CSc 110, Spring 2017

Lecture 26: Lists of Lists

List of lists mystery

```
def mystery(data, pos, n):
    result = []
    for i in range(0, n):
        for j in range(0, n):
            result.append(data[i + pos][j + pos])
    return result
```

Suppose that a variable called grid has been declared as follows:

```
grid = [[8, 2, 7, 8, 2, 1], [1, 5, 1, 7, 4, 7],
        [5, 9, 6, 7, 3, 2], [7, 8, 7, 7, 7, 9],
        [4, 2, 6, 9, 2, 3], [2, 2, 8, 1, 1, 3]]
```

which means it will store the following 6-by-6 grid of values:

8	2	7	8	2	1
1	5	1	7	4	7
5	9	6	7	3	2
7	8	7	7	7	9
4	2	6	9	2	3
2	2	8	1	1	3

Function Call	Contents of List Returned
`mystery(grid, 2, 2)`	_____
`mystery(grid, 0, 2)`	_____
`mystery(grid, 3, 3)`	_____

For each call at right, indicate what value is returned. If the function call results in an error, write error instead.

Find Lucky 7

Write a function `lucky(m)` that takes a rectangular list `m` and looks for the number 7 in `m`. If found, `lucky` returns a list containing the row and column position of 7, and if not found, returns an empty list.

Example:

```
z = [[20, 3, 6], [4, 12, 18], [6, 13, 5], [15, 7, 8]]
lucky(z)
```

Returns

```
[3,1]
```

Mountain peak

Write a program that reads elevation data from a file, draws it on a `DrawingPanel` and finds the path from the highest elevation to the edge of the region.

Data:

```
34 76 87 9 34 8  22 33 33 33 45 65 43 22
5  7  88 0 56 76 76 77 4  45 55 55 4  5
…
```

Mountain peak

Consider the data:

```
34  76  87  9  34  8   22  33  33  33  45  65  43  22
5   7   88  0  56  76  76  77  4   45  55  55  4   5
```

…

Each line is a row of elevations ➔ we will create a list of lists of elevations

First steps:

1) create a mapping of the data representation to DrawingPanel components
2) read in the data
3) draw an image of the elevation data using DrawingPanel components

```
[ [34, 76, 87, 9, 34, 8, 22, 33, 33, 33, 45, 65, 43, 22]
   [5,   7, 88, 0, 56, 76, 76, 77, 4, 45, 55, 55,  4,  5]
   …
 ]
```

Each row becomes a row of rectangles in the DrawingPanel

Each rectangle is 1 pixel wide

If the mountain data is stored in a list of lists `data`, how large do we make the DrawingPanel?

```
p = DrawingPanel( width ??, height ??)
```

```
[ [34, 76, 87, 9, 34, 8, 22, 33, 33, 33, 45, 65, 43, 22]
   [5,   7, 88, 0, 56, 76, 76, 77, 4, 45, 55, 55,  4,  5]
   …
 ]
```

Each row becomes a row of rectangles in the DrawingPanel

Each rectangle is 1 pixel wide

The elevation is mapped to a level of black or white, a shade of grey, creating a greyscale image:

- white is weakest (higher in elevation)
- black is strongest (lower in elevation)

```
p.canvas.create_rectangle(x, y, x + 1, y + 1,
                          outline=map elevation to a shade of grey)
```

Mapping indices to arguments

```
data =
 [ [34, 76, 87, 9, 34, 8, 22, 33, 33, 33, 45, 65, 43, 22]
   [5,   7, 88, 0, 56, 76, 76, 77, 4, 45, 55, 55,  4,  5]...
 ]
```

For the first row:

```
p.canvas.create_rectangle(0, 0, 1, 1, outline = color of 34)
p.canvas.create_rectangle(1, 0, 2, 1, outline = color of 76)
p.canvas.create_rectangle(2, 0, 3, 1, outline = color of 87)
p.canvas.create_rectangle(3, 0, 4, 1, outline = color of 9)
....
```

Mapping to indices to arguments

```
data =
 [ [34, 76, 87, 9, 34, 8, 22, 33, 33, 33, 45, 65, 43, 22]
   [5,   7, 88, 0, 56, 76, 76, 77, 4, 45, 55, 55,  4,  5]...
 ]

for row in range(0, len(data)):
    for col in range(0, len(data[row])):
        color = get_color(data[row][col])
        p.canvas.create_rectangle(col, row, col + 1, row + 1, outline = color)
```

```
p.canvas.create_rectangle(0, 0, 1, 1, outline = color of 34-- data[0][0])
p.canvas.create_rectangle(1, 0, 2, 1, outline = color of 76-- data[0][1])
p.canvas.create_rectangle(2, 0, 3, 1, outline = color of 87-- data[0][2])
p.canvas.create_rectangle(3, 0, 4, 1, outline = color of  9-- data[0][3])
...
```

2) Read in the data

```
from drawingpanel import *
from random import *

def main():
    file = open("mountaindata.dat")
    lines = file.readlines()

    data = []
    for line in lines:
        data.append(line.split())
    p = DrawingPanel(len(data[0]), len(data))
    draw_image(p, data)
```

3) Draw the elevation image

```
# draws the passed in data on the passed in drawing panel.
# The data is a list of lists of numbers representing
# elevation data.
def draw_image(p, data):
    for row in range(0, len(data)):
        # data[row] -> [3, 5, 76, 3]
        for col in range(0, len(data[row])):
            color = get_color(int(data[row][col]))
            p.canvas.create_rectangle(col, row, col + 1,
                                      row + 1, outline=color)
```

Mountain peak

```
data =
  [ [34, 76, 87, 9, 34, 8, 22, 33, 33, 33, 45, 65, 43, 22]
    [5,   7, 88, 0, 56, 76, 76, 77, 4, 45, 55, 55,  4, 5]
    ...
  ]
```

Next steps:

4) Find the peak
5) Find the steepest path down
6) Draw the path in yellow

4) Find the peak

```
data =
 [ [34, 76, 87, 9, 34, 8, 22, 33, 33, 33, 45, 65, 43, 22]
   [5,   7, 88, 0, 56, 76, 76, 77, 4, 45, 55, 55,  4, 5]
   ...
 ]
```

Find the largest elevation in the list of lists. Write `find_peak(data)`

Return a tuple of the location in the 2d list

5) Find the steepest path

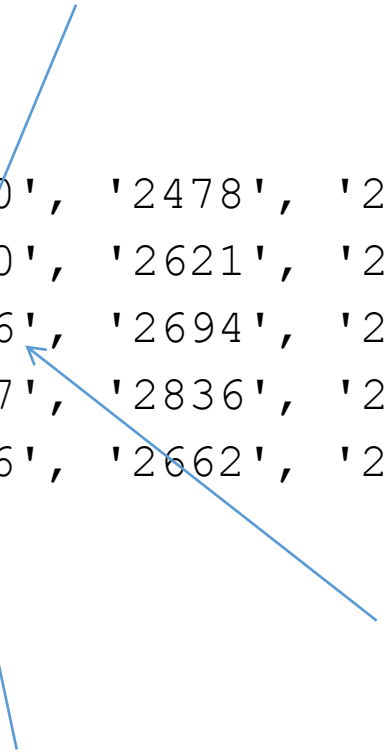
```
data =
[['2537', '2483', '2475', '2480', '2518', '2532', '2480', '2478', '2431']
 ['2541', '2549', '2614', '2700', '2647', '2746', '2690', '2621', '2550']
 ['2525', '2525', '2640', '2769', '2802', '2883', '2856', '2694', '2631']
 ['2514', '2505', '2526', '2614', '2717', '2715', '2867', '2836', '2771']
 ['2506', '2482', '2480', '2528', '2518', '2561', '2586', '2662', '2654']
 ['2527', '2477', '2464', '2459', '2452', '2475', '2480', '2500', '2518']
 ['2544', '2505', '2488', '2454', '2442', '2445', '2446', '2467', '2470']
 ['2528', '2486', '2464', '2446', '2434', '2436', '2442', '2444', '2450']
 ['2464', '2505', '2482', '2456', '2433', '2463', '2462', '2489', '2467']
 ['2532', '2541', '2519', '2515', '2496', '2502', '2529', '2519', '2553']]
```

How do we determine the steepest path?

We would need to compare the peak to each neighbor.

5) Find the steepest path down

```
data =
[['2537', '2483', '2475', '2480', '2518', '2532', '2480', '2478', '2431']
 ['2541', '2549', '2614', '2700', '2647', '2746', '2690', '2621', '2550']
 ['2525', '2525', '2640', '2769', '2802', '2883', '2856', '2694', '2631']
 ['2514', '2505', '2526', '2614', '2717', '2715', '2867', '2836', '2771']
 ['2506', '2482', '2480', '2528', '2518', '2561', '2586', '2662', '2654']]
 ...
]
```



We will simplify this problem.

Look at only three neighbors:

up

down

front

If peak is at location `data[r][c]`, define each above.

5) Find the steepest path down

```
data =
[['2537', '2483', '2475', '2480', '2518', '2532', '2480', '2478', '2431']
 ['2541', '2549', '2614', '2700', '2647', '2746', '2690', '2621', '2550']
 ['2525', '2525', '2640', '2769', '2802', '2883', '2856', '2694', '2631']
 ['2514', '2505', '2526', '2614', '2717', '2715', '2867', '2836', '2771']
 ...]
```

Compare and find the smallest of the three to create the next path element.

What happens if there are ties?

5) Find the steepest path down

Rules for ties.

If up == down but < front, choose randomly between them.

up = 2550

down = 2550

front = 2690

If front ties with up or down, choose front.

up = 2690	up = 2550
down = 2550	down = 2690
front = 2550	front = 2550

5) Pseudocode for find_path

```
initialize current location ←      (this is both a row and column)
make an empty list for path
while location is still within the list bounds
        assign up, front and down
        if (up < down and down < front)
                append up location to path
        else if (down < up and down < front)
                append down location to path
        else if (down == up and up < front)
                chose randomly between down and up
                append one of them to path
        else
                append front location to path
        update current location based on the chosen next location for path
return path
```

6) Pseudocode for draw_path

For each tuple in the path

Using the column and row given in the tuple, draw

a rectangle that is one pixel wide and filled in with yellow