Table 1. Precision and Efficiency results of CSC, Z-2obj, C-2obj, D-2obj, and M-2obj, whereas CI and 2OBJ are presented as baselines.

| Program | Analysis | T | S | #MFC | #PCS | #RM | #CE | Program | Analysis | T | S | #MFC | #PCS | #RM | #CE | Program | Analysis | T | S | #MFC | #PCS | #RM | #CE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| antlr | 2obj | 26.5 | - | 510 | 1631 | 7806 | 51264 | avrora | 2obj | 18.8 | - | 568 | 933 | 10940 | 48361 | batik | 2obj | 810.7 | - | 2142 | 4956 | 20254 | 107822 |
| | ci | 4.8 | 5.5X | 1124 | 1976 | 8190 | 57341 | | ci | 5.5 | 3.4X | 1188 | 1372 | 11373 | 55476 | | ci | 13.3 | 61.0X | 3403 | 5810 | 20994 | 127604 |
| | CSC | 5.7 | 4.6X | 812 | 1896 | 8153 | 54460 | | CSC | 6.3 | 3.0X | 882 | 1283 | 11282 | 52535 | | CSC | 18.6 | 43.6X | 2846 | 5524 | 20819 | 121105 |
| | Z-2obj | 23.3 | 1.1X | 528 | 1650 | 7836 | 51391 | | Z-2obj | 18.0 | 1.0X | 595 | 948 | 10969 | 48466 | | Z-2obj | 427.8 | 1.9X | 2161 | 4968 | 20265 | 107892 |
| | C-2obj | 13.8 | 1.9X | 510 | 1631 | 7806 | 51264 | | C-2obj | 14.8 | 1.3X | 568 | 933 | 10940 | 48361 | | C-2obj | 430.3 | 1.9X | 2142 | 4956 | 20254 | 107822 |
| | D-2obj | 17.2 | 1.5X | 510 | 1631 | 7806 | 51264 | | D-2obj | 19.6 | 1.0X | 568 | 933 | 10940 | 48361 | | D-2obj | 297.1 | 2.7X | 2142 | 4958 | 20254 | 107824 |
| | M-2obj | 10.8 | 2.5X | 510 | 1631 | 7806 | 51264 | | M-2obj | 12.8 | 1.5X | 568 | 933 | 10940 | 48361 | | M-2obj | 230.9 | 3.5X | 2150 | 4962 | 20254 | 107828 |
| biojava | 2obj | 13.5 | - | 436 | 843 | 7440 | 34802 | bloat | 2obj | 352.9 | - | 1285 | 1566 | 9019 | 56577 | bytecode-viewer | 2obj | 2992.2 | - | 4064 | 4626 | 14210 | 100280 |
| | ci | 4.5 | 3.0X | 1046 | 1236 | 7910 | 41678 | | ci | 5.5 | 64.5X | 2082 | 2249 | 9454 | 67338 | | ci | 9.4 | 316.6X | 4723 | 5616 | 14637 | 110795 |
| | CSC | 5.7 | 2.4X | 687 | 1150 | 7853 | 38403 | | CSC | 7.6 | 46.4X | 1594 | 2166 | 9414 | 63909 | | CSC | 21.7 | 138.0X | 4366 | 5547 | 14601 | 106506 |
| | Z-2obj | 13.6 | 1.0X | 449 | 876 | 7487 | 34947 | | Z-2obj | 291.4 | 1.2X | 1309 | 1597 | 9061 | 56784 | | Z-2obj | 2146.0 | 1.4X | 4080 | 4644 | 14246 | 100443 |
| | C-2obj | 10.8 | 1.2X | 436 | 843 | 7440 | 34802 | | C-2obj | 214.4 | 1.6X | 1285 | 1566 | 9019 | 56577 | | C-2obj | 1693.2 | 1.8X | 4064 | 4626 | 14210 | 100280 |
| | D-2obj | 12.9 | 1.0X | 436 | 843 | 7440 | 34802 | | D-2obj | 30.2 | 11.7X | 1285 | 1566 | 9019 | 56577 | | D-2obj | 725.3 | 4.1X | 4064 | 4626 | 14210 | 100280 |
| | M-2obj | 8.8 | 1.5X | 436 | 843 | 7440 | 34802 | | M-2obj | 20.4 | 17.3X | 1285 | 1566 | 9019 | 56577 | | M-2obj | 243.4 | 12.3X | 4065 | 4629 | 14210 | 100283 |
| chart | 2obj | 100.2 | - | 1337 | 2027 | 15149 | 72650 | check-style | 2obj | Oom | - | - | - | - | - | classy-shark | 2obj | 22.3 | - | 564 | 1117 | 9393 | 44257 |
| | ci | 9.2 | 10.9X | 2560 | 2703 | 15923 | 86433 | | ci | 8.2 | >657.7X | 1939 | 2760 | 12766 | 80169 | | ci | 5.3 | 4.2X | 1323 | 1682 | 10178 | 56231 |
| | CSC | 10.4 | 9.6X | 1914 | 2405 | 15545 | 78847 | | CSC | 10.3 | >521.7X | 1503 | 2641 | 12713 | 74197 | | CSC | 7.1 | 3.1X | 876 | 1400 | 9489 | 48577 |
| | Z-2obj | 52.9 | 1.9X | 1376 | 2045 | 15234 | 72989 | | Z-2obj | 1489.6 | >3.6X | 1132 | 2249 | 12342 | 67170 | | Z-2obj | 22.2 | 1.0X | 581 | 1124 | 9412 | 44332 |
| | C-2obj | 70.5 | 1.4X | 1337 | 2027 | 15149 | 72650 | | C-2obj | 3822.0 | >1.4X | 1109 | 2216 | 12307 | 66970 | | C-2obj | 19.2 | 1.2X | 564 | 1117 | 9393 | 44257 |
| | D-2obj | 48.5 | 2.1X | 1337 | 2027 | 15149 | 72658 | | D-2obj | 43.3 | >124.7X | 1109 | 2216 | 12307 | 66970 | | D-2obj | 18.6 | 1.2X | 564 | 1117 | 9393 | 44257 |
| | M-2obj | 26.5 | 3.8X | 1337 | 2027 | 15149 | 72658 | | M-2obj | 24.9 | >216.8X | 1110 | 2216 | 12307 | 66970 | | M-2obj | 12.3 | 1.8X | 564 | 1117 | 9393 | 44257 |
| dcevm | 2obj | 374.1 | - | 2225 | 4417 | 20531 | 100557 | ddjava | 2obj | 10.9 | - | 367 | 815 | 6840 | 32248 | eclipse | 2obj | Oom | - | - | - | - | - |
| | ci | 13.5 | 27.7X | 3593 | 5669 | 21503 | 124314 | | ci | 4.1 | 2.7X | 880 | 1177 | 7249 | 38462 | | ci | 18.8 | >287.7X | 5090 | 10672 | 23386 | 182975 |
| | CSC | 15.2 | 24.6X | 2917 | 4932 | 20958 | 108001 | | CSC | 4.8 | 2.3X | 618 | 1093 | 7205 | 35797 | | CSC | 20.7 | >261.4X | 4282 | 10250 | 22977 | 172521 |
| | Z-2obj | 195.3 | 1.9X | 2316 | 4464 | 20573 | 100824 | | Z-2obj | 13.0 | 0.8X | 384 | 827 | 6855 | 32316 | | Z-2obj | Oom | - | - | - | - | - |
| | C-2obj | 245.1 | 1.5X | 2227 | 4425 | 20532 | 100594 | | C-2obj | 8.9 | 1.2X | 367 | 815 | 6840 | 32248 | | C-2obj | 1528.0 | >3.5X | 3612 | 9703 | 22627 | 162654 |
| | D-2obj | 214.2 | 1.7X | 2231 | 4431 | 20532 | 100608 | | D-2obj | 10.9 | 1.0X | 367 | 815 | 6840 | 32248 | | D-2obj | 598.6 | >9.0X | 3612 | 9703 | 22627 | 162654 |
| | M-2obj | 92.8 | 4.0X | 2241 | 4433 | 20535 | 100629 | | M-2obj | 8.4 | 1.3X | 367 | 815 | 6840 | 32248 | | M-2obj | 291.4 | >18.5X | 3612 | 9703 | 22627 | 162659 |
| findbugs | 2obj | 811.2 | - | 2013 | 3508 | 16264 | 87808 | fop | 2obj | 10.2 | - | 395 | 830 | 7591 | 34364 | h2 | 2obj | 17.0 | - | 398 | 911 | 7559 | 36261 |
| | ci | 9.7 | 83.7X | 3448 | 4435 | 16774 | 105576 | | ci | 4.0 | 2.5X | 911 | 1210 | 7997 | 40423 | | ci | 4.6 | 3.7X | 943 | 1274 | 7959 | 42799 |
| | CSC | 11.6 | 70.0X | 2766 | 4212 | 16705 | 96294 | | CSC | 4.5 | 2.2X | 653 | 1121 | 7944 | 37562 | | CSC | 5.2 | 3.3X | 687 | 1194 | 7914 | 40294 |
| | Z-2obj | 164.4 | 4.9X | 2044 | 3512 | 16276 | 87855 | | Z-2obj | 13.1 | 0.8X | 417 | 852 | 7621 | 34496 | | Z-2obj | 14.7 | 1.2X | 423 | 929 | 7591 | 36379 |
| | C-2obj | 76.2 | 10.6X | 2014 | 3508 | 16264 | 87808 | | C-2obj | 9.2 | 1.1X | 395 | 830 | 7591 | 34364 | | C-2obj | 11.6 | 1.5X | 398 | 911 | 7559 | 36261 |
| | D-2obj | 60.1 | 13.5X | 2014 | 3508 | 16264 | 87808 | | D-2obj | 11.9 | 0.9X | 395 | 830 | 7591 | 34364 | | D-2obj | 13.5 | 1.3X | 398 | 911 | 7559 | 36261 |
| | M-2obj | 35.7 | 22.7X | 2017 | 3511 | 16268 | 87838 | | M-2obj | 8.2 | 1.2X | 395 | 830 | 7591 | 34364 | | M-2obj | 8.9 | 1.9X | 398 | 911 | 7559 | 36261 |
| hsqldb | 2obj | 11.8 | - | 407 | 847 | 6981 | 34881 | jd | 2obj | 58.0 | - | 1592 | 2831 | 17000 | 82056 | JPC | 2obj | 65.3 | - | 1356 | 4237 | 15553 | 81294 |
| | ci | 4.4 | 2.7X | 922 | 1202 | 7386 | 41755 | | ci | 10.0 | 5.8X | 2714 | 3750 | 17878 | 95602 | | ci | 10.3 | 6.3X | 2252 | 4934 | 16138 | 94701 |
| | CSC | 5.0 | 2.3X | 657 | 1119 | 7331 | 38607 | | CSC | 11.8 | 4.9X | 2127 | 3278 | 17354 | 87467 | | CSC | 11.4 | 5.7X | 1790 | 4763 | 16034 | 87453 |
| | Z-2obj | 12.7 | 0.9X | 428 | 868 | 7015 | 35020 | | Z-2obj | 41.8 | 1.4X | 1686 | 2871 | 17045 | 82387 | | Z-2obj | 40.2 | 1.6X | 1382 | 4274 | 15582 | 81489 |
| | C-2obj | 9.4 | 1.3X | 407 | 847 | 6981 | 34881 | | C-2obj | 62.0 | 0.9X | 1592 | 2831 | 17000 | 82060 | | C-2obj | 56.8 | 1.2X | 1356 | 4238 | 15553 | 81307 |
| | D-2obj | 11.8 | 1.0X | 407 | 847 | 6981 | 34881 | | D-2obj | 52.3 | 1.1X | 1592 | 2832 | 17000 | 82061 | | D-2obj | 57.8 | 1.1X | 1356 | 4243 | 15554 | 81319 |
| | M-2obj | 8.6 | 1.4X | 407 | 847 | 6981 | 34881 | | M-2obj | 29.4 | 2.0X | 1597 | 2832 | 17000 | 82061 | | M-2obj | 31.2 | 2.1X | 1360 | 4243 | 15554 | 81321 |
| luindex | 2obj | 10.7 | - | 395 | 923 | 7019 | 33587 | lusearch | 2obj | 11.8 | - | 409 | 1119 | 7671 | 36464 | mindustry | 2obj | 9.3 | - | 378 | 778 | 6497 | 30844 |
| | ci | 3.9 | 2.7X | 920 | 1283 | 7409 | 39677 | | ci | 4.2 | 2.8X | 1032 | 1490 | 8094 | 43014 | | ci | 3.8 | 2.4X | 865 | 1136 | 6907 | 36808 |
| | CSC | 4.5 | 2.4X | 641 | 1201 | 7357 | 36882 | | CSC | 4.8 | 2.5X | 724 | 1411 | 8053 | 40001 | | CSC | 4.3 | 2.2X | 622 | 1051 | 6862 | 33970 |
| | Z-2obj | 12.1 | 0.9X | 417 | 944 | 7048 | 33718 | | Z-2obj | 13.7 | 0.9X | 434 | 1143 | 7700 | 36598 | | Z-2obj | 11.9 | 0.8X | 398 | 805 | 6540 | 30984 |
| | C-2obj | 8.8 | 1.2X | 395 | 923 | 7019 | 33588 | | C-2obj | 9.3 | 1.3X | 409 | 1119 | 7671 | 36464 | | C-2obj | 8.4 | 1.1X | 378 | 778 | 6497 | 30844 |
| | D-2obj | 11.1 | 1.0X | 395 | 923 | 7019 | 33588 | | D-2obj | 13.2 | 0.9X | 409 | 1119 | 7671 | 36464 | | D-2obj | 9.8 | 1.0X | 378 | 778 | 6497 | 30844 |
| | M-2obj | 7.9 | 1.4X | 395 | 923 | 7019 | 33588 | | M-2obj | 8.4 | 1.4X | 409 | 1119 | 7671 | 36464 | | M-2obj | 7.3 | 1.3X | 378 | 778 | 6497 | 30844 |
| open-telemetry | 2obj | 9.2 | - | 351 | 767 | 6303 | 29976 | pmd | 2obj | 32.5 | - | 1398 | 2354 | 11851 | 59910 | recaf | 2obj | 475.3 | - | 3247 | 5701 | 27823 | 142265 |
| | ci | 3.9 | 2.4X | 825 | 1117 | 6713 | 35944 | | ci | 6.5 | 5.0X | 2265 | 2950 | 12365 | 69505 | | ci | 20.4 | 23.3X | 5127 | 7402 | 29038 | 187415 |
| | CSC | 4.2 | 2.2X | 581 | 1035 | 6668 | 33157 | | CSC | 7.6 | 4.3X | 1748 | 2710 | 12273 | 64834 | | CSC | 34.0 | 14.0X | 4138 | 6702 | 28300 | 161535 |
| | Z-2obj | 10.8 | 0.9X | 365 | 789 | 6335 | 30086 | | Z-2obj | 31.8 | 1.0X | 1428 | 2375 | 11882 | 60047 | | Z-2obj | 261.6 | 1.8X | 3378 | 5732 | 27857 | 142450 |
| | C-2obj | 7.9 | 1.2X | 351 | 767 | 6303 | 29976 | | C-2obj | 33.2 | 1.0X | 1398 | 2354 | 11851 | 59910 | | C-2obj | 296.4 | 1.6X | 3249 | 5716 | 27823 | 142326 |
| | D-2obj | 9.9 | 0.9X | 351 | 767 | 6303 | 29976 | | D-2obj | 25.6 | 1.3X | 1398 | 2354 | 11851 | 59910 | | D-2obj | 268.5 | 1.8X | 3249 | 5722 | 27823 | 142332 |
| | M-2obj | 7.4 | 1.3X | 351 | 767 | 6303 | 29976 | | M-2obj | 16.8 | 1.9X | 1398 | 2354 | 11851 | 59910 | | M-2obj | 161.7 | 2.9X | 3257 | 5722 | 27826 | 142365 |
| sqlite-jdbc | 2obj | 8.7 | - | 351 | 768 | 6322 | 30094 | sunflow | 2obj | 35.7 | - | 1172 | 1965 | 13313 | 61168 | tesseract | 2obj | 11.7 | - | 399 | 843 | 7743 | 37267 |
| | ci | 3.8 | 2.3X | 826 | 1118 | 6732 | 36062 | | ci | 8.2 | 4.3X | 2146 | 2553 | 13981 | 72716 | | ci | 4.6 | 2.5X | 1013 | 1291 | 8313 | 45068 |
| | CSC | 4.4 | 2.0X | 581 | 1036 | 6687 | 33275 | | CSC | 9.0 | 4.0X | 1660 | 2359 | 13797 | 67237 | | CSC | 6.1 | 1.9X | 747 | 1216 | 8270 | 41968 |
| | Z-2obj | 11.5 | 0.8X | 365 | 790 | 6354 | 30204 | | Z-2obj | 27.2 | 1.3X | 1215 | 1988 | 13401 | 61537 | | Z-2obj | 13.8 | 0.8X | 421 | 867 | 7775 | 37383 |
| | C-2obj | 7.9 | 1.1X | 351 | 768 | 6322 | 30094 | | C-2obj | 32.1 | 1.1X | 1186 | 1994 | 13346 | 61442 | | C-2obj | 10.0 | 1.2X | 399 | 843 | 7743 | 37267 |
| | D-2obj | 9.8 | 0.9X | 351 | 768 | 6322 | 30094 | | D-2obj | 31.2 | 1.1X | 1172 | 1965 | 13314 | 61173 | | D-2obj | 12.3 | 1.0X | 399 | 843 | 7743 | 37267 |
| | M-2obj | 7.2 | 1.2X | 351 | 768 | 6322 | 30094 | | M-2obj | 19.1 | 1.9X | 1172 | 1965 | 13314 | 61173 | | M-2obj | 8.9 | 1.3X | 399 | 843 | 7743 | 37267 |
| tomcat | 2obj | 16.8 | - | 402 | 871 | 6978 | 33095 | trade-beans | 2obj | 26.7 | - | 466 | 967 | 8021 | 39111 | xalan | 2obj | 372.9 | - | 592 | 1643 | 9666 | 46782 |
| | ci | 4.0 | 4.1X | 931 | 1320 | 7388 | 39513 | | ci | 4.7 | 5.7X | 1095 | 1420 | 8652 | 47885 | | ci | 5.2 | 71.3X | 1298 | 2084 | 10092 | 54001 |
| | CSC | 4.6 | 3.6X | 665 | 1243 | 7340 | 37125 | | CSC | 5.5 | 4.9X | 786 | 1314 | 8546 | 44610 | | CSC | 6.0 | 61.6X | 884 | 1967 | 10034 | 50747 |
| | Z-2obj | 13.8 | 1.2X | 421 | 895 | 7022 | 33248 | | Z-2obj | 22.2 | 1.2X | 501 | 1017 | 8213 | 40042 | | Z-2obj | 194.5 | 1.9X | 609 | 1665 | 9697 | 46916 |
| | C-2obj | 10.0 | 1.7X | 402 | 871 | 6978 | 33095 | | C-2obj | 14.9 | 1.8X | 481 | 999 | 8065 | 39461 | | C-2obj | 218.4 | 1.7X | 592 | 1643 | 9666 | 46782 |
| | D-2obj | 11.3 | 1.5X | 402 | 871 | 6978 | 33095 | | D-2obj | 15.4 | 1.7X | 466 | 967 | 8021 | 39111 | | D-2obj | 27.7 | 13.5X | 592 | 1643 | 9666 | 46782 |
| | M-2obj | 8.2 | 2.1X | 402 | 871 | 6978 | 33095 | | M-2obj | 10.5 | 2.6X | 466 | 967 | 8021 | 39111 | | M-2obj | 14.3 | 26.0X | 592 | 1643 | 9666 | 46782 |

Table 2. Precision and Efficiency results of CSC, Z-3obj, C-3obj, D-3obj, and M-3obj, whereas CI and 3OBJ are presented as baselines.

| Program | Analysis | T | S | #MFC | #PCS | #RM | #CE |
|---|---|---|---|---|---|---|---|
| antlr | 3obj | 526.2 | - | 450 | 1624 | 7805 | 51237 |
| | ci | 4.8 | 108.7X | 1124 | 1976 | 8190 | 57341 |
| | CSC | 5.7 | 92.0X | 812 | 1896 | 8153 | 54460 |
| | Z-3obj | 235.8 | 2.2X | 473 | 1643 | 7835 | 51364 |
| | C-3obj | 127.1 | 4.1X | 450 | 1624 | 7805 | 51237 |
| | D-3obj | 19.2 | 27.3X | 450 | 1627 | 7805 | 51240 |
| | M-3obj | 11.1 | 47.4X | 450 | 1626 | 7805 | 51239 |
| biojava | 3obj | 1053.9 | - | 347 | 837 | 7439 | 34756 |
| | ci | 4.5 | 232.7X | 1046 | 1236 | 7910 | 41678 |
| | CSC | 5.7 | 186.5X | 687 | 1150 | 7853 | 38403 |
| | Z-3obj | 211.7 | 5.0X | 369 | 870 | 7486 | 34901 |
| | C-3obj | 190.3 | 5.5X | 347 | 837 | 7439 | 34756 |
| | D-3obj | 15.3 | 69.0X | 347 | 839 | 7439 | 34758 |
| | M-3obj | 9.2 | 114.8X | 347 | 838 | 7439 | 34757 |
| chart | 3obj | Oom | - | - | - | - | - |
| | ci | 9.2 | >587.6X | 2560 | 2703 | 15923 | 86433 |
| | CSC | 10.4 | >519.7X | 1914 | 2405 | 15545 | 78847 |
| | Z-3obj | 428.9 | >12.6X | 1280 | 2021 | 15204 | 72544 |
| | C-3obj | Oot | - | - | - | - | - |
| | D-3obj | 183.8 | >29.4X | 1230 | 2005 | 15119 | 72228 |
| | M-3obj | 52.8 | >102.2X | 1230 | 2004 | 15119 | 72227 |
| dcevm | 3obj | Oom | - | - | - | - | - |
| | ci | 13.5 | >399.4X | 3593 | 5669 | 21503 | 124314 |
| | CSC | 15.2 | >355.0X | 2917 | 4932 | 20958 | 108001 |
| | Z-3obj | Oom | - | - | - | - | - |
| | C-3obj | Oot | - | - | - | - | - |
| | D-3obj | 1125.9 | >4.8X | 2131 | 4396 | 20493 | 100083 |
| | M-3obj | 504.9 | >10.7X | 2131 | 4396 | 20493 | 100084 |
| findbugs | 3obj | Oom | - | - | - | - | - |
| | ci | 9.7 | >557.3X | 3448 | 4435 | 16774 | 105576 |
| | CSC | 11.6 | >465.9X | 2766 | 4212 | 16705 | 96294 |
| | Z-3obj | Oot | - | - | - | - | - |
| | C-3obj | 524.3 | >10.3X | 1632 | 3477 | 16217 | 86892 |
| | D-3obj | 64.4 | >83.9X | 1652 | 3478 | 16217 | 86899 |
| | M-3obj | 37.4 | >144.3X | 1652 | 3478 | 16219 | 86915 |
| hsqldb | 3obj | 588.8 | - | 355 | 840 | 6980 | 34854 |
| | ci | 4.4 | 134.7X | 922 | 1202 | 7386 | 41755 |
| | CSC | 5.0 | 116.8X | 657 | 1119 | 7331 | 38607 |
| | Z-3obj | 168.2 | 3.5X | 382 | 861 | 7014 | 34993 |
| | C-3obj | 161.6 | 3.6X | 355 | 840 | 6980 | 34854 |
| | D-3obj | 13.9 | 42.5X | 355 | 843 | 6980 | 34857 |
| | M-3obj | 8.9 | 65.8X | 355 | 842 | 6980 | 34856 |
| luindex | 3obj | 376.2 | - | 341 | 916 | 7018 | 33560 |
| | ci | 3.9 | 96.5X | 920 | 1283 | 7409 | 39677 |
| | CSC | 4.5 | 82.9X | 641 | 1201 | 7357 | 36882 |
| | Z-3obj | 138.8 | 2.7X | 364 | 937 | 7047 | 33691 |
| | C-3obj | 124.5 | 3.0X | 341 | 916 | 7018 | 33561 |
| | D-3obj | 13.8 | 27.3X | 341 | 919 | 7018 | 33564 |
| | M-3obj | 8.3 | 45.3X | 341 | 918 | 7018 | 33563 |
| open-telemetry | 3obj | 325.3 | - | 296 | 760 | 6303 | 29955 |
| | ci | 3.9 | 83.2X | 825 | 1117 | 6713 | 35944 |
| | CSC | 4.2 | 77.5X | 581 | 1035 | 6668 | 33157 |
| | Z-3obj | 104.9 | 3.1X | 318 | 783 | 6335 | 30066 |
| | C-3obj | 108.6 | 3.0X | 296 | 760 | 6303 | 29955 |
| | D-3obj | 11.5 | 28.3X | 296 | 762 | 6303 | 29957 |
| | M-3obj | 7.7 | 42.4X | 296 | 762 | 6303 | 29957 |
| sqlite-jdbc | 3obj | 310.9 | - | 296 | 761 | 6322 | 30073 |
| | ci | 3.8 | 81.0X | 826 | 1118 | 6732 | 36062 |
| | CSC | 4.4 | 70.3X | 581 | 1036 | 6687 | 33275 |
| | Z-3obj | 102.4 | 3.0X | 318 | 784 | 6354 | 30184 |
| | C-3obj | 106.2 | 2.9X | 296 | 761 | 6322 | 30073 |
| | D-3obj | 11.2 | 27.7X | 296 | 763 | 6322 | 30075 |
| | M-3obj | 7.5 | 41.2X | 296 | 763 | 6322 | 30075 |
| tomcat | 3obj | 687.6 | - | 345 | 866 | 6977 | 33068 |
| | ci | 4.0 | 169.8X | 931 | 1320 | 7388 | 39513 |
| | CSC | 4.6 | 149.1X | 665 | 1243 | 7340 | 37125 |
| | Z-3obj | 167.6 | 4.1X | 374 | 891 | 7022 | 33226 |
| | C-3obj | 143.0 | 4.8X | 345 | 866 | 6977 | 33068 |
| | D-3obj | 13.1 | 52.6X | 345 | 868 | 6977 | 33070 |
| | M-3obj | 8.8 | 78.1X | 345 | 868 | 6977 | 33070 |
| avrora | 3obj | 2592.0 | - | 496 | 929 | 10939 | 48330 |
| | ci | 5.5 | 470.4X | 1188 | 1372 | 11373 | 55476 |
| | CSC | 6.3 | 409.5X | 882 | 1283 | 11282 | 52535 |
| | Z-3obj | 890.2 | 2.9X | 536 | 944 | 10969 | 48439 |
| | C-3obj | 587.3 | 4.4X | 496 | 929 | 10939 | 48330 |
| | D-3obj | 22.0 | 117.9X | 496 | 931 | 10939 | 48332 |
| | M-3obj | 13.0 | 199.2X | 496 | 930 | 10939 | 48336 |
| bloat | 3obj | Oot | - | - | - | - | - |
| | ci | 5.5 | >987.2X | 2082 | 2249 | 9454 | 67338 |
| | CSC | 7.6 | >710.5X | 1594 | 2166 | 9414 | 63909 |
| | Z-3obj | 4784.5 | >1.1X | 1215 | 1583 | 9045 | 56555 |
| | C-3obj | 1458.7 | >3.7X | 1188 | 1552 | 9003 | 56348 |
| | D-3obj | 34.6 | >156.3X | 1188 | 1555 | 9003 | 56351 |
| | M-3obj | 20.4 | >264.3X | 1188 | 1554 | 9003 | 56350 |
| check-style | 3obj | Oom | - | - | - | - | - |
| | ci | 8.2 | >657.7X | 1939 | 2760 | 12766 | 80169 |
| | CSC | 10.3 | >521.7X | 1503 | 2641 | 12713 | 74197 |
| | Z-3obj | Oot | - | - | - | - | - |
| | C-3obj | Oot | - | - | - | - | - |
| | D-3obj | 50.1 | >107.9X | 996 | 2172 | 12260 | 66188 |
| | M-3obj | 27.9 | >193.3X | 1000 | 2171 | 12260 | 66188 |
| ddjava | 3obj | 398.8 | - | 312 | 810 | 6840 | 32226 |
| | ci | 4.1 | 98.0X | 880 | 1177 | 7249 | 38462 |
| | CSC | 4.8 | 83.4X | 618 | 1093 | 7205 | 35797 |
| | Z-3obj | 126.2 | 3.2X | 336 | 823 | 6855 | 32290 |
| | C-3obj | 119.2 | 3.3X | 312 | 810 | 6840 | 32226 |
| | D-3obj | 13.3 | 30.1X | 312 | 812 | 6840 | 32228 |
| | M-3obj | 8.5 | 46.9X | 312 | 812 | 6840 | 32229 |
| fop | 3obj | 363.4 | - | 336 | 824 | 7591 | 34344 |
| | ci | 4.0 | 91.1X | 911 | 1210 | 7997 | 40423 |
| | CSC | 4.5 | 80.0X | 653 | 1121 | 7944 | 37562 |
| | Z-3obj | 120.3 | 3.0X | 370 | 846 | 7621 | 34476 |
| | C-3obj | 108.1 | 3.4X | 336 | 824 | 7591 | 34344 |
| | D-3obj | 13.0 | 27.9X | 336 | 826 | 7591 | 34346 |
| | M-3obj | 8.4 | 43.2X | 336 | 825 | 7591 | 34345 |
| jd | 3obj | Oom | - | - | - | - | - |
| | ci | 10.0 | >538.4X | 2714 | 3750 | 17878 | 95602 |
| | CSC | 11.8 | >459.2X | 2127 | 3278 | 17354 | 87467 |
| | Z-3obj | 265.0 | >20.4X | 1600 | 2818 | 16979 | 81855 |
| | C-3obj | 281.9 | >19.2X | 1491 | 2751 | 16875 | 81318 |
| | D-3obj | 99.9 | >54.1X | 1491 | 2754 | 16875 | 81326 |
| | M-3obj | 39.7 | >136.2X | 1491 | 2754 | 16875 | 81327 |
| lusearch | 3obj | 582.3 | - | 357 | 1112 | 7670 | 36437 |
| | ci | 4.2 | 139.6X | 1032 | 1490 | 8094 | 43014 |
| | CSC | 4.8 | 121.6X | 724 | 1411 | 8053 | 40001 |
| | Z-3obj | 180.8 | 3.2X | 382 | 1136 | 7699 | 36571 |
| | C-3obj | 151.3 | 3.8X | 357 | 1112 | 7670 | 36437 |
| | D-3obj | 14.5 | 40.2X | 357 | 1115 | 7670 | 36440 |
| | M-3obj | 9.6 | 61.0X | 357 | 1114 | 7670 | 36439 |
| pmd | 3obj | 872.1 | - | 1333 | 2348 | 11851 | 59851 |
| | ci | 6.5 | 133.3X | 2265 | 2950 | 12365 | 69505 |
| | CSC | 7.6 | 114.3X | 1748 | 2710 | 12273 | 64834 |
| | Z-3obj | 287.6 | 3.0X | 1374 | 2369 | 11882 | 59988 |
| | C-3obj | 170.7 | 5.1X | 1333 | 2348 | 11851 | 59851 |
| | D-3obj | 27.8 | 31.3X | 1333 | 2350 | 11851 | 59853 |
| | M-3obj | 19.5 | 44.6X | 1333 | 2349 | 11851 | 59852 |
| sunflow | 3obj | Oom | - | - | - | - | - |
| | ci | 8.2 | >654.5X | 2146 | 2553 | 13981 | 72716 |
| | CSC | 9.0 | >600.7X | 1660 | 2359 | 13797 | 67237 |
| | Z-3obj | 779.3 | >6.9X | 1116 | 1976 | 13382 | 61274 |
| | C-3obj | 606.2 | >8.9X | 1083 | 1976 | 13325 | 61154 |
| | D-3obj | 53.2 | >101.4X | 1071 | 1955 | 13294 | 60907 |
| | M-3obj | 20.3 | >266.5X | 1071 | 1954 | 13294 | 60919 |
| trade-beans | 3obj | 4379.4 | - | 401 | 962 | 7989 | 38931 |
| | ci | 4.7 | 927.8X | 1095 | 1420 | 8652 | 47885 |
| | CSC | 5.5 | 799.2X | 786 | 1314 | 8546 | 44610 |
| | Z-3obj | 1685.7 | 2.6X | 448 | 1015 | 8209 | 39991 |
| | C-3obj | 1152.1 | 3.8X | 417 | 991 | 8040 | 39276 |
| | D-3obj | 18.1 | 241.6X | 401 | 964 | 7989 | 38933 |
| | M-3obj | 11.3 | 387.9X | 401 | 963 | 7991 | 38941 |
| batik | 3obj | Oom | - | - | - | - | - |
| | ci | 13.3 | >406.3X | 3403 | 5810 | 20994 | 127604 |
| | CSC | 18.6 | >290.2X | 2846 | 5524 | 20819 | 121105 |
| | Z-3obj | Oot | - | - | - | - | - |
| | C-3obj | Oom | - | - | - | - | - |
| | D-3obj | Oom | - | - | - | - | - |
| | M-3obj | 777.5 | >6.9X | 2044 | 4930 | 20243 | 106779 |
| bytecode-viewer | 3obj | Oot | - | - | - | - | - |
| | ci | 9.4 | >571.4X | 4723 | 5616 | 14637 | 110795 |
| | CSC | 21.7 | >249.0X | 4366 | 5547 | 14601 | 106506 |
| | Z-3obj | Oot | - | - | - | - | - |
| | C-3obj | Oot | - | - | - | - | - |
| | D-3obj | Oot | - | - | - | - | - |
| | M-3obj | 1858.6 | >2.9X | 3661 | 4195 | 14042 | 94460 |
| classy-shark | 3obj | 3020.7 | - | 484 | 1106 | 9384 | 44166 |
| | ci | 5.3 | 566.7X | 1323 | 1682 | 10178 | 56231 |
| | CSC | 7.1 | 425.4X | 876 | 1400 | 9489 | 48577 |
| | Z-3obj | 1407.2 | 2.1X | 512 | 1113 | 9407 | 44251 |
| | C-3obj | 1058.6 | 2.9X | 484 | 1106 | 9384 | 44166 |
| | D-3obj | 21.9 | 137.9X | 484 | 1108 | 9384 | 44168 |
| | M-3obj | 13.3 | 226.9X | 484 | 1107 | 9386 | 44176 |
| eclipse | 3obj | Oom | - | - | - | - | - |
| | ci | 18.8 | >287.7X | 5090 | 10672 | 23386 | 182975 |
| | CSC | 20.7 | >261.4X | 4282 | 10250 | 22977 | 172521 |
| | Z-3obj | Oot | - | - | - | - | - |
| | C-3obj | Oom | - | - | - | - | - |
| | D-3obj | Oom | - | - | - | - | - |
| | M-3obj | 3739.3 | >1.4X | 3484 | 9661 | 22572 | 161716 |
| h2 | 3obj | 1942.4 | - | 336 | 907 | 7557 | 36232 |
| | ci | 4.6 | 423.2X | 943 | 1274 | 7959 | 42799 |
| | CSC | 5.2 | 376.4X | 687 | 1194 | 7914 | 40294 |
| | Z-3obj | 650.3 | 3.0X | 373 | 925 | 7590 | 36354 |
| | C-3obj | 427.4 | 4.5X | 336 | 907 | 7557 | 36232 |
| | D-3obj | 17.0 | 114.5X | 336 | 909 | 7558 | 36237 |
| | M-3obj | 10.0 | 193.9X | 336 | 908 | 7558 | 36236 |
| JPC | 3obj | 1438.2 | - | 1204 | 4101 | 15206 | 79620 |
| | ci | 10.3 | 139.5X | 2252 | 4934 | 16138 | 94701 |
| | CSC | 11.4 | 125.9X | 1790 | 4763 | 16034 | 87453 |
| | Z-3obj | 194.6 | 7.4X | 1234 | 4139 | 15233 | 79803 |
| | C-3obj | 168.0 | 8.6X | 1204 | 4102 | 15206 | 79633 |
| | D-3obj | 67.9 | 21.2X | 1204 | 4105 | 15207 | 79641 |
| | M-3obj | 25.4 | 56.7X | 1204 | 4119 | 15209 | 79684 |
| mindustry | 3obj | 325.0 | - | 321 | 771 | 6495 | 30815 |
| | ci | 3.8 | 85.1X | 865 | 1136 | 6907 | 36808 |
| | CSC | 4.3 | 75.2X | 622 | 1051 | 6862 | 33970 |
| | Z-3obj | 111.3 | 2.9X | 352 | 799 | 6540 | 30962 |
| | C-3obj | 109.1 | 3.0X | 321 | 771 | 6495 | 30815 |
| | D-3obj | 11.5 | 28.2X | 321 | 773 | 6495 | 30817 |
| | M-3obj | 7.7 | 42.4X | 321 | 773 | 6495 | 30817 |
| recaf | 3obj | Oom | - | - | - | - | - |
| | ci | 20.4 | >265.1X | 5127 | 7402 | 29038 | 187415 |
| | CSC | 34.0 | >158.6X | 4138 | 6702 | 28300 | 161535 |
| | Z-3obj | Oom | - | - | - | - | - |
| | C-3obj | Oom | - | - | - | - | - |
| | D-3obj | 1172.3 | >4.6X | 3037 | 5651 | 27467 | 140236 |
| | M-3obj | 498.0 | >10.8X | 3038 | 5646 | 27468 | 140249 |
| tesseract | 3obj | 733.4 | - | 341 | 836 | 7743 | 37221 |
| | ci | 4.6 | 159.1X | 1013 | 1291 | 8313 | 45068 |
| | CSC | 6.1 | 120.0X | 747 | 1216 | 8270 | 41968 |
| | Z-3obj | 198.5 | 3.7X | 372 | 861 | 7775 | 37339 |
| | C-3obj | 185.6 | 4.0X | 341 | 836 | 7743 | 37221 |
| | D-3obj | 14.1 | 52.1X | 341 | 838 | 7743 | 37223 |
| | M-3obj | 9.4 | 77.8X | 341 | 838 | 7743 | 37223 |
| xalan | 3obj | Oom | - | - | - | - | - |
| | ci | 5.2 | >1032.5X | 1298 | 2084 | 10092 | 54001 |
| | CSC | 6.0 | >892.6X | 884 | 1967 | 10034 | 50747 |
| | Z-3obj | 1545.4 | >3.5X | 561 | 1658 | 9696 | 46887 |
| | C-3obj | 464.5 | >11.6X | 539 | 1636 | 9665 | 46753 |
| | D-3obj | 31.7 | >170.2X | 539 | 1639 | 9665 | 46756 |
| | M-3obj | 15.7 | >343.5X | 539 | 1638 | 9665 | 46755 |

Table 3. Heuristics time comparison of Zipper, Conch, DebloaterX, and Moon

| Program | CI | Zipper | Conch | DebloaterX | **Moon** | Program | CI | Zipper | Conch | DebloaterX | **Moon** | Program | CI | Zipper | Conch | DebloaterX | **Moon** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| antlr | 4.8 | 10.7 | 7.6 | 11.8 | **8.4** | ddjava | 4.1 | 8.0 | 5.9 | 8.4 | **6.6** | mindustry | 3.8 | 7.7 | 5.4 | 7.7 | **6.0** |
| avrora | 5.5 | 11.9 | 9.1 | 15.7 | **10.2** | eclipse | 18.8 | 208.7 | 226.4 | 76.5 | **46.8** | opentelemetry | 3.9 | 7.3 | 5.1 | 7.6 | **6.1** |
| batik | 13.3 | 57.2 | 55.1 | 51.4 | **30.7** | findbugs | 9.7 | 31.9 | 32.2 | 45.3 | **27.0** | pmd | 6.5 | 17.4 | 15.8 | 19.1 | **12.6** |
| biojava | 4.5 | 9.1 | 6.3 | 9.6 | **7.2** | fop | 4.0 | 8.6 | 6.1 | 9.2 | **6.4** | recaf | 20.4 | 95.2 | 93.4 | 106.7 | **58.6** |
| bloat | 5.5 | 11.7 | 11.8 | 15.1 | **11.0** | h2 | 4.6 | 8.8 | 6.6 | 9.8 | **7.2** | sqlite-jdbc | 3.8 | 7.3 | 5.1 | 7.5 | **5.9** |
| bytecodeviewer | 9.4 | 24.1 | 30.8 | 39.1 | **30.0** | hsqldb | 4.4 | 8.6 | 6.0 | 8.7 | **6.9** | sunflow | 8.2 | 18.0 | 21.6 | 23.5 | **15.2** |
| chart | 9.2 | 37.0 | 27.8 | 30.3 | **18.7** | jd | 10.0 | 26.1 | 42.2 | 33.0 | **20.4** | tesseract | 4.6 | 9.3 | 6.9 | 9.6 | **7.5** |
| checkstyle | 8.2 | 43.2 | 17.8 | 25.8 | **17.3** | JPC | 10.3 | 21.5 | 26.7 | 30.2 | **18.3** | tomcat | 4.0 | 8.6 | 5.9 | 8.7 | **6.7** |
| classyshark | 5.3 | 13.6 | 11.6 | 13.7 | **9.8** | luindex | 3.9 | 8.0 | 5.5 | 8.4 | **6.4** | tradebeans | 4.7 | 11.2 | 8.2 | 11.1 | **7.9** |
| dcevm | 13.5 | 52.3 | 58.6 | 49.2 | **29.9** | lusearch | 4.2 | 8.9 | 5.8 | 10.0 | **6.8** | xalan | 5.2 | 16.8 | 9.4 | 13.6 | **9.5** |