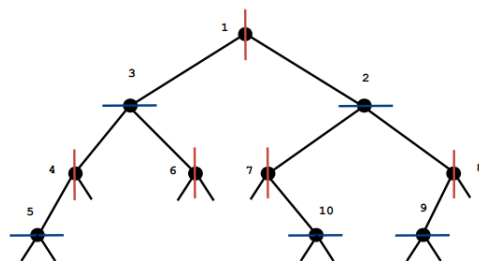
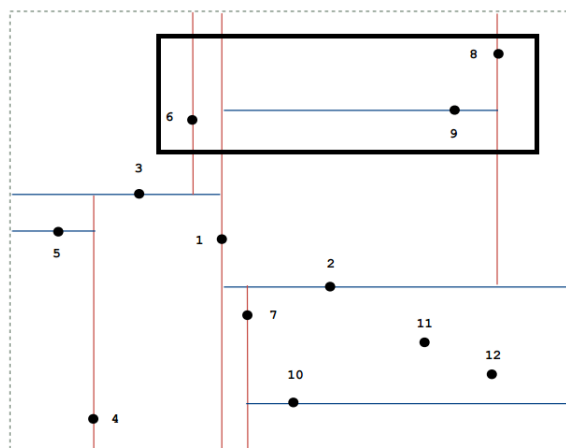


## Week 7 Activity

### 1. Kd-Trees

The figures below illustrate the results of inserting points 1 through 10 into a 2d-tree.



- (a) Circle all of the the points below in the 2d-tree that are examined (not necessarily just those inside the query rectangle) during the range search for the query rectangle specified above.

1 2 3 4 5 6 7 8 9 10

- (b) Draw the result of inserting point 11, then point 12 in the two figures above.

## 2. Undirected Graphs

### (a) Code Tracing

Consider the following Graph processing code.

```
private void foo(Graph G, int s) {
    Queue<Integer> q = new Queue<Integer>();
    for (int v = 0; v < G.V(); v++)
        distTo[v] = INFINITY;
    distTo[s] = 0;
    marked[s] = true;
    q.enqueue(s);

    while (!q.isEmpty()) {
        int v = q.dequeue();
        for (int w : G.adj(v)) {
            if (!marked[w]) {
                edgeTo[w] = v;
                distTo[w] = distTo[v] + 1; /* line 1 */
                marked[w] = true;         /* line 2 */
                q.enqueue(w);
            }
        }
    }
}
```

- i. What is the purpose of line 1?
- ii. What if marked array is not updated (i.e line 2 removed)

(b) Given the following algorithms, identify them as in one of the following categories.

- Any programmer could do it.
- Typical diligent algorithms student could do it.
- Hire an expert.
- Intractable.
- No one knows.

Algorithm 1: Find a cycle in a graph

Algorithm 2: Identify connected components in a graph

Algorithm 3: Is a graph bipartite?

Algorithm 4: Is there a cycle that contains every vertex exactly once?

Algorithm 5: Are two graphs identical except for the names of the vertices?

3. Design Problem (Bonus) The 1D nearest neighbour data structure has the following API.

- constructor: create an empty data structure.
- insert(x): insert the real number x into the data structure.
- query(y): return the real number in the data structure that is closest to y (or null if no such number).

Design a data structure that performs each operation in logarithmic time in the worst-case. Your answer will be graded on correctness, efficiency, clarity, and succinctness. You may use any of the data structures discussed in this course provided you clearly specify it.