

BaRcelona Summer School for Demography  
Module 2: Demography in R

# Mortality and Fertility

8 July, 2025

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**ikerbasque**  
Basque Foundation for Science



**CED<sup>R</sup>**  
CENTRE D'ESTUDIS  
DEMOGRÀFICS

# Workshop plan, July 7-11, 2025

1: Monday      Intro concepts, and R setup

**2: Tuesday      Mortality and fertility**

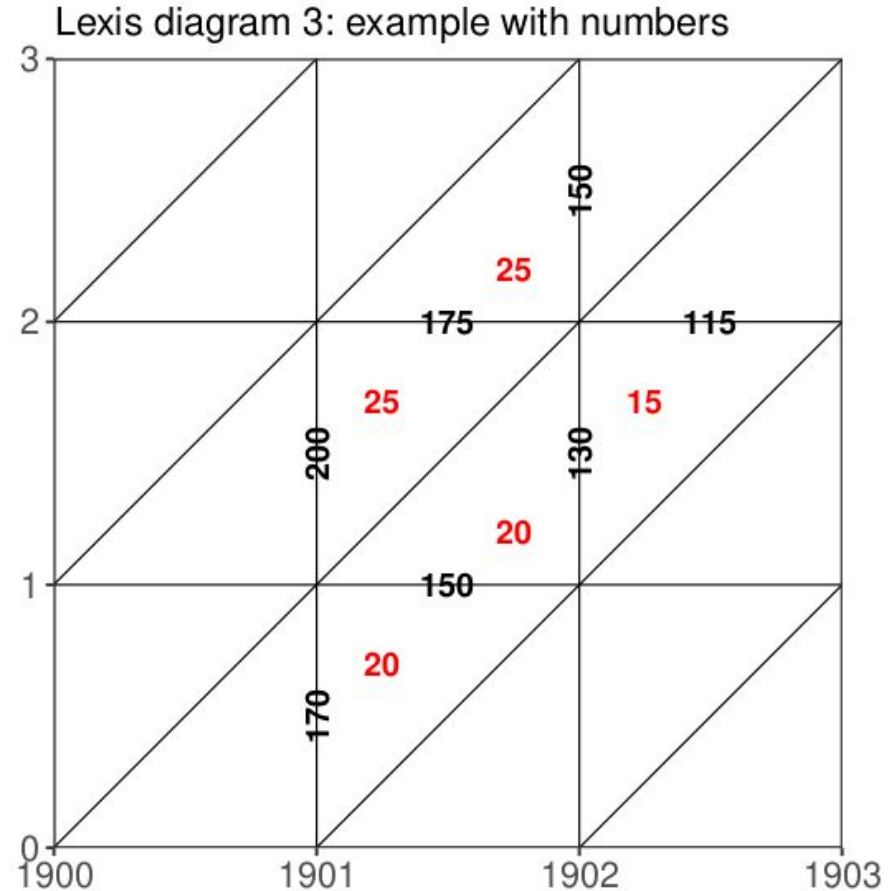
3: Wednesday   Standardization & decomposition

4: Thursday      Growth

5: Friday          Projection

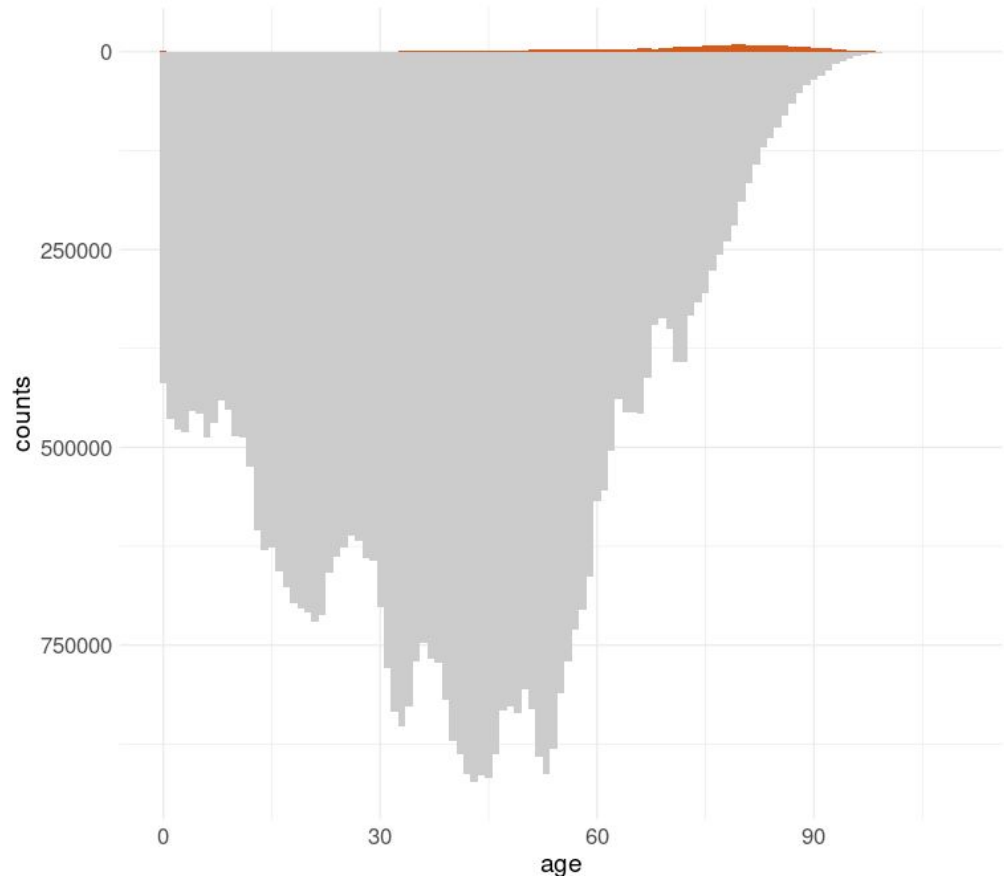
# Review of session 1

- age, period, cohort
- rates, probabilities, counts, ratios, stocks, flows
- Crude rate versus age-specific rate
- R projects, R markdown
- Objects, functions, grammar

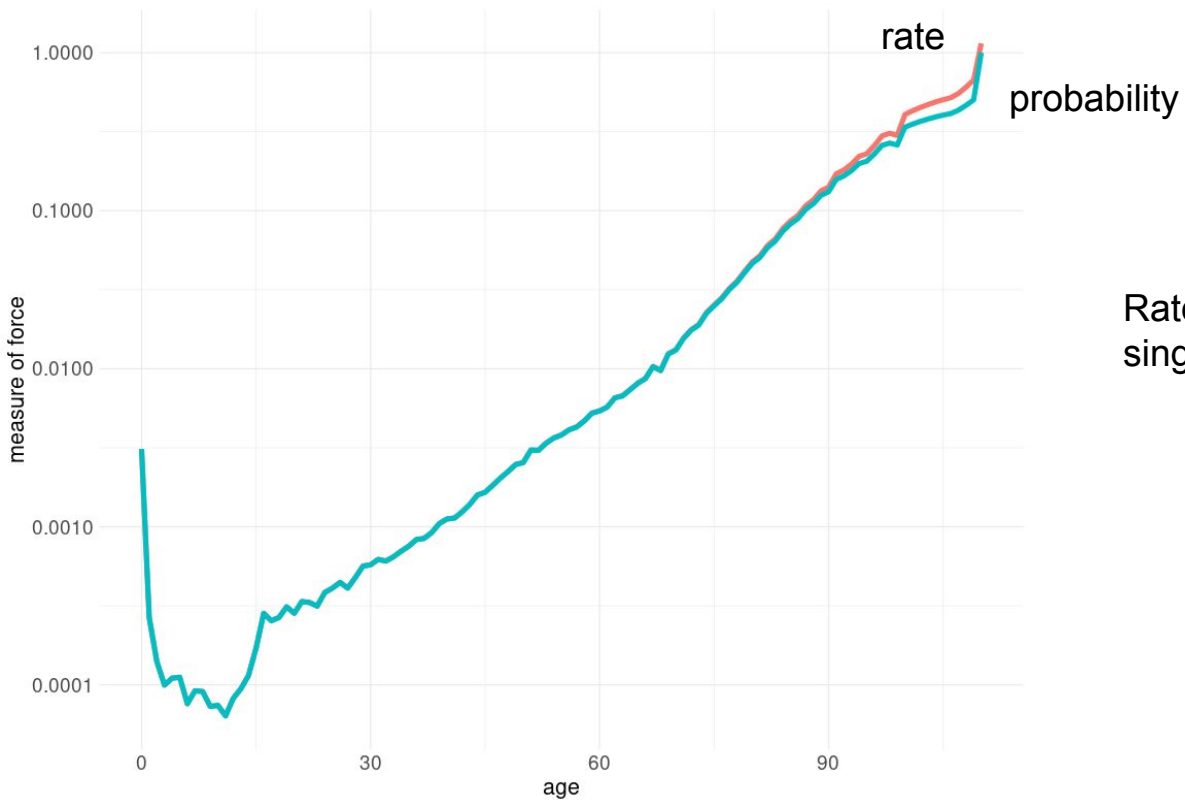


# Mortality:

$$M(x) = D(x) / E(x)$$

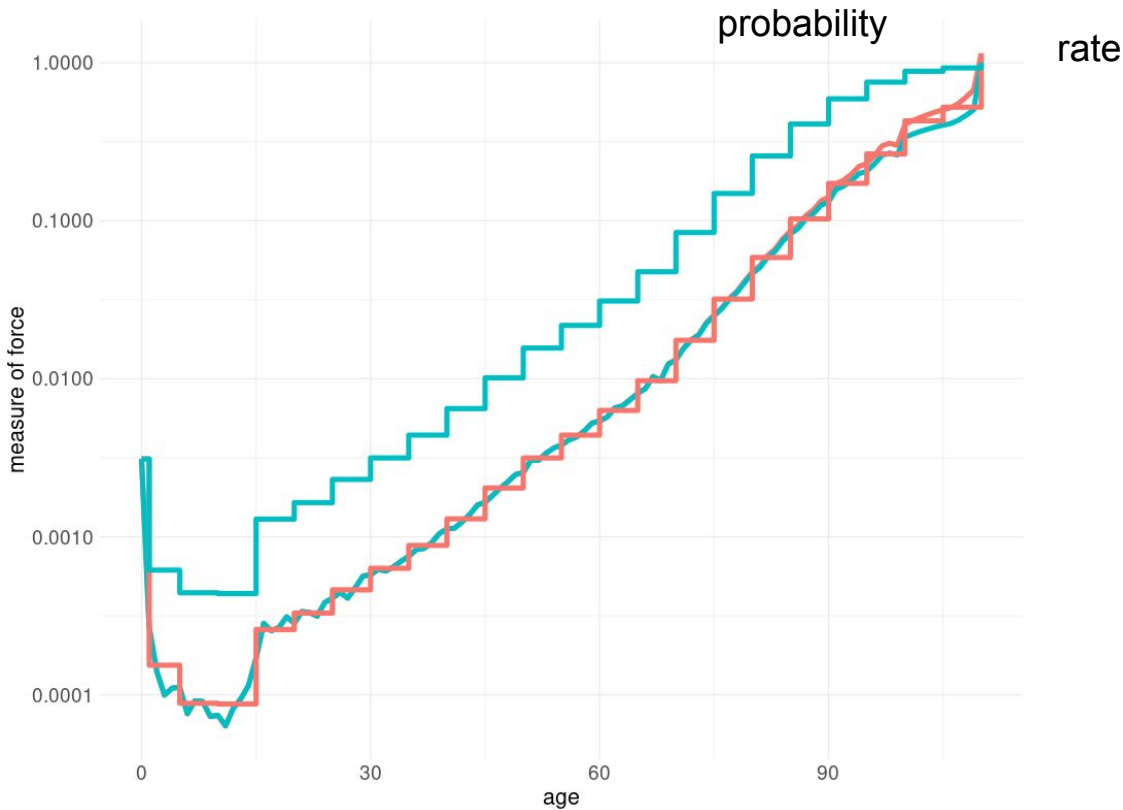


# Mortality



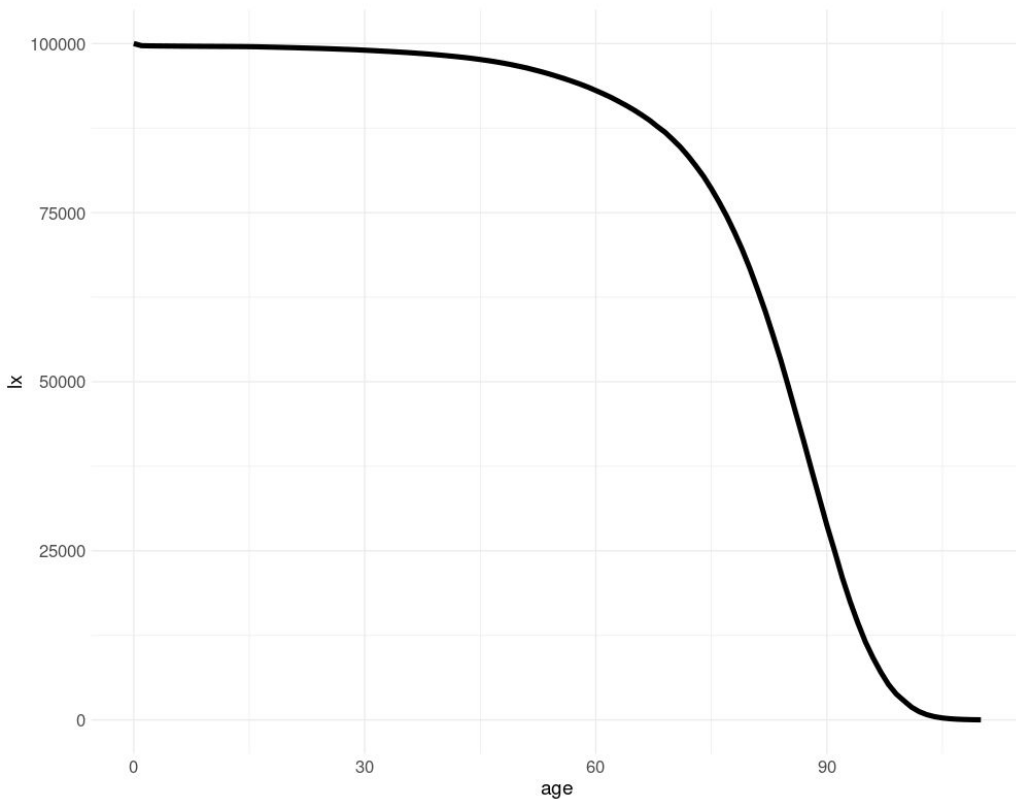
Rates and probabilities are very close for single-age data

# Mortality



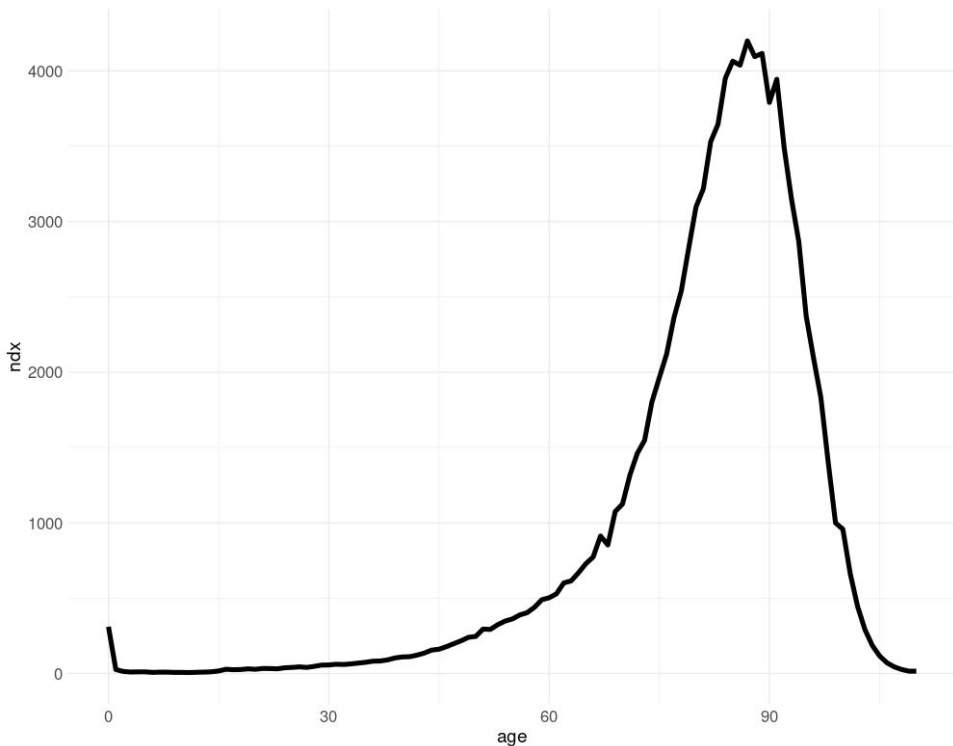
It makes a big difference for data in wider age groups!

# Mortality



The survivorship curve is inferred by chaining survival probabilities together over successive ages. This is the main trick of the period lifetable and why we call it synthetic. Further quantities are derived from this.

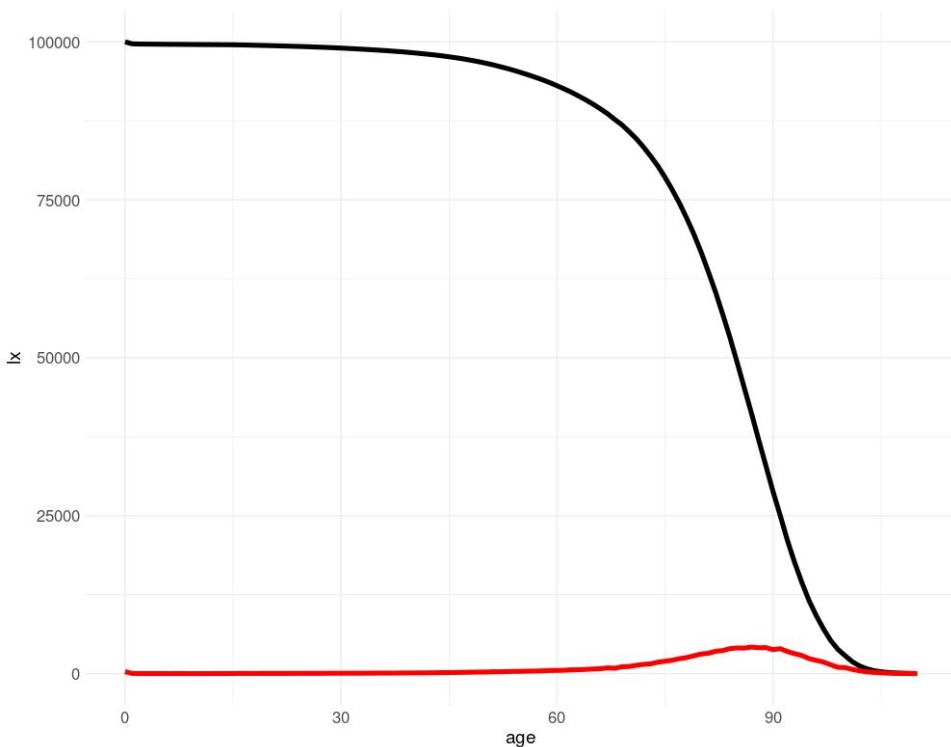
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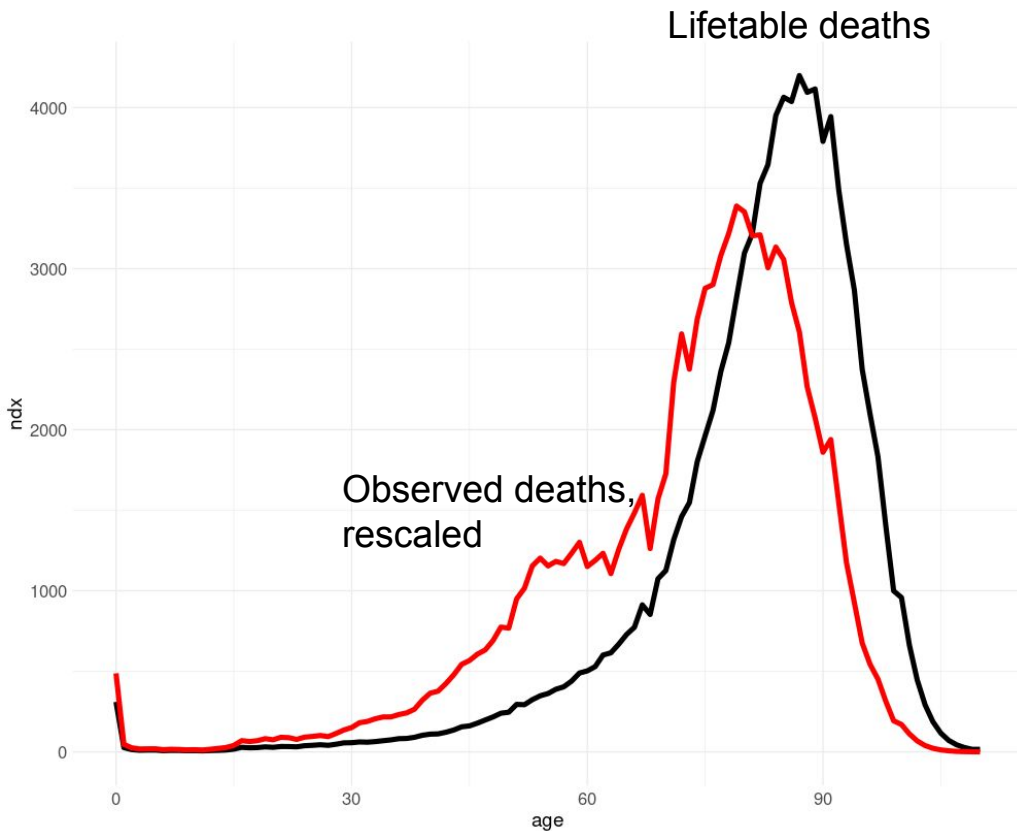


# Mortality



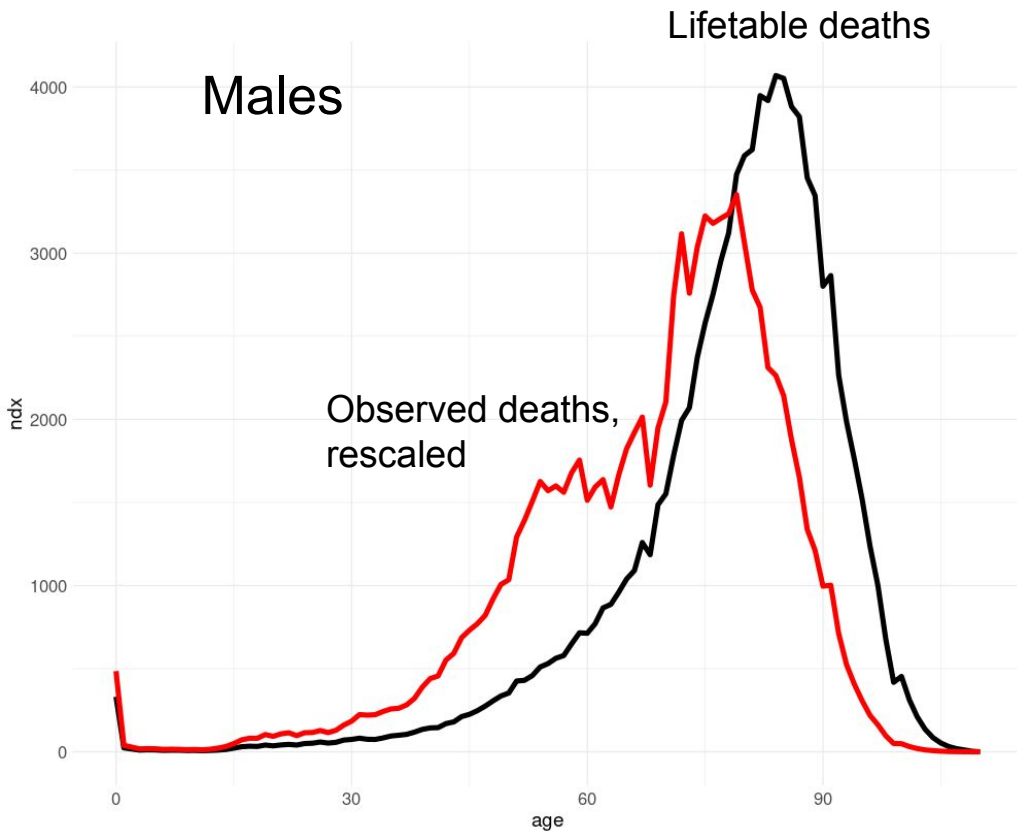
The survivorship curve is inferred by chaining survival probabilities together over successive ages. This is the main trick of the period life table and why we call it synthetic. Further quantities are derived from this, such as the life table death distribution. These two functions go hand-in-hand. You might even try drawing them together.

# Mortality



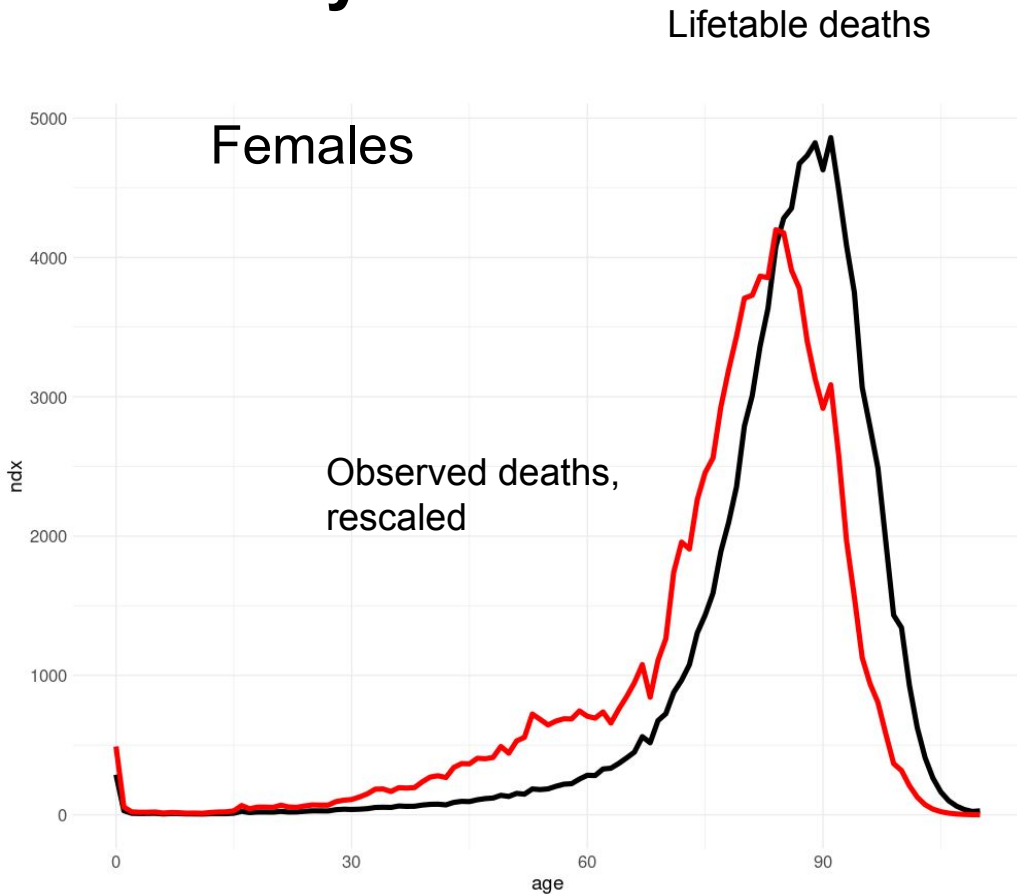
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# Mortality

Life expectancy ( $e_0$ ) can be thought of as the **average age at death**, where ***lifetable deaths are the weights***.

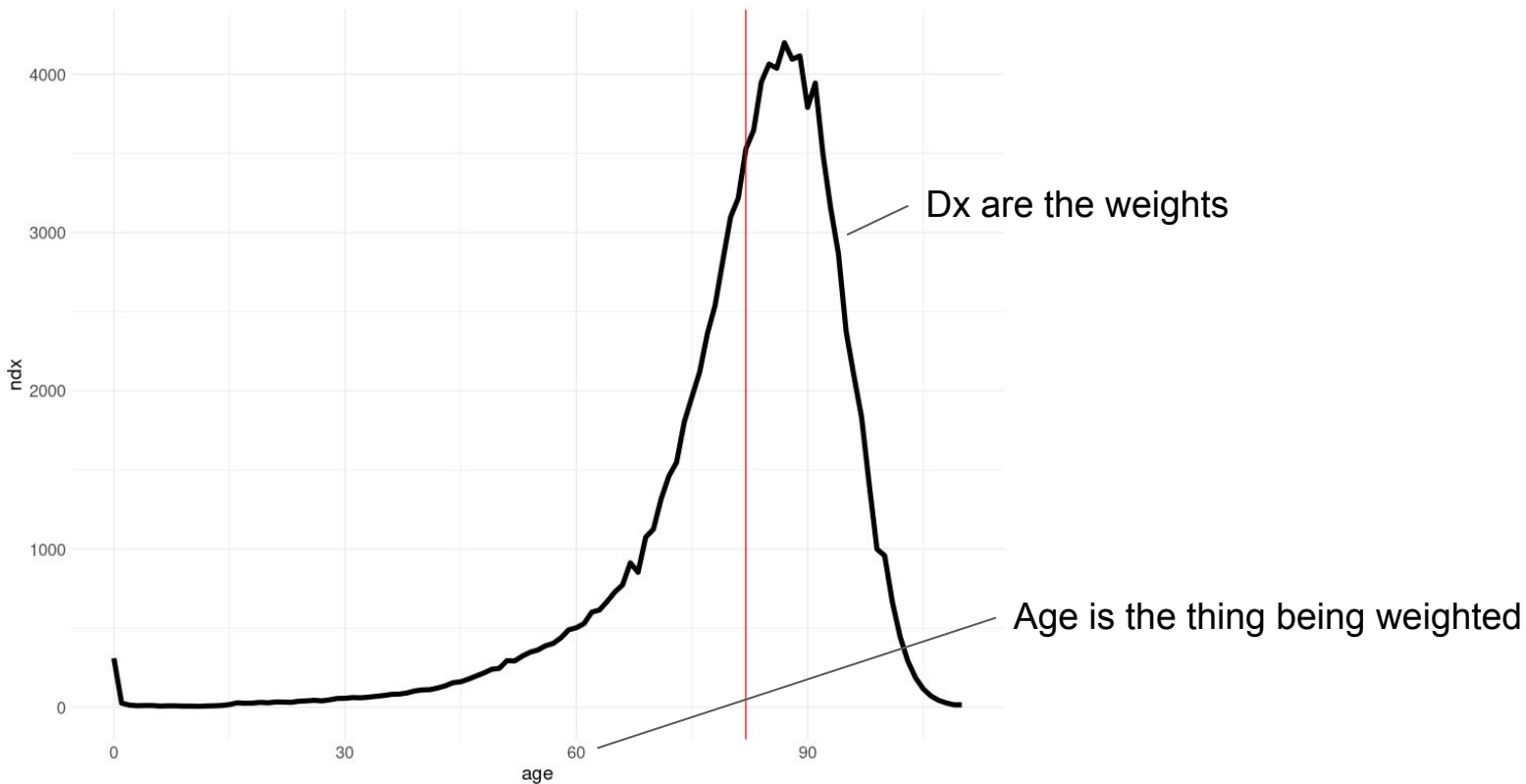
- equivalent to saying  $e_0$  is equal to the **area under the survival curve**,  $l_x$ . In practice we do this, but first understand the  $dx$ -weighted age at death.

All other details are one of four kinds:

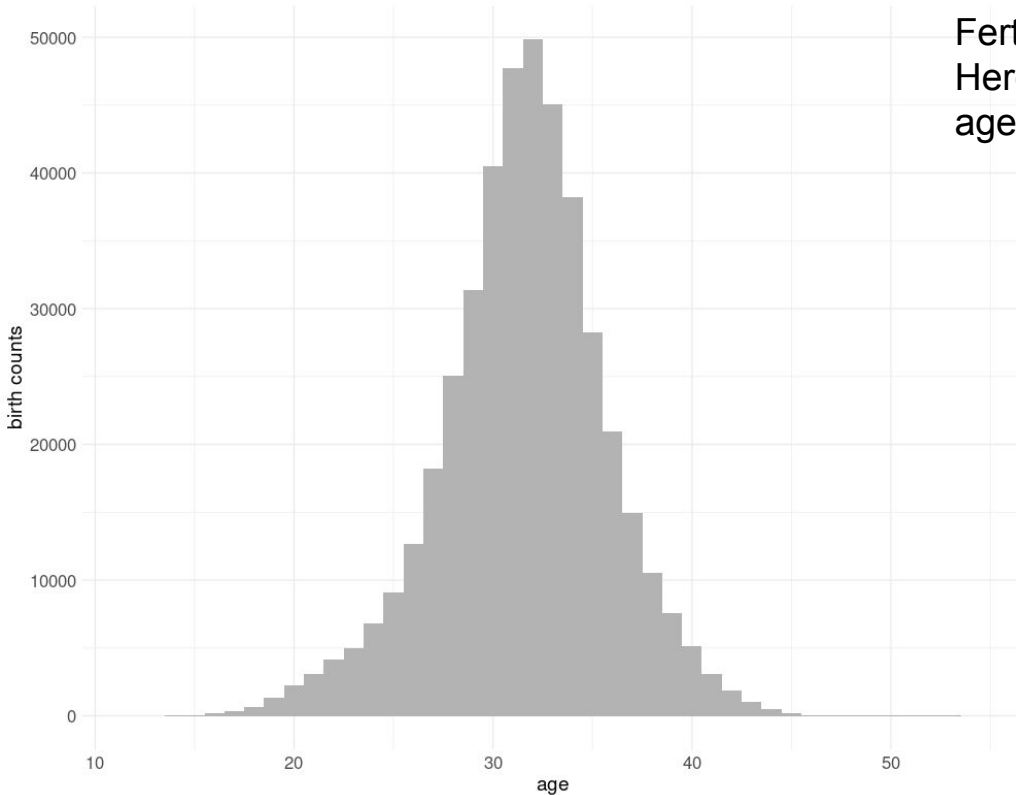
1. Details for converting rates to probabilities
2. Adjustments to approximate the area under  $l_x$  given discrete data.
3. Adjustments to calculate remaining life expectancy at each age rather than just for age 0.
4. Adjustments for what values to use for the highest age (closeout)

# Mortality

Life expectancy is the lifetable's mean age at death, 81.98 in this case.



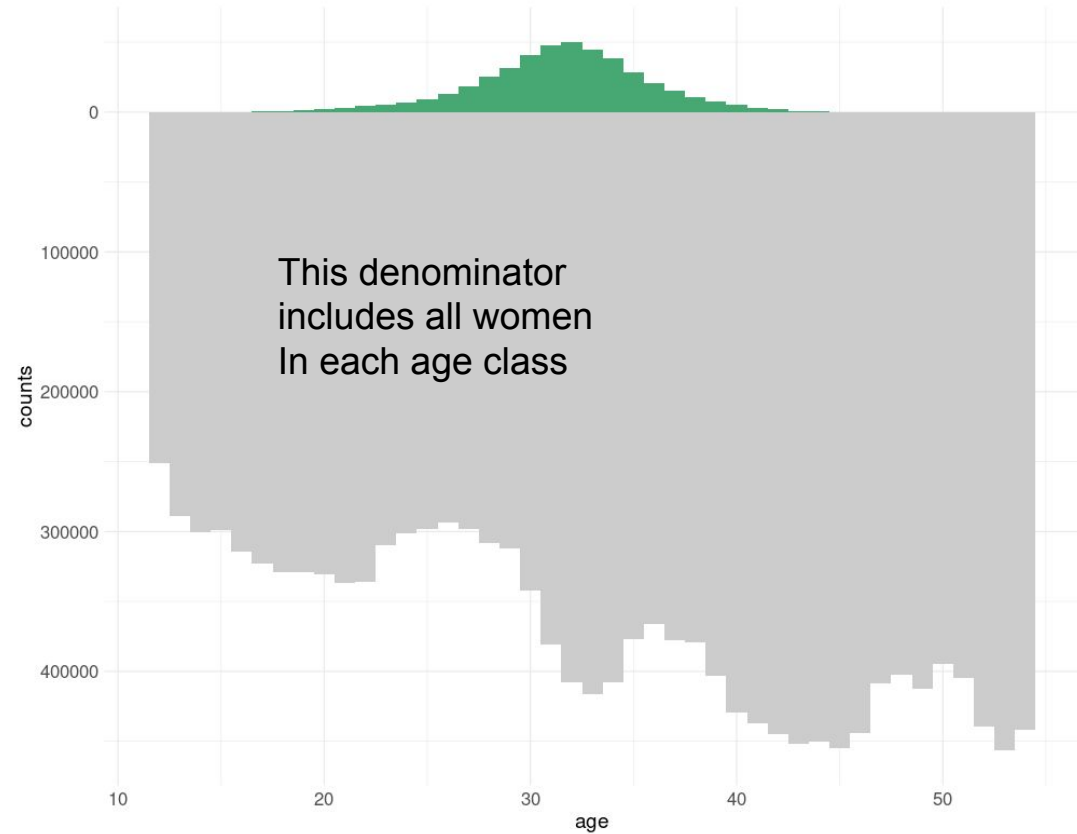
# Fertility



Fertility analysis starts with the registration of births, Here birth records have been tabulated to birth counts by age of mother.

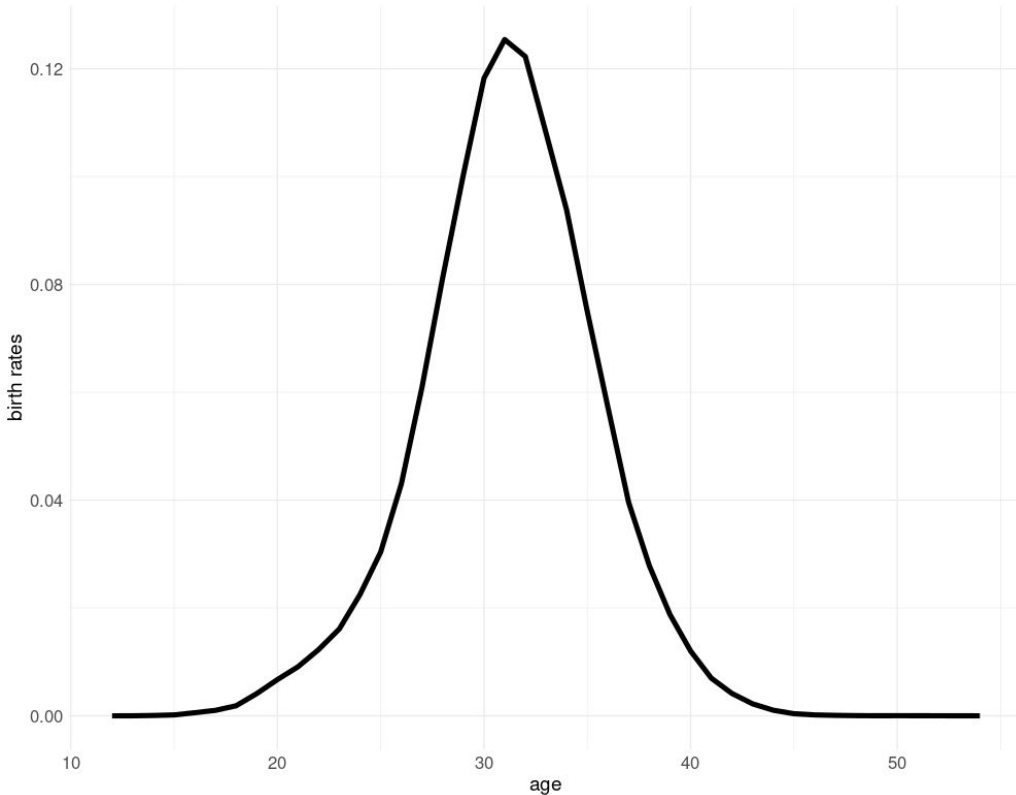
# Fertility

$$F(x) = B(x) / E(x)$$



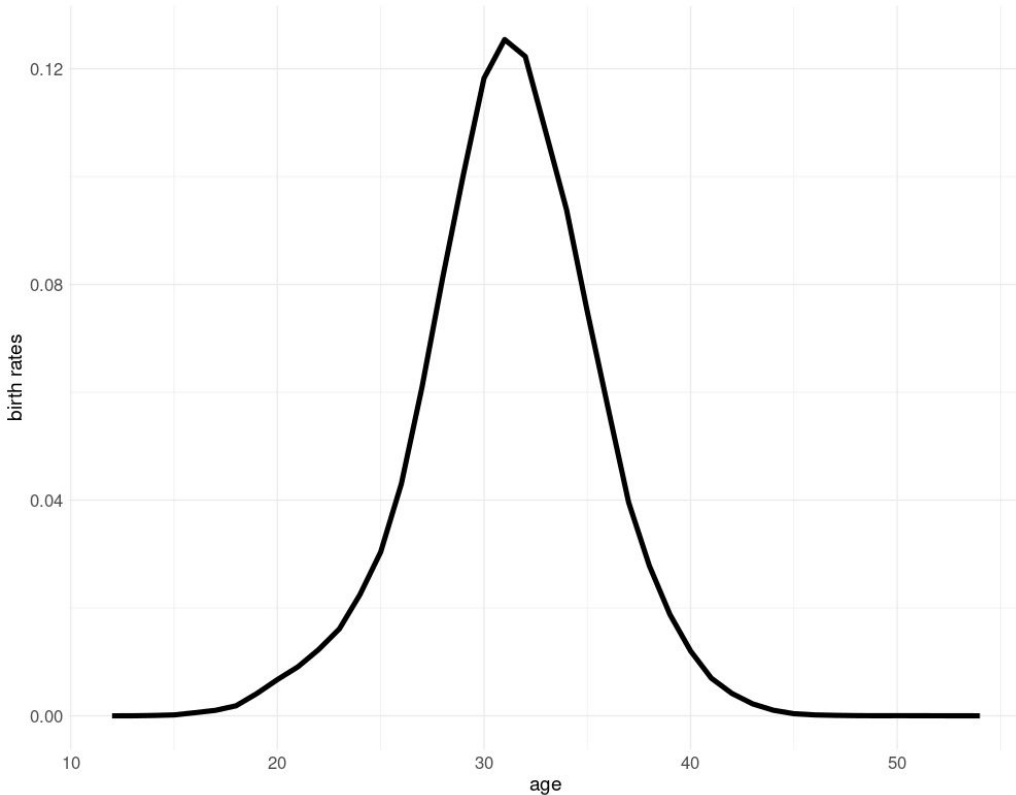


# Fertility



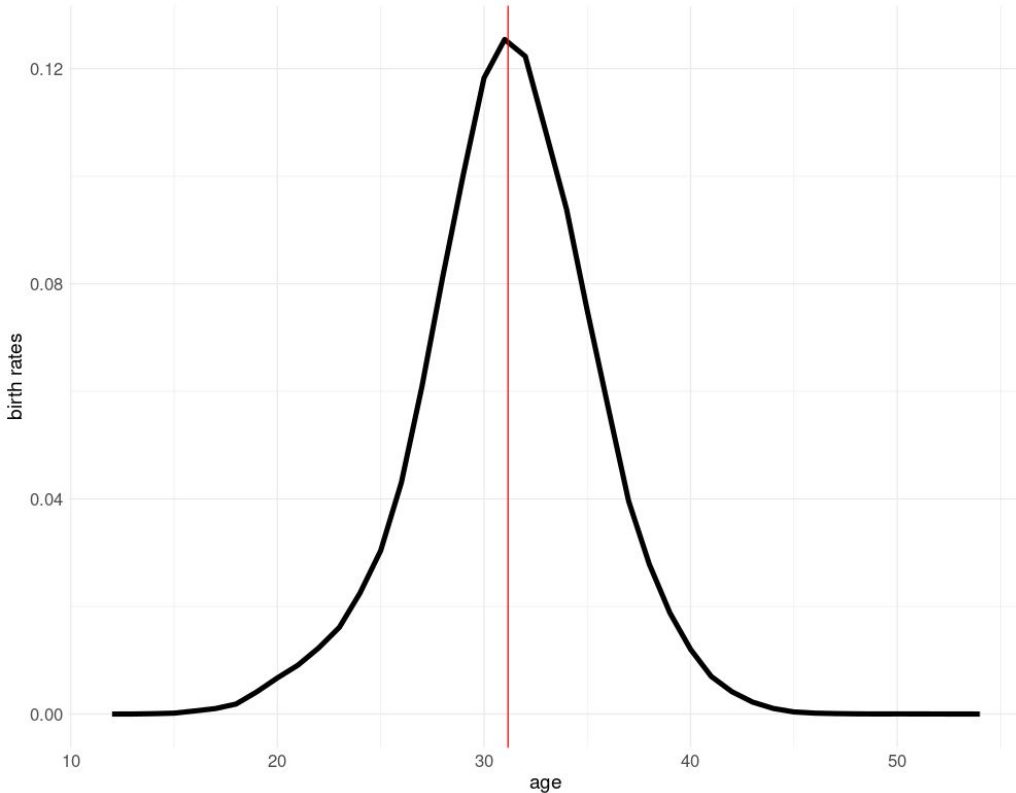
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Birth rates are often denoted  $F_x$  or ASFR (age-specific fertility rates). Unless otherwise stated, age means age of mother. The total fertility rate TFR is the sum of these, in this case 1.2. The mean age of childbearing (MAC or MAB) sometimes uses these rates as weights. Here the MAB matches the mode, 31.2.

# Summary

**TFR** and **e0** both hold the demographic rates of period constant and imagine a synthetic lifecourse running through them.

Neither is a projection

Both are useful: they convert to meaningful units (babies, years of life)

Both summarize rates, where we treat rates as a proxy for conditions. Rates might be a deficient proxy, but they're better than the other quantities we have (counts)...

**Time for us to move to R!**