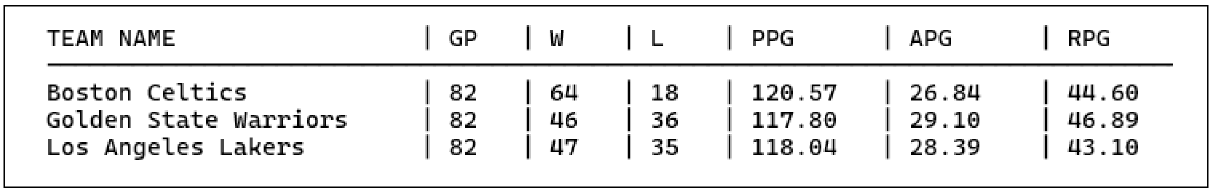
MODUL 3

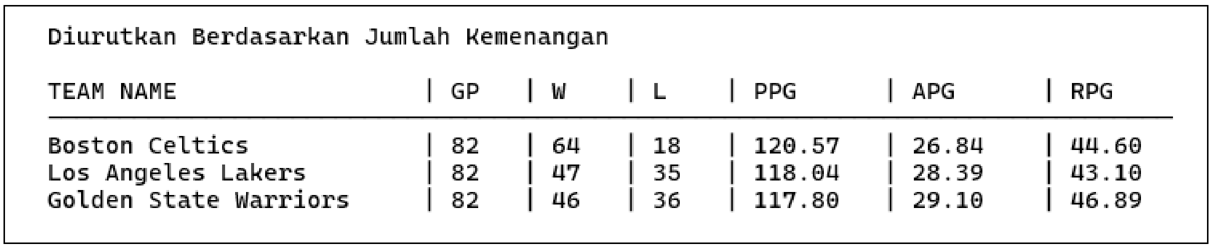
HARD

Roman is a sports analyst.He works collecting NBA player data and drawing conclusions from that data. On his first day of work, he was given data on 3 NBA teams.



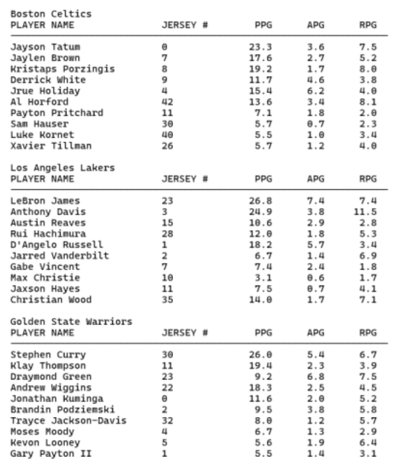
```
TEAM NAME                  | GP   | W    | L    | PPG       | APG       | RPG
──────────────────────────────────────────────────────────────────────────────

Boston Celtics             | 82   | 64   | 18   | 120.57    | 26.84     | 44.60
Golden State Warriors      | 82   | 46   | 36   | 117.80    | 29.10     | 46.89
Los Angeles Lakers         | 82   | 47   | 35   | 118.04    | 28.39     | 43.10
```

Then, he was assigned to sort the teams. Roman felt that the task was too easy, so to add challenge, he used quicksort to sort them based on the number of team wins.



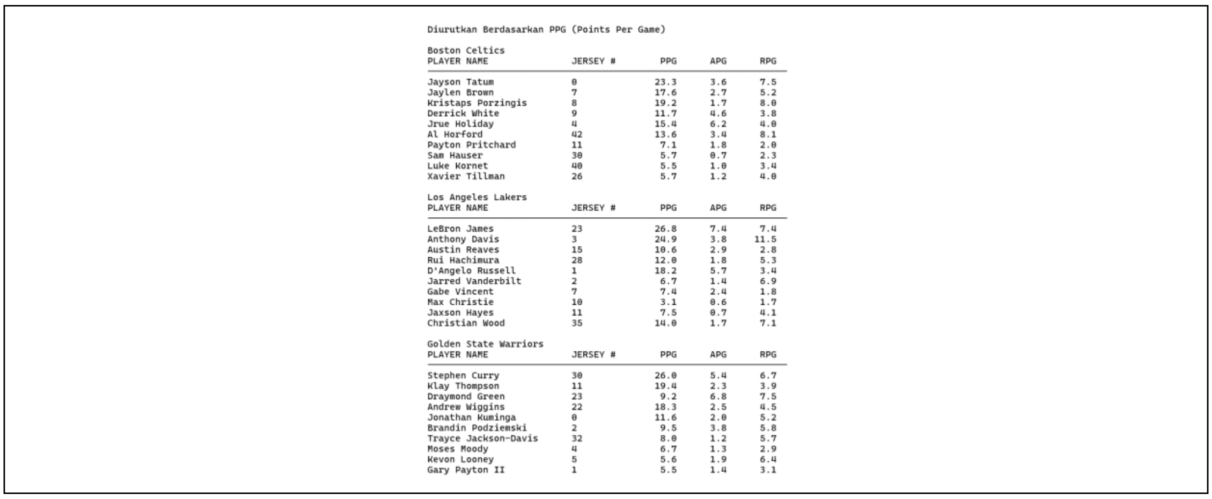
```
Diurutkan Berdasarkan Jumlah Kemenangan

TEAM NAME                  | GP   | W    | L    | PPG       | APG       | RPG
──────────────────────────────────────────────────────────────────────────────

Boston Celtics             | 82   | 64   | 18   | 120.57    | 26.84     | 44.60
Los Angeles Lakers         | 82   | 47   | 35   | 118.04    | 28.39     | 43.10
Golden State Warriors      | 82   | 46   | 36   | 117.80    | 29.10     | 46.89
```

Because the task he was doing was too easy, he asked for another task to work on. For the next task, he was given data on all the players from each team.



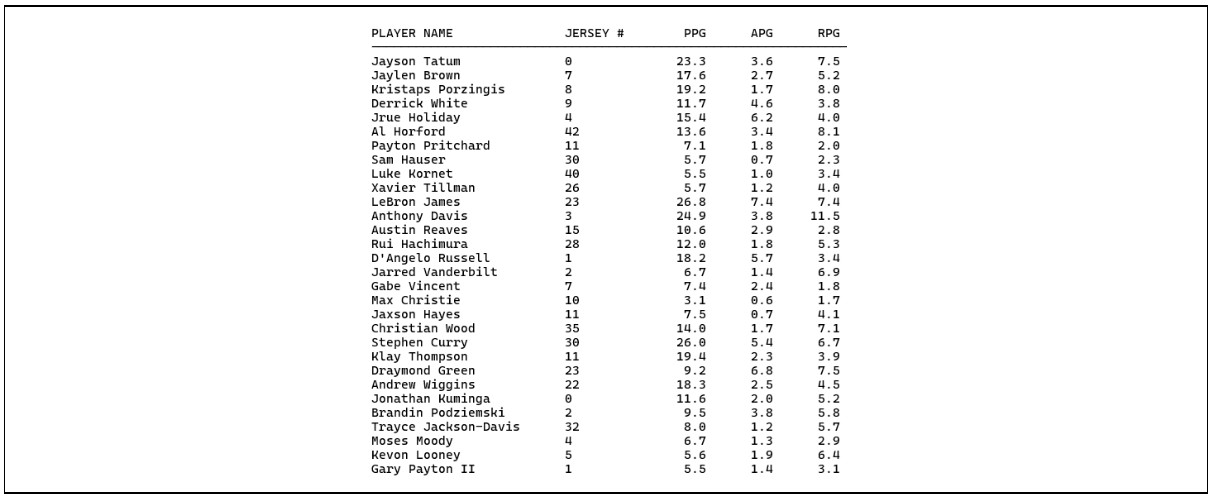
```
Boston Celtics
PLAYER NAME               JERSEY #         PPG      APG      RPG
─────────────────────────────────────────────────────────────────

Jayson Tatum              0               23.3      3.6      7.5
Jaylen Brown              7               17.6      2.7      5.2
Kristaps Porzingis        8               19.2      1.7      8.0
Derrick White             9               11.7      4.6      3.8
Jrue Holiday              4               15.4      6.2      4.0
Al Horford                42              13.6      3.4      8.1
Payton Pritchard          11               7.1      1.8      2.0
Sam Hauser                30               5.7      0.7      2.3
Luke Kornet               40               5.5      1.0      3.4
Xavier Tillman            26               5.7      1.2      4.0

Los Angeles Lakers
PLAYER NAME               JERSEY #         PPG      APG      RPG
─────────────────────────────────────────────────────────────────

LeBron James              23              26.8      7.4      7.4
Anthony Davis             3               24.9      3.8     11.5
Austin Reaves             15              10.6      2.9      2.8
Rui Hachimura             28              12.0      1.8      5.3
D'Angelo Russell          1               18.2      5.7      3.4
Jarred Vanderbilt         2                6.7      1.4      6.9
Gabe Vincent              7                7.4      2.4      1.8
Max Christie              10               3.1      0.6      1.7
Jaxson Hayes              11               7.5      0.7      4.1
Christian Wood            35              14.0      1.7      7.1

Golden State Warriors
PLAYER NAME               JERSEY #         PPG      APG      RPG
─────────────────────────────────────────────────────────────────

Stephen Curry             30              26.0      5.4      6.7
Klay Thompson             11              19.4      2.3      3.9
Draymond Green            23               9.2      6.8      7.5
Andrew Wiggins            22              18.3      2.5      4.5
Jonathan Kuminga          0               11.6      2.0      5.2
Brandin Podziemski        2                9.5      3.8      5.8
Trayce Jackson-Davis      32               8.0      1.2      5.7
Moses Moody               4                6.7      1.3      2.9
Kevon Looney              5                5.6      1.9      6.4
Gary Payton II            1                5.5      1.4      3.1
```

Roman was tasked with finding the NBA MVP candidate. Since the previous task was still too easy for Roman, he decided to use merge sort to sort all players from each team based on PPG (Points Per Game).



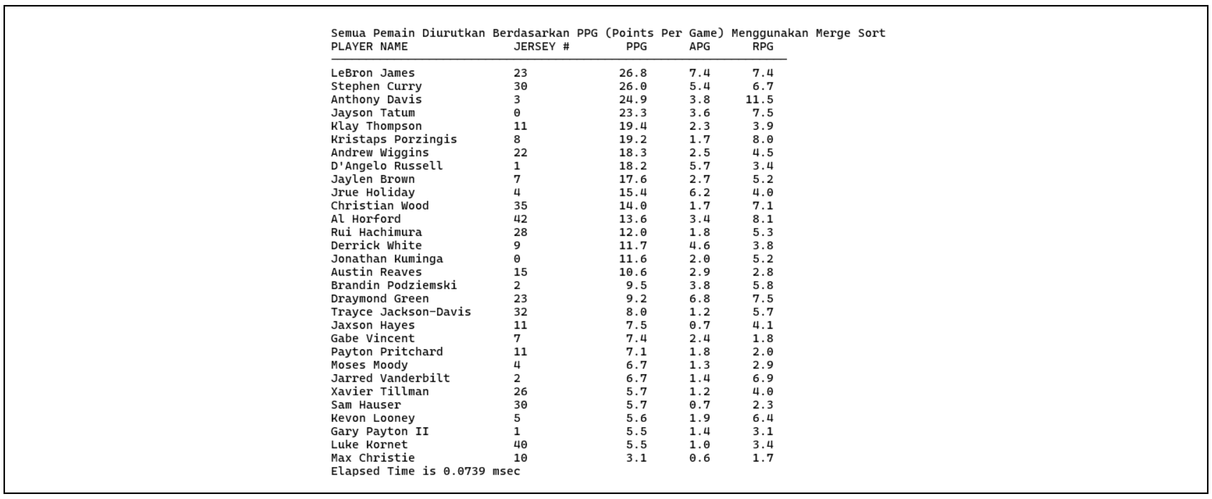
```
Diurutkan Berdasarkan PPG (Points Per Game)

Boston Celtics
PLAYER NAME               JERSEY #        PPG      APG      RPG
-----------------------------------------------------------------
Jayson Tatum              0              23.3      3.6      7.5
Jaylen Brown              7              17.6      2.7      5.2
Kristaps Porzingis        8              19.2      1.7      8.0
Derrick White             9              11.7      4.6      3.8
Jrue Holiday              4              15.4      6.2      4.0
Al Horford                42             13.6      3.4      8.1
Payton Pritchard          11              7.1      1.8      2.0
Sam Hauser                30              5.7      0.7      2.3
Luke Kornet               40              5.5      1.0      3.4
Xavier Tillman            26              5.7      1.2      4.0

Los Angeles Lakers
PLAYER NAME               JERSEY #        PPG      APG      RPG
-----------------------------------------------------------------
LeBron James              23             26.8      7.4      7.4
Anthony Davis             3              24.9      3.8     11.5
Austin Reaves             15             10.6      2.9      2.8
Rui Hachimura             28             12.0      1.8      5.3
D'Angelo Russell          1              18.2      5.7      3.4
Jarred Vanderbilt         2               6.7      1.4      6.9
Gabe Vincent              7               7.4      2.4      1.8
Max Christie              10              3.1      0.6      1.7
Jaxson Hayes              11              7.5      0.7      4.1
Christian Wood            35             14.0      1.7      7.1

Golden State Warriors
PLAYER NAME               JERSEY #        PPG      APG      RPG
-----------------------------------------------------------------
Stephen Curry             30             26.0      5.4      6.7
Klay Thompson             11             19.4      2.3      3.9
Draymond Green            23              9.2      6.8      7.5
Andrew Wiggins            22             18.3      2.5      4.5
Jonathan Kuminga          0              11.6      2.0      5.2
Brandin Podziemski        2               9.5      3.8      5.8
Trayce Jackson-Davis      32              8.0      1.2      5.7
Moses Moody               4               6.7      1.3      2.9
Kevon Looney              5               5.6      1.9      6.4
Gary Payton II            1               5.5      1.4      3.1
```

After sorting all players from all teams, Roman felt this method was ineffective for finding the MVP, so he then tried combining all players into one list.



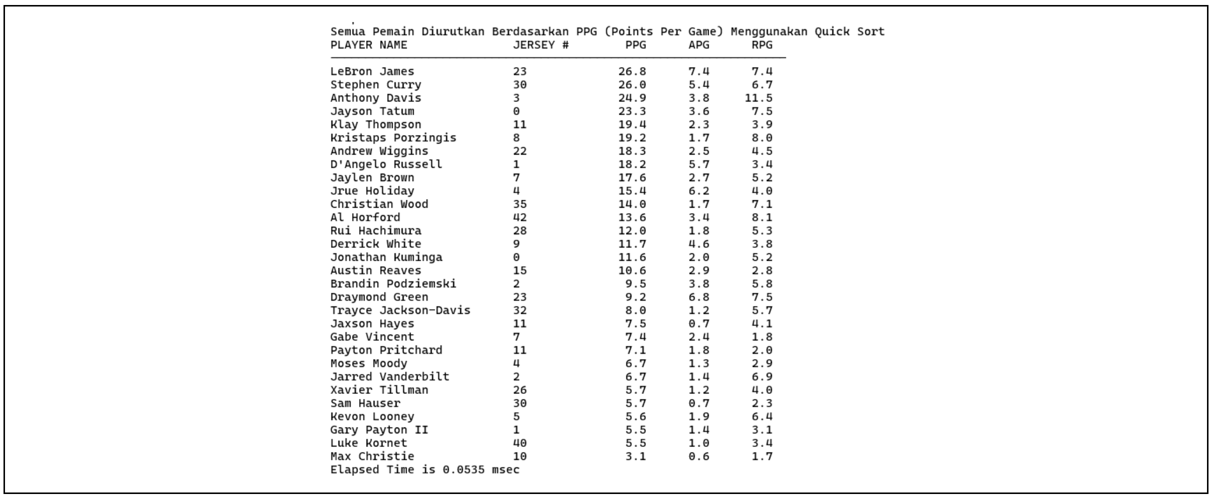
```
PLAYER NAME               JERSEY #        PPG      APG      RPG
-----------------------------------------------------------------
Jayson Tatum              0              23.3      3.6      7.5
Jaylen Brown              7              17.6      2.7      5.2
Kristaps Porzingis        8              19.2      1.7      8.0
Derrick White             9              11.7      4.6      3.8
Jrue Holiday              4              15.4      6.2      4.0
Al Horford                42             13.6      3.4      8.1
Payton Pritchard          11              7.1      1.8      2.0
Sam Hauser                30              5.7      0.7      2.3
Luke Kornet               40              5.5      1.0      3.4
Xavier Tillman            26              5.7      1.2      4.0
LeBron James              23             26.8      7.4      7.4
Anthony Davis             3              24.9      3.8     11.5
Austin Reaves             15             10.6      2.9      2.8
Rui Hachimura             28             12.0      1.8      5.3
D'Angelo Russell          1              18.2      5.7      3.4
Jarred Vanderbilt         2               6.7      1.4      6.9
Gabe Vincent              7               7.4      2.4      1.8
Max Christie              10              3.1      0.6      1.7
Jaxson Hayes              11              7.5      0.7      4.1
Christian Wood            35             14.0      1.7      7.1
Stephen Curry             30             26.0      5.4      6.7
Klay Thompson             11             19.4      2.3      3.9
Draymond Green            23              9.2      6.8      7.5
Andrew Wiggins            22             18.3      2.5      4.5
Jonathan Kuminga          0              11.6      2.0      5.2
Brandin Podziemski        2               9.5      3.8      5.8
Trayce Jackson-Davis      32              8.0      1.2      5.7
Moses Moody               4               6.7      1.3      2.9
Kevon Looney              5               5.6      1.9      6.4
Gary Payton II            1               5.5      1.4      3.1
```

After creating a list of all players in the NBA, Roman sorted all players based on PPG using merge sort.



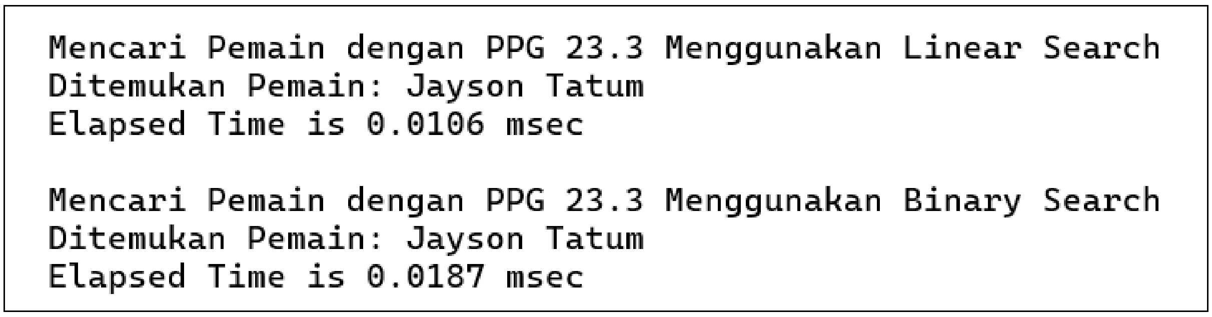
```
Semua Pemain Diurutkan Berdasarkan PPG (Points Per Game) Menggunakan Merge Sort
PLAYER NAME               JERSEY #        PPG      APG      RPG
-----------------------------------------------------------------
LeBron James              23             26.8      7.4      7.4
Stephen Curry             30             26.0      5.4      6.7
Anthony Davis             3              24.9      3.8     11.5
Jayson Tatum              0              23.3      3.6      7.5
Klay Thompson             11             19.4      2.3      3.9
Kristaps Porzingis        8              19.2      1.7      8.0
Andrew Wiggins            22             18.3      2.5      4.5
D'Angelo Russell          1              18.2      5.7      3.4
Jaylen Brown              7              17.6      2.7      5.2
Jrue Holiday              4              15.4      6.2      4.0
Christian Wood            35             14.0      1.7      7.1
Al Horford                42             13.6      3.4      8.1
Rui Hachimura             28             12.0      1.8      5.3
Derrick White             9              11.7      4.6      3.8
Jonathan Kuminga          0              11.6      2.0      5.2
Austin Reaves             15             10.6      2.9      2.8
Brandin Podziemski        2               9.5      3.8      5.8
Draymond Green            23              9.2      6.8      7.5
Trayce Jackson-Davis      32              8.0      1.2      5.7
Jaxson Hayes              11              7.5      0.7      4.1
Gabe Vincent              7               7.4      2.4      1.8
Payton Pritchard          11              7.1      1.8      2.0
Moses Moody               4               6.7      1.3      2.9
Jarred Vanderbilt         2               6.7      1.4      6.9
Xavier Tillman            26              5.7      1.2      4.0
Sam Hauser                30              5.7      0.7      2.3
Kevon Looney              5               5.6      1.9      6.4
Gary Payton II            1               5.5      1.4      3.1
Luke Kornet               40              5.5      1.0      3.4
Max Christie              10              3.1      0.6      1.7
Elapsed Time is 0.0739 msec
```

Since Roman had learned quick sort the previous day, he tried using it for this task.



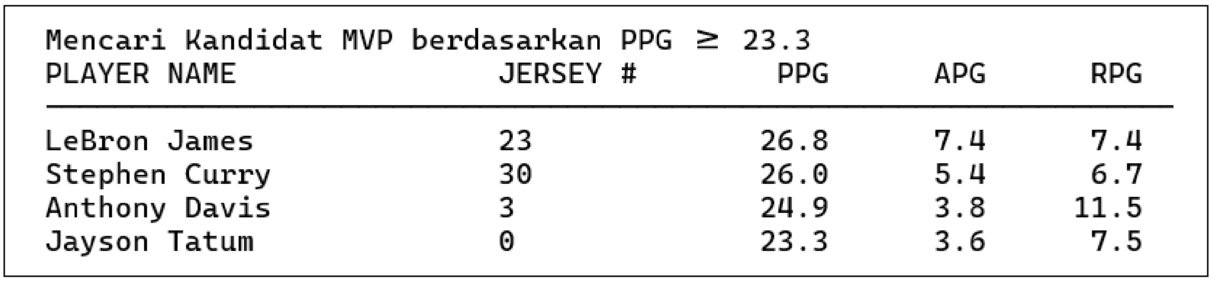
```
Semua Pemain Diurutkan Berdasarkan PPG (Points Per Game) Menggunakan Quick Sort
PLAYER NAME                 JERSEY #         PPG       APG       RPG
--------------------------------------------------------------------
LeBron James                23              26.8       7.4       7.4
Stephen Curry               30              26.0       5.4       6.7
Anthony Davis               3               24.9       3.8      11.5
Jayson Tatum                0               23.3       3.6       7.5
Klay Thompson               11              19.4       2.3       3.9
Kristaps Porzingis          8               19.2       1.7       8.0
Andrew Wiggins              22              18.3       2.5       4.5
D'Angelo Russell            1               18.2       5.7       3.4
Jaylen Brown                7               17.6       2.7       5.2
Jrue Holiday                4               15.4       6.2       4.0
Christian Wood              35              14.0       1.7       7.1
Al Horford                  42              13.6       3.4       8.1
Rui Hachimura               28              12.0       1.8       5.3
Derrick White               9               11.7       4.6       3.8
Jonathan Kuminga            0               11.6       2.0       5.2
Austin Reaves               15              10.6       2.9       2.8
Brandin Podziemski          2                9.5       3.8       5.8
Draymond Green              23               9.2       6.8       7.5
Trayce Jackson-Davis        32               8.0       1.2       5.7
Jaxson Hayes                11               7.5       0.7       4.1
Gabe Vincent                7                7.4       2.4       1.8
Payton Pritchard            11               7.1       1.8       2.0
Moses Moody                 4                6.7       1.3       2.9
Jarred Vanderbilt           2                6.7       1.4       6.9
Xavier Tillman              26               5.7       1.2       4.0
Sam Hauser                  30               5.7       0.7       2.3
Kevon Looney                5                5.6       1.9       6.4
Gary Payton II              1                5.5       1.4       3.1
Luke Kornet                 40               5.5       1.0       3.4
Max Christie                10               3.1       0.6       1.7
Elapsed Time is 0.0535 msec
```

Then Roman wanted to find players based on their PPG, so he used linear search and binary search to search through the sorted player list (regardless of whether it was merged or quick-sorted).



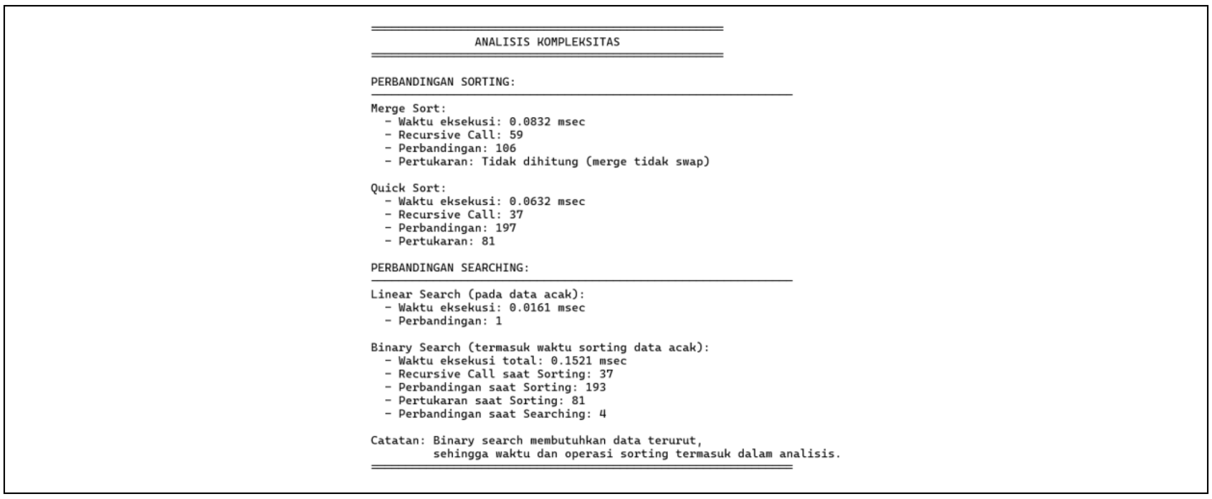
```
Mencari Pemain dengan PPG 23.3 Menggunakan Linear Search
Ditemukan Pemain: Jayson Tatum
Elapsed Time is 0.0106 msec

Mencari Pemain dengan PPG 23.3 Menggunakan Binary Search
Ditemukan Pemain: Jayson Tatum
Elapsed Time is 0.0187 msec
```

Since Roman wanted to find the best player so far, he combined linear search and binary search (by first finding the player's PPG using binary search, then using linear search for upward iteration) to find MVP candidates based on minimum PPG.



```
Mencari Kandidat MVP berdasarkan PPG ≥ 23.3
PLAYER NAME                 JERSEY #         PPG       APG       RPG
--------------------------------------------------------------------
LeBron James                23              26.8       7.4       7.4
Stephen Curry               30              26.0       5.4       6.7
Anthony Davis               3               24.9       3.8      11.5
Jayson Tatum                0               23.3       3.6       7.5
```

Then Roman wanted to understand more clearly the differences between each searching and sorting algorithm he used.



```
══════════════════════════════════════════════
              ANALISIS KOMPLEKSITAS
══════════════════════════════════════════════

PERBANDINGAN SORTING:
───────────────────────────────────────────────────────
Merge Sort:
  - Waktu eksekusi: 0.0832 msec
  - Recursive Call: 59
  - Perbandingan: 106
  - Pertukaran: Tidak dihitung (merge tidak swap)

Quick Sort:
  - Waktu eksekusi: 0.0632 msec
  - Recursive Call: 37
  - Perbandingan: 197
  - Pertukaran: 81

PERBANDINGAN SEARCHING:
───────────────────────────────────────────────────────
Linear Search (pada data acak):
  - Waktu eksekusi: 0.0161 msec
  - Perbandingan: 1

Binary Search (termasuk waktu sorting data acak):
  - Waktu eksekusi total: 0.1521 msec
  - Recursive Call saat Sorting: 37
  - Perbandingan saat Sorting: 193
  - Pertukaran saat Sorting: 81
  - Perbandingan saat Searching: 4

Catatan: Binary search membutuhkan data terurut,
         sehingga waktu dan operasi sorting termasuk dalam analisis.
═══════════════════════════════════════════════════════
```

Use the output above to analyze the questions below.

- Analyze the sorting and searching results that have been performed, comparing the results of each sorting and searching algorithm. Which algorithm is the most effective and efficient according to the available data for each sorting and searching task?
- Provide reasons for each algorithm as to why it is faster or slower than the others.

Notes :

- To calculate the search and sort time, you can use the following code or another algorithm:

```
long startTime = System.nanoTime();
//kode
long elapsedTime = System.nanoTime() - startTime;
System.out.println("Elapsed   Time   is   "   +   (elapsedTime   /
1000000.0) + " msec");
```

Aturan :

- Use the merge sort and selection sort methods.
- Use the linear search and binary search methods.
- Perform sorting and searching on the data and compare the time effectiveness of each sorting and searching. (The data compared is 100 data, 200 data and 300 data).
- Example of comparison results

Number of Data	Linear Search	Binary Search	Merge Sort	Quick Sort
100	time	time	time	time
200	time	time	time	time
300	time	time	time	time

- Analyze the results of the sorting and searching that has been done, compare the results of each sorting and searching algorithm. Which algorithm is the most effective and efficient according to the available data for each sorting and searching.