

REPORT

For the report of this project, I used the big-input.txt provided for the experimentation.

The characteristics of the big-input.txt is as follows:

Categories: 24

Apps: 217

The requirements for this report are to showcase our binary search trees and hash table.

For the case of the hash table, the table size created after doubling the amount of apps and finding the nearest prime number larger than the amount. We also want to show the chain length of l , $0 \leq l \leq l_{max}$. l is the length of the current chain, and l_{max} is the max number of chains.

For the case of the binary search trees, we want to display the amount of nodes each tree has, and also show the max height of each tree along with the height of both the left and right subtrees.

Lastly, we want to show the time difference between searching within the hash table, and searching within the binary search tree.

For the results, I will provide snippets of the output along with clarification and the full output at the end of the report.

HASH TABLE SNIPPET

```
APP AMOUNT = 217
```

```
TABLESIZE = 439
```

```
LOAD FACTOR = N/M = (APP AMOUNT)/(TABLE SIZE) = 0.49
```

```
hash[374]: ->WatchESPN ->Badoo Premium ->Sky Guide: View Stars Night or Day ->Shopkins Magazine [0 <= 4 <= 4]
hash[375]: ->Hair Color Dye [0 <= 1 <= 4]
hash[376]: [0 <= 0 <= 4]
hash[377]: [0 <= 0 <= 4]
hash[378]: [0 <= 0 <= 4]
hash[379]: ->Snapchat [0 <= 1 <= 4]
hash[380]: [0 <= 0 <= 4]
hash[381]: ->Akinator the Genie [0 <= 1 <= 4]
hash[382]: ->PAUSE ->Geometry Dash [0 <= 2 <= 4]
```

In this case with a total of 217 apps, we will double the amount which results to 434, and the nearest larger prime number is 439. 439 is our table size that will help spread the app data, instead of having larger chains.

Our max chain ends up being 4, and the second picture shows a snippet of the hashtable between index 414 to 417. This counts the amount of data and therefore shows the amount of chains within each index. Our load factor is the amount of apps divided by the table size. In this case the result printed is that our load factor is 0.49.

BINARY SEARCH TREE SNIPPET

```
BST CATEGORY: Finance
TOTAL NODES: 7
MAX HEIGHT: 3
HEIGHT LEFT: 3
HEIGHT RIGHT: 2

BST CATEGORY: Food & Drink
TOTAL NODES: 12
MAX HEIGHT: 5
HEIGHT LEFT: 3
HEIGHT RIGHT: 5

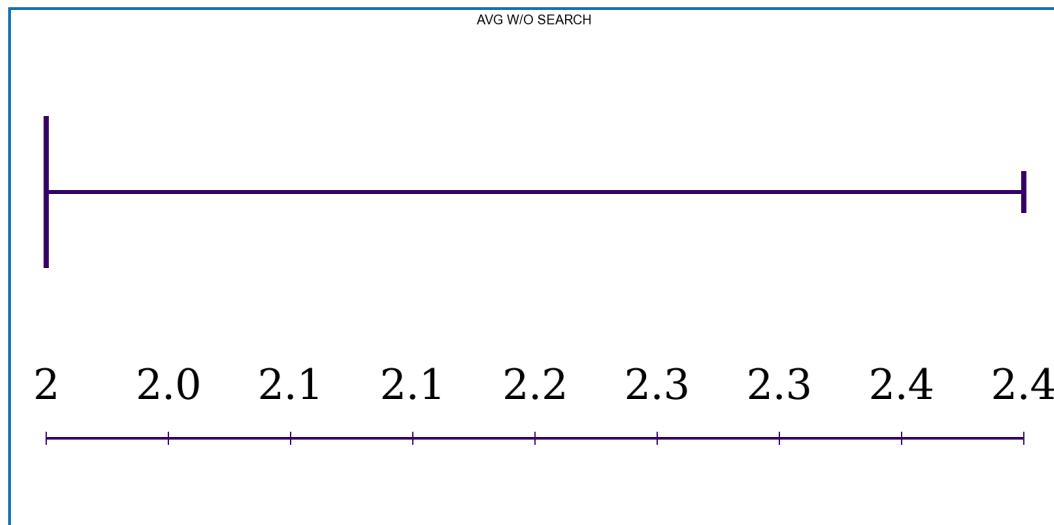
BST CATEGORY: Games
TOTAL NODES: 20
MAX HEIGHT: 6
HEIGHT LEFT: 5
HEIGHT RIGHT: 6
```

Each category is set up with their own binary search tree. This too is also a snippet of the output listed for a total of 24 categories.

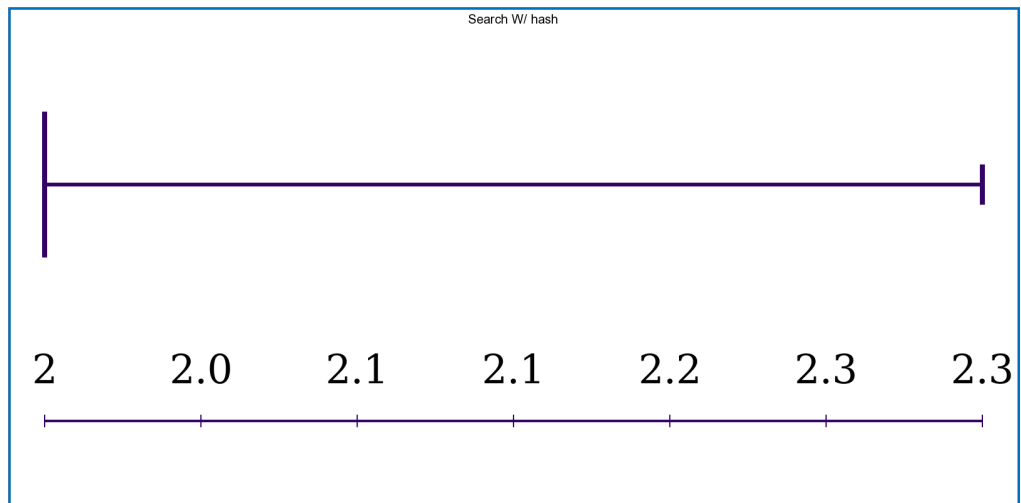
We see the total nodes each tree holds, and takes the max height of both the left and right sub trees. The count starts from the leaves until it reaches the top.

BST VS HASH TABLE TIME

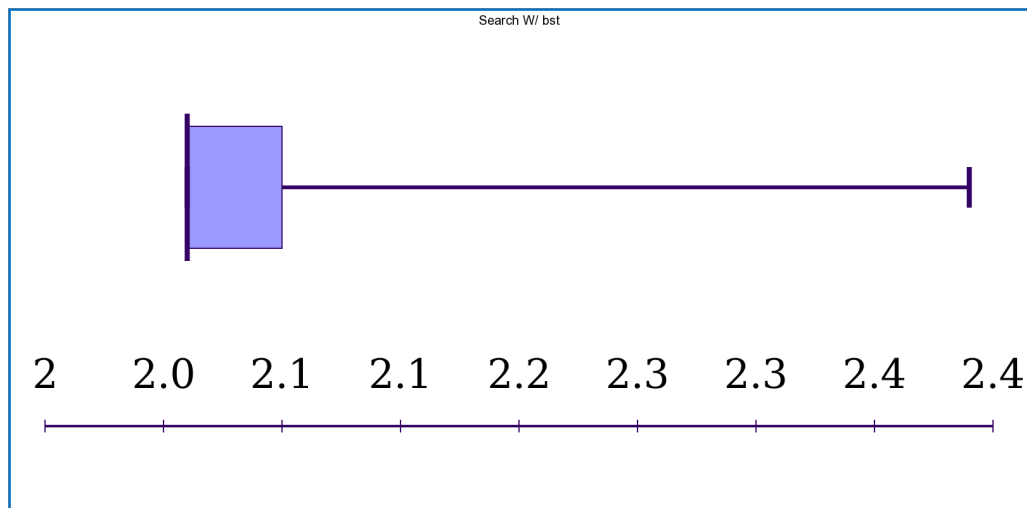
This case took a bit more time to create. I first took the average of 20 runs without the search function. To make the box and whiskers plot easier to read, I created each plot with non-decimal point numbers. **The time listed in each plot is in milliseconds.**



The average and the lowest was rounded to 2 milliseconds. The first run was the highest at 2.4 milliseconds. The box and whiskers plot doesn't really have a box because the time was mostly consistent except for the first run.



I then did a search for 100 of the 217 apps provided. I ran the search for all 100 items 20 separate times. It actually did not change much from just running the program without any search. This is the same case as before, except for the first run, all other runs were consistent.



In the case of searching within the BST, we were very close to the amount of time for hash tables. The time was actually a bit more fluctuated. My hypothesis is that time depended on the height of the tree being searched.

FULL OUTPUT OF REPORT

**** REPORT ****

BST CATEGORY: Books
TOTAL NODES: 8
MAX HEIGHT: 4
HEIGHT LEFT: 4
HEIGHT RIGHT: 2

BST CATEGORY: Business
TOTAL NODES: 11
MAX HEIGHT: 5
HEIGHT LEFT: 2
HEIGHT RIGHT: 5

BST CATEGORY: Catalogs
TOTAL NODES: 7
MAX HEIGHT: 5
HEIGHT LEFT: 5
HEIGHT RIGHT: 0

BST CATEGORY: Education
TOTAL NODES: 9
MAX HEIGHT: 3
HEIGHT LEFT: 3
HEIGHT RIGHT: 3

BST CATEGORY: Entertainment
TOTAL NODES: 13
MAX HEIGHT: 7
HEIGHT LEFT: 1
HEIGHT RIGHT: 7

BST CATEGORY: Finance
TOTAL NODES: 7
MAX HEIGHT: 3
HEIGHT LEFT: 3
HEIGHT RIGHT: 2

BST CATEGORY: Food & Drink
TOTAL NODES: 12
MAX HEIGHT: 5
HEIGHT LEFT: 3
HEIGHT RIGHT: 5

BST CATEGORY: Games
TOTAL NODES: 20
MAX HEIGHT: 6
HEIGHT LEFT: 5
HEIGHT RIGHT: 6

BST CATEGORY: Health & Fitness
TOTAL NODES: 10
MAX HEIGHT: 4
HEIGHT LEFT: 4
HEIGHT RIGHT: 3

BST CATEGORY: Kids
TOTAL NODES: 7
MAX HEIGHT: 3
HEIGHT LEFT: 3
HEIGHT RIGHT: 1

BST CATEGORY: Lifestyle
TOTAL NODES: 7
MAX HEIGHT: 3
HEIGHT LEFT: 2
HEIGHT RIGHT: 3

BST CATEGORY: Magazines & Newspapers
TOTAL NODES: 6
MAX HEIGHT: 3
HEIGHT LEFT: 3
HEIGHT RIGHT: 0

BST CATEGORY: Medical
TOTAL NODES: 7
MAX HEIGHT: 4
HEIGHT LEFT: 0
HEIGHT RIGHT: 4

BST CATEGORY: Music
TOTAL NODES: 11
MAX HEIGHT: 5
HEIGHT LEFT: 5
HEIGHT RIGHT: 1

BST CATEGORY: Navigation
TOTAL NODES: 11
MAX HEIGHT: 5
HEIGHT LEFT: 1
HEIGHT RIGHT: 5

BST CATEGORY: News
TOTAL NODES: 10
MAX HEIGHT: 4
HEIGHT LEFT: 2
HEIGHT RIGHT: 4

BST CATEGORY: Photo & Video
TOTAL NODES: 7
MAX HEIGHT: 4
HEIGHT LEFT: 0
HEIGHT RIGHT: 4

BST CATEGORY: Productivity
TOTAL NODES: 11
MAX HEIGHT: 5
HEIGHT LEFT: 5
HEIGHT RIGHT: 3

BST CATEGORY: Reference
TOTAL NODES: 5
MAX HEIGHT: 2
HEIGHT LEFT: 2
HEIGHT RIGHT: 2

BST CATEGORY: Social Networking
TOTAL NODES: 8
MAX HEIGHT: 4
HEIGHT LEFT: 4
HEIGHT RIGHT: 2

BST CATEGORY: Sports
TOTAL NODES: 12
MAX HEIGHT: 5
HEIGHT LEFT: 5
HEIGHT RIGHT: 3

BST CATEGORY: Travel
TOTAL NODES: 3
MAX HEIGHT: 2
HEIGHT LEFT: 0
HEIGHT RIGHT: 2

BST CATEGORY: Utilities
TOTAL NODES: 11
MAX HEIGHT: 5
HEIGHT LEFT: 5
HEIGHT RIGHT: 2

BST CATEGORY: Weather
TOTAL NODES: 4
MAX HEIGHT: 2
HEIGHT LEFT: 1
HEIGHT RIGHT: 2

hash[0]: [0 <= 0 <= 4]
hash[1]: [0 <= 0 <= 4]
hash[2]: [0 <= 0 <= 4]
hash[3]: [0 <= 0 <= 4]
hash[4]: [0 <= 0 <= 4]
hash[5]: [0 <= 0 <= 4]
hash[6]: [0 <= 0 <= 4]
hash[7]: [0 <= 0 <= 4]
hash[8]: ->Dunkin' Donuts [0 <= 1 <= 4]
hash[9]: [0 <= 0 <= 4]
hash[10]: [0 <= 0 <= 4]

hash[11]: [0 <= 0 <= 4]
hash[12]: [0 <= 0 <= 4]
hash[13]: [0 <= 0 <= 4]
hash[14]: ->The Weather Channel [0 <= 1 <= 4]
hash[15]: [0 <= 0 <= 4]
hash[16]: [0 <= 0 <= 4]
hash[17]: [0 <= 0 <= 4]
hash[18]: [0 <= 0 <= 4]
hash[19]: ->Fantastical 2 for iPhone [0 <= 1 <= 4]
hash[20]: ->ClassDojo [0 <= 1 <= 4]
hash[21]: ->BTN2Go ->WhatsApp Messenger [0 <= 2 <= 4]
hash[22]: [0 <= 0 <= 4]
hash[23]: [0 <= 0 <= 4]
hash[24]: [0 <= 0 <= 4]
hash[25]: [0 <= 0 <= 4]
hash[26]: ->Essential Anatomy 5 [0 <= 1 <= 4]
hash[27]: [0 <= 0 <= 4]
hash[28]: [0 <= 0 <= 4]
hash[29]: ->Gmail - email from Google [0 <= 1 <= 4]
hash[30]: ->Bank of America [0 <= 1 <= 4]
hash[31]: [0 <= 0 <= 4]
hash[32]: [0 <= 0 <= 4]
hash[33]: [0 <= 0 <= 4]
hash[34]: [0 <= 0 <= 4]
hash[35]: [0 <= 0 <= 4]
hash[36]: ->QR Reader for iPhone [0 <= 1 <= 4]
hash[37]: [0 <= 0 <= 4]
hash[38]: ->PhotoMath [0 <= 1 <= 4]
hash[39]: [0 <= 0 <= 4]
hash[40]: ->FanDuel: One Day Fantasy Sports Leagues [0 <= 1 <= 4]
hash[41]: [0 <= 0 <= 4]
hash[42]: [0 <= 0 <= 4]
hash[43]: [0 <= 0 <= 4]
hash[44]: ->iCatcher! Podcast Player [0 <= 1 <= 4]
hash[45]: ->Star Walk 2 [0 <= 1 <= 4]
hash[46]: ->Elmo Calls ->McDonald's [0 <= 2 <= 4]
hash[47]: [0 <= 0 <= 4]
hash[48]: [0 <= 0 <= 4]
hash[49]: [0 <= 0 <= 4]
hash[50]: ->Pocket God [0 <= 1 <= 4]
hash[51]: ->SoundCloud - Music & Audio [0 <= 1 <= 4]
hash[52]: [0 <= 0 <= 4]
hash[53]: ->Yahoo Mail [0 <= 1 <= 4]
hash[54]: ->HBO NOW [0 <= 1 <= 4]
hash[55]: ->Police Scanner+ Free [0 <= 1 <= 4]
hash[56]: ->Instagram [0 <= 1 <= 4]
hash[57]: [0 <= 0 <= 4]
hash[58]: [0 <= 0 <= 4]
hash[59]: ->Messenger [0 <= 1 <= 4]
hash[60]: ->Purify Blocker [0 <= 1 <= 4]
hash[61]: ->iTunes Connect [0 <= 1 <= 4]
hash[62]: ->myAT&T [0 <= 1 <= 4]
hash[63]: [0 <= 0 <= 4]
hash[64]: [0 <= 0 <= 4]

```
hash[65]: [0 <= 0 <= 4]
hash[66]: [0 <= 0 <= 4]
hash[67]: [0 <= 0 <= 4]
hash[68]: ->Starbucks [0 <= 1 <= 4]
hash[69]: [0 <= 0 <= 4]
hash[70]: [0 <= 0 <= 4]
hash[71]: [0 <= 0 <= 4]
hash[72]: [0 <= 0 <= 4]
hash[73]: [0 <= 0 <= 4]
hash[74]: [0 <= 0 <= 4]
hash[75]: [0 <= 0 <= 4]
hash[76]: ->Jo-Ann [0 <= 1 <= 4]
hash[77]: [0 <= 0 <= 4]
hash[78]: ->Univision Deportes ->Stylebook ->Adobe Acrobat Reader [0 <=
3 <= 4]
hash[79]: [0 <= 0 <= 4]
hash[80]: ->Pinterest ->Sleep Pillow Sounds [0 <= 2 <= 4]
hash[81]: ->National Geographic Magazine ->xTube [0 <= 2 <= 4]
hash[82]: [0 <= 0 <= 4]
hash[83]: ->Shazam - Discover music, artists, videos & lyrics [0 <= 1 <=
4]
hash[84]: ->Tollsmart [0 <= 1 <= 4]
hash[85]: [0 <= 0 <= 4]
hash[86]: [0 <= 0 <= 4]
hash[87]: [0 <= 0 <= 4]
hash[88]: ->Plague Inc. [0 <= 1 <= 4]
hash[89]: [0 <= 0 <= 4]
hash[90]: ->MotionX GPC [0 <= 1 <= 4]
hash[91]: [0 <= 0 <= 4]
hash[92]: [0 <= 0 <= 4]
hash[93]: ->Snap Upload for snapchat [0 <= 1 <= 4]
hash[94]: [0 <= 0 <= 4]
hash[95]: ->Boating USA [0 <= 1 <= 4]
hash[96]: ->TeamSpeak 3 [0 <= 1 <= 4]
hash[97]: ->Geekbench 3 ->Swype [0 <= 2 <= 4]
hash[98]: [0 <= 0 <= 4]
hash[99]: [0 <= 0 <= 4]
hash[100]: [0 <= 0 <= 4]
hash[101]: [0 <= 0 <= 4]
hash[102]: [0 <= 0 <= 4]
hash[103]: [0 <= 0 <= 4]
hash[104]: ->Transit Directions by Moovit [0 <= 1 <= 4]
hash[105]: ->Overcast: Podcast Player [0 <= 1 <= 4]
hash[106]: [0 <= 0 <= 4]
hash[107]: [0 <= 0 <= 4]
hash[108]: [0 <= 0 <= 4]
hash[109]: [0 <= 0 <= 4]
hash[110]: [0 <= 0 <= 4]
hash[111]: [0 <= 0 <= 4]
hash[112]: [0 <= 0 <= 4]
hash[113]: ->Psych! [0 <= 1 <= 4]
hash[114]: [0 <= 0 <= 4]
hash[115]: [0 <= 0 <= 4]
hash[116]: ->BillMinder [0 <= 1 <= 4]
```

```
hash[117]: ->Toca Hair Salon 2      [0 <= 1 <= 4]
hash[118]:      [0 <= 0 <= 4]
hash[119]:      [0 <= 0 <= 4]
hash[120]: ->Sago Mini Babies      [0 <= 1 <= 4]
hash[121]: ->Touch Surgery, Surgical Simulator ->Cosmopolitan Magazine US
            [0 <= 2 <= 4]
hash[122]: ->Geocaching ->PAW Patrol Rescue Run      [0 <= 2 <= 4]
hash[123]: ->Candy Crush Soda Saga      [0 <= 1 <= 4]
hash[124]: ->Wake Alarm Clock ->Baby Heartbeats      [0 <= 2 <= 4]
hash[125]:      [0 <= 0 <= 4]
hash[126]: ->City Maps 2Go Pro      [0 <= 1 <= 4]
hash[127]: ->EWallpaper      [0 <= 1 <= 4]
hash[128]: ->Sonic Dash 2      [0 <= 1 <= 4]
hash[129]: ->ThemeLocks ->YL Oils & Young Living Oils      [0 <= 2 <= 4]
hash[130]:      [0 <= 0 <= 4]
hash[131]:      [0 <= 0 <= 4]
hash[132]:      [0 <= 0 <= 4]
hash[133]:      [0 <= 0 <= 4]
hash[134]:      [0 <= 0 <= 4]
hash[135]:      [0 <= 0 <= 4]
hash[136]: ->Forbes Magazine      [0 <= 1 <= 4]
hash[137]:      [0 <= 0 <= 4]
hash[138]: ->DailyMVP: Daily Fantasy Sports      [0 <= 1 <= 4]
hash[139]:      [0 <= 0 <= 4]
hash[140]:      [0 <= 0 <= 4]
hash[141]:      [0 <= 0 <= 4]
hash[142]:      [0 <= 0 <= 4]
hash[143]:      [0 <= 0 <= 4]
hash[144]: ->PayPal      [0 <= 1 <= 4]
hash[145]:      [0 <= 0 <= 4]
hash[146]:      [0 <= 0 <= 4]
hash[147]:      [0 <= 0 <= 4]
hash[148]:      [0 <= 0 <= 4]
hash[149]:      [0 <= 0 <= 4]
hash[150]:      [0 <= 0 <= 4]
hash[151]: ->Pandora - Free Music & Radio      [0 <= 1 <= 4]
hash[152]: ->Flashlight ->Google Docs      [0 <= 2 <= 4]
hash[153]: ->hocus.      [0 <= 1 <= 4]
hash[154]: ->Scribblenauts Remix ->doTERRA      [0 <= 2 <= 4]
hash[155]:      [0 <= 0 <= 4]
hash[156]: ->Afterlight ->GoodRx      [0 <= 2 <= 4]
hash[157]:      [0 <= 0 <= 4]
hash[158]:      [0 <= 0 <= 4]
hash[159]: ->Ultimate Guitar Tabs      [0 <= 1 <= 4]
hash[160]: ->Google Maps      [0 <= 1 <= 4]
hash[161]: ->Fit Men Cook ->HomeBudget with Sync      [0 <= 2 <= 4]
hash[162]:      [0 <= 0 <= 4]
hash[163]:      [0 <= 0 <= 4]
hash[164]:      [0 <= 0 <= 4]
hash[165]:      [0 <= 0 <= 4]
hash[166]: ->Google      [0 <= 1 <= 4]
hash[167]: ->Chrome      [0 <= 1 <= 4]
hash[168]:      [0 <= 0 <= 4]
hash[169]:      [0 <= 0 <= 4]
```

```
hash[170]: ->Medium ->The Wonder Weeks [0 <= 2 <= 4]
hash[171]: ->Fitbit [0 <= 1 <= 4]
hash[172]: [0 <= 0 <= 4]
hash[173]: ->Project Color by The Home Depot [0 <= 1 <= 4]
hash[174]: [0 <= 0 <= 4]
hash[175]: ->Tinder [0 <= 1 <= 4]
hash[176]: ->Phone Tracker for iPhones [0 <= 1 <= 4]
hash[177]: ->Square Register [0 <= 1 <= 4]
hash[178]: ->Minecraft: Pocket Edition [0 <= 1 <= 4]
hash[179]: [0 <= 0 <= 4]
hash[180]: [0 <= 0 <= 4]
hash[181]: ->Rainbow Loom Pro [0 <= 1 <= 4]
hash[182]: [0 <= 0 <= 4]
hash[183]: [0 <= 0 <= 4]
hash[184]: [0 <= 0 <= 4]
hash[185]: ->GIF Keyboard [0 <= 1 <= 4]
hash[186]: ->Tiny Scanner Pro [0 <= 1 <= 4]
hash[187]: [0 <= 0 <= 4]
hash[188]: ->Follow Boss [0 <= 1 <= 4]
hash[189]: [0 <= 0 <= 4]
hash[190]: [0 <= 0 <= 4]
hash[191]: ->djay 2 for iPhone [0 <= 1 <= 4]
hash[192]: [0 <= 0 <= 4]
hash[193]: ->Mixologist [0 <= 1 <= 4]
hash[194]: ->College Football Radio & Live Scores! [0 <= 1 <= 4]
hash[195]: [0 <= 0 <= 4]
hash[196]: [0 <= 0 <= 4]
hash[197]: [0 <= 0 <= 4]
hash[198]: ->Stack the States [0 <= 1 <= 4]
hash[199]: ->Printer Pro [0 <= 1 <= 4]
hash[200]: [0 <= 0 <= 4]
hash[201]: [0 <= 0 <= 4]
hash[202]: [0 <= 0 <= 4]
hash[203]: [0 <= 0 <= 4]
hash[204]: ->Abby Lee Dance Secrets [0 <= 1 <= 4]
hash[205]: [0 <= 0 <= 4]
hash[206]: [0 <= 0 <= 4]
hash[207]: [0 <= 0 <= 4]
hash[208]: [0 <= 0 <= 4]
hash[209]: [0 <= 0 <= 4]
hash[210]: [0 <= 0 <= 4]
hash[211]: [0 <= 0 <= 4]
hash[212]: [0 <= 0 <= 4]
hash[213]: ->Sing! Karaoke by Smule ->Indeed Job Search [0 <= 2 <= 4]
hash[214]: [0 <= 0 <= 4]
hash[215]: [0 <= 0 <= 4]
hash[216]: [0 <= 0 <= 4]
hash[217]: ->PBS KIDS Video ->Balloons TD 5 [0 <= 2 <= 4]
hash[218]: [0 <= 0 <= 4]
hash[219]: [0 <= 0 <= 4]
hash[220]: [0 <= 0 <= 4]
hash[221]: [0 <= 0 <= 4]
hash[222]: ->AccuWeather [0 <= 1 <= 4]
hash[223]: [0 <= 0 <= 4]
```

hash[224]: ->FOX Sports GO [0 <= 1 <= 4]
hash[225]: [0 <= 0 <= 4]
hash[226]: ->Premium Music for Spotify [0 <= 1 <= 4]
hash[227]: ->1010! [0 <= 1 <= 4]
hash[228]: [0 <= 0 <= 4]
hash[229]: ->CNN App for iPhone [0 <= 1 <= 4]
hash[230]: ->MLB.com At Bat [0 <= 1 <= 4]
hash[231]: [0 <= 0 <= 4]
hash[232]: [0 <= 0 <= 4]
hash[233]: ->7-Eleven, Inc. [0 <= 1 <= 4]
hash[234]: [0 <= 0 <= 4]
hash[235]: [0 <= 0 <= 4]
hash[236]: [0 <= 0 <= 4]
hash[237]: [0 <= 0 <= 4]
hash[238]: ->Chase Mobile [0 <= 1 <= 4]
hash[239]: [0 <= 0 <= 4]
hash[240]: ->Monogram it! [0 <= 1 <= 4]
hash[241]: ->iTrans NYC Subway [0 <= 1 <= 4]
hash[242]: ->Reeder 2 ->NYTimes [0 <= 2 <= 4]
hash[243]: [0 <= 0 <= 4]
hash[244]: ->7 Minute Workout Challenge [0 <= 1 <= 4]
hash[245]: [0 <= 0 <= 4]
hash[246]: [0 <= 0 <= 4]
hash[247]: [0 <= 0 <= 4]
hash[248]: ->GrubHub [0 <= 1 <= 4]
hash[249]: [0 <= 0 <= 4]
hash[250]: ->Plane Finder [0 <= 1 <= 4]
hash[251]: [0 <= 0 <= 4]
hash[252]: [0 <= 0 <= 4]
hash[253]: ->Hype Machine [0 <= 1 <= 4]
hash[254]: [0 <= 0 <= 4]
hash[255]: [0 <= 0 <= 4]
hash[256]: [0 <= 0 <= 4]
hash[257]: ->MyChart ->DC Comics: Batman #1 [0 <= 2 <= 4]
hash[258]: [0 <= 0 <= 4]
hash[259]: ->SkyDroid - Golf GPS ->IronMobile - Ironman Athlete Tracker
[0 <= 2 <= 4]
hash[260]: [0 <= 0 <= 4]
hash[261]: ->Mad Libs [0 <= 1 <= 4]
hash[262]: ->Google Translate ->Ocarina [0 <= 2 <= 4]
hash[263]: ->Dataman Next [0 <= 1 <= 4]
hash[264]: ->Loopy HD [0 <= 1 <= 4]
hash[265]: ->Google Drive [0 <= 1 <= 4]
hash[266]: ->YouTube Kids ->TapeACallPro [0 <= 2 <= 4]
hash[267]: ->Google Classroom ->Scanner Pro by Readdle [0 <= 2 <= 4]
hash[268]: ->NOAA Radar Pro [0 <= 1 <= 4]
hash[269]: ->Zombies, Run! ->Bowling King [0 <= 2 <= 4]
hash[270]: [0 <= 0 <= 4]
hash[271]: [0 <= 0 <= 4]
hash[272]: ->Finished Results Live [0 <= 1 <= 4]
hash[273]: [0 <= 0 <= 4]
hash[274]: ->Weather Live ->Domino's Pizza USA [0 <= 2 <= 4]
hash[275]: [0 <= 0 <= 4]
hash[276]: [0 <= 0 <= 4]

```
hash[277]:          [0 <= 0 <= 4]
hash[278]: ->YouTube ->Pocket Casts          [0 <= 2 <= 4]
hash[279]:          [0 <= 0 <= 4]
hash[280]: ->IntelliDrink PRO - Blood Alcohol Content Calculator      [0 <=
1 <= 4]
hash[281]:          [0 <= 0 <= 4]
hash[282]:          [0 <= 0 <= 4]
hash[283]:          [0 <= 0 <= 4]
hash[284]: ->iHandy Translator Pro ->Color Splash      [0 <= 2 <= 4]
hash[285]:          [0 <= 0 <= 4]
hash[286]:          [0 <= 0 <= 4]
hash[287]:          [0 <= 0 <= 4]
hash[288]:          [0 <= 0 <= 4]
hash[289]: ->Full Fitness      [0 <= 1 <= 4]
hash[290]:          [0 <= 0 <= 4]
hash[291]: ->Netflix      [0 <= 1 <= 4]
hash[292]:          [0 <= 0 <= 4]
hash[293]:          [0 <= 0 <= 4]
hash[294]: ->My Verizon Mobile      [0 <= 1 <= 4]
hash[295]: ->Dropbox ->Colorfy      [0 <= 2 <= 4]
hash[296]:          [0 <= 0 <= 4]
hash[297]: ->Facebook Pages Manager      [0 <= 1 <= 4]
hash[298]: ->Billionaire.      [0 <= 1 <= 4]
hash[299]: ->Crystal      [0 <= 1 <= 4]
hash[300]: ->Forks Over Knives      [0 <= 1 <= 4]
hash[301]:          [0 <= 0 <= 4]
hash[302]: ->Superimpose      [0 <= 1 <= 4]
hash[303]:          [0 <= 0 <= 4]
hash[304]:          [0 <= 0 <= 4]
hash[305]:          [0 <= 0 <= 4]
hash[306]:          [0 <= 0 <= 4]
hash[307]: ->Fox News      [0 <= 1 <= 4]
hash[308]: ->Heads Up! ->Sherlock: Interactive Adventure      [0 <= 2 <= 4]
hash[309]:          [0 <= 0 <= 4]
hash[310]: ->ESPN ->iTunes U      [0 <= 2 <= 4]
hash[311]: ->Tattoo Fonts      [0 <= 1 <= 4]
hash[312]:          [0 <= 0 <= 4]
hash[313]:          [0 <= 0 <= 4]
hash[314]:          [0 <= 0 <= 4]
hash[315]:          [0 <= 0 <= 4]
hash[316]: ->Twitter      [0 <= 1 <= 4]
hash[317]:          [0 <= 0 <= 4]
hash[318]:          [0 <= 0 <= 4]
hash[319]: ->Paprika Recipe Manager      [0 <= 1 <= 4]
hash[320]: ->Tweetbot 4 for Twitter      [0 <= 1 <= 4]
hash[321]:          [0 <= 0 <= 4]
hash[322]:          [0 <= 0 <= 4]
hash[323]: ->Where's my MBTA Bus?      [0 <= 1 <= 4]
hash[324]: ->TED Books      [0 <= 1 <= 4]
hash[325]: ->Nike+ Running      [0 <= 1 <= 4]
hash[326]:          [0 <= 0 <= 4]
hash[327]: ->Stride & Prejudice      [0 <= 1 <= 4]
hash[328]:          [0 <= 0 <= 4]
hash[329]:          [0 <= 0 <= 4]
```

```
hash[330]: ->Game of Life Classic Edition      [0 <= 1 <= 4]
hash[331]:      [0 <= 0 <= 4]
hash[332]:      [0 <= 0 <= 4]
hash[333]:      [0 <= 0 <= 4]
hash[334]:      [0 <= 0 <= 4]
hash[335]:      [0 <= 0 <= 4]
hash[336]: ->WolframAlpha      [0 <= 1 <= 4]
hash[337]: ->Toca Kitchen 2    [0 <= 1 <= 4]
hash[338]:      [0 <= 0 <= 4]
hash[339]:      [0 <= 0 <= 4]
hash[340]: ->Wish - Shopping Made Fun      [0 <= 1 <= 4]
hash[341]:      [0 <= 0 <= 4]
hash[342]:      [0 <= 0 <= 4]
hash[343]:      [0 <= 0 <= 4]
hash[344]:      [0 <= 0 <= 4]
hash[345]:      [0 <= 0 <= 4]
hash[346]:      [0 <= 0 <= 4]
hash[347]:      [0 <= 0 <= 4]
hash[348]:      [0 <= 0 <= 4]
hash[349]: ->HotSchedules      [0 <= 1 <= 4]
hash[350]:      [0 <= 0 <= 4]
hash[351]:      [0 <= 0 <= 4]
hash[352]: ->Daily Craigslist Unlimited      [0 <= 1 <= 4]
hash[353]:      [0 <= 0 <= 4]
hash[354]:      [0 <= 0 <= 4]
hash[355]: ->Facebook      [0 <= 1 <= 4]
hash[356]:      [0 <= 0 <= 4]
hash[357]:      [0 <= 0 <= 4]
hash[358]:      [0 <= 0 <= 4]
hash[359]:      [0 <= 0 <= 4]
hash[360]: ->BuzzFeed      [0 <= 1 <= 4]
hash[361]:      [0 <= 0 <= 4]
hash[362]:      [0 <= 0 <= 4]
hash[363]: ->VIP Pool Party      [0 <= 1 <= 4]
hash[364]:      [0 <= 0 <= 4]
hash[365]:      [0 <= 0 <= 4]
hash[366]: ->Snagajob      [0 <= 1 <= 4]
hash[367]: ->Scout GPS Navigation, ETA, Maps & Traffic      [0 <= 1 <= 4]
hash[368]:      [0 <= 0 <= 4]
hash[369]:      [0 <= 0 <= 4]
hash[370]:      [0 <= 0 <= 4]
hash[371]:      [0 <= 0 <= 4]
hash[372]: ->Facetune      [0 <= 1 <= 4]
hash[373]:      [0 <= 0 <= 4]
hash[374]: ->WatchESPN ->Badoo Premium ->Sky Guide: View Stars Night or
Day ->Shopkins Magazine      [0 <= 4 <= 4]
hash[375]: ->Hair Color Dye      [0 <= 1 <= 4]
hash[376]:      [0 <= 0 <= 4]
hash[377]:      [0 <= 0 <= 4]
hash[378]:      [0 <= 0 <= 4]
hash[379]: ->Snapchat      [0 <= 1 <= 4]
hash[380]:      [0 <= 0 <= 4]
hash[381]: ->Akinator the Genie      [0 <= 1 <= 4]
hash[382]: ->PAUSE ->Geometry Dash      [0 <= 2 <= 4]
```

```
hash[383]:      [0 <= 0 <= 4]
hash[384]: ->Dubsmash  [0 <= 1 <= 4]
hash[385]: ->eBay      [0 <= 1 <= 4]
hash[386]:      [0 <= 0 <= 4]
hash[387]:      [0 <= 0 <= 4]
hash[388]: ->FIFA 16 Ultimate Team      [0 <= 1 <= 4]
hash[389]:      [0 <= 0 <= 4]
hash[390]: ->Fitness Buddy ->Sleep Cycle alarm clock ->Need for Speed
           [0 <= 3 <= 4]
hash[391]: ->The Wall Street Journal      [0 <= 1 <= 4]
hash[392]:      [0 <= 0 <= 4]
hash[393]:      [0 <= 0 <= 4]
hash[394]:      [0 <= 0 <= 4]
hash[395]:      [0 <= 0 <= 4]
hash[396]: ->Photo Plastic  [0 <= 1 <= 4]
hash[397]:      [0 <= 0 <= 4]
hash[398]: ->Uber          [0 <= 1 <= 4]
hash[399]:      [0 <= 0 <= 4]
hash[400]:      [0 <= 0 <= 4]
hash[401]: ->Sky Whale      [0 <= 1 <= 4]
hash[402]: ->Vine           [0 <= 1 <= 4]
hash[403]: ->What's On?     [0 <= 1 <= 4]
hash[404]:      [0 <= 0 <= 4]
hash[405]: ->iDownloads PLUS FREE ->The Walking Dead: No Man's Land [0 <=
2 <= 4]
hash[406]:      [0 <= 0 <= 4]
hash[407]:      [0 <= 0 <= 4]
hash[408]: ->Weird But True [0 <= 1 <= 4]
hash[409]:      [0 <= 0 <= 4]
hash[410]: ->Yelp           [0 <= 1 <= 4]
hash[411]:      [0 <= 0 <= 4]
hash[412]:      [0 <= 0 <= 4]
hash[413]:      [0 <= 0 <= 4]
hash[414]: ->Microsoft Outlook ->Hulu      [0 <= 2 <= 4]
hash[415]:      [0 <= 0 <= 4]
hash[416]: ->Skeletal Anatomy 3D [0 <= 1 <= 4]
hash[417]: ->Spotify Music ->Emoji 3 PRO      [0 <= 2 <= 4]
hash[418]:      [0 <= 0 <= 4]
hash[419]:      [0 <= 0 <= 4]
hash[420]:      [0 <= 0 <= 4]
hash[421]: ->PewDiePie ->Poems by Heart      [0 <= 2 <= 4]
hash[422]: ->Dude, your car! ->Jubitron the Girl Robot [0 <= 2 <= 4]
hash[423]:      [0 <= 0 <= 4]
hash[424]: ->Pizza Hut      [0 <= 1 <= 4]
hash[425]:      [0 <= 0 <= 4]
hash[426]:      [0 <= 0 <= 4]
hash[427]:      [0 <= 0 <= 4]
hash[428]: ->MapQuest: Free Navigation, GPC, Maps & Traffic ->Toca Life:
City [0 <= 2 <= 4]
hash[429]:      [0 <= 0 <= 4]
hash[430]: ->Al Gore -- Our Choice: A Plan to Solve the Climate Crisis
           [0 <= 1 <= 4]
hash[431]:      [0 <= 0 <= 4]
hash[432]: ->MealBoard      [0 <= 1 <= 4]
```



```
hash[433]:      [0 <= 0 <= 4]
hash[434]:      [0 <= 0 <= 4]
hash[435]: ->Smashy Road: Wanted  [0 <= 1 <= 4]
hash[436]:      [0 <= 0 <= 4]
hash[437]:      [0 <= 0 <= 4]
hash[438]:      [0 <= 0 <= 4]
APP AMOUNT = 217
```

```
TABLESIZE = 439
```

```
LOAD FACTOR = N/M = (APP AMOUNT)/(TABLE SIZE) = 0.49
MAX NODES = 4
```