

问题描述

实验题目

利用链式存储结构实现一元多项式的运算

基本要求

必做：一元多项式的创建、显示、求和（求差）、求值；销毁、清空、修改（添加项、删除项、修改系数或指数）

选做：微分（N阶）、不定积分、定积分、乘法、除法、乘方

概要设计

存储结构为链表，链表的每个结点代表多项式中的一项，包含系数和指数。要求系数为非零浮点数，指数为整数。整个链表各结点按指数排序链接在一起，不存在指数相同的结点。链表头结点不属于多项式，尾结点的`next`指针必须为空。

数据结构定义

定义`term`为单个项，该结构体包含系数`coef`、指数`expn`和结构体指针`next`，`polynomial`为`term`的链表

```
typedef struct term{
    float coef;
    int expn;
    struct term *next;
} term, *polynomial;
```

API

```

polynomial CreatePolyn (int);           // Create a polynomial
Status DestroyPolyn (polynomial *);    // Destroy a polynomial
Status ClearPolyn (polynomial );       // Clear a polynomial
void PrintPolyn (polynomial );         // Print a polynomial
int PolynLength (polynomial );         // Return length of polynomial
void AddPolyn (polynomial A, polynomial B); // A->A+B, then clear B
void SubtractPolyn (polynomial A, polynomial B); // A->A-B, then clear B
void MultiplyPolyn (polynomial A, polynomial B); // A->A*B, then clear B
void PowerPolyn (polynomial, int);      // Power a polynomial
void DerivePolyn (polynomial, polynomial, int); // Derivation of a
polynomial
void IntPolyn (polynomial, polynomial, int); // Integrate of a
polynomial
float DIntPolyn (polynomial, int, float, float); // Integrate with up and
down bound
Status CalcValue (polynomial, float, float *); // Value of a polynomial
Status AddTerm (polynomial , float, int);      // Add a term to a
polynomial
Status DelTerm (polynomial, int);             // Del a term from a
polynomial
Status SetCoef (polynomial, float, int);      // Set the coefficient of
a term
Status SetExpn (polynomial, int, int);        // Set the expn of a term
Status CopyPolyn (polynomial, polynomial );   // Copy a polynomial

```

源文件组织

- Polynomial.h: 提供数据结构定义和相关函数声明
- Polynomial.c: 实现同名头文件中声明的函数
- main.c: 主程序源文件

算法思路

为了保证整个链表有序，没有不合要求的结点，在对链表内容进行修改时都需要额外的检查。

AddTerm函数

在创建等多个函数里都调用了AddTerm

```
Status AddTerm (polynomial P, float coef, int expn)
```

该函数根据给定的系数和指数分配结点，然后将结点插入给定的链表，并且保证插入后整个 链表仍然符合设计要求。流程如下

1. 判断给定系数、指数、链表是否符合要求
2. 遍历链表寻找插入位置
3. 若链表中有指数更大的项，插入在它前面

4. 若链表中有指数相同的项，与其系数相加并判断是否为0
5. 若遍历结束，插入到链表尾部

遍历技巧

由于涉及到了链表的操作，遍历链表需要一定技巧。定义两个指向结点的指针 eb 和 ef ，分别指向相邻的前后结点，初始值为头结点和多项式第一项。总将 ef 指向的项作为当前项 进行操作。

```
term *eb = P, *ef = P->next;
while (ef) {
    // some operations
    // ...
    eb = eb->next;
    ef = ef->next;
}
```

程序测试

设定多项式 $f(x)$ 和 $g(x)$

多项式相加

```
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
1
f(x) 1.00*x(0) 3.00*x(1) -3.00*x(2) 7.00*x(3) 4.00*x(4)
g(x) 8.00*x(0) 4.00*x(1) 3.00*x(2) 2.00*x(3) 6.00*x(6)
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
2
9.00*x(0) 7.00*x(1) 9.00*x(3) 4.00*x(4) 6.00*x(6)
```

添加项

向 $f(x)$ 添加一项

```
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
1
f(x) 1.00*x(0) 3.00*x(1) -3.00*x(2) 7.00*x(3) 4.00*x(4)
g(x) 8.00*x(0) 4.00*x(1) 3.00*x(2) 2.00*x(3) 6.00*x(6)
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
3
> input term (coef expn)
1.2 8
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
1
f(x) 1.00*x(0) 3.00*x(1) -3.00*x(2) 7.00*x(3) 4.00*x(4) 1.20*x(8)
g(x) 8.00*x(0) 4.00*x(1) 3.00*x(2) 2.00*x(3) 6.00*x(6)
```

删除项

从f(x)中删除一项

```
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
1
f(x) 1.00*x(0) 3.00*x(1) -3.00*x(2) 7.00*x(3) 4.00*x(4) 1.20*x(8)
g(x) 8.00*x(0) 4.00*x(1) 3.00*x(2) 2.00*x(3) 6.00*x(6)
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
4
> input expn:
3
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
1
f(x) 1.00*x(0) 3.00*x(1) -3.00*x(2) 4.00*x(4) 1.20*x(8)
g(x) 8.00*x(0) 4.00*x(1) 3.00*x(2) 2.00*x(3) 6.00*x(6)
```

修改系数

```
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
1
f(x) 1.00*x(0) 3.00*x(1) -3.00*x(2) 4.00*x(4) 1.20*x(8)
g(x) 8.00*x(0) 4.00*x(1) 3.00*x(2) 2.00*x(3) 6.00*x(6)
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
5
> input new coefficient and position
5 2
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
1
f(x) 1.00*x(0) 5.00*x(1) -3.00*x(2) 4.00*x(4) 1.20*x(8)
g(x) 8.00*x(0) 4.00*x(1) 3.00*x(2) 2.00*x(3) 6.00*x(6)
```

修改指数

```
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
1
f(x) 1.00*x(0) 5.00*x(1) -3.00*x(2) 4.00*x(4) 1.20*x(8)
g(x) 8.00*x(0) 4.00*x(1) 3.00*x(2) 2.00*x(3) 6.00*x(6)
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
6
> input new expn and position
2 2
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
1
f(x) 1.00*x(0) 2.00*x(2) 4.00*x(4) 1.20*x(8)
g(x) 8.00*x(0) 4.00*x(1) 3.00*x(2) 2.00*x(3) 6.00*x(6)
```

求导

```
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
1
f(x) 1.00*x(0) 2.00*x(2) 4.00*x(4) 1.20*x(8)
g(x) 8.00*x(0) 4.00*x(1) 3.00*x(2) 2.00*x(3) 6.00*x(6)
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
7
> input Derive n
1
f(x) 1.00*x(0) 2.00*x(2) 4.00*x(4) 1.20*x(8)
after Derive 4.00*x(1) 16.00*x(3) 9.60*x(7)
```

不定积分

```
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
1
f(x) 1.00*x(0) 2.00*x(2) 4.00*x(4) 1.20*x(8)
g(x) 8.00*x(0) 4.00*x(1) 3.00*x(2) 2.00*x(3) 6.00*x(6)
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
8
> input Integrate n
1
f(x) 1.00*x(0) 2.00*x(2) 4.00*x(4) 1.20*x(8)
after Integrate 1.00*x(1) 0.67*x(3) 0.80*x(5) 0.13*x(9)
```

定积分

```
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
1
f(x) 1.00*x(0) 2.00*x(2) 4.00*x(4) 1.20*x(8)
g(x) 8.00*x(0) 4.00*x(1) 3.00*x(2) 2.00*x(3) 6.00*x(6)
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
9
> input Integrate n, start, end
1 2 3
DInt output = 2738.600098
```

多项式相乘

```
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
1
f(x) 1.00*x(0) 2.00*x(2) 4.00*x(4) 1.20*x(8)
g(x) 8.00*x(0) 4.00*x(1) 3.00*x(2) 2.00*x(3) 6.00*x(6)
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
10
8.00*x(0) 4.00*x(1) 19.00*x(2) 10.00*x(3) 38.00*x(4) 20.00*x(5) 18.00*x(6) 8.00*x(7) 21.60*x(8) 4.80*x(9) 2
7.60*x(10) 2.40*x(11) 7.20*x(14)
```

乘方

```
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
1
f(x) 1.00*x(0) 2.00*x(2) 4.00*x(4) 1.20*x(8)
g(x) 8.00*x(0) 4.00*x(1) 3.00*x(2) 2.00*x(3) 6.00*x(6)
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
11
> input power
2
Please input command: (0=quit, 1=display, 2=AddPolyn, 3=AddTerm, 4=DelTerm, 5=SetCoef, 6=SetExpn, 7=Derive,
8=Integrate, 9=DIntegrate, 10=Multiply, 11=Power, 12=Clear, 13=Destroy)
1
f(x) 1.00*x(0) 4.00*x(2) 12.00*x(4) 16.00*x(6) 18.40*x(8) 4.80*x(10) 9.60*x(12) 1.44*x(16)
g(x) 8.00*x(0) 4.00*x(1) 3.00*x(2) 2.00*x(3) 6.00*x(6)
```