Week12 MyMapReduce

1 作业内容

MapReduce是利用多进程并行处理文件数据的典型场景。作为一种编程模型，其甚至被称为Google的”三驾马车“之一(尽管目前由于内存计算等的普及已经被逐渐淘汰)。在编程模型中，Map进行任务处理，Reduce进行结果归约。本周作业要求利用Python多进程实现MapReduce模型下的文档库（课程中心的THUNews.rar中包含了88724篇文档）词频统计功能。具体地：

1. Map进程读取文档并进行词频统计，返回该文本的词频统计结果。
2. Reduce进程收集所有Map进程提供的文档词频统计，更新总的文档库词频。
3. 主进程可提前读入所有的文档的路径列表，供多个Map进程竞争获取文档路径；或由主进程根据Map进程的数目进行分发；或者单独实现一个分发进程，与多个MAP进程通信。
4. 实现一个Map进程执行完毕返回数据后，传递给Reduce进行更新文档库的词频表。
5. 观察Reduce模块接收文档数据的顺序，是否和输入顺序一致。
6. 记录程序运行时间，比较不同Map进程数量对运行时间的影响，可以做出运行时间-进程数目的曲线并进行简要分析。

2 具体实现

- 文本处理

```python
# -*- coding=utf-8 -*-
# @Time:
# @Author: zjh
# @File: MyMapReduce.py
# @Software: PyCharm

import os,time
import jieba
import json
import collections
from multiprocessing import Pool,Manager,Process


def frequency(word_list):
    """
    cal the frequency for each word from a word list
    :param word_list: a list contains each word in the text
    :return: an ordered dictionary with word and its frequency
            by desc in a text
    """
    WordDict = {}
    for c in word_list:
        if c in WordDict.keys():
            WordDict[c] += 1
        else:
            WordDict[c] = 1
    WordFreq = collections.OrderedDict(sorted(WordDict.items(), key=lambda
dc:dc[1],
                                              reverse=True))
    return WordFreq
```

- map进程池的target函数

```
def map(q,folder_name,file_name,stopword):
    '''
    word frequency analysis, turn a path into an ordered dictionary
    the first step of MapReduce work: split
    :param folder_name: the folder name of the texts
    :param file_name: the text name (a text)
    :param stopword: import from a txt file
    :return: put the ordered dictionary with word frequency into the queue
    '''
    #print(f"{folder_name}/{file_name}")
    with open(os.path.join(folder_name, file_name), "r", encoding="utf-8") as f:
        text = f.read()
    txt_list = jieba.lcut(text)
    # 过滤停用词
    text_list = list()
    for word in txt_list:
        if word not in stopword:
            text_list.append(word)
    word_freq = frequency(txt_list)
    q.put(word_freq)

    #print(f"[{file_name}] mapped! -- by {os.getpid()}")
```

`q.put(word_freq)`：把单个文本的word_freq上传到queue中，供进程间通信

- reduce进程的target函数

```
def reduce(q,length):
    '''
    get the freq_dict from the map process
    :param q: a queue for delivering information
    :param length: the number of texts
    :return: a dictionary
    '''
    dictionary = {}
    count_ok_text = 0
    while True:
        #print("now:",count_ok_text,"  already done:
{:.2f}%".format(count_ok_text/length*100))
        td = q.get()
        for key, value in td.items():
            if key in dictionary.keys():
                dictionary[key] += value
            else:
                dictionary[key] = value
        count_ok_text += 1
        if count_ok_text >= length:
            break

    dictionary = collections.OrderedDict(sorted(dictionary.items(), key=lambda
dc: dc[1],
                                                reverse=True))

    '''print the dictionary to the disk'''
    wd = ""
    for key,value in dictionary.items():
        wd = wd + str(key) + "\t" + str(value) + "\n"

    with open("word_frequency.txt","w",encoding="utf-8") as f:
        f.write(wd)

    #print(dictionary)
```

`td = q.get()` 从队列中获取数据

- 进程关系

```
def main(process_num):
    # find the file
    folder_name = "../texts/THUCN"
    file_names = os.listdir(folder_name)
    # create the stopword
    with open("../texts/stopwords_list.txt", "r", encoding="utf-8") as f:
        stopword = f.read().splitlines()
    stopword.append("\n")

    # create a queue
    q = Manager().Queue()
    # create a process pool
    mpo = Pool(process_num)
    for file_name in file_names:
        mpo.apply_async(map, args=(q, folder_name, file_name, stopword,))

    r = Process(target=reduce, args=(q, len(file_names),))
    r.start()

    mpo.close()
    mpo.join()
    #r.close()
    r.join()

if __name__ == "__main__":
    start = time.time()
    main(5)
    period = time.time() - start
    print("period",period)
```

- `q = Manager().Queue()` 通过manager暴露Queue，
- `mpo = Pool(process_num)` 创建Map进程池，每个文件遍历输入，选择空闲的进程使用，从而实现供多个Map进程竞争获取文档路径

-
  ```
  for file_name in file_names:
          mpo.apply_async(map, args=(q, folder_name, file_name, stopword,))
  ```

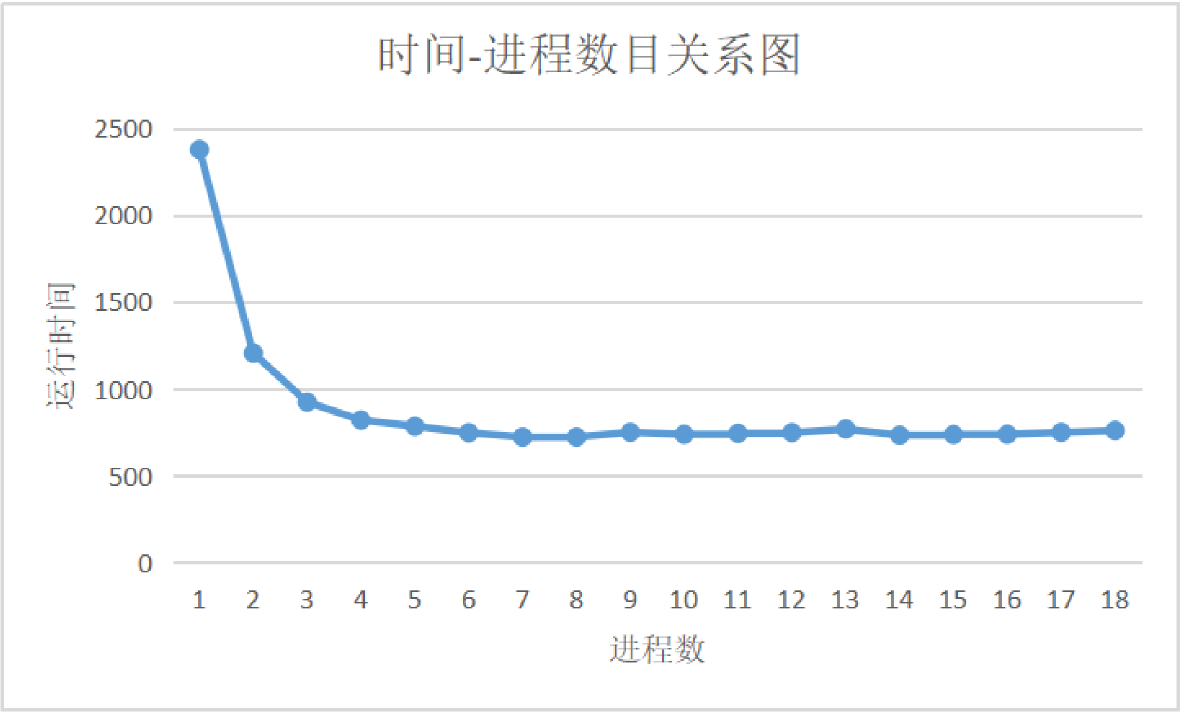
  回调函数：任意任务完成会通知主进程，主进程调用另一个map函数
- `r = Process(target=reduce, args=(q, len(file_names),))` 创建Reduce进程
- `r.start()` 创建reduce进程
- `mpo.close()` 关闭进程池

- `mpo.join()`, `r.join()` 让子进程等待主进程

3 结果分析

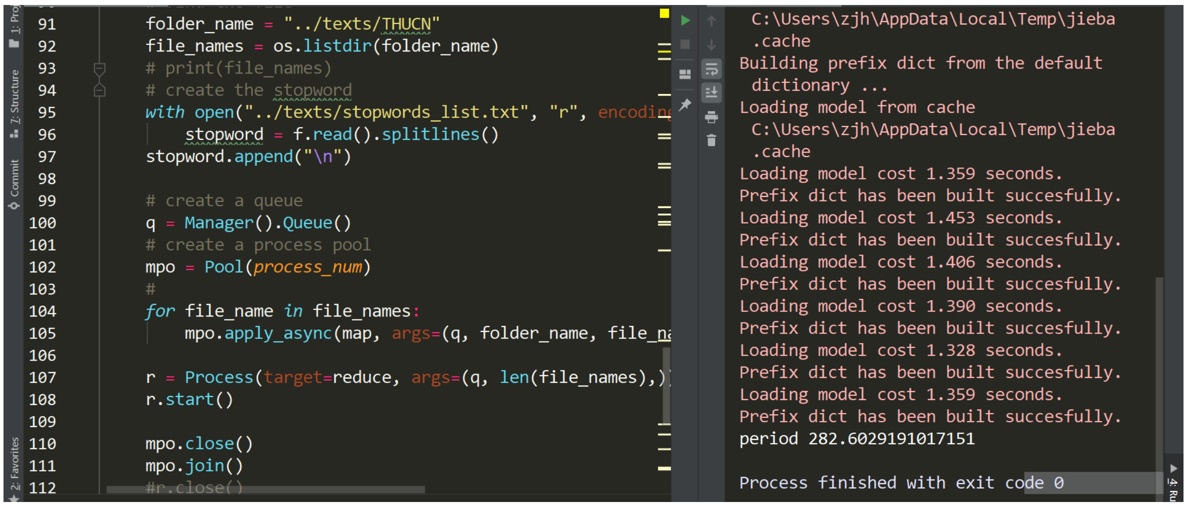
保留一个print语句，进行停用词处理，各个进程数随时间的变化关系如下

进程数	运行时间	进程数	运行时间	进程数	运行时间
1	2377.328962	7	721.7349632	13	768.2294867
2	1204.904902	8	721.8808563	14	732.0407689
3	922.9586208	9	749.429702	15	735.9098136
4	819.518266	10	737.1559186	16	737.6912248
5	784.1106601	11	743.1214669	17	749.0388205
6	746.46192	12	747.4230361	18	759.1900346



当进程数小于4时，运行时间随着进程数的增加显著减少；当进程数大于4后，运行时间随着进程数的增加降低不明显，当进程数到达7之后，再提高进程数基本对运行时间没有什么影响，最终运行时间保持在大约750s的水平上

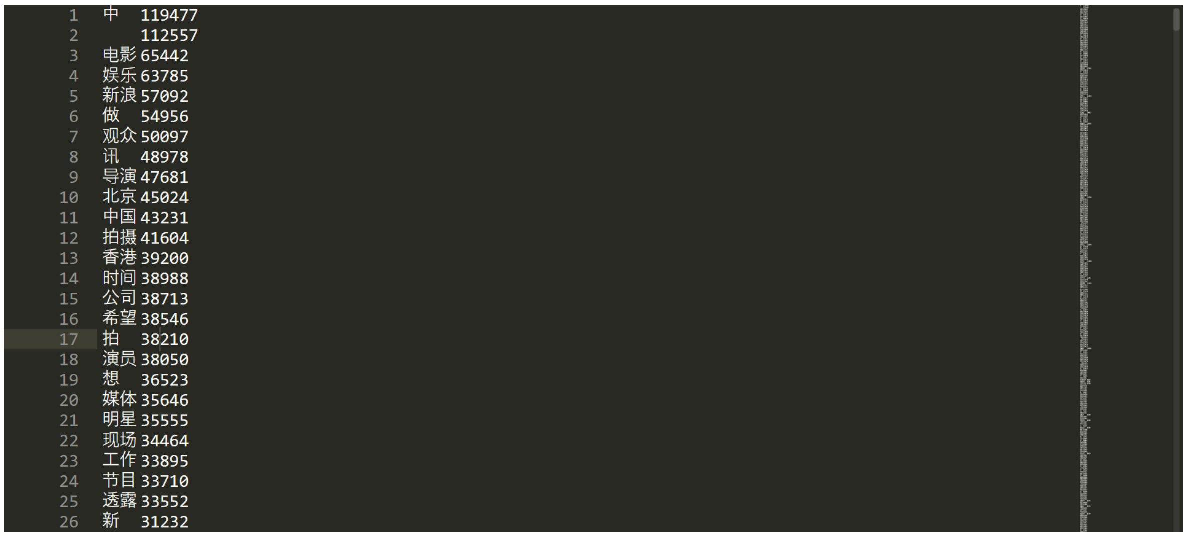
- 关闭print语句和停用词处理，开启6个进程池，再次运行，大致可以看出处理的最短时间大致为282.60s



```python
    folder_name = "../texts/THUCN"
    file_names = os.listdir(folder_name)
    # print(file_names)
    # create the stopword
    with open("../texts/stopwords_list.txt", "r", encodin
        stopword = f.read().splitlines()
    stopword.append("\n")

    # create a queue
    q = Manager().Queue()
    # create a process pool
    mpo = Pool(process_num)
    #
    for file_name in file_names:
        mpo.apply_async(map, args=(q, folder_name, file_n

    r = Process(target=reduce, args=(q, len(file_names),))

    r.start()

    mpo.close()
    mpo.join()
    #r.close()
```

```
 C:\Users\zjh\AppData\Local\Temp\jieba
 .cache
Building prefix dict from the default
 dictionary ...
Loading model from cache
 C:\Users\zjh\AppData\Local\Temp\jieba
 .cache
Loading model cost 1.359 seconds.
Prefix dict has been built succesfully.
Loading model cost 1.453 seconds.
Prefix dict has been built succesfully.
Loading model cost 1.406 seconds.
Prefix dict has been built succesfully.
Loading model cost 1.390 seconds.
Prefix dict has been built succesfully.
Loading model cost 1.328 seconds.
Prefix dict has been built succesfully.
Loading model cost 1.359 seconds.
Prefix dict has been built succesfully.
period 282.6029191017151

Process finished with exit code 0
```

- 词频字典如下所示



```
中	119477
 	112557
电影	65442
娱乐	63785
新浪	57092
做	54956
观众	50097
讯	48978
导演	47681
北京	45024
中国	43231
拍摄	41604
香港	39200
时间	38988
公司	38713
希望	38546
拍	38210
演员	38050
想	36523
媒体	35646
明星	35555
现场	34464
工作	33895
节目	33710
透露	33552
新	31232
```