Health Analytics Workshop

MODELLING NEGLECTED TROPICAL DISEASES IN INDIA

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IIT Bombay, 30 Aug - 1 Sep 2023

DAY 2

Day 2

9:30 am	Plenary talk by Dr Tanu Jain, NCVBDC
10:15 am	Plenary talk by Dr Vinod P. Choudhary, NCVBDC
11:00 am	Tea break
11:15 am	Recap of Day 1 and Introduction to Day 2
11:45 am	Break-out session
1:00 pm	Lunch
2:00 pm	Break-out session (continued)
3:15 pm	Tea break
3:30 pm	Interactive review of challenges
5.00 pm	Close

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11:15 – 11:45 am

RECAP DAY 1

Recap of Day 1

1. Introduction to the epidemiology and control of VL
2. Draft initial research question in pairs
3. Development of compartmental models + template VL model
4. Choose and refine research question + design conceptual model in groups
5. Data needs + strategies to address lack of data

Questions about:

- Any of the workshop sessions on VL so far
- The template VL model
- Parameter values in the hand-out

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Goal of Day 2

- Implement two versions of your group's conceptual model:
  - Deterministic
  - Stochastic (if time allows, prioritise the deterministic version)

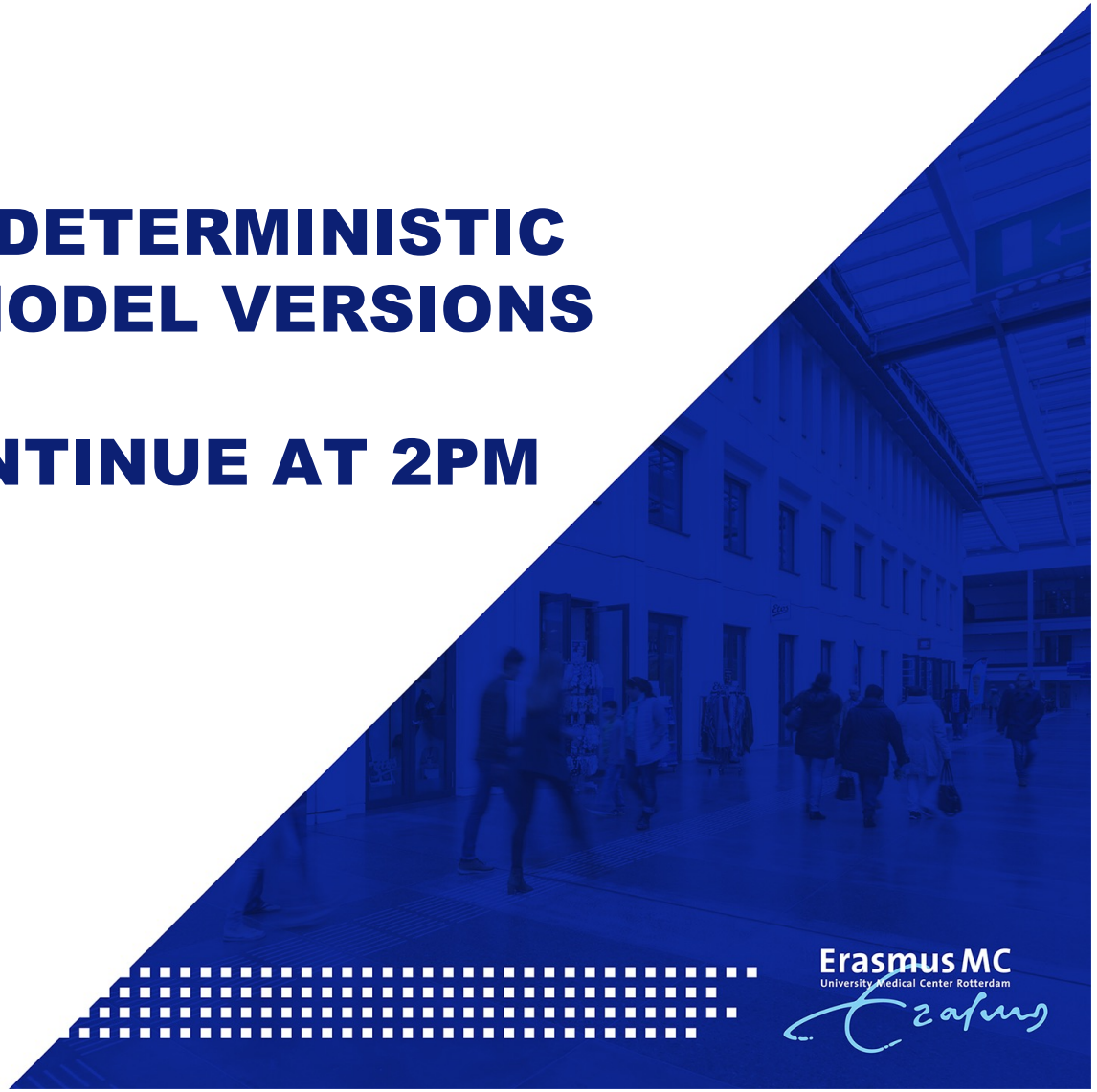
- Get some hands-on experience working with the *pomp* package in R
  - Based on a template VL model that you can adjust yourself

- Draft a visualisation of the model-predicted answer to the research question
  - Discuss results and encountered challenges

11:45 am – 3:15 pm

BREAK-OUT: BUILD DETERMINISTIC AND STOCHASTIC MODEL VERSIONS

LUNCH AT 1PM, CONTINUE AT 2PM



Link between deterministic and stochastic model versions

Deterministic model:

- Fractions of population transition between compartments

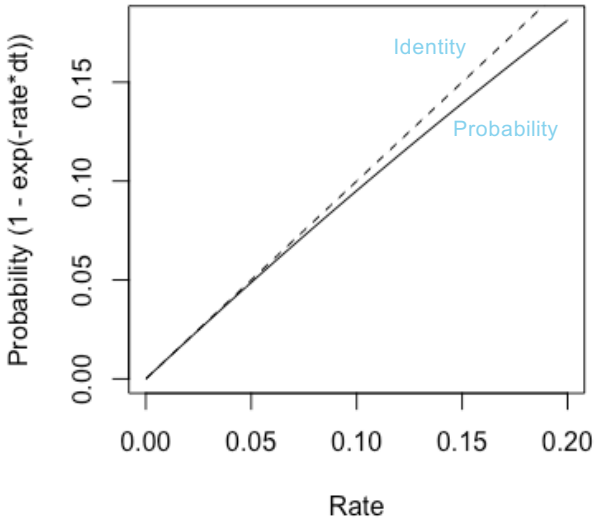
Stochastic model:

- Discrete number of individuals transition between compartments
  - Multinomial draws for number of transitions per Δt

- Define transition probability $P_{X \to Y}$ from compartment X to Y, given all exit rates $\rho_{X \to i}$ from X:

$$P_{X \to Y} = \frac{\rho_{X \to Y}}{\sum_i \rho_{X \to i}} \cdot (1 - \exp[-\Delta t \cdot \sum_i \rho_{X \to i}])$$

- For VL model here, we take fixed time step size Δt (Euler steps) of 1 day
  - Chosen such that $\Delta t \times$ the highest rate in the human part of the model is $\ll 0.1$, and $\ll 1$ in the sandfly model (fly dynamics are almost instantaneous compared to humans in this VL model)



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Notes on sandfly sub-model

The stochastic model is actually a hybrid model:

- Sandfly model is implemented deterministically
- Little point in simulating individual sandflies
  - Dynamics are almost instantaneous, compared to humans
  - We have no idea how many sandflies there are in absolute terms and how many of them are relevant for transmission

Pomp

Package for Partially Observed Markov Processes (https://kingaa.github.io/pomp/)

- Convenient to develop model code that will be translated to C and compiled
- A lot of additional functionality that we will not use

Ingredients

- C-snippets of model code (strings that will be translated to C code and compiled)
  - Function to set initial values
  - Function to calculate derivatives
  - “Accumulator” variables (stochastic model only) that keep track of how many individuals transitioned (useful for calcuating incidences)
- Vectors of state names (i.e., compartments) and parameter names
- Named vector of fixed parameter values (i.e., these have the same value throughout a simulation)
  - Including initial values (must have same names as states, but with suffix ”_0”)
- Optional: table of time-varying parameter values

Stochastic model only:

- Vector of accumulator names

Go through example script

Break-out instructions

Code repository: https://github.com/Ananthu89/NDMC-VL-Workshop-IITB-2023

- Run the example script
  - Have a look at the C-snippets and see if you understand what's going on
- Develop code in R for a deterministic (and stochastic?) version of your group's conceptual model
  - Make a copy of what you want to work on and adapt the copy, leaving the original intact
- Perform sense checks and debug any discrepancies between the two model versions
  - Refer to readme.md at the above web address
- Produce a plot that illustrates the answer to your group's research question
- Prepare 2 slides to guide discussion about your model during the next session (send to trainers)
  - Results / plot + interpretation
  - Encountered challenges

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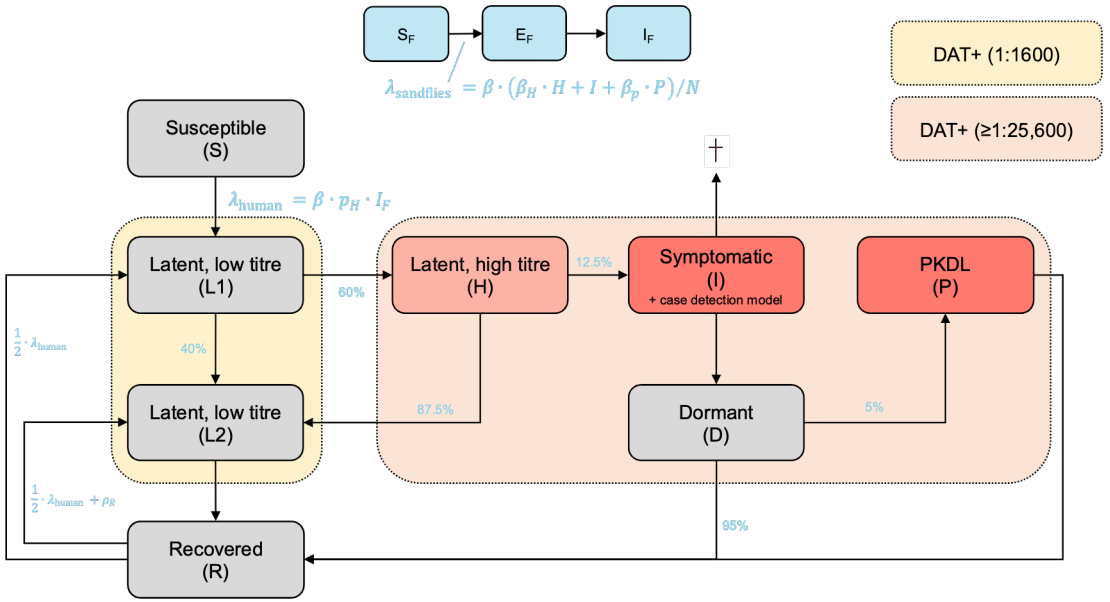
Sense checks to perform

- Does the population size remain stable?
- Do the deterministic and stochastic model agree?
- …

Debugging strategy

- Temporarily simplify the two model versions and compare them again
  - Set a strategically chosen rate to zero, e.g., rate from H to I (but make sure that H is at least somewhat infective towards sandflies then)



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3:15 pm – 3:30 pm

TEA BREAK

3:30 – 5:00 pm

INTERACTIVE REVIEW OF RESULTS AND CHALLENGES ENCOUNTERED DURING MODEL BUILDING