Foundations of Data Science Capstone Project

World Population Projections

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Introduction

▷ Population projections are **essential element of policy-making** - they are used in:

- ◆ Estimating central and local finance allocation

- ◆ Planning housing and land use

- ◆ Health care planning - for modelling and projecting health care indicators

- ◆ Weighting national and regional surveys

- ◆ Creating teacher workforce models at a national and local level

- ◆ Assessing ageing population and understanding its implications

Capstone Project Problem

Estimating aggregate, age-specific, and sex-specific population projections until 2100 for 200+ countries

Theoretical Model

▷ Population projections are estimated using the **demographic balancing equation**

$$P_{c,t} = P_{c,t-1} + B_{c,t} - D_{c,t} + M_{c,t} \; \text{———————————————————————} \; (i)$$

where $P_{c,t}$ is the population prediction in country c at time t,

$P_{c,t-1}$ is the population prediction in country c at time t−1,

$B_{c,t}$ is the number of births in country c at time t,

$D_{c,t}$ the number of deaths in country c at time t,

$M_{c,t}$ net migration in country c at time t.

▷ Methodology uses the **cohort component method** to decompose the equation into age-specific and sex-specific components for population projections

Data

▷ The following data input is required for each country:

◆ Sex-specific and age-specific population estimates at the initial time t = 0

◆ Projections of total fertility rate (TFR)

◆ Projections of fertility distribution over ages

◆ Projections of sex ratio at birth

◆ Projections of male and female life expectancy at birth (e0)

◆ Historical data on sex- and age-specific death rates (for t ≤ 0)

◆ Projections of sex- and age-specific net migration

▷ **Data Source —** United Nations 2012 Population Division Database since 1950

Empirical Model

▷ Analysis is divided into three steps

▷ **Step 1 —** Simulating a large set of trajectories for future values of total fertility rates using Bayesian hierarchical estimates

◆ Done via **BayesTFR** package in R software

▷ **Step 2 —** Simulating a large and equal set of trajectories for future values of life expectancies using Bayesian hierarchical estimates

◆ Done via **BayesLife** package in R software

▷ **Step 3 —** Converting trajectories from previous models to age-specific and sex-specific population projections using cohort component method

◆ Done via **BayesPop** package in R software

World Population Projections
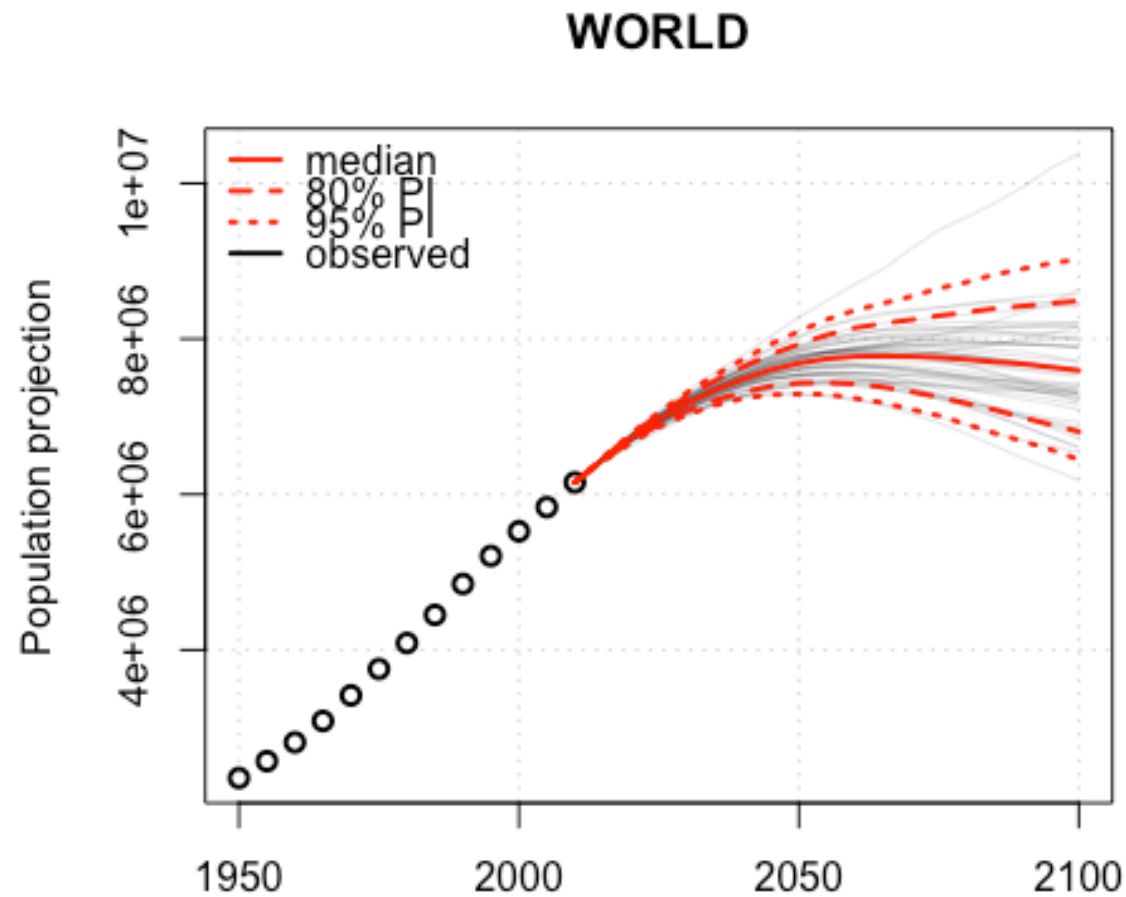
Fig. 1 Total population (1950 to 2100)
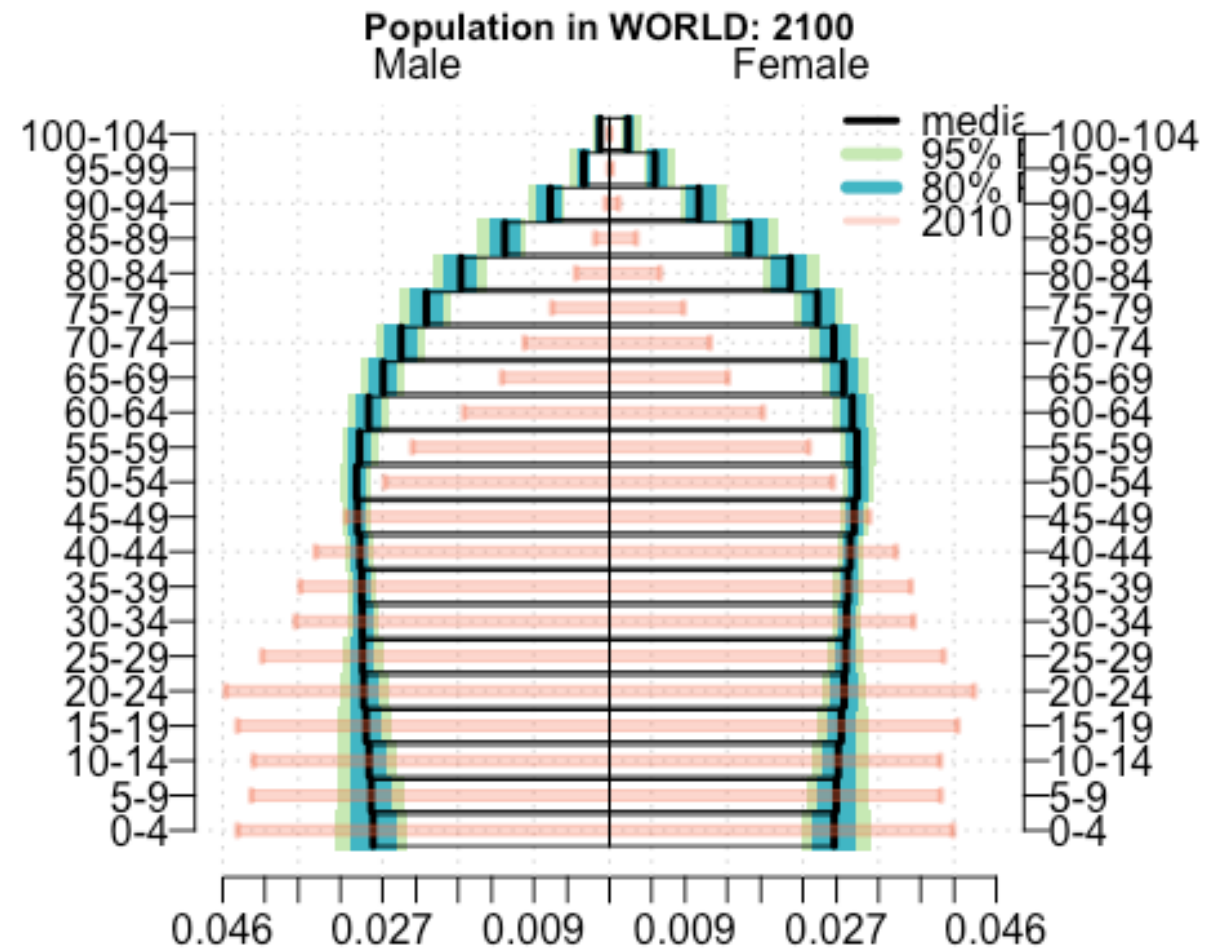
Fig. 2 Population by age and sex (2010 and 2100)

Region Specific — Europe
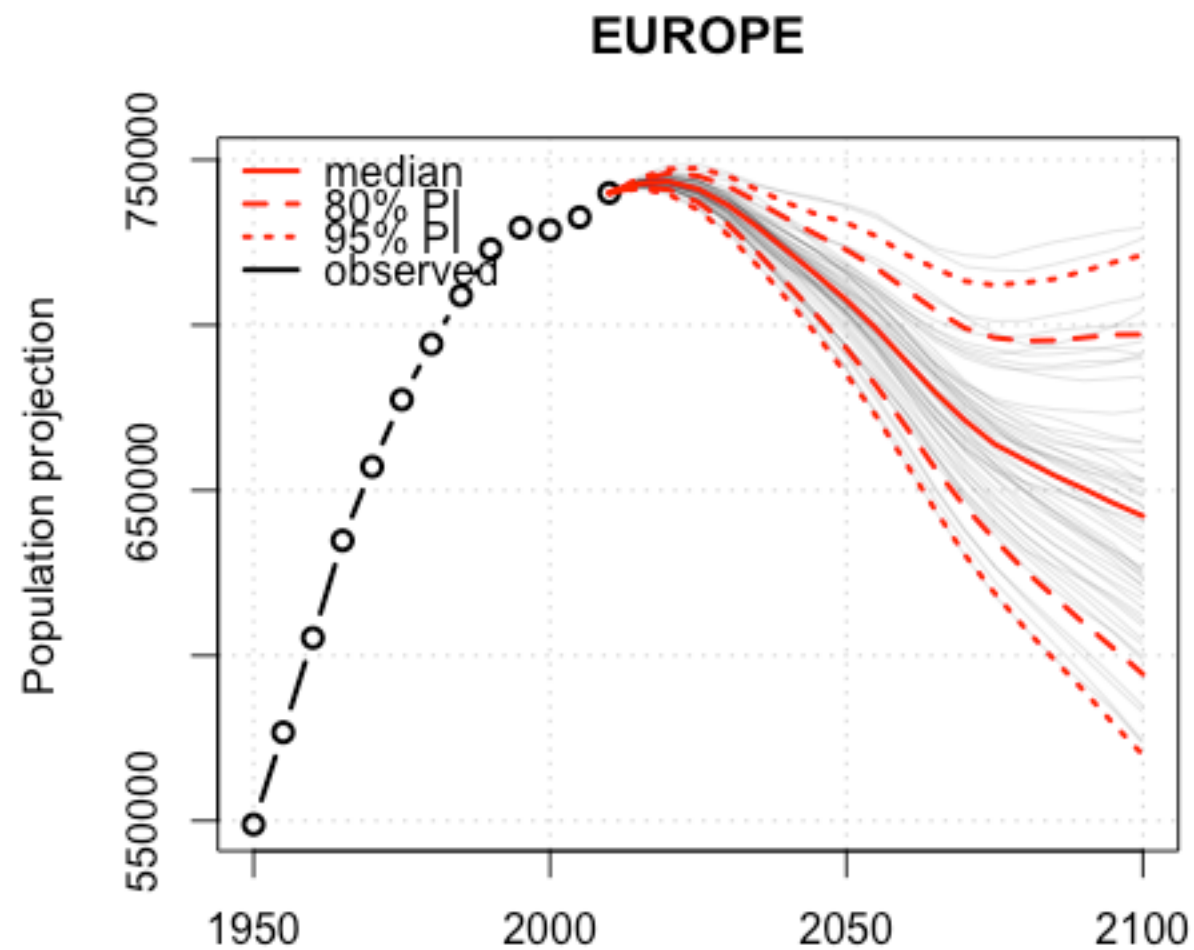
Fig. 3 Total population (1950 to 2100)
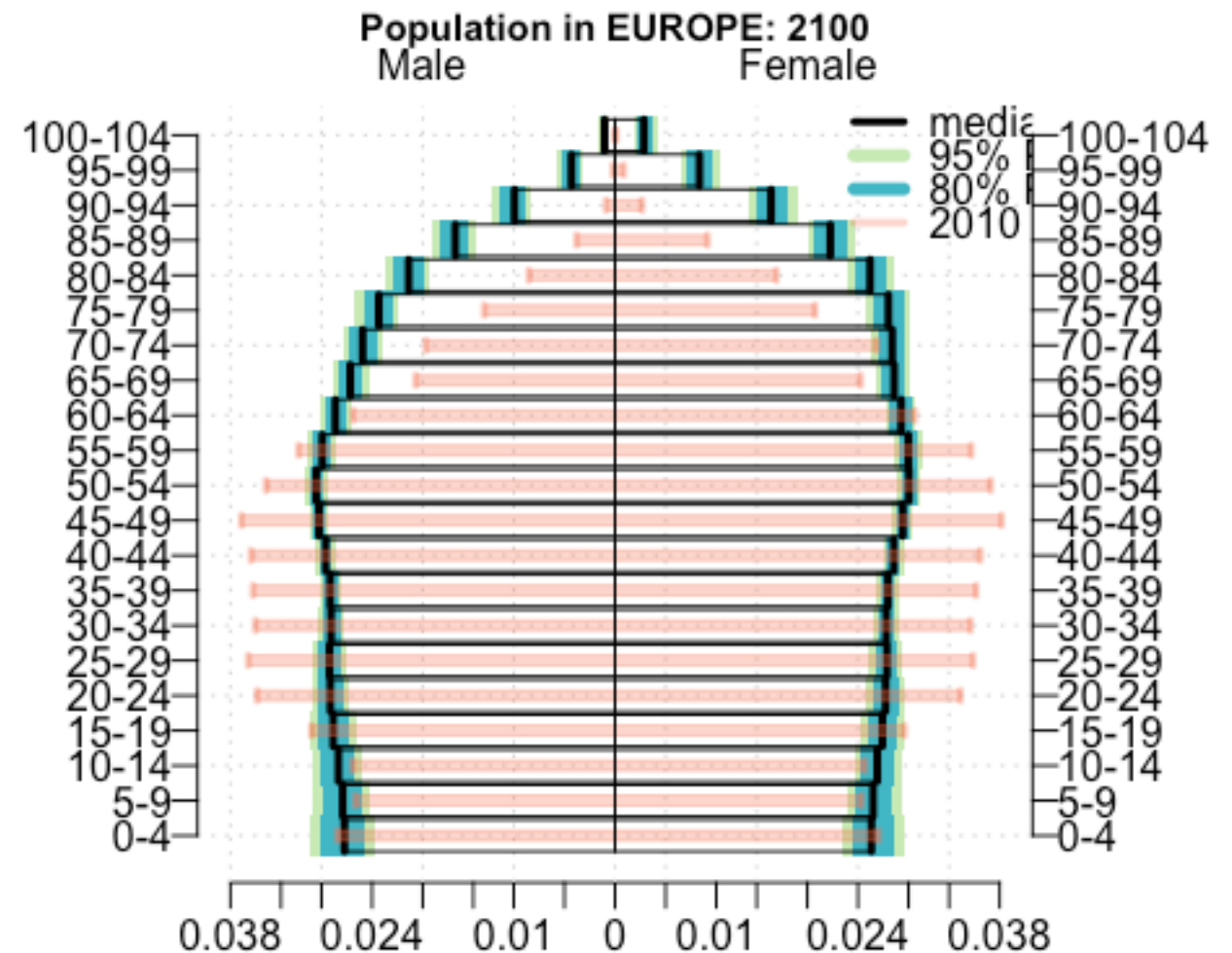
Fig. 4 Population by age and sex (2010 and 2100)
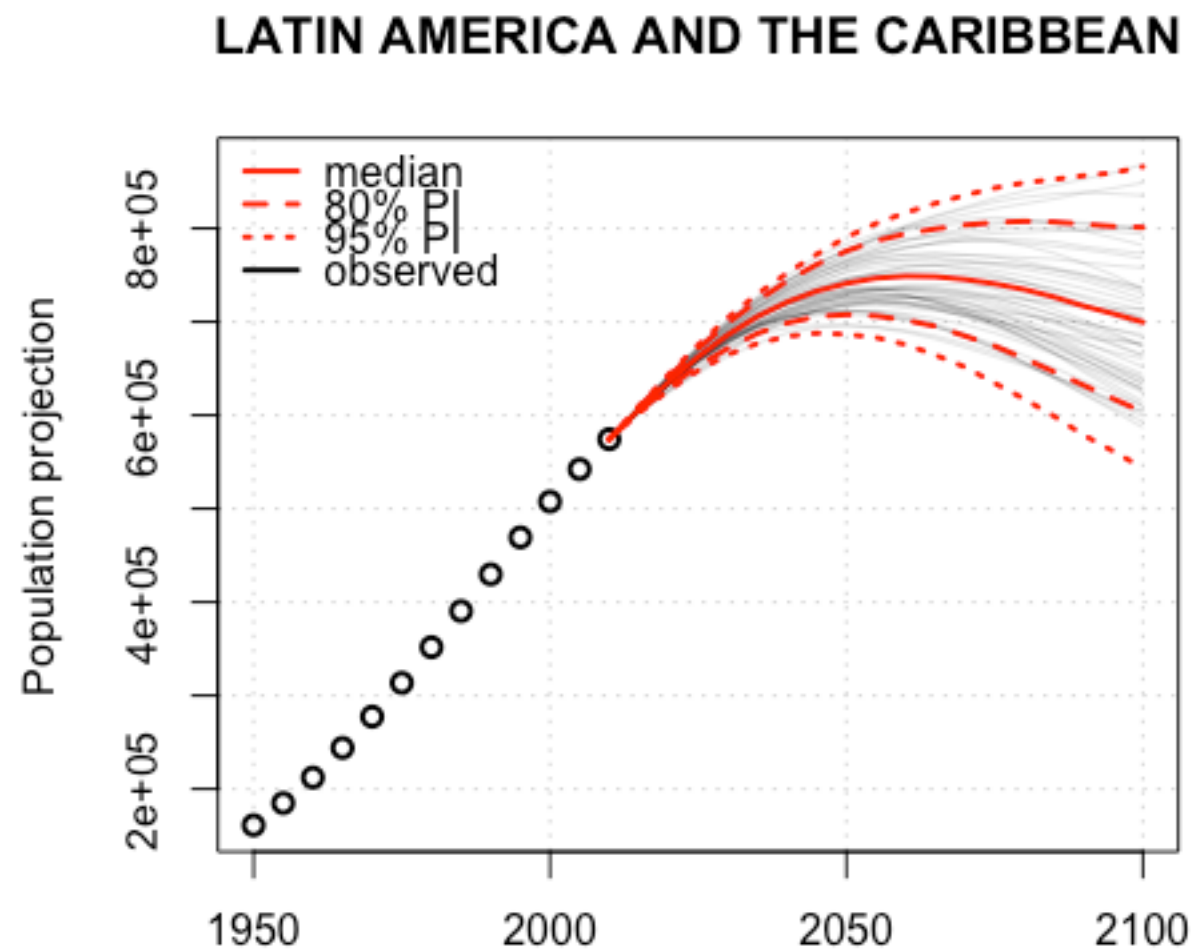
Region Specific — Latin Am.
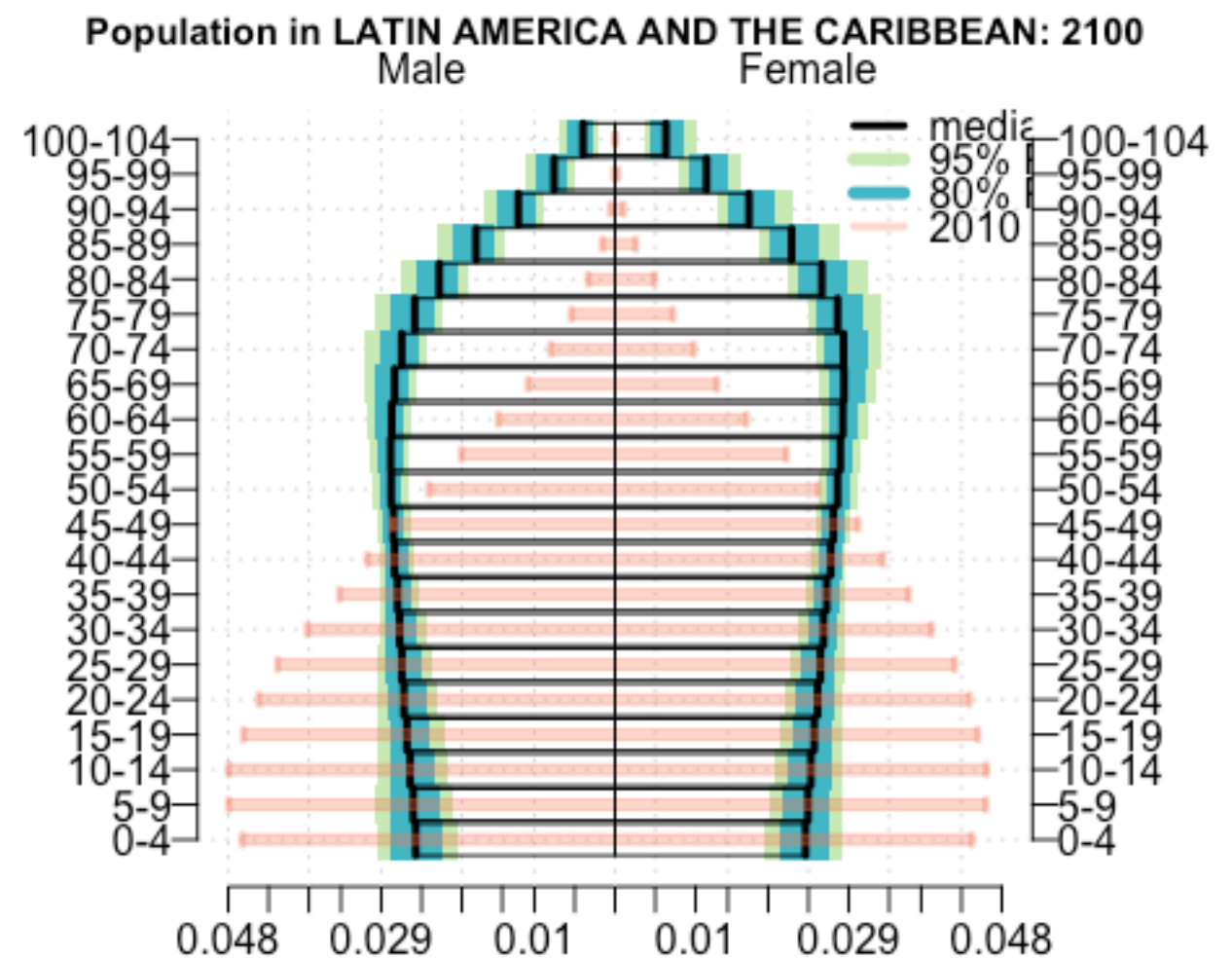

Fig. 5 Total population (1950 to 2100)

Fig. 6 Population by age and sex (2010 and 2100)
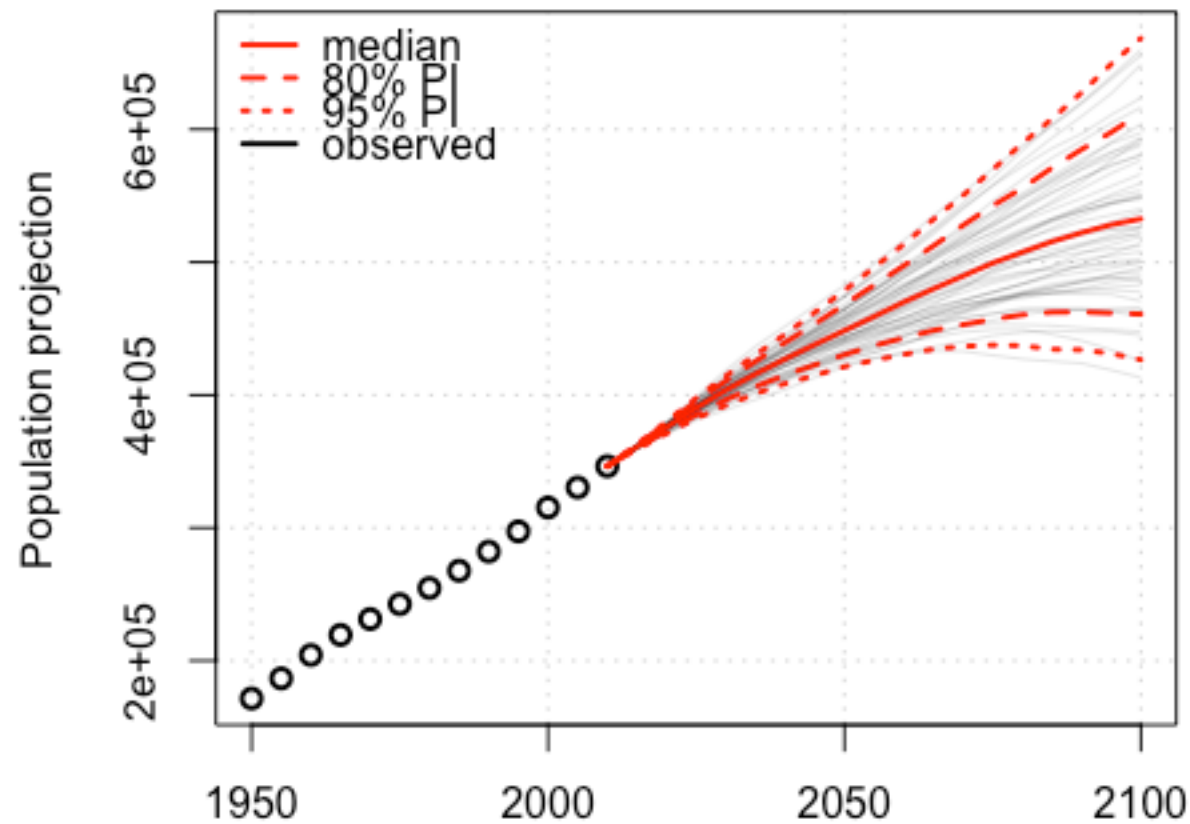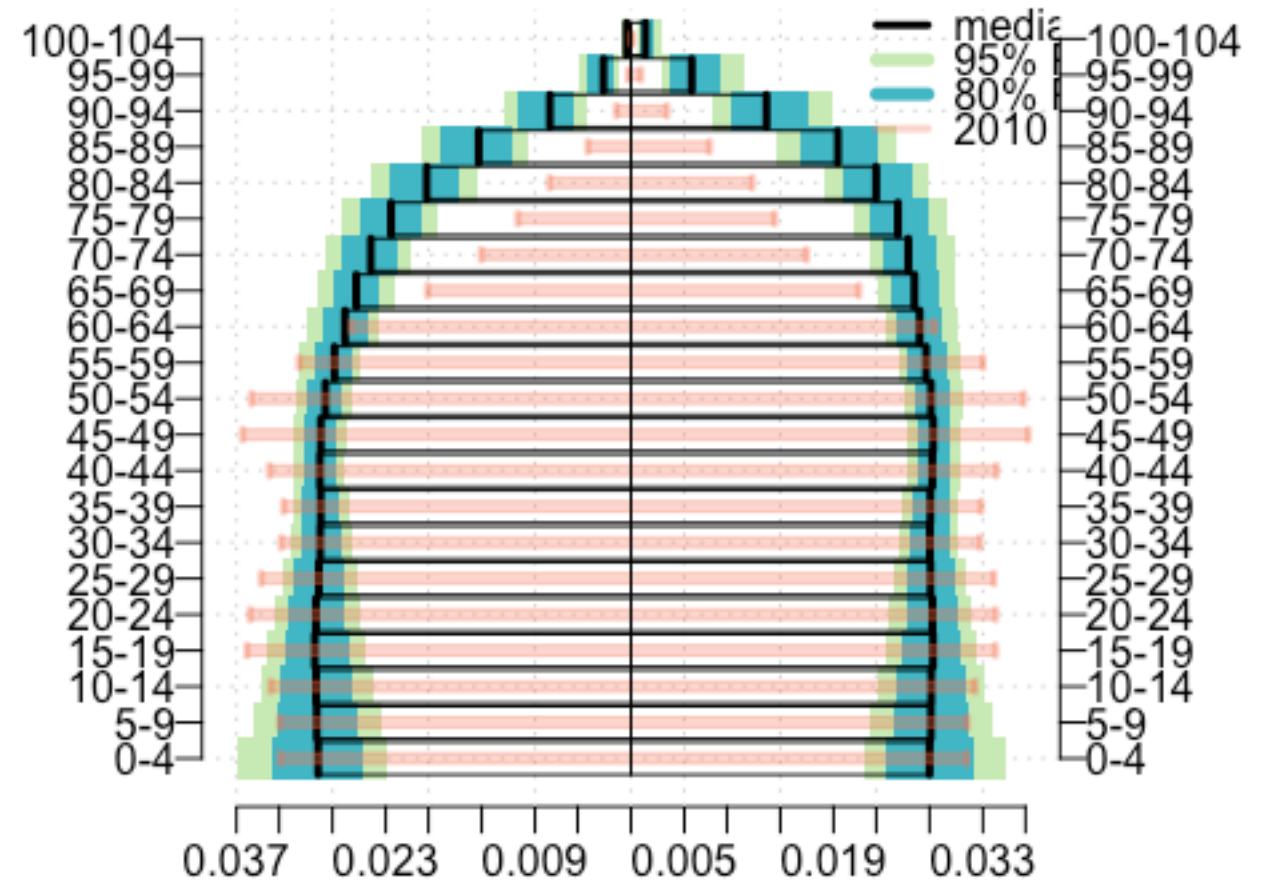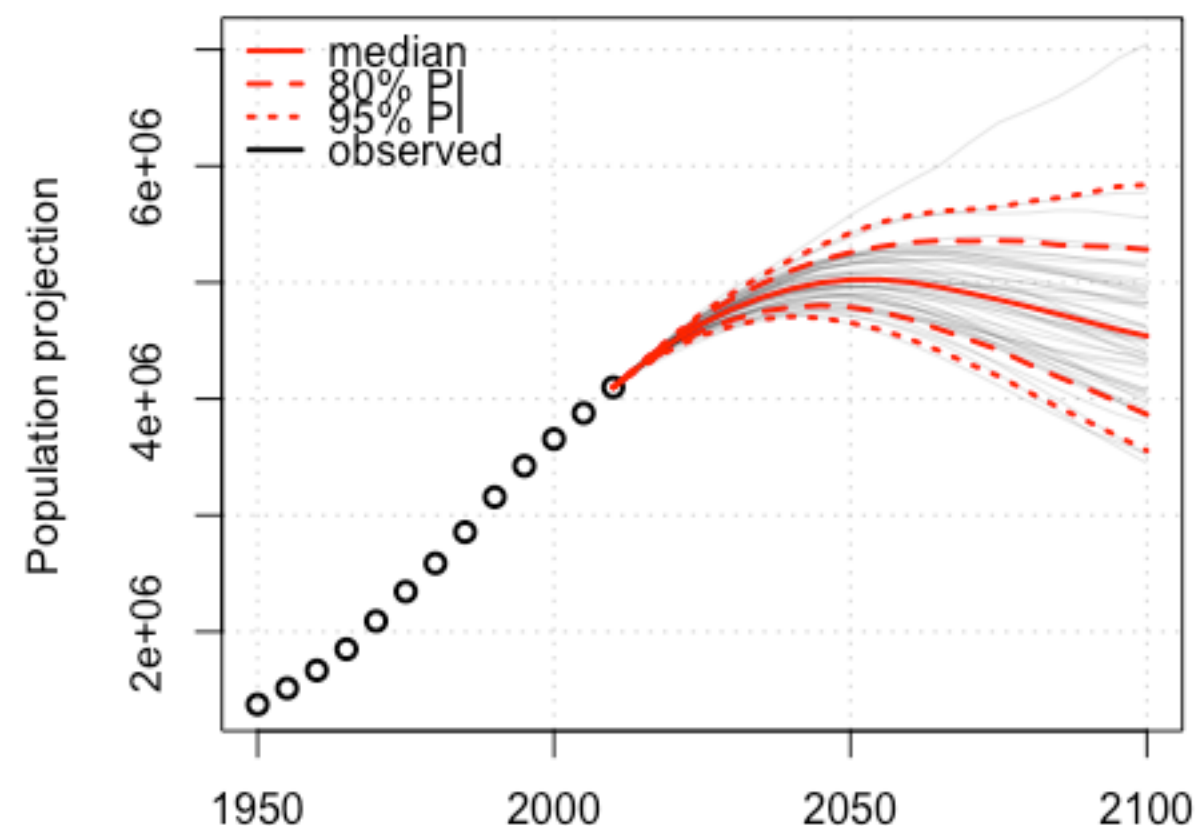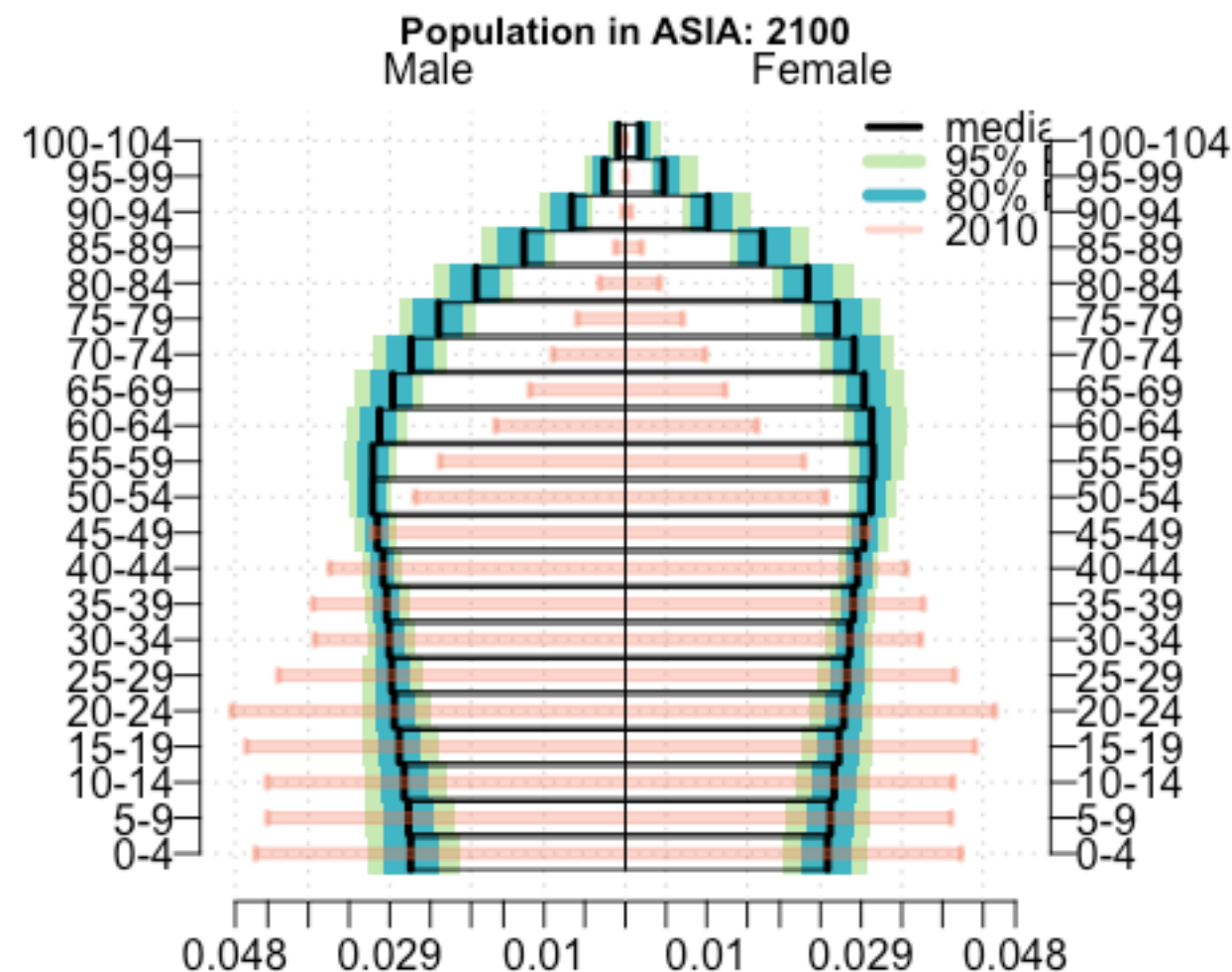
Region Specific — North Am.

Fig. 7 Total population 1950 to 2100

Fig. 8 Population by age and sex (2010 and 2100)

Region Specific — Asia

Fig. 9 Total population (1950 to 2100)

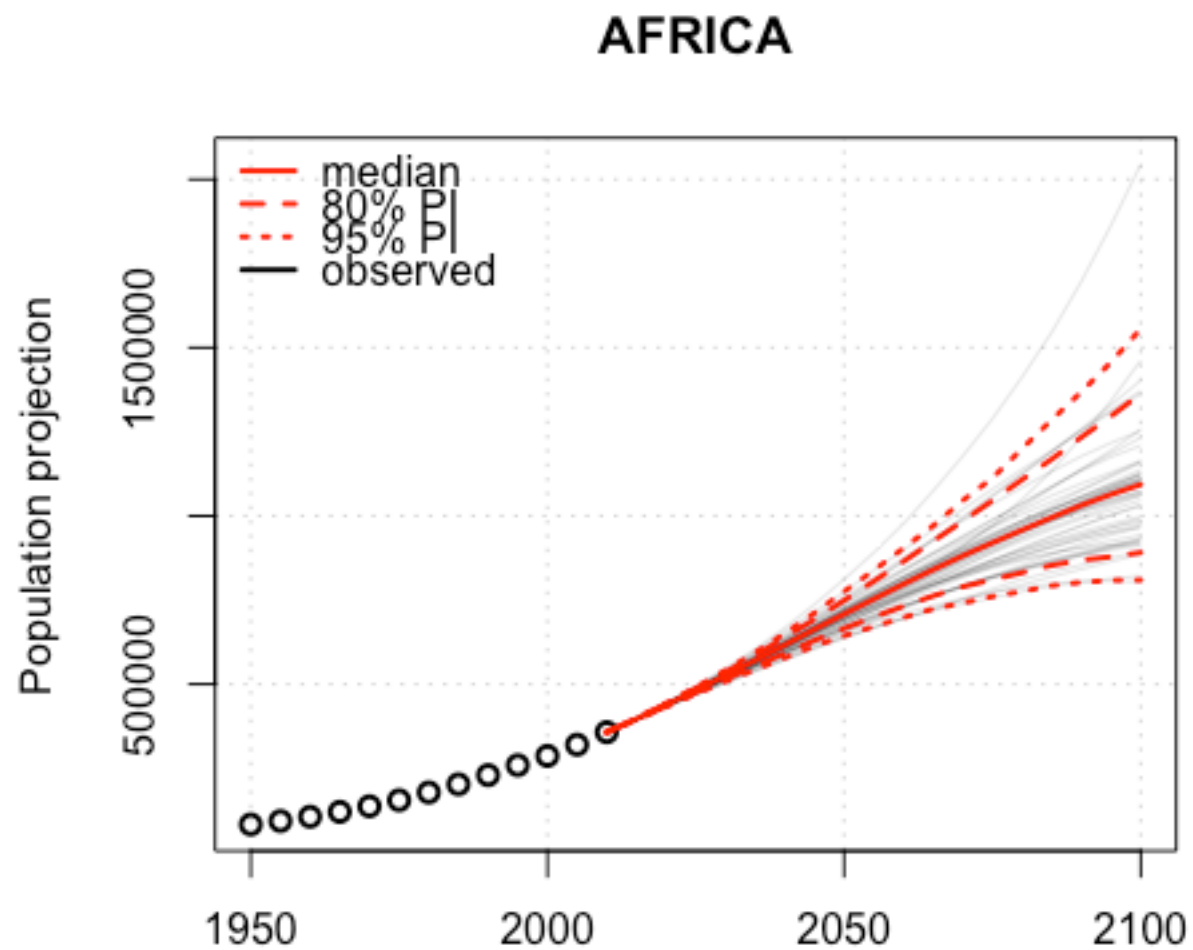Fig. 10 Population by age and sex (2010 and 2100)

Region Specific — Africa
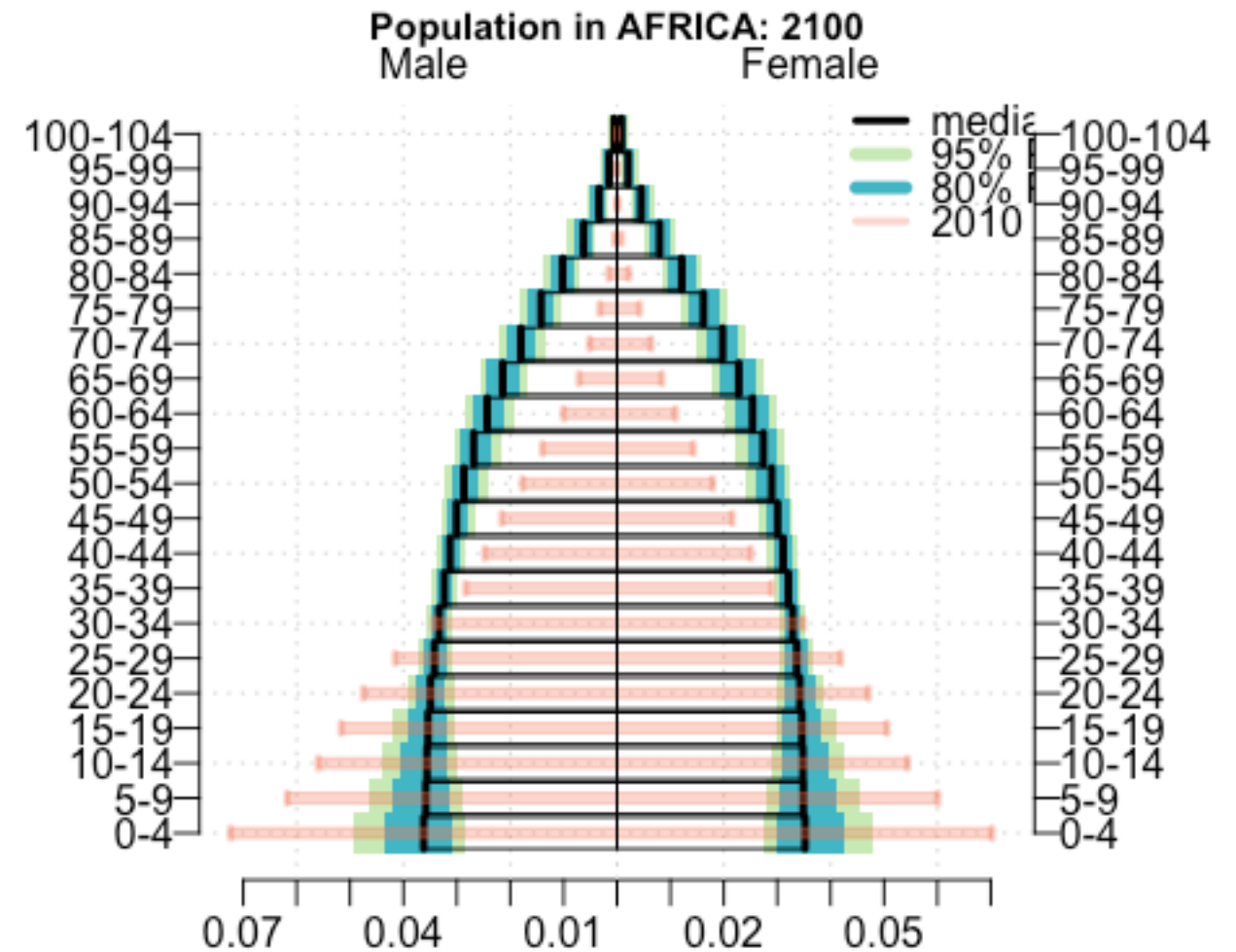

Fig. 11 Total population (1950 to 2100)

Fig. 12 Population by age and sex (2010 and 2100)
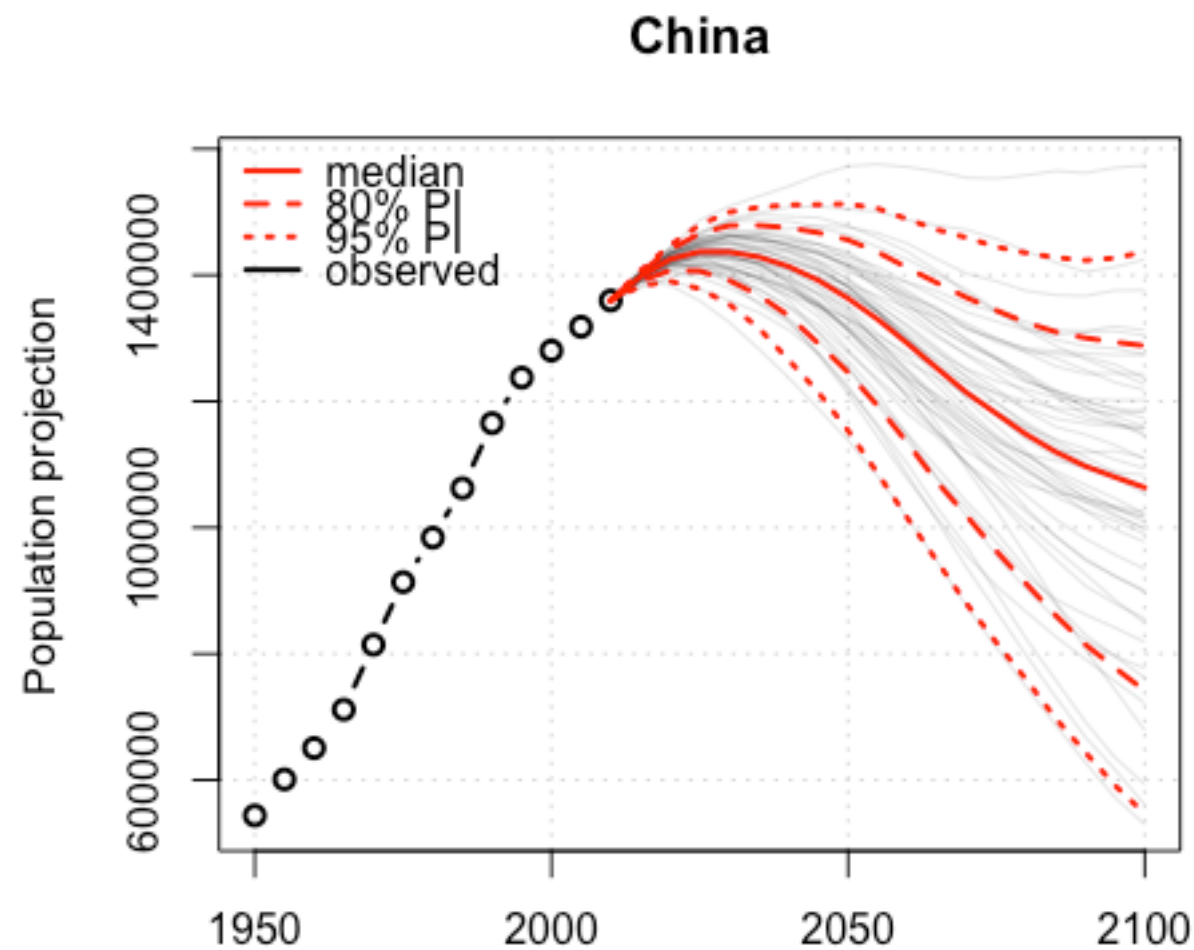
Country Specific — China
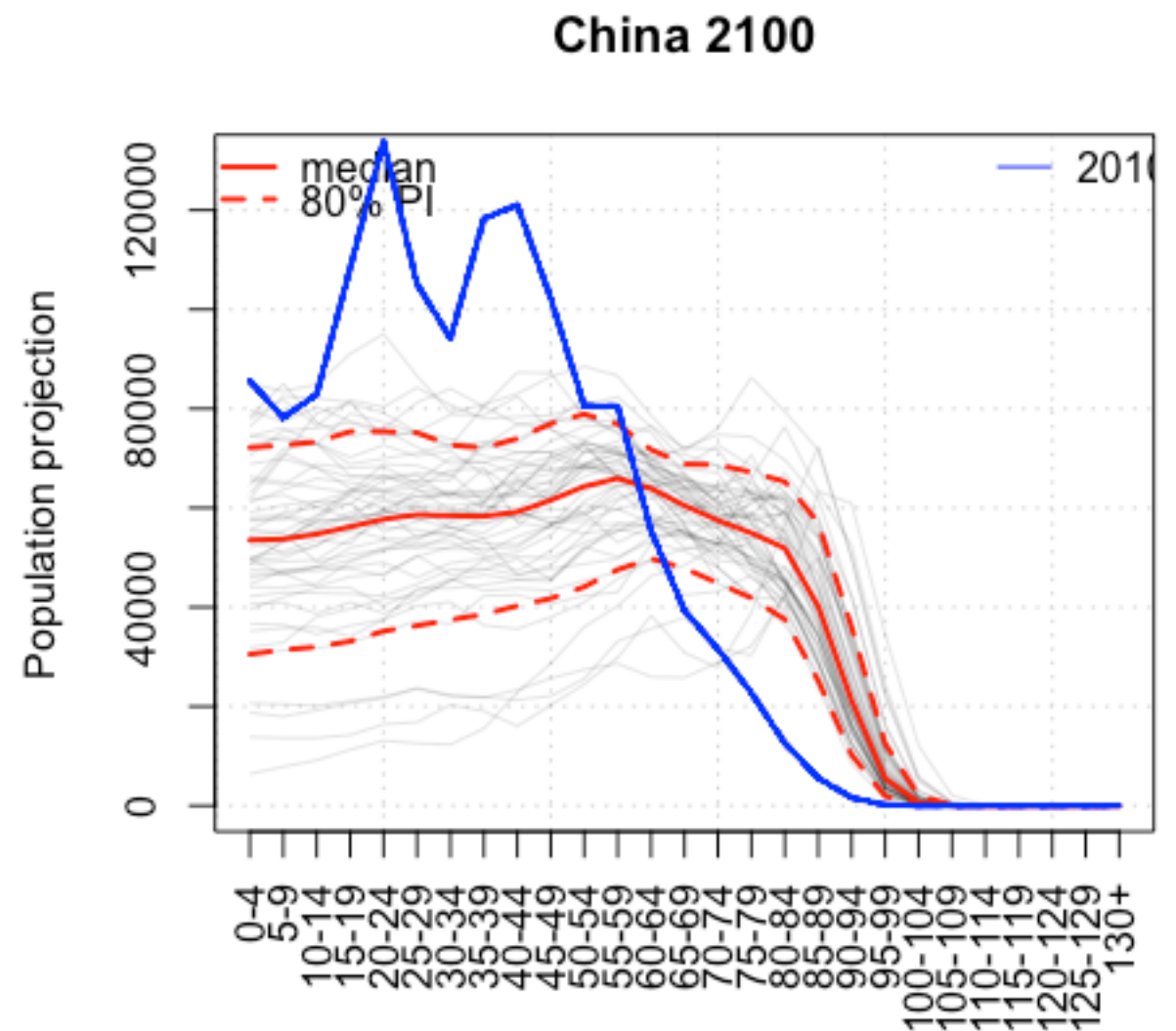

Fig. 13 Total population (1950 to 2100)

Fig. 14 Population by age (2010 to 2100)
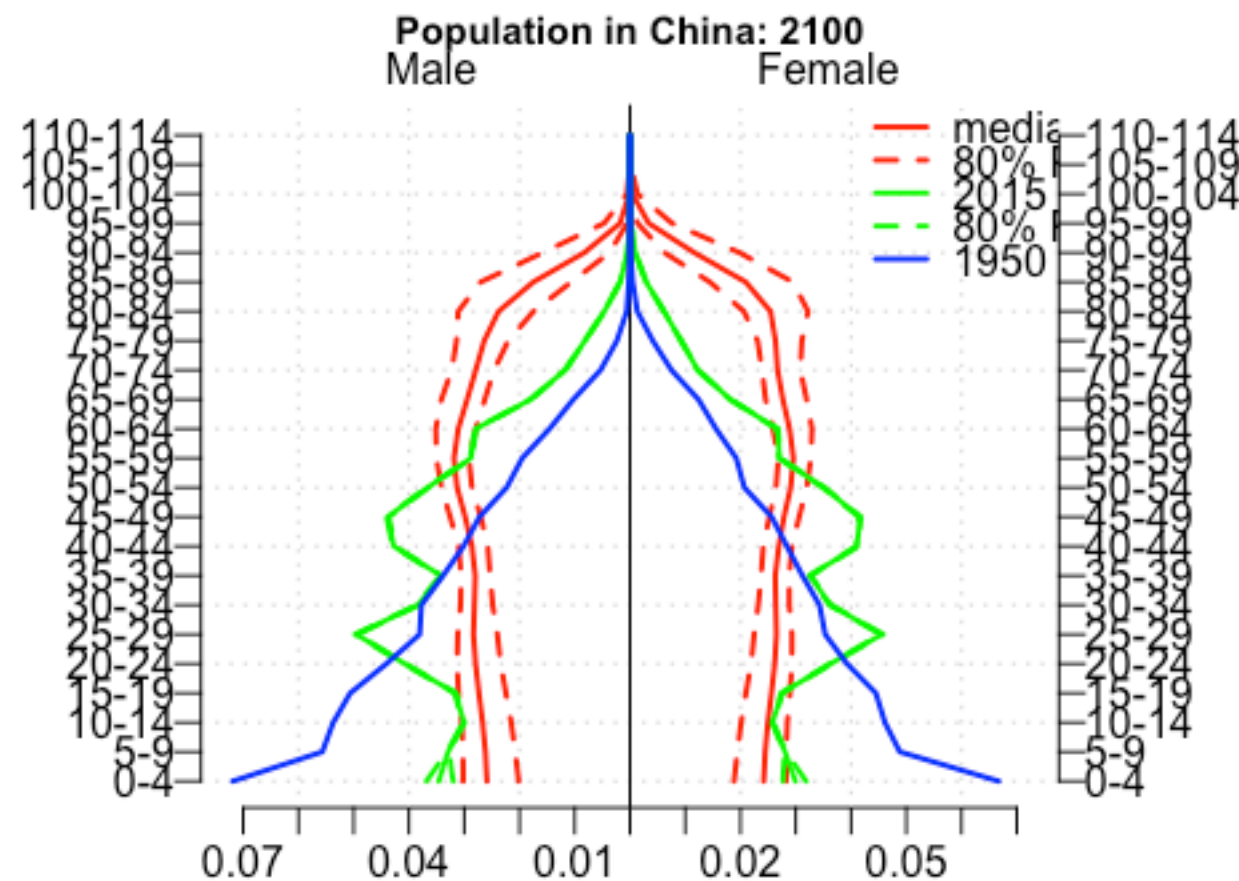
Country Specific — China

Fig. 15 Population by age and sex (1950, 2015 and 2100)
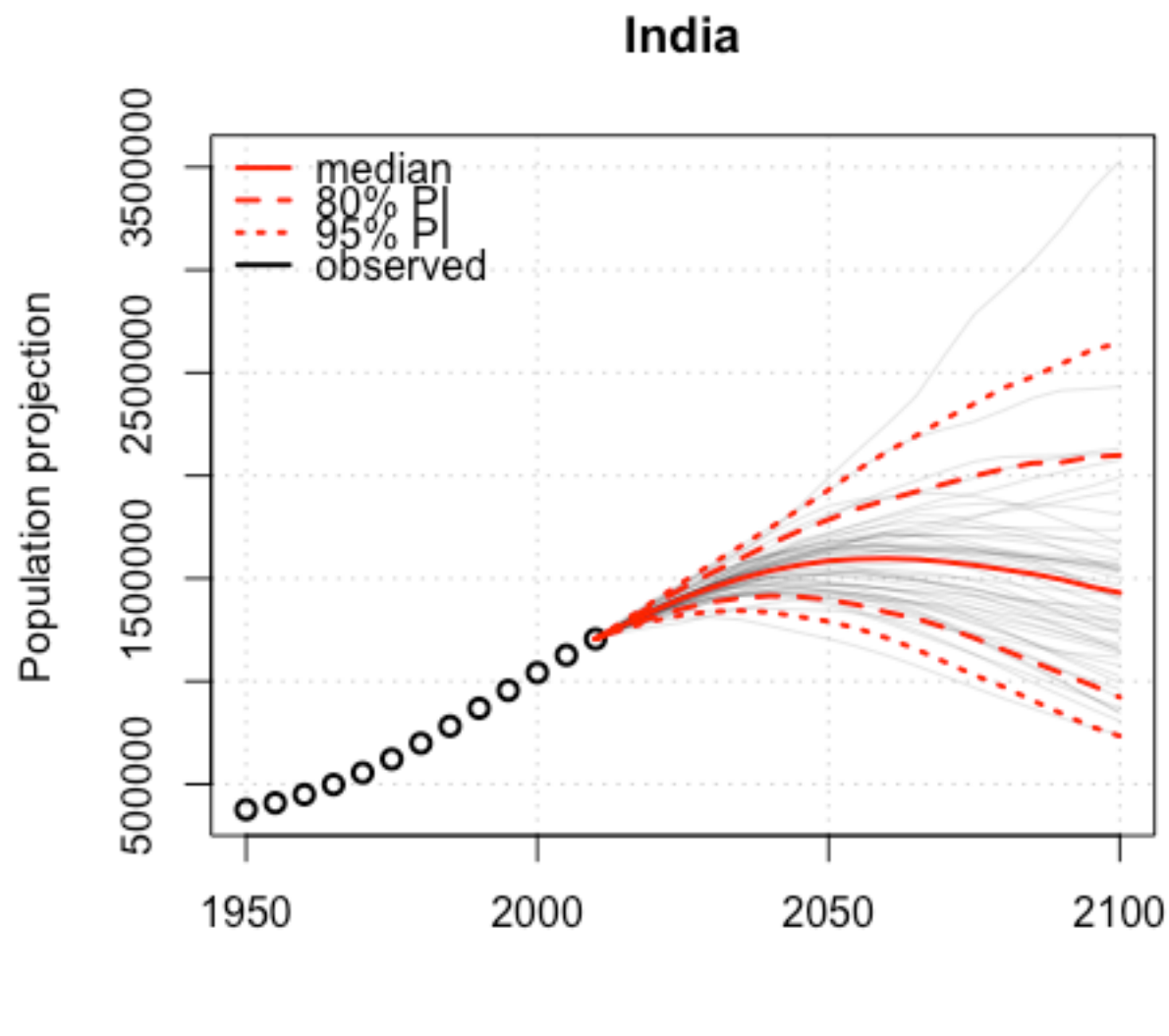
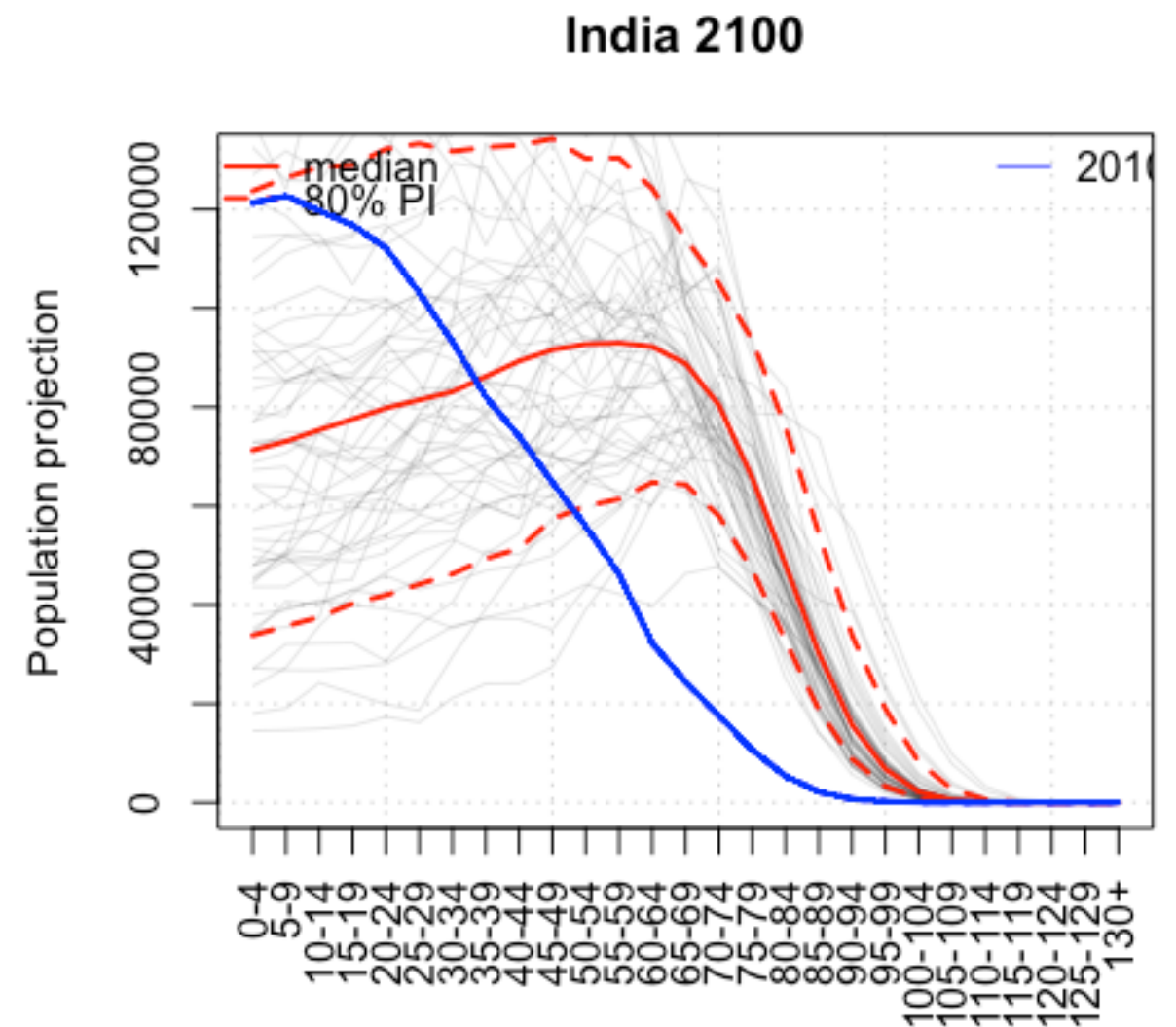# Country Specific — India

Fig. 16 Total population (1950 to 2100)

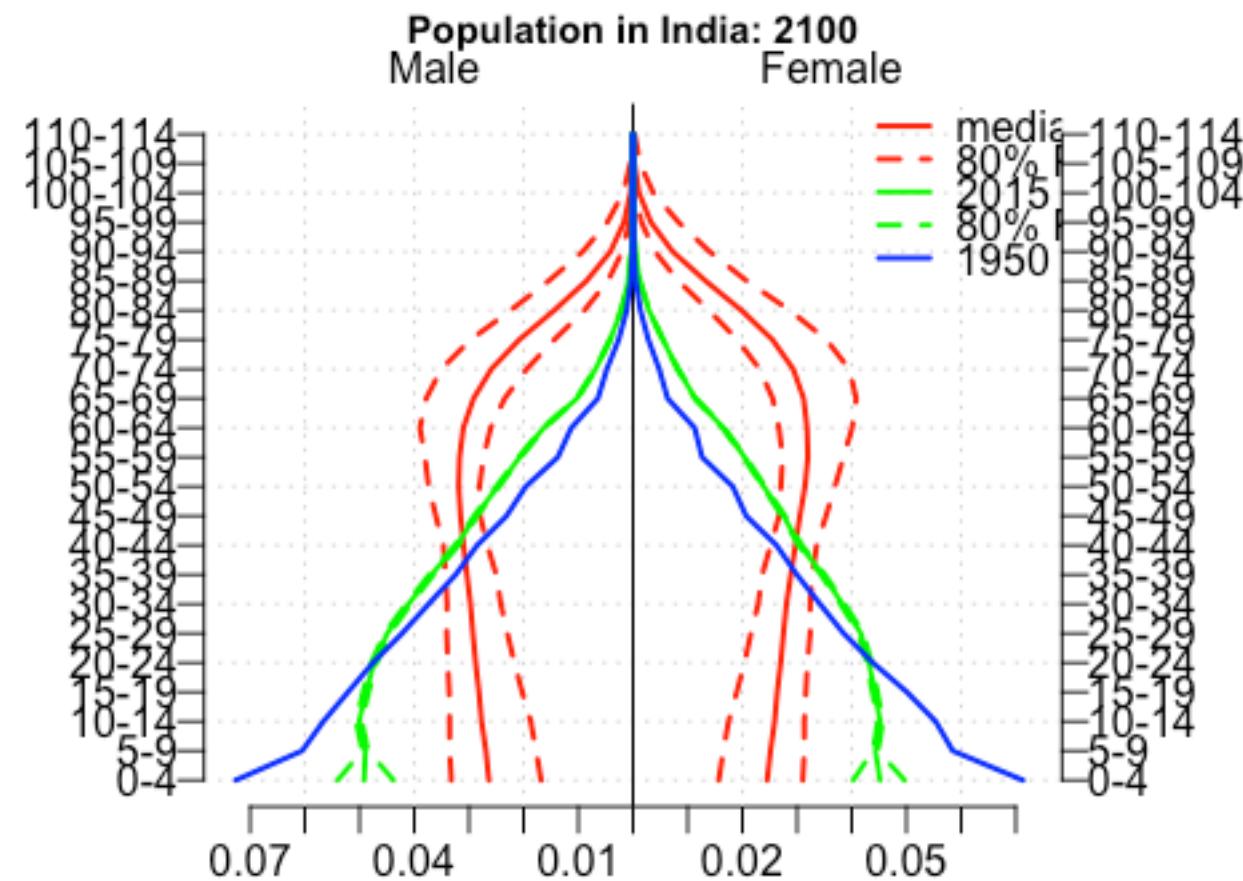Fig. 17 Population by age (2010 to 2100)

Country Specific — India

Fig. 18 Population by age and sex (1950, 2015 and 2100)

Conclusion

▷ Population ageing evident in all regions

▷ Negative population growth in Europe, Asia and Latin America

▷ Massive increase in population in Africa