**Part 3 Discussions**

1. Interpret the data in the matrix, and discuss the social factors that influence those numbers.

There are several social factors that can influence the size of a population. The population in question has a dramatic decrease in population before bouncing back 20%. This could be due in part to the population’s food source not being able to keep up with the increasing population. Or there could have been a war that killed off many of the population. The dramatic increase could be associated with peacetime and an influx of returning soldiers. This could be similar to the baby boom that America experienced after WWII.

2. What will the population distribution be in 2010? 2020? 2030? 2040? 2050? Calculate also the total population in those years, and by what fraction the total population changed each year.

Below are the population distributions, total population, and fraction of change calculations for the given years.

2010- {{ 3.023809524 },{ 0.7 },{ 0.769047619 },{ 0.771428571 },{ 0.9 },{ 0.838095238 },{ 0.647619048 },{ 0.44 },{ 0.171428571 }}; 8.261428571 \* (10^15) people in the population; 41.821 % decrease

2020 -{{ 0.816929134 },{ 0.7 },{ 0.196771654 },{ 0.228897638 },{ 0.229606299 },{ 0.26192126 },{ 0.221732283 },{ 0.164913386 },{ 0.058204724 }}}; 2.878976 \* (10^15) people in the population, 65.152 % decrease

2030 - { 0.7 },{ 0.728337349 },{ 0.216780723 },{ 0.252173494 },{ 0.247333012 },{ 0.256493494 },{ 0.208994699 },{ 0.080747952 }}; 2.690860723 \* (10 ^15) people in the population; 6.534 % decrease

2040 - {{ 1.183044815 },{ 0.7 },{ 0.37814399 },{ 0.416596222 },{ 0.123994781 },{ 0.14103352 },{ 0.12575125 },{ 0.125518377 },{ 0.053129472 }}; 3.247212427 \* (10^15) people in the population; 20.676 % increase

2050 - {{ 1.389038221 },{ 0.7 },{ 0.502939527 },{ 0.287672611 },{ 0.316925103 },{ 0.092232691 },{ 0.095369858 },{ 0.081846825 },{ 0.042439095 }}; 3.508463931 \* (10^15) people in the population; 8.045 % increase

3. Use the power method to calculate the largest eigenvalue of the Leslie matrix A. The iteration of the power method should stop when you get 8 digits of accuracy. What does this tell you? Will the population go to zero, become stable, or be unstable in the long run? Discuss carefully and provide the mathematical arguments for your conclusion. You might want to investigate the convergence of ||Ak||.

After implementing the Power method to find eigenvalues and eigenvectors, the iteration of the power method stopped within 8 digits of accuracy and provided us with the following number: 1.28865623.  Based on our mathematical calculations, we predict that the population will become unstable in the long run.   We have ample mathematical arguments to support this conclusion.  When we look at the convergence of ||Ak||, it is clear that the approximated eigenvalue λ and approximated eigenvector v output lead to a largest eigenvalue that mathematically proves that the population is growing or shrinking faster than manageable.   A lower eigenvalue (less than one) leads to slower growth and a more stable rate, but our rate of convergence is clearly the mark of an unstable population.  Also, looking at the population distributions by year, we also see an exponential growth or dramatic decay in population in 2020 and 2030 and in 2040 and 2050, respectively.  Using the rules of the Power Method and the results of the iterations, we can clearly see that the population is unstable.

4. Suppose we are able to decrease the birth rate of the second age group by half in 2020. What are the predictions for 2030, 2040 and 2050? Calculate again the largest eigenvalue of A (to 8 digits of accuracy) with your program and discuss its meaning regarding the population in the long run.

If we were to cut in half the birthrate for the second age group in 2020, we expect to see stability in the following decades of 2020-2050. We found the largest eigenvalue to be 1.16790271 with up to eight digits of accuracy. In the long run, this means the population that we are studying would be more stable, as it is closer to 1.