Assignment 2

Problems identified by x.y(z) denote the problem “y”, in chapter “x” of the textbook, with part “z”. If “z” is not noted, then the entire problem is required.

Assignment 2a
- 2.5(a, c, e) Use the master theorem, show work.
- Solve recurrence relation $T(n) = 2T(n/3) + n$. Use the master theorem, show work.

Assignment 2b
- 2.5(b, d) Use the master theorem, show comparison.
- Solve recurrence relation $T(n) = 8T(n/3) + n^2$. Use the master theorem, show work.
- 2.5(g) Use the substitution method. Show the pattern and determination of $k_{\text{max}}$.

Assignment 2c
- 2.5(f, h) Use the substitution method. Show the pattern and determination of $k_{\text{max}}$.
- 2.16 Find an algorithm, give pseudo-code, argue correctness, analyze the runtime, showing it is $O(\log(n))$. The values stored are integers, not necessarily positive. Hint: You should know how to find items in a sorted array in $O(\log(n))$.
- Write the function `unsigned int binary_search( const std::vector<int> &data, int value )`. Verify that the function will correctly find the index of `value` within `data`. You may assume that `value` is present, and `data` is already sorted in ascending order. At the top of your source, include a comment with your estimated Big-Oh complexity of the algorithm.

Assignment 2d
- 2.5(i, j) Use the substitution method. Show the pattern and determination of $k_{\text{max}}$.
- 2.19 Analyze the complexity of the algorithm for part (a). Provide your divide and conquer solution and its complexity analysis for part (b).
- Write the function `unsigned int ternary_search( const std::vector<int> &data, int value )`. Verify that the function will correctly find the index of `value` within `data`. You may assume that `value` is present, and `data` is already sorted in ascending order. At the top of your source, include a comment with your estimated Big-Oh complexity of the algorithm. `ternary_search` divides its input array into 3 equally sized groups, in the same way that `binary_search` divides into 2 equally sized groups.

Assignment 2e
- 2.5(k) Use the substitution method. Show the pattern and determination of $k_{\text{max}}$.
- 2.22 Find an algorithm, give pseudo-code, argue correctness, analyze the runtime, showing it is $O(\log(m) + \log(n))$.
- If one algorithm is $O(\log(m+n))$, another is $O(\log(m) + \log(n))$, which is more efficient? Give your proof.
- Time `binary_search` and `ternary_search` on vectors of sizes $2^0$, $2^1$, ..., $2^{30}$. Be sure to do correct statistical data collection. Submit a table of the data collected, and declaration of which appears to be faster.

Assignment 2f
- 2.14 Find a divide-and-conquer algorithm, write the recurrence relation, solve it.
- 2.34 Find a divide-and-conquer algorithm, write the recurrence relation, solve it. The book says “linear”. We are not as optimistic. Any polynomial divide-and-conquer algorithm is acceptable.
- Chart the normalized runtimes of `binary_search` and `ternary_search`, along with $N^{1/2}$, $N^{1/3}$, LOG_2(N), LOG_3(N) and 1. Submit the chart, and a statement discussing which algorithm has better Big-Oh, and which algorithm is faster.

Assignment 2z, Due Never (optional)
- 2.4(A) Write down the recurrence relation. Solve it.
- 2.4(B) Write down the recurrence relation. Solve it.
- 2.4(part C) Write down the recurrence relation. Solve it.
- 2.4 Which would you choose?
• 2.25(a) Fill in the missing code, give a recurrence relation, and solve it.
• 2.25(b) Fill in the missing code, give a recurrence relation, and solve it.
• 2.17 Find an algorithm, prove the runtime is \( O(\log(n)) \).

Submission

• Submit your solutions by the due date and time. For written problems, your work and answers as a PDF. For code, submit the source code. For tables and graphs, submit a PDF.