CSE 331 21wi Representation Exposure Worksheet **Sample Solution**

Consider the following code that contains two ADTs: a mutable 2-D `Point` class and a `PointSet` class which is essentially identical to the `CharSet` class used as an example in lecture. There is also a `Main` class with a `main` method that creates instances of these classes and calls some of their methods. Answer questions about this code on the following page.

```
/** 2-d (x,y) mutable point on the plane */
class Point {
  private int x, y;
  public Point(int x, int y) {
    this.x = x; this.y = y;
  }
  public void setX(int x) { this.x = x; }
  public void setY(int y) { this.y = y; }
}

/** Set of 2-D Points */
class PointSet {
  // RI: elts has no nulls and no duplicates
  private List<Point> elts;

  public PointSet() { elts = new ArrayList<Point>(); }

  /** add a point to this */
  public void add(Point p) {
    // ... check for duplicates omitted
    elts.add(p);
  }

  // Three methods that return a list of the set elements
  public List<Point> getElts1() { return elts; }
  public List<Point> getElts2() { return new ArrayList<Point>(elts); }
  public List<Point> getElts3() {
    return Collections.unmodifiableList(elts);
  }
}

class Main {
  public static void main(String[] args) {
    PointSet ps = new PointSet();
    ps.add(new Point(1,2));
    ps.add(new Point(17,42));

    List<Point> e1 = ps.getElts1();
    List<Point> e2 = ps.getElts2();
    List<Point> e3 = ps.getElts3();
    // draw a diagram of memory when execution reaches here
  }
}
```

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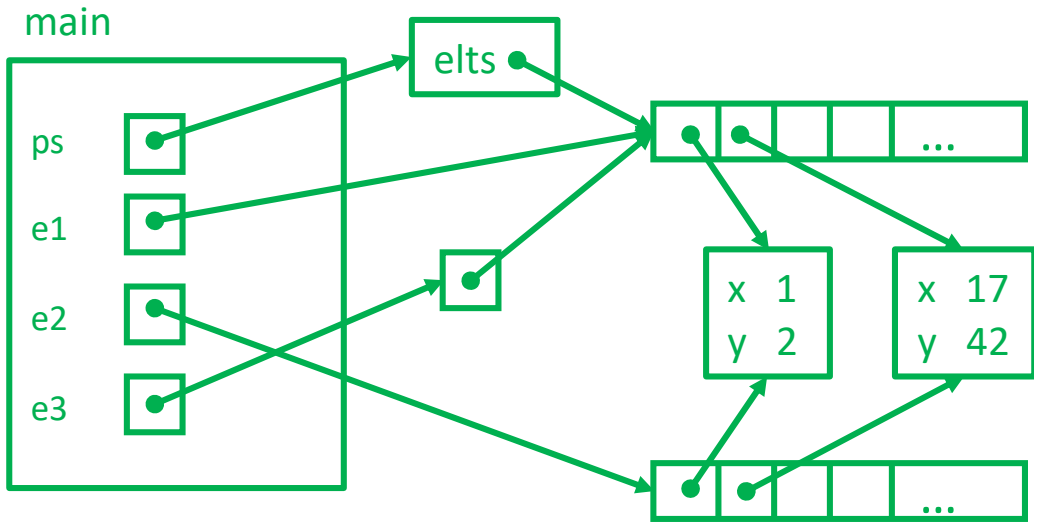
1. (CSE 143 review) Draw a diagram of memory showing all the variables and objects that exist at the end of method `main` when it is executed. Be sure you clearly show the distinction between local variables in `main` and Java objects referenced by those variables and by other objects. The results of the first two assignments, which create a `PointSet` and add a `Point` to it, are given below to help you get started. Add to this diagram to show the effect of the rest of the code.



2. Do any of the three implementations of method `getElts` (`getElts1`, `getElts2`, `getElts3`) have potential representation exposure problems? If so, explain which method(s) have the problem and why. (Briefly)

Yes, all three methods have representation exposure problems.

`getElts1` returns a reference to the private `PointSet` list `elts` to the caller, which means the caller can modify that list.

Since `Point` objects are mutable, all three methods return lists that refer to the original `Point` objects, which means the caller can modify any of the `Points`, changing the ones that are stored in (referenced by) the original `PointSet`.