移动计算及应用开发技术作业

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移动计算及应用开发技术课程作业，要求实现处理 Android 应用的生命周期行为，并在此基础上实现对选择排序算法的计时。代码已上传至 Github 仓库。

一、处理 Android 应用的生命周期行为

考虑实现处理 Activity 和 Fragment 的生命周期，参考开发者文档提供的生命周期回调函数，编写简易的测试代码如代码 1 所示。当 Activity 类所提供核心回调：onCreate()、onStart()、onResume()、onPause()、onStop() 、onRestart()和 onDestroy()中某一个触发时，会在 Logcat 处打印相应的日志信息。对 Fragment 的处理除了多了几个回调操作以外，完全一致，不再赘述。

代码 1 MainActivity.java

```
public class MainActivity extends AppCompatActivity {
    static final String TAG = "LifeCycleTest";
    static final String TAG_MSG_OWNER = "MainActivity: ";

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);
        Toolbar toolbar = findViewById(R.id.toolbar);
        setSupportActionBar(toolbar);
        Log.d(TAG, TAG_MSG_OWNER + "onCreate");
    }

    @Override
    public boolean onCreateOptionsMenu(Menu menu) {
        // Inflate the menu; this adds items to the action bar if it is present.
        getMenuInflater().inflate(R.menu.menu_main, menu);
        return true;
    }

    @Override
    public boolean onOptionsItemSelected(MenuItem item) {
        // Handle action bar item clicks here. The action bar will
        // automatically handle clicks on the Home/Up button, so long
        // as you specify a parent activity in AndroidManifest.xml.
        int id = item.getItemId();

        //noinspection SimplifiableIfStatement
        if (id == R.id.action_settings) {
            return true;
        }

        return super.onOptionsItemSelected(item);
    }

    @Override
    public void onStart() {
        super.onStart();
        Log.d(TAG, TAG_MSG_OWNER + "onStart");
    }

    @Override
    public void onResume() {
        super.onResume();
        Log.d(TAG, TAG_MSG_OWNER + "onResume");
    }

    @Override
    public void onPause() {
        super.onPause();
        Log.d(TAG, TAG_MSG_OWNER + "onPause");
    }

    @Override
    public void onStop() {
        super.onStop();
        Log.d(TAG, TAG_MSG_OWNER + "onStop");
    }

    @Override
    public void onRestart() {
        super.onRestart();
        Log.d(TAG, TAG_MSG_OWNER + "onRestart");
    }

    @Override
    public void onDestroy() {
        super.onDestroy();
        Log.d(TAG, TAG_MSG_OWNER + "onDestroy");
    }
}
```

当应用启动时，打印日志内容如下。说明当 Activity 启动时，首先会执行 Activity 的 onCreate()回调，接着依次执行依赖于此 Activity 的 Fragment 的 onAttach(), onCreate(), onCreateView(), onViewCreated(), onStart()回调。待 Fragment 初始化以后，Activity 接着执行 onStart(), onResume(). 最后，Fragment 执行 onResume().

```
2020-11-14 23:59:57.686 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: MainActivity: onCreate
2020-11-14 23:59:57.691 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: RunCodeFragment: onAttach
2020-11-14 23:59:57.691 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: RunCodeFragment: onCreate
2020-11-14 23:59:57.691 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: RunCodeFragment: onCreateView
```

```
2020-11-14 23:59:57.716 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: RunCodeFragment: onViewCreated
2020-11-14 23:59:57.735 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: RunCodeFragment: onStart
2020-11-14 23:59:57.735 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: MainActivity: onStart
2020-11-14 23:59:57.736 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: MainActivity: onResume
2020-11-14 23:59:57.736 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: RunCodeFragment: onResume
```

当切换至另一个 Fragment 时，打印日志内容如下。说明当执行 Fragment 切换操作时，首先会对将要切换到的 Fragment 执行初始化操作，等到完成 onResume()回调之后，再对之前的 Fragment 执行 onPause(), onStop(), onDestroyView()回调。

```
2020-11-15 00:04:33.595 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: ViewRunCodeTimeFragment: onAttach
2020-11-15 00:04:33.595 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: ViewRunCodeTimeFragment: onCreate
2020-11-15 00:04:33.595 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: ViewRunCodeTimeFragment: onCreateView
2020-11-15 00:04:33.605 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: ViewRunCodeTimeFragment: onViewCreated
2020-11-15 00:04:33.607 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: ViewRunCodeTimeFragment: onStart
2020-11-15 00:04:33.608 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: ViewRunCodeTimeFragment: onResume
2020-11-15 00:04:33.609 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: RunCodeFragment: onPause
2020-11-15 00:04:33.609 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: RunCodeFragment: onStop
2020-11-15 00:04:33.614 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: RunCodeFragment: onDestroyView
```

当切换至桌面时，打印日志内容如下。说明当执行切换到桌面操作时，首先会对当前的 Fragment 及依附的 Activity 分别执行 onPause(), onStop()回调。

```
2020-11-15 00:08:28.643 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: ViewRunCodeTimeFragment: onPause
```

```
2020-11-15 00:08:28.643 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: MainActivity: onPause
2020-11-15 00:08:29.586 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: ViewRunCodeTimeFragment: onStop
2020-11-15 00:08:29.586 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: MainActivity: onStop
```

当从桌面切回 App 时，打印日志内容如下。说明 Activity 首先执行 onRestart()回调，接下来对之前使用的 Fragment 和 Activity 分别执行 onStart(), onResume()回调。

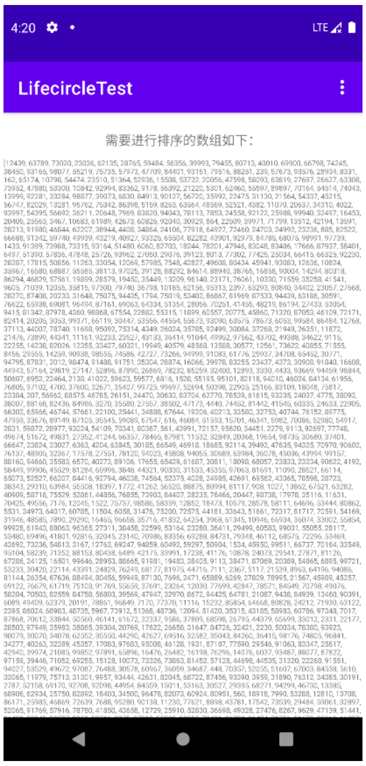
```
2020-11-15 00:10:59.886 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: MainActivity: onRestart
2020-11-15 00:10:59.887 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: ViewRunCodeTimeFragment: onStart
2020-11-15 00:10:59.887 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: MainActivity: onStart
2020-11-15 00:10:59.888 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: MainActivity: onResume
2020-11-15 00:10:59.888 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: ViewRunCodeTimeFragment: onResume
```

当退出 App 时，打印日志内容如下。说明 Fragment 和其依附的 Activity 首先执行 onPause(), onStop()回调，接下来 Fragment 执行 onDestroyView(), onDetach()回调，最后 Activity 执行 onDestroy()回调，宣布 App 的生命周期结束。

```
2020-11-15 00:13:01.653 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: RunCodeFragment: onPause
2020-11-15 00:13:01.653 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: MainActivity: onPause
2020-11-15 00:13:02.388 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: RunCodeFragment: onStop
2020-11-15 00:13:02.388 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: MainActivity: onStop
2020-11-15 00:13:02.389 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: RunCodeFragment: onDestroyView
2020-11-15 00:13:02.390 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: RunCodeFragment: onDetach
2020-11-15 00:13:02.390 18896-18896/com.coursework.lifecycletest D/LifeCycleTest: MainActivity: onDestroy
```

二、实现对选择排序算法的计时

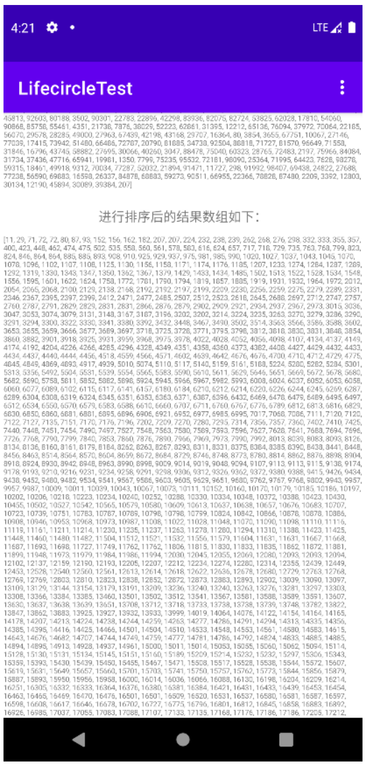
实验采用 ViewModel 实现不同 Fragment 之间的数据共享。首先生成 0-100000 的随机数（可能存在相同数字）组成的大小为 6000 的整数数组，如图 1 所示。接下来执行选择排序算法，将算法的结果赋值给界面上的 TextView，如图 2 所示。此外，将算法执行的时间通过自定义的 ViewModel 类共享给另一个 Fragment，通过切换至该 Fragment 查看花费的时间，如图 3 所示。



需要进行排序的数组如下：

```
[12439, 63789, 73020, 23036, 62135, 28765, 59484, 56356, 39993, 79455, 80713, 40010, 69900, 66798, 74245,
38450, 93165, 98077, 55219, 75735, 57973, 47709, 84401, 93151, 79516, 88251, 239, 57673, 93576, 28934, 8331,
162, 65174, 10798, 54474, 23510, 51364, 52936, 15508, 53732, 20056, 47598, 58093, 63819, 27697, 26627, 63308,
73952, 47880, 53300, 10842, 92994, 83362, 9178, 56392, 21220, 5301, 62460, 55597, 89897, 70164, 54514, 74043,
13999, 92281, 33284, 98877, 39073, 6830, 84913, 90127, 56720, 35992, 22475, 31130, 21564, 54337, 45215,
56747, 82029, 13281, 95762, 75342, 86398, 5159, 8263, 63564, 48569, 52521, 4382, 11070, 20637, 34310, 4022,
93997, 54395, 56692, 36211, 20648, 7969, 83820, 94043, 78113, 7853, 24558, 92122, 25988, 99940, 32497, 16453,
20405, 25563, 3467, 10683, 61989, 42673, 60826, 92040, 30929, 864, 22509, 39971, 71799, 13512, 42194, 13591,
28213, 91980, 46844, 62207, 38944, 4408, 34864, 24106, 77918, 64927, 72460, 24703, 24992, 23236, 885, 82522,
66688, 91342, 59740, 49939, 43219, 40927, 93325, 65504, 82282, 43901, 92979, 84785, 68075, 98991, 97739,
1433, 91399, 73988, 73315, 93164, 51480, 6060, 82703, 18244, 78201, 47946, 83048, 83486, 17666, 87937, 58401,
6497, 51390, 57836, 47848, 25726, 93962, 27050, 29076, 39123, 8013, 77302, 77425, 25034, 66415, 66325, 92230,
28287, 17815, 50856, 11263, 33054, 12069, 57985, 7548, 42827, 49608, 80434, 45941, 93083, 12636, 10824,
35967, 16580, 68887, 55585, 38113, 97025, 39128, 88292, 84614, 88940, 38765, 16858, 90004, 14294, 80318,
86294, 46829, 57561, 19899, 28579, 19450, 35449, 13209, 96140, 23171, 76061, 10330, 71559, 35258, 41541,
9605, 71039, 12055, 35815, 97300, 79740, 36798, 10185, 62156, 95313, 2397, 63293, 80840, 34402, 23057, 27668,
28270, 87408, 20233, 31648, 75075, 94435, 1794, 75019, 53402, 86867, 81969, 87533, 94439, 63186, 30591,
76622, 65938, 69081, 96494, 87161, 69063, 64334, 51354, 28056, 70251, 41455, 48219, 86194, 27433, 53054,
9415, 81342, 87978, 4360, 98868, 67554, 22882, 55315, 11899, 60557, 20775, 45860, 71320, 87053, 46109, 72171,
82414, 20205, 3053, 99371, 66119, 30447, 53556, 44554, 55673, 93090, 63575, 78673, 6053, 99584, 86484, 12768,
37113, 44007, 78740, 11698, 95092, 75314, 4349, 26024, 35785, 92499, 30084, 37268, 21949, 26351, 11872,
21476, 73899, 44341, 11161, 92233, 23527, 43133, 36414, 91044, 49952, 97562, 43702, 49388, 34622, 9115,
22255, 14238, 82026, 12355, 33427, 60321, 19949, 40579, 48568, 13588, 30577, 12561, 73622, 40855, 71555,
8456, 29555, 14259, 90938, 98555, 74586, 42727, 73266, 94999, 91083, 61776, 25937, 34708, 65452, 30771,
94795, 87831, 2012, 98474, 91488, 91751, 35304, 28874, 16066, 39978, 83255, 23437, 4373, 30908, 91840, 16608,
44943, 57164, 29819, 27147, 52896, 87890, 26869, 78232, 85259, 32400, 12893, 3330, 4433, 93669, 94459, 98844,
50607, 6952, 22464, 2138, 41022, 59623, 59577, 6816, 1528, 55195, 95101, 82118, 94010, 46024, 84134, 61956,
76805, 97102, 4700, 37600, 32671, 35407, 99725, 99697, 52694, 50398, 22905, 25166, 83109, 18048, 75817,
23384, 207, 56962, 88575, 46785, 26151, 24470, 30633, 83704, 62770, 78539, 61615, 93235, 24037, 4775, 38092,
38007, 88168, 82436, 84986, 3270, 35580, 27557, 38502, 47173, 4440, 74452, 81442, 41545, 60335, 24633, 22905,
66302, 65966, 46744, 57661, 22100, 25441, 34888, 67644, 19206, 40213, 33580, 32753, 40744, 76152, 89775,
47959, 33676, 89149, 87105, 35545, 59089, 67547, 616, 46084, 51593, 15701, 46341, 5982, 70086, 52980, 54917,
2831, 59872, 28977, 93024, 54109, 70341, 80367, 561, 43991, 72157, 95620, 34451, 2279, 9113, 92697, 77748,
49674, 51672, 49831, 27352, 41244, 66357, 78465, 87981, 11532, 32849, 20368, 19654, 98735, 30680, 37401,
66647, 23824, 23027, 6363, 4204, 63845, 30185, 66549, 46918, 18685, 92114, 39492, 47635, 94325, 70970, 90602,
76137, 48905, 32367, 17578, 27551, 78120, 94023, 45808, 94055, 30689, 63984, 36078, 45036, 43994, 99157,
88160, 94660, 35583, 6570, 40273, 89106, 17655, 65429, 61687, 30811, 18098, 68057, 23833, 23234, 90622, 4192,
58449, 99906, 45529, 81284, 65996, 3848, 44321, 90330, 31533, 45355, 97063, 81691, 11090, 28521, 66114,
65073, 52527, 66207, 84416, 92794, 46038, 74564, 52375, 4028, 24985, 42691, 69562, 43365, 78598, 28723,
38343, 29310, 63984, 55508, 18397, 1772, 41262, 56520, 88875, 80994, 81117, 908, 1027, 13862, 67521, 63282,
40909, 58718, 75529, 52861, 44856, 76855, 73903, 84407, 28235, 76466, 20447, 98738, 17978, 35116, 11631,
70425, 49556, 7176, 12045, 1522, 75737, 98586, 58359, 12852, 18473, 10579, 28578, 58111, 64696, 53444, 80862,
5531, 34973, 64017, 60785, 11504, 6058, 31476, 75200, 72575, 44181, 33643, 51661, 72317, 81717, 70591, 54169,
31946, 48585, 7890, 29290, 16465, 96658, 35716, 41832, 64254, 3968, 61345, 10946, 66934, 36074, 33002, 55854,
99928, 61943, 88063, 96365, 27311, 38458, 22599, 53164, 23280, 36411, 29499, 60583, 99031, 55055, 28117,
53480, 69496, 41801, 92816, 32045, 23140, 70986, 83356, 69288, 84731, 79348, 46112, 68575, 72296, 53469,
43692, 73236, 54813, 3167, 12763, 69247, 94859, 60492, 59297, 50904, 1534, 45950, 99511, 66737, 70164, 33549,
95104, 58239, 71352, 88153, 80438, 6489, 42175, 33991, 17238, 41176, 10878, 24073, 29541, 27871, 81126,
67286, 24125, 16501, 99646, 28953, 88665, 91981, 19483, 38405, 9113, 38471, 87069, 20389, 54865, 6895, 99721,
53233, 30420, 22114, 43391, 24829, 76249, 68177, 81975, 44716, 7111, 2367, 5117, 21539, 8963, 64196, 94086,
81144, 26354, 67636, 88494, 80456, 59949, 87130, 7696, 2471, 65889, 6269, 27809, 78995, 21567, 45989, 45257,
69122, 76679, 61719, 75103, 91769, 55659, 37691, 23264, 12030, 77699, 42847, 78571, 84549, 70798, 49076,
58204, 70503, 82559, 84758, 56803, 39569, 47947, 32970, 8672, 94425, 64781, 21087, 9438, 84939, 13460, 90391,
6089, 49409, 62379, 20191, 78861, 96849, 7170, 77370, 11116, 15232, 85854, 64668, 80828, 24212, 71930, 63122,
2395, 86024, 68983, 48735, 5967, 73912, 51368, 48736, 12094, 51420, 35315, 43185, 58983, 60786, 97348, 7017,
87868, 70612, 33844, 50560, 46141, 61672, 32337, 9586, 37809, 68598, 26795, 44379, 65699, 33012, 2331, 22177,
28503, 97949, 35983, 38865, 39304, 20769, 17622, 26658, 31647, 84726, 32421, 2230, 50034, 78380, 93923,
90079, 30070, 34078, 62552, 35550, 44290, 42627, 69516, 32582, 35043, 84260, 36415, 98176, 74805, 96841,
34277, 40263, 32389, 45357, 17083, 97683, 95008, 46128, 1931, 87187, 77590, 29546, 91063, 83347, 25617,
42940, 39974, 21085, 99852, 97891, 65896, 16476, 26482, 16198, 76296, 14076, 6037, 93487, 88077, 87822,
97159, 39446, 71052, 69255, 15128, 10073, 73326, 73863, 81452, 57128, 44698, 44535, 31320, 22268, 91551,
94027, 53529, 49672, 97087, 76488, 30578, 60967, 36059, 34687, 448, 70357, 52055, 51607, 67003, 84538, 5610,
33065, 11979, 75713, 31301, 9957, 93444, 42631, 82045, 68722, 87456, 93390, 3959, 31890, 76312, 34385, 30191,
2787, 52158, 69170, 92708, 92098, 44954, 84559, 15011, 53163, 30527, 29395, 68271, 94299, 46730, 13385,
68906, 62934, 25750, 82892, 18403, 34500, 96478, 82073, 60924, 80951, 560, 18918, 7990, 53288, 12810, 13708,
86171, 25983, 46869, 72639, 7688, 95280, 90138, 11230, 77621, 8898, 43781, 17542, 73539, 29484, 59061, 32897,
52065, 91769, 57916, 78780, 41850, 43658, 12729, 25910, 52830, 36698, 49328, 27476, 8267, 9629, 47139, 51441,
```

图 1 待排序数组



```
45813, 92603, 80188, 3502, 90301, 22783, 22896, 42298, 83936, 82075, 82724, 53825, 62028, 17810, 54060,
90868, 85758, 55461, 4351, 21738, 7876, 38029, 52223, 62861, 31395, 12212, 65136, 76094, 37972, 70064, 22185,
56070, 29578, 28285, 49000, 27963, 67439, 42198, 43168, 29707, 16364, 80, 3854, 3655, 67751, 10067, 27146,
77039, 17415, 73942, 51480, 66486, 72787, 20790, 81885, 34738, 92504, 88818, 71727, 81570, 96649, 71558,
31846, 16796, 43745, 58882, 27695, 30066, 40260, 3047, 88478, 75040, 60323, 28765, 72483, 2197, 75966, 84084,
31734, 37436, 47716, 65941, 19981, 1350, 7799, 75235, 95532, 72181, 98090, 25364, 71995, 64423, 7628, 98278,
59315, 18461, 49918, 9312, 70034, 77287, 52032, 21894, 91471, 11727, 298, 91992, 98407, 69438, 24822, 27688,
77238, 56590, 69883, 16598, 26337, 84878, 68883, 59273, 90511, 66955, 22366, 78828, 87480, 2209, 3392, 12803,
30134, 12190, 45894, 30089, 39384, 207]
```

进行排序后的结果数组如下:

```
[11, 29, 71, 72, 72, 80, 87, 93, 152, 156, 162, 182, 207, 207, 224, 232, 238, 239, 262, 268, 276, 298, 332, 333, 355, 357,
400, 423, 448, 462, 474, 475, 502, 535, 558, 560, 561, 578, 583, 616, 624, 657, 717, 718, 729, 735, 763, 768, 799, 823,
824, 846, 864, 864, 885, 885, 893, 908, 910, 925, 929, 937, 975, 981, 985, 990, 1020, 1027, 1037, 1043, 1045, 1070,
1078, 1096, 1102, 1107, 1108, 1125, 1130, 1156, 1158, 1171, 1174, 1176, 1185, 1207, 1233, 1274, 1284, 1287, 1289,
1292, 1319, 1330, 1343, 1347, 1350, 1362, 1367, 1379, 1429, 1433, 1434, 1485, 1502, 1513, 1522, 1528, 1534, 1548,
1556, 1595, 1601, 1622, 1624, 1758, 1772, 1781, 1790, 1794, 1819, 1857, 1885, 1919, 1931, 1932, 1964, 1972, 2012,
2054, 2065, 2068, 2100, 2129, 2138, 2168, 2192, 2192, 2197, 2199, 2209, 2230, 2256, 2259, 2275, 2279, 2289, 2331,
2346, 2367, 2395, 2397, 2399, 2412, 2471, 2477, 2485, 2507, 2512, 2523, 2618, 2645, 2688, 2697, 2712, 2747, 2757,
2760, 2787, 2791, 2829, 2829, 2831, 2831, 2866, 2876, 2879, 2902, 2909, 2921, 2934, 2937, 2967, 2973, 3015, 3036,
3047, 3053, 3074, 3079, 3131, 3148, 3167, 3187, 3196, 3202, 3202, 3214, 3224, 3235, 3263, 3270, 3279, 3286, 3290,
3291, 3294, 3300, 3322, 3330, 3341, 3380, 3392, 3432, 3448, 3467, 3490, 3502, 3514, 3563, 3566, 3586, 3588, 3602,
3653, 3655, 3659, 3666, 3677, 3689, 3697, 3718, 3725, 3728, 3771, 3795, 3798, 3812, 3818, 3830, 3831, 3848, 3854,
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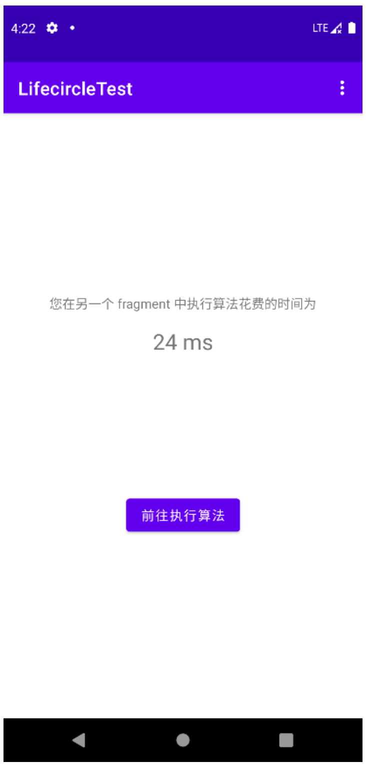
图 2 排序后数组



您在另一个 fragment 中执行算法花费的时间为

24 ms

图 3 查看排序花费的时间