MAT259 Proj 4: 3D Interactive Visualization

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Concept

For this project, I am interested in exploring the temporal check-out patterns of all dewey classes and classify all 1000 sessions into different clustered groups/dispersed outliers based on their temporal signature similarities and investigating how to effectively visualize temporal patterns and classification results together in an interactive 3D environment.

Visual Design

We are the astronomers of the information universe! I would like to integrate the beauty of the universe/galaxies pictures captured by space telescopes into consideration for the design of visualizing the clusters of dewey classes. The color hue schema will refer to the galaxy color and brightness analog to the sparking and glowing galaxies.

Time Schedule

2014.03.01~03.04: Develop the query and collect the data from Seattle Public Library; Preprocess the raw data into appropriate data formats/structure for better visual interacton.

2014.03.04~03.07: Implement the classification algorithm to classify all 1000 dewey classes based on their temporal check-out frequencies.

2014.03.07~03.13: Detailed visual design and implementation in Processing; discuss with classmates and receive feedback.

2014.03.14~03.18: Improve the project based on feedback and comments; Prepare for the final presentation.

Data and Query

(1) Daily Dewey Classes Check-outs in the Year 2013

```
SELECT dayofyear(cout), floor(deweyClass) AS dewey, count(*) /*select the dewey decimal classes by integer dewey sessions*/

FROM inraw
```

WHERE deweyClass is not null AND (cout)>"2013-01-01" AND date(cout)<"2013-12-31"

GROUP BY dayofyear(cout), dewey;

Processing Time: 37.034 seconds and 142336 rows returned.

Results: http://www.geog.ucsb.edu/~sgao/mat259/2013DailyDeweyCheckouts.csv

(2) Monthly Dewey Classes Check-outs between the years 2007~2013

SELECT year(cout), month(cout), floor(deweyClass) AS dewey, count(*) /*select the dewey decimal classes by integer*/

FROM inraw

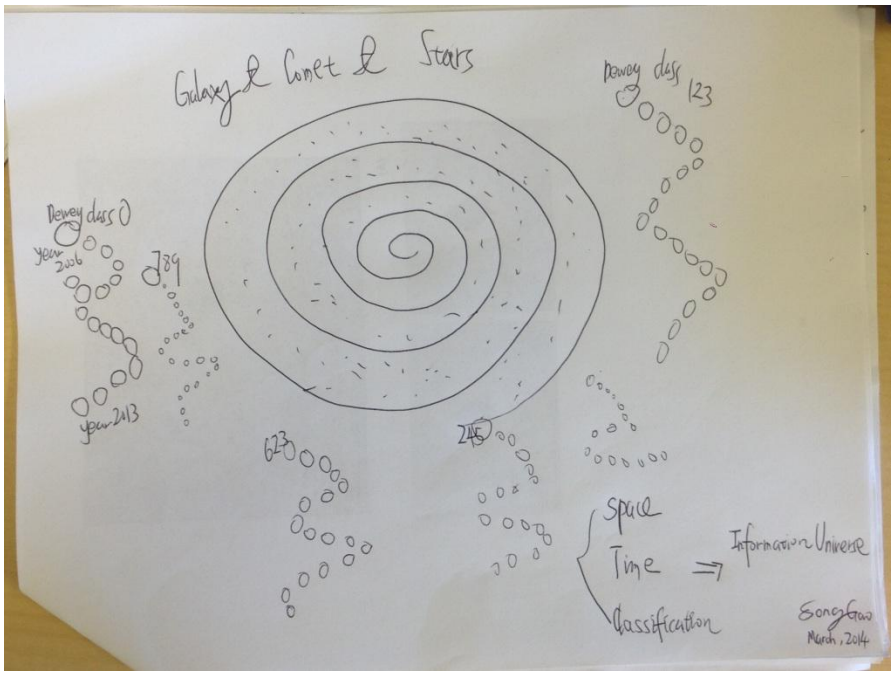
WHERE deweyClass is not null AND (cout)>"2006-01-01" AND date(cout)<"2013-12-31"

GROUP BY year(cout), month(cout), dewey;

Processing Time: 93.179 seconds and 72201 rows returned.

Results:
http://www.geog.ucsb.edu/~sgao/mat259/2006_2013_MonthlyDeweyCheckouts.csv

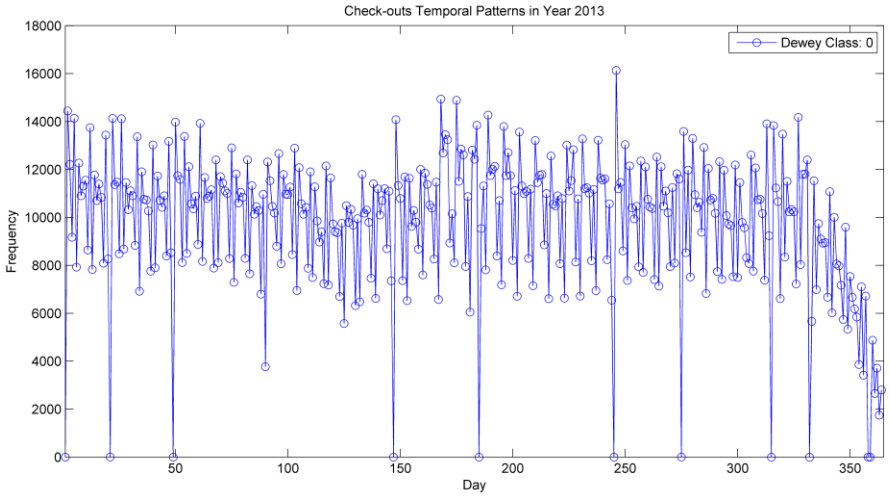
Doodle

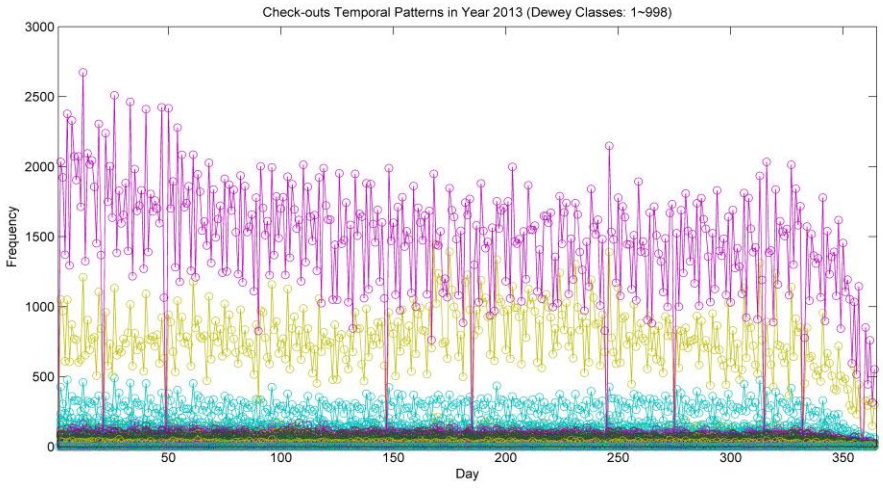


Clustering Procedures and Visual Products

Procedure 1: I need to cluster all dewey classes based on their check-outs temporal patterns by using Multidimensional Scaling (MDS). The MDS method can help to visualize the similarity of dewey classes. It refers to a set of related ordination techniques that have been widely used in information visualization. An MDS algorithm aims to layout each individual class in a N-dimensional space such that the between-class similarities or distances are preserved as well as possible. The results of MDS can assign a coordinate to each dewey class.

The time series graphs of check-outs patterns for all dewey classes are shown as follows: (It indicates that the magnitude of check-outs frequency of dewey class 0 is too large, it might to be considered as a outlier.)

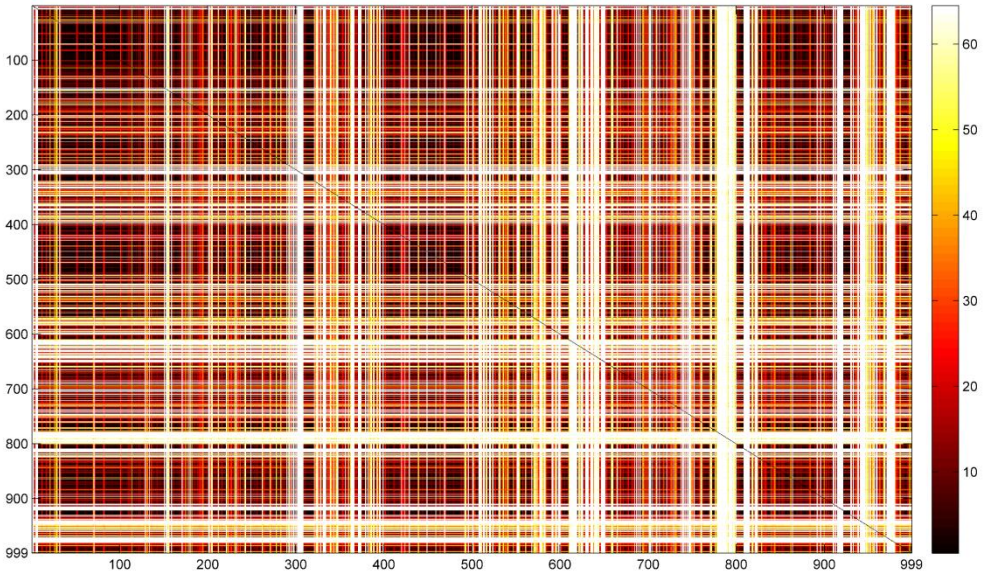




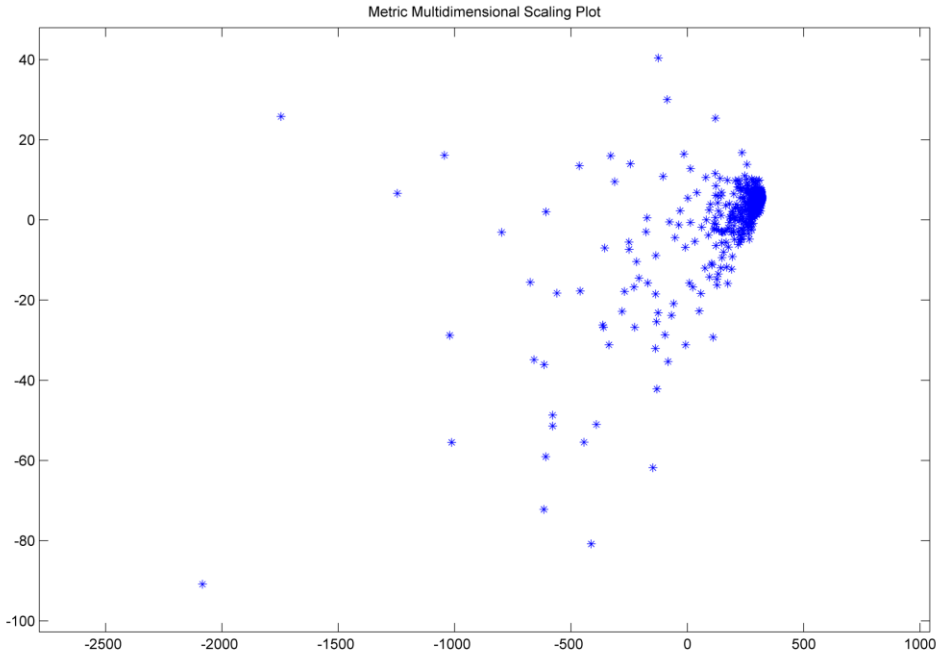
Then, I computed the ***Minkowski distance*** between pairs of dewey classes in the 999-by-364 data matrix.

$$d_{st} = \sqrt[2]{\sum_{i=1}^{n}(s_i - t_i)^2}$$

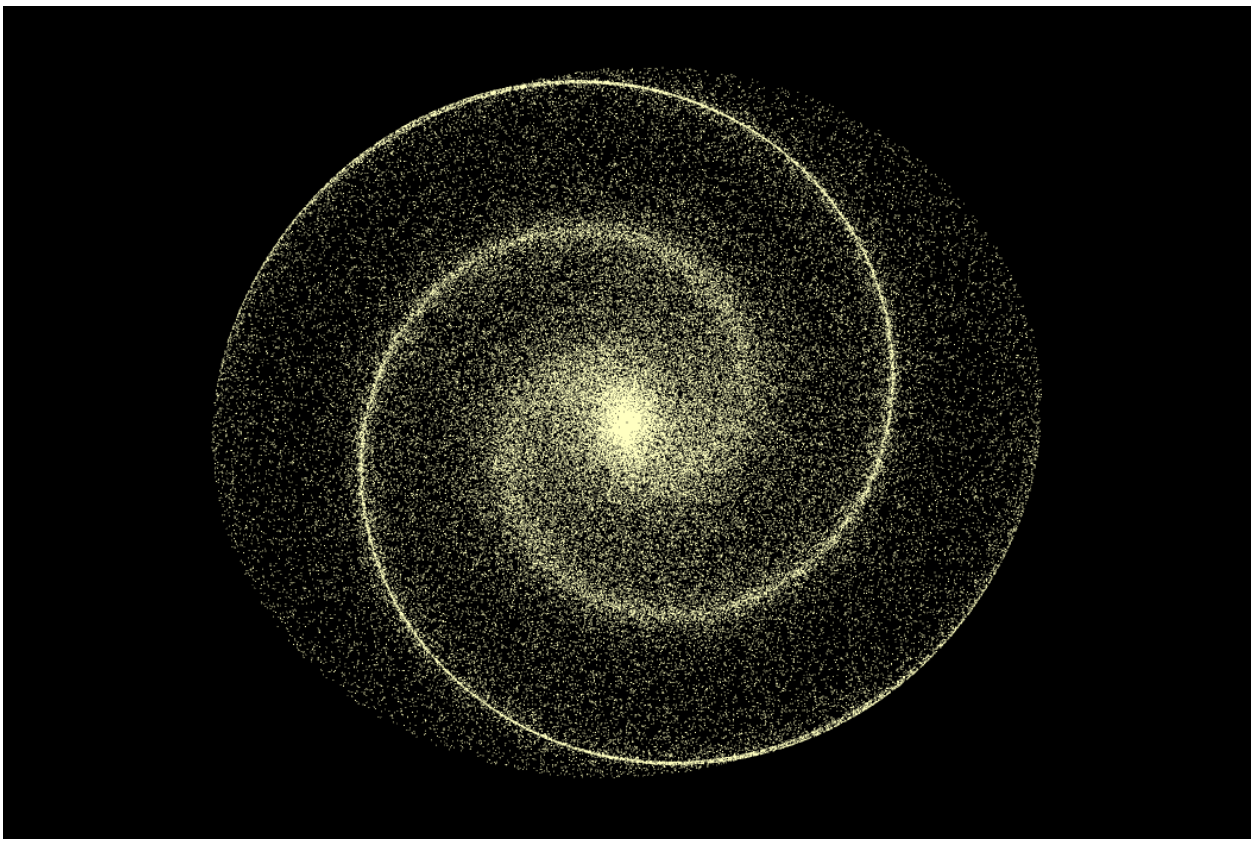
where *s, t* stands for two dewey classes; and s_i and t_i is their corresponding check-outs frequency in the *i* day of year (n=364). The visualization of ***dissimilarity matrix*** for all dewey classed are shown below: The more bright color of cell represents the large r dissimilarity between dewey classes regarding their temporal signatures.



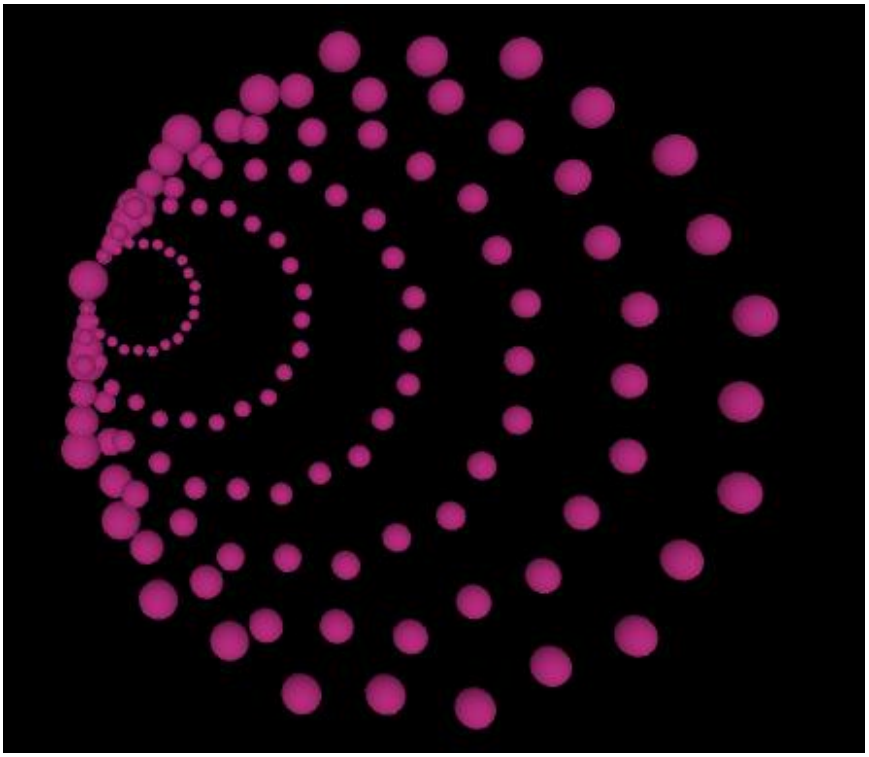
Based on the dissimilarity matrix generated above, then I applied the MDS algorithm to generate the MDS plot and derive the coordinates for dewey classes considering their similarity values.



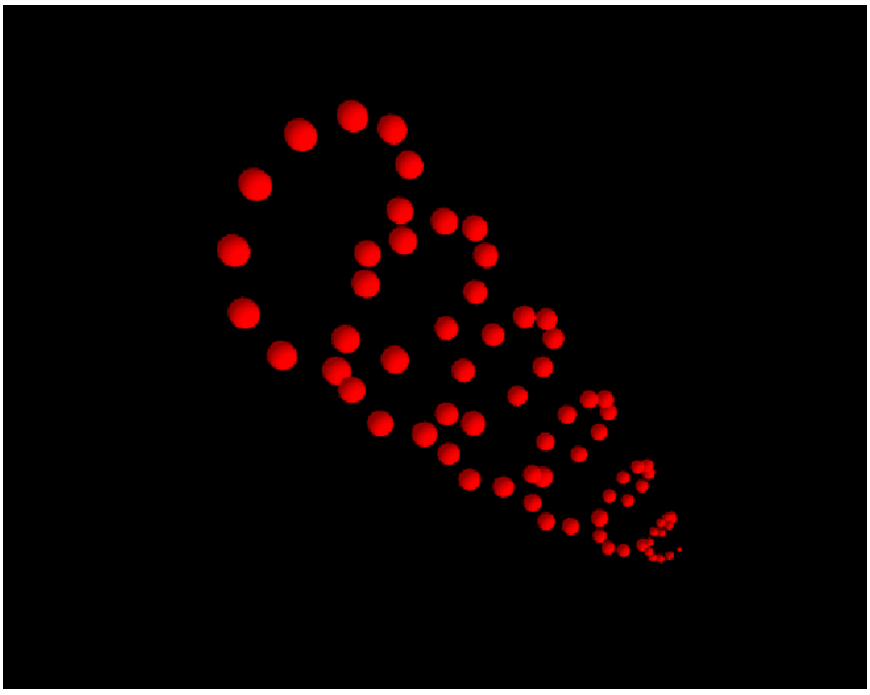
Procedure 2: Designing and implementing the spiral galaxy and the spiral comets to represent the dewey classes in the information universe.



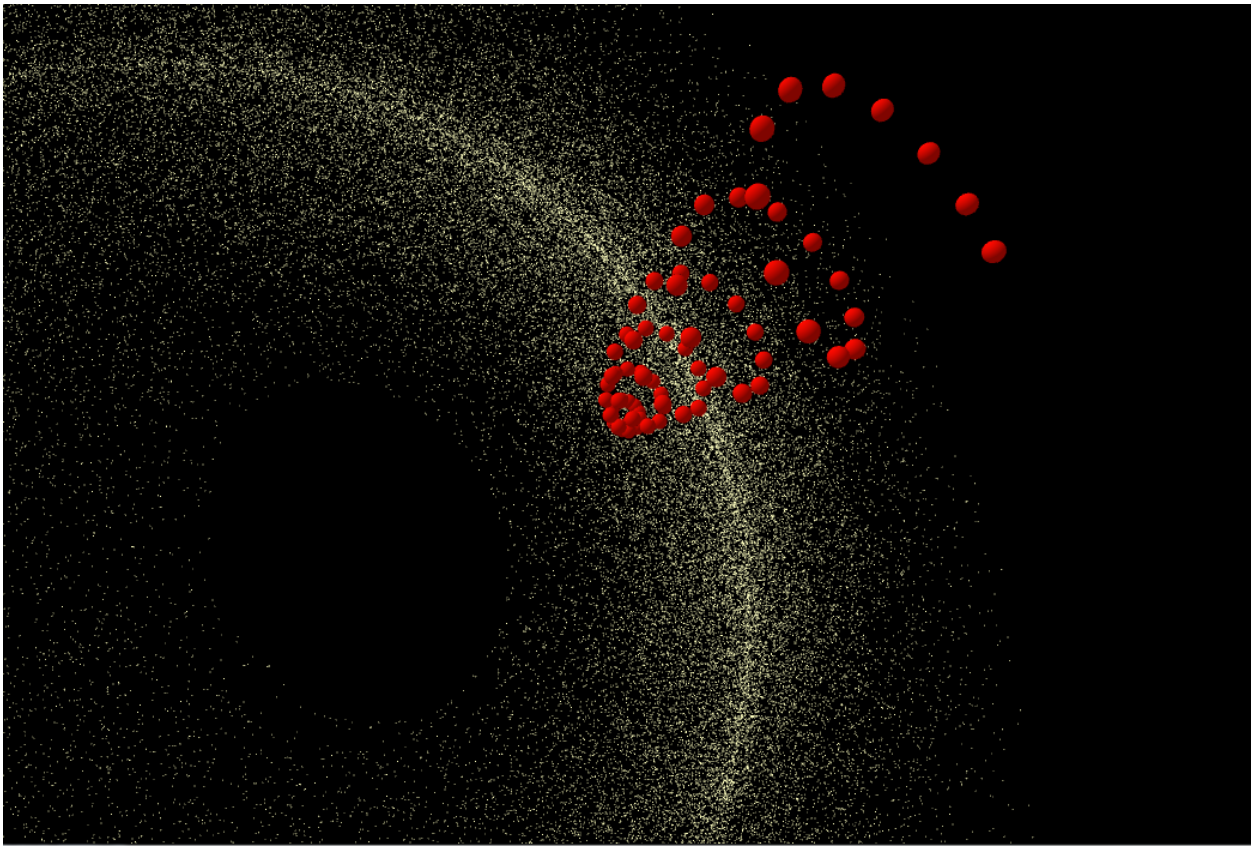
In the following, I tried different two types of spiral shaped of comets to represent the monthly patterns of one dewey class between 2006~2013.



Circular Shapes



or 3D Spirals



Then, it adds the dewey class “comet” into the library “information universe”