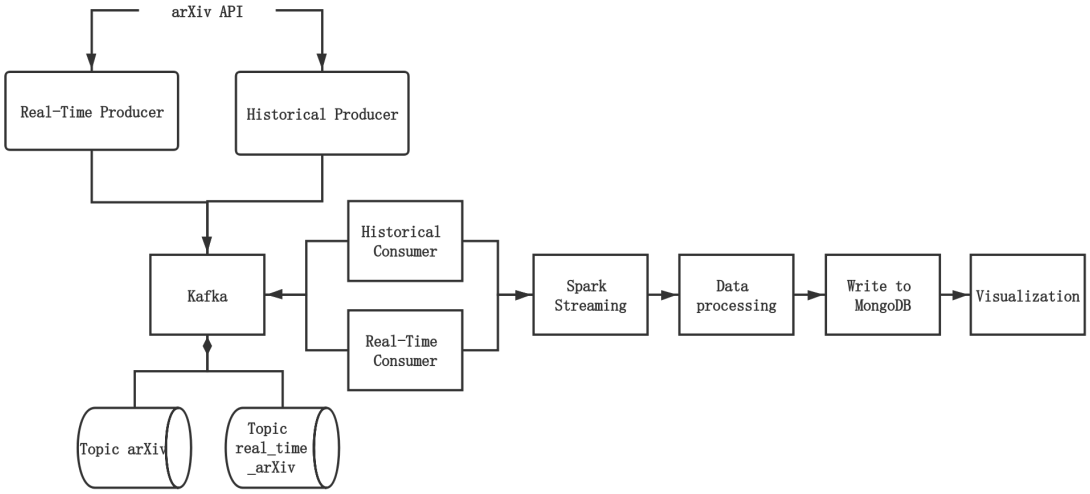
Data Intensive Computing

arXiv Streaming Processing

Jiang Zehao
Marini Luca

1 Our Methodology



The above chart summarizes the main components of this project:

- **arXiv API:**
  - Get response including all kinds of basic information about the papers by sending specified queries for historical and real-time.
- **Producers:**
  - Get papers' data from the arXiv API in XML format;
  - send each paper to Kafka as a tuple of (key, value). The value contains paper's fields in json format.
  - Do some basic preprocessing. We compared the published time and the updated time of the paper to see if this paper is version 1. We also extracted the common words in the title and the abstract, used python nltk package to remove the stop words to get a more detailed idea of the paper's topic.
  - Real-Time Producer:
    - Get papers from yesterday to simulate real-time processing and sends to Kafka *real_ time_ arXiv* topic. The reason why we don't actually use the latest feed of this API is that now it only refreshes at midnight every day.
  - Historical Producer:
    - Get all papers' information and sends to Kafka *arXiv* topic.
- **Kafka:**
  - Topic *arXiv*: it will store information about all papers.

  - Topic *real_ time_ arXiv*: it will store information about yesterday papers.

- **Consumers:**
  - pull data from Kafka
  - exploit Spark Streaming to process the incoming data from Kafka. They save it in a Spark DataFrame that takes the schema from the json format of the received value
  - Perform some Data Processing tasks. One thing about spark streaming dataframe is that in order to apply functions like *groupBy* or *agg*, the dataframe must contain watermark. Here we added a *time* column with the current timestamp and defined an event time watermark with a *delayThreshold* of 15 seconds. This is to know when a given time window aggregation can be finalized and thus can be emitted when using output modes that do not allow updates. We then used *window* function to define a 10 seconds unbounded window frame to groupBy on.
  - Write data to MongoDB.
  - Real-Time Consumer:
    - Consumes papers' information from yesterday from topic *real_ time_ arXiv*.
  - Historical Consumer:
    - Consumes all papers' information from topic *arXiv*.

- **MongoDB:**
  - Store all the papers' original and processed information, whereby the primary key of paper id was used.

- **Visualization:**
  - Users can visualize data in one or multiple dashboards with MongoDB Charts. We created multiple graphs and charts for users to visualize, both on historical and real-time data.
  - Admins can query the data with MongoDB Compass.

2 Dataset

The data source of this project is retrieved from arXiv API [1]. It offers programmatic access to all the papers on *arXiv.org* and contains information related to each paper such as its title, authors, summary, etc. The following table lists each element of the returned results.

element	explanation
<title>	The title of the feed.
<id>	A unique id assigned to this query.
<updated>	Last time search results for this query were updated.
<published>	The date that version 1 of the article was submitted.
<summary>	The article abstract.
<author>	One for each author.
<arxiv:primary_category>	The primary arXiv category.
<arxiv:comment>	The authors comment if present.

3 How to run the project

Follow the instructions of *this Readme*.

4 Visualization

Because of the limitation of the report, we can only show 2 of the charts we created.

Some users might be interested in knowing the trend of a certain topic, e.g. is there an increasing number of computer science related papers over the years? Which subject is becoming obsolete? Such questions can be answered by the following kind of trend line graph, which shows the number of pages in every category within a period of time. Users can adjust themselves the window or use more detailed common words to search instead of general categories. Others might wonder which subject has most papers. With this pie chart, we can say that mathematics wins by a lot.

See more charts examples *here*.

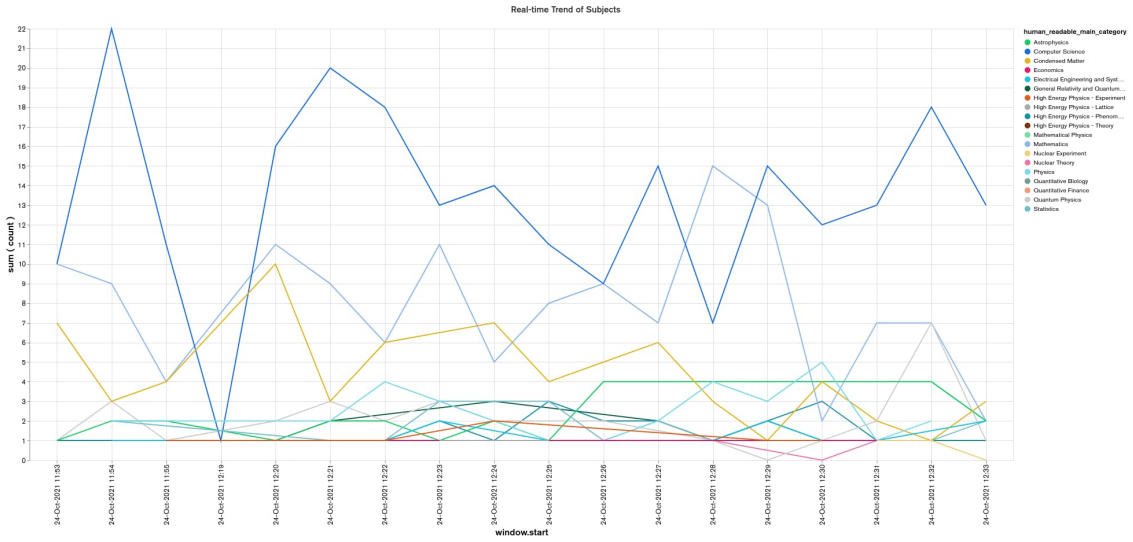


Figure 1: Real-time Trend of Subjects

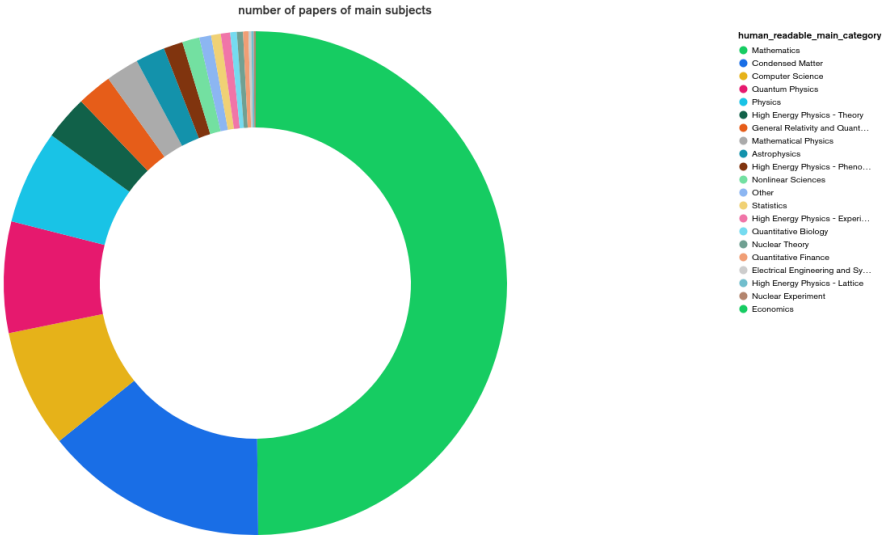


Figure 2: Number of Papers of Main Subjects

References

[1] arXiv. *arXiv API Access*. URL: `https://arxiv.org/help/api/`.