Fertility (and futures?) of 45 countries: Lexis surface data visualisations

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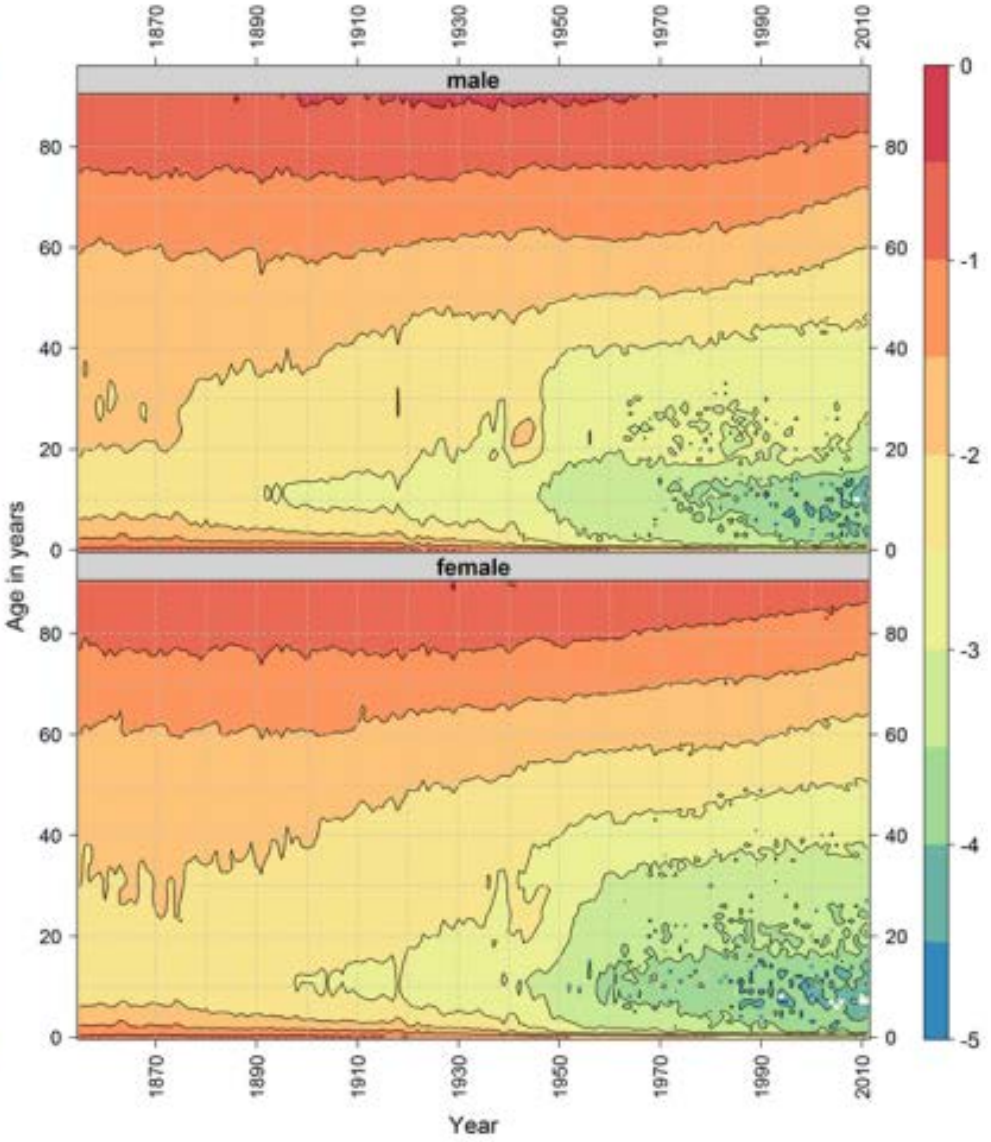
Introduction: Fertility in Europe

- Fertility has been declining
- There are differences between European regions
- … And between Europe and other parts of the world

Introduction: Lexis Surfaces

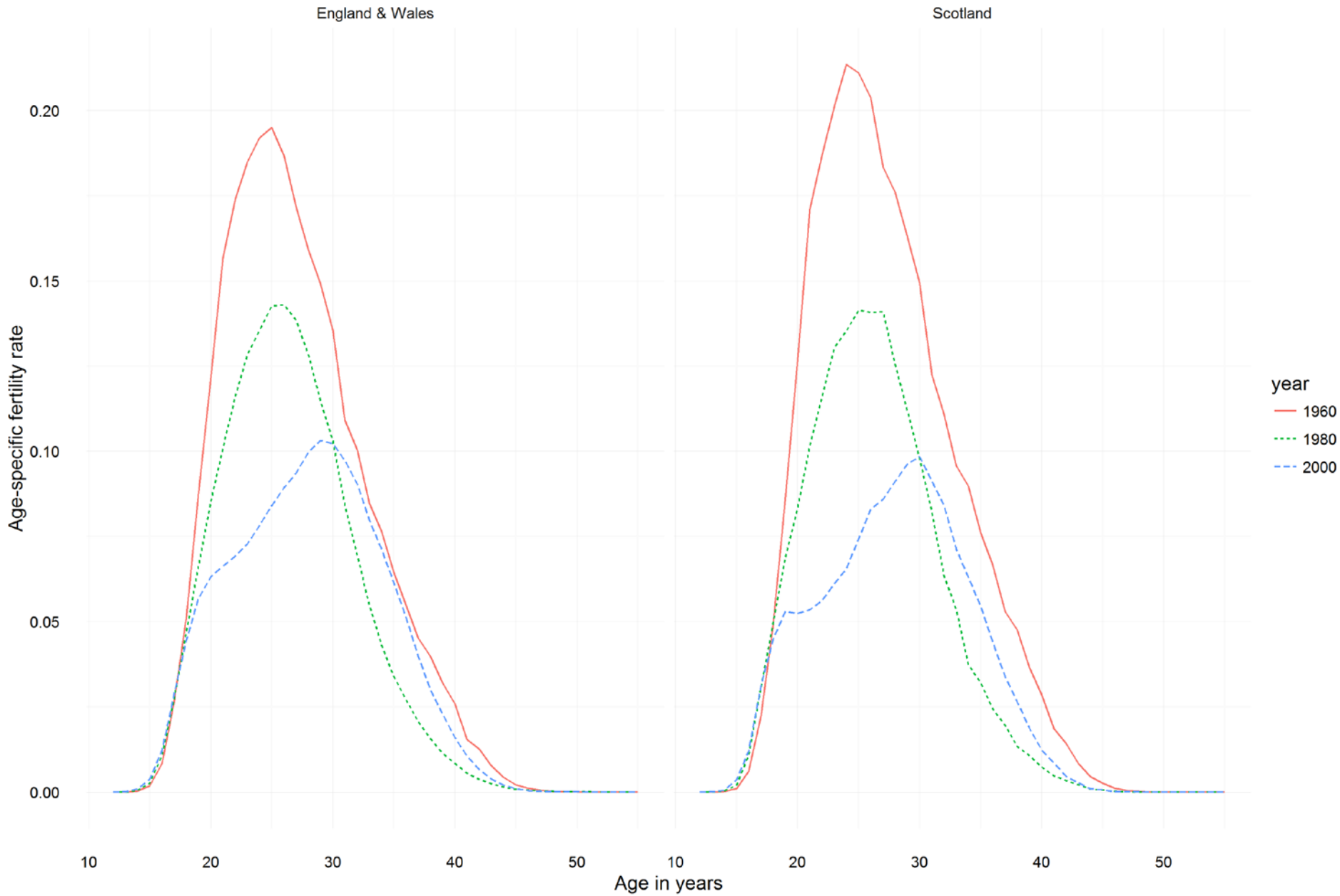
- Share the challenge and techniques of map-makers
  - How to visually represent three dimensional relationships on a two dimensional surface
- Treating time like space
  - Spatial maps have latitude and longitude
  - Temporal maps (Lexis surfaces) have absolute time and relative time
    - Absolute time: year
    - Relative time: time since birth, time since first child, time since leaving education, etc



https://ije-blog.com/2016/06/27/lexis-cubes-1-from-maps-of-space-to-maps-of-time/

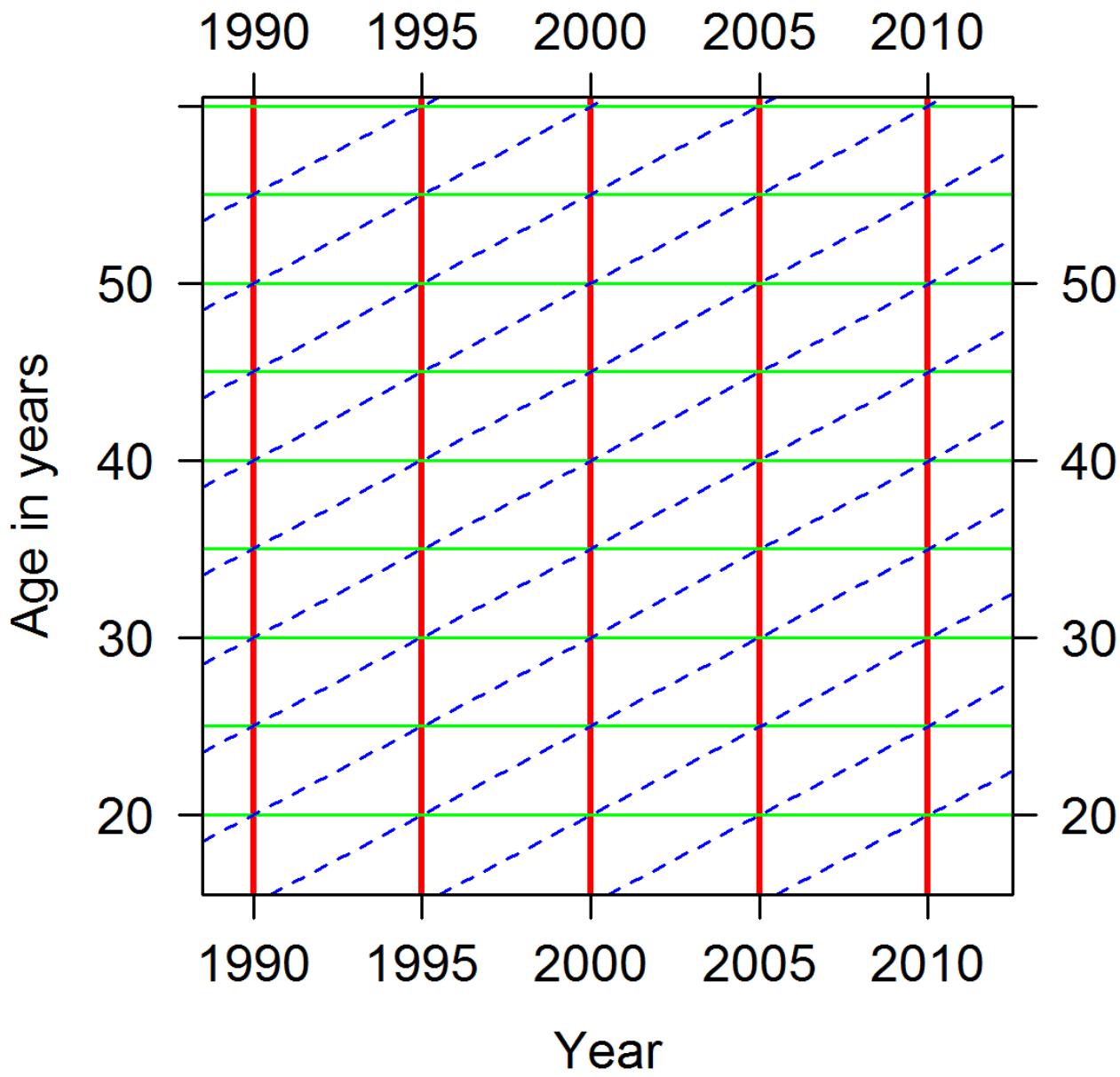
Demographic definitions of fertility

- Not about biological potential, but about ‘realisation of outcome’
- Age-specific fertility rates
  - Number of live births/woman of age x in period (year/birth year) y
  - (Various technical complications about defining age and period: squares, triangles or parallelograms)
- Schedule of fertility rate with age
- Total fertility rates as a period-based measure


England & Wales
Scotland
Age-specific fertility rate
0.20
0.15
0.10
0.05
0.00
10
20
30
40
50
Age in years
year
1960
1980
2000

Period measures and cohort measures

- Total fertility rates as a period-based measure:
  - Observations of schedule of age and fertility rate observed in a period
  - Effectively produces a ‘synthetic cohort’
  - (n.b. biological and demographic uses of the term ‘period’ are distinct)


1990
1995
2000
2005
2010
50
40
30
20
Age in years
Year

Period measures and cohort measures

- Real cohorts are birth cohorts
  - Total fertility of 1920s cohorts: known
  - Total fertility of 1980s cohorts: unknown

- Important unknowns
  - Time to first birth
  - Interval between births (Tempo changes)

Methods: data

- Human Fertility Database: http://www.humanfertility.org/
- Human Fertility Collection: http://www.fertilitydata.org/
- Preferential ‘munging’ of the two:
  - *1) HFD;*
  - *2) HFC:*
    - i) STAT: Official statistical data : Data that come from statistical publications and official websites of national statistical offices
    - ii) ODE: European Demographic Observatory (L'Observatoire Démographique Européen)
- Reference: http://www.fertilitydata.org/cgi-bin/collections.php
- Additional ‘munging’ to impute ASMRs in more recent missing years

Methods: Software

- R with Github
- R packages:
  - *Lattice/LatticeExtra: main maps*
  - *R2stl: 3D printable STL files (HFD only)*
  - *Wickhamese packages – readr, tidyr, stringr, dplyr, purr – for general data management and automation*
- Github
  - *https://github.com/JonMinton/comparative_fertility/*
  - *https://github.com/JonMinton/Statistical_Sculpture/*

Methods: Producing cumulative cohort fertility rates

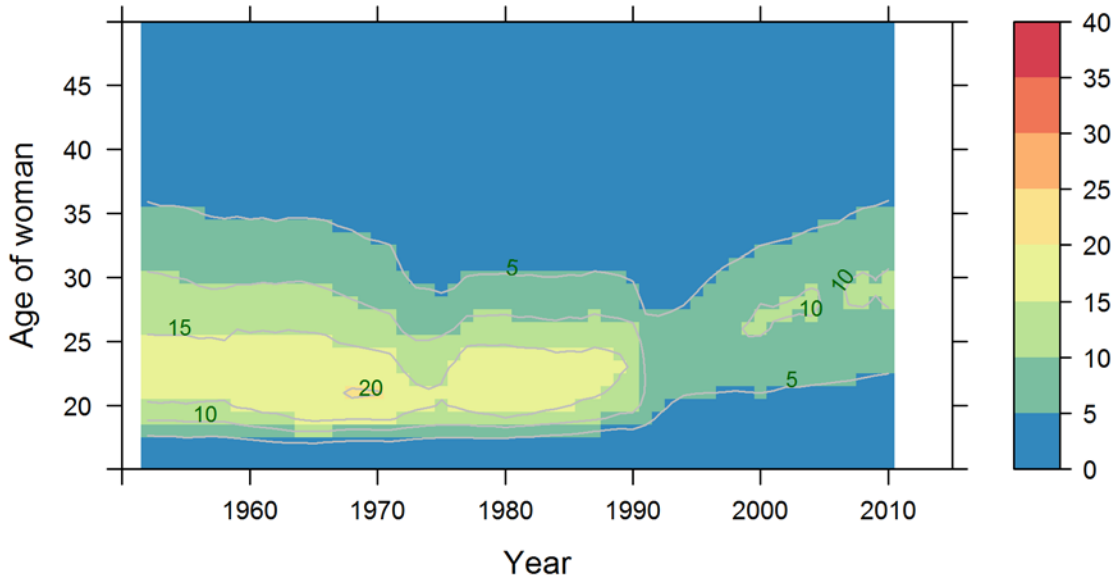
- Given ASFRs, at what age do different birth cohorts ‘achieve’ a given number of children?
- CCFRs of 1.30, 1.50, 1.80, and 2.05 are highlighted as contours
  - *2.05 = ‘replacement fertility levels’*
  - *The 1.30 line always below 1.50 line, 1.50 below 1.80, 1.80 below 2.05*
  - *If a contour line is not visible for a particular birth cohort, that birth cohort did not achieve that cumulative fertility rate*
  - *If 2.05 line not visible: long term ageing and declining population*
- For the final latticeplot – country tiles are coloured by region, and arranged by fertility rate in last year

Methods: Graphs produced

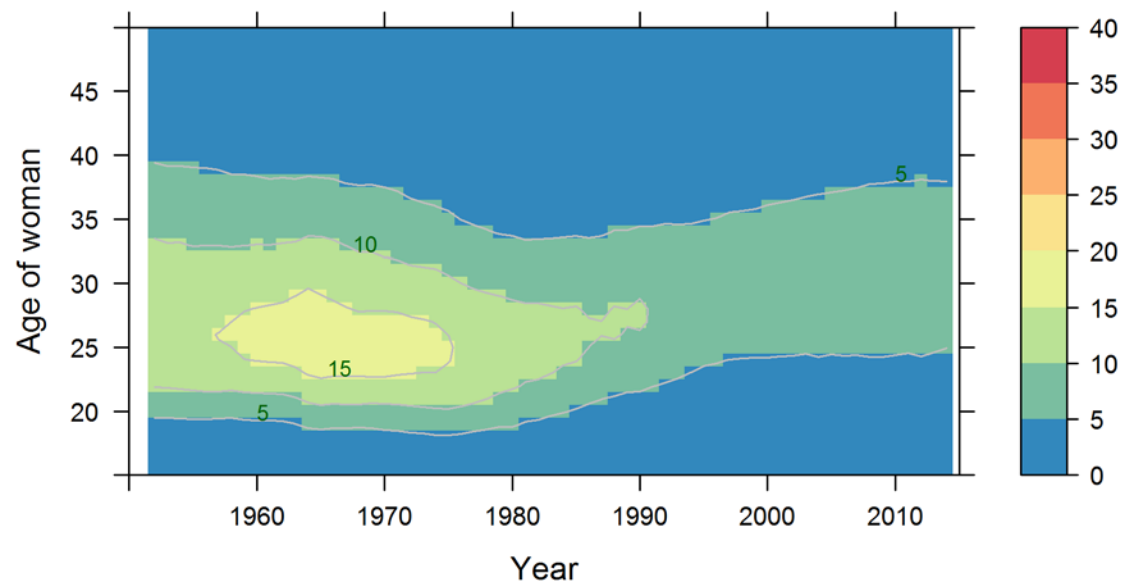
- Heatmaps/level plots of ASMRs given age and year
- Contour maps of ASMRs given age and year
- Heatmaps/level plots of ASMRs given age and birth year
- Cumulative cohort fertility maps
  - Contours giving CCFRs, colour/shade giving ASMRs
- CCFR latticeplot for all countries

Results

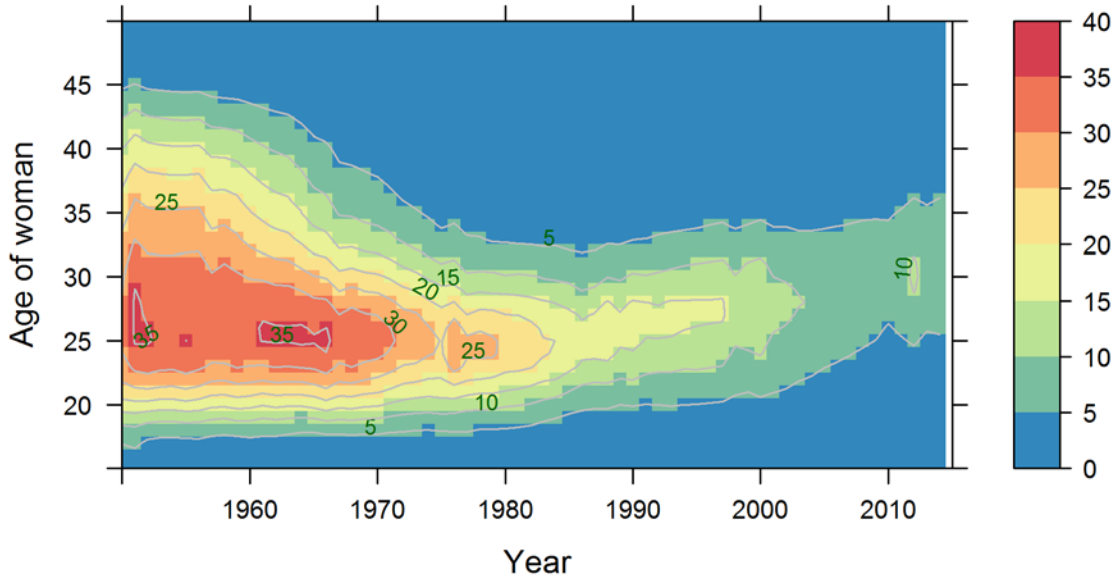
Germany, East (West)



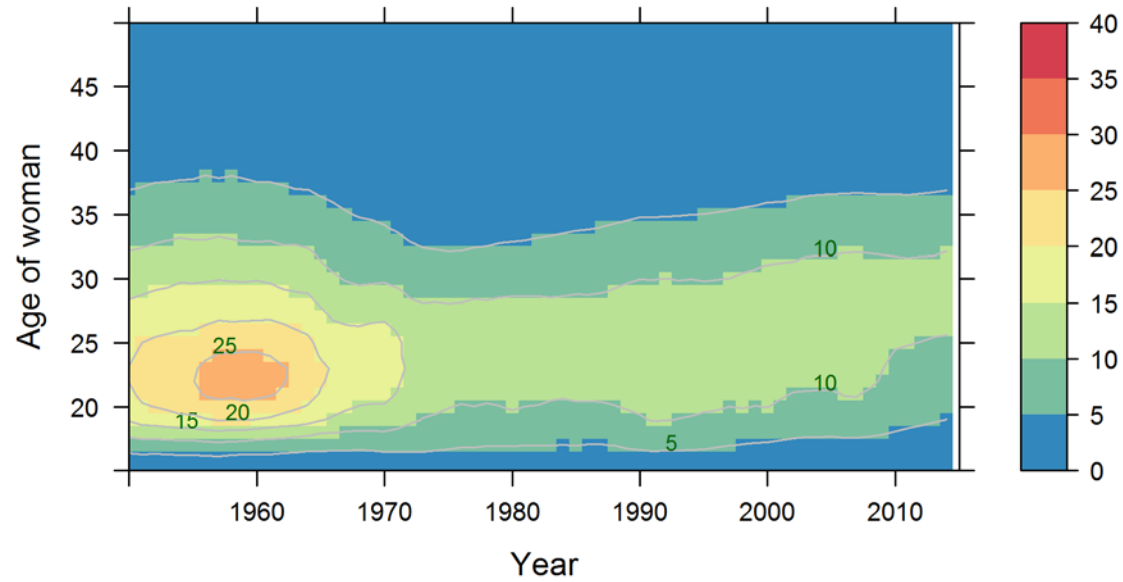
Italy (South)



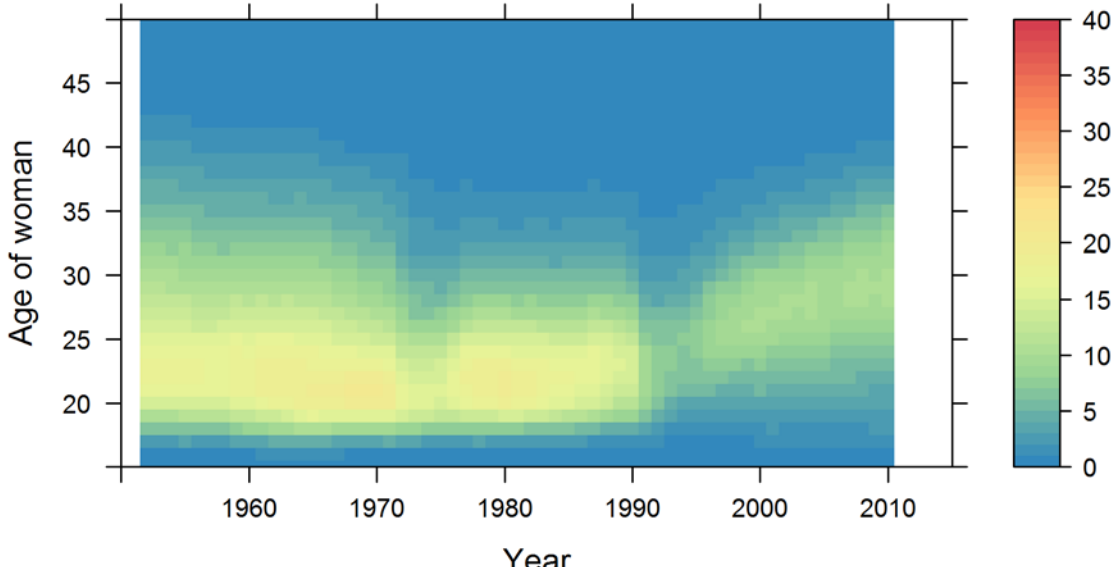
Taiwan (Asian)



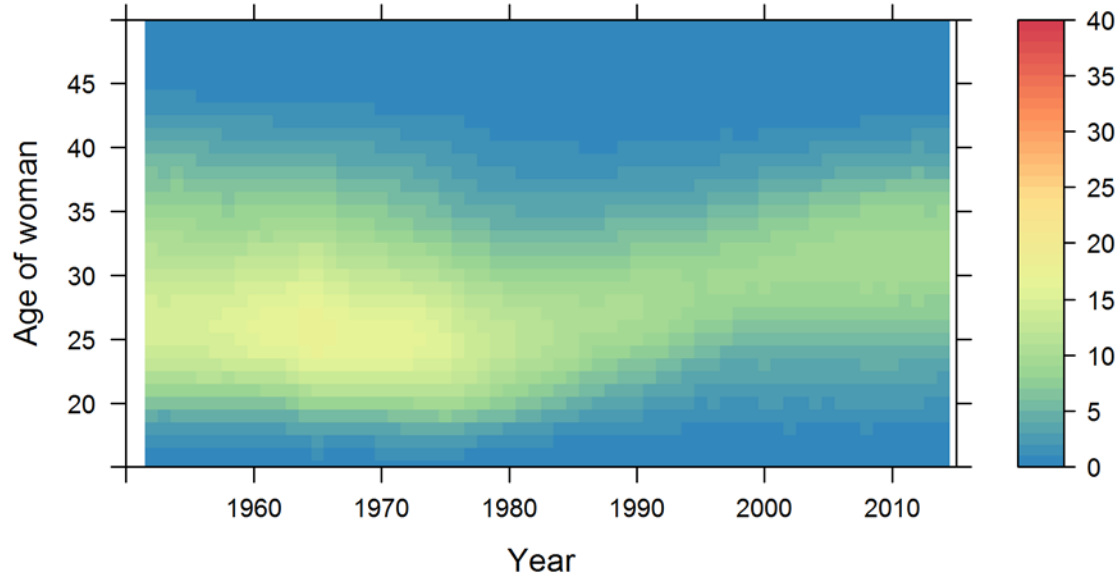
United States of America (Anglophone)



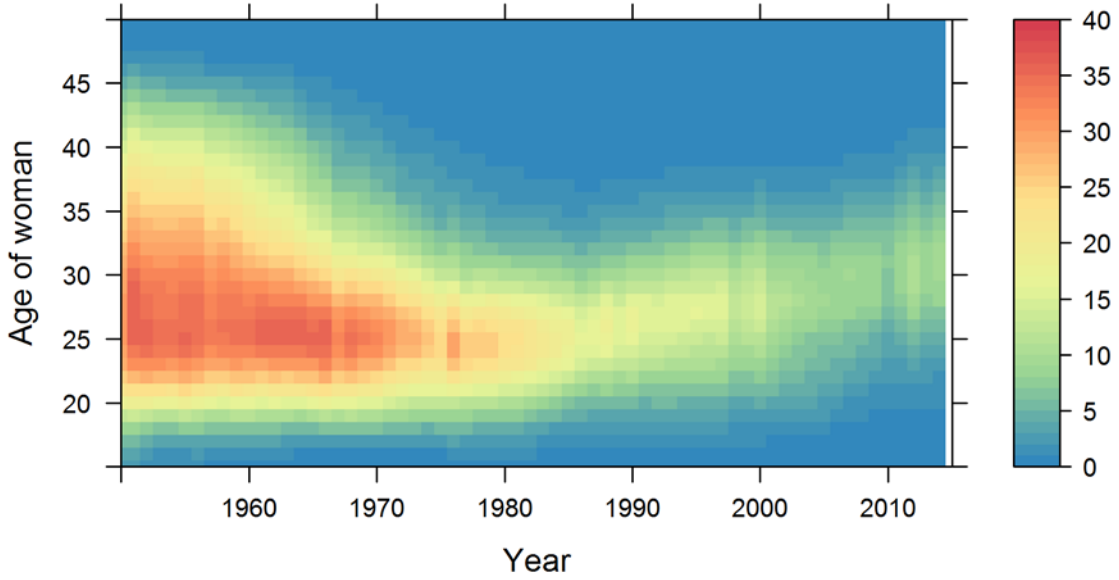
Germany, East (West)



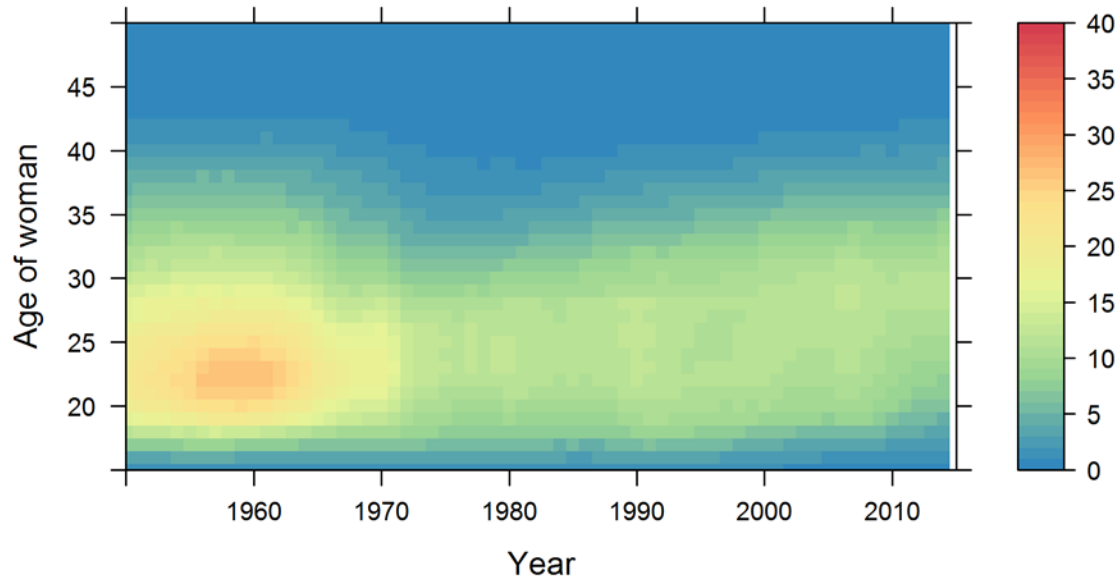
Italy (South)

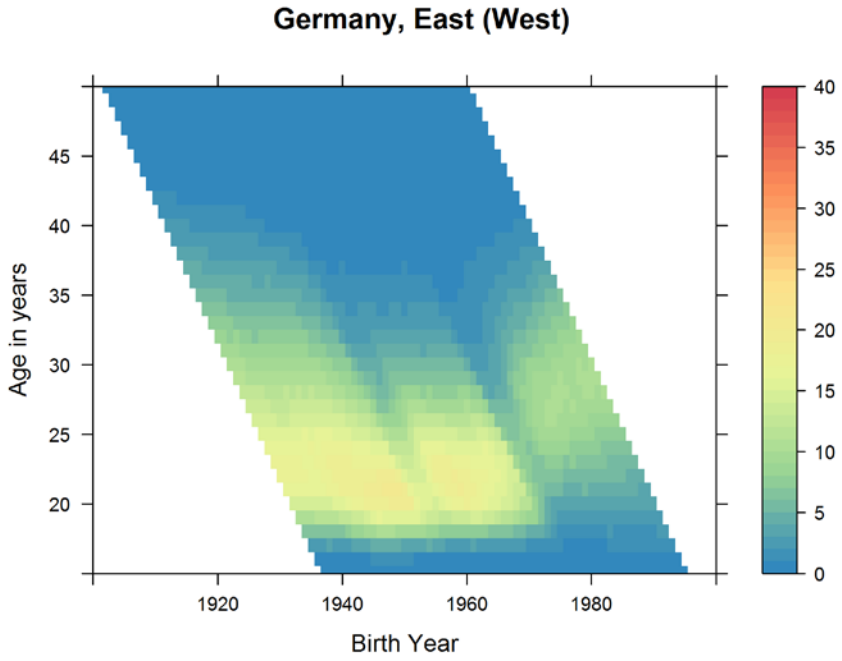


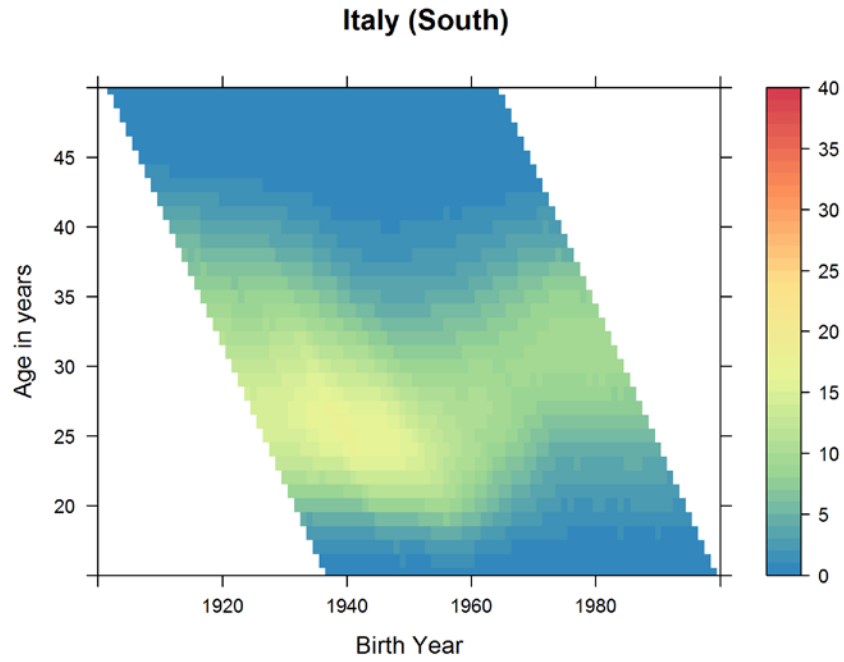
Taiwan (Asian)

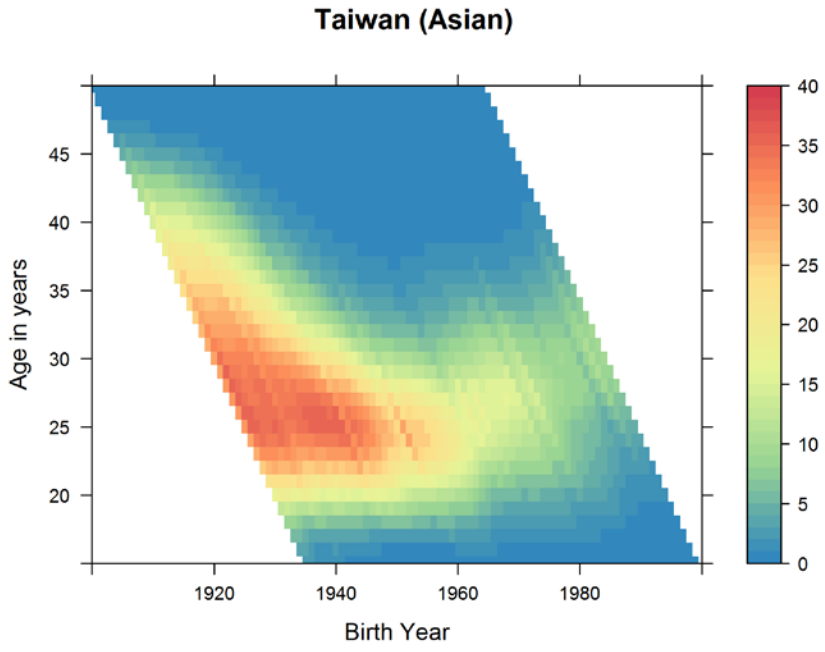


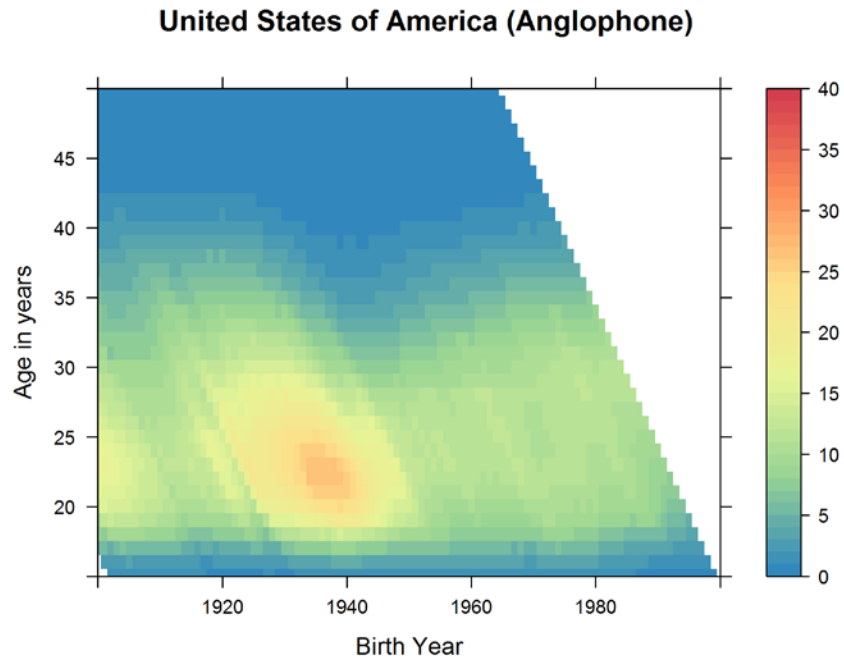
United States of America (Anglophone)

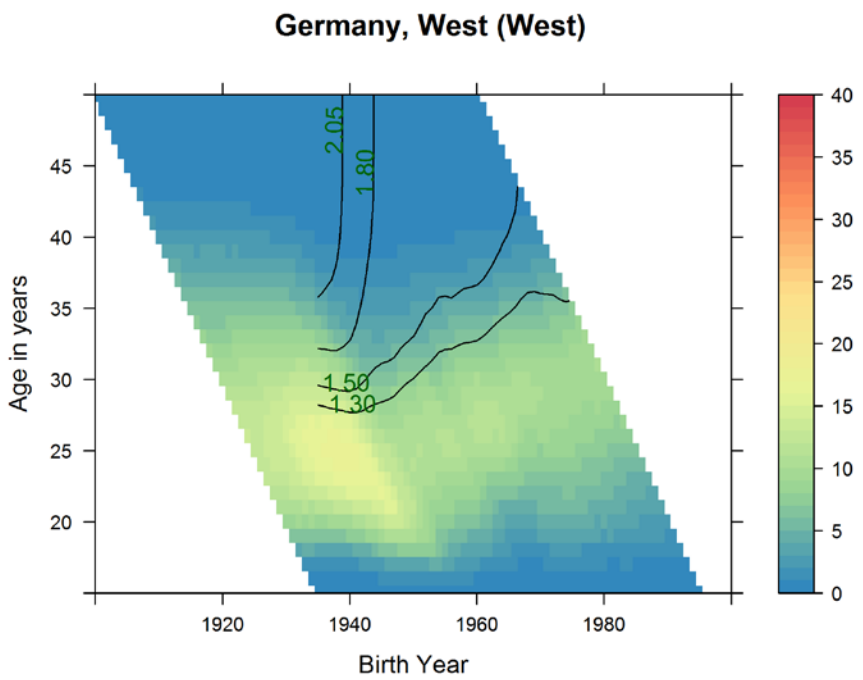


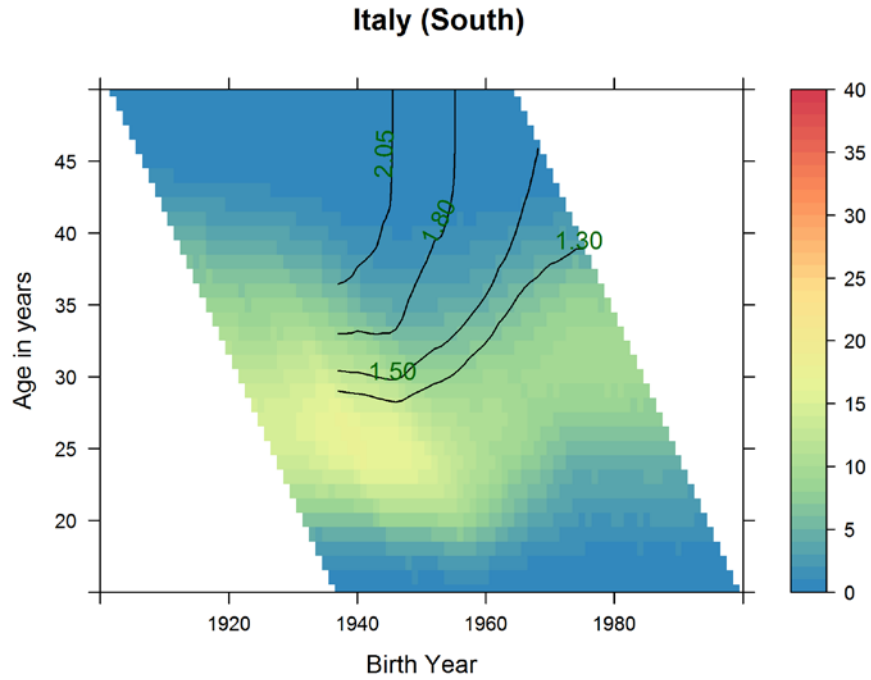

Germany, East (West)
Age in years
Birth Year
20
25
30
35
40
45
1920
1940
1960
1980
0
5
10
15
20
25
30
35
40

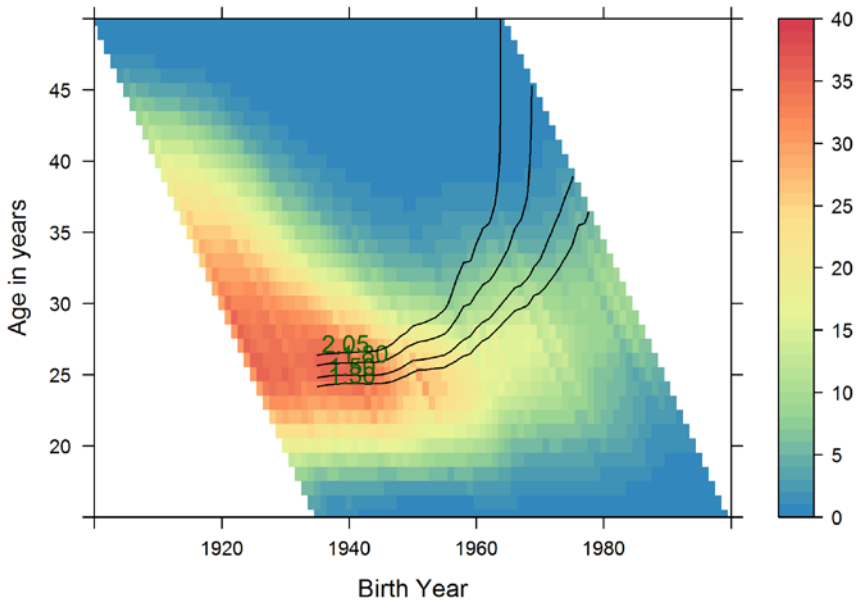

Italy (South)
Age in years
Birth Year
20
25
30
35
40
45
1920
1940
1960
1980
0
5
10
15
20
25
30
35
40

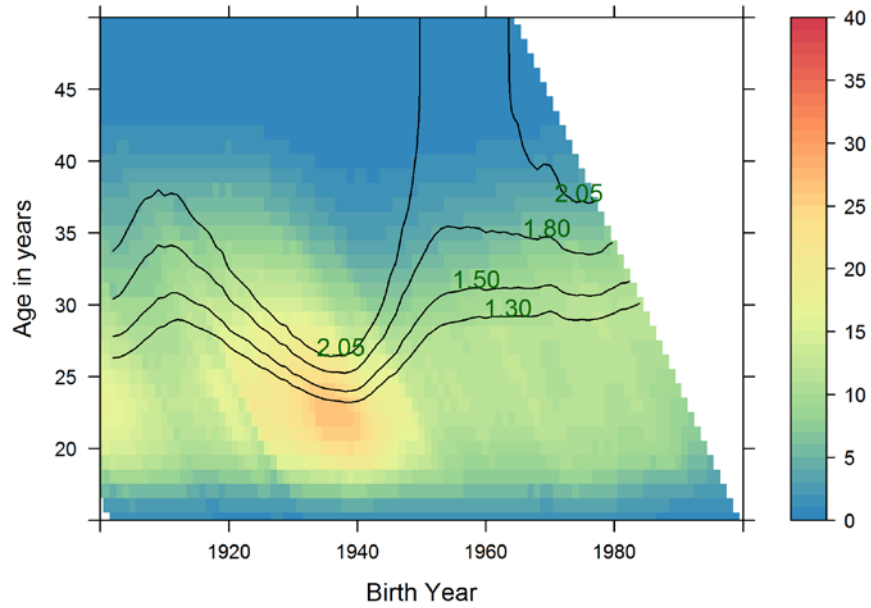

Taiwan (Asian)
Age in years
Birth Year
20
25
30
35
40
45
1920
1940
1960
1980
0
5
10
15
20
25
30
35
40

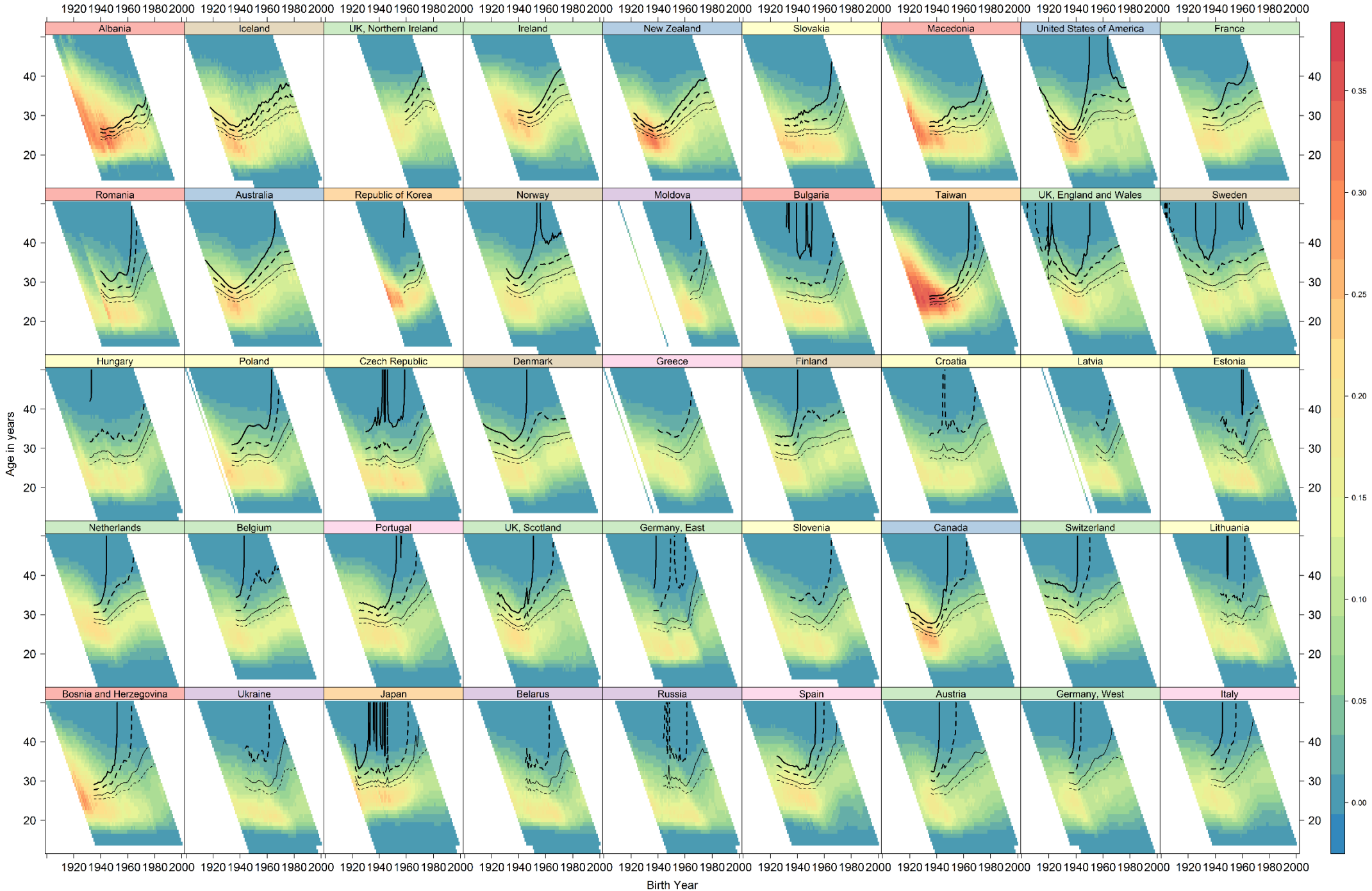

United States of America (Anglophone)
Age in years
Birth Year
20
25
30
35
40
45
1920
1940
1960
1980
0
5
10
15
20
25
30
35
40


Germany, West (West)
Age in years
Birth Year
2.05
1.80
1.50
1.30


Italy (South)
Age in years
Birth Year
2.05
1.80
1.50
1.30


Taiwan (Asian)
Age in years
Birth Year
2.05
1.80
1.50


United States of America (Anglophone)
Age in years
Birth Year
2.05
1.80
1.50
1.30


Albania
Iceland
UK, Northern Ireland
Ireland
New Zealand
Slovakia
Macedonia
United States of America
France
Romania
Australia
Republic of Korea
Norway
Moldova
Bulgaria
Taiwan
UK, England and Wales
Sweden
Hungary
Poland
Czech Republic
Denmark
Greece
Finland
Croatia
Latvia
Estonia
Netherlands
Belgium
Portugal
UK, Scotland
Germany, East
Slovenia
Canada
Switzerland
Lithuania
Bosnia and Herzegovina
Ukraine
Japan
Belarus
Russia
Spain
Austria
Germany, West
Italy
1920 1940 1960 1980 2000
20 30 40
Age in years
Birth Year
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35

Discussion: Methodological Contributions

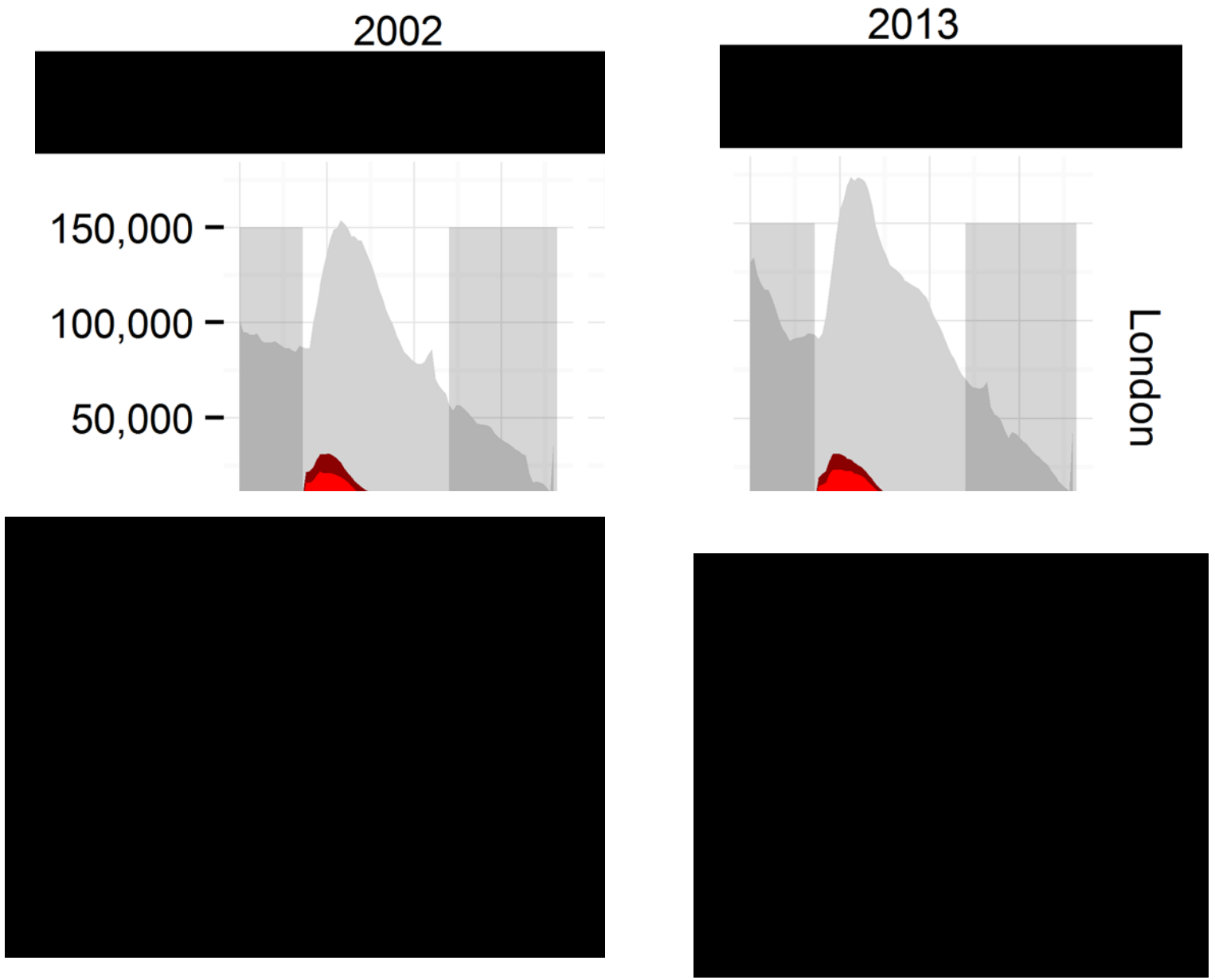
- Much data can be shown and made sense of at a time
  - *Nearly 100 000 values represented in the latticeplot*
- Complex data vis: A need to slow… down
  - Guiding through steps
- Intuitive sense of where different countries are heading
- Plotting of contours gives an approximate sense of trajectories:
  - *Extrapolate iff age < 42? Vertical if age >= 42?*
- Ordering in latticeplot is for last year but implied trendlines suggest which are stabilising and which are changing

Discussion: Substantive Contributions

- Most (‘developed’) countries do not achieve replacement fertility levels
- Countries that have include: Albania, Iceland, Ireland, New Zealand, USA, Norway?
- No strong overall relationship between countries’ CCFRs and regions
  - *Southern and Central European countries tend have low fertility*
  - *Small countries with relatively high fertility*
- Ordering in latticeplot is by fertility in last year, but lines show different trajectories

Discussions: Speculations

- Primary and secondary effects of migration
  - *USA fertility recovery and Mexican immigration?*
- Germany, Austria and openness to migration
- Differences between Scotland and England/Wales (‘Wangland’)
- Regional differences within countries
  - *London and the rest*


2002
2013
150,000
100,000
50,000
London

Discussion: Refugee Crises and European Demographic Trajectories

- Almost all European countries need migration to stabilise dependency ratios
  - Primary effects: More 25 year olds now
  - Secondary effects (perhaps): higher fertility rates so more 25 year olds in the next generation
- Within EU, countries with lower fertility appear more accepting of refugees
  - Austria, Germany, Italy?

Discussion: Brexit

- Brexit: Mass migration is the solution to long-term decline in Europe, not the problem
- As long as
  - short-term costs
  - regional variations in service demand
- - can be mitigated appropriately
- Conservatives: Austerity
- Labour (or a bit of it): Migration Relief Fund
- Scarcity: “Charity begins at home”

For further information

- NCRM podcast:
  - http://www.ncrm.ac.uk/resources/podcasts/view.php/Visualising-social-trends-in-3D
- Blogs:
  - https://ije-blog.com/2016/06/27/lexis-cubes-1-from-maps-of-space-to-maps-of-time/
  - https://ije-blog.com/2016/06/27/lexis-cubes-2-case-study-log-mortality-for-males-in-finland-1878-to-2012/
- Papers:
  - http://www.ncbi.nlm.nih.gov/pubmed/24062300
  - http://jech.bmj.com/content/early/2016/03/01/jech-2014-205226.abstract
  - http://www.sciencedirect.com/science/article/pii/S1877584514000173
- Github repos (as before)
- Or… email Jonathan.Minton@Glasgow.ac.uk

- Thanks for listening!