CSE 331 21au Representation Exposure Worksheet Sample Solution

Consider the following code that contains two ADTs: a 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) point on the plane */
class Point {
  private int x, y;
  public Point(int x, int y) {
    this.x = x; 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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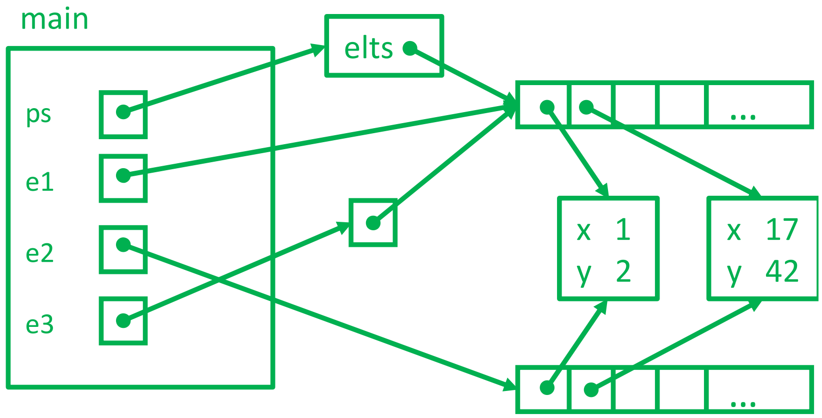
1. (CSE 143 review) Draw a diagram of memory showing all the variables and objects that exist at the end of method `main` when it is executed. Be sure you clearly show the distinction between local variables in `main` and Java objects referenced by those variables and by other objects. The results of 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)

getElts1 has rep exposure as a client can directly modify the list. The other two do not (getElts2 copies the list, getElts3 wraps it in an unmodifiable list).

3. Now, let's say that the Point class is designed as follows:

```
/** 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; }
}
```

Which of the three implementations of `getElts` would have potential representation exposure problems? Why?

All three do. If Point is mutable, users can change the values regardless of how we return our list. This could violate our invariant (for example the user could make duplicates in the set). To remedy this, we would have to do a deep copy (copy each of the points themselves when adding to the set and returning from our getElts methods).