Programming and Data Structure Lab [CS19003][Section-1] Assignment-1

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Write a C program for the tasks as described below. Save the file as **A01_[Roll_Number].c**. Build and run to check your program. Upload the .c file for the assignment in MS teams.

1. Read two degree 2 polynomials f and g of the form:

$$f(x) = a_0 + a_1x + a_2x^2$$
$$g(x) = b_0 + b_1x + b_2x^2,$$

   where all the coefficients are integer modulo prime $p = 59$. Add $f(x)$ and $g(x)$ to compute another degree two polynomial $h(x)$. Print $f(x)$, $g(x)$ and $h(x)$ using **coefficient representation**.

2. Consider the polynomials $f(x)$ and $g(x)$ from the first part of the assignment. Read 3 unique integers modulo p and evaluate $f(x)$ and $g(x)$ on those points. If 3 integers are **not unique** print an **error message** and exit. Let $\{\alpha_1, \alpha_2, \alpha_3\}$ are those points, then the evaluation should give us $\{f(\alpha_1), f(\alpha_2), f(\alpha_3)\}$ and $\{g(\alpha_1), g(\alpha_2), g(\alpha_3)\}$. Add them point-wise to obtain:

$$\{f(\alpha_1) + g(\alpha_1), f(\alpha_2) + g(\alpha_2), f(\alpha_3) + g(\alpha_3)\}.$$

   Define polynomial $m(x)$ in the point-value representation as:

$$\{\{\alpha_1, m(\alpha_1)\}, \{\alpha_2, m(\alpha_2)\}, \{\alpha_3, m(\alpha_3)\}\}$$
$$:= \{\{\alpha_1, f(\alpha_1) + g(\alpha_1)\}, \{\alpha_2, f(\alpha_2) + g(\alpha_2)\}, \{\alpha_3, f(\alpha_3) + g(\alpha_3)\}\}.$$

   Print $f(x)$, $g(x)$ and $m(x)$ using **point-value representation**.

3. Here we will **check equivalence** between coefficient representation and point-value representation of a polynomial. Consider $\{\{\alpha_1, m(\alpha_1)\}, \{\alpha_2, m(\alpha_2)\}, \{\alpha_3, m(\alpha_3)\}\}$ from the second part of the assignment. Compute the polynomial $m(x)$ in coefficient representation from the point-value representation (Use the Lagrange interpolation for this purpose). Print $m(x)$ and $h(x)$ in coefficient representation to check whether they are **equivalent**. If they are not equivalent print an error message.

Lagrange Interpolation: Consider a degree two polynomial $f(x)$. Let $\{\{\alpha_1, f(\alpha_1)\}, \{\alpha_2, f(\alpha_2)\}, \{\alpha_3, f(\alpha_3)\}\}$ be one point value representation of $f(x)$. Then we can write $f(x)$ as:

$$f(x) = f(\alpha_1) \cdot \frac{(x-\alpha_2)(x-\alpha_3)}{(\alpha_1-\alpha_2)(\alpha_2-\alpha_3)} + f(\alpha_2) \cdot \frac{(x-\alpha_1)(x-\alpha_3)}{(\alpha_2-\alpha_1)(\alpha_2-\alpha_3)} + f(\alpha_3) \cdot \frac{(x-\alpha_1)(x-\alpha_2)}{(\alpha_3-\alpha_1)(\alpha_3-\alpha_2)}.$$

Note:

- You can not use Array, Loops, Iterations for this assignment.
- Consider all the operations defined over modulo prime p.