Graph visualisations of COVID-19 cases in the Italian municipality of Vo’

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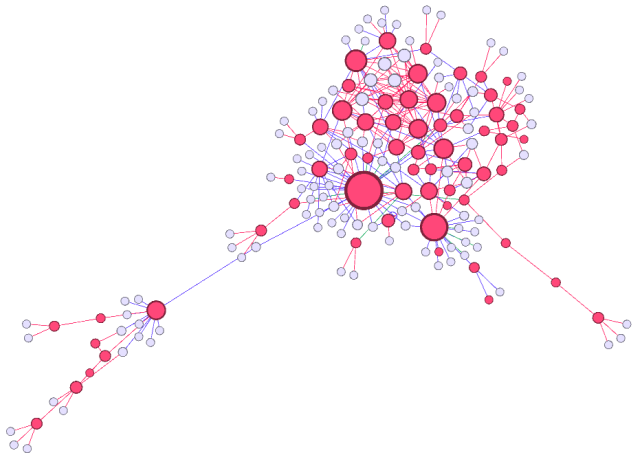


Location

- **Vo’** is a small town in Italy, 50 km west of Venice

The pandemic

- In February and March 2020, during pandemic lockdown, 80% of the 3200 inhabitants were screened for SARS-CoV2 infection
- Most had two tests performed, 2 weeks apart
- A significant proportion of positive cases were asymptomatic

- The results were published in:

  Suppression of a SARS-CoV-2 outbreak in the Italian municipality of Vo'. Imperial College COVID-19 Response Team, Lavezzo E, Franchin E, Ciavarella C, Cuomo-Dannenburg G, Barzon L, et al. Nature [Internet]. 2020 Jun 30;

The source of the data

- The authors made available the data and the **R** code at: https://github.com/ncov-ic/SEIR_Covid_Vo

- The data is a unique resource for epidemiologists and statisticians
  - A single easy to read **Excel** file
  - **Very detailed:** gender and age stratification, household identifiers, symptoms check list, severity, hospitalization, outcome
  - Contact tracing provided by **adjacency matrix**
  - **Viral levels** in swabs (no.of PCR cycles), **body temperature**
  - **Longitudinal data** - affords a glimpse into the temporal dynamics of SARS-CoV2 infection

- Has the potential to become the ”**Framingham study**” of COVID-19

Zuin, Marco, Claudio Bilato, Giovanni Zuliani, and Loris Roncon. 2020. “Italian Vò Municipality Cohort and COVID-19 Epidemiology: The ‘Framingham’ Study of the 21st Century.” *European Journal of Internal Medicine* 0 (0). https://doi.org/10.1016/j.ejim.2020.07.015.

Graph visualisations

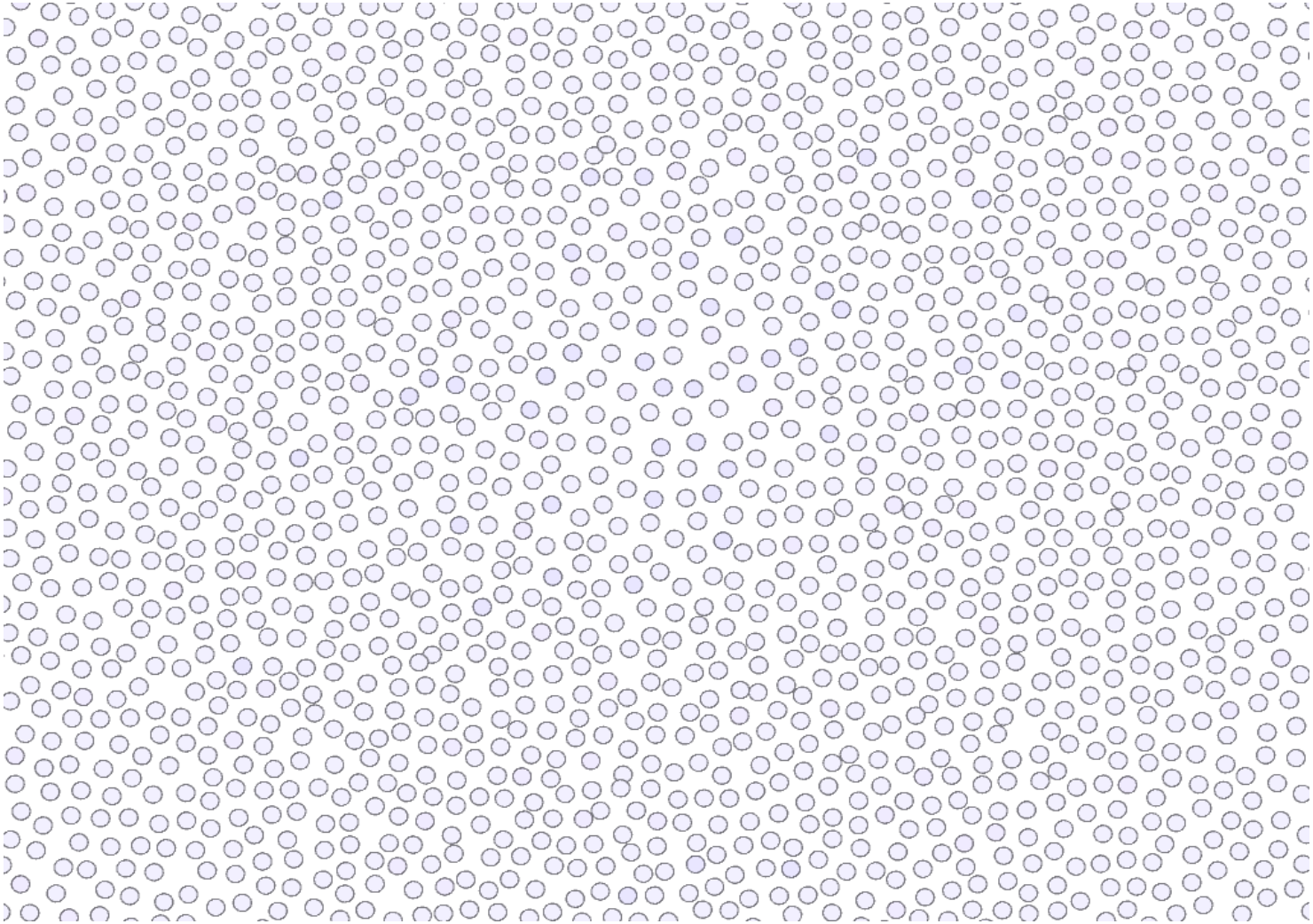
- I analyzed the data and constructed **contact graphs** for visualizations

- Each point (node in a graph) represents an individual
- The color of the point signifies the status:
  - **Gray** – **negative** and asymptomatic, or unknown
  - **Red** – SARS-CoV2 **positive**, symptomatic disease
  - **Light red** - SARS-CoV2 **positive**, asymptomatic
  - **Blue** – **negative**, symptomatic (e.g. fever caused by flu etc.)

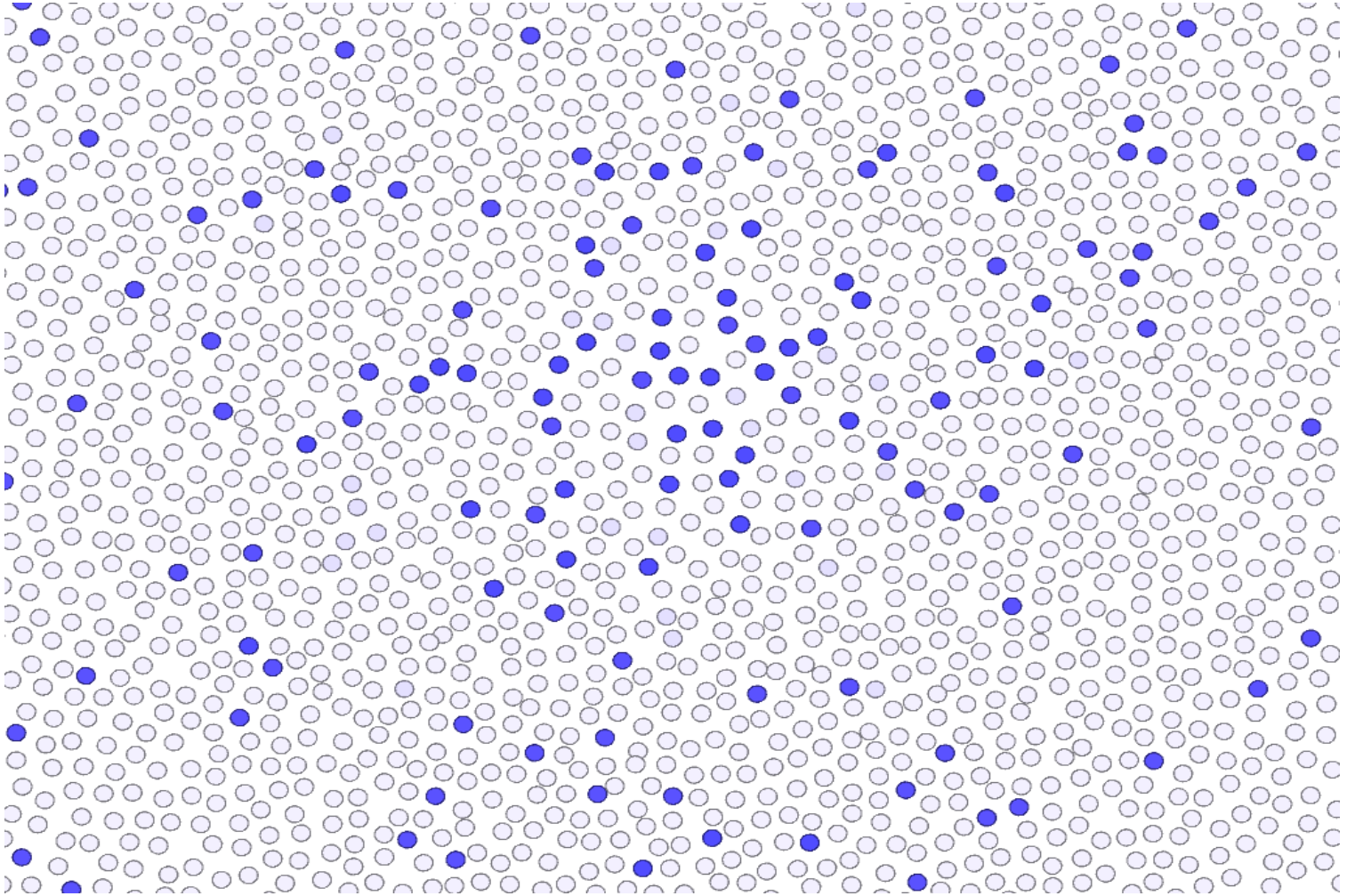
- In the following visualisations, the sequence of slides is not necessarily the temporal sequence of the actual discovery of cases
- The proximity of two points in the graph plane does not signify geographic proximity of their households

- The data seem to tell an interesting story of their own, if only visually, with no graph-theoretic statistics employed

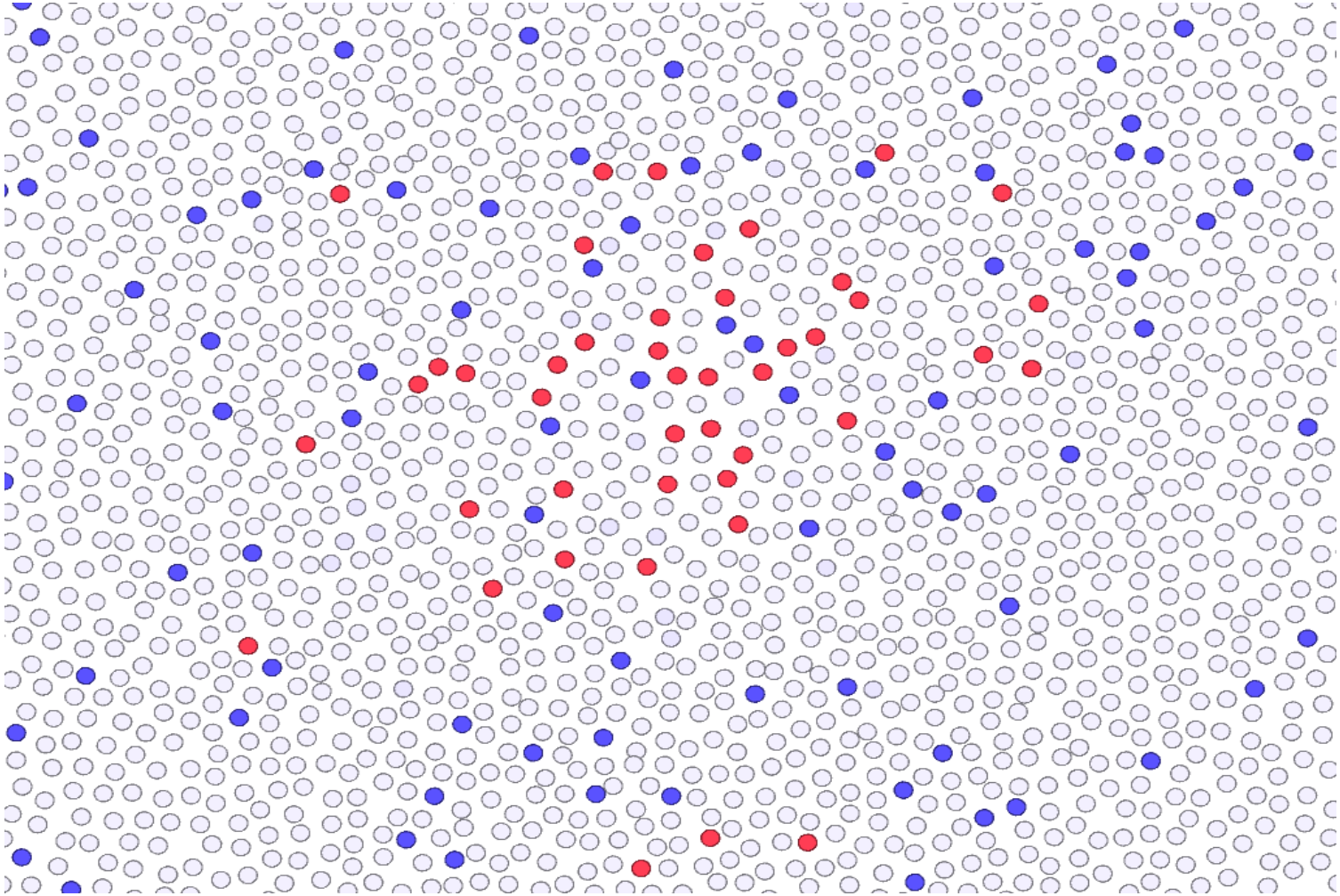
At first, everyone’s status is unknown



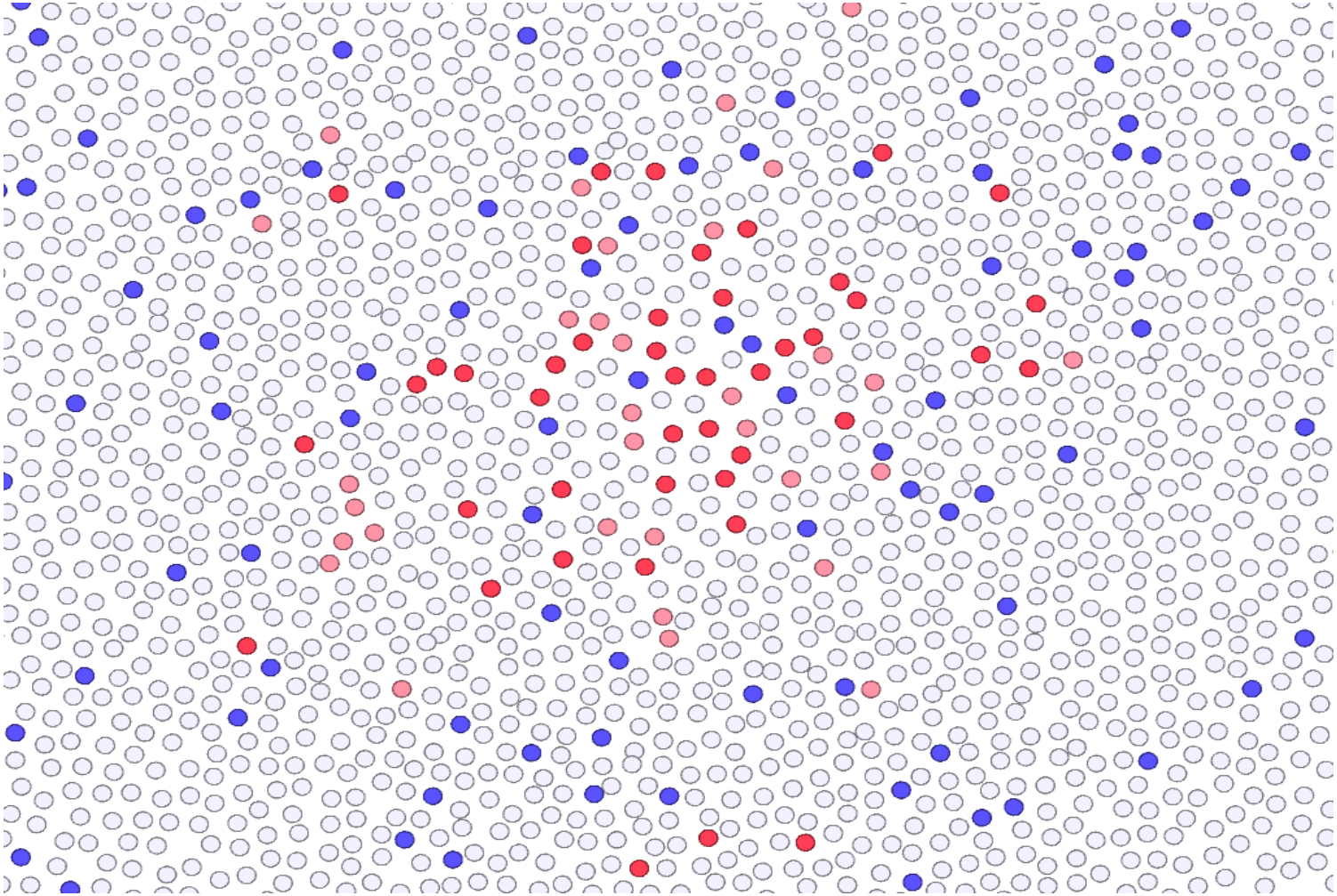
Some inhabitants display **symptoms**



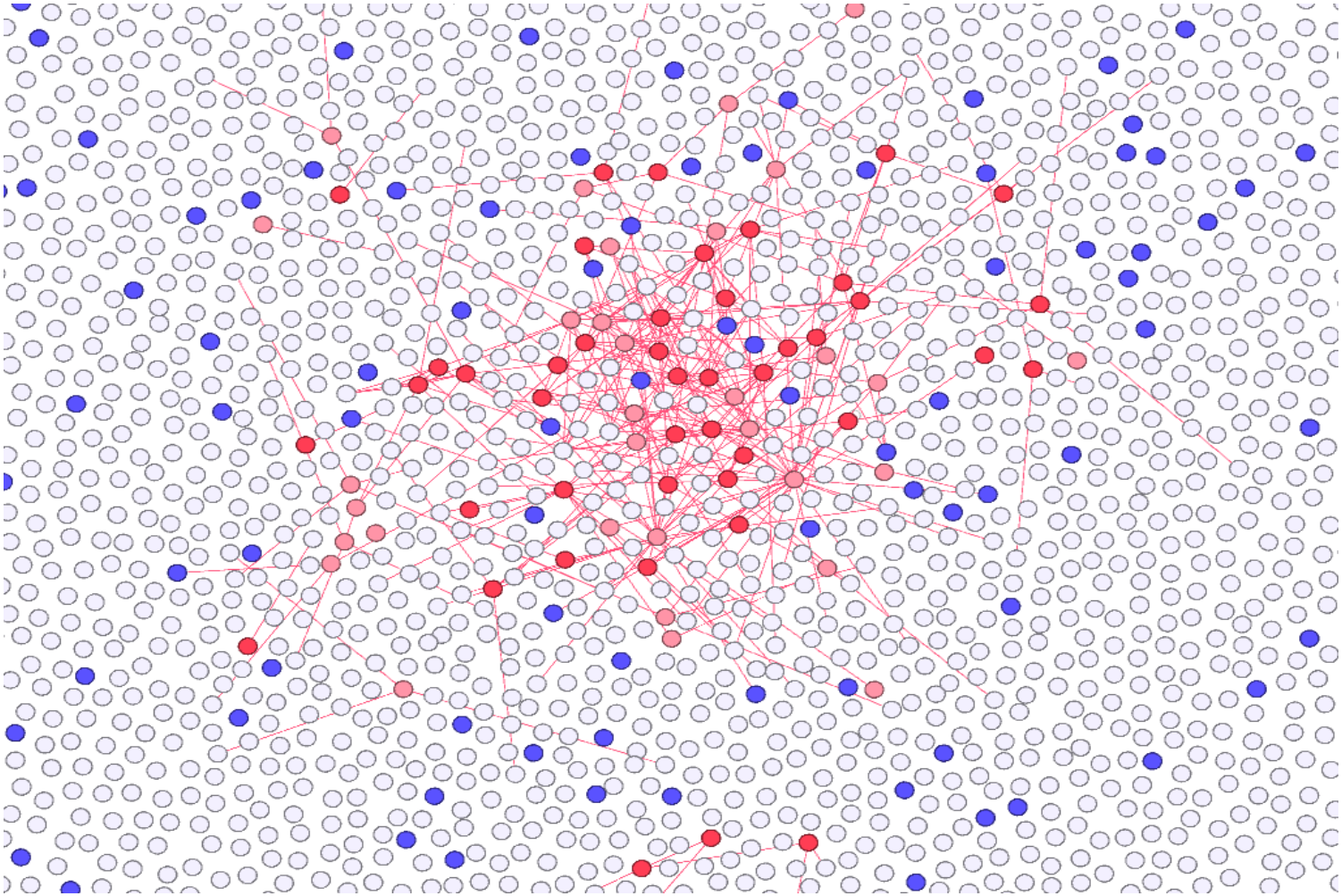
Some of the symptomatic are **COVID +**



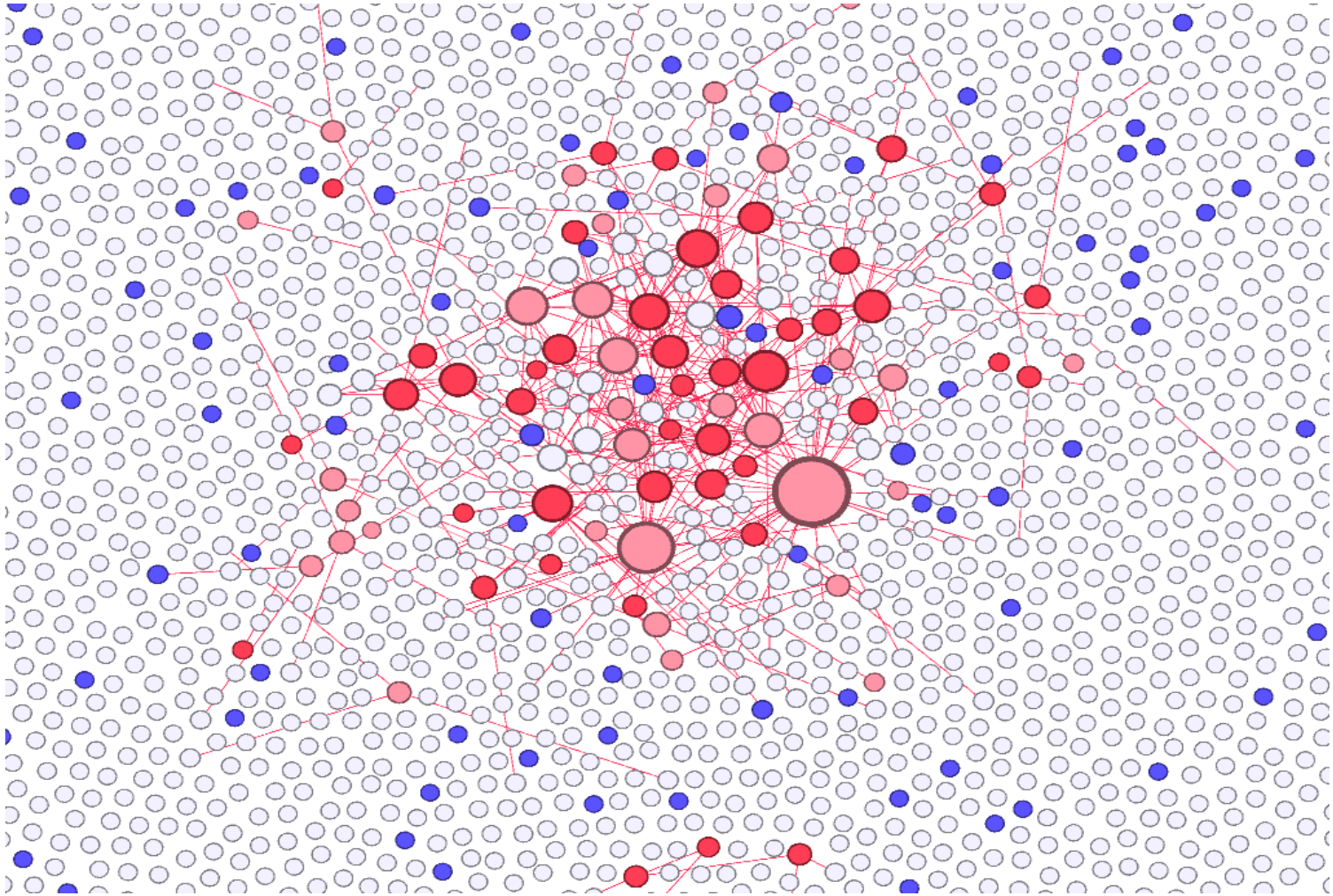
Some more COVID+ are asymptomatic



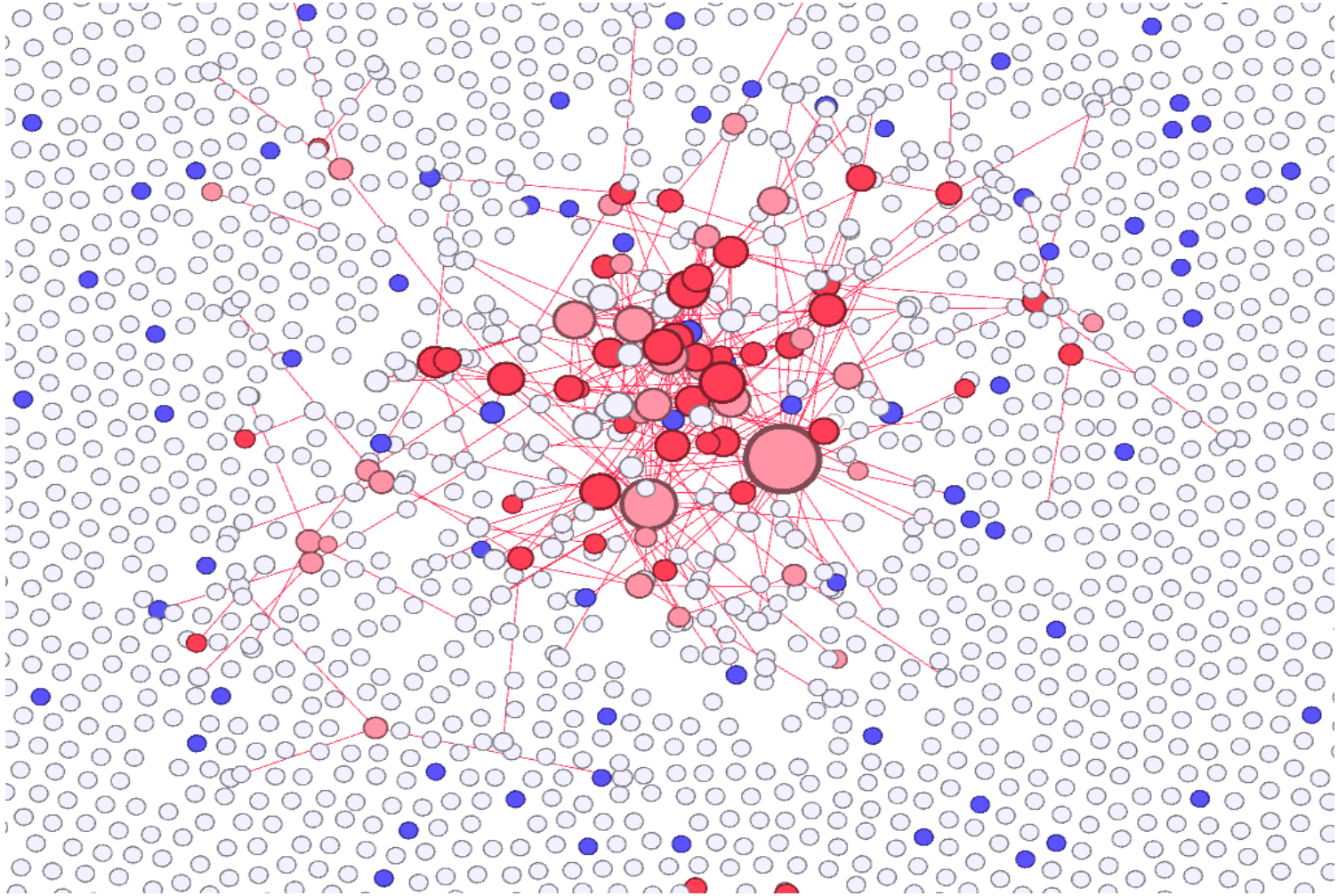
There is a contact net between cases



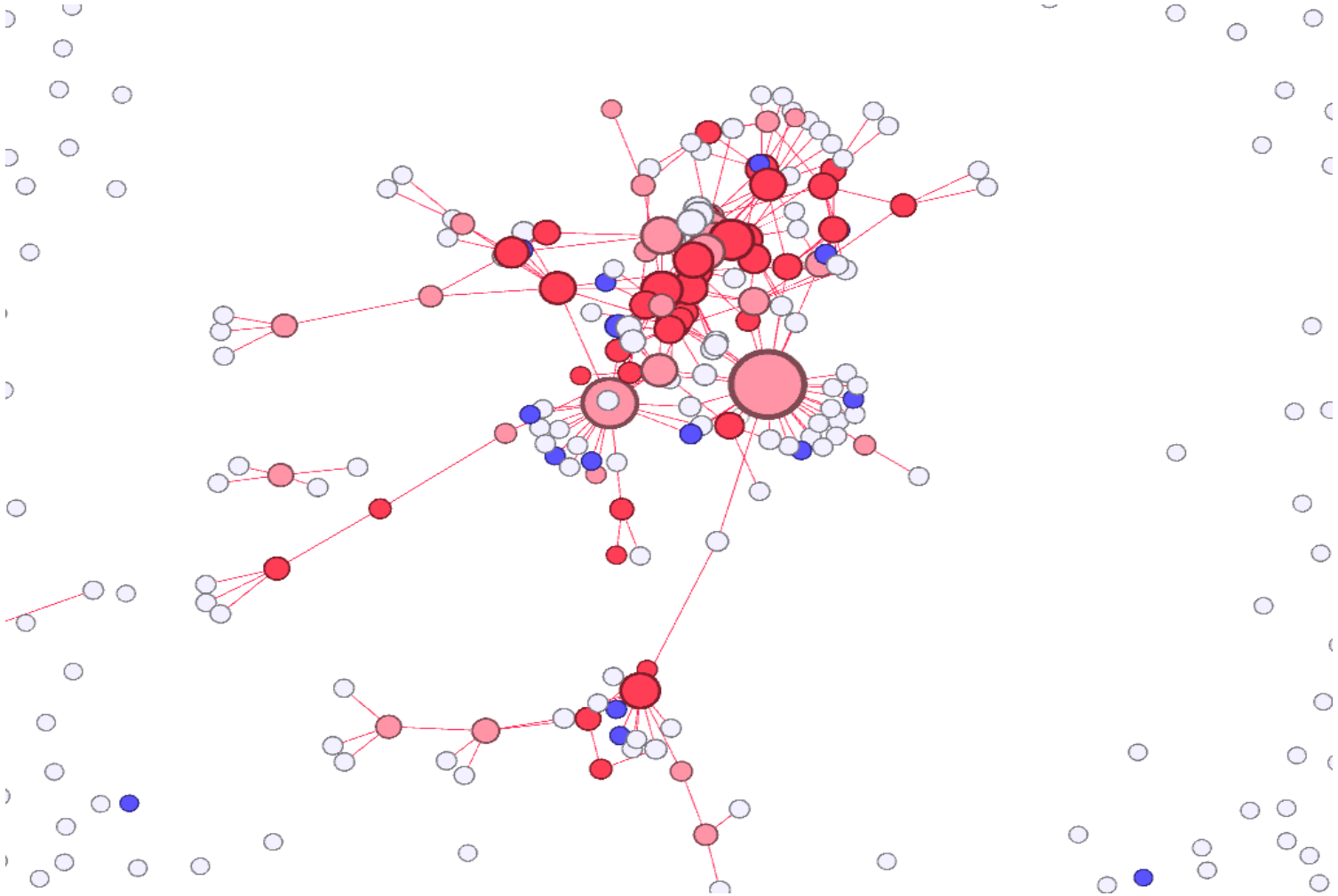
Resize point by the number of contacts



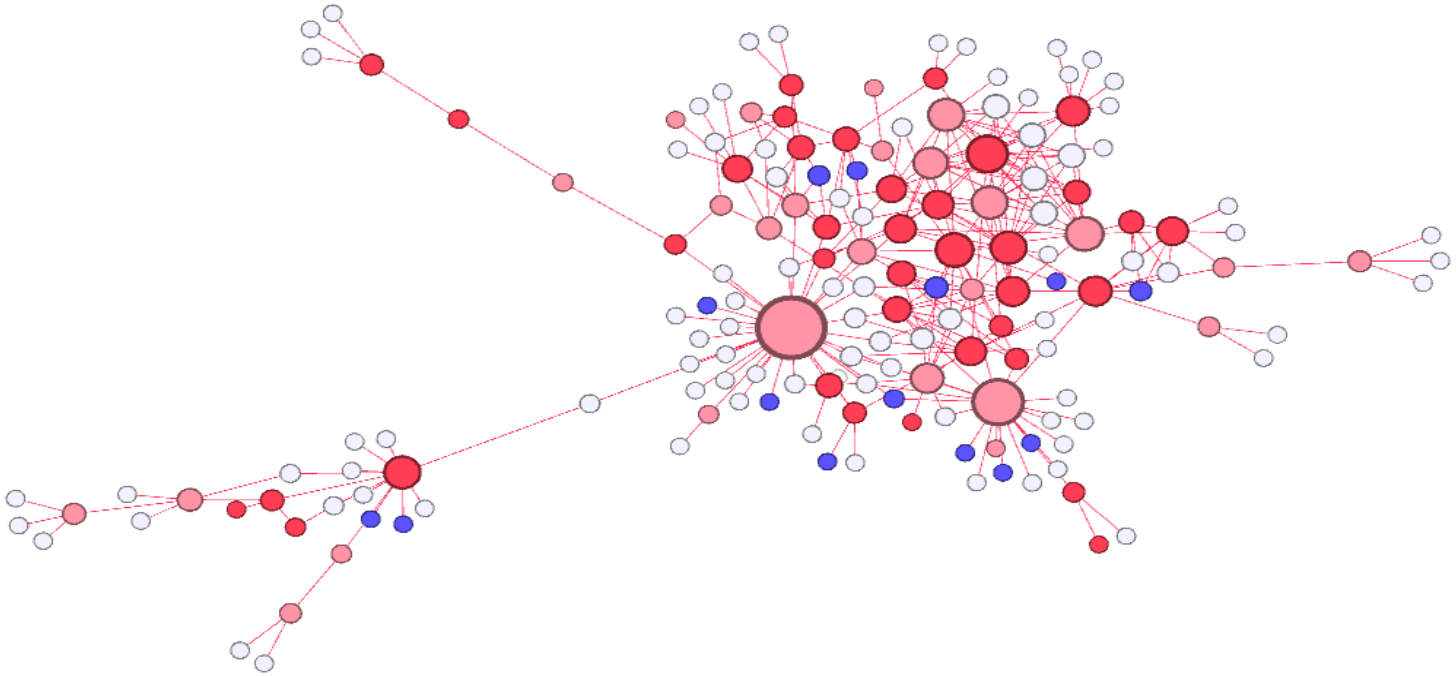
Reshape graph to cluster positive cases



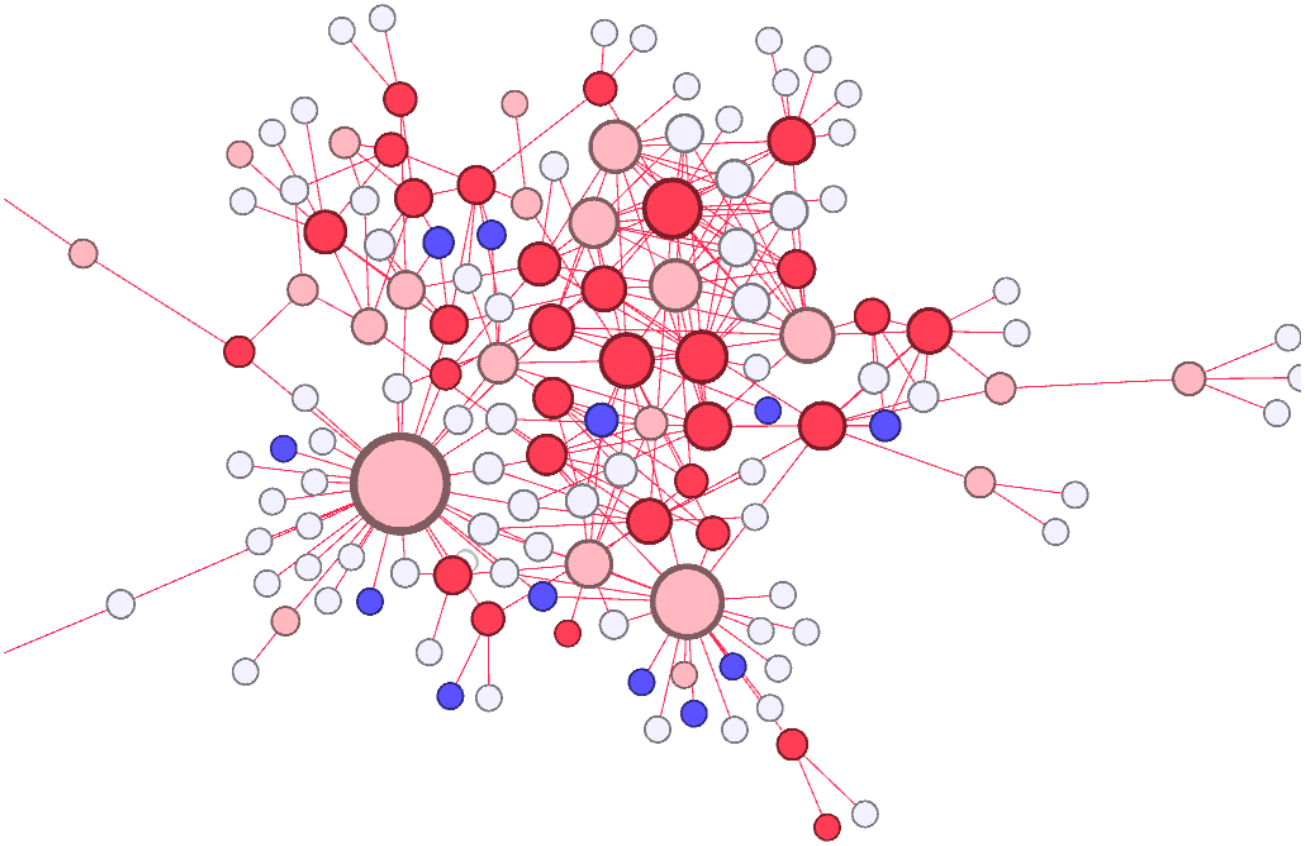
Reshaping



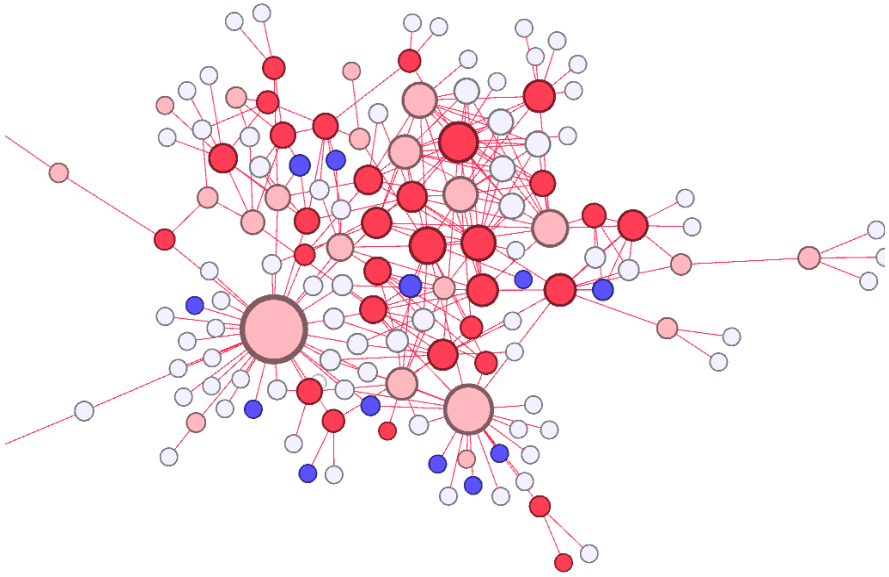
A contact net of COVID+ emerges



A close-up of the network

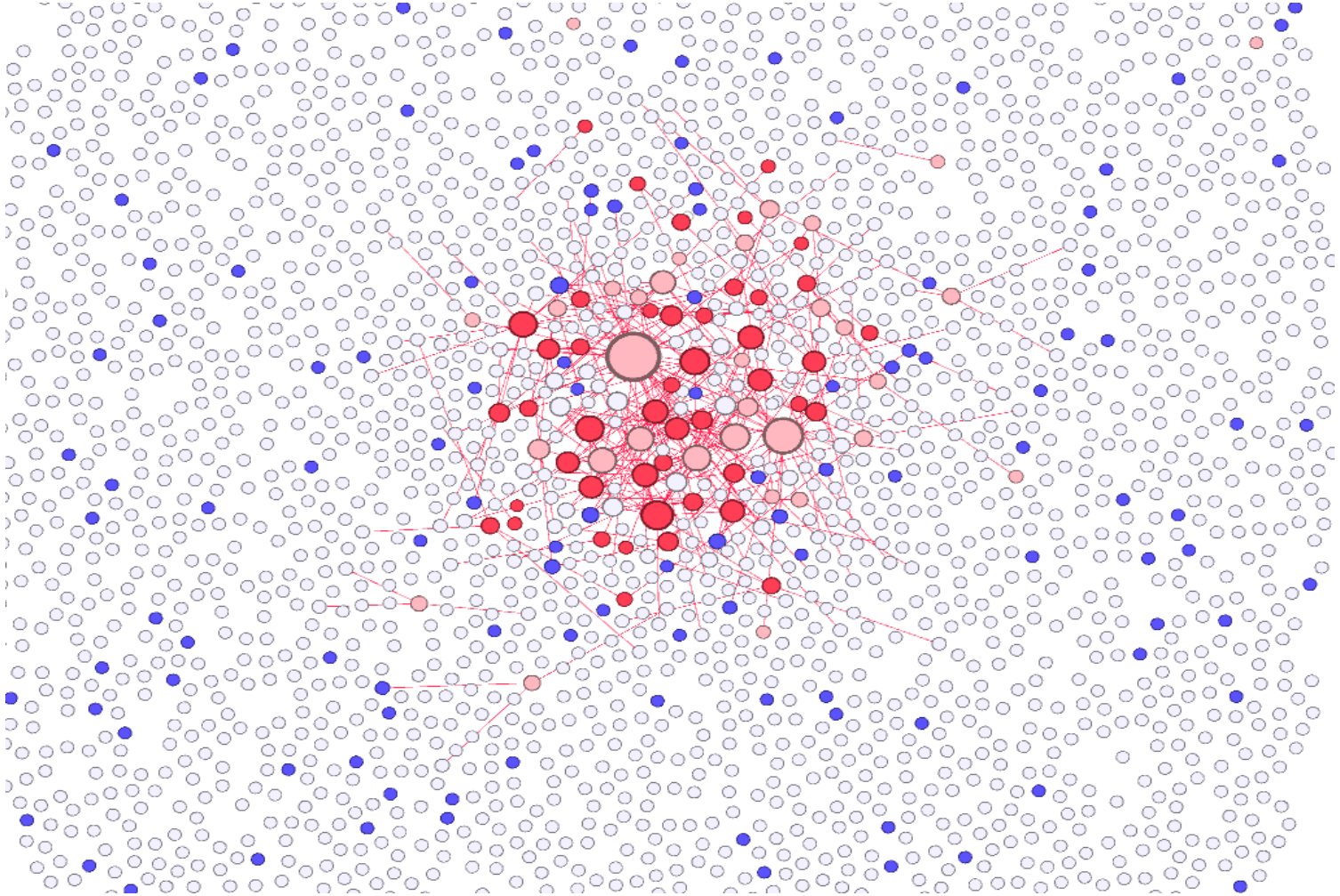


Some features of the network

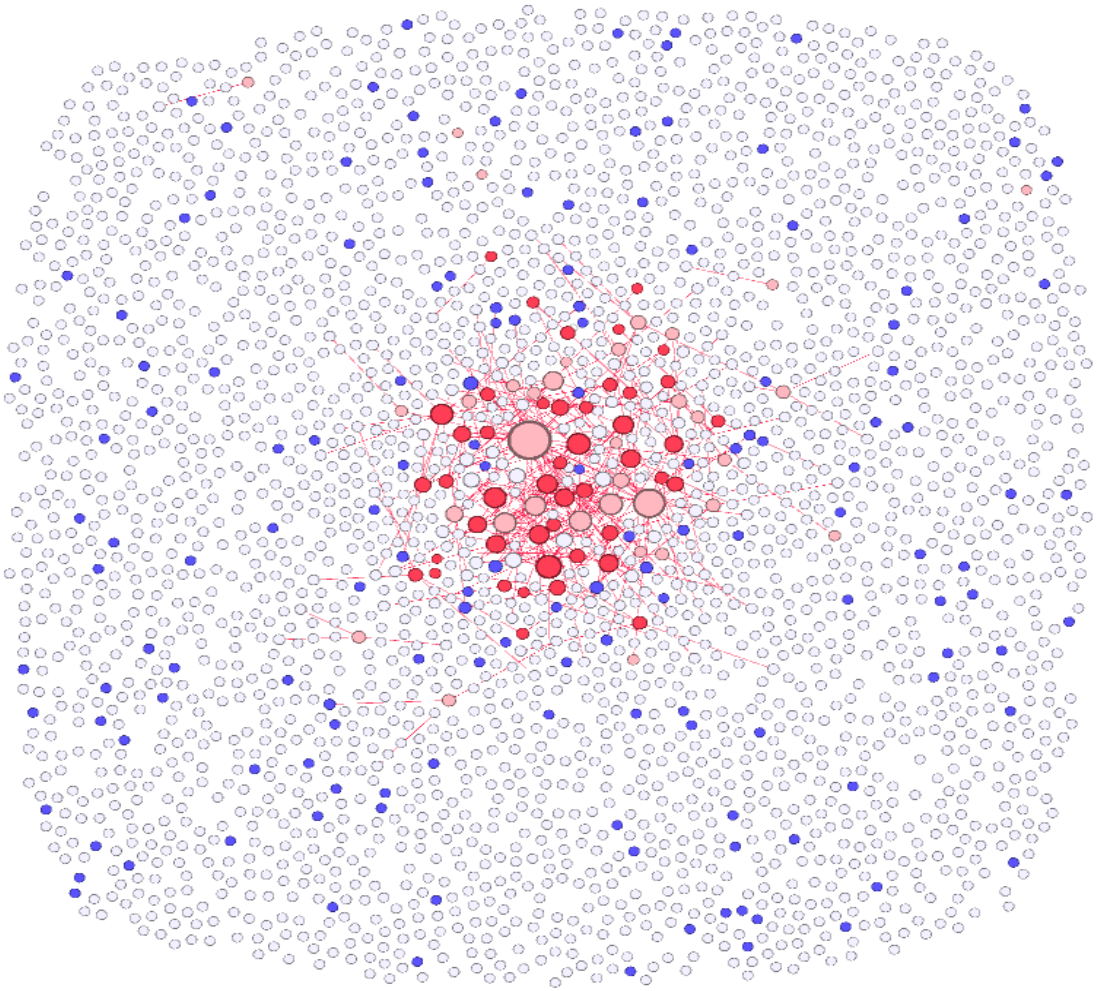


- Many **COVID+** cases are clustered, some **symptomatic** and some **asymptomatic**, a lot of household contacts
- A very well connected, **asymptomatic COVID+ case** did not spread much disease (large point at bottom left)
- In the entourage of COVID+ cases, there are always **symptomatic cases from other diseases (blue points)**

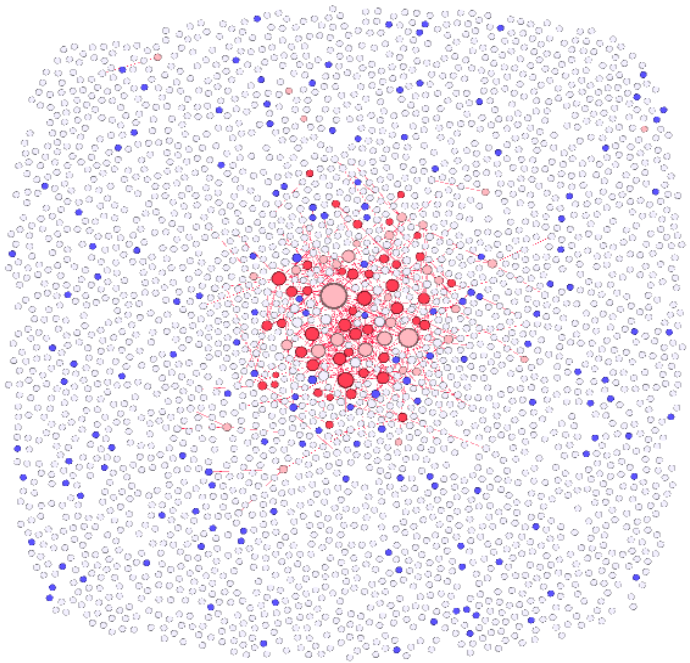
Putting the net back among its peers



The whole population sampled



A bird’s eye view of the town



Conclusions

- An intuitive sense can be made of :
  - how common the infection is
  - how frequent is the asymptomatic carrier status
  - how often other diseases can produce symptoms similar to COVID-19, in the vicinity of COVID cases
  - how all of the above occur, interact, and transform into each other not in a well-mixed system, but within a coherent **structure**
- The graph data, the code and the images are available at:

  https://github.com/Haplea-Ioan-Stefan/COVID_Vo

Thank you!