

RECON

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

Thibaut Jombart

28th November 2016

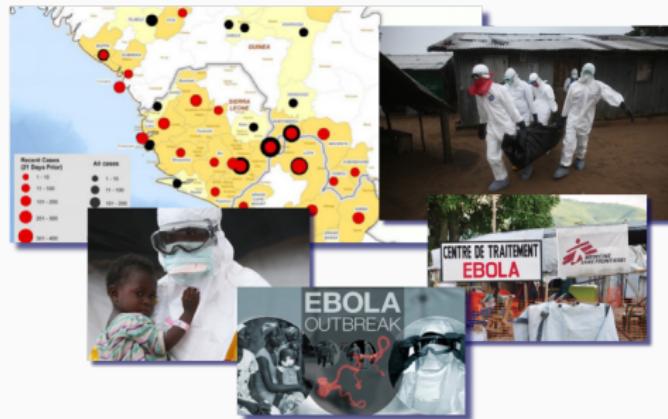
Imperial College London

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



Lessons learnt from the Ebola response



Lessons learnt from the Ebola response

WHO Ebola response team

Help improving situation awareness

EBOLA OUTBREAK

December 2013 March 2014 August 2014 September 2015

First case WHO notified First data/report Latest data update

Imperial College Ebola team

Lessons learnt from the Ebola response



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, treatments effects
- **predictions:** case incidence, mortality, evaluate interventions
- **report:** (semi-)automated situation reports

Who do we need to develop these tool?



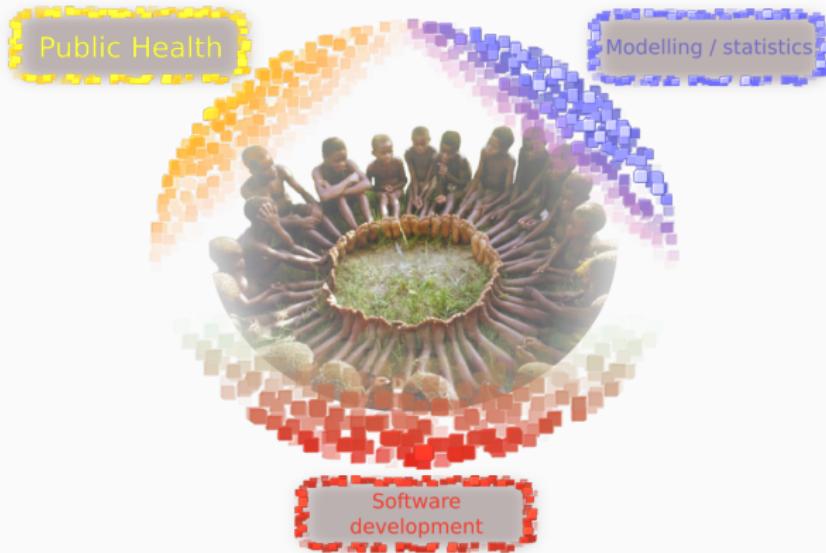
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The R Epidemics Consortium

Hackout 3: a hackathon for emergency outbreak response

Last summer at the *rOpenSci* headquarters (Berkeley)



CDC
CENTERS FOR DISEASE
CONTROL AND PREVENTION

World Health Organization

MÉDECINS SANS FRONTIÈRES
DOCTORS WITHOUT BORDERS

Public Health Agency of Canada

MRC
Centre for Outbreak Analysis and Modelling

National Institute for Public Health and the Environment
Ministry of Health, Welfare and Sport

Imperial College London

UNIVERSITY OF CAMBRIDGE

UNIVERSITY OF OXFORD

LONDON SCHOOL OF HYGIENE & TROPICAL MEDICINE

Public Health England

ECDC
EUROPEAN CENTRE FOR DISEASE PREVENTION AND CONTROL

BERKELEY
Institute for Data Science

wellcome trust
sanger
institute

JOHNS HOPKINS
BLOOMBERG SCHOOL
of PUBLIC HEALTH

Hackout 3: from ideas to projects to...



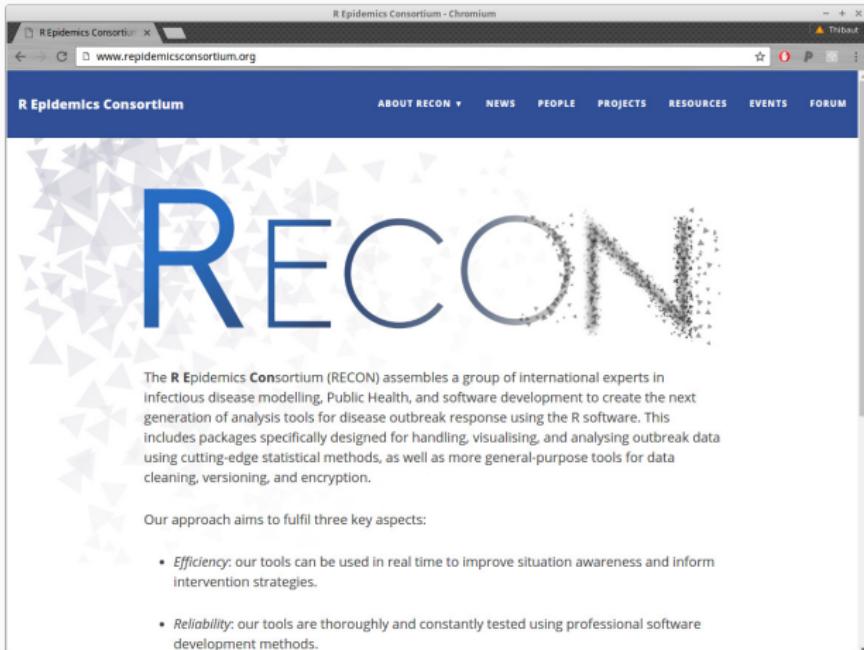
Hackout 3: from ideas to projects to...



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  .



The screenshot shows a web browser window displaying the 'R Epidemics Consortium' website. The title bar reads 'R Epidemics Consortium - Chromium'. The address bar shows the URL 'www.repidemicsconsortium.org'. The page header has a dark blue background with white text, featuring the 'RECON' logo in large blue letters. Below the logo is a paragraph of text about the consortium's purpose. A sidebar on the left contains a list of key aspects. At the bottom, there is a footer with the website's name.

R Epidemics Consortium - Chromium

www.repidemicsconsortium.org

R Epidemics Consortium

ABOUT RECON NEWS PEOPLE PROJECTS RESOURCES EVENTS FORUM

RECON

The R Epidemics Consortium (RECON) assembles a group of international experts in infectious disease modelling, Public Health, and software development to create the next generation of analysis tools for disease outbreak response using the R software. This includes packages specifically designed for handling, visualising, and analysing outbreak data using cutting-edge statistical methods, as well as more general-purpose tools for data cleaning, versioning, and encryption.

Our approach aims to fulfil three key aspects:

- *Efficiency*: our tools can be used in real time to improve situation awareness and inform intervention strategies.
- *Reliability*: our tools are thoroughly and constantly tested using professional software development methods.

repidemicsconsortium.org

RECON

www.repidemicsconsortium.org

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

RECON package: what do we aim for?

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

RECON package: what do we aim for?

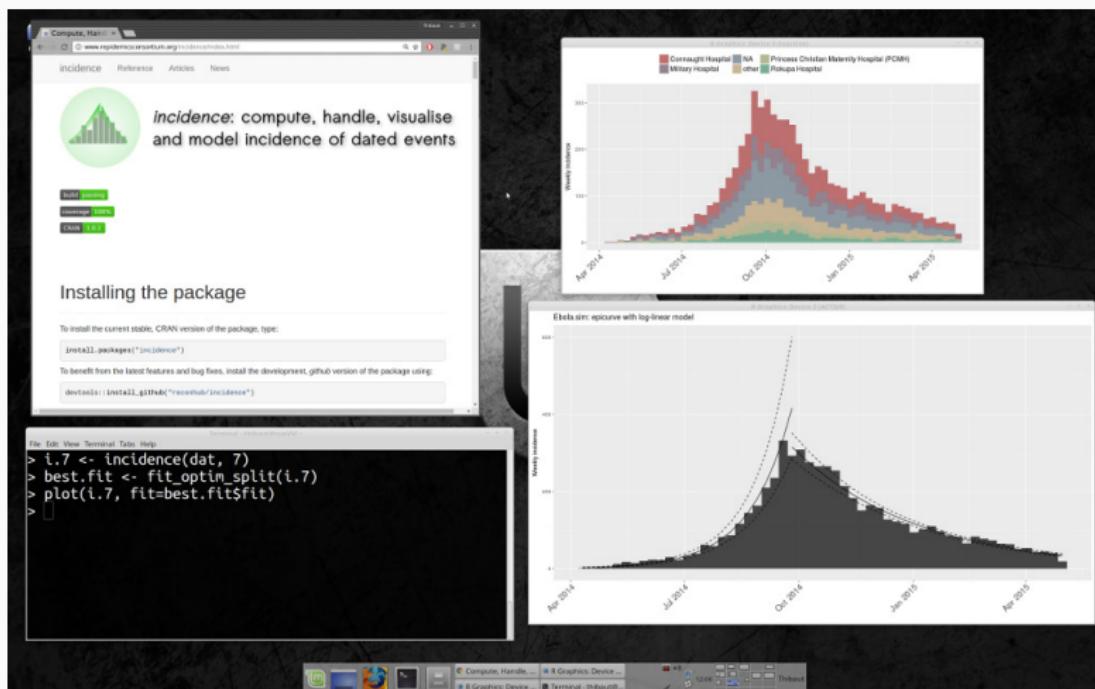
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- **reliability**: outputs can be trusted; **continuous integration, extensive unit testing, code review, good practices**

RECON package: what do we aim for?

- **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

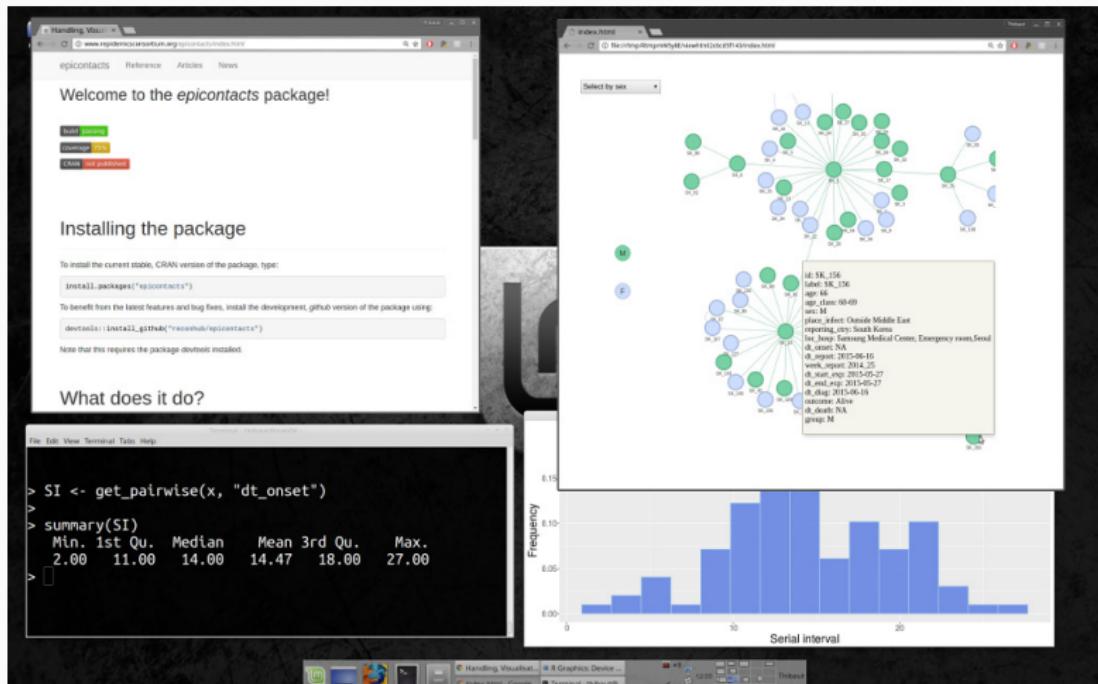
incidence: computation, handling, visualisation and modelling of epicurves



www.repidemicsconsortium.org/incidence

[released]

epicontacts: handling, visualisation and analysis of epidemiological contacts



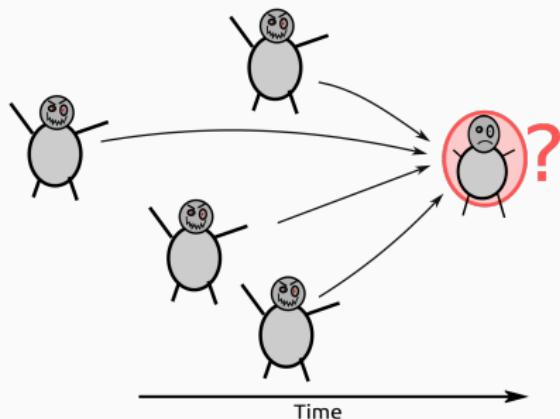
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[release December 2016]

outbreaker2: inferring who infects whom in an outbreak

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

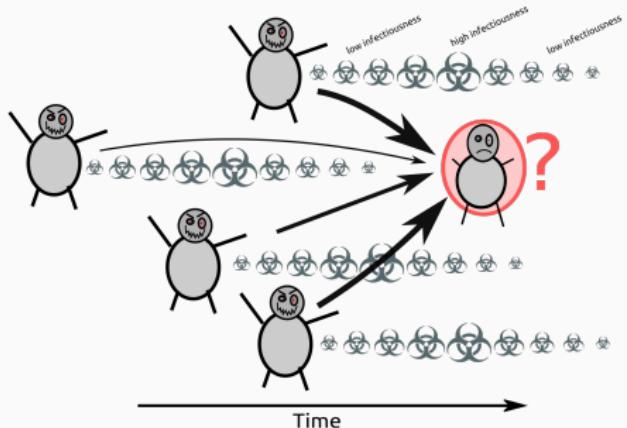
(Jombart et al, PLoS Comp Biol, 2014)



outbreaker2: inferring who infects whom in an outbreak

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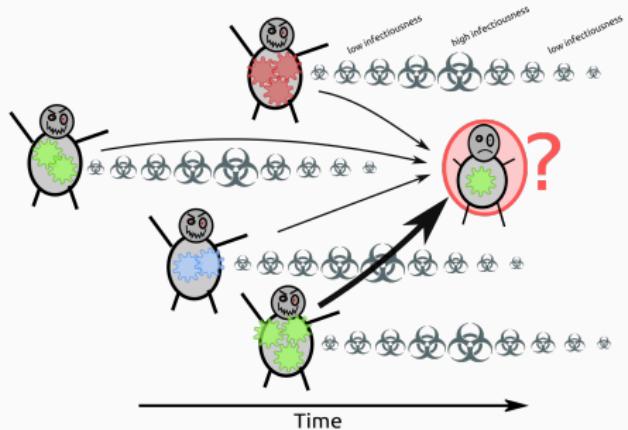


Since *outbreaker*: new models, data, and questions.

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)



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

But: little code availability, limited flexibility.

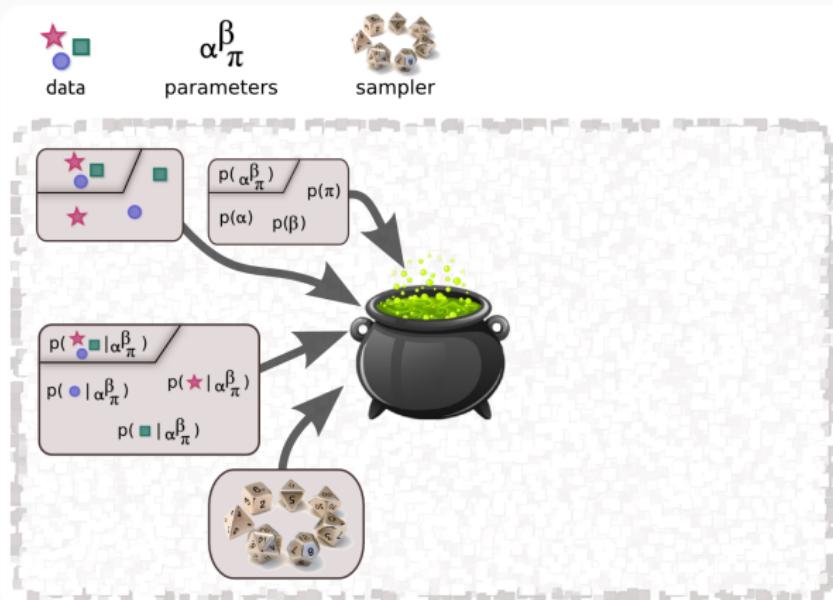
outbreaker2: a general cauldron for cooking methods

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



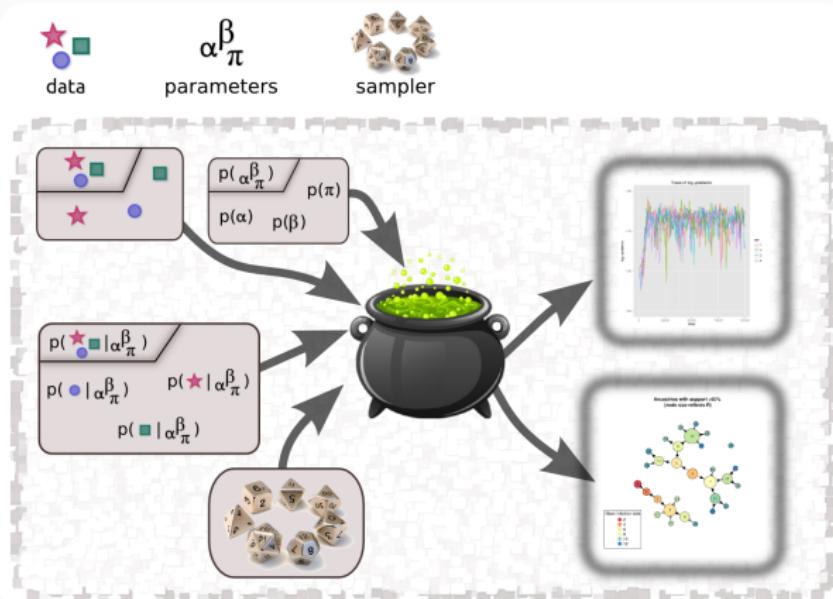
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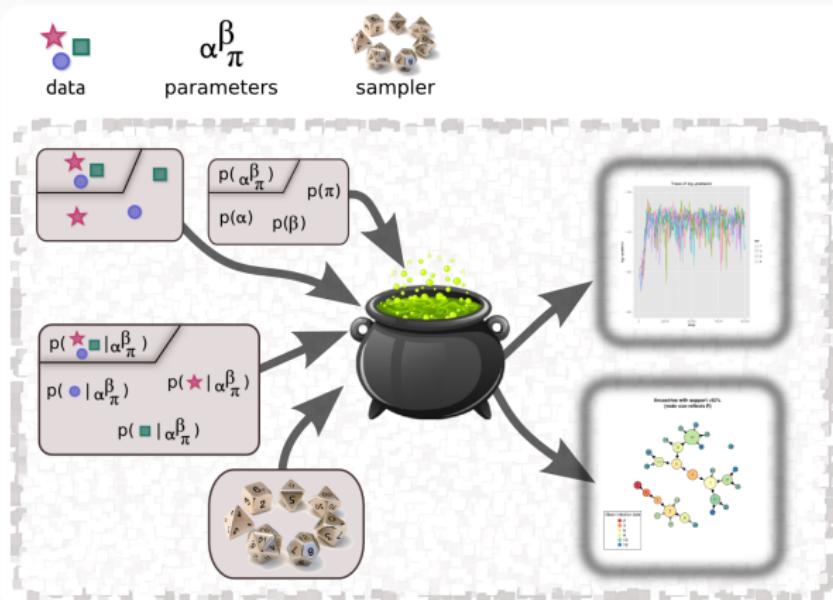
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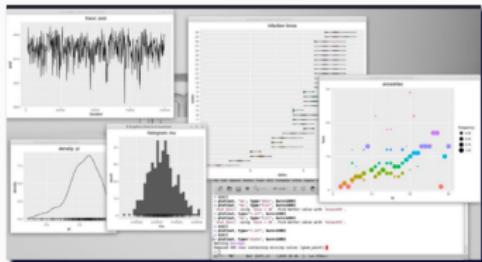
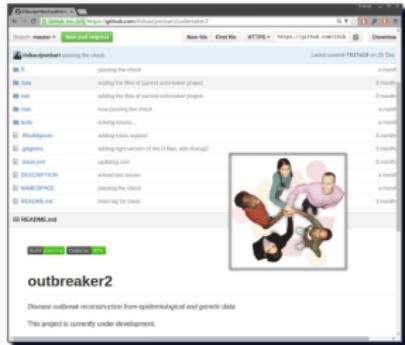
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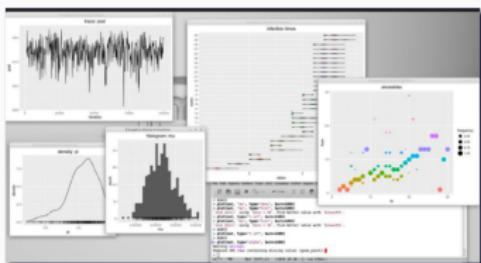
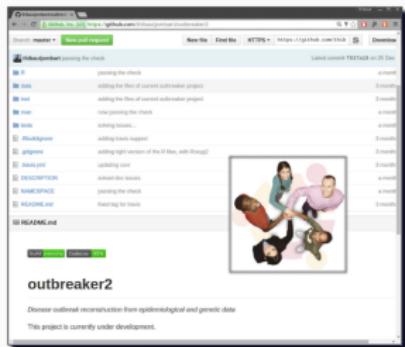


Modularity is key to generalising approaches

outbreaker2: a general tool for outbreak reconstruction



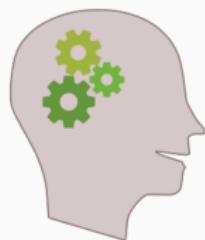
outbreaker2: a general tool for outbreak reconstruction



- **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

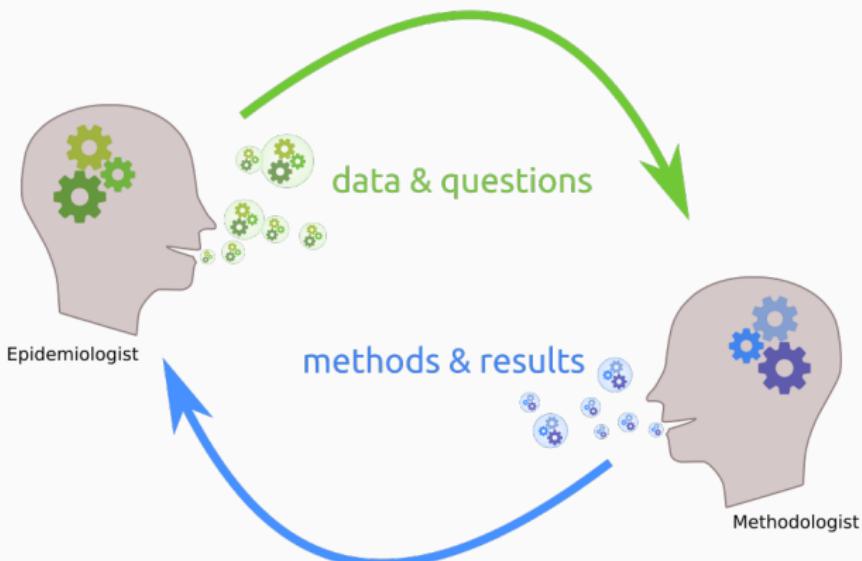


Epidemiologist

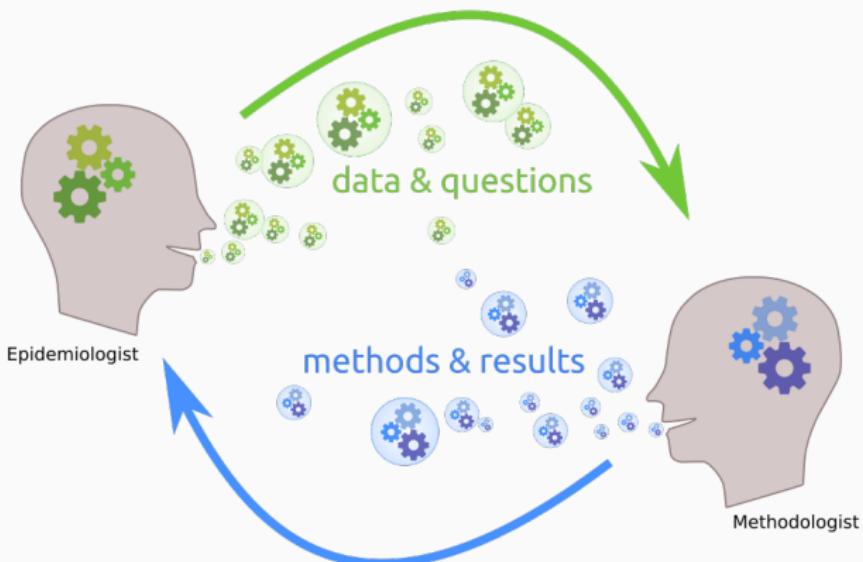


Methodologist

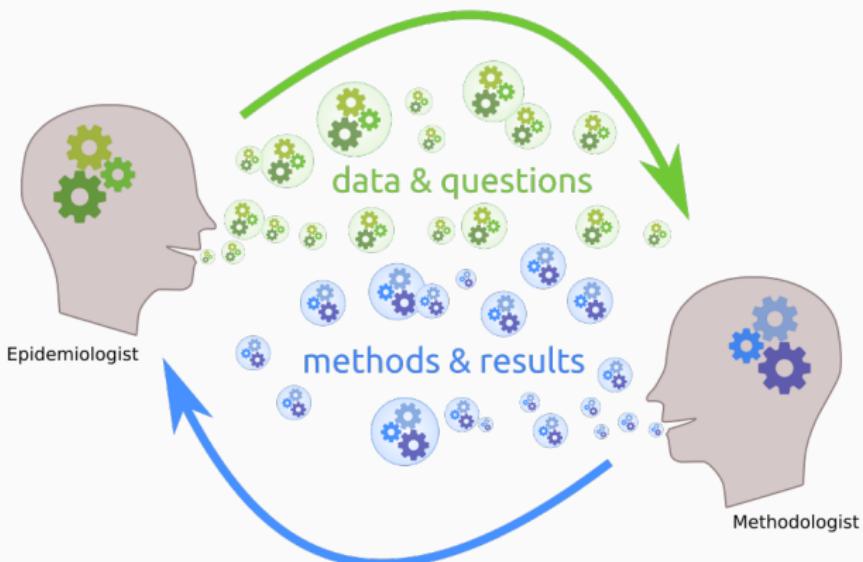
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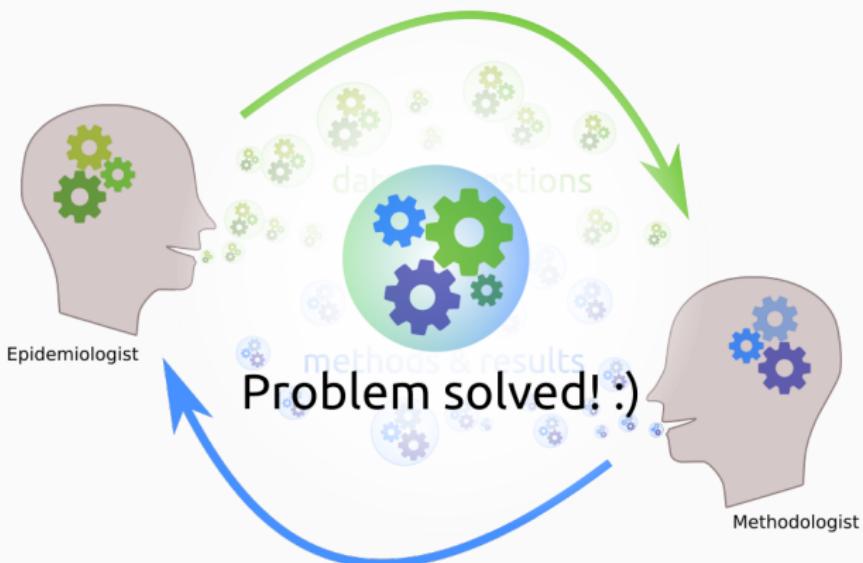
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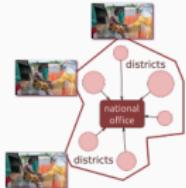
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Outbreak response context creates distance and delays



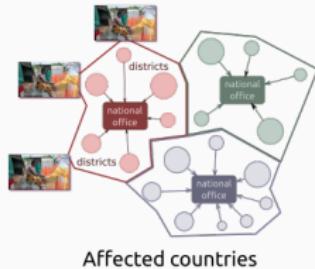
Outbreak response context creates distance and delays



Affected countries



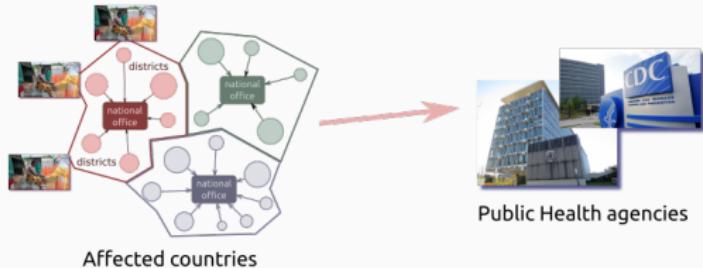
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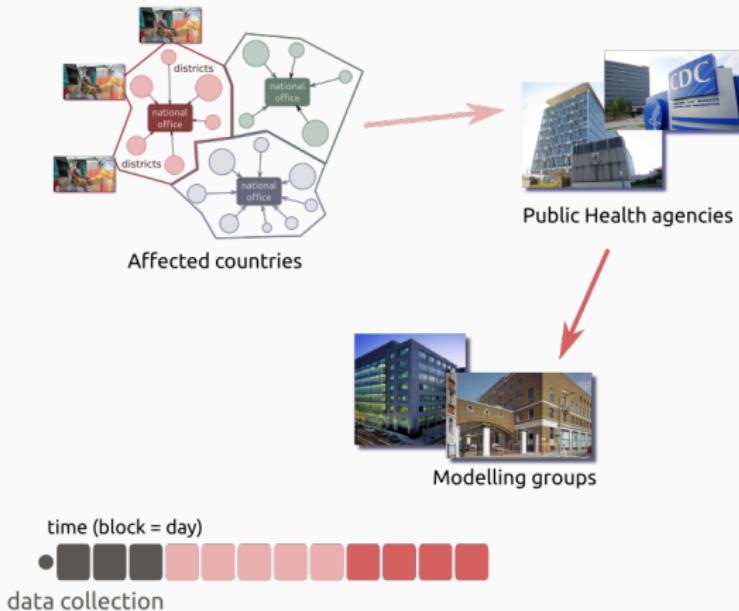
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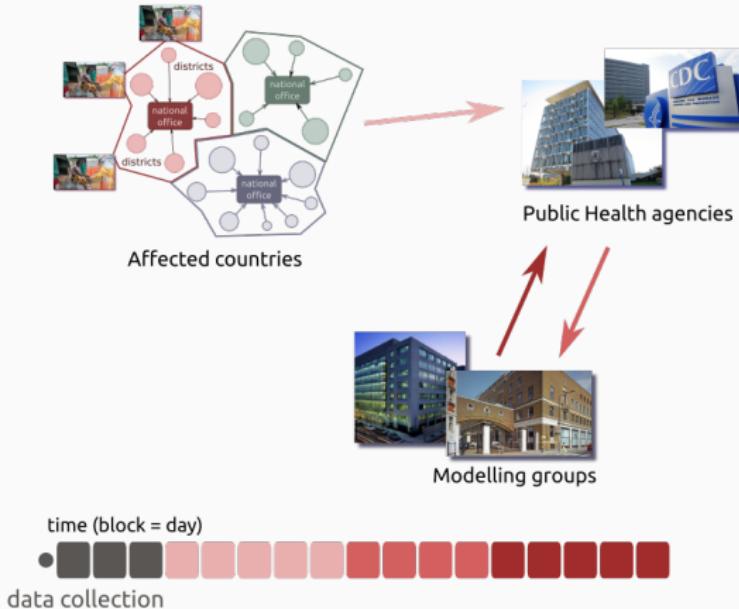
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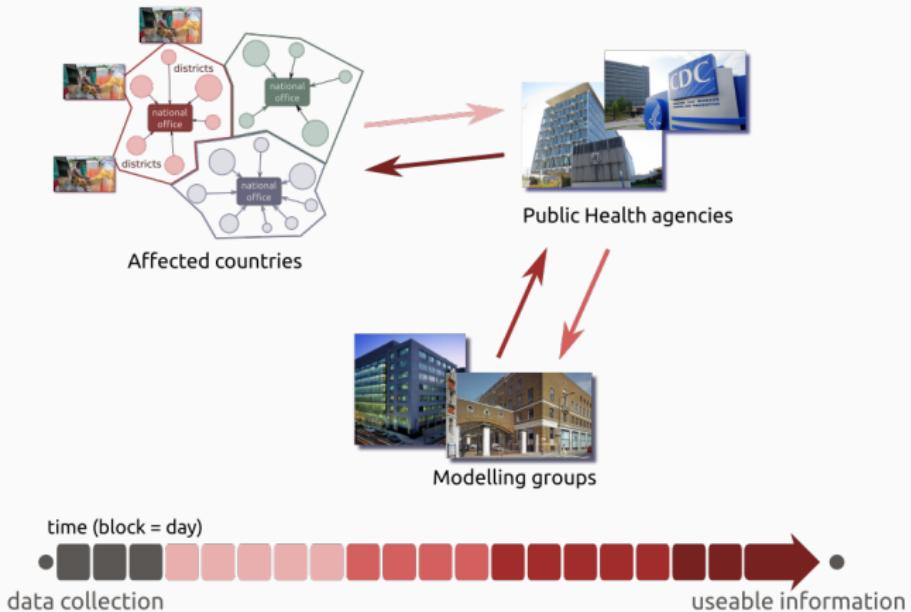
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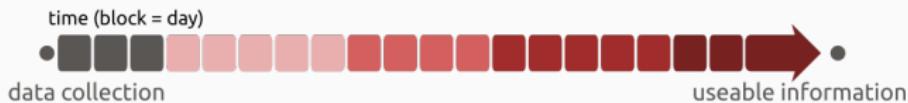
Outbreak response context creates distance and delays



Outbreak response context creates distance and delays



Outbreak response context creates distance and delays



Potential of embedding methodologists in outbreak response teams.

Thanks to...

- **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