Memory Allocation

```
public class Point {

   public Point(int x, int y) {
     px = x;
     py = y;
   }

   public void move(int dx,
                    int dy) {
     px += dx;
     py += dy;
   }

   /* instance variables */
   private int px;
   private int py;
}
```

```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(2, 3);
     Point p2 = new Point(4, 5);
     p1.move(10, 11);
   }
}
```

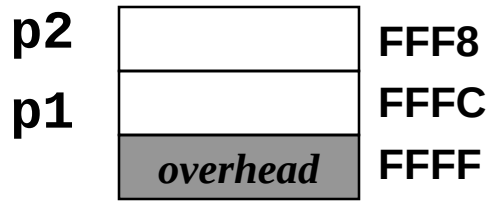
Memory Allocation

heap ***stack***

```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(2, 3);
     Point p2 = new Point(4, 5);
     p1.move(10, 11);
   }

}
```

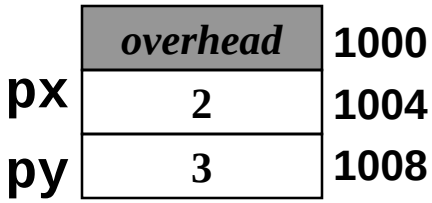
Memory Allocation

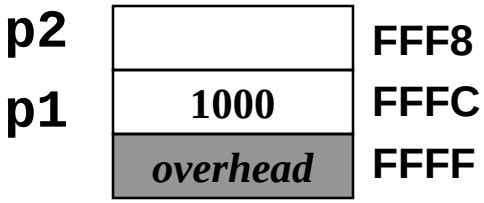
heap ***stack***




```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(2, 3);
     Point p2 = new Point(4, 5);
     p1.move(10, 11);
   }

}
```

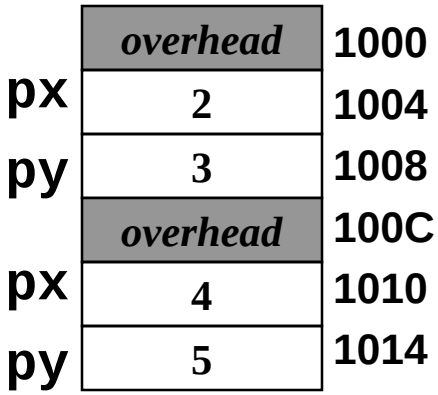
Memory Allocation

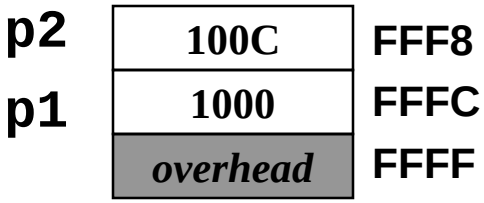





```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
      Point p1 = new Point(2, 3);
      Point p2 = new Point(4, 5);
      p1.move(10, 11);
   }

}
```

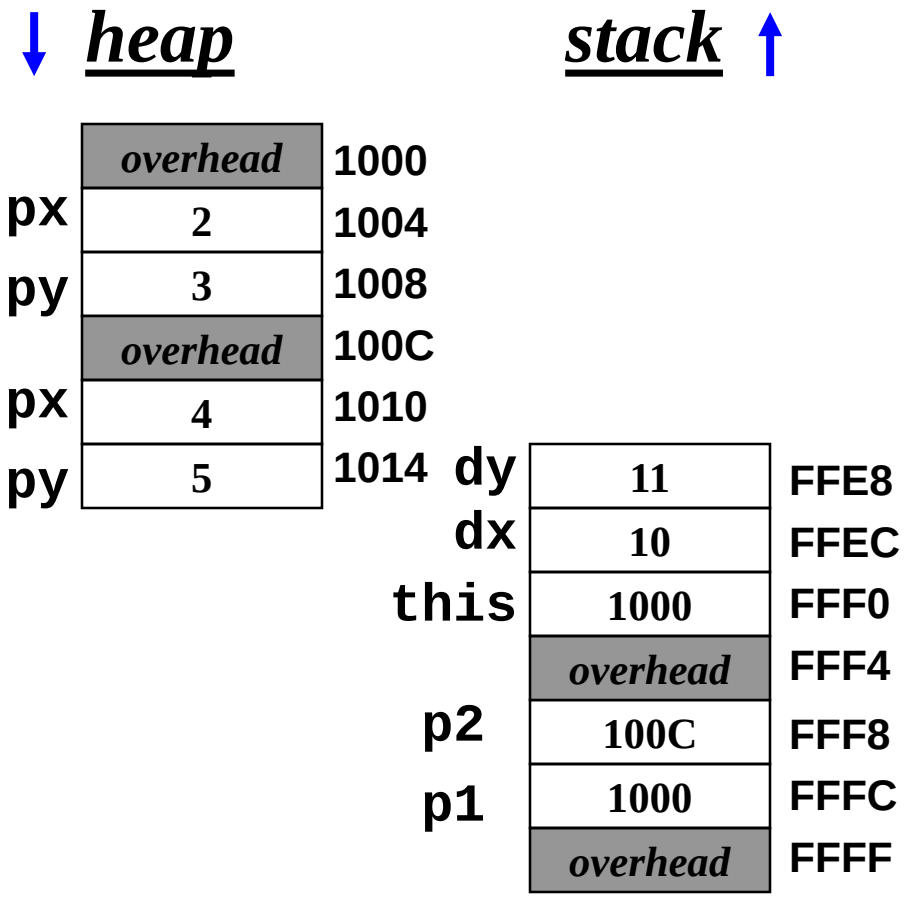
Memory Allocation






```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
      Point p1 = new Point(2, 3);
      Point p2 = new Point(4, 5);
      p1.move(10, 11);
   }

}
```

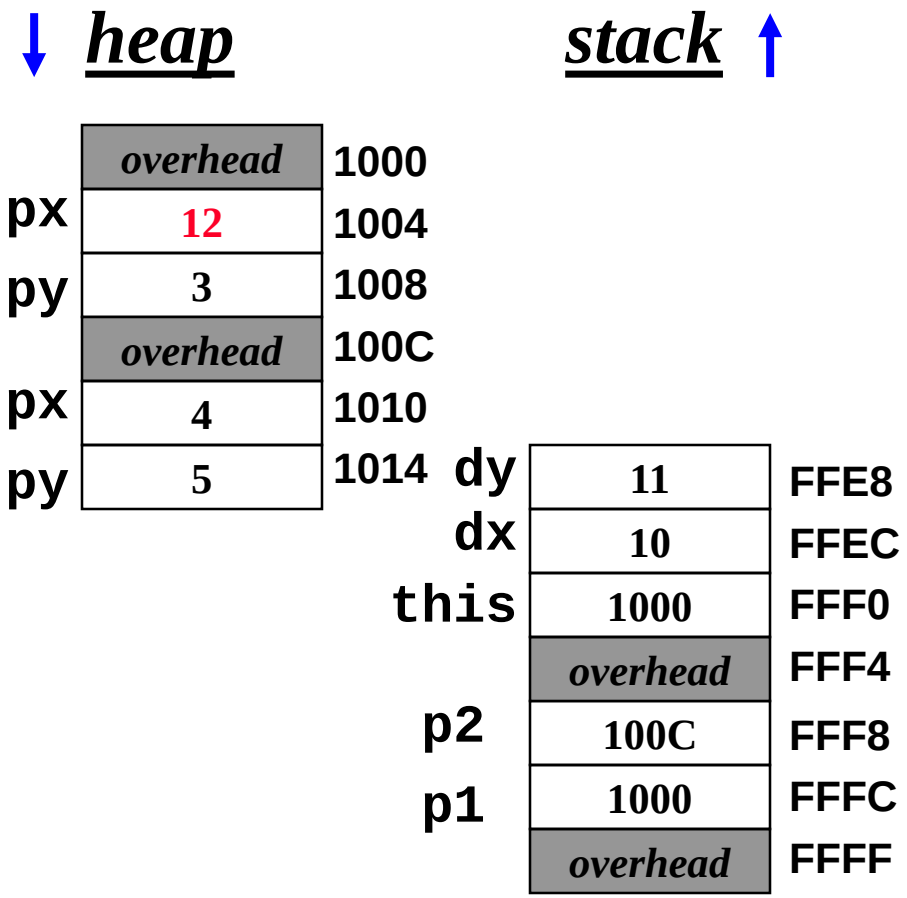
Memory Allocation




```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(2, 3);
     Point p2 = new Point(4, 5);
     p1.move(10, 11);
   }

}
```

```
   public void move(int dx,
                    int dy) {
     px += dx;
     py += dy;
   }
```

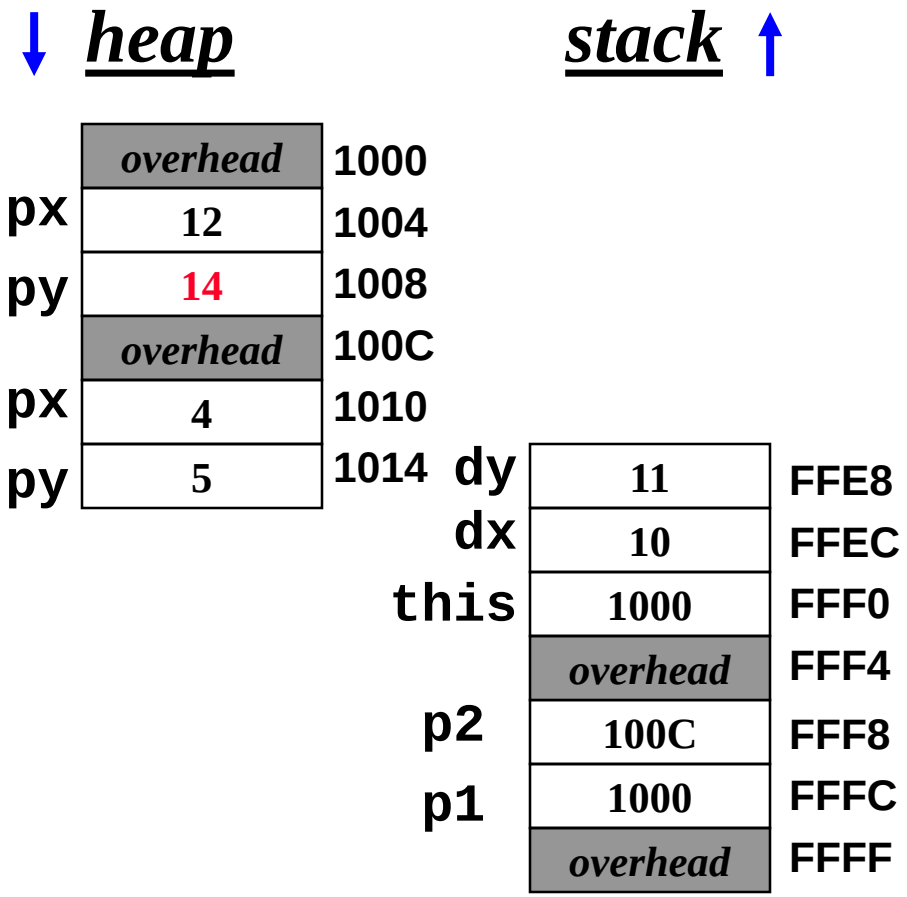
Memory Allocation




```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(2, 3);
     Point p2 = new Point(4, 5);
     p1.move(10, 11);
   }

}
```

```
   public void move(int dx,
                    int dy) {
     px += dx;
     py += dy;
   }
```

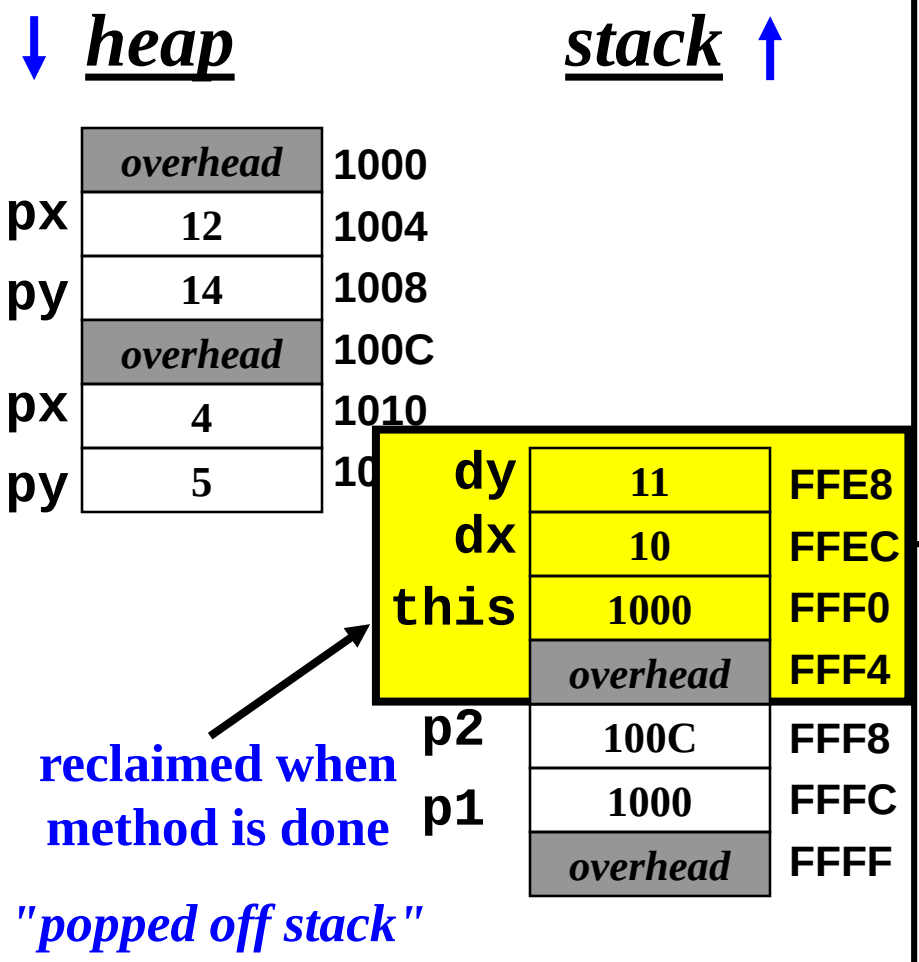
Memory Allocation




```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(2, 3);
     Point p2 = new Point(4, 5);
     p1.move(10, 11);
   }

}
```

```
   public void move(int dx,
                    int dy) {
     px += dx;
     py += dy;
   }
```

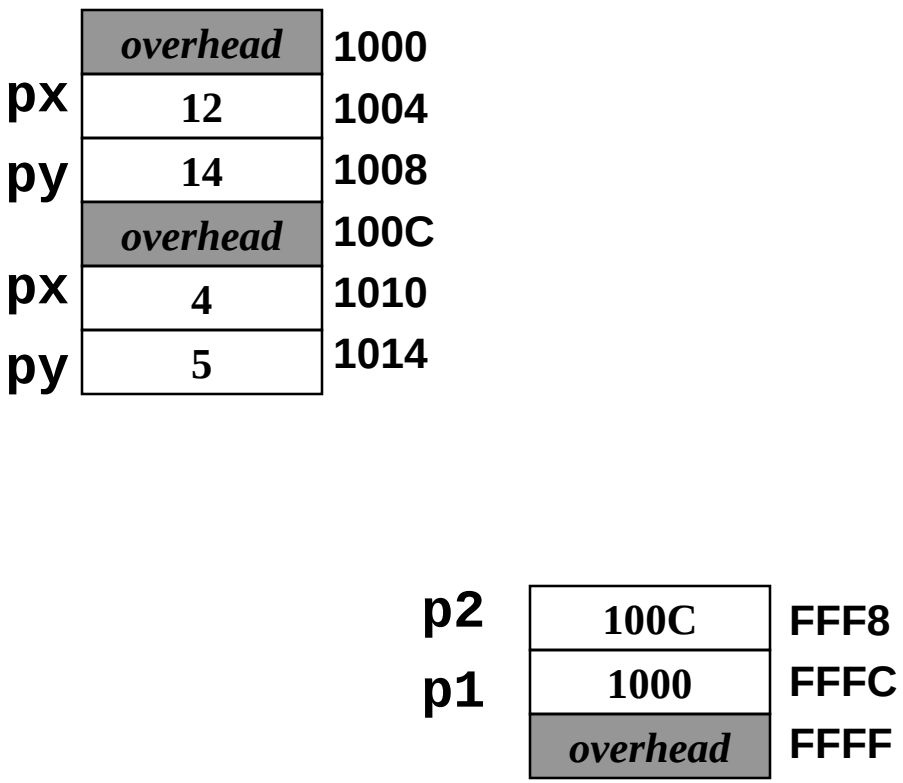
Memory Allocation




```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(2, 3);
     Point p2 = new Point(4, 5);
     p1.move(10, 11);
   }

}
```

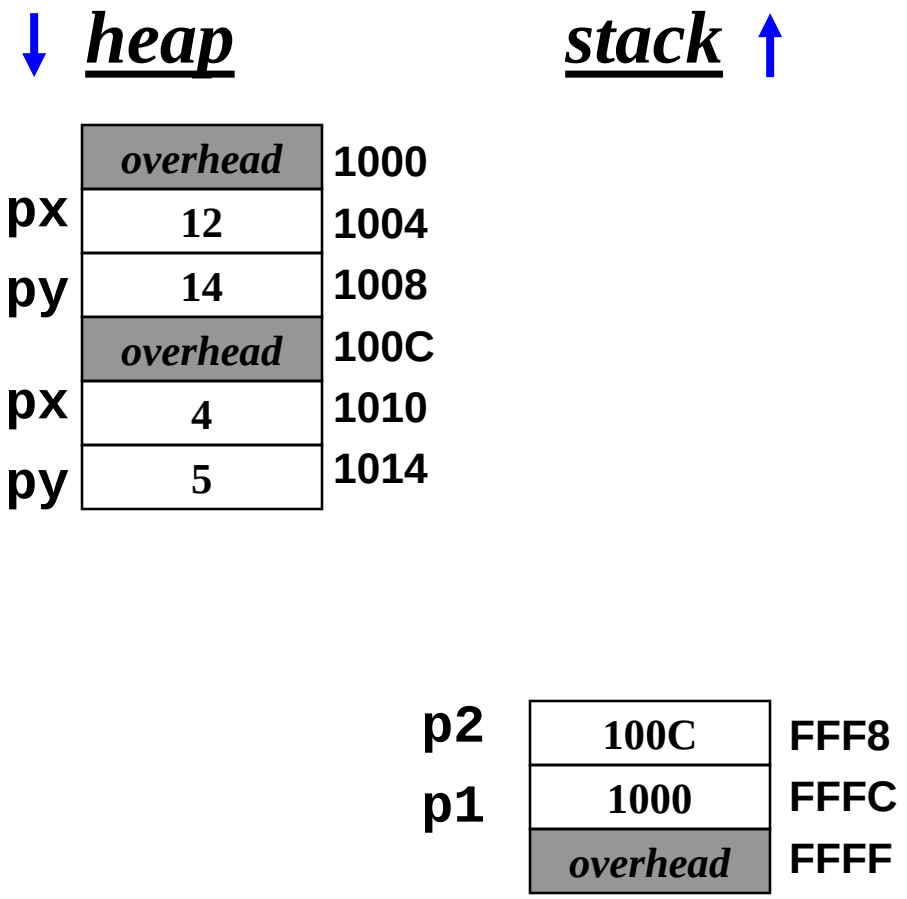
```
   public void move(int dx,
                    int dy) {
     px += dx;
     py += dy;
   }
```

Memory Allocation



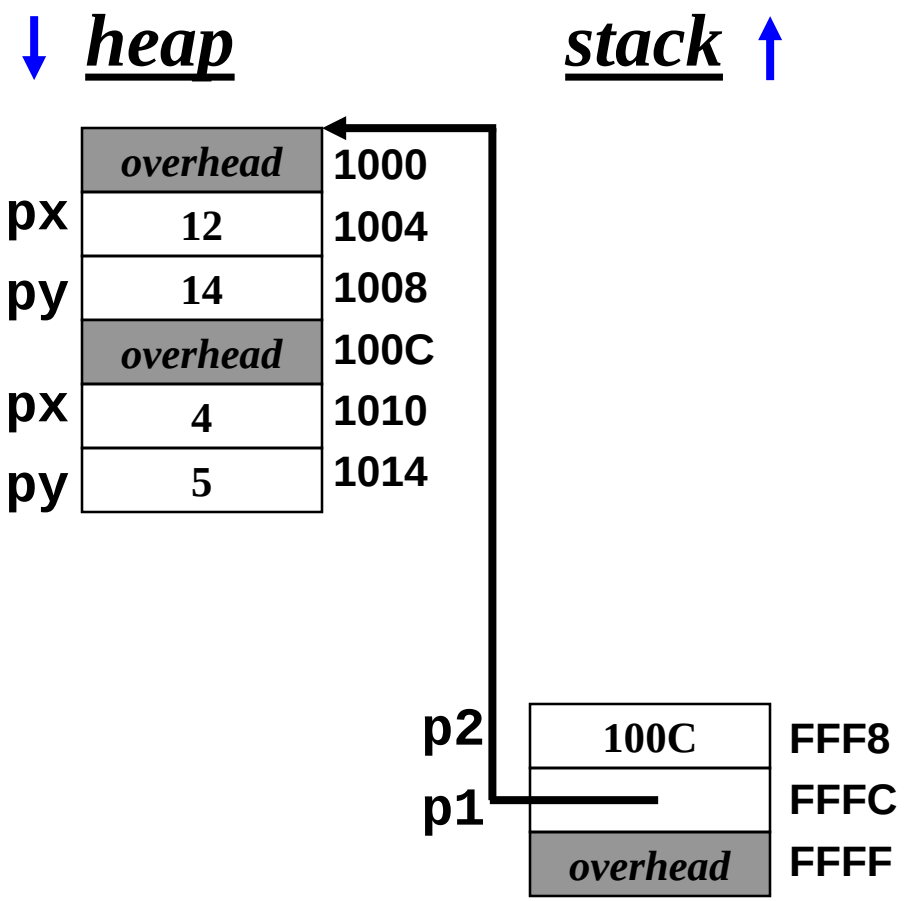

```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(2, 3);
     Point p2 = new Point(4, 5);
     p1.move(10, 11);
     ...
   }
}
```

Pointer Viewpoint



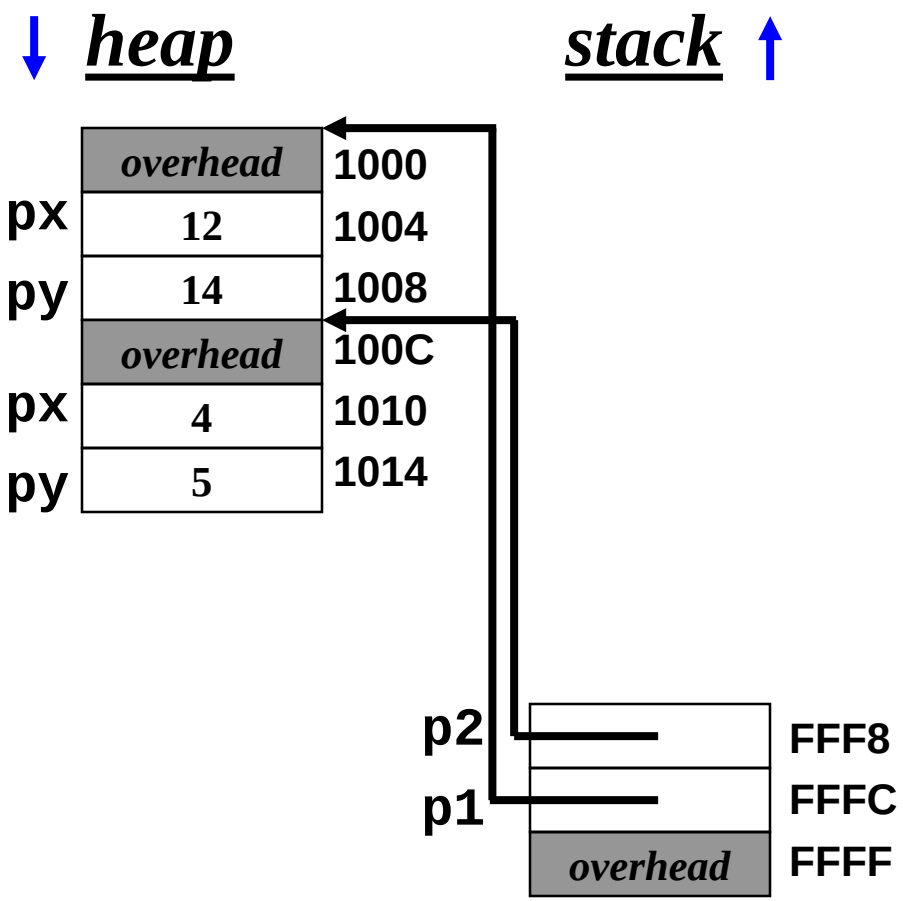

```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(2, 3);
     Point p2 = new Point(4, 5);
     p1.move(10, 11);
     ...
   }
}
```

Pointer Viewpoint




```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(2, 3);
     Point p2 = new Point(4, 5);
     p1.move(10, 11);
     ...
   }
}
```

Pointer Viewpoint




```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(2, 3);
     Point p2 = new Point(4, 5);
     p1.move(10, 11);
     ...
   }
}
```

Another Example

```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(1, 2);
     Point p2 = p1;
     p2.move(3, 4);

     Point p3;
     p3.move(1, 1);
   }
}
```

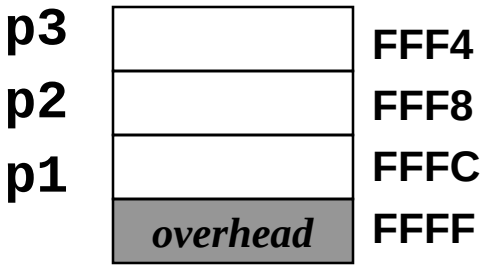
Another Example

heap ***stack***

```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(1, 2);
     Point p2 = p1;
     p2.move(3, 4);

     Point p3;
     p3.move(1, 1);
   }
}
```

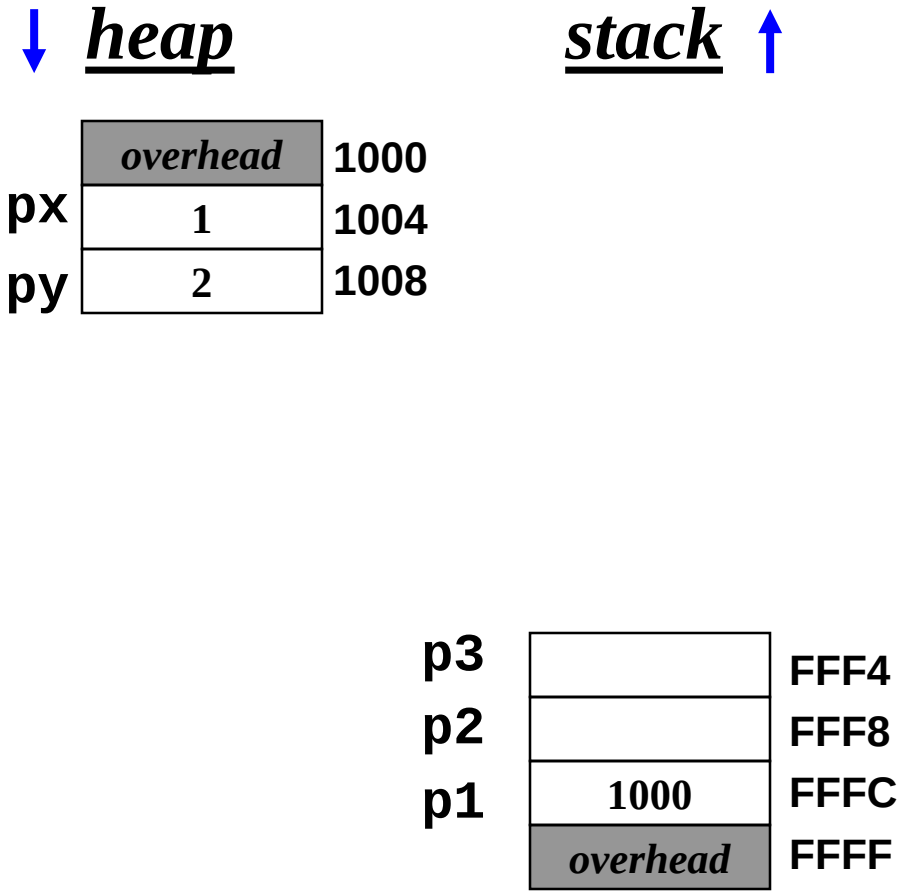
Another Example

heap ***stack***



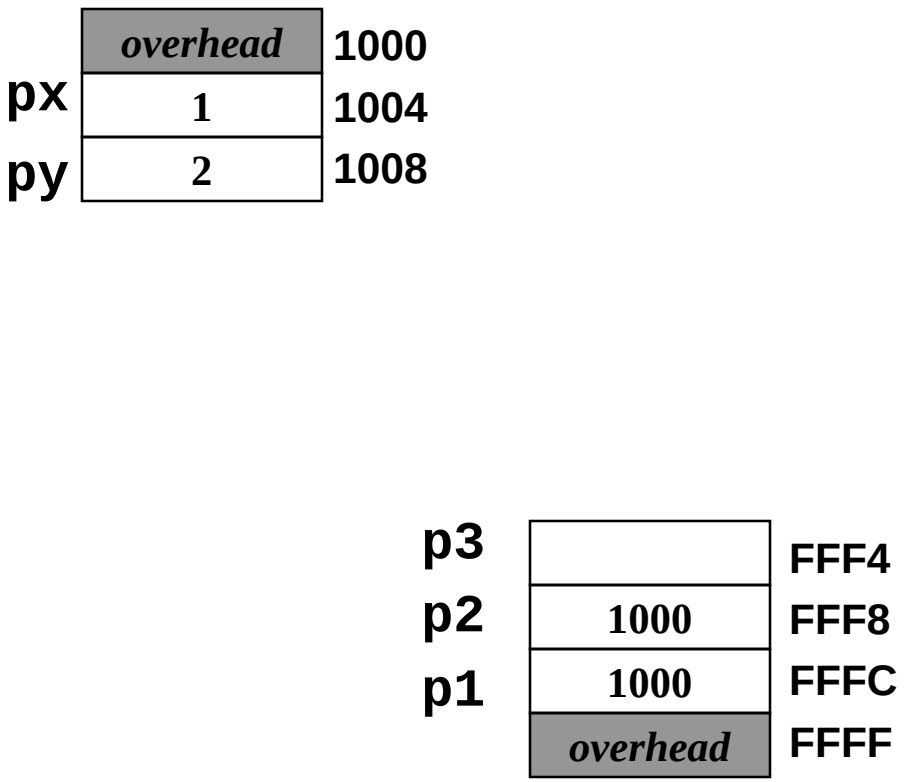

```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(1, 2);
     Point p2 = p1;
     p2.move(3, 4);

     Point p3;
     p3.move(1, 1);
   }
}
```

Another Example



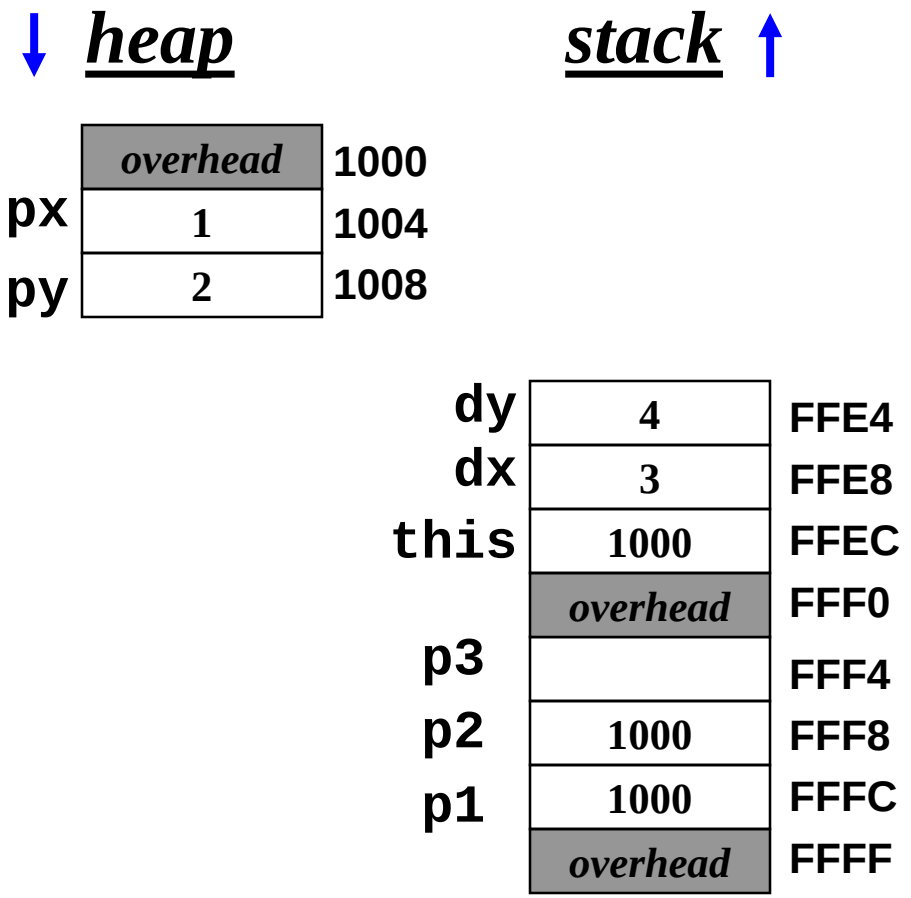

```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
      Point p1 = new Point(1, 2);
      Point p2 = p1;
      p2.move(3, 4);

      Point p3;
      p3.move(1, 1);
   }
}
```

Another Example




```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
      Point p1 = new Point(1, 2);
      Point p2 = p1;
      p2.move(3, 4);

      Point p3;
      p3.move(1, 1);
   }
}
```

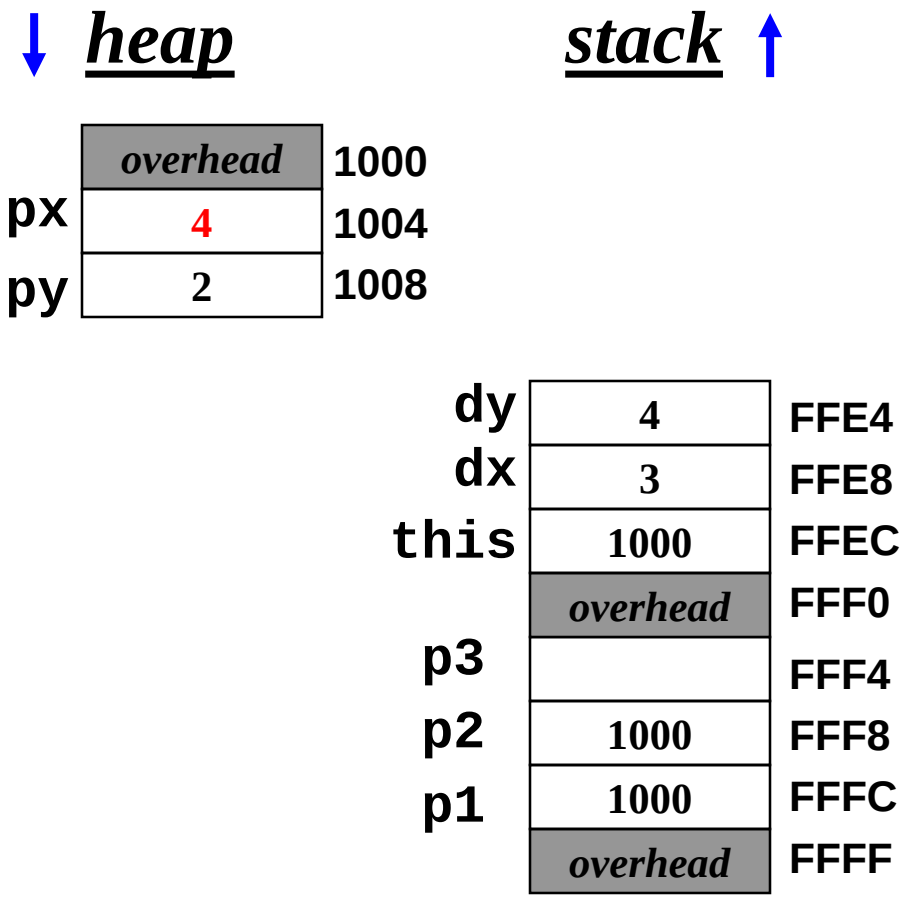
Another Example




```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(1, 2);
     Point p2 = p1;
     p2.move(3, 4);

     Point p3;
     p3.move(1, 1);
   }
}
```

```
   public void move(int dx,
                    int dy) {
     px += dx;
     py += dy;
   }
```

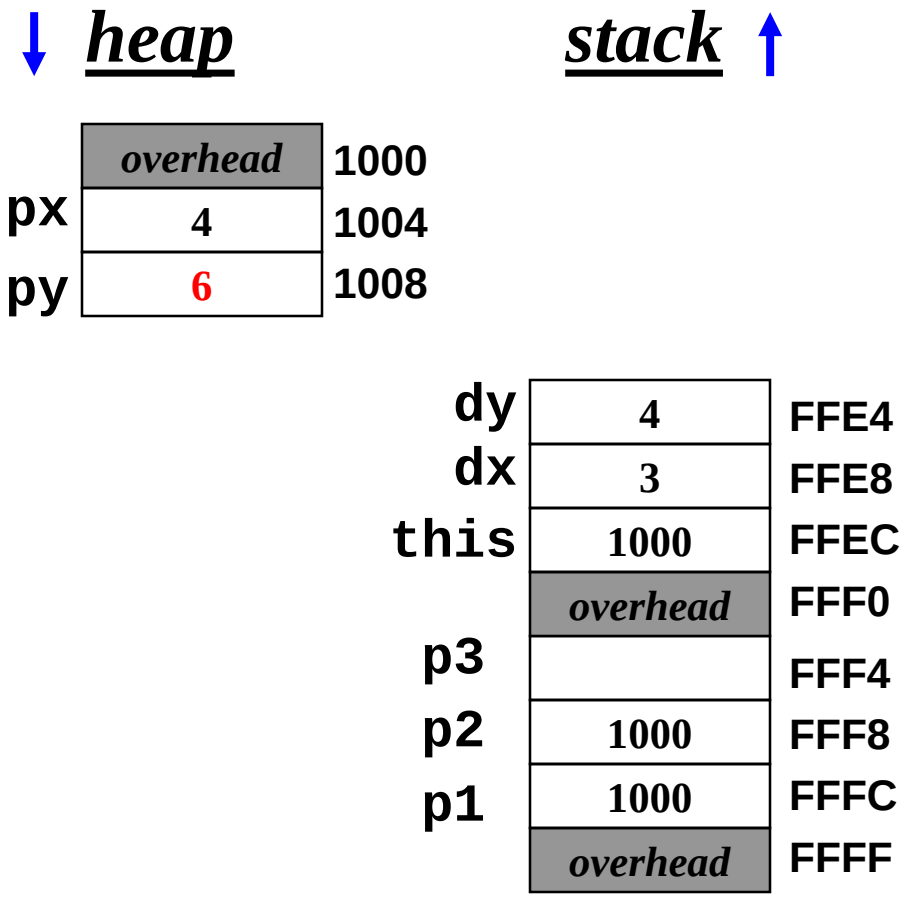
Another Example




```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(1, 2);
     Point p2 = p1;
     p2.move(3, 4);

     Point p3;
     p3.move(1, 1);
   }
}
```

```
   public void move(int dx,
                    int dy) {
     px += dx;
     py += dy;
   }
```

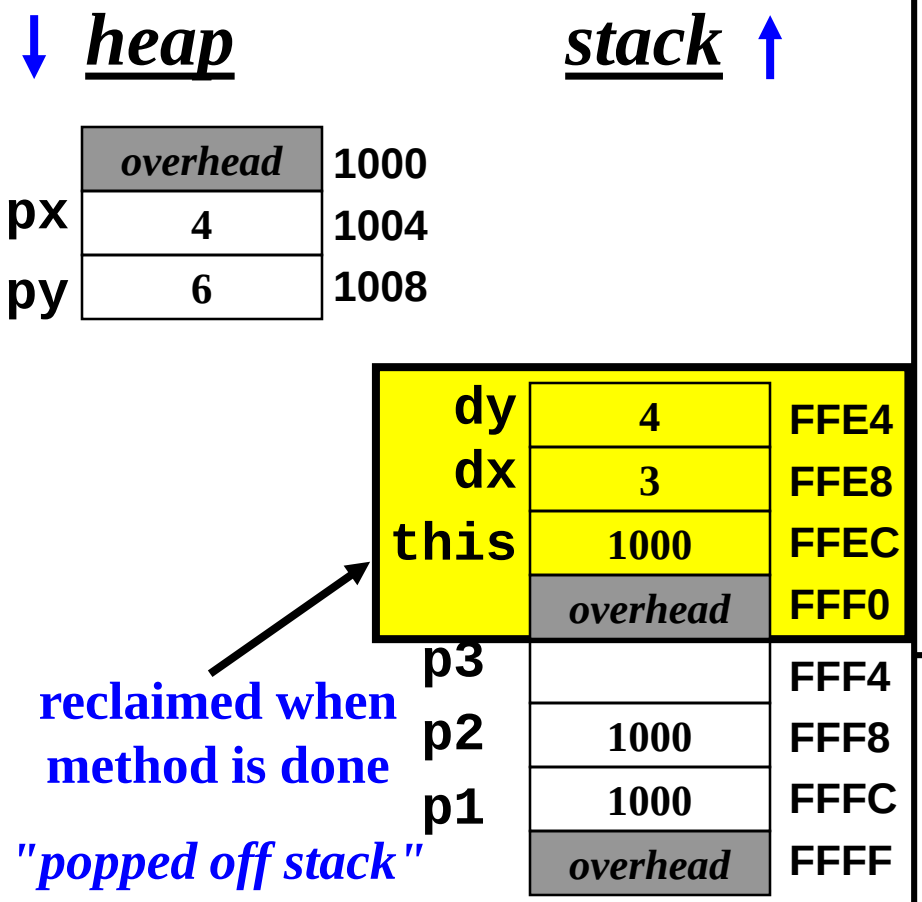
Another Example




```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(1, 2);
     Point p2 = p1;
     p2.move(3, 4);

     Point p3;
     p3.move(1, 1);
   }
}
```

```
   public void move(int dx,
                    int dy) {
     px += dx;
     py += dy;
   }
```

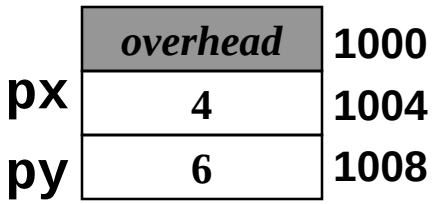
Another Example

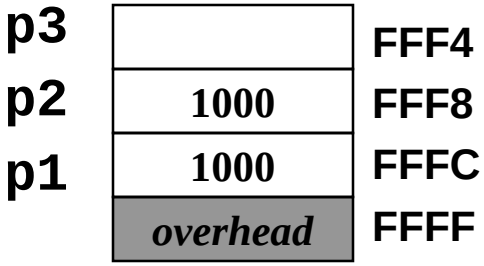



```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(1, 2);
     Point p2 = p1;
     p2.move(3, 4);

     Point p3;
     p3.move(1, 1);
   }
}
```

```
   public void move(int dx,
                    int dy) {
     px += dx;
     py += dy;
   }
```

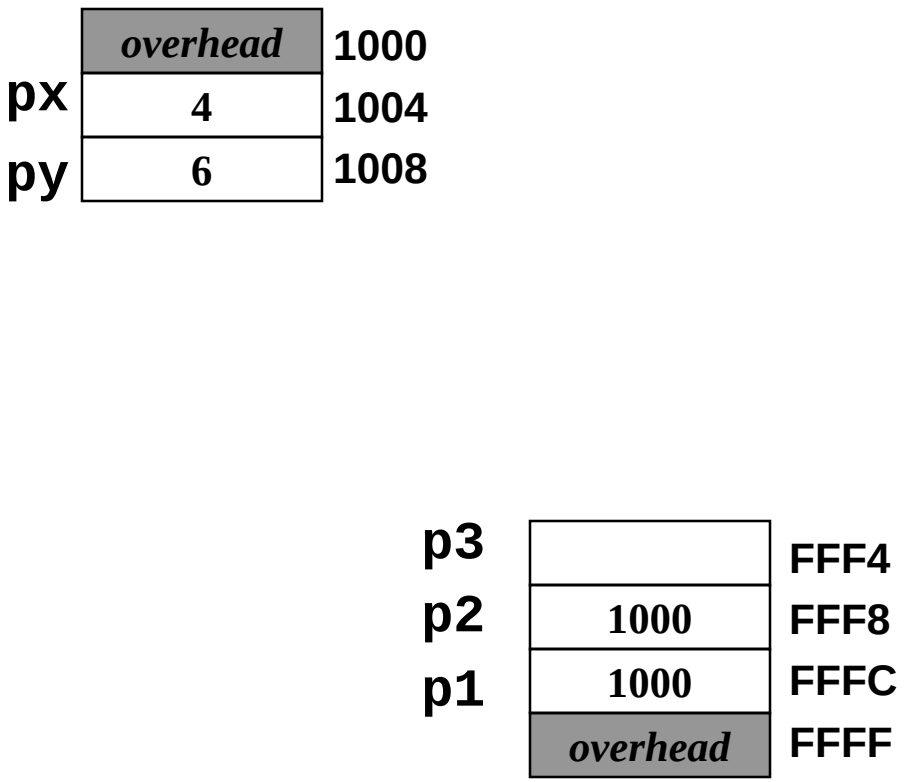
Another Example





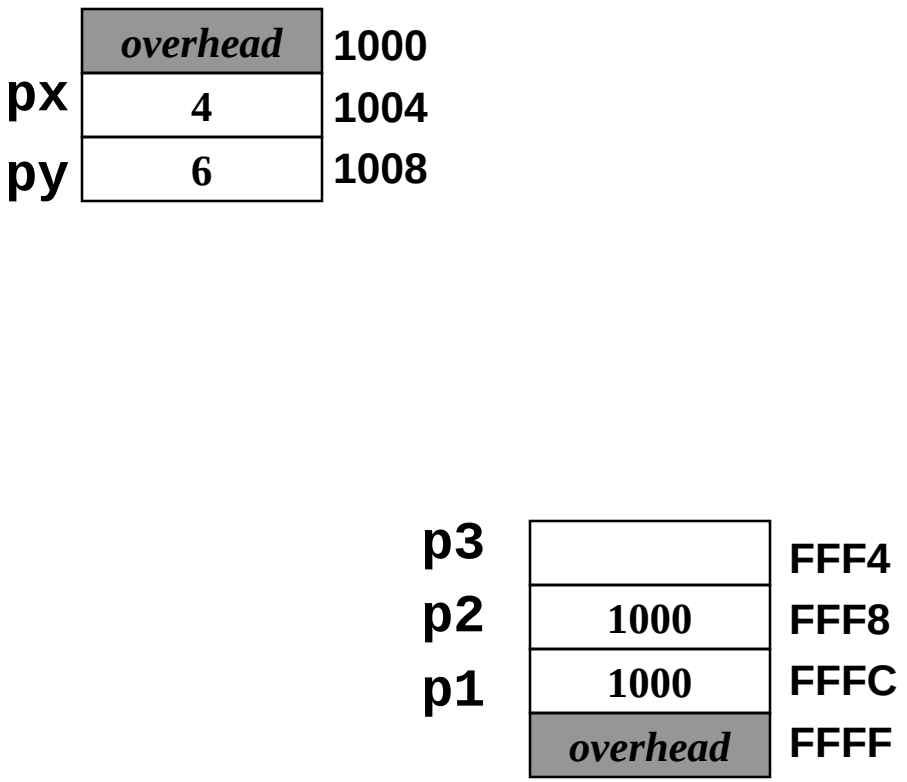

```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(1, 2);
     Point p2 = p1;
     p2.move(3, 4);

     Point p3;
     p3.move(1, 1);
   }
}
```

Another Example



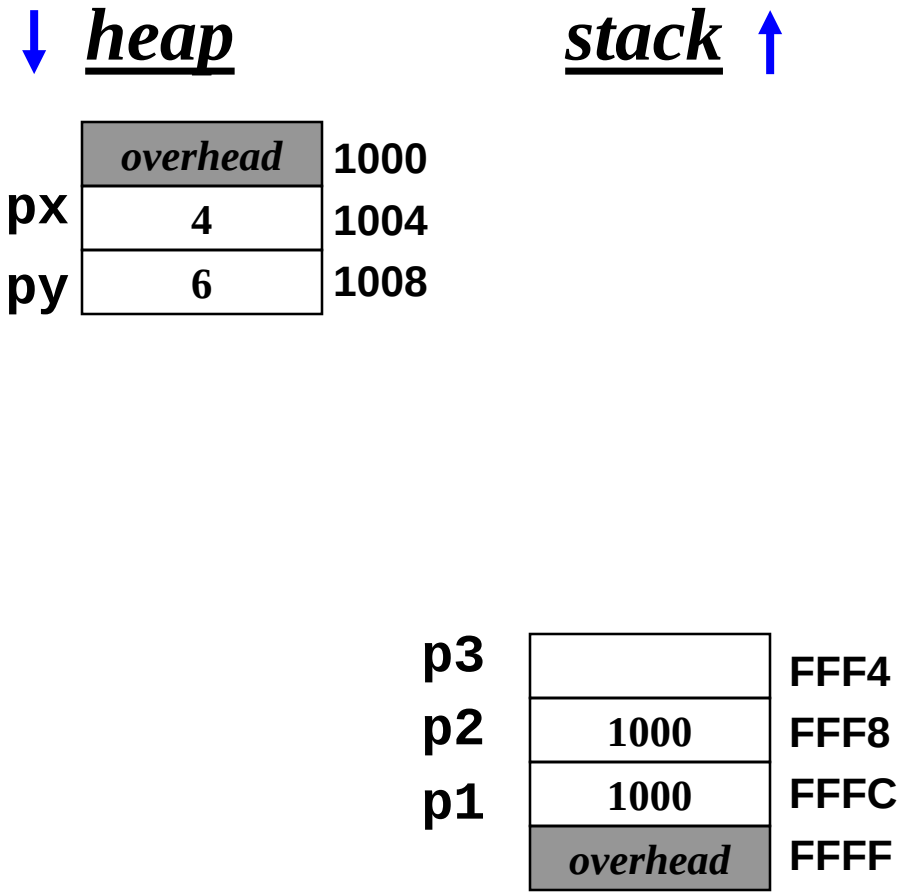

```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(1, 2);
     Point p2 = p1;
     p2.move(3, 4);

     Point p3;
     p3.move(1, 1);
   }
}
```

Another Example




```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(1, 2);
     Point p2 = p1;
     p2.move(3, 4);

     Point p3;
     p3.move(1, 1);
   }
}
```

Another Example




```
public class MyProgram
       extends ConsoleProgram {

   public void run() {
     Point p1 = new Point(1, 2);
     Point p2 = p1;
     p2.move(3, 4);

     Point p3;
     p3.move(1, 1);
   }
}
```

ERROR!

p3 is not pointing to a valid object!

(null dereference)