Data Mining The Computer Structures Class

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> What is essential is invisible to the eye. de Saint Exup6ry (1971)

1 What is Data Mining

Data mining is the process to discover knowledge from the database Wikipedia (2014*a*). It's a rapidly expanding subject across computer science, statistics, and many, many other areas (Brookshear 2011, p.414). I think data mining is the technology that helps people understand **what** has happened. Sometimes, understanding the **what** will help us discover the knowledge of **why**. We might not be able to understand **why** in some situations, but it can still help us to predict the future. The forms of data mining includes:

Class Description
: finds the common character among given data collection.

Cluster analysis
: divides the given data collection into group with unique characters.

Class discrimination
: studies the properties that distinguishing the data groups.

Association analysis
: studies the link between the data groups.

Outlier analysis
: find the information that is not related to the norm, or the noisy data.

sequential pattern analysis
: is a common scene of data mining, which is applied on sequential data over a timeline to indentify patterns.

2 An Example

Our Computer Structures course has been running for 11 weeks. There have been many posts by the colleagues in my class in the discussion. I will try to mine this database and see what I can find.

I will use IPython Notebook Pérez & Granger (2007) and Pandas McKinney (n.d.) as tools to show this example. Below is some preparing code that imports the Python libraries that will be used later.

```
%matplotlib inline
import pandas
import numpy
import re
from datetime import datetime
```

2.1 Data pre-processing

Data mining is not looking at the magical crystal ball to seek for a clue. It comes from the data we prepared. "Garbage in, garbage out" is particularly true to data mining Wikipedia (2014*b*). This is the most trivial and time-consuming step, but it's very important.

I've put all our posts from the previous 10 weeks in the a database now. The database is ... just a csv file that store all the information in plain text format. The data table include these columns: author, date, minutes_of_the_day, post, thread, weekday, content, and content length. And then I cannot wait to see what we have been talking about.

The above *tag cloud* Wikipedia (2014*d*) is from all our post content. I don't know why but it seems we like to use the word "use" a lot. Other than that, we use a lot of "compute", "system", "data", "algorithm". If you look harder, you can see "Craig" and "Terry".

2.2 Class Description

First, I load the data from the database (the csv file) into a Pandas DataFrame. Pandas DataFrame is a two dimensional data structure that can do many data mining and plotting things. After loading the data, I display the first 5 posts.

```
posts = pandas.read_csv("threads/allpost.csv").drop("Unnamed: 0", 1)
posts[:5][["author","date", "post", "length"]]
```

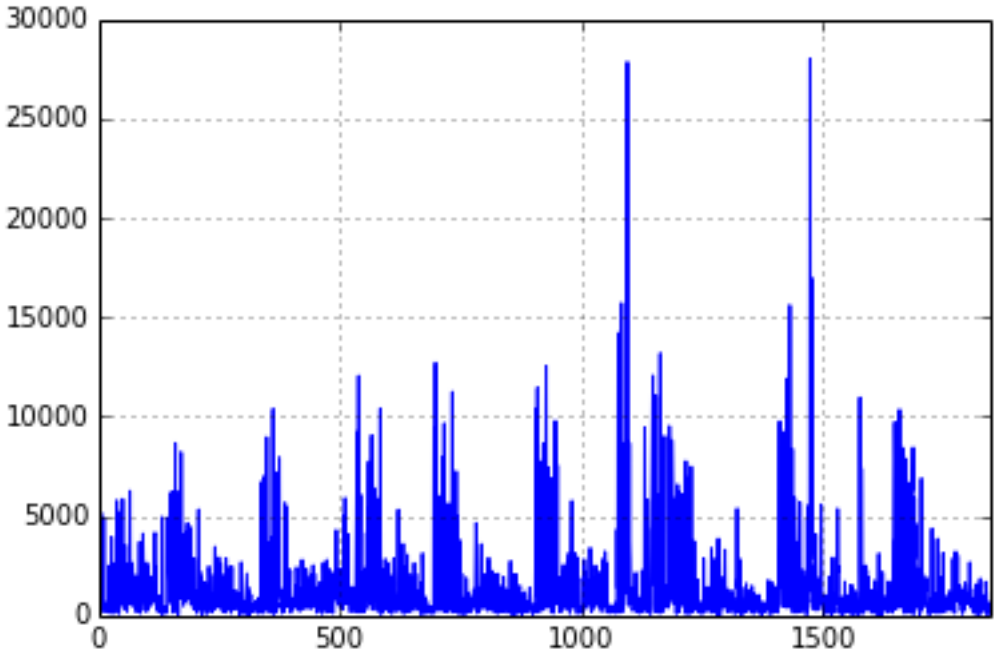
```
Out[174]:              author                 date  \
          0     Anthony Ayoola  2014-08-29 17:55:00
          1          Terry Yin  2014-09-04 04:34:00
          2  Christopher Burns  2014-09-04 06:53:00
          3  BABATUNDE KOLAWOLE  2014-09-04 08:17:00
          4          Terry Yin  2014-09-04 06:41:00

                                                 post  length
          0                          Your history of computing    4865
          1  RE: My first Computing Experience { A (long) s...    1004
          2  RE: My first Computing Experience { A (long) s...    1348
          3  RE: My first Computing Experience { A (long) s...    1257
          4                      RE: Your history of computing    4587
```

Then, let's see if we can find anything by plotting the post length on a timeline (the record is already sorted by date of post).

```
posts.length.plot()
```

Out[200]: <matplotlib.axes.AxesSubplot at 0x10f9392d0>



It seems that our posts are getting longer and longer since the first week. And there seems to be a pattern. So what if we group our post by weekdays?

```
d = posts.groupby("weekday").aggregate({"length":[numpy.sum, numpy.mean, numpy.count_nonzero]})
d
```

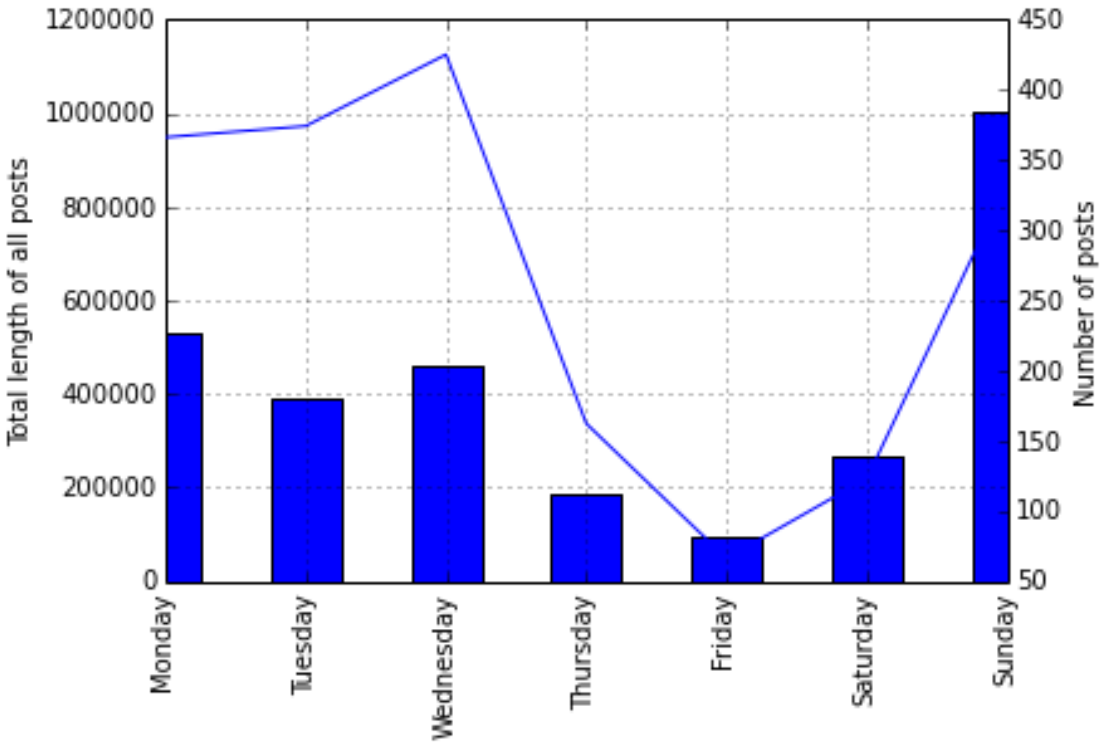
Out[198]:

	length		
	sum	mean	count_nonzero
weekday			
0	528551	1444.128415	366
1	390041	1042.890374	374
2	458212	1078.145882	425
3	183239	1131.104938	162
4	93266	1413.121212	66
5	268022	2179.040650	123
6	1000720	3005.165165	333

Let's plot the data and see what we can see.

```
d.index = ['Monday', 'Tuesday', 'Wednesday', 'Thursday', 'Friday', 'Saturday', 'Sunday']
d.length["sum"].plot(kind='bar').set_ylabel('Total length of all posts')
d.length["count_nonzero"].plot(secondary_y=True).set_ylabel('Number of posts')
```

```
Out[188]: <matplotlib.text.Text at 0x10f399850>
```



This is probably obvious even without the data. But now we can clearly see that we write long posts on Sunday, but we write more posts on Wednesday.

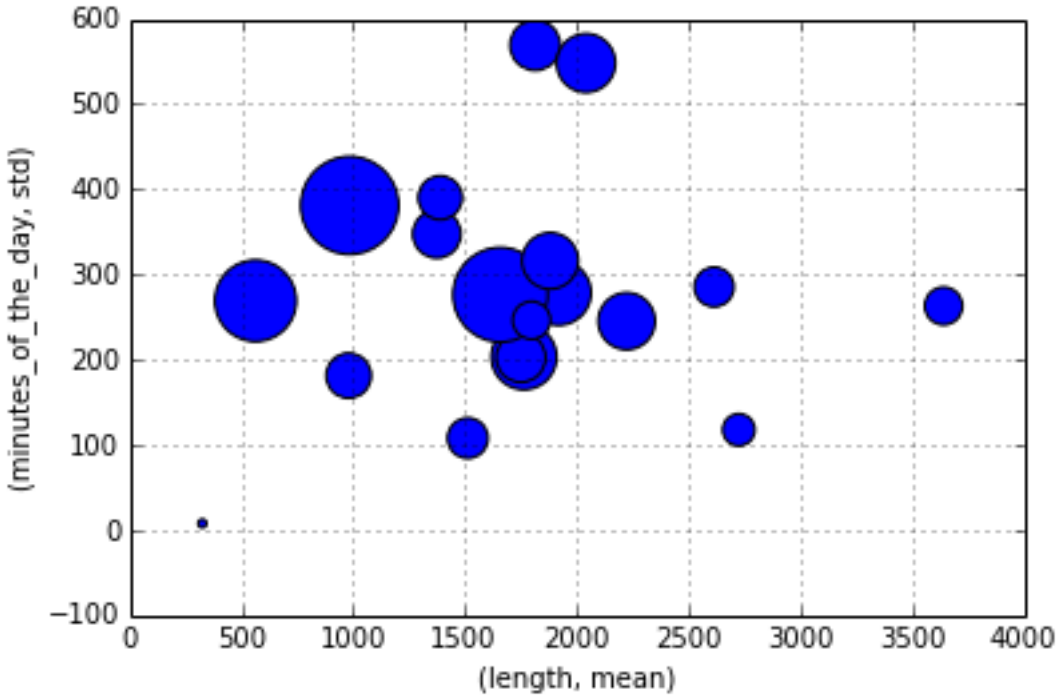
2.3 Cluster analysis

There must be some different behavioural types in all the colleague (and Dr. Ayoola). Let's what we can get by grouping by the author of the posts.

In the data I prepared, there is one column named `minutes_of_the_day`. It is the minutes passed since the beginning of that day. We are going to get the **standard deviation** (Wikipedia 2014*c*, std) of the `minutes_of_the_day` of each author. Let's assume this standard deviation will show whether a colleague follows a fixed time schedule for study or follows a more flexible style.

```
d=posts.groupby("author").aggregate(
        {"length":[numpy.mean, numpy.count_nonzero],
         "minutes_of_the_day":numpy.std})
d.plot(kind='scatter', x=('length', 'mean'), y=('minutes_of_the_day', 'std'), s=d.length['count_nonzero']*5)
```

Out[199]: <matplotlib.axes.AxesSubplot at 0x10f6d2910>



In the above picture, each bubble represents one colleague. The size of the bubble represents the number of posts he every posted. X-axis is the average post length. Y-axis is the standard deviation of time. From the picture we can see, most colleagues study in around 5 hours (300minutes) time frame. There are a couple of colleagues who are very disciplined. They study in a 2 hours frame (the two near the bottom, excluding the one on the bottom left corner).

3 Conclusion

The quality of the input is crucial for data mining. Many people do data mining spend most of their time preparing their data. It's the same for the easy example I just showed above. I spend most of my time collecting all the posts, parsing the raw data (HTML), improving data quality and putting the data into database. Once the data is ready, tools like Pandas are pretty handy to further explore the data and visualize them.

References

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