We are considering data from March 2016, 2017, 2018, 2019 and 2020.

Data:

- $x_{t,k}$, deaths in town t in March of the year $k \neq 2020$.
- y_t, deaths in town t in March 2020.

Hypotheses:

- Deaths not due to COVID–19 follow the same distribution, aside from a proportional factor that varies from town to town
- Deaths due to COVID–19 follow the same distribution within a province, aside from a proportional factor that varies from town to town
- The growth in the number of deaths in March 2020 is due to COVID–19.

Variables:

- $X_t = \alpha_t \cdot \mathcal{D}(1, \sigma)$, deaths not due to COVID–19 in town t
- $Y_t = \alpha_t \cdot \alpha_p \cdot \mathcal{D}(1, \sigma_p)$, deaths in town t of province p in 2020, whose value is unknown

Goal:

- Estimate $D := \sum_t y_t + \sum_t Y_t - \sum_t X_t$, death toll of COVID–19

Estimators:

$$\bar{\alpha}_t := \frac{1}{4} \sum_k x_{t,k} \tag{1}$$

$$\bar{\sigma} := \frac{1}{4} \sum_k \left(\frac{\sum_t x_{t,k}}{\sum_t \bar{\alpha}_t} \right)^2 - 1 \tag{2}$$

The first is the average of deaths in a town in a year.
The second means that we are considering the variance of the deaths in the entire region. Indeed:

$$\sum_t X_t = \sum_t \alpha_t \cdot \mathcal{D}(1, \sigma)$$

$$\bar{\alpha}_p := \frac{\sum_{t \in P} y_t}{\sum_{t \in P} \bar{\alpha}_t} \tag{3}$$

Punctual estimation:

$$\bar{D} := \sum_t y_t + \sum_P \bar{\alpha}_p \sum_{t \in P} \bar{\alpha}_t - \sum_t \bar{\alpha}_t \tag{4}$$

Intervals:

$$\bar{D}_{0.04} = \sum_t (y_t - \bar{\alpha}_t(1 + 2\bar{\sigma})) + \sum_P (\bar{\alpha}_p^{min} - 1 + 2\bar{\sigma}) \sum_{t \in P} \bar{\alpha}_t \tag{5}$$

$$\bar{D}_{0.96} = \sum_t (y_t - \bar{\alpha}_t(1 - 2\bar{\sigma})) + \sum_P (\bar{\alpha}_p^{max} - 1 - 2\bar{\sigma}) \sum_{t \in P} \bar{\alpha}_t \tag{6}$$