A Bayesian spatio-temporal model for integrating multiple sources of covid burden

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COVID-19 tests are commonly used to provide an estimate of the progress of the pandemic. However, community testing programs are typically biased due to the differential uptake across the population, for instance by symptoms or occupation. We propose an integrative framework to provide an estimate of the burden of COVID-19 at high spatio-temporal resolution. Anchored in a Bayesian hierarchical modelling perspective, our modular framework allows, if appropriate, to incorporate different sub-models for each data source and to include spatial and temporal dependencies as well as adjusting for covariate effect. At the same time the joint formulation means that uncertainty is propagated throughout the model. We apply our framework to integrate two different type of information on the daily number of cases at the lower tier local authority level in England: direct estimates coming from randomized surveys and testing programs and indirect estimates coming from hospital admission numbers. We show how this integrated framework is able to estimate metrics of disease progression such as incidence or prevalence, and how favorably our estimates compare to those based on unadjusted test counts only.