Movie Knowledge Question & Answer

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GItHub:https://github.com/GuoYunZheSE/MovieKnowledge

Website Accessible: http://121.40.189.99:4753/#/ (IMPORTANT: Please read the demo description section of the report before trying our demos)

2022/02/06

Data Source and Data Process

Data Craw

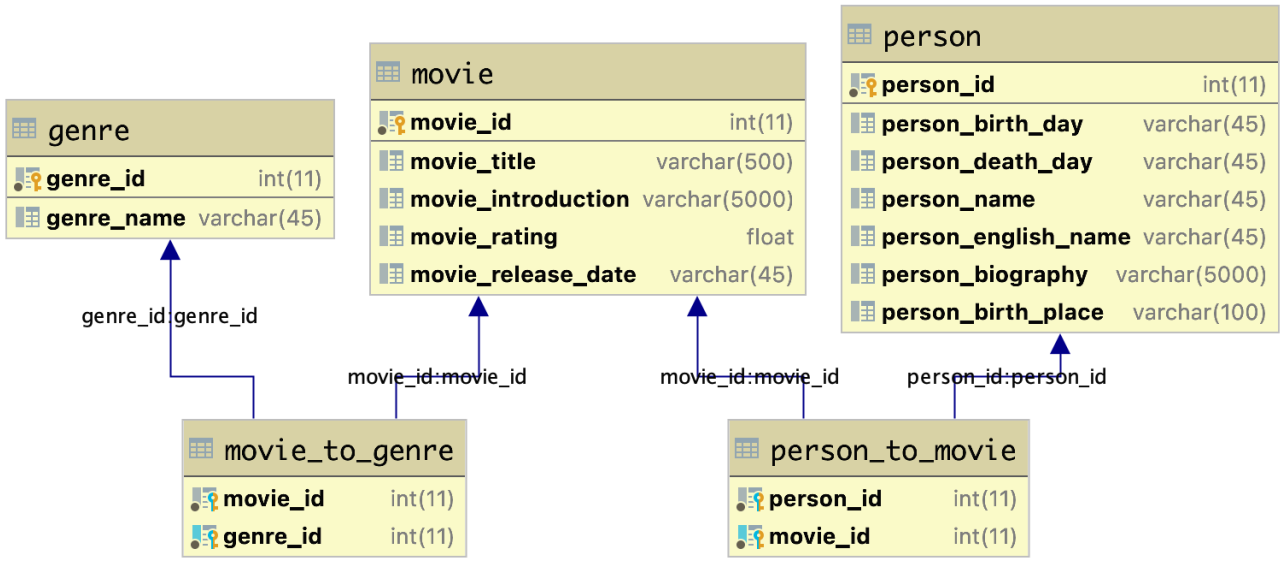
The data is obtained from The Movie Database (TMDB)website, which officially provides API KEY for registered users to query and download the data.

Basic information of actors include: name, English name, date of birth, date of death, place of birth, and personal profile.

Basic information of the movie includes: movie title, movie synopsis, movie rating, movie release date, and movie genre.

In this example, we take **Leonardo DiCaprio** as the initial entry point and get all the movies he has appeared in; then we get all the actors and actresses in these movies; finally we get all the movies in which all the actors and actresses have appeared. After de-duplication, we get **1976** actors' basic information and **29174** movies' basic information. The data is saved in **MySQL**.

The ER graph is :



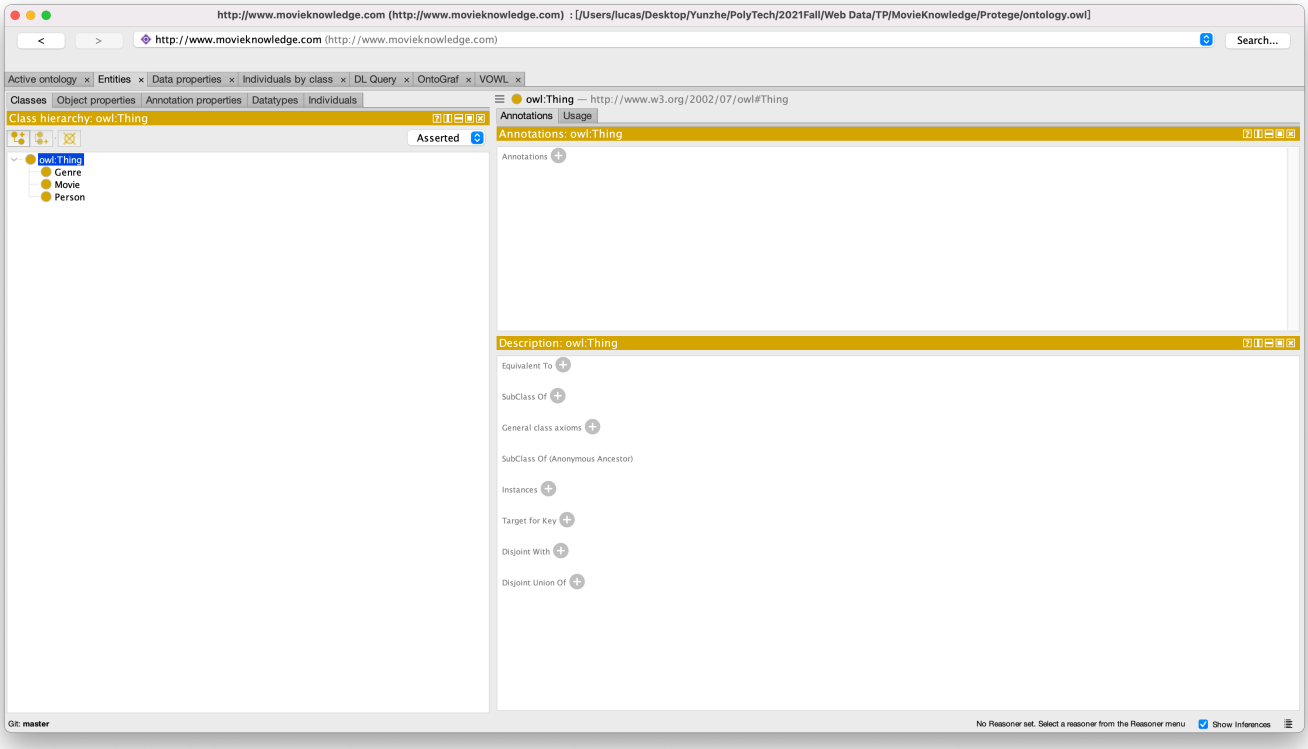
The basic statistics are as follows.

1. Number of actors: 1976

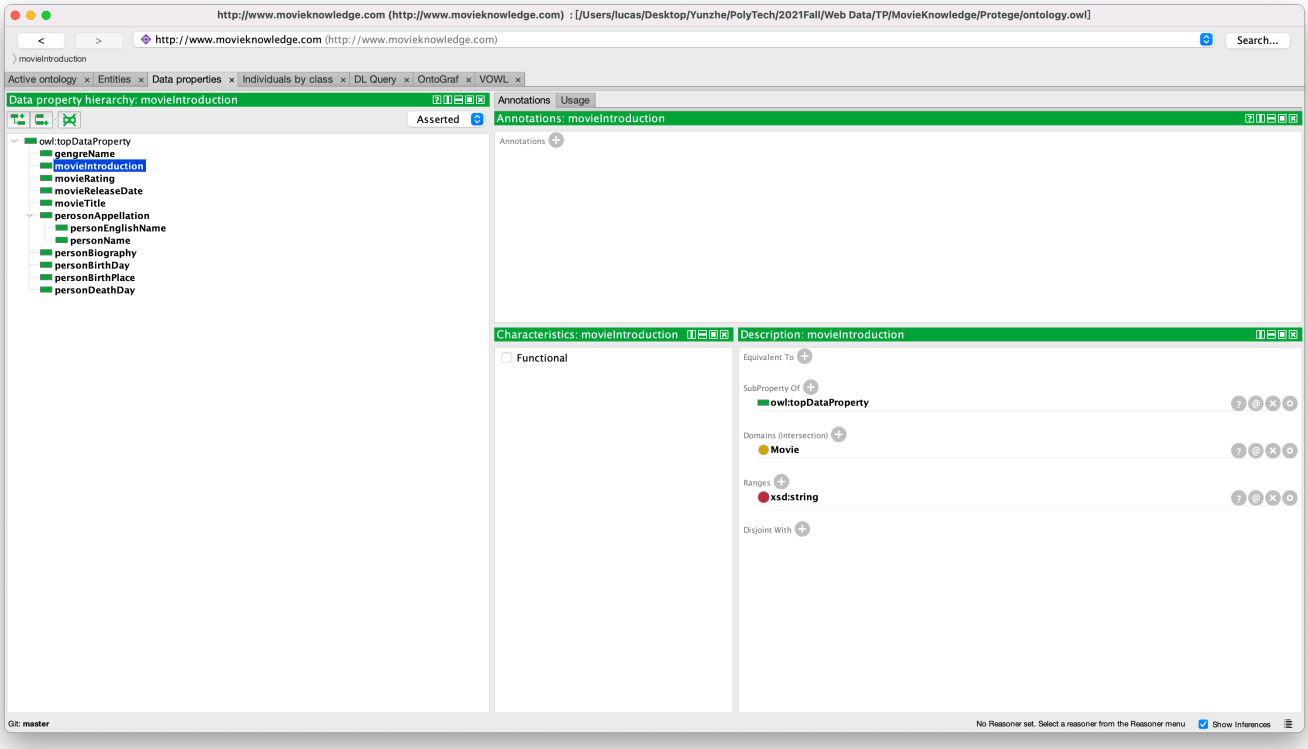
2. Number of movies: 29174
3. Film genres: 19 categories
4. Relationship between characters and movies: 48101
5. Relationship between movies and genres: 55968

Ontology modeling

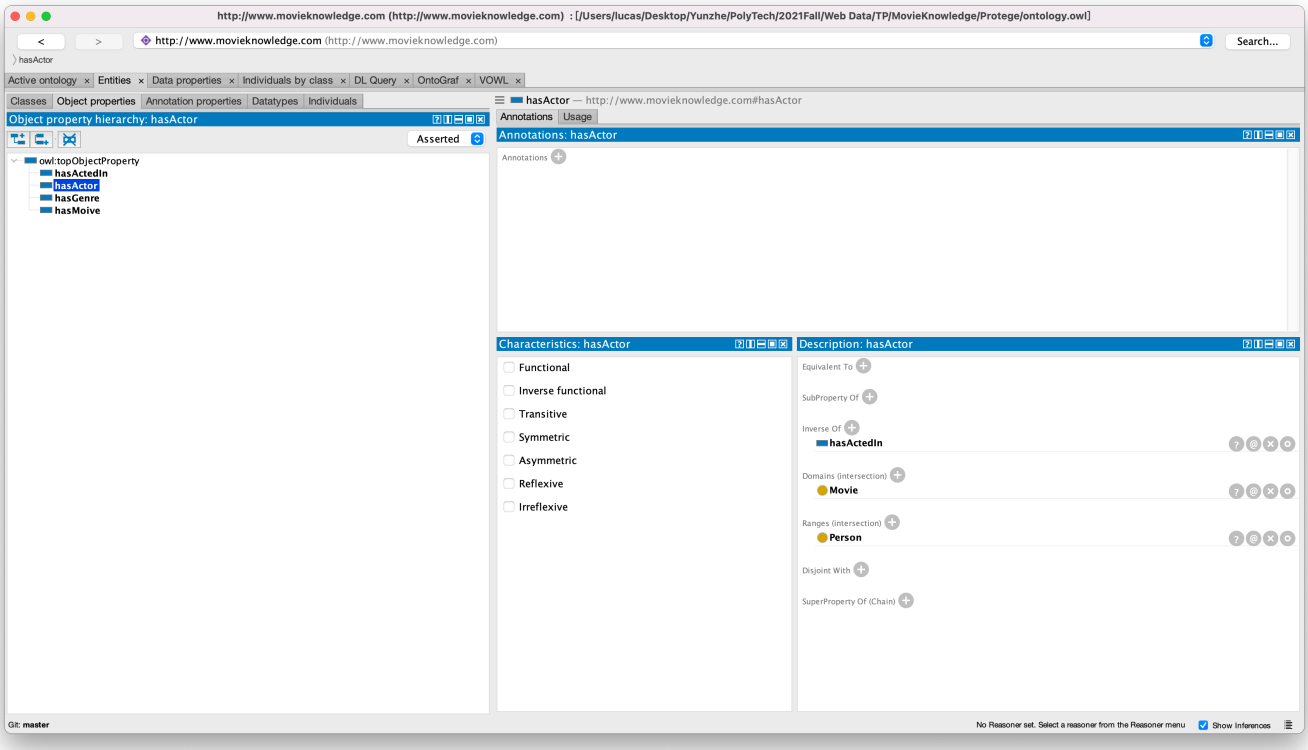
Entities



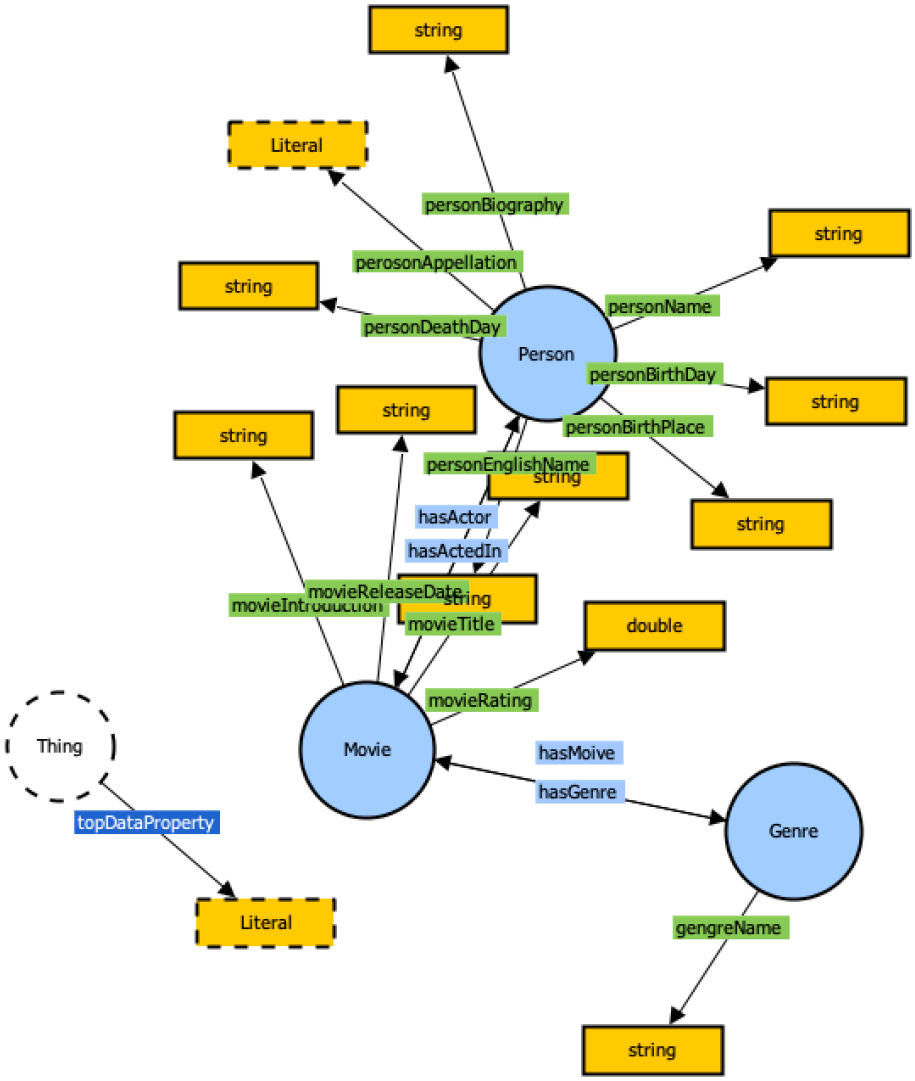
Data Properities



Object Properities



Over All



Map SQL to RDF by d2rq

D2RQ provides its own mapping language in a form similar to R2RML. d2rq has the convenience of automatically generating a predefined mapping file based on the database, and users can modify this file to map the data to their own ontology.

Generate Mapping File

```
generate-mapping -u root -o movie_mapping.ttl jdbc:mysql:///MovieKnowledge
```

After some modification, we can get our mapping file `movie_mapping.ttl` like this:

```
@prefix map: <#> .
@prefix db: <> .
@prefix vocab: <vocab/> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
```

```
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
@prefix d2rq: <http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RQ/0.1#> .
@prefix jdbc: <http://d2rq.org/terms/jdbc/> .
@prefix : <http://www.movieknowledge.com#> .

map:database a d2rq:Database;
  d2rq:jdbcDriver "com.mysql.jdbc.Driver";
  d2rq:jdbcDSN "jdbc:mysql:///MovieKnowledge";
  d2rq:username "root";
  d2rq:password "yourpassword";
  jdbc:zeroDateTimeBehavior "convertToNull";
  jdbc:autoReconnect "true";
  .
# Table genre
map:genre a d2rq:ClassMap;
  d2rq:dataStorage map:database;
  d2rq:uriPattern "genre/@@genre.genre_id@@";
  d2rq:class :Genre;
  d2rq:classDefinitionLabel "genre";
  .
map:genre_genre_name a d2rq:PropertyBridge;
  d2rq:belongsToClassMap map:genre;
  d2rq:property :genreName;
  d2rq:propertyDefinitionLabel "genre genre_name";
  d2rq:column "genre.genre_name";
  .
```

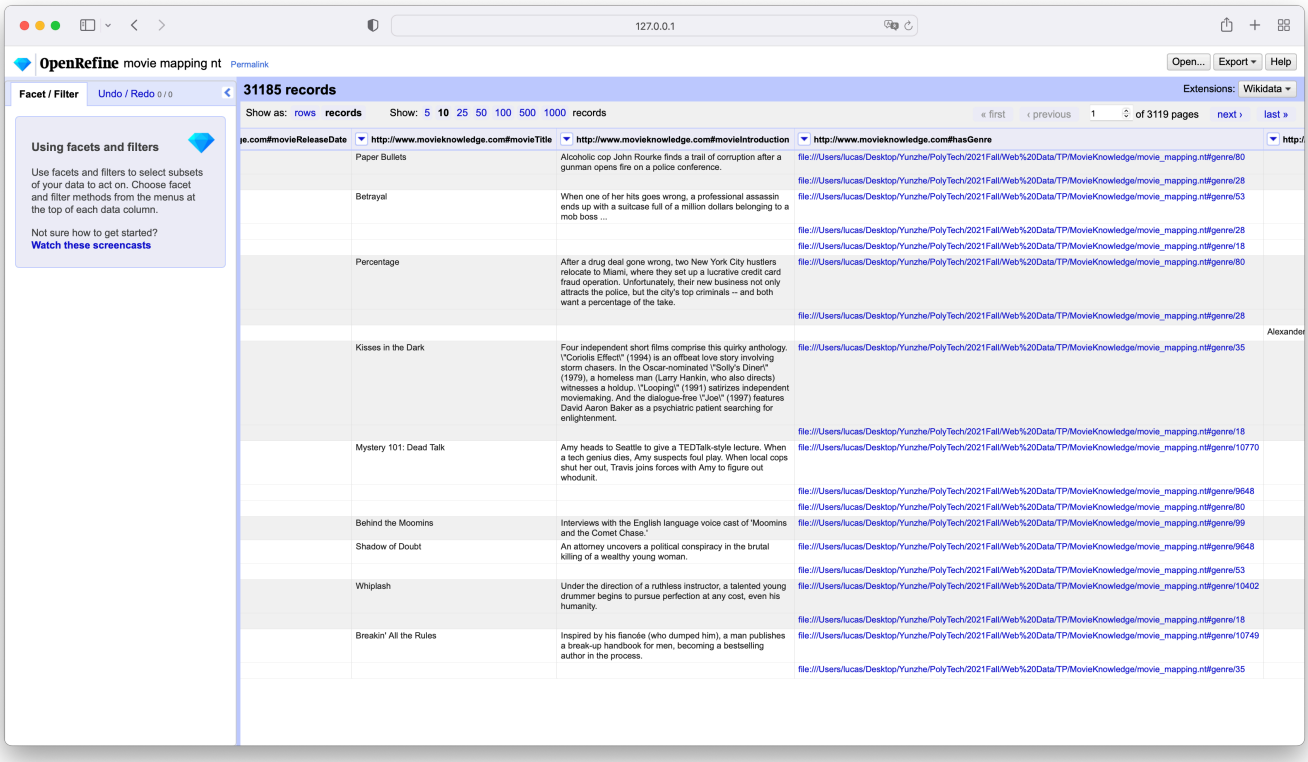
Generate RDF File Automatically

```
./dump-rdf -o movie_mapping.nt ./movie_mapping.ttl
```

The Turtle RDF file contains something like this:

```
<file:///Users/lucas/Desktop/Yunzhe/PolyTech/2021Fall/Web%20Data/TP/MovieKnowledge/movie_mapping.nt#person/2955369> <http://www.movieknowledge.com#PersonBirthDay> "1949-01-12" .
<file:///Users/lucas/Desktop/Yunzhe/PolyTech/2021Fall/Web%20Data/TP/MovieKnowledge/movie_mapping.nt#person/2955369> <http://www.movieknowledge.com#personBiography> "David Luban is a University Professor and Professor of Law and Philosophy. Since 2013, he has also served as Class of 1984 Distinguished Chair in Ethics at the U.S. Naval Academy's Stockdale Center for Ethical Leadership." .
<file:///Users/lucas/Desktop/Yunzhe/PolyTech/2021Fall/Web%20Data/TP/MovieKnowledge/movie_mapping.nt#person/2955369> <http://www.movieknowledge.com#personBirthPlace> "Milwaukee, Wisconsin, USA" .
<file:///Users/lucas/Desktop/Yunzhe/PolyTech/2021Fall/Web%20Data/TP/MovieKnowledge/movie_mapping.nt#person/2955369> <http://www.movieknowledge.com#personEnglishName> "David Luban" .
<file:///Users/lucas/Desktop/Yunzhe/PolyTech/2021Fall/Web%20Data/TP/MovieKnowledge/movie_mapping.nt#person/2955369> <http://www.w3.org/1999/02/22-rdf-syntax-ns#type> <http://www.movieknowledge.com#person> .
```

We can see the content more clearly by `OpenRefine`:



Apache Jena SPARQL Endpoint

The section we will use in this subsection are: **TDB**, **Jena** and **Fuseki**.

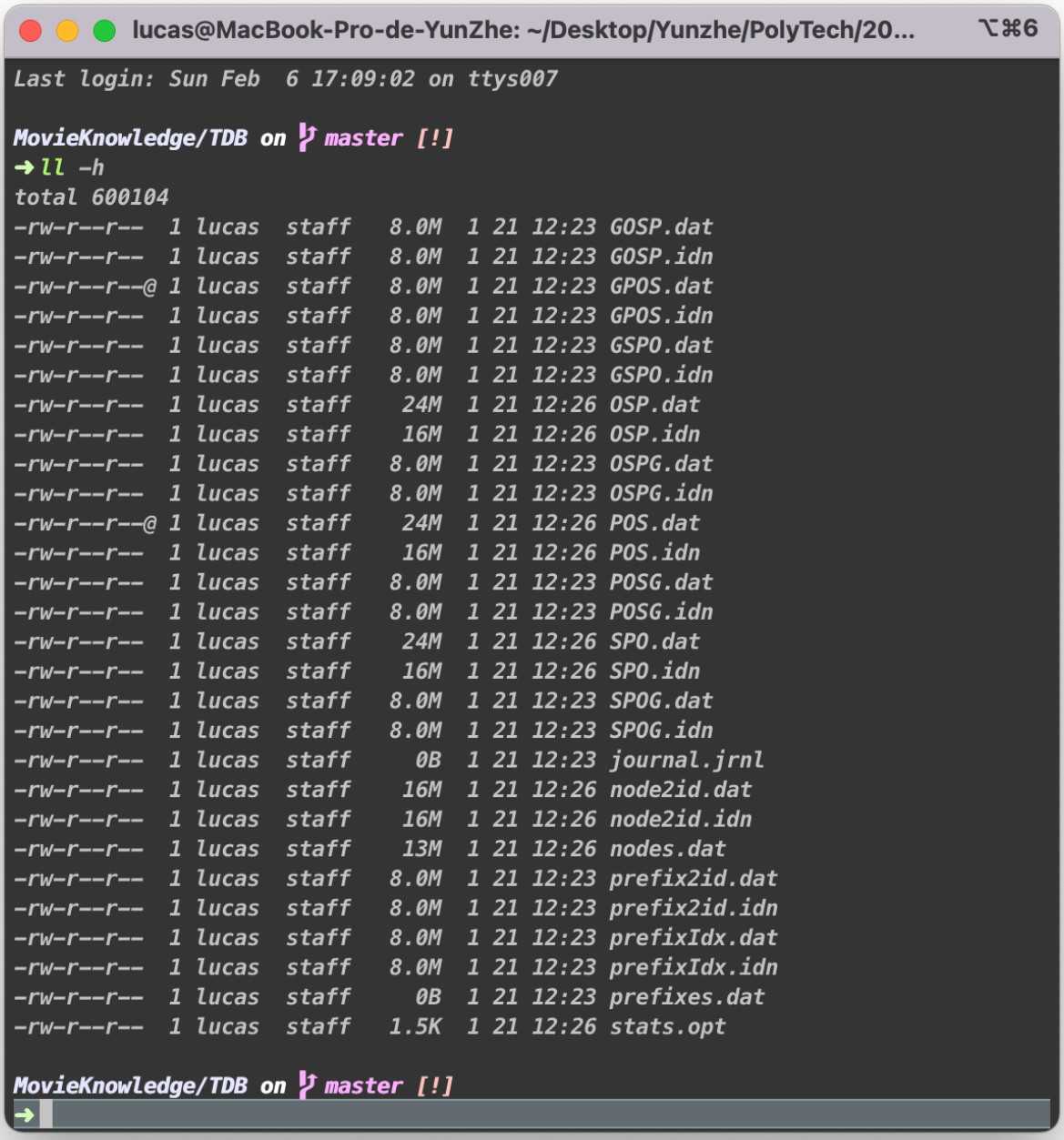
1. TDB is a component used by Jena to store RDF, and is a technology that belongs to the storage level. It can provide very high RDF storage performance in standalone case. The latest version of TDB is currently TDB2 and is not compatible with TDB1. 2.
2. Jena provides RDFS, OWL and generic rule reasoner. In fact, Jena's RDFS and OWL reasoner are also

implemented by Jena's own general-purpose rule reasoner.

3. Fuseki is a SPARQL server, or SPARQL endpoint, provided by Jena, which provides four modes of operation: standalone, as a service of the system, as a web application, or as an embedded server. Movie title, movie synopsis, movie rating, movie release date, and movie genre.

Generate TDB Storage By Jena

```
./tdbloader --loc="./MovieKnowledge/TDB" "./MovieKnowledge/movie_mapping.nt"
```

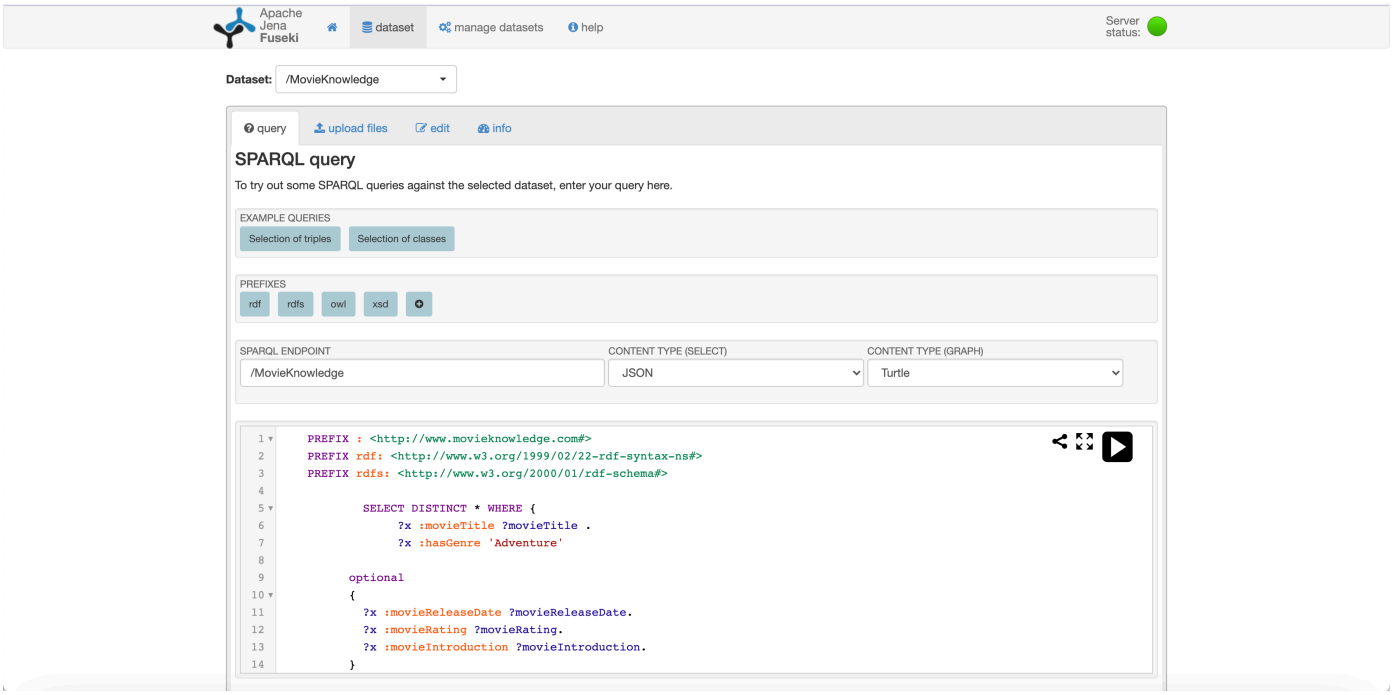


Start Fuseki Service

1. Go to the "apache-jena-fuseki" folder, run `./fuseki-server`, and exit. The program will automatically create the "run" folder in the current directory for us.
2. Move our ontology file "ontology.owl" to the "databases" folder under the "run" folder and change the "owl" extension to "ttl".
3. In the "configuration" folder under the "run" folder, create a text file named "fuseki_conf.ttl" , and add the configuration.

```
@prefix :      <http://base/#> .
@prefix tdb:   <http://jena.hpl.hp.com/2008/tdb#> .
@prefix rdf:   <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix ja:    <http://jena.hpl.hp.com/2005/11/Assembler#> .
@prefix rdfs:  <http://www.w3.org/2000/01/rdf-schema#> .
@prefix fuseki: <http://jena.apache.org/fuseki#> .

:service1        a                 fuseki:Service ;
fuseki:dataset                     <#dataset> ;
fuseki:name                        "MovieKnowledge" ;
fuseki:serviceQuery                "query" , "sparql" ;
fuseki:serviceReadGraphStore       "get" ;
fuseki:serviceReadWriteGraphStore "data" ;
fuseki:serviceUpdate               "update" ;
fuseki:serviceUpload               "upload" .

<#dataset> rdf:type ja:RDFDataset ;
    ja:defaultGraph <#model_inf> ;
    .

<#model_inf> a ja:InfModel ;
    ja:MemoryModel <#tdbGraph> ;

    #本体文件的路径
    ja:content [ja:externalContent <file:///Applications/apache-jena-fuseki-
4.3.2/run/databases/ontology.ttl> ] ;

<#tdbGraph> rdf:type tdb:GraphTDB ;
    tdb:dataset <#tdbDataset> ;
    .

<#tdbDataset> rdf:type tdb:DatasetTDB ;
    tdb:location "/Users/lucas/Desktop/Yunzhe/PolyTech/2021Fall/Web
Data/TP/MovieKnowledge/TDB" ;
    ja:context[ ja:cxName "arqTimeout"; ja:cxtValue "1000"]
    .
```

The service is hosted on port `3030`



Website Demo

I used a separate front-end and back-end development approach, using vue.js for the front-end, mainly responsible for sending requests and displaying results.

The backend uses `django` and uses the `SPARQLWrapper` package to further wrap our SPARQL query, so I will focus on our backend implementation in this section.

FrontEnd

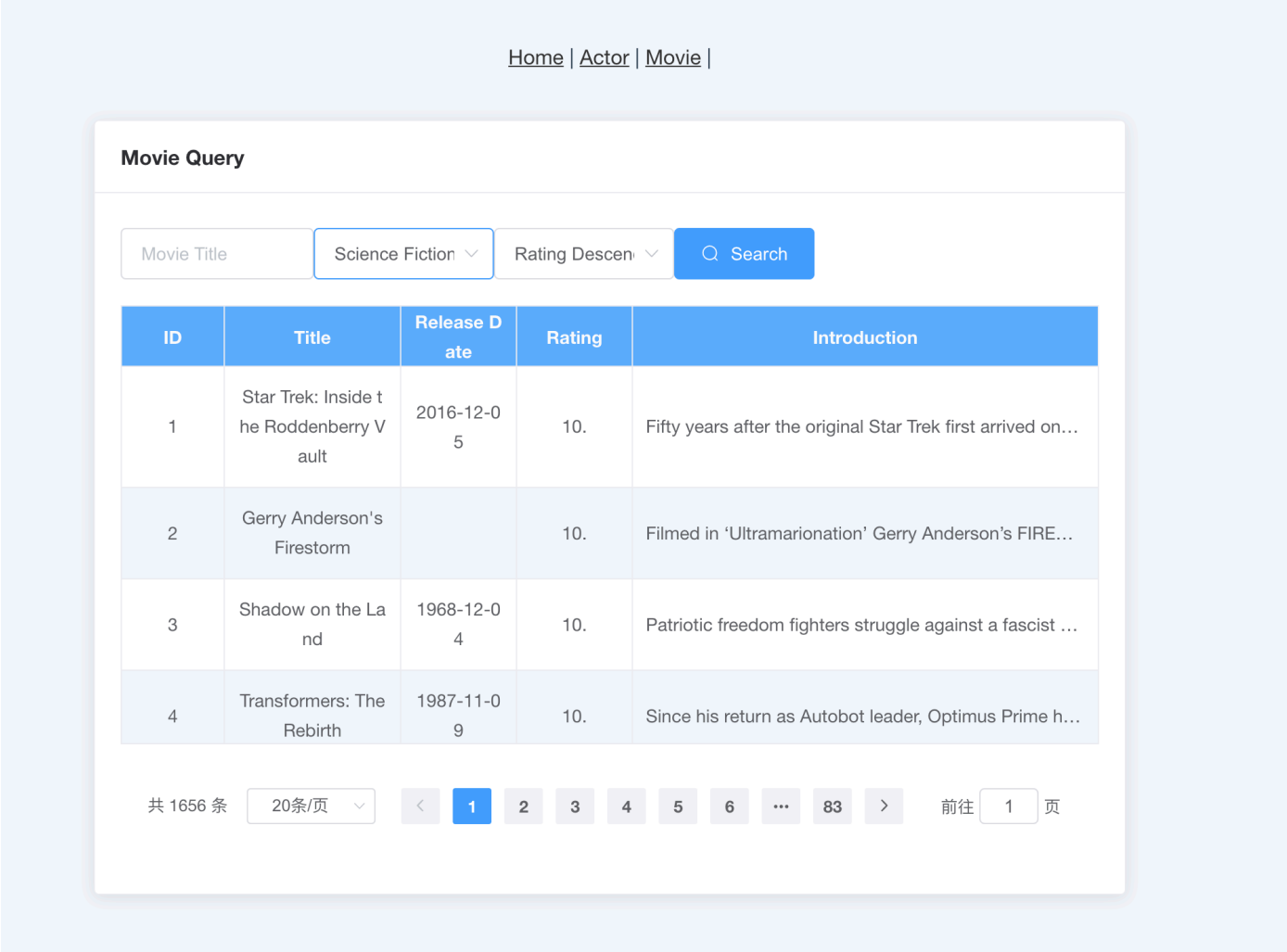
I used `elelment-ui` in order to develop the interface more conveniently.

I also used `axios` for request.

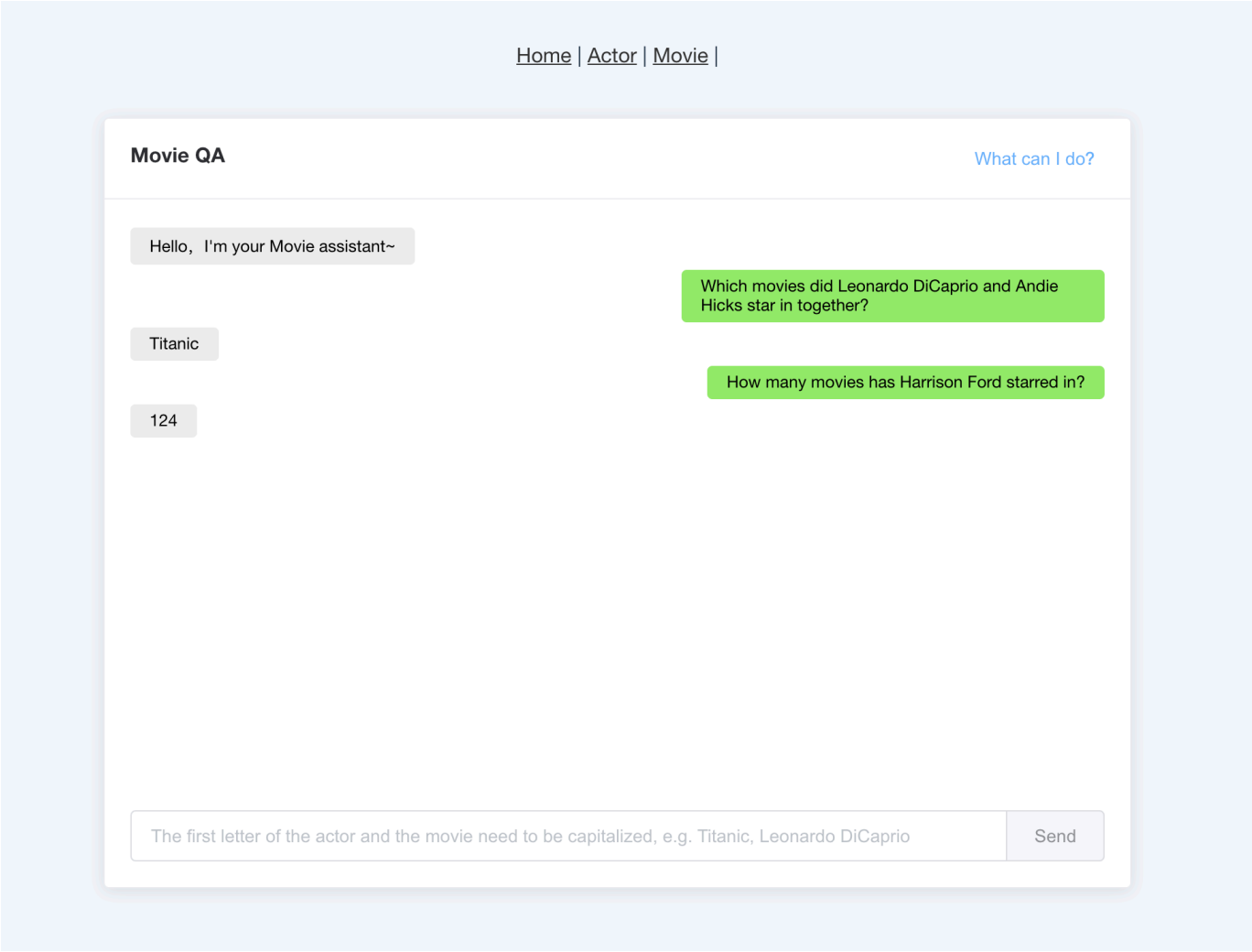
```
import axios from 'axios';
import { API_HOST } from '../config.json';

export function sendMessage(sender, message) {
  return axios.post(`${API_HOST}/Answer/`, { sender, message });
}
export function QuuryActor(queryParams) {
  return axios.get(`${API_HOST}/QueryActor/`, { params: queryParams });
}
export function QueryMovie(queryParams) {
  return axios.get(`${API_HOST}/QueryMovie/`, { params: queryParams });
}
```

BackEnd

We have implemented two functions based on the knowledge graph, one is to display the data in the form of a table where users can find and filter, we call it **Custom Search**:



The other is **Question and Answer**:



Implementation of Custom Search

This implementation is simple, we pre-define some template and fill them according to the request send to server:

```
SPARQL_PREXIX = u"""
    PREFIX : <http://www.movieknowledge.com#>
    PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
    PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
"""

SPARQL_SELECT_TEM = '''
            {prefix}
            SELECT DISTINCT {select} WHERE {{
                {expression}
                {filter}
            }}
            {pagination}
'''
```

The search follows this pattern: `http://127.0.0.1:8000/api/QueryActor/?page=1&limit=20&sort=+PersonBirthDay`

Implementation of Question and Answer

This feature uses regular expressions to do semantic parsing. We need a third-party library to do the initial natural language processing (POS entity recognition), and then use a library that supports word-level regular matching to do the subsequent semantic matching.

We use spacy for POS and entity recognition (names of people and movies). In our demo, the accuracy of entity recognition is not acceptable for human names and movie titles. Therefore, we directly export the names of people and movies in the database as external dictionaries; load the external dictionaries when using spacy, so that the problem of entity recognition can be solved:

```
  def train_ER(self, file_path: str, entity_type: str, entity_pattern):
        ruler = EntityRuler(self.nlp, overwrite_ents=True)
        jsonData = None
        with open(file_path) as f:
            jsonData = json.load(f)
        patterns = [{"label": entity_type, "pattern": each[entity_pattern]} for each in
jsonData]
        ruler.add_patterns(patterns)
        ruler.name = f"{entity_type}_ruler"
        self.nlp.add_pipe(ruler)
```

After converting natural language to word-based basic units, we use **REfO** (Regular Expressions for Objects) to complete semantic matching.

```
rules = [
    Rule(condition_num=2, condition=person_entity + Star(Any(), greedy=False) + movie +
Star(Any(), greedy=False), action=QuestionSet.has_movie_question),
    Rule(condition_num=2, condition=(movie_entity + Star(Any(), greedy=False) + actor +
Star(Any(), greedy=False)) | (actor + Star(Any(), greedy=False) + movie_entity +
Star(Any(), greedy=False)), action=QuestionSet.has_actor_question),
    Rule(condition_num=3, condition=person_entity + Star(Any(), greedy=False) +
person_entity + Star(Any(), greedy=False) + (movie | Star(Any(), greedy=False)),
action=QuestionSet.has_cooperation_question),
]
```

After a successful match, we get its corresponding SPARQL template we pre-wrote, then send a query to **Fuseki** server, and finally print out the result.

Demo Explanation

> IMPORTANT: The demo is host in a alibaba cloud server, which is in China and has only 4 GB memory. Therefore, the demo may be slow.
>
> Because the full movie data is too big and the server memory is small, please DO NOT use the Movie Custom Search part.
>
> You can find the demo: http://121.40.189.99:4753/#/

Custom Search

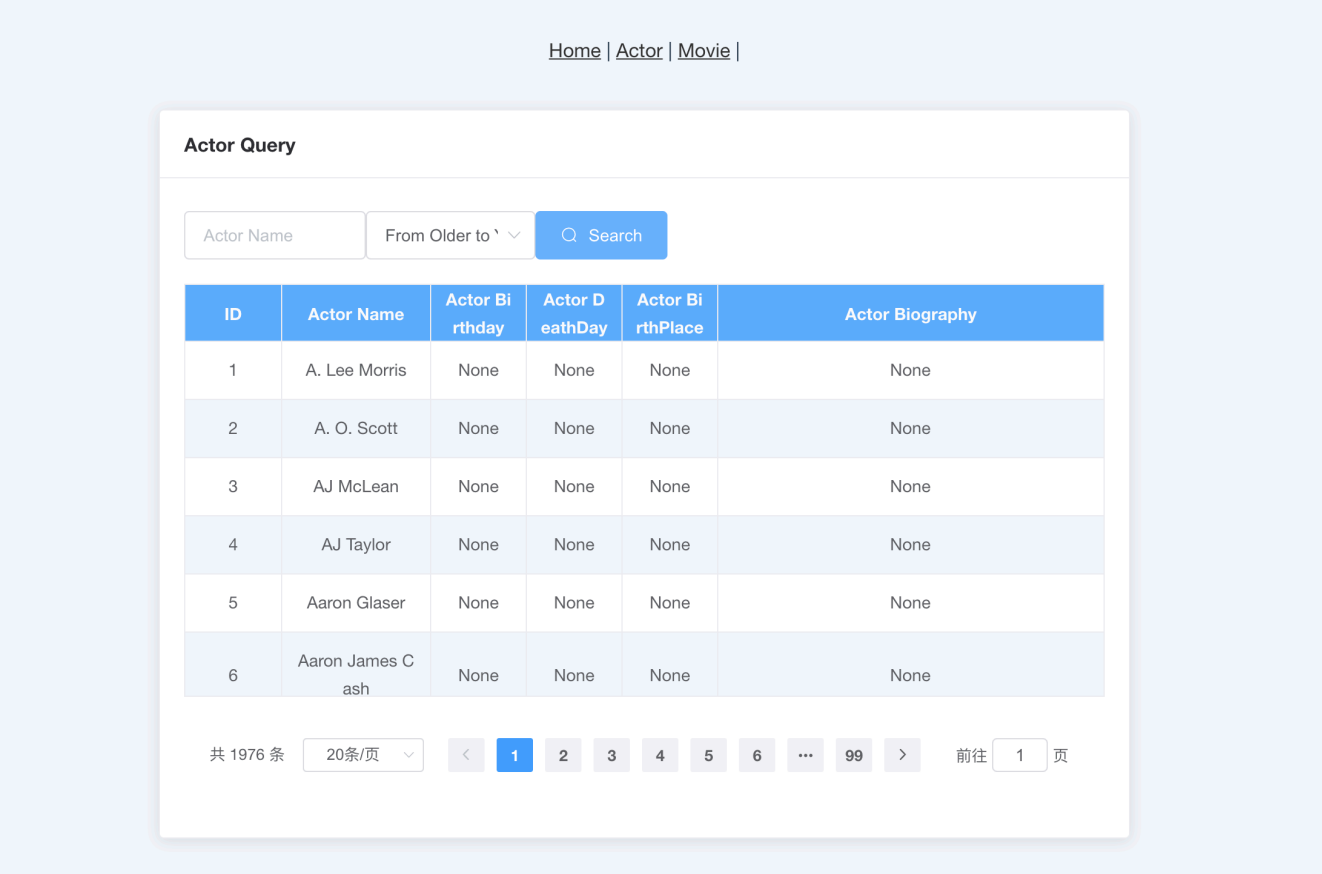
1. Request URL: http://127.0.0.1:8000/api/QueryActor/?page=1&limit=20&sort=%2BPersonBirthDay
2. BackEnd Log:

```
    PREFIX : <http://www.movieknowledge.com#>
    PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
    PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>

            SELECT DISTINCT * WHERE {

        ?x :personEnglishName ?personEnglishName .

        optional
        {
        ?x :PersonBirthDay ?PersonBirthDay.
        ?x :personDeathDay ?personDeathDay.
        ?x :personBiography ?personBiography.
        ?x :personBirthPlace ?personBirthPlace.
        }


            }
            ORDER BY ?PersonBirthDay LIMIT 20 OFFSET 0

[06/Feb/2022 19:23:21] "GET /api/QueryActor/?page=1&limit=20&sort=%2BPersonBirthDay HTTP/1.1" 200 2901
```

3. Fuseki Log:

```
20:23:21 INFO  Fuseki          :: [591] 200 OK (179 ms)
20:23:21 INFO  Fuseki          :: [592] GET http://127.0.0.1:3030/MovieKnowledge/query?query=%0A++++++++++++%0A++++PREFIX+%3A+%3Chttp%3A//www.movie
knowledge.com%23%3E%0A++++PREFIX+rdf%3A+%3Chttp%3A//www.w3.org/1999/02/22-rdf-syntax-ns%23%3E%0A++++PREFIX+rdfs%3A+%3Chttp%3A//www.w3.org/2000/01/r
df-schema%23%3E%0A%0A++++++++++++SELECT+DISTINCT+%2A+WHERE+%7B%0A++++++++++++++++%0A++++++++%3Fx+%3ApersonEnglishName+%3FpersonEnglishName+.%0A%0A+
+++++++optional%0A++++++++%7B%0A++++++++%3Fx+%3APersonBirthDay+%3FPersonBirthDay.%0A++++++++%3Fx+%3ApersonDeathDay+%3FpersonDeathDay.%0A+++++++%3F
x+%3ApersonBiography+%3FpersonBiography.%0A++++++++%3Fx+%3ApersonBirthPlace+%3FpersonBirthPlace.%0A++++++++%7D%0A++++++++%0A++++++++++++++++%0A++++
++++++++%7D%0A++++++++++++ORDER+BY+%3FPersonBirthDay+LIMIT+20+OFFSET+0%0A&format=json&output=json&results=json
20:23:21 INFO  Fuseki          :: [592] Query =                    PREFIX : <http://www.movieknowledge.com#>     PREFIX rdf: <http://www.w3.org/1999
/02/22-rdf-syntax-ns#>     PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>             SELECT DISTINCT * WHERE {                          ?x
:personEnglishName ?personEnglishName .          optional        {        ?x :PersonBirthDay ?PersonBirthDay.        ?x :personDeathDay ?personD
eathDay.        ?x :personBiography ?personBiography.        ?x :personBirthPlace ?personBirthPlace.        }
    }           ORDER BY ?PersonBirthDay LIMIT 20 OFFSET 0
20:23:21 INFO  Fuseki          :: [592] 200 OK (133 ms)
```

4. Result:



Question and Answer

1. Question:

```
{"sender":"2022-02-06T19:25:53.837Z6BIMK8QTI8","message":"What movies did Leonardo DiCaprio act in?"}
```

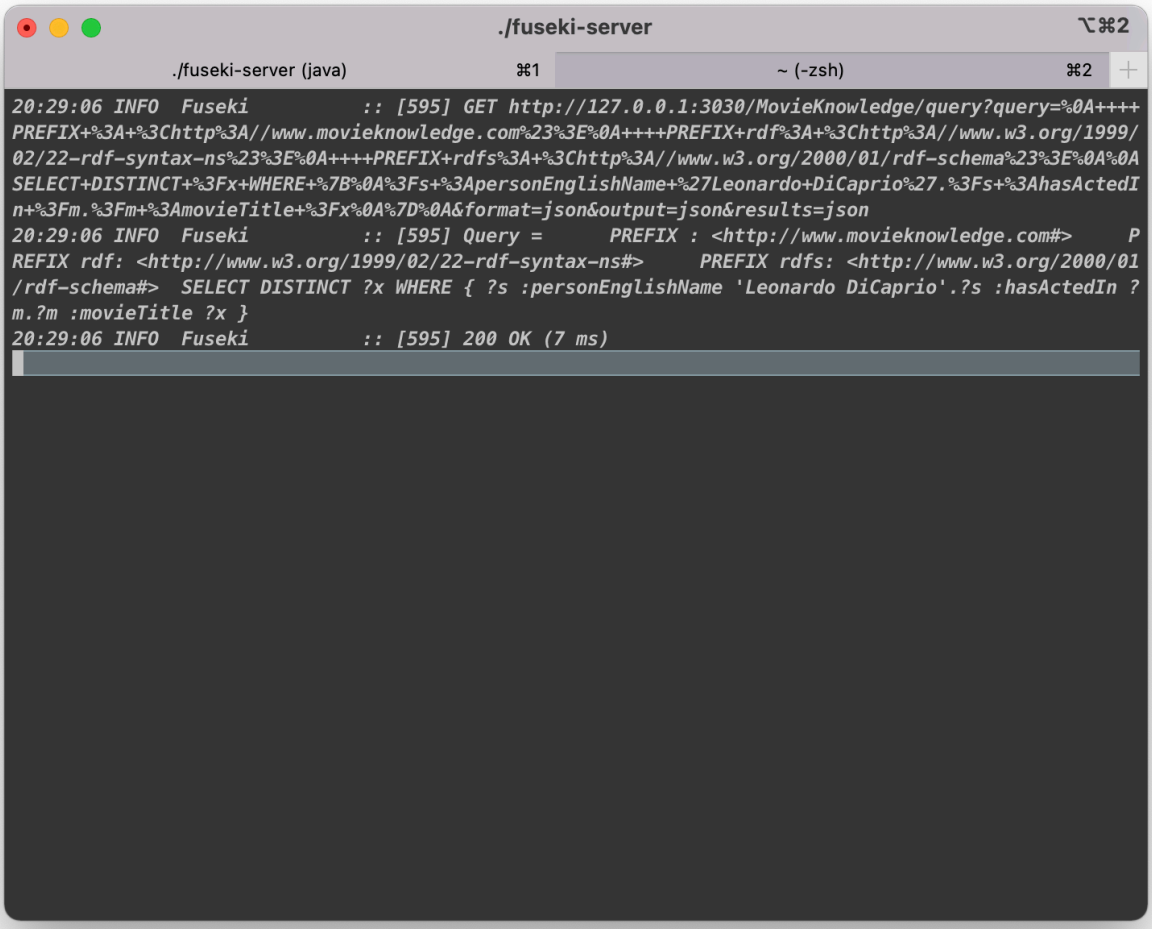
2. BackEnd:
    1. POS:

```
Leonardo DiCaprio Person
What DET
movies NOUN
did AUX
act VERB
in ADP
? PUNCT
```

    2. SPARQL Matched:

```
SPARQL:
    PREFIX : <http://www.movieknowledge.com#>
    PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
    PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>

SELECT DISTINCT ?x WHERE {
?s :personEnglishName 'Leonardo DiCaprio'.?s :hasActedIn ?m.?m :movieTitle ?x
}

[06/Feb/2022 19:26:01] "POST /api/Answer/ HTTP/1.1" 200 1373
```

3. Fuseki:



4. Result:

Movie QA

What can I do?

Hello，I'm your Movie assistant~

What movies did Leonardo DiCaprio act in?

Notes on an American Film Director at Work、The Wolf of Wall Street、Everything's Cool、kid 90、Critters 3、Titanic、X-Girl、The Black Hand、Spielberg、What's Eating Gilbert Grape、Catch Me If You Can: Behind the Camera、Portrait of Leonardo: The Kid Who Took Hollywood、The Audition、Inception: The Cobol Job、Killers of the Flower Moon、Gangs of New York、Don't Look Up、The Basketball Diaries、The Great Gatsby、Before the Flood、The Quick and the Dead、The 11th Hour、Another Round、The Concert for New York City、JAPANARAMA! Psycho TV From Japan Vol. 1、The Aviator、Teslafy Me、Blood Diamond、Salvator mundi、Revolutionary Road、Marvin's Room、The Foot Shooting Party、Total Eclipse、This Boy's Life、Inception、Celebrity、The Lost Leonardo、Reflections on Titanic、Body of Lies、Mickey's Safety Club: Street Safe, Street Smart、Shutter Island、IMAX Hubble、Ice on Fire、A World Unseen: The Revenant、The Wolf

The first letter of the actor and the movie need to be capitalized, e.g. Titanic, Leonardo DiCaprio

Send