

Population Mathematics

Due: 16 March 2015

Adapted from Bowman Dickson



Which countries are growing fastest? Slowest? Which are actually declining in population? What will our population look like 40 years from now?

It's going to be very different. For example, India is projected to surpass China to become the most populous country in the world, growing from 1.3 billion to 1.6 billion people. (China is projected to be at 1.4 billion in 2050). That increase of 0.3 billion (300 million) is nearly the current populations of the US. A handful of countries are expected to nearly double their population or more, including Yemen (25 million – 45 million), Ethiopia (99 million – 188 million), Uganda (40 million – 104 million), the Democratic Republic of the Congo (71 million – 155 million), Afghanistan (32 million – 57 million), and Nigeria (183 million – 440 million).

Many other countries are expected to lose population over the course of the next 40 years. Ukraine is expected to go from 44.6 million people to 33.7 million people, losing a whopping 32% of their population. Nineteen other countries are expected to be less populous in 2050 than they are now including Russia, Japan, Germany, Poland, Italy, Greece, Romania and Bulgaria (which is projected to lose 30% of its population). The world will be a very different place in 2050.

Goal: Using data from the UN World Population Prospects, graph the population data for three different countries from the year 1950-2080. Use technology to develop a polynomial trend line. Then, in a typed report describe how the population has changed over the past 65 years and will change for the next 65 using the calculus concepts of increasing/decreasing, concave up/concave down, relative extremes and inflection points. Then, try to connect some of the trends that you see to history and global affairs.

Picking Countries: You can pick your favorite or dream destinations, countries in the same region, countries with similar sizes but in very different regions, or some other combination: try to pick something that ties your countries together. Be creative and mindful of your choices, as you will research and explain your findings.

Some historical trends to consider:

After effects of WWII (Japan, Italy, Germany, Russia, UK, US, France); Colonialism in Africa and Middle East; Breakup of Soviet Union (Russia and former USSR states of Kazakhstan, Ukraine, Kyrgyzstan, Azerbaijan, among many others); Korean War (US, China, the two Koreas); Vietnam War (Vietnam, Cambodia, Laos); Rwandan Genocide (and Uganda, DRC, Tanzania, Burundi); Middle Eastern conflicts (Iraq, Afghanistan, Israel, Palestinian territories, Lebanon); AIDS crisis (Botswana, Zambia, Zimbabwe, Lesotho, Namibia, Swaziland, South Africa); One-Child Policy in China (Kenya and India have implemented family planning programs as well).

Part 1: Population

Step 1: Gather Population Data:

Use the UN population tool: http://esa.un.org/unpd/wpp/unpp/panel_population.htm

j.mp/UNPOP

1. For "Select Variables" select Population.
2. For "Select Country/Region" scroll through and CTRL+click the three countries you've picked.
3. For "Select End Year" choose 2080. Leave everything else as-is.

4. Click “Download as .csv File” and open in Excel.

Step 2: Create Scatter Plot in Excel:

1. Change the heading of the column that reads “Value” to “Population (thousands)”
2. Click the 1950 cell for your first country. It should be cell D2. Use the mouse and drag so that all of the relevant data in the Year and Population columns is selected. (D2 all the way through E28).
3. With the data selected, click the Insert tab on the top ribbon, then Chart, then Scatter.
4. A chart should appear. Double click “Chart Title” to change it to “[Country] Population”
5. Under “Chart Tools” at the top, select “Layout” and then “Axes Labels”. Add both labels and change them to the appropriate text.

Step 3: Develop a Trendline

1. Right-Click one of the scatter plot’s points and select “Add Trendline”.
2. In the window, select “Polynomial”, change the order to “3” and check “Display equation on chart”
3. Right-Click the equation after it has appeared in the chart and select “Format Trendline Label”
4. Change Category from “General” to “Number”.

Repeat the steps for the other 2 country charts. You can then copy/paste your charts into a Word document for easy access later. SAVE IT.

Step 4: Graphical Analysis

Questions your report should answer:

1. Where are the critical points? What do these tell you about the population?
2. Where are the inflection points? What do these tell you about population growth/decline?
3. When is the population increasing and when is it decreasing?
4. When is the graph concave up? When is it concave down?
5. When is the population increasing the most rapidly? Decreasing the most rapidly?
6. Are there any particular points of interest in the graph?

Part 2: Population Rates

Use the UN population tool: http://esa.un.org/unpd/wpp/unpp/panel_population.htm j.mp/UNPOP

Step 1: Select Detailed Data

1. On the right column menu of the website, click “Detailed Indicators”
2. Under Select Variables, CTRL+click the following: CRUDE BIRTH RATE; CRUDE DEATH RATE; NET MIGRATION RATE
3. Under Select Country, choose the first of your 3 countries.
4. Change “Select End Year” to 2080, and click Download as .csv file.

Step 2: Organize Data

1. Change E1 from Value to “Birth Rate”, then in F1 write “Death Rate”, in G1 “Migration Rate” and H1 “Overall”
2. Highlight the death rate values (E28-53). Copy these values. Then click F2 and paste.
3. Repeat for migration rate (E54-79) and paste in G2.

4. Now click the cell H2. Type in the following exactly: $=E2-F2+G2$. This will calculate the overall rate by taking the birth rate, subtracting the death rate, and adding the net migration rate.
5. In the bottom right corner of H2 cell is a small black square. Click and hold that square with the mouse. The icon will transform into a cross. While holding the mouse button, move the mouse down to H27 and release. The rest of the column should now be filled in.
6. With the mouse, highlight the entire rectangle from D1 to H27. Then click Insert, then Scatter.
7. Change the chart title and add the appropriate axis labels.

Repeat these steps for your other 2 countries. No trend line equation is needed for this data. Copy and paste your charts into your Word document and SAVE IT.

Step 3: Graphical Analysis

Compare the charts generated from Part 1 and Part 2. Your report should answer the following:

1. How are the graphs (especially the overall rate) related to the population graph?
2. What do the zeros/roots/x-intercepts on the rate graphs correspond to on the population graph?
3. What do maxima and minima on the rate graphs correspond to on the population graph?
4. What other information do the birth and death rates give you?

Part 3: Analysis

In a report (at least 2 double spaced pages of text not counting graphs), explain how the countries populations have changed in the past 65 years and how they may change in the next 65. Be sure to answer the questions raised in the graphical analysis steps above, as well as any others you may wish to write about. Include some historical analysis or predictions about what caused/causes the changes you see.

You should use some/all of these terms in your analysis: relative maximum, relative minimum, rate of change, fast/slow growth or decline, increasing/decreasing at an increasing/decreasing rate, inflection point, first derivative, second derivative, concave up, concave down.

(Extra Credit) Part 4: Mathematical Analysis

Using the trend line equations generated by Excel, find their relative extremes and inflection points.

NAME:

	EXCELLENT	GOOD	FAIR	POOR
DATA AND GRAPHS Present data and graphs about the populations of the countries that you studied. <div style="border: 1px solid black; width: 50px; height: 20px; display: inline-block;"></div> / 8	-data correctly and accurately graphed	-data correctly and accurately graphed	-minor mistakes in the graphing	-data not correctly & accurately graphed
	-graph presentation is concise and grouped well	-graphs are grouped well and overall presentation is understandable	-graph presentation understandable but could be more efficient	-graphs presentation is confusing and not organized
	-graphs clearly and appropriately titled	-graphs have titles that are accurate	-most graphs have titles	-graphs missing titles
	-axes clearly labeled on all graphs	-axes labeled on all graphs	-axes labeled on most graphs	-axes not labeled on most graphs
	-graphs labeled for ease of reference in text	-graphs labeled for ease of reference in text	-graphs not labeled well for ease of reference in text	-graphs poorly labeled; confusing references in text
	+7-8 POINTS	+5-6 POINTS	+3-4 POINTS	+0-2 POINTS
ANALYSIS Based on the data you collected, write an analysis that discusses trends in population growth and decline. <div style="border: 1px solid black; width: 50px; height: 20px; display: inline-block;"></div> / 14	-analysis is well organized with an introduction, conclusion and overall structure	-analysis is organized, contains overall structure that is easy to follow	-topics are organized, but maybe don't fit well together, difficult to read at times	-analysis is disorganized and hard to follow; just random statements put together
	-actual data/graphs used well to support claims about trends	-actual data/graphs mentioned to support analysis	-some claims supported by data and graphs	- data/graphs not used well to support analysis
	-concepts and special points from calculus elucidated in discussing trends	-concepts and special points from calculus discussed to analyze trends	-concepts and special points from calculus mentioned	-concepts and special points from calculus discussed to analyze trends
	-graphs of growth rate trends clearly used to deeply analyze population	-graphs of growth rate trends mentioned to analyze population	- growth rate trends discussed but not related to the population	-growth rate trends not discussed, not related to the population
	-discussion in depth and substantive, goes above and beyond basic requirements	-discussion substantive, hits many interesting points and bring them together	-discussion good, but could use more depth, misses out some opportunities for discussion	-discussion skims the surface, misses crucial points and seems incomplete
	+13-14 POINTS	+10-12 POINTS	+6-9 POINTS	+0-5 POINTS
MECHANICS Present your project in a professional manner. <div style="border: 1px solid black; width: 50px; height: 20px; display: inline-block;"></div> / 3	-spelling /grammar are flawless	-no major mistakes in spelling/grammar	-some mistakes in spelling/grammar	-major mistakes in spelling/grammar
	-writing style clear and easy to read	-writing style clear and easy to read	-writing style could be more clear	-writing style gets in the way of ideas
	-presentation is neat, professional organized and well formatted	-presentation is neat professional and organized	-presentation does not get in the way, not entirely clear	-presentation is messy, distracts from the project
	+3 POINTS	+2 POINTS	+1 POINTS	+0 POINTS

TOTAL: / 25 =

SF.m Population Data and Graphs	0	1	2	3	3.5	4
SF.n Analysis of Population Data	0	1	2	3	3.5	4

