**External BST- Performance Comparison**

Here I have implemented 4 different BST i.e. Course, Fine, Lazy and optimistic and compared performance of all of them. For each implementation I created two different test files to check sequential and concurrent behavior. Please run relevant file in order to test each implementations sequential and concurrent behavior. For more detail please refer Readme.txt.

I tried to run two different sets of experiment with varying load, first set with 20 max thread and second set with 50 max thread . The result of these two sets of experiment are almost similar which is explained below

* 1. **Contains 90%, insert 5%, delete 5%**

Course grained perform worst. Performance of fine grained and optimistic are almost same and lie between course grained and lazy implementation. Lazy implementation perform better among all of them.

* 1. **Contains 80%, insert 10%, delete 10%**

Performance of course grained and fine grained becomes almost same. Performance of fine grained implementation goes down. Performance of optimistic search tree remains same and

Lazy implementation perform better among all of them.

* 1. **Contains 50%, insert 25%, delete 25%**

Fine grain starts performing worst than all other implementations. But for coarse grain it remains almost same. Performance of optimistic and lazy implementation is almost equal and better than other two.

* 1. **Contains 25%, insert 50%, delete2 5%**

Almost same as of above case.

1. **Max Number of concurrent threads = 20**

## Contains 90%, insert 5%, delete 5%

Performance comparison of External BST implementation - On Intel core i-7 processor.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Threads | Coarse Grained | Fine Grained | Optimistic | Lazy |
| 5 | 171 | 94 | 234 | 71 |
| 6 | 125 | 46 | 78 | 31 |
| 7 | 187 | 63 | 93 | 47 |
| 8 | 187 | 78 | 94 | 62 |
| 9 | 219 | 93 | 78 | 47 |
| 10 | 234 | 94 | 94 | 63 |
| 11 | 235 | 109 | 93 | 46 |
| 12 | 265 | 125 | 156 | 63 |
| 13 | 281 | 125 | 157 | 78 |
| 14 | 312 | 140 | 172 | 78 |
| 15 | 344 | 142 | 171 | 79 |
| 16 | 343 | 156 | 156 | 78 |
| 17 | 376 | 156 | 172 | 93 |
| 18 | 406 | 172 | 203 | 110 |
| 19 | 405 | 187 | 204 | 93 |
| 20 | 453 | 188 | 156 | 94 |

## Contains 80%, insert 10%, delete 10%

Performance comparison of External BST implementation - On Intel core i-7 processor.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Threads | Coarse Grained | Fine Grained | Optimistic | Lazy |
| 5 | 187 | 156 | 359 | 203 |
| 6 | 125 | 125 | 62 | 47 |
| 7 | 156 | 156 | 94 | 47 |
| 8 | 171 | 171 | 78 | 62 |
| 9 | 219 | 187 | 78 | 47 |
| 10 | 219 | 234 | 78 | 47 |
| 11 | 250 | 251 | 109 | 62 |
| 12 | 296 | 265 | 109 | 78 |
| 13 | 312 | 297 | 126 | 63 |
| 14 | 282 | 312 | 140 | 78 |
| 15 | 343 | 344 | 141 | 79 |
| 16 | 375 | 327 | 141 | 94 |
| 17 | 390 | 376 | 140 | 93 |
| 18 | 438 | 406 | 172 | 125 |
| 19 | 437 | 422 | 172 | 109 |
| 20 | 468 | 452 | 172 | 125 |

## Contains 50%, insert 25%, delete 25%

Performance comparison of External BST implementation - On Intel core i-7 processor.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Threads | Coarse Grained | Fine Grained | Optimistic | Lazy |
| 5 | 187 | 327 | 312 | 265 |
| 6 | 109 | 343 | 78 | 47 |
| 7 | 172 | 407 | 78 | 63 |
| 8 | 203 | 468 | 94 | 62 |
| 9 | 249 | 530 | 109 | 78 |
| 10 | 267 | 594 | 109 | 79 |
| 11 | 265 | 671 | 109 | 78 |
| 12 | 281 | 719 | 141 | 109 |
| 13 | 312 | 781 | 142 | 94 |
| 14 | 313 | 827 | 156 | 125 |
| 15 | 374 | 890 | 156 | 124 |
| 16 | 390 | 968 | 187 | 125 |
| 17 | 407 | 1014 | 172 | 141 |
| 18 | 436 | 1062 | 203 | 140 |
| 19 | 453 | 1140 | 205 | 158 |
| 20 | 484 | 1187 | 218 | 156 |

## Contains 25%, insert 50%, delete 25%

Performance comparison of External BST implementation - On Intel core i-7 processor.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Threads | Coarse Grained | Fine Grained | Optimistic | Lazy |
| 5 | 187 | 327 | 312 | 265 |
| 6 | 109 | 343 | 78 | 47 |
| 7 | 172 | 407 | 78 | 63 |
| 8 | 203 | 468 | 94 | 62 |
| 9 | 249 | 530 | 109 | 78 |
| 10 | 267 | 594 | 109 | 79 |
| 11 | 265 | 671 | 109 | 78 |
| 12 | 281 | 719 | 141 | 109 |
| 13 | 312 | 781 | 142 | 94 |
| 14 | 313 | 827 | 156 | 125 |
| 15 | 374 | 890 | 156 | 124 |
| 16 | 390 | 968 | 187 | 125 |
| 17 | 407 | 1014 | 172 | 141 |
| 18 | 436 | 1062 | 203 | 140 |
| 19 | 453 | 1140 | 205 | 158 |
| 20 | 484 | 1187 | 218 | 156 |

1. **Max Number of concurrent threads = 50**

## Contains 90%, insert 5%, delete 5%.

Performance comparison of External BST implementation - On Intel core i-7 processor

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Threads | Coarse Grained | Fine Grained | Optimistic | Lazy |
| 10 | 281 | 156 | 359 | 188 |
| 12 | 281 | 109 | 109 | 74 |
| 14 | 358 | 141 | 173 | 78 |
| 16 | 391 | 171 | 140 | 78 |
| 18 | 422 | 172 | 156 | 109 |
| 20 | 468 | 203 | 172 | 109 |
| 22 | 500 | 220 | 203 | 125 |
| 24 | 562 | 250 | 203 | 125 |
| 26 | 610 | 249 | 250 | 140 |
| 28 | 639 | 281 | 234 | 172 |
| 30 | 736 | 296 | 265 | 141 |
| 32 | 749 | 313 | 281 | 203 |
| 34 | 796 | 344 | 299 | 187 |
| 36 | 844 | 358 | 312 | 188 |
| 38 | 891 | 360 | 328 | 218 |
| 40 | 951 | 376 | 343 | 203 |
| 42 | 985 | 405 | 360 | 205 |
| 44 | 1045 | 422 | 390 | 219 |
| 46 | 1094 | 437 | 400 | 281 |
| 48 | 1140 | 453 | 417 | 280 |
| 50 | 1171 | 484 | 421 | 297 |

## Contains 80%, insert 10%, delete 10%

Performance comparison of External BST implementation - On Intel core i-7 processor

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Threads | Coarse Grained | Fine Grained | Optimistic | Lazy |
| 10 | 250 | 234 | 386 | 188 |
| 12 | 265 | 234 | 125 | 63 |
| 14 | 343 | 280 | 125 | 78 |
| 16 | 375 | 328 | 156 | 109 |
| 18 | 375 | 391 | 172 | 93 |
| 20 | 421 | 421 | 203 | 125 |
| 22 | 484 | 438 | 203 | 141 |
| 24 | 532 | 485 | 219 | 140 |
| 26 | 546 | 514 | 265 | 141 |
| 28 | 610 | 562 | 265 | 160 |
| 30 | 655 | 609 | 297 | 159 |
| 32 | 687 | 640 | 297 | 172 |
| 34 | 749 | 672 | 328 | 202 |
| 36 | 782 | 717 | 327 | 188 |
| 38 | 843 | 751 | 360 | 235 |
| 40 | 874 | 796 | 375 | 218 |
| 42 | 922 | 812 | 406 | 250 |
| 44 | 984 | 875 | 421 | 249 |
| 46 | 1030 | 905 | 422 | 249 |
| 48 | 1063 | 936 | 454 | 282 |
| 50 | 1108 | 969 | 453 | 281 |

## Contains 50%, insert 25%, delete 25%

Performance comparison of External BST implementation - On Intel core i-7 processor

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Threads | Coarse Grained | Fine Grained | Optimistic | Lazy |
| 10 | 281 | 578 | 343 | 203 |
| 12 | 327 | 686 | 140 | 109 |
| 14 | 343 | 765 | 172 | 109 |
| 16 | 376 | 796 | 171 | 125 |
| 18 | 452 | 704 | 203 | 140 |
| 20 | 499 | 1076 | 220 | 156 |
| 22 | 547 | 1157 | 249 | 171 |
| 24 | 593 | 1327 | 265 | 270 |
| 26 | 657 | 1545 | 297 | 374 |
| 28 | 702 | 1656 | 313 | 374 |
| 30 | 766 | 1765 | 340 | 256 |
| 32 | 795 | 1841 | 343 | 250 |
| 34 | 860 | 2014 | 390 | 265 |
| 36 | 905 | 2029 | 391 | 281 |
| 38 | 968 | 2169 | 421 | 293 |
| 40 | 1031 | 1842 | 453 | 312 |
| 42 | 1078 | 2171 | 468 | 343 |
| 44 | 1109 | 2435 | 484 | 344 |
| 46 | 1187 | 2606 | 530 | 359 |
| 48 | 1234 | 2731 | 525 | 374 |
| 50 | 1296 | 2856 | 609 | 405 |

## Contains 25%, insert 50%, delete 25%

Performance comparison of External BST implementation - On Intel core i-7 processor

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Threads | Coarse Grained | Fine Grained | Optimistic | Lazy |
| 10 | 312 | 509 | 374 | 266 |
| 12 | 375 | 936 | 156 | 124 |
| 14 | 405 | 1108 | 172 | 125 |
| 16 | 438 | 1250 | 203 | 157 |
| 18 | 499 | 1140 | 220 | 172 |
| 20 | 546 | 1389 | 265 | 187 |
| 22 | 641 | 1624 | 265 | 219 |
| 24 | 687 | 1858 | 312 | 219 |
| 26 | 719 | 1874 | 327 | 250 |
| 28 | 749 | 2312 | 359 | 266 |
| 30 | 844 | 2513 | 374 | 296 |
| 32 | 842 | 2559 | 407 | 297 |
| 34 | 999 | 2871 | 438 | 312 |
| 36 | 1014 | 3090 | 436 | 344 |
| 38 | 1126 | 2981 | 485 | 358 |
| 40 | 1030 | 3402 | 499 | 423 |
| 42 | 1093 | 3526 | 531 | 406 |
| 44 | 1314 | 3745 | 547 | 405 |
| 46 | 1311 | 3870 | 577 | 451 |
| 48 | 1327 | 4041 | 594 | 453 |
| 50 | 1385 | 4229 | 640 | 468 |