problem5

To store all the letters, binary tree needs 11 level of heights.
By this level we can know it takes $O(\log2(11))$ to search a value in the worst case of a binary tree
while it takes $O(1)$ in the hashtable.
Therefore, in this case we can have faster result in the hash table.

109, 15, 60, 31, 170, 486, 36, 178, 110, 243, 354,
377, 199, 279, 439, 40, 31, 375, 475, 23, 155, 86,
363, 341, 253, 510, 4, 100, 162, 457, 376, 59, 179,
186, 411, 155, 380, 330, 323, 134, 341, 14, 381, 236,
412, 373, 85, 351, 323, 157, 459, 511, 363, 453, 199,
463, 477, 371, 334, 253, 206, 26, 370, 362, 47, 506,
213, 280, 175, 314, 80, 243, 332, 353, 156, 228, 95,
96, 70, 0, 196, 71, 364, 379, 377, 471, 289, 66,
427, 42, 474, 350, 172, 321, 359, 4, 138, 254, 249,
124, 423, 338, 49, 507, 502, 293, 53, 182, 180, 213,
229, 296, 365, 483, 427, 486, 111, 294, 166, 19, 484,
93, 440, 152, 346, 167, 406, 13, 192, 76, 510, 34,
303, 340, 251, 457, 267, 471, 39, 428, 234, 455, 471,
509, 318, 344, 489, 379, 188, 337, 472, 494, 245, 188,
293, 45, 410, 177, 196, 187, 323, 494, 85, 131, 406,
327, 477, 310, 349, 288, 249, 496, 326, 468, 479, 392,
374, 451, 468, 60, 84, 262, 335, 210, 381, 134, 9,
129, 436, 25, 356, 67, 98, 459, 453, 95, 278, 337,
220, 270, 63, 351, 79, 370, 448, 406, 58, 286, 272,
441, 381, 362, 342, 415, 54, 207, 429, 399, 473, 420,
189, 182, 29, 173, 301, 354, 139, 44, 296, 383, 425,
12, 481, 52, 494, 284, 418, 95, 175, 325, 505, 511,
339, 258, 463, 369, 12, 28, 85, 509, 221, 123, 114,
128, 105, 413, 223, 329, 119, 51, 425, 501, 404, 40,
449, 339, 444, 378, 344, 290, 199, 360, 353, 220, 261,
103, 254, 439, 305, 234, 393, 480, 226, 437, 372, 490,
36, 79, 238, 108, 496, 27, 71, 274, 367, 337, 355,
339, 208, 378, 43, 279, 230, 347, 66, 108, 190, 136,
401, 487, 431, 259, 455, 309, 427, 335, 59, 400, 288,
360, 342, 116, 364, 25, 263, 134, 435, 478, 127, 240,
382, 241, 466, 6, 470, 501, 289, 511, 129, 75, 379,
148, 470, 340, 145, 317, 313, 13, 143, 88, 180, 481,
124, 501, 421, 475, 316, 44, 236, 129, 59, 91, 114,
401, 133, 396, 485, 220, 232, 126, 420, 420, 295, 185,
109, 501, 339, 206, 411, 391, 110, 13, 68, 443, 380,
72, 364, 401, 58, 374, 419, 469, 426, 397, 171, 190,
477, 66, 301, 431, 77, 53, 352, 429, 479, 207, 180,
221, 283, 453, 355, 35, 320, 232, 77, 196, 312, 313,
293, 474, 509, 147, 257, 470, 135, 430, 316, 104, 167,
428, 331, 378, 343, 103, 152, 91, 37, 322, 381, 194,
127, 11, 155, 506, 233, 477, 474, 59, 370, 288, 42,
38, 356, 419, 22, 112, 177, 493, 357, 313, 444, 198,
470, 167, 204, 439, 381, 61, 487, 22, 368, 397, 434,
398, 138, 78, 17, 368, 119, 376, 472, 509, 127, 296,
120, 435, 416, 89, 94, 345, 197, 381, 373, 245, 84,
221, 497, 357, 295, 316, 299, 310, 364, 452, 49, 149,
65, 83, 304, 48, 369, 457,

```
2 0 0 1 2 2 0 1 0 2
0 0 1 2 0 1 0 1 0 0
4 1 1 0 2 1 1 0 0 7
0 3 0 0 1 1 0 1 0 0
2 1 0 0 0 0 1 3 0 0
0 2 2 2 3 0 0 2 1 1
4 0 1 1 3 1 0 1 0 0
0 0 0 0 0 4 0 0 0 0
2 3 2 0 0 2 0 1 1 0
1 1 1 2 1 0 2 1 0 0
0 4 1 2 2 0 0 0 1 0
2 0 2 3 2 1 0 2 0 0
0 0 0 0 2 1 1 3 1 3
0 0 2 1 0 1 0 0 1 0
1 1 0 3 0 3 1 0 1 2
0 0 3 0 0 2 1 0 2 0
1 0 0 0 1 4 2 0 0 1
0 2 1 1 0 1 0 4 0 1
3 0 2 0 1 3 1 0 1 0
1 1 0 2 1 1 2 0 0 3
1 0 0 0 0 0 1 0 0 1
1 1 1 2 0 0 1 1 0 3
2 1 2 0 0 1 0 0 2 1
0 2 1 1 0 0 0 2 0 2
2 0 1 0 3 2 0 1 1 0
0 0 2 3 0 3 2 0 1 1
2 4 0 1 2 1 1 3 0 0
2 0 0 0 0 1 0 1 1 0
1 1 2 1 0 0 2 2 3 1
0 1 3 0 2 1 0 0 2 0
1 0 0 0 3 2 0 0 1 3
2 2 0 1 0 0 0 2 0 0
2 0 0 3 2 6 1 0 2 1
0 0 0 1 4 2 2 2 0 1
3 2 3 0 3 3 0 1 2 0
3 1 2 1 0 0 0 2 0 0
2 2 1 1 1 2 0 2 2 2
1 1 0 5 0 2 3 0 0 0
0 4 1 1 0 3 0 1 0 2
0 2 1 0 0 1 1 1 0 0
0 2 2 0 1 0 1 0 2 1
2 0 0 0 2 2 1 6 1 0
3 1 0 0 1 2 1 0 0 3
0 1 2 1 2 0 0 0 0 0
4 1 3 0 0 1 0 0 4 3
0 1 0 0 1 1 0 2 0 2
0 0 1 0 3 1 0 3 2 0
```

0 2 0 1 0 0 1 1 2 0
1 0 1 1 1 0 1 1 3 1
1 1 0 2 0 2 1 1 0 1
1 0 1 0 0 1 0 3 1 3
1 0

The level of balance tree: 11

#of conflict=0 : 223, 43.5547 %
#of conflict=1 : 144, 28.125 %
#of conflict=2 : 90, 17.5781 %
#of conflict=3 : 40, 7.8125 %
#of conflict=4 : 11, 2.14844 %
#of conflict=5 : 1, 0.195312 %
#of conflict=6 : 2, 0.390625 %
#of conflict=7 : 1, 0.195312 %
#of conflict=8 : 0, 0 %
#of conflict=9 : 0, 0 %
#of conflict=10 : 0, 0 %
#of conflict=11 : 0, 0 %
#of conflict=12 : 0, 0 %
#of conflict=13 : 0, 0 %
0 --> BBA --> JBV
        1
        2
3 --> YXK
4 --> PHN --> RIN
5 --> BKX --> AKZ
        6
7 --> MRX
        8
9 --> QVJ --> KMP
        10
        11
12 --> QEV
13 --> ALD --> BKE
        14
15 --> FJP
        16
17 --> RQP
        18
        19
20 --> ZIV --> WHU --> ZIV --> YIT
21 --> AHL
22 --> TFM
        23
24 --> FXM --> EXO
25 --> QNW
26 --> JCC

```
        27
        28
29 --> HLL --> IKK --> XVQ --> XVS --> YVQ --> YVP --> HLJ
        30
31 --> TSJ --> VRK --> UPK
        32
        33
34 --> GWH
35 --> JKW
        36
37 --> IHP
        38
        39
40 --> JYU --> LXU
41 --> YSF
        42
        43
        44
        45
46 --> RAG
47 --> CEQ --> ADQ --> ADR
        48
        49
        50
51 --> PMF --> SNE
52 --> BQM --> CSN
53 --> MGY --> MGZ
54 --> MWN --> OYN --> OWN
        55
        56
57 --> EEJ --> TNS
58 --> DVA
59 --> SJJ
60 --> GVO --> HUM --> GTN --> BOU
        61
62 --> WAO
63 --> GFY
64 --> PXH --> SYI --> QZI
65 --> TJZ
        66
67 --> XML
        68
        69
        70
        71
        72
        73
```

74
75 --> XJS --> ZLR --> YKR --> XLQ
76
77
78
79
80 --> MTT --> OTV
81 --> LAY --> JAY --> KAW
82 --> KPM --> JQO
83
84
85 --> PGP --> RGS
86
87 --> NFL
88 --> OUA
89
90 --> RVM
91 --> CZX
92 --> DOO
93 --> QFX --> QDZ
94 --> ALI
95
96 --> UZB --> FKU
97 --> HBL
98
99
100
101 --> ZIX --> XIY --> XIX --> SDF
102 --> GOH
103 --> VES --> UDP
104 --> DKB --> UTH
105
106
107
108 --> LMV
109
110 --> HJN --> ZVU
111
112 --> UQO --> TPO
113 --> FVY --> OBR --> DUZ
114 --> YVC --> WVB
115 --> GXJ
116
117 --> XFL --> YDJ
118
119
120

```
        121
        122
        123
124 --> SRA --> RPC
125 --> CUL
126 --> NJT
127 --> QAJ --> PBK --> PAL
128 --> BFV
129 --> LXF --> LXE --> TBY
        130
        131
132 --> SMH --> QOG
133 --> ARQ
        134
135 --> MXP
        136
        137
138 --> DDM
        139
140 --> WPG
141 --> CNY
        142
143 --> WBR --> ZCS --> YCP
        144
145 --> RXL --> RYK --> RZJ
146 --> VOC
        147
148 --> XMN
149 --> ISZ --> GPZ
        150
        151
152 --> MJC --> IDH --> IFH
        153
        154
155 --> JUL --> JTL
156 --> XJV
        157
158 --> KFV --> JFV
        159
160 --> MIH
        161
        162
        163
164 --> EBT
165 --> WWS --> XWR --> ZWQ --> ZWP
166 --> QGT --> SGT
        167
```

168
169 --> OUF
170
171 --> QVP --> STP
172 --> UKG
173 --> ORJ
174
175 --> AKK
176
177 --> FLW --> DJY --> UXD --> DLW
178
179 --> PSY
180 --> CXI --> UGN --> AXG
181
182 --> YKA --> XKA
183
184 --> VDT
185 --> UVL --> TVJ --> DJE
186 --> DWU
187
188 --> LBH
189
190 --> ZHH
191 --> IJS
192
193 --> UQP --> VQP
194 --> MCV
195 --> ZUD
196 --> IZO --> GZM
197
198
199 --> MMQ --> OOP --> ONS
200 --> QDG
201
202
203
204
205
206 --> AUO
207
208
209 --> BDZ
210 --> UDC
211 --> DGJ
212 --> DYB
213 --> PNK --> QNK
214

```
        215
216 --> OYU
217 --> BDD
        218
219 --> TNY --> FFR --> FFQ
220 --> DTI --> EUI
221 --> PKP
222 --> GVT --> HTT
        223
        224
225 --> HGD
        226
        227
228 --> FPN --> ESO
229 --> WNR
        230
231 --> LIP --> JHR
232 --> XAB
233 --> GEK
        234
        235
        236
237 --> XJX --> ZKW
        238
239 --> KEY --> JDZ
240 --> ASB --> CSA
        241
242 --> MZC
        243
244 --> SZN --> LQV --> QWO
245 --> EBZ --> FBZ
        246
247 --> SHZ
248 --> AMG
        249
        250
        251
252 --> QTU --> RTV
253 --> ULK --> TLL --> FCD
        254
255 --> QHD --> RHD --> SID
256 --> GQH --> CJN
        257
258 --> FNC
259 --> GAQ
260 --> STC --> QUA
261 --> CZL --> BZL --> AZK --> AYK
```

262
263 --> ZKD
264 --> XXV --> YZT
265 --> TEY
266 --> VUM
267 --> FZX --> EYZ --> EXW
268
269
270 --> LSC --> LPB
271
272
273
274
275 --> OAW
276
277 --> HZP
278 --> KOG
279
280 --> MOV
281 --> SEK
282 --> CGT --> CHT
283 --> OBF
284
285
286 --> RSH --> QQH
287 --> AVS --> BVS
288 --> MMA --> NOA --> NMA
289 --> QBP
290
291 --> VEF
292 --> EGO --> URT --> EIO
293
294 --> SNO --> POO
295 --> BPY
296
297
298 --> GLC --> IJC
299
300 --> DDU
301
302
303
304 --> KKM --> JKO --> JLO
305 --> XCY --> YAW
306
307
308 --> VOG

309 --> DPP --> KWL --> FQS
310 --> YOU --> XNV
311 --> IVF --> IVD
        312
313 --> WCE
        314
        315
        316
317 --> LUR --> KUQ
        318
        319
320 --> RJU --> LIA
        321
        322
323 --> OZF --> OXF --> NYE
324 --> BBN --> BCM
325 --> SWS --> RXR --> QWR --> RZQ --> PYQ --> RYR
326 --> DFB
        327
328 --> RJB --> RKA
329 --> BNL
        330
        331
        332
333 --> QTW
334 --> UJN --> EBI --> DBI --> DBG
335 --> EMY --> DNZ
336 --> PGI --> WMA
337 --> ALR --> GPL
        338
339 --> TZJ
340 --> HBT --> IBT --> HCV
341 --> STF --> PUF
342 --> TGV --> UIT --> TIU
        343
344 --> XJH --> WKI --> WKG
345 --> YXW --> YYW --> YYY
        346
347 --> TUQ
348 --> MFU --> ICA
        349
350 --> LCN --> KBN --> JAN
351 --> LPF
352 --> WIN --> XGN
353 --> YZF
        354
        355

```
        356
357 --> NSQ --> NRR
        358
        359
360 --> AYN --> CXO
361 --> MOZ --> OMW
362 --> QDM
363 --> CHW
364 --> MBH
365 --> FJL --> DJL
        366
367 --> RSJ --> PPK
368 --> AUT --> TIA
369 --> OND --> NNE
370 --> PBV
371 --> AIF
        372
373 --> FHP --> FGR --> FIR --> TRW --> UQW
        374
375 --> SOQ --> QOQ
376 --> HXU --> HWT --> BVB
        377
        378
        379
        380
381 --> FFX --> TQD --> TPD --> FDY
382 --> FVM
383 --> YQQ
        384
385 --> JLS --> KKQ --> JLR
        386
387 --> HHJ
        388
389 --> TNJ --> UMK
        390
391 --> YOZ --> WMZ
392 --> GVG
        393
        394
395 --> MJJ
396 --> SCC
397 --> BEJ
        398
        399
        400
401 --> QJZ --> PJY
402 --> BQG --> CQI
```

403
404 --> NYI
405
406 --> PWV
407
408 --> FPU --> DSU
409 --> SKD
410 --> BMM --> BOO
411
412
413
414 --> SWA --> QZC
415 --> DBK --> TKP
416 --> FRA
417 --> YME --> RGJ --> RIL --> QIJ --> ZMD --> SHL
418 --> HSO
419
420 --> EMI --> TXM --> TZM
421 --> ICZ
422
423
424 --> LUA
425 --> WLL --> ZKL
426 --> HMU
427
428
429 --> HBD --> IAE --> GBE
430
431 --> KBP
432 --> KRH --> JPH
433 --> XIS
434 --> XXG --> ZZG
435
436
437
438
439
440 --> QVI --> JNN --> RTH --> QVI
441 --> BYP
442 --> MQC --> OPA --> MSA
443
444
445 --> OCJ
446
447
448 --> PPN --> PQN --> PSM --> SSM
449 --> UGF --> TIE --> VGD

450
451 --> RCZ
452
453
454 --> EGU
455 --> EXK
456
457 --> CTE --> ATD
458
459 --> ZEW --> WEW
460
461
462 --> UPI
463
464 --> YQV --> YSU --> YST
465 --> GWF
466
467 --> XEF --> XDD --> XDD
468 --> MOI --> IHO
469
470
471 --> KYR --> LWQ
472
473 --> HTK
474
475
476 --> NLO
477 --> QCE
478 --> ADM --> CDN
479
480 --> DGB
481
482 --> QMC
483 --> APK
484 --> OGT
485
486 --> BAV
487 --> RYW
488 --> UMO --> VNN --> TON
489 --> FSX
490 --> QKH
491 --> ANP
492
493 --> YAL --> OTP
494
495 --> QZF --> PXD
496 --> DCN

497 --> FRF
     498
499 --> IPQ
500 --> JGI
     501
502 --> IFC
     503
     504
505 --> KTE
     506
507 --> GOW --> IOZ --> INX
508 --> LFM
509 --> UVX --> UTX --> UTY
510 --> NHB
     511

           YYY
         YYW
      YXW
        YZT
    XXV
         ZWP
        ZWQ
         XWR
      WWS
        YXK
         ZZG
   XXG
        YZF
      ZVU
         YVP
        YVQ
         XVS
     XVQ
          ZUD
        WVB
      YVC
        YST
   YSU
        YQV
      YQQ
        WPG
     YSF
         WMZ
        YOZ
         XNV
      YOU

WNR

XMN

XML

ZMD

YME

WMA

ZKW

XJX

XJV

XLQ

YKR

ZLR

XJS

ZKL

WLL

WKG

WKI

XJH

ZKD

XKA

YKA

XIX

XIY

ZIX

YIT

ZIV

WHU

ZIV

XIS

XGN

WIN

ZHH

WEW

ZEW

YDJ

XFL

XDD

XDD

XEF

YAW

XCY

YCP

ZCS

WBR

WAO

YAL

WCE

XAB
TZM
TXM
TZJ
UXD
UZB
UTY
UTX
UVX
TUQ
VUM
TVJ
UVL
UTH
UQW
TRW
URT
VQP
UQP
TPO
UQO
UPK
VRK
TSJ
UPI
TPD
TQD
TNY
TNS
TON
VNN
UMO
UMK
TNJ
VOG
VOC
TJZ
TKP
UJN
TLL
ULK
UKG
TIU
UIT
TGV
UGN
VGD

```
                    TIE
            UGF
                TIA
        TEY
                    VDT
                UDP
            VES
                TFM
                    VEF
    UDC
                    TBY
                RYW
            PWV
                    RYR
                PYQ
                    RZQ
                QWR
                RXR
        SWS
                    QWO
                SZN
            RZJ
                RYK
            RXL
                    QZI
                SYI
            PXH
                PXD
QZF
                    QZC
                SWA
            QTW
                    RTV
                QTU
                    STP
        QVP
                RVM
            QVJ
                    QVI
                RTH
        QVI
                    PUF
                STF
                    QUA
            STC
                PSY
        RQP
```

```
                              SSM
                         PSM
                    PQN
                         PPN
          PPK
               RSJ
                    QQH
             RSH
                  RPC
          SRA
                    QNW
                         QOQ
                    SOQ
                         POO
               SNO
                    QNK
                  PNK
                    QOG
SMH
               SNE
             PMF
                  QMC
            PJY
             QJZ
         RJU
          PKP
             SJJ
       QKH
                 SKD
               RKA
            RJB
                 SHZ
             SGT
                  QGT
          RGS
             PGP
                 RIN
           PHN
                    SHL
                QIJ
             RIL
                  RGJ
      PGI
              SID
            RHD
         QHD
                QDZ
```

```
                    QFX
            QEV
                QDM
                    SEK
        QDG
                    SDF
                RCZ
            PBV
                    QBP
                PAL
                    PBK
        QAJ
                    RAG
                QCE
                    SCC
                OYU
                    MXP
                        OWN
                OYN
                    MWN
NYI
                    NYE
                OXF
                    OZF
            MZC
                        OTV
                    MTT
                OTP
                    OUF
                        OUA
        MRX
                    NRR
                NSQ
                        ORJ
                    MSA
            OPA
                    MQC
                OMW
                    MOZ
        MOV
                    ONS
                OOP
            MMQ
                MOI
                    NNE
        OND
                    NMA
```

```
                              NOA
                                MMA
                        NJT
                            NLO
                                  MJJ
                        MJC
                            MGZ
      MGY
                        OGT
                            MIH
                      NHB
                        MFU
                  NFL
                              OAW
                        MCV
                      OBR
                        OCJ
            MBH
                              OBF
                        LXU
                      JYU
                        LWQ
                  KYR
                        KWL
                            LXE
                      LXF
                            KUQ
                        LUR
                            JTL
R -> JUL
                            KTE
                        LUA
                      LQV
                            JQO
                        KPM
                            JPH
                  KRH
                            LPF
                        LPB
                            LSC
                      LMV
                        KMP
                JNN
                            KOG
                        JKW
                              JLR
                        KKQ
```

```
            JLS
                    JLO
                JKO
            KKM
                JHR
        LIP
                JGI
            LIA
                    JDZ
                KEY
                    JFV
            KFV
                LFM
            KAW
                JAY
    LAY
                JBV
            KBP
                JAN
            KBN
            LCN
                LBH
        JCC
                HWT
            HXU
        HZP
                GZM
            IZO
            GXJ
    GWH
                GWF
            HTT
        GVT
                GTN
            HUM
                GVO
        HTK
                GVG
                    IVD
            IVF
                GPZ
            ISZ
                IPQ
            HSO
                GPL
    GQH
                INX
```

```
                        IOZ
                            GOW
                    HMU
                            GOH
                    IJS
                        HJN
                            HLJ
            IKK
                    HLL
                        IJC
                GLC
                        IHP
                    IHO
                        HHJ
        HGD
                    GFY
                GEK
                    IFH
            IDH
                        IFC
                    ICZ
                        HCV
                IBT
                HBT
                        GAQ
    HBL
                    GBE
                IAE
                    HBD
            ICA
                        EXW
                    EYZ
                        FZX
                DWU
                    EXO
            FXM
                    EXK
                        DYB
                DUZ
                    FVY
            FVM
                    EUI
                DTI
                        DVA
                    FSX
                        DSU
    FPU
```

```
                    FQS
            DPP
        ESO
            FPN
    FRF
                FRA
            DNZ
                EMY
        DOO
            EMI
    FNC
            DLW
        DJY
    FLW
                FKU
            FJP
                DJL
        FJL
                DJE
            DKB
EGU
                FIR
            FGR
        FHP
                EIO
            EGO
                DGJ
        DGB
                    FDY
                FFX
                    DDU
                FFQ
                FFR
                    DDM
            EEJ
                DFB
            FBZ
    EBZ
            EBT
                DCN
        DBK
                DBG
            DBI
        EBI
                FCD
            CZX
        BYP
```

```
                        CXO
AYN
                            AYK
                        AZK
                            BZL
                    CZL
                        AXG
                CXI
                        AUT
                            BVS
                    AVS
                            AUO
                        CUL
                            ATD
                        CTE
                            BVB
            BPY
                        ARQ
                            CSN
                    BQM
                            APK
                                CQI
                        BQG
                            CSA
                ASB
                        CNY
                            BOU
                    ANP
                        BOO
                BMM
                        BNL
                    AMG
                        AKZ
            BKX
                        ALR
                    CJN
                        AKK
                ALI
                        BKE
                    ALD
                CHW
                    CHT
                CGT
                    AHL
                        AIF
            BDZ
                        BFV
```

```
            ADR
                ADQ
        CEQ
            CDN
        ADM
                BEJ
            BDD
                BAV
            BCM
            BBN
                BBA
RUN SUCCESSFUL (total time: 912ms)
```