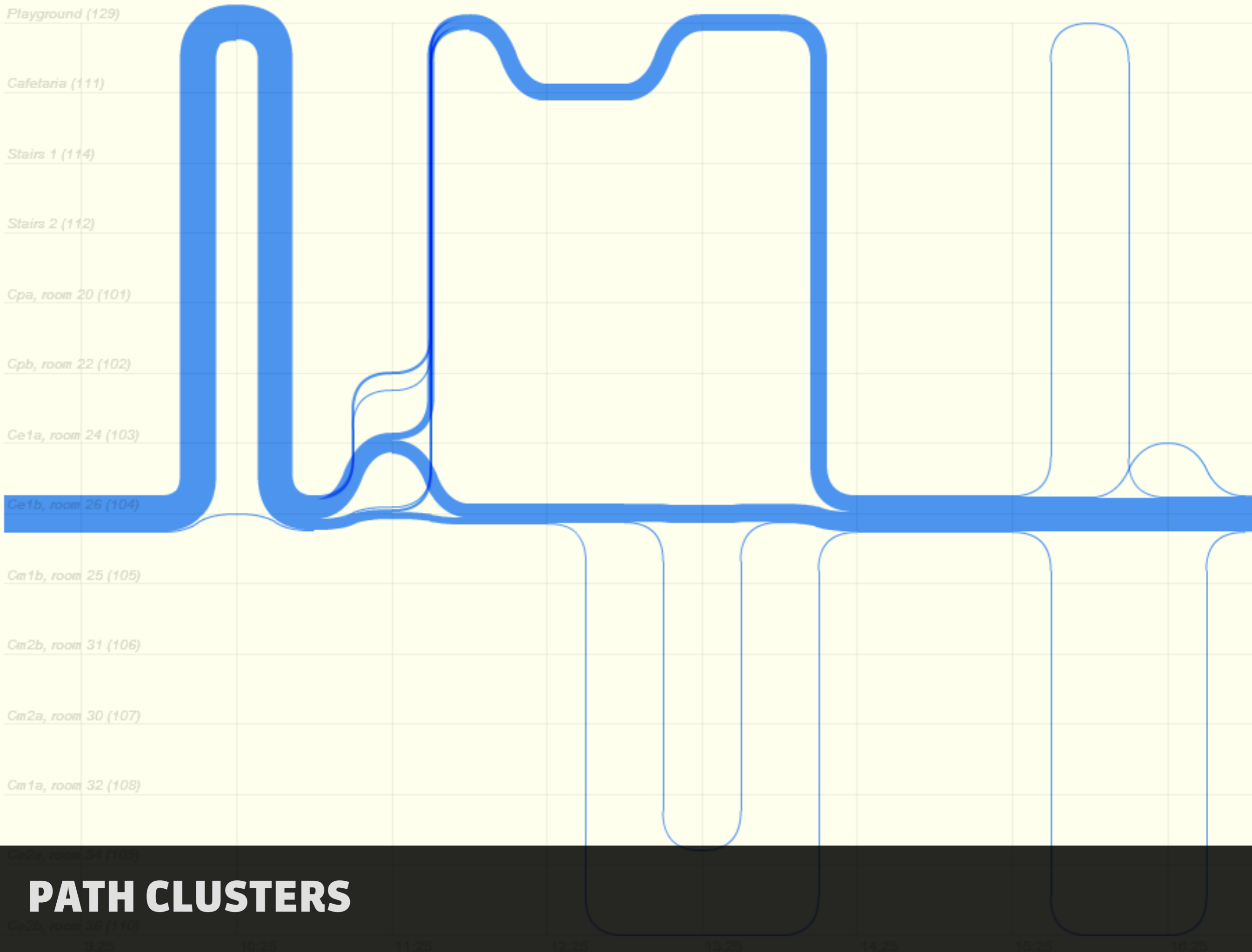
Cm1b, room 25 (105)

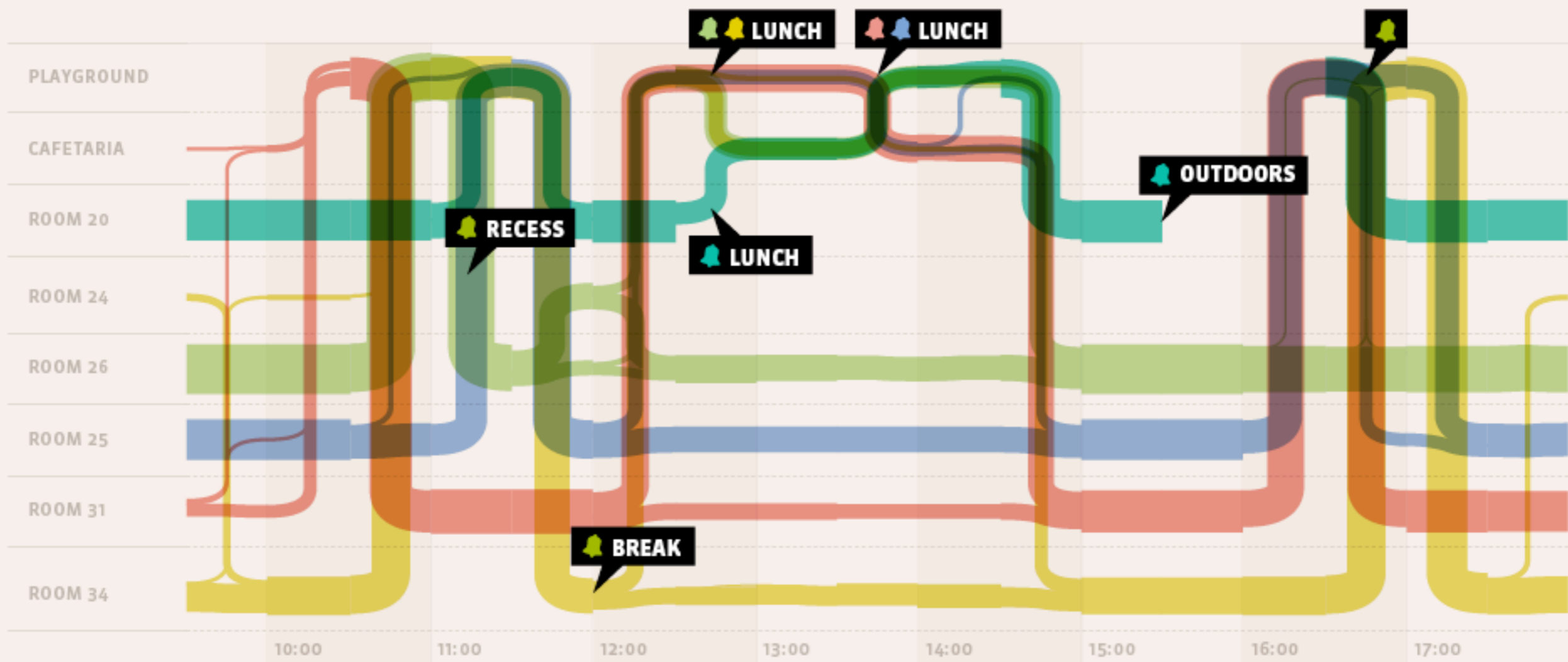
Cm2b, room 31 (106)

Cm2a, room 30 (107)

Cm1a, room 32 (108)

PATH CLUSTERS





LYON SCHOOL EXPERIMENT

PLAYGROUND

NETARIA

DM 20

DM 24

DM 26

DM 25

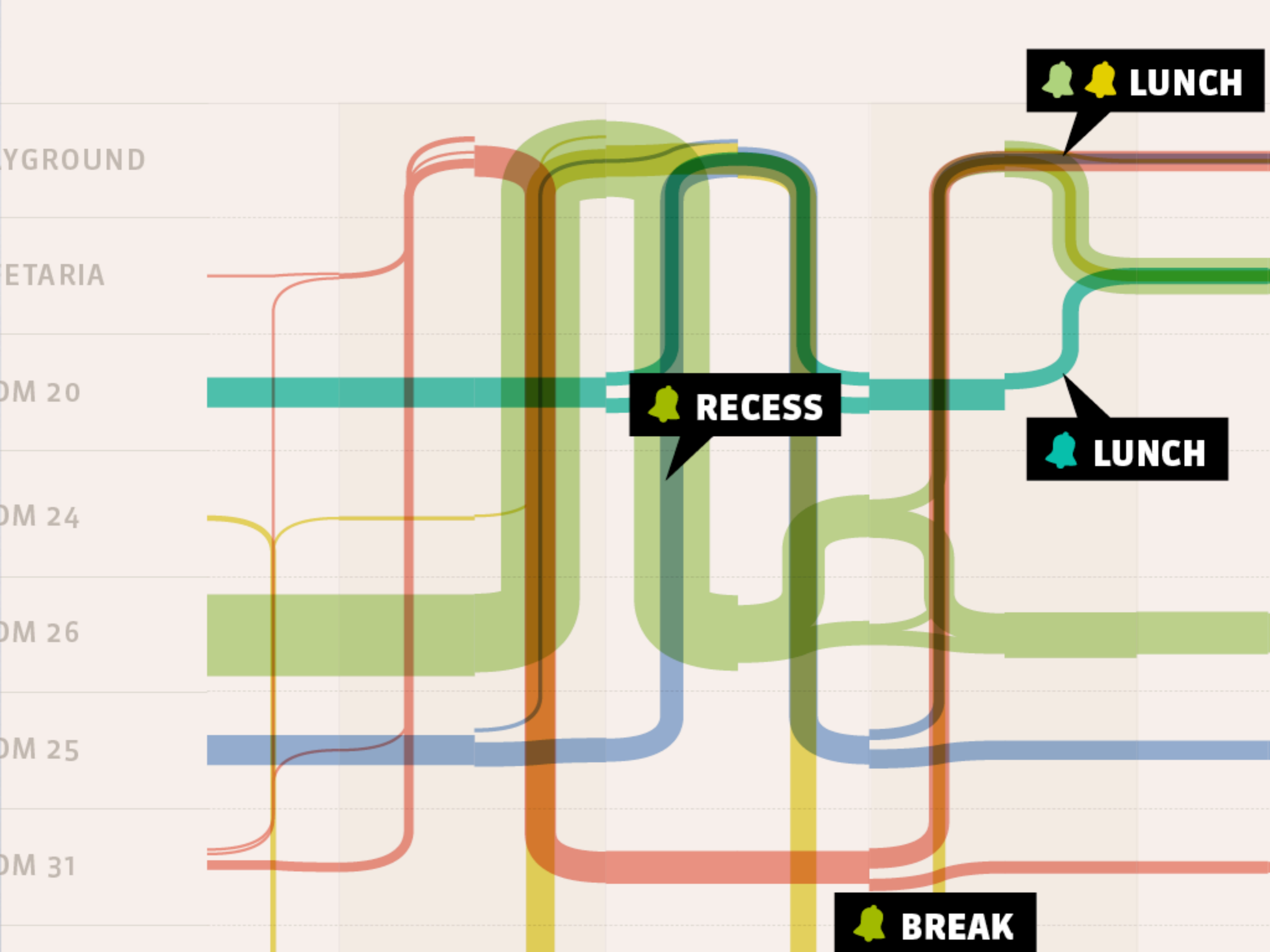
DM 31

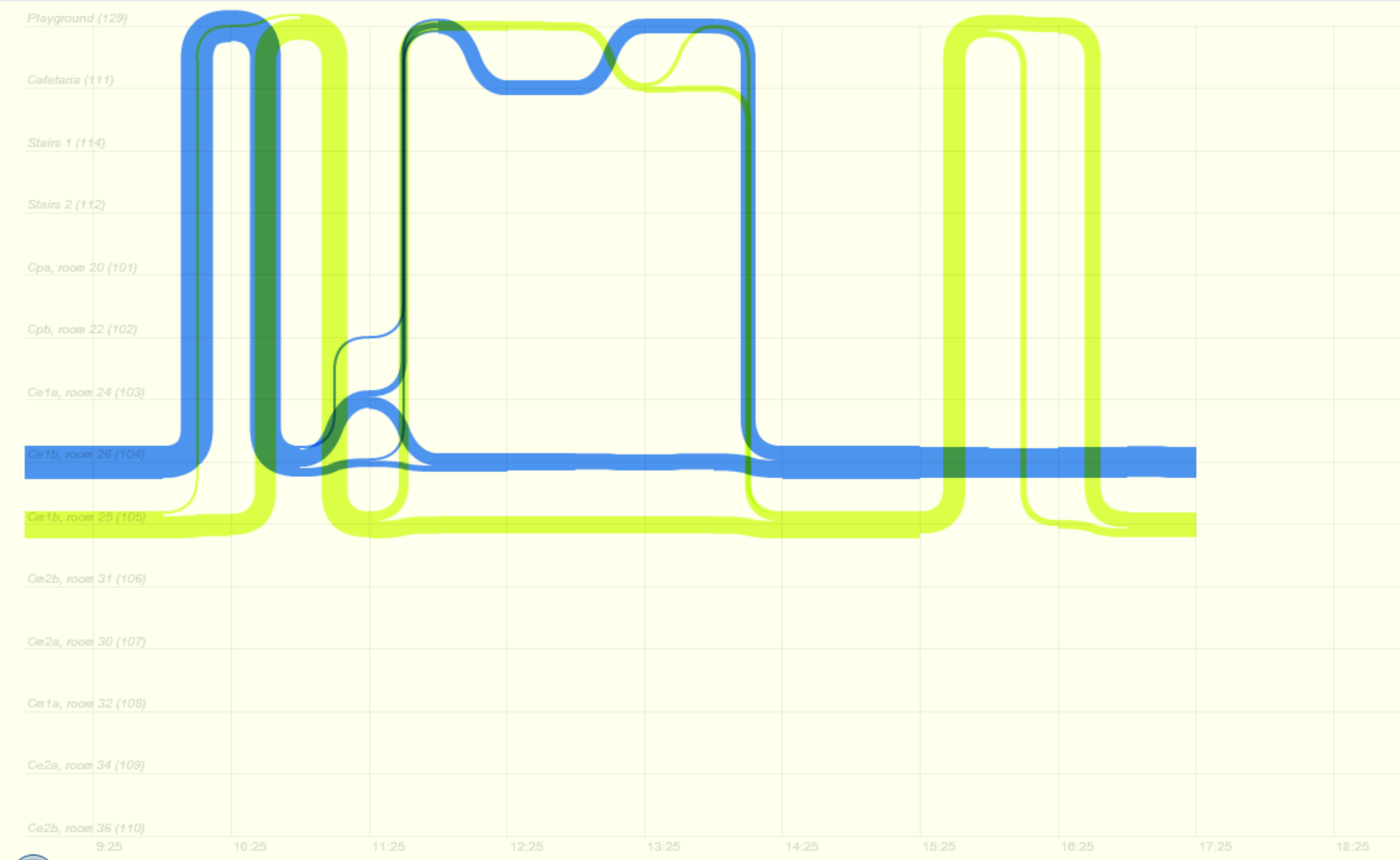
 **LUNCH**

 **RECESS**

 **LUNCH**

 **BREAK**



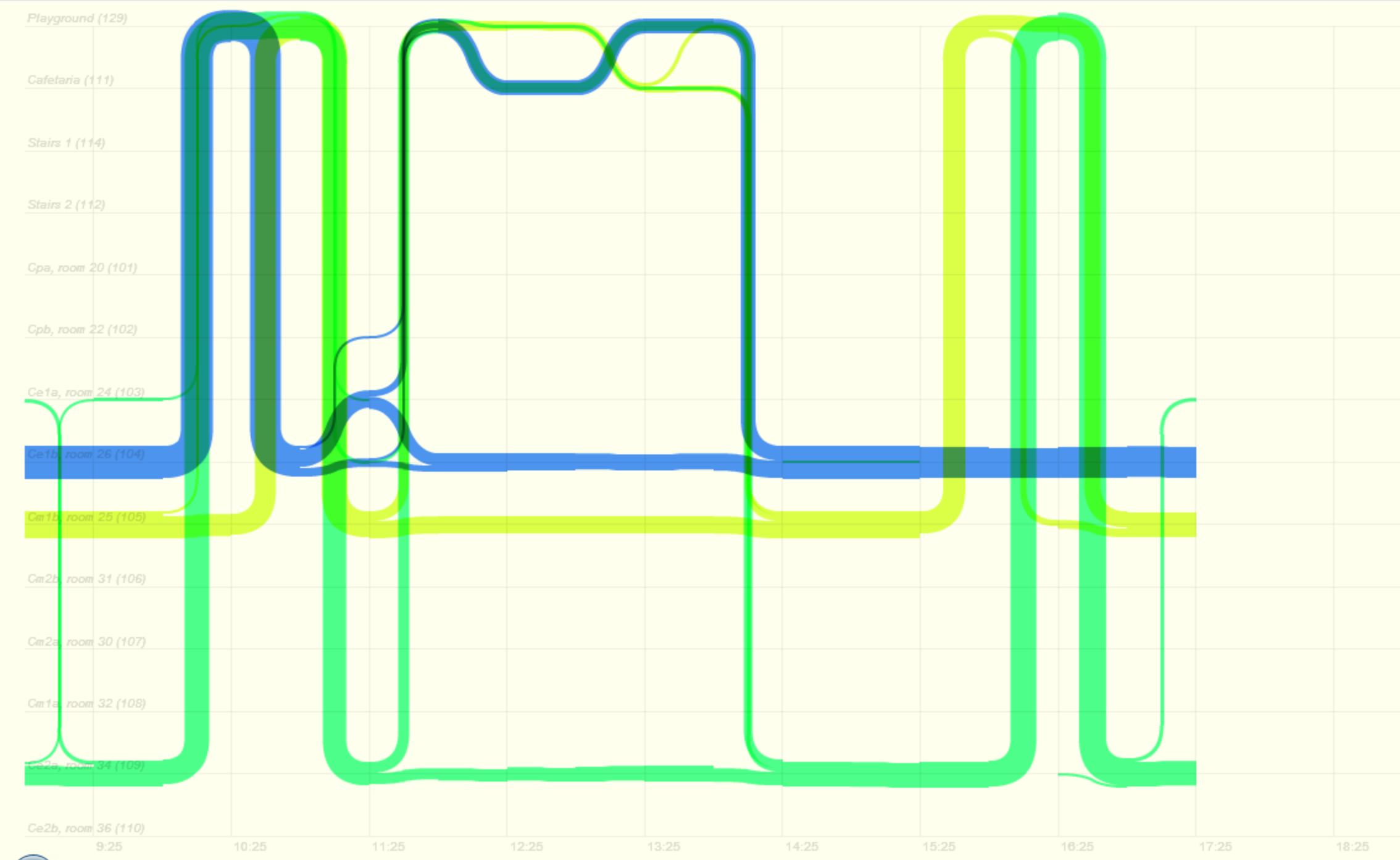


Control **Tags** **Segm...**

- Readers
- Day
- sex
- classe
 - CE2-B
 - CM1-B
 - CE2-A
 - CE1-B
 - CM1-A
 - CE1-A
 - CM2-B
 - CM2-A
 - CP-A
 - CP-B
 - Select all
- type
- Model
 - Time slice: 30
- SVG
- mu-Function
- Background
- Lines
- Dots
- Flow
- Adjacent flows
 - Single height: 1
 - Height Thresh.: 2
 - Bundle alpha: 0.7
- Force-directed Flows

Generate [Back to setup](#)

SOFTWARE

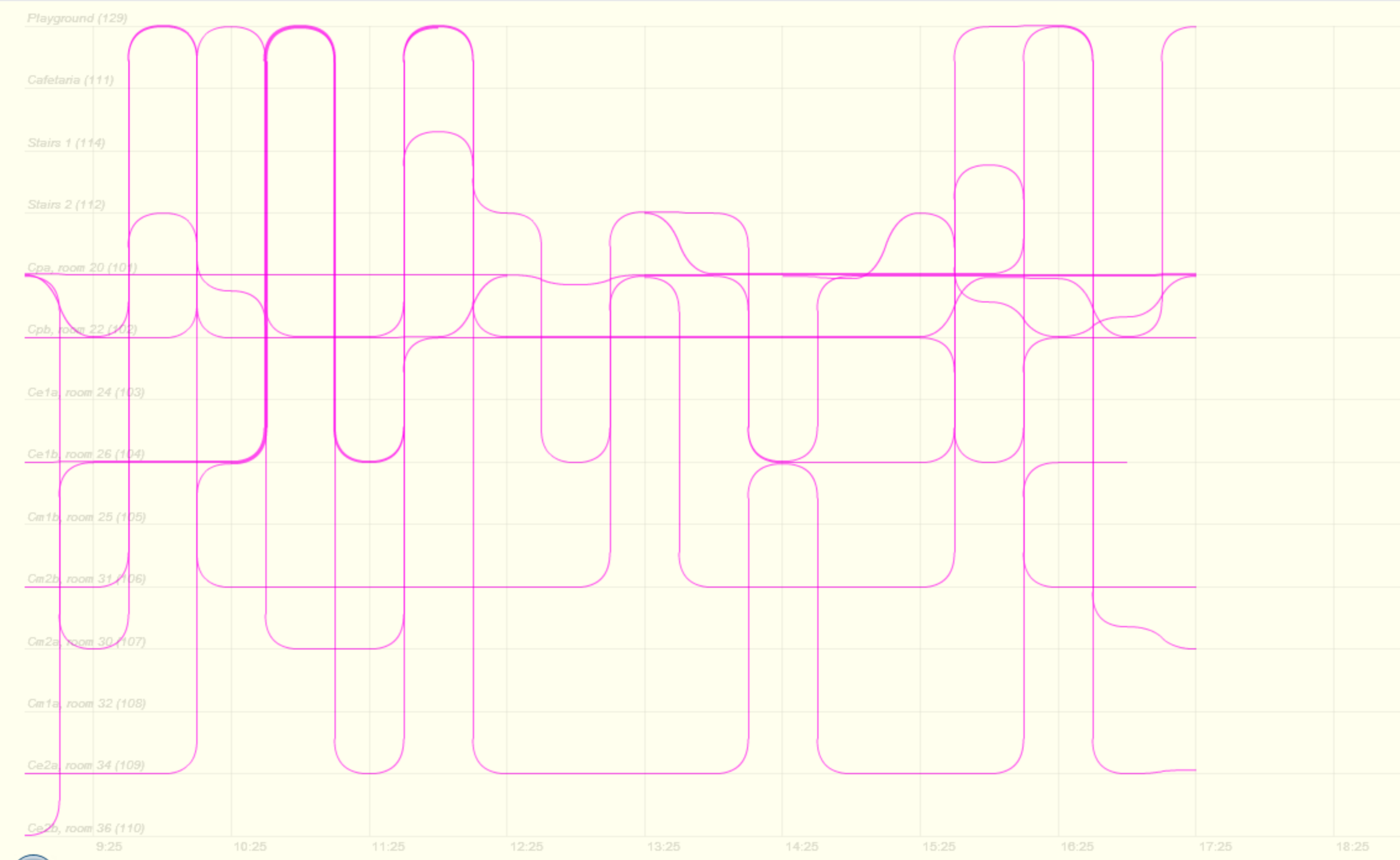


Control **Tags** Segm...

- Readers
- Day
- sex
- classe
 - CE2-B
 - CM1-B
 - CE2-A
 - CE1-B
 - CM1-A
 - Select all
 - CE1-A
 - CM2-B
 - CM2-A
 - CP-A
 - CP-B
- type
- Model
 - Time slice: 30
 - SVG
 - mu-Function
 - Background
 - Lines
 - Dots
 - Flow
 - Adjacent flows
 - Single height: 1
 - Height Thresh.: 2
 - Bundle alpha: 0.7
 - Force-directed Flows

Generate Back to setup

FILTER GROUPS

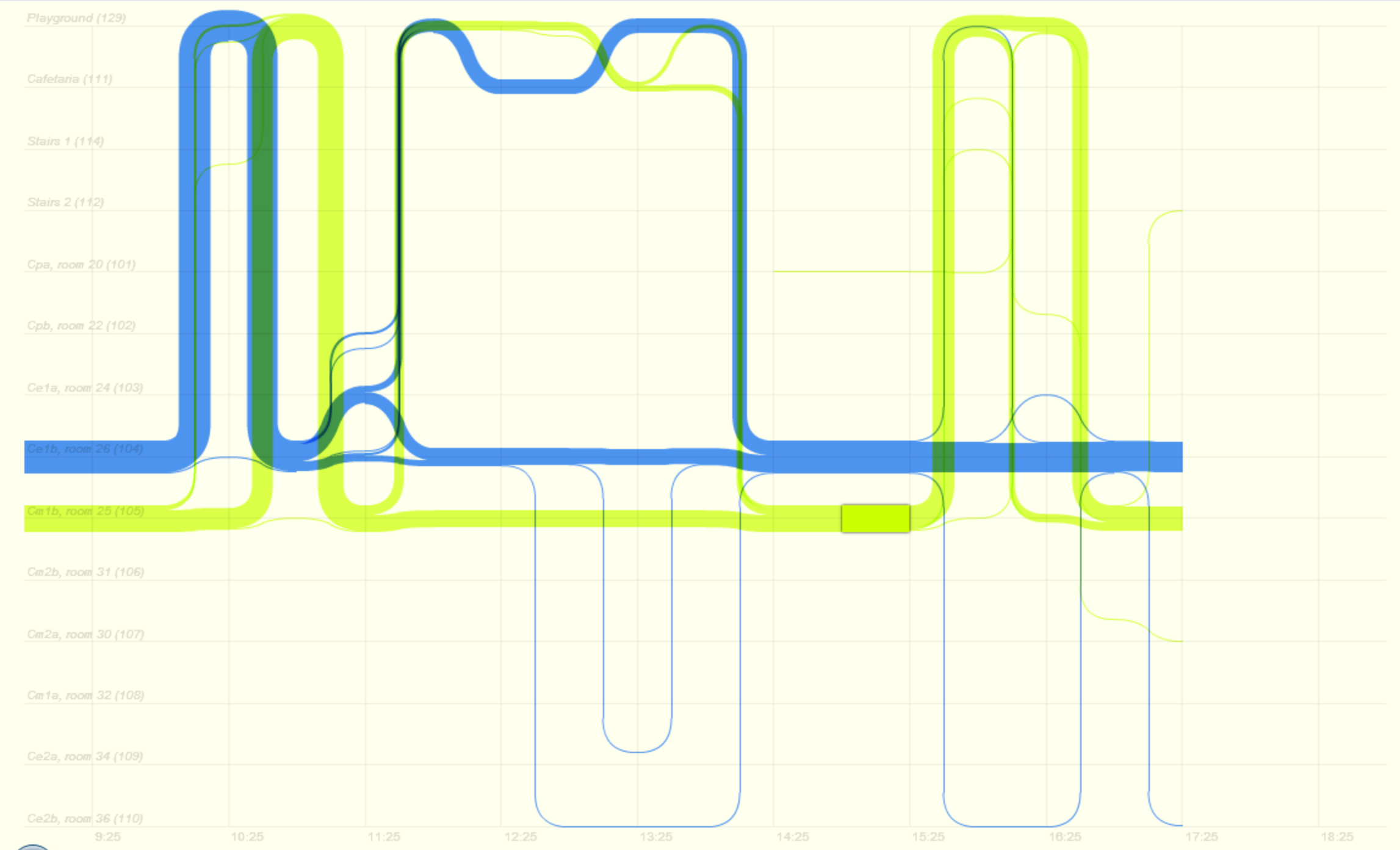


Control **Tags** **Segm...**

- Readers
 - Day
 - sex
 - classe
 - type
 - other
 - teacher
 - Select all
- Model
 - Time slice: 30
 - SUG
 - mu-Function
 - Background
 - Lines
 - Dots
 - Flow
 - Adjacent flows
 - Single height: 1
 - Height Thresh.: 0
 - Bundle alpha: 0.7
 - Force-directed Flows

Generate [Back to setup](#)

FILTER GROUPS



Control **Tags** **Segm...**

sex

- female 9
- male 13

type

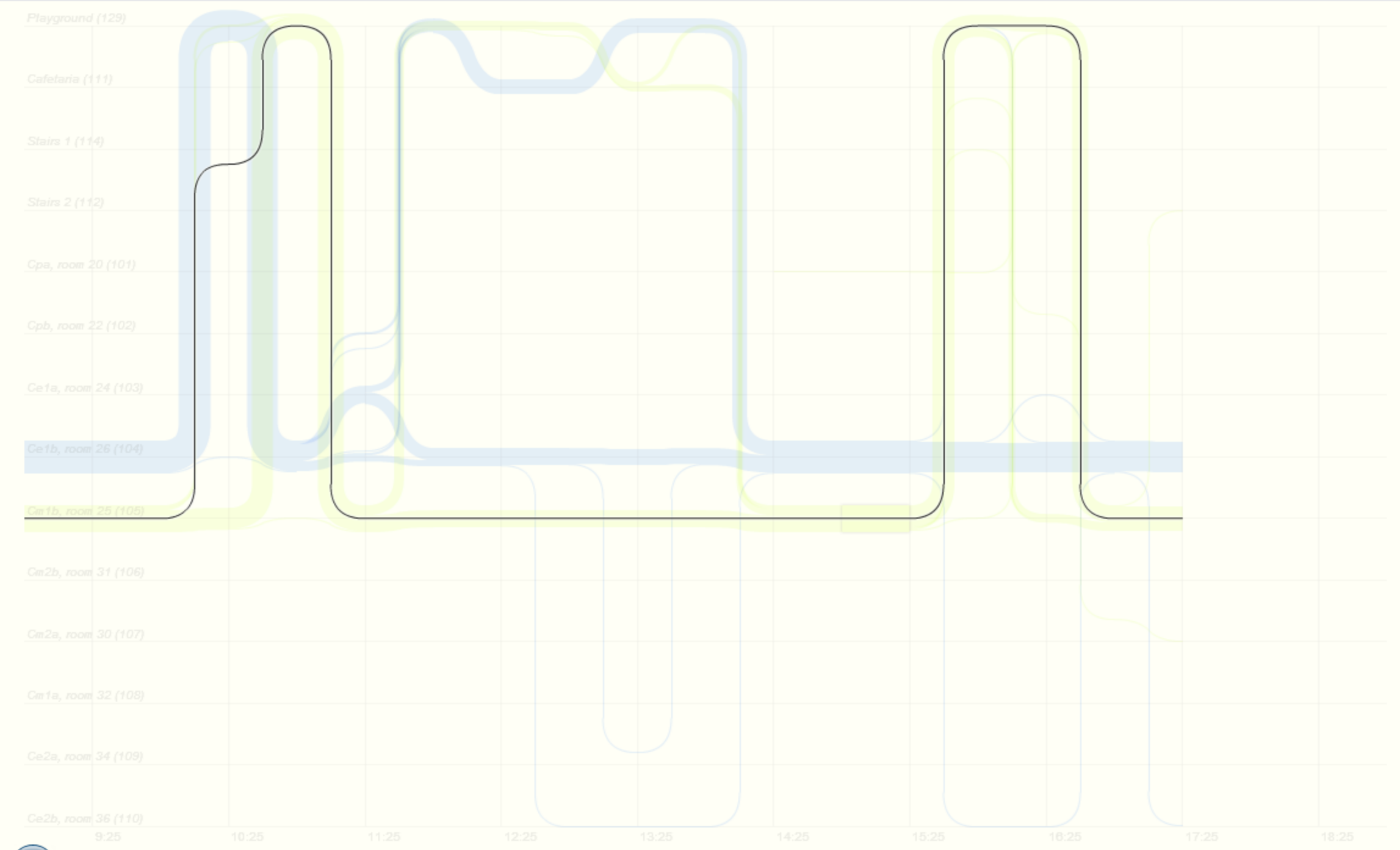
- student 22

classe

- CM1-B 22

1630	1632	1802	1803
1807	1819	1821	1831
1835	1836	1601	1857
1865	1880	1885	1888
1892	1895	1818	1866
1805	1847		

SHOW DETAILS

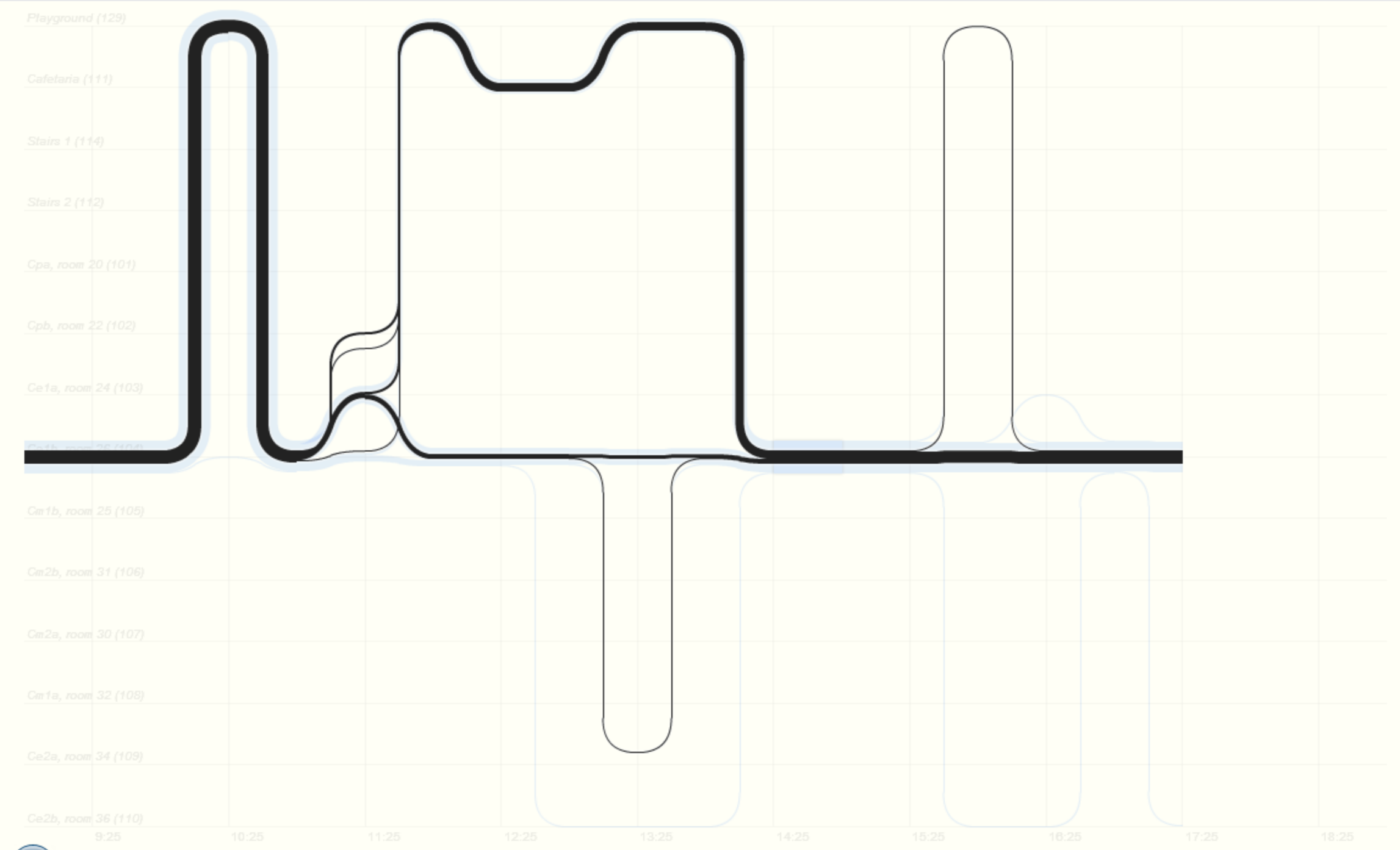


Control **Tags** **Segm...**

- sex**
 - female 9
 - male 13
- type**
 - student 22
- classe**
 - CM1-B 22

1630	1632	1802	1803
1807	1819	1821	1831
1835	1836	1601	1857
1865	1880	1885	1888
1892	1895	1818	1866
1805	1847		

TRACK SINGLE TAGS



Control **Tags** **Segm...**

sex

- male 11
- female 15

type

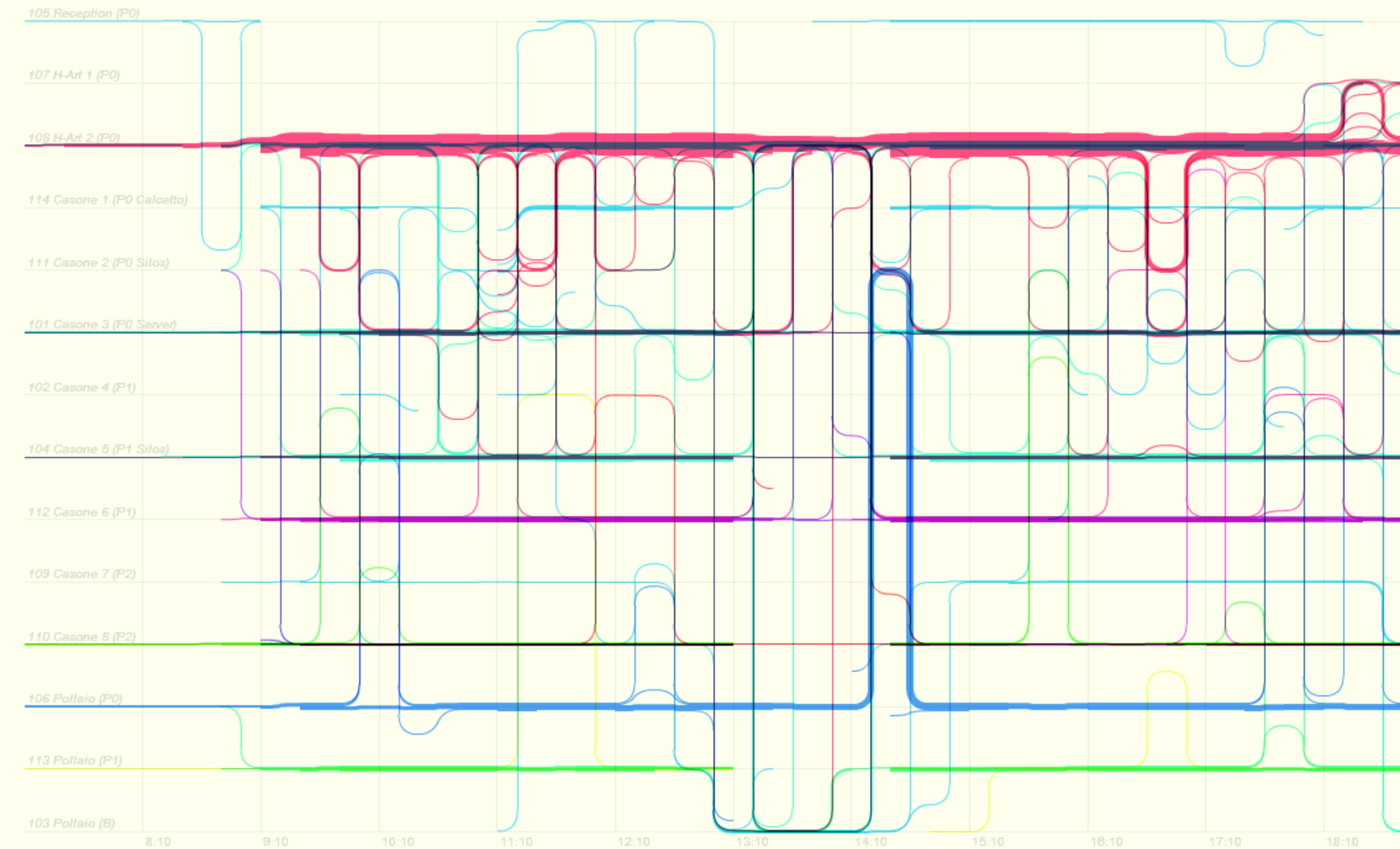
- other 1
- student 26

classe

- CE1-B 27

1861	1702	1858	1854
1897	1710	1713	1704
1706	1708	1739	1743
1749	1650	1732	1855
1718	1851	1863	1872
1877	1883	1887	1889
1890	1898	1715	

TRACK GROUPS OF TAGS



Control	Tags	Segm...
Readers		
Day		
startup		
<input checked="" type="checkbox"/> Logo.pro	<input checked="" type="checkbox"/> Shado + Neu	
<input checked="" type="checkbox"/> Log607	<input checked="" type="checkbox"/> NEW TV	
<input checked="" type="checkbox"/> DomainsIncome	<input checked="" type="checkbox"/> NewTV	
<input checked="" type="checkbox"/> Thounds	<input checked="" type="checkbox"/> UannaBe	
<input checked="" type="checkbox"/> Shado	<input checked="" type="checkbox"/> H-Farm	
<input checked="" type="checkbox"/> H-Umus	<input checked="" type="checkbox"/> unknown st	
<input checked="" type="checkbox"/> Logo pro	<input checked="" type="checkbox"/> Show Me	
<input checked="" type="checkbox"/> Zooppa	<input checked="" type="checkbox"/> H-art	
<input checked="" type="checkbox"/> h-Art		
<input checked="" type="checkbox"/> Select all		
ruolo di coordinamento		
<input type="checkbox"/> unknown ruolo di co...	<input type="checkbox"/> Si	
<input type="checkbox"/> No (a volte)	<input type="checkbox"/> No	
<input type="checkbox"/> N		
<input type="checkbox"/> Select all		
coordinamento compiti operativi		
<input type="checkbox"/> Coordinamento di ru...	<input type="checkbox"/> Coordiname	
<input type="checkbox"/> unknown coordina...		
<input type="checkbox"/> Select all		
tipologia contratto		
<input type="checkbox"/> Partita lua	<input type="checkbox"/> Amministrat	
<input type="checkbox"/> Dipendente	<input type="checkbox"/> Dirigente	
<input type="checkbox"/> Partita lua - Esterno	<input type="checkbox"/> Esterno	
<input type="checkbox"/> Co.co.pro	<input type="checkbox"/> Amministrat	
<input type="checkbox"/> Prestazione occasion...	<input type="checkbox"/> Apprendista	
<input type="checkbox"/> Contratto legislazion...	<input type="checkbox"/> Stagista	
<input type="checkbox"/> Stagista (dal1 luglio c...	<input type="checkbox"/> Esterno	
<input type="checkbox"/> Select all		
lavoro individuale/team		
<input type="checkbox"/> Team	<input type="checkbox"/> Individuale f	

EXPLORE LARGER ORGANIZATIONS

2009

Infectious Exhibition

Science Gallery

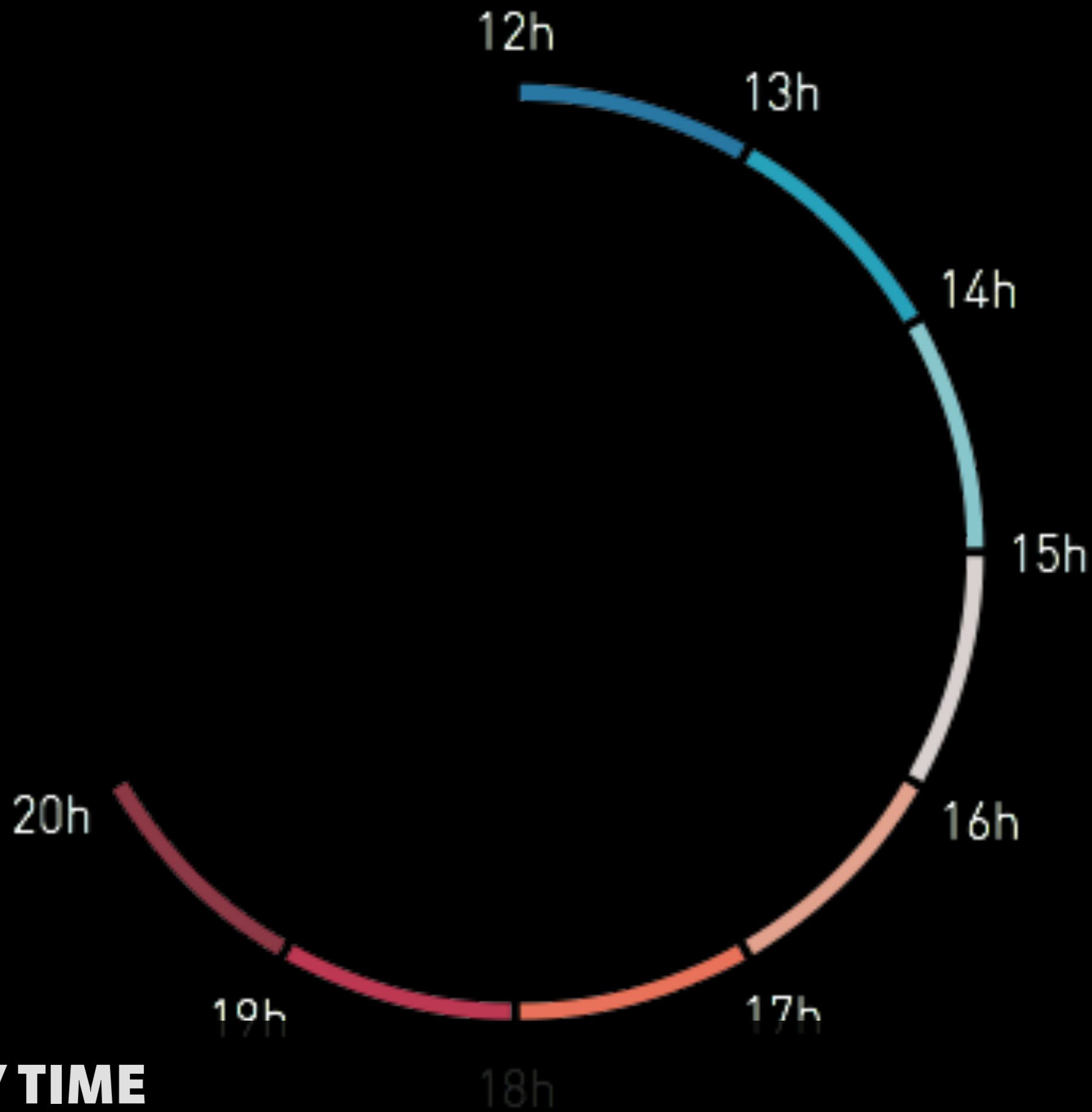
COMPARE NETWORK DATA



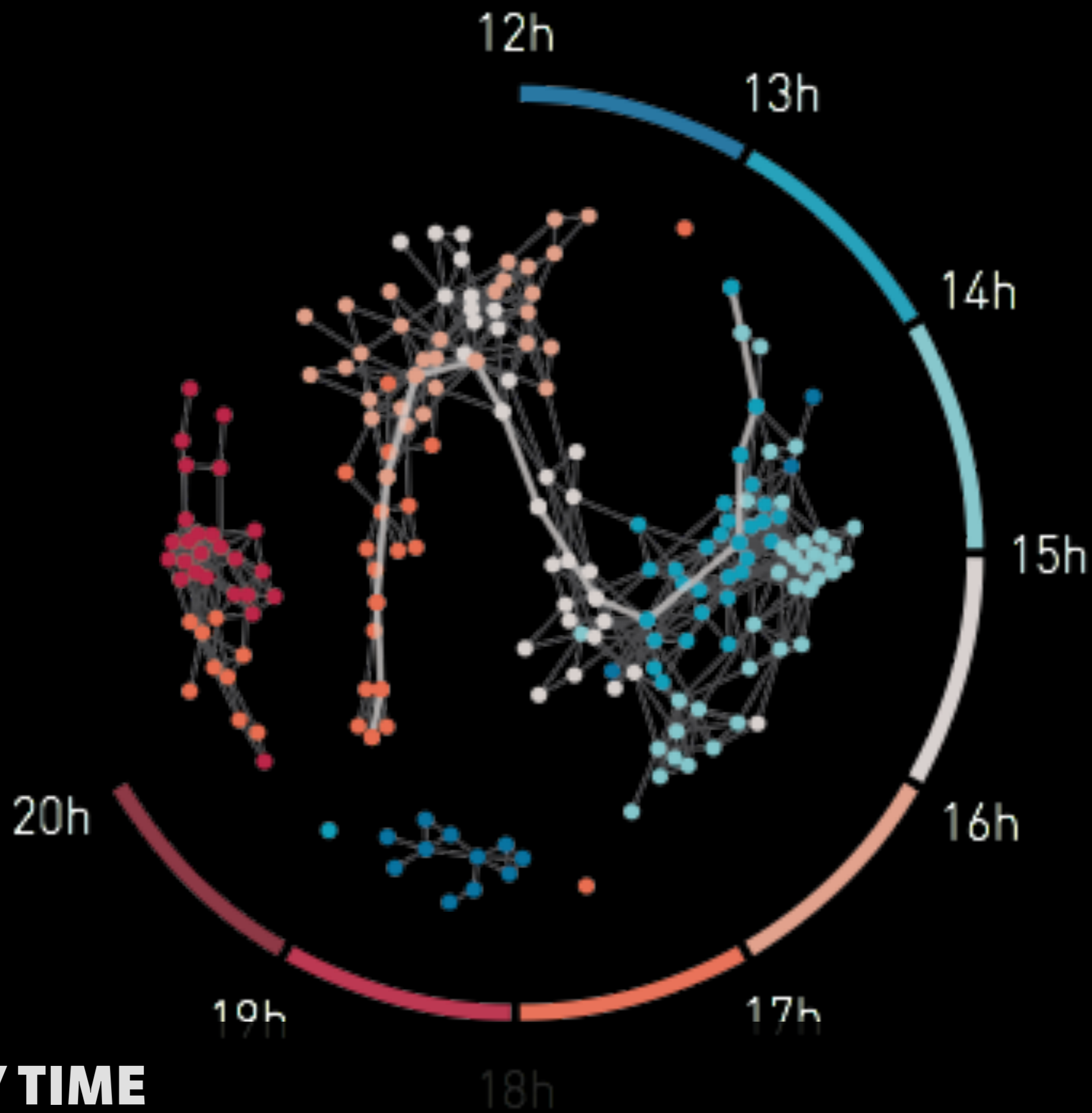
INFECTIOUS: STAY AWAY



CUMULATIVE CONTACT GRAPH



+ ENTRY TIME



+ ENTRY TIME



+ CONTACT ACTIVITY

21/5



4/6



15/7



27/5



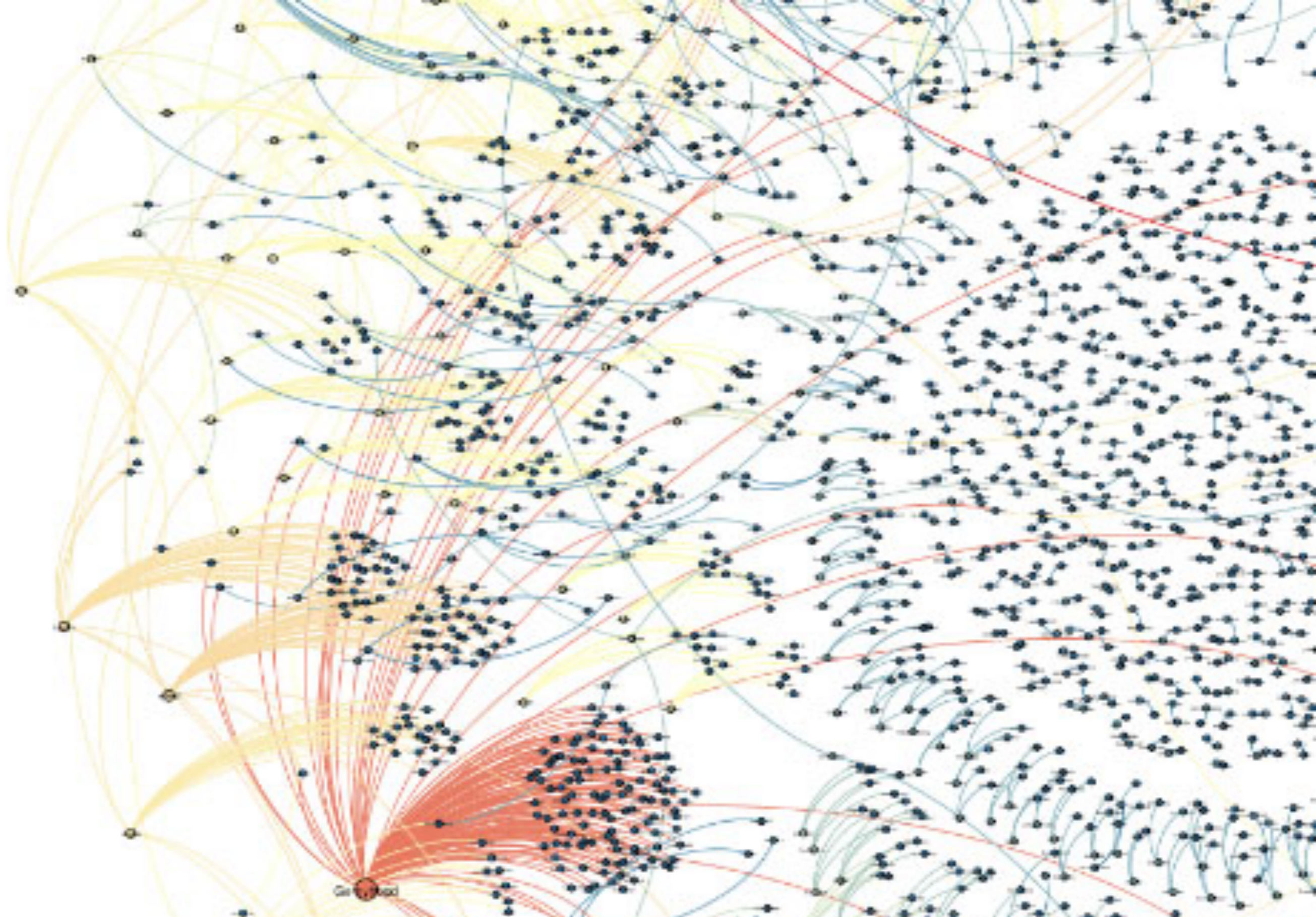
DIFFERENT DAYS

3. ONLINE MEDIA

WHY IS IT IMPORTANT?

Understand and represent:
information spreading
trans-mediatic diffusion
opinion dynamics

Social media role in USA elections
Middle-east spring events

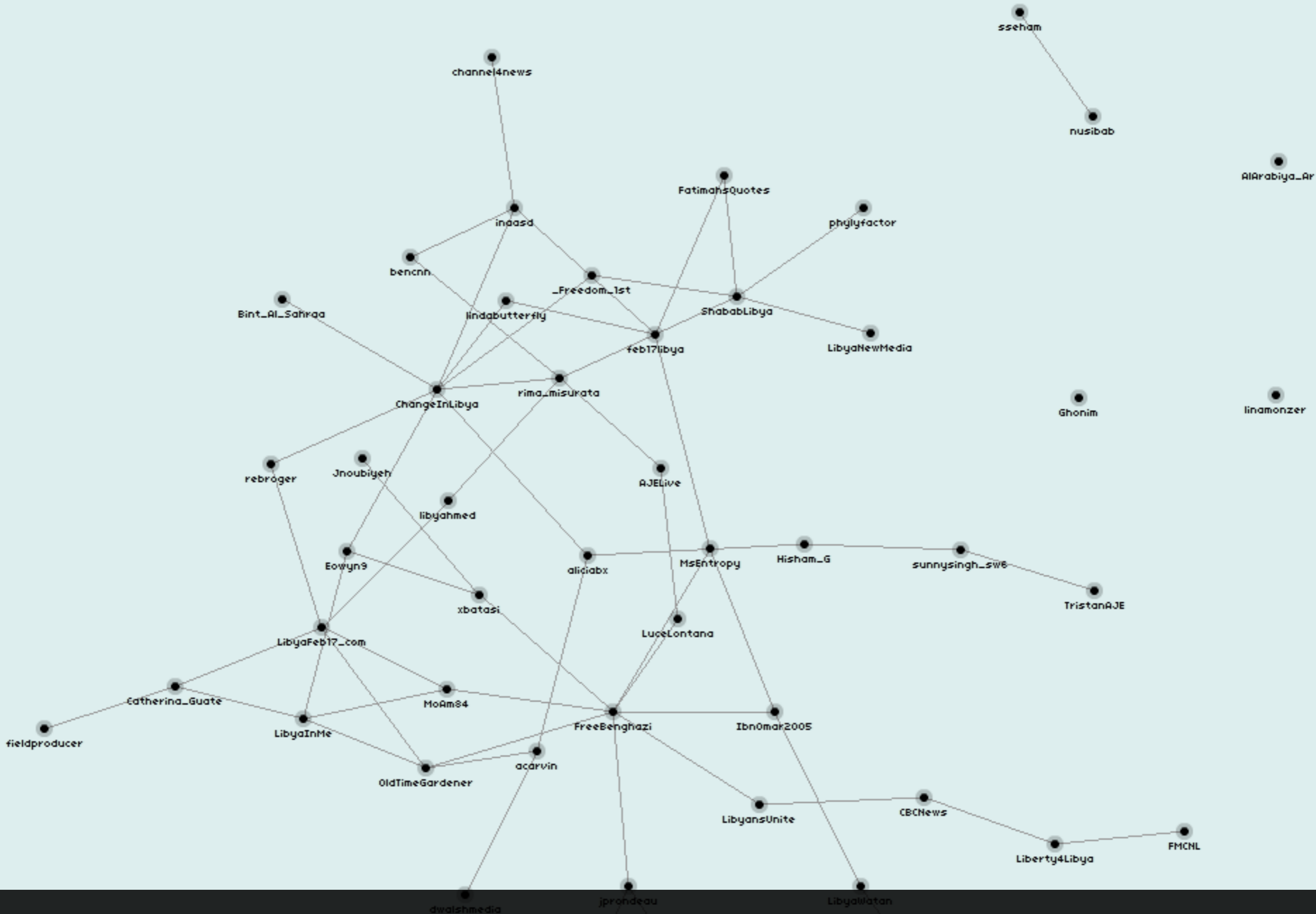


A. PANISSON – THE EGYPTIAN REVOLUTION ON TWITTER

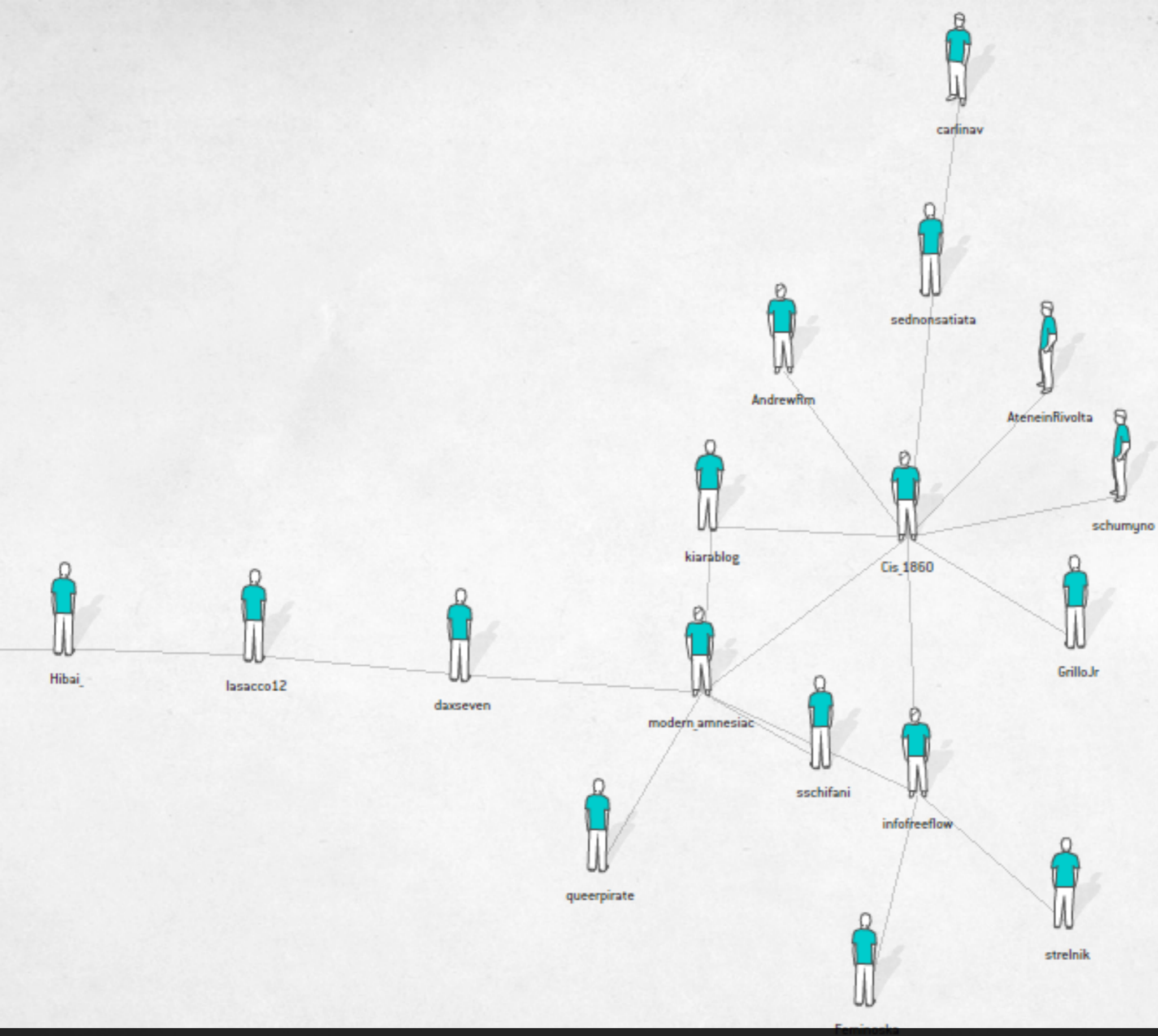
2011

DATAINTERFACES.ORG

EXPOSE INFORMATION DIFFUSION



DATAINTERFACES.ORG – RETWEETING DYNAMICS



DATAINTERFACES.ORG – RETWEETING DYNAMICS

MODEL **VIEW**

RELATED FILTER

BASE FILTER

BACKGROUND

BACKGROUND RENDERERS

IMAGE

LAYOUT

FORCE DIRECTED

NODE FILTERS

DEFAULT NODE RENDERER

EDGE FILTERS

STANDARD EDGE RENDERER



DATAINTERFACES.ORG – RETWEETING DYNAMICS

nchest74

2011

DATAINTERFACES.ORG

EXPOSE TWITTER DISCUSSIONS

NOTAV

BLOCCARE

BASE

PRESIDIO

DELLATTACCO

CAMPO

POLIZIA

STAZIONE

APPUNTAMENTO

IMPRESSIONANTE

1200

DELLAUTOSTRADA

FOTO

BARRICATE

VIDEO

DIRETTA

BUSSOLENO

LAUTOSTRADA

PRESSI

BABILA

BARDONECCHIA

INERME

SCHUMYNO

MILANO

TORINO

BLOCCATA

STATALE

CONTRO

BLOCCO

VERSANTE

PUNTO

BEPPE_GRILLO

VALLE

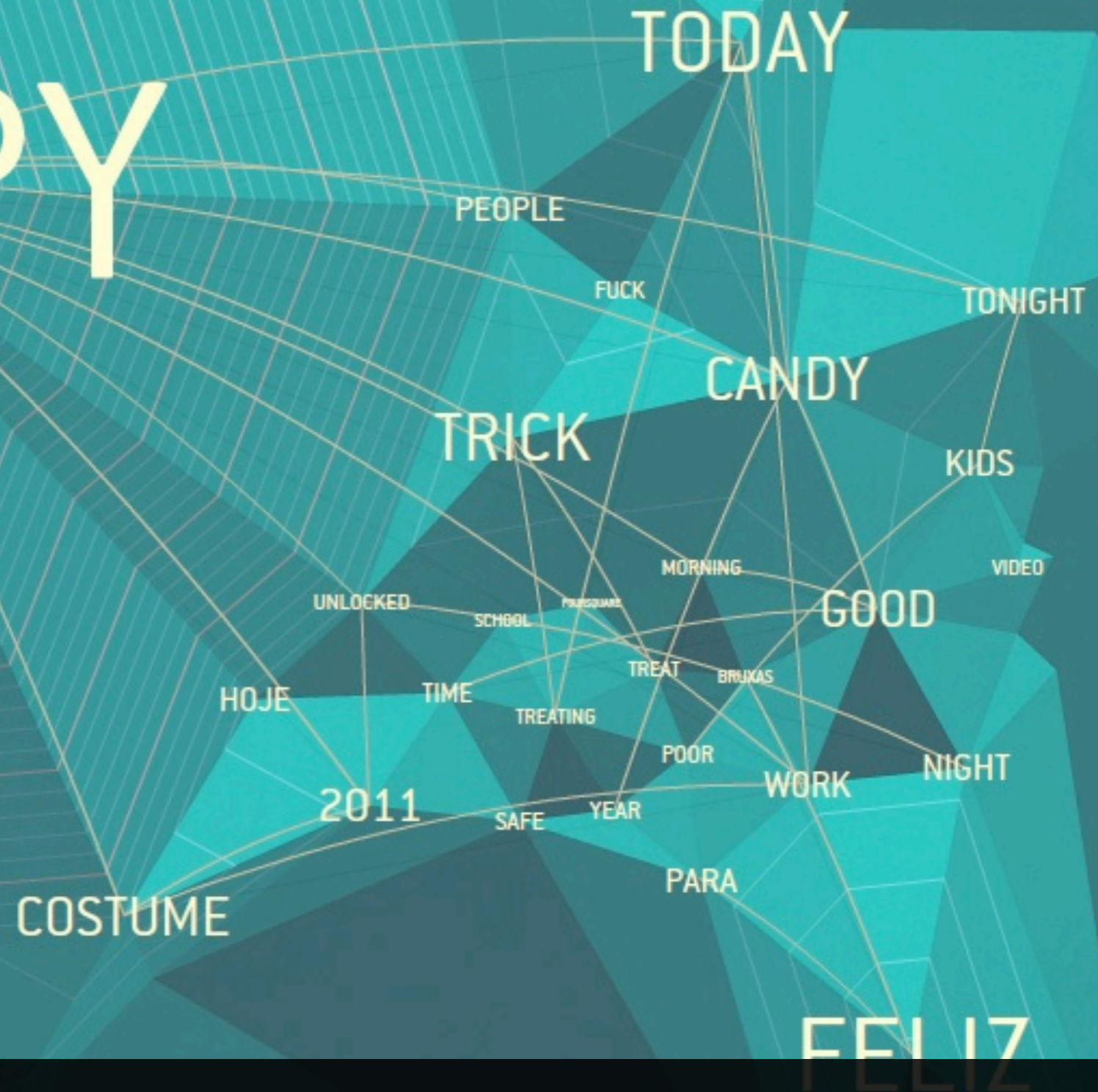
FORZE

2011

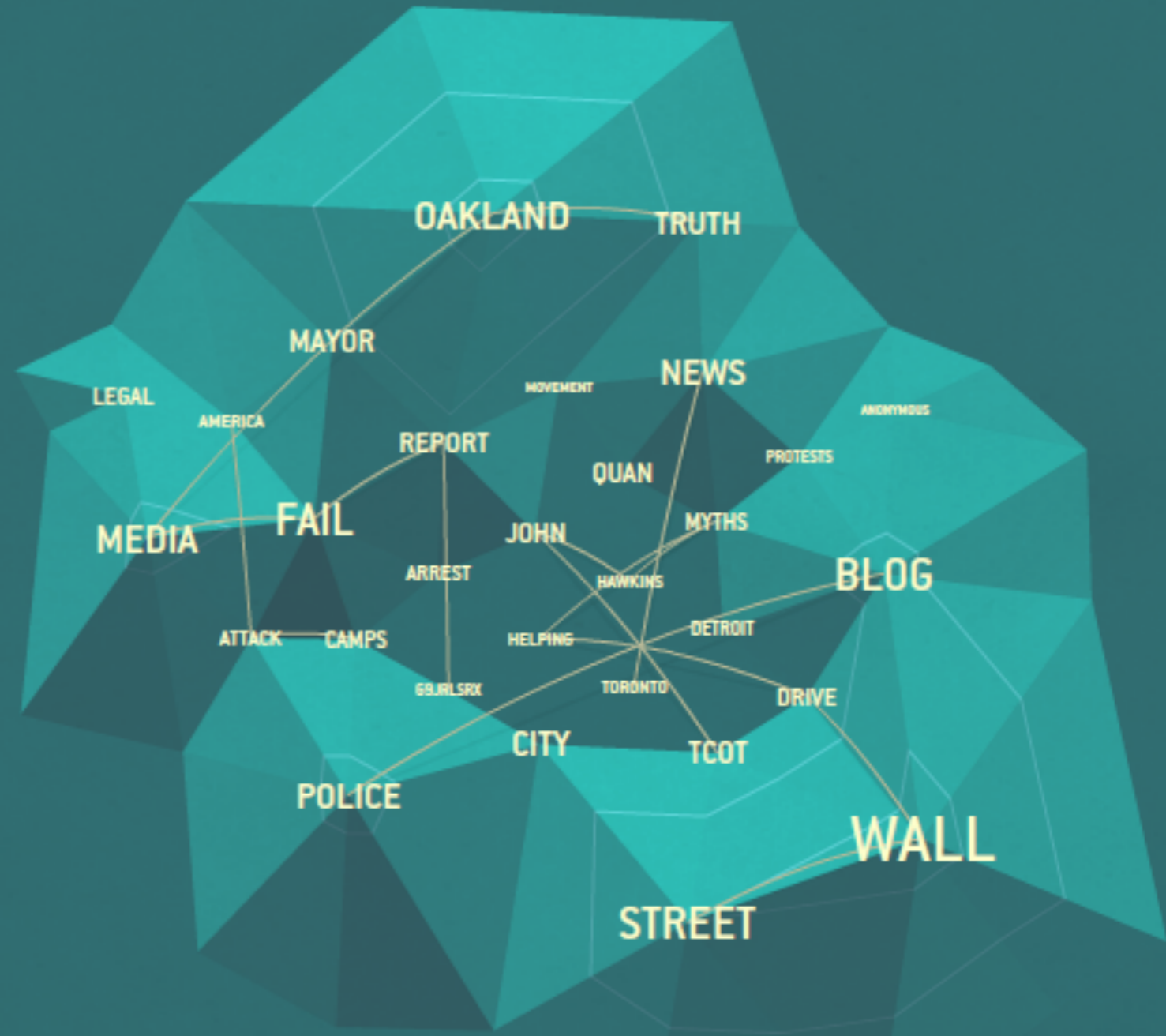
DATAINTERFACES.ORG – TWITTER OROGRAPHIES

EXPOSE SEMANTIC SPACE

HAPPY



“HALLOWEEN” TWITTER SEMANTIC SPACE



“OCCUPY” TWITTER SEMANTIC SPACE

isi.it

gleamviz.org

sociopatterns.org

datainterfaces.org