Name: ***Samuel Sovi***

Assignment: 9

Complete & Correct:	48 / 48
Tests:	0 / 0
Format and Comments:	6 / 6
Writeup:	6 / 6
Total Score:	60 / 60

Comments:

1. looks good, all unit and perf tests pass, graphs look good

Unit test output:

```
==712765== Memcheck, a memory error detector
==712765== Copyright (C) 2002-2017, and GNU GPL'd, by Julian Seward et al.
==712765== Using Valgrind-3.15.0 and LibVEX; rerun with -h for copyright info
==712765== Command: ./hw9_test
==712765==
[==========] Running 21 tests from 1 test suite.
[----------] Global test environment set-up.
[----------] 21 tests from BasicAVLMapTests
[ RUN      ] BasicAVLMapTests.EmptyCheck
[       OK ] BasicAVLMapTests.EmptyCheck (11 ms)
[ RUN      ] BasicAVLMapTests.InsertCheck
[       OK ] BasicAVLMapTests.InsertCheck (4 ms)
[ RUN      ] BasicAVLMapTests.RValueAccessCheck
[       OK ] BasicAVLMapTests.RValueAccessCheck (3 ms)
[ RUN      ] BasicAVLMapTests.LValueAccessCheck
[       OK ] BasicAVLMapTests.LValueAccessCheck (3 ms)
[ RUN      ] BasicAVLMapTests.SimpleContainsCheck
[       OK ] BasicAVLMapTests.SimpleContainsCheck (3 ms)
[ RUN      ] BasicAVLMapTests.MoreInvolvedContainsCheck
[       OK ] BasicAVLMapTests.MoreInvolvedContainsCheck (2 ms)
[ RUN      ] BasicAVLMapTests.EraseCheck
[       OK ] BasicAVLMapTests.EraseCheck (18 ms)
[ RUN      ] BasicAVLMapTests.KeyRangeCheck
[       OK ] BasicAVLMapTests.KeyRangeCheck (12 ms)
[ RUN      ] BasicAVLMapTests.SortedKeyCheck
[       OK ] BasicAVLMapTests.SortedKeyCheck (5 ms)
[ RUN      ] BasicAVLMapTests.InvalidKeyCheck
[       OK ] BasicAVLMapTests.InvalidKeyCheck (30 ms)
[ RUN      ] BasicAVLMapTests.NextKeyCheck
[       OK ] BasicAVLMapTests.NextKeyCheck (7 ms)
[ RUN      ] BasicAVLMapTests.PrevKeyCheck
[       OK ] BasicAVLMapTests.PrevKeyCheck (7 ms)
[ RUN      ] BasicAVLMapTests.DestructorCheck
[       OK ] BasicAVLMapTests.DestructorCheck (3 ms)
[ RUN      ] BasicAVLMapTests.CopyConstructorCheck
[       OK ] BasicAVLMapTests.CopyConstructorCheck (5 ms)
[ RUN      ] BasicAVLMapTests.CopyAssignmentCheck
[       OK ] BasicAVLMapTests.CopyAssignmentCheck (8 ms)
[ RUN      ] BasicAVLMapTests.MoveConstructorCheck
```

```
[       OK ] BasicAVLMapTests.MoveConstructorCheck (5 ms)
[ RUN      ] BasicAVLMapTests.MoveAssignmentCheck
[       OK ] BasicAVLMapTests.MoveAssignmentCheck (7 ms)
[ RUN      ] BasicAVLMapTests.HeightEmptyCheck
[       OK ] BasicAVLMapTests.HeightEmptyCheck (1 ms)
[ RUN      ] BasicAVLMapTests.SimpleHeightCheck
[       OK ] BasicAVLMapTests.SimpleHeightCheck (4 ms)
[ RUN      ] BasicAVLMapTests.InsertRebalanceCheck
[       OK ] BasicAVLMapTests.InsertRebalanceCheck (22 ms)
[ RUN      ] BasicAVLMapTests.EraseRebalanceCheck
[       OK ] BasicAVLMapTests.EraseRebalanceCheck (13 ms)
[----------] 21 tests from BasicAVLMapTests (194 ms total)

[----------] Global test environment tear-down
[==========] 21 tests from 1 test suite ran. (234 ms total)
[  PASSED  ] 21 tests.
==712765==
==712765== HEAP SUMMARY:
==712765==     in use at exit: 0 bytes in 0 blocks
==712765==   total heap usage: 824 allocs, 824 frees, 155,615 bytes allocated
==712765==
==712765== All heap blocks were freed -- no leaks are possible
==712765==
==712765== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 0 from 0)
```

Performance test output:

```
# All times in milliseconds (msec)
# Column 1 = input data size
# Column 2 = binsearch map insert
# Column 3 = hash map insert
# Column 4 = bst map insert
# Column 5 = avl map insert
# Column 6 = binsearch map erase
# Column 7 = hash map erase
# Column 8 = bst map erase
# Column 9 = avl map erase
# Column 10 = binsearch map contains
# Column 11 = hash map contains
# Column 12 = bst map contains
# Column 13 = avl map contains
# Column 14 = binsearch map find range
# Column 15 = hash map find range
# Column 16 = bst map find range
# Column 17 = avl map find range
# Column 18 = binsearch map next key
# Column 19 = hash map next key
# Column 20 = bst map next key
# Column 21 = avl map next key
# Column 22 = binsearch map sorted keys
# Column 23 = hash map sorted keys
# Column 24 = bst map sorted keys
# Column 25 = avl map sorted keys
# Column 26 = bst map height
# Column 27 = avl map height
# Column 28 = log base 2 of input size
0 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.
10000 0.04 0.00 0.00 0.00 0.04 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.09 0.00 0.00 0.00 0.06 0.00 0.00 0.18 1.05 0.1
20000 0.07 0.00 0.01 0.00 0.07 0.00 0.01 0.00 0.00 0.00 0.01 0.00 0.00 0.18 0.01 0.00 0.00 0.16 0.01 0.00 0.43 2.11 0.4
30000 0.10 0.00 0.01 0.00 0.10 0.00 0.01 0.00 0.00 0.00 0.01 0.00 0.00 0.25 0.02 0.00 0.00 0.21 0.01 0.00 0.49 3.40 0.6
40000 0.22 0.00 0.01 0.00 0.23 0.00 0.02 0.00 0.00 0.00 0.01 0.00 0.00 0.37 0.02 0.00 0.00 0.31 0.01 0.00 1.04 6.88 1.1
```

```
50000 0.26 0.00 0.01 0.00 0.27 0.00 0.02 0.00 0.00 0.00 0.02 0.00 0.04 0.49 0.07 0.04 0.00 0.41 0.02 0.00 1.21 9.50 1.4
60000 0.16 0.00 0.02 0.00 0.17 0.00 0.03 0.00 0.00 0.00 0.01 0.00 0.01 0.65 0.04 0.01 0.00 0.50 0.02 0.00 0.98 7.77 1.5
70000 0.18 0.00 0.01 0.00 0.19 0.00 0.01 0.00 0.00 0.00 0.01 0.00 0.03 0.98 0.06 0.04 0.00 0.78 0.01 0.00 1.27 9.53 2.3
80000 0.19 0.00 0.04 0.00 0.20 0.00 0.05 0.00 0.00 0.00 0.03 0.00 0.03 1.28 0.10 0.04 0.00 1.09 0.04 0.00 1.46 10.81 2.
90000 0.20 0.00 0.01 0.00 0.20 0.00 0.02 0.00 0.00 0.00 0.05 0.00 0.04 1.54 0.10 0.06 0.00 1.15 0.02 0.00 1.70 12.80 3.
100000 0.21 0.00 0.04 0.00 0.21 0.00 0.04 0.00 0.00 0.00 0.05 0.00 0.06 1.83 0.16 0.07 0.00 1.61 0.06 0.00 1.76 14.23 4
57.46user 0.01system 0:57.48elapsed 99%CPU (0avgtext+0avgdata 18360maxresident)k
0inputs+64outputs (0major+4934minor)pagefaults 0swaps
```