**Experiment 17**

**Polynomials using Linked List**

**Date:** 19-11-2020

**Aim:** To receive two polynomials and print their sum and product

**Data Structure Used:** Linked List

**Operation Used:** Comparisons, addition, multiplication

**Algorithm for Addition (ADD\_POLY):**

**Input:** Two polynomial, A and B with the terms as the nodes of a linked list and ‘a’ denoting the number of terms in polynomial A and ‘b’ denoting the number of terms in polynomial ‘B’

**Output:** Sum of the polynomial ‘C’

**Data Structure Used :** Linked List

Step 1 : Start

Step 2 : Receive two polynomial in linked list

Step 3 : i = A → Header //Pointer to the header of polynomial A

Step 4 : j = B → Header //Pointer to the polynomial B

Step 5 : while i =! NULL and j=! NULL

Step 1: new=GetNode(Node)

Step 1 : if i→ pow == j→ pow

Step 1: new→ pow = i→ pow

Step 2: new → coeff = i → coeff+j → coeff

Step 3: C.addNode(new)

Step 4: i=i→link

Step 5: j=j->link

Step 2: else if i→pow < j→pow

Step 1: new → pow = j→pow

Step 2: new→ coeff=j→ coeff

Step 3: C.addNode(new)

Step 4: j=j→ link

Step 3: else if i → pow > j → pow

Step 1: new→coeff = i->coeff

Step 2: new→pow = i→ pow

Step 3: i=i → link

Step 4: C.addNode(new)

Step 4: Endif

Step 6 : EndWhile

Step 7 : while i!=NULL

Step 1: new→coeff = i → coeff

Step 2: new→pow = i → pow

Step 3: i = i → link

Step 4: C.addNode(new)

Step 8: EndWhile

Step 9: while j!=NULL

Step 1: new = GetNode(Node)

Step 2: new → pow = j→pow

Step 3: new→ coeff=j→ coeff

Step 4: C.addNode(new)

Step 5: j=j→ link

Step 10 : EndWhile

Step 11 : return c

Step 12 : Stop

**Description of the Algorithm:**

In this algorithm the polynomials’ terms are the nodes of a linked list and there are 2 pointers i and j, which points to the nodes of A and B respectively. If the powers of a term in A and B are equal then the coefficeint are added and the sum is put into a new node (new). Which is then added to the end of the resultant polynomial C. If the coefficientof the term in A is greater than the term in B then the term is added to the end of B. Likewise for B also.

**Algorithm for Multiplication(MUL\_POLY):**

**Input:** A and B, two polynomials with the terms as nodes of a linked list with pow being the power of the term and coeff being the coefficient

**Output:** Polynomial C, with

**Data Structure used:** Linked list

**Steps:**

Step 1:Start

Step 2: receive two polynomials

Step 3:i = A→ head

Step 4: j = B→ head

Step 5: initialize C as a polynomial with 0 as the only term

Step 6: k = 0

Step 7: while(k<B→numberOfTerms)

Step 1: j = B → head

Step 2: while(j!=NULL)

Step 1: new = GetNode(Node)

Step 2; new→pow = i→pow+j→ pow

Step 3: new → coeff = i→ coeff \* i→ coeff

Step 4: temp.addNode(new)

Step 5: j = j→link

Step 3: End While

Step 4: C= ADD\_POLY(C,temp)

Step 5: i=i→ link

Step 6: k++

Step 8: EndWhile

Step 9: return C

Step 10: Stop

**Description of the Algorithm:**

The polynomial product of (6X2+1)\*(7X2+3X+1) can be expressed as, 0+(6X2+1)\*(7X2)+(6X2+1)\*(3X+(6X2+1)\*1. Here we just need to multiply the first polynomial with one of the terms from the second and feed the result obtained before and the result obtained now to the addition function and then after the algorithm has been executed number of times as there are number of terms in B. We get the product of the polynomial.

**Result:** the Program is successfully compiled and the desired output is obtained.

**Program/ Source Code:**

/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\* Sum And Product of a Polynomial

\* Done By Rohit Karunakaran

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#include<stdio.h>

#include<stdlib.h>

/\* Input : 2 polynomials of the form

\* a0\*X^n + a1\*X^n-1 + a2\*X^n-2 ..... an

\* Output: First polynomial the second polynomial and there sum

\*/

typedef struct Node

{

int coeff;

int pow;

struct Node\* link;

}PolyNode;

typedef struct Polynomial

{

int numberOfTerms;

PolyNode\* Head; //Header contians the first polynomial, so it has to be printed

PolyNode\* Trail;

}Poly;

//UTILITY FUNCTIONS START

void initPoly(Poly \*\*a)

{

\*a = (Poly\*)malloc(sizeof(Poly));

(\*a)->Head = NULL;

(\*a)->Trail= NULL;

(\*a)->numberOfTerms=0;

}

void addNode(Poly \*a,int pow, int coeff)

{

PolyNode\* n = (PolyNode\*) malloc(sizeof(PolyNode));

if(n!=NULL){

n->coeff = coeff; n->pow = pow; n->link=NULL;

if(a->Trail ==NULL)

{

a->Head = n;

}

else

{

a->Trail->link = n;

}

a->Trail = n;

}

else

{

return;

}

}

void deleteNode(Poly \*a,PolyNode \*b)

{

PolyNode \*ptr=a->Head;

if(ptr==NULL)return;

while(ptr->link!=b&&ptr!=NULL){ptr=ptr->link;} //Traverse till you find the node b

if(ptr==NULL){return;} //If there is no such node then, return

else

{

if(ptr->link->link==NULL)

{

free(ptr->link);

ptr->link=NULL;

}

else

{

PolyNode \*tmp = ptr->link;

ptr->link = tmp->link;

free(tmp);

}

}

}

void freePoly(Poly \*\*poly)

{

if(\*poly !=NULL)

{

PolyNode \*i,\*tmp;

i=(\*poly)->Head;

while(i!=NULL)

{

tmp=i;

i=i->link;

free(tmp);

}

free (\*poly);

}

return;

}

//UTILITY FUNCTIONS END

/\* Funtion to print the polynomials\*/

void printPoly(Poly\* a){

/\* Input: Polynomial stored in the structure Polynomial

\* Ouput: prints the polynomial

\*/

//int iterCount = a->numberOfTerms;

//int i;

PolyNode \*ptr=a->Head;

while(ptr!=a->Trail){

printf("%d\*X^%d + ",ptr->coeff,ptr->pow);

ptr = ptr->link;

}

printf("%d\*X^%d",ptr->coeff,ptr->pow);

}

/\* Funtion to convert the polynomial into tuple\*/

Poly\* createPolyFromString(char\* s){

/\* Input: String of charecters

\*

\* Output: the Head node of the linked list contating the polynomial

\* \*/

Poly\* a=NULL;initPoly(&a);

int i;

int count = 0;

int numberStack[2];

int numberStackTop = -1;

int number = 0,pow,coeff;

int negative = 0;

//parsing the string

for(i = 0; s[i]!='\0'; i++){

if(s[i] == '-'){

negative = 1;

}

if(s[i]>='0'&&s[i]<='9'){

while((s[i]!= 'X'||s[i]!='x'||s[i]!=' '||s[i]!='^') && (s[i]>='0'&&s[i]<='9')){

// here s[i] will only be numbers

number = number\*10+(s[i]-'0');

i++;

}

if(negative) numberStack[++numberStackTop] = -1\*number;

else numberStack[++numberStackTop] = number;

i--;

negative = 0;

number = 0;

}

if(i!=0&&(s[i]=='-'||s[i]=='+'||s[i]=='\0')){//&&s[i-1]!='^'){

if(numberStackTop==0)

{

if(s[i-1]=='X')

numberStack[++numberStackTop] = 1;

else

numberStack[++numberStackTop] = 0;

}

count++;

pow = numberStack[numberStackTop--];

coeff = numberStack[numberStackTop--];

addNode(a,pow,coeff);

}

}

if(numberStackTop==0)

{

if(s[i-1]=='X')

numberStack[++numberStackTop] = 1;

else

numberStack[++numberStackTop] = 0;

}

count++;

pow = numberStack[numberStackTop--];

coeff = numberStack[numberStackTop--];

addNode(a,pow,coeff);

a->numberOfTerms = count;

return a;

}

/\*Funtion to find the sum of the polynomials\*/

Poly\* sumOfPoly(Poly\* a, Poly\* b)

{

Poly\* c = (Poly\*)malloc(sizeof(Poly));

initPoly(&c);

PolyNode \*i=a->Head;

PolyNode \*j=b->Head;

while(i!=NULL&&j!=NULL)

{

if(i->pow==j->pow)

{

if(i->coeff+j->coeff!=0)

addNode(c,i->pow,i->coeff+j->coeff);

i=i->link;

j=j->link;

}

else if(i->pow>j->pow)

{

addNode(c,i->pow,i->coeff);

i=i->link;

}

else if(i->pow<j->pow)

{

addNode(c,j->pow,j->coeff);

j=j->link;

}

c->numberOfTerms++;

}

while(i!=NULL)

{

addNode(c,i->pow,i->coeff);

i=i->link;

c->numberOfTerms++;

}

while(j!=NULL)

{

addNode(c,j->pow,j->coeff);

j=j->link;

c->numberOfTerms++;

}

return c;

}

Poly\* productOfPolynomials(Poly\* a,Poly\*b)

{

Poly \*c=NULL;

Poly \*temp=NULL;

//intiPoly(Temp);

int k = 0;

PolyNode \*i = a->Head;

PolyNode \*j = b->Head;

while(k<a->numberOfTerms)

{

//i=a->Head;

j=b->Head;

if(c==NULL)

{

initPoly(&c);

while(j!=NULL)

{

addNode(c,i->pow+j->pow,i->coeff\*j->coeff);

j=j->link;

}

}

else

{

initPoly(&temp);

while(j!=NULL)

{

addNode(temp,i->pow+j->pow,i->coeff\*j->coeff);

j=j->link;

}

c=sumOfPoly(c,temp);

}

i=i->link;

freePoly(&temp);

k++;

}

return c;

}

int main(){

Poly\* a;

Poly\* b;

Poly\* c;

int strLength = 100;

char\* polyString = (char\*) malloc(strLength\*sizeof(char));

/\*Read the polynomials\*/

fflush(stdin);

printf("Enter polynomial 1 in the form : a0\*X^n + a1\*X^n-1 + a2\*X^n-2 ..... an\*X^0 --> ");

scanf("%[^\n]",polyString);

scanf("%\*c"); //remove the \n charecter from the input stream

a = createPolyFromString(polyString);

free(polyString);

fflush(stdin);

fflush(stdout);

polyString = (char\*) malloc(strLength\*sizeof(char));

printf("Enter polynomial 2 in the form : a0\*X^n + a1\*X^n-1 + a2\*X^n-2 ..... an\*X^0 --> ");

scanf("%[^\n]",polyString);

b = createPolyFromString(polyString);

free(polyString);

/\*Finish reading Polynomials\*/

printf("\nPolynomial 1 is: ");

printPoly(a);

printf("\nPolynomial 2 is: ");

printPoly(b);

c = sumOfPoly(a,b); //Find the sum of the polynomials

printf("\nSum is ");

printPoly(c);

c = productOfPolynomials(a,b);

printf("\nProduct is ");

printPoly(c);

printf("\n");

freePoly(&a);

freePoly(&b);

freePoly(&c);

return 0;

}

**Sample Input/Output:**



