Architectures for Modelling Covid-19

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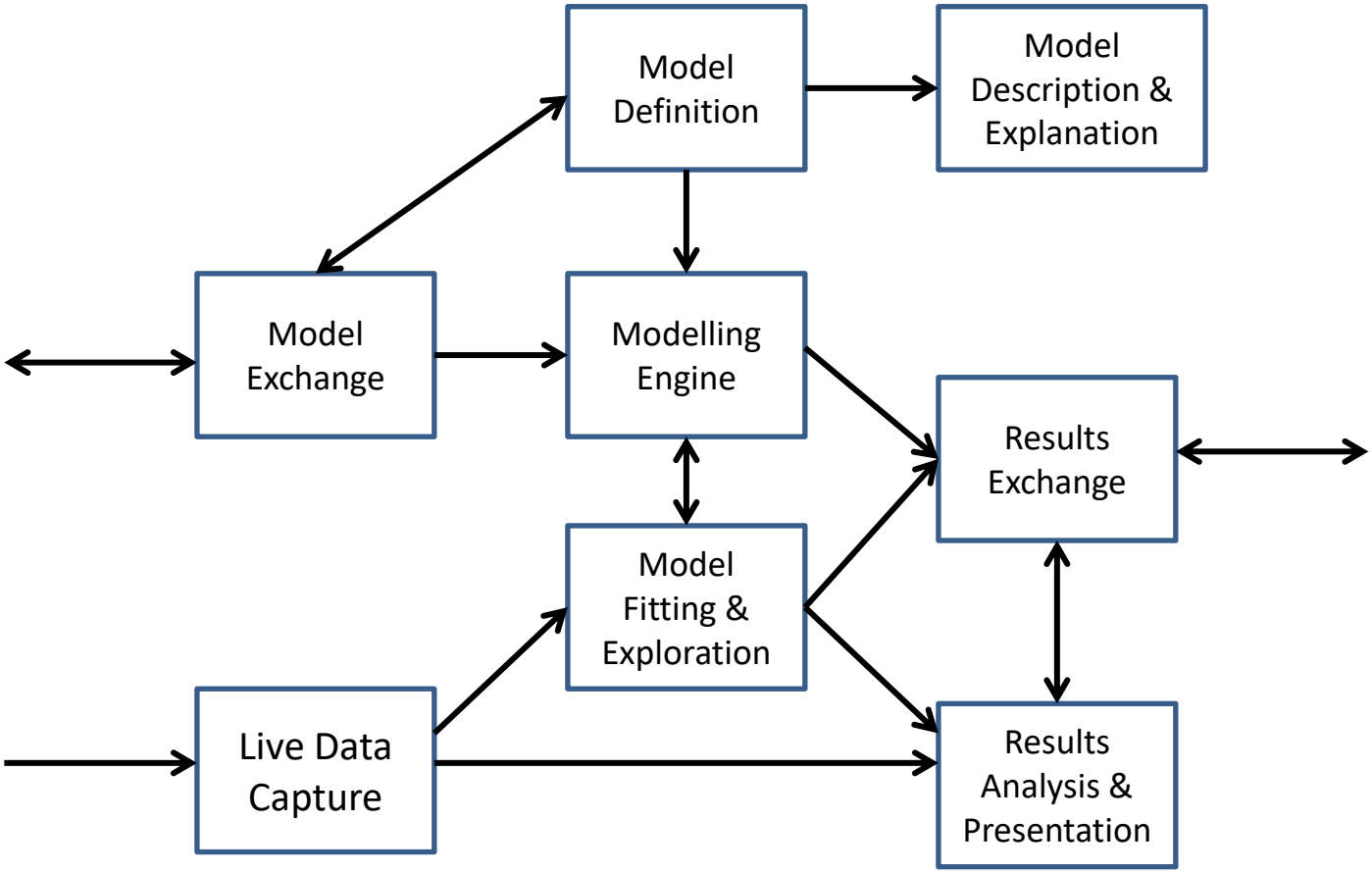
These slides are a summary of an accompanying paper. Please see the paper for more detail.

Requirements for Covid-19 Modelling Architectures

- Needed to model:
  - The spread of the virus
  - Containment measures
  - Social and Economic Impact
- Models should be reliable and responsive – calibrated against data
- Tracking data and modelling should be integrated
- Local and regional models are more tractable and responsive than national models
- Models and outputs should be accessible to peer review and challenge
- Modelling frameworks should be configurable and interoperable, to re-run models from other sources.

An Architecture to Meet the Requirements



Avoiding Lock-in

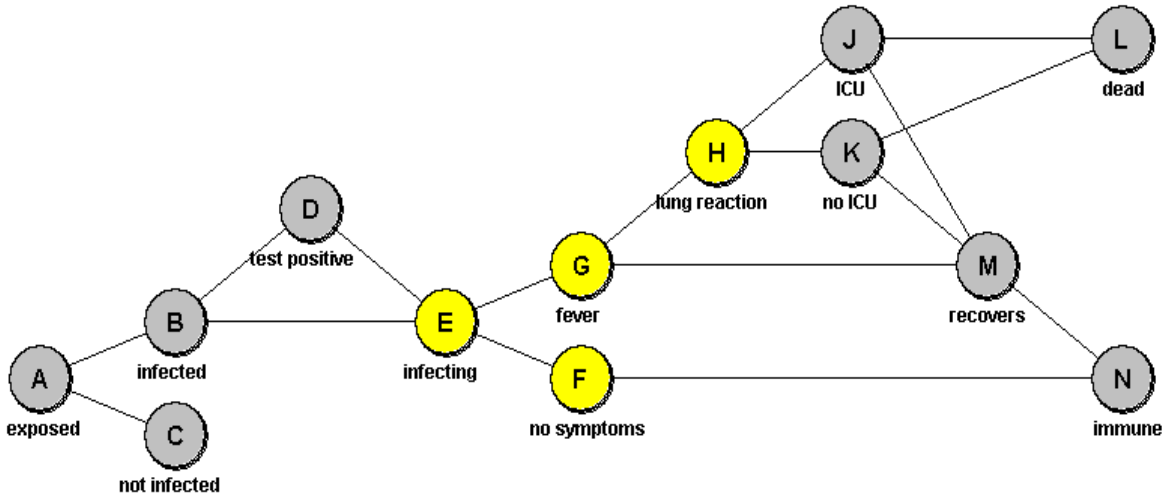
- Many industries have worldwide standards for information exchange, e.g.:
  - Air travel
  - Finance
  - Retail
- Healthcare IT has achieved only limited information exchange:
  - Healthcare professionals cannot easily find out what other treatments their patients are receiving – even in the same hospital
  - Free exchange of healthcare information has been a low priority
  - Healthcare providers are locked in to their IT suppliers
  - Quality of patient care has suffered (lack of joined-up care)
- Open standards for healthcare data exchange are fighting an uphill struggle against lock-in:
  - Health Level 7
  - OpenEHR
- If the same degree of lock-in applies to Covid-19 management, society will suffer
- We must define open interchange standards now, and ensure they are applied

An Illustrative Modelling Framework

- Designed to illustrate the architectural issues, making them concrete
- Download from https://github.com/robertworden/Covid-Modelling, and run in 5 minutes
- Agent-based (Monte Carlo) model of
  - Progression of Covid-19 in individuals
  - Spread of the disease, and containment measures
  - Impact on social and economic activity
- Many limitations
- Features illustrated on the following slides

Configurable Disease State Model

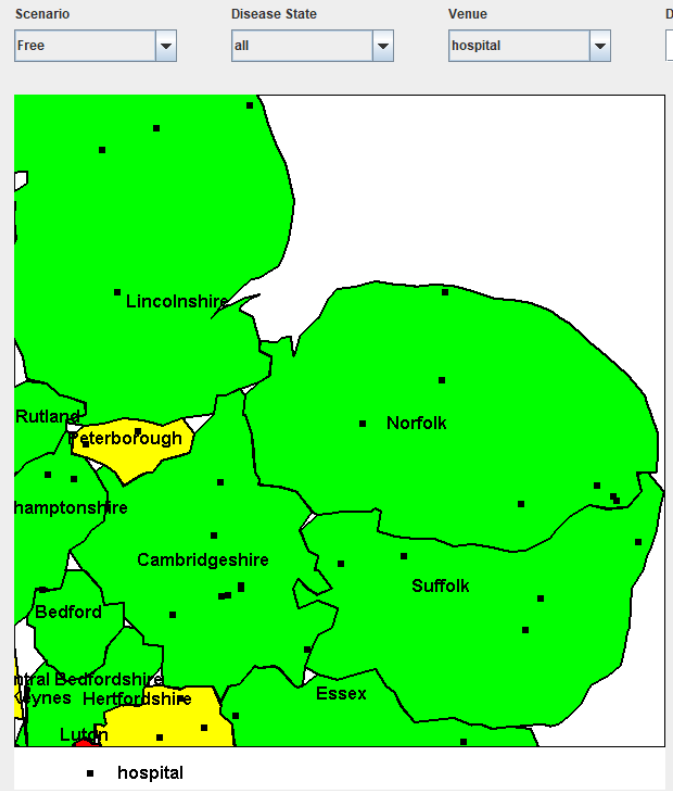
- Defined in data: could be:



- Or could be (SEIR):

Demographic Model

- Regions
- Households
- People
- Meeting Places
- Potential Meetings



Randomly generated , or use real data

Impact on social and economic activity is measured by change in meetings

Containment Measures

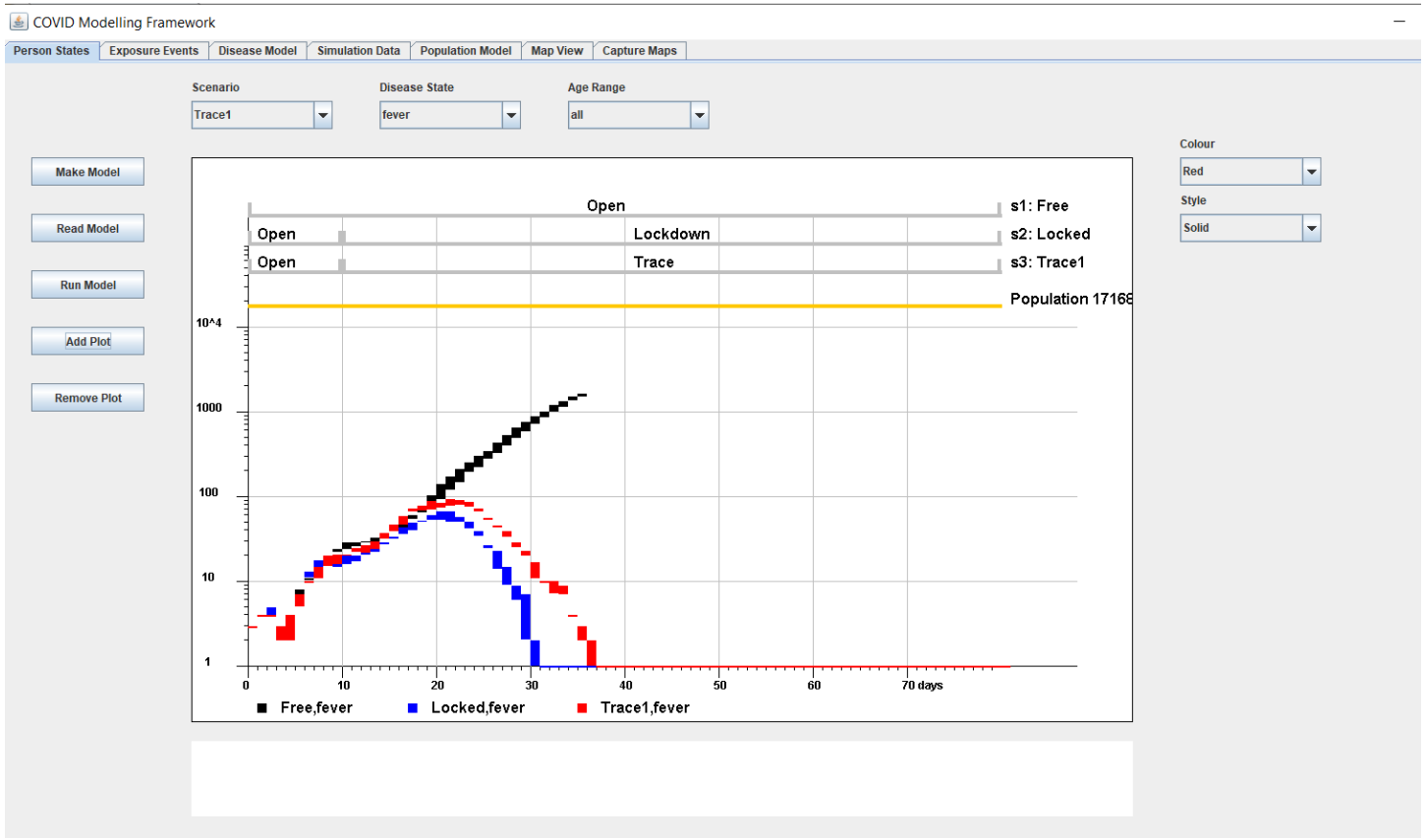
- Compare different sets of policies in different **scenarios**, applied in different **periods**
- Two kinds of containment policy:
  - **Meeting policies**: prevent or discourage certain types of meeting (lockdowns)
  - **Notify Policies**: notify people of events – e.g. they have met an infected person (tracing)

The Model Engine

- Agent based simulation:
  - Individuals , not populations
  - Step the model forward, 1 day at a time
  - Randomised meetings in meeting places and at home
  - Meetings modulated by containment policies
- Run different scenarios, periods, policies
- Multiple runs to assess random variability

Examining Model Results

- Simple graphs and charts – illustrative only, e.g:



Components of a Modelling Architecture

Component	Illustrative framework	What is needed
Model Definition	Csv files – basic but flexible	Guided model definition tools
Model exchange	Csv files	Open interchange standards for model definitions
Model Explanation	Simple Help files	User evaluation of tools for model explanation
Model Engine	Agent-based only; configurable	Choice of configurable engines
Model fitting and exploration	Basic side-by-side comparison	Bayesian Model Selection and evaluation; data exploration tools
Model results exchange	-	Define open standards for exchange of model results
Data Capture	No facilities	Use open standards for disease data capture – e.g. HL7 Version 2, HL7 FHIR. Tools to test and manage data quality

Local Tracking and Modelling

- With widespread testing and contact tracing, there is scope for big improvements in model quality and reliability.
- To achieve this, models must be close to the data – integrated tracking and modelling
- This is best done at local level, not national level:
  - Local conditions vary widely
  - Faster response without national data collection
  - Better local understanding of data quality issues
  - Rapid local responses are required to control disease
- The best national models will be federated local models

Competition and Diversity of Modelling Tools

- Covid-19 tracking and modelling tools will be hugely important for society
- Many tools and frameworks will emerge – in different product categories (e.g. a personal risk tracking app)
- It is very important to sustain competition, so that the best tools can be widely used:
  - Require **Open Interchange Standards**, avoiding lock-in to any tool or supplier
  - Hold open **Modelling Competitions** (challenges) to find the best tools

Conclusion

- This paper has presented some ideas about the architectures of Covid-19 modelling frameworks
- These ideas are preliminary and incomplete; the aim is just to stimulate discussion.
- Please contribute your own ideas.
- Getting the architectures of these tools right – while we still have a chance – is hugely important for society.