# 数据结构实验报告

# 实验一：一元多项式的加减

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# 一. 程序设计相关信息

## 1. 实验题目

实验一：一元多项式的加减运算

【问题描述】

请编写一个程序，完成一元多项式的存储，并实现两个多项式的相加减及相乘运算。

【基本要求】

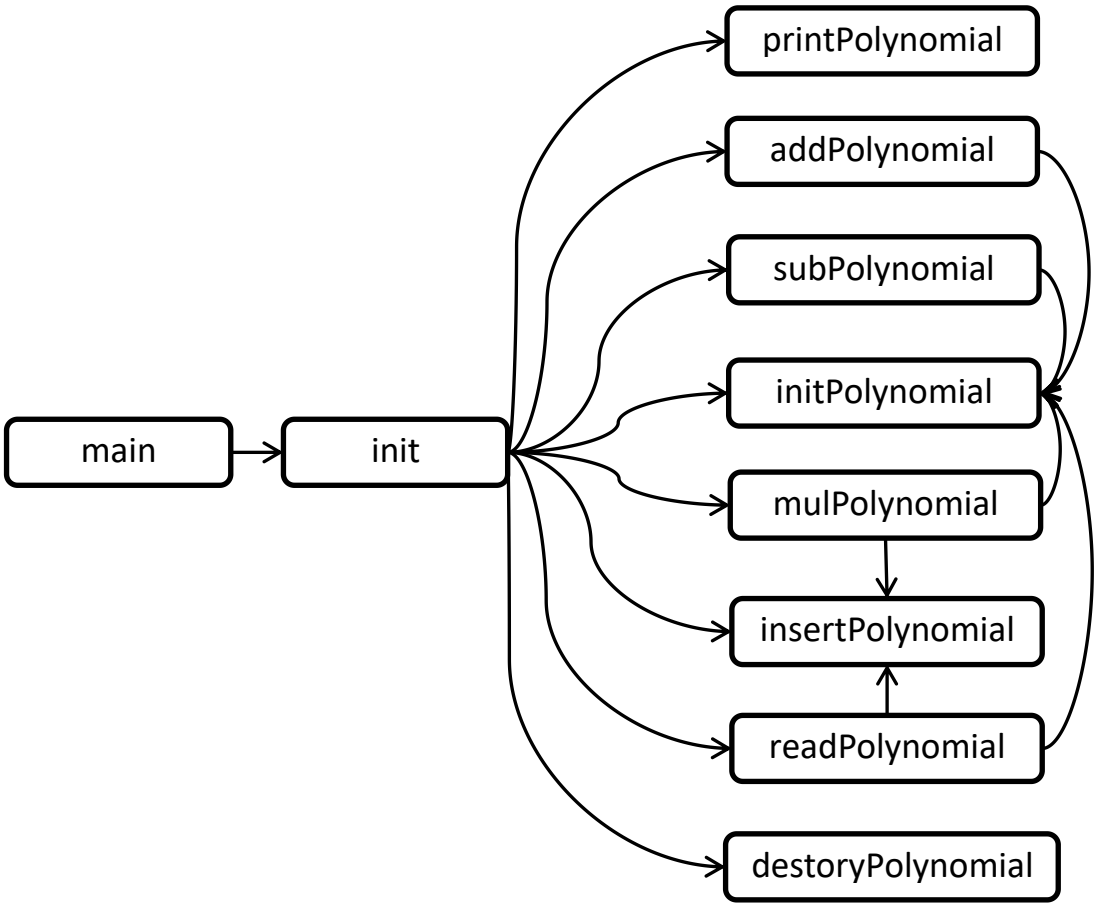
（1）随机从键盘上输入多项式，构建单链表存储医院多项式，其中单链表的数据域包括系数和指数两项

（2）最后的结果输出形式为 result=3+4X^2+5X^2

## 2. 实验项目的目的

深入理解单链表并进行应用，顺便进行字符串处理，学会合理地设置函数，使函数复用率高。

## 3. 实验项目程序结构



## 4. 实验项目中各文件函数功能描述

```
void init(); //读入数据，控制进程
void initPolynomial(Polynomial*&); //初始化多项式单链表
void readPolynomial(Polynomial*&); //读取多项式，进行字符串处理
void printPolynomial(Polynomial*); //打印多项式
void destoryPolynomial(Polynomial*&); //销毁多项式单链表
void insertPolynomial(Polynomial*&, Polynomial*&); //插入排序单式至多项式的正确位置
void addPolynomial(Polynomial*&, Polynomial*&, Polynomial*&); //多项式加法，由第三个参数返回结果
void subPolynomial(Polynomial*&, Polynomial*&, Polynomial*&); //多项式减法，由第三个参数返回结果
void mulPolynomial(Polynomial*&, Polynomial*&, Polynomial*&); //多项式乘法，由第三个参数返回结果
```

## 5. 算法描述

【数据结构】

有序单链表：用于存储和表示指数由高到低的多项式，链表中存储指数/系数和下一项的地址，只存储系数不为 0 的项。

【设计思路】

读取实现：对于一个多项式的字符串，以加号分割，加号后第一个为数字则为系数，否则系数为 1,字符‘x’后若为‘^’则指数为其后面的数字，否则指数为 1。对于数，遇见连续数字在小数点前则前面的数×10 加上当前的数字，在小数点后则前面的数+当前的数字/小数位数。

时间复杂度 O(Lenth)

插入实现：插入排序，从前至后找到比需要插入单式的指数更小的位置前一个为止，若指数相等则合并，若指数不相等则插入。

时间复杂度 O(n)

加法实现:两个多项式归并,指数上若 A[i]>B[j]则 i++,若 A[i]<B[j]则 j++，若 A[i]==B[j]则相加系数并 i++j++。

时间复杂度 O(m+n)

加法实现:两个多项式归并,指数上若 A[i]>B[j]则 i++,若 A[i]<B[j]则 j++，若 A[i]==B[j]则相减系数并 i++j++。

时间复杂度 O(m+n)

乘法实现：暴力枚举两个多项式的每一位，并相乘，将结果项插入至新的多项式。

时间复杂度 O(m*n^2)

### 6. 实验数据和实验结果分析

相加：

```
Please enter the first polynomial:
x^2-123.423x^3+x
Please enter the second polynomial:
-5x^3-0.232x-x^2
Please select a polynomial operation(1.Add;2.Subtract;3.Multiply):
1
Result:
-128.423x^3+0.768x
请按任意键继续. . .
```

相减：

```
Please enter the first polynomial:
x+x^3+x^4
Please enter the second polynomial:
0.123x^3-x+x^4
Please select a polynomial operation(1.Add;2.Subtract;3.Multiply):
2
Result:
0.877x^3+2x
请按任意键继续. . .
```

相乘：

```
Please enter the first polynomial:
10.22x^100-x^1000+0.24x^233
Please enter the second polynomial:
78x^256+890.02x^3-x
Please select a polynomial operation(1.Add;2.Subtract;3.Multiply):
3
Result:
-78x^1256-890.02x^1003+x^1001+18.72x^489+797.16x^356+213.605x^236-0.24x^234+9096x^103-10.22x^101
请按任意键继续. . .
```

运行结果良好。

### 7. 实验体会

对单链表有了更加深入的认识，熟悉了二路归并等相关算法。运算的实现倒还算是简单，处理输入的字符串却废了不少功夫，比如系数指数省略，负数、小数的处理等，看来对字符串的操作要更熟悉一点才行。另外乘法运算过于暴力，暂时未想出以当前数据结构的更优解决方案。

## 二. 源代码

```cpp
#include <cstdio>
#include <cstdlib>
using namespace std;

#define MaxLenth 100010
```

```
typedef struct Poly {
	double coefficient, index;
	struct Poly * next;
}Polynomial;

void init(); //读入数据，控制进程
void initPolynomial(Polynomial*&); //初始化多项式单链表
void readPolynomial(Polynomial*&); //读取多项式，进行字符串处理
void printPolynomial(Polynomial*); //打印多项式
void destoryPolynomial(Polynomial*&); //销毁多项式单链表
void insertPolynomial(Polynomial*&, Polynomial*&); //插入单式至多项式的正确位置
void addPolynomial(Polynomial*&, Polynomial*&, Polynomial*&); //多项式加法，由第三个参数返回结果
void subPolynomial(Polynomial*&, Polynomial*&, Polynomial*&); //多项式减法，由第三个参数返回结果
void mulPolynomial(Polynomial*&, Polynomial*&, Polynomial*&); //多项式乘法，由第三个参数返回结果

Polynomial *polyA, *polyB, *polyC;

int main() {
	init();
	system("pause");
	return 0;
}

void initPolynomial(Polynomial *&L) {
	L = (Polynomial *)malloc(sizeof(Polynomial));
	L->next = NULL;
	L->coefficient = L->index = 0;
}

void destoryPolynomial(Polynomial *&L) {
	Polynomial *pre = L, *p = L->next;
	while (p != NULL) {
		free(pre);
		pre = p;
		p = p->next;
	}
	free(pre);
}

void insertPolynomial(Polynomial *&L, Polynomial *&x) {
	Polynomial *p = L;
	while (p->next != NULL && p->next->index >= x->index)
		p = p->next;
	if (p->index == x->index && p != L) {
```

```
            p->coefficient += x->coefficient;
            free(x);
        }
        else
        {
            x->next = p->next;
            p->next = x;
        }
}

void printPolynomial(Polynomial *L) {
        Polynomial *p = L->next;
        if (p == NULL) {
            puts("0");
            return;
        }
        while (p != NULL) {
            if (p != L->next && p->coefficient > 0) printf("+");
            if (p->coefficient != 0) {
                if (p->coefficient != 1 && p->coefficient != -1) printf("%g", p->coefficient);
                if (p->coefficient == -1) printf("-");
                if (p->index != 0)
                    if (p->index != 1) printf("x^%g", p->index);
                    else printf("x");
                else if (p->coefficient == 1 || p->coefficient == -1) printf("1");
            }
            p = p->next;
        }
        puts("");
}

void readPolynomial(Polynomial *&L) {
        char poly[MaxLenth]={'\0'};
        Polynomial *p;
        scanf("%s", poly);
        for (int i = 0; poly[i]!='\0';) {
            double c = 0, x = 0, f = 1, d = 1;
            if (poly[i]== '-') i++, f=-1;
            if (poly[i]== '+') i++, f=1;
            if (poly[i] >= '0' && poly[i] <= '9') {
                while (poly[i] >= '0' && poly[i] <= '9') {
                    c *= 10;
                    c += poly[i] - '0';
                    i++;
```

```
                }
                if (poly[i] == '.') {
                        i++;
                        while (poly[i] >= '0' && poly[i] <= '9') {
                                d /= 10;
                                c += d * (poly[i] - '0');
                                i++;
                        }
                }
        }
        else c = 1;
        if (poly[i] == 'x') {
                i++;
                if (poly[i]=='^') {
                        i++;
                        while (poly[i] >= '0' && poly[i] <= '9') {
                                x *= 10;
                                x += poly[i] - '0';
                                i++;
                        }
                }
                else x = 1;
        }
        else x = 0;
        if (c != 0) {
                initPolynomial(p);
                p->coefficient = c * f;
                p->index = x;
                insertPolynomial(L, p);
        }
    }
}

void addPolynomial(Polynomial *&A, Polynomial *&B, Polynomial *&C) {
    Polynomial *p = A->next, *q = B->next, *r = C, *s;
    while (p != NULL && q != NULL) {
        if (p->index > q -> index) {
                initPolynomial(s);
                s->coefficient = p->coefficient;
                s->index = p->index;
                s->next = r->next;
                r->next = s;
                p = p->next;
                r = r->next;
```

```
            }
            else if (p->index < q -> index) {
                  initPolynomial(s);
                  s->coefficient = q->coefficient;
                  s->index = q->index;
                  s->next = r->next;
                  r->next = s;
                  q = q->next;
                  r = r->next;
            }
            else if (p->index == q -> index) {
                  if (p->coefficient + q->coefficient != 0) {
                        initPolynomial(s);
                        s->coefficient = p->coefficient + q->coefficient;
                        s->index = q->index;
                        s->next = r->next;
                        r->next = s;
                        r = r->next;
                  }
                  p = p->next;
                  q = q->next;
            }
      }
      while (p!=NULL) {
            initPolynomial(s);
            s->coefficient = p->coefficient;
            s->index = p->index;
            s->next = r->next;
            r->next = s;
            p = p->next;
            r = r->next;
      }
      while (q!=NULL) {
            initPolynomial(s);
            s->coefficient = q->coefficient;
            s->index = q->index;
            s->next = r->next;
            r->next = s;
            q = q->next;
            r = r->next;
      }
}

void subPolynomial(Polynomial *&A, Polynomial *&B, Polynomial *&C) {
```

```
Polynomial *p = A->next, *q = B->next, *r = C, *s;
while (p != NULL && q != NULL) {
	if (p->index > q -> index) {
		initPolynomial(s);
		s->coefficient = p->coefficient;
		s->index = p->index;
		s->next = r->next;
		r->next = s;
		p = p->next;
		r = r->next;
	}
	else if (p->index < q -> index) {
		initPolynomial(s);
		s->coefficient = -q->coefficient;
		s->index = q->index;
		s->next = r->next;
		r->next = s;
		q = q->next;
		r = r->next;
	}
	else if (p->index == q -> index) {
		if (p->coefficient - q->coefficient != 0) {
			initPolynomial(s);
			s->coefficient = p->coefficient - q->coefficient;
			s->index = q->index;
			s->next = r->next;
			r->next = s;
			r = r->next;
		}
		p = p->next;
		q = q->next;
	}
}
while (p!=NULL) {
	initPolynomial(s);
	s->coefficient = p->coefficient;
	s->index = p->index;
	s->next = r->next;
	r->next = s;
	p = p->next;
	r = r->next;
}
while (q!=NULL) {
	initPolynomial(s);
```

```
            s->coefficient = q->coefficient;
            s->index = q->index;
            s->next = r->next;
            r->next = s;
            q = q->next;
            r = r->next;
      }
}

void mulPolynomial(Polynomial *&A, Polynomial *&B, Polynomial *&C) {
      Polynomial *p = A->next, *q = B->next, *r = C, *s;
      while (p!=NULL) {
            q = B->next;
            while (q!=NULL) {
                  initPolynomial(s);
                  s->coefficient = p->coefficient * q->coefficient;
                  s->index = p->index + q->index;
                  insertPolynomial(C, s);
                  q = q->next;
            }
            p = p->next;
      }
}

void init() {
      initPolynomial(polyA);
      initPolynomial(polyB);
      initPolynomial(polyC);
      printf("Please enter the first polynomial:\n");
      readPolynomial(polyA);
      printf("Please enter the second polynomial:\n");
      readPolynomial(polyB);
      printf("Please select a polynomial operation(1.Add;2.Subtract;3.Multiply):\n");
      int x;
      scanf("%d", &x);
      if (x == 1) addPolynomial(polyA, polyB, polyC);
      else if (x == 2) subPolynomial(polyA, polyB, polyC);
      else if (x == 3) mulPolynomial(polyA, polyB, polyC);
      printf("Result:\n");
      printPolynomial(polyC);
      destoryPolynomial(polyA);
      destoryPolynomial(polyB);
      destoryPolynomial(polyC);
}
```