KOSTAT-UNFPA Summer Seminar on Population

Workshop 1: Demographic Analysis: Methods and Tools in R

# Projection

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# Workshop plan, July 1-5, 2024

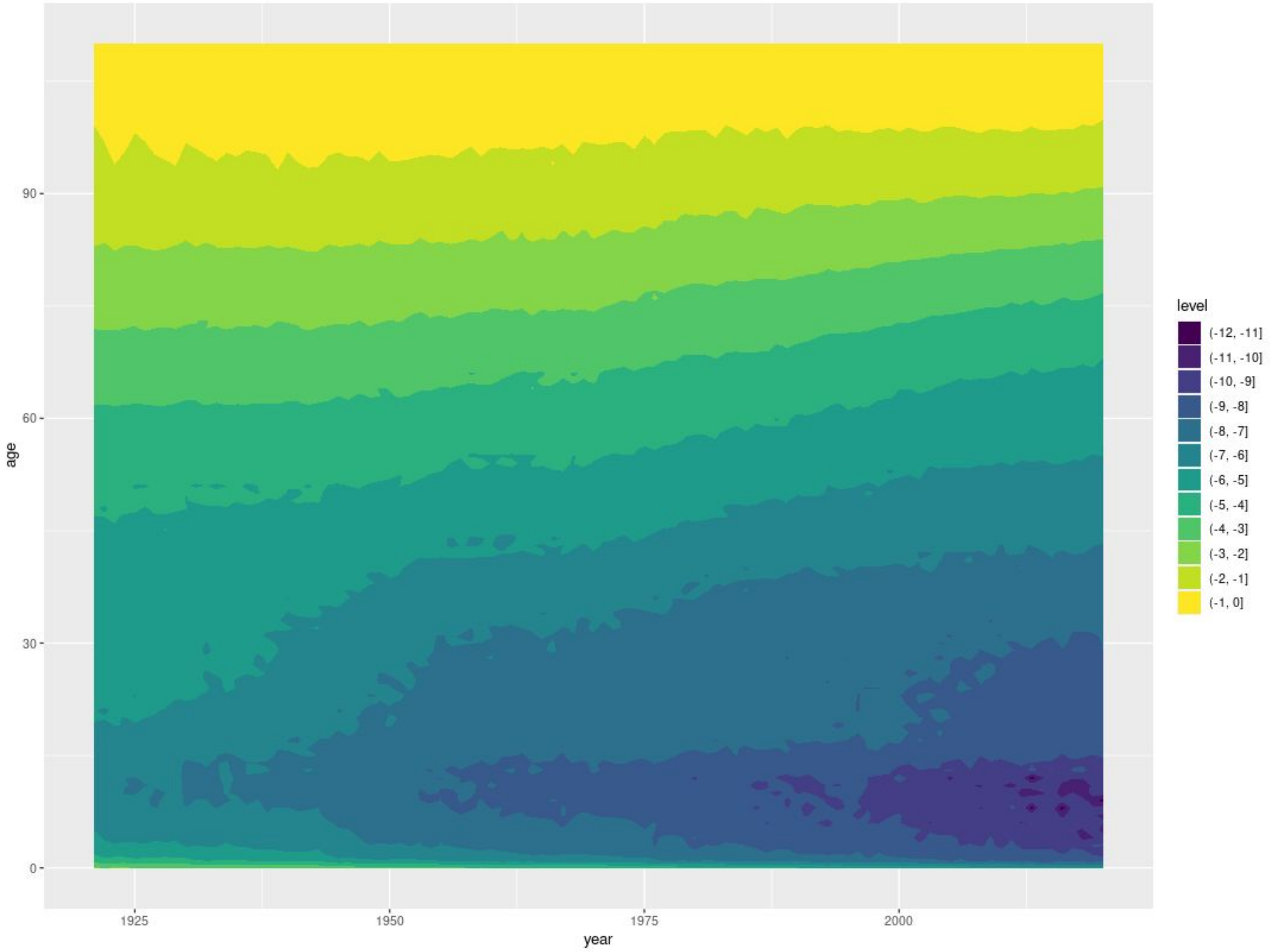
| | |
|---|---|
| 1: Monday | Intro concepts, and R setup |
| 2: Tuesday | Mortality and fertility |
| 3: Wednesday | Structure |
| 4: Thursday | Growth |
| **5: Friday** | **Projection** |

# Review of session 4

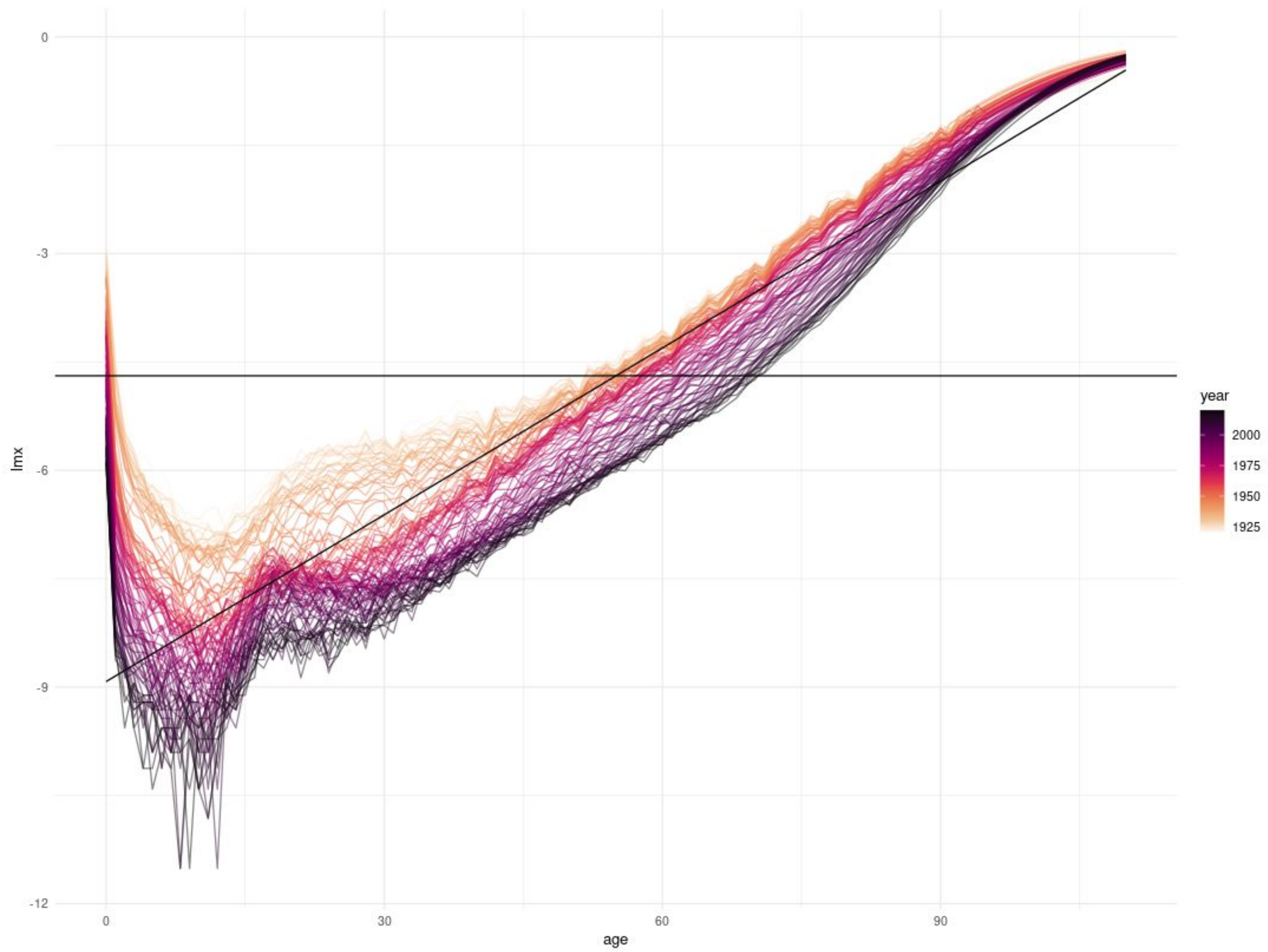
- Geometric and exponential growth
- Stationary and stable structure
- Stable structure in periods; stationary structure in cohorts
- Stable populations don’t happen; change is constant
- Period perspective justifiable for life expectancy, but net reproductivity results are not.
- `colorspace` for good palettes.
- Pyramid tips
- `cross_join()`

# Projection

- Predict the past/present to predict the future
- Simplify
- Extrapolate



age
90
60
30
0
1925
1950
1975
2000
year
level
(-12, -11]
(-11, -10]
(-10, -9]
(-9, -8]
(-8, -7]
(-7, -6]
(-6, -5]
(-5, -4]
(-4, -3]
(-3, -2]
(-2, -1]
(-1, 0]


0
-3
-6
-9
-12
lmx
0
30
60
90
age
year
2000
1975
1950
1925

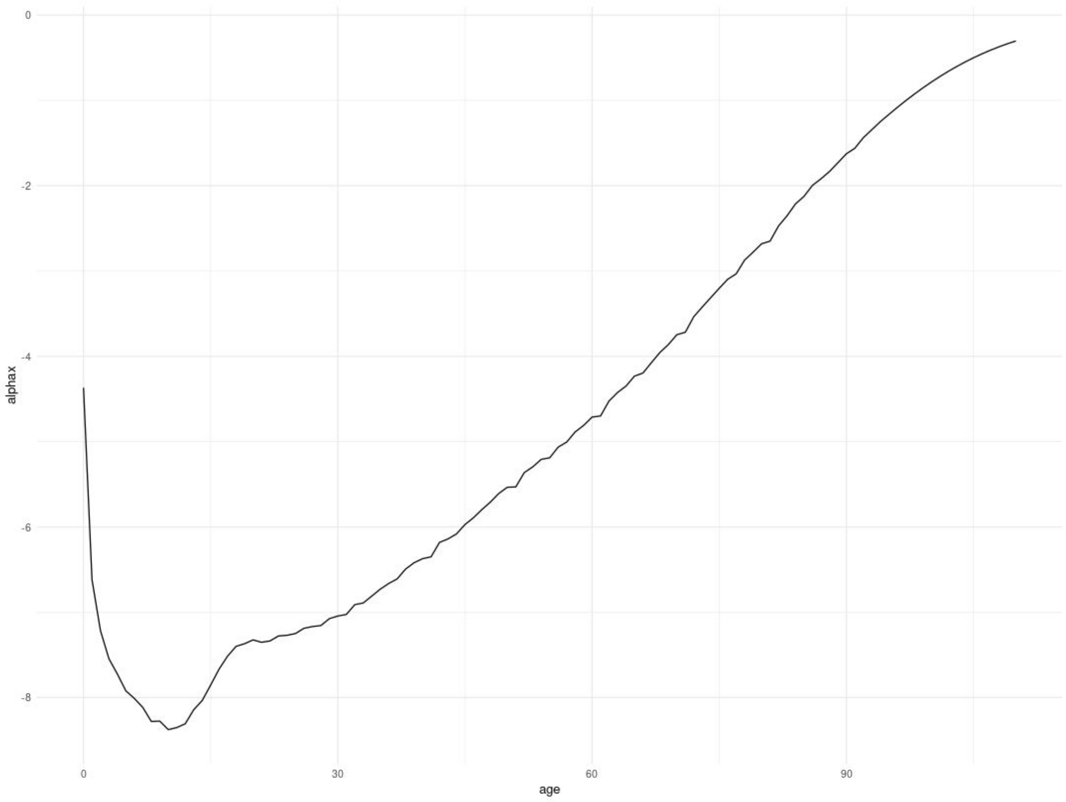
# % Variance (of log rates) explained

| Parameters | |
|---|---|
| 1 (simple intercept) | Total var = 276 |
| 2 (line) | **66.4 %** |
| 3 (simple plane) | **72.9 %** |
| 4 (plane with tilt) | **75.0 %** |
| 200 (each year has own line) | **75.2 %** |
| 111 (age intercepts) | **76.5 %** |
| 222 (each age has own line) | **93.9 %** |

# Lee Carter method

$$ln(m_x(t)) = \alpha_x + \beta_x \kappa(t) + \epsilon_x(t)$$

# Alpha



# Calculating beta and kappa

SVD - singular value decomposition

Factorize a matrix **M** into pieces **d**, **U**, **V**, such that:

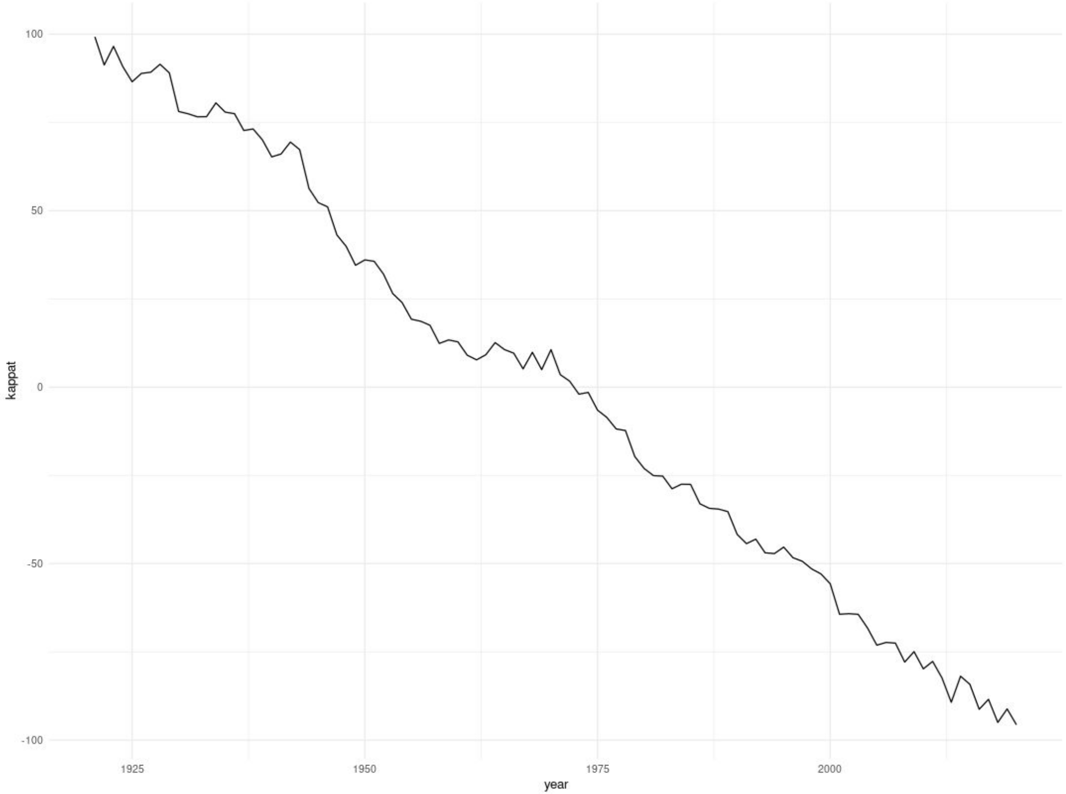
**M = U diag(d) V**$^T$

$\beta(x)$ (age slopes) derived from **U** (scale first column to 1)

$\kappa(t)$ (secular change) derived from **V** (scale first column of **V** to sum to first element of **d**

# Beta(x) age slopes

# Kappa(t) the trend to extrapolate



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| 111 (age intercepts) | **76.5 %** |
| 222 (each age has own line) | **93.9 %** |
| 224 (LC, simple) | **94.2 %** |

$$ln(m_x(t)) = \alpha_x + \beta_x \kappa(t) + \epsilon_x(t)$$