Digital Population Twins in JUNE

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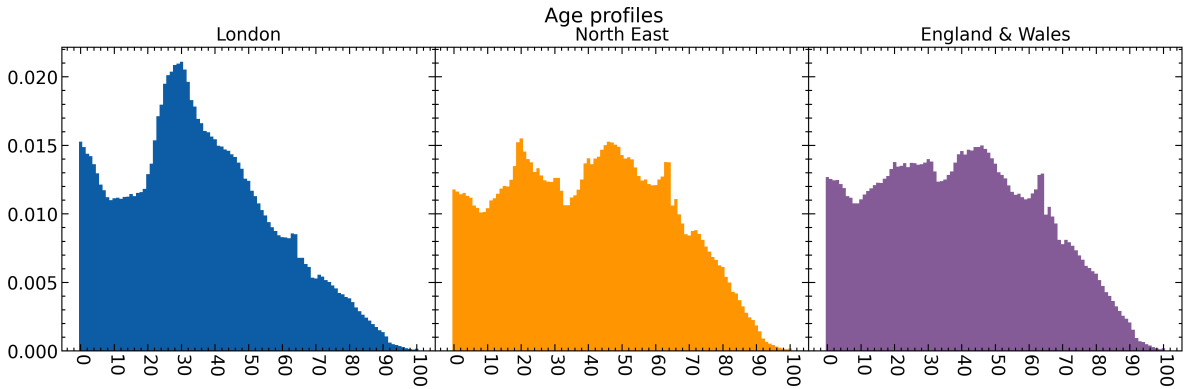
DAFNI @ Durham 13.12.2023

motivation: why granularity matters in epidemiology

- impact of COVID=19 highly age-dependent
  $\longrightarrow$ **need geographical granularity for regional planning**

(coincidence: Durham hosts & maintains England & Wales census data of past decades)

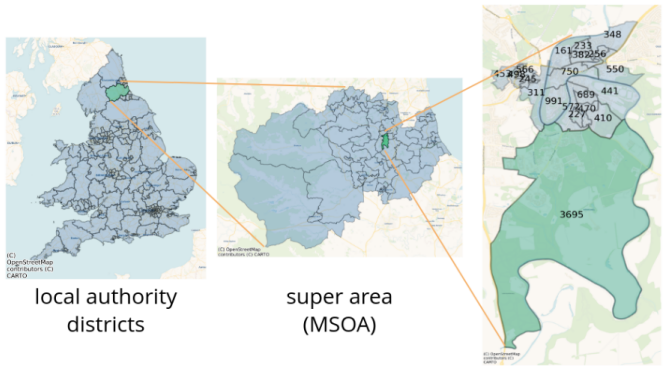


inputs: demographics

- last census (2011)

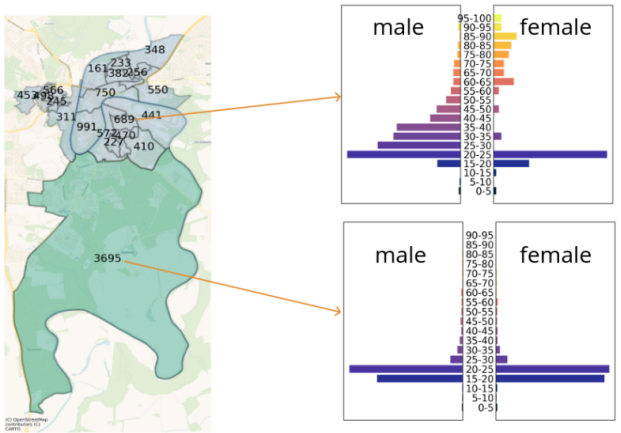
  (data freely available from Office for National Statistics)

- hierarchical data structure



- OA's with $\sim$ 250 residents, with similar characteristics

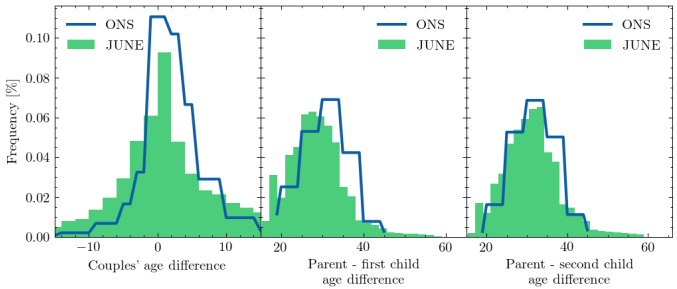
- build virtual population in OA: age, gender, ethnicity, deprivation index
- example: Durham



virtual households

- correct compositions important: primary place for infections
- household composition in 20 categories at OA level

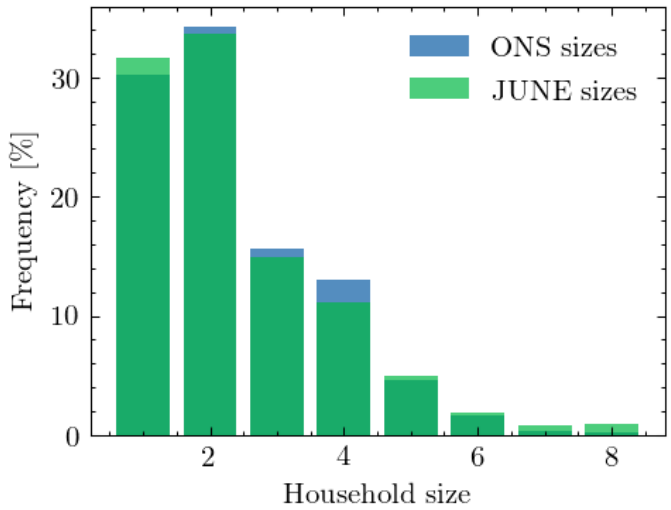
(children, young adults, adults, old adults)



- also: communal facilities

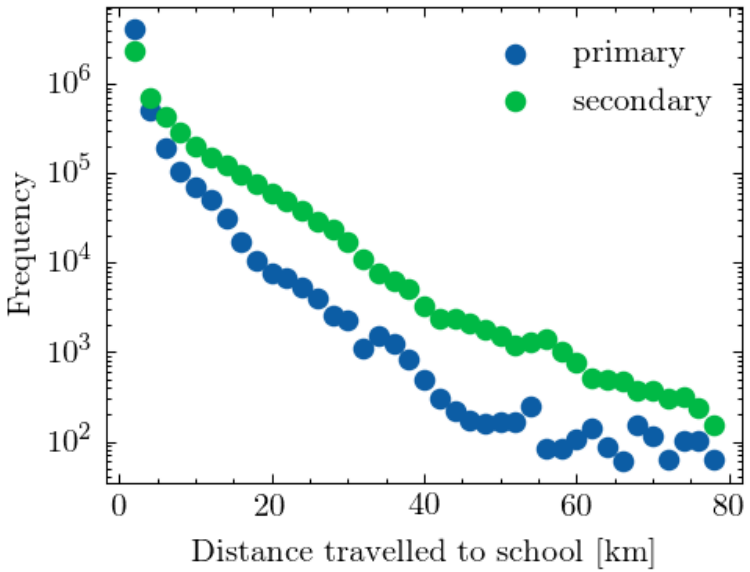
(carehomes)

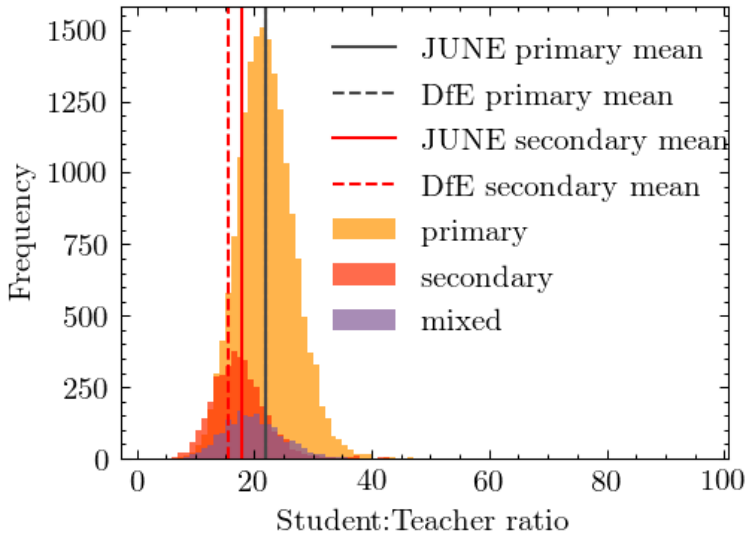
- further test: interplay with social mixing
- example: North-East England



virtual schools

- information about schools: age range of children and locations
- send kids to nearest age-appropriate structure
- could modulate this with school sizes, if necessary

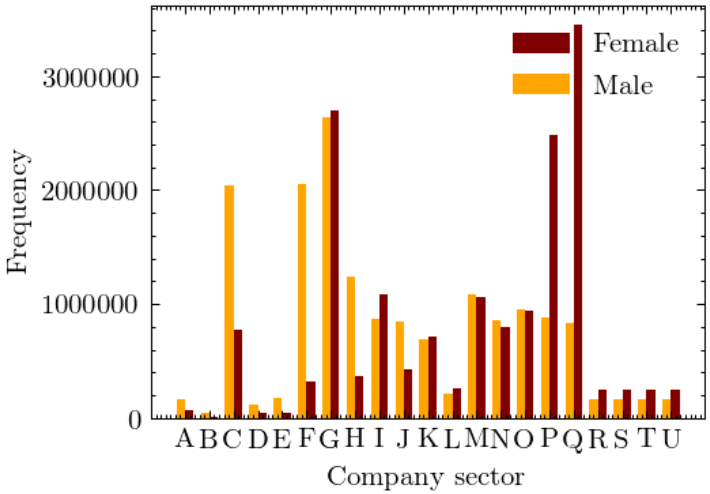


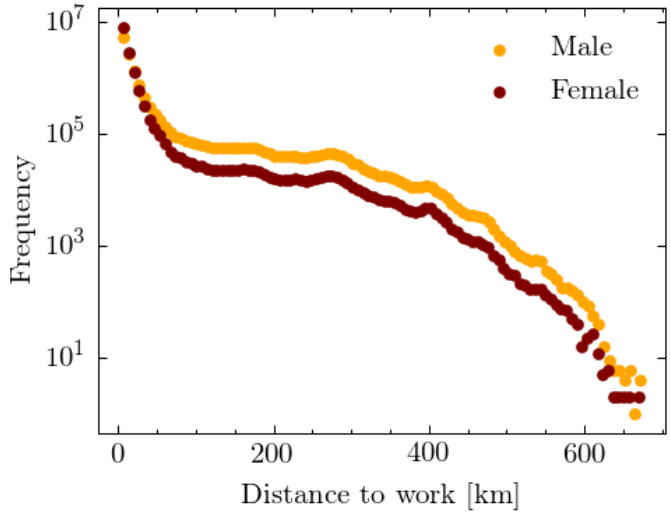


work & virtual companies

- workers and companies in ~ 20 macro-sectors at MSOA level
- know age/sex distribution in sectors nation wide
- distribute workers over companies (we know their sizes in bins)

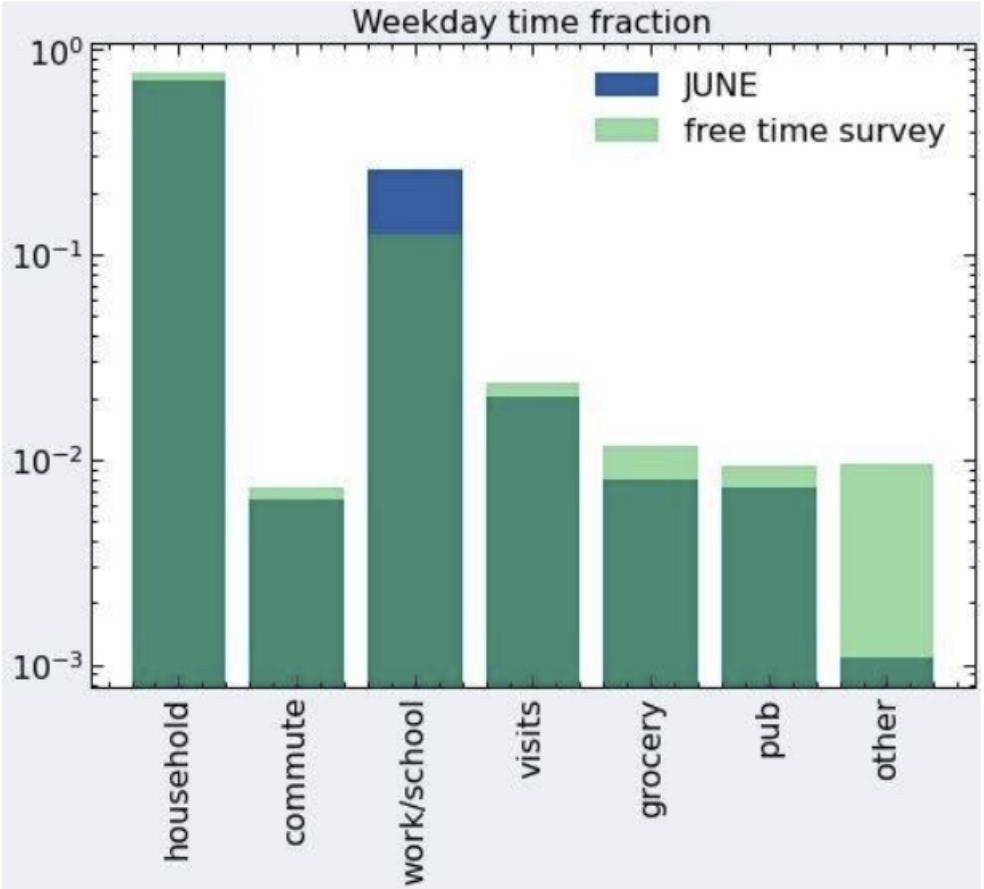
  (construct a big origin-destination matrix & optimise)
- information about commute mode: public vs. private





daily activities: average time budget

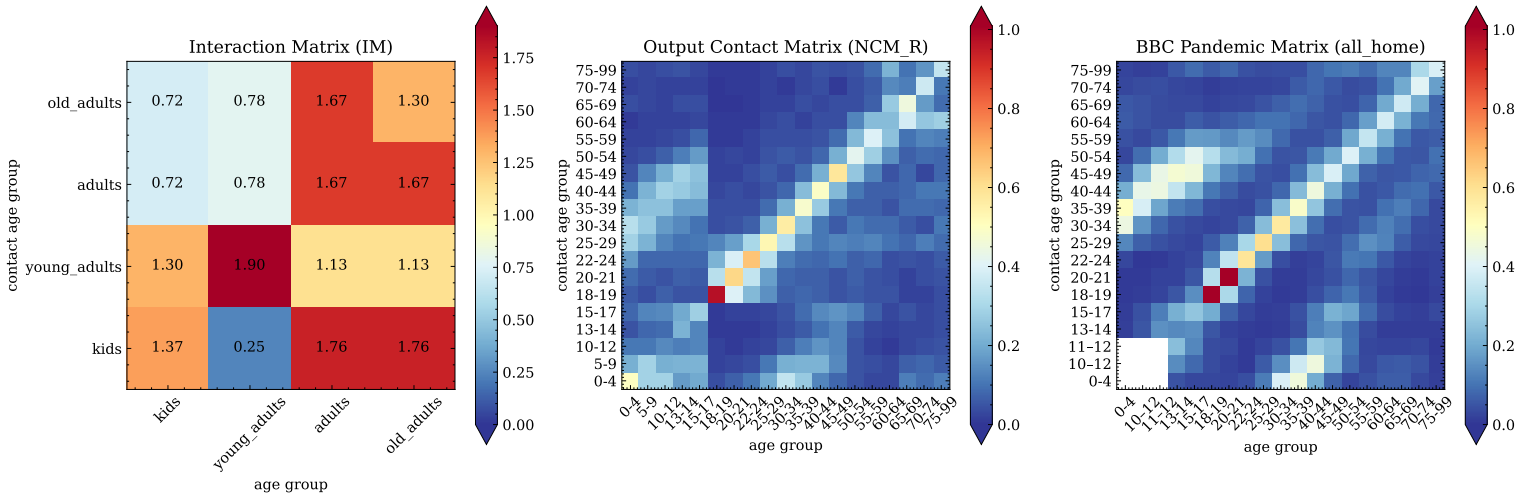
- compare our simulation with data from ONS
- average time spent per day in different activities



social mixing matrices

- denote number of contacts of person with age i with person of age j
- somewhat tricky format: averages over full population
  $\longrightarrow$ have to normalise it to our fractured social environment
  $\longrightarrow$ interplay with household sizes etc. (may have to be fitted?)
- usually used in compartment models (SEIR)
  $\longrightarrow$ compartments often organised by age/sex
  with limited geographic or sociological granularity
- example: household interactions vs. BBC pandemics project

(census has 4 categories of residents: kids, young adults, adults, old adults)



summary

- constructed an individual-based model with supreme granularity: demography, geography, sociology
- model informed operational planning of NHS:
  - → early warning of second wave
  - → projections for school re-opening, Delta and Omicron waves
  - → understanding of transmission sociology
- code is highly flexible:
  - → addition of new effects & policies relatively painless
  - → adaptation to new environments: Cox's Bazaar
  - → adaptation to New Zealand underway
- challenge to widespread perception in computational sociology: more and better detail often helps