MONASH University

MONASH BUSINESS SCHOOL

Forecasting the age structure of the scientific workforce in Australia

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Australian Academy of Science

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

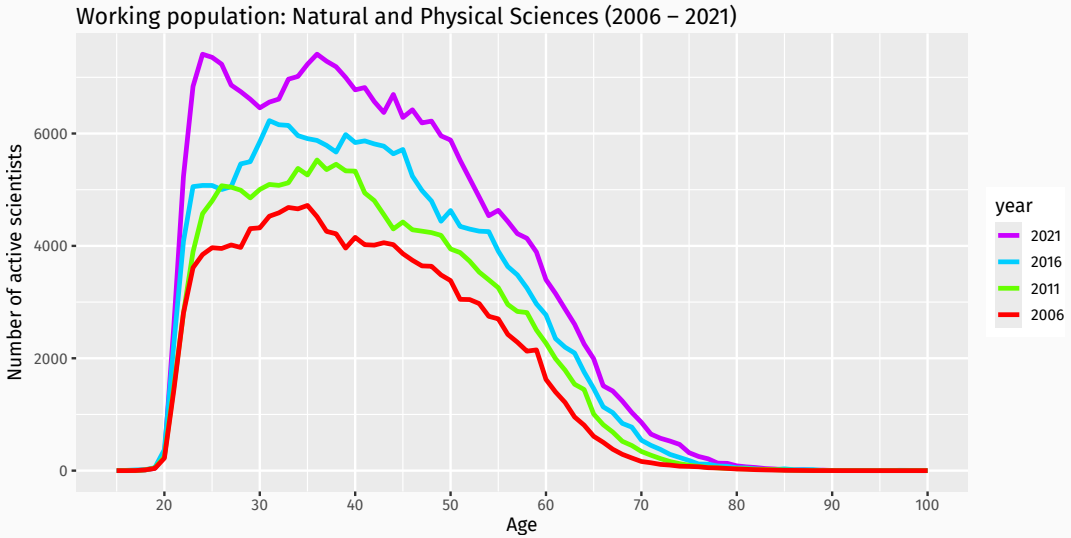
$$P_{x+1,t+1} = P_{x,t}(1 - q_{x,t} - r_x) + g_x G_t + E_{x,t}$$

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: $P_{x,t}$

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



Working population: $P_{x,t}$

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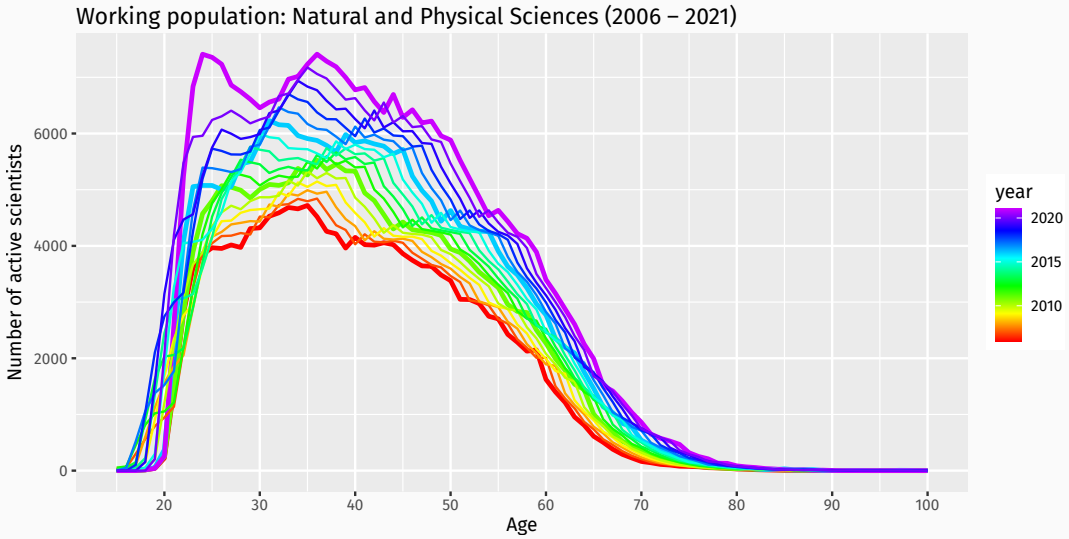
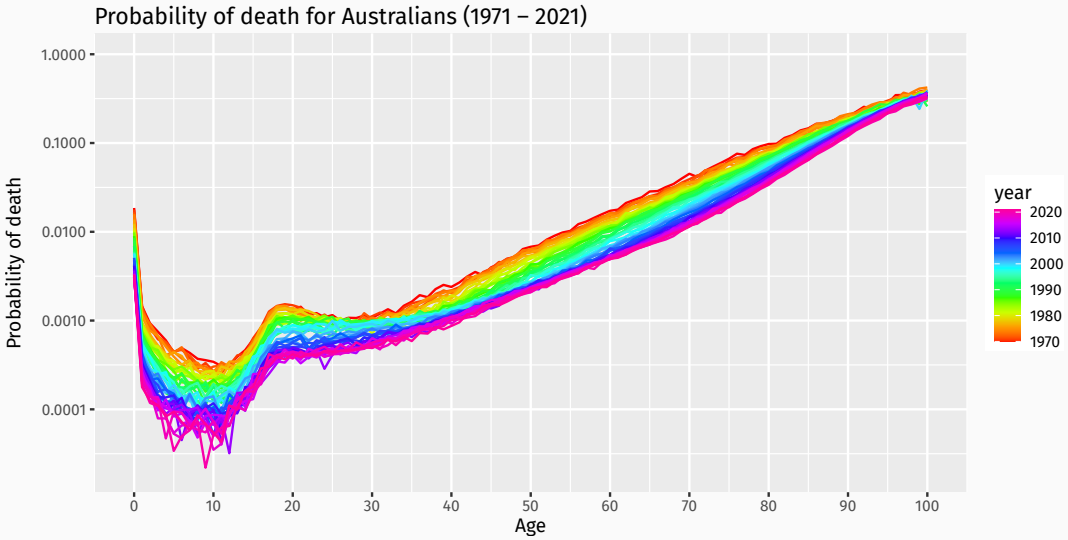


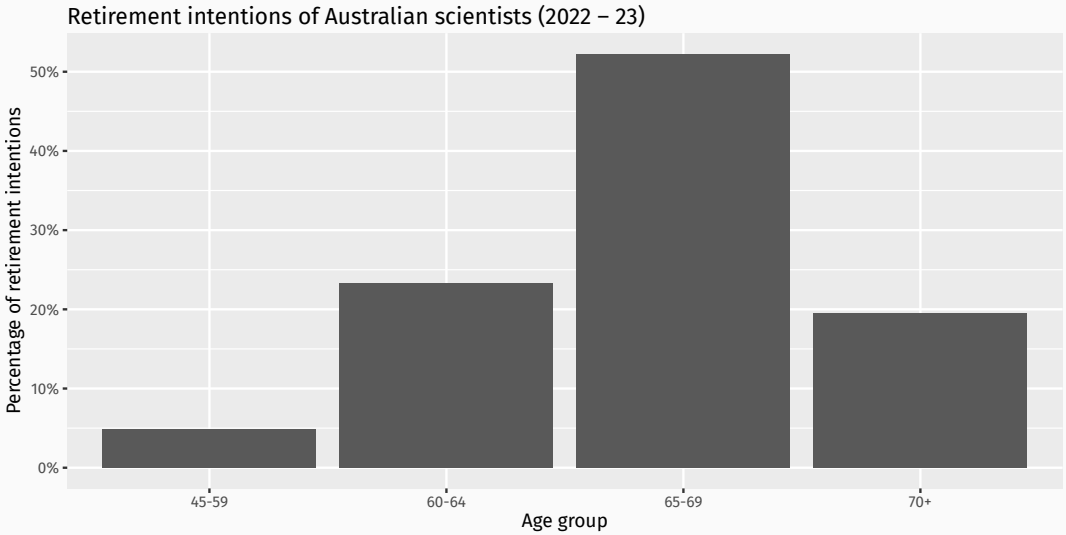
Death probability: $q_{x,t}$

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



Retirement rates: r_x

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



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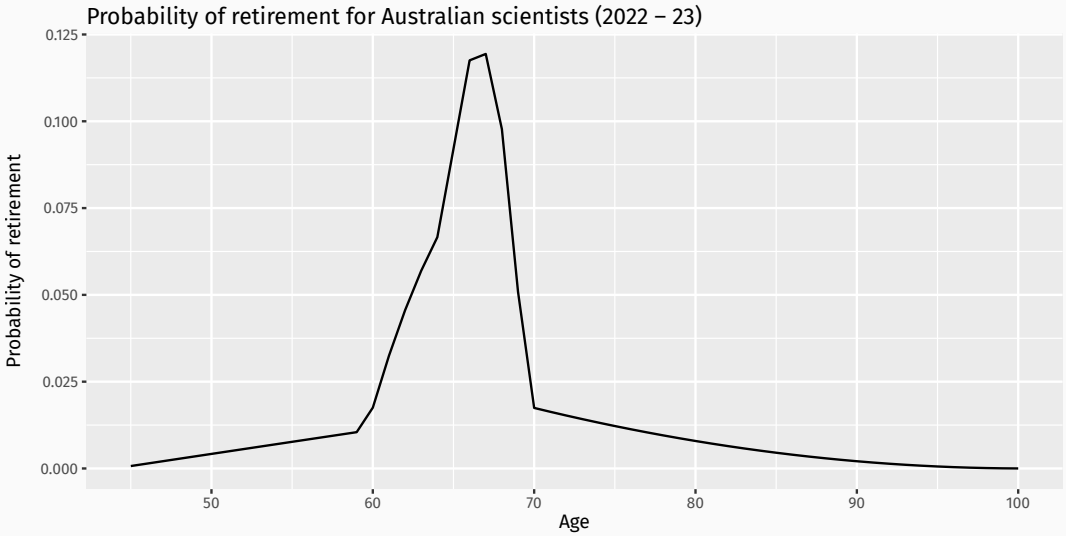
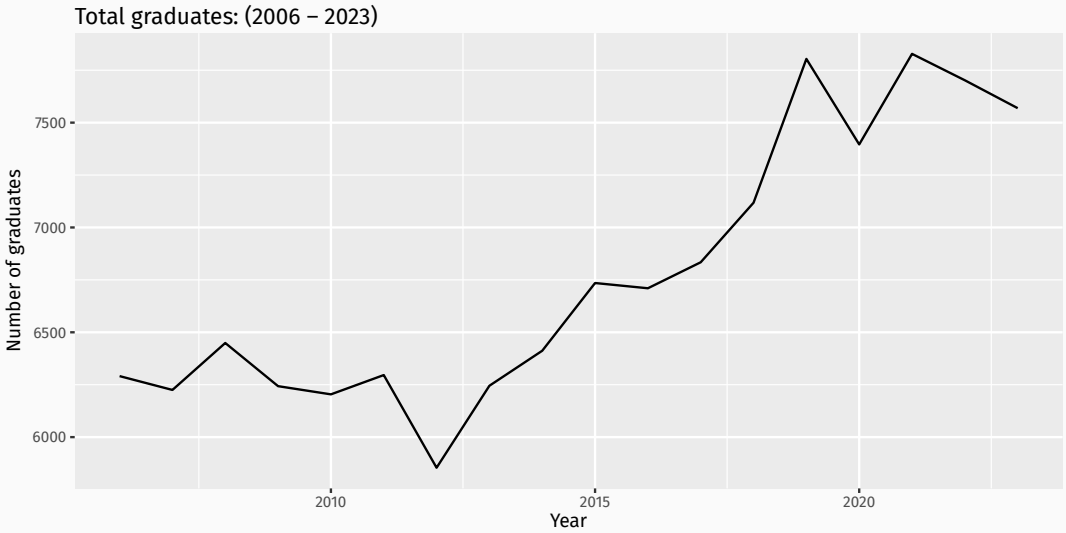


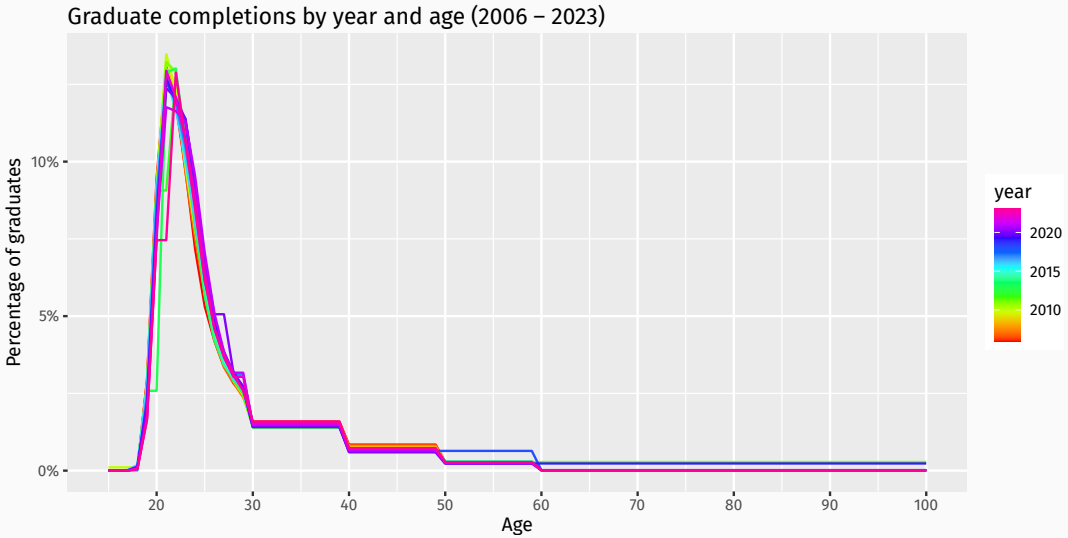
Graduate completions: G_t

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



Graduate completions: g_x

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



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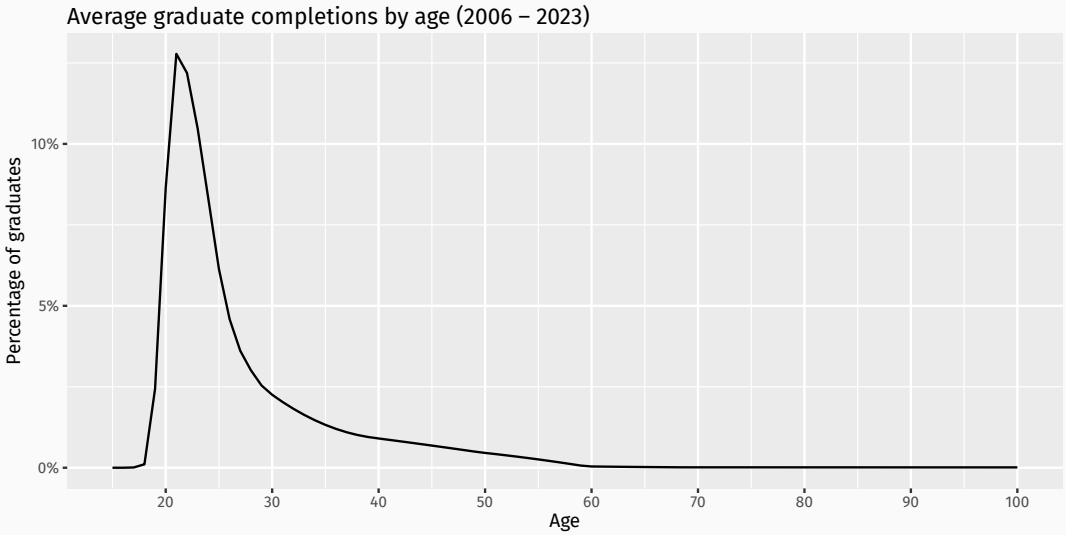

Remainder: $E_{x,t}$

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

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

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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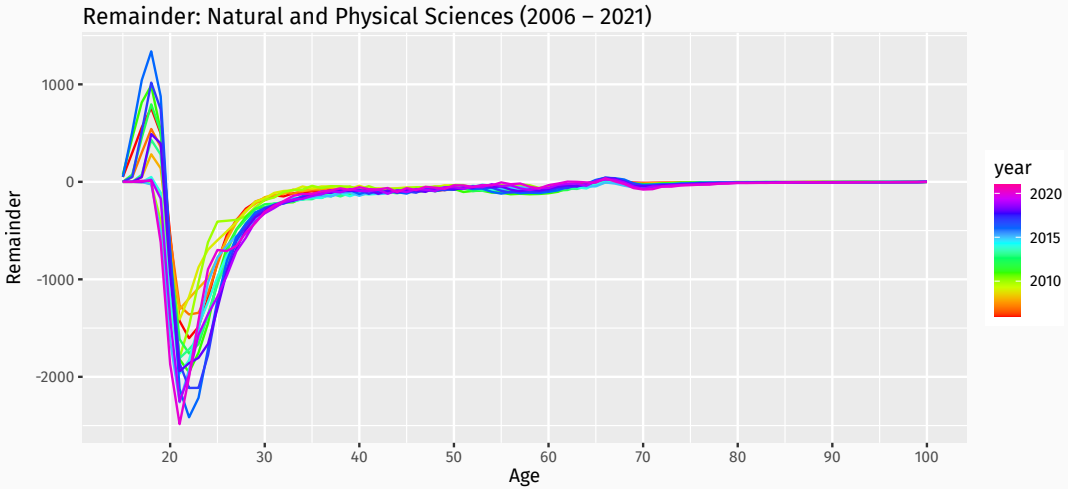


Forecasting models

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

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

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

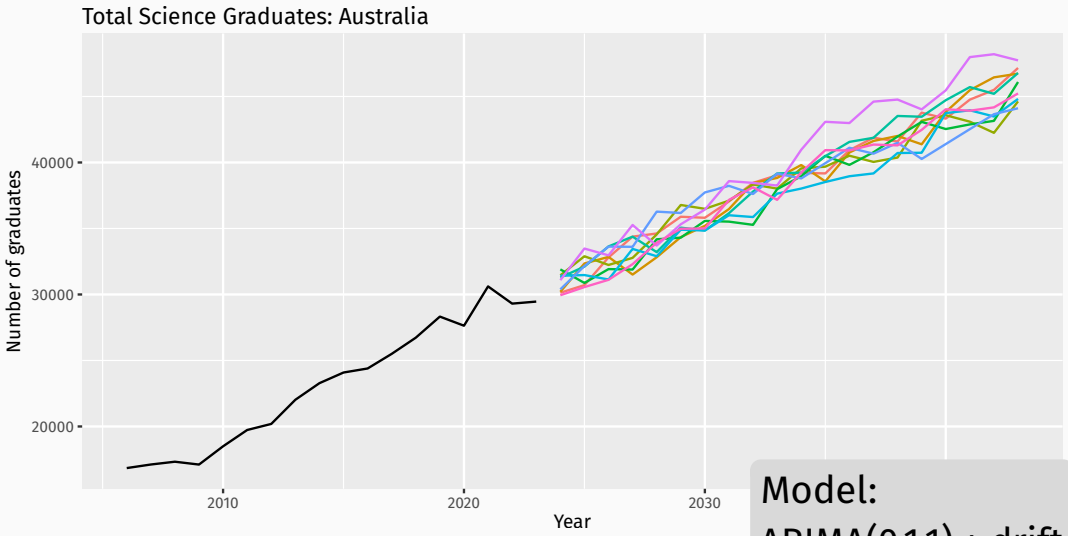
$q_{x,t}$ functional time series model

$E_{x,t}$ functional time series model

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

Forecasting models: G_t

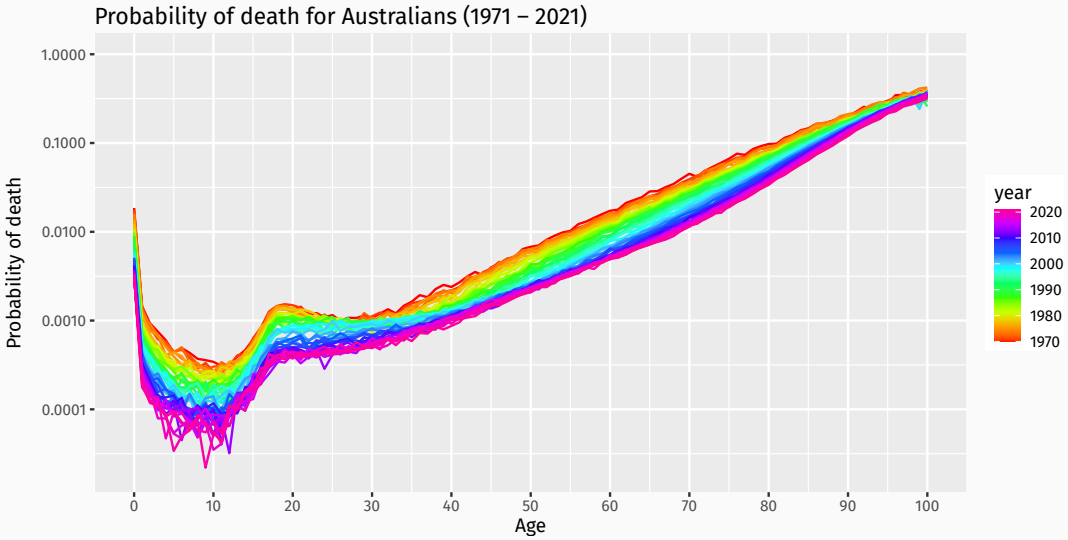
$$P_{x+1,t+1} = P_{x,t}(1 - q_{x,t} - r_x) + g_x G_t + E_{x,t}$$



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

Forecasting models: $q_{x,t}$

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



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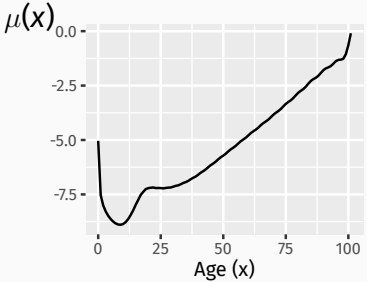
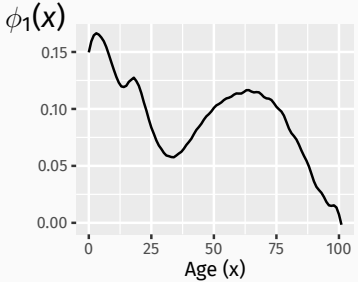
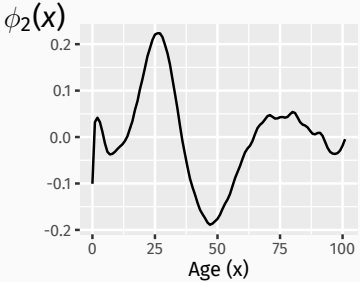
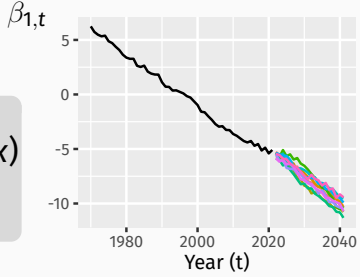


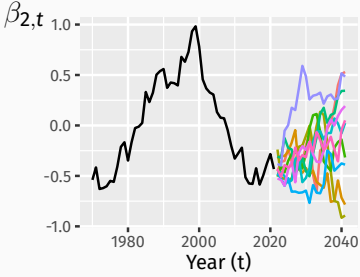




$$q_{x,t} = \mu(x) + \sum_{k=1}^{6} \beta_{k,t}\phi_k(x) + \varepsilon_t(x)$$

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





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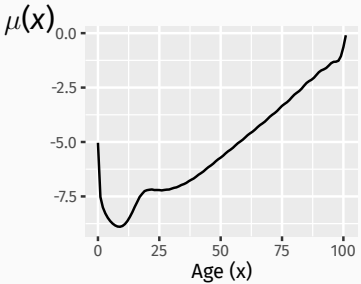

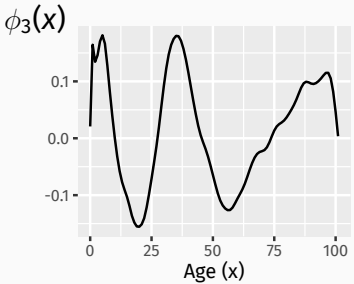

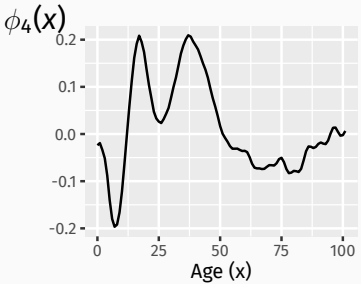

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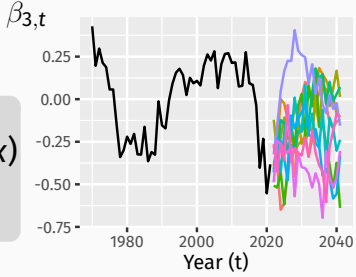

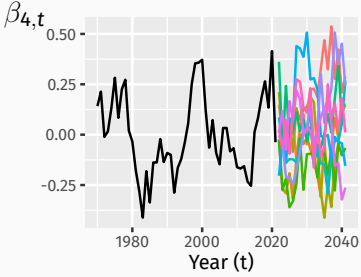

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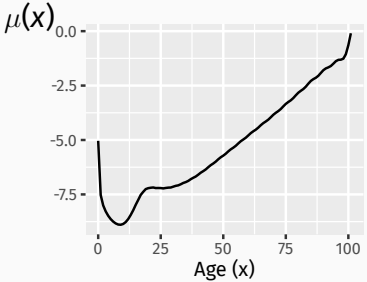

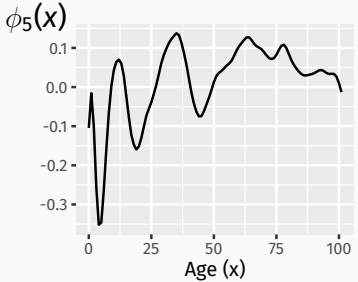

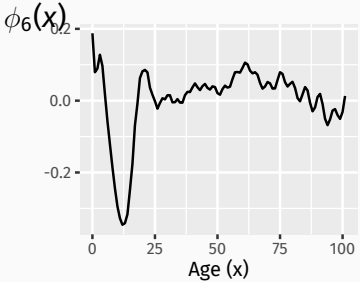

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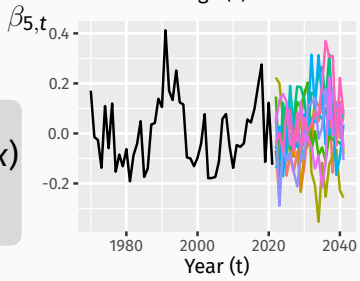

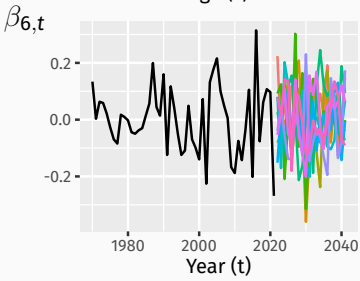

Forecasting models: $q_{x,t}$

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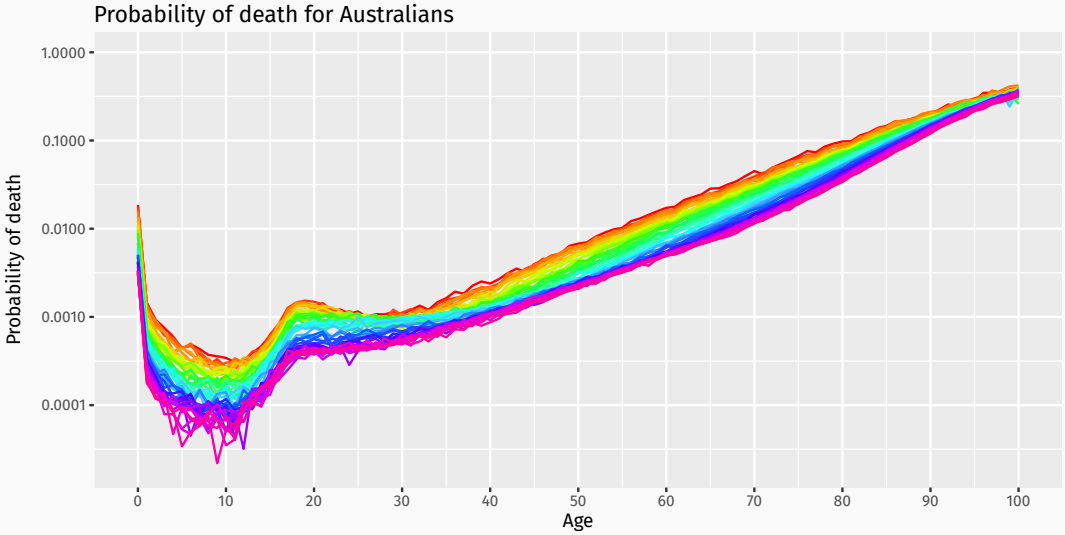

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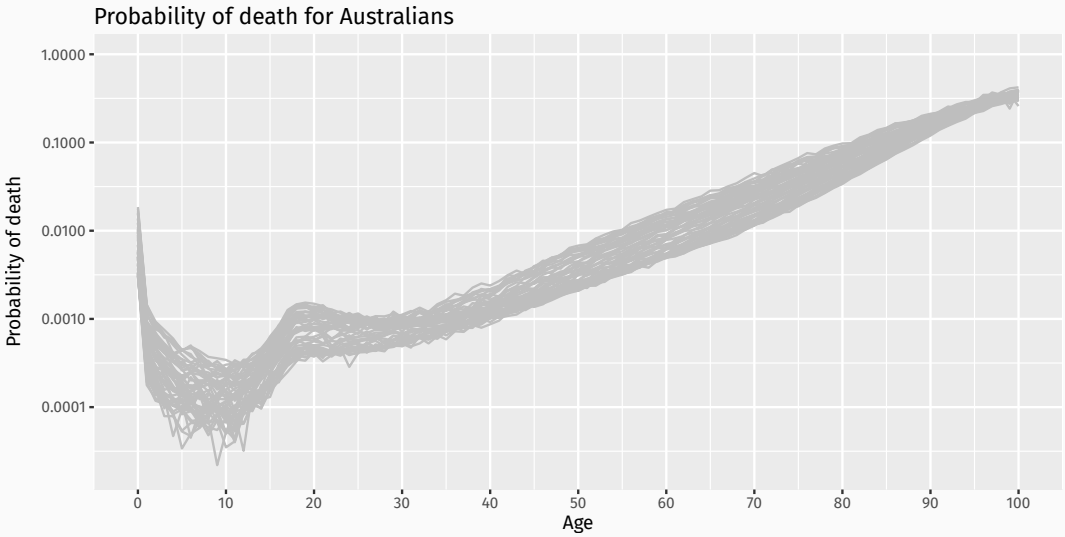

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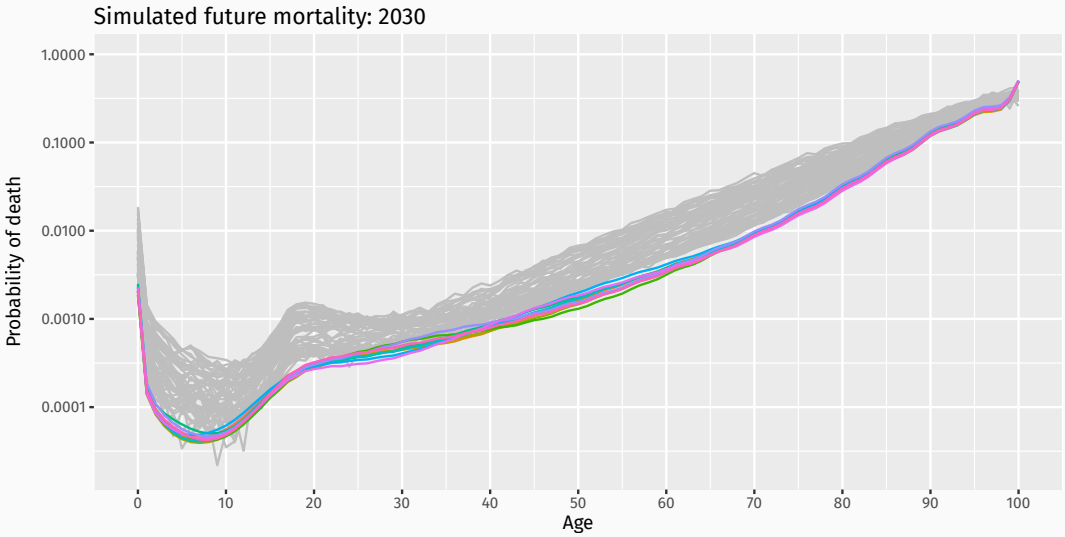

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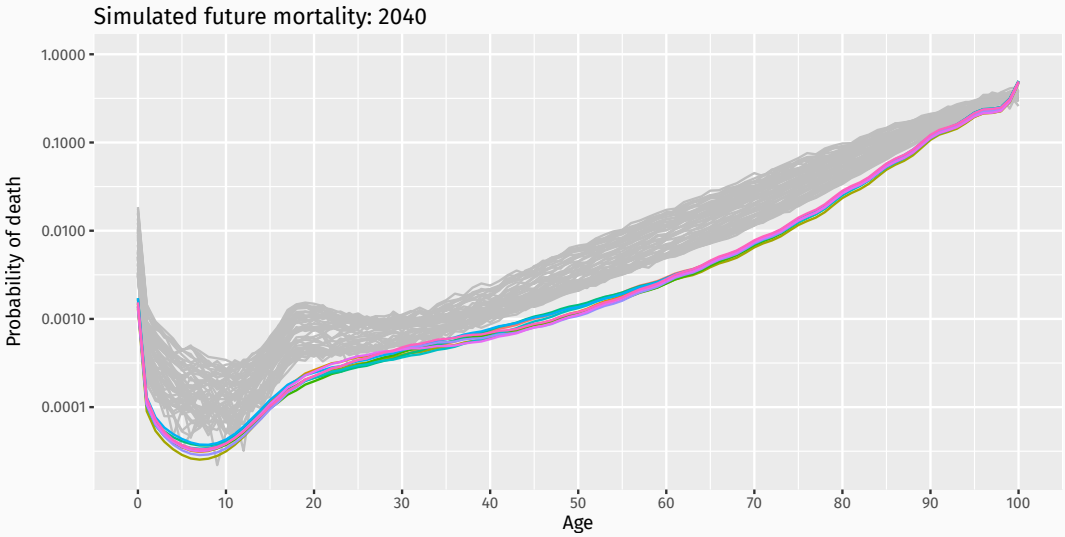

Remainder: $E_{x,t}$

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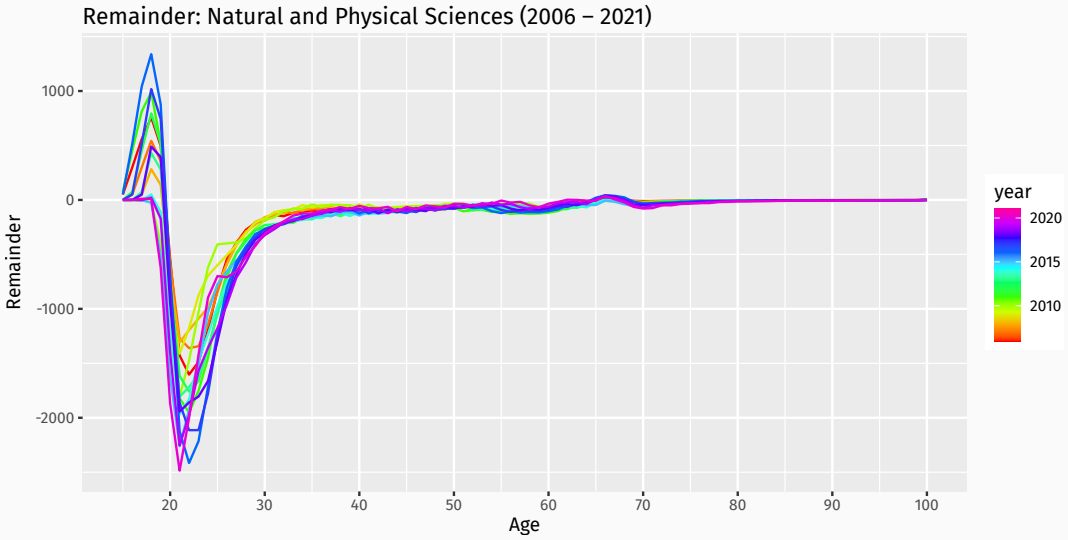

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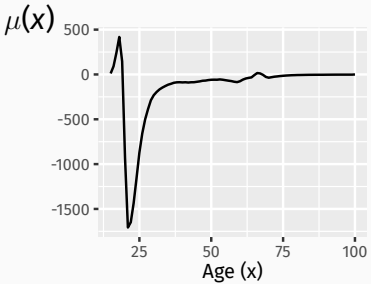

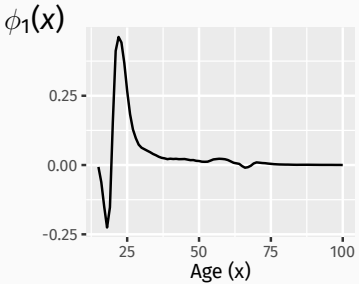

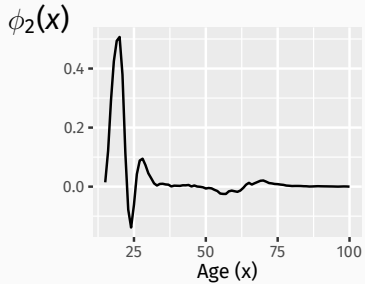

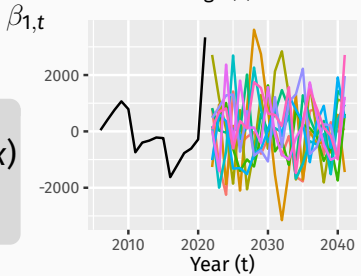

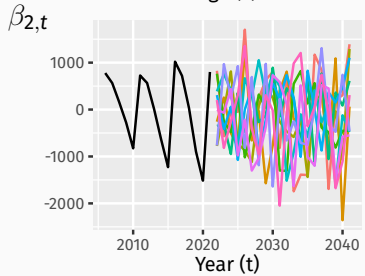

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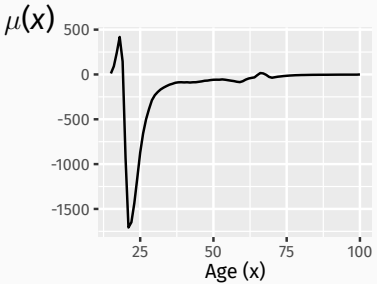
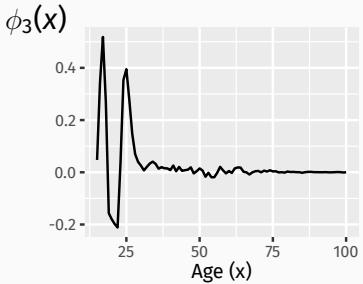
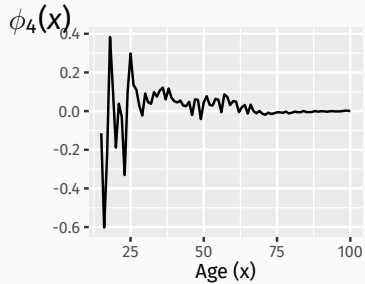
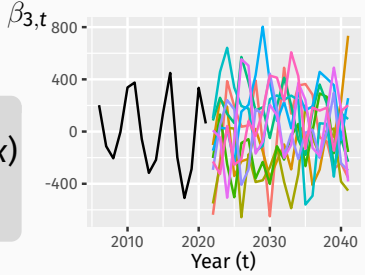
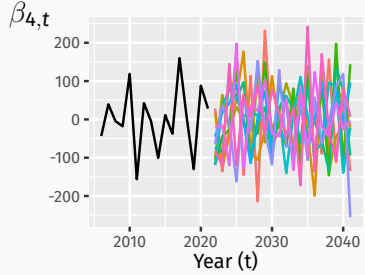








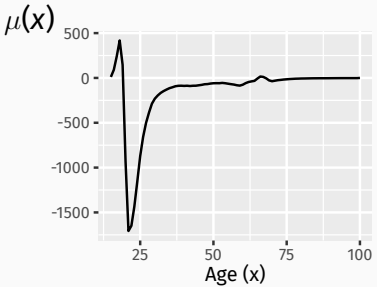


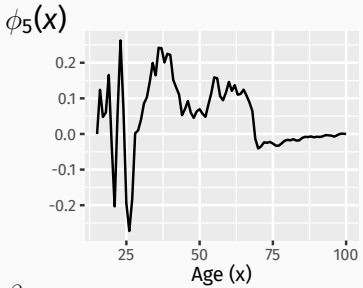
$$E_{x,t} = \mu(x) + \sum_{k=1}^{6} \beta_{k,t}\phi_k(x) + \varepsilon_t(x)$$

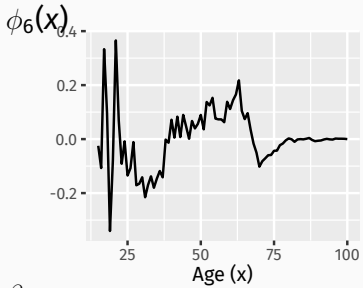
$$\beta_{k,t} \sim \text{ARIMA}$$

Forecasting models: $E_{x,t}$

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







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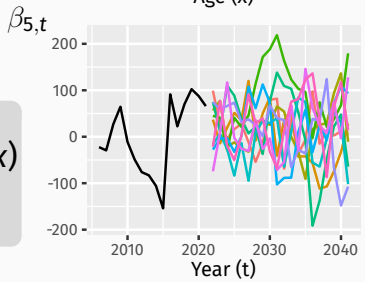
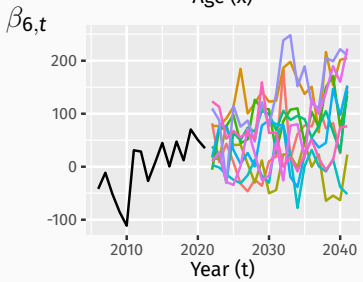
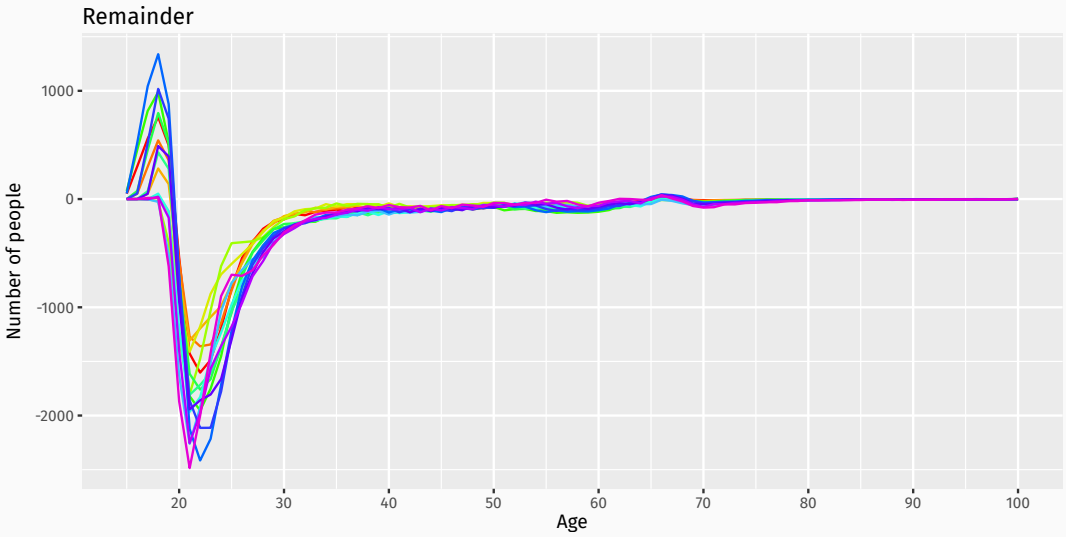




Forecasting models: $E_{x,t}$

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



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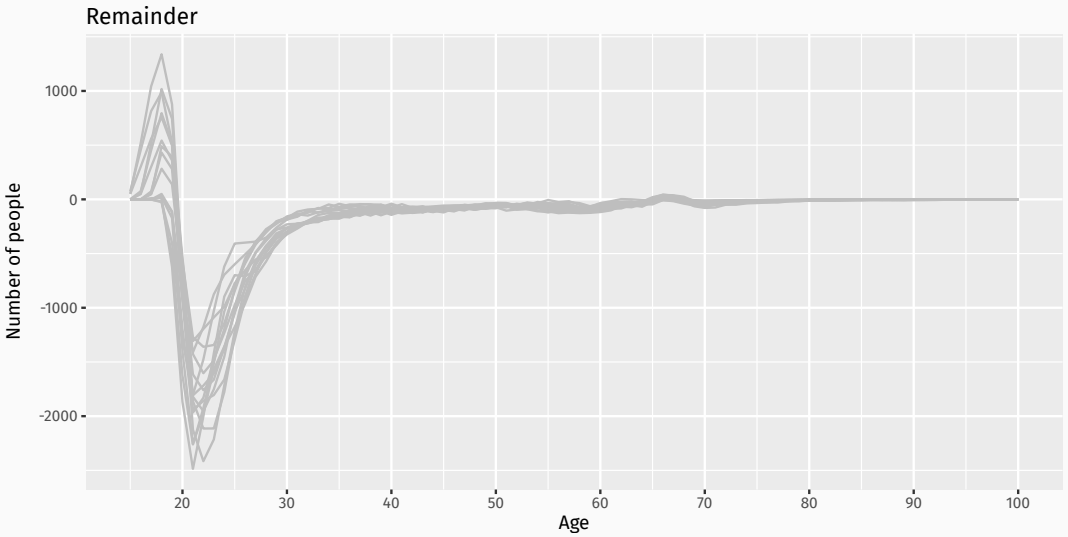

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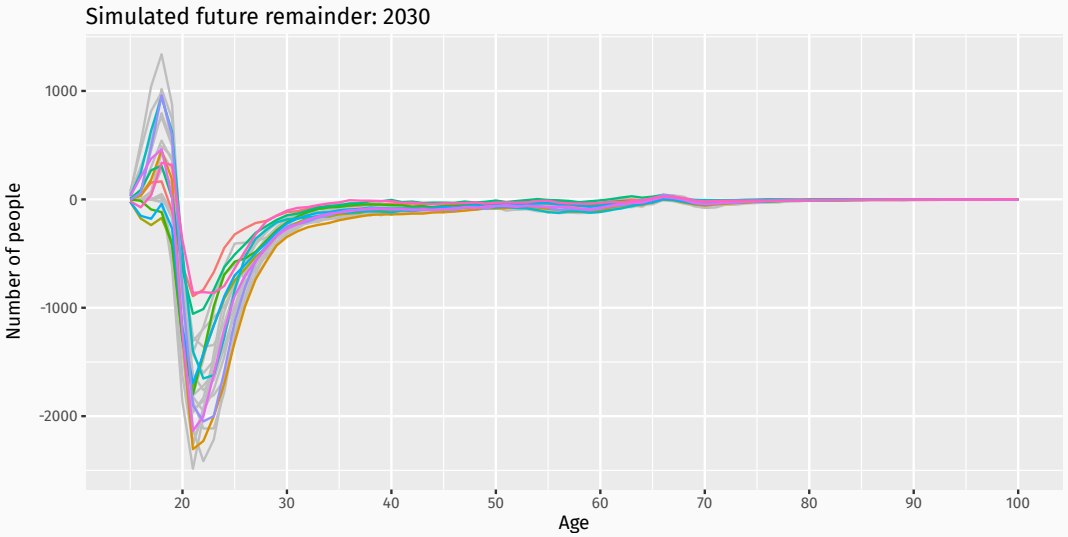

Forecasting models: $E_{x,t}$

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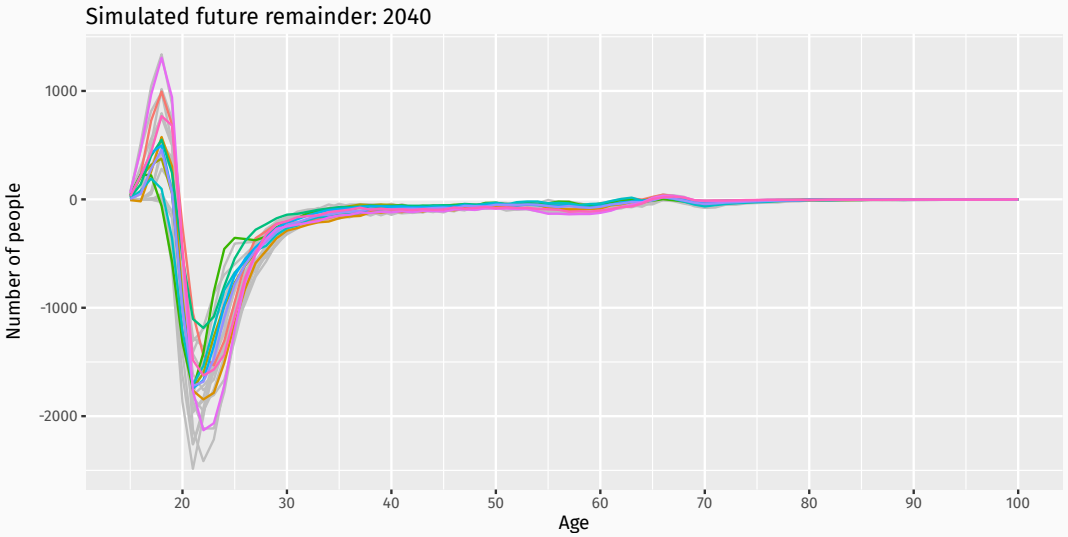
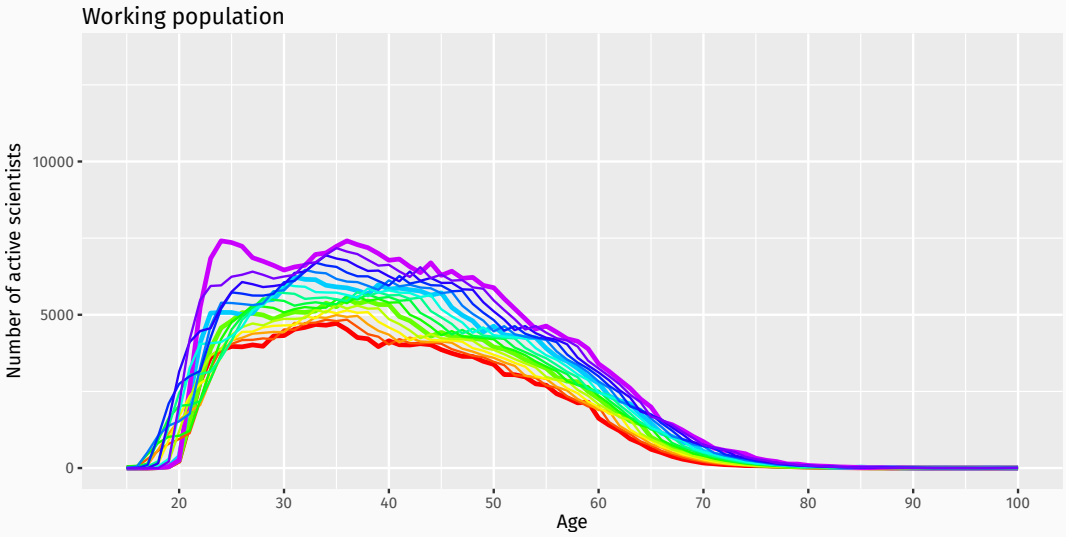


Final forecasts: $P_{x,t}$

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



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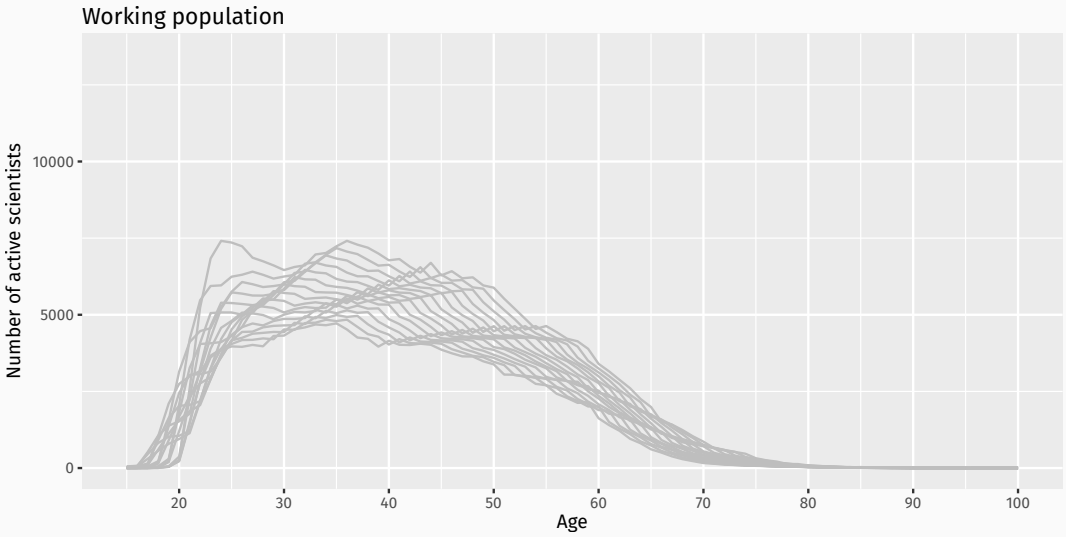

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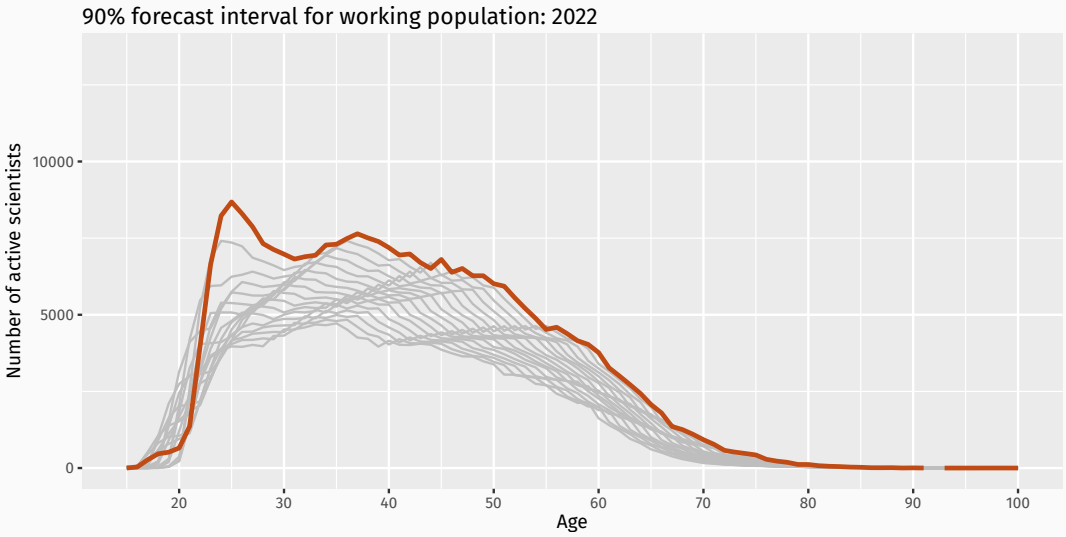

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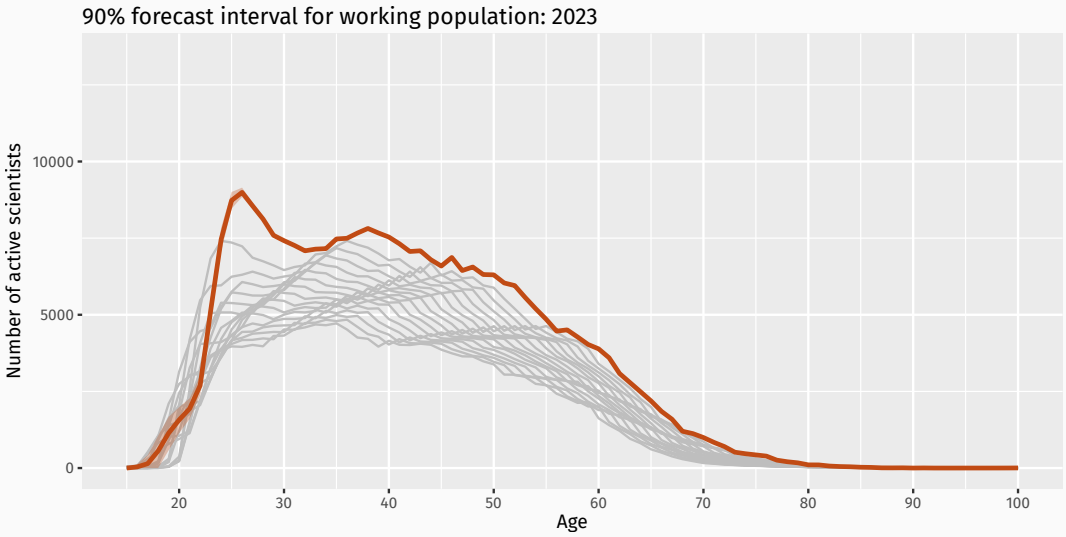

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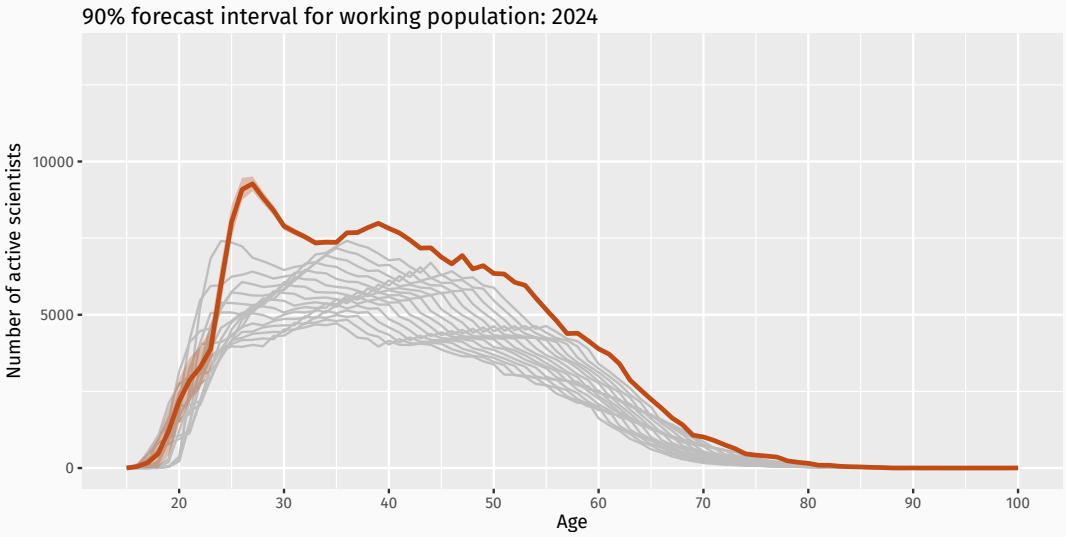

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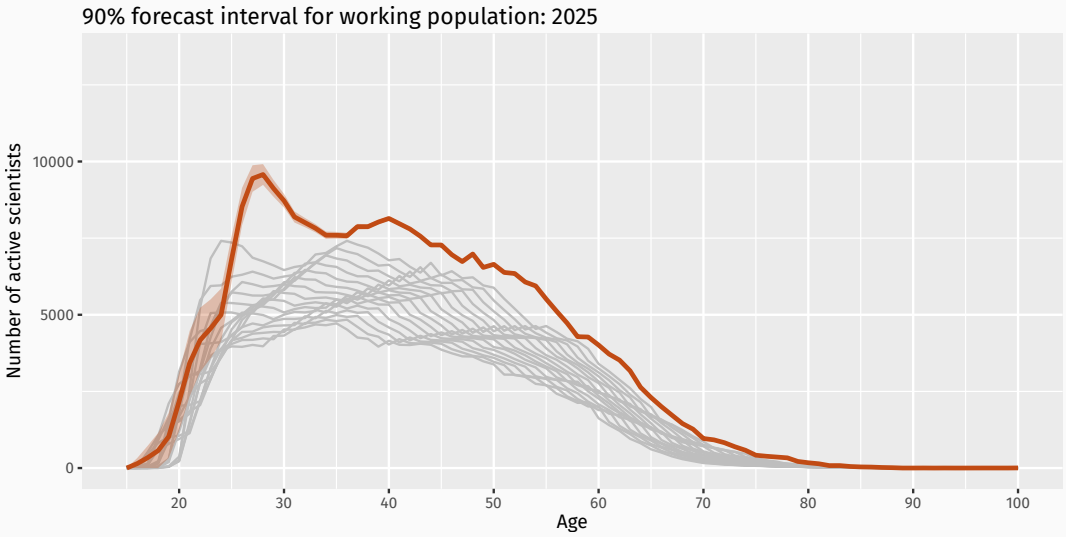

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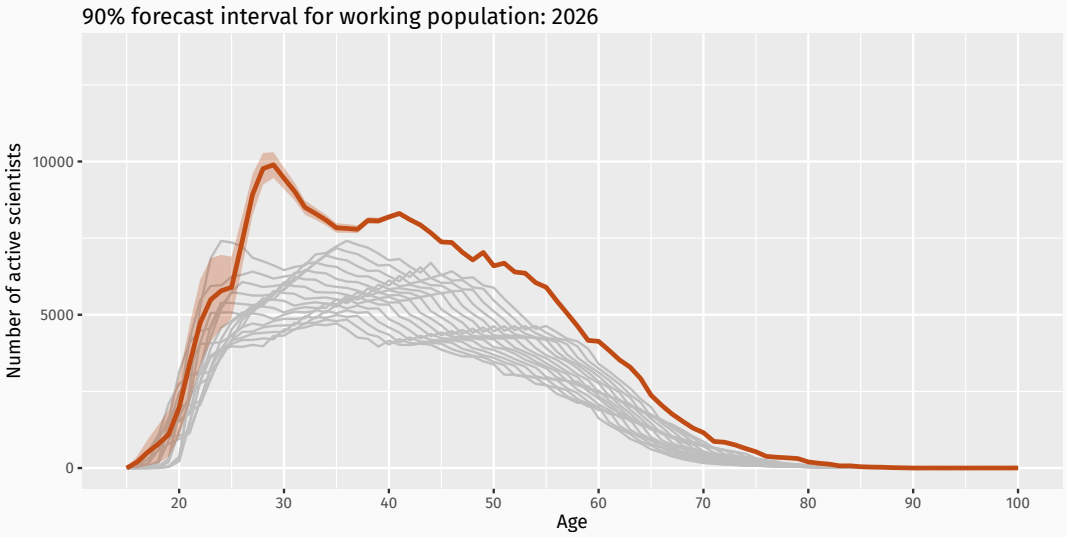

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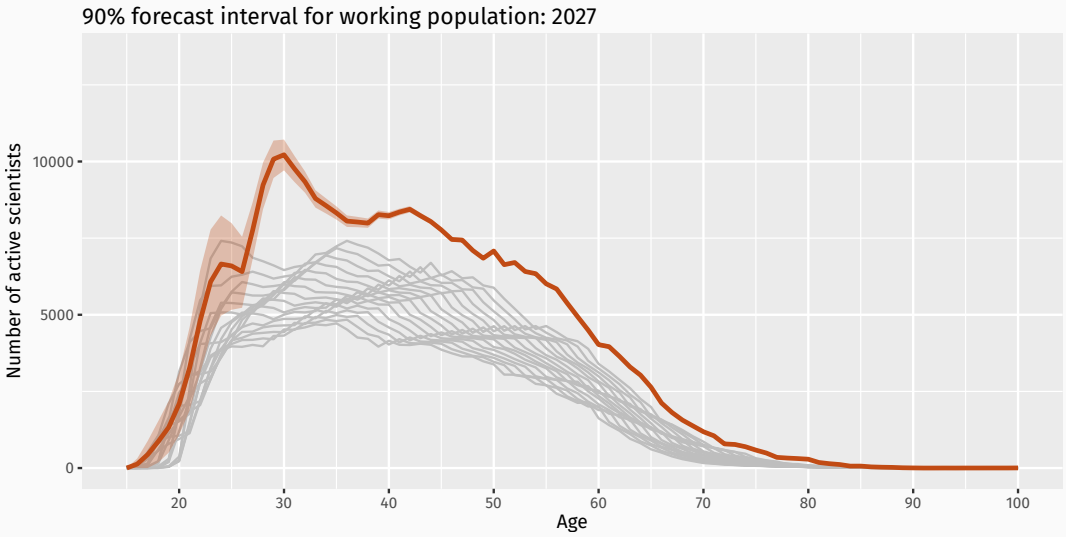

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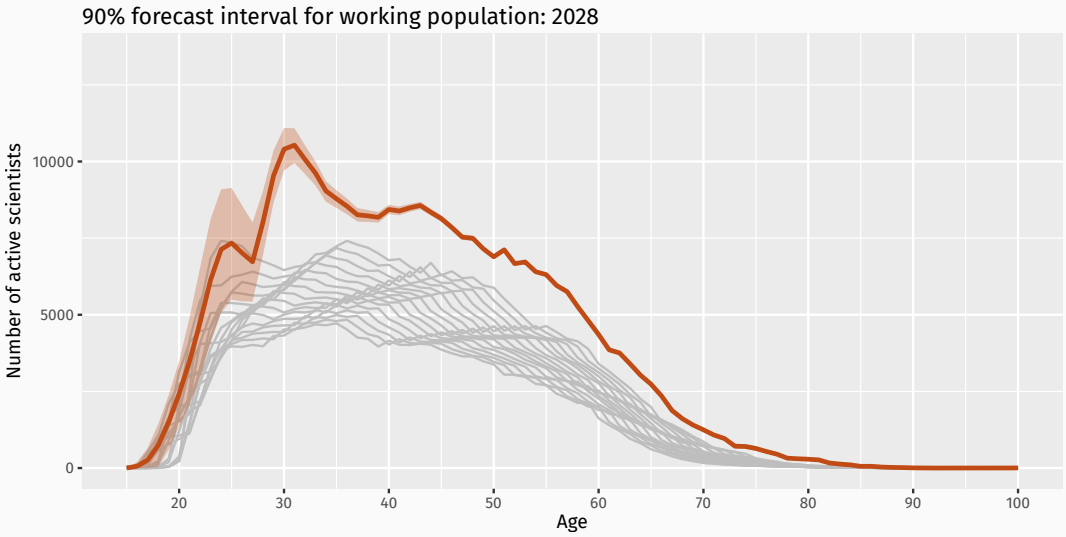

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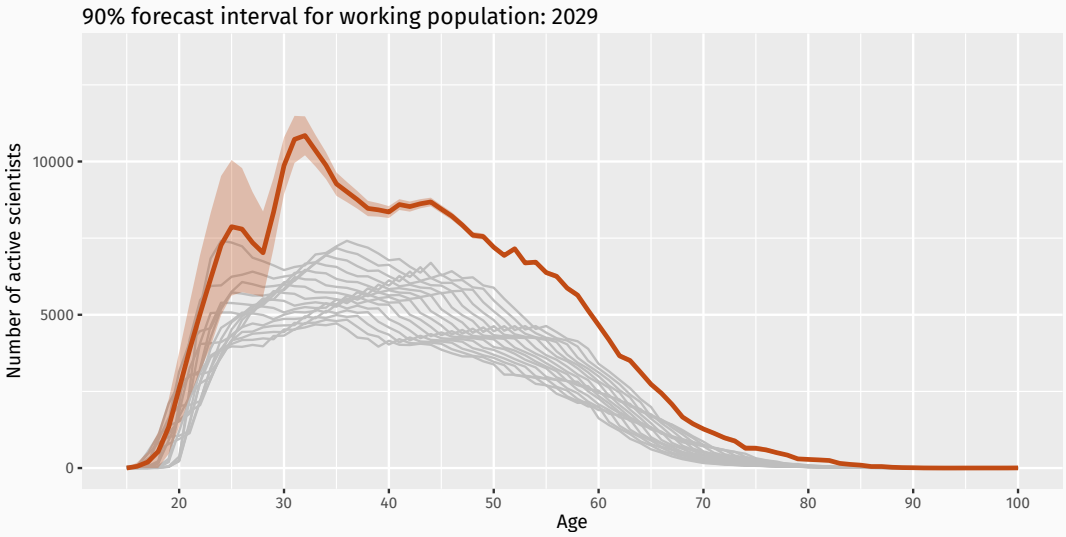

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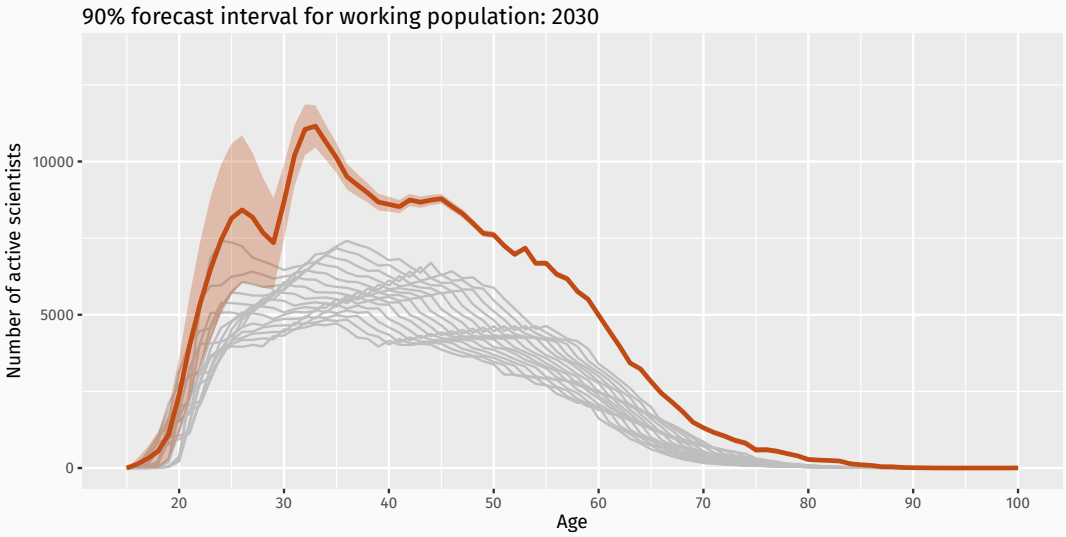

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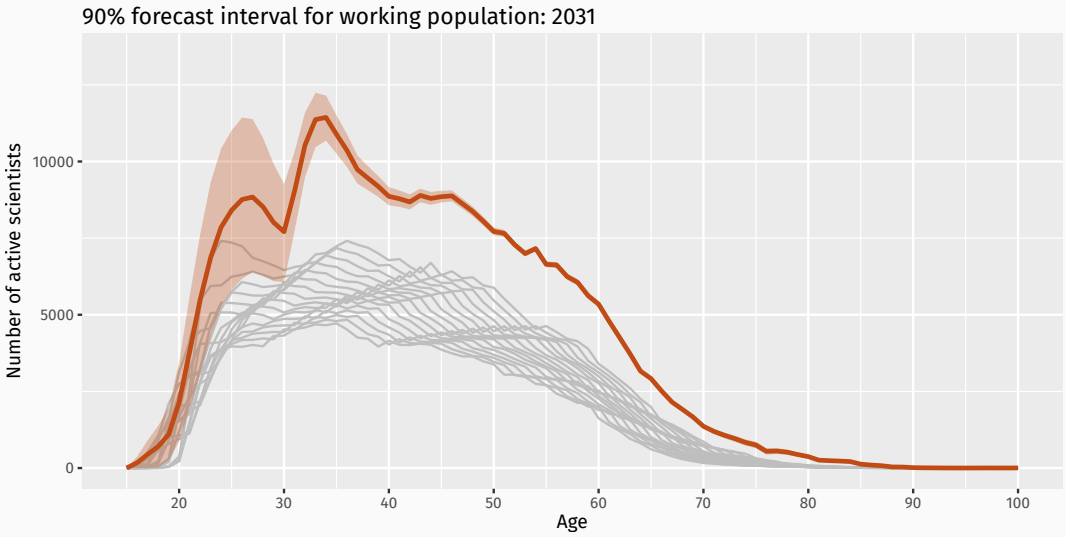

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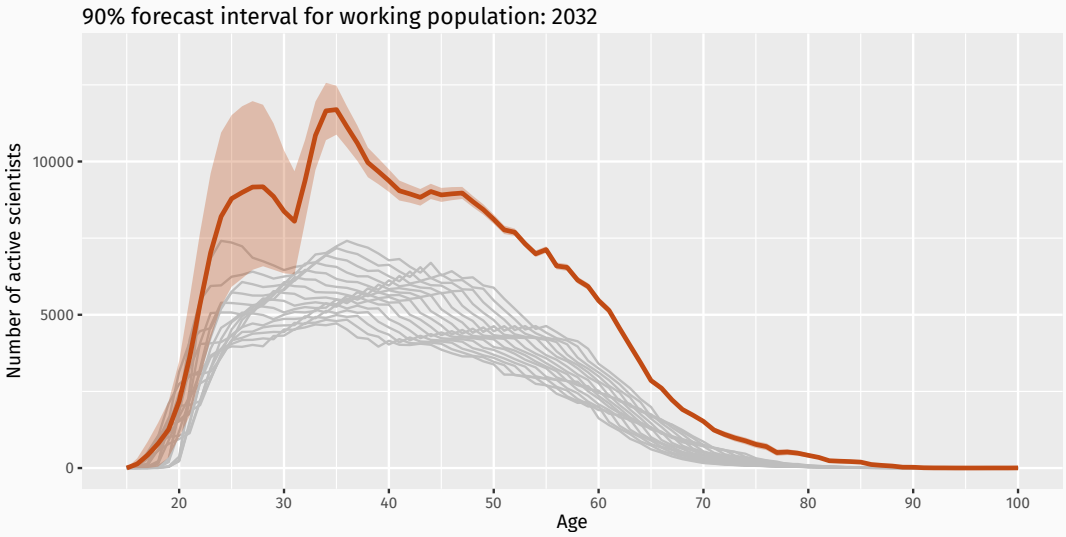

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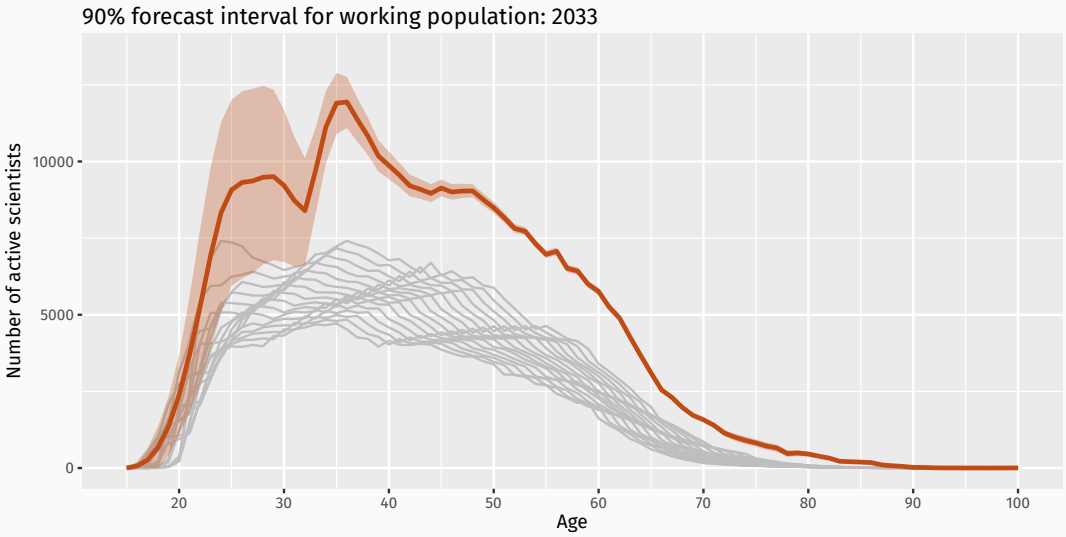

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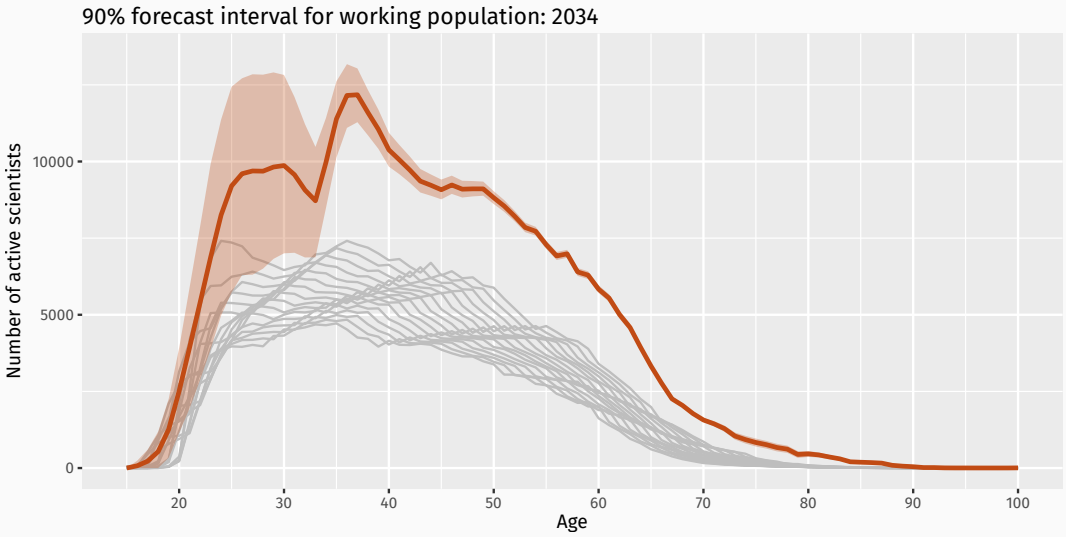

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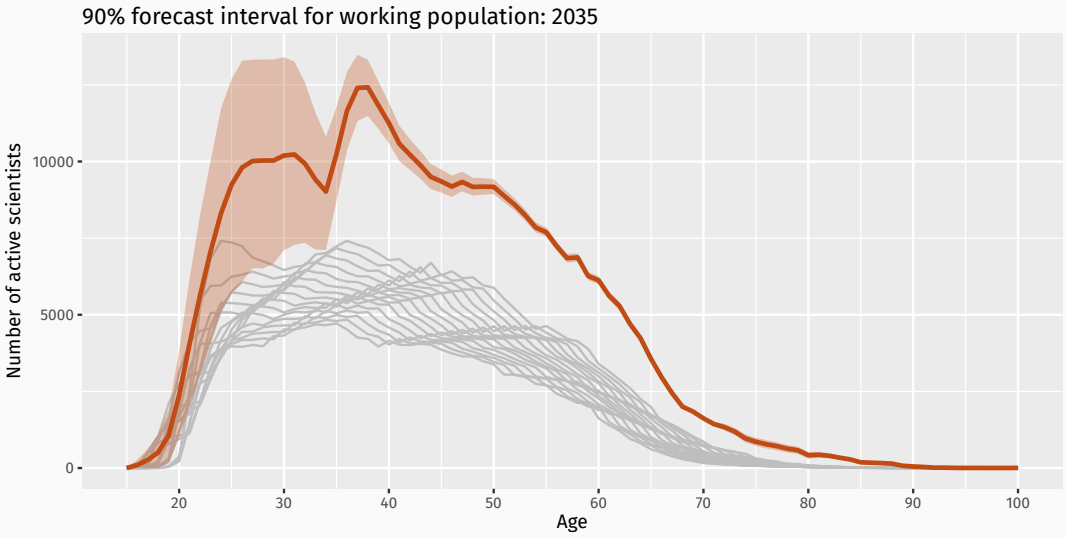
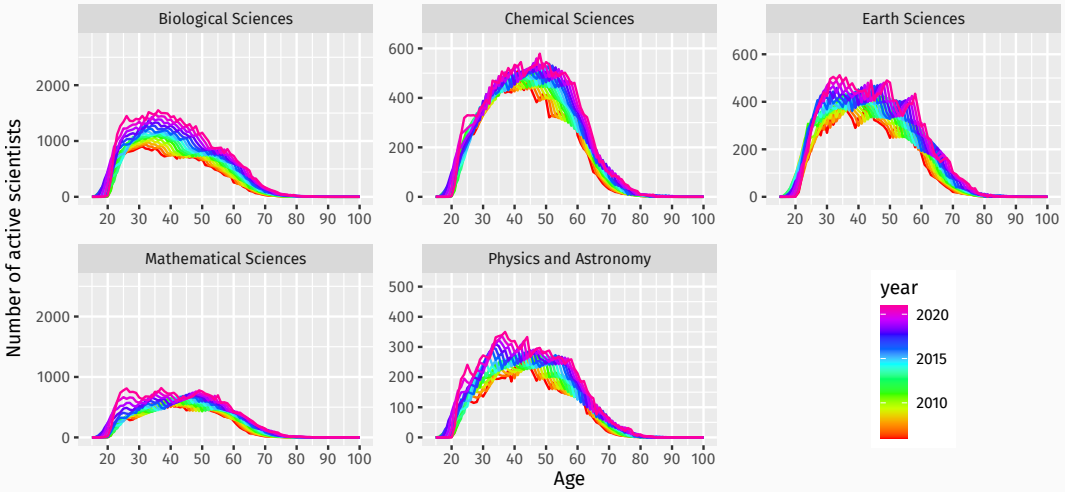


Population by discipline

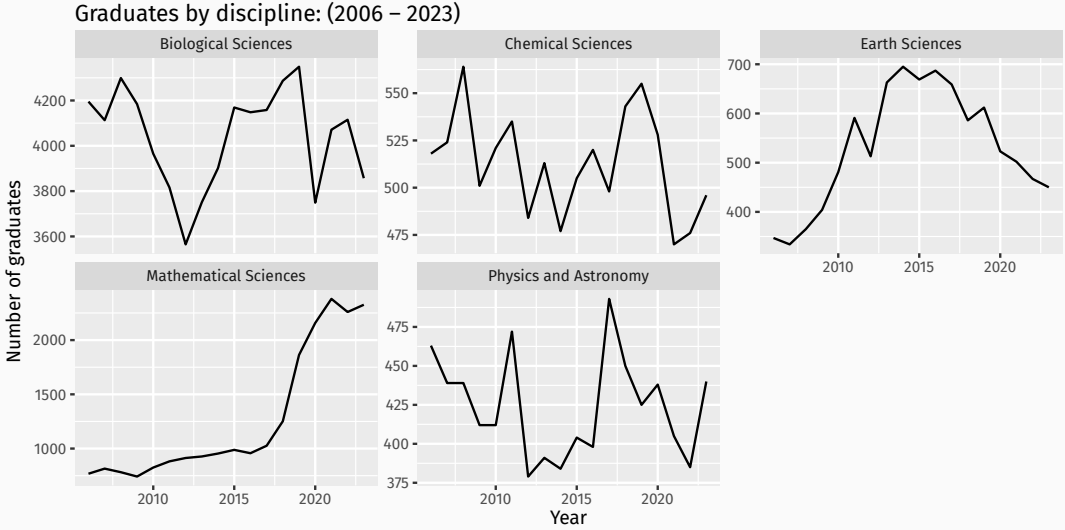
$$P_{x+1,t+1,i} = P_{x,t,i}(1 - q_{x,t} - r_x) + g_x G_{t,i} + E_{x,t,i}$$

Working population by discipline



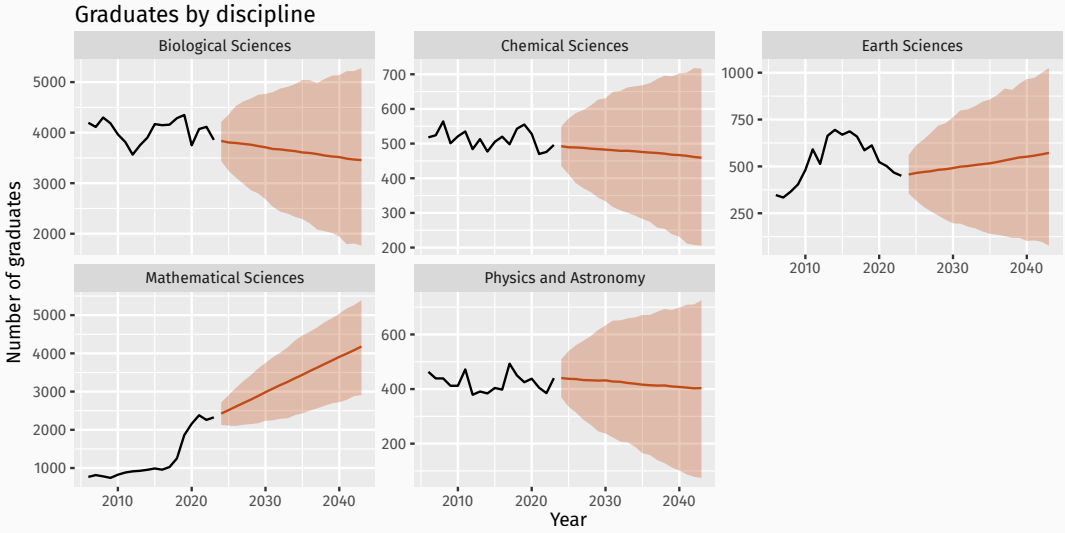
Graduates by discipline

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



Graduate forecasts

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



Population by discipline

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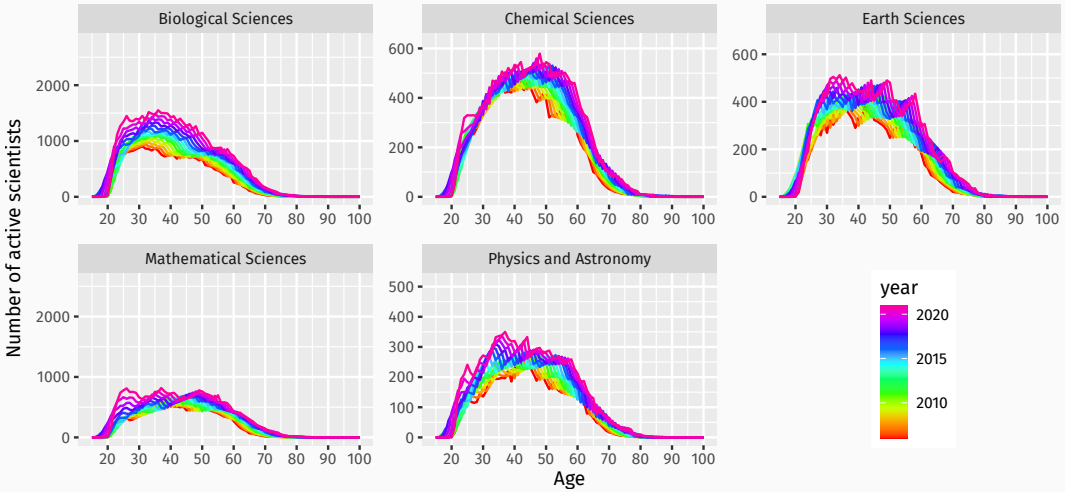
Working population by discipline



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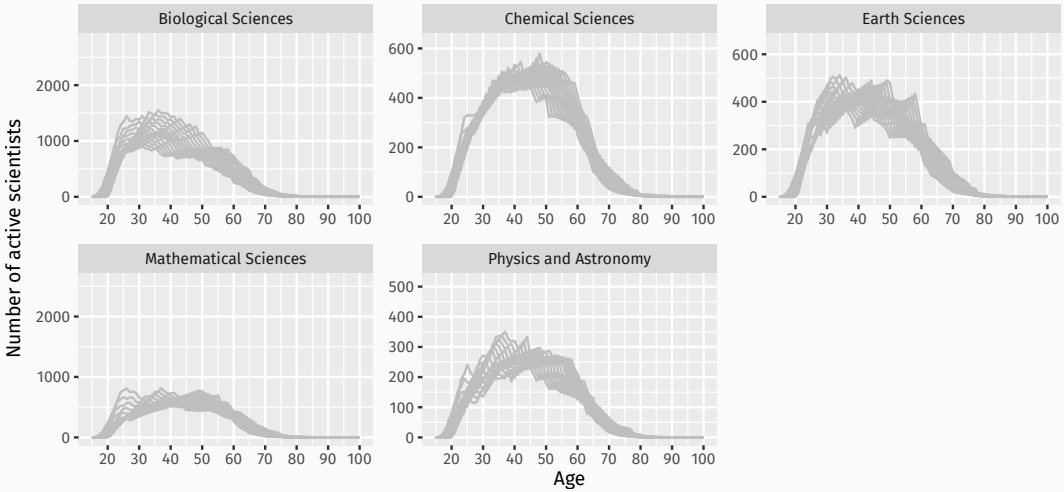

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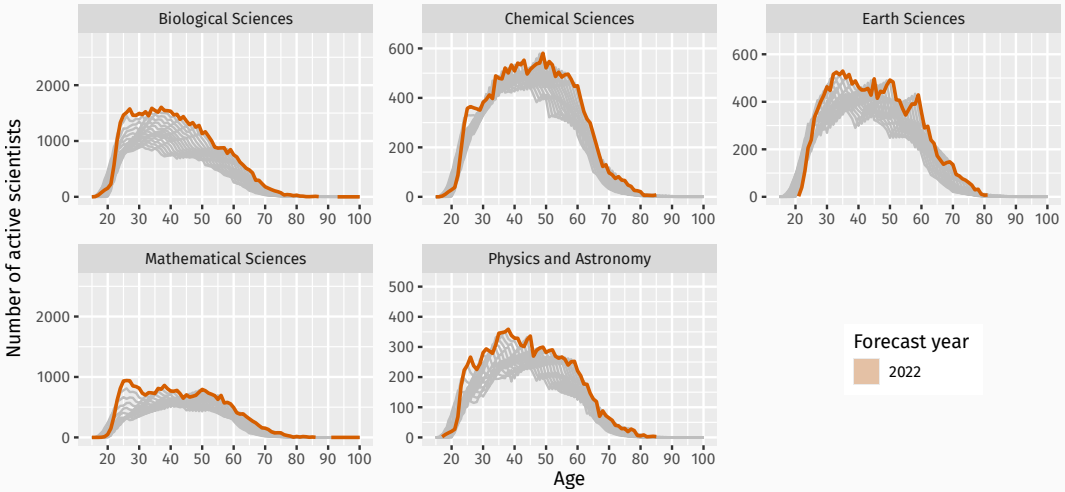
90% forecast interval for working population by discipline



Forecasts by discipline

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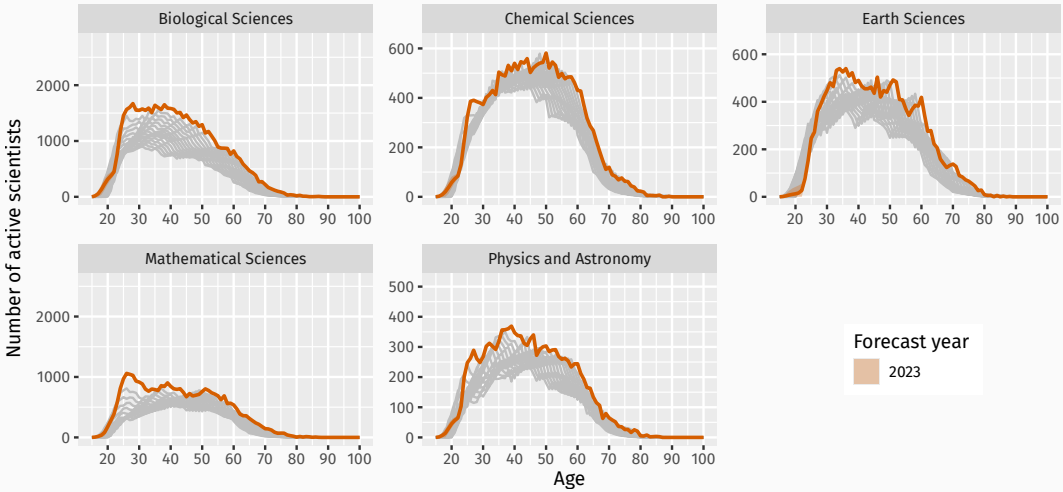

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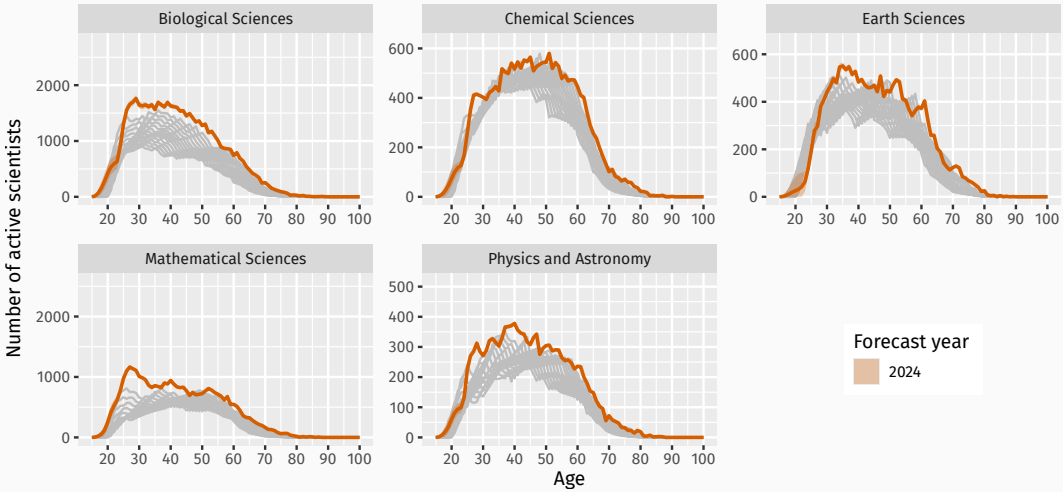

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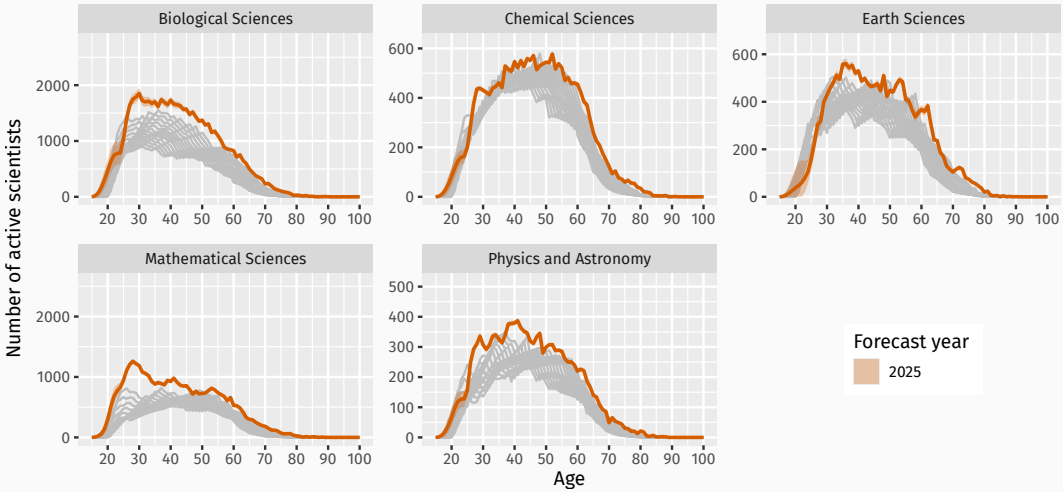

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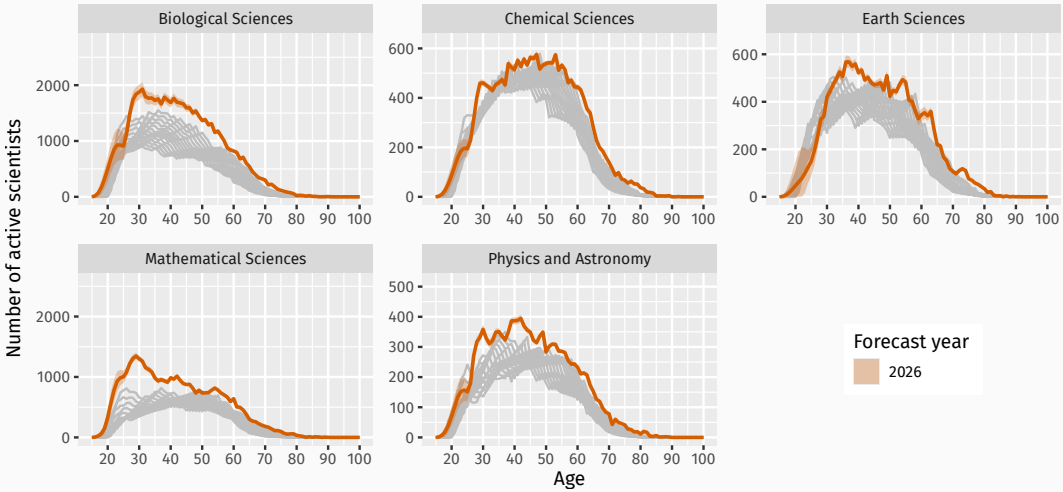
90% forecast interval for working population by discipline



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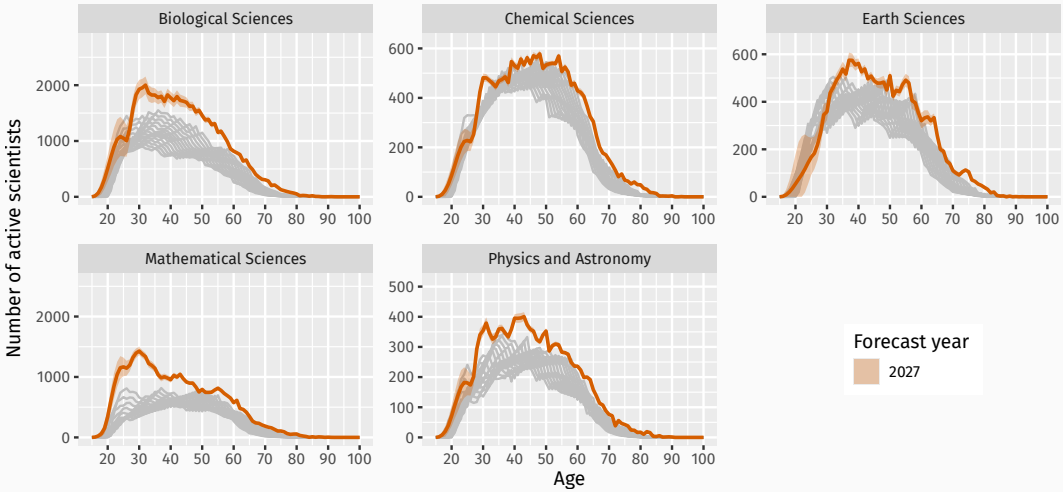

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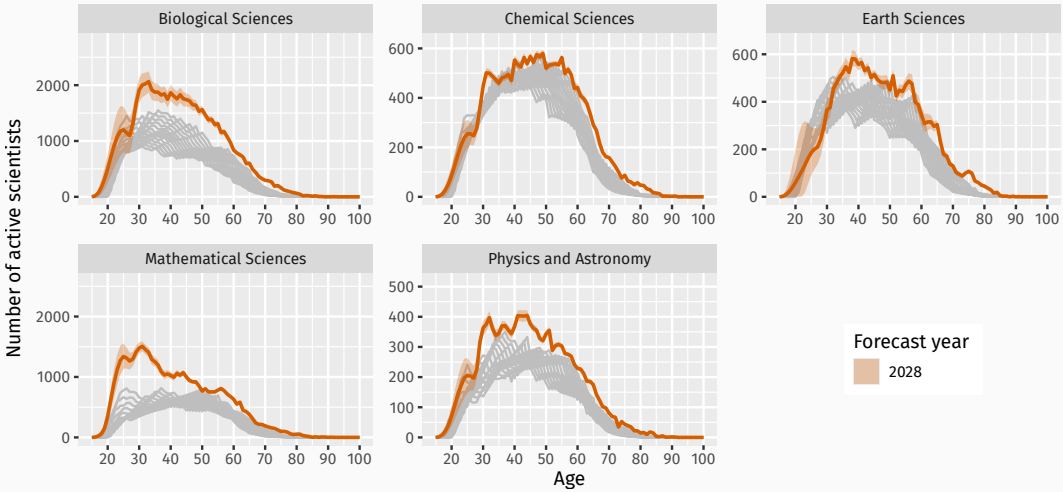

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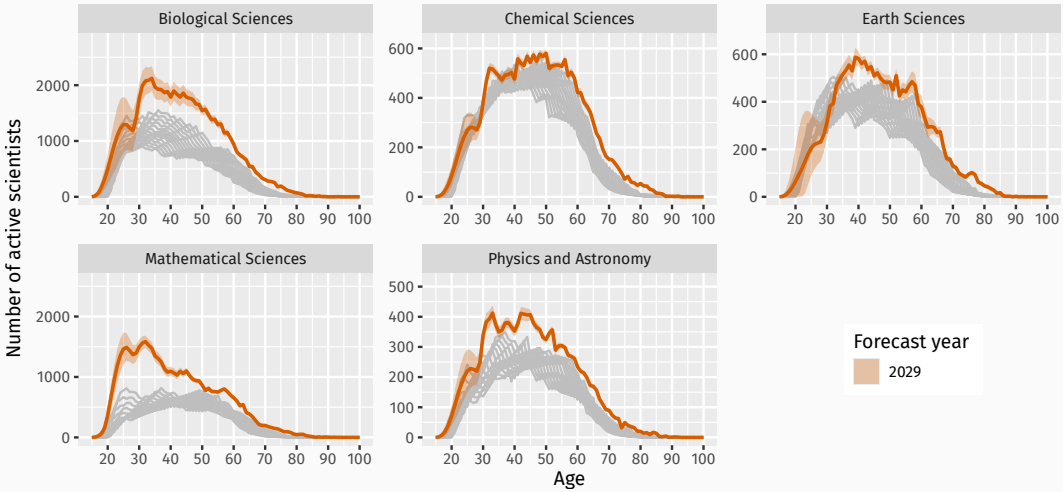

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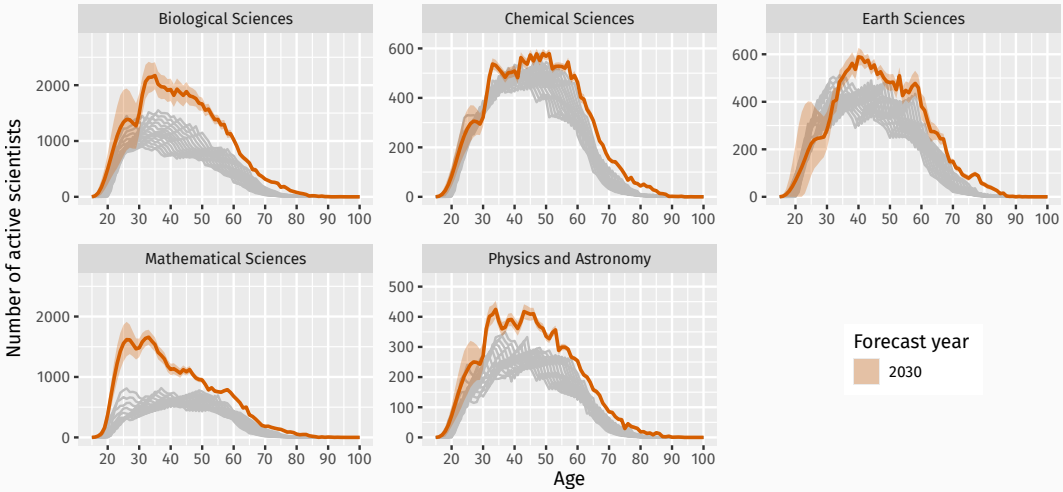

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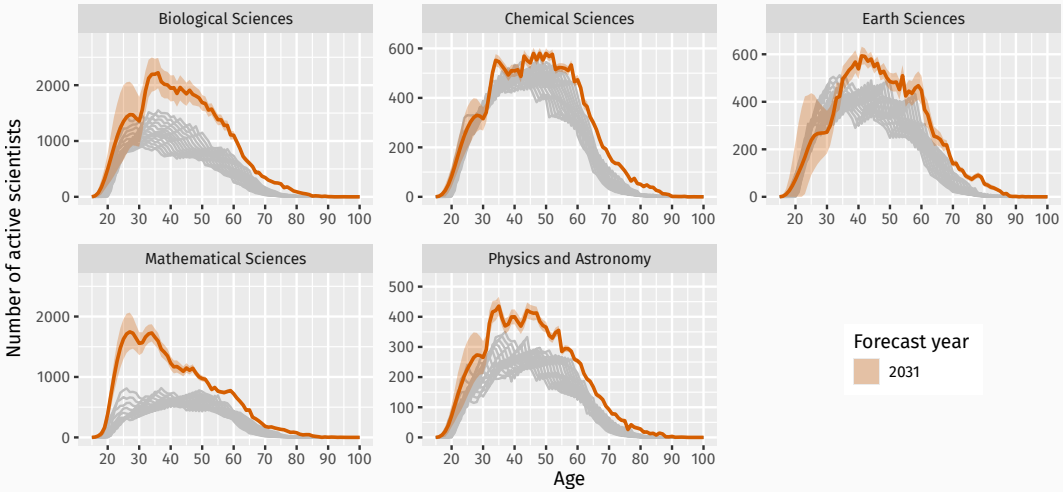

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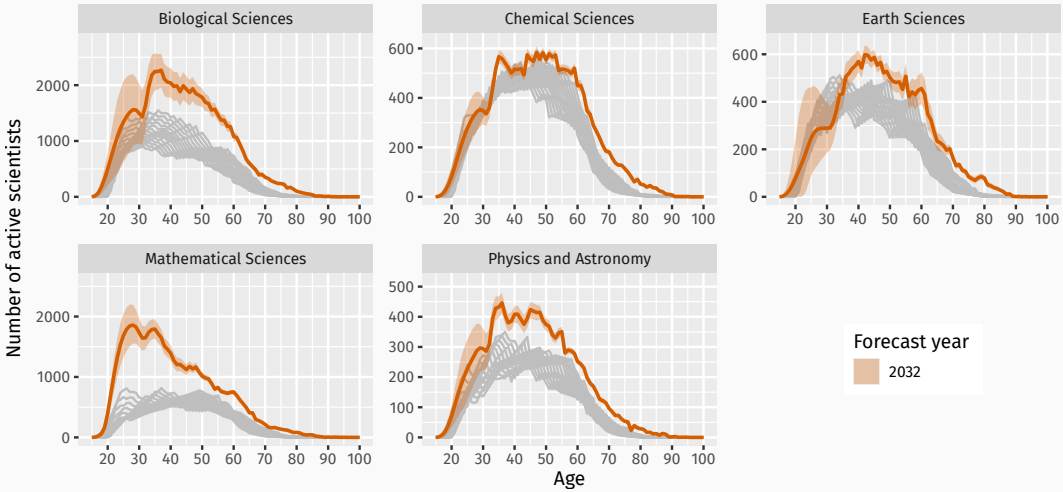

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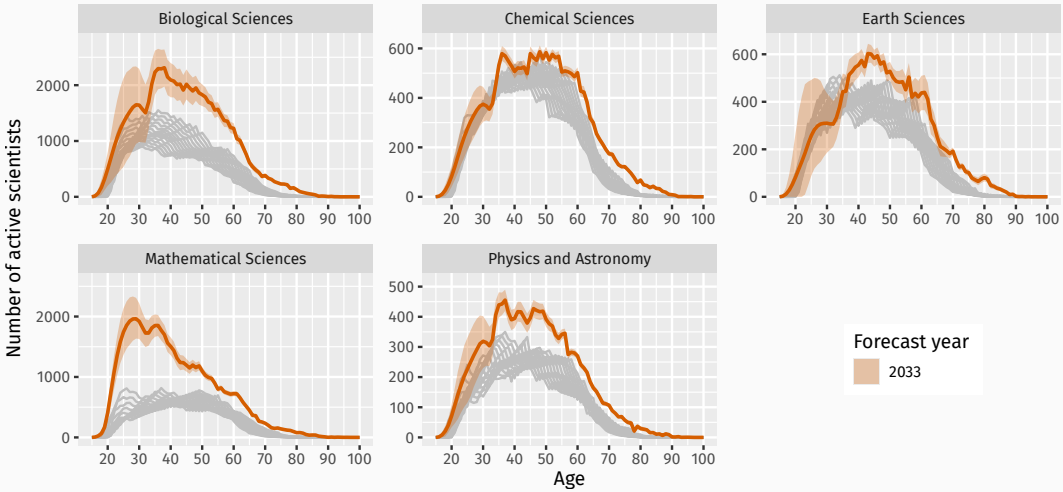

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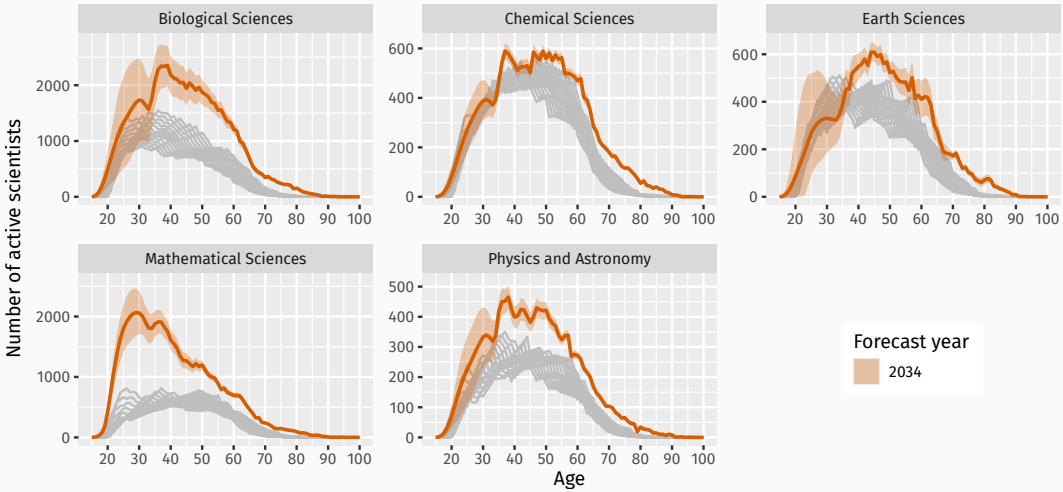

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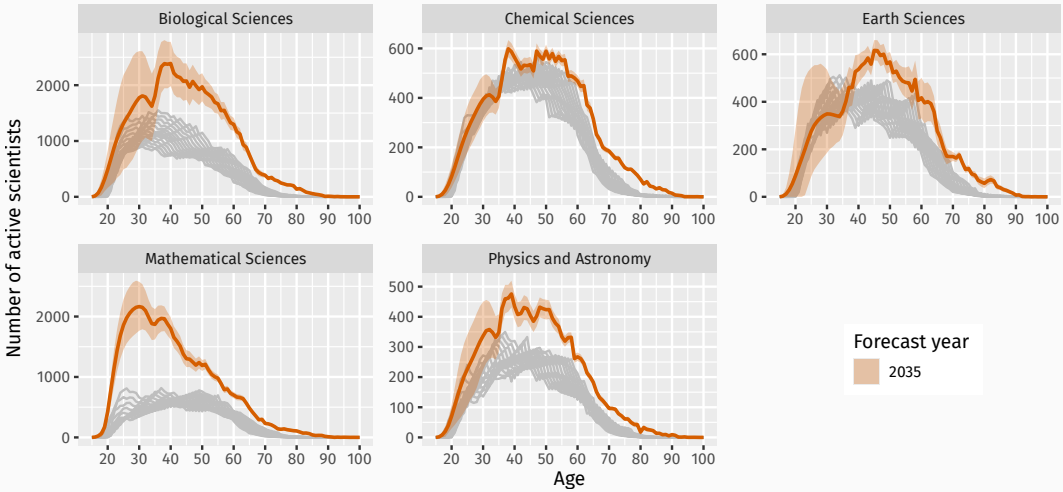

More information

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