CSE 373 Optional Section
Union Find, Homework 4

2013-10-31 & 2013-11-05
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Agenda

• Candy
• Interview Question
• Geopolitical Union Find
• Homework 4
Interview Question

- **Social network connectivity.** Given a social network containing N members and a log file containing M timestamps at which times pairs of members formed friendships, design an algorithm to determine the earliest time at which all members are connected (i.e., every member is a friend of a friend of a friend ... of a friend). Assume that the log file is sorted by timestamp and that friendship is an equivalence relation. The running time of your algorithm should be MlogN or better and use extra space proportional to N.
Interview Question 2

• How can I test if a singly-linked list is a palindrome?
Geopolitical Union Find

- [YouTube Video](http://www.youtube.com/watch?v=NvQtlusaEqM&list=PLOzUGhfPlMJzUf9_yqnNWKuNUjlTK0YCv&index=1)
Homework 4

• What numbers do we care about?
  – How many rooms are in the maze?
  – Height or Number of Rows
  – Width or Number of Columns
  – How many interior walls
  – How many exterior walls

• What are dimensions of any 2D collections?
Homework 4

• By the numbers
  – For a maze with 4 rows and 5 columns:
  – 20 total rooms
  – 49 walls
  – 31 interior walls
    • 16 vertical interior walls (4 x 4)
    • 15 horizontal interior walls (3 x 5)
Homework 4

• By the numbers
  – For a maze with 3 rows and 7 columns:
  – 21 total rooms
  – 52 walls
  – 32 interior walls
    • 18 vertical interior walls (3 x 6)
    • 14 horizontal interior walls (2 x 7)
Homework 4

• What data structures do we want?
  – A UnionFind array that has each room’s set
  – Something to keep track of walls
    • Recommendation:
      • Have two arrays, one for vertical and one for horizontal
Homework 4

• How to visualize the selection.
  – Each room is responsible for knowing its set and its walls left of and below it.
Homework 4

• Thereby for a maze (height = 3, width = 4):
Homework 4

• The rooms are numbered like this:
Homework 4

• After uniting all of the nodes, the UnionFind array looks like this:
Homework 4

• The walls to the left of each room are valued as such (1 means that the wall is in the maze)
Homework 4

• Likewise, for the horizontal walls below each room:
Homework 4

• All together, the numbers for the rooms and the walls look like this:
Homework 4

- With 3 arrays that look like this:

<table>
<thead>
<tr>
<th>index</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set</td>
<td>-1</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>9</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>wall_h</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>wall_v</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
Homework 4

• Now that you have your data structures you want to make your mazes!

• Find walls to remove
  – Find at random, rooms, walls, and/or neighbors
  – Make sure you want to remove it
    • Its neighbors are disjoint but adjacent
    • Its not exterior
  – Remove it, mark it in your array for vertical or horizontal walls arrays, and check if you should continue removing walls
Homework 4

• To show your mazes:
  – Make the top row of walls
  – For each row
    • Make a row of rooms and vertical walls
    • Make a row of horizontal walls below this row of rooms
  – Make sure that you have an opening at the entrance and exit
Homework 4

• Checking for adjacency where $w$ is the width and $i$ is the index of your room. Make sure to not modify or jump over exterior walls.
Homework 4

- The solution is 0 4 8 9 5 6 10 11
Homework 4

• If you remove any interior wall there will be a cycle: