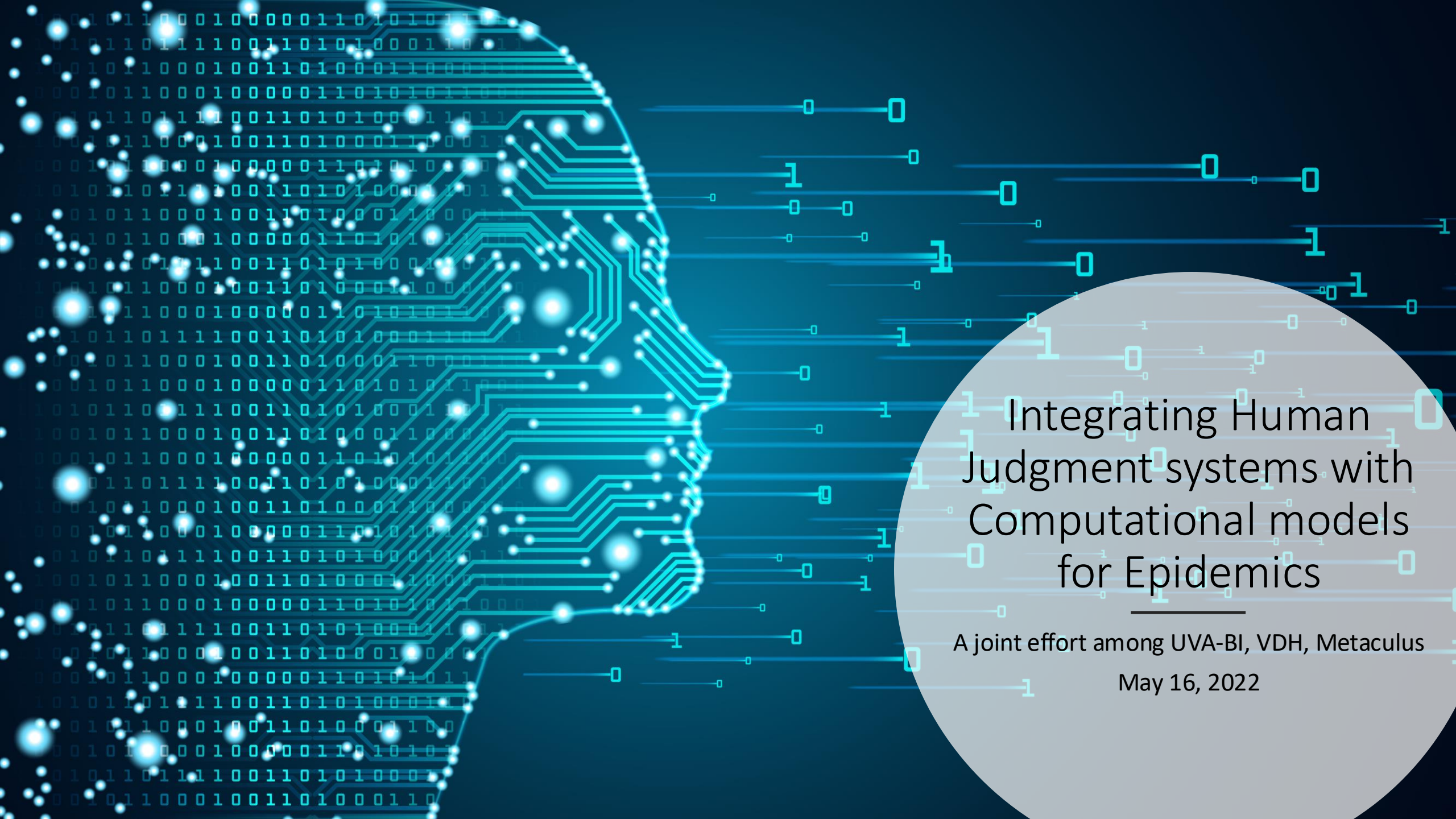


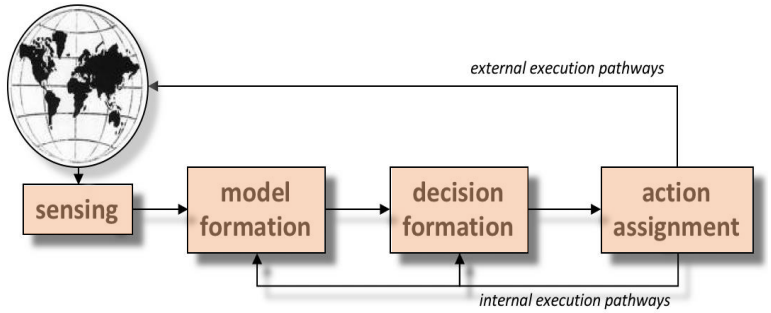
Integrating Human Judgment systems with Computational models for Epidemics

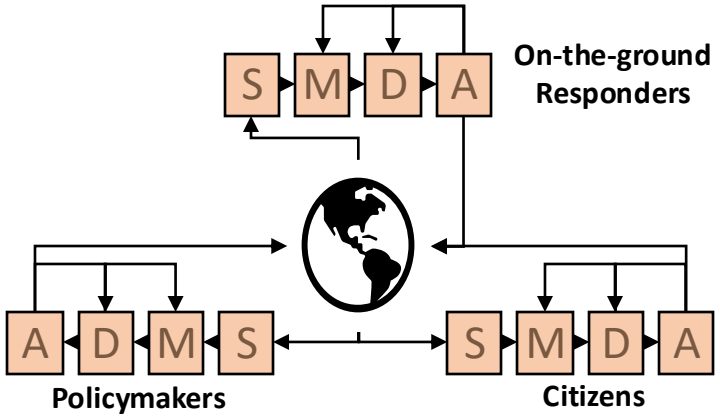
A joint effort among UVA-BI, VDH, Metaculus

May 16, 2022

Agent-modeling vs Human judgment ensembles

- Modeling decentralized decision making across social scales essential to understand socio-technical systems
- Individual and collective behavior
  - Varying and sometimes conflicting objectives
  - Information asymmetry & spheres of influence





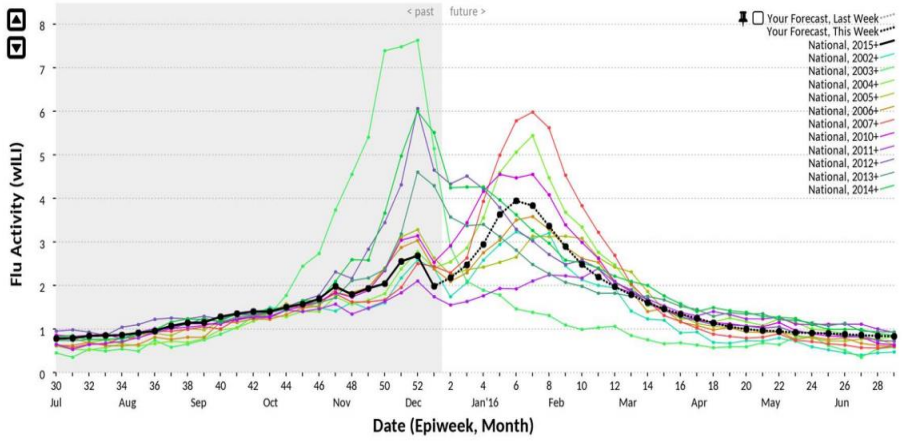
Human judgment ensembles (HJE) can combine inputs (forecasts, estimates, policies) from multiple individuals to generate robust inputs for policymakers. Could include:

- informed community members/generalists (citizen science)
- consortium of domain experts (modeling consortiums)
- consensus among policymakers (panels, table-top exercises)

Prior Work: Human judgment for disease forecasting

EpiCast

- Trajectory forecasting through web-based user interface.
- Consistently more accurate than many statistical models for 2014-15, 2015-16 seasons



Farrow, David C., et al. "A human judgment approach to epidemiological forecasting." *PLoS computational biology* 13.3 (2017): e1005248.

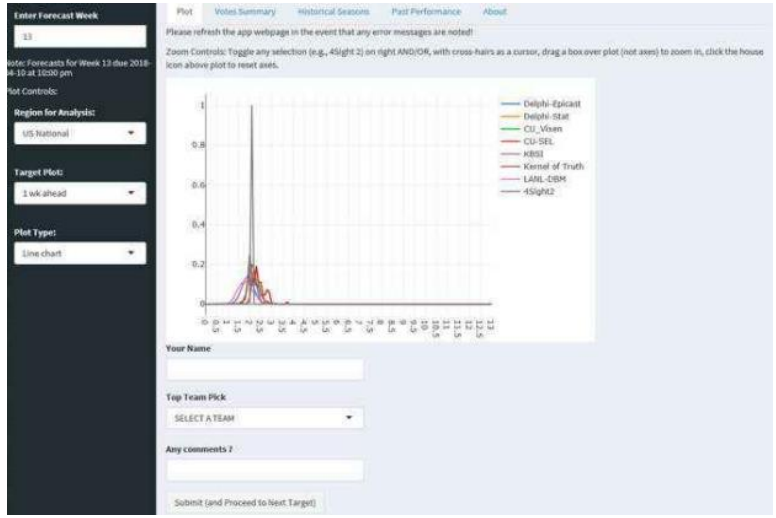
My4Sight

- Ranking existing models through an interactive drag-n-drop platform.
- Can also get user confidence on the ranking.

Akupatni, V. B. (2015). *My4Sight: A Human Computation Platform for Improving Flu Predictions* (Doctoral dissertation, Virginia Tech).

PPFST Crowd

- Selecting top model based on probabilistic predictions per target.
- Better than unweighted average and all but one component model.



Morgan, Jeffrey J., Otto C. Wilson, and Prahlad G. Menon. "The wisdom of crowds approach to influenza-rate forecasting." *ASME International Mechanical Engineering Congress and Exposition*. Vol. 52026 (2018).

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Other human judgment efforts during COVID-19

- Case and death forecasts obtained from a mixed pool of experts and non-experts
- Submitted to European ForecastHub
- Comparison with Bayesian semi-mechanistic models (renewal and convolution)

Comparing human and model-based forecasts of COVID-19 in Germany and Poland

Nikos I. Bosse, Sam Abbott, Johannes Bracher, Habakuk Hain, Billy J. Quilty, Mark Jit, Centre for the Mathematical Modelling of Infectious Diseases COVID-19 Working Group, Edwin van Leeuwen, Anne Cori, Sebastian Funk

- Combining computational and human judgment through an ensemble
- Generalist crowds from Good Judgment and Metaculus
- CDC ForecastHub submissions on a monthly basis from Jan-Jun 2021

Chimeric forecasting: combining probabilistic predictions from computational models and human judgment

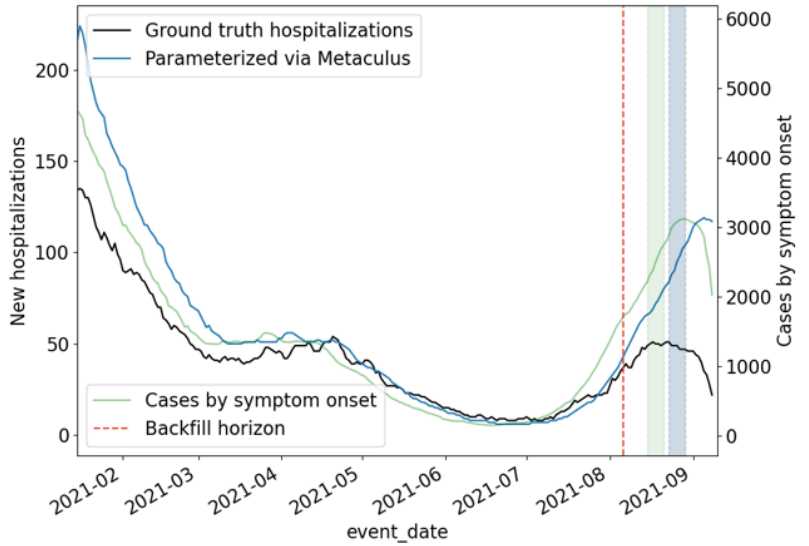
Thomas McAndrew, Allison Codi, Juan Cambeiro, Tamay Besiroglu, David Braun, Eva Chen, Luis Enrique Urtubey de Cesaris, Damon Luk

Collaborative tournaments: UVA-BI, VDH, Metaculus

Lightning Round (Aug-Sep 2021)

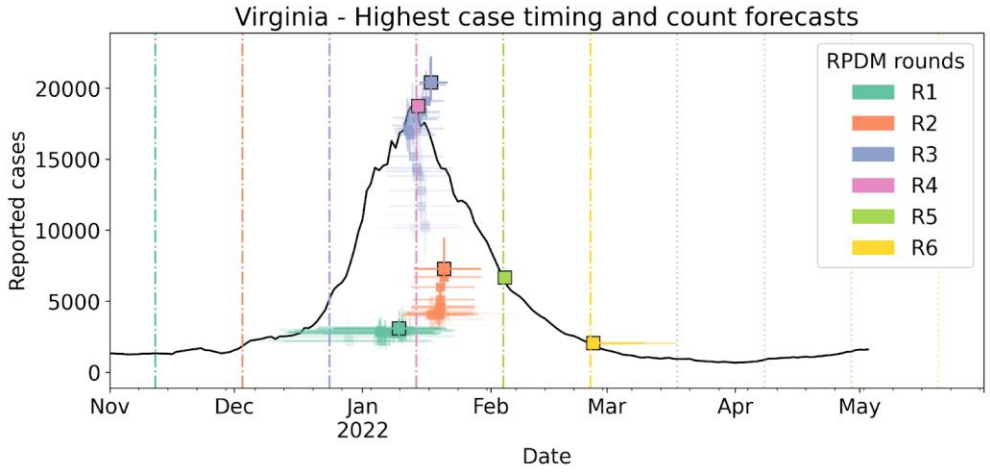
- 4 weekly rounds of 7 questions (Wed 8AM– Sun 8AM)
- Questions on epidemiological and behavioral indicators
  - Test positivity, Hospitalizations
  - Mask wearing, Vaccine uptake
- Couple of questions on model parameters/output
- *Early success in using simpler models for outcome projections*

Hospitalizations parameterized by CHR from Metaculus



Real-time Pandemic Decision Making (Nov 2021 – May 2022)

- 9 rounds of 10-12 questions. Each active for 3 weeks.
- Questions about case rates, hospitalizations, vaccine uptake
- Rounds 1-6 coincide with Omicron BA.1 wave
- *Qualitative and quantitative insights from ensemble performance*



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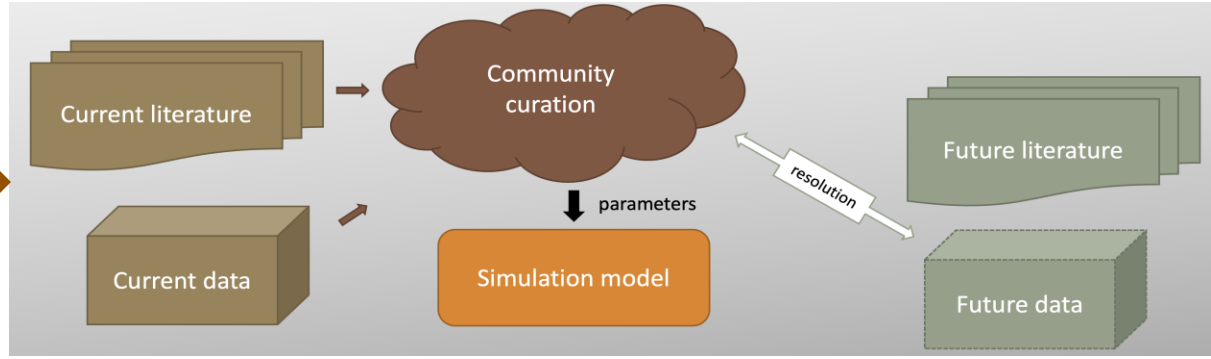
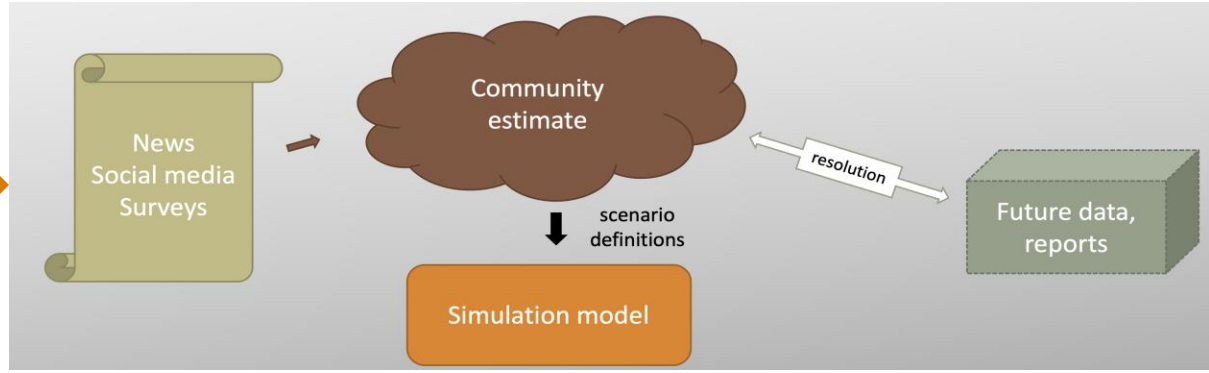
Enhancing Models through Human Judgment

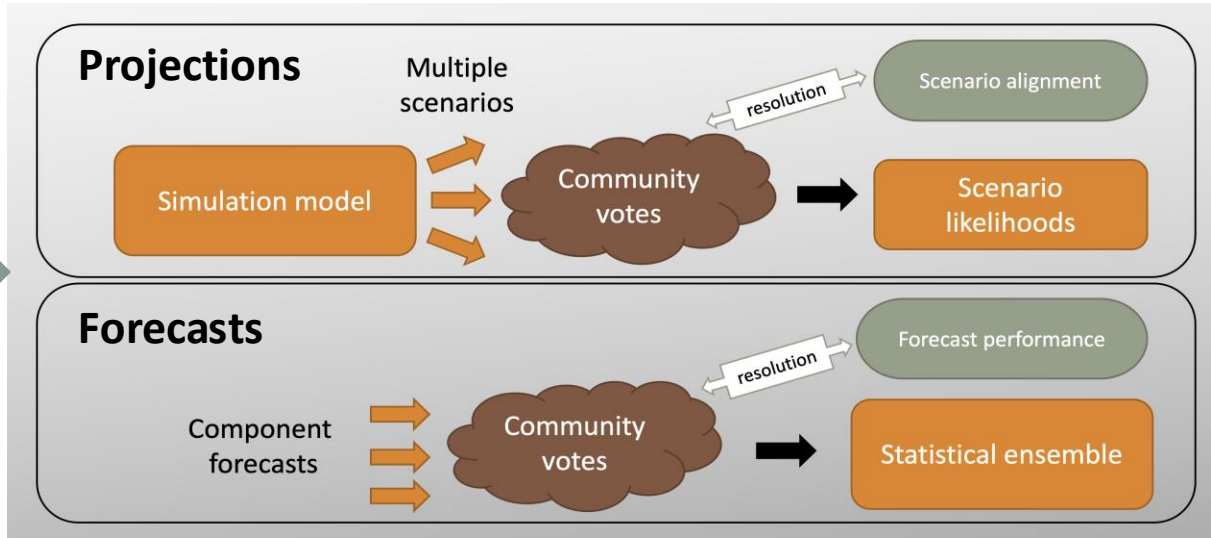
Model parameterization



Scenario specification



Selection & Reweighting



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Overall Architecture