**Business Understanding:**

“Predict the population of 2122.” Such a task is quite daunting on the surface, as many factors need to be considered- not just the changes in population per country, but also how a growing population’s continuous use of resources affects further growth. This resource consumption is charted through either a population’s “carrying capacity” (the maximum possible population for a given species based on the resources its environment holds and how many resources are required to sustain one individual)[[1]](#footnote-1) based on where that population is located, or through cataclysmic developments caused by those resources, either directly, like a forest fire razing an entire harvest of crops, or indirectly, like a war over the control of a valuable resource such as oil. For this reason, current population and expected population growth per country, as well the chance for catastrophe and wars, will be used to chart the predicted population in 2122.

The primary datasets used come from an article in Our World In Data[[2]](#footnote-2), published in 2013 and most recently revised in 2019. It contains data such as population density (as some countries are more densely or sparsely populated than others, and as such, their growths would differ from that of other countries), current population estimates for each country, and current global population estimates. Each of these three metrics are similarly useful for projecting population, and thus, all three will be factored into a final number, averaging the results of each.

**Ways to Measure Population- Global Growth Rate:**

The naïve solution to this problem is to project and extrapolate an exponential equation for the next one hundred years (Pn = Po \* er\*t), where Po is the “starting population” at a given time t=0 (corresponding to 2022), e is Euler’s number, r is the population’s growth rate, and t is the time elapsed in years (in this case, 100). Using the most recent year’s measured change in population (an increase of about 80 million people, or 1% of the population)[[3]](#footnote-3), Pn should be 7,953,952,567 \* e0.01\*100 = **21,621,084,727** people in 2122.

Chart, line chart

Description automatically generatedFigure 1: Simple Exponential Estimate of Population in 2122

However, this number is highly skewed, as the growth rate of humanity in the last one hundred years has eclipsed the growth of Earth’s population by several orders of magnitude, meaning the current “growth rate” is not at all what it used to be, even a hundred years ago.

Chart

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Figure 2: World Population Graph[[4]](#footnote-4)

This number also does not account for the *carrying capacity[[5]](#footnote-5)* of the earth, which scientists estimate to be slightly more than ten billion people. As the carrying capacity largely limits the growth of a population, human population growth can more *closely* be modeled logistically, because the population would otherwise reach this ‘carrying capacity’ within a few decades, as Pn = K / (1 + ((K – Po) / Po) \* e-r\*t, where K is the carrying capacity of the Earth (in this case, estimated to be 10.5 billion). Thus, our new population would be 10,500,000,000 / 1 + ((10,500,000,000-7,953,952,567) / 7,953,952,567) \* e-0.01\*100 = **9,393,807,594** people in 2122.

Chart, line chart

Description automatically generatedFigure 3: Carrying Capacity-bound Estimate of Population in 2122

A population growing closer to the carrying capacity of its environment will gradually slow its growth, and this is reflected in the population’s average growth rate over the last seventy years.

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Figure 4: Average Population Growth Rates from 1950 to 2022[[6]](#footnote-6)

According to Our World in Data, “The UN projects that the global population increases from a population of 7.7 billion in 2019 to 10.9 billion by the end of the century. By that time, the UN projects, fast global population growth will come to an end.”[[7]](#footnote-7) As this is less than an order of magnitude off from the number resulting from factoring in a carrying capacity, we can reasonably conclude that the carrying capacity of the Earth is at least *close* to 10.5 billion people.

**Ways to Measure Population- By Country, % Change in Population:**

Another estimate for population can be performed by analyzing each country’s local trends and summing them all. However, Our World in Data features estimated and imputed data from as far back as 10,000 B.C., which does not accurately reflect modern population trends. To account for this, only population numbers from 1820-2021 were used to create an “average change in population per year” over this almost-two-hundred-year timespan. With an estimate of growth, this number can then be used to extrapolate the population in 2022.

(paragraph about the results we got)

**Causality of Catastrophe:**

**Final Number:**

Each of these three methods has their own pros and cons. While a scientific adherence to carrying capacity corrects matches predicted behavior for a population quickly approaching the potential limit of the earth, it does not account for anything less than a global scale. Small-scale catastrophes or changes in political climate that can restrict specific countries are typically hidden by the breadth of a singular, large equation. Conversely, a population estimate that tracks each individual country’s population changes does not properly scope any wide-scale catastrophes or trends- which makes it quite hard to extrapolate with (especially over a great length of time) due to the lack of an overarching trend to follow.

As all three of these methods have their own pros and cons, the most accurate estimate should average and draw from all three of these estimation methods, leveraging the strengths of all three to mitigate the weaknesses of each of them. Based on these three methods, the population in 2122 can be predicted to be (9,393,807,594 + Y + Z ) / 3 =

1. https://www.science.org.au/curious/earth-environment/how-many-people-can-earth-actually-support [↑](#footnote-ref-1)
2. https://ourworldindata.org/world-population-growth#population-growth-by-country [↑](#footnote-ref-2)
3. https://www.worldometers.info/world-population/world-population-projections/ [↑](#footnote-ref-3)
4. https://www.worldometers.info/world-population/ [↑](#footnote-ref-4)
5. https://www.science.org.au/curious/earth-environment/how-many-people-can-earth-actually-support [↑](#footnote-ref-5)
6. https://www.worldometers.info/world-population/ [↑](#footnote-ref-6)
7. https://ourworldindata.org/future-population-growth [↑](#footnote-ref-7)