# Project 4

## Group Members

Abhishek Gupta (axg137230) and Manuj Singh (mxs135630)

## Objective

To develop a program that implements arithmetic with large integers, of arbitrary size. The program should be capable of arithmetic operations like addition, subtraction, multiplication, and power.

## Implementation

The big number is represented by linked list in the reverse order with each node containing single integer. For example, number 123456789 will be represented as shown below:

9 -> 8 -> 7 -> 6 -> 5 -> 4 -> 3 -> 2 -> 1 -> NULL

This implementation only works for base 10. Below section explains how each of the arithmetic operation is implemented.

### Addition:

The addition operation is a simple one. Below is the thought process behind it.

1. Iterate through both the lists till both reaches till the end.
2. Add each values stored in each node of two lists and keep inserting the sum into third list. Also maintain the carry along with it.
3. Since the third list will be produced in the order, so to maintain consistency reverse it.

### Subtraction:

Below is the thought process behind implementing subtraction. We are subtracting second list from the first one.

1. Iterate through both the list till both reaches the end.
2. Subtract value in the node of second list from the value in the node of first list.
3. Maintain carry flag if it is less and add 10 to the value of node from first list.
4. Store the result in the third list.
5. If first list reaches end earlier than the second one; set all nodes of third list to zero. (Negative result)
6. If value of last node of first list is smaller than the value of last node of second list; set all nodes of third list to zero. (Negative result)
7. Removing all zeros in the beginning of the third list.
8. Since the third list will be produced in the order, so to maintain consistency reverse it.

### Multiplication:

The approach of multiplication uses two result list, one stored the previous multiplication result and used for the next one. Below is the thought process behind implementing multiplication.

1. Choose the smaller list. For simplicity we will multiply larger list to smaller list.
2. Iterate the larger list for every node in the smaller list.
3. Store the result in the third temp list, also maintain carry along with it.
4. Assign reverse of temp list to the result list. Use this resultant list in the next iteration for addition with the next multiplication rounds.
5. Finally after the iteration ends, the resultant list contains the final result.

### Power:

The power operation finds first number to power of second number in the argument list. This function make use of multiplication and subtraction. The thought process behind the implementation is explained below.

1. Keep on multiplying first list with itself and store in third list and reduce 1 from the second list.
2. Repeat this step till the second argument becomes 1.
3. Third list will contain the final result.

### Input Pattern:

The input file is read and each pattern is store in the array of string with line number as index. Then array is being iterated and computations is done. For every new variable found, a Hash Map contains that variable as key and it value as the value in the map.

## Development Platform/System Information

Language: JAVA

JDK version: JDK1.8