

COMP261 Assignment 3 Answers

My program does everything set out in the assignment handout.

I tested the program worked by comparing the values given for number of articulation points and the minimum spanning tree provided for the small data set.

I also created some unit tests to check the functionality of my disjoint set class.

Articulation points

Pseudocode of AP algorithm used.

```
let allNodes = collection of all the nodes in the graph
let articulationNodes = empty collection to store articulation points

loop until allNodes is empty
    let rootNode = first node from allNodes
    let visitedNodes = empty collection to store nodes visited
    let rootChildCount = 0 // Used to find if root is an AP

    let fringe = empty stack for fringe elements
    loop until fringe is empty
        let node = peek from fringe
        let previousNode = parent of node

        if node.depth is set
            node.reachBack = node.depth = current fringe element depth
            add every node except the parent of node to node.children

            if node is a direct child of rootNode and previousNode is rootNode
                increment rootChildCount
            else if node.children is not empty
                let child = get and remove a node from node.children
                if child.depth is set
                    node.reachBack = min(node.reachBack, child.depth)
                else
                    add child to fringe with depth = node.depth + 1 and parent = node
                end if
            else
                if node is not rootNode
                    previousNode.reachBack = min(node.reachBack, previousNode.reachBack)
                    if node.reachBack >= previousNode.reachBack and previousNode has more than 1 child
                        add previousNode to articulationNodes
                    end if
                end if
                remove node from fringe
            end if
        end loop

        if rootChildCount <= 1 // this indicates that the root was not an AP
            remove the root node from articulationNodes
        end if

        remove every node inside visitedNodes from allNodes
    end loop
```

Depth and reachback

- A
 - Depth: 0
 - Reach-back: 0
- B
 - Depth: 1
 - Reach-back: 0
- C
 - Depth: 2
 - Reach-back: 2
- D
 - Depth: 3
 - Reach-back: 0
- E
 - Depth: 2
 - Reach-back: 0

- F
 - Depth: 5
 - Reach-back: 4
- G
 - Depth: 4
 - Reach-back: 4
- H
 - Depth: 4
 - Reach-back: 4
- I
 - Depth: 6
 - Reach-back: 4
- J
 - Depth: 6
 - Reach-back: 6

List of points

- B > C is a child of B that has a reach-back of 2 while B has a depth of 1, this indicates that there are no alternative paths for C making B an AP
- D > D has two children which both have reach-back values higher than the depth of D indicating that D is an AP
- H > H has two children which both have reach-back values that are higher or equal to the depth of H which indicates that H is an AP
- F > F has the child J which has a reach back higher than the depth of F which indicates that F is an AP

Minimum spanning tree

Pseudocode of MST algorithm used.

```

let djSet = disjoint set
let fringe = priority queue sorted by ascending segment length
let mst = collection of segments representing the minimum spanning tree
add all segments in graph to the fringe

loop until fringe is empty
  let segment = get and remove segment from fringe

  if not djSet.find(segment start, segment end) // Checks if start and end are not in the same disjoint set subtree
    djSet.union(segment start, segment end) // Merge the trees
    add segment to mst
  end if
end loop

```

Prim's algorithm

1. AD 2
2. DE 6
3. EF 3
4. BE 4
5. BG 1
6. BC 2
7. CH 4
8. HI 6

Kruskal's algorithm

This is the tree of the disjoint set at the end of the algorithm.

(This assumes that when Union(x, y) is called, x root becomes the parent of y root as long as the depth of y root is shorter or equal to the depth of x root)

Kruskal's Algorithm disjoint set state

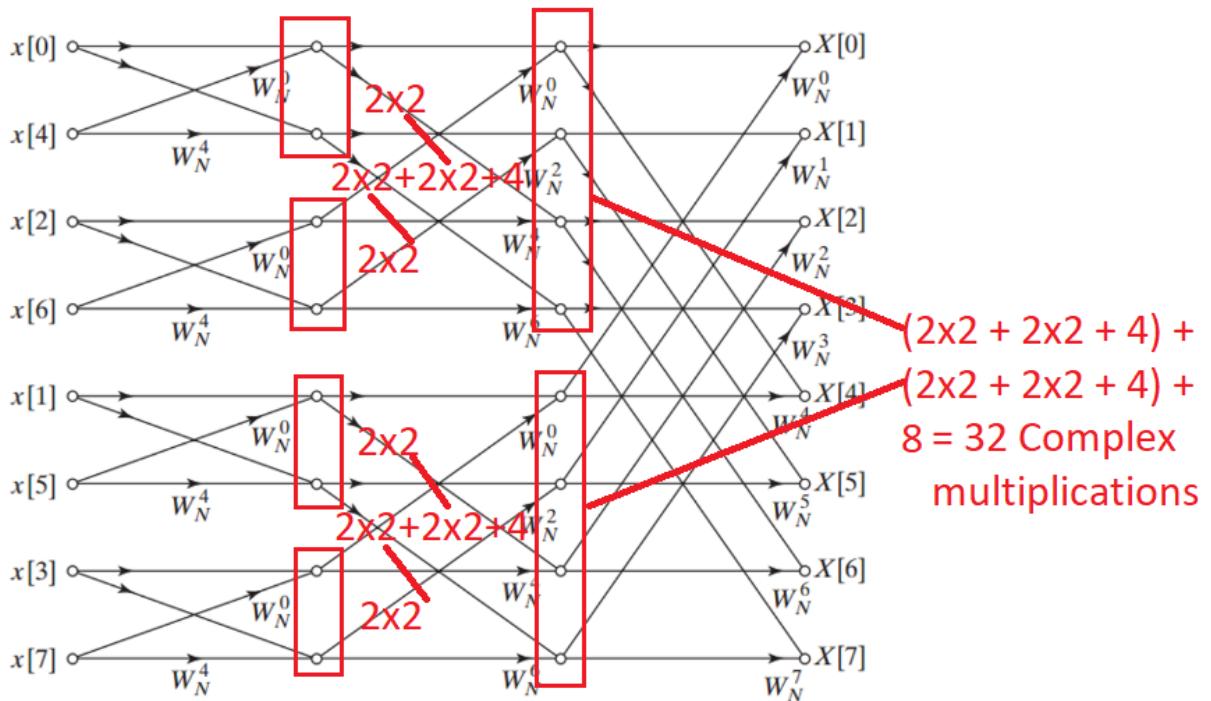
If the Union method makes x the parent of y, then the following image will be the resulting tree.

Kruskal's Algorithm disjoint set state

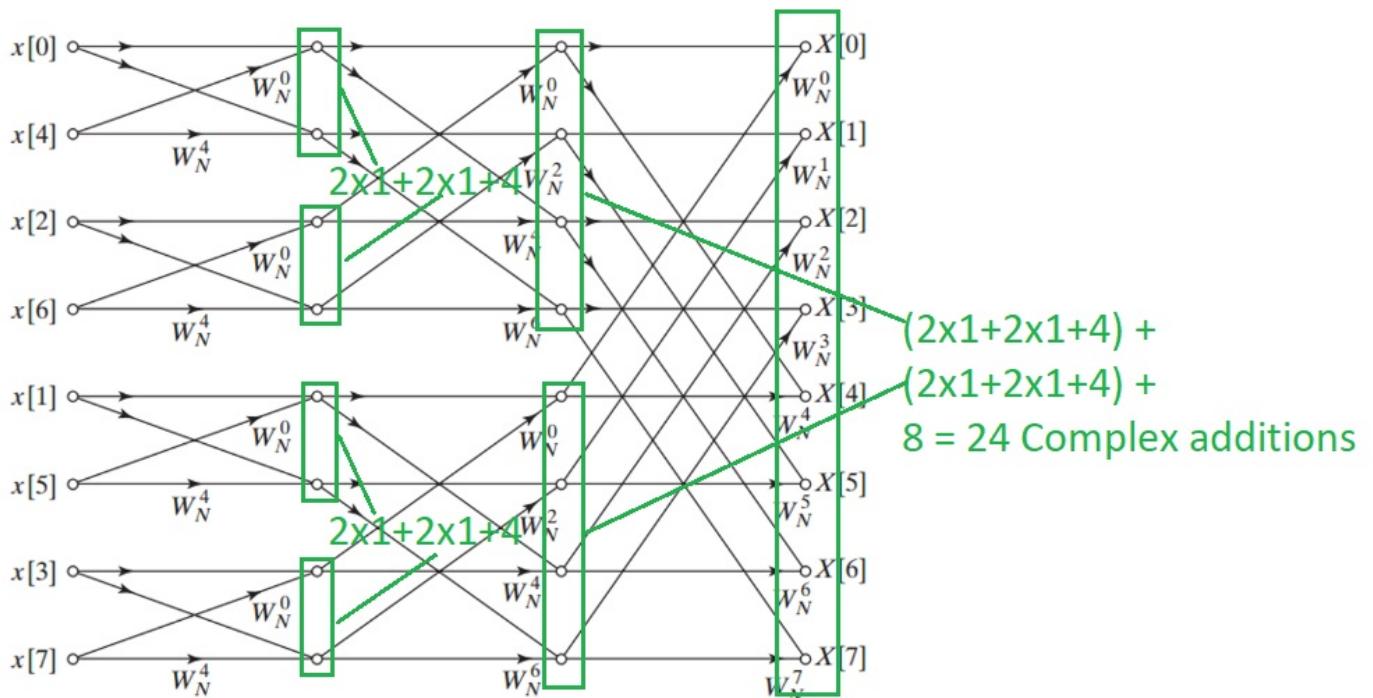
FFT

Calculate complex multiplications and additions

Multiplication



Addition:



Order of 16 point time series

0 8 4 12 2 10 6 14 19 5 13 3 11 7 15