RECON

Building the next generation of statistical tools for outbreak response using R

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28th November 2016

Imperial College London
MRC Centre for Outbreak Analysis and Modelling

Outline

1. Lessons learnt from the Ebola outbreak response
2. The R Epidemics Consortium
3. Up-and-coming RECON packages
4. Methodological dialogue during outbreak response

Ebola response

Lessons learnt from the Ebola response

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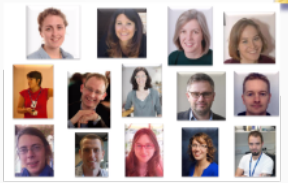

Imperial College Ebola team

Lessons learnt from the Ebola response

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Most statistical/modelling tools for situation awareness missing.

What tools do we need?

Some examples:

- **data cleaning:** dictionaries, entry matching
- **graphics:** case incidence in space and time, contact tracing
- **parameter estimation:** key delays, transmissibility
- **estimate / test CFR:** gender, health care workers, treaments effects
- **predictions:** case incidence, mortality, evaluate interventions
- **report:** (semi-)automated situation reports

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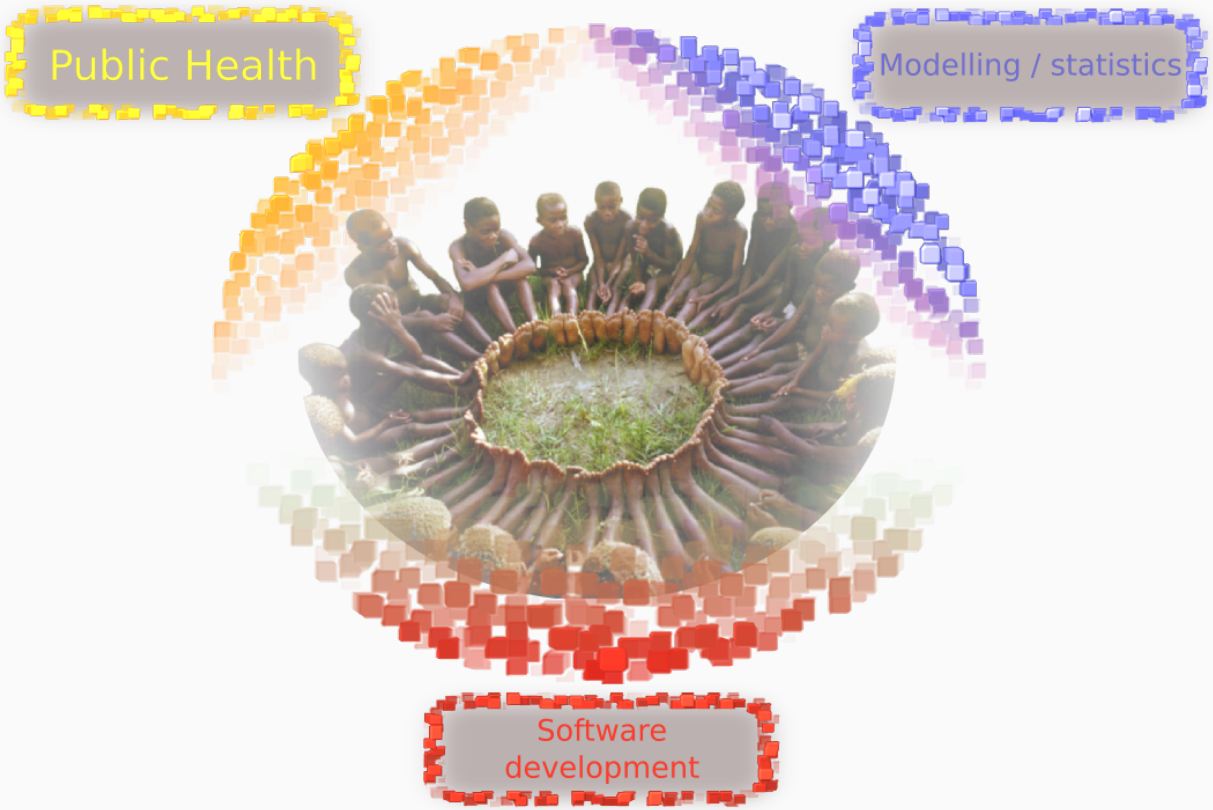

The R Epidemics Consortium

Hackout 3: a R hackathon for emergency outbreak response

Last summer at the *rOpenSci* headquarters (Berkeley)

Hackout 3: from ideas to projects to...

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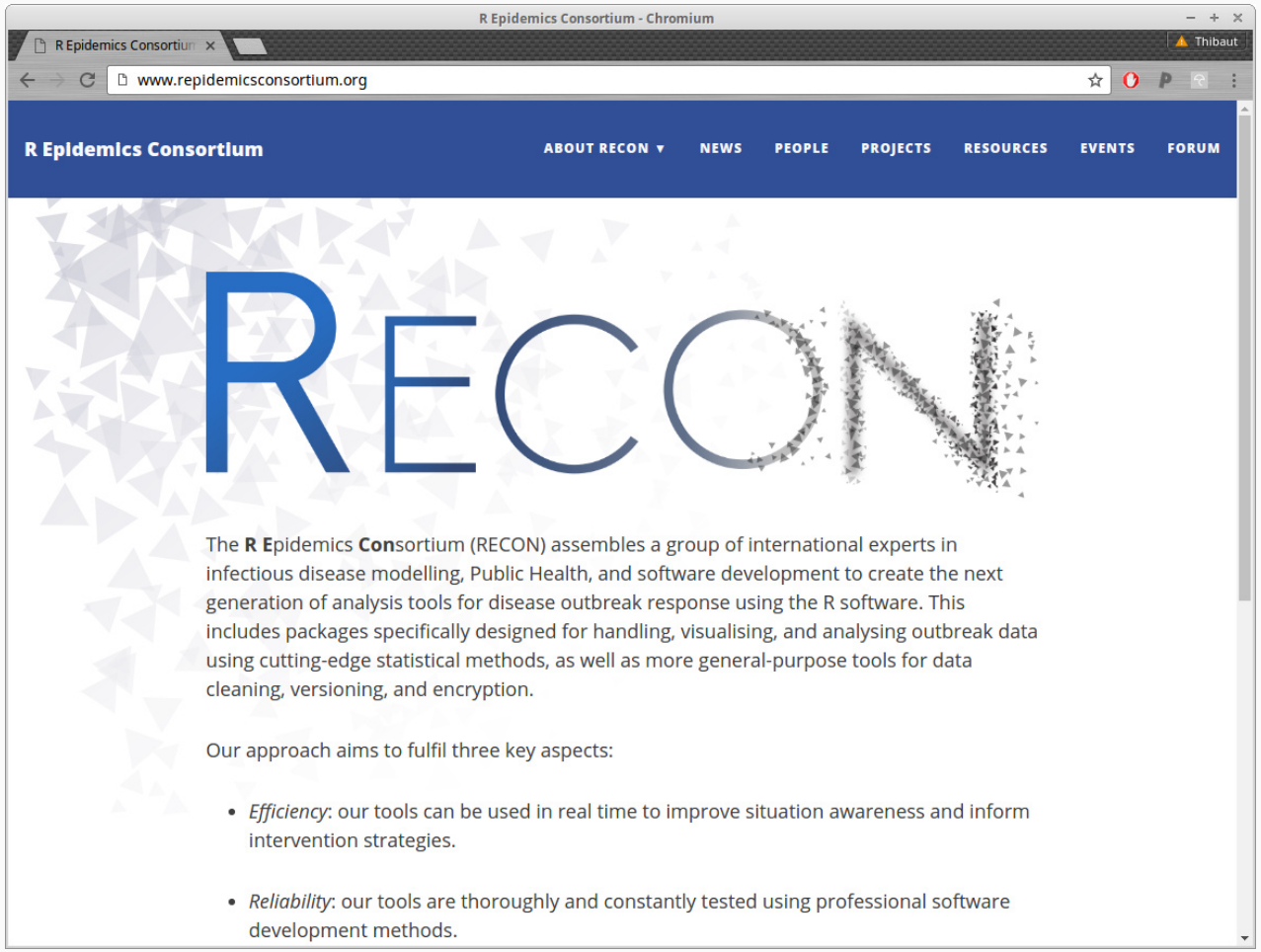
How do we keep momentum once the event is over?

RECON: the R Epidemics Consortium

A taskforce to build a new generation of outbreak response tools in .



www.repidemicsconsortium.org

In a nutshell

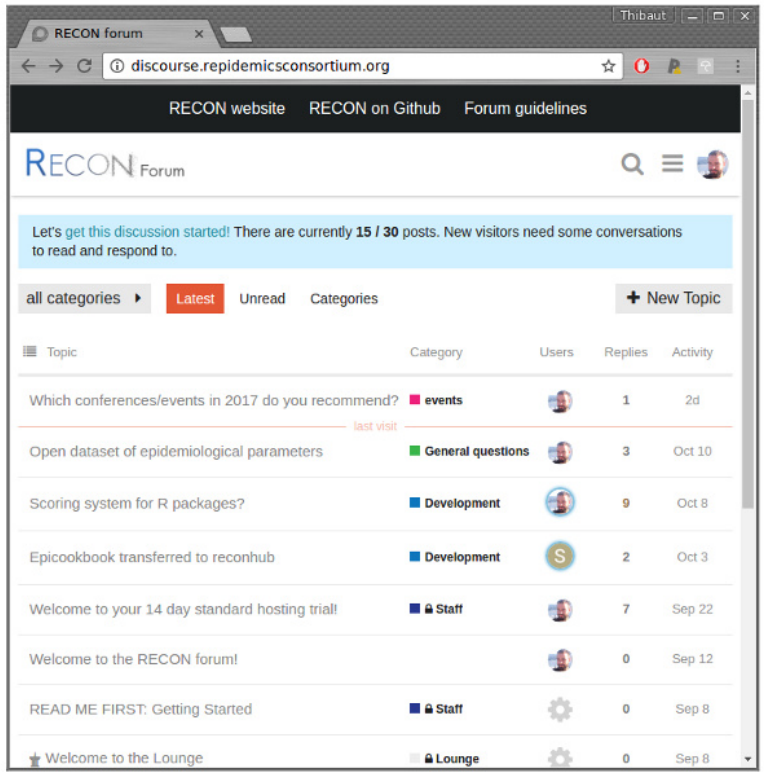
RECON

www.repidemicsconsortium.org

- started 6th September 2016
- 46 people (41 members, 5 board)
- 10 countries, $>$ 20 institutions
- $\sim$ 10 new packages coming
- public forum, blog, online resources

The RECON forum

A platform for discussing epidemics analysis in R.



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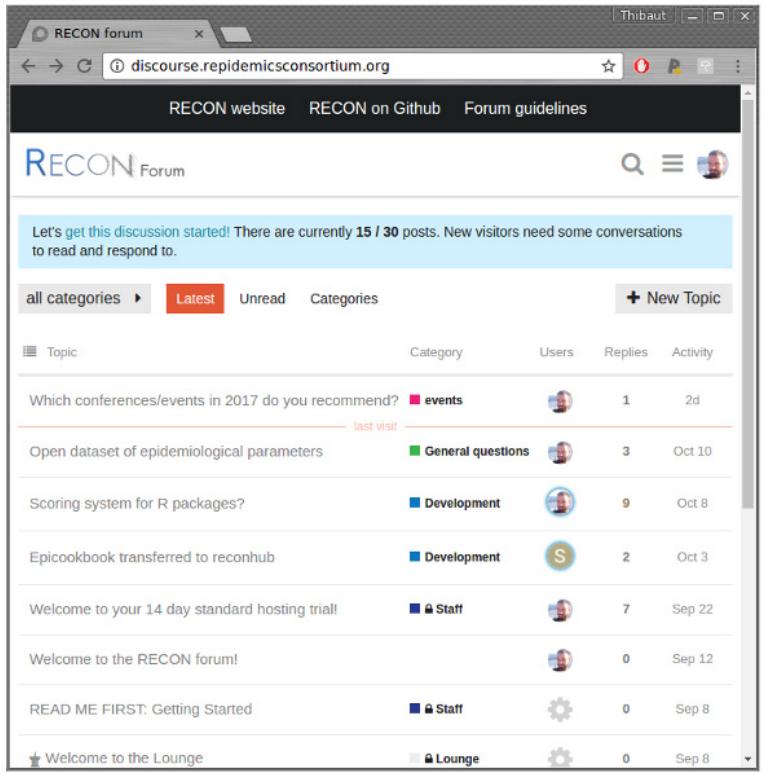

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Join us!

RECON package: what do we aim for?

- **efficiency**: useful for improving situation awareness in real time; cutting-edge, computer-efficient statistical methods

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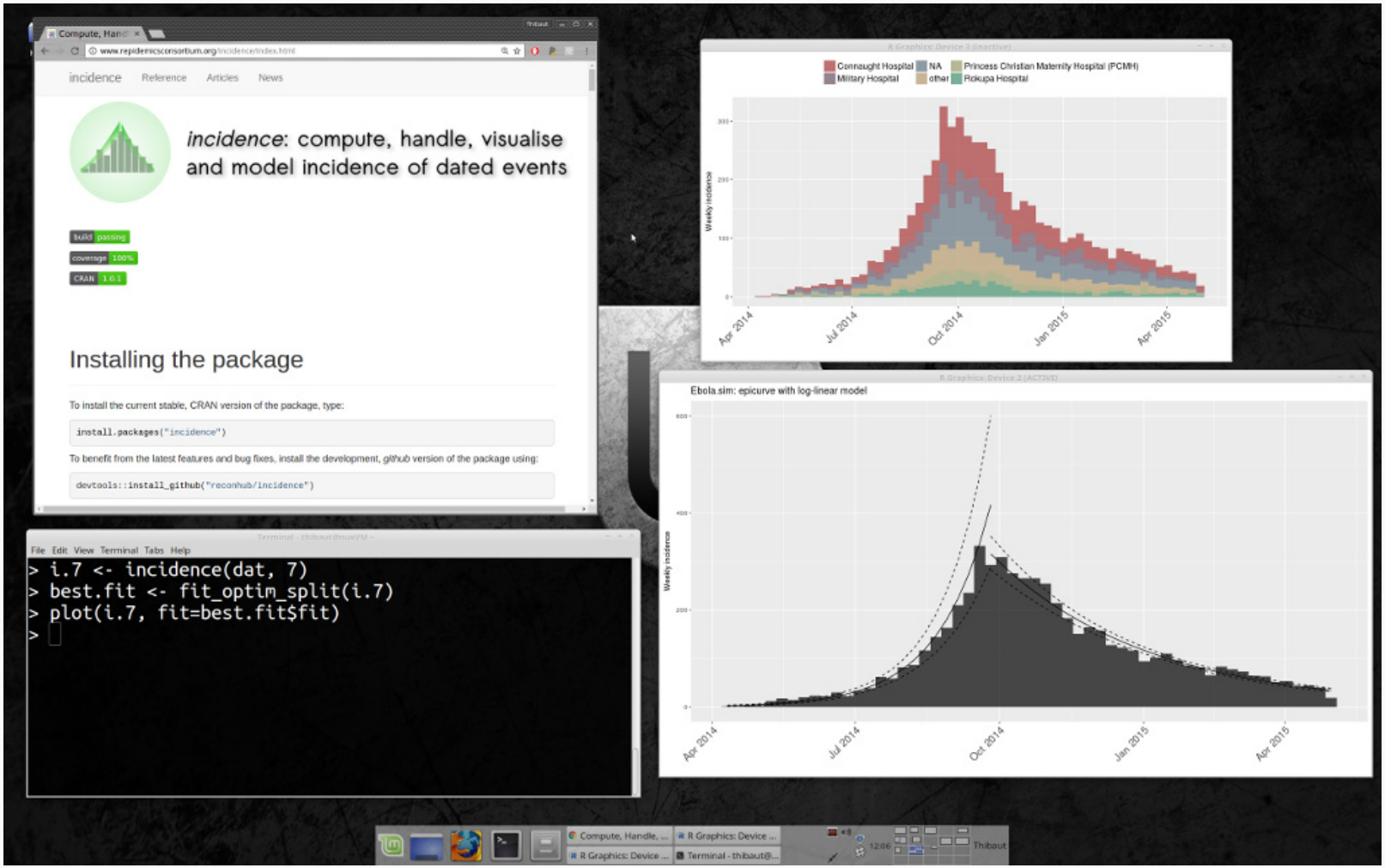
- **efficiency**: useful for improving situation awareness in real time; cutting-edge, computer-efficient statistical methods
- **reliability**: outputs can be trusted; continuous integration, extensive unit testing, code review, good practices
- **accessibility**: widely available, easy learning curve; extensive documentation, tutorials, websites, forum

Up-and-coming RECON packages

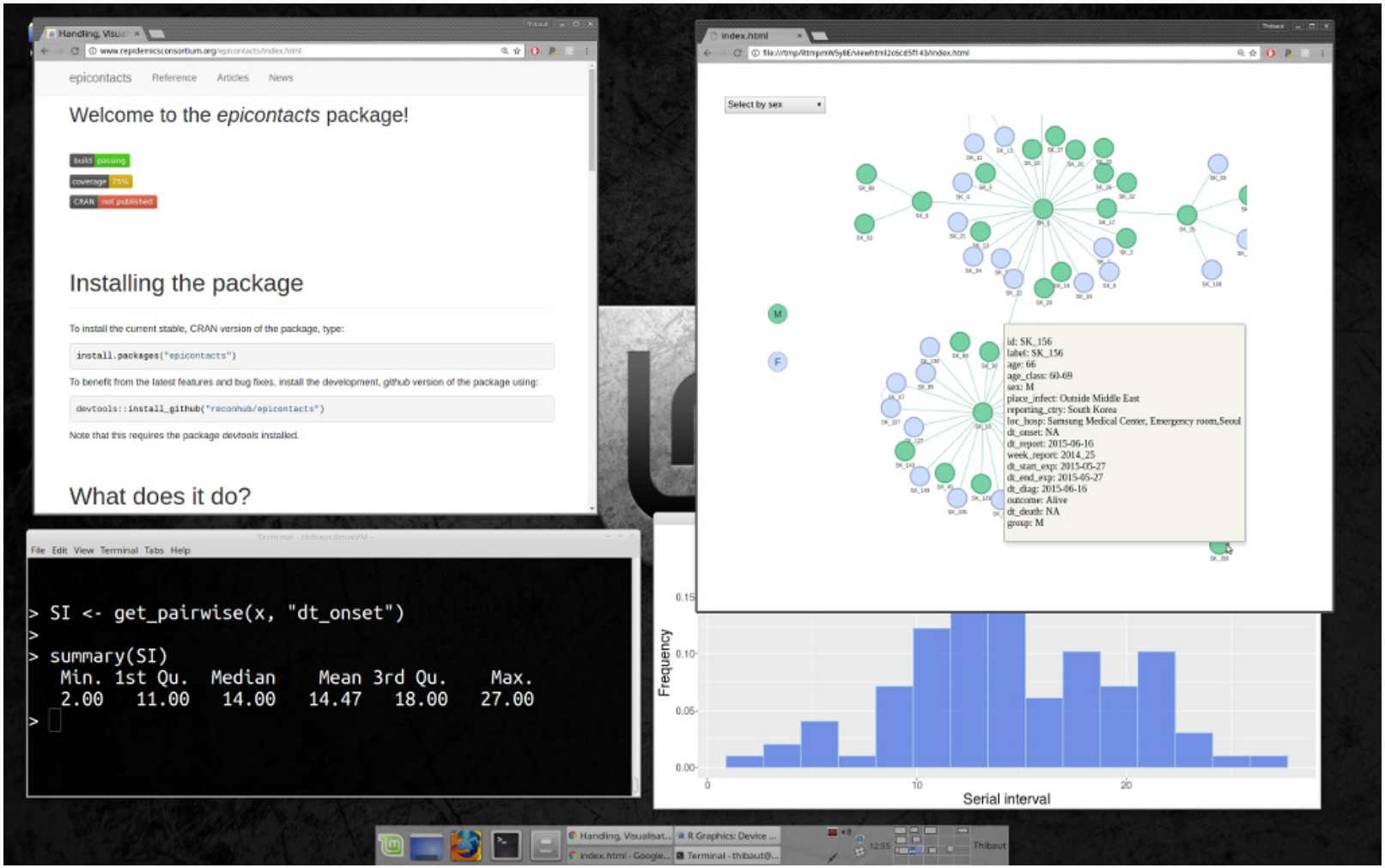
incidence: computation, handling, visualisation and modelling of epicurves



www.repidemicsconsortium.org/incidence

[released]

epicontacts: handling, visualisation and analysis of epidemiological contacts



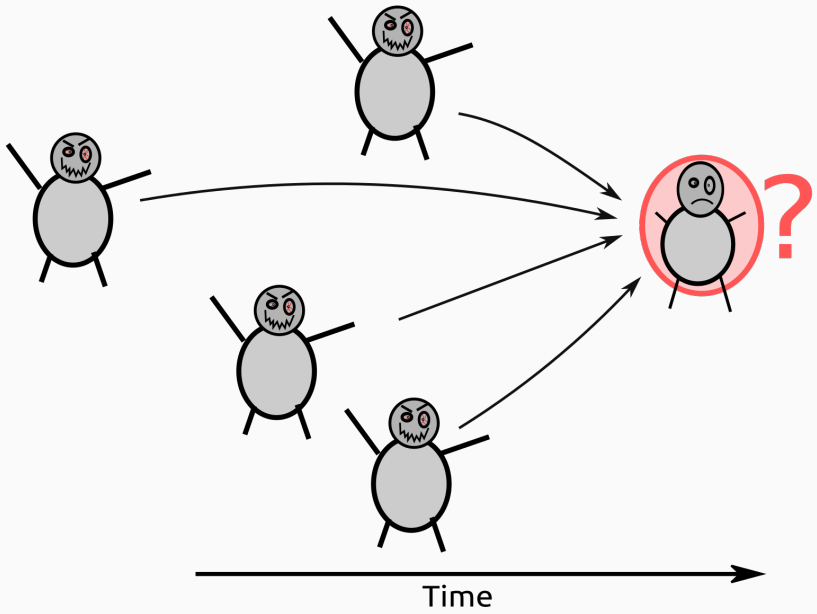
www.repidemicsconsortium.org/epicontacts

[release December 2016]

outbreaker2: inferring who infects whom in an outbreak

Original *outbreaker* model: timing of symptoms and pathogen genomes to infer infectors

(Jombart *et al*, PLoS Comp Biol, 2014)



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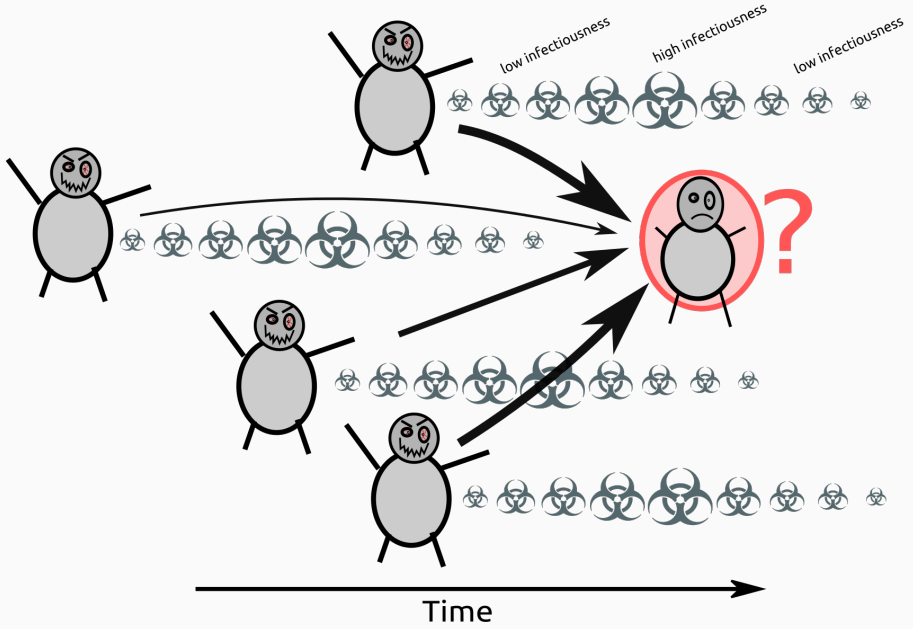

Since *outbreaker*: new models, data, and questions.

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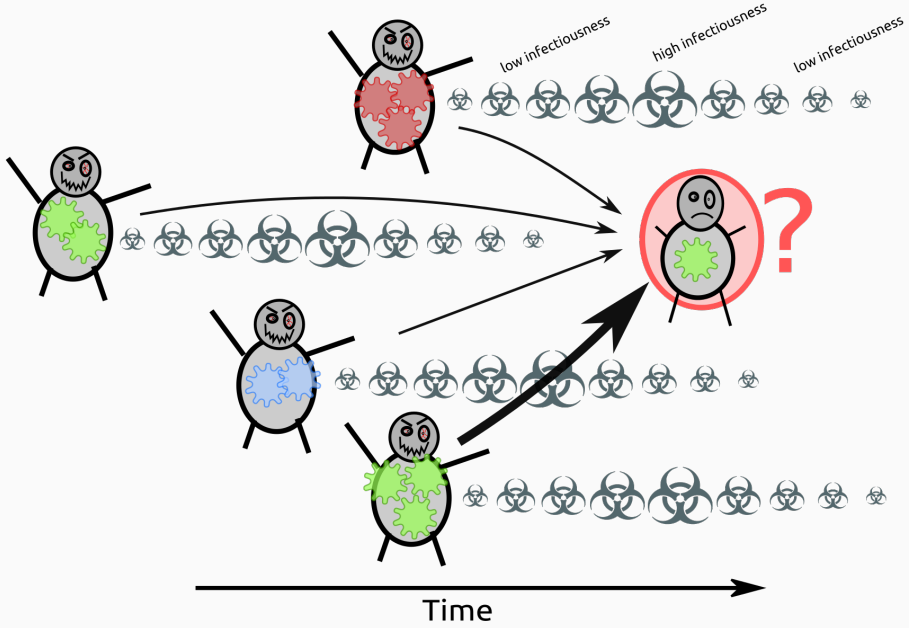

Since *outbreaker*: new models, data, and questions.

But: methodological niche fragmented.

Are different methods really... different?

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Different models can lead to very similar implementations.

Can we find a general formulation?

What do these model look like?

- a, b, c: different types of data
- θ: parameters / augmented data

Data are often assumed to be *conditionally independent*:

$$p(a, b, c|\theta) = p(a|\theta)p(b|\theta)p(c|\theta)$$

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Components can be treated as plugins.

outbreaker2: a general cauldron for cooking methods

Use-your-own: data type, likelihood, prior, MCMC.

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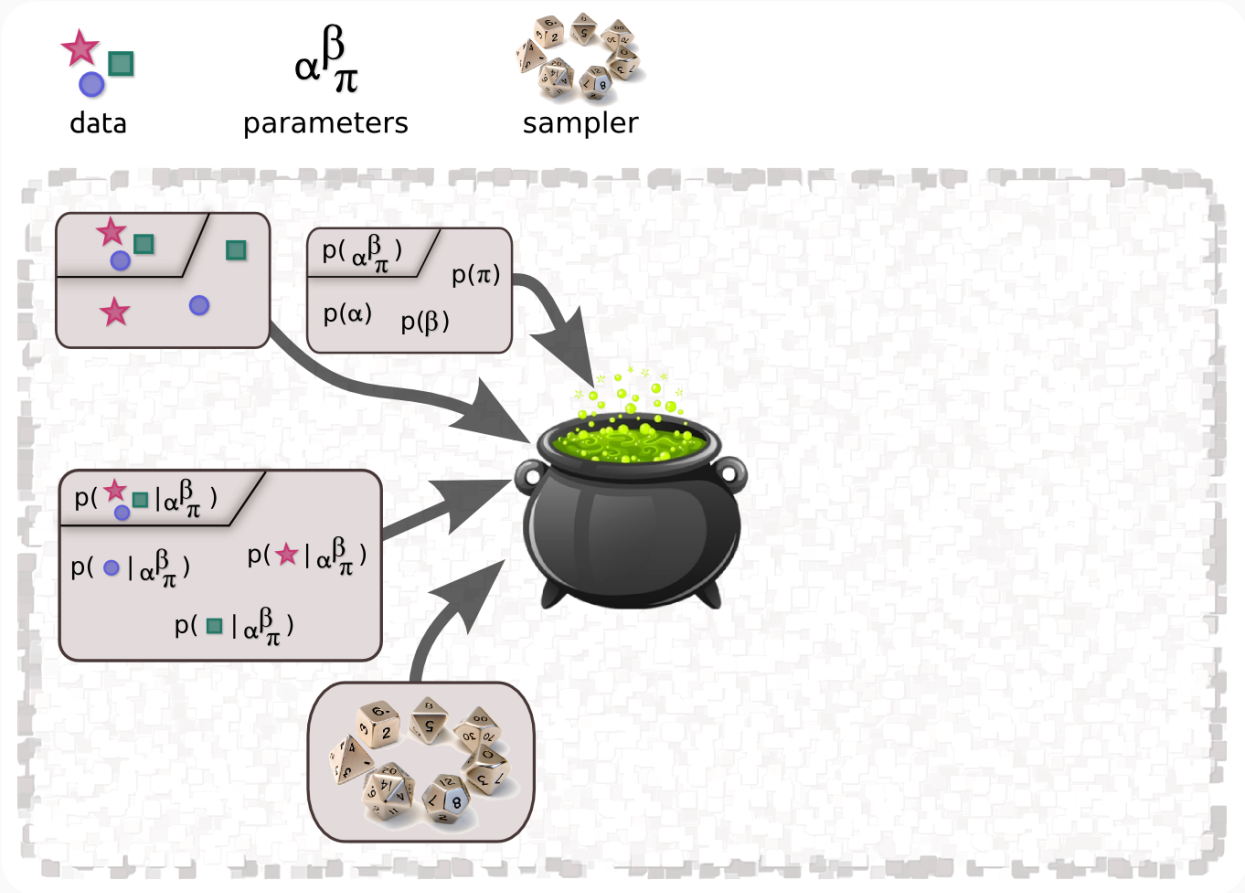

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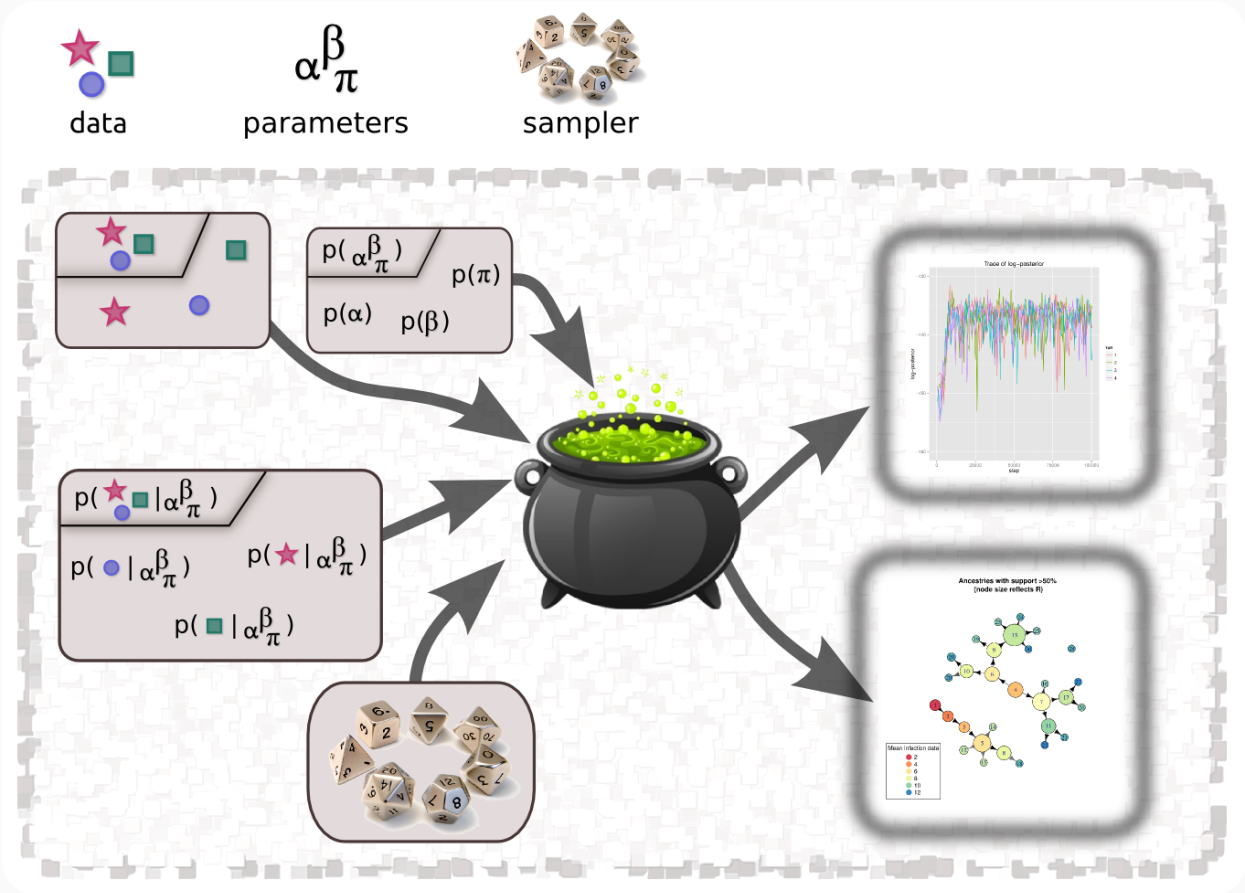

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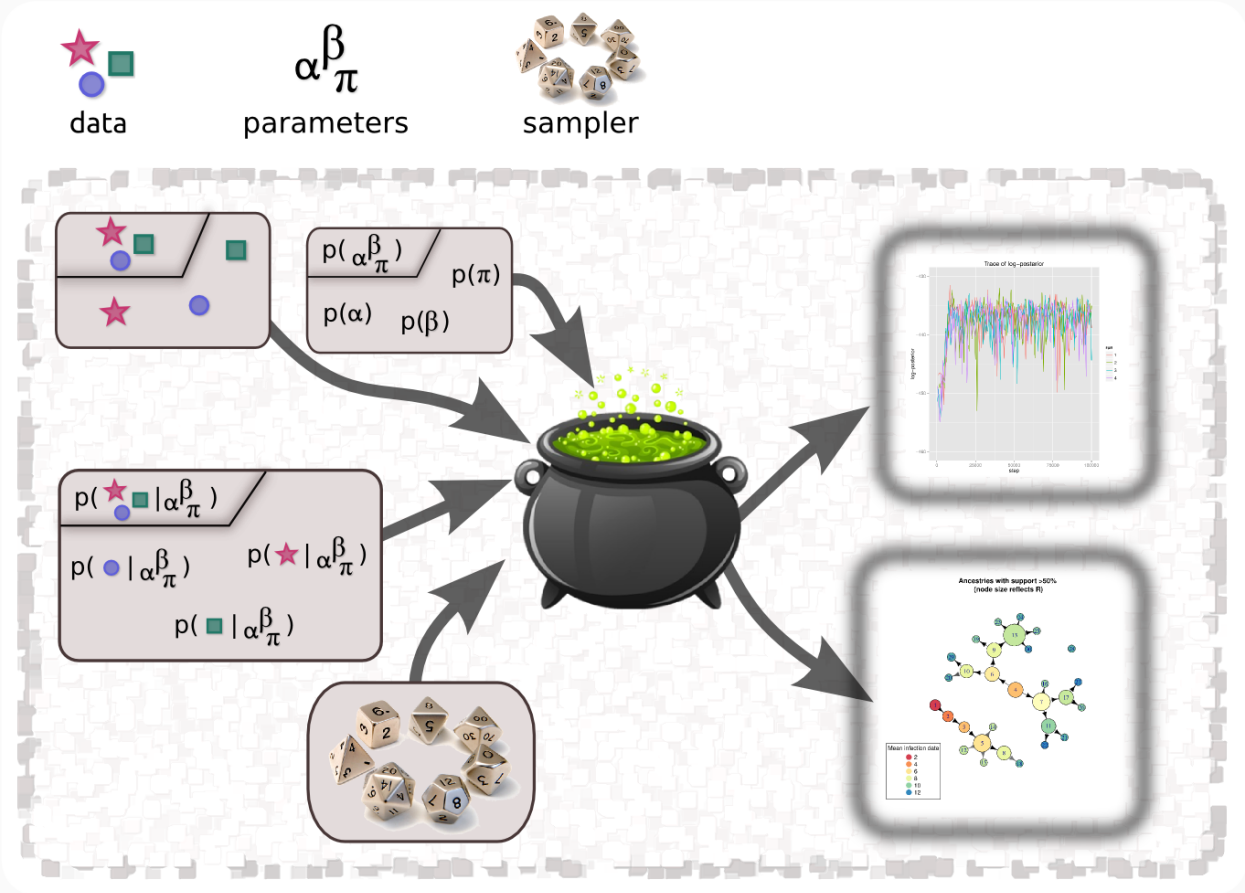
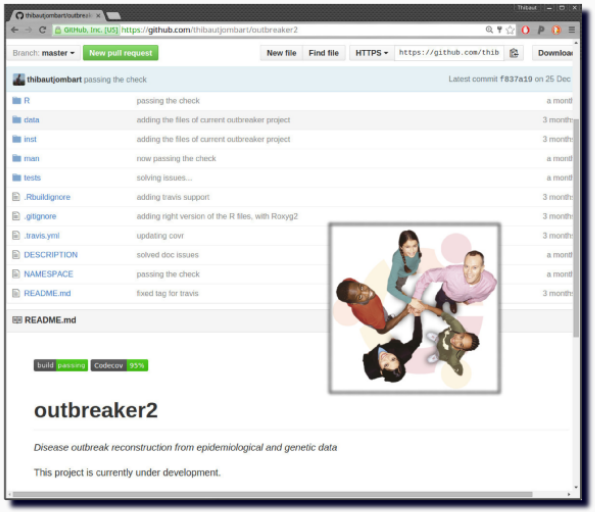
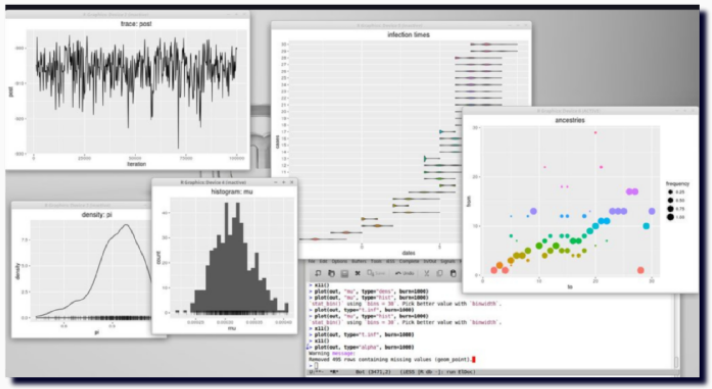


Modularity is key to generalising approaches

outbreaker2: a general tool for outbreak reconstruction





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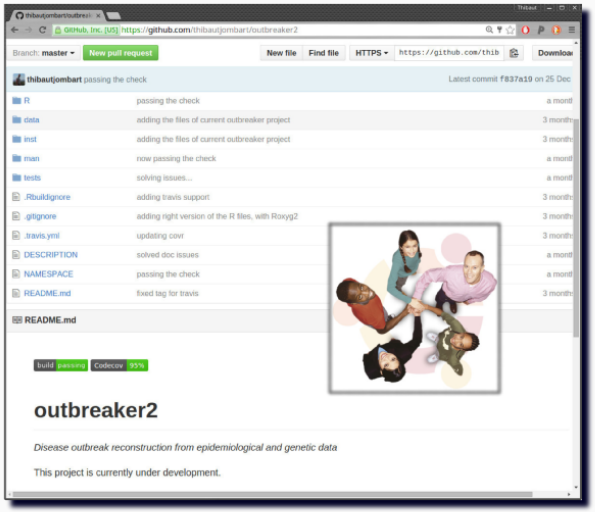
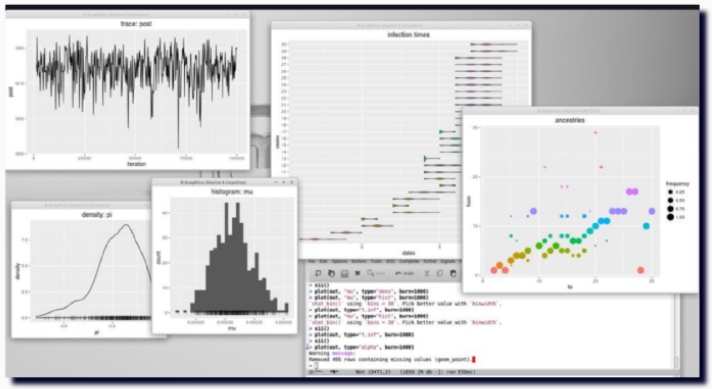
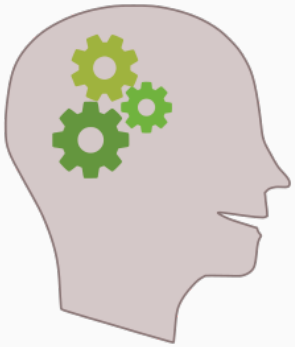




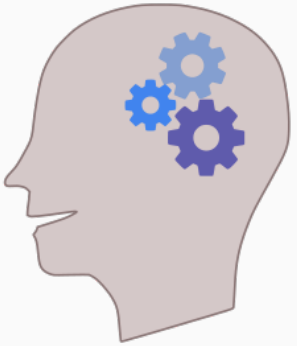
- **modularity**: customise model and sampler, optional Rcpp
- **reliability**: continuous integration, extensive unit testing (aiming for 100% coverage)
- **prettier**: plot methods using *ggplot2*, interactive networks visualisation
- enable **contributions from the community**
- release planned for early 2017

Methodological dialogue

Methodological development relies on an interdisciplinary dialogue



Epidemiologist



Methodologist

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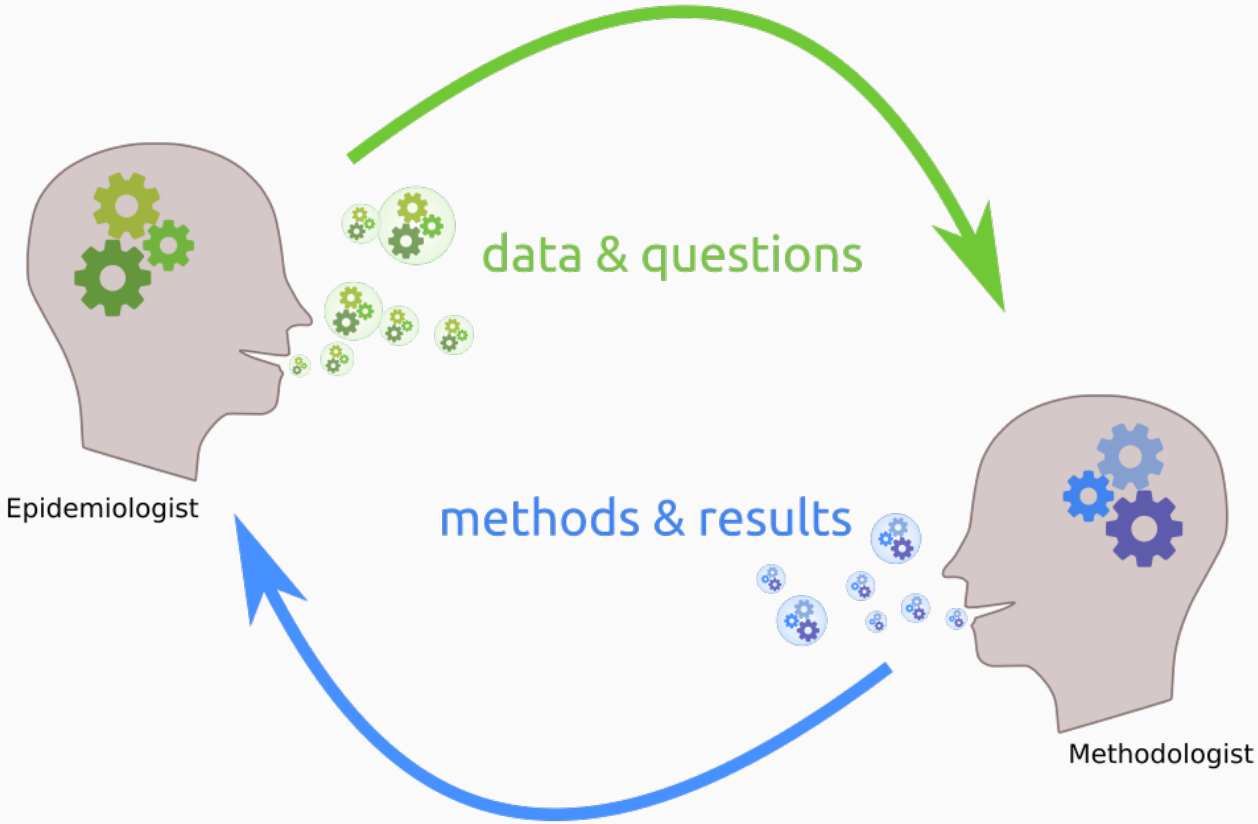

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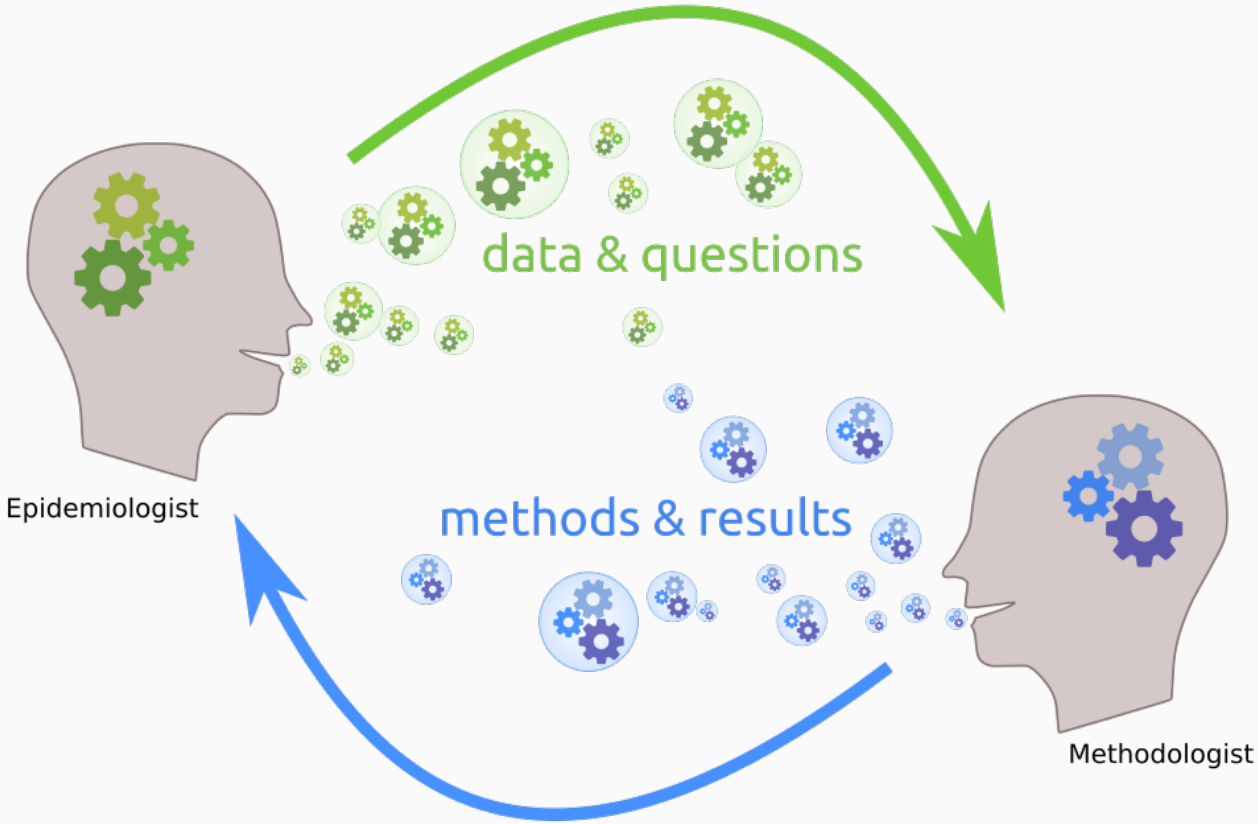

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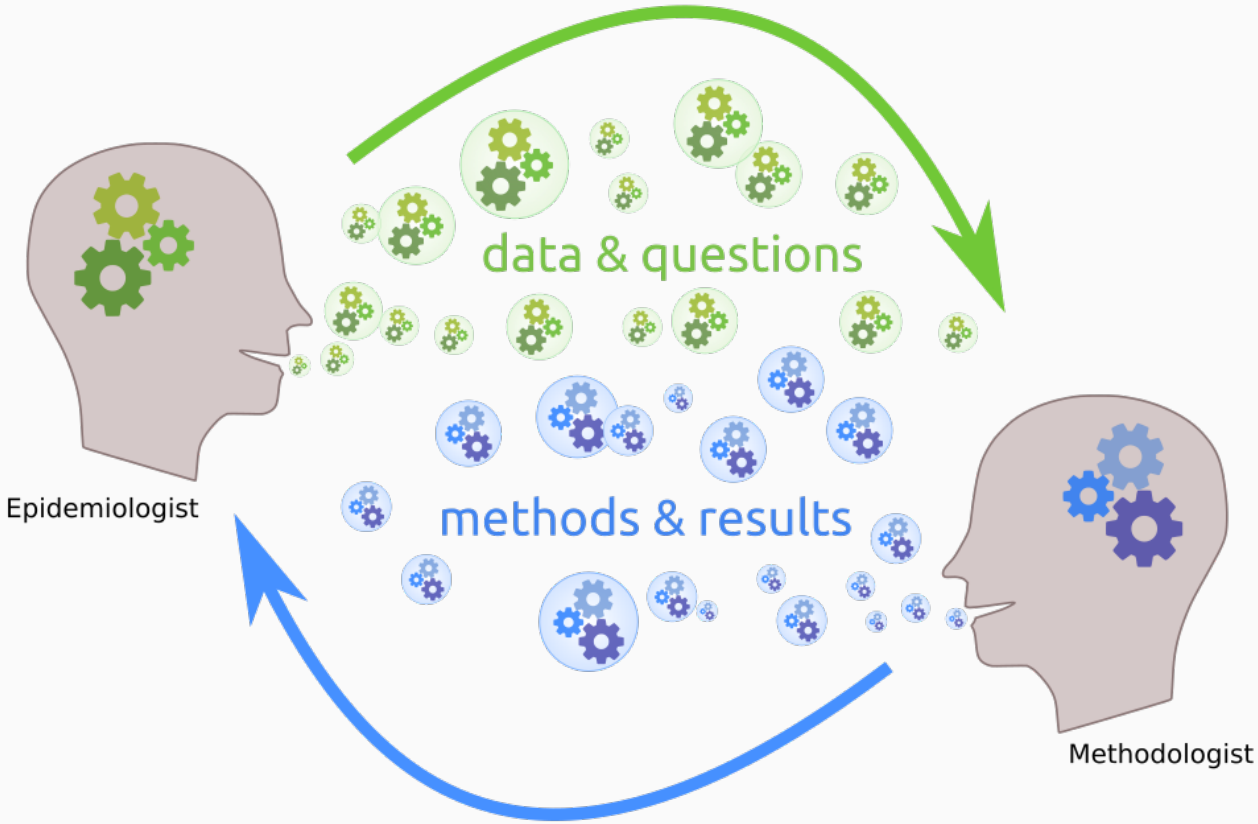

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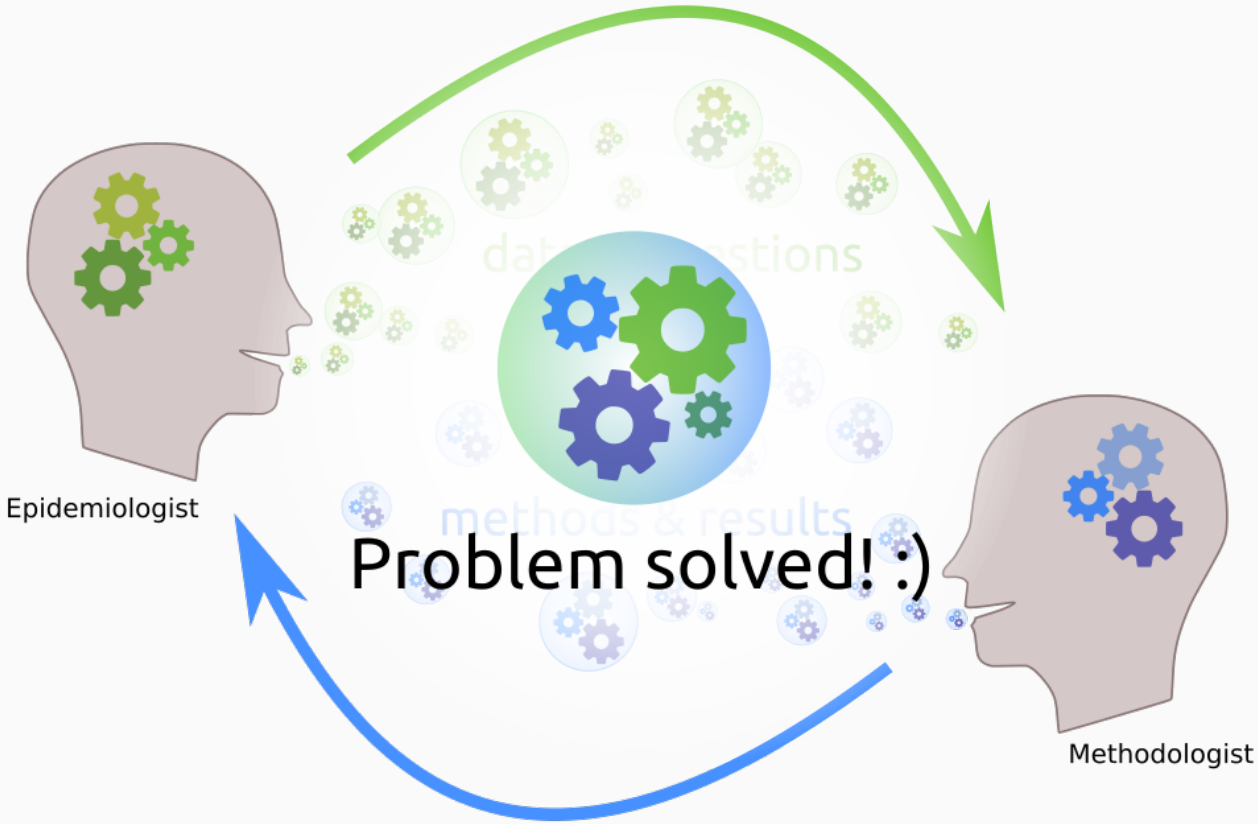

Outbreak response context creates distance and delays

Affected countries

data collection

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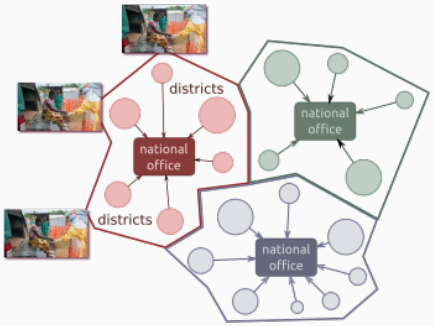

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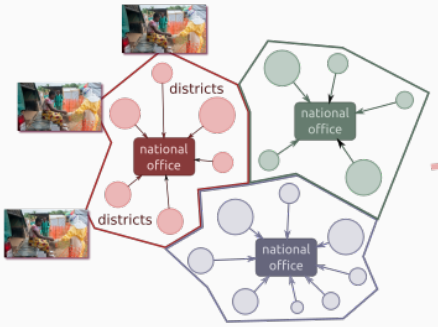
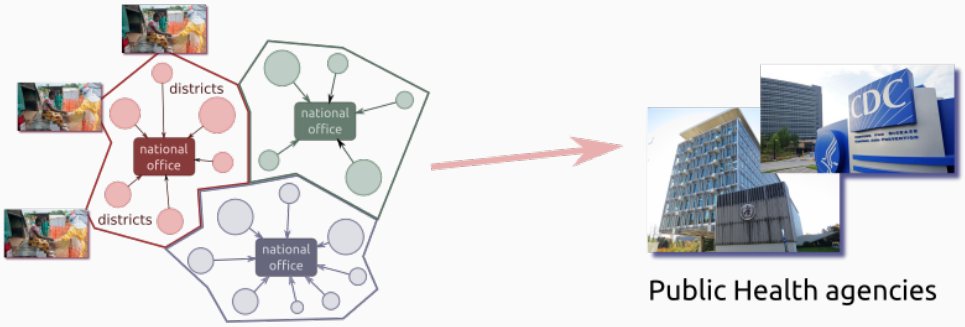


Affected countries

Public Health agencies

data collection

Outbreak response context creates distance and delays



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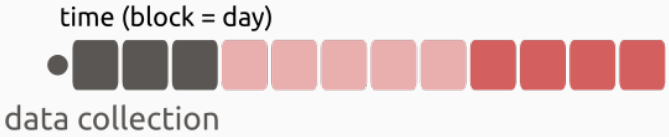
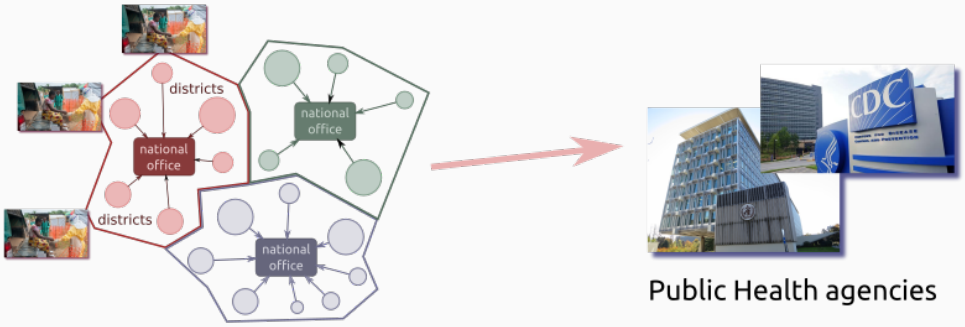


Outbreak response context creates distance and delays



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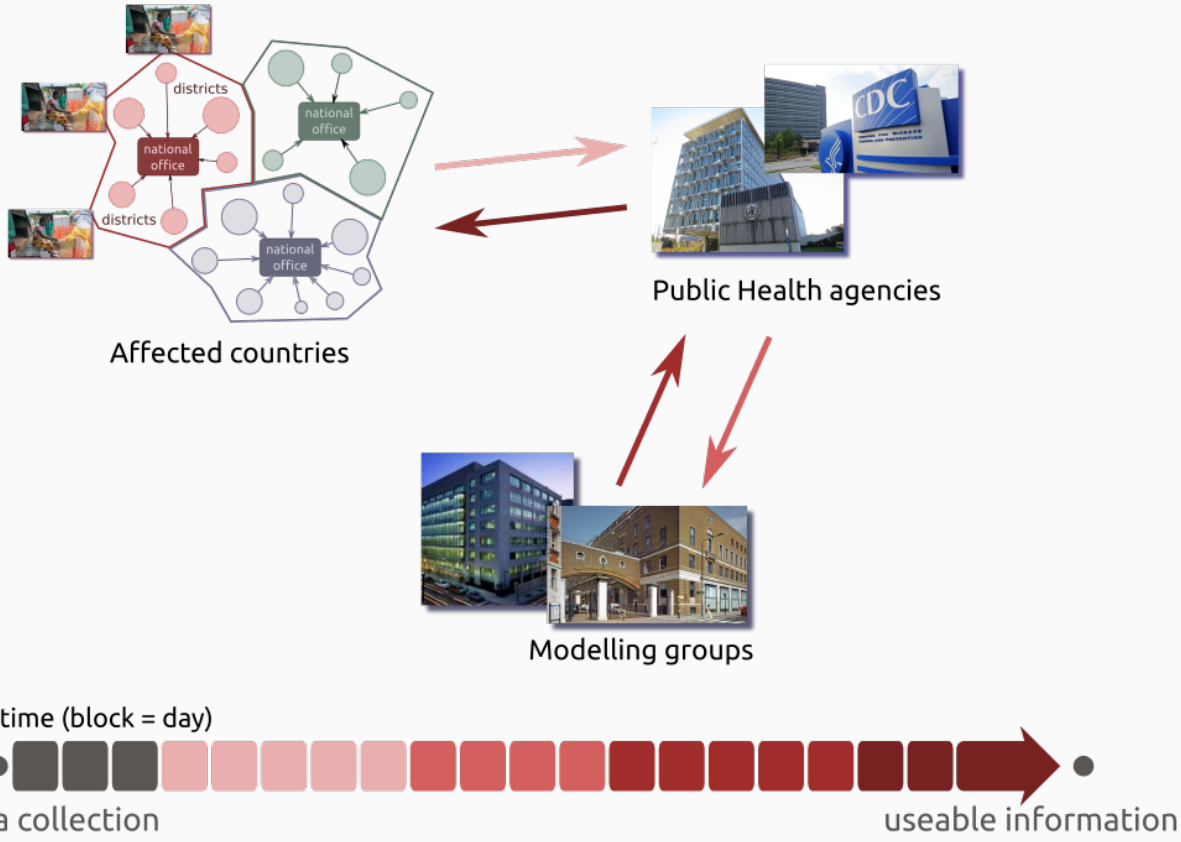
Modelling groups

time (block = day)

data collection

Outbreak response context creates distance and delays



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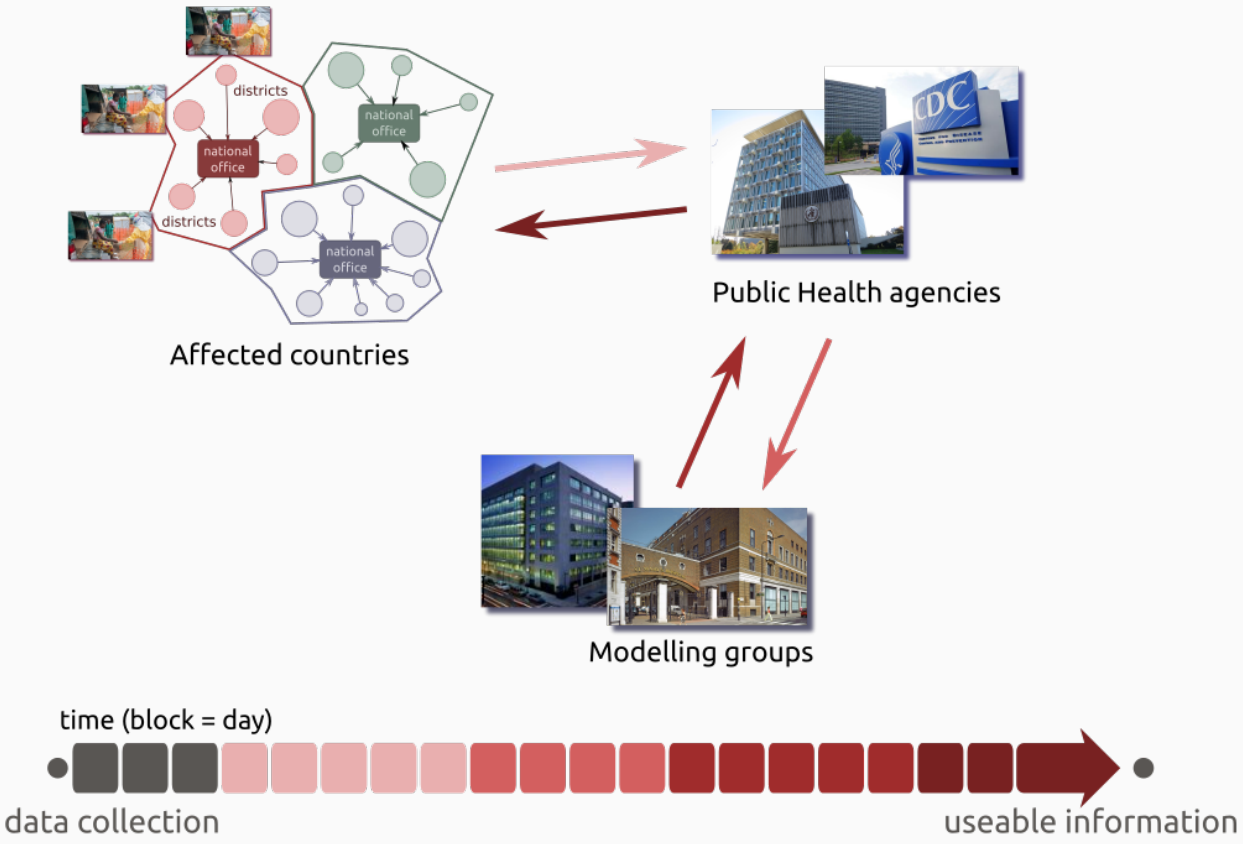
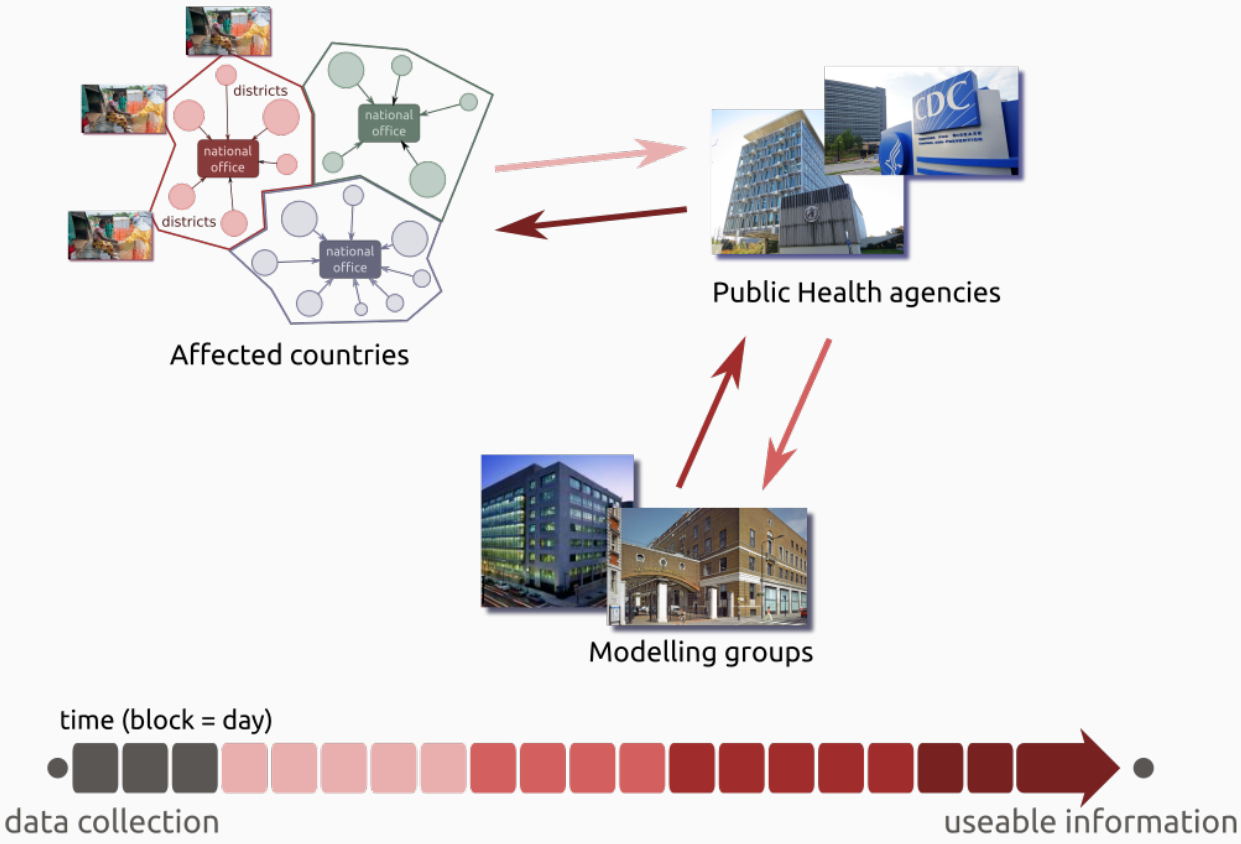


- efficient tools can shorten delays

Outbreak response context creates distance and delays



- efficient tools can shorten delays
- potential of embedding methodologists in outbreak response teams

Thanks to...

- **ESCAIDE organisers**
- **Imperial College:** Neil Ferguson, Rich Fitzjohn, Anne Cori, Finlay Campbell, Evgenia Markvardt, James Hayward
- **UC Berkeley:** Karthik Ram
- **Groups:** WHO Ebola Response Team, Hackout 1/2/3, RECON members
- **funding:** HPRU-NIHR, MRC

More on:

www.repidemicsconsortium.org

Questions?