**Actual Test Results:**

Data Array 1

001 004 008 014 017 024 029 031 041 044 046 048 054 055 060 064 067 068 073 074

077 078 082 083 088 092 103 116 125 127 128 131 132 134 138 142 144 146 147 148

151 175 179 180 181 194 205 206 209 211 232 235 242 265 267 273 279 291 296 311

313 315 318 325 330 335 338 342 343 356 360 370 372 373 376 386 387 390 394 410

417 423 431 442 450 453 456 461 465 467 471 477 481 482 484 489 490 497 498 501

Data Array 2

000 001 003 004 006 013 014 019 026 029 030 031 032 034 039 040 044 049 050 055

058 066 068 070 075 079 081 083 087 092 101 104 111 114 117 118 119 120 123 124

125 126 128 133 135 138 142 152 153 154 155 159 160 162 164 165 166 167 173 174

175 177 179 180 181 183 184 186 187 190 192 194 195 196 204 206 207 209 210 211

213 214 221 223 232 236 238 239 243 247 252 254 255 256 259 261 263 265 266 267

270 272 274 276 278 281 282 283 289 295 298 305 306 307 312 313 315 316 317 319

322 323 326 327 329 331 333 335 339 345 346 347 352 357 358 360 363 364 372 373

374 378 380 384 385 387 390 391 392 396 398 401 402 403 406 409 411 412 414 417

418 423 424 428 431 433 434 435 436 438 440 443 444 445 446 449 450 451 453 454

455 457 460 463 468 469 471 474 477 478 480 487 488 489 493 496 497 500 503 504

508 509 510 521 522 530 535 545 547 549 550 551 560 561 562 564 565 568 569 571

574 575 577 585 592 594 595 596 602 603 607 612 613 614 615 622 624 625 627 631

633 636 637 641 645 646 648 654 655 660 661 667 668 675 678 679 685 691 692 693

696 697 700 708 709 714 717 718 722 724 729 730 738 739 741 742 746 748 750 751

755 759 760 762 767 769 770 772 773 775 776 778 780 787 792 797 804 805 807 808

819 822 823 826 828 831 840 844 851 855 857 858 859 861 864 865 871 873 874 875

882 883 886 888 890 891 894 897 911 913 914 916 923 924 928 929 934 935 937 938

939 942 943 953 954 956 957 961 962 965 966 967 971 976 977 978 988 992 995 1,004

1,009 1,010 1,012 1,019 1,025 1,029 1,032 1,035 1,036 1,038 1,044 1,046 1,047 1,048 1,052 1,056 1,058 1,062 1,065 1,067

1,068 1,069 1,071 1,073 1,076 1,082 1,085 1,086 1,087 1,089 1,090 1,092 1,093 1,095 1,099 1,100 1,101 1,102 1,103 1,105

1,108 1,109 1,112 1,113 1,114 1,116 1,121 1,122 1,125 1,127 1,129 1,131 1,132 1,136 1,137 1,140 1,141 1,143 1,150 1,151

1,152 1,154 1,156 1,157 1,158 1,160 1,162 1,167 1,170 1,171 1,173 1,174 1,177 1,178 1,182 1,184 1,189 1,193 1,194 1,195

1,200 1,202 1,207 1,209 1,211 1,215 1,217 1,218 1,221 1,222 1,223 1,231 1,235 1,239 1,249 1,250 1,251 1,252 1,256 1,263

1,268 1,269 1,270 1,271 1,275 1,281 1,282 1,283 1,285 1,286 1,288 1,289 1,290 1,292 1,297 1,298 1,299 1,305 1,315 1,318

1,324 1,326 1,327 1,328 1,329 1,330 1,331 1,334 1,338 1,339 1,340 1,341 1,344 1,345 1,346 1,349 1,350 1,352 1,355 1,365

1,368 1,369 1,371 1,372 1,373 1,374 1,377 1,378 1,379 1,385 1,386 1,388 1,391 1,394 1,399 1,400 1,403 1,405 1,407 1,414

1,415 1,418 1,421 1,428 1,429 1,430 1,431 1,435 1,436 1,437 1,438 1,440 1,441 1,442 1,443 1,445 1,446 1,448 1,449 1,450

1,451 1,456 1,458 1,459 1,461 1,464 1,468 1,469 1,470 1,472 1,474 1,478 1,482 1,485 1,486 1,491 1,493 1,495 1,496 1,499

1,500 1,501 1,502 1,504 1,506 1,508 1,510 1,513 1,516 1,518 1,519 1,521 1,525 1,528 1,535 1,536 1,537 1,538 1,539 1,540

1,549 1,550 1,551 1,554 1,555 1,560 1,564 1,567 1,569 1,570 1,571 1,574 1,577 1,581 1,585 1,587 1,590 1,591 1,592 1,594

1,595 1,596 1,600 1,601 1,605 1,607 1,616 1,618 1,619 1,626 1,627 1,628 1,633 1,635 1,639 1,640 1,645 1,646 1,647 1,648

1,651 1,657 1,658 1,663 1,665 1,675 1,676 1,678 1,681 1,682 1,684 1,686 1,687 1,688 1,690 1,692 1,695 1,698 1,701 1,703

1,706 1,707 1,708 1,710 1,711 1,715 1,719 1,722 1,725 1,726 1,731 1,732 1,734 1,736 1,738 1,739 1,740 1,741 1,742 1,745

1,747 1,748 1,753 1,754 1,755 1,757 1,759 1,761 1,762 1,763 1,765 1,766 1,773 1,774 1,776 1,779 1,785 1,793 1,800 1,802

1,804 1,808 1,809 1,810 1,812 1,813 1,814 1,816 1,823 1,824 1,825 1,826 1,828 1,830 1,831 1,835 1,838 1,839 1,843 1,846

1,847 1,852 1,863 1,866 1,867 1,868 1,872 1,873 1,876 1,877 1,878 1,879 1,880 1,882 1,885 1,887 1,889 1,890 1,897 1,905

1,907 1,911 1,912 1,915 1,918 1,922 1,931 1,936 1,940 1,941 1,943 1,944 1,946 1,947 1,951 1,958 1,959 1,963 1,964 1,968

1,970 1,973 1,974 1,975 1,981 1,985 1,987 1,990 1,991 1,992 1,994 1,995 1,998 2,001 2,002 2,004 2,005 2,013 2,020 2,026

2,027 2,029 2,030 2,031 2,033 2,042 2,043 2,047 2,051 2,052 2,053 2,057 2,059 2,062 2,065 2,069 2,070 2,071 2,072 2,076

2,077 2,078 2,080 2,082 2,088 2,092 2,093 2,096 2,097 2,101 2,102 2,104 2,106 2,112 2,114 2,115 2,116 2,117 2,123 2,124

2,126 2,128 2,129 2,133 2,139 2,140 2,142 2,148 2,153 2,154 2,157 2,160 2,162 2,167 2,171 2,175 2,178 2,191 2,196 2,197

2,198 2,199 2,205 2,209 2,211 2,212 2,215 2,216 2,220 2,222 2,223 2,224 2,227 2,228 2,229 2,231 2,234 2,247 2,248 2,250

2,251 2,252 2,255 2,256 2,259 2,262 2,263 2,266 2,271 2,272 2,287 2,288 2,291 2,292 2,294 2,297 2,299 2,304 2,305 2,310

2,313 2,315 2,322 2,323 2,324 2,327 2,330 2,331 2,333 2,335 2,339 2,342 2,348 2,350 2,352 2,354 2,355 2,357 2,358 2,359

2,360 2,362 2,365 2,375 2,377 2,380 2,382 2,383 2,388 2,391 2,394 2,395 2,397 2,398 2,399 2,401 2,409 2,410 2,412 2,414

2,415 2,416 2,418 2,419 2,422 2,423 2,424 2,428 2,432 2,440 2,441 2,443 2,449 2,450 2,453 2,457 2,459 2,461 2,464 2,467

2,469 2,470 2,471 2,477 2,483 2,493 2,494 2,495 2,497 2,499 2,500 2,502 2,505 2,507 2,508 2,510 2,513 2,515 2,519 2,521

2,522 2,527 2,529 2,534 2,535 2,536 2,537 2,538 2,545 2,553 2,554 2,557 2,558 2,560 2,562 2,570 2,574 2,575 2,580 2,581

2,582 2,590 2,593 2,597 2,600 2,601 2,602 2,608 2,610 2,617 2,623 2,624 2,625 2,631 2,634 2,635 2,636 2,638 2,647 2,650

2,653 2,655 2,656 2,657 2,658 2,659 2,661 2,664 2,665 2,668 2,670 2,673 2,678 2,680 2,681 2,682 2,688 2,693 2,694 2,695

Hash Array of size 151

151 001 453 456 004 -001 -001 -001 008 311 461 313 465 315 014 467 318 017 471 -001

-001 -001 -001 325 024 175 477 -001 179 029 180 031 181 330 335 481 338 482 484 489

342 041 343 194 044 490 046 497 048 498 501 -001 -001 -001 054 055 205 206 209 356

060 211 360 -001 064 -001 -001 067 068 370 372 373 -001 073 074 376 -001 077 078 -001

-001 232 082 083 235 386 387 -001 088 390 -001 242 092 394 -001 -001 -001 -001 -001 -001

-001 -001 -001 103 -001 -001 -001 -001 410 -001 -001 -001 -001 -001 265 417 116 267 -001 -001

-001 423 273 -001 -001 125 -001 127 128 279 431 131 132 -001 134 -001 -001 -001 138 -001

291 442 142 -001 144 296 146 147 148 450 -001

Hash Array of size 1499

000 001 1,499 003 004 1,500 006 1,501 1,502 1,504 1,506 1,508 1,510 013 014 1,513 -001 1,516 -001 019

1,518 1,519 1,521 -001 -001 -001 026 1,525 -001 029 030 031 032 1,528 034 -001 1,535 1,536 1,537 039

040 1,538 1,539 1,540 044 -001 -001 -001 -001 049 050 1,549 1,550 1,551 -001 055 1,554 1,555 058 -001

-001 1,560 -001 -001 -001 1,564 066 -001 068 1,567 070 1,569 1,570 1,571 -001 075 1,574 -001 1,577 079

-001 081 1,581 083 -001 -001 1,585 087 1,587 -001 -001 1,590 092 1,591 1,592 1,594 1,595 1,596 -001 -001

-001 101 1,600 1,601 104 -001 1,605 -001 1,607 -001 -001 111 -001 -001 114 -001 -001 117 118 119

120 1,616 1,618 123 124 125 126 1,619 128 1,626 1,627 1,628 -001 133 1,633 135 1,635 -001 138 -001

1,639 1,640 142 -001 -001 -001 1,645 1,646 1,647 1,648 -001 -001 152 153 154 155 1,651 -001 1,657 159

160 1,658 162 -001 164 165 166 167 1,663 1,665 -001 -001 -001 173 174 175 1,675 177 1,676 179

180 181 1,678 183 184 1,681 186 187 1,682 1,684 190 1,686 192 1,687 194 195 196 1,688 1,690 1,692

1,695 1,698 1,701 -001 204 1,703 206 207 1,706 209 210 211 1,707 213 214 1,708 1,710 1,711 1,715 -001

1,719 221 -001 223 1,722 -001 1,725 1,726 -001 -001 -001 -001 232 1,731 1,732 1,734 236 1,736 238 239

1,738 1,739 1,740 243 1,741 1,742 1,745 247 1,747 1,748 -001 -001 252 -001 254 255 256 1,753 1,754 259

1,755 261 1,757 263 1,759 265 266 267 1,761 1,762 270 1,763 272 1,765 274 1,766 276 1,773 278 1,774

1,776 281 282 283 1,779 -001 1,785 -001 -001 289 -001 -001 -001 -001 1,793 295 -001 -001 298 -001

-001 1,800 -001 1,802 -001 305 306 307 1,804 1,808 1,809 1,810 312 313 1,812 315 316 317 1,813 319

1,814 1,816 322 323 1,823 1,824 326 327 1,825 329 1,826 331 1,828 333 1,830 335 1,831 1,835 -001 339

1,838 1,839 -001 -001 1,843 345 346 347 1,846 1,847 -001 -001 352 1,852 -001 -001 -001 357 358 -001

360 -001 -001 363 364 1,863 -001 1,866 1,867 1,868 -001 -001 372 373 374 1,872 1,873 1,876 378 1,877

380 1,878 1,879 1,880 384 385 1,882 387 1,885 1,887 390 391 392 1,889 1,890 -001 396 -001 398 1,897

-001 401 402 403 -001 -001 406 1,905 1,907 409 -001 411 412 1,911 414 1,912 1,915 417 418 1,918

-001 -001 -001 423 424 1,922 -001 -001 428 -001 -001 431 1,931 433 434 435 436 1,936 438 -001

440 1,940 1,941 443 444 445 446 1,943 1,944 449 450 451 1,946 453 454 455 1,947 457 1,951 1,958

460 1,959 -001 463 1,963 1,964 -001 -001 468 469 1,968 471 1,970 -001 474 1,973 1,974 477 478 1,975

480 -001 1,981 -001 -001 -001 1,985 487 488 489 1,987 1,990 1,991 493 1,992 1,994 496 497 1,995 1,998

500 -001 2,001 503 504 2,002 2,004 2,005 508 509 510 -001 -001 -001 2,013 -001 -001 -001 -001 -001

-001 521 522 2,020 -001 -001 -001 2,026 2,027 -001 530 2,029 2,030 2,031 2,033 535 -001 -001 -001 -001

-001 -001 -001 2,042 2,043 545 -001 547 2,047 549 550 551 2,051 2,052 2,053 -001 -001 -001 2,057 -001

560 561 562 2,059 564 565 2,062 2,065 568 569 2,069 571 2,070 2,071 574 575 2,072 577 2,076 2,077

2,078 2,080 -001 2,082 -001 585 -001 -001 -001 2,088 -001 -001 592 2,092 594 595 596 2,093 2,096 2,097

-001 -001 602 603 2,101 2,102 2,104 607 2,106 -001 -001 -001 612 613 614 615 2,112 2,114 2,115 2,116

2,117 -001 622 -001 624 625 2,123 627 2,124 2,126 2,128 631 2,129 633 2,133 -001 636 637 -001 -001

2,139 641 2,140 2,142 -001 645 646 -001 648 2,148 -001 -001 -001 -001 654 655 2,153 2,154 2,157 -001

660 661 2,160 2,162 -001 -001 -001 667 668 2,167 -001 -001 2,171 -001 -001 675 2,175 -001 678 679

2,178 -001 -001 -001 -001 685 -001 -001 -001 -001 -001 691 692 693 2,191 -001 696 697 2,196 2,197

700 2,198 2,199 -001 -001 -001 2,205 -001 708 709 2,209 -001 2,211 2,212 714 -001 2,215 717 718 2,216

-001 2,220 722 2,222 724 2,223 2,224 -001 2,227 729 730 2,228 2,229 2,231 -001 2,234 -001 -001 738 739

-001 741 742 -001 -001 -001 746 -001 748 2,247 750 751 2,248 2,250 2,251 755 2,252 2,255 2,256 759

760 2,259 762 2,262 2,263 -001 -001 767 2,266 769 770 -001 772 773 2,271 775 776 2,272 778 -001

780 -001 -001 -001 -001 -001 -001 787 2,287 2,288 -001 -001 792 2,291 2,292 2,294 -001 797 2,297 -001

2,299 -001 -001 -001 804 805 2,304 807 808 2,305 -001 2,310 -001 -001 2,313 -001 2,315 -001 -001 819

-001 -001 822 823 2,322 2,323 826 2,324 828 2,327 -001 831 2,330 2,331 2,333 -001 2,335 -001 -001 -001

840 2,339 -001 2,342 844 -001 -001 -001 -001 2,348 -001 851 2,350 2,352 -001 855 2,354 857 858 859

2,355 861 2,357 2,358 864 865 2,359 2,360 2,362 2,365 -001 871 -001 873 874 875 2,375 -001 2,377 -001

-001 2,380 882 883 2,382 2,383 886 -001 888 2,388 890 891 2,391 -001 894 2,394 2,395 897 2,397 2,398

2,399 -001 2,401 -001 -001 -001 -001 -001 -001 -001 2,409 911 2,410 913 914 2,412 916 2,414 2,415 2,416

2,418 2,419 -001 923 924 2,422 2,423 2,424 928 929 2,428 -001 -001 2,432 934 935 -001 937 938 939

-001 2,440 942 943 2,441 2,443 -001 -001 -001 -001 2,449 2,450 -001 953 954 2,453 956 957 2,457 -001

2,459 961 962 2,461 -001 965 966 967 2,464 2,467 2,469 971 2,470 2,471 -001 -001 976 977 978 2,477

-001 -001 -001 -001 2,483 -001 -001 -001 988 -001 -001 -001 992 -001 2,493 995 2,494 2,495 2,497 -001

2,499 2,500 -001 2,502 1,004 -001 2,505 -001 2,507 1,009 1,010 2,508 1,012 2,510 2,513 -001 2,515 -001 -001 1,019

2,519 -001 2,521 2,522 -001 1,025 -001 -001 2,527 1,029 2,529 -001 1,032 -001 -001 1,035 1,036 2,534 1,038 2,535

2,536 2,537 2,538 -001 1,044 -001 1,046 1,047 1,048 2,545 -001 -001 1,052 -001 2,553 2,554 1,056 -001 1,058 2,557

2,558 2,560 1,062 2,562 -001 1,065 -001 1,067 1,068 1,069 -001 1,071 2,570 1,073 -001 2,574 1,076 2,575 -001 -001

-001 2,580 1,082 2,581 2,582 1,085 1,086 1,087 -001 1,089 1,090 2,590 1,092 1,093 2,593 1,095 -001 -001 2,597 1,099

1,100 1,101 1,102 1,103 2,600 1,105 2,601 2,602 1,108 1,109 2,608 2,610 1,112 1,113 1,114 -001 1,116 -001 2,617 -001

-001 1,121 1,122 -001 2,623 1,125 2,624 1,127 2,625 1,129 -001 1,131 1,132 2,631 -001 2,634 1,136 1,137 2,635 2,636

1,140 1,141 2,638 1,143 -001 -001 -001 -001 2,647 -001 1,150 1,151 1,152 2,650 1,154 2,653 1,156 1,157 1,158 2,655

1,160 2,656 1,162 2,657 2,658 2,659 2,661 1,167 2,664 2,665 1,170 1,171 2,668 1,173 1,174 2,670 2,673 1,177 1,178 2,678

-001 2,680 1,182 2,681 1,184 2,682 -001 -001 -001 1,189 2,688 -001 -001 1,193 1,194 1,195 2,693 2,694 2,695 -001

1,200 -001 1,202 -001 -001 -001 -001 1,207 -001 1,209 -001 1,211 -001 -001 -001 1,215 -001 1,217 1,218 -001

-001 1,221 1,222 1,223 -001 -001 -001 -001 -001 -001 -001 1,231 -001 -001 -001 1,235 -001 -001 -001 1,239

-001 -001 -001 -001 -001 -001 -001 -001 -001 1,249 1,250 1,251 1,252 -001 -001 -001 1,256 -001 -001 -001

-001 -001 -001 1,263 -001 -001 -001 -001 1,268 1,269 1,270 1,271 -001 -001 -001 1,275 -001 -001 -001 -001

-001 1,281 1,282 1,283 -001 1,285 1,286 -001 1,288 1,289 1,290 -001 1,292 -001 -001 -001 -001 1,297 1,298 1,299

-001 -001 -001 -001 -001 1,305 -001 -001 -001 -001 -001 -001 -001 -001 -001 1,315 -001 -001 1,318 -001

-001 -001 -001 -001 1,324 -001 1,326 1,327 1,328 1,329 1,330 1,331 -001 -001 1,334 -001 -001 -001 1,338 1,339

1,340 1,341 -001 -001 1,344 1,345 1,346 -001 -001 1,349 1,350 -001 1,352 -001 -001 1,355 -001 -001 -001 -001

-001 -001 -001 -001 -001 1,365 -001 -001 1,368 1,369 -001 1,371 1,372 1,373 1,374 -001 -001 1,377 1,378 1,379

-001 -001 -001 -001 -001 1,385 1,386 -001 1,388 -001 -001 1,391 -001 -001 1,394 -001 -001 -001 -001 1,399

1,400 -001 -001 1,403 -001 1,405 -001 1,407 -001 -001 -001 -001 -001 -001 1,414 1,415 -001 -001 1,418 -001

-001 1,421 -001 -001 -001 -001 -001 -001 1,428 1,429 1,430 1,431 -001 -001 -001 1,435 1,436 1,437 1,438 -001

1,440 1,441 1,442 1,443 -001 1,445 1,446 -001 1,448 1,449 1,450 1,451 -001 -001 -001 -001 1,456 -001 1,458 1,459

-001 1,461 -001 -001 1,464 -001 -001 -001 1,468 1,469 1,470 -001 1,472 -001 1,474 -001 -001 -001 1,478 -001

-001 -001 1,482 -001 -001 1,485 1,486 -001 -001 -001 -001 1,491 -001 1,493 -001 1,495 1,496 -001 -001

Sequential Search 1:

Position of the element 18 is:-1

Position of the element 69 is:-1

Position of the element 201 is:-1

Position of the element 331 is:-1

Position of the element 429 is:-1

Position of the element 17 is:4

Position of the element 67 is:16

Position of the element 209 is:48

Position of the element 372 is:72

Position of the element 498 is:98

Average number of comparisons for Sequential search: 92

Binary Search 1:

Position of the element 18 is:-1

Position of the element 69 is:-1

Position of the element 201 is:-1

Position of the element 331 is:-1

Position of the element 429 is:-1

Position of the element 17 is:4

Position of the element 67 is:16

Position of the element 209 is:48

Position of the element 372 is:72

Position of the element 498 is:98

Average number of comparisons for Binary search: 19

Hash Search 1:

Position of the element 18 is:-1

Position of the element 69 is:-1

Position of the element 201 is:-1

Position of the element 331 is:-1

Position of the element 492 is:-1

Position of the element 17 is:17

Position of the element 67 is:67

Position of the element 209 is:58

Position of the element 372 is:70

Position of the element 498 is:49

Average number of comparisons for Hash search: 13

Sequential Search 2:

Position of the element 20 is:-1

Position of the element 832 is:-1

Position of the element 1452 is:-1

Position of the element 1937 is:-1

Position of the element 2615 is:-1

Position of the element 87 is:28

Position of the element 851 is:308

Position of the element 1350 is:496

Position of the element 1990 is:747

Position of the element 2631 is:973

Average number of comparisons for Sequential search: 1022

Binary Search 2:

Position of the element 20 is:-1

Position of the element 832 is:-1

Position of the element 1452 is:-1

Position of the element 1937 is:-1

Position of the element 2615 is:-1

Position of the element 87 is:28

Position of the element 851 is:308

Position of the element 1350 is:496

Position of the element 1990 is:747

Position of the element 2631 is:973

Average number of comparisons for Binary search: 29

Hash Search 2:

Position of the element 20 is:-1

Position of the element 832 is:-1

Position of the element 1452 is:-1

Position of the element 1937 is:-1

Position of the element 2615 is:-1

Position of the element 87 is:87

Position of the element 851 is:851

Position of the element 1350 is:1350

Position of the element 1990 is:491

Position of the element 2631 is:1133

Average number of comparisons for Hash search: 4

Six Statements:

1. As the size of the data array increases Hash search becomes more efficient. This is visible when we compare the average number of comparisons for search 1 which was 13 to the average number of comparisons for search 2 to be 4. I attribute this to the larger array size meaning more values Hash to their position immediately and there is less of a need for linear probing.
2. For Smaller arrays the difference in average number of comparisons between Binary search and Hash search increases from 6 comparisons to 23 comparisons. I have determined this increase due to the fact that for Binary search the number of comparisons increases from search 1 to search 2 but this is the opposite for Hash search.
3. Sequential search increases in inefficiency as the array size also increases. For search 1 sequential search took on average 92, this number increases to 1022 for larger arrays in search 2. The algorithm is doing more work as it moves through the array 1 element at a time and is very costly
4. For Hash search a check had to be added to see if an element at a certain index was -1. This shows that the element being searched for is not in the array because it would have been linearly probed so the search would not reach a -1.
5. Binary Search is very efficient for both small and larger arrays. The number of average comparisons only increase by 10 from 19 to 29 over the two searches respectively. This is significant because the divide and conquer nature of binary search allows the size of the array to become insignificant.
6. For this specific problem I think Hash search is the best algorithm as it increases in efficiency and performance as the array size increases. Binary search is very consistent across the two sets of data but with Hash search when there are few key collisions and empty locations it can find elements the quickest.