

Big Data Assignment 1

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March 1, 2024



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Contents

1	Find or Create a Suitable Data Set	2
1.1	Data Set Explanation	2
1.2	Data Pre-Processing	2
2	Design a MongoDB Database	3
2.1	Collection 1 - books	3
2.2	Collection 2 - users	6
2.3	Explanation and Justification	9
2.3.1	Books	9
2.3.2	Users	9
3	Create and Load This MongoDB Database	11
3.1	Load the Database	11
3.1.1	Books Collection	11
3.1.2	Users Collection	11
3.2	TODO Testing	11

1 Find or Create a Suitable Data Set

1.1 Data Set Explanation

Link to the dataset: <https://github.com/zygmuntz/goodbooks-10k>

The dataset initially contained multiple csv files representing information on books, and user data on book ratings. This dataset was chosen as its ideal for a MongoDB database due to its semi-structured nature and nested data, which is particularly useful for storing ratings and book tags.

Dataset Content:

- **books.csv**: Each entry represents a book with a unique `book_id`. There are multiple data fields for a book:
 - **book_id, goodreads_book_id, best_book_id, work_id**: Unique id's representing a book, each with a different purpose. We only used `book_id` and `goodreads_book_id` as they're used to link books to user `ratings` and user `to_read` lists.
 - **ratings_1, ratings_2, ...**: Number of user ratings by rating value. eg. `ratings_1` represents the number of 1 star ratings given to that book.
 - The rest of the fields are self explanatory but include info relating to authors, title, release date, and isbn number.
- **ratings.csv**: Each entry is a `user_id` to `book_id` mapping with a rating.
- **book_tags.csv**: Each entry is a `book_id` to `tag_id` mapping.
- **tags.csv**: Each entry is a `tag_id` to `tag_name` mapping.
- **to_read.csv** : Each entry is a `user_id` to `goodreads_book_id` mapping which represents a user adding a book to their `to_read` list.

1.2 Data Pre-Processing

The data was processed such that the data was represented in JSON format with evidence of nested objects so that we could demonstrate the capabilities of MongoDB.

Here is a quick outline on how we processed the data to create JSON files:

Libraries used: Pandas, PyArrow, Faker

Pandas was used to load the csv files into dataframes where we merged data and applied `group by` aggregate functions to obtain lists of data objects per a unique entry id. This was useful, for example, when we obtained a list of tags per `book_id`.

Faker was used to generate random usernames for each id that were then written to `user_data.csv`. The dataframes were then converted into JSON files.

All data pre-processing code is in the data-processing directory but the output JSON files are included in the final submission.

2 Design a MongoDB Database

Both Collection Schemas were designed by creating hand-made JSON example objects. Each of these objects shows what a document in the DB would look like. Underneath each JSON example, we have included a diagram which represents the example's nesting visually.

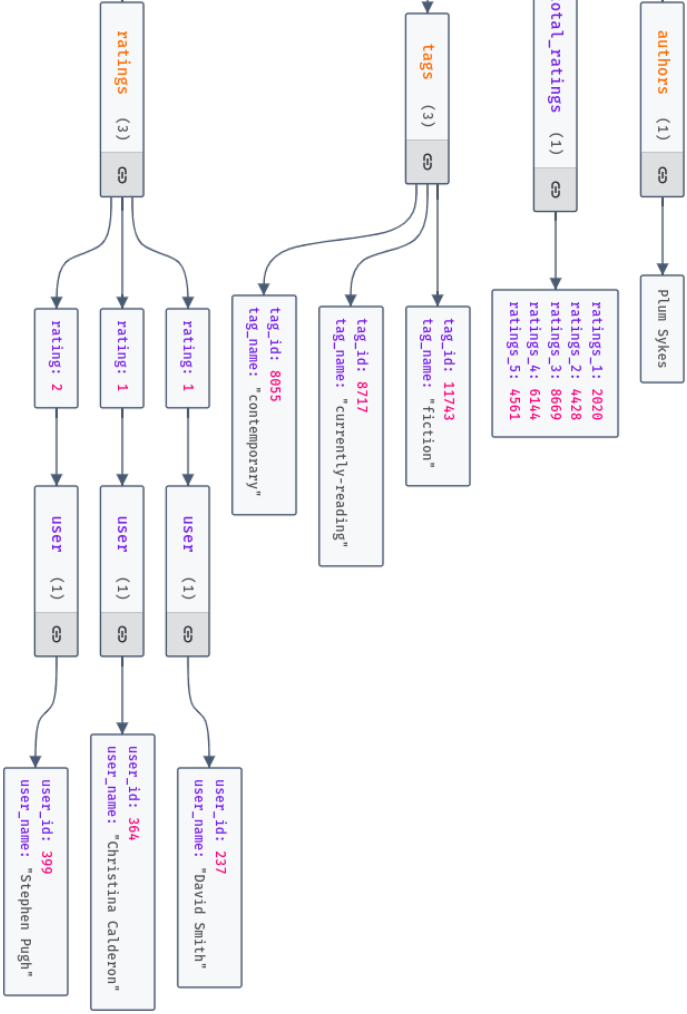
2.1 Collection 1 - books

JSON example

```
{
  "book_id": "98",
  "isbn": "1401359604",
  "isbn13": "9781401359610.0",
  "authors": [
    "Plum Sykes"
  ],
  "original_publication_year": 2004,
  "title": "Bergdorf Blondes",
  "language_code": "en-US",
  "average_rating": 3.26,
  "ratings_count": 23795,
  "total_ratings": {
    "ratings_1": 2020,
    "ratings_2": 4428,
    "ratings_3": 8669,
    "ratings_4": 6144,
    "ratings_5": 4561
  },
  "image_url": "https://s.gr-assets.com/assets/nophoto/book/111x148-bcc042a9c91a29c1d680899eff700a03.png",
  "tags": [
    {
      "tag_id": 11743,
      "tag_name": "fiction"
    },
    {
      "tag_id": 8717,
      "tag_name": "currently-reading"
    },
    {
      "tag_id": 8055,
      "tag_name": "contemporary"
    }
  ],
  "ratings": [
    {
      "user": {
        "user_id": 237,
        "user_name": "David Smith"
      },
      "rating": 1
    },
  ],
}
```

```
{
  "user": {
    "user_id": 364,
    "user_name": "Christina Calderon"
  },
  "rating": 1
},
{
  "user": {
    "user_id": 399,
    "user_name": "Stephen Pugh"
  },
  "rating": 2
}
]
```

book_id: "98"
isbn: "1401359604"
isbn13: "9781401359610_0"
original_publication_year: 2004
title: "Bergdorf Blondes"
language_code: "en-US"
average_rating: 3.26
ratings_count: 23795
image_url: "https://s.gr-assets.com/assets/nophoto/book/11x148-bcc04299c9a29c1d6889994ff7-



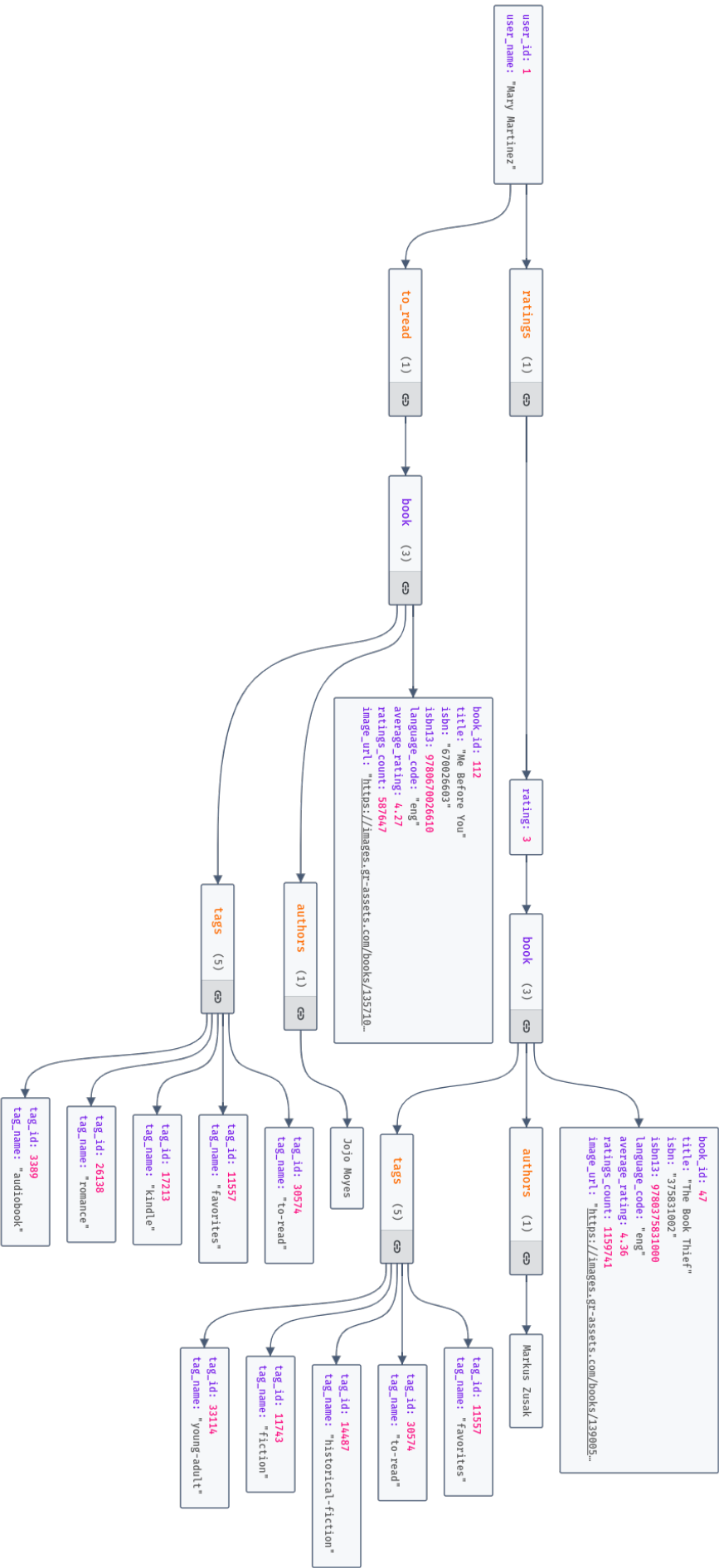
2.2 Collection 2 - users

```
{
  "user_id": 1,
  "user_name": "Mary Martinez",
  "ratings": [
    {
      "book": {
        "book_id": 47,
        "authors": [
          "Markus Zusak"
        ],
        "title": "The Book Thief",
        "isbn": "375831002",
        "isbn13": 9780375831000.0,
        "language_code": "eng",
        "average_rating": 4.36,
        "ratings_count": 1159741,
        "image_url": "https://images.gr-assets.com/books/1390053681m/19063.jpg",
        "tags": [
          {
            "tag_id": 11557,
            "tag_name": "favorites"
          },
          {
            "tag_id": 30574,
            "tag_name": "to-read"
          },
          {
            "tag_id": 14487,
            "tag_name": "historical-fiction"
          },
          {
            "tag_id": 11743,
            "tag_name": "fiction"
          },
          {
            "tag_id": 33114,
            "tag_name": "young-adult"
          }
        ]
      },
      "rating": 3
    }
  ],
  "to_read": [
```

```

{
  "book": {
    "book_id": 112,
    "authors": [
      "Jojo Moyes"
    ],
    "title": "Me Before You",
    "isbn": "670026603",
    "isbn13": 9780670026610.0,
    "language_code": "eng",
    "average_rating": 4.27,
    "ratings_count": 587647,
    "image_url": "https://images.gr-assets.com/books/1357108762m/15507958.jpg",
    "tags": [
      {
        "tag_id": 30574,
        "tag_name": "to-read"
      },
      {
        "tag_id": 11557,
        "tag_name": "favorites"
      },
      {
        "tag_id": 17213,
        "tag_name": "kindle"
      },
      {
        "tag_id": 26138,
        "tag_name": "romance"
      },
      {
        "tag_id": 3389,
        "tag_name": "audiobook"
      }
    ]
  }
}
]
}

```

2.3 Explanation and Justification

The data in CSV format emulates the functionality of a relational database. Many of the fields have foreign keys that point to elements in the other CSV files. Document store database favour efficiency over consistency, thus, we have nested a copy of the relevant object where the value would have otherwise been a foreign key. The process by how this was achieved was highlighted in “[Data Pre-Processing](#)”.

The data was seeded into the following 2 collections:

- books
- users

2.3.1 Books

The books collection roughly followed the format of books.csv (outlined in “[Data Set Explanation](#)”) with some modifications. We omitted unnecessary information and altered the names of some of the properties to make their semantic meaning clearer. As a result each book document includes:

- General information about the book (title, author, original_publication_year, etc.).
- Aggregated rating values (average_rating, total_ratings, ratings_counts).
- A ratings list
 - Each element represents a user’s review of that book. It includes the user’s basic information and the assigned rating score.
- A tags list. Each tag represents a genre or category the book belongs to.

The most significant element of our design was the aforementioned nesting. Rather than store a separate tags collection, all the tags associated with the book are stored as a list of objects. The same is true for ratings, which is a list of rating objects.

Use case examples:

- Collection of books: Querying to see the average rating of a book and the distribution of ratings of a particular book

2.3.2 Users

Unlike books, the users collection does not directly correspond to a csv file. Instead, users was created by combining data from ratings.csv, to_read.csv, and books.csv. We chose to create the user collection in order to demonstrate the importance of collection design with regards to query efficiency. While the users contains a lot of duplicate data from books, it does so in a way that places information about the users at the top of the nesting hierarchy. This means that data about individual users can be obtained without performing expensive joins. The chosen collection design allows one to access, store and perform analytics from the perspective of the user. Each document in the users collection includes the following:

- A `user_id` and `user_name` (randomly generated, as explained in “[Data Pre-Processing](#)”).
- A `ratings` list:
 - Each element represents a score that the user has given to a book.
 - The element includes a `book` object and a given `rating` score.
 - The nested `book` object includes all high-level data about that book, as would be found in the `books` collection.
- A `to_read` list.
 - Each element represents a book that the user has added to their `to_read` list (ie. plans to read that book).
 - The element is represented as a `book` object that is identical in structure to those represented in the `ratings` list.

Use case examples:

Collection of users: what books user X wants to read.

3 Create and Load This MongoDB Database

3.1 Load the Database

The process of creating and loading the database was significantly simplified on account of the fact that we had already [Pre-Processed](#) the data into JSON format. For each collection, a shell command is called to seed the JSON data into their associated collections. The creation of the database is implicit ie. inserting data into the non-existent database leads to its creation. The commands use `mongoimport`, a CLI tool designed for extracting data from plain-text formats (eg. JSON) and inserting them into MongoDB databases.

3.1.1 Books Collection

```
mongoimport --db bookstore --collection books --file mongo-seed/books.json --jsonArray
```

3.1.2 Users Collection

```
mongoimport --db bookstore --collection users --file mongo-seed/users.json --jsonArray
```

3.2 TODO Testing

The shell commands were tested and the output has been annotated on the following page:

```
80Assignment1 on / main [ $? ] via @ v18.17.1 via v3.11.5
} mongosh
Current Mongosh Log ID: 65e02d3d4ff0cb22198e19a8
Connecting to: mongod://127.0.0.1:27017/?directConnection=true&serverSelectionTimeoutMS=2000&appName=mongosh+2.1.5
Using MongoDB: 7.0.5
Using Mongosh: 2.1.5

For mongosh info see: https://docs.mongodb.com/mongod-shell/

-----
The server generated these startup warnings when booting
2024-02-28T15:34:02.442+00:00: Access control is not enabled for the database. Read and write access to data and configuration is unrestricted
2024-02-28T15:34:02.442+00:00: vm.max_map_count is too low
-----

test> show dbs
admin      48.00 KiB
config    108.00 KiB
local      72.00 KiB
test>

80Assignment1 on / main [ $? ] via @ v18.17.1 via v3.11.5 took 28s
} mongoimport --db bookstore --collection users --file mongo-seed/users.json --jsonArray
} mongoimport --db bookstore --collection books --file mongo-seed/books.json --jsonArray
2024-02-29T09:08:31.249+0200 connected to: mongod://localhost/
2024-02-29T09:08:31.589+0200 255 document(s) imported successfully. 0 document(s) failed to import.
2024-02-29T09:08:31.602+0200 connected to: mongod://localhost/
2024-02-29T09:08:31.824+0200 2184 document(s) imported successfully. 0 document(s) failed to import.

80Assignment1 on / main [ $? ] via @ v18.17.1 via v3.11.5
} mongosh
Current Mongosh Log ID: 65e02d938dc73afd1fd4d2df
Connecting to: mongod://127.0.0.1:27017/?directConnection=true&serverSelectionTimeoutMS=2000&appName=mongosh+2.1.5
Using MongoDB: 7.0.5
Using Mongosh: 2.1.5

For mongosh info see: https://docs.mongodb.com/mongod-shell/

-----
The server generated these startup warnings when booting
2024-02-28T15:34:02.442+00:00: Access control is not enabled for the database. Read and write access to data and configuration is unrestricted
2024-02-28T15:34:02.442+00:00: vm.max_map_count is too low
-----

test> use bookstore
switched to db bookstore
bookstore>

80Assignment1 on / main [ $? ] via @ v18.17.1 via v3.11.5 took 1m
} mongosh
Current Mongosh Log ID: 65e02dd18ea8219511814a69
Connecting to: mongod://127.0.0.1:27017/?directConnection=true&serverSelectionTimeoutMS=2000&appName=mongosh+2.1.5
Using MongoDB: 7.0.5
Using Mongosh: 2.1.5

For mongosh info see: https://docs.mongodb.com/mongod-shell/

-----
The server generated these startup warnings when booting
2024-02-28T15:34:02.442+00:00: Access control is not enabled for the database. Read and write access to data and configuration is unrestricted
2024-02-28T15:34:02.442+00:00: vm.max_map_count is too low
-----

test> show dbs
admin      48.00 KiB
bookstore  2.28 MiB
config    108.00 KiB
local      72.00 KiB
test> use bookstore
switched to db bookstore
bookstore> db.books.find({ tags: { $elemMatch: { tag_name: "mystery" } } }, { _id: 0, title: 1, authors: { $slice: 1 }, average_rating: 1 }).sort({ average_rating: -1 }).limit(5)
[
  {
    authors: [ 'Arthur Conan Doyle' ],
    title: 'Sherlock Holmes: The Complete Novels and Stories, Volume I',
    average_rating: 4.45
  }
]
```

Show that db "bookstore" does not exist.

Import JSON

use bookstore

Bookstore is now 2.28MiB

Confirm with query.
Couldn't fit it in fully.