The Map-Reduce Programming Paradigm

M.Sc. course on "Technologies for Big Data Analysis" - Assignment 2

CHRISTOS BALAKTSIS (506) and VASILEIOS PAPASTERGIOS (505), Aristotle University, Greece

1 Introduction

The current document is a technical report for the second programming assignment in the M.Sc. course on *Technologies for Big Data Analysis*, offered by the *DWS M.Sc Program*[1] of the Aristotle University of Thessaloniki, Greece. The course is taught by Professor Apostolos Papadopoulos [2]. The authors attended the course during their first year of Ph.D. studies at the Institution.

The assignment contains 4 sub-problems and is part of a series, comprising 3 programming assignments on the following topics:

Assignment 1 Multi-threading Programming and Inter-Process Communication
Assignment 2 The Map-Reduce Programming Paradigm
Assignment 3 Big Data Analytics with Scala and Apache Spark

In this document we focus on Assignment 2 and its 4 sub-problems. We refer to them as *problems* in the rest of the document for simplicity. The source code of our solution has been made available at the following public repository in the GitHub platform: `https://github.com/Bilpapster/big-data-playground`.

Roadmap. The rest of our work is structured as follows. We devote one section to each one of the 4 problems. That means problems 1, 2, 3 and 4 are presented in section 2, section 3, section 4 and section 5 respectively. For each problem, we first provide the problem statement, as given by the assignment. Next, we thoroughly present the reasoning and/or methodology we have adopted to approach the problem and devise a solution. Wherever applicable, we also provide insights about the source code implementation we have developed. Finally, we conclude our work in section 6. The appendix includes the evaluation results for any issues that necessitated them.

2 Problem 1: Numeronyms

We discuss here the first problem of the assignment. The main target of the assignment is to get acquainted with the MapReduce programming model in Hadoop framework in Java programming language. This is a WordCount problem's variation.

2.1 Problem Statement

Implement a **MapReduce** program, a variation of the **word-count** problem, to generate and count "numeronyms". Numeronyms correspond to words as shown below:

- s5n – shorten
- h7k – hyperlink
- l10n – localization

[1] https://dws.csd.auth.gr/
[2] https://datalab-old.csd.auth.gr/~apostol/

Authors' Contact Information: Christos Balaktsis (506), balaktsis@csd.auth.gr; Vasileios Papastergios (505), papster@csd.auth.gr, Aristotle University, Thessaloniki, Greece.

- i18n – internationalization

A numeronym of a word is defined as an alphanumeric string formed by taking the first and last character of the word and inserting between them the count of characters between the first and the last. More specifically, the program should process words with a length of 3 characters or more, generate numeronyms, and then output the frequency of each numeronym.

The program should ignore:

- words shorter than 3 characters
- punctuation marks
- uppercase/lowercase differences, i.e., it should be *case-insensitive*

Additionally, a parameter k will be given, representing the minimum number of occurrences of a numeronym that we are interested in. The program output should be a list of numeronyms and the frequency of each numeronym that is greater than or equal to the parameter k specified by the user.

2.2 Proposed approach

2.2.1 Setting. Our implementation is run and tested in a Linux environment with 12 cores, using the Java programming language. We have used the Java Development Kit (JDK) version 11.0.11. The source code is developed in IntelliJ IDEA Community Edition 2021.1.1 and managed using Maven as the build tool.

The project's dependencies, including Hadoop libraries, are defined in the `pom.xml` file located in the root of the repository. The project is compiled and executed directly from IntelliJ IDEA.

To run the project, open the `NumeronymsMaster` class in IntelliJ IDEA, and execute the main method. You will need to specify the following command-line arguments:

- `<input_path>` specifies the directory containing the input text files, located at `map-reduce/ numeronyms /input`.
- `<output_path>` specifies the directory where the MapReduce output will be written, which will be created in the `out` folder.
- <k> is the minimum frequency threshold for numeronyms to be included in the results.

IntelliJ IDEA will handle the compilation and execution automatically when the main method is run. Make sure to configure the input and output paths as required for your specific run.

Note that the command-line arguments must follow the specified order and format. If any of the arguments are missing or invalid, the program will terminate with an appropriate error message.

2.2.2 Implementation. The proposed approach leverages the MapReduce programming model to compute numeronyms from a given input dataset. A numeronym is a concise representation of a word, typically formed by retaining the first and last letters while replacing the intervening characters with their count. This section outlines the methodology implemented across three key components: the driver class, the mapper, and the reducer. This methodology supports flexible configuration through command-line arguments, enabling users to specify the threshold k and the minimum word length for numeronym generation. The use of the MapReduce paradigm ensures scalability and parallel processing for large datasets, making the approach well-suited for distributed systems.

The driver class, `NumeronymsMaster`, orchestrates the overall MapReduce job. It takes command-line arguments for the input and output directories as well as a threshold parameter k, which determines the minimum frequency for numeronyms to be included in the final output. The following steps are executed:

- Input and output paths are parsed, and any pre-existing output directory is deleted using the `Utilities.deleteDirectory` method.
- A Hadoop configuration object is initialized with two parameters:

  - `numeronyms.k`: The threshold k.
  - `numeronyms.l`: The minimum word length (default value is 3) required for numeronym generation.
- The job is configured to use the `NumeronymMapper` and `NumeronymReducer` classes, with input and output formats set to `TextInputFormat` and `TextOutputFormat`, respectively.
- Finally, the job waits for completion before terminating.

The `NumeronymMapper` class is responsible for processing each line of the input text file and emitting numeronym -frequency pairs. The following steps are performed:

- During setup, the minimum word length (`numeronyms.l`) is retrieved from the configuration.
- Each input line is tokenized into individual words, and non-alphabetic characters are removed from each token.
- For valid words (those with lengths greater than or equal to the specified minimum), a numeronym is constructed by concatenating the first character, the number of intervening characters, and the last character.
- A key-value pair is emitted, where the key is the numeronym and the value is a count of one.

The `NumeronymReducer` class aggregates the frequency counts for each numeronym and filters out those below the specified threshold k. The process includes:

- Retrieving the threshold value (`numeronyms.k`) from the configuration during the setup phase.
- Summing the values for each numeronym key received from the mapper.
- Emitting numeronyms that meet or exceed the threshold k along with their corresponding frequencies.

2.2.3 Evaluation. The experiments were executed using the dataset 'SherlockHolmes.txt' with a parameter setting of $k = 10$. This configuration was chosen to evaluate the performance and the behavior of the system under moderate conditions. The dataset, containing a series of textual records, was processed to analyze various patterns and results.

To provide a comprehensive overview, the results of the experiment, including the detailed values derived from the dataset, are presented in Appendix A in a 2-column format.

3 Problem 2: Movie Analytics

The second problem focuses on producing analytic insights from an IMDB dataset.

3.1 Problem Statement

Implement a **MapReduce** program to perform analytics tasks on an IMDB dataset about movies. The utter goal of your analysis would be to extract useful insights from the available movie data that will assist the IMDB team provide better recommendations for movies, based on their genre and/or country. In particular, the dataset (`movies.csv`) contains the following fields:

- imdbID: unique identifier of the movie in the IMDB database
- title: the movie title
- year: the year the movie was first released
- duration: the duration of the movie
- genre(s): the genre or genres in which the movie is classified
- premier date: the date of the first showing of the movie
- score: the IMDB score of the movie
- country/-ies: the country or countries the movie was produced in

You are asked to implement Map-Reduce source code in Java programming language for the following analytics tasks:

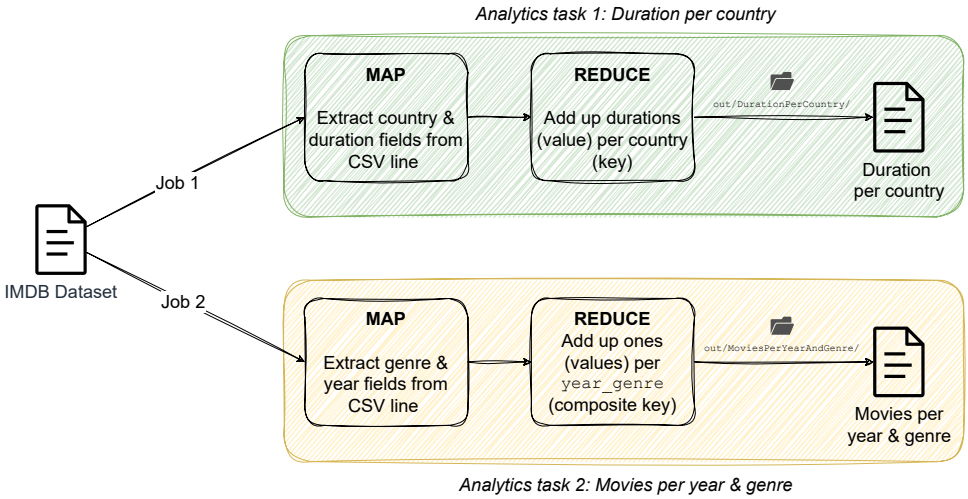


Fig. 1. The MapReduce solution architecture for the movie analytics problem. Two separate jobs are executed to solve the two tasks, namely duration per country (green) and movies per year & genre (yellow). The two tasks also create separate subdirectories for writing the results.

- Calculate the total duration of all movies per country. Note that in case multiple countries are recorded for a movie, the respective duration should be counted for all of them separately.
- Calculate the total number of movies per year and genre, having IMDB score over 8. For movies that have more than one genre, the sum should be separate for each genre.

3.2 Proposed approach

3.2.1 Setting. Our implementation is run and tested in a Linux environment with 12 cores, using the Java programming language. We have used the Java Development Kit (JDK) version 11.0.11. The source code is developed in IntelliJ IDEA Community Edition 2021.1.1 and managed using Maven as the build tool.

The project's dependencies, including Hadoop libraries, are defined in the `pom.xml` file located in the root of the repository. The project is compiled and executed directly from IntelliJ IDEA.

To run the project, open the `MovieAnalyticsMaster` class in IntelliJ IDEA, and execute the main method. You will need to specify the following command-line arguments:

- `<input_path>` specifies the directory containing the input text files, located at `map-reduce/movieAnalytics/input`.
- `<output_path>` specifies the directory where the MapReduce output will be written, which will be created in the `out` folder.

IntelliJ IDEA will handle the compilation and execution automatically when the main method is run. Make sure to configure the input and output paths as required for your specific run. Note that the command-line arguments must follow the specified order and format. If any of the arguments are missing or invalid, the program will terminate with an appropriate error message.

3.2.2 Implementation. The proposed approach leverages the MapReduce programming paradigm to compute the analytical insights for the two tasks. Figure 1 depicts the architecture of our solution as a diagram. We opt for executing two separate jobs; one for each task presented by the problem statement.

Task 1: Duration per country. One map-reduce cycle is enough to handle this task, as depicted in the top part of Figure 1 in green color. The map function parses the CSV file line by line and extracts the useful fields from each line. In this case, the useful fields are the country (or countries) the movie was produced and the movie duration, i.e., the fourth and ninth fields in the input line respectively. We employ more complex logic to handle cases where there are multiple countries in a single movie. In particular, we parse again the field and tokenize it into the separate countries, producing a key-value pair for each country-duration pair within a movie. The reduce function is, then, trivial; it just adds up the durations (value) per country (key) and outputs the results. The interested reader can refer to the `CSVProcessor.java` (mapper), `AnayticsEngine.java` (reducer) and `MovieAnalyticsMaster.java` (driver) files for the source code implementation of our solution.

Task 2: Movies per year & genre w.r.t. score constraint. The task is similar to the first one, with the only difference lying in the fields extracted from the input CSV line. In this case, we are interested about the year, the genre (or genres) and score fields, i.e., the third, fifth and seventh fields in the input CSV line. The map function produces key-value pairs in the form `(composite_key, 1)`, where the composite key consists of the year and the genre of the respective movie concatenated by an underscore, e.g., `2024_action`. We handle multiple genres per movie similarly with the multiple countries in task 1. We employ the same trivial reducer that adds up the values (ones) per (composite) key, as shown in the bottom part of Figure 1 in yellow color.

3.2.3 Evaluation. Our solution is tested using the provided IMDB dataset, namely `movies.csv`. We list the execution results in Appendix B.

4 Problem 3: DNA Sequence Patterns

The third problem focuses on mining unstructured data, namely DNA sequences, encoded in text format.

4.1 Problem Statement

A DNA sequence consists of four distinct symbols, namely A, G, C, and T. For instance, the following lines represent a part of the DNA sequence of the E. Coli bacterium [3]:

```
AGCTTTTCATTCTGACTGCAACGGGCAATATGTCTCTGTGTGGATTAAAAAAAGAGTGTCTGATAGCAGC
TTCTGAACTGGTTACCTGCCGTGAGTAAATTAAAATTTTATTGACTTAGGTCACTAAATACTTTAACCAA
TATAGGCATAGCGCACAGACAGATAAAAATTACAGAGTACACAACATCCATGAAACGCATTAGCACCACC
ATTACCACCACCATCACCATTACCACAGGTAACGGTGCGGGCTGACGCGTACAGGAAACACAGAAAAAAG
```

Implement a **MapReduce** program that computes the frequency (i.e., number of occurrences) of all subsequences of lengths 2, 3, and 4 that are present in the input DNA sequence. Note that the processing of each line should be independent of all other lines. Use the file `ecoli.txt` to test your solution.

4.2 Proposed approach

4.2.1 Setting. Our implementation is run and tested in a Linux environment with 12 cores, using the Java programming language. We have used the Java Development Kit (JDK) version 11.0.11. The source code is developed in IntelliJ IDEA Community Edition 2021.1.1 and managed using Maven as the build tool.

The project's dependencies, including Hadoop libraries, are defined in the `pom.xml` file located in the root of the repository. The project is compiled and executed directly from IntelliJ IDEA. To run the project, open the `DNASequenceAnalyticsMaster` class in IntelliJ IDEA, and execute the main method. You will need to specify the following command-line arguments:

[3] https://en.wikipedia.org/wiki/Pathogenic_Escherichia_coli

Algorithm 1 Populating DNA subsequences

```
▷ Input: a DNA sequence line (variable line) ◁
for length ∈ {2, 3, 4} do
    Create a sliding window window of length length.
    Place left end of window at the start of line.
    while right end of window has not exceeded line do
        subsequence ← contents of window
        Yield (subsequence, 1) key-value pair.
        Slide window to the right by 1.
```

- `<input_path>` specifies the directory containing the input text files, located at `map-reduce/dnaSequencePatterns/input`.
- `<output_path>` specifies the directory where the MapReduce output will be written, which will be created in the `out` folder.

IntelliJ IDEA will handle the compilation and execution automatically when the main method is run. Make sure to configure the input and output paths as required for your specific run. Note that the command-line arguments must follow the specified order and format. If any of the arguments are missing or invalid, the program will terminate with an appropriate error message.

4.2.2 Implementation. Algorithm 1 summarizes the most substantial part of our implementation, namely the logic that is implemented inside the mappers of our solution. At every execution of the map function, a DNA sequence line is given as input to the mapper. The latter is responsible for populating all possible subsequences of length 2, 3 and 4. We employ a sliding window that is nested inside a for-loop defining the subsequence length. The source code implementation of Algorithm 1 can be found in the `DNASequenceProcessor.java` file.

4.2.3 Evaluation. Our solution is tested using the provided DNA sequence, namely `ecoli.txt`. We list the execution results in Appendix C.

5 Problem 4: Probabilistic graph

We discuss here the fourth problem of the assignment. The main target of the assignment is to get acquainted with performing various MapReduce phases on a pipeline frame.

5.1 Problem Statement

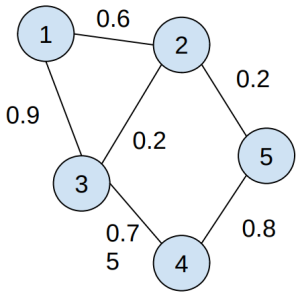
We are given an input file in text format where each line contains a connection between two vertices of a network and a probability value. For each edge e, there is a probability value $p(e)$ which indicates the probability that the two vertices are connected by the edge. Obviously, the values of $p(e)$ range between 0 and 1. The values in each line are separated by a space. Consider the network shown in the previous figure. The edge connecting vertices 4 and 5 has a probability of 0.8, the edge connecting vertices 2 and 3 has a probability of 0.2, etc.

The file corresponding to this graph would be:

1 2 0.6, 1 3 0.9, 2 3 0.2, 3 4 0.75, 2 5 0.2, 4 5 0.8,

The edges are generally stored in random order in the file, so we cannot assume they have a specific arrangement. The following tasks are requested:

(1) Write a Java program that computes the average degree for all the vertices.
(2) The average degree is defined as the sum of the probabilities of the edges that fall on a vertex.



(3) For example, in the previous diagram, the average degree of vertex 3 is $0.9 + 0.2 + 0.75 = 1.85$.
(4) Before performing this calculation, you should ignore all edges with a probability less than a threshold T , which should be passed as a parameter to the main function.
(5) Modify the code from task 1 so that, at the end, only the vertices with an average degree greater than the average of the degrees of all the vertices are displayed in the output.

5.2 Proposed approach

5.2.1 Setting. Our implementation is run and tested in a Linux environment with 12 cores, using the Java programming language. We have used the Java Development Kit (JDK) version 11.0.11. The source code is developed in IntelliJ IDEA Community Edition 2021.1.1 and managed using Maven as the build tool.

The project's dependencies, including Hadoop libraries, are defined in the `pom.xml` file located in the root of the repository. The project is compiled and executed directly from IntelliJ IDEA.

To run the project, open the `GraphMaster` class in IntelliJ IDEA, and execute the main method. You will need to specify the following command-line arguments:

- `<input_path>` specifies the directory containing the input text files, located at `map-reduce/ probabilisticGraph /input`.
- `<output_path>` specifies the directory where the MapReduce output will be written, which will be created in the `out` folder.
- `<T>` is the minimum edge-degree threshold for vertices to be included in the results.

IntelliJ IDEA will handle the compilation and execution automatically when the main method is run. Make sure to configure the input and output paths as required for your specific run.

Note that the command-line arguments must follow the specified order and format. If any of the arguments are missing or invalid, the program will terminate with an appropriate error message.

5.2.2 Implementation. The problem at hand involves processing a probabilistic graph, where each edge connects two vertices with a probability value. The task is to compute the average degree for each vertex, considering only edges whose probability exceeds a given threshold T. The methodology proposed here utilizes a distributed MapReduce framework, implemented using Hadoop, to efficiently process and analyze large-scale graph data. The approach is divided into three main phases, each handled by separate MapReduce jobs, with intermediate results passed between the phases.

The `GraphMaster` class serves as the orchestrator of the entire MapReduce process. It manages the execution of the three phases, invoking the appropriate MapReduce jobs in sequence. The main steps executed by `GraphMaster` are:

(1) It retrieves the command-line arguments, including the input and output directories as well as the threshold value T, which determines which edges to consider in the graph.

(2) It initiates the first MapReduce job to compute the degree of each vertex in the graph. The input consists of edge data, and the output is a summation of edge probabilities for each vertex.
(3) After the first job completes, the `GraphMaster` starts the second MapReduce job to calculate the mean degree of the graph, using the results from the first job.
(4) Once the mean degree is computed, `GraphMaster` starts the third MapReduce job, which filters out the vertices with degrees lower than the mean degree.
(5) It cleans up intermediate directories after each phase and moves the final output to the desired location.

`GraphMaster` coordinates these steps by configuring and executing the MapReduce jobs, ensuring that each phase depends on the results of the previous one.

The entire process consists of three MapReduce jobs, executed sequentially:

(1) **Phase 1:** The first job computes the degree of each vertex by summing the probabilities of the edges connected to it. It produces intermediate results for each vertex.
(2) **Phase 2:** The second job calculates the mean degree by summing the degrees from the first phase and dividing by the total number of vertices.
(3) **Phase 3:** The third job filters out the vertices with a degree lower than the mean degree and produces the final filtered result.

After each job completes, intermediate data is written to disk and passed as input to the subsequent job. The final output consists of the vertices whose degree exceeds or equals the mean degree.

Phase 1: Calculating Vertex Degree The first MapReduce job is responsible for calculating the degree of each vertex in the graph, where the degree is defined as the sum of the probabilities of the edges connected to that vertex. The degree of each vertex is computed by the `GraphMapper` and `GraphReducer` classes.

The `GraphMapper` class reads each edge from the input data, which consists of lines containing two vertices and the associated probability value. It splits each line into two components (the two vertices), and for each vertex, it emits the corresponding probability value as the output. The mapper also checks if the probability value exceeds the threshold T, which is provided as a configuration parameter. If the probability is greater than or equal to T, it emits the vertex along with the corresponding probability.

The `GraphReducer` class receives the vertex and associated probability values emitted by the mapper. For each vertex, it sums up all the probabilities of the edges connected to that vertex, and emits the pair as output.

Phase 2: Calculating the Mean Degree The second phase of the approach calculates the mean degree of all vertices. This is done by summing the degree values from the previous phase and dividing by the total number of vertices.

The `MeanMapper` class receives the degree values from the output of the first MapReduce job. It emits two key-value pairs for each input line: a count of the number of vertices and the sum of the degree values. These are emitted with fixed keys (`"count"` and `"sum"`) so that they can be aggregated in the reducer.

The `MeanReducer` class processes the count and sum values emitted by the mapper. It calculates the total sum and count of vertices and then writes these values as output. The mean degree is calculated by dividing the sum by the count, and the result is stored for use in the next phase.

Phase 3: Filtering Vertices by Mean Degree In the third phase, the vertices whose degree is greater than or equal to the mean degree calculated in Phase 2 are selected. This phase uses the results from Phase 1 and Phase 2, applying the filtering criteria to retain only those vertices with a degree greater than or equal to the mean.

The `FilterMapper` class takes the degree values emitted by the first reducer and writes them as key-value pairs. Each key is a vertex, and the value is the degree of that vertex. The mapper does not perform any filtering; instead, it simply passes the values along to the reducer.

The `FilterReducer` class filters out the vertices whose degree is less than the mean degree. It retrieves the mean degree from the configuration, and for each vertex, it compares the degree value to the mean. If the degree is greater than or equal to the mean, it emits the vertex along with its degree. This final output contains only the vertices that satisfy the filtering criteria.

5.2.3 Evaluation. The experiments were executed using the dataset ‘collins.txt‘ with a parameter setting of $T = 0.8$.

To provide a comprehensive overview, the results of the experiment, including the detailed values derived from the dataset, are presented in subsection C.1 in a 2-column format.

6 Conclusion

In this document we have presented our solutions and rationale for solving the second assignment of the M.Sc. course on *Technologies for Big Data Analysis*, offered by the *DWS M.Sc. Program*. For each one of the four problems of the assignment, we have presented their statement, as well as the solution approach we have adopted. All execution results with the provided datasets can be found in the appendices of our work.

A Problem 1 execution results

In the following 8-columned pages, the experimental results of section's 2 problem are presented, as the raw output of the MapReduce execution.

a10c: 34
a10d: 486
a10e: 386
a10g: 175
a10h: 58
a10l: 131
a10m: 15
a10n: 260
a10p: 48
a10r: 68
a10s: 429
a10t: 72
a10y: 190
a10z: 50
a11a: 36
a11c: 36
a11d: 165
a11e: 136
a11g: 101
a11n: 202
a11p: 16
a11r: 13
a11s: 266
a11t: 115
a11y: 119
a12c: 18
a12d: 94
a12e: 95
a12g: 47
a12l: 20
a12n: 65
a12s: 139
a12t: 59
a12y: 36
a13e: 10
a13g: 19
a13n: 22
a13s: 112
a13t: 36
a13y: 36
a14c: 12
a14e: 16
a14n: 114
a14s: 16
a14t: 17
a14y: 38
a15s: 33
a16s: 18
a3d: 38224
a3e: 3767
a3k: 248
a3l: 4077
a3m: 353
a3o: 106
a3r: 198
a3t: 428
a3y: 1193
a4a: 458
a4d: 166
a4e: 249
a4h: 13
a4n: 15
a4o: 773
a4s: 483
a4t: 47
a4y: 1588
a5a: 41
a5d: 1360
a5e: 1377
a5g: 841
a5i: 11
a5l: 112
a5m: 56
a5n: 916
a5r: 1604
a5s: 213
a5t: 1767
a5w: 94
a5y: 201
a6a: 112
a6d: 785
a6e: 615
a6g: 214
a6h: 21
a6k: 151
a6l: 192
a6m: 20
a6n: 456
a6p: 84
a6r: 523
a6s: 1197
a6t: 811
a6w: 1078
a6y: 204
a7a: 431
a7c: 52
a7d: 1076
a7e: 685
a7g: 71
a7h: 12
a7l: 116
a7n: 83
a7r: 843
a7s: 1203
a7t: 1011
a7x: 17
a7y: 756
a8a: 28
a8c: 37
a8d: 1790
a8e: 386
a8g: 625
a8h: 328
a8l: 125
a8m: 239
a8n: 982
a8r: 98
a8s: 469
a8t: 440
a8x: 10
a8y: 328
a9a: 27
a9c: 23
a9d: 531
a9e: 369
a9g: 548
a9l: 62
a9n: 555
a9r: 235
a9s: 622
a9t: 287
a9v: 38
a9y: 286
b10a: 17
b10d: 86
b10e: 58
b10g: 28
b10l: 20
b10m: 12
b10n: 13
b10r: 33
b10s: 227
b10t: 43
b10y: 10
b11a: 10
b11d: 79
b11g: 15
b11m: 34
b11n: 21
b11o: 48
b11s: 75
b11t: 13
b11y: 19
b12d: 36
b12e: 20
b12g: 10
b12l: 18
b12s: 25
b12t: 10
b12w: 10
b12y: 21
b13e: 10
b13v: 13
b3d: 352
b3e: 11
b3g: 145
b3r: 22
b3t: 5674
b3w: 35
b3x: 66
b3y: 223
b4d: 268
b4e: 883
b4f: 10
b4g: 96
b4h: 538
b4k: 969
b4l: 288
b4m: 16
b4n: 2688
b4r: 102
b4s: 119
b4t: 458
b4w: 98
b4y: 459
b5a: 77
b5d: 934
b5e: 330
b5f: 29
b5g: 1080
b5h: 103
b5k: 342
b5l: 11
b5m: 29
b5n: 1190
b5r: 60
b5s: 1288
b5t: 212
b5w: 111
b5y: 101
b6a: 42
b6d: 865
b6e: 3041
b6f: 52
b6g: 84
b6h: 123
b6i: 20
b6l: 39
b6m: 41
b6n: 329
b6r: 436
b6s: 390
b6t: 347
b6u: 17
b6w: 15
b6y: 181
b7a: 31
b7c: 25
b7d: 248
b7e: 1005
b7g: 339
b7h: 371
b7i: 31
b7k: 28
b7l: 16
b7m: 61
b7n: 861
b7o: 15
b7r: 238
b7s: 741
b7t: 494
b7u: 16
b7y: 196
b8a: 121
b8d: 308
b8e: 83
b8g: 451
b8h: 15
b8l: 55
b8m: 41
b8n: 53
b8o: 105
b8r: 55
b8s: 795
b8t: 62
b8v: 148
b8y: 78
b9a: 26
b9d: 95
b9e: 232
b9g: 271
b9h: 18
b9i: 161
b9l: 175
b9n: 274
b9r: 19
b9s: 163
b9t: 150
b9y: 19
c10a: 49
c10d: 460
c10e: 395
c10g: 362
c10l: 129
c10n: 689
c10r: 18
c10s: 818
c10t: 97
c10y: 256
c11a: 21
c11d: 116
c11e: 272
c11g: 141
c11l: 92
c11n: 403
c11p: 12
c11r: 16
c11s: 341
c11t: 74
c11y: 181
c12d: 107
c12e: 284
c12g: 46
c12h: 11
c12l: 15
c12n: 673
c12r: 10
c12s: 173
c12t: 45
c12y: 124
c13d: 80
c13e: 35
c13g: 61
c13l: 29
c13n: 220
c13s: 379
c13y: 83
c14a: 14
c14c: 94
c14e: 47
c14l: 93
c14n: 20
c14s: 84
c14y: 29
c15d: 11
c15e: 12
c15s: 24
c15y: 18
c16e: 39
c16f: 10
c3b: 34
c3n: 872
c3p: 117
c3t: 210
c3y: 140
c4a: 35
c4b: 72
c4d: 333
c4e: 2548
c4f: 18
c4k: 36
c4l: 246
c4m: 88
c4n: 92
c4p: 105
c4r: 31
c4s: 42
c4t: 739

c4w: 12
c4y: 285
c5a: 45
c5c: 10
c5d: 2428
c5e: 804
c5f: 320
c5g: 24
c5h: 168
c5i: 18
c5k: 237
c5l: 318
c5m: 77
c5n: 161
c5p: 33
c5r: 479
c5s: 1360
c5t: 1031
c5y: 130
c6a: 44
c6c: 40
c6d: 871
c6e: 1144
c6g: 247
c6h: 125
c6l: 61
c6m: 30
c6n: 676
c6r: 706
c6s: 929
c6t: 568
c6x: 23
c6y: 363
c7a: 23
c7c: 148
c7d: 1329
c7e: 561
c7g: 328
c7h: 15
c7k: 80
c7l: 690
c7m: 35
c7n: 703
c7o: 27
c7r: 658
c7s: 834
c7t: 612
c7x: 23
c7y: 1192
c8a: 125
c8c: 46
c8d: 582
c8e: 638
c8g: 570
c8h: 26
c8l: 573
c8n: 523
c8o: 18
c8r: 285
c8s: 2081
c8t: 341
c8x: 16
c8y: 394
c9a: 39
c9d: 1289
c9e: 440
c9g: 137
c9l: 41
c9m: 42
c9n: 616
c9r: 485
c9s: 836
c9t: 198
c9v: 10
c9y: 381
d10a: 113
d10c: 142
d10d: 345
d10e: 169
d10g: 194
d10l: 29
d10n: 175
d10r: 15
d10s: 211
d10t: 120
d10v: 44
d10y: 259
d11a: 13
d11d: 205
d11e: 106
d11g: 78
d11h: 32
d11l: 23
d11m: 17
d11n: 352
d11s: 176
d11t: 121
d11y: 63
d12d: 112
d12e: 70
d12g: 44
d12l: 21
d12n: 162
d12s: 168
d12t: 32
d12y: 37
d13d: 84
d13e: 52
d13g: 13
d13n: 63
d13s: 29
d13t: 13
d14d: 17
d14g: 16
d14n: 27
d14s: 10
d14t: 11
d14y: 13
d15n: 31
d15s: 19
d3c: 10
d3d: 1874
d3e: 335
d3g: 71
d3m: 55
d3n: 29
d3s: 11
d3y: 882
d4a: 19
d4d: 284
d4e: 602
d4g: 27
d4h: 19
d4k: 187
d4l: 170
d4m: 29
d4n: 1183
d4p: 258
d4r: 935
d4s: 900
d4t: 713
d4u: 19
d4w: 203
d4y: 161
d5a: 11
d5d: 114
d5e: 296
d5g: 250
d5h: 374
d5k: 109
d5l: 77
d5m: 43
d5n: 209
d5s: 415
d5t: 305
d5y: 245
d6a: 39
d6d: 313
d6e: 549
d6g: 566
d6h: 10
d6i: 14
d6l: 146
d6m: 27
d6n: 177
d6r: 617
d6s: 281
d6t: 341
d6y: 154
d7b: 13
d7c: 21
d7d: 989
d7e: 1011
d7g: 439
d7l: 18
d7n: 43
d7o: 10
d7p: 56
d7r: 107
d7s: 665
d7t: 220
d7v: 366
d7y: 183
d8a: 46
d8c: 93
d8d: 903
d8e: 536
d8g: 305
d8h: 52
d8k: 15
d8l: 119
d8m: 37
d8n: 272
d8r: 296
d8s: 475
d8t: 183
d8v: 284
d8y: 138
d9a: 31
d9d: 793
d9e: 326
d9g: 169
d9m: 14
d9n: 202
d9r: 48
d9s: 855
d9t: 470
d9v: 26
d9y: 257
e10c: 57
e10d: 104
e10e: 256
e10g: 553
e10h: 23
e10l: 67
e10m: 91
e10n: 431
e10s: 136
e10t: 195
e10y: 610
e11a: 49
e11d: 331
e11e: 20
e11g: 29
e11l: 62
e11m: 20
e11n: 195
e11s: 134
e11t: 95
e11y: 115
e12a: 11
e12c: 16
e12d: 49
e12g: 79
e12l: 13
e12n: 38
e12s: 88
e12t: 23
e12y: 20
e13n: 15
e13s: 59
e13t: 75
e13y: 91
e14g: 10
e14s: 24
e14y: 14
e3a: 11
e3c: 18
e3d: 456
e3e: 137
e3r: 45
e3t: 67
e4a: 12
e4e: 304
e4h: 409
e4l: 53
e4n: 941
e4r: 253
e4s: 1113
e4t: 149
e4y: 129
e5a: 13
e5d: 43
e5e: 56
e5h: 117
e5k: 85
e5l: 164
e5n: 46
e5r: 210
e5s: 98
e5t: 327
e5w: 87
e5y: 1240
e6a: 13
e6d: 174
e6e: 651
e6g: 39
e6h: 189
e6i: 12
e6m: 10
e6n: 28
e6r: 335
e6s: 496
e6t: 710
e6y: 213
e7a: 18
e7c: 69
e7d: 1198
e7e: 588
e7g: 279
e7h: 213
e7l: 29
e7m: 11
e7n: 255
e7o: 10
e7r: 569
e7s: 575
e7t: 209
e7v: 28
e7y: 234
e8a: 11
e8c: 152
e8d: 864
e8e: 572
e8g: 232
e8l: 107
e8m: 19
e8n: 348
e8r: 62
e8s: 531
e8t: 40
e8y: 174
e9c: 42
e9d: 544
e9e: 386
e9g: 244
e9h: 75
e9l: 122
e9n: 283
e9r: 31
e9s: 330
e9t: 153
e9y: 634
f10d: 228
f10e: 83
f10g: 95
f10h: 29
f10n: 128
f10p: 42
f10r: 20
f10s: 124
f10t: 63
f10v: 12
f10y: 242
f11d: 19
f11e: 46
f11g: 73
f11l: 21
f11n: 42
f11s: 142
f11t: 15
f11y: 59
f12g: 14
f12n: 11
f12s: 33
f13s: 10
f3d: 18
f3e: 47
f3g: 340
f3n: 26
f3o: 17
f3r: 7246
f3t: 128
f3w: 453
f3x: 44
f3y: 33
f4d: 493
f4e: 2351
f4g: 31
f4h: 16
f4i: 27
f4k: 35
f4l: 859
f4m: 6376
f4p: 28
f4r: 444
f4s: 73
f4t: 1443

f4w: 96
f4x: 11
f4y: 21
f5a: 22
f5d: 1113
f5e: 402
f5g: 32
f5h: 404
f5k: 140
f5l: 132
f5n: 23
f5r: 353
f5s: 867
f5t: 1749
f5y: 346
f6a: 61
f6d: 958
f6e: 500
f6g: 183
f6h: 1159
f6l: 60
f6n: 122
f6o: 13
f6r: 892
f6s: 520
f6t: 319
f6w: 344
f6y: 435
f7a: 76
f7d: 590
f7e: 324
f7g: 756
f7h: 48
f7l: 282
f7m: 220
f7n: 410
f7r: 333
f7s: 1066
f7t: 43
f7y: 265
f8d: 604
f8e: 190
f8g: 218
f8h: 39
f8k: 11
f8l: 56
f8m: 21
f8n: 226
f8r: 152
f8s: 473
f8t: 118
f8y: 223
f9a: 17
f9c: 12
f9d: 147
f9e: 131
f9g: 266
f9h: 26
f9k: 31
f9l: 51
f9n: 454
f9o: 16
f9r: 24
f9s: 309
f9t: 53
f9y: 59
g10a: 20
g10d: 16
g10g: 52
g10n: 37
g10r: 12
g10s: 120
g10t: 643
g10y: 40
g11d: 60
g11g: 22
g11l: 21
g11m: 126
g11n: 89
g11r: 20
g11s: 71
g12d: 10
g12l: 16
g12s: 74
g13y: 10
g14g: 10
g18g: 13
g3d: 305
g3m: 13
g3n: 54
g3p: 44
g3s: 11
g3t: 752
g3y: 33
g4d: 855
g4e: 1349
g4f: 13
g4l: 185
g4m: 20
g4n: 91
g4p: 14
g4s: 269
g4t: 44
g4w: 255
g4y: 110
g5a: 40
g5d: 278
g5e: 276
g5f: 47
g5g: 369
g5h: 15
g5i: 10
g5m: 59
g5n: 594
g5p: 168
g5s: 549
g5t: 935
g5y: 136
g6a: 13
g6d: 281
g6e: 336
g6g: 256
g6h: 223
g6l: 22
g6n: 305
g6p: 63
g6r: 47
g6s: 717
g6t: 10
g6y: 229
g7a: 83
g7d: 366
g7e: 126
g7g: 314
g7h: 19
g7l: 848
g7m: 25
g7n: 29
g7p: 15
g7r: 167
g7s: 328
g7t: 31
g7y: 216
g8c: 29
g8d: 221
g8e: 185
g8g: 232
g8l: 37
g8n: 73
g8r: 139
g8s: 306
g8t: 83
g8y: 37
g9a: 19
g9d: 33
g9e: 65
g9g: 188
g9n: 179
g9r: 45
g9s: 160
g9t: 37
g9y: 190
h10a: 55
h10c: 17
h10d: 35
h10e: 22
h10g: 26
h10h: 21
h10l: 76
h10n: 44
h10s: 207
h10y: 38
h11a: 19
h11c: 13
h11d: 17
h11e: 143
h11g: 21
h11n: 16
h11s: 32
h11y: 13
h12a: 17
h12c: 12
h12f: 55
h12g: 12
h12s: 90
h13d: 13
h13s: 20
h3d: 7393
h3e: 11
h3m: 5193
h3p: 37
h3r: 5252
h3s: 11727
h3t: 268
h3w: 1296
h3y: 47
h4d: 2139
h4e: 4797
h4f: 251
h4g: 59
h4h: 286
h4k: 11
h4l: 277
h4m: 38
h4n: 22
h4o: 53
h4p: 259
h4r: 557
h4s: 66
h4t: 229
h4y: 50
h5d: 709
h5e: 1028
h5h: 23
h5i: 10
h5l: 22
h5n: 184
h5o: 10
h5r: 193
h5s: 1072
h5t: 311
h5y: 509
h6a: 30
h6c: 33
h6d: 321
h6e: 212
h6g: 718
h6h: 170
h6i: 14
h6n: 214
h6r: 443
h6s: 1051
h6t: 96
h6w: 55
h6y: 274
h7a: 16
h7d: 544
h7e: 44
h7f: 1487
h7g: 535
h7h: 13
h7l: 48
h7m: 25
h7n: 48
h7r: 466
h7s: 490
h7t: 118
h7y: 683
h8c: 47
h8d: 313
h8e: 182
h8g: 47
h8h: 10
h8l: 66
h8n: 150
h8o: 22
h8s: 254
h8t: 33
h8y: 89
h9a: 19
h9c: 10
h9d: 139
h9e: 136
h9g: 70
h9k: 10
h9n: 61
h9s: 256
h9t: 18
h9y: 121
i10d: 309
i10e: 645
i10g: 134
i10l: 234
i10n: 306
i10s: 253
i10t: 99
i10y: 163
i11d: 212
i11e: 172
i11g: 127
i11l: 15
i11m: 10
i11n: 300
i11r: 23
i11s: 229
i11t: 191
i11y: 354
i12d: 19
i12e: 359
i12g: 33
i12l: 55
i12n: 505
i12s: 141
i12t: 52
i12y: 145
i13e: 100
i13l: 51
i13n: 35
i13r: 20
i13s: 32
i13t: 33
i13y: 222
i14e: 26
i14n: 20
i14s: 16
i14y: 13
i15y: 17
i16e: 39
i3e: 78
i3i: 91
i3k: 12
i3l: 278
i3n: 24
i3s: 2045
i4a: 188
i4e: 25
i4h: 11
i4n: 128
i4o: 2120
i4s: 12
i4t: 50
i5a: 23
i5c: 25
i5e: 118
i5h: 20
i5l: 32
i5n: 39
i5r: 65
i5s: 91
i5t: 20
i5x: 17
i5y: 73
i6a: 11
i6c: 10
i6d: 291
i6e: 216
i6f: 264
i6m: 34
i6n: 64
i6s: 110
i6t: 119
i6y: 127
i7a: 32
i7d: 420
i7e: 352
i7g: 18
i7h: 14
i7l: 35
i7n: 37
i7s: 296
i7t: 134
i7y: 44
i8a: 25
i8d: 845
i8e: 317
i8g: 88
i8l: 221
i8m: 41
i8n: 96
i8r: 90
i8s: 247
i8t: 414
i8y: 305
i9a: 14
i9d: 418
i9e: 538
i9g: 250
i9h: 35

i9l: 24
i9n: 557
i9r: 89
i9s: 381
i9t: 371
i9w: 34
i9y: 124
j10n: 23
j10s: 33
j12n: 27
j13e: 10
j13n: 15
j3w: 33
j3y: 103
j4e: 80
j4k: 10
j4n: 208
j4p: 13
j4s: 45
j4t: 773
j4y: 62
j5e: 106
j5n: 22
j5s: 137
j5t: 329
j5y: 14
j6d: 170
j6e: 10
j6g: 19
j6h: 47
j6l: 53
j6s: 239
j6t: 39
j6y: 49
j7e: 83
j7g: 71
j7n: 87
j7r: 20
j7s: 26
j7y: 127
j8e: 15
j8g: 12
j8l: 26
j8n: 52
j8s: 46
j8t: 34
j8y: 72
j9d: 21
j9n: 108
j9s: 24
j9y: 17
k11a: 25
k11d: 10
k11n: 15
k3y: 23
k4d: 194
k4e: 135
k4g: 211
k4l: 64
k4n: 35
k4p: 151
k4s: 59
k4t: 279
k4v: 17
k4w: 1529
k5e: 45
k5k: 12
k5l: 48
k5n: 379
k5s: 255
k5y: 18
k6a: 26
k6d: 279
k6r: 22
k6s: 52
k6y: 118
k7a: 20
k7d: 49
k7e: 29
k7g: 213
k7h: 15
k7m: 24
k7n: 117
k7s: 39
k7v: 448
k8a: 21
k8f: 11
k8g: 26
k8s: 131
k8v: 70
k8y: 70
k9e: 71
k9i: 17
k9s: 32
k9t: 22
l10d: 24
l10e: 52
l10g: 13
l10n: 42
l10p: 56
l10s: 135
l10t: 27
l10y: 15
l11d: 16
l11e: 112
l11g: 15
l11n: 56
l11s: 40
l11y: 10
l12a: 19
l12d: 13
l12g: 11
l12n: 22
l12s: 129
l13n: 11
l13s: 19
l3d: 274
l3e: 109
l3g: 157
l3p: 63
l3s: 20
l3t: 573
l3w: 486
l3y: 289
l4b: 213
l4d: 791
l4e: 3014
l4g: 942
l4h: 10
l4k: 658
l4n: 42
l4p: 53
l4s: 1182
l4t: 1734
l4y: 164
l5a: 17
l5c: 15
l5d: 371
l5e: 965
l5g: 114
l5h: 291
l5l: 303
l5n: 102
l5r: 934
l5s: 739
l5t: 480
l5y: 49
l6a: 41
l6d: 1083
l6e: 1215
l6g: 269
l6h: 66
l6l: 31
l6n: 315
l6r: 930
l6s: 314
l6t: 52
l6x: 25
l6y: 241
l7c: 10
l7d: 391
l7e: 80
l7g: 952
l7l: 90
l7n: 92
l7r: 47
l7s: 505
l7t: 46
l7v: 10
l7y: 211
l8d: 221
l8e: 195
l8g: 201
l8n: 79
l8r: 97
l8s: 142
l8t: 42
l8y: 75
l9a: 102
l9c: 23
l9d: 105
l9e: 45
l9g: 121
l9n: 29
l9r: 46
l9s: 137
l9y: 53
m10c: 11
m10d: 82
m10e: 72
m10g: 27
m10l: 50
m10m: 13
m10n: 58
m10r: 12
m10s: 199
m10t: 63
m10y: 69
m11a: 133
m11d: 16
m11e: 51
m11g: 26
m11i: 81
m11n: 10
m11r: 10
m11s: 90
m11t: 20
m11y: 26
m12d: 10
m12e: 155
m12h: 22
m12n: 24
m12r: 32
m12s: 88
m12y: 31
m13g: 38
m13l: 11
m13n: 29
m13s: 160
m14s: 65
m15s: 10
m3b: 26
m3d: 61
m3n: 2654
m3p: 40
m3s: 58
m3t: 547
m3y: 2535
m4d: 514
m4e: 3829
m4h: 671
m4k: 98
m4l: 32
m4n: 233
m4s: 396
m4t: 2077
m4y: 1246
m5a: 308
m5c: 59
m5d: 312
m5e: 66
m5h: 389
m5l: 109
m5m: 27
m5n: 51
m5o: 12
m5r: 150
m5s: 701
m5t: 832
m5y: 567
m6a: 46
m6d: 390
m6e: 621
m6f: 223
m6g: 365
m6l: 117
m6m: 62
m6n: 227
m6o: 72
m6r: 1005
m6s: 452
m6t: 569
m6u: 10
m6v: 12
m6w: 803
m6x: 10
m6y: 443
m7a: 163
m7c: 23
m7d: 388
m7e: 302
m7g: 624
m7h: 27
m7l: 178
m7m: 40
m7n: 265
m7r: 38
m7s: 1188
m7t: 11
m7y: 221
m8a: 24
m8c: 41
m8d: 222
m8e: 505
m8g: 123
m8i: 56
m8k: 29
m8l: 137
m8m: 17
m8n: 158
m8r: 283
m8s: 535
m8t: 448
m8y: 608
m9a: 25
m9c: 18
m9d: 138
m9e: 125
m9g: 46
m9h: 10
m9i: 28
m9l: 28
m9m: 24
m9n: 49
m9o: 30
m9r: 36
m9s: 505
m9t: 124
m9y: 92
n10a: 11
n10c: 16
n10d: 20
n10e: 41
n10g: 23
n10h: 21
n10k: 18
n10n: 29
n10s: 57
n10y: 30
n11g: 24
n11m: 22
n11n: 11
n11s: 35
n11t: 16
n11y: 62
n12d: 18
n12g: 18
n12s: 83
n13d: 18
n13n: 33
n13s: 12
n15d: 12
n17s: 13
n3p: 10
n3r: 275
n3t: 6590
n3w: 2862
n4d: 156
n4e: 683
n4k: 193
n4l: 58
n4r: 286
n4s: 237
n4t: 281
n4y: 35
n5d: 75
n5e: 457
n5h: 222
n5i: 10
n5l: 79
n5o: 22
n5r: 590
n5s: 189
n5t: 335
n5y: 58
n6a: 20
n6d: 138
n6e: 345
n6g: 13
n6i: 10
n6l: 107
n6n: 210
n6r: 379
n6s: 243
n6t: 10
n6w: 77
n6y: 268
n7a: 1119

n7d: 203
n7e: 76
n7g: 662
n7k: 12
n7l: 164
n7n: 10
n7r: 179
n7s: 364
n7t: 73
n7y: 71
n8a: 25
n8d: 33
n8e: 134
n8g: 64
n8l: 288
n8n: 619
n8p: 11
n8r: 84
n8s: 932
n8y: 47
n9a: 35
n9d: 68
n9e: 56
n9g: 16
n9i: 66
n9l: 17
n9n: 23
n9r: 23
n9s: 168
n9t: 53
n9y: 486
o10d: 65
o10e: 91
o10g: 26
o10h: 28
o10l: 26
o10n: 177
o10s: 177
o10y: 31
o11d: 36
o11g: 54
o11n: 51
o11s: 94
o11y: 79
o12a: 14
o12d: 30
o12g: 17
o12n: 94
o12s: 23
o12y: 91
o13s: 108
o3d: 1140
o3e: 3233
o3f: 625
o3g: 15
o3h: 13
o3k: 27
o3l: 33
o3n: 777
o3r: 1064
o3t: 1956
o4d: 13
o4e: 567
o4h: 27
o4l: 24
o4n: 302
o4o: 159
o4r: 1263
o4s: 213
o4y: 1890
o5a: 16
o5d: 19
o5e: 27
o5g: 44
o5m: 23
o5n: 465
o5r: 2249
o5s: 20
o5t: 173
o5y: 12
o6a: 76
o6d: 243
o6e: 181
o6g: 17
o6k: 100
o6n: 171
o6r: 13
o6s: 913
o6t: 159
o6y: 47
o6z: 22
o7a: 31
o7c: 14
o7d: 336
o7e: 273
o7f: 26
o7g: 151
o7k: 10
o7n: 232
o7r: 491
o7s: 236
o7t: 11
o7y: 47
o8a: 30
o8d: 564
o8e: 194
o8g: 69
o8h: 12
o8k: 37
o8l: 189
o8m: 34
o8n: 59
o8r: 29
o8s: 467
o8t: 117
o8w: 18
o8y: 100
o9a: 13
o9d: 111
o9e: 220
o9g: 218
o9h: 11
o9n: 252
o9p: 28
o9s: 367
o9t: 11
o9w: 19
o9y: 56
p10a: 38
p10c: 17
p10d: 138
p10e: 184
p10g: 464
p10h: 54
p10l: 128
p10m: 121
p10n: 521
p10r: 124
p10s: 413
p10t: 142
p10y: 317
p11c: 22
p11d: 50
p11e: 166
p11g: 88
p11n: 117
p11r: 25
p11s: 289
p11t: 24
p11y: 240
p12a: 159
p12d: 37
p12e: 46
p12g: 14
p12l: 106
p12n: 115
p12r: 13
p12s: 131
p12t: 18
p12y: 223
p13e: 19
p13g: 10
p13k: 11
p13l: 20
p13n: 38
p13r: 22
p13s: 62
p13y: 20
p14s: 14
p15s: 11
p3a: 11
p3d: 19
p3n: 31
p3r: 88
p3s: 170
p3t: 465
p3y: 123
p4a: 67
p4d: 122
p4e: 410
p4h: 115
p4k: 99
p4l: 60
p4m: 39
p4n: 463
p4p: 11
p4r: 186
p4s: 205
p4t: 1040
p4y: 256
p5a: 255
p5c: 17
p5d: 98
p5e: 1330
p5f: 30
p5h: 143
p5k: 10
p5l: 69
p5n: 102
p5o: 26
p5p: 31
p5r: 766
p5s: 870
p5t: 299
p5y: 332
p6a: 44
p6c: 307
p6d: 1413
p6e: 4994
p6g: 85
p6h: 106
p6l: 75
p6n: 277
p6o: 11
p6r: 213
p6s: 813
p6t: 205
p6w: 26
p6y: 342
p7a: 93
p7c: 94
p7d: 592
p7e: 843
p7g: 540
p7k: 18
p7l: 134
p7m: 147
p7n: 223
p7r: 246
p7s: 1374
p7t: 1435
p7x: 39
p7y: 237
p8a: 149
p8c: 136
p8d: 819
p8e: 1405
p8g: 312
p8h: 16
p8i: 16
p8k: 12
p8l: 356
p8m: 66
p8n: 539
p8r: 160
p8s: 2343
p8t: 221
p8y: 390
p9a: 56
p9c: 35
p9d: 714
p9e: 216
p9g: 257
p9h: 43
p9l: 405
p9m: 20
p9n: 169
p9o: 13
p9r: 73
p9s: 633
p9t: 494
p9y: 262
q10d: 23
q10g: 13
q10s: 20
q11g: 27
q13n: 10
q13r: 16
q14s: 26
q3e: 16
q4t: 11
q5e: 500
q5k: 75
q5n: 18
q5r: 13
q5t: 145
q6s: 12
q6y: 15
q7l: 31
q7r: 62
q7y: 276
q8d: 17
q8n: 339
q8s: 77
q8y: 38
q9d: 28
q9g: 18
q9s: 218
r10d: 398
r10e: 234
r10g: 175
r10l: 75
r10m: 39
r10n: 640
r10r: 11
r10s: 168
r10t: 29
r10y: 99
r11d: 110
r11e: 78
r11g: 87
r11h: 14
r11l: 13
r11n: 151
r11s: 259
r11t: 28
r11y: 55
r12d: 15
r12e: 26
r12g: 29
r12n: 115
r12s: 72
r12y: 59
r13d: 11
r13e: 17
r13n: 13
r13s: 25
r13y: 71
r14e: 39
r14g: 10
r14n: 87
r14s: 24
r14y: 39
r15s: 104
r3b: 10
r3d: 252
r3e: 18
r3g: 12
r3m: 24
r3n: 458
r3p: 15
r3t: 11
r3w: 79
r4d: 472
r4e: 1174
r4f: 30
r4g: 78
r4h: 129
r4k: 124
r4l: 129
r4m: 905
r4n: 90
r4o: 22
r4p: 11
r4r: 49
r4s: 142
r4t: 262
r4y: 39
r5d: 675
r5e: 195
r5h: 130
r5l: 142
r5m: 20
r5n: 75
r5r: 210
r5s: 525
r5t: 714
r5w: 12
r5y: 426
r6a: 185
r6d: 791
r6e: 290
r6f: 65
r6g: 174
r6k: 46
r6l: 115
r6m: 135
r6n: 775

r6r: 415
r6s: 464
r6t: 710
r6v: 715
r6w: 43
r6y: 402
r7a: 32
r7d: 1139
r7e: 542
r7g: 496
r7h: 25
r7i: 15
r7l: 179
r7n: 502
r7r: 111
r7s: 1095
r7t: 329
r7y: 473
r8c: 69
r8d: 2212
r8e: 325
r8g: 237
r8h: 68
r8l: 24
r8n: 327
r8r: 184
r8s: 560
r8t: 254
r8y: 147
r9c: 15
r9d: 317
r9e: 186
r9g: 642
r9m: 32
r9n: 141
r9r: 21
r9s: 475
r9t: 164
r9y: 15
s10c: 158
s10d: 321
s10e: 125
s10g: 230
s10l: 69
s10m: 50
s10n: 196
s10o: 32
s10r: 44
s10s: 469
s10t: 204
s10y: 114
s11a: 24
s11c: 28
s11d: 98
s11e: 98
s11g: 154
s11h: 43
s11l: 141
s11m: 17
s11n: 206
s11r: 21
s11s: 151
s11t: 51
s11w: 12
s11y: 108
s12d: 79
s12e: 107
s12g: 40
s12h: 15
s12i: 17
s12n: 81
s12r: 15
s12s: 239
s12t: 10
s12y: 148
s13d: 49
s13e: 38
s13g: 17
s13l: 15
s13n: 29
s13r: 10
s13s: 67
s13t: 43
s13y: 51
s14e: 17
s14n: 11
s14s: 29
s14t: 55
s14y: 47
s15n: 10
s15r: 10
s15y: 10
s16n: 14
s16s: 10
s3a: 74
s3b: 18
s3c: 72
s3d: 87
s3e: 4950
s3m: 55
s3n: 409
s3r: 176
s3t: 801
s3w: 600
s3x: 160
s3y: 858
s4a: 109
s4b: 23
s4d: 3697
s4e: 3848
s4f: 26
s4g: 123
s4h: 1441
s4k: 207
s4l: 309
s4m: 135
s4n: 1527
s4p: 361
s4r: 148
s4s: 446
s4t: 1025
s4w: 355
s4y: 85
s5a: 449
s5d: 886
s5e: 2969
s5f: 189
s5g: 42
s5h: 371
s5k: 522
s5l: 2431
s5m: 131
s5n: 545
s5o: 17
s5p: 350
s5r: 145
s5s: 1274
s5t: 1035
s5w: 24
s5y: 451
s6a: 44
s6b: 12
s6c: 51
s6d: 3507
s6e: 1353
s6g: 824
s6h: 368
s6k: 162
s6l: 238
s6m: 373
s6n: 423
s6r: 559
s6s: 2097
s6t: 927
s6w: 135
s6y: 689
s7a: 153
s7b: 12
s7c: 26
s7d: 1327
s7e: 1364
s7g: 1121
s7h: 163
s7i: 13
s7l: 555
s7m: 74
s7n: 390
s7o: 14
s7r: 627
s7s: 1252
s7t: 434
s7v: 34
s7w: 29
s7y: 655
s8a: 29
s8c: 43
s8d: 882
s8e: 550
s8g: 1342
s8h: 211
s8k: 203
s8l: 219
s8m: 19
s8n: 509
s8r: 325
s8s: 1622
s8t: 287
s8v: 15
s8x: 30
s8y: 1160
s9a: 35
s9c: 50
s9d: 806
s9e: 371
s9g: 1178
s9h: 14
s9i: 67
s9k: 21
s9l: 98
s9m: 13
s9n: 429
s9o: 13
s9r: 137
s9s: 1044
s9t: 194
s9y: 486
t10a: 13
t10d: 74
t10e: 100
t10g: 49
t10h: 15
t10l: 32
t10n: 41
t10r: 53
t10s: 521
t10t: 128
t10y: 60
t11d: 112
t11e: 135
t11g: 36
t11h: 33
t11l: 27
t11n: 68
t11r: 11
t11s: 324
t11t: 32
t11y: 34
t12d: 29
t12e: 58
t12g: 18
t12h: 23
t12n: 10
t12s: 121
t12y: 42
t13d: 10
t13e: 14
t13n: 16
t13s: 23
t13y: 18
t14n: 32
t14s: 22
t15n: 11
t3a: 104
t3e: 79438
t3n: 223
t3o: 1608
t3p: 45
t3t: 20
t3x: 75
t3y: 137
t4d: 590
t4e: 2747
t4k: 903
t4l: 849
t4m: 2353
t4n: 3322
t4p: 45
t4r: 83
t4s: 4312
t4t: 12263
t4u: 40
t4y: 3875
t5a: 66
t5b: 50
t5c: 30
t5d: 552
t5e: 6460
t5f: 10
t5g: 303
t5h: 365
t5k: 820
t5l: 88
t5n: 516
t5p: 12
t5r: 3002
t5s: 1525
t5t: 146
t5w: 142
t5y: 165
t6a: 40
t6d: 1075
t6e: 817
t6f: 115
t6g: 502
t6h: 658
t6l: 94
t6n: 384
t6r: 481
t6s: 1255
t6t: 198
t6x: 17
t6y: 417
t7a: 30
t7c: 48
t7d: 340
t7e: 126
t7f: 32
t7g: 579
t7h: 891
t7l: 104
t7n: 101
t7o: 49
t7r: 119
t7s: 882
t7t: 950
t7y: 163
t8a: 23
t8c: 32
t8d: 414
t8e: 370
t8g: 350
t8h: 15
t8l: 76
t8n: 157
t8o: 31
t8r: 292
t8s: 365
t8t: 34
t8w: 120
t8y: 235
t9c: 48
t9d: 151
t9e: 291
t9g: 139
t9h: 45
t9k: 31
t9l: 16
t9n: 39
t9o: 11
t9r: 13
t9s: 250
t9t: 406
t9x: 17
t9y: 166
u10d: 775
u10e: 20
u10g: 69
u10l: 22
u10n: 74
u10r: 12
u10s: 23
u10t: 56
u10y: 71
u11d: 54
u11e: 78
u11g: 42
u11s: 41
u11t: 15
u11y: 111
u12d: 29
u12e: 43
u12s: 17
u12y: 82
u13d: 21
u13e: 32
u13g: 85
u13s: 10
u13y: 43
u14e: 21
u14y: 16
u15y: 10
u16l: 15
u3e: 313
u3m: 11
u4a: 12
u4d: 271
u4h: 18
u4n: 1106

u4o: 13
u5d: 52
u5e: 192
u5g: 47
u5l: 497
u5n: 265
u5r: 1283
u5s: 17
u5t: 30
u5y: 17
u6d: 608
u6e: 216
u6g: 15
u6l: 87
u6n: 32
u6r: 19
u6s: 336
u6t: 45
u6y: 26
u7a: 10
u7d: 96
u7e: 19
u7g: 21
u7l: 37
u7m: 119
u7n: 97
u7o: 42
u7s: 93
u7y: 591
u8d: 65
u8e: 44
u8g: 38
u8l: 16
u8n: 50
u8s: 67
u8y: 68
u9d: 228
u9e: 42
u9g: 41
u9l: 77
u9n: 40
u9s: 56
u9t: 10
u9y: 56
v10d: 18
v10e: 18
v10n: 14
v10r: 16
v10s: 72
v10y: 46
v11n: 12
v11y: 12
v12n: 24
v13h: 11
v13t: 20
v3i: 32
v3l: 80
v3n: 27
v4a: 72
v4d: 20
v4e: 171
v4i: 39
v4l: 21
v4n: 136
v4s: 60
v4t: 65
v4w: 173
v4y: 1394
v5a: 93
v5d: 61
v5e: 630
v5l: 45
v5r: 25
v5s: 296
v5t: 134
v5x: 31
v6a: 77
v6d: 93
v6e: 97
v6i: 214
v6l: 144
v6m: 17
v6n: 29
v6r: 17
v6s: 372
v6t: 33
v6y: 118
v7a: 37
v7d: 31
v7e: 312
v7g: 42
v7k: 10
v7n: 31
v7o: 10
v7r: 72
v7s: 497
v7t: 68
v7y: 265
v8a: 153
v8d: 92
v8e: 152
v8g: 35
v8h: 31
v8l: 18
v8n: 37
v8r: 50
v8s: 242
v8t: 25
v8y: 104
v9a: 17
v9e: 86
v9g: 20
v9i: 12
v9l: 18
v9n: 24
v9r: 12
v9s: 164
v9y: 46
w10d: 28
w10e: 13
w10g: 28
w10l: 18
w10n: 180
w10r: 21
w10s: 62
w11d: 34
w11g: 21
w11s: 45
w12d: 11
w3b: 20
w3n: 74
w3o: 2992
w3r: 844
w3s: 11367
w3t: 64
w3x: 21
w3y: 1522
w4d: 469
w4e: 4923
w4f: 56
w4g: 47
w4h: 9956
w4k: 625
w4l: 2928
w4m: 556
w4n: 2930
w4p: 68
w4r: 28
w4s: 160
w4t: 4856
w4y: 16
w5d: 2652
w5e: 3284
w5f: 11
w5g: 116
w5h: 4911
w5l: 29
w5n: 664
w5r: 194
w5s: 1155
w5t: 165
w5y: 84
w6d: 743
w6e: 45
w6g: 66
w6h: 89
w6m: 25
w6n: 580
w6r: 152
w6s: 495
w6t: 114
w6w: 187
w6y: 187
w7d: 411
w7e: 173
w7g: 745
w7l: 10
w7m: 60
w7n: 260
w7r: 503
w7s: 213
w7t: 1070
w7w: 34
w7y: 80
w8d: 187
w8e: 13
w8g: 108
w8l: 16
w8n: 44
w8o: 19
w8r: 176
w8s: 160
w8t: 10
w8w: 41
w8y: 17
w9d: 139
w9e: 35
w9g: 81
w9i: 29
w9k: 20
w9l: 33
w9n: 96
w9r: 37
w9s: 72
w9t: 28
w9y: 21
x3i: 74
x3v: 34
x3x: 19
x4i: 56
x4y: 30
x5i: 33
x5s: 53
y10s: 20
y3s: 675
y3t: 476
y3u: 5361
y4d: 94
y4k: 193
y4r: 1539
y5d: 33
y5e: 119
y5g: 622
y5h: 65
y5l: 76
y5s: 656
y5v: 11
y6d: 11
y6s: 21
y6w: 55
y7d: 16
y7g: 11
y7r: 40
y8f: 160
y8g: 20
y8l: 15
y8n: 10
y8t: 11
y9l: 11
y9y: 56
z4e: 23
z4l: 24
z5m: 12
z6r: 12
z7s: 10
z7v: 37

B Problem 2 execution results

We list here the execution results of our solution for the second problem (movie analytics) tested on the `movies.csv` dataset. Task 1 (duration per country) produces the following results:

Afghanistan: 815
Albania: 646
Algeria: 2115
American Samoa: 247
Angola: 357
Argentina: 28813
Armenia: 264
Aruba: 739
Australia: 66068
Austria: 22925
Bahamas: 560
Bahrain: 87
Bangladesh: 429
Barbados: 92
Belarus: 427
Belgium: 54192
Bermuda: 95
Bhutan: 291
Bolivia: 797
Bosnia and Herzegovina: 2207
Botswana: 295
Brazil: 27333
Bulgaria: 5430
Burkina Faso: 903
Burma: 95
Cambodia: 894
Cameroon: 615
Canada: 210826
Chad: 493
Chile: 6178
China: 42089
Colombia: 3810
Congo: 88
Costa Rica: 431
Croatia: 4340

Cuba: 2899
Cyprus: 948
Czech Republic: 15317
Czechoslovakia: 8434
Cóte d'Ivoire: 180
Denmark: 44186
Dominican Republic: 866
East Germany: 2095
Ecuador: 893
Egypt: 3090
El Salvador: 167
Estonia: 4651
Ethiopia: 537
Faroe Islands: 97
Federal Republic of Yugoslavia: 2167
Finland: 48990
France: 467279
Gabon: 80
Georgia: 1846
Germany: 226808
Ghana: 655
Greece: 20305
Greenland: 90
Grenada: 79
Guatemala: 638
Guinea: 90
Haiti: 498
Honduras: 80
Hong Kong: 66567
Hungary: 19668
Iceland: 7839
India: 110215
Indonesia: 3931
Iran: 11762
Iraq: 1365
Ireland: 26506
Isle Of Man: 396
Israel: 16662
Italy: 288407
Jamaica: 807
Japan: 178558
Jordan: 1313
Kazakhstan: 2145
Kenya: 523
Korea: 90
Kosovo: 188
Kuwait: 273
Kyrgyzstan: 400
Laos: 289
Latvia: 2297
Lebanon: 1289
Liberia: 283
Libya: 520
Liechtenstein: 1011
Lithuania: 3772
Luxembourg: 11976
Macao: 175
Madagascar: 204
Malaysia: 1338
Mali: 220
Malta: 885
Martinique: 103
Mauritania: 515
Mexico: 35560
Micronesia: 85
Moldova: 95
Monaco: 189
Mongolia: 186
Montenegro: 439
Morocco: 4525
Namibia: 105
Nepal: 797
Netherlands: 47054
New Zealand: 14561
Nicaragua: 183
Nigeria: 494
North Korea: 508
Norway: 26476
Pakistan: 1728
Palestine: 1530
Panama: 903
Papua New Guinea: 295
Paraguay: 317
Peru: 2436
Philippines: 7882
Poland: 35543
Portugal: 15232
Puerto Rico: 1322
Qatar: 1036
Republic of Macedonia: 1515
Reunion: 38
Romania: 15739
Russia: 50757
Rwanda: 527
Samoa: 110
Saudi Arabia: 490
Senegal: 1462
Serbia: 4337
Serbia and Montenegro: 1314
Singapore: 4557
Slovakia: 2525
Slovenia: 2956
Somalia: 90
South Africa: 14688
South Korea: 56245
Soviet Union: 51353
Spain: 116651
Sri Lanka: 318
Suriname: 105
Sweden: 68956
Switzerland: 34516
Syria: 447
Taiwan: 16618
Tajikistan: 351
Tanzania: 441
Thailand: 10189
The Democratic Republic Of Congo: 98
Trinidad and Tobago: 86
Tunisia: 2236
Turkey: 20068
UK: 492616
USA: 2276142
Uganda: 243
Ukraine: 4616
United Arab Emirates: 3202
Uruguay: 2038
Uzbekistan: 324
Vanuatu: 100
Venezuela: 2014
Vietnam: 1261
West Germany: 58480
Yugoslavia: 8742
Zaire: 80
Zimbabwe: 210

Task 2 (movies per year and genre) produces the following results:

1973_Adventure: 1
1973_Drama: 1
1973_History: 1
1976_Comedy: 2
1976_Drama: 1
1976_History: 1
1976_Mystery: 1
1976_Romance: 1
1979_Adventure: 1
1979_Crime: 1
1979_Mystery: 1
1982_Comedy: 1
1982_Drama: 1
1985_Documentary: 1
1985_History: 1
1988_Comedy: 1
1988_Drama: 2
1988_Sci-Fi: 1
1996_Documentary: 1
1996_Music: 1
2001_Documentary: 1
2001_Music: 1
2002_Documentary: 1
2002_Music: 1
2004_Adventure: 1
2004_Documentary: 2
2004_Drama: 1
2004_Music: 1
2004_Romance: 1
2006_Animation: 1
2006_Crime: 1
2006_Drama: 1

2007_Documentary: 1	2008_Crime: 1	2015_Action: 1
2007_War: 1	2008_Drama: 1	2015_Adventure: 1
2008_Action: 1	2009_Documentary: 1	2015_Animation: 1

C Problem 3 execution results

We list here the execution results of our solution for the third problem (mining DNA sequence patterns).

AA: 328236	ACTA: 6151	ATGC: 20429	CCCG: 15287	CTAT: 8656	GCA: 92010	GGTC: 12705
AAA: 104317	ACTC: 9238	ATGG: 18458	CCCT: 8538	CTC: 40893	GCAA: 25483	GGTG: 21949
AAAA: 33151	ACTG: 19234	ATGT: 13456	CCG: 83289	CTCA: 11330	GCAC: 17151	GGTT: 19244
AAAC: 23753	ACTT: 12409	ATT: 79882	CCGA: 14961	CTCC: 9005	GCAG: 27535	GT: 248313
AAAG: 21525	AG: 231133	ATTA: 18033	CCGC: 27044	CTCG: 9953	GCAT: 20449	GTA: 50415
AAAT: 24342	AGA: 54161	ATTC: 16435	CCGG: 22950	CTCT: 9969	GCC: 88989	GTAA: 17001
AAC: 79028	AGAA: 17403	ATTG: 19826	CCGT: 17149	CTG: 98461	GCCA: 29986	GTAC: 11373
AACA: 20648	AGAC: 10050	ATTT: 24372	CCT: 48210	CTGA: 23008	GCCC: 14823	GTAG: 8902
AACC: 19257	AGAG: 10211	CA: 316026	CCTA: 3855	CTGC: 26589	GCCG: 26984	GTAT: 12435
AACG: 22994	AGAT: 15668	CAA: 73266	CCTC: 7577	CTGG: 31803	GCCT: 15890	GTC: 51835
AACT: 14967	AGC: 77456	CAAA: 22726	CCTG: 23291	CTGT: 15584	GCG: 109836	GTCA: 17297
AAG: 60678	AGCA: 21971	CAAC: 20654	CCTT: 12788	CTT: 60920	GCGA: 23903	GTCC: 7788
AAGA: 16071	AGCC: 16675	CAAG: 9104	CG: 336756	CTTA: 9264	GCGC: 33151	GTCG: 16319
AAGC: 18678	AGCG: 25147	CAAT: 19716	CGA: 67889	CTTC: 19829	GCGG: 26823	GTCT: 9694
AAGG: 12858	AGCT: 12547	CAC: 63948	CGAA: 17983	CTTG: 9033	GCGT: 24346	GTG: 63314
AAGT: 12151	AGG: 48468	CACA: 12311	CGAC: 16249	CTTT: 21881	GCT: 76778	GTGA: 17966
AAT: 79476	AGGA: 10559	CACC: 22156	CGAG: 9748	GA: 259534	GCTA: 10018	GTGC: 16924
AATA: 19820	AGGC: 15860	CACG: 15464	CGAT: 22883	GAA: 79933	GCTC: 12590	GTGG: 17237
AATC: 19663	AGGG: 8625	CACT: 13051	CGC: 110789	GAAA: 25923	GCTG: 34350	GTGT: 10240
AATG: 20320	AGGT: 12704	CAG: 100434	CGCA: 24078	GAAC: 16861	GCTT: 18657	GTT: 79059
AATT: 18529	AGT: 47616	CAGA: 20813	CGCC: 33151	GAAG: 19665	GG: 262488	GTTA: 16434
AC: 249408	AGTA: 9965	CAGC: 35398	CGCG: 26624	GAAT: 16328	GGA: 53753	GTTC: 17014
ACA: 56161	AGTC: 8810	CAGG: 23383	CGCT: 25227	GAC: 52428	GGAA: 19116	GTTG: 20618
ACAA: 15670	AGTG: 12816	CAGT: 19337	CGG: 83179	GACA: 12301	GGAC: 7800	GTTT: 23816
ACAC: 10371	AGTT: 15280	CAT: 73632	CGGA: 16056	GACC: 13006	GGAG: 9031	TA: 205922
ACAG: 15775	AT: 300819	CATA: 12645	CGGC: 27287	GACG: 17325	GGAT: 16986	TAA: 65882
ACAT: 13477	ATA: 60954	CATC: 24906	CGGG: 15314	GACT: 8996	GGC: 88242	TAAA: 21016
ACC: 71689	ATAA: 20773	CATG: 14370	CGGT: 23289	GAG: 40596	GGCA: 25961	TAAC: 16559
ACCA: 22611	ATAC: 12580	CATT: 20651	CGT: 70033	GAGA: 11040	GGCC: 11862	TAAG: 9452
ACCC: 11515	ATAG: 8878	CC: 263858	CGTA: 13496	GAGC: 12222	GGCG: 32556	TAAT: 17886
ACCG: 23794	ATAT: 17794	CCA: 82832	CGTC: 17128	GAGG: 7602	GGCT: 16561	TAC: 50347
ACCT: 12668	ATC: 82787	CCAA: 12835	CGTG: 15524	GAGT: 9126	GGG: 45460	TACA: 10059
ACG: 70094	ATCA: 26028	CCAC: 17548	CGTT: 22855	GAT: 82717	GGGA: 10600	TACC: 16192
ACGA: 13381	ATCC: 17273	CCAG: 32327	CT: 229235	GATA: 19089	GGGC: 14376	TACG: 13286
ACGC: 24945	ATCG: 22966	CCAT: 18863	CTA: 25613	GATC: 17963	GGGG: 8241	TACT: 10026
ACGG: 17017	ATCT: 15258	CCC: 45696	CTAA: 7124	GATG: 24737	GGGT: 11534	TAG: 26041
ACGT: 13674	ATG: 72908	CCCA: 12842	CTAC: 8601	GATT: 19727	GGT: 71145	TAGA: 5424
ACT: 47752	ATGA: 19462	CCCC: 8337	CTAG: 832	GC: 373030	GGTA: 16193	TAGC: 9993

TAGG: 3925	TCAC: 17939	TCGC: 24051	TGAA: 24226	TGGA: 15772	TTA: 65815	TTG: 73641
TAGT: 6296	TCAG: 23293	TCGG: 15163	TGAC: 17537	TGGC: 29388	TTAA: 19955	TTGA: 18260
TAT: 60595	TCAT: 19783	TCGT: 13856	TGAG: 11019	TGGG: 12603	TTAC: 17042	TTGC: 25756
TATA: 8542	TCC: 53611	TCT: 53062	TGAT: 25925	TGGT: 22534	TTAG: 7013	TTGG: 12823
TATC: 18970	TCCA: 16156	TCTA: 5213	TGC: 91073	TGT: 55861	TTAT: 20781	TTGT: 15705
TATG: 12412	TCCC: 10346	TCTC: 10881	TGCA: 18677	TGTA: 9995	TTC: 80237	TTT: 105118
TATT: 19788	TCCG: 15949	TCTG: 20097	TGCC: 25972	TGTC: 12434	TTCA: 24566	TTTA: 21113
TC: 259648	TCCT: 10428	TCTT: 16105	TGCG: 23857	TGTG: 12072	TTCC: 18731	TTTC: 25763
TCA: 80436	TCG: 68674	TG: 312973	TGCT: 21277	TGTT: 20499	TTCG: 18383	TTTG: 23085
TCAA: 18194	TCGA: 14613	TGA: 79892	TGG: 81523	TT: 329732	TTCT: 17327	TTTT: 33542

C.1 Problem 4 execution results

In the following 4-columned pages, the experimental results of section's 5 problem are presented, as the raw output of the 3rd MapReduce phase execution.

102: 20.772281	136: 13.721149	214: 19.809753000000004	260: 33.483572999999986
104: 29.609879	137: 13.660803000000001	215: 22.834134999999996	261: 32.508742999999996
105: 27.598046999999998	138: 13.738254000000001	216: 22.450407999999996	264: 12.784288
107: 14.800885000000003	140: 11.448863	217: 12.86093	265: 17.312394
109: 27.163701999999994	141: 12.826131	219: 13.857943	266: 16.947997
110: 16.304225	143: 12.803862	220: 26.279680999999997	267: 26.82996199999999
111: 42.771938	154: 13.723290000000002	221: 15.366022000000003	268: 13.143828000000001
112: 9.670065000000001	170: 35.83375399999999	222: 10.174368	269: 9.54012
113: 28.587929000000003	174: 39.935224000000005	223: 31.783763000000004	27: 18.650638999999998
114: 17.573652999999997	175: 42.11639699999999	226: 11.464125999999998	270: 12.200784000000002
115: 33.936378	176: 33.780936999999994	227: 9.910114	272: 27.8627
116: 25.765458000000002	180: 9.111828999999998	228: 26.034533	273: 20.449326000000003
117: 30.000875	187: 10.061923	229: 17.984762	274: 21.781969000000004
1180: 9.566474	191: 21.271617	23: 8.068862	275: 18.921694000000002
1181: 8.554887	192: 22.415023999999995	231: 11.600534	277: 13.899377000000001
1182: 10.499468	193: 24.815881999999995	232: 21.044421999999994	278: 45.28685699999998
1183: 8.272158999999998	194: 15.367017	24: 15.912360000000001	279: 36.933221999999994
1186: 8.551493	197: 19.721797	244: 20.739924000000002	280: 36.45238099999999
120: 8.667856	198: 20.10406	245: 26.42594699999999	283: 21.347036
121: 24.678666000000003	200: 26.785185	246: 12.422665	285: 39.845339
122: 62.881582	202: 20.554610999999998	247: 12.198811000000001	287: 15.863291
124: 23.14891	203: 26.437709999999992	249: 19.911965999999996	288: 24.174710999999995
128: 13.860000000000001	204: 21.193861000000002	25: 9.950251999999999	289: 20.507460000000005
129: 13.828262	205: 18.054205999999997	250: 20.231632999999995	29: 10.500267
130: 12.778032	206: 12.843962	251: 35.69873999999999	290: 15.802384000000002
131: 14.548629	208: 18.285626	252: 13.855876000000002	292: 34.518677
132: 13.780112000000003	209: 9.478037	254: 8.187458	293: 42.414617
133: 12.777426	210: 18.463774999999995	255: 27.296618	294: 39.387104
134: 17.525341	211: 26.206232	257: 20.167998999999995	295: 33.319982999999986
135: 12.858882000000001	213: 8.21817	258: 13.343784000000001	296: 26.437148

30: 13.124654000000001
300: 16.612497
301: 35.508855000000004
302: 40.46924
303: 30.324057999999997
304: 34.186174
306: 12.180608
308: 49.780783000000014
309: 21.140049
310: 16.898876
311: 9.782459
318: 11.424189000000002
32: 7.906732000000001
320: 15.995923000000003
322: 12.928547
323: 12.95803
324: 14.145467000000002
325: 16.820611
326: 9.210550999999999
327: 8.77006
328: 11.502478
329: 9.477534
330: 7.819681999999999
331: 12.199909
333: 17.355712
334: 16.773555
335: 12.816709
336: 9.472820000000002
337: 16.717836
338: 14.435681000000002
34: 8.902532
341: 13.712019000000002
342: 12.777168000000001
343: 21.60238899999999
344: 13.763916
345: 9.50445
346: 13.803495
347: 13.770425000000001
348: 13.696388000000002
349: 12.777321
35: 8.831461000000001
350: 13.700356000000001
351: 12.82703
352: 18.913772999999996
353: 13.840302000000001
354: 12.026345
355: 13.838998000000002
356: 13.709090000000002
36: 7.751157000000001
361: 13.740885
37: 9.843972
378: 7.955433
379: 11.753690999999998
38: 10.698117
380: 9.03648
381: 31.255191
385: 16.697326
386: 13.088604999999998
389: 43.11891100000001
39: 10.792126000000001
391: 7.855742000000001
40: 7.842008000000001
405: 18.636048
406: 30.94102599999999
408: 16.025723
409: 21.124420999999998
410: 19.690642
412: 12.448818000000001
413: 21.007549999999995
414: 19.201738999999996
415: 20.822085
416: 20.244446999999994
417: 20.336876999999998
418: 20.905703999999997
419: 16.571078
420: 14.833722000000003
421: 22.127405999999997
422: 20.207241999999997
423: 19.837138999999997
424: 22.204759999999993
425: 20.3222
427: 18.573423000000002
428: 18.402874999999998
429: 20.996679999999998
431: 17.247738000000005
432: 7.730989
433: 20.990592000000003
437: 13.467927000000001
438: 22.538098999999995
439: 20.257774999999995
440: 18.640948999999996
441: 22.565751999999993
442: 22.468430999999992
443: 22.236632999999994
444: 12.668758
445: 21.391153999999997
446: 20.229419
447: 23.098830999999993
448: 23.389274999999994
449: 21.425622999999995
450: 20.304112999999994
451: 21.309653999999995
452: 21.574356999999992
453: 21.216737999999992
454: 21.305387999999994
455: 22.443621999999994
456: 18.427684
457: 23.612626999999996
458: 20.137554999999995
468: 16.434241
473: 15.624302000000002
490: 15.118589000000002
492: 29.037201999999994
494: 14.964478999999999
497: 7.779587000000001
505: 22.493396999999998
507: 16.502023
508: 13.205226000000001
509: 10.297368000000002
510: 17.989523
511: 14.096020000000003
512: 7.909458999999998
529: 16.491923000000003
530: 20.54695299999999
531: 13.581469
532: 18.63035
533: 16.137291
534: 15.585291000000002
535: 13.489995
536: 15.663219000000002
537: 15.558095000000002
538: 20.604023999999995
539: 15.567038000000002
540: 10.592666000000001
541: 13.301682
542: 13.708515000000002
544: 8.796812000000001
545: 7.992185
546: 8.689068
547: 17.435207
548: 14.626078000000001
549: 8.902671000000002
550: 15.475738000000002
563: 12.416060000000002
604: 14.693641000000001
605: 14.628854
606: 13.673755000000003
607: 13.823655000000002
608: 13.666609
609: 14.749676000000001
610: 14.726731000000003
611: 12.480203
612: 21.530917999999996
639: 16.345097000000003
64: 11.651773
640: 26.79545999999999
641: 27.95541699999999
642: 22.714243999999994
643: 28.925386
644: 27.951106
645: 9.891883
646: 22.266540999999997
647: 17.500691000000003
653: 31.20108699999998
654: 11.212689
655: 15.470210000000002
656: 13.714576000000001
659: 14.530663000000002
660: 14.484713000000001
661: 14.486255000000002
663: 14.393031
664: 15.657084000000003
665: 12.470333000000002
666: 15.570483000000001
667: 8.476292
668: 8.400375
669: 12.719472000000001
670: 12.759070000000001
671: 18.786868000000002
672: 12.737939000000003
673: 11.354866
674: 12.464726000000002
675: 14.512069
676: 12.633483

677: 15.30606
678: 13.630705
679: 22.209649
680: 26.49534299999999
681: 11.586703
682: 11.780345000000002
683: 10.837639
684: 11.369396
685: 20.680481999999994
686: 28.644553999999992
687: 13.618457000000001
70: 12.576885000000003
702: 15.804968
703: 18.989590999999997
711: 8.769808000000001
72: 13.937429
729: 11.920043
73: 33.317902999999994
739: 14.833940000000002
74: 9.418914
741: 17.572777
743: 16.54965
744: 13.711973000000002
745: 14.759685000000001
746: 14.843160000000001
75: 8.17184
76: 35.16477499999998
765: 8.972965
773: 9.301499
778: 9.388625000000001
779: 8.382993
78: 35.074965
79: 18.829224
792: 9.650819
793: 21.405161999999994
794: 7.747058000000001
796: 7.746258000000001
797: 20.176615999999996
80: 19.708188999999997
81: 27.764969999999987
82: 8.954957
822: 7.824752000000001
827: 26.284926
828: 31.25722999999999
83: 16.828261
830: 12.777338
84: 17.39505
845: 19.799999999999997
846: 23.372872999999995
847: 21.634598999999994
848: 21.599697999999993
849: 20.692736999999997
85: 17.810776
850: 21.486940999999995
851: 20.637819999999998
852: 20.758516999999994
853: 19.714644999999994
854: 20.674989999999998
858: 10.127550999999999
859: 13.744827
86: 9.620828000000001
860: 13.392533000000002
861: 12.716919
862: 14.757012000000001
863: 14.737124000000001
870: 12.684738000000001
871: 12.674369
872: 11.814398
873: 12.763509
874: 10.89
875: 12.642457000000002
876: 12.794634000000002
877: 9.48321
878: 12.762451
879: 13.635698000000001
880: 12.768133
881: 12.801868000000002
882: 10.89
893: 7.887907
894: 9.918199
895: 16.402685000000005
896: 15.014125
901: 10.018733
902: 18.710283
915: 9.631426000000001
917: 9.638277000000002
918: 10.553774
919: 8.431745
922: 10.480677000000002
926: 20.516713999999997
927: 18.237036999999997
928: 18.419195
929: 20.752049999999997
930: 13.043696999999998
931: 18.611175
932: 20.685094999999997
933: 20.786459999999995
935: 20.676130999999998
936: 21.667931999999997
937: 19.520974999999996
941: 25.234674999999996
948: 16.893155
950: 20.797809999999995
951: 19.461768999999997
953: 18.305716999999998