

Prediction of Mortality. A Comparative Danish Study

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Agenda

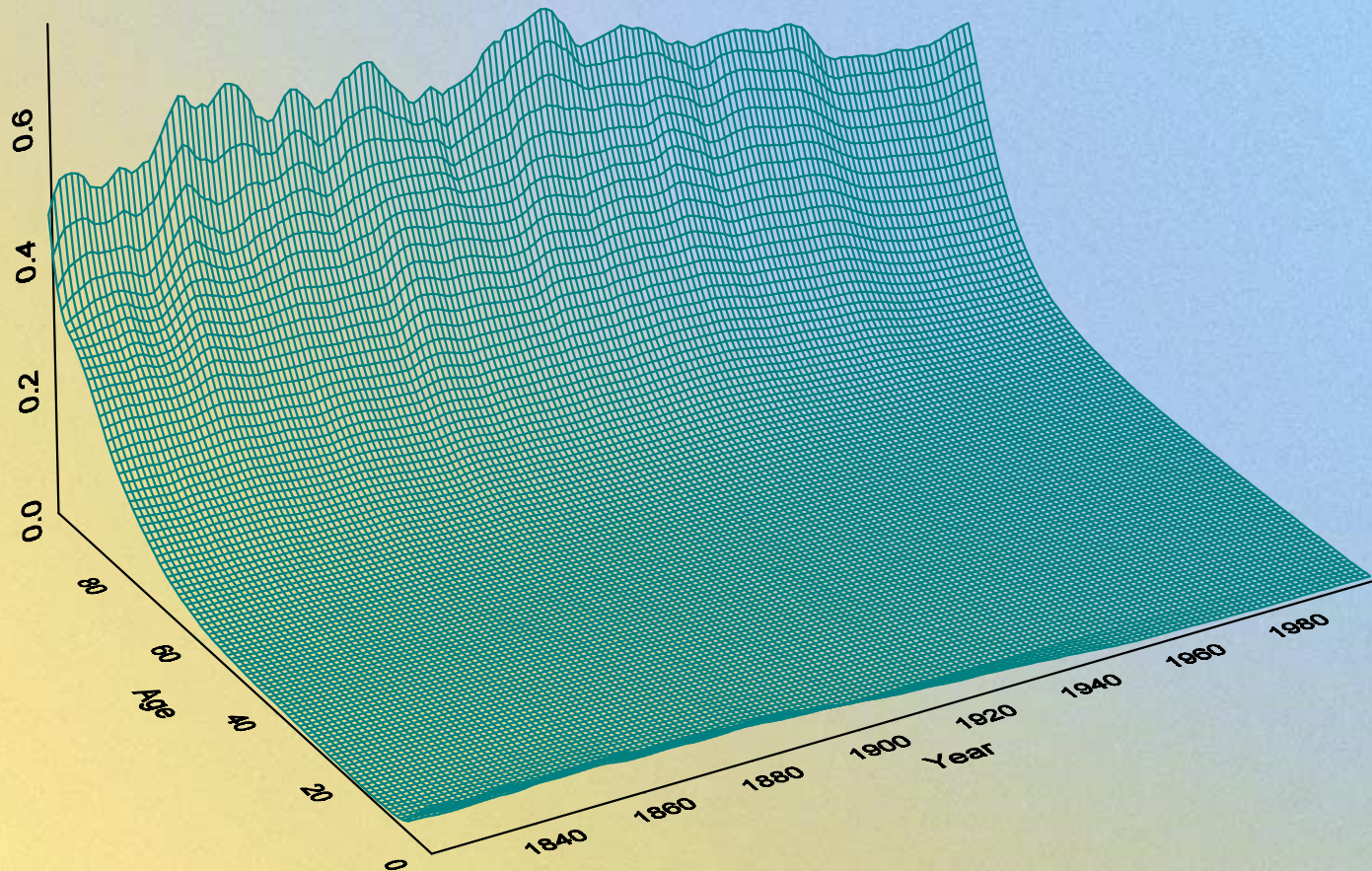
- Two-dimensional mortality estimator $\alpha(t,x)$.
 - ▶ t = chronological year
 - ▶ x = age
- Prediction model
- Validate or back test the prediction model:
 - ▶ hazards or ratios of hazards
 - ▶ summary statistics (life expectancy)
- Prediction error as an extra discounting factor

Data description

Danish population

- Time periode: 1900 - 1996
- Ages: 0 - 100 years
- Women and men
- Occurrence (integer age, integer year)
- Exposure (integer age, integer year)

'Smooth' mortality estimator



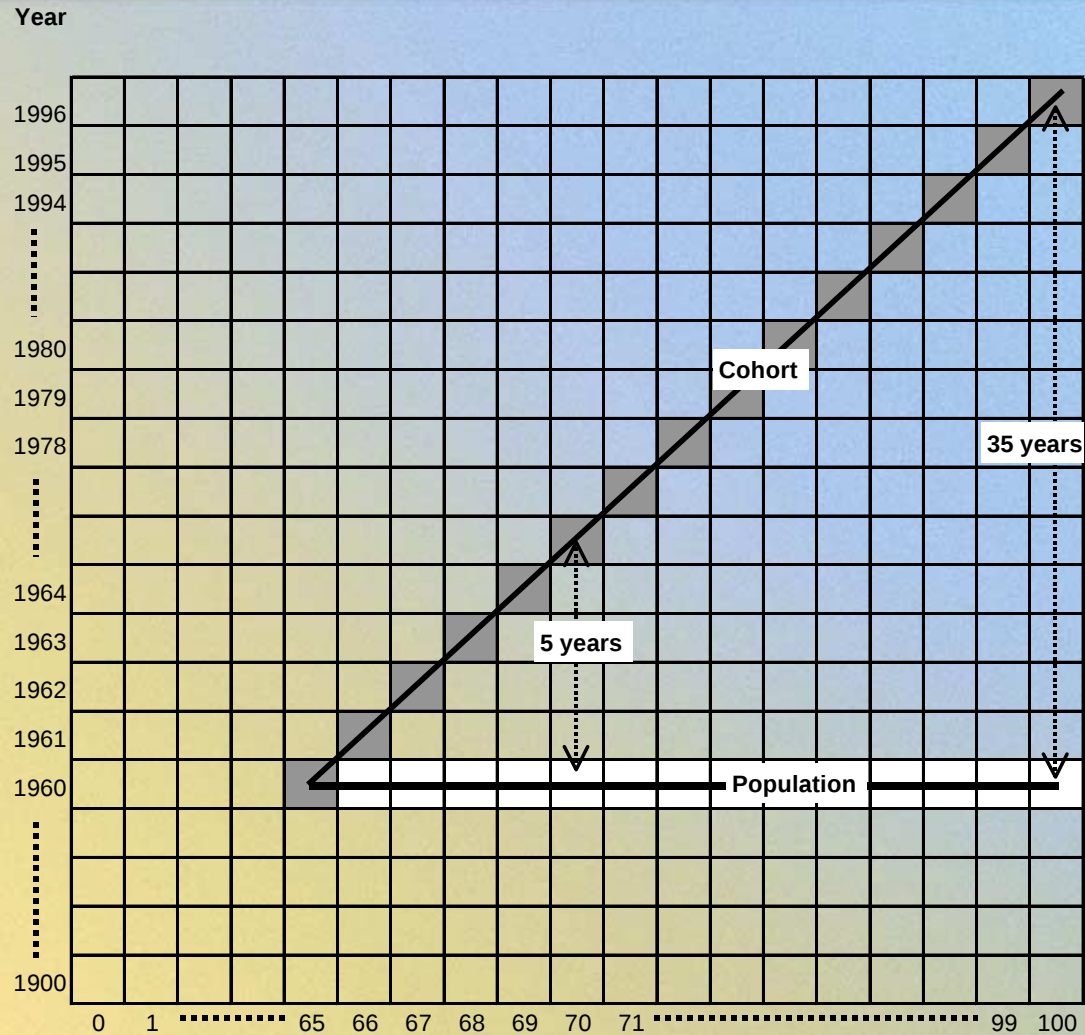
The Prediction problem

- Predict the future mortality of people aged 65 today

Model:

- Mortality does not change with respect to chronological time
- How to validate the prediction model?

Implications of prediction model

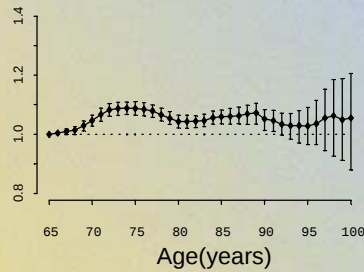


Back testing magnitude of historical errors

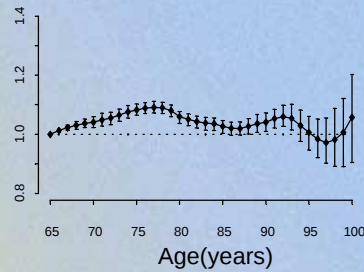
- Ratio between predicted hazard and experienced hazard.
$$\lambda(1960, 65 + u) = \frac{\alpha(1960, 65 + u)}{\alpha(1960 + u, 65 + u)}$$
- Life expectancy - predicted vs. experienced
 - ▶ life span from 65-100 years.
- Present value of life annuities
 - ▶ 0% and 5% interest scenario
 - ▶ prediction error calculated as extra discounting

Men, hazard ratios

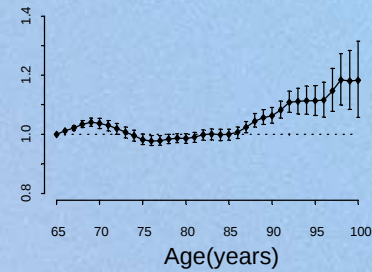
Men - 1900



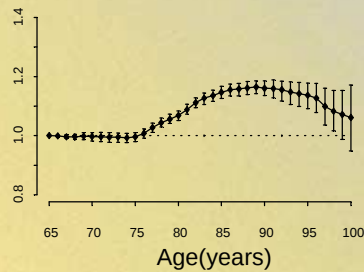
Men - 1910



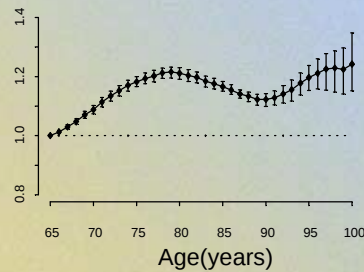
Men - 1920



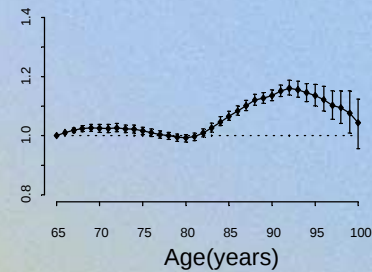
Men - 1930



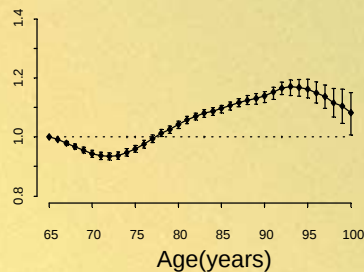
Men - 1940



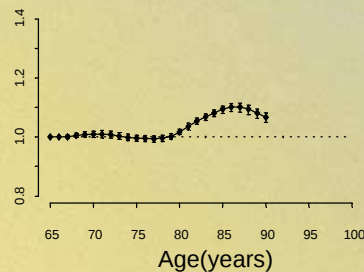
Men - 1950



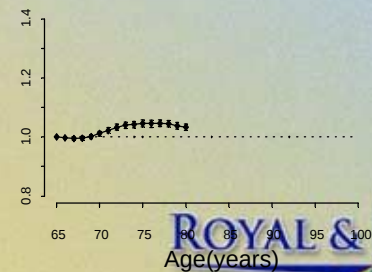
Men - 1960



Men - 1970

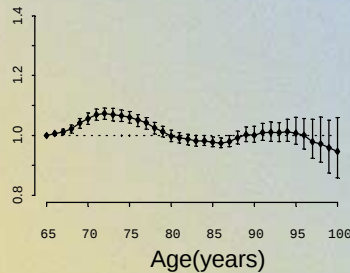


Men - 1980

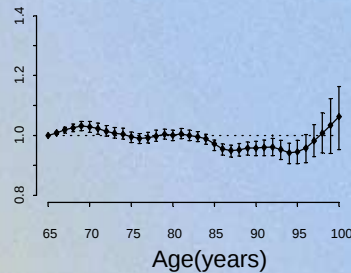


Women, hazard ratios

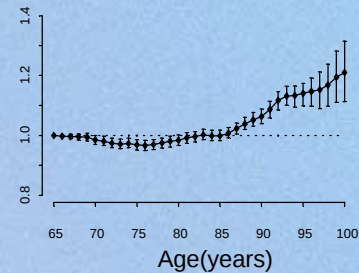
Women - 1900



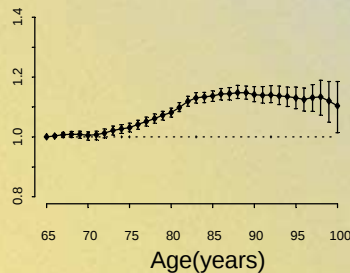
Women - 1910



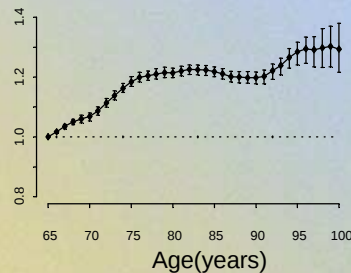
Women - 1920



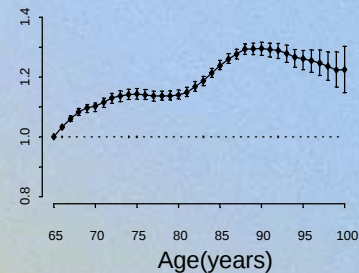
Women - 1930



Women - 1940



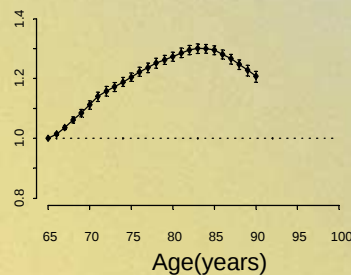
Women - 1950



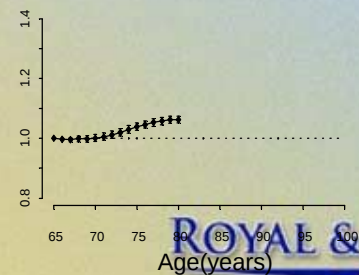
Women - 1960



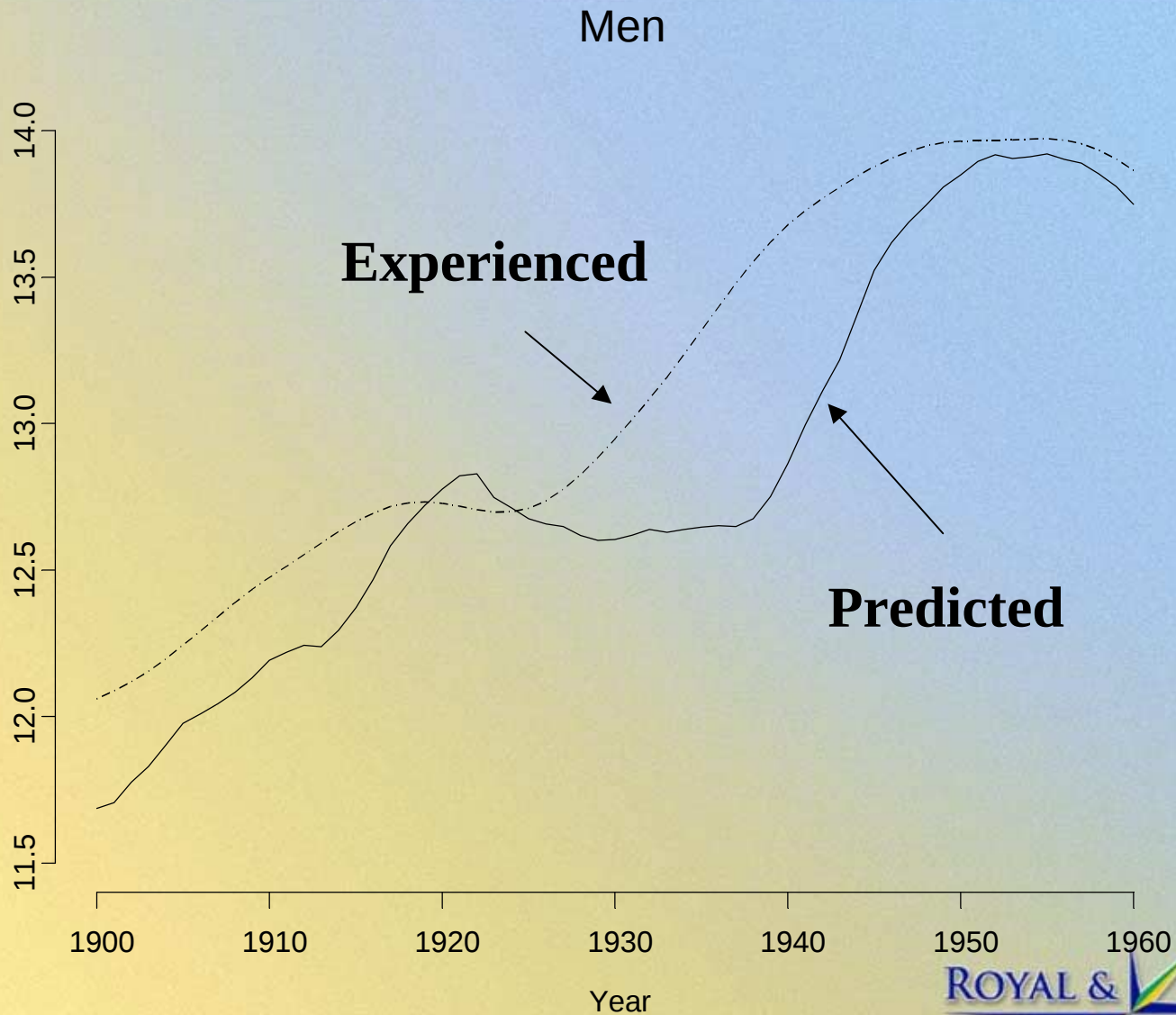
Women - 1970



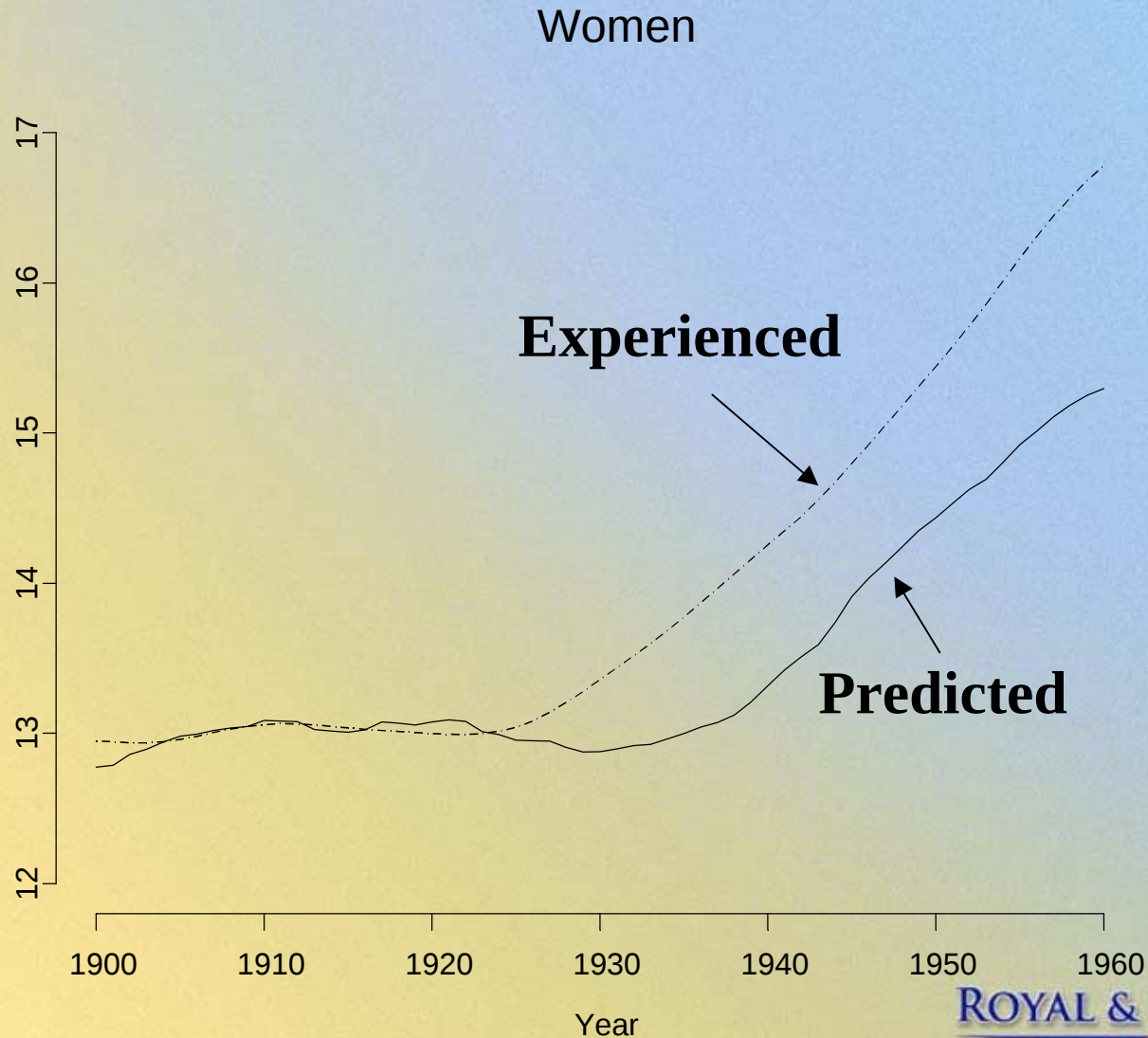
Women - 1980



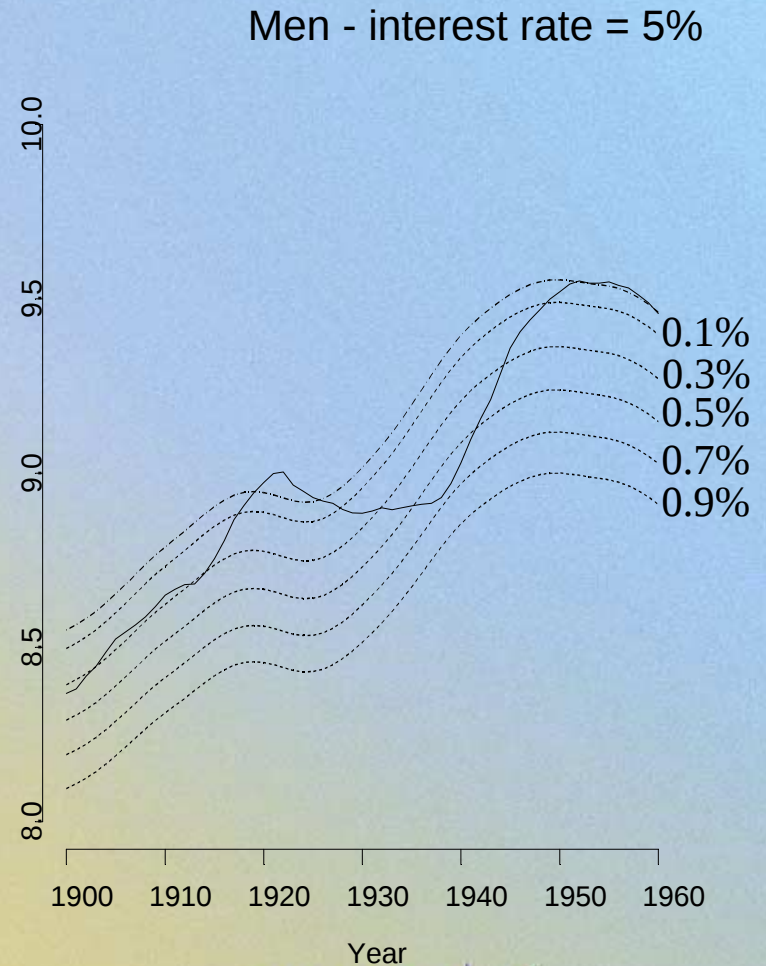
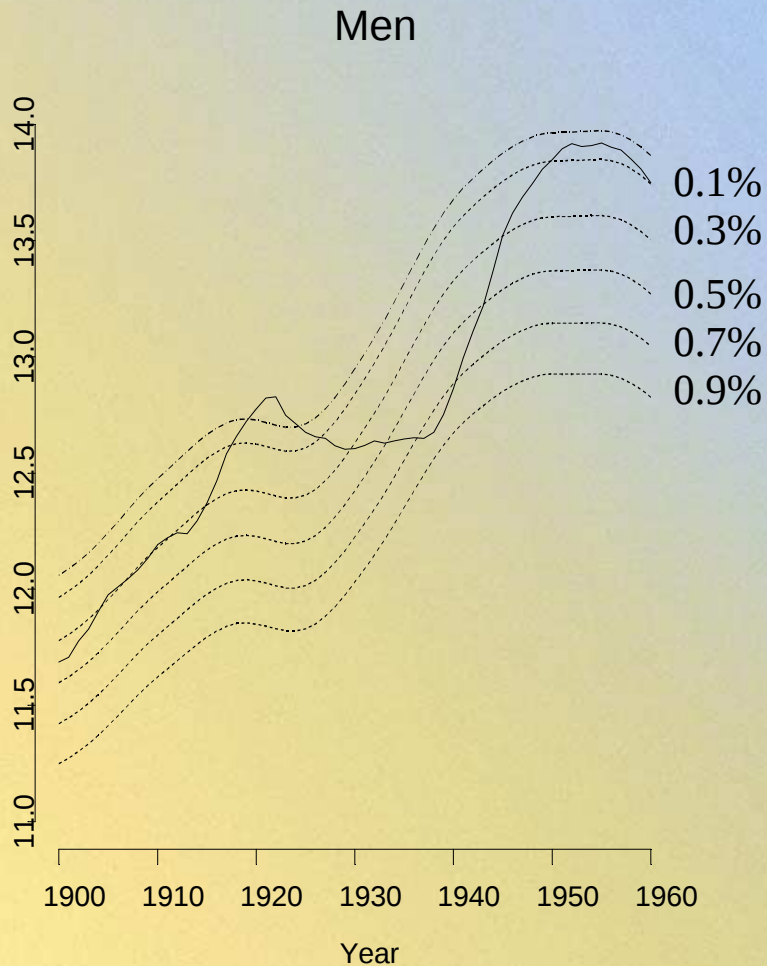
Life expectancy- 65 years old



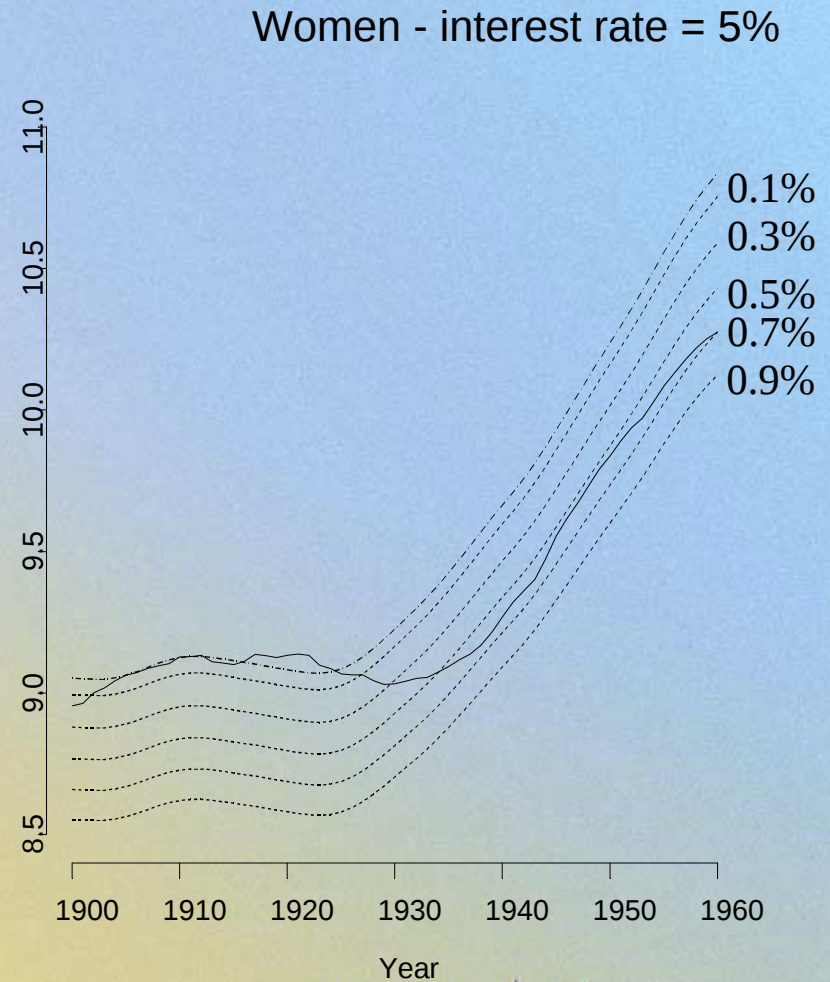
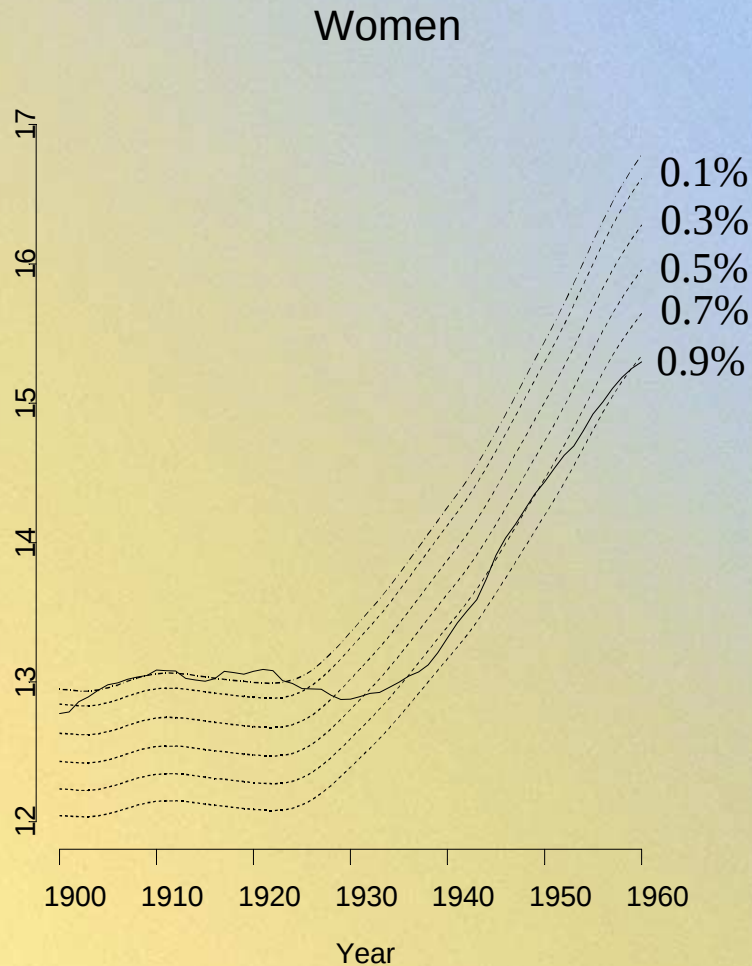
Life expectancy - 65 years old



Prediction error as interest



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Conclusion

- Any prediction model should undergo validation
- Our naive prediction model does not fit data

however,

- Understanding prediction errors gives an idea of required extra reserves on life annuities
- Summary statistics are more easy to understand and communicate