See the Assessment Guide for information on how to interpret this report.

ASSESSMENT SUMMARY

```
Compilation:  PASSED
API:          PASSED

SpotBugs:     PASSED
PMD:          PASSED
Checkstyle:   FAILED (0 errors, 2 warnings)

Correctness:  41/41 tests passed
Memory:       1/1 tests passed
Timing:       41/41 tests passed

Aggregate score: 100.00%
[ Compilation: 5%, API: 5%, Style: 0%, Correctness: 60%, Timing: 10%, Memory: 20% ]
```

ASSESSMENT DETAILS

```
The following files were submitted:
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2.3K Apr 10 12:10 BruteCollinearPoints.java
2.6K Apr 10 12:10 FastCollinearPoints.java
4.5K Apr 10 12:10 Point.java


================================================================================
*  COMPILING
================================================================================


% javac Point.java
*-----------------------------------------------------------

% javac LineSegment.java
*-----------------------------------------------------------

% javac BruteCollinearPoints.java
*-----------------------------------------------------------

% javac FastCollinearPoints.java
*-----------------------------------------------------------


================================================================

Checking the APIs of your programs.
*-----------------------------------------------------------
Point:

BruteCollinearPoints:

FastCollinearPoints:

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================================================================================
*  CHECKING STYLE AND COMMON BUG PATTERNS
================================================================================


% spotbugs *.class
*-----------------------------------------------------------


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% pmd .
*-----------------------------------------------------------


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% checkstyle *.java
*-----------------------------------------------------------
[WARN] BruteCollinearPoints.java:33:30: Do not use the letter 'l' as a local variable name. It is hard to distinguish from the number '1'. [LocalVaria
[WARN] Point.java:96:19: The class 'bySlope' must start with an uppercase letter and use CamelCase. [TypeName]
Checkstyle ends with 0 errors and 2 warnings.

% custom checkstyle checks for Point.java
*-----------------------------------------------------------

% custom checkstyle checks for BruteCollinearPoints.java
*-----------------------------------------------------------

% custom checkstyle checks for FastCollinearPoints.java
*-----------------------------------------------------------
```

```
================================================================


*****************************************************************************
*  TESTING CORRECTNESS
*****************************************************************************

Testing correctness of Point
*-----------------------------------------------------------
Running 3 total tests.

Test 1: p.slopeTo(q)
  * positive infinite slope, where p and q have coordinates in [0, 500)
  * positive infinite slope, where p and q have coordinates in [0, 32768)
  * negative infinite slope, where p and q have coordinates in [0, 500)
  * negative infinite slope, where p and q have coordinates in [0, 32768)
  * positive zero     slope, where p and q have coordinates in [0, 500)
  * positive zero     slope, where p and q have coordinates in [0, 32768)
  * symmetric for random points p and q with coordinates in [0, 500)
  * symmetric for random points p and q with coordinates in [0, 32768)
  * transitive for random points p, q, and r with coordinates in [0, 500)
  * transitive for random points p, q, and r with coordinates in [0, 32768)
  * slopeTo(), where p and q have coordinates in [0, 500)
  * slopeTo(), where p and q have coordinates in [0, 32768)
  * slopeTo(), where p and q have coordinates in [0, 10)
  * throw a java.lang.NullPointerException if argument is null
==> passed

Test 2: p.compareTo(q)
  * reflexive, where p and q have coordinates in [0, 500)
  * reflexive, where p and q have coordinates in [0, 32768)
  * antisymmetric, where p and q have coordinates in [0, 500)
  * antisymmetric, where p and q have coordinates in [0, 32768)
  * transitive, where p, q, and r have coordinates in [0, 500)
  * transitive, where p, q, and r have coordinates in [0, 32768)
  * sign of compareTo(), where p and q have coordinates in [0, 500)
  * sign of compareTo(), where p and q have coordinates in [0, 32768)
  * sign of compareTo(), where p and q have coordinates in [0, 10)
  * throw java.lang.NullPointerException exception if argument is null
==> passed

Test 3: p.slopeOrder().compare(q, r)
  * reflexive, where p and q have coordinates in [0, 500)
  * reflexive, where p and q have coordinates in [0, 32768)
  * antisymmetric, where p, q, and r have coordinates in [0, 500)
  * antisymmetric, where p, q, and r have coordinates in [0, 32768)
  * transitive, where p, q, r, and s have coordinates in [0, 500)
  * transitive, where p, q, r, and s have coordinates in [0, 32768)
  * sign of compare(), where p, q, and r have coordinates in [0, 500)
  * sign of compare(), where p, q, and r have coordinates in [0, 32768)
  * sign of compare(), where p, q, and r have coordinates in [0, 10)
  * throw java.lang.NullPointerException if either argument is null
==> passed


Total: 3/3 tests passed!


================================================================
*****************************************************************************
*  TESTING CORRECTNESS (substituting reference Point and LineSegment)
*****************************************************************************

Testing correctness of BruteCollinearPoints
*-----------------------------------------------------------
Running 17 total tests.

The inputs satisfy the following conditions:
  - no duplicate points
  - no 5 (or more) points are collinear
  - all x- and y-coordinates between 0 and 32,767

Test 1: points from a file
  * filename = input8.txt
  * filename = equidistant.txt
  * filename = input40.txt
  * filename = input48.txt
==> passed

Test 2a: points from a file with horizontal line segments
  * filename = horizontal5.txt
  * filename = horizontal25.txt
==> passed

Test 2b: random horizontal line segments
  *  1 random horizontal line segment
  *  5 random horizontal line segments
  * 10 random horizontal line segments
  * 15 random horizontal line segments
==> passed

Test 3a: points from a file with vertical line segments
  * filename = vertical5.txt
  * filename = vertical25.txt
==> passed

Test 3b: random vertical line segments
  *  1 random vertical line segment
  *  5 random vertical line segments
  * 10 random vertical line segments
  * 15 random vertical line segments
==> passed
```

```
Test 4a: points from a file with no line segments
  * filename = random23.txt
  * filename = random38.txt
==> passed

Test 4b: random points with no line segments
  *  5 random points
  * 10 random points
  * 20 random points
  * 50 random points
==> passed

Test 5: points from a file with fewer than 4 points
  * filename = input1.txt
  * filename = input2.txt
  * filename = input3.txt
==> passed

Test 6: check for dependence on either compareTo() or compare()
        returning { -1, +1, 0 } instead of { negative integer,
        positive integer, zero }
  * filename = equidistant.txt
  * filename = input40.txt
  * filename = input48.txt
==> passed

Test 7: check for fragile dependence on return value of toString()
  * filename = equidistant.txt
  * filename = input40.txt
  * filename = input48.txt
==> passed

Test 8: random line segments, none vertical or horizontal
  *  1 random line segment
  *  5 random line segments
  * 10 random line segments
  * 15 random line segments
==> passed

Test 9: random line segments
  *  1 random line segment
  *  5 random line segments
  * 10 random line segments
  * 15 random line segments
==> passed

Test 10: check that data type is immutable by testing whether each method
         returns the same value, regardless of any intervening operations
  * input8.txt
  * equidistant.txt
==> passed

Test 11: check that data type does not mutate the constructor argument
  * input8.txt
  * equidistant.txt
==> passed

Test 12: numberOfSegments() is consistent with segments()
  * filename = input8.txt
  * filename = equidistant.txt
  * filename = input40.txt
  * filename = input48.txt
  * filename = horizontal5.txt
  * filename = vertical5.txt
  * filename = random23.txt
==> passed

Test 13: throws an exception if either the constructor argument is null
         or any entry in array is null
  * argument is null
  * Point[] of length 10, number of null entries = 1
  * Point[] of length 10, number of null entries = 10
  * Point[] of length 4, number of null entries = 1
  * Point[] of length 3, number of null entries = 1
  * Point[] of length 2, number of null entries = 1
  * Point[] of length 1, number of null entries = 1
==> passed

Test 14: check that the constructor throws an exception if duplicate points
  * 50 points
  * 25 points
  * 5 points
  * 4 points
  * 3 points
  * 2 points
==> passed


Total: 17/17 tests passed!


================================================================
Testing correctness of FastCollinearPoints
*----------------------------------------------------------
Running 21 total tests.

The inputs satisfy the following conditions:
  - no duplicate points
  - all x- and y-coordinates between 0 and 32,767

Test 1: points from a file
  * filename = input8.txt
  * filename = equidistant.txt
  * filename = input40.txt
```

```
  * filename = input48.txt
  * filename = input299.txt
==> passed

Test 2a: points from a file with horizontal line segments
  * filename = horizontal5.txt
  * filename = horizontal25.txt
  * filename = horizontal50.txt
  * filename = horizontal75.txt
  * filename = horizontal100.txt
==> passed

Test 2b: random horizontal line segments
  *  1 random horizontal line segment
  *  5 random horizontal line segments
  * 10 random horizontal line segments
  * 15 random horizontal line segments
==> passed

Test 3a: points from a file with vertical line segments
  * filename = vertical5.txt
  * filename = vertical25.txt
  * filename = vertical50.txt
  * filename = vertical75.txt
  * filename = vertical100.txt
==> passed

Test 3b: random vertical line segments
  *  1 random vertical line segment
  *  5 random vertical line segments
  * 10 random vertical line segments
  * 15 random vertical line segments
==> passed

Test 4a: points from a file with no line segments
  * filename = random23.txt
  * filename = random38.txt
  * filename = random91.txt
  * filename = random152.txt
==> passed

Test 4b: random points with no line segments
  *  5 random points
  * 10 random points
  * 20 random points
  * 50 random points
==> passed

Test 5a: points from a file with 5 or more on some line segments
  * filename = input9.txt
  * filename = input10.txt
  * filename = input20.txt
  * filename = input50.txt
  * filename = input80.txt
  * filename = input300.txt
  * filename = inarow.txt
==> passed

Test 5b: points from a file with 5 or more on some line segments
  * filename = kw1260.txt
  * filename = rs1423.txt
==> passed

Test 6: points from a file with fewer than 4 points
  * filename = input1.txt
  * filename = input2.txt
  * filename = input3.txt
==> passed

Test 7: check for dependence on either compareTo() or compare()
        returning { -1, +1, 0 } instead of { negative integer,
        positive integer, zero }
  * filename = equidistant.txt
  * filename = input40.txt
  * filename = input48.txt
  * filename = input299.txt
==> passed

Test 8: check for fragile dependence on return value of toString()
  * filename = equidistant.txt
  * filename = input40.txt
  * filename = input48.txt
==> passed

Test 9: random line segments, none vertical or horizontal
  *  1 random line segment
  *  5 random line segments
  * 25 random line segments
  * 50 random line segments
  * 100 random line segments
==> passed

Test 10: random line segments
  *  1 random line segment
  *  5 random line segments
  * 25 random line segments
  * 50 random line segments
  * 100 random line segments
==> passed

Test 11: random distinct points in a given range
  * 5 random points in a 10-by-10 grid
  * 10 random points in a 10-by-10 grid
  * 50 random points in a 10-by-10 grid
```

```
  * 90 random points in a 10-by-10 grid
  * 200 random points in a 50-by-50 grid
==> passed

Test 12: m*n points on an m-by-n grid
  * 3-by-3 grid
  * 4-by-4 grid
  * 5-by-5 grid
  * 10-by-10 grid
  * 20-by-20 grid
  * 5-by-4 grid
  * 6-by-4 grid
  * 10-by-4 grid
  * 15-by-4 grid
  * 25-by-4 grid
==> passed

Test 13: check that data type is immutable by testing whether each method
         returns the same value, regardless of any intervening operations
  * input8.txt
  * equidistant.txt
==> passed

Test 14: check that data type does not mutate the constructor argument
  * input8.txt
  * equidistant.txt
==> passed

Test 15: numberOfSegments() is consistent with segments()
  * filename = input8.txt
  * filename = equidistant.txt
  * filename = input40.txt
  * filename = input48.txt
  * filename = horizontal5.txt
  * filename = vertical5.txt
  * filename = random23.txt
==> passed

Test 16: throws an exception if either constructor argument is null
         or any entry in array is null
  * argument is null
  * Point[] of length 10, number of null entries = 1
  * Point[] of length 10, number of null entries = 10
  * Point[] of length 4, number of null entries = 1
  * Point[] of length 3, number of null entries = 1
  * Point[] of length 2, number of null entries = 1
  * Point[] of length 1, number of null entries = 1
==> passed

Test 17: check that the constructor throws an exception if duplicate points
  * 50 points
  * 25 points
  * 5 points
  * 4 points
  * 3 points
  * 2 points
==> passed


Total: 21/21 tests passed!


================================================================
********************************************************************************
*  MEMORY
********************************************************************************

Analyzing memory of Point
*-----------------------------------------------------------
Running 1 total tests.

The maximum amount of memory per Point object is 32 bytes.

Student memory = 24 bytes (passed)

Total: 1/1 tests passed!


================================================================



********************************************************************************
*  TIMING
********************************************************************************

Timing BruteCollinearPoints
*-----------------------------------------------------------
Running 10 total tests.

Test 1a-1e: Find collinear points among n random distinct points


                                              slopeTo()
             n    time     slopeTo()   compare()  + 2*compare()        compareTo()
-----------------------------------------------------------------------------------------------
=> passed    16   0.00        5580           0           5580                 167
=> passed    32   0.00      108376           0         108376                 620
=> passed    64   0.02     1908144           0        1908144                2320
=> passed   128   0.10    32012128           0       32012128                8864
=> passed   256   1.45   524410560           0      524410560               34362
==> 5/5 tests passed

Test 2a-2e: Find collinear points among n/4 arbitrary line segments
```

```
                                                 slopeTo()
             n    time     slopeTo()   compare()  + 2*compare()        compareTo()
-----------------------------------------------------------------------------------------------
=> passed    16   0.00         5580           0           5580                 162
=> passed    32   0.00       108376           0         108376                 618
=> passed    64   0.01      1908144           0        1908144                2317
=> passed   128   0.12     32012128           0       32012128                8859
=> passed   256   1.40    524410560           0      524410560               34351
==> 5/5 tests passed

Total: 10/10 tests passed!


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Timing FastCollinearPoints
*-----------------------------------------------------------
Running 31 total tests.

Test 1a-1g: Find collinear points among n random distinct points


                                                 slopeTo()
             n    time     slopeTo()   compare()  + 2*compare()        compareTo()
-----------------------------------------------------------------------------------------------
=> passed    64   0.01         9828       18375          46578                20387
=> passed   128   0.01        40132       88038         216208                96724
=> passed   256   0.03       162180      412474         987128               445855
=> passed   512   0.17       652036     1892777        4437590              2023361
=> passed  1024   0.69      2614788     8551908       19718604              9090876
=> passed  2048   1.66     10472452    38139767       86751986             40359695
==> 6/6 tests passed

lg ratio(slopeTo() + 2*compare()) = lg (86751986 / 19718604) = 2.14
=> passed

==> 7/7 tests passed

Test 2a-2g: Find collinear points among the n points on an n-by-1 grid

                                                 slopeTo()
             n    time     slopeTo()   compare()  + 2*compare()        compareTo()
-----------------------------------------------------------------------------------------------
=> passed    64   0.00         9828        4699          19226                 8919
=> passed   128   0.00        40132       17667          75466                30892
=> passed   256   0.01       162180       68460         299100               112105
=> passed   512   0.04       652036      268886        1189808               422799
=> passed  1024   0.13      2614788     1064001        4742790              1635586
=> passed  2048   0.10     10472452     4229165       18930782              6423519
=> passed  4096   0.37     41916420    16855066       75626552             25442817
==> 7/7 tests passed

lg ratio(slopeTo() + 2*compare()) = lg (75626552 / 18930782) = 2.00
=> passed

==> 8/8 tests passed

Test 3a-3g: Find collinear points among the n points on an n/4-by-4 grid

                                                 slopeTo()
             n    time     slopeTo()   compare()  + 2*compare()        compareTo()
-----------------------------------------------------------------------------------------------
=> passed    64   0.00         9828       14755          39338                18770
=> passed   128   0.00        40132       43572         127276                71690
=> passed   256   0.01       162180      149072         460324               276015
=> passed   512   0.03       652036      547086        1746208              1072432
=> passed  1024   0.11      2614788     2085378        6785544              4207021
=> passed  2048   0.26     10472452     8118235       26708922             16597648
=> passed  4096   1.01     41916420    31982559      105881538             65820065
==> 7/7 tests passed

lg ratio(slopeTo() + 2*compare()) = lg (105881538 / 26708922) = 1.99
=> passed

==> 8/8 tests passed

Test 4a-4g: Find collinear points among the n points on an n/8-by-8 grid

                                                 slopeTo()
             n    time     slopeTo()   compare()  + 2*compare()        compareTo()
-----------------------------------------------------------------------------------------------
=> passed    64   0.00         9828       17794          45416                20707
=> passed   128   0.00        40132       75441         191014                92946
=> passed   256   0.01       162180      231411         625002               371861
=> passed   512   0.04       652036      852928        2357892              1469621
=> passed  1024   0.13      2614788     3257786        9130360              5836186
=> passed  2048   0.46     10472452    12692831       35858114             23255432
=> passed  4096   1.66     41916420    50030502      141977424             92725991
==> 7/7 tests passed

lg ratio(slopeTo() + 2*compare()) = lg (141977424 / 35858114) = 1.99
=> passed

==> 8/8 tests passed

Total: 31/31 tests passed!


================================================================
```