

NEXT GENERATION CB HAZARD PREDICTION AND CONSEQUENCE ASSESSMENT WITH MULTI-ECHELON DECISION SUPPORT APPLICATIONS

Enabling Decision Support with Next Generation Disease Forecasting and Chemical Hazard Prediction

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CrystalCast is a disease forecasting and chemical hazard prediction tool that combines multiple epidemiological intervention models from different organisations within a rigorous statistical framework to predict outbreaks, anticipate impacts on the population and inform interventions.

Developed to support scientists and decision makers, and used in the UK Government Covid-19 response, CrystalCast is a flexible and extensible system for chemical and biological hazard modelling. CrystalCast enables disease forecasting and chemical hazard prediction through a single unified platform that combines multiple epidemiological intervention models from different organisations within a rigorous statistical framework to predict outbreaks, anticipate impacts on the population and inform intervention strategy. Suitable for all complex situational awareness and forecasting applications. It transforms complex data derived from multiple models that provide situational awareness and forecasting, into simple and informative outputs that enable decision makers to leverage intelligence faster and with increased confidence.

Mathematical models are crucial for understanding and predicting diverse processes, from disease outbreaks to economic planning. Various modelling strategies produce different hypotheses and predictions, reflecting genuine uncertainty. However, without expert interpretation and validation, decision-makers may be overwhelmed with information but lack a deep understanding.

CrystalCast integrates these disparate hypotheses by using statistical techniques to offset the strengths and weaknesses of the different models, resulting in a unified picture that provides improved situational awareness and forecasting, and communicating the complex multivariate outputs as easily understood and actionable information.

CrystalCast utilizes a visualisation process developed to empower non-experts to make decisions based on uncertain information.

CrystalCast provides the computational tools needed to drill down on the details of model behaviour. The input-output relationship of an integrated CrystalCast model can be explored via sensitivity analysis to determine the effect each input has on the model result. Bayesian inference is used to infer model parameters from data to calibrate models to represent an ongoing scenario.

Human interventions in modelled processes can be guided by robust multivariate optimization procedures, considering all sources of uncertainty to determine the most effective interventions for desired outcomes. Predictions from external models can be combined using stacking algorithms, leveraging past performance to weigh their contributions to forecasts and nowcasts. Importantly, statistical emulators support these computationally intensive processes, designed, and trained by users to reduce runtime for costly components of a modelling chain.

'What if' scenarios

As well as supporting externally generated model predictions, users can plan for possible future events by creating "what-if" scenarios. Combined model outputs The platform's ability to combine multiple model outputs provides users with an integrated and holistic view of each scenario.

Insightful & actionable information

CrystalCast's visualisation feature offers easy interpretation of complex data through a web-enabled GUI. It's fully customizable, generating interactive displays and capable of producing standard user-defined PowerPoint presentations to facilitate discussions and decision-making.

The screenshot shows the CrystalCast web interface. At the top left, there's a 'Tools and Settings' section with a 'Create a new scenario or choose from the favourite scenarios or the list below' prompt. In the center is a 'Bio' hub with various icons for different models like 'Chemical Hazard', 'Flu with egg', 'World 20', 'Coronavirus', 'Multiple dispersion models', 'Spatial Flu', 'Antibody response', 'SIR', 'SEIR', and 'Stochastic'. To the right is the 'CrystalCast development' logo. Below the hub is a 'Scenarios' table with columns for Scenario, Model, Agent, Description, and Last Accessed.

Scenario	Model	Agent	Description	Last Accessed
Flu with egg simulation	simulation	Flu	SEIR	2020-12-21 13:47:00
World 20 predictions	stochastic	Coronavirus	ExternalCOVID19	2020-12-21 13:47:00
Coronavirus simulator	single	Coronavirus	SEIR	2020-12-21 13:47:00
Multiple dispersion models	simulation	Airborne	Wind Rose & FDI & Competing Risks & Individual	2020-12-21 13:46:00
Spatial Flu	simulation	Flu	SEIR	2020-12-21 13:46:00

