

Program Structures and Algorithms

Spring 2023(SEC – 8)

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Task: Solve 3-SUM using the Quadrithmic, Quadratic, and (bonus point) quadraticWithCalipers approaches

Brief explanation of why the quadratic method works:

The quadratic method for solving ThreeSum works by iterating over each possible middle index (j) in the input array, and then expanding the range of the other two indices (i and k) outwards from that middle index (j).

For each middle index, the algorithm uses nested for loops to iterate over all possible values of i and k. For each combination of i and k, it checks whether the sum of the three numbers at index points i, j and k is equal to zero. If it is, a new Triple object will be created with the indices i, j and k and added to the list of triples.

Since the time complexity of each sub-space is $O(N)$ and there are N sub-spaces, the overall time complexity of this approach is $O(N^2)$. This approach is considered as quadratic because the time complexity is $O(N^2)$ which means that the algorithm's running time increases quadratically as the size of input increases.

Unit Test Screenshots:

```
no org.junit.Ignore // Slow
public void testGetTriples() {
    Supplier<int[]> intsSupplier = new Source(10, 1000).intsSupplier(1000);
    int[] ints = intsSupplier.get();
    ThreeSum target = new ThreeSumQuadratic(ints);
    Triple[] triplesQuadratic = target.getTriples();
    Triple[] triplesCubic = new ThreeSumCubic(ints).getTriples();
    int expected1 = triplesCubic.length;
    assertEquals(expected1, triplesQuadratic.length);
}

no org.junit.Ignore // Slow
public void testGetTriples001() {
    int[] ints = new int[]{-40, -20, -10, 0, 5, 10, 30, 40};
    Arrays.sort(ints);
    System.out.println("ints: " + Arrays.toString(ints));
    ThreeSum target = new ThreeSumQuadratic(ints);
    Triple[] triples = target.getTriples();
    System.out.println("triples: " + Arrays.toString(triples));
}
```

Run: ThreeSumTest

Tests passed: 11 of 11 tests - Took 354ms

ThreeSumTest (jdk9u-cv20230303) Test554m

ints: [-40, -20, -10, 0, 5, 10, 30, 40]

triples: [Triple(x=0, y=3, z=7), Triple(x=0, y=5, z=5), Triple(x=1, y=2, z=6), Triple(x=2, y=3, z=5), Triple(x=5, y=12, z=17), Triple(x=5, y=13, z=16), Triple(x=6, y=12, z=16), Triple(x=10, y=12, z=13), Triple(x=-51, y=2, z=49), Triple(x=-51, y=9, z=42), Triple(x=-44, y=2, z=42), Triple(x=-11, y=2, z=9), [-72, -50, -43, -29, -14, 5, 12, 24, 39, 54], Triple(x=3, y=9, z=7)]

ints: [-40, -20, -10, 0, 5, 10, 30, 40]

triples: [Triple(x=0, y=3, z=7), Triple(x=0, y=5, z=5), Triple(x=1, y=2, z=6), Triple(x=2, y=3, z=5), Triple(x=5, y=12, z=17), Triple(x=5, y=13, z=16), Triple(x=6, y=12, z=16), Triple(x=10, y=12, z=13), Triple(x=-51, y=2, z=49), Triple(x=-51, y=9, z=42), Triple(x=-44, y=2, z=42), Triple(x=-11, y=2, z=9), [-72, -50, -43, -29, -14, 5, 12, 24, 39, 54], Triple(x=3, y=9, z=7)]

Process finished with exit code 0