CIS 343 – Structure of Programming Languages
Winter 2016, Section 1, 2/16/2016

Programming Assignment #2
Matrix Operations in C
Due Date: Tuesday, March 1, 2016

Write a program in C that implements operations on matrices. Your program consist of the following three C (source and header) files:

1. `matrix.h` (provided to you and should **not be modified**)
2. `matrix.c` (complete the implementation of the functions in this file)
3. `main.c` (driver program to test your implementation and should **not be modified**)

Function and Type Declarations in "`matrix.h`" File

```
typedef struct {
   int rows;
   int columns;
   int *data;  // pointer to a dynamically allocated
               // array of integers
} Matrix;

Matrix *create(int rows, int columns);

int getValueAt(Matrix *m, int row, int column);

void setValueAt(Matrix *m, int row, int column, int value);

Matrix *add(Matrix *m1, Matrix *m2);

Matrix *subtract(Matrix *m1, Matrix *m2);

Matrix *transpose(Matrix *m);

Matrix *scalarMultiply(Matrix *m, int scalar);

Matrix *multiply(Matrix *m1, Matrix *m2);
```

Sample Program Execution

```
****** Matrix Operations Menu ******
C: Create Matrices A and B
P: Print Matrices A and B
A: Add [A + B]
S: Difference [A - B]
T: Transpose [A' OR B']
K: Scalar Multiply [k * A OR k * B)]
M: Multiply [A * B]
Q: Quit
Enter your selection (C,P,A,S,T,K,M,Q): l
Enter number of rows and columns for Matrix A: 3 2
Enter 2 integer values for row 1: 0 4
Enter 2 integer values for row 2: 7 0
Enter 2 integer values for row 3: 3 1
Enter number of rows and columns for Matrix B: 3 2
Enter 2 integer values for row 1: 1 2
Enter 2 integer values for row 2: 2 3
Enter 2 integer values for row 3: 0 4
****** Matrix Operations Menu ******
C: Create Matrices A and B
P: Print Matrices A and B
A: Add [A + B]
S: Difference [A - B]
T: Transpose [A' OR B']
K: Scalar Multiply [k * A OR k * B)]
M: Multiply [A * B]
Q: Quit
Enter your selection (C,P,A,S,T,K,M,Q): p
Matrix A:
0 4
7 0
3 1
Matrix B:
1 2
2 3
0 4
****** Matrix Operations Menu ******
C: Create Matrices A and B
P: Print Matrices A and B
A: Add [A + B]
S: Difference [A - B]
T: Transpose [A' OR B']
K: Scalar Multiply [k * A OR k * B)]
M: Multiply [A * B]
Q: Quit
Enter your selection (C,P,A,S,T,K,M,Q): a
1 6
9 3
3 5
```

```
****** Matrix Operations Menu ******
C: Create Matrices A and B
P: Print Matrices A and B
A: Add [A + B]
S: Difference [A - B]
T: Transpose [A' OR B']
K: Scalar Multiply [k * A OR k * B)]
M: Multiply [A * B]
Q: Quit
Enter your selection (C,P,A,S,T,K,M,Q): d
-1 2
5 -3
3 -3
****** Matrix Operations Menu ******
C: Create Matrices A and B
P: Print Matrices A and B
A: Add [A + B]
S: Difference [A - B]
T: Transpose [A' OR B']
K: Scalar Multiply [k * A OR k * B)]
M: Multiply [A * B]
Q: Quit
Enter your selection (C,P,A,S,T,K,M,Q): t
Transpose matrix A or B? b
1 2 0
2 3 4
****** Matrix Operations Menu ******
C: Create Matrices A and B
P: Print Matrices A and B
A: Add [A + B]
S: Difference [A - B]
T: Transpose [A' OR B']
K: Scalar Multiply [k * A OR k * B)]
M: Multiply [A * B]
Q: Quit
Enter your selection (C,P,A,S,T,K,M,Q): p
Matrix A:
0 4
7 0
3 1
Matrix B:
1 2
2 3
0 4
****** Matrix Operations Menu ******
C: Create Matrices A and B
P: Print Matrices A and B
A: Add [A + B]
S: Difference [A - B]
T: Transpose [A' OR B']
K: Scalar Multiply [k * A OR k * B)]
M: Multiply [A * B]
```

```
Q: Quit
Enter your selection (C,P,A,S,T,K,M,Q): s
Enter value of k: -2
Scalar multiply matrix A or B? a
0 -8
-14 0
-6 -2
****** Matrix Operations Menu ******
C: Create Matrices A and B
P: Print Matrices A and B
A: Add [A + B]
S: Difference [A - B]
T: Transpose [A' OR B']
K: Scalar Multiply [k * A OR k * B)]
M: Multiply [A * B]
Q: Quit
Enter your selection (C,P,A,S,T,K,M,Q): l
Enter number of rows and columns for Matrix A: 2 3
Enter 3 integer values for row 1: 2 1 3
Enter 3 integer values for row 2: -2 2 1
Enter number of rows and columns for Matrix B: 3 2
Enter 2 integer values for row 1: 2 1
Enter 2 integer values for row 2: 3 2
Enter 2 integer values for row 3: -2 2
****** Matrix Operations Menu ******
C: Create Matrices A and B
P: Print Matrices A and B
A: Add [A + B]
S: Difference [A - B]
T: Transpose [A' OR B']
K: Scalar Multiply [k * A OR k * B)]
M: Multiply [A * B]
Q: Quit
Enter your selection (C,P,A,S,T,K,M,Q): p
Matrix A:
2 1 3
-2 2 1
Matrix B:
2 1
3 2
-2 2
****** Matrix Operations Menu ******
C: Create Matrices A and B
P: Print Matrices A and B
A: Add [A + B]
S: Difference [A - B]
T: Transpose [A' OR B']
K: Scalar Multiply [k * A OR k * B)]
M: Multiply [A * B]
Q: Quit
Enter your selection (C,P,A,S,T,K,M,Q): m
1 10
```

```
0 4
****** Matrix Operations Menu ******
C: Create Matrices A and B
P: Print Matrices A and B
A: Add [A + B]
S: Difference [A - B]
T: Transpose [A' OR B']
K: Scalar Multiply [k * A OR k * B)]
M: Multiply [A * B]
Q: Quit
Enter your selection (C,P,A,S,T,K,M,Q): a
Add failed: Matrix A and B do not have same size.
****** Matrix Operations Menu ******
C: Create Matrices A and B
P: Print Matrices A and B
A: Add [A + B]
S: Difference [A - B]
T: Transpose [A' OR B']
K: Scalar Multiply [k * A OR k * B)]
M: Multiply [A * B]
Q: Quit
Enter your selection (C,P,A,S,T,K,M,Q): d
Subtract failed: Matrix A and B do not have same size.
****** Matrix Operations Menu ******
C: Create Matrices A and B
P: Print Matrices A and B
A: Add [A + B]
S: Difference [A - B]
T: Transpose [A' OR B']
K: Scalar Multiply [k * A OR k * B)]
M: Multiply [A * B]
Q: Quit
Enter your selection (C,P,A,S,T,K,M,Q): l
Enter number of rows and columns for Matrix A: 2 3
Enter 3 integer values for row 1: 2 2 5
Enter 3 integer values for row 2: 5 5 5
Enter number of rows and columns for Matrix B: 2 3
Enter 3 integer values for row 1: 5 6 7
Enter 3 integer values for row 2: 2 3 4
****** Matrix Operations Menu ******
C: Create Matrices A and B
P: Print Matrices A and B
A: Add [A + B]
S: Difference [A - B]
T: Transpose [A' OR B']
K: Scalar Multiply [k * A OR k * B)]
M: Multiply [A * B]
Q: Quit
Enter your selection (C,P,A,S,T,K,M,Q): p
Matrix A:
2 2 5
5 5 5
```

```
Matrix B:
5 6 7
2 3 4
****** Matrix Operations Menu ******
C: Create Matrices A and B
P: Print Matrices A and B
A: Add [A + B]
S: Difference [A - B]
T: Transpose [A' OR B']
K: Scalar Multiply [k * A OR k * B)]
M: Multiply [A * B]
Q: Quit
Enter your selection (C,P,A,S,T,K,M,Q): m
Multiply failed: # of columns in A is not equal to # of rows in B.
****** Matrix Operations Menu ******
C: Create Matrices A and B
P: Print Matrices A and B
A: Add [A + B]
S: Difference [A - B]
T: Transpose [A' OR B']
K: Scalar Multiply [k * A OR k * B)]
M: Multiply [A * B]
Q: Quit
Enter your selection (C,P,A,S,T,K,M,Q): q
Bye.
```

Program Compilation and Execution

```
$ gcc -Wall -std=c99 -o matrix *.c          (command to compile)
$ ./matrix                                  (command to run)
```

Deliverables

1. **Upload only `matrix.c` file on Blackboard by midnight on due date.**
2. **I will use the submission date/time on Blackboard as your official submission date/time.**
3. **It is your responsibility to make sure the submission on Blackboard went through successfully.**
4. **Because of possible portability issues, make sure your program compiles and runs on EOS machines before submitting any source file(s) on Blackboard. I will compile, run, and test your program on EOS when grading.**
5. **Late penalty (10% per day) applies after midnight on Tuesday, March 1, 2016.**