



ສະຖາບັນ ປັດສະເຕີ ລາວ
INSTITUT PASTEUR DU LAOS



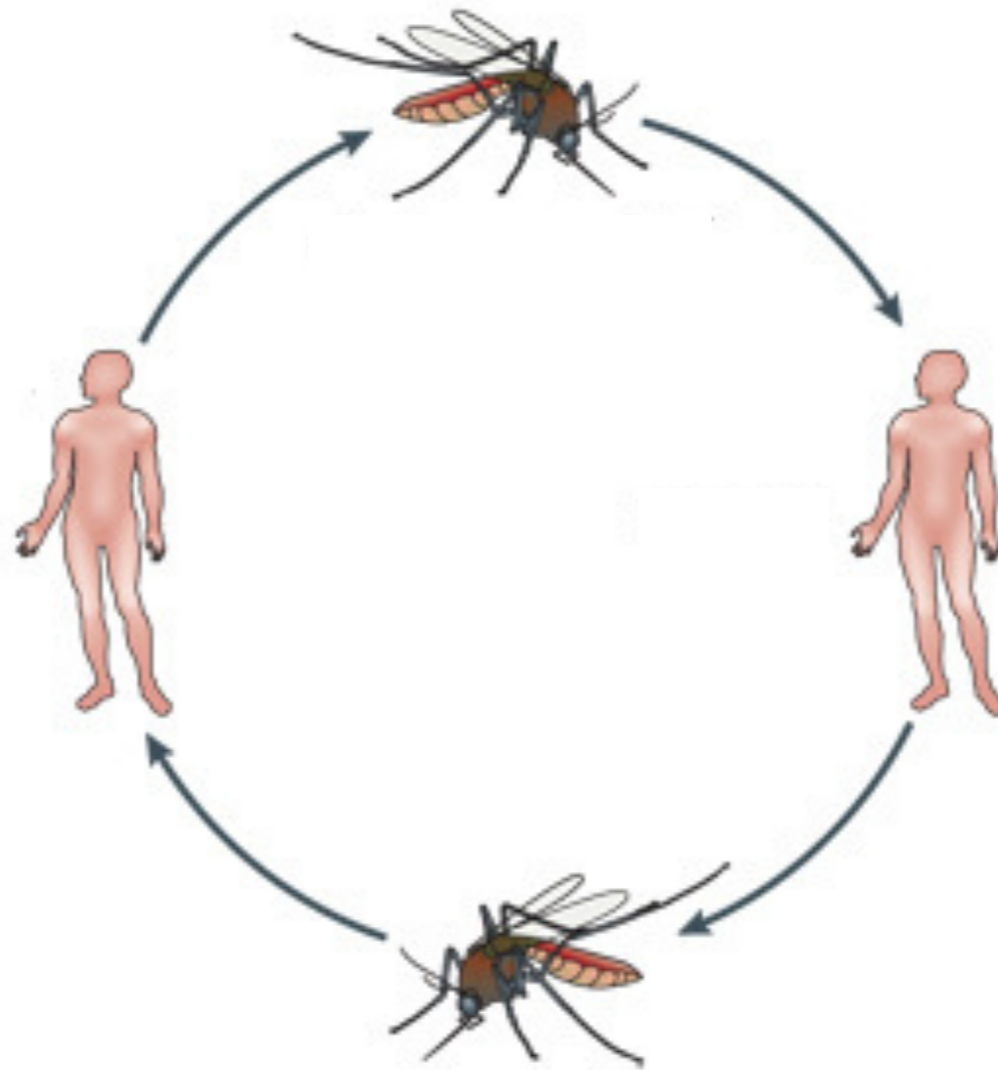
Data modeling and outbreak simulator

Marc Choisy

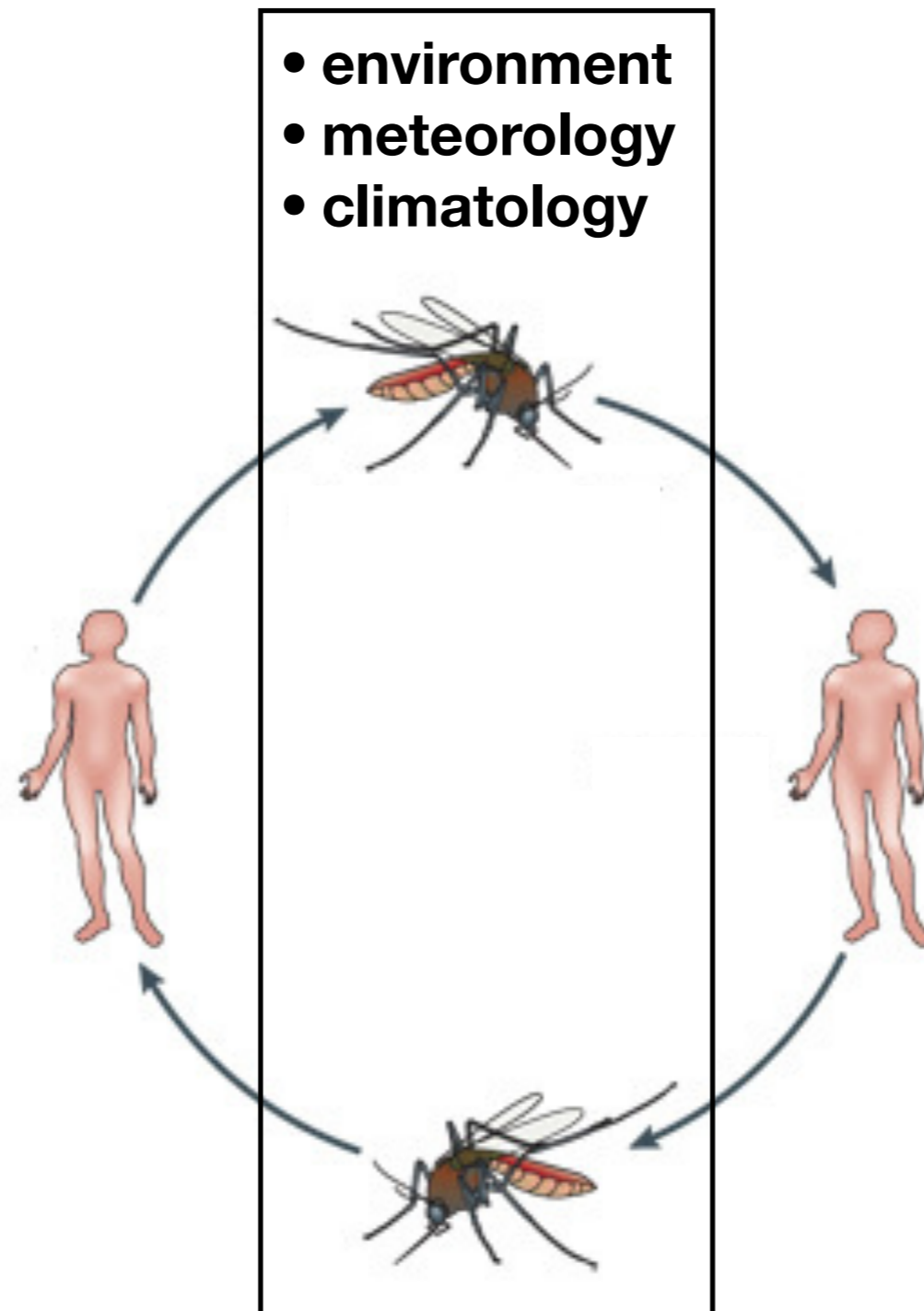
Institut de Recherche pour le Développement
Hanoi, Vietnam



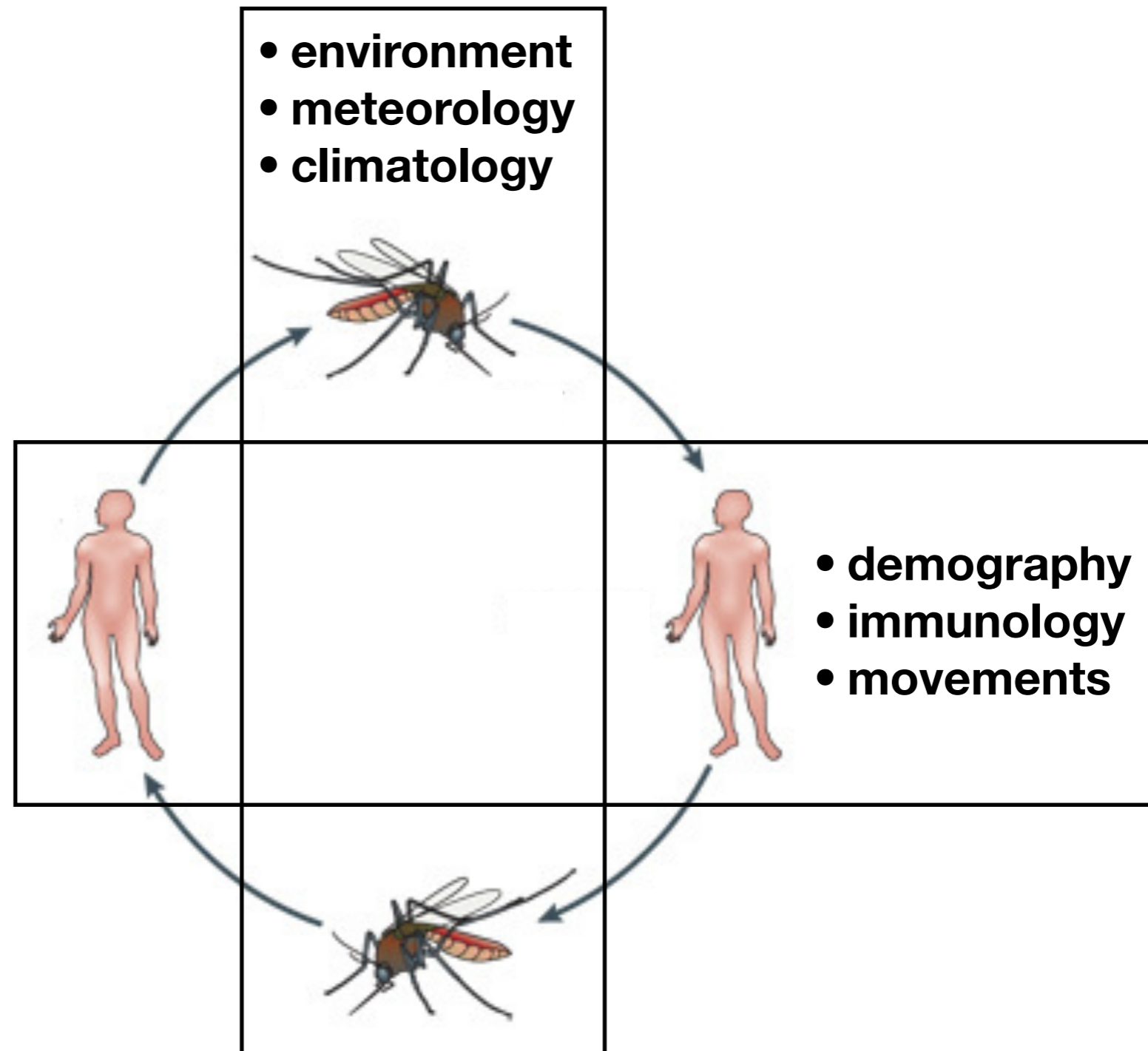
Dengue transmission



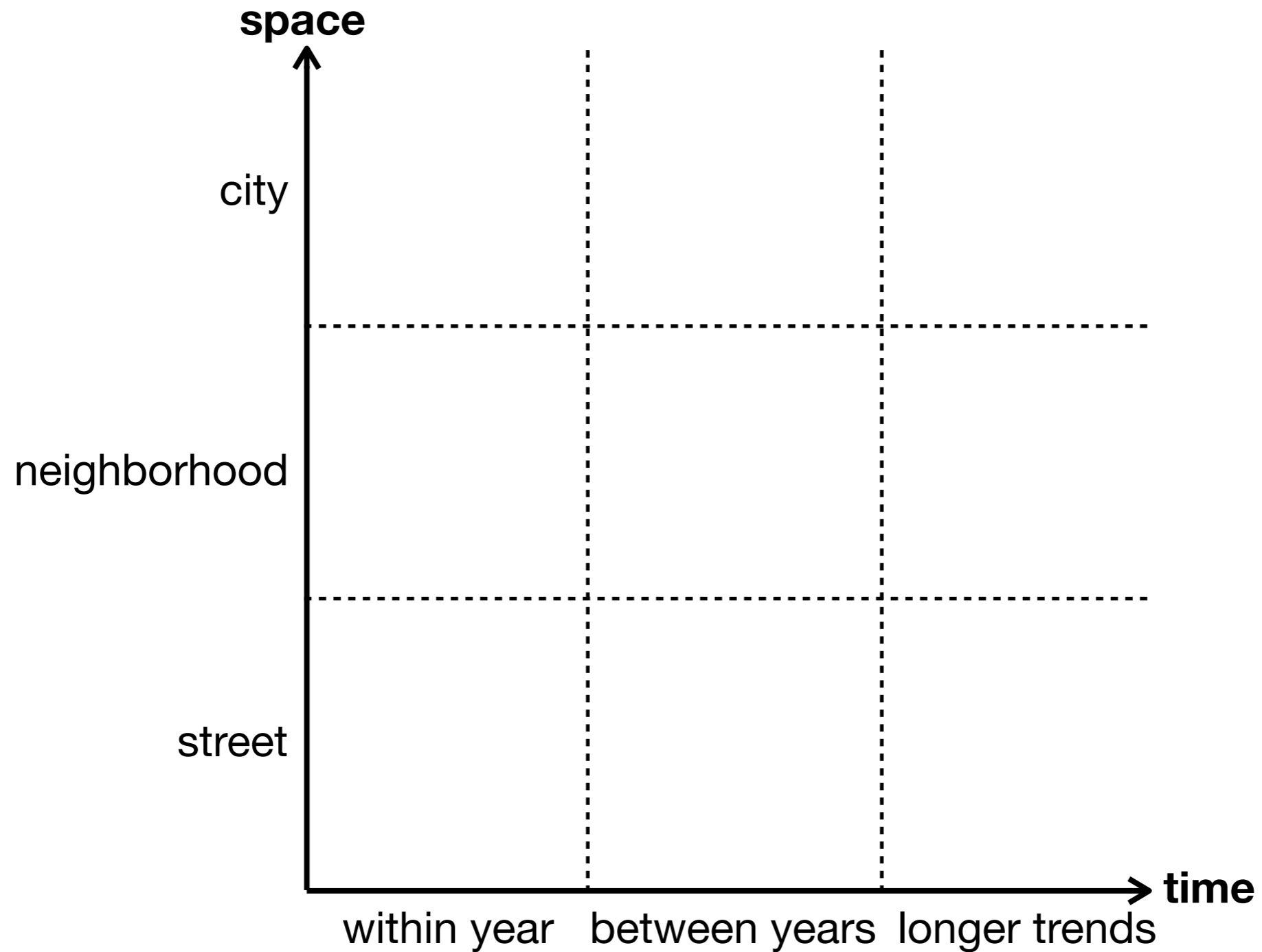
Dengue transmission



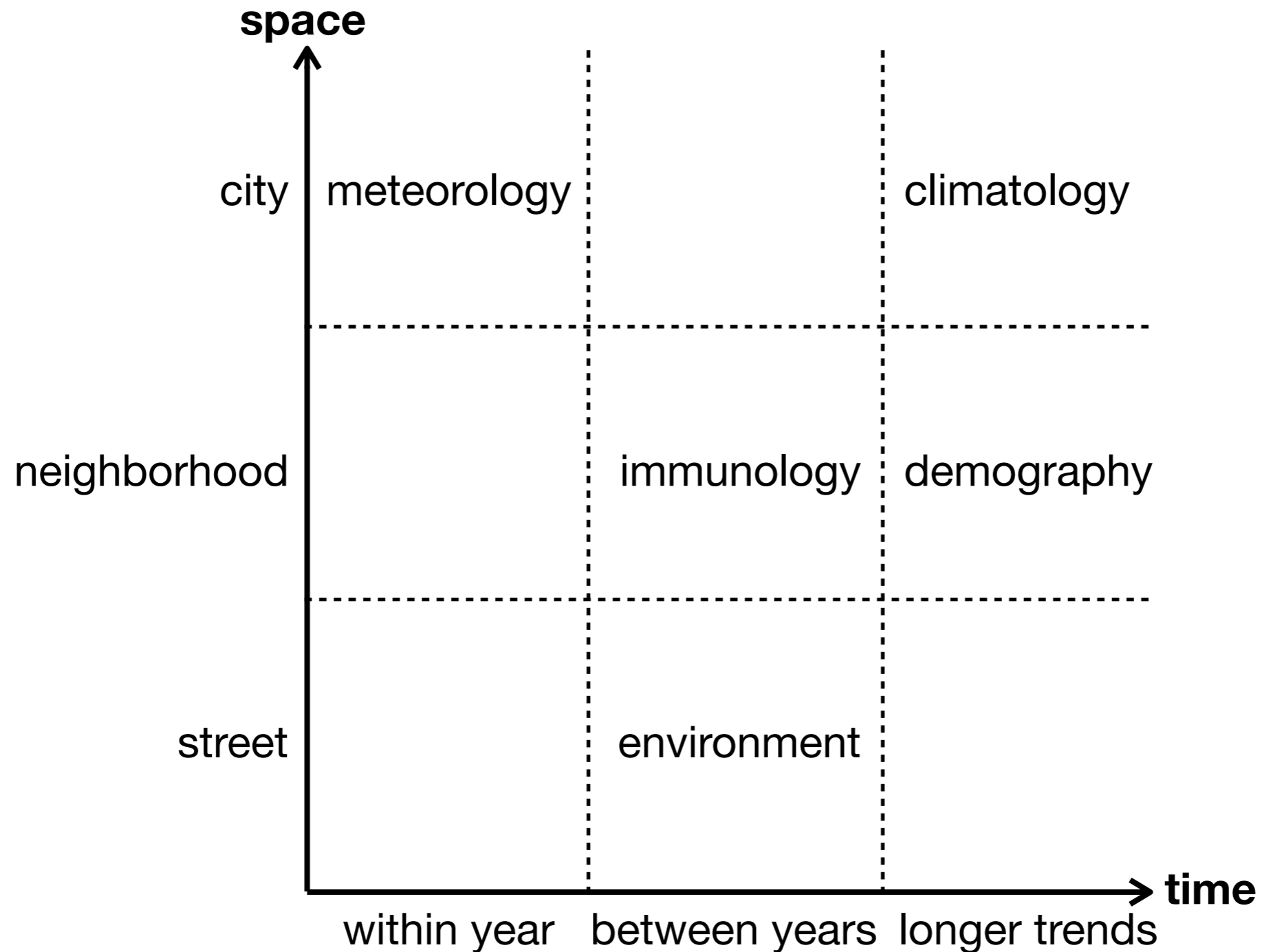
Dengue transmission



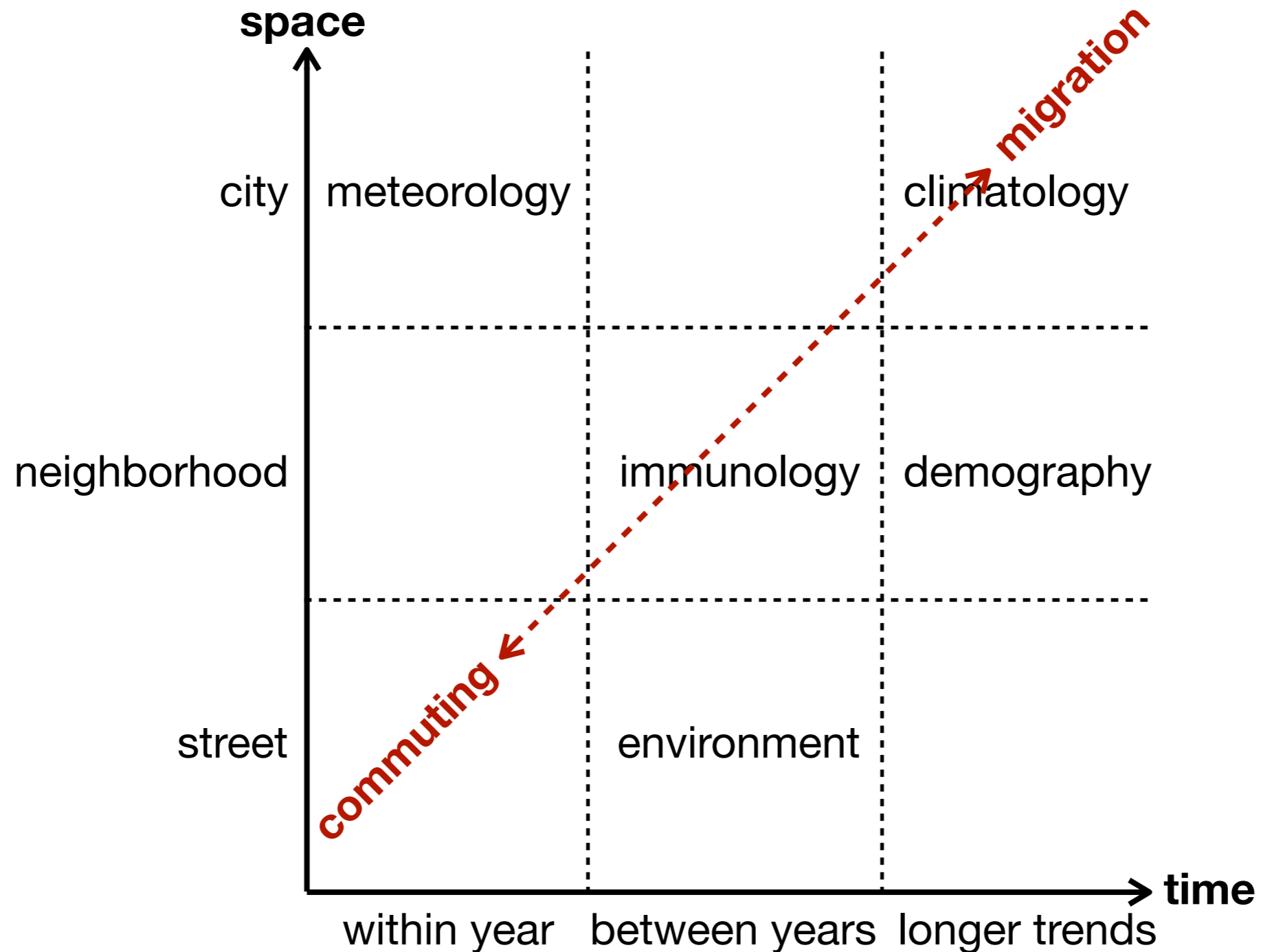
Space, time, movements



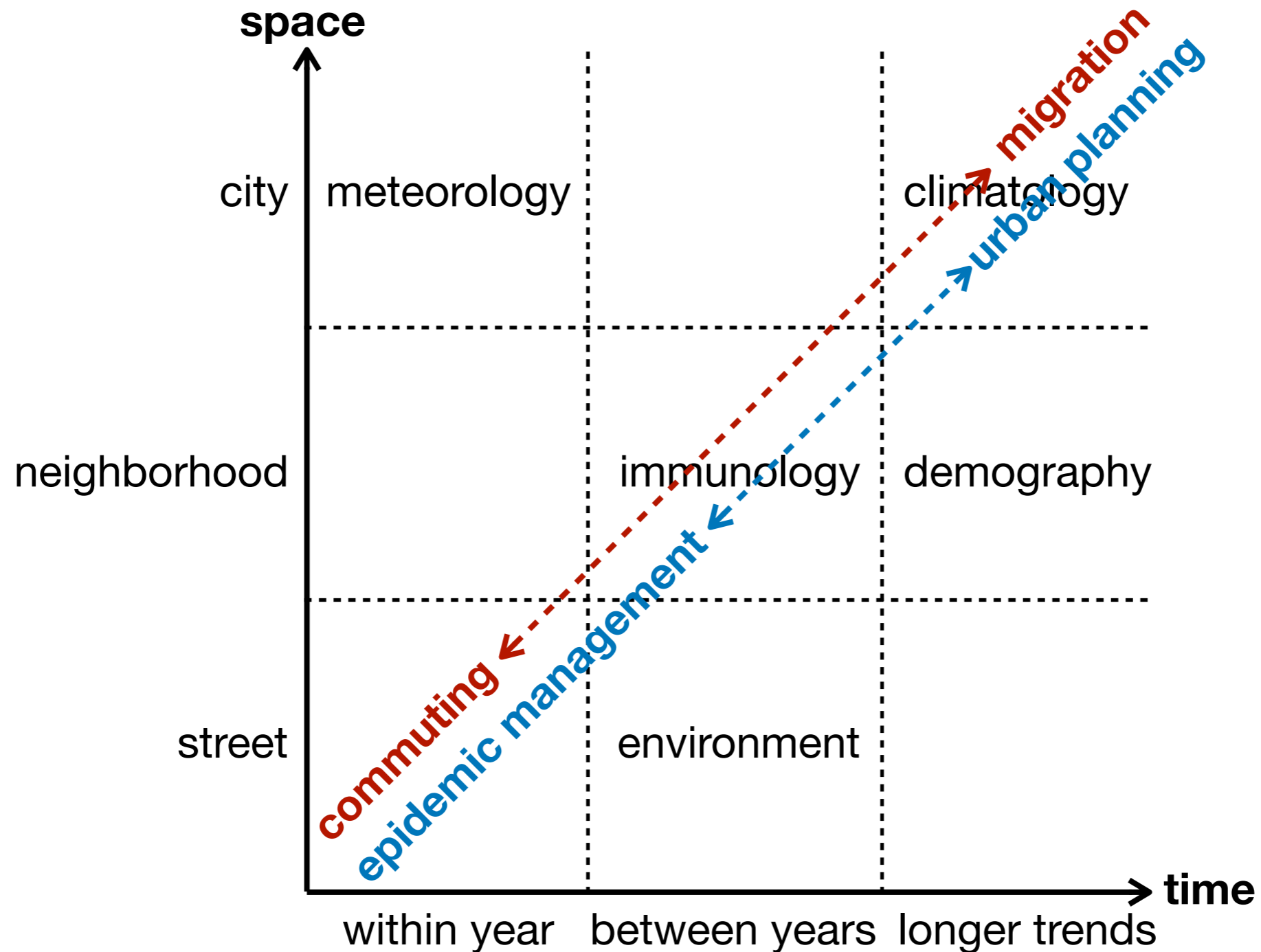
Space, time, movements



Space, time, movements



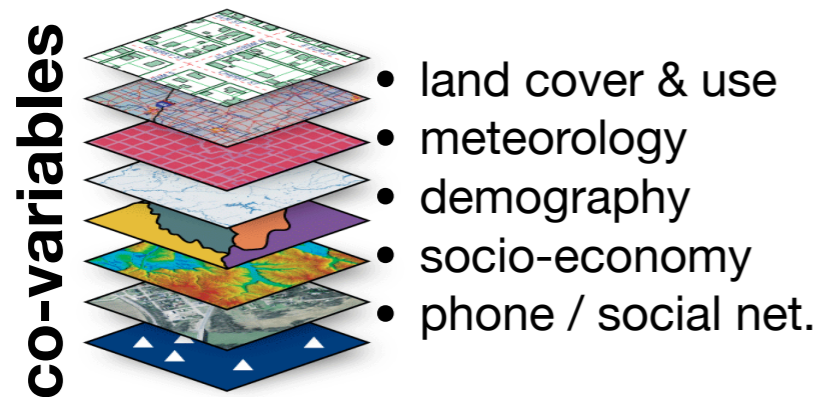
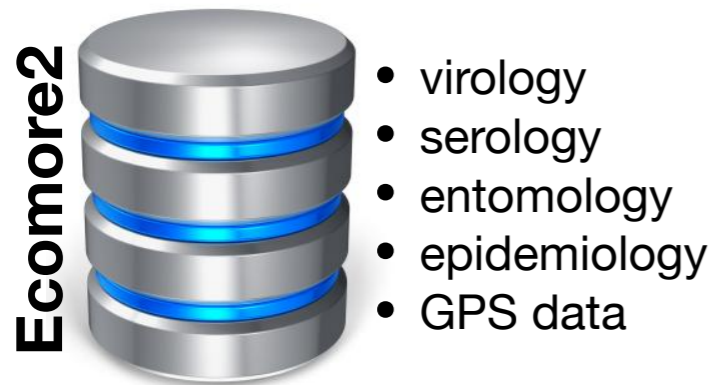
Space, time, movements



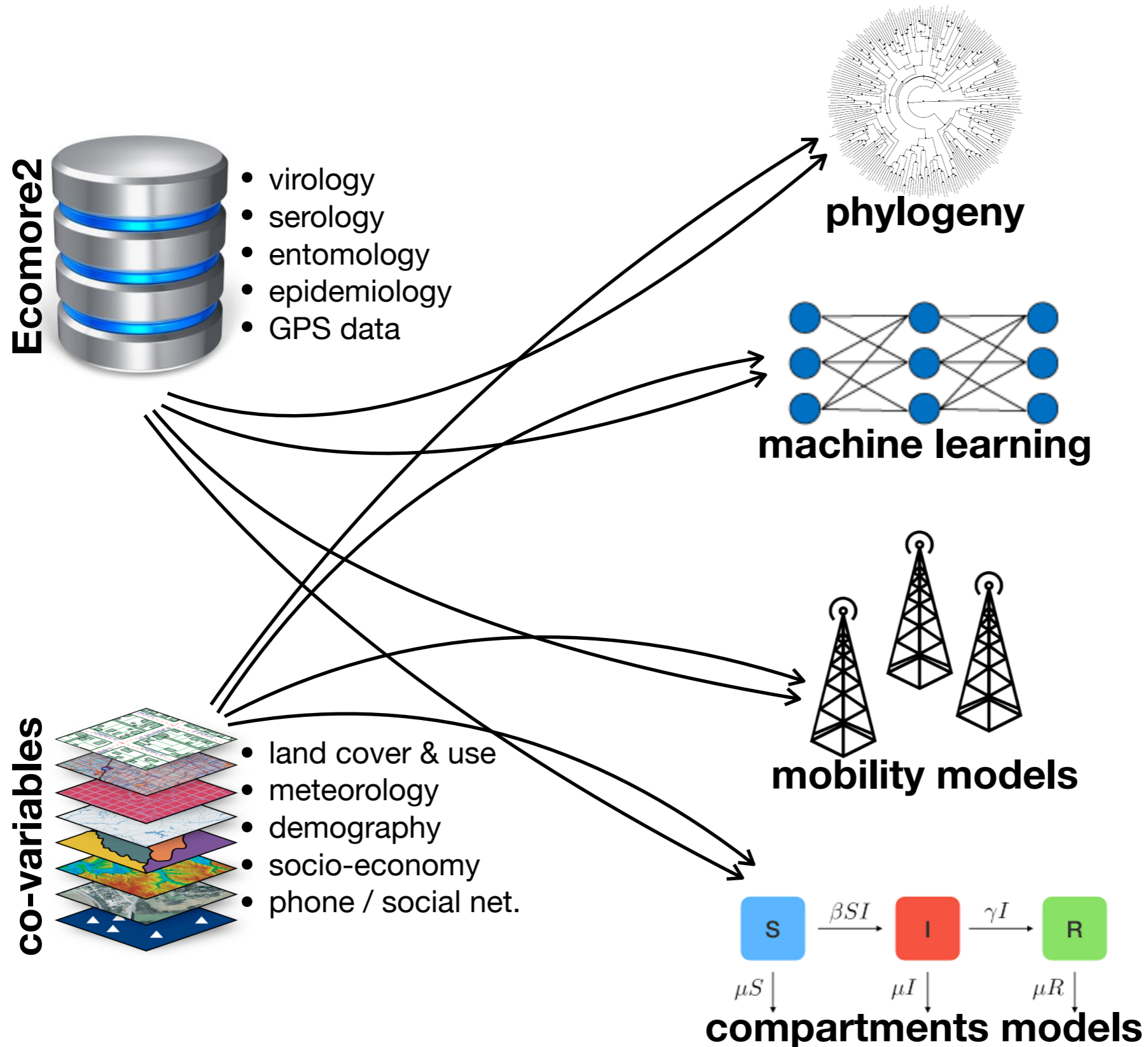
Data and models integration



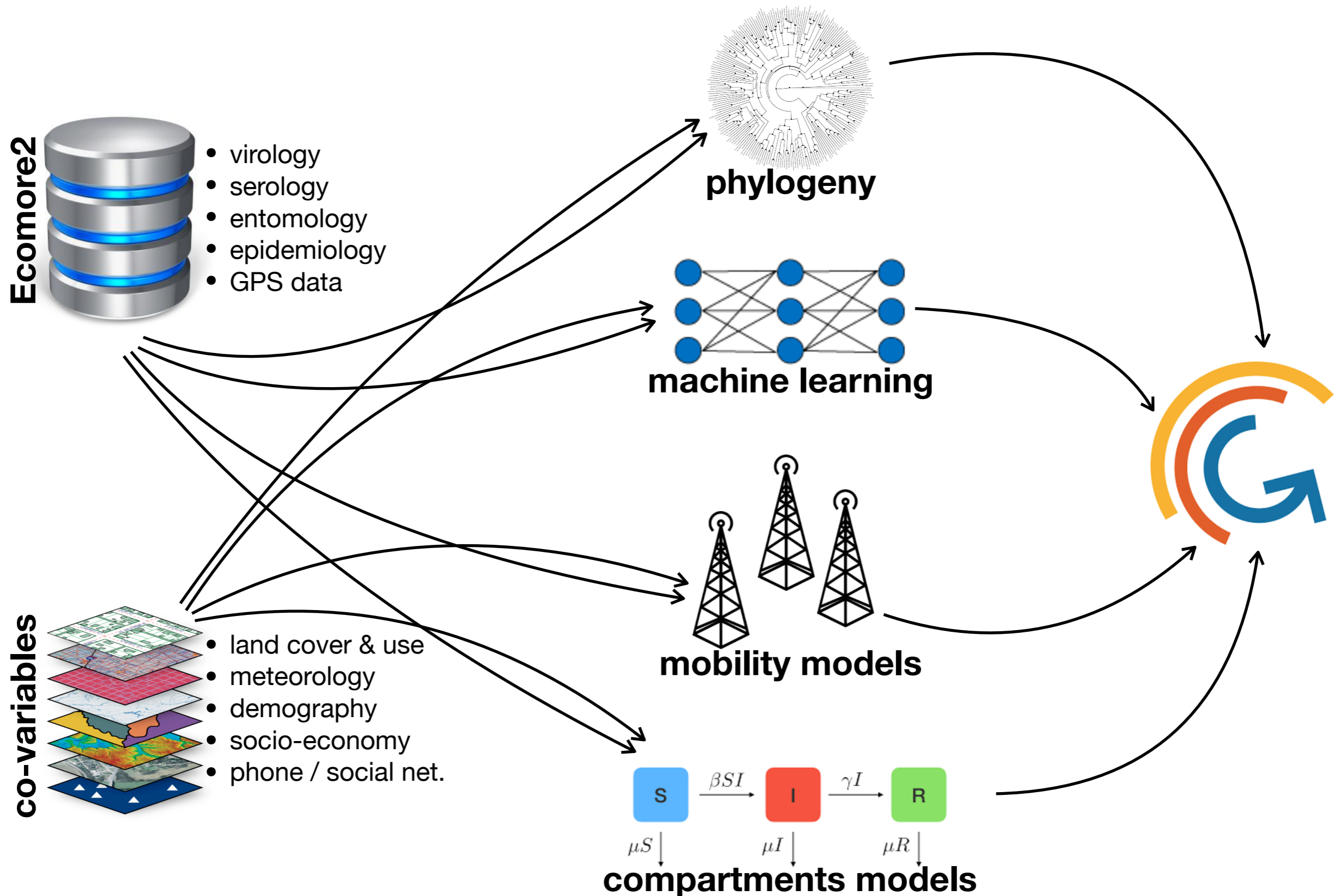
Data and models integration



Data and models integration



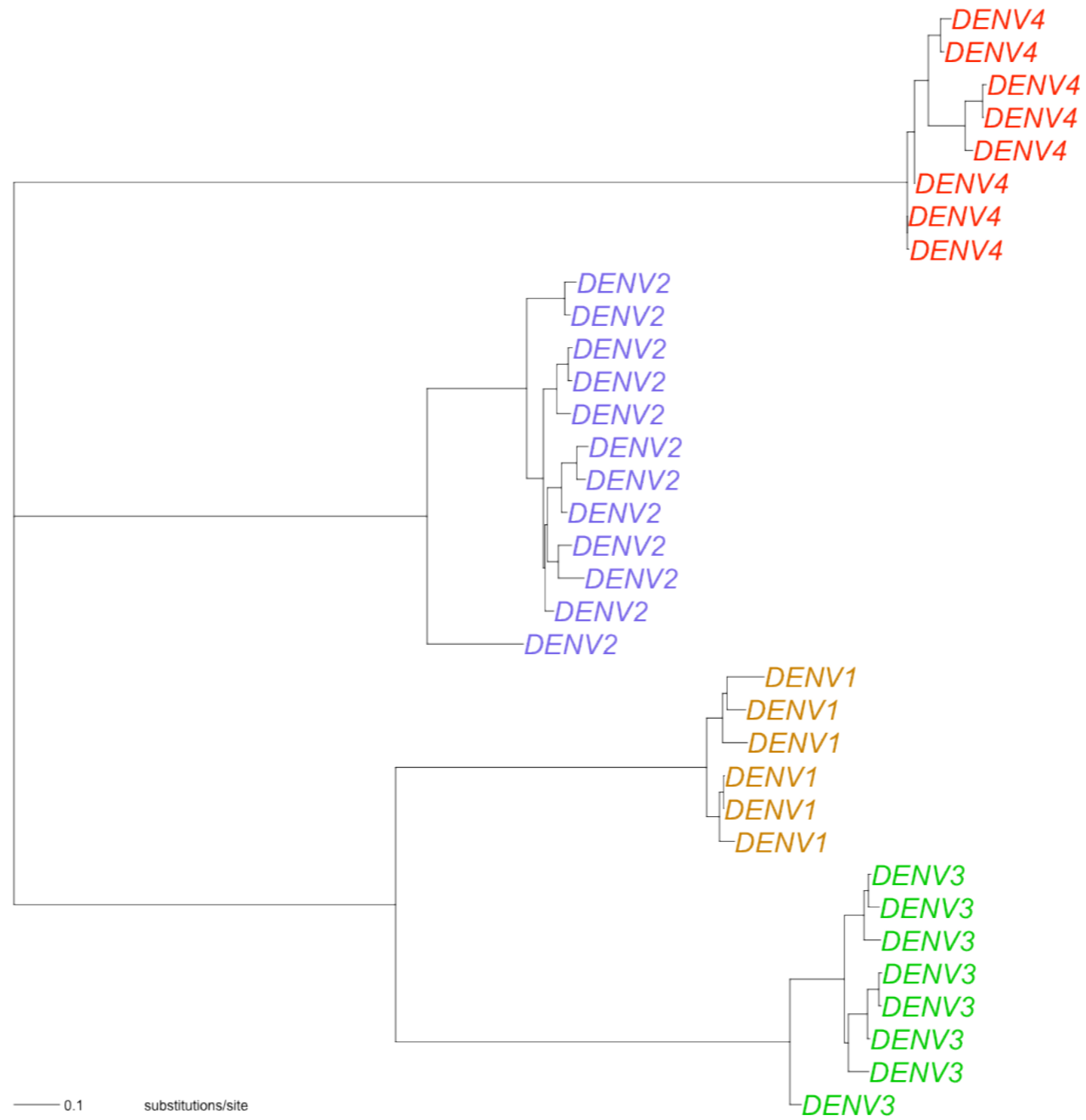
Data and models integration



Phylogeny

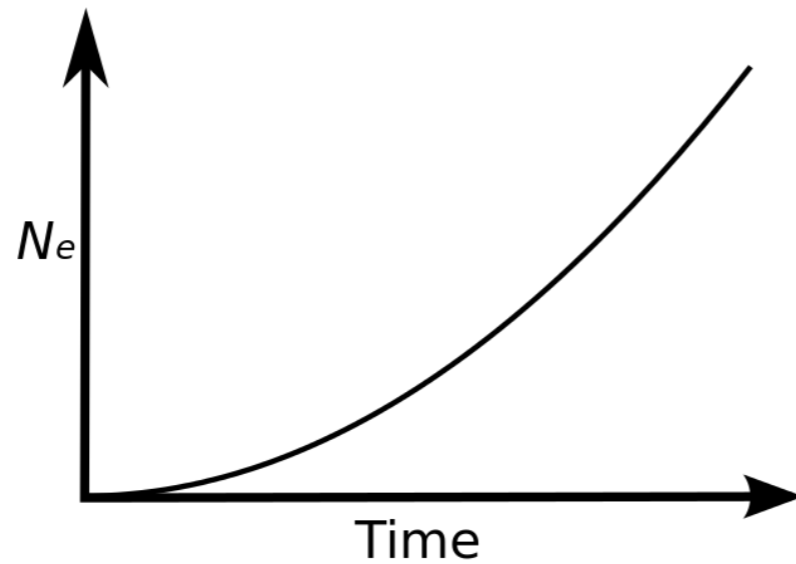
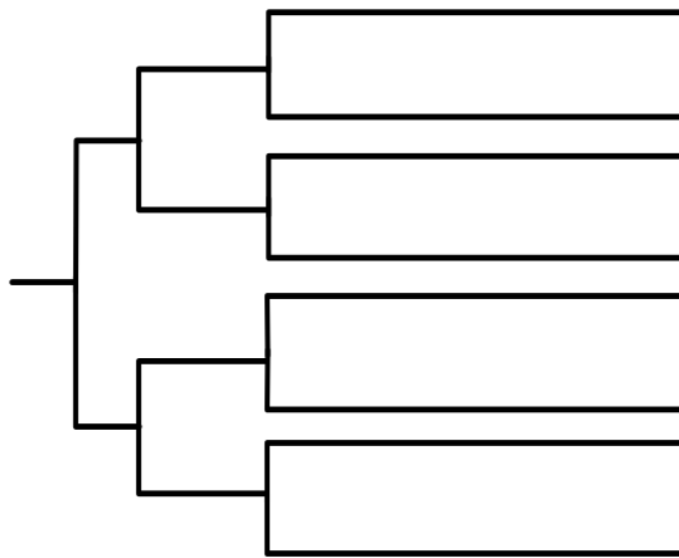
- quantifying transmission
- quantifying movements
- identifying viral sources

Phylogenetic analyses

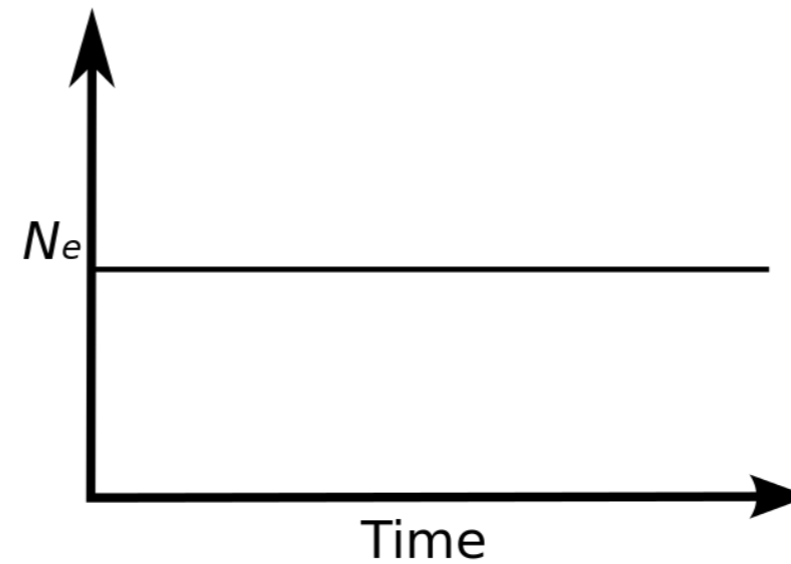
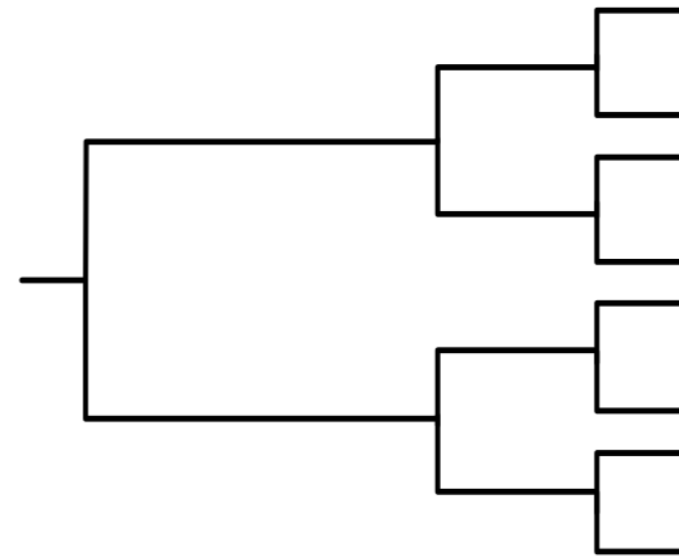


Phylo-dynamics

Exponential Growth

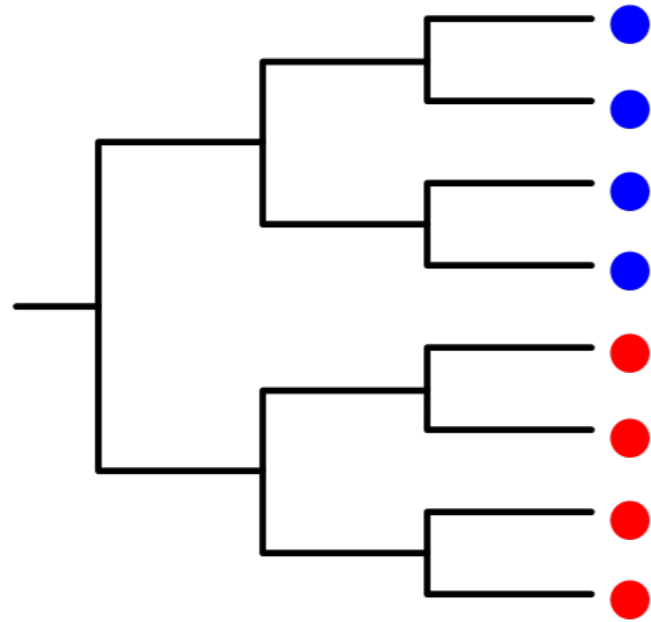


Constant Population Size

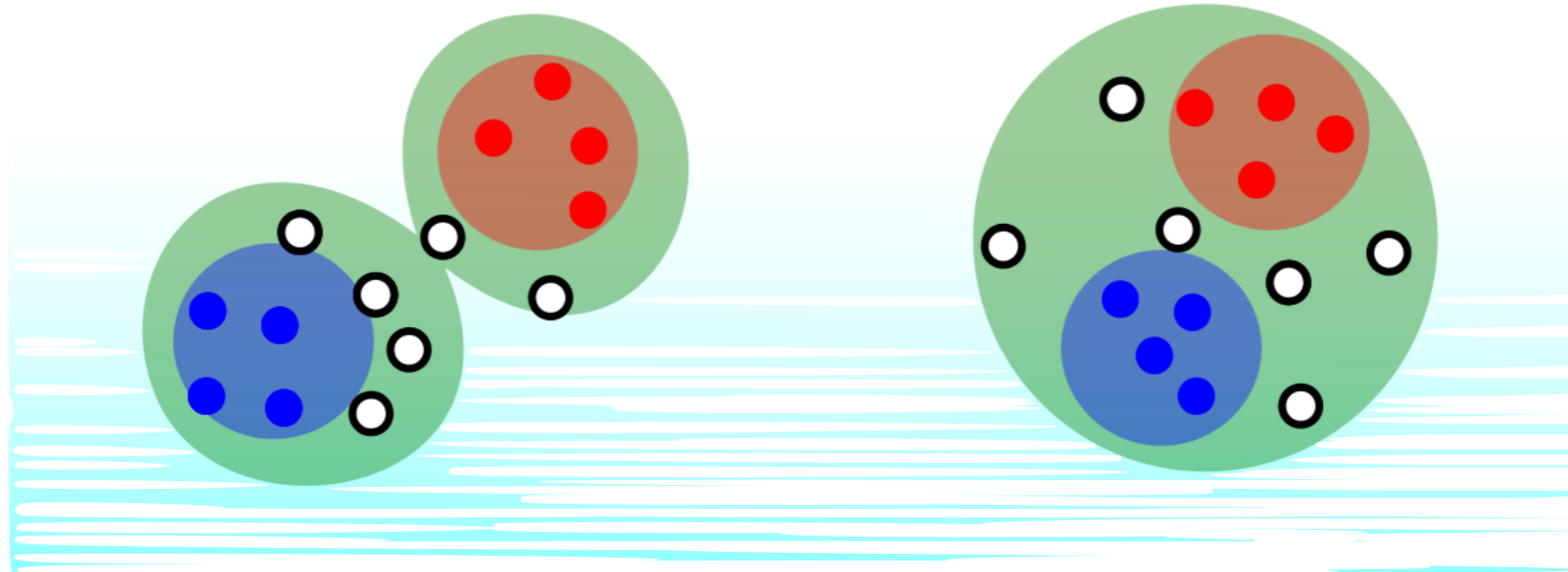
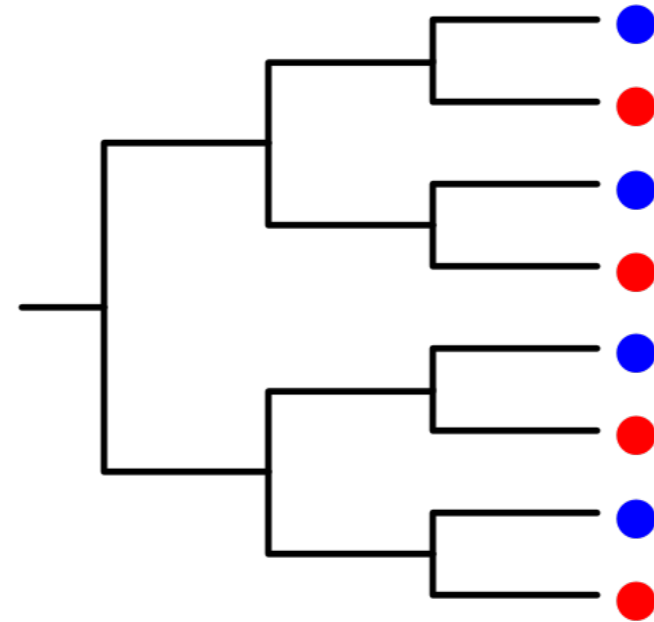


Phylo-geography

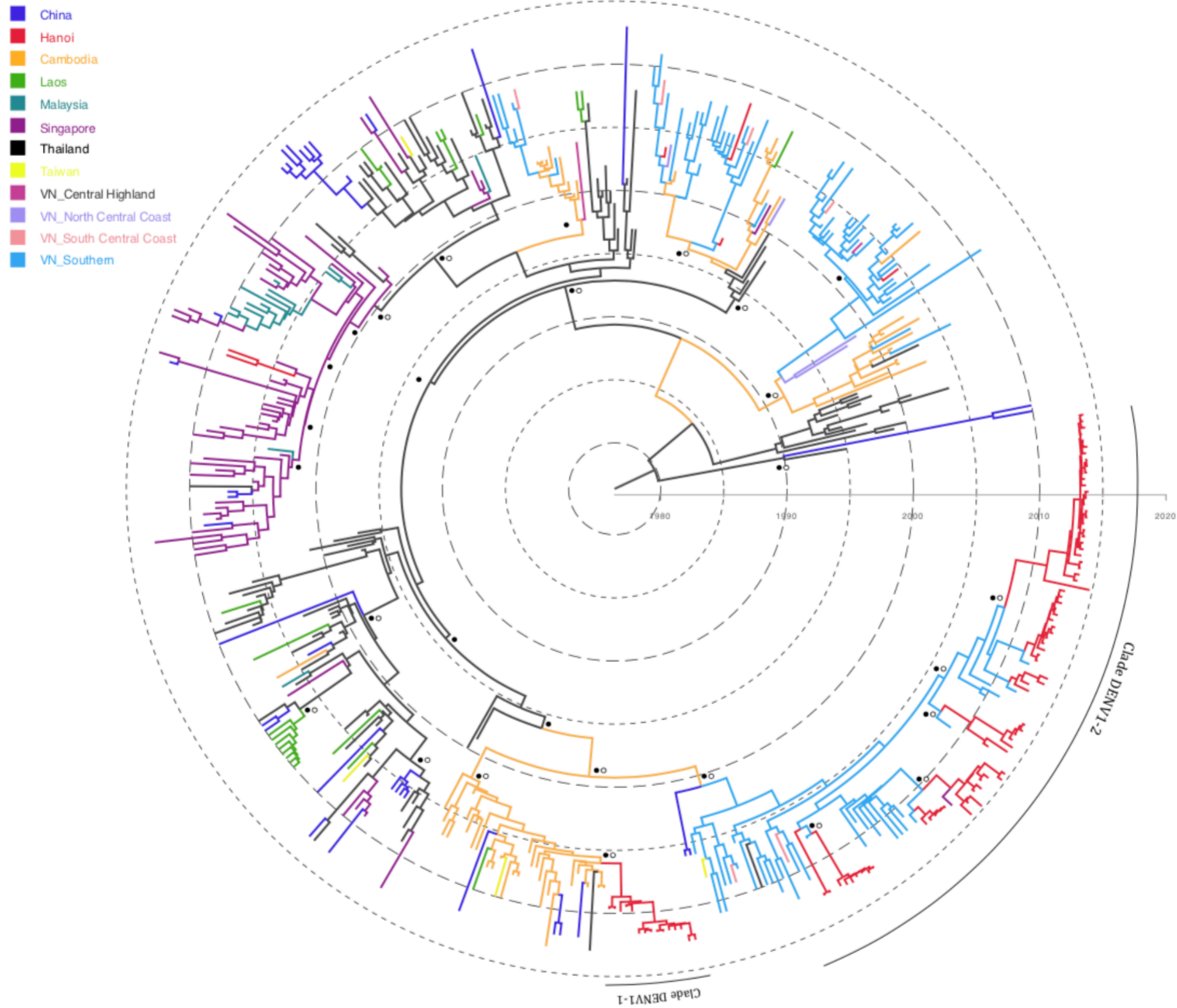
Structured Host Population



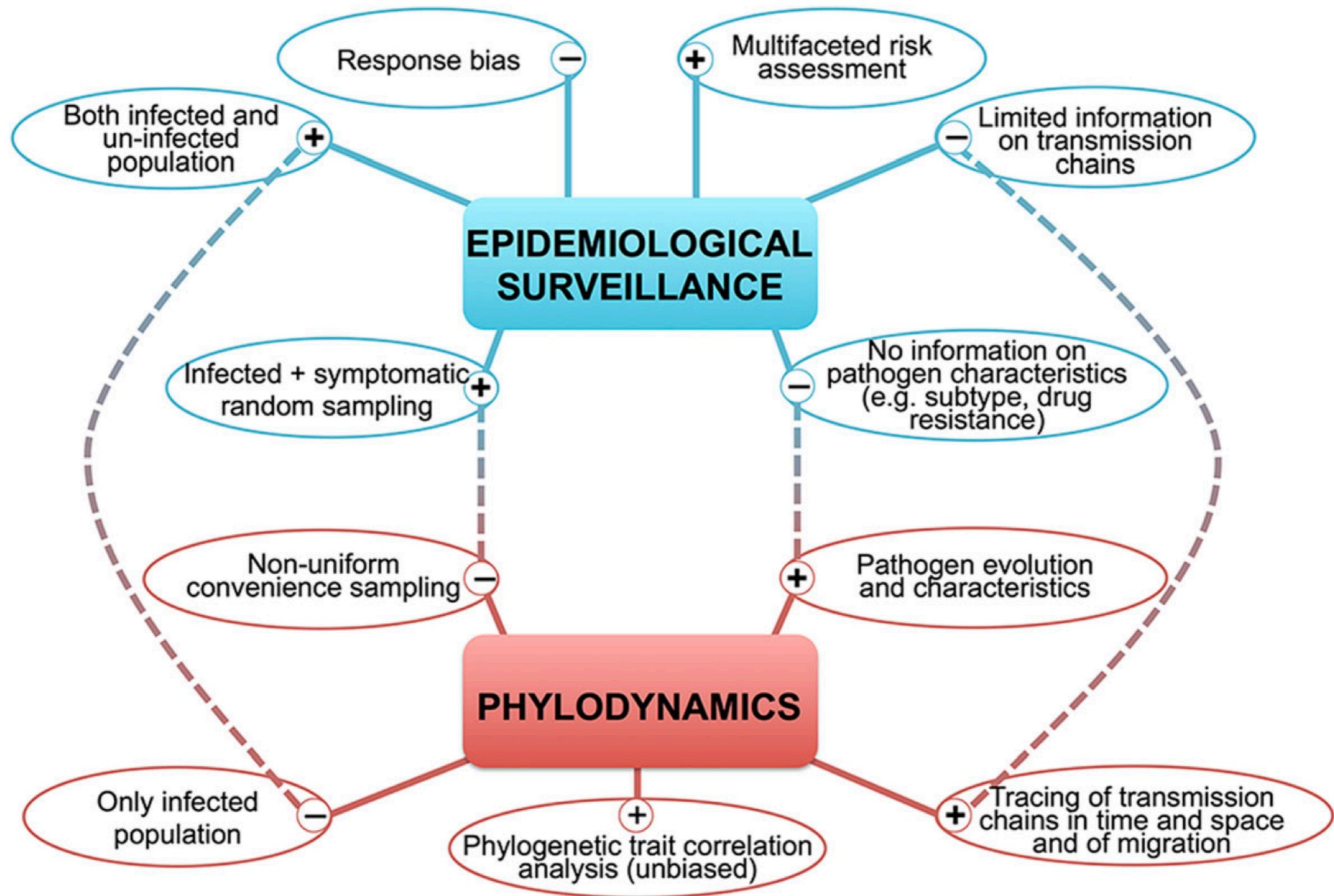
Unstructured Host Population



Phylo-geography



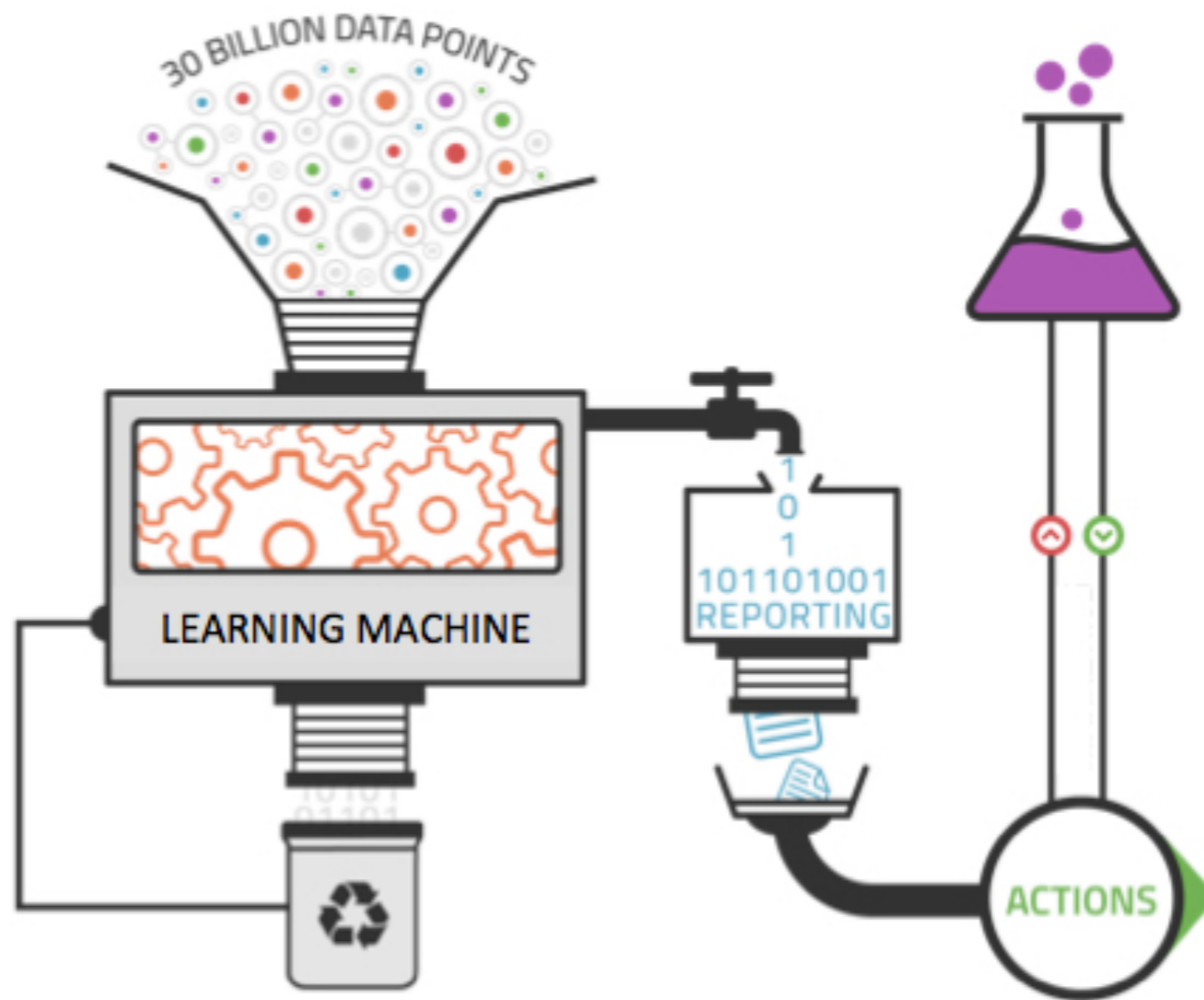
Phylogenetic surveillance



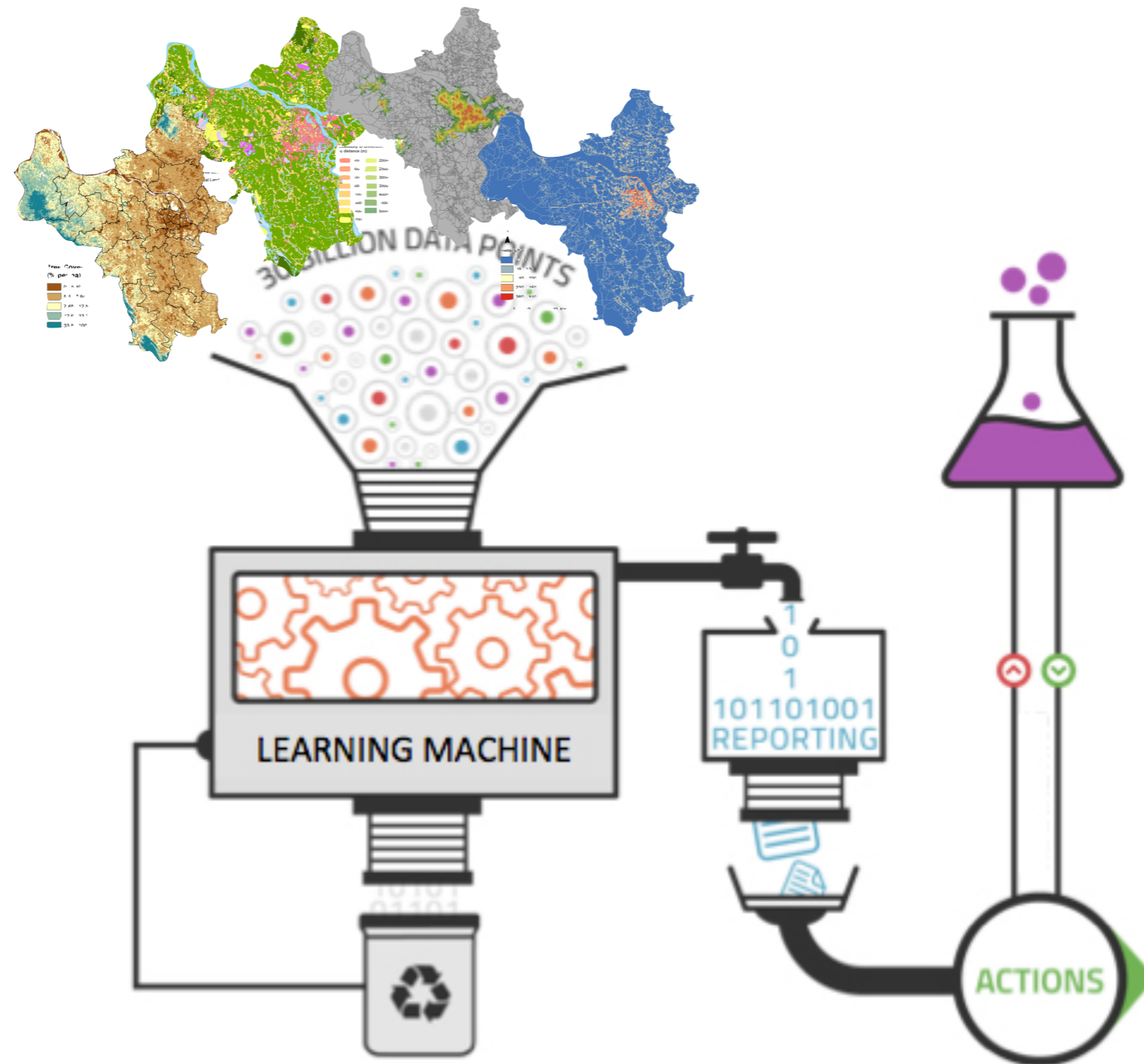
Machine learning

A modern and powerful way to identify risk factors

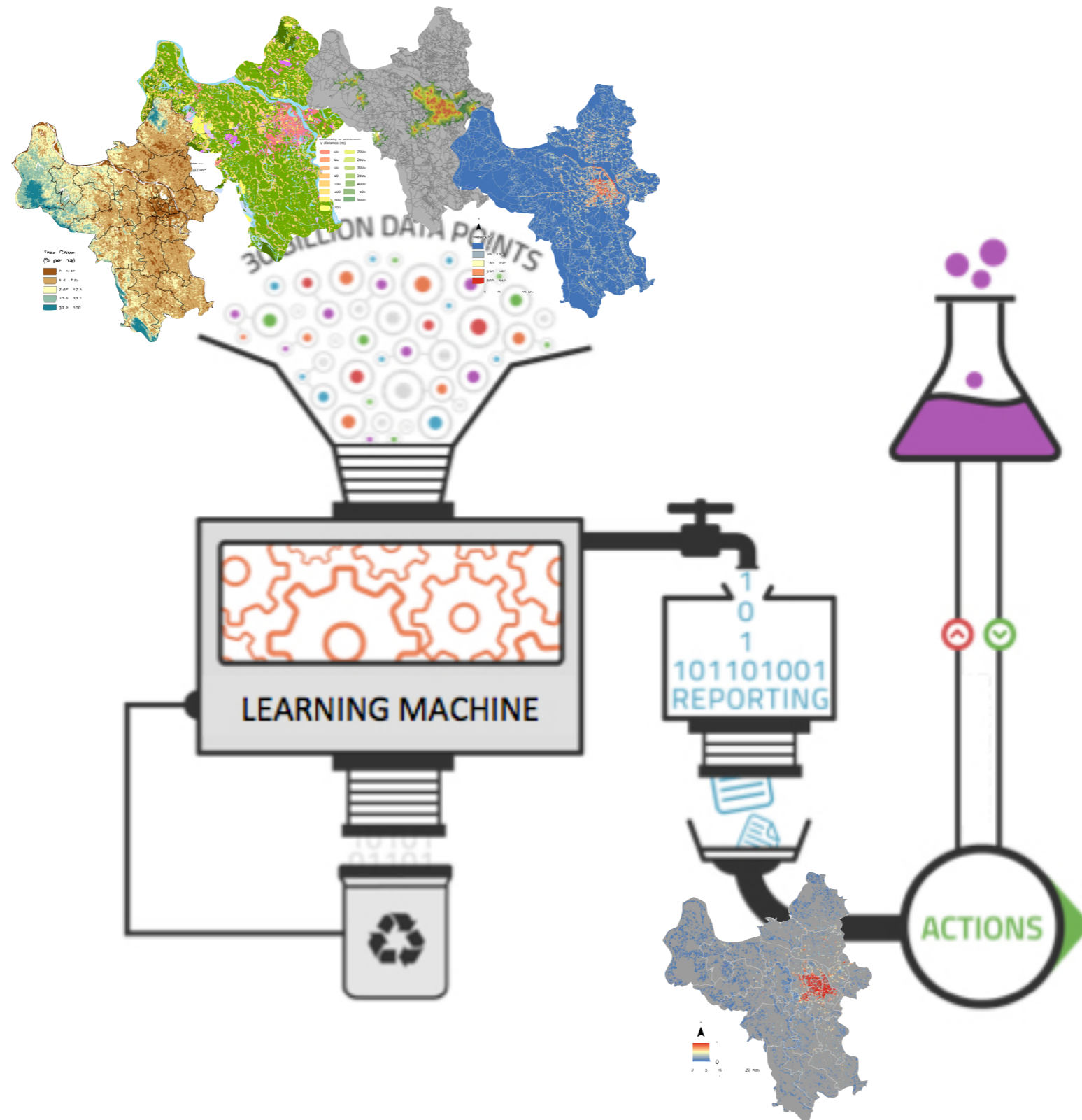
Machine learning



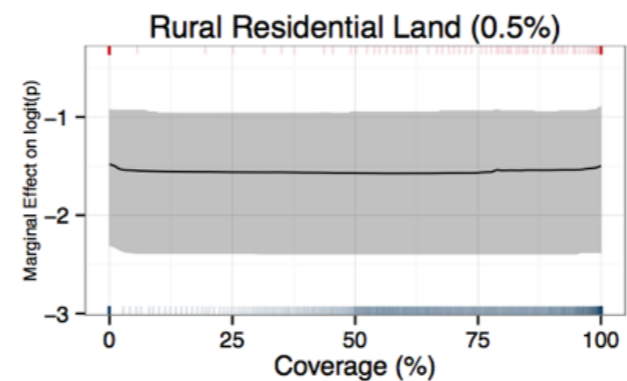
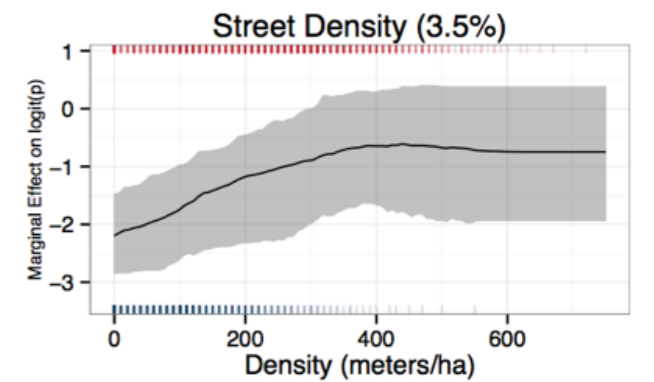
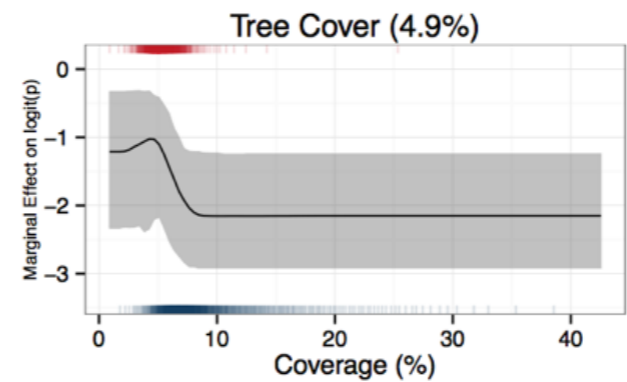
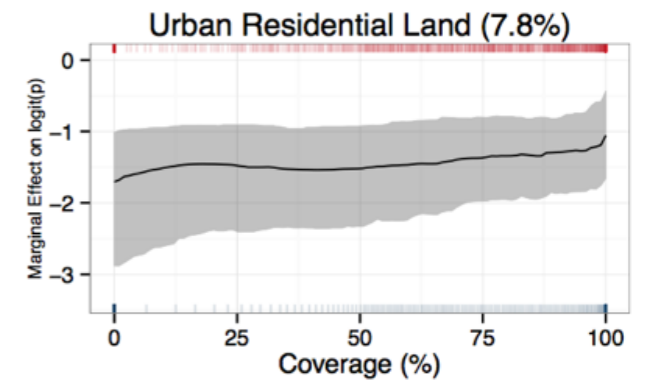
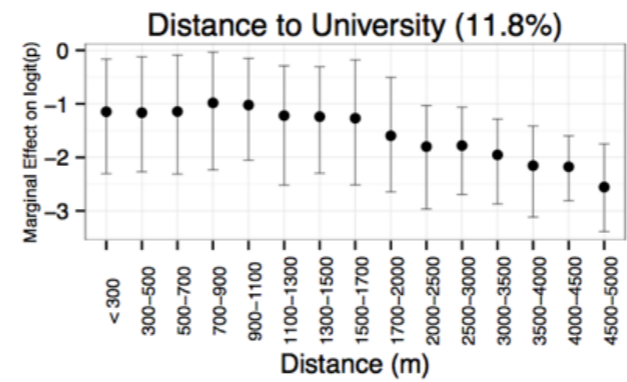
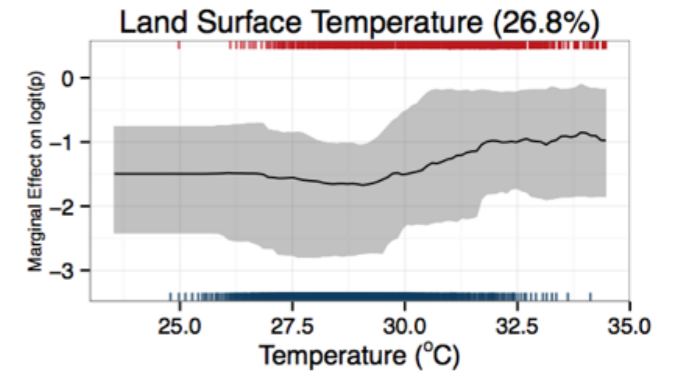
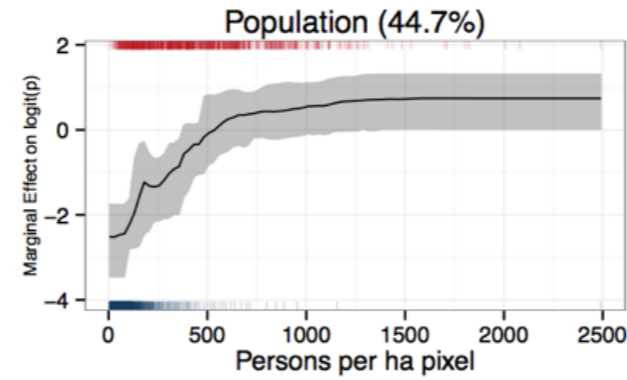
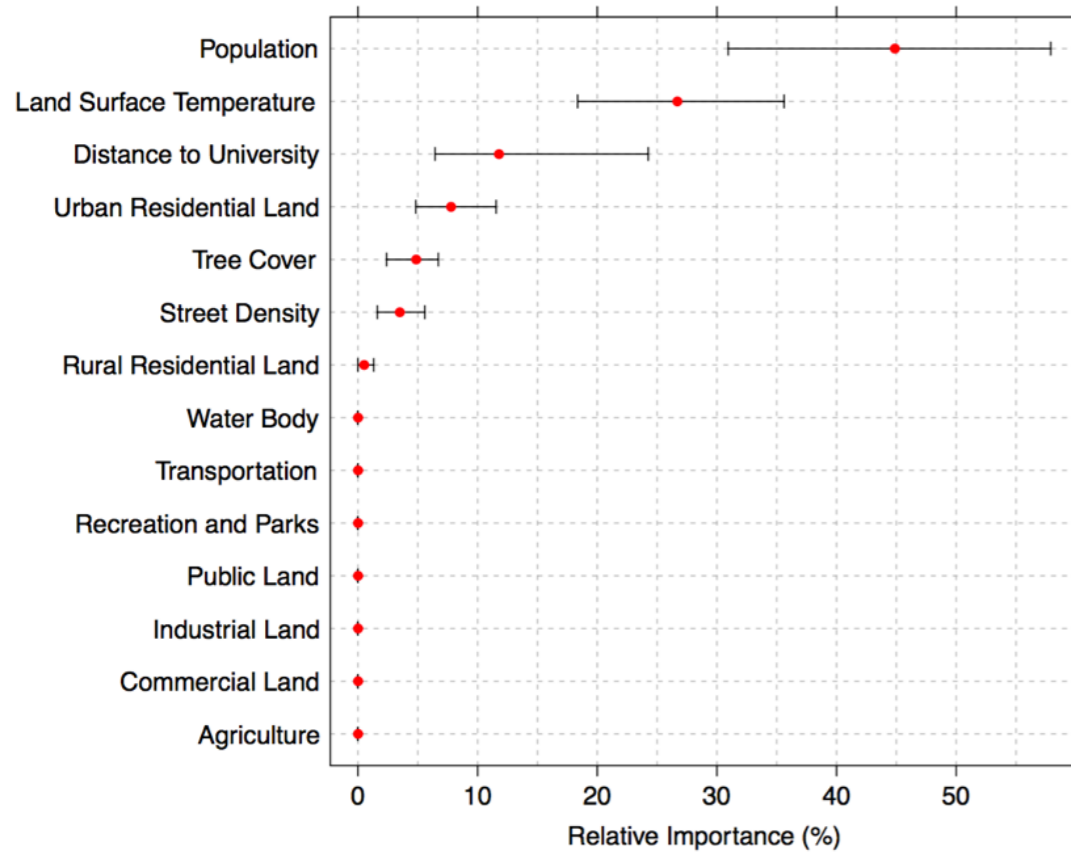
Machine learning



Machine learning



Machine learning



Mobility models

Mobile phones data

A_NU...	B_NU...	CELL_ID	LOCATION	TIER3_NAME	MAIN_GROUP	CALLI...	CALLI...	EVENT_...	EVENT...	TWIN	DESTINATI...	COST_...	PRODUCT
423	20923...	23214...	(null) Norge	SMS i Norge	SMS	(null)	242013...	15.02.2011	(null)	(null)	(null)	(null)	04720
424	20923...	23214...	(null) Norge	SMS i Norge	SMS	(null)	242013...	15.02.2011	(null)	(null)	(null)	(null)	04720
425	20923...	23214...	(null) Norge	SMS i Norge	SMS	(null)	242013...	15.02.2011	(null)	(null)	(null)	(null)	04720
426	24115...	46230...	242012040141314 Utland	NR - Utgående tale	Tale	35526...	242050...	15.02.2011	(null)	(null)	NOR	Z-NR-MOC	(null)
427	46240...	30623...	242011170104261 Norge	Til fastnett	Tale	12164...	242010...	15.02.2011	(null)	(null)	(null)	F-FAST...	04720
428	46240...	24002...	242012070143948 Norge	Til operatører hos Netcom	Tale	12164...	242010...	15.02.2011	(null)	(null)	(null)	X-NETW...	04720
429	46240...	30598...	242012070143948 Norge	Til fastnett	Tale	12164...	242010...	15.02.2011	(null)	(null)	(null)	F-FAST...	04720
430	46240...	24002...	242012070143948 Norge	Til operatører hos Netcom	Tale	12164...	242010...	15.02.2011	(null)	(null)	(null)	X-NETW...	04720
431	46240...	24002...	(null) Norge	Til operatører hos Netcom	Tale	12164...	242010...	15.02.2011	(null)	(null)	(null)	X-NETW...	04720
432	46240...	11168...	(null) Norge	Til fastnett	Tale	12164...	242010...	15.02.2011	(null)	(null)	(null)	F-FAST...	04720
433	48311...	45754...	(null) Norge	Viderekobling i Telenors Nett	Tale	(null)	242010...	15.02.2011	(null)	(null)	NOR	M-MOBI...	04577
434	48311...	(null)	(null) Norge	Internett	Internett	(null)	242010...	14.02.2011	45259	(null)	(null)	T3-VOT	04577
435	48311...	(null)	(null) Norge	Internett	Internett	(null)	242010...	14.02.2011	297421	(null)	(null)	T3-VOT	04577
436	48311...	(null)	(null) Norge	Internett	Internett	(null)	242010...	14.02.2011	468	(null)	(null)	T3-VOT	04577
437	48311...	(null)	(null) Norge	Internett	Internett	(null)	242010...	15.02.2011	7854	(null)	(null)	T3-VOT	04577
438	48311...	(null)	(null) Norge	Internett	Internett	(null)	242010...	15.02.2011	352	(null)	(null)	T3-VOT	04577
439	48311...	(null)	(null) Norge	Internett	Internett	(null)	242010...	14.02.2011	152	(null)	(null)	T3-VOT	04577
440	48311...	(null)	(null) Norge	Internett	Internett	(null)	242010...	14.02.2011	70509	(null)	(null)	T3-VOT	04577
441	48311...	(null)	(null) Norge	Internett	Internett	(null)	242010...	14.02.2011	144	(null)	(null)	T3-VOT	04577
442	48311...	(null)	(null) Norge	Internett	Internett	(null)	242010...	14.02.2011	3711	(null)	(null)	T3-VOT	04577
443	48311...	(null)	(null) Norge	Internett	Internett	(null)	242010...	14.02.2011	3202	(null)	(null)	T3-VOT	04577
444	48311...	(null)	(null) Norge	Internett	Internett	(null)	242010...	14.02.2011	152	(null)	(null)	T3-VOT	04577
445	45047...	49639...	(null) Norge	SMS i Norge	SMS	(null)	242010...	15.02.2011	(null)	(null)	(null)	(null)	04747
446	22637...	(null)	(null) Utland	GPRS i utlandet	Internett	(null)	238209...	15.02.2011	341	(null)	(null)	T3-VOT	(null)
447	46835...	23959...	242012080150195 Norge	NR - Utgående SMS	SMS	35821...	242050...	14.02.2011	(null)	(null)	(null)	Z-MO	(null)
448	23170...	(null)	242011450118026 Utland	NR - Inngående tale/data/fax	Tale	35492...	242059...	14.02.2011	(null)	(null)	(null)	Z-MTC	(null)
449	23698...	(null)	242011560112573 Utland	NR - Inngående tale/data/fax	Tale	35489...	242050...	15.02.2011	(null)	(null)	(null)	Z-MTC	(null)
450	29651...	(null)	(null) Norge	Internett	Internett	(null)	242059...	14.02.2011	28754	(null)	(null)	T3-VOT	(null)
451	48376...	23959...	(null) Norge	SMS	SMS	35536...	242059...	15.02.2011	(null)	(null)	(null)	T3-TA2...	(null)
1792	23825...	36243...	0 Norge	Tale	Tale	(null)	(null)	15.02.2011	(null)	(null)	(null)	F-FAST...	04008
1793	23825...	45754...	0 Norge	Tale	Tale	(null)	(null)	15.02.2011	(null)	(null)	(null)	M-MOBI...	04008
1794	130055	45558...	(null) Norge	SMS	SMS	(null)	(null)	15.02.2011	(null)	(null)	(null)	(null)	02092
1795	47589...	45850...	(null) Norge	SMS i Norge	SMS	(null)	242013...	14.02.2011	(null)	(null)	(null)	(null)	04140
1796	47589...	24063...	(null) Norge	SMS i Norge	SMS	(null)	242013...	14.02.2011	(null)	(null)	(null)	(null)	04140
1797	47589...	24063...	(null) Norge	SMS i Norge	SMS	(null)	242013...	14.02.2011	(null)	(null)	(null)	(null)	04140
1798	47589...	49864...	(null) Norge	SMS i Norge	SMS	(null)	242013...	15.02.2011	(null)	(null)	(null)	(null)	04140
1799	47589...	45797...	(null) Norge	SMS i Norge	SMS	(null)	242013...	15.02.2011	(null)	(null)	(null)	(null)	04140
1800	47589...	45006...	(null) Norge	SMS i Norge	SMS	(null)	242013...	15.02.2011	(null)	(null)	(null)	(null)	04140
1801	47589...	45872...	(null) Norge	Internt til kollega - SMS	SMS	(null)	242013...	15.02.2011	(null)	(null)	(null)	(null)	04140
1802	46633...	47516...	242015040147145 Utland	NR - Utgående tale	Tale	35629...	242050...	14.02.2011	(null)	(null)	NOR	Z-NR-MOC	(null)
1803	22600...	45001...	(null) Norge	NR - Inngående SMS	SMS	35486...	242059...	14.02.2011	(null)	(null)	(null)	T3-TA2...	(null)
1804	46642...	45001...	(null) Norge	NR - Inngående SMS	SMS	11808...	242050...	15.02.2011	(null)	(null)	(null)	T3-TA2...	(null)
1805	46809...	49792...	(null) Utland	Fri bruk SMS i	SMS	(null)	242013...	14.02.2011	(null)	(null)	(null)	(null)	04712
1806	46809...	20022...	(null) Utland	Fri bruk SMS i	SMS	(null)	242013...	14.02.2011	(null)	(null)	(null)	(null)	04712
1807	46809...	20022...	(null) Utland	Fri bruk SMS i	SMS	(null)	242013...	14.02.2011	(null)	(null)	(null)	(null)	04712

A number

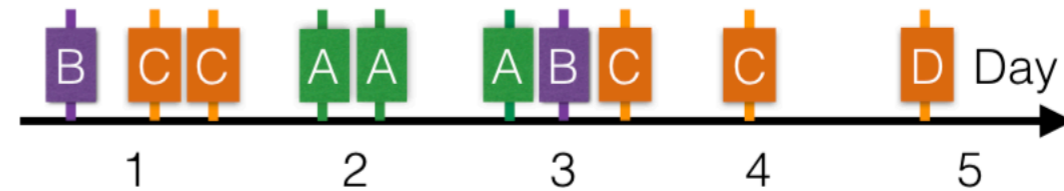
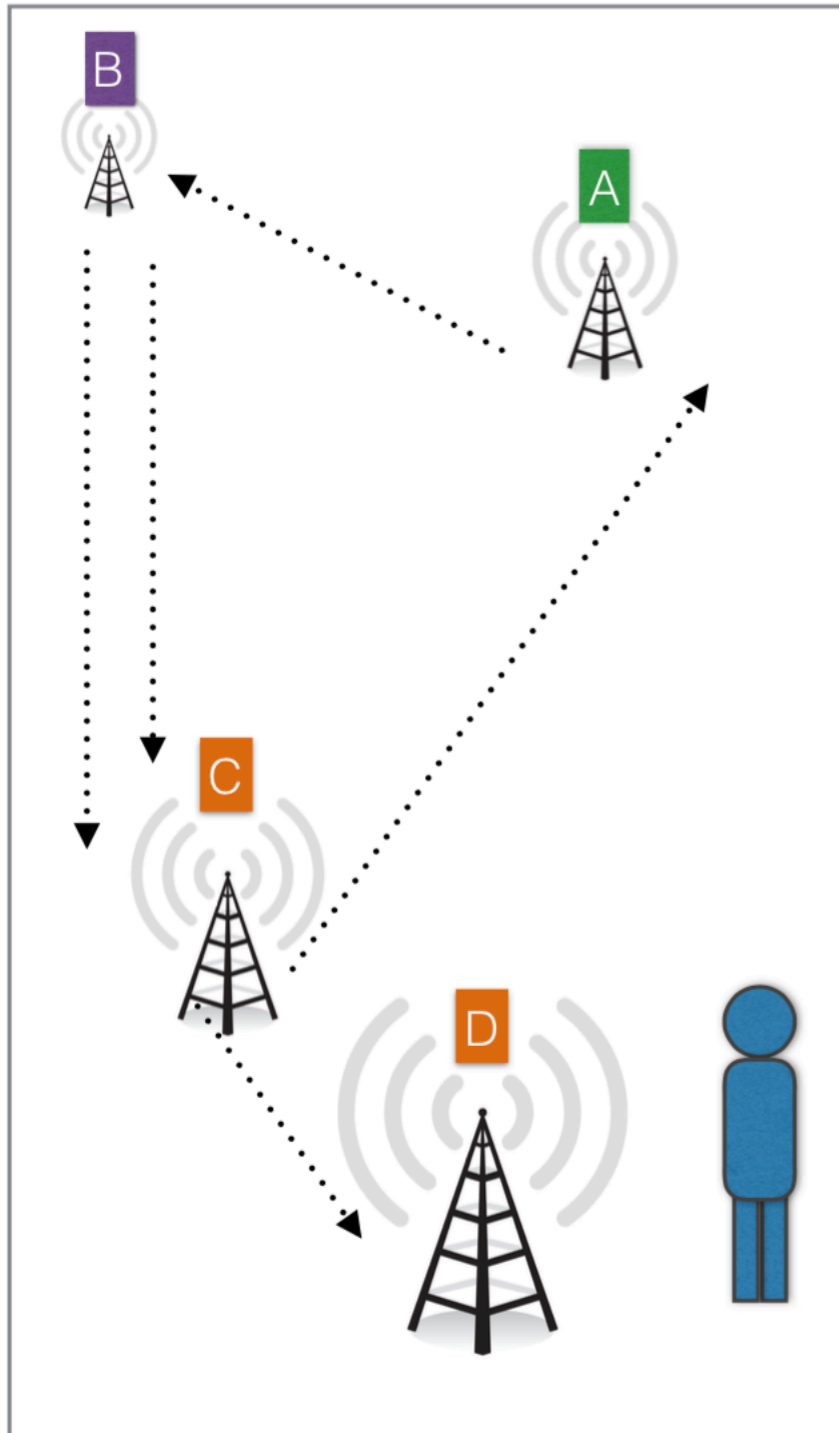
B number

Type

CELL ID

Date and Time

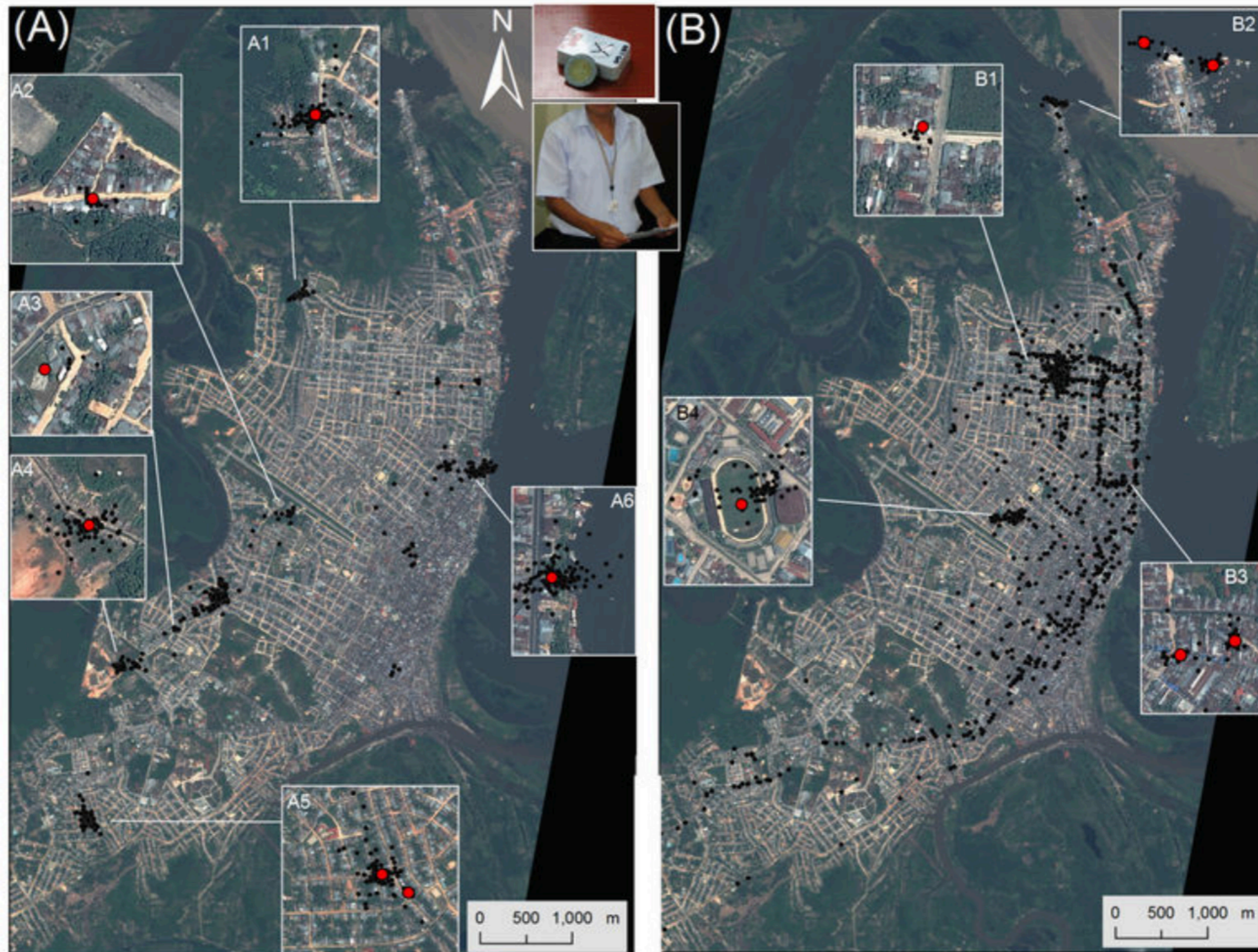
Mobile phones data



Day	Tower per day	Location per day
1	C	Orange bar
2	A	Green bar
3	B	Purple bar
4	C	Orange bar
5	D	Orange bar

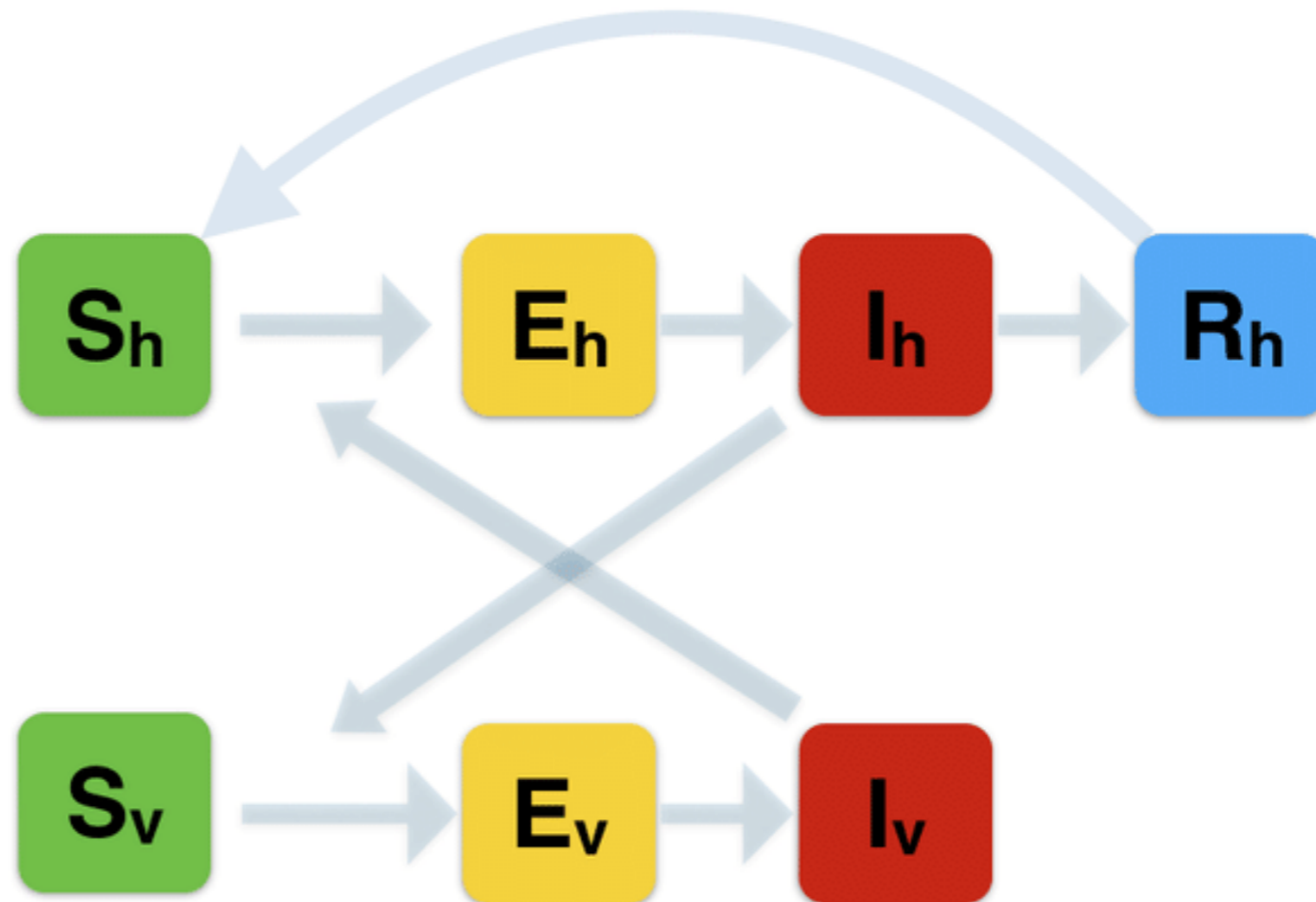
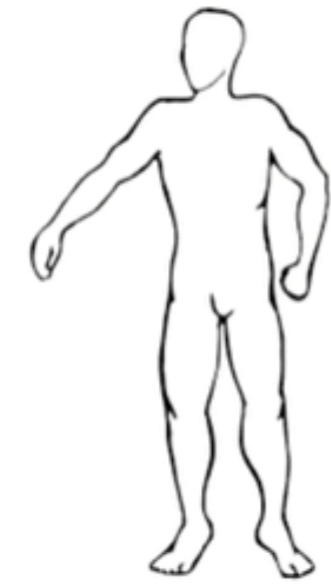
Trips

GPS data loggers



Transmission models

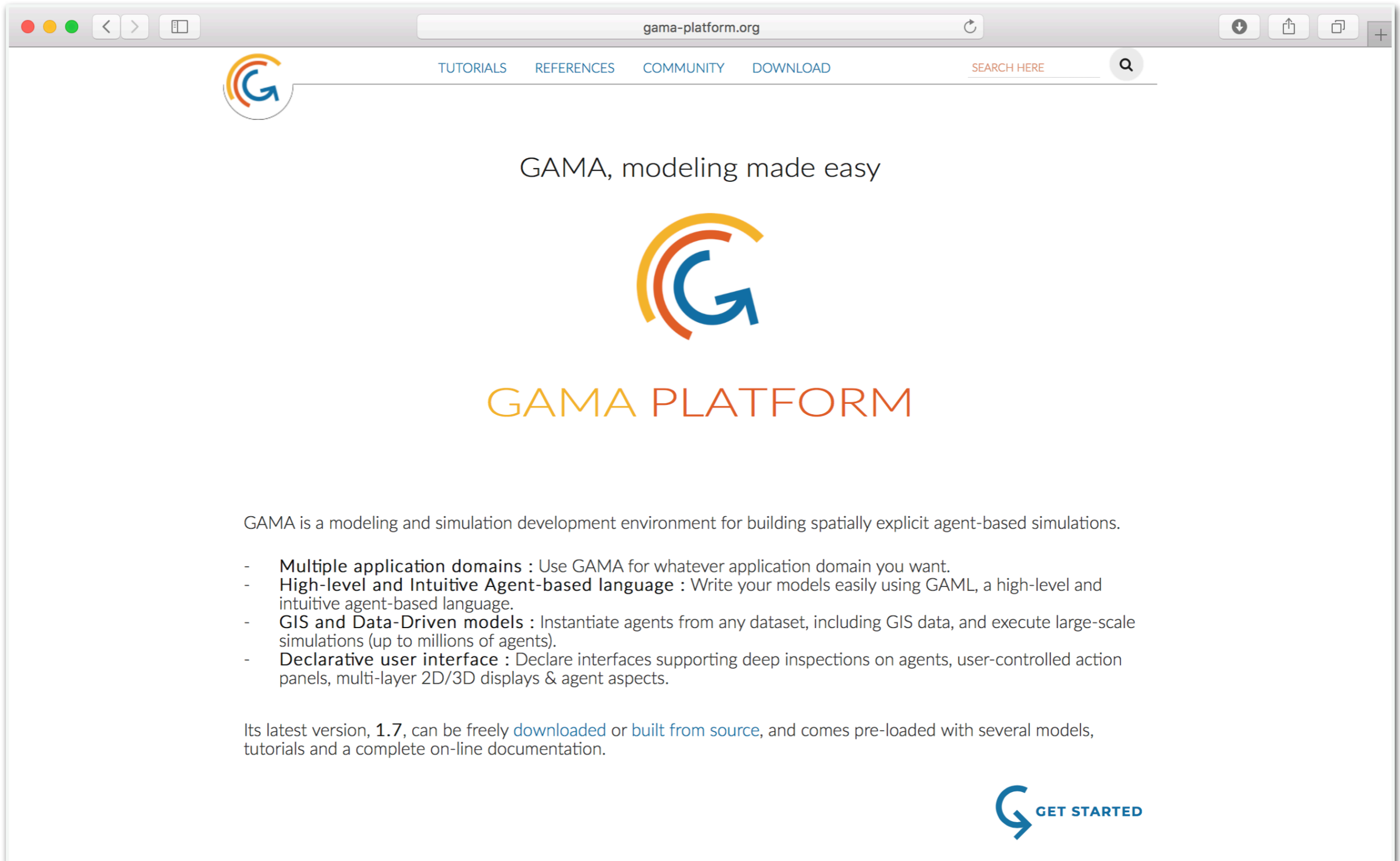
Compartments models



GAMA simulator

Integrating data and models
for forecasting and planning

GAMA simulation platform



The image shows a browser window displaying the GAMA platform website. The browser's address bar shows 'gama-platform.org'. The website features a navigation menu with 'TUTORIALS', 'REFERENCES', 'COMMUNITY', and 'DOWNLOAD', along with a search bar labeled 'SEARCH HERE'. The main content area includes the GAMA logo, the tagline 'GAMA, modeling made easy', and the text 'GAMA PLATFORM'. Below this, a paragraph describes GAMA as a modeling and simulation development environment. A list of features follows, including multiple application domains, high-level agent-based language, GIS and data-driven models, and a declarative user interface. At the bottom, it mentions the latest version (1.7) and provides a 'GET STARTED' button.

gama-platform.org

TUTORIALS REFERENCES COMMUNITY DOWNLOAD SEARCH HERE


GAMA, modeling made easy

GAMA PLATFORM

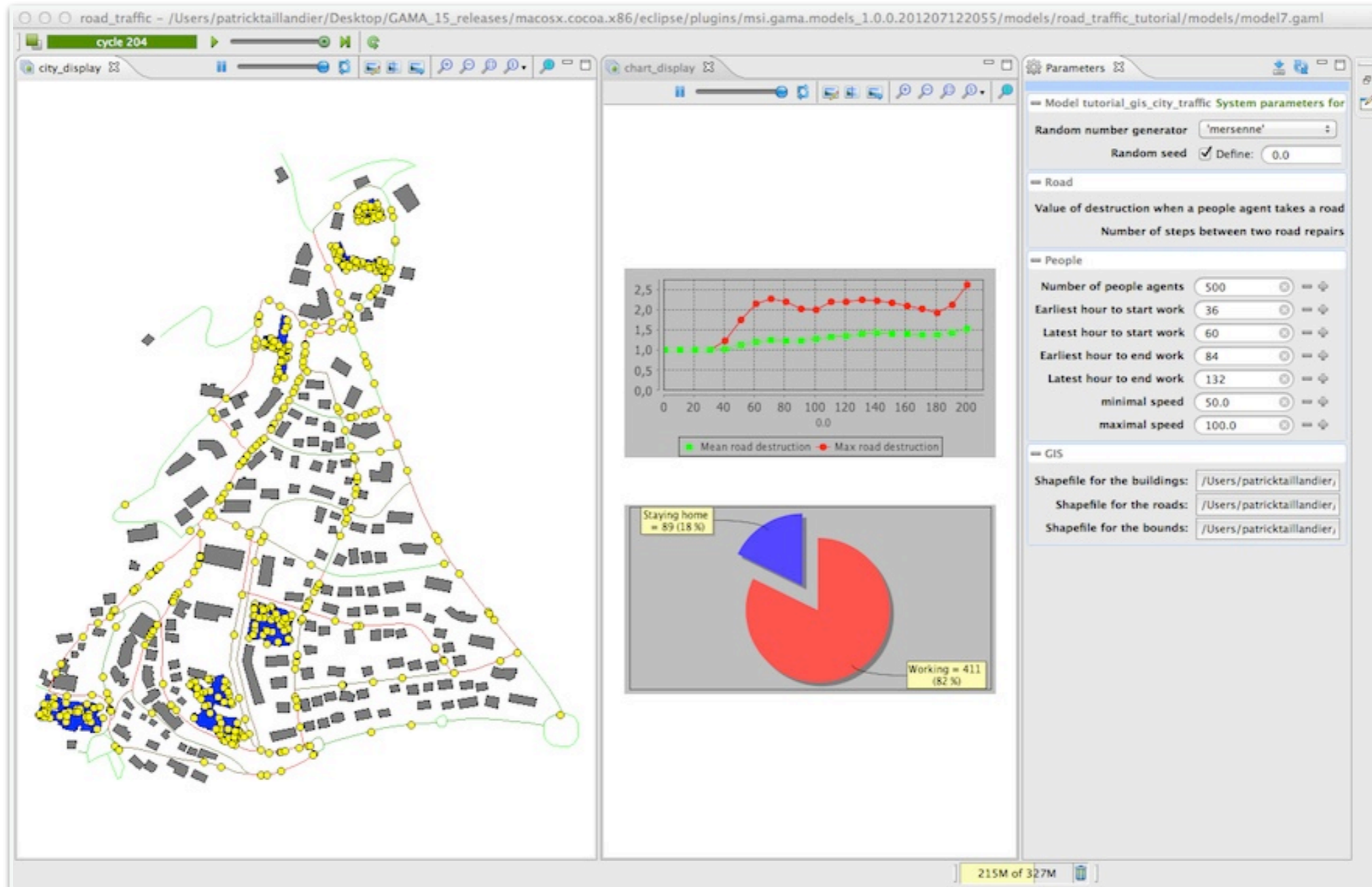
GAMA is a modeling and simulation development environment for building spatially explicit agent-based simulations.

- **Multiple application domains** : Use GAMA for whatever application domain you want.
- **High-level and Intuitive Agent-based language** : Write your models easily using GAML, a high-level and intuitive agent-based language.
- **GIS and Data-Driven models** : Instantiate agents from any dataset, including GIS data, and execute large-scale simulations (up to millions of agents).
- **Declarative user interface** : Declare interfaces supporting deep inspections on agents, user-controlled action panels, multi-layer 2D/3D displays & agent aspects.

Its latest version, **1.7**, can be freely [downloaded](#) or [built from source](#), and comes pre-loaded with several models, tutorials and a complete on-line documentation.

 GET STARTED

GAMA simulation platform



GAMA simulation platform

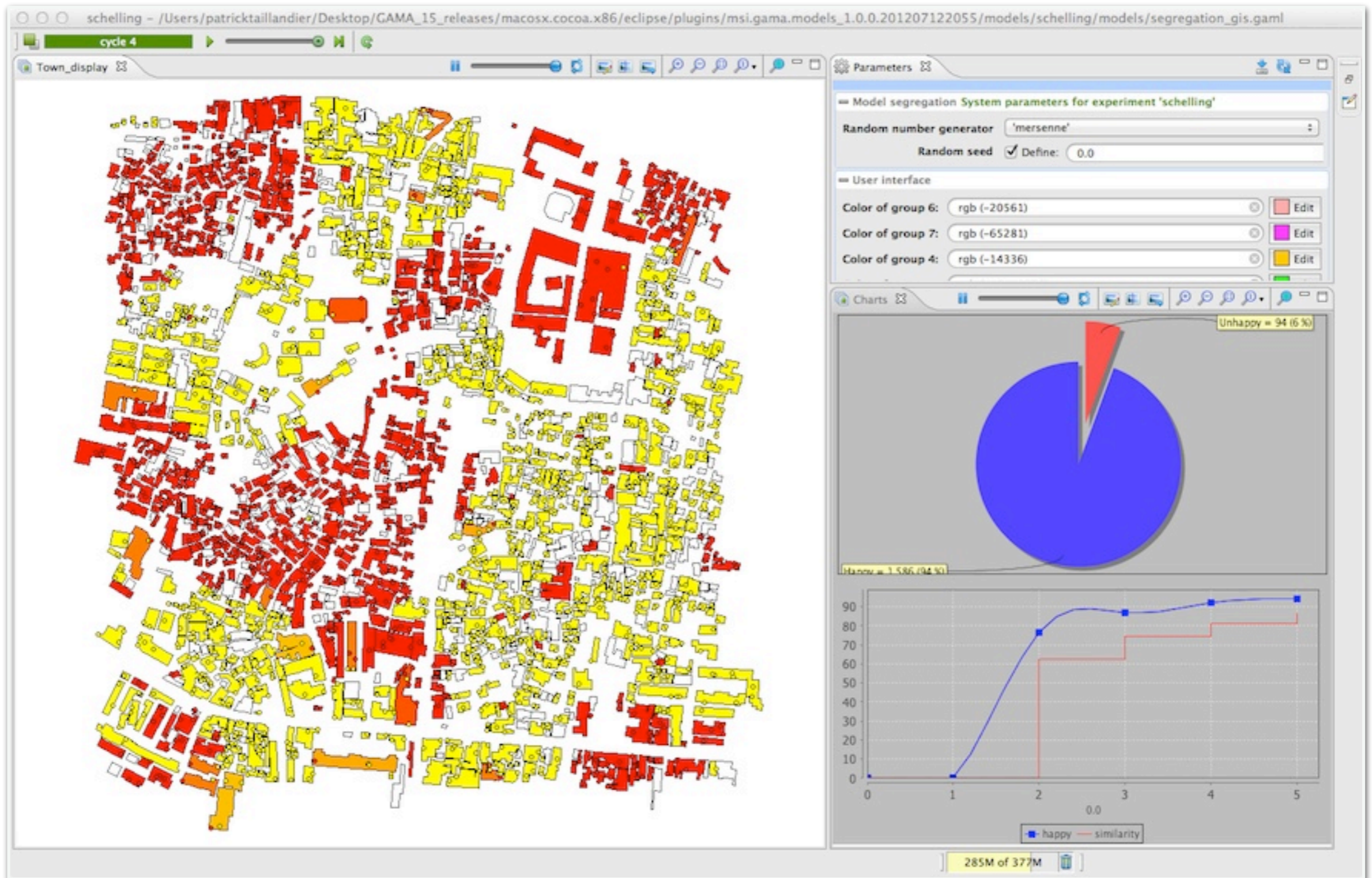
The screenshot displays the GAMA simulation platform interface, which is divided into several key components:

- Model Library (Left Panel):** A tree view showing the project structure, including folders for 'Models library (27)', 'Shared models (0)', and 'User models (2)'. Under 'User models', there is a folder named 'Miro' containing sub-folders 'doc', 'images', 'includes', and 'models'. The 'models' folder contains files 'miro_ensemble.gaml', 'miro2.gaml', 'miro3.gaml', and 'modelTC.gaml'. A 'MyTest' folder is also visible at the bottom.
- Simulation Displays (Top Middle and Right):** Two windows showing the simulation environment. The left window, titled 'opportunity display', shows a map with green and black elements. The right window, titled 'city display', shows a detailed map of a city with numerous small, multi-colored agents (red, yellow, blue, green) moving across a network of roads.
- Activity Information (Middle Bottom):** A window containing a line graph. The y-axis ranges from 0 to 1,000. The x-axis is labeled 't' and ranges from 0 to 1,500. The graph shows two data series: 'Trava' (red line) and 'Demanda' (yellow line). The 'Demanda' series starts at approximately 1,000 and gradually decreases to about 500. The 'Trava' series remains near zero.
- Console (Bottom Left):** A text area displaying the simulation's execution log. It shows various events such as 'arrived', 'reflex 1 33100 Accompagnement', 'Tache courante terminée Domicil', and 'Changement d'activité Achats'.
- Code Editor (Bottom Right):** A window titled 'miro2.gaml' and 'modelTC.gaml' showing GAMA code. The code includes a 'Run experiments:' section with the following logic:

```
set step value: 5;
do write {
  org message value: 'Timetable loading...';
}

let currentPers type: Int value: -1; //timetable at (0,0);
let mycount type: int value: 0;
let currentlist type: list of: activity value:nil;
loop temp_line over: rows list(timetable)
{
  if condition: ( ( Int( list(temp_line) at 0) != currentPers) and (currentlist != nil) and currentPers != -1)
  {
    do write {
      org message value: 'temp_line: ' + (first(currentlist as list) as activity).startingDate; // + ( first(currentlist as list) as Activity);
    }
  }
}
```


GAMA simulation platform



Uses of the simulator

- determining epidemic risk of next season
- epidemics forecasting: where, when, how much, how long
- helping epidemics prevention: where, when, how
- helping interventions during epidemics
- helping urban planning

Thank you
Questions