Forecasting the age structure of the scientific workforce in Australia

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Ideal labour force model

$$P_{x+1,t+1} = P_{x,t} - D_{x,t} - R_{x,t} + G_{x,t} - C_{x,t} + N_{x,t}$$

x = Age

t = Year

$P_{x,t}$ = number of equivalent full-time workers

$D_{x,t}$ = number of deaths

$R_{x,t}$ = number of retirements

$G_{x,t}$ = number of graduates who work in science

$C_{x,t}$ = net number of people who have a career change

$N_{x,t}$ = net number of migrants

Pragmatic labour force model

$$P_{x+1,t+1} = P_{x,t}(1 - q_{x,t} - r_x) + g_x G_t + E_{x,t}$$

x = Age

t = Year

$P_{x,t}$ = number of equivalent full-time workers

$q_{x,t}$ = probability of death

r_x = probability of retirement

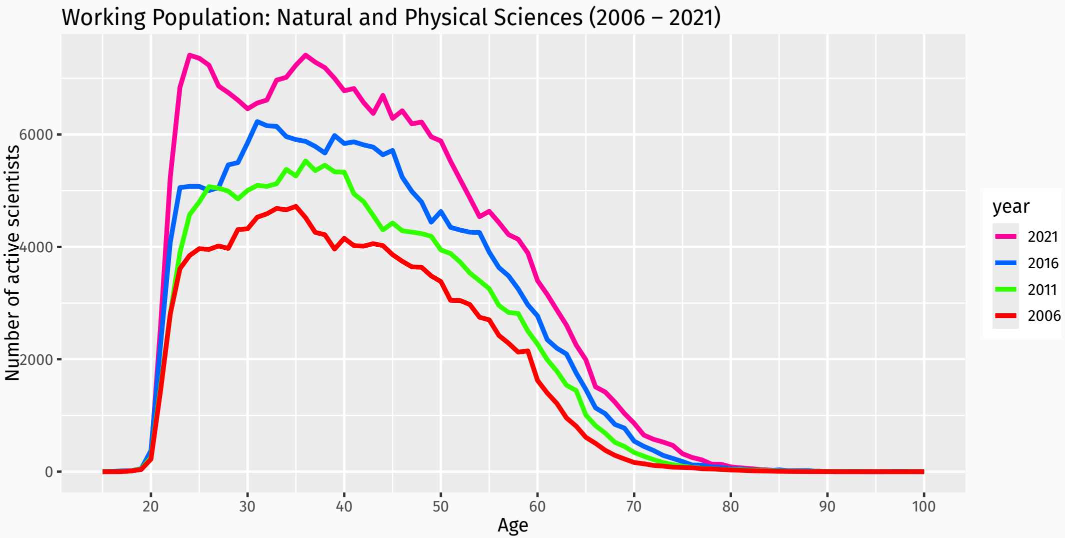
g_x = proportion of graduates by age

G_t = total number of graduates in science

$E_{x,t}$ = remainder

Working population: $P_{x,t}$

$$P_{x+1,t+1} = P_{x,t}(1 - q_{x,t} - r_x) + g_x G_t + E_{x,t}$$



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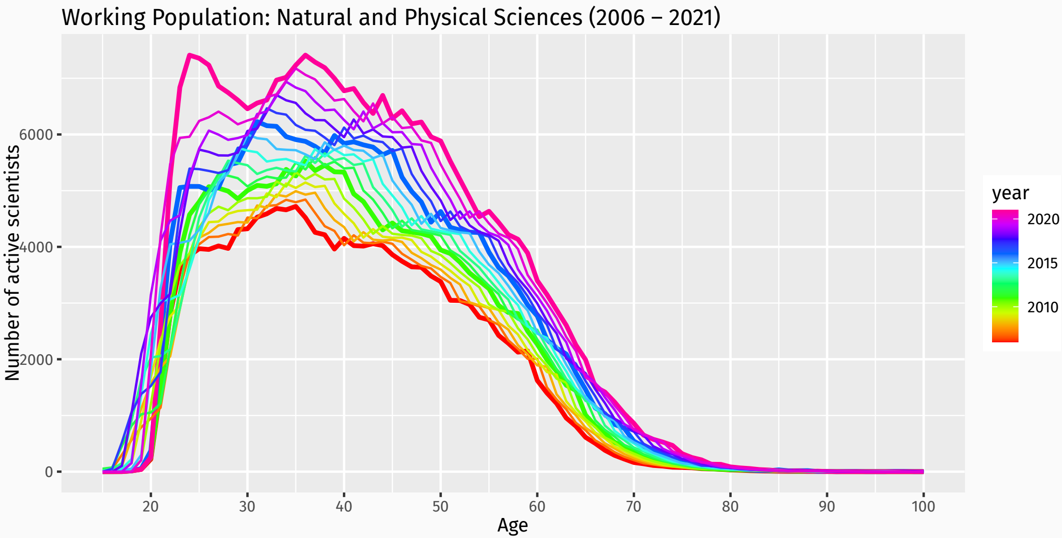
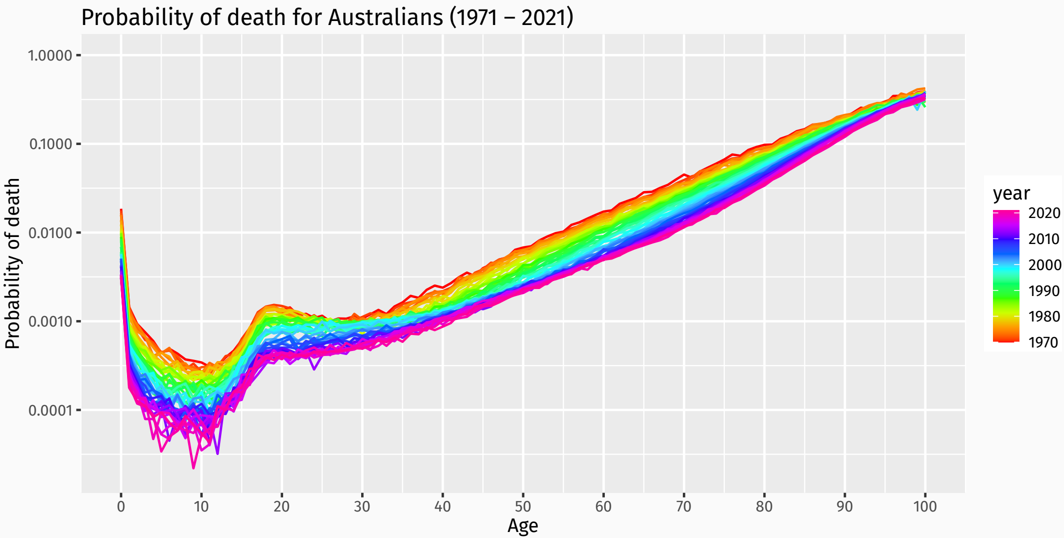


Death rates: $q_{x,t}$

$$P_{x+1,t+1} = P_{x,t}(1 - q_{x,t} - r_x) + g_x G_t + E_{x,t}$$



Retirement rates: r_x

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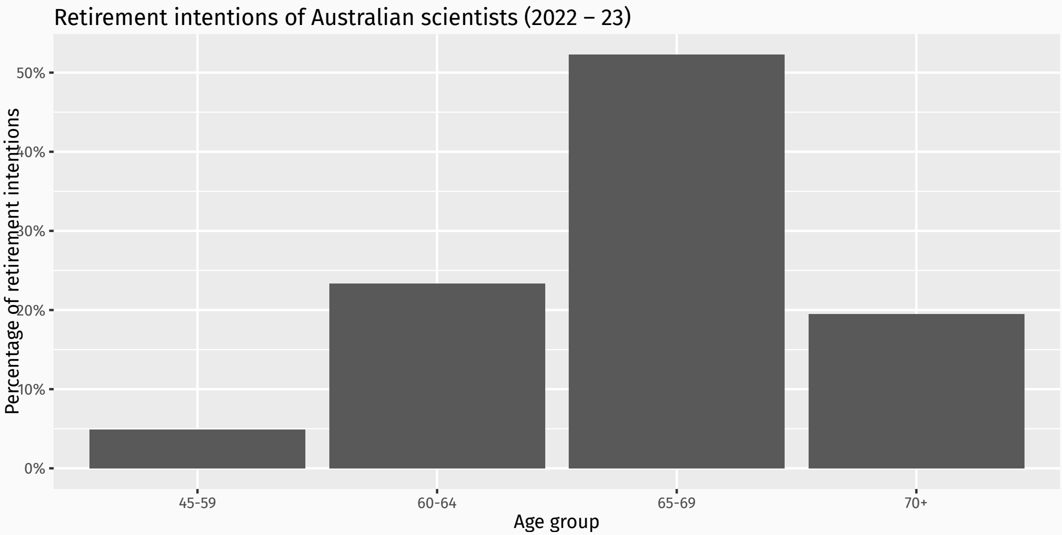

Retirement rates: r_x

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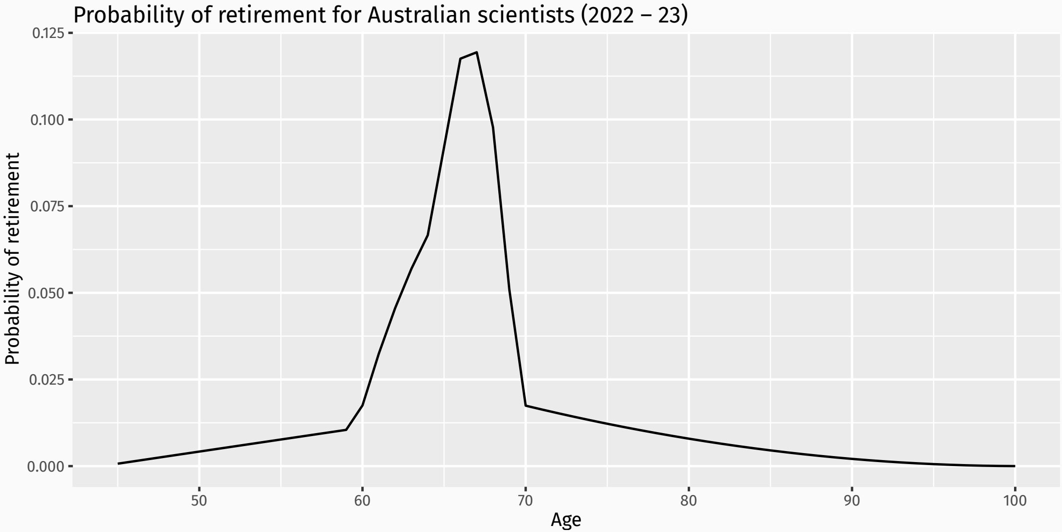
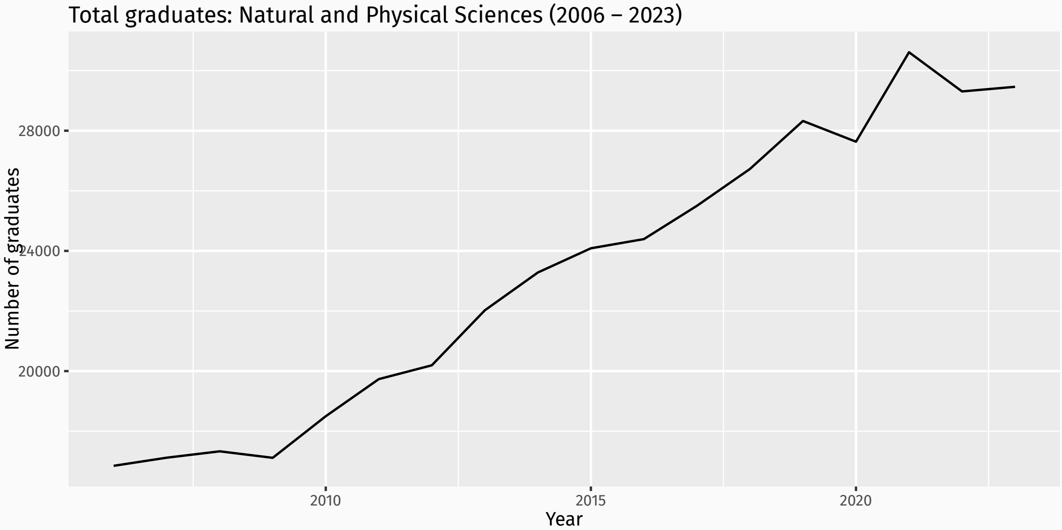


Graduate completions: G_t

$$P_{x+1,t+1} = P_{x,t}(1 - q_{x,t} - r_x) + g_x G_t + E_{x,t}$$



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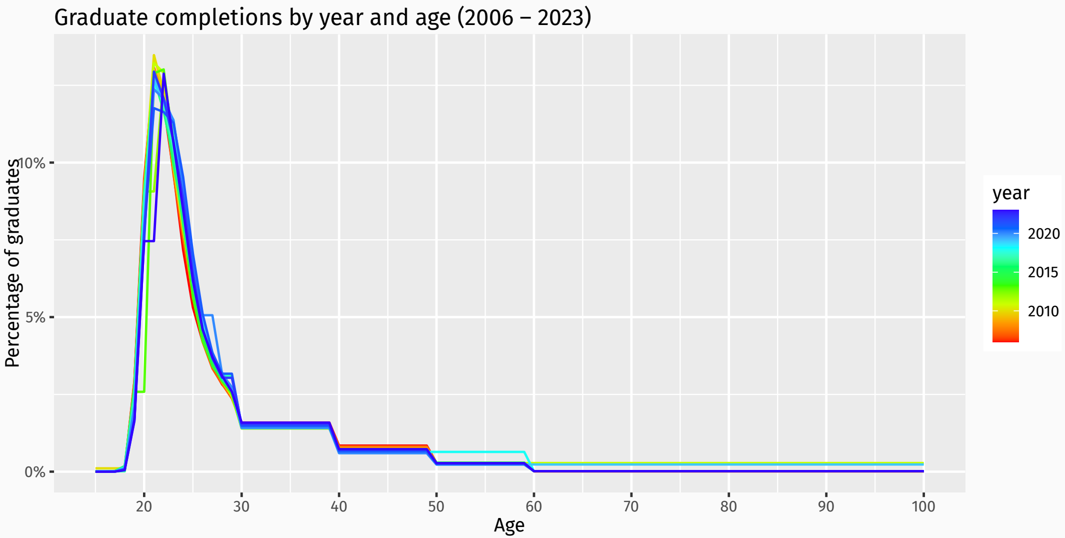

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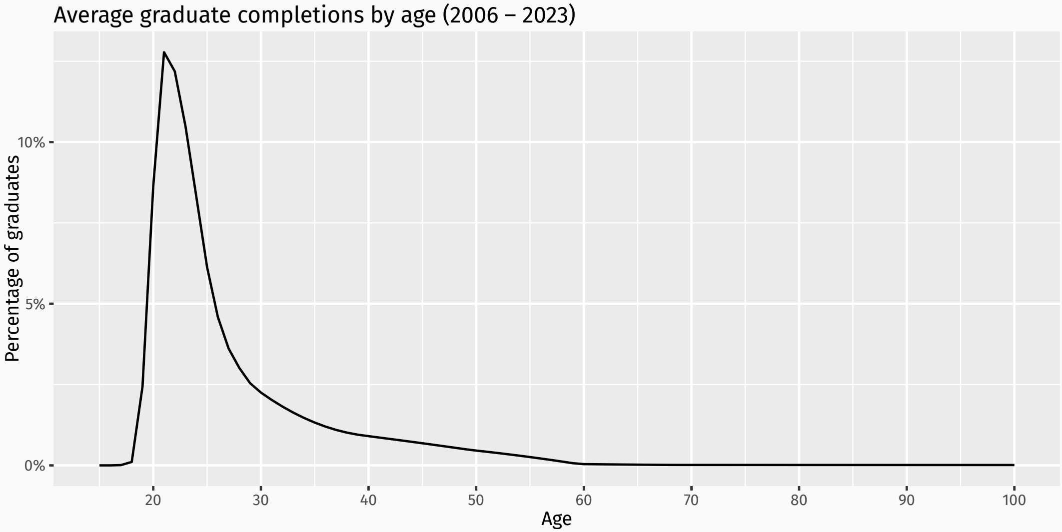

Remainder: $E_{x,t}$

$$P_{x+1,t+1} = P_{x,t}(1 - q_{x,t} - r_x) + g_x G_t + E_{x,t}$$

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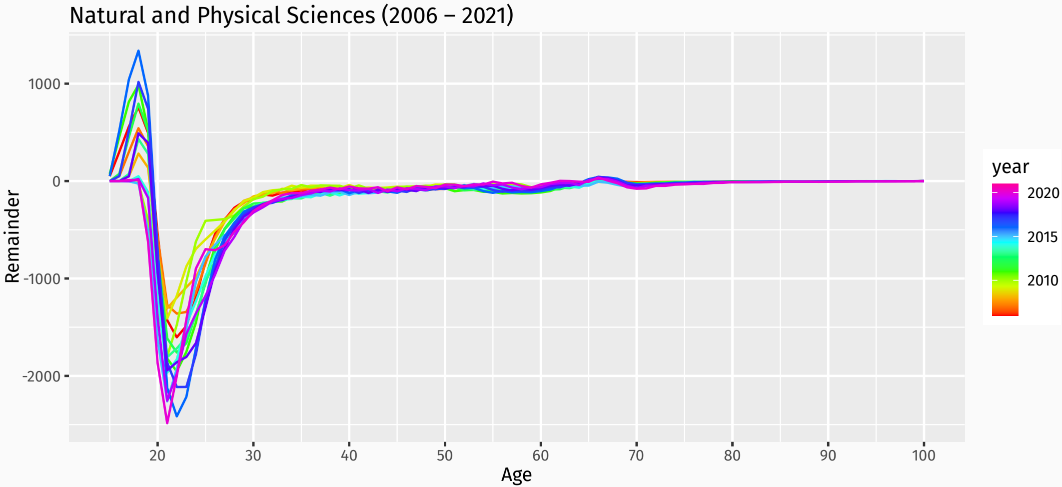

Forecasting models

$$P_{x+1,t+1} = P_{x,t}(1 - q_{x,t} - r_x) + g_x G_t + E_{x,t}$$

G_t	ARIMA model of total graduates by year
$q_{x,t}$	functional time series model
$E_{x,t}$	functional time series model

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- Future sample paths of all components simulated to obtain probabilistic forecasts of $P_{x,t}$

Forecasting models: G_t

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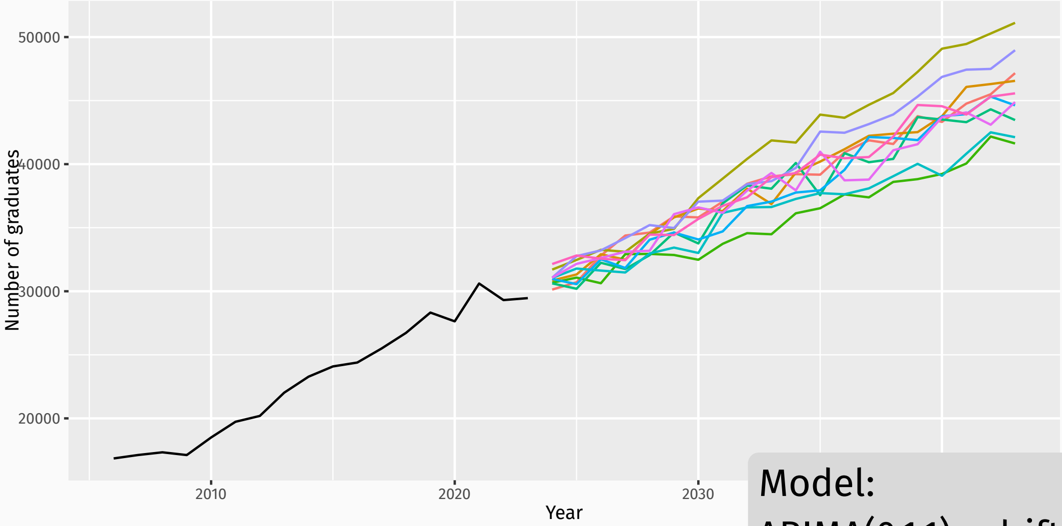

Model:
ARIMA(0,1,1) + drift

Forecasting models: $q_{x,t}$

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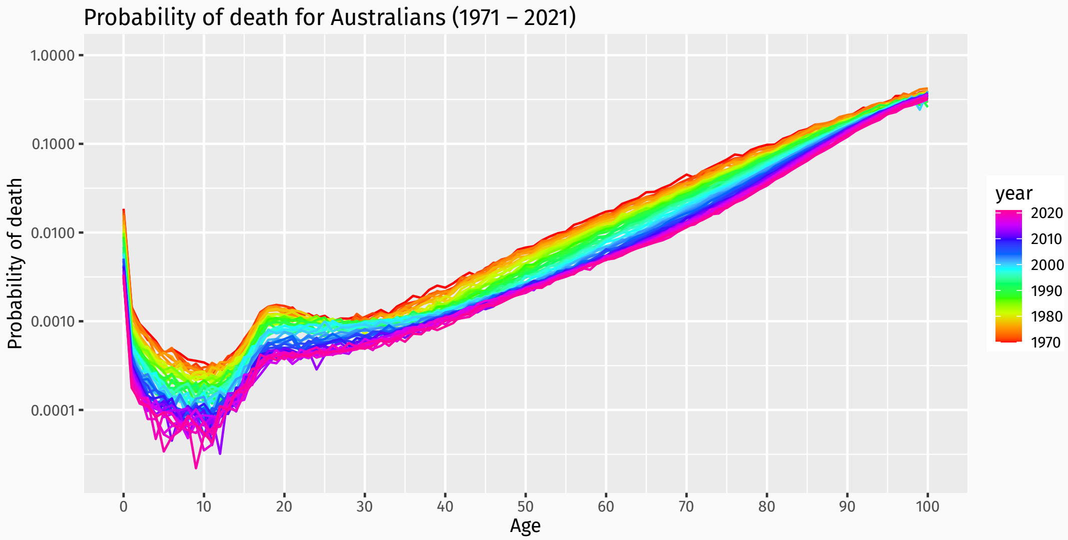

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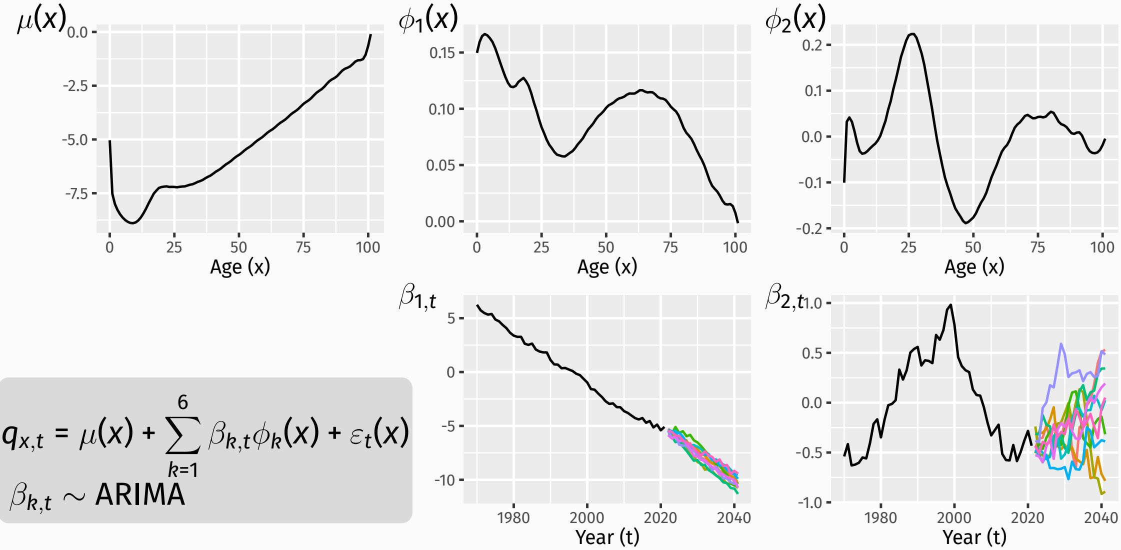

$$q_{x,t} = \mu(x) + \sum_{k=1}^{6} \beta_{k,t}\phi_k(x) + \varepsilon_t(x)$$

$$\beta_{k,t} \sim \text{ARIMA}$$

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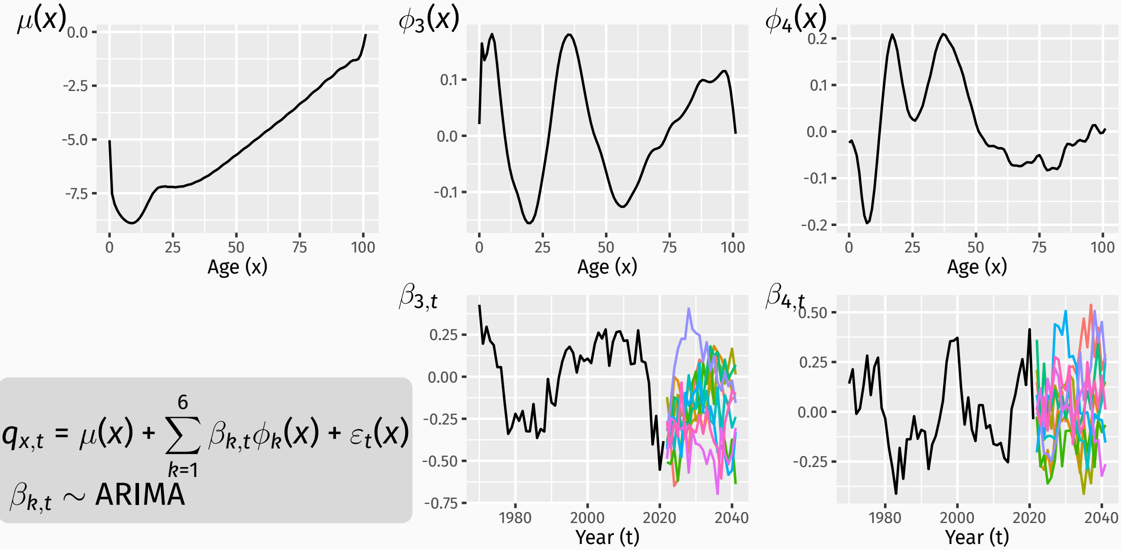

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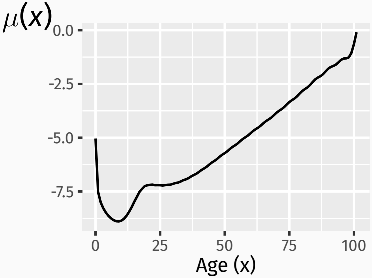

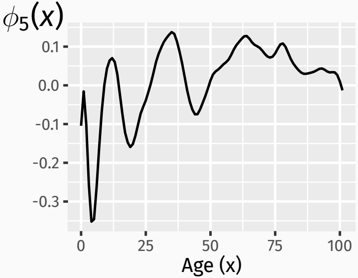

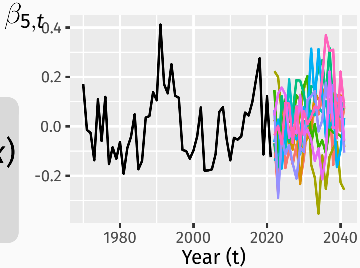

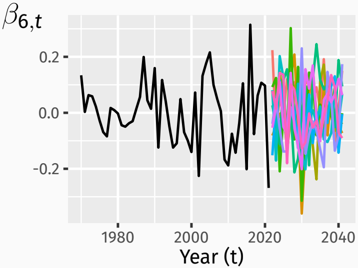

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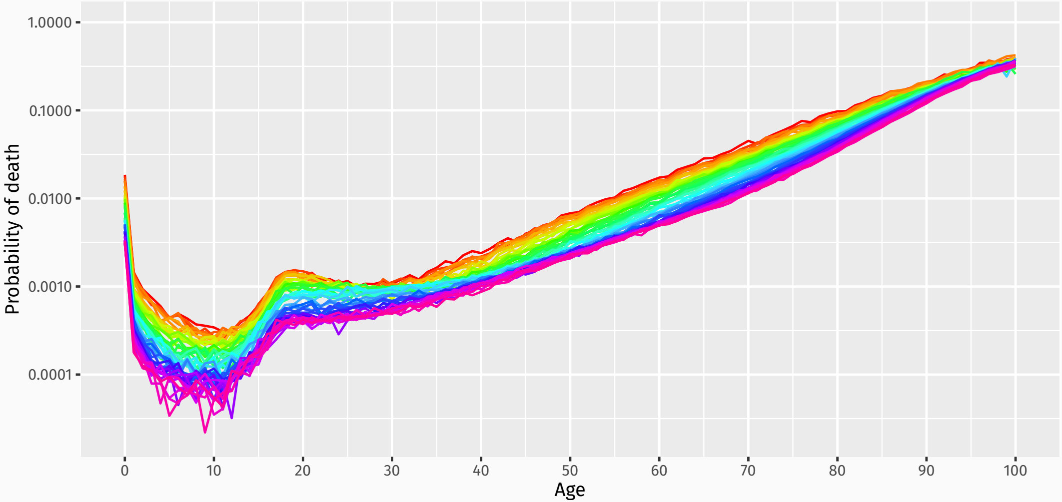
Probability of death for Australians (1971 – 2021)



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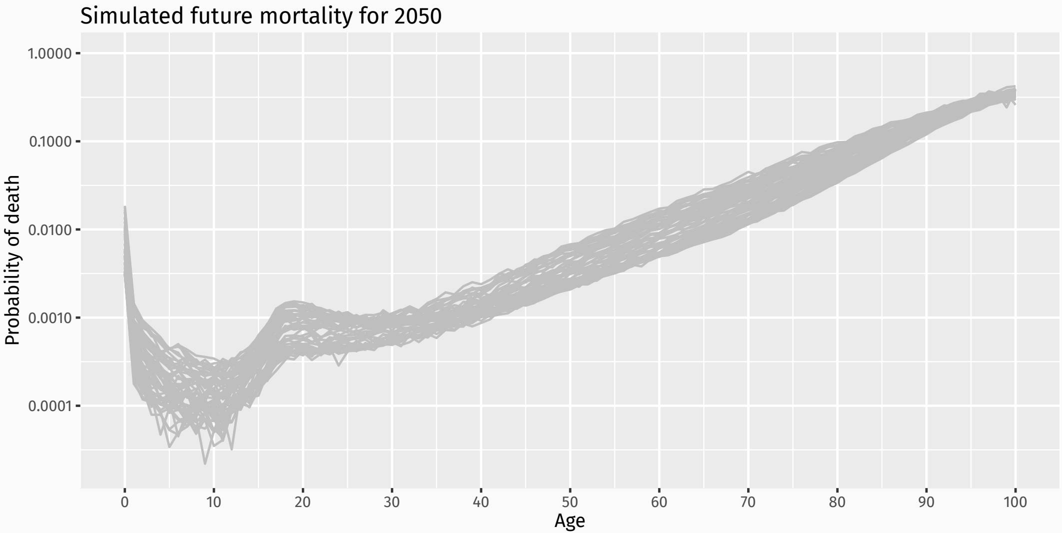

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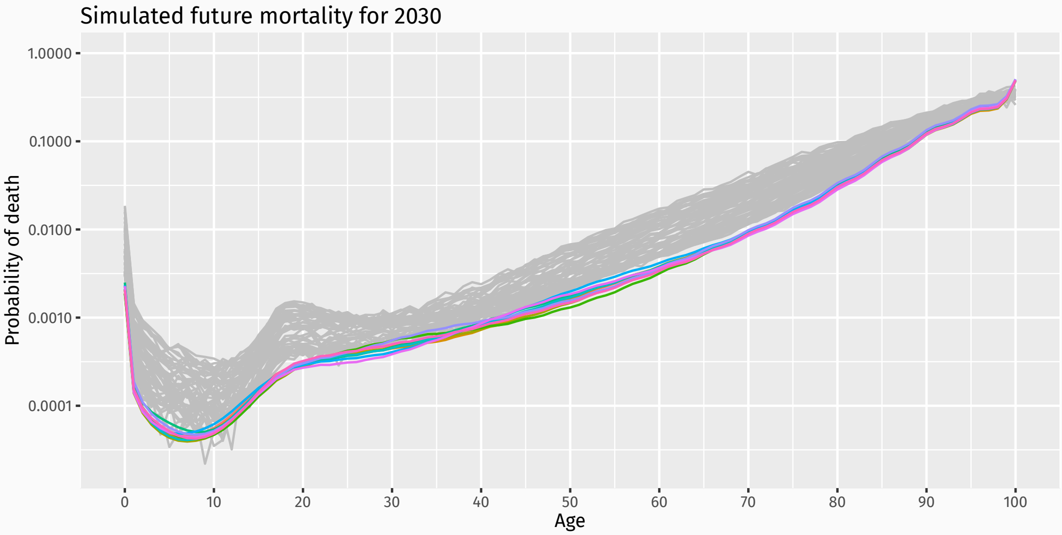

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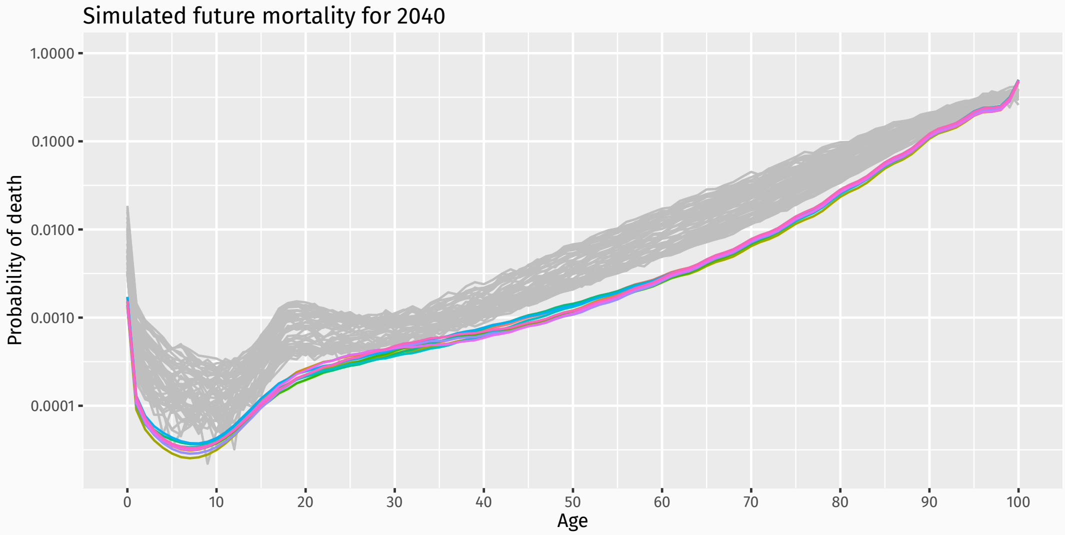

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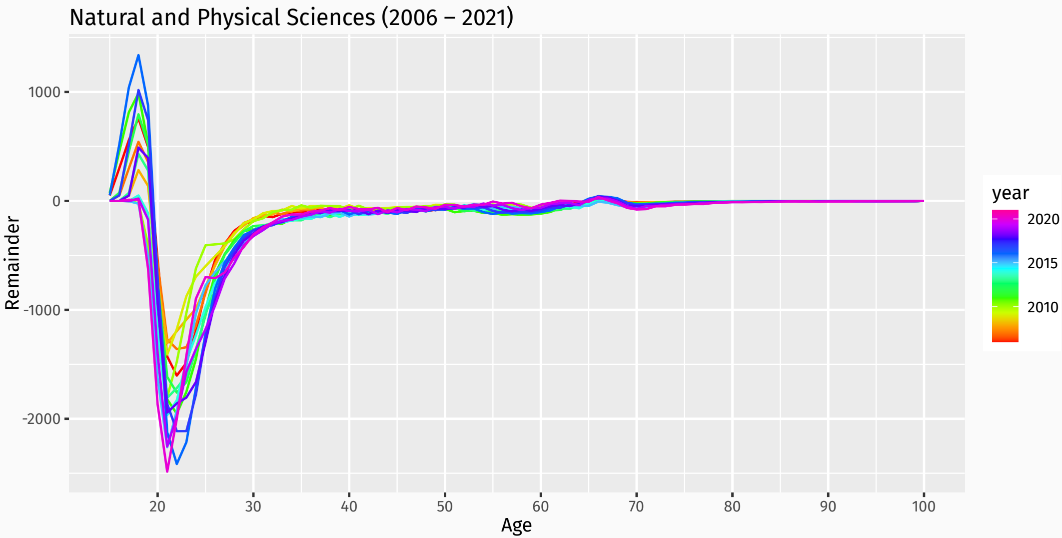

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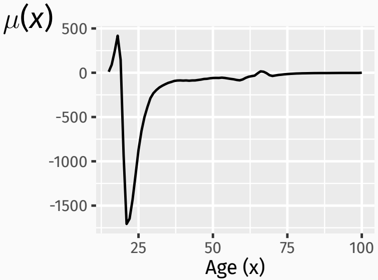

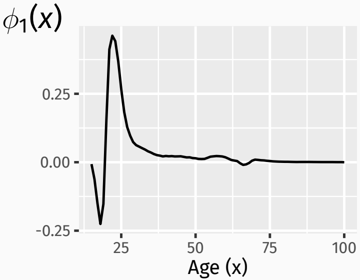

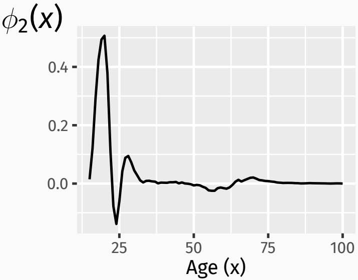

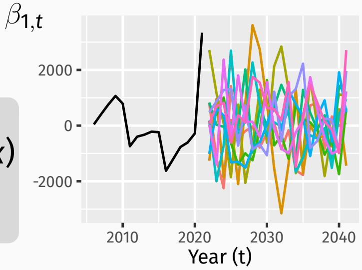

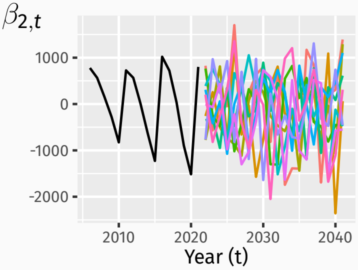

$$E_{x,t} = \mu(x) + \sum_{k=1}^{6} \beta_{k,t}\phi_k(x) + \varepsilon_t(x)$$

$$\beta_{k,t} \sim \text{ARIMA}$$

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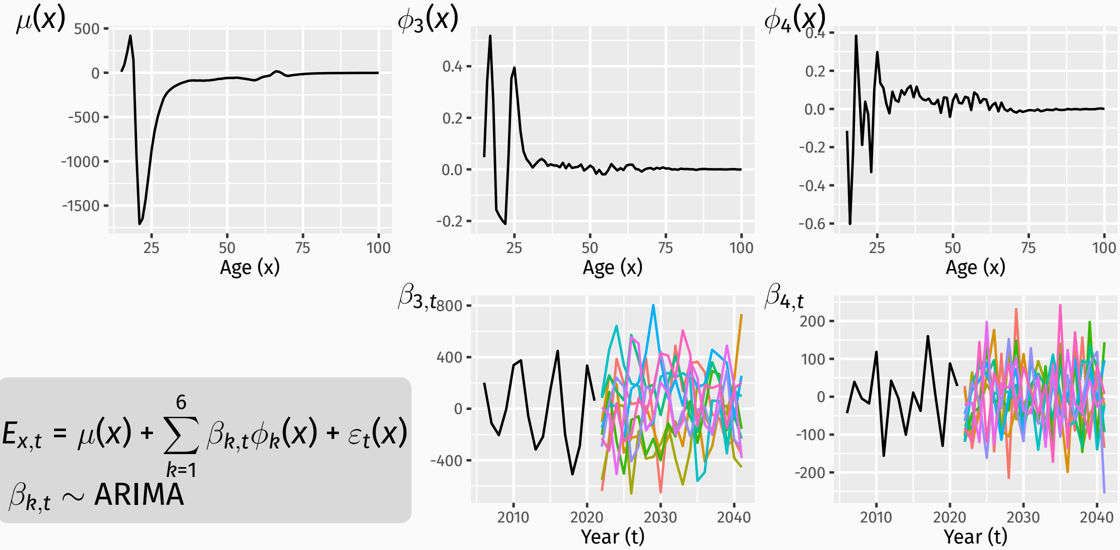

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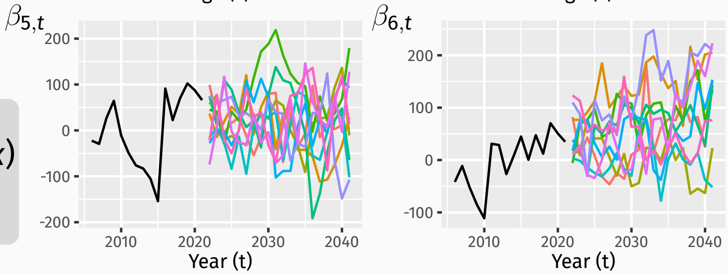

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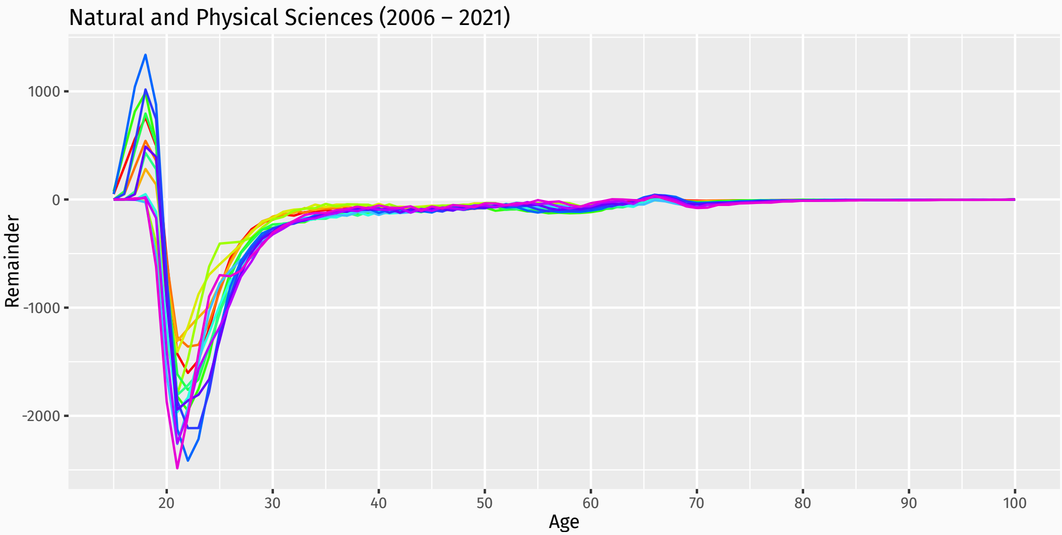

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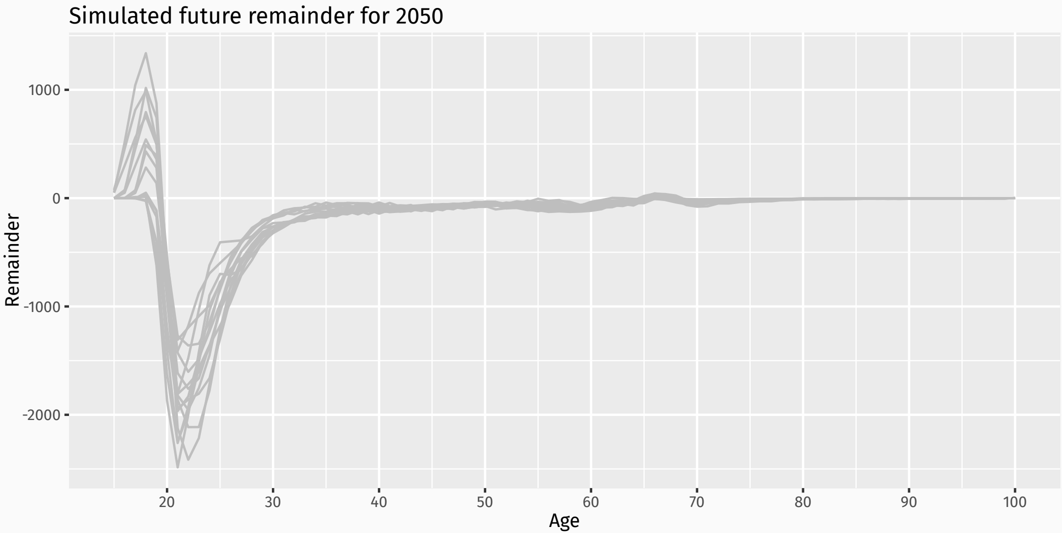

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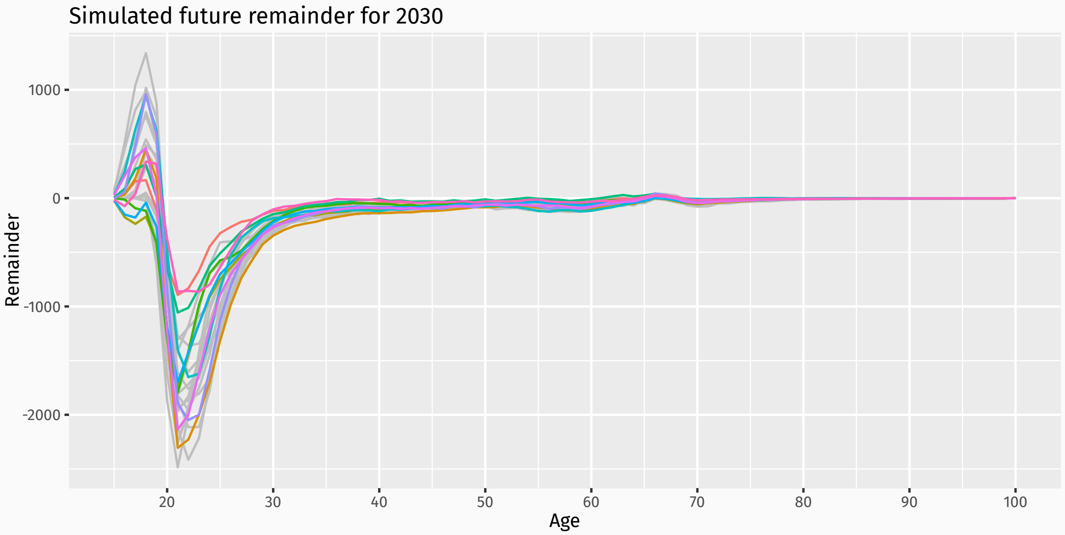

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