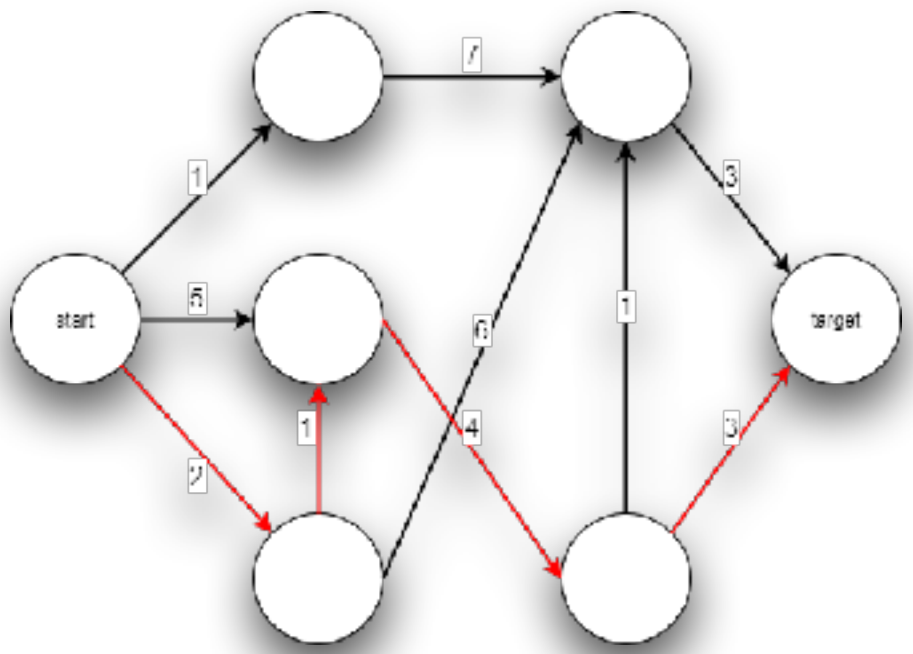
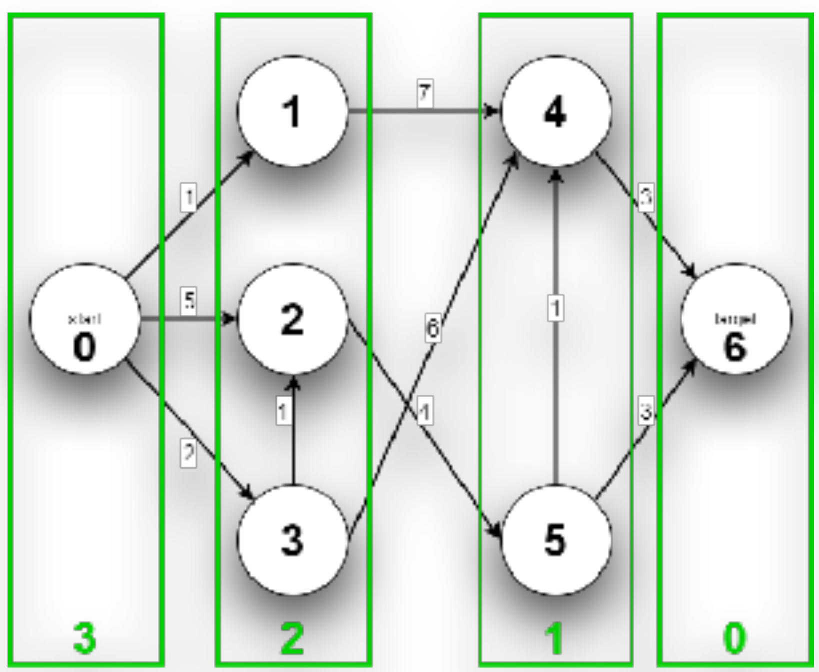
**Vedant Mishra**
**19BCE7354**

**A*** is a heuristic path searching graph algorithm. This means that given a weighed graph, it outputs the shortest path between two given nodes.
The algorithm is guaranteed to terminate for non-infinite graphs with non-negative edge weights. Additionally, if you manage to ensure certain properties when designing your **heuristic** it will also always return an almost-optimal solution in a pretty efficient manner.



```
public class Node implements Comparable<Node> {
    // Id for readability of result purposes
    private static int idCounter = 0;
    public int id;

    // Parent in the path
    public Node parent = null;

    public List<Edge> neighbors;

    // Evaluation functions
    public double f = Double.MAX_VALUE;
    public double g = Double.MAX_VALUE;
    // Hardcoded heuristic
    public double h;

    Node(double h){
        this.h = h;
        this.id = idCounter++;
        this.neighbors = new ArrayList<>();
    }

    @Override
    public int compareTo(Node n) {
        return Double.compare(this.f, n.f);
    }

    public static class Edge {
        Edge(int weight, Node node){
            this.weight = weight;
            this.node = node;
        }

        public int weight;
        public Node node;
    }

    public void addBranch(int weight, Node node){
        Edge newEdge = new Edge(weight, node);
        neighbors.add(newEdge);
    }

    public double calculateHeuristic(Node target){
        return this.h;
    }
}
public static Node aStar(Node start, Node target){
  TreeSet<Node> closedList = new TreeSet<>();
```

```java
    TreeSet<Node> openList = new TreeSet<>();

    start.f = start.g + start.calculateHeuristic(target);
    openList.add(start);

    while(!openList.isEmpty()){
        Node n = openList.first();
        if(n == target){
            return n;
        }

        for(Node.Edge edge : n.neighbors){
            Node m = edge.node;
            double totalWeight = n.g + edge.weight;

            if(!openList.contains(m) && !closedList.contains(m)){
                m.parent = n;
                m.g = totalWeight;
                m.f = m.g + m.calculateHeuristic(target);
                openList.add(m);
            } else {
                if(totalWeight < m.g){
                    m.parent = n;
                    m.g = totalWeight;
                    m.f = m.g + m.calculateHeuristic(target);

                    if(closedList.contains(m)){
                        closedList.remove(m);
                        openList.add(m);
                    }
                }
            }
        }

        openList.remove(n);
        closedList.add(n);
    }
    return null;
}

public static void printPath(Node target){
    Node n = target;

    if(n==null)
        return;

    List<Integer> ids = new ArrayList<>();
```

```java
    while(n.parent != null){
        ids.add(n.id);
        n = n.parent;
    }
    ids.add(n.id);
    Collections.reverse(ids);

    for(int id : ids){
        System.out.print(id + " ");
    }
    System.out.println("");
}
public static void main(String[] args) {
    Node head = new Node(3);
    head.g = 0;

    Node n1 = new Node(2);
    Node n2 = new Node(2);
    Node n3 = new Node(2);

    head.addBranch(1, n1);
    head.addBranch(5, n2);
    head.addBranch(2, n3);
    n3.addBranch(1, n2);

    Node n4 = new Node(1);
    Node n5 = new Node(1);
    Node target = new Node(0);

    n1.addBranch(7, n4);
    n2.addBranch(4, n5);
    n3.addBranch(6, n4);

    n4.addBranch(3, target);
    n5.addBranch(1, n4);
    n5.addBranch(3, target);

    Node res = aStar(head, target);
    printPath(res);
}
```

```
0 3 2 5 6
```