PPD - Lab 5

1. O(n^2) algorithm
   Computes the basic multiplication algorithm, multiplying every coefficient of the first polynomial with every coefficient from the second polynomial.

2. O(n^2) parallel
   Performs the basic multiplication algorithm using a ThreadPoolExecutor that manages task execution, ensuring threads execute concurrently without interfering with each other. Each thread operates on a distinct range of indices, calculated during task partitioning.

3. Karatsuba algorithm
   Each polynomial is recursively divided in 2 parts: the low part(lower degree coefficients) and the high part (higher degree coefficients). If we are in the best case where either of the two polynomials are of degree one, we will do the basic computation(O(n^2) algorithm, for efficiency. If not, compute recursively three key products:
   - P1: product of the lower parts of the 2 polynomials (lower1*lower2)
   - P2: product of the sums of the higher part and lower part of each polynomial ((low1+high1)*(low2+high2))
   - P3: product of the higher parts of the 2 polynomials (high1*high2).

   After obtaining these 3 products, we combine them for the final result:
   we shift the higher part to its place by adding n number of zeros, remove the overlapping terms (by computing p2-p3-p1) then shifting the result by n/2 number of zeros and adding the lower part. The final formula is:

   p3*(x^n) + (p2-p3-p1)*x^(n/2) + p1, where n=max degree

4. Karatsuba parallel
   We parallelize the algorithm described at 3 by using a fixed thread pool managed by ExecutorService. Each subproblem is submitted as a task, returning a Future to retrieve results after completion. To optimize performance, when recursion depth exceeds a threshold or polynomials' degree are small enough, the computation switches to sequential approach.

Algorithm	Degree	Time
Regular Sequential	50	0.001s
Regular Sequential	100	0.002s
Regular Sequential	150	0.003s
Regular Parallel	50	0.003s
Regular Parallel	100	0.004s
Regular Parallel	150	0.005s
Karatsuba Sequential	50	0.003s
Karatsuba Sequential	100	0.006s
Karatsuba Sequential	150	0.008s
Karatsuba Parallel	50	0.012s
Karatsuba Parallel	100	0.013s
Karatsuba Parallel	150	0.012s