

# COMP 3031 Assignment 1: SML programming

Fall 2019

Due: 5PM on Oct 9 2019 (Wednesday)

## Instructions

- There are five questions in this assignment. Each question counts for two points. The total number of points is 10.
- Write your functions exactly the same as defined in the problem description (name, type, and functionality). In addition, you can write any helper functions as needed and call any built-in SML functions available in the lab machine.
- Put your entire solution in a single text file called "ass1.sml". In this file, put down your name, ITSC account, and student ID as a comment (surrounded by “(” and “)”) on the first line.
- Submit your file through the Canvas before the deadline.
- Your submission will be tested in the SML interpreter on a lab machine by issuing the following command: - use "ass1.sml";
- No late submissions will be accepted.

An  $H \times W$  matrix consists of  $H$  rows and  $W$  columns. In this assignment, we define a matrix type as follows: `type matrix = real list list;`

For all questions, you can assume the user input is correct.

## Question 1. Get an element in a matrix

Write a function to return the element located at the  $i$ -th row and  $j$ -th column of a matrix.

```
fun MatGet(Mat: matrix, i:int, j: int):real;
```

```
- MatGet;
```

```
val it = fn : matrix * int * int -> real
```

### Examples:

```
- val m = [[1.0,2.0,3.0],[4.0,5.0,6.0],[7.0,8.0,9.0]];
```

```
- MatGet(m,0,0);
```

```
val it = 1.0 : real
```

```
- MatGet(m,1,2);
```

```
val it = 6.0 : real
```

```
- MatGet(m,2,1);
```

```
val it = 8.0 : real
```

## Question 2. Get the mean value of a matrix

Write a function to return the mean value (sum/count) of a matrix: fun MatMean(Mat: matrix):real

```
- MatMean;  
val it = fn : matrix -> real
```

### Examples:

```
- val m = [[1.0,2.0,3.0],[4.0,5.0,6.0],[7.0,8.0,9.0]];  
- MatMean(m);  
val it = 5.0 : real
```

```
- val MatA = [[1.0,3.0],[~1.0,1.1]];  
- MatMean(MatA);  
val it = 1.025 : real
```

## Question 3. Crop

Write a function to return the sub-matrix in a given area of a matrix. The area is given by two two-integer tuples (H\_start, H\_end), and (W\_start,W\_end). The returned sub-matrix consists of all elements in the given area:

```
fun MatCrop (Mat: matrix, (H_start, H_end), (W_start, W_end)):matrix;
```

```
- MatCrop;  
val it = fn : matrix * (int * int) * (int * int) -> matrix
```

### Examples:

```
- val m = [[1.0,2.0,3.0],[4.0,5.0,6.0],[7.0,8.0,9.0]];  
- MatCrop(m,(1,3),(1,3));  
val it = [[5.0,6.0],[8.0,9.0]] : matrix  
- MatCrop(m,(0,1),(0,1));  
val it = [[1.0]] : matrix
```

## Question 4. Binarization

Write a function to return the binarization matrix for a given matrix and a threshold: If an element in the given matrix is less than the threshold, the corresponding element in the binarization matrix is set to 0. Otherwise, it is set to 1.

```
fun MatBinary(Mat: matrix, threshold: real): matrix;
```

```
- MatBinary;  
val it = fn : matrix * real -> matrix;
```

### Examples:

```
- val m = [[1.0,2.0,3.0],[4.0,5.0,6.0],[7.0,8.0,9.0]];  
- MatBinary(m,4.0);  
  
val it = [[0.0,0.0,0.0],[1.0,1.0,1.0],[1.0,1.0,1.0]] : matrix
```

```
- val MatA = [[1.0,3.0],[~1.0,1.1]];
- MatBinary(MatA,0.9);
val it = [[1.0,1.0],[0.0,1.0]] : matrix
```

### Question 5. Matrix Dot Product

Write a function to return the dot product result of two given matrices. The output matrix  $C = A \times B$  is such that each element  $C(i,j)$  is the dot product of the  $i$ -th row of  $A$  and the  $j$ -th column of  $B$ .

```
fun MatDot(MatA: matrix, MatA: matrix):matrix;
```

```
- MatDot;
val it = fn : matrix * matrix -> matrix
```

#### Examples:

```
- val m = [[1.0,2.0,3.0],[4.0,5.0,6.0],[7.0,8.0,9.0]];
- MatDot(m,m);
val it = [[30.0,36.0,42.0],[66.0,81.0,96.0],[102.0,126.0,150.0]] : matrix
```

```
- val Mat1 = [[1.0]]:matrix;
- MatDot(Mat1,Mat1);
val it = [[1.0]] : matrix
```

```
- val MatX = [[0.0,1.0,1.0],[2.0, 2.0, 2.0]]:matrix;
- val MatY = [[1.0,3.0,1.0],[2.0, 2.0, 0.0], [3.0, 1.0, 1.0]]:matrix;
- MatDot(MatX,MatY);
val it = [[5.0,3.0,1.0], [12.0,12.0,4.0]] : matrix
```