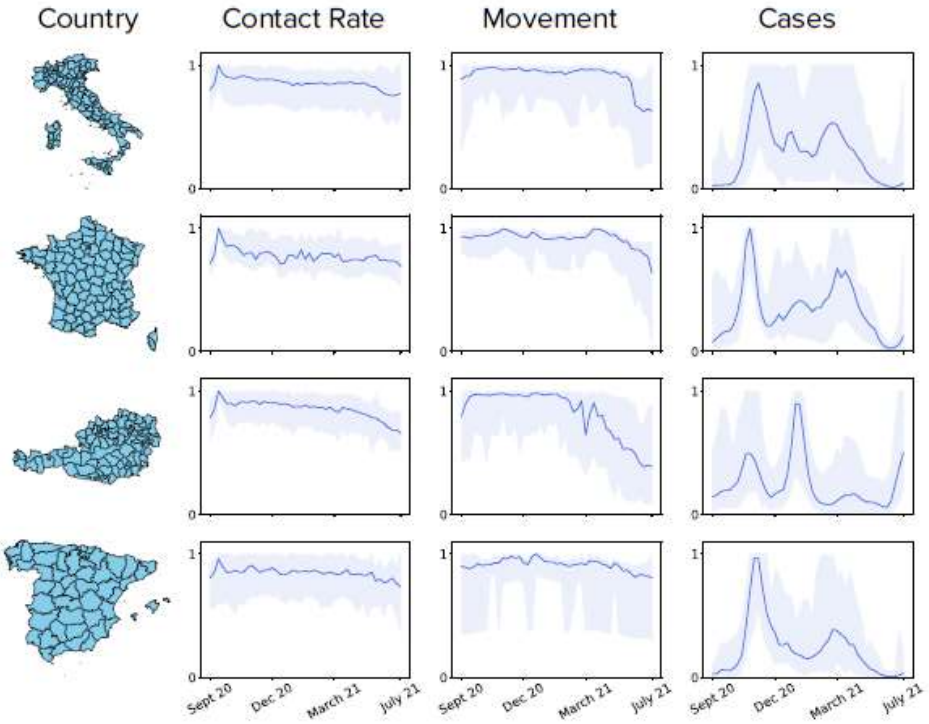

Fig. 1. Summary of behavioral and epidemiological indicators. In each country under study (from top to bottom: Italy, France, Austria, and Spain), we consider three different types of indicators: contact rates, movements (here for the sake of simplicity we only show the short-range movements), and COVID-19 cases. In each plot, the blue shaded area highlights the within-country variability, corresponding to time series in every administrative subdivision. The solid line represents the average value. All curves are normalized between 0 and 1, corresponding to their maximum value.

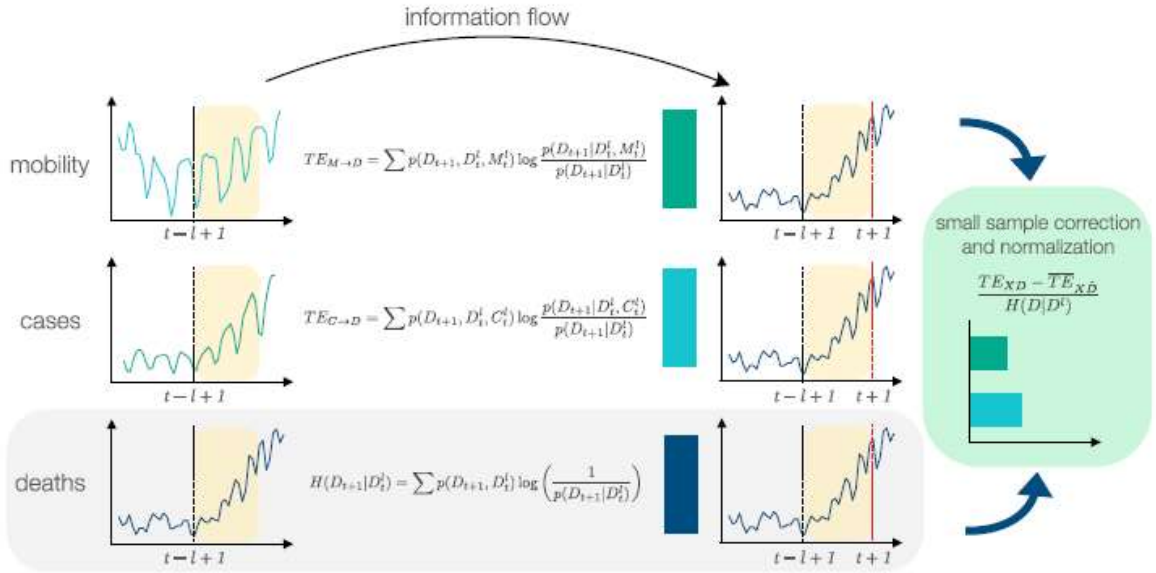

Fig. 2. Illustration of study design. We computed the transfer entropy $TE_{X\to Y}$ to measure the information flow between source X (on the left) and target time series Y (right), for a given time lag l. In the figure example, as target time series we consider the number of COVID-19 deaths, $D(t)$. As source time series, we consider either mobility indicators, $M^s(t)$, $M(t)$, $CR(t)$, or COVID-19 cases $C(t)$. Transfer entropy quantifies the amount of information that is added by past knowledge of mobility or cases (green and cyan bars, respectively) to current knowledge of deaths, with respect to the knowledge of past deaths only (blue bar). After correcting the TE for small sample sizes, and normalizing by the reference value represented by the blue bar, we finally compare the normalized effective transfer entropy of mobility and cases (rightmost box).

epidemiological time series such as the reported number of COVID-19 attributed deaths $D(t)$ and cases $C(t)$, in each administrative unit, and for different temporal lags l, using the definition of Shannon entropy, as described by the equations in Fig. 2. Intuitively, the transfer entropy between mobility and deaths, $TE_{M^s\to D}$ (resp. $TE_{M\to D}$ and $TE_{M'\to D}$), can be interpreted as the degree of uncertainty of the reported deaths, D, at time t that is solved jointly by the time series of deaths and mobility trends M^s (resp. M and M') and exceeds the current degree of uncertainty of D, which can be solved by D's own past.