

Data Structures

Homework 2

基本題(%)

- Given the need to perform polynomial ($a(x)=a_nx^n+a_{n-1}x^{n-1}+\dots+a_1x+a_0$) computations (e.g. addition, subtraction, multiplications, etc.). The polynomials all have integer coefficients and powers. Furthermore, all polynomials will have at most 100 terms (e.g. power from 0 to 99). Answer the following questions according to the “efficient” memory representation for a polynomial ADT.

How many integers are needed to represent each polynomial? Please explain your answer.

(a) $a(x)=99x^{99}+98x^{98}+\dots+2x^2+1x+100$

(b) $a(x)=2x^2+1x+100$

(c) $a(x)=99x^{99}+100$

- Given the following sparse matrices $A_{7 \times 9}$ and $B_{9 \times 5}$.

| A | row | col | value |
|-------|-----|-----|-------|
| A[0] | 7 | 9 | 15 |
| A[1] | 0 | 0 | 1 |
| A[2] | 0 | 1 | 2 |
| A[3] | 0 | 7 | 1 |
| A[4] | 1 | 3 | 1 |
| A[5] | 1 | 6 | 2 |
| A[6] | 2 | 1 | -1 |
| A[7] | 3 | 4 | 4 |
| A[8] | 3 | 6 | 1 |
| A[9] | 3 | 8 | 2 |
| A[10] | 4 | 4 | 1 |
| A[11] | 5 | 1 | 2 |
| A[12] | 5 | 4 | 4 |
| A[13] | 5 | 8 | -1 |
| A[14] | 6 | 0 | -1 |
| A[15] | 6 | 1 | -1 |

| B | row | col | value |
|------|-----|-----|-------|
| B[0] | 9 | 5 | 8 |
| B[1] | 0 | 1 | 1 |
| B[2] | 0 | 3 | 1 |
| B[3] | 4 | 0 | 2 |
| B[4] | 4 | 3 | -1 |
| B[5] | 7 | 1 | 1 |
| B[6] | 7 | 3 | 1 |
| B[7] | 8 | 0 | 2 |
| B[8] | 8 | 2 | 1 |

- Use the fast transpose algorithm on B to get B^T and show the result of resultant array for storing B^T .
- Compute $A \times B$ using the fast sparse matrix multiplication algorithm. Show $A \times B$ in matrix form.

進階題(20%)

3.

(1) need Coding

According to the representation I of polynomial, please write a function *coeff* to return the coefficient of the term with given power.

```
int coeff1 (polynomial_type a, int p);
```

► Representation I

```
► define MAX_degree 101 /*MAX degree of polynomial+1*/
typedef struct {
    int degree;
    int float coef[MAX_degree];
} polynomial;
```

(2) need Coding

According to the representation II of polynomial, please write a function *coeff* to return the coefficient of the term with given power.

```
int coeff2 (polynomial_type a, int p);
```

► Representation II

```
► MAX_TERMS 100 /*size of terms array*/
typedef struct {
    int float coef;
    int expon;
} polynomial;
► polynomial terms [MAX_TERMS];
int avail = 0;
```

(1) 及(2)多項式的給定可直接在主程式中指定或另寫多項式輸入函式後在主程式中呼叫，使用方式請寫在報告中，並將執行結果截圖附在報告中。

(3) Please compare the time complexity of (1) and (2), respectively, if there are n nonzero terms in the polynomial and the degree of the polynomial is m .

(4) Please compare the time complexity of using representation I and representation II to implement polynomial addition, respectively.