Modelling infectious diseases with EpiGraph

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Overview

- ▸ Computer architecture group

- ▸ EpiGraph project started in 2010

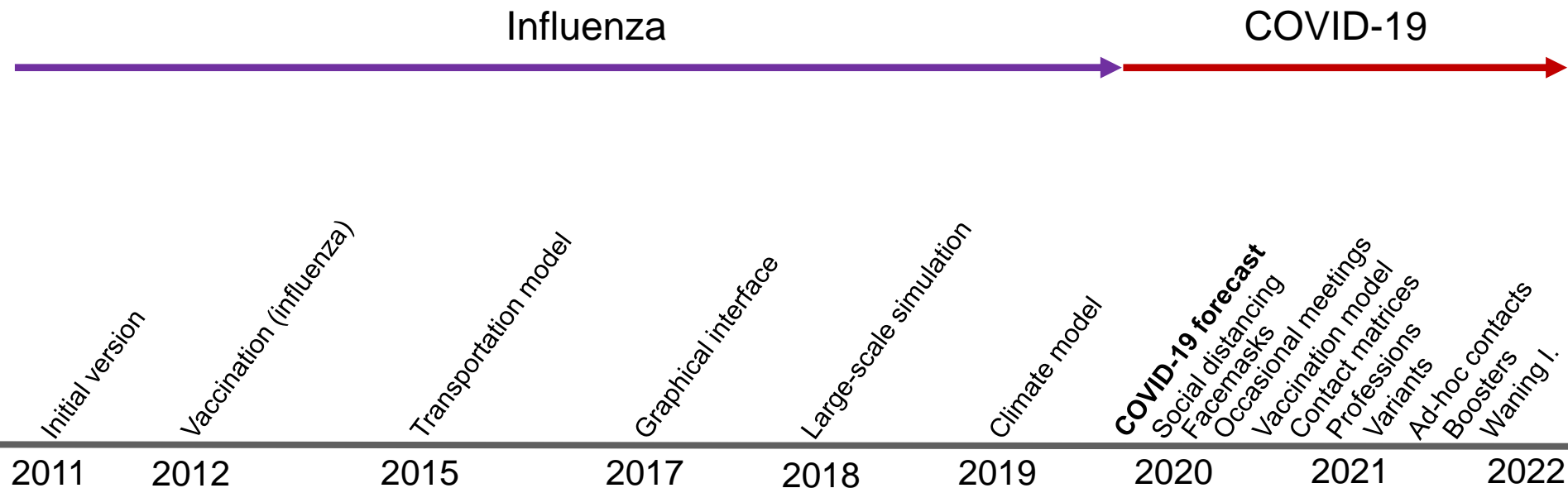- ▸ HPC infrastructure provided by the Spanish Supercomputing Network

Overview

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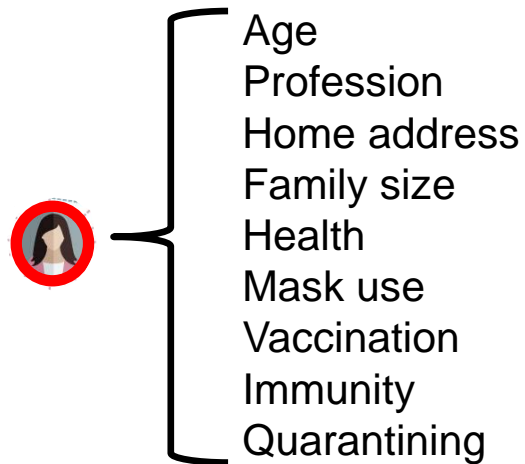- ▶ HPC infrastructure provided by the Spanish Supercomputing Network

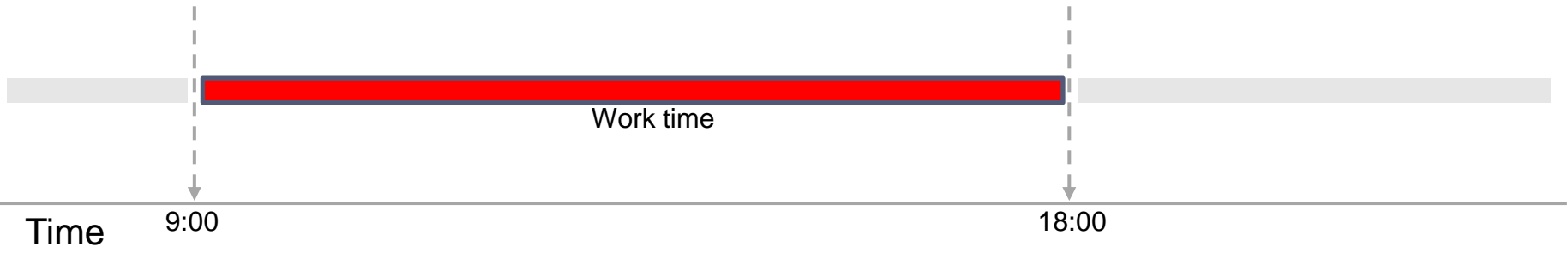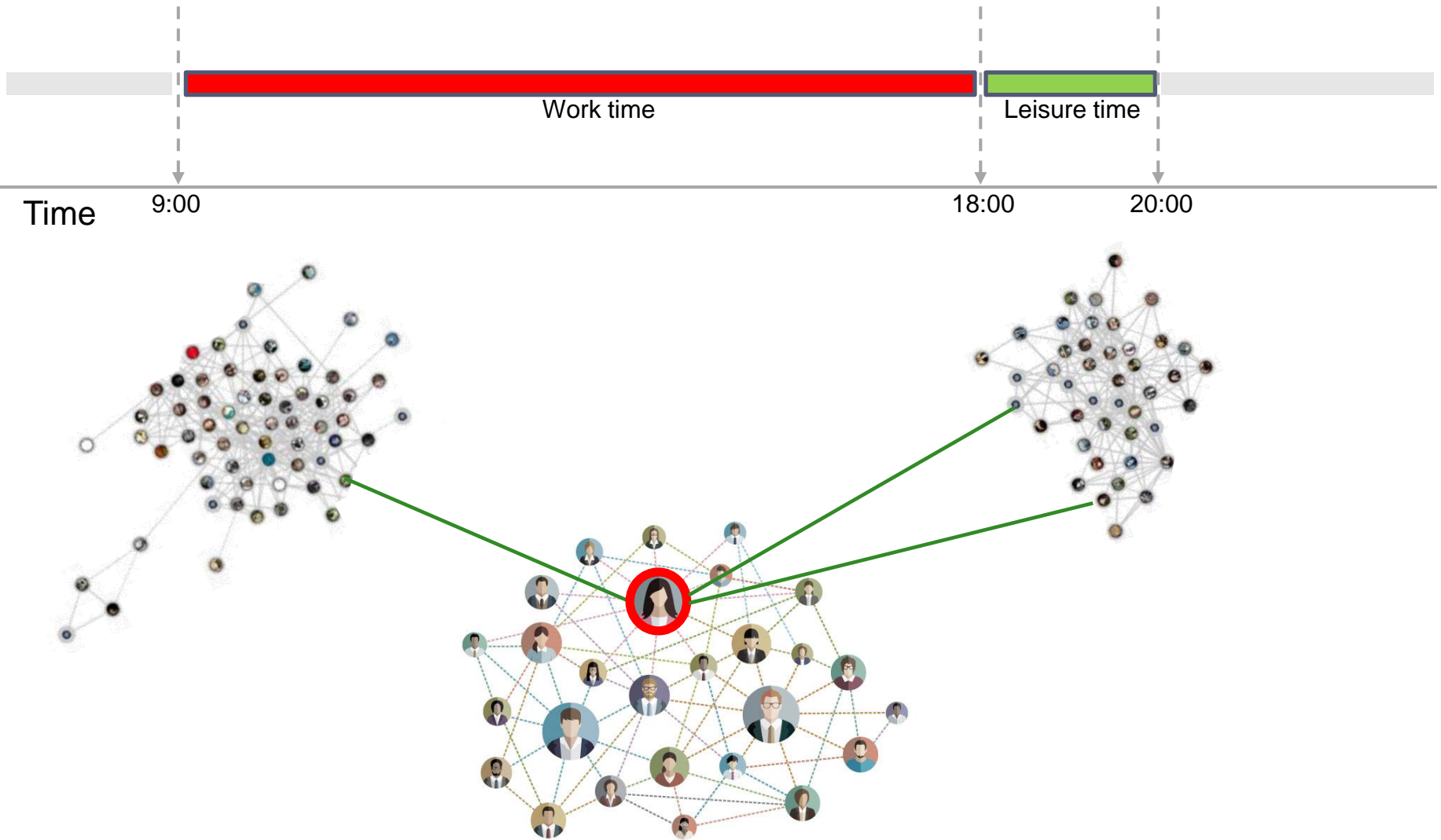Influenza   COVID-19

2011	2012	2015	2017	2018	2019	2020	2021	2022

Initial version · Vaccination (influenza) · Transportation model · Graphical interface · Large-scale simulation · Climate model · **COVID-19 forecast** · Social distancing · Facemasks · Occasional meetings · Vaccination model · Contact matrices · Professions · Variants · Ad-hoc contacts · Boosters · Waning I.

Social model

Age
Profession
Home address
Family size
Health
Mask use
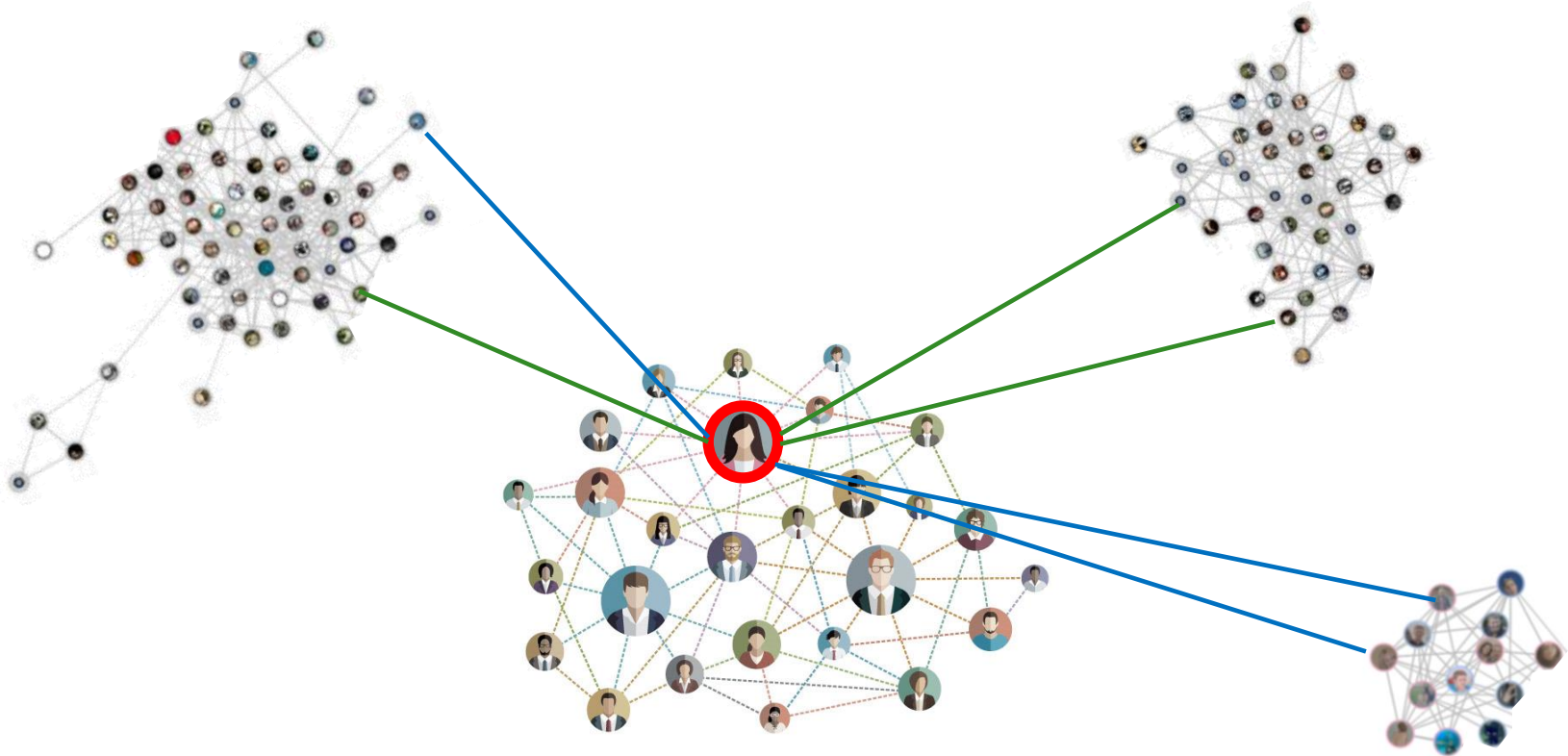Vaccination
Immunity
Quarantining

Social model

Time
9:00
Work time
18:00

Work group

Social model

Social model

Social model

Enron

Facebook

Connection graph

Family

Work

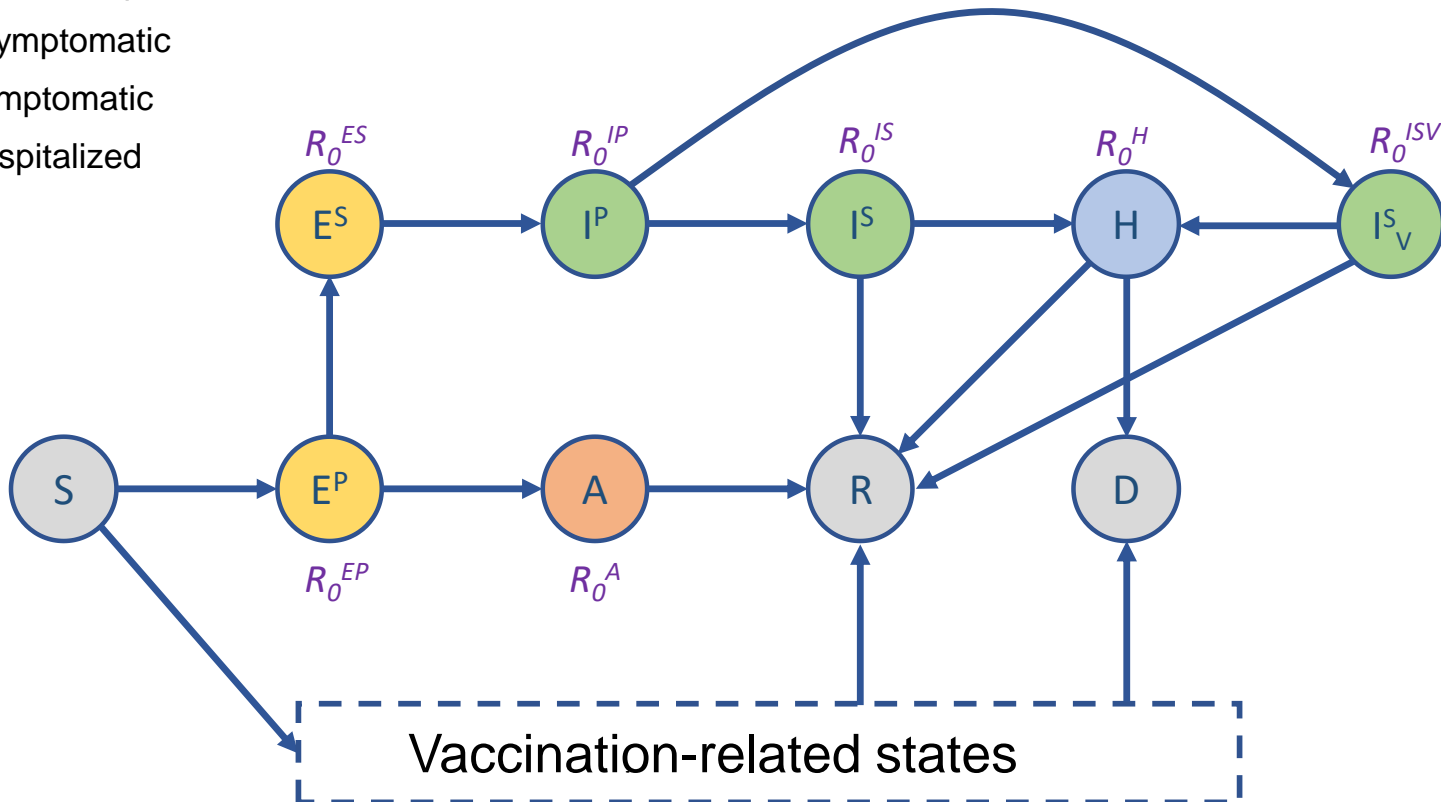**Leisure**
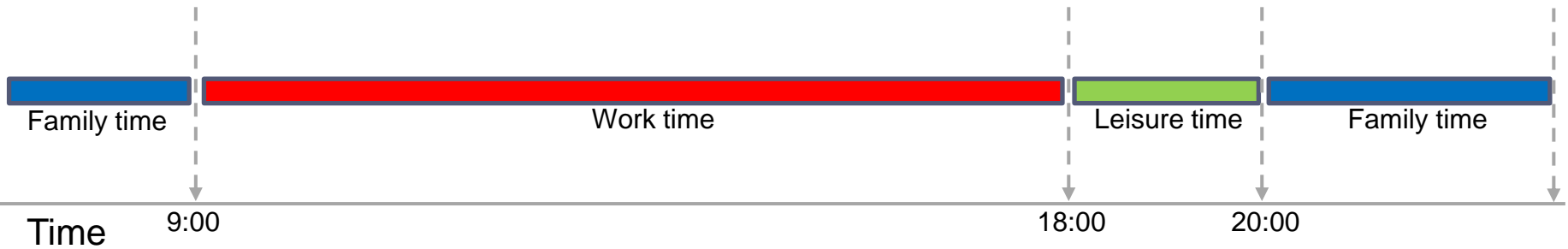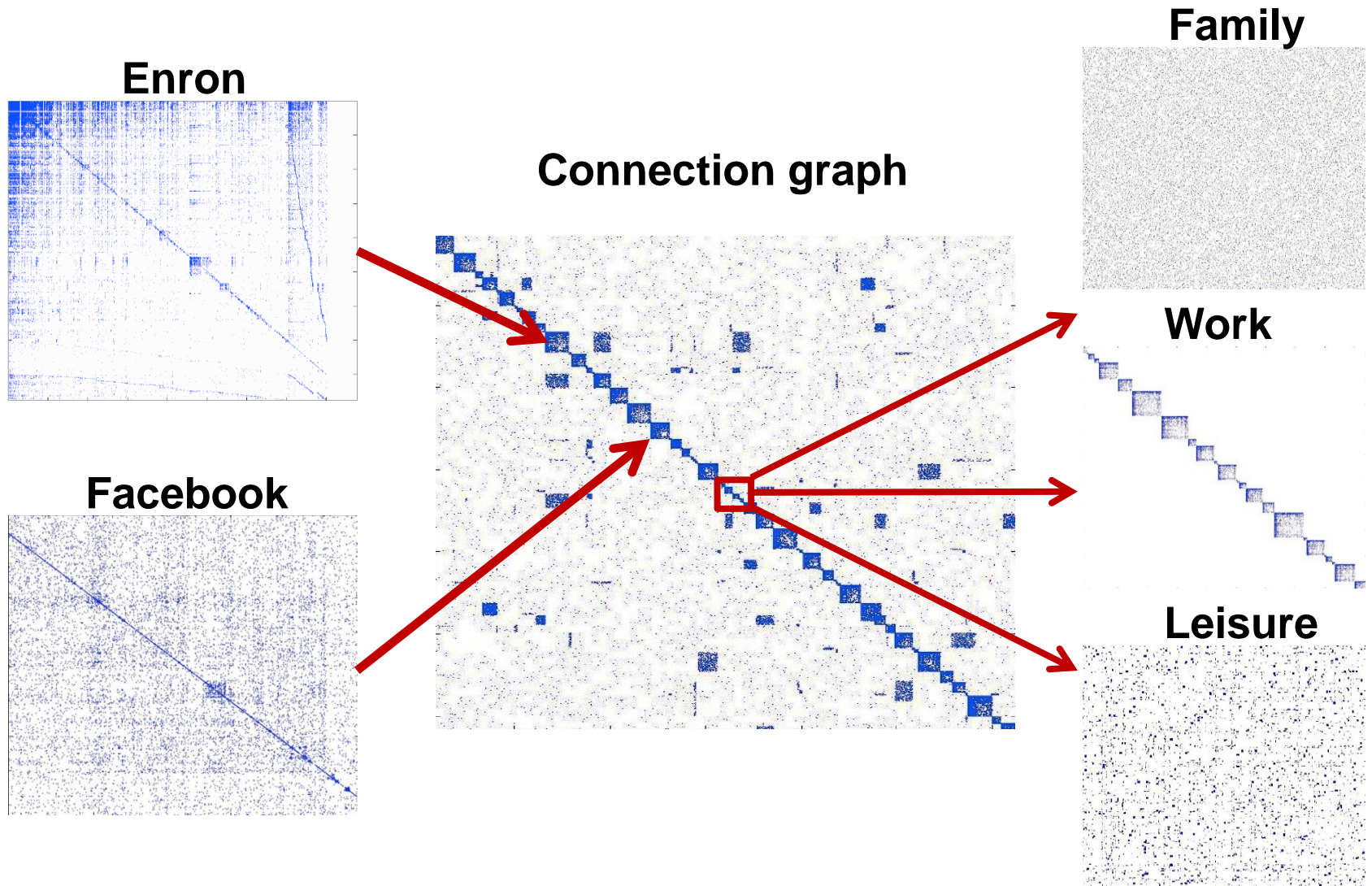
Social model

▸ **Contact matrices**

▸ **Static profession-specific contacts**
  - ▸ Teachers with students
  - ▸ Care givers with elderly people in nursing homes

▸ **Dynamic profession-specific contacts**
  - ▸ Non-front line health professionals
  - ▸ Front line health professionals
    - ▸ Higher risk of contact with COVID-19 infected individuals
  - ▸ Hospitality (catering workers)
  - ▸ Security services (police, etc.)

▸ **Occasional social meetings**

Epidemic model

▸ Extended SEIR model

Non-infected
Incubation period
Asymptomatic
Symptomatic
Hospitalized

R_0^{ES} R_0^{IP} R_0^{IS} R_0^{H} R_0^{ISV}

E^S I^P I^S H I^S_V

S E^P A R D

R_0^{EP} R_0^{A}

Vaccination-related states

Projects

Start year	Scope	Partner
2020	Forecast	Spanish National Epidemiology Centre (NEC)
2020	Spanish COVID-19 vaccination strategy	Spanish Ministry of Health (MoH)
2021	Removal of restriction analysis	NEC, MoH
2022	Long-term forecast	MoH, EUCovid-19ForecastHub
2022	Social disparities	NEC, University of Rostock
2022	Multi-source and multi-method prediction	Regional Government of Madrid

Social disparities

- Prof. Gabriele Doblhammer

- University of Rostock, Chair of Empirical Methods in Social Science and Demography

- Study the relationship between the COVID-19 incidence rates and the socioeconomic characteristics of different counties in Germany

  - *Regional Characteristics of the Second Wave of SARS-CoV-2 Infections and COVID-19 Deaths in Germany*. **Int J Environ Res Public Health.** *2021*

  - *Social disparities in the first wave of COVID-19 infections in Germany: A county-scale explainable machine learning approach.* **BMJ Open.** *2022*

PredCov

Research strands

Epidemiological models
- EpiGraph
- CoronaSurvey
- Machine learning

Social analysis
- Contact tracing
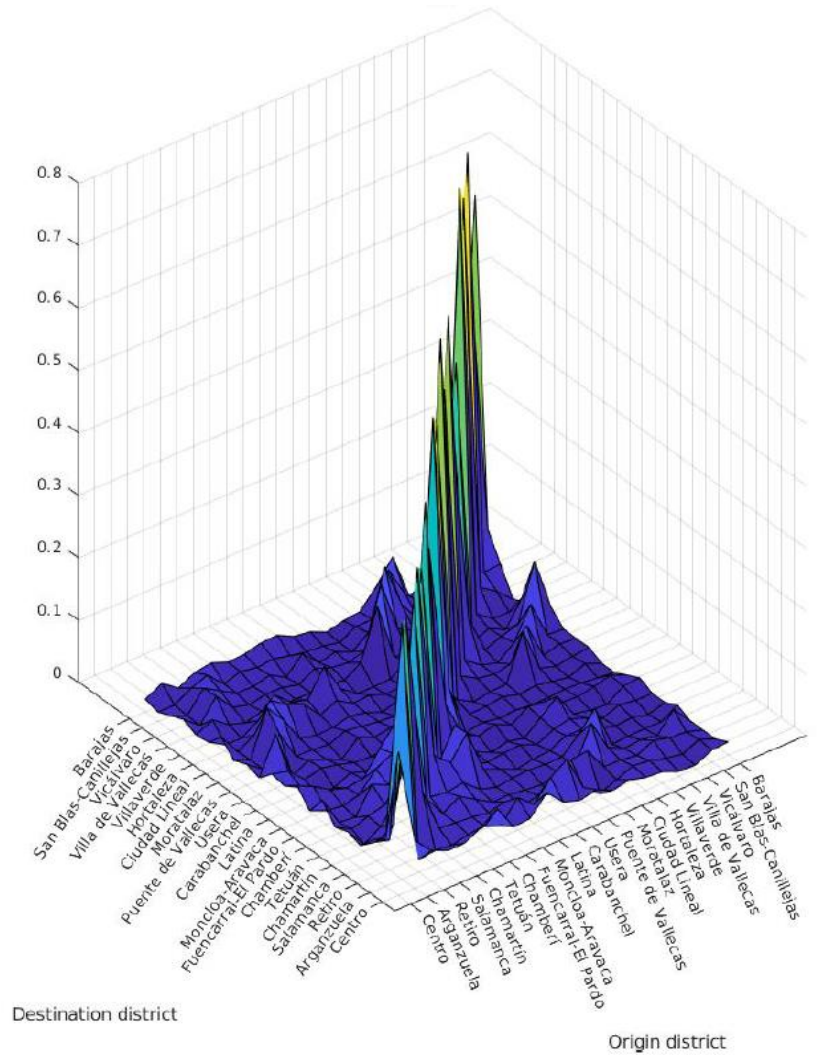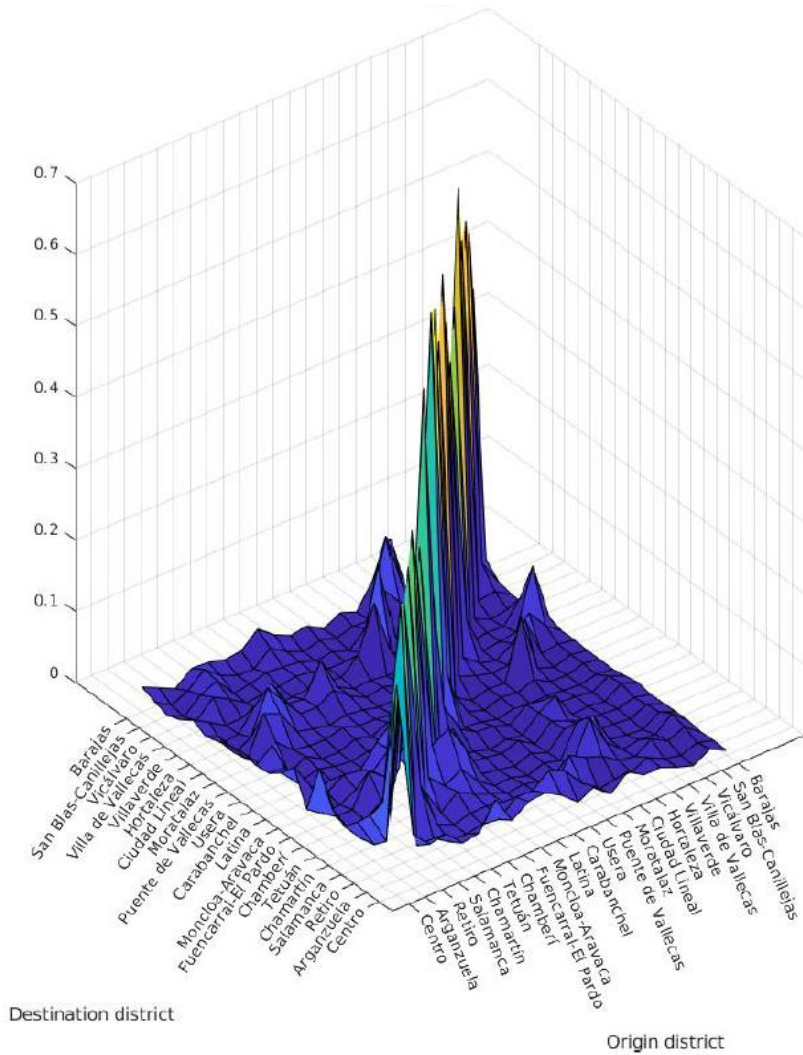- Mobility analysis
- Population habits

Media analysis
- Public debate
- Public perception of risk
- Fake news

Economic analysis
- Sectors experiencing growth or shrinking
- Economic policy design

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Comunidad de Madrid

UNIÓN EUROPEA
REACT-EU
Fondo Europeo de
Desarrollo Regional

PredCov

- Madrid mobility survey (2018)

- Face-to-face interviews with every family member
  - 34,652 samples

- Phone interviews with one family member
  - 50,412 samples

- Survey consists of 22 questions with 9 questions related to each journey made.

Contact

- Project web page
  - https://www.arcos.inf.uc3m.es/epigraph
  - https://www.arcos.inf.uc3m.es/predcov

- Contact: David E. Singh
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  - https://www.arcos.inf.uc3m.es/dexposito