Scotland Vaping Project Presentation

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20 June 2025

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Simplified ABM from UK Smoking Contagion Model

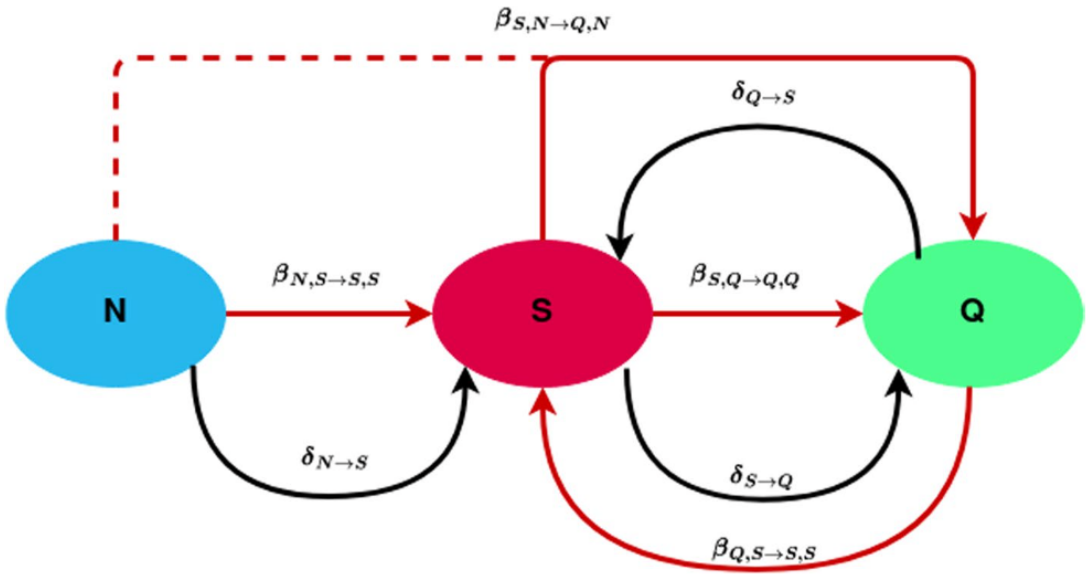

Fig. 1 The figure shows the schematic representation of the state change processes involved in the ABM. The interaction parameters are represented by the red arrows, while the black arrows show the spontaneous terms in the schematic. All three state-change processes are shown in the figure. First, an N-agent can initiate smoking spontaneously ($\delta_{N\to S}$) or due to the interaction with an S-agent ($\beta_{N,S\to S,S}$). Similarly, an S-agent can quit spontaneously ($\delta_{S\to Q}$) or due to interaction with other non-smoker agents (Q-agent: $\beta_{S,Q\to Q,Q}$ or N-agent: $\beta_{S,N\to Q,N}$). Like the other processes, Q-agents relapse into smoking spontaneously ($\delta_{Q\to S}$) or due to interaction ($\beta_{Q,S\to S,S}$) with an S-agent

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Scotland Vaping Trend (2019-2023)

- Collected from Scottish Health Survey (SHeS) smoking tables: e-cigarette or vaping device use, by age.
- Data for year 2020 are omitted since they were not collected for uncertain reasons.

Index	% NEVERSMOKER	% SMOKER	% QUITTER
2019	78	5	17
2021	75	6	19
2022	61	15	24
2023	59	22	19

Bayesian Optimization for Likelihood-Free Inference (BOLFI)

- $U(0,1)$ priors for $\beta_{N,S\to S,S}$ and $\beta_{S,Q\to Q,Q}$.
- Simulated data were generated by the simplified ABM simulator with different network models
- Cell-to-cell differences as summary statistics.
- Euclidean distance between the simulated and observed data as discrepancy measure.
- Logarithm of the discrepancy measure as the BOLFI target.
- initial_evidence = 200, n_evidence = 1000, acq_noise_var = 0.01

Optimal Parameters and Log-discrepancy

```
Progress [==========================================]
100.0% Complete
INFO:elfi.methods.posteriors:Using optimized minimum value (3.0333)
of the GP discrepancy mean function as a threshold
INFO:elfi.methods.posteriors:Using optimized minimum value (3.0333)
of the GP discrepancy mean function as a threshold
Parameters: ['beta_QS_to_SS_er', 'beta_SN_to_QN_er']
Optimal values: [0.96366351 0.04241617]
Optimal log-discrepancy: 2.820421337441635
Parameters: ['beta_QS_to_SS_er', 'beta_SN_to_QN_er']
Optimal values: [0.963663505701265, 0.042416174415403 71]
Optimal log-discrepancy: 2.820421337441635
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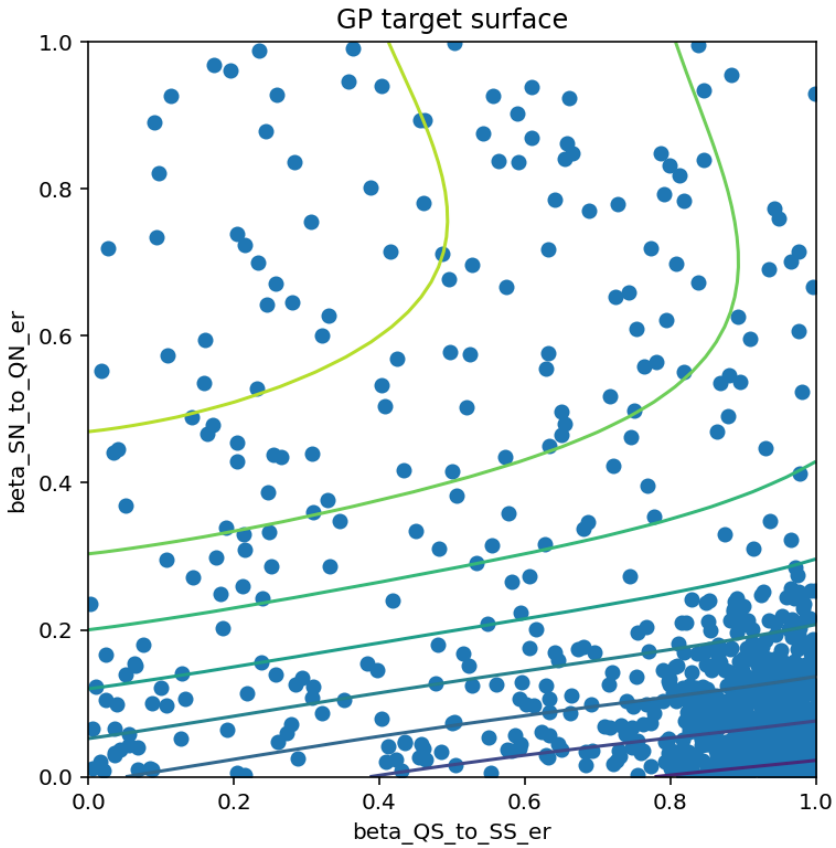
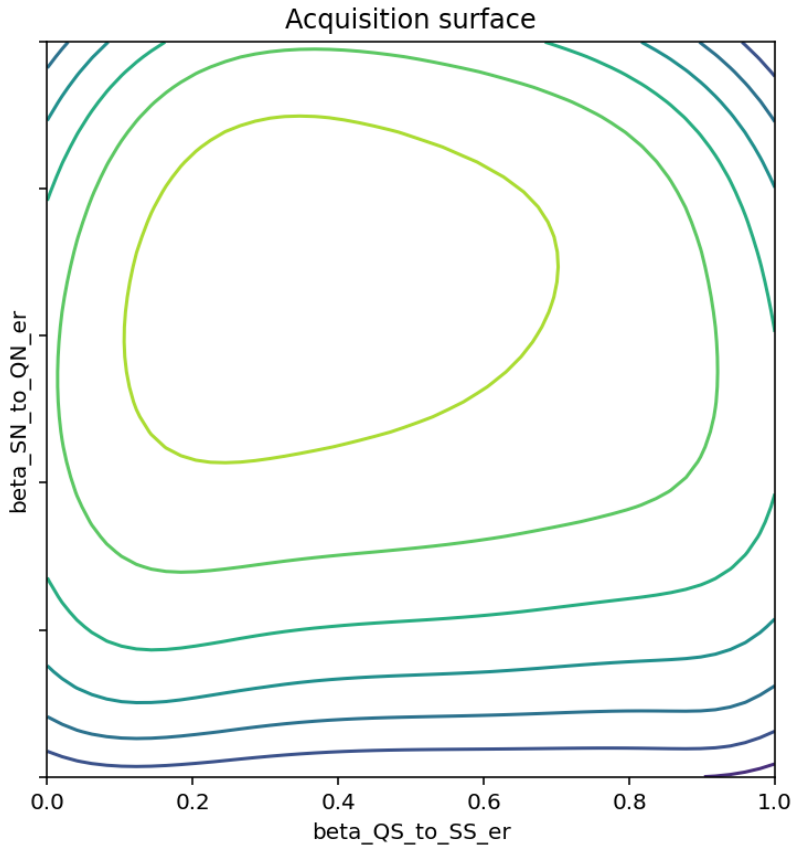
GP Target Model





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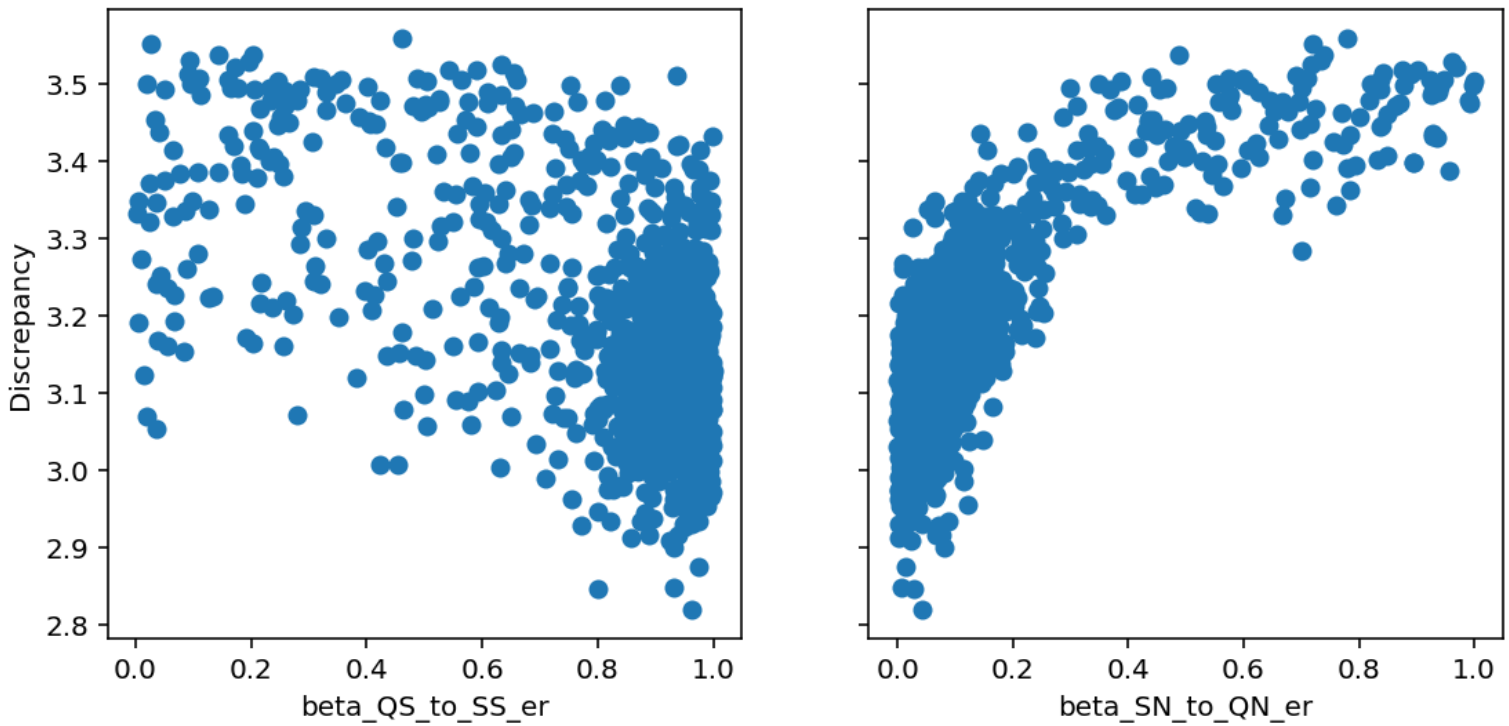
Log-discrepancy against Parameter Value (Default)



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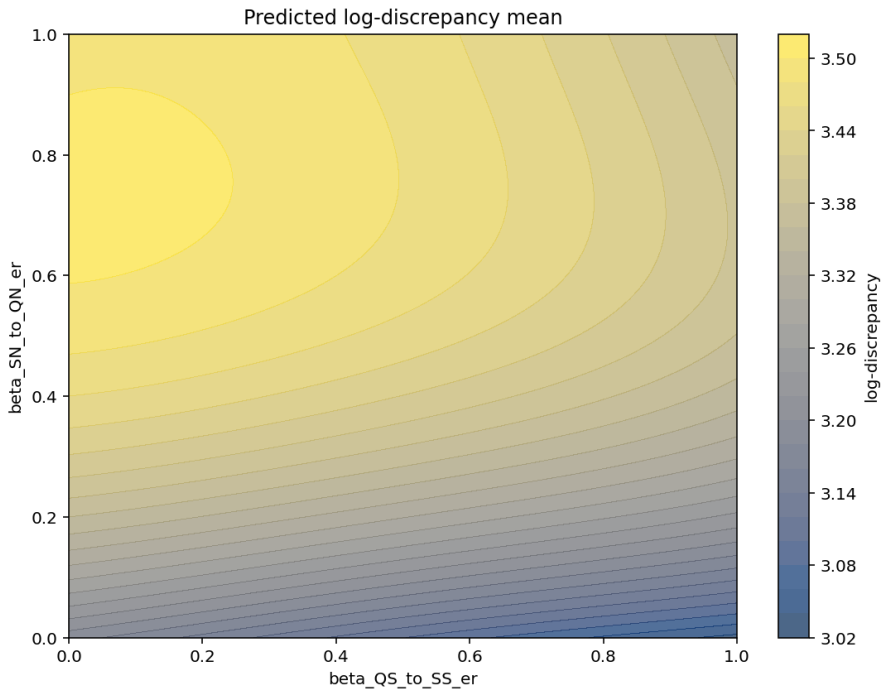
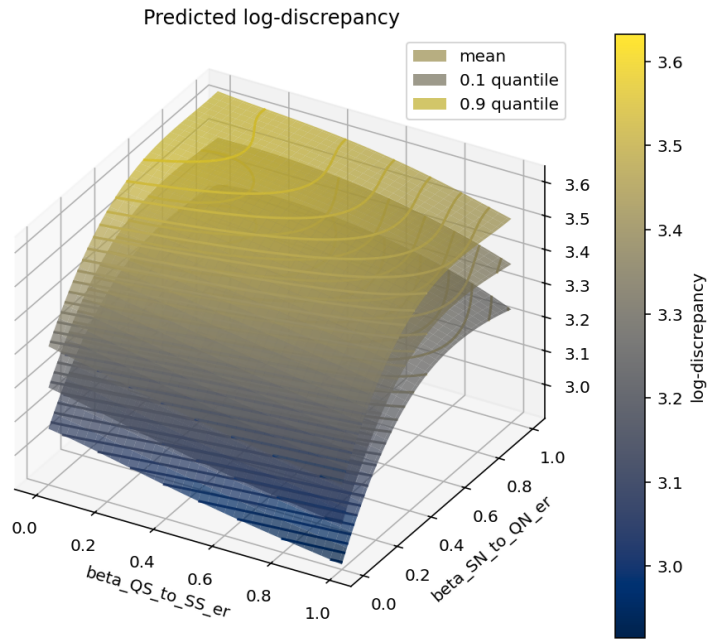
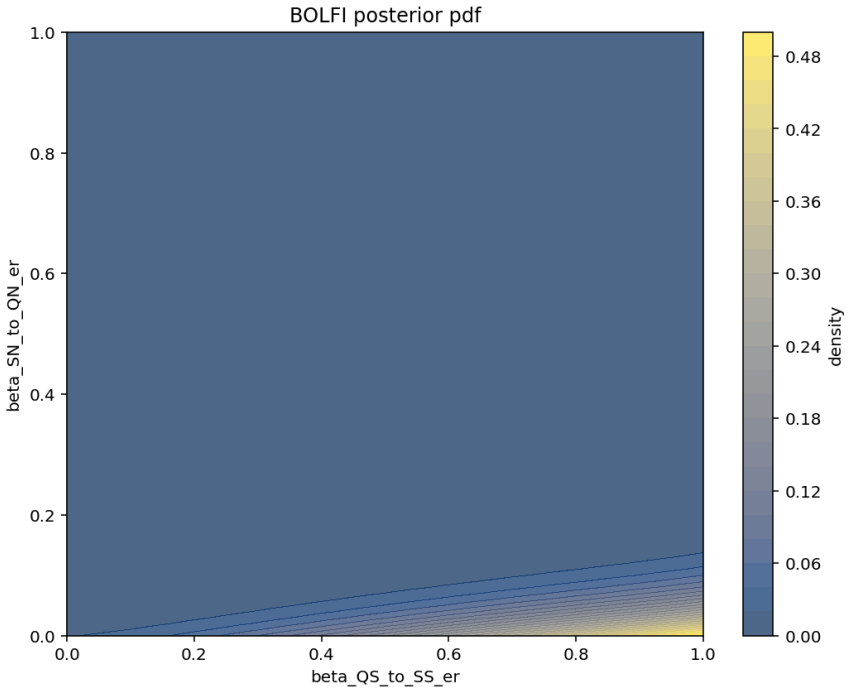
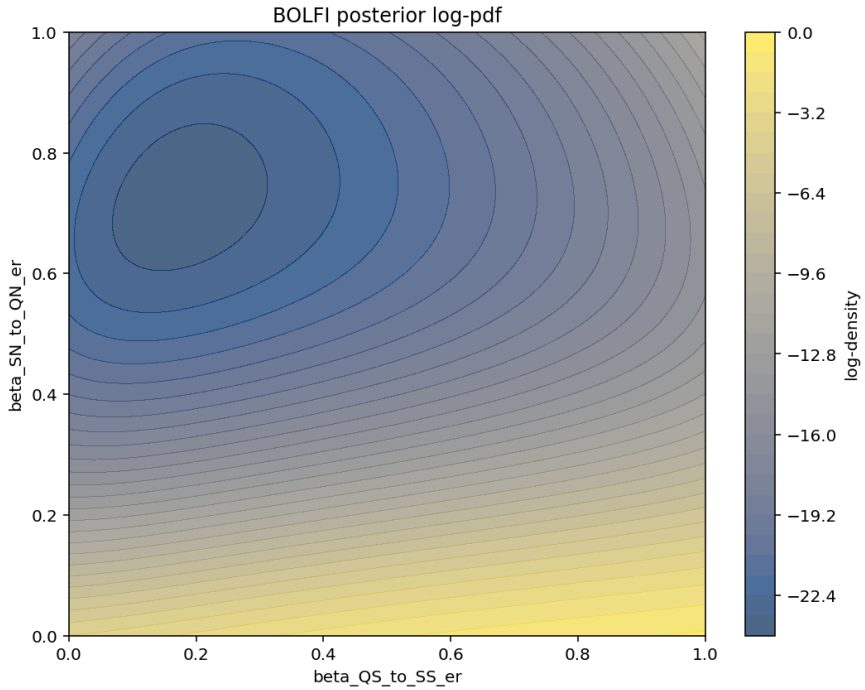
Log-discrepancy against Parameter Value (Contour and Surfaces)





BOLFI Posterior (Contours)





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Observed Data and Simulated Data

Index	% NEVERSMOKER	% SMOKER	% QUITTER
2019	78	5	17
2021	75	6	19
2022	61	15	24
2023	59	22	19

Index	% NEVERSMOKER	% SMOKER	% QUITTER
2019	78	5	17
2021	74	9.8	16.2
2022	71.7	12.5	15.8
2023	69	15.5	15.5

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Discussions and Possible Direction for Further Improvements

- It can be observed that the discrepancy between the simulated data and observed data is still very large, though we have used the optimal parameter values.
- Inappropriate value used for $\beta_{N,S\to S,S}$ is the primary cause, as it would also influence the calibration for other parameters
- The observed data might also be improved by combining the data collected from the youngsters with our current data.
- Doing this would produce the trend of e-cigarette or vaping device use within a single group of people over years. This would be particularly useful to monitor the trend over a longer period of time when we also intend to consider the vital dynamics.

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The End

Thank you very much for your time!

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