TEXAS A&M UNIVERSITY

# SOCI 320–500
## Demographic Methods
## Fall 2019

**ASSIGNMENT 1**
**Due by September 22, 2019 (Sunday) at 11:59pm**
**Maximum of possible points: 20**

### Instructor information

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### Purpose

The purpose of this assignment is to test the knowledge about topics on exponential growth, as well as on periods and cohorts discussed in the classroom. These topics are the foundation to understand a series of demographic methods that will be discussed throughout this course (Wachter, Kenneth W. 2014. **Essential Demographic Methods**. Cambridge: Harvard University Press).

### Task

The following questions are related to demographic concepts and methods. Answers to substantive questions should be no more than 150 words and written in Microsoft Word. The Word document should be on US Letter paper size, one-inch margins, Arial font, size 11, 1.5 line spacing. Answers to methods questions should be solved in Microsoft Excel, but the final results and interpretations should be exported and properly formatted in the Word document. Look at examples of how to properly format tables and figures in Word at http://www.ernestoamaral.com/docs/soci320-19fall/Examples_tab_fig.pdf.

Questions highlighted in yellow were already answered by the professor as examples. The file with answers is available in the course website and should be read by students. These questions are not worth any points.

Extra questions are highlighted in red and are worth 1 point each.

All other questions are worth 2 points each.

### Submission

Students must email the Excel file to the professor. The Word file should be submitted through Turnitin within eCampus. Turnitin is an online database system designed to help instructors **detect plagiarism**, track citations, facilitate peer reviews, and provide paperless grading markup in written assignments. Students should develop this assignment **individually**.

## Questions – Chapter 1 – Exponential growth

1.0. Define the following concepts in demography: balancing equation, population growth rate, exponential growth, closed populations, and doubling times.

1.1. Between 1960 and 1975 the population of Indonesia grew from about 100.6 million to 137.5 million. Between 1990 and 2000 it grew from 187.7 million to 225.0 million. Find the growth rates between 1960 and 1975 and between 1990 and 2000. Have the growth rates increased or decreased?

1.2. If the average growth rate for the Indonesian population between 2000 and 2020 turns out to be 18 per thousand per year, what will the population in 2020 be?

1.3. The population of Nigeria in 1960 was about 39.2 million. The average growth rate *R* during the 1960s was 23.99 per thousand per year. During the 1970s it was 28.41; during the 1980s, 29.41; during the 1990s, 35.169. It is predicted to be around 30 per thousand per year from 2000 to 2020. Draw a rough freehand graph of the logarithm of Nigerian population over time based on these data, label the axes, and predict the population in 2020. [*You can draw the graph manually, digitalize your diagram, and insert in Microsoft Word.*]

1.4. How much longer would it take the population of Indonesia to double, as compared with Nigeria, under the rates precited for 2000 to 2020?

1.5. Official U.S. Census counts are shown in Table 1. What were the yearly growth rates and population doubling times between the following years: (a) 1790 to 1900? (b) 1900 to 1950? (c) 1950 to 2000? (d) 1790 to 2000?

**Table 1. U.S. Census counts in millions**

| Year | Population | Year | Population | Year | Population | Year | Population |
|---|---|---|---|---|---|---|---|
| 1790 | 3.929 | 1850 | 23.192 | 1910 | 91.972 | 1970 | 203.212 |
| 1800 | 5.308 | 1860 | 31.443 | 1920 | 105.711 | 1980 | 226.546 |
| 1910 | 7.240 | 1870 | 39.818 | 1930 | 122.775 | 1990 | 248.710 |
| 1820 | 9.638 | 1880 | 50.156 | 1940 | 131.669 | 2000 | 281.421 |
| 1830 | 12.866 | 1890 | 62.948 | 1950 | 150.697 | 2010 | 308.745 |
| 1840 | 17.069 | 1900 | 75.995 | 1960 | 178.464 | | |

Source: Wachter KW. 2014. Essential Demographic Methods. Cambridge: Harvard University Press. p.28

1.6. If world population grew from 6.851 billion at mid-year 2010 to 7.017 billion at mid-year 2012, what was the growth rate *R*? If world population continued to grow at or near this rate, how long would it take for the population to triple? How long for population to grow by 1 billion more beyond the 2012 level?

1.7. Suppose the world's population began to decline at rate of $R = 0.007$ per year. How many years would it take for population size to return from its 2012 level to its 1950 level?

1.8. If $R = 0.035$ and $t = 20$ years, what is $\exp(Rt)$? Estimate and interpret the natural log of the square root of $\exp(Rt)$? [*Tip: Exponential function is the inverse function for natural logarithms.*] What is the doubling time for a population growing at a rate of 35 per thousand per year?

1.9. At mid-year 2012 Brazil, Pakistan, and Nigeria had similar total populations, 194, 188, and 170 million, respectively. Growth rates were 0.011, 0.021, and 0.024 per year. Suppose growth continues at these rates for at least 8 years. Use the exponential model to project populations for these three countries in 2020. Would their rankings change?

1.10. What is the natural logarithm of 1 billion? From data in Table 1.2 (page 16, Wachter, 2014), working on a logarithmic scale, estimate the year at which China's population passed 1 billion.

1.11. Dates at which world population first exceeded each number of billions from 1 to 7 are estimated to be (1) 1800, (2) 1925, (3) 1960, (4) 1974, (5) 1987, (6) 1999, and (7) 2011. Find the growth rate between each of these dates.

1.12. Suppose we care about 20% accuracy in predictions of proportional increases in population for countries like Egypt with growth rates around 21 per thousand. How soon would multiplicative effects be sure to become important?

1.13. From the U.S. Census counts in Table 1, find the growth rate between 1900 and 2000 to six decimal places. Use this growth rate along with the population in 1900 to predict populations throughout the century from an exponential model with constant growth. Draw a plot showing the actual census counts as points and the predicted census counts as a curve. Differences between observed and predicted values reflect the effects of changing growth rates over time. Are these differences more or less important than the multiplicative effects visible in the steepening of the predicted curve?

## Questions – Chapter 2 – Periods and cohorts

2.0. Define and differentiate the following concepts: period person-years lived, cohort person-years lived, rates, probabilities, and ratios.

2.1. Of the world's 10 most populous countries in 2012 (Table 2.1, page 37, Wachter, 2014), which has the highest rate of immigration today? Which has the lowest Infant Mortality Rate? What fraction of the world's population is comprised by these 10 most populous countries? Search for current population data at World Bank Data (http://data.worldbank.org/).

2.2. Mexico is the country with the eleventh largest population in the world. Its Crude Birth Rate during 2012 is reported to have been 20.44 per thousand, and 2,373,020 are reported to have been born. What mid-year population size would be consistent with these numbers?

2.3. Poland has a nearly stationary population, with $e_0 = 76$. There were about 380,000 births in 2012. What was the approximate size of the population?

2.4. Study the data in Table 2.1 (page 37, Wachter, 2014), and determine whether $be_0$ is typically greater than, equal to, or less than 1 in a growing population. [*$b$ = CBR / 1,000 = crude birth rate / 1,000*].

2.5. From an almanac or other source, find dates of birth and death for the presidents of the United States from Theodore Roosevelt to Barack Obama. Draw a freehand Lexis diagram with the lifelines of these presidents. Label the axes clearly. [*You can do this exercise manually, digitalize your diagram, and insert in Microsoft Word.*]

(a) Draw and label a line representing the age 30 and a line representing the year 1945.
(b) Draw and label the area containing person-years lived by people between the ages of 20 and 30 for the years between 1964 and 1968.
(c) Draw and label the area representing the whole lifetime experience of the cohort aged 10 to 30 in 1917.

2.6. Work out an estimate of how many humans have ever lived based on the estimate for the time before the dawn of agriculture given in the text and the estimates of population sizes given in Table 1.4 (page 25, Wachter, 2014) under the assumption of constant rates of growth between the years cited in the table. For average lifespans, use 30 years before 1750, 40 years for 1750 to 1950, 50 years for 1950 to 1975, and 60 years for 1975 to 2000.