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MACM 316 Assignment 5: Report

Synopsis

The goal of this report is to investigate the distribution of the roots of all binary polynomials of a given maximum degree *d*. In other words, we will be computing and plotting

R_d = {$r \in$ C: *r* is a root of a binary polynomail of degree n $\leq d$} with coefficients $a_n, a_{n-1},..., a_0 \in \{-1, 1\}$.

Discussion

After several runs of my code, there were at total *d* roots for a *d*-degree binary polynomials of the 2^{d+1} different permutations of the polynomial coefficients.

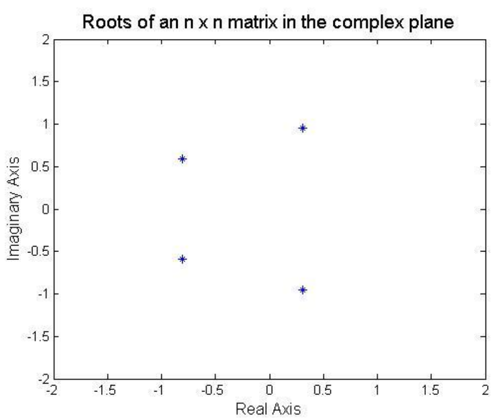

Figure 1. Roots of 4th degree polynomial

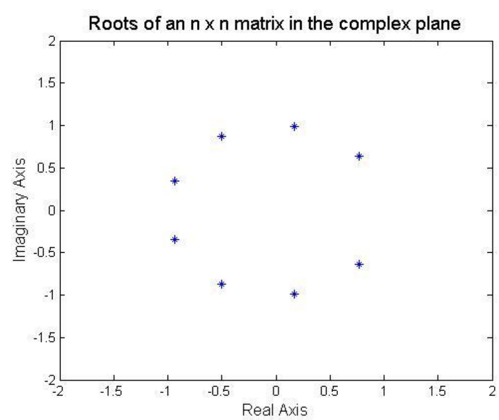

Figure 2. Roots of 8th degree polynomial

In *Figure 1*, The roots of the 4th degree polynomial first appear to be arbitrary, however, the degree increases in *Figure 2*, the roots of the polynomials start settling between {-1, 1} on both the y and x-axis. As mentioned above, in *figure 1*, there is a total of 4 roots for a 4th degree polynomial and in *figure 2*, there is a total of 8 roots for an 8th degree polynomial, and in *Figure 3*, 12 roots for a 12th degree polynomial

The roots of the polynomials consistently form a circle with the radius of 1 on the plot in *Figure 3*. By definition, *a circle with a radius of one* is called the unit circle. The unit circle becomes apparent as the degree of *d* becomes larger as in *Figure 4*. From the results of *RandPolyRoots.m* which computes the roots of random coefficients of numerous matrices which also forms the unit circle when plotted in a robust manner, I can conclude that plotting the roots of any polynomial will result in the unit circle.

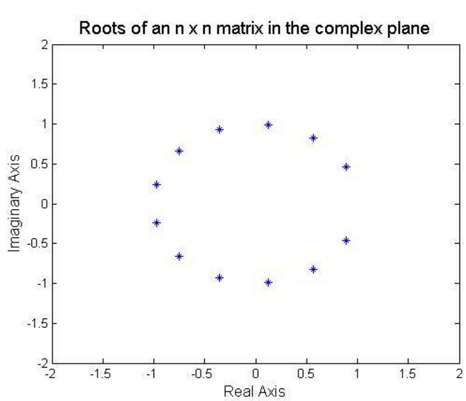

Figure 3. Roots of 4th degree polynomial

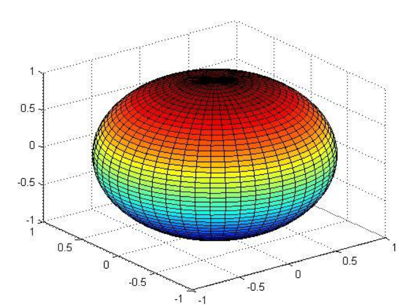
Figure 4. Unit Circle from Roots of Polynomial