Healthier Together
Improving health and care in Bristol, North Somerset and South Gloucestershire

NHS
Bristol, North Somerset and South Gloucestershire
Integrated Care Board

BNSSG Dynamic Population Model

Midlands Analyst Network Huddle

2024-10-17

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Where is BNSSG

- About 1 million people
- Bristol
  North Somerset
  South Gloucestershire
- Rough demographics not too dissimilar to England

Team Structure

- **4** Data Scientists (led by Richard Wood)

- Build data science models within the ICB to solve problems and inform decisions
  - flows through the system (eg hospitals)
  - forecasting/projections
  - collaborating across NHS & academia

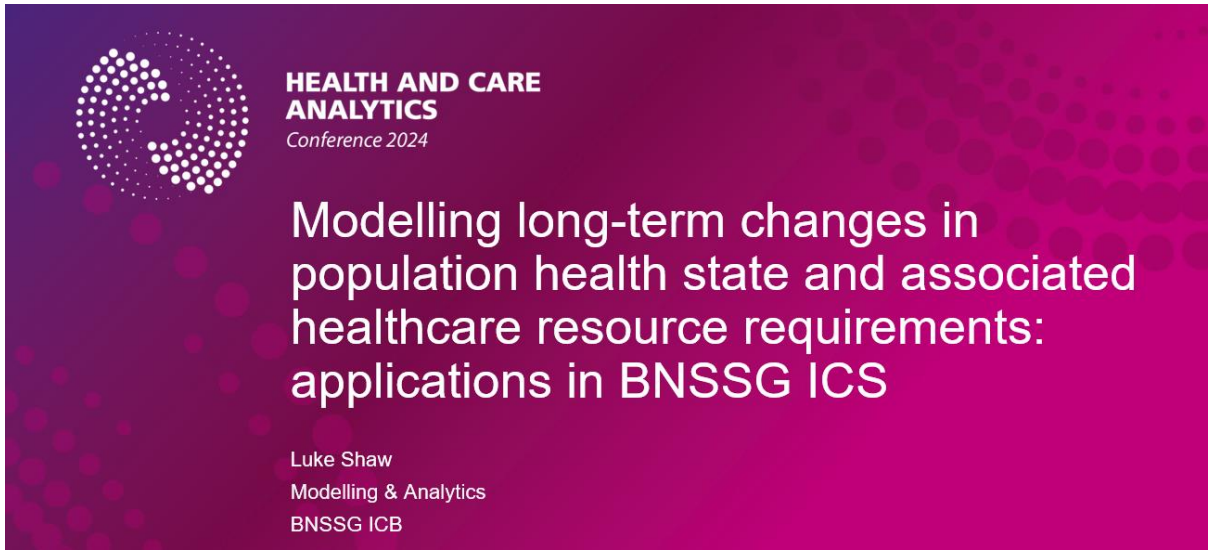
- → Modelling & Analytics Team (~4)
  → Systems Intelligence team (~30)
  →Transformation & Digital Directorate (~70)
  → Integrated Care Board (~500)

Tech Stack

- BNSSG-hosted SQL servers
- Model built in R
- Model run locally (have desktops for extra power)

HACA 2024

- No knowledge assumed
- More detail on model structure
- Developments (v2 not v1)



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HACA Slides

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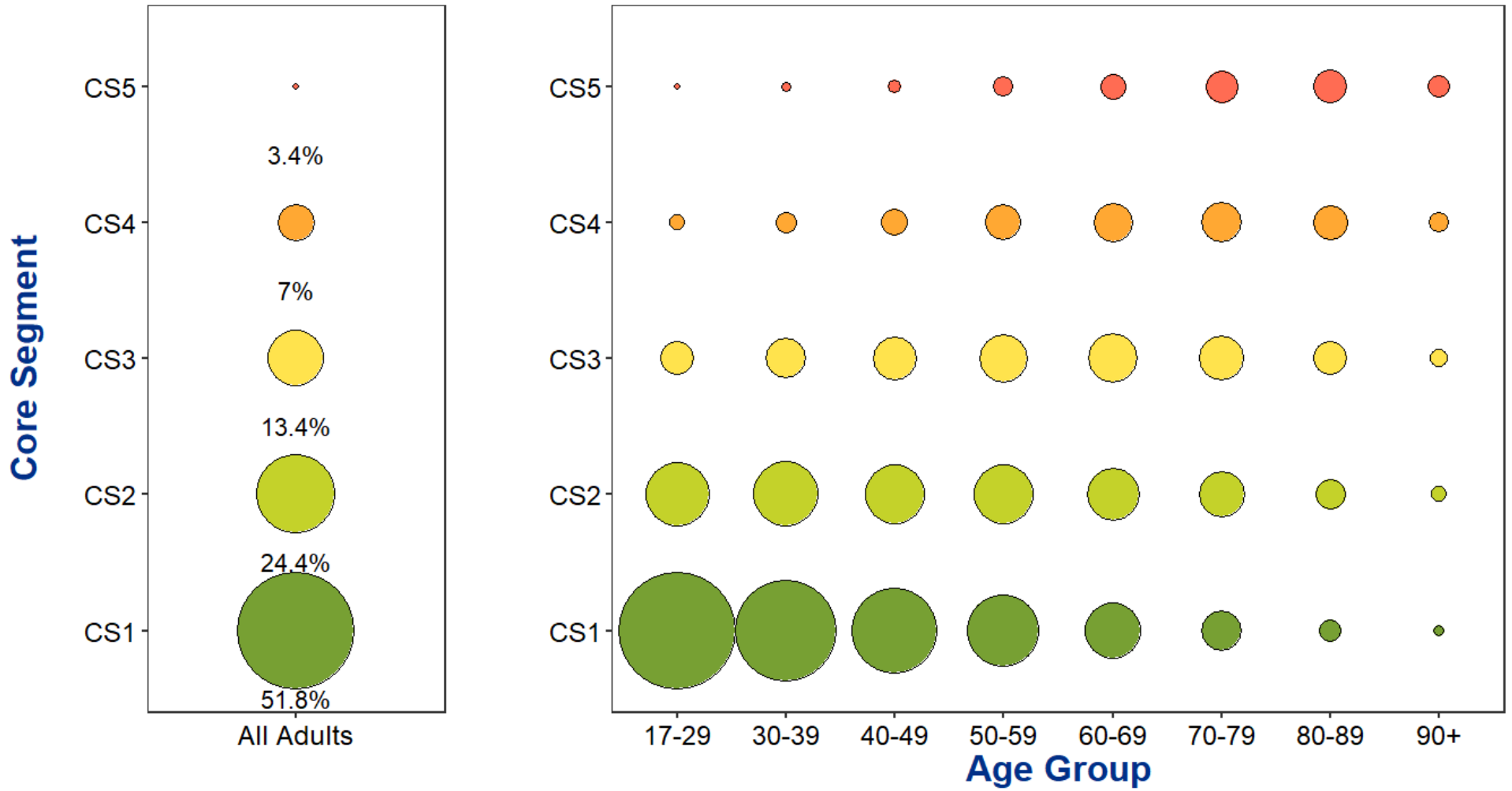
Version 2

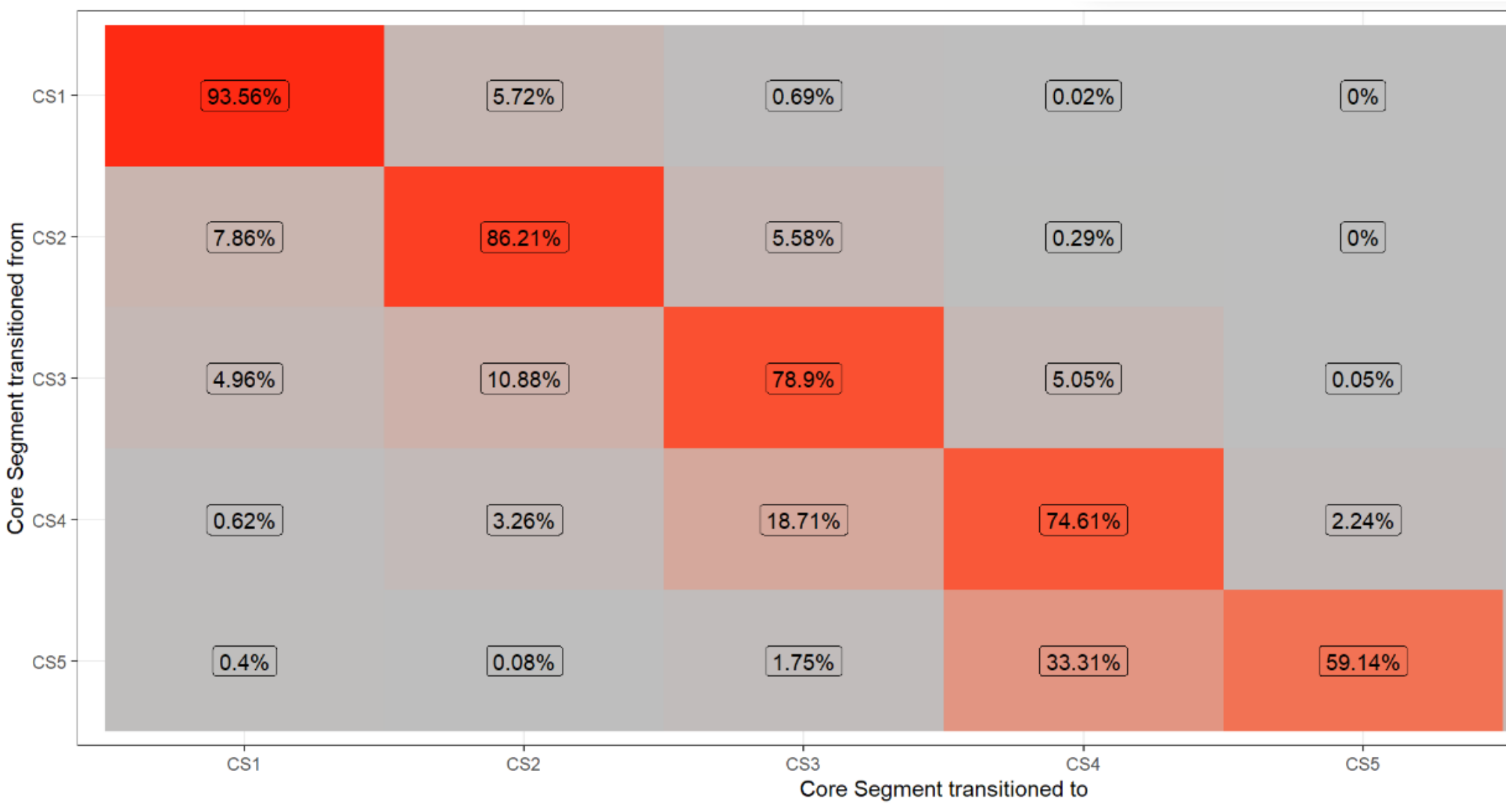
DPM V1 - 5 starting states

DPM v2 40 starting states

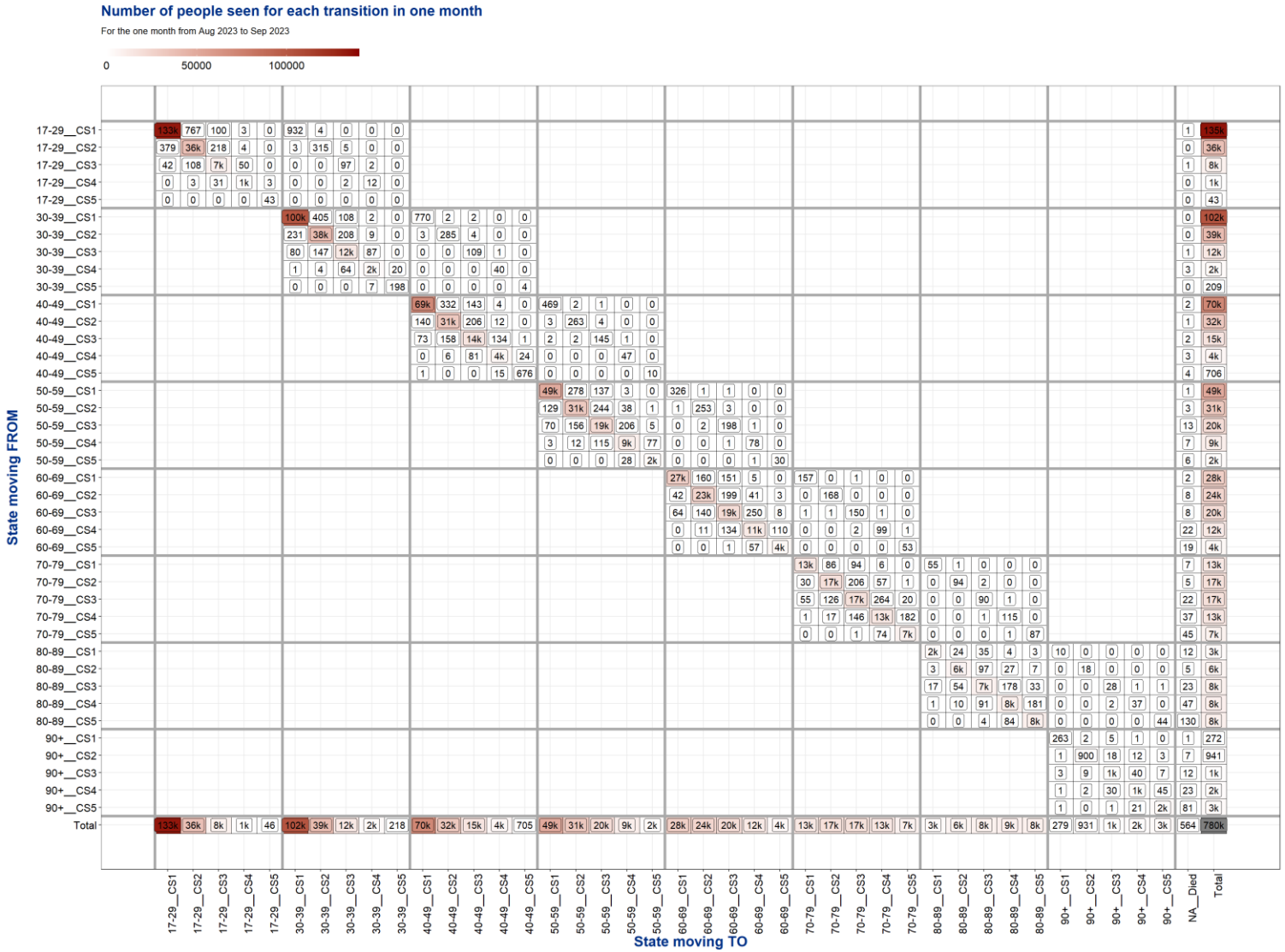
Size determined by number of people in that state in BNSSG 17+ population



V1 Transition Matrix

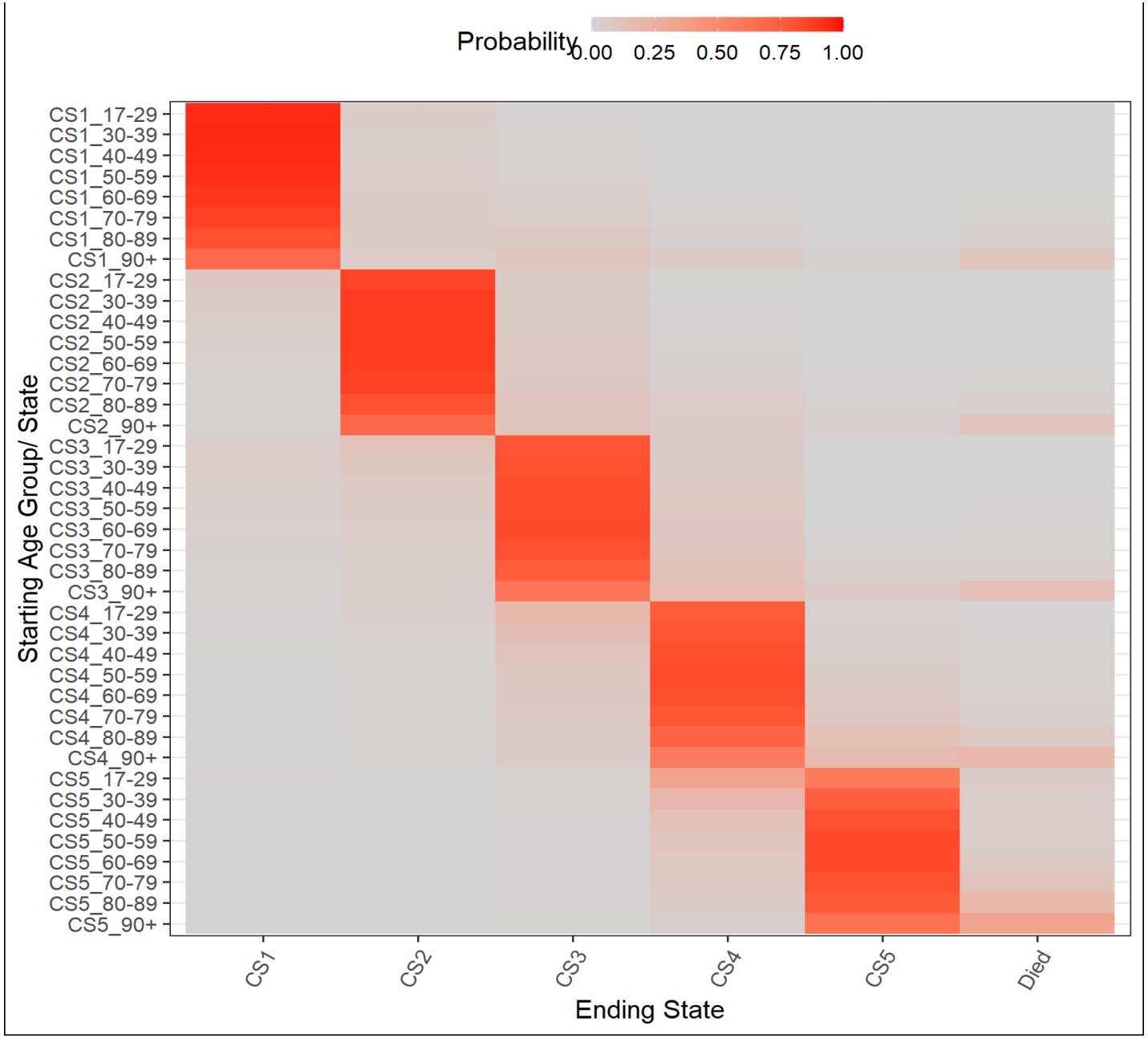


V2 Transition Matrix?



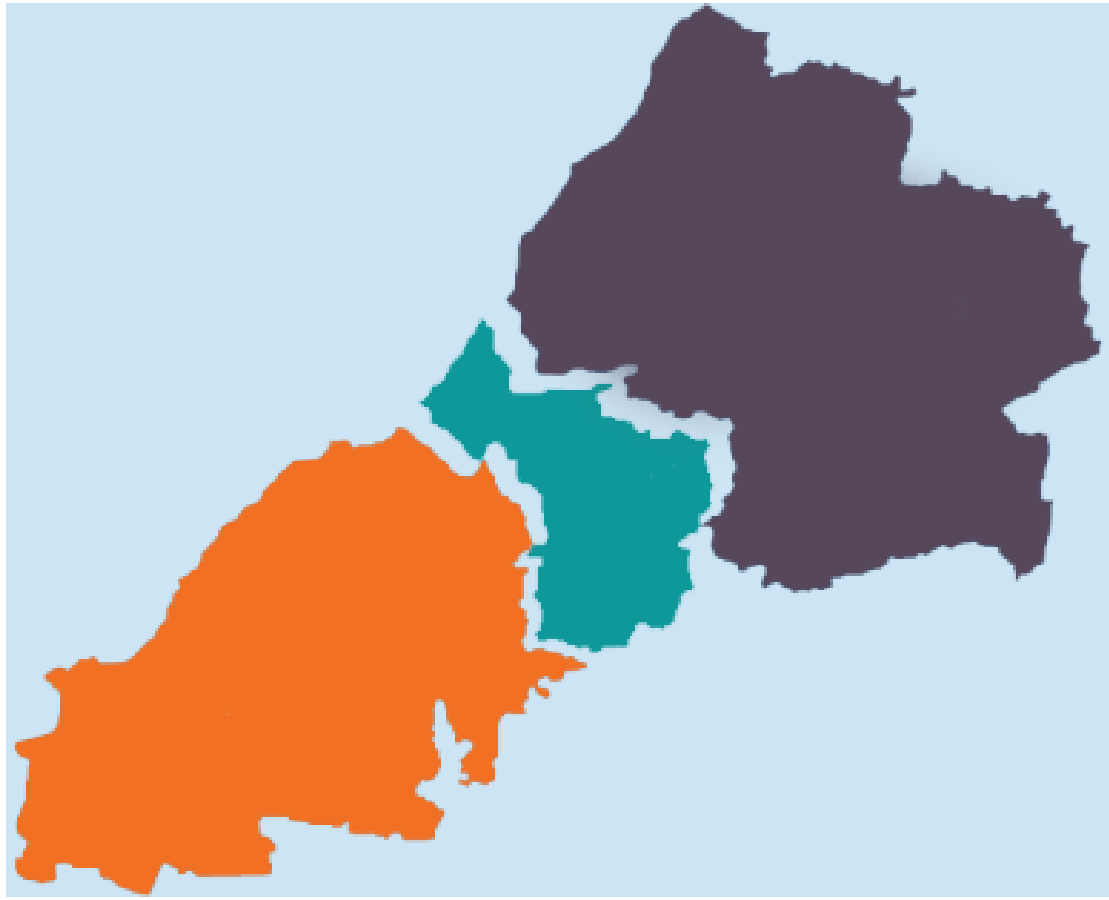
1640

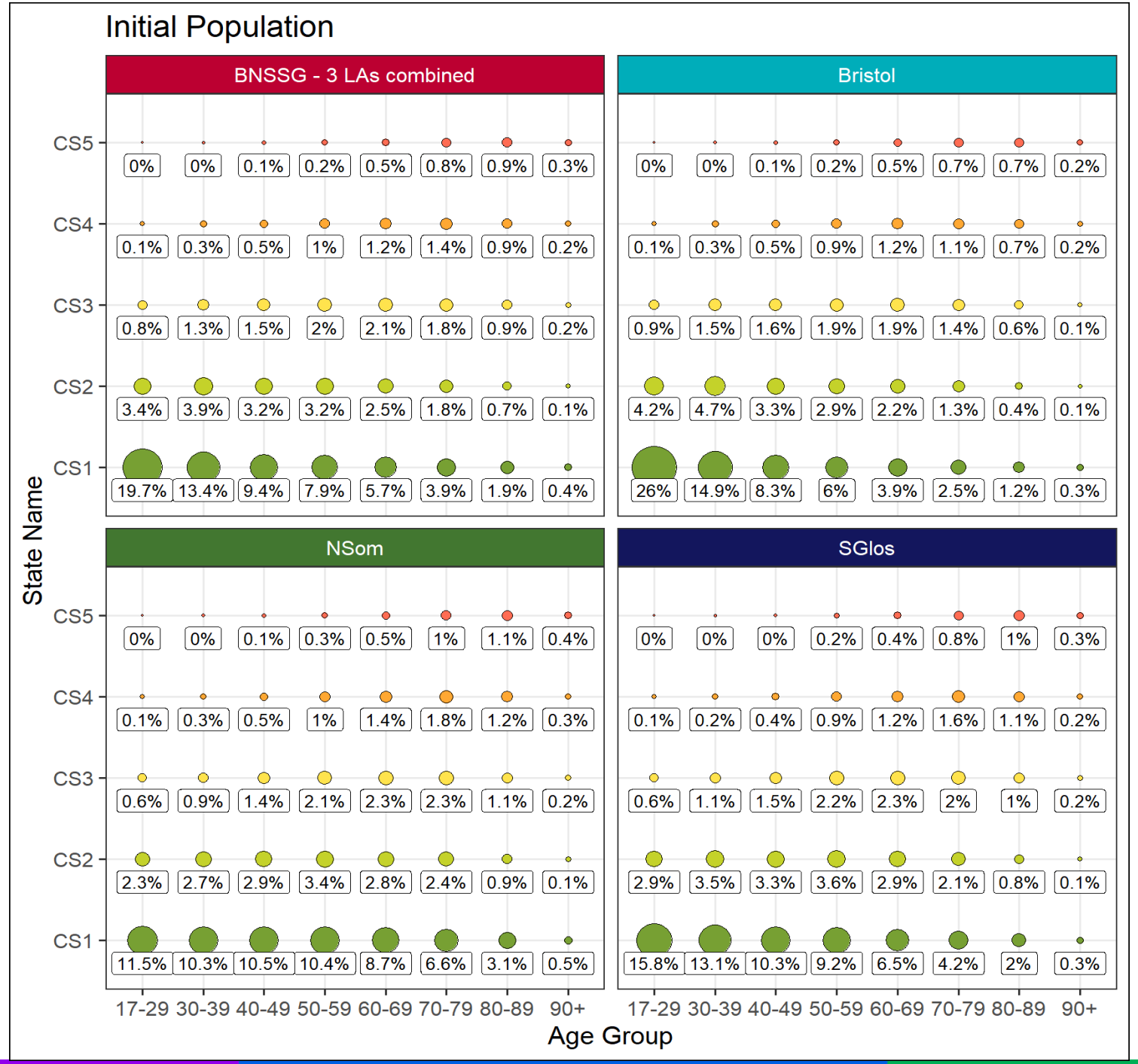
- v1: **25** transitions
- v2: **240** transitions



Local Authority Level

- User Feedback
- Expand Use Cases for the model
- More accurate estimates

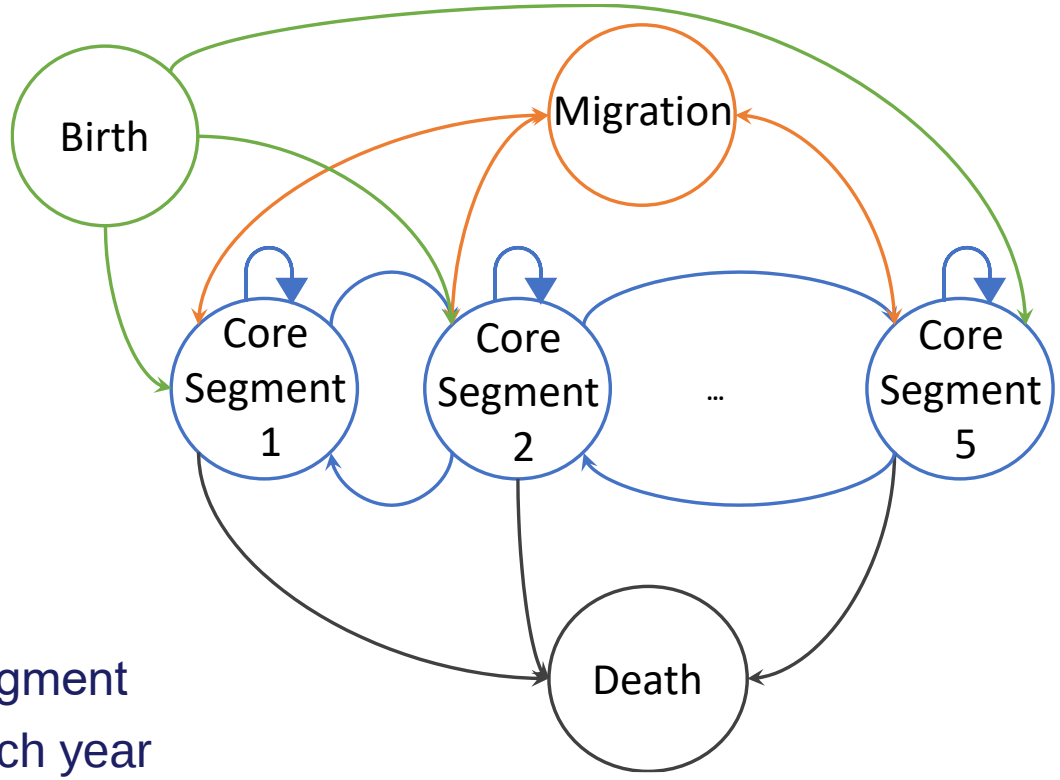



Initial Population
BNSSG - 3 LAs combined
Bristol
NSom
SGlos
CS5
CS4
CS3
CS2
CS1
State Name
0% 0% 0.1% 0.2% 0.5% 0.8% 0.9% 0.3%
0.1% 0.3% 0.5% 1% 1.2% 1.4% 0.9% 0.2%
0.8% 1.3% 1.5% 2% 2.1% 1.8% 0.9% 0.2%
3.4% 3.9% 3.2% 3.2% 2.5% 1.8% 0.7% 0.1%
19.7% 13.4% 9.4% 7.9% 5.7% 3.9% 1.9% 0.4%
0% 0% 0.1% 0.2% 0.5% 0.7% 0.7% 0.2%
0.1% 0.3% 0.5% 0.9% 1.2% 1.1% 0.7% 0.2%
0.9% 1.5% 1.6% 1.9% 1.9% 1.4% 0.6% 0.1%
4.2% 4.7% 3.3% 2.9% 2.2% 1.3% 0.4% 0.1%
26% 14.9% 8.3% 6% 3.9% 2.5% 1.2% 0.3%
0% 0% 0.1% 0.3% 0.5% 1% 1.1% 0.4%
0.1% 0.3% 0.5% 1% 1.4% 1.8% 1.2% 0.3%
0.6% 0.9% 1.4% 2.1% 2.3% 2.3% 1.1% 0.2%
2.3% 2.7% 2.9% 3.4% 2.8% 2.4% 0.9% 0.1%
11.5% 10.3% 10.5% 10.4% 8.7% 6.6% 3.1% 0.5%
0% 0% 0% 0.2% 0.4% 0.8% 1% 0.3%
0.1% 0.2% 0.4% 0.9% 1.2% 1.6% 1.1% 0.2%
0.6% 1.1% 1.5% 2.2% 2.3% 2% 1% 0.2%
2.9% 3.5% 3.3% 3.6% 2.9% 2.1% 0.8% 0.1%
15.8% 13.1% 10.3% 9.2% 6.5% 4.2% 2% 0.3%
17-29 30-39 40-49 50-59 60-69 70-79 80-89 90+
Age Group

Stochasticity

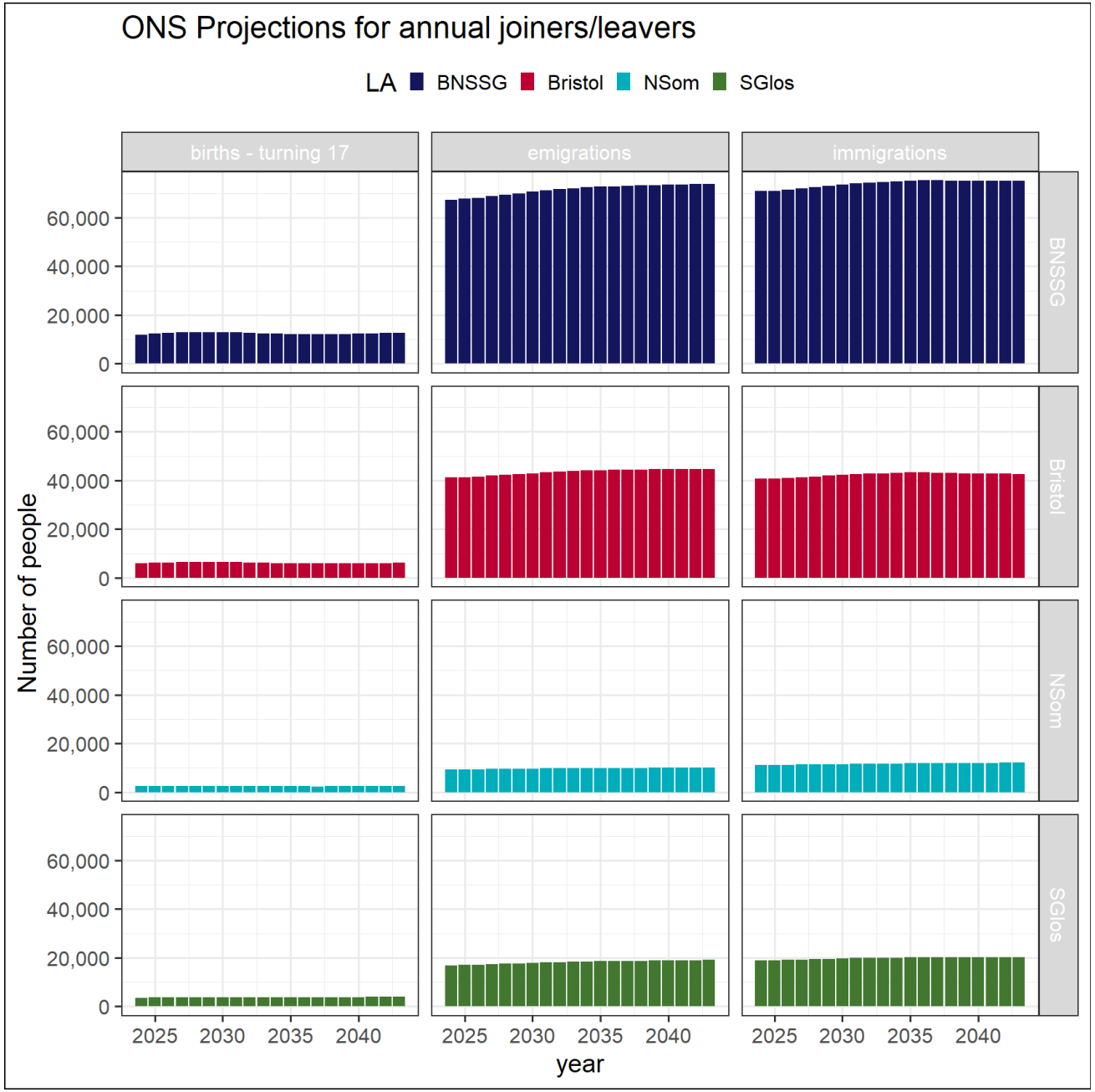
- V1 (and v2 can be) **deterministic** calculated on aggregate

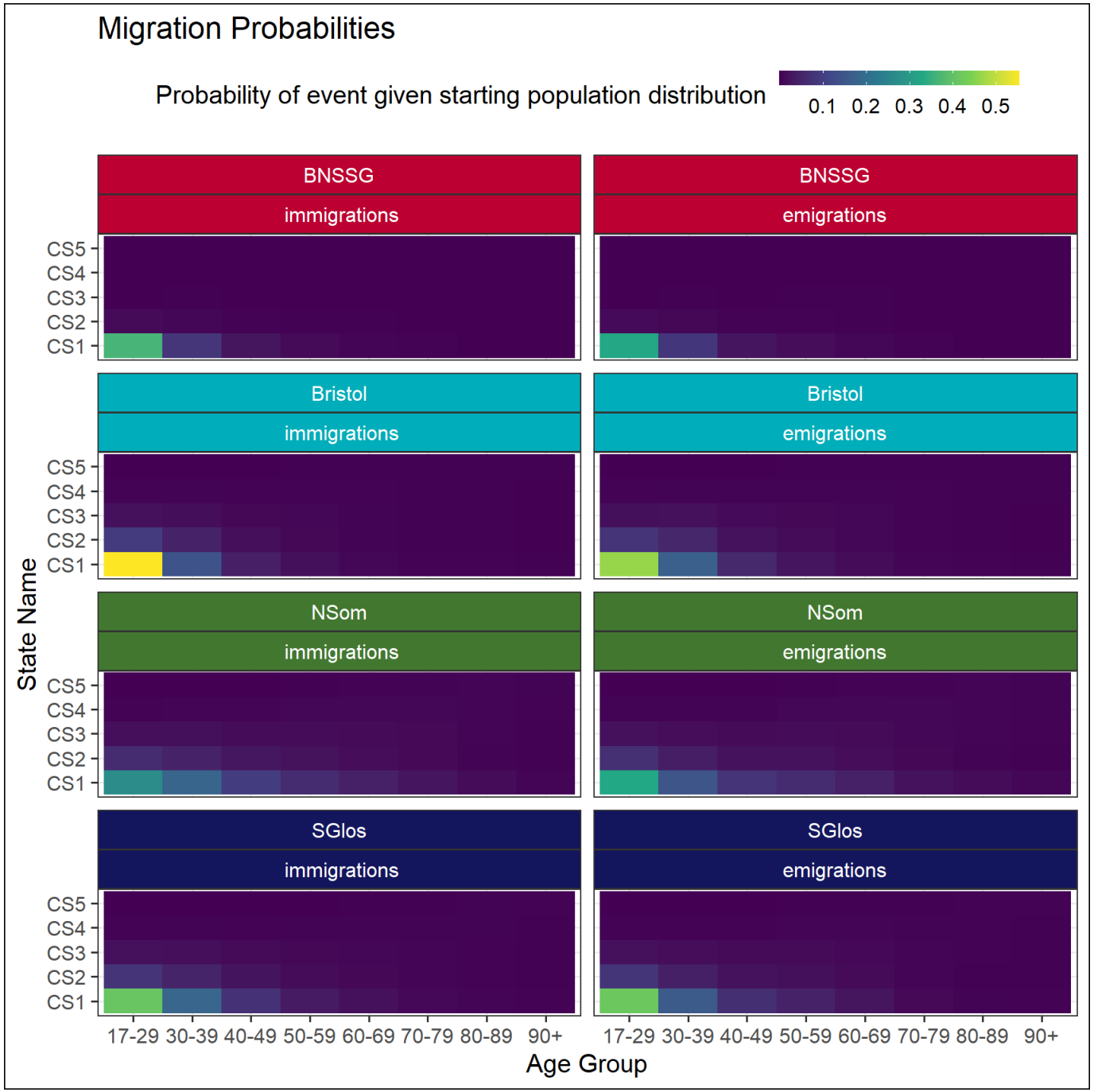
- V2 can run at individual-level
  - start with random population sample
  - at person-level have someone's age and Core Segment
  - probabilistically sample Core Segment change each year
  - aggregate up at the end



Migration Profiles

- V1: net migration
- V2: immigration & emigration




Migration Probabilities
Probability of event given starting population distribution
0.1 0.2 0.3 0.4 0.5
BNSSG
immigrations
BNSSG
emigrations
Bristol
immigrations
Bristol
emigrations
NSom
immigrations
NSom
emigrations
SGlos
immigrations
SGlos
emigrations
State Name
CS5
CS4
CS3
CS2
CS1
17-29 30-39 40-49 50-59 60-69 70-79 80-89 90+
Age Group

Resident or Registered

- ONS values are in terms of **RESIDENT** population (where people live)

- ICB values are in terms of **GP REGISTERED** population (who is registered to a GP)

- Differences:
  - Size
  - Cross-border healthcare utilisation
  - Who is missing (unregistered ~5%, registered but moved on ~10%)

For v2 we think of everything in terms of **RESIDENT** population as that's what ONS projections use

We have to make assumptions about the missing population from registered, **assume CS1.**

Other Changes

- Deaths as an output, not input
- Stochasticity – microsimulation model

Assumptions List

a) 17+ population only

b) Cost = tariff per unit. Cost per person assumed to stay the same through time

c) Same level of delivery per person expected under current DPM model

d) Source = SWD, any activity not in System Wide Dataset not included

e) Data for forming current understanding only from May 2021 to Mar 2024

f) Transition Probabilities between states (including death probabilities) are the average from SWD cleaned data (people in the data for past 12 months) between May 2021 and Mar 2024.

g) Wherever population figures are used, we are using ONS Local Authority estimates and projections. These are the best guess for the resident population, which is slightly different to the BNSSG-registered patient population. For health states, we use the System Wide Dataset (SWD). The scaling of health states up to match ONS population figures is done assuming missing at random.

h) Migration numbers and age distribution are from ONS, with health state distribution within age taken as random.

i) Initial Population being adjusted to ONS populations assumes non-registration is from CS1 patients in that age group (down to 5-year levels) who are not registered due to not having symptoms.

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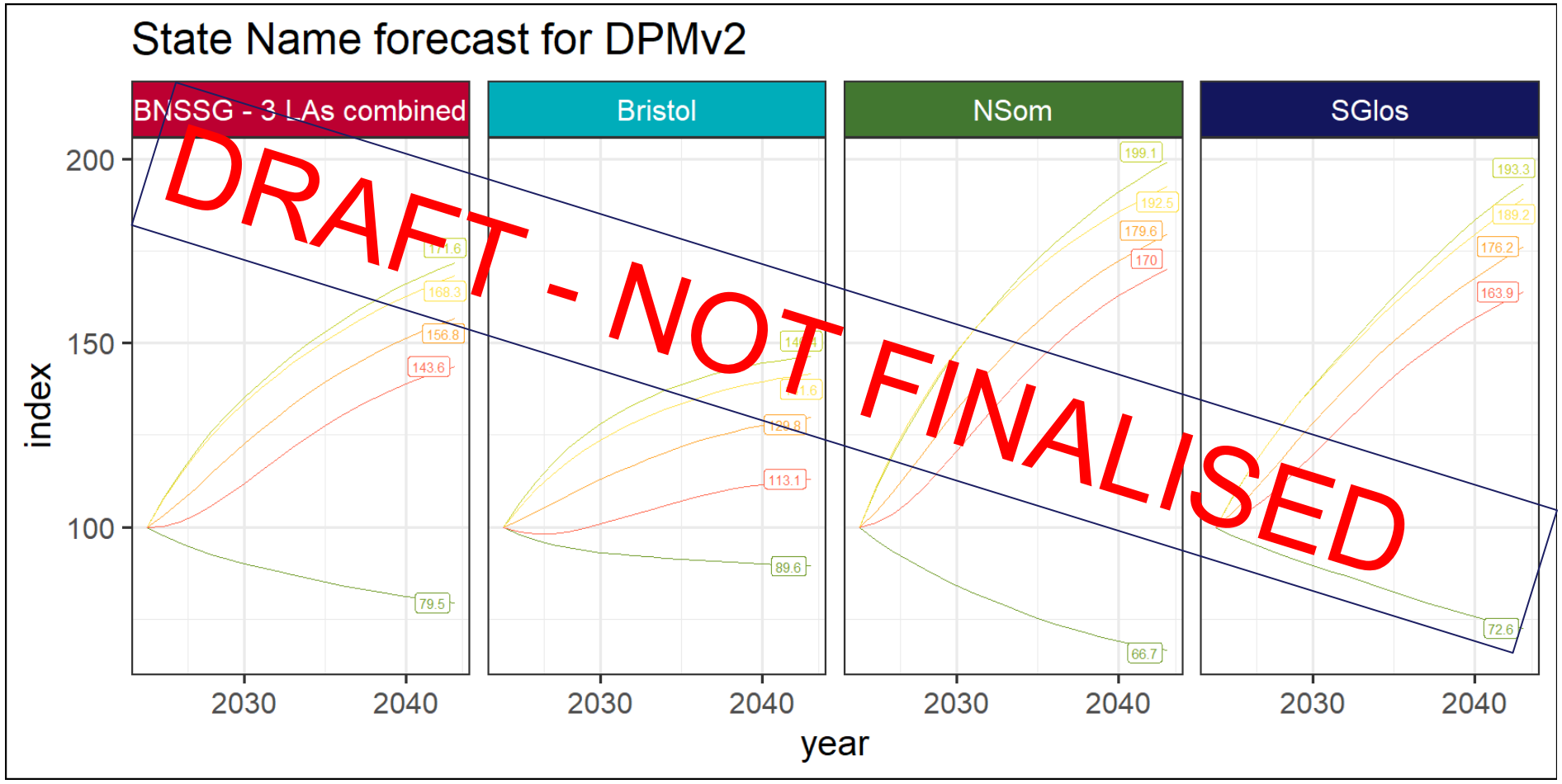
Outputs

V2 – same trends



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Thank you

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