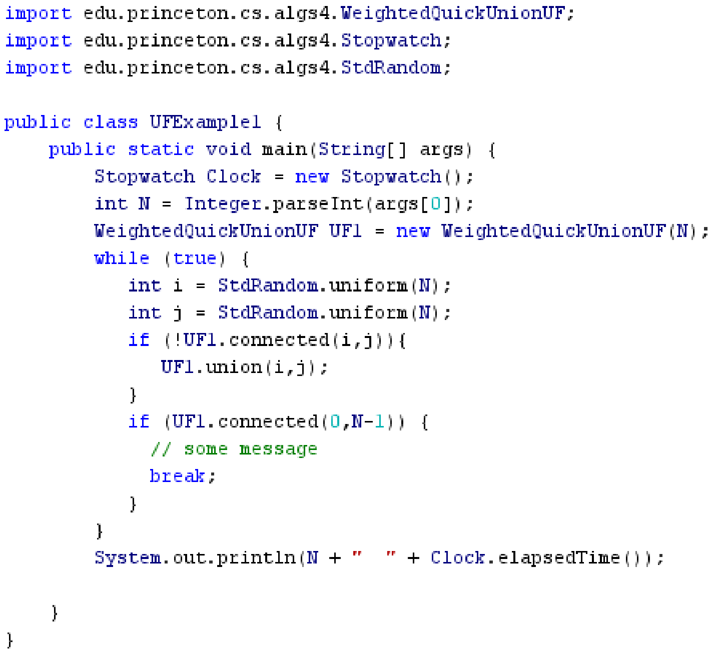
COS 226 Algorithms and Data Structures
Computer Science Department
Princeton University
Spring 2016

Week 1 Activities

1. **Running and testing Sample Code (10 mins)**

   Copy the following code and header information from course precept page, compile and run. This code uses algs4 library WeightedQuickUnionUF.



```
import edu.princeton.cs.algs4.WeightedQuickUnionUF;
import edu.princeton.cs.algs4.Stopwatch;
import edu.princeton.cs.algs4.StdRandom;

public class UFExample1 {
    public static void main(String[] args) {
        Stopwatch Clock = new Stopwatch();
        int N = Integer.parseInt(args[0]);
        WeightedQuickUnionUF UF1 = new WeightedQuickUnionUF(N);
        while (true) {
           int i = StdRandom.uniform(N);
           int j = StdRandom.uniform(N);
           if (!UF1.connected(i,j)){
              UF1.union(i,j);
           }
           if (UF1.connected(0,N-1)) {
             // some message
             break;
           }
        }
        System.out.println(N + "  " + Clock.elapsedTime());

    }
}
```

2. **Analysis of runtime (15 mins)**
   The runtime of an algorithm can be estimated using experimental values.

   (a) Build a table of values, N versus runtime T using the UFExample1 (given above). Consider only the run times greater than 1 second (why?). Use the doubling principle to increase the value of N (That is, $N = 1000, 2000, 4000$ etc).

N					
T					

   (b) Assuming the code runs in polynomial time, we will use the formula $T = aN^b$ to estimate runtime T for a data set of size N. Compute the values of a and b up to two decimal places (Do not round the exponent).

3. **Memory Analysis (10 mins)**

Suppose that the Java library java.util.LinkedList is implemented using a doubly-linked list, maintaining a reference to the first and last node in the list, along with its size.

```
public class LinkedList<Item> {
  private Node first; // the first node in the linked list
  private Node last; // the last node in the linked list
  private int N; // number of items in the linked list
  private class Node {
    private Item item; // the item reference
    private Node next, prev; // the next and previous nodes
  }
  ...
}
```

Using the 64-bit memory cost model from the textbook, how much memory (in bytes) does a Node object use and how much does a LinkedList object use to store N items? Do not include the memory for the items themselves but do include the memory for the references to them.

(a) Memory of a node

(b) Memory of a LinkedList with N nodes.

4. **Percolation Assignment (15 mins)**

Our first programming assignment is to write a program to estimate the value of the percolation threshold via Monte Carlo simulation.

(a) What is percolation and how can Union-Find be used to simulate a percolating system?

(b) Learn the methods to be implemented in the Percolation class.

```
public class Percolation {
  public Percolation(int N);
  public void open(int row, int col);
  public boolean isOpen(int row, int col);
  public boolean isFull(int row, int col);
  public int numberOfOpenSites();
  public boolean percolates()
}
```

(c) WeightedQuickUnionUF is from algs4. What is the runtime complexity of WeightedQuickUnionUF methods, union and find?

(d) Discuss the assignment deliverables, Percolation.java and PercolationStats.java and readme.txt files. More specifically discuss readme.txt