Analysis of Users' Emotion using Bio-signals

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Overview

- Most famous and popular approach of recommendation system is based on the analysis of metadata on consumed contents.
- However, according to some analysis, even the best RS can only recommend contents with the accuracy of around 20%.
- This is because the genre, for example, which is one of the metadata, can be interpreted differently from person to person.
  - For example, a move which is taken as Sci-Fi by a person could be taken differently as action by another person.
- Thus, in order to increase the accuracy of RS, we have to know what emotion and feeling are actually perceived by users.
  - In addition, such emotion shall be evaluated objectively, but not subjectively.
- With the above consideration, we focus on bio-signals from which user's emotion is to be analyzed.

Bio-signals to be used with AV System

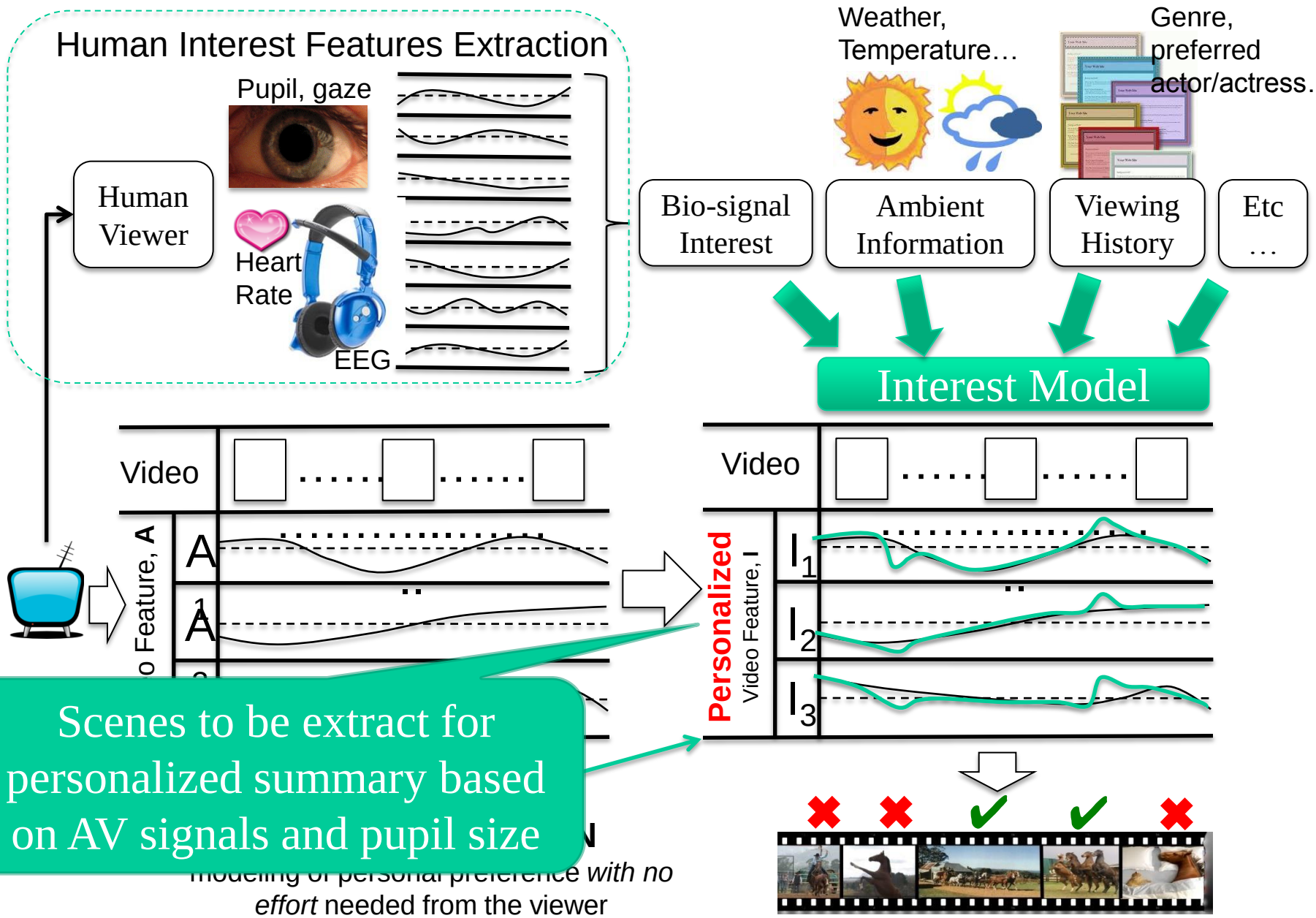
- Gazing point and pupil size
  - Level of interest, focal point, concentration can be obtained.
  - It's natural to use eyes to watch AV contents.
  - Non-restrictive data collection can be done by eye-tracker.
  - The price of eye-tracker is getting cheaper, year by year.
- Brain wave
  - Various emotion can be evaluated.
  - Low price and easy-to-use EEG systems are now available.
  - Basically it's somewhat restrictive for measurement, however, it could be implemented with glasses in future.
- Hear beat rate and blood pressure
  - Level of tension and/or relax can be retrieved.
  - It's somewhat restrictive.
- Salivary amylase
  - Level of stress can be measured.
  - Putting a chip into mouth is necessary.
- Sweating
  - Mainly, to measure the sweating on palm to measure the stress level.
  - It's somewhat restrictive.

- With the above observation, we focus on to use eye-tracker to extract gaze and pupil size, and brain wave using EEG.

Some Research Projects

- Personalized summary of movies using gaze and pupil size
- Automatic classification of video genre based on pupil size
- User emotion analysis using brain wave and pupil size
- Emotion analysis while reading comics using gaze, blinking, pupil size
- User preference analysis and grouping of users based on the similarity of gaze.
- Taste preference analysis using brain wave
- Personalized image classification using gaze
- Personalized music genre classification using brain wave
- Analysis of users' surprise and confusion using brain wave

Personalized summary of movies using gaze and pupil size (1/2)



Personalized summary of movies using gaze and pupil size (2/2)

Experiment Result for Short Film[1], with high narrative nature

Method	Precision	Recall
Our Proposal	79.3%	41.6%
Arousal Model	65.3%	33.6%
Constant Interval	57.1%	29.3%

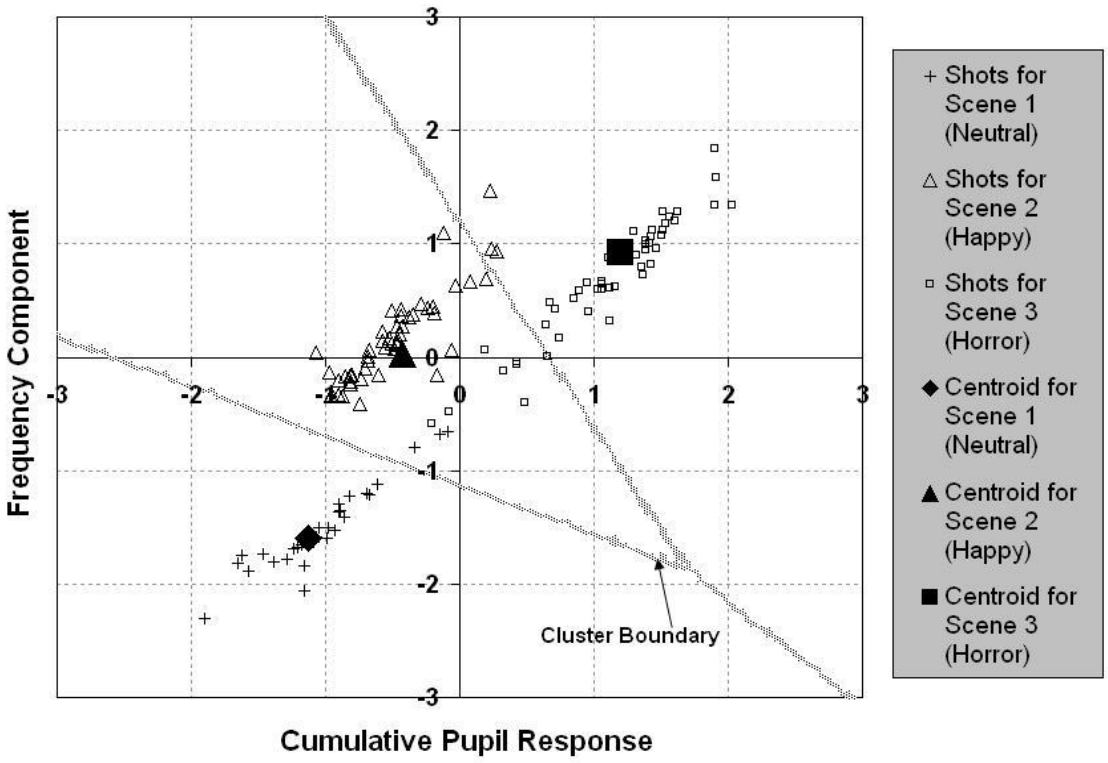
Experiment Result for Documentary[2] video

Method	Precision	Recall
Our Proposal	47.3%	39.8%
Arousal Model	39.3%	29.5%
Constant Interval	28.6%	17.5%

- Our proposed method achieved highest result for both test videos
- For short video which conform to film grammar, arousal model[3] achieve precision at around 65%, while our proposal's precision is nearly 80%
- Documentary video has very low in narrative nature → the general precision and recall is low
- In general for both the cases, our proposed method achieves improvement around 20 points over constant interval sampling

1. "Signs", website, 2008. http://patrickhughes.com.au/shorts/
2. "ディープ・ブルー", Website, 2003, http://www.deep-blue.jp/
3. Alan Hanjalic and Li-Qun Xu, "Affective Video Content Representation and Modelling", IEEE Transactions on Multimedia, Vol. 7, No. 1, February 2005

Automatic classification of video genre based on pupil size



Clustering result for a test subject into 3 different scenes

Principal Component Analysis shows that 2 PC contributed to majority of the data variance

Subject	Variance Contribution of 2 PCs			features
	First PC	Second PC	Both	
1	69.58%	23.56%	93.14%	CPR, FC
2	66.03%	26.39%	92.42%	CPR, FC
3	66.52%	25.48%	92.00%	CPR, FC
4	66.68%	25.47%	92.15%	CPR, FC
5	64.17%	24.78%	88.95%	CPR, FC
6	67.26%	25.11%	92.37%	CPR, FC

Classification results for all subjects with the selected features

Subject	Accuracy
1	75.86%
2	66.96%
3	80.65%
4	70.97%
5	89.06%
6	47.86%
Average	71.89%

Findings:

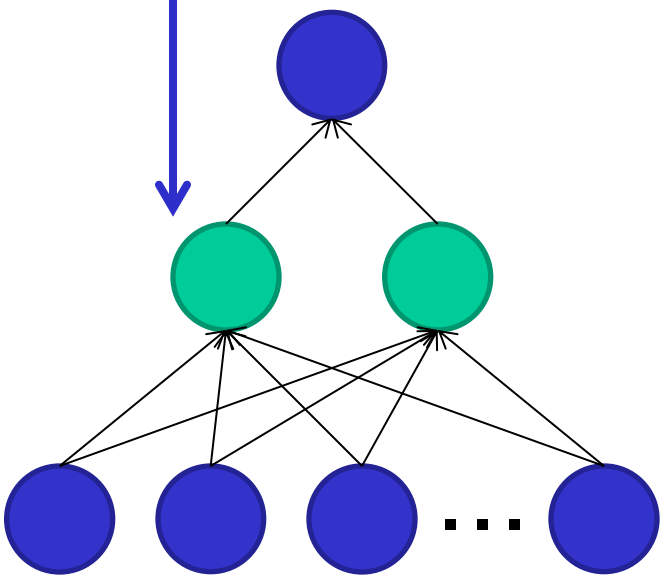
•An encouraging ation accuracy of 89.06% is achieved, with average accuracy 71.89%

Scenes can be classified into neutral, happy, horror automatically by pupil size.

User emotion analysis using brain wave and pupil size (1/2)

The intermediate layer : 2

The existence of functional modules in the brain responsible for the contraction and expansion of the pupil size[5]



Neural Network 3 layer model
(multi-layer perceptron)

The output layer : cumulating pupil size

- The temporal summation value of the cumulating pupil size in 1 second.

※We re-arrange the data to compensate the eye blinking by applying linear interpolation using the value before and after it.

The input layer : back ground activity of brain

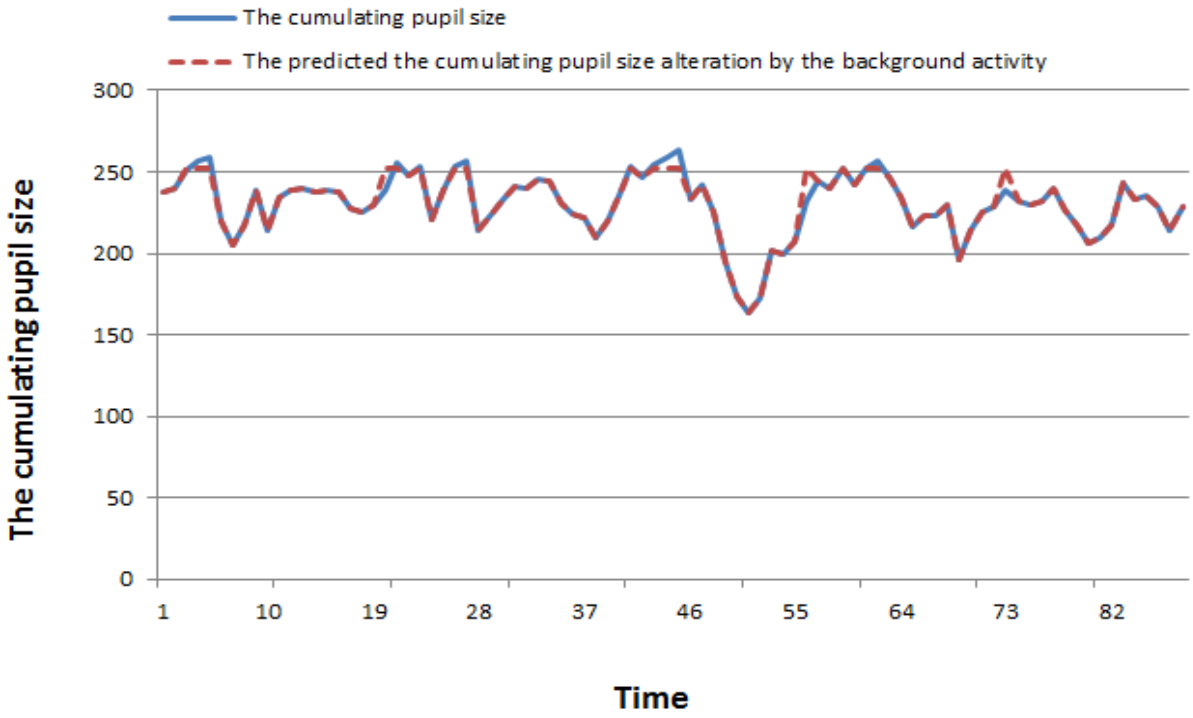
- The power ratio of the frequency component of the background activity of the past 5 seconds and the future 5 seconds from each time point.

α_low	8-9Hz	α_high	10-12Hz
β_low	13-17Hz	β_high	18-30Hz
γ_low	31-40Hz	γ_high	41Hz-

[5]Shigeyoshi ASANO, Ikki YASUIKE, Minoru NAKAYAMA, Yasutaka SHIMIZU, “A Pupil ...n Model with Neural Network for Brightness Change”, The Transactions of the ...mation and Communication Engineers, A Vol.J77-A No.5 ...anese)

By neural network, the relationship between pupil size and brain wave is analyzed.

User emotion analysis using brain wave and pupil size (2/2)



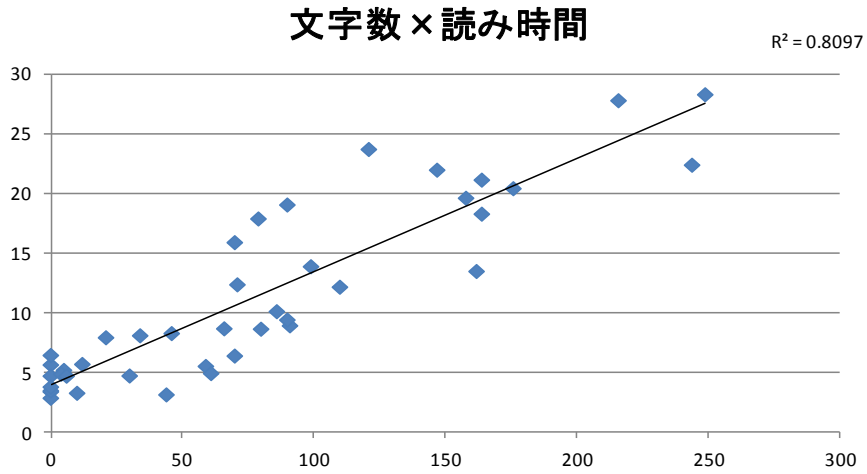
R-square value : 0.967368

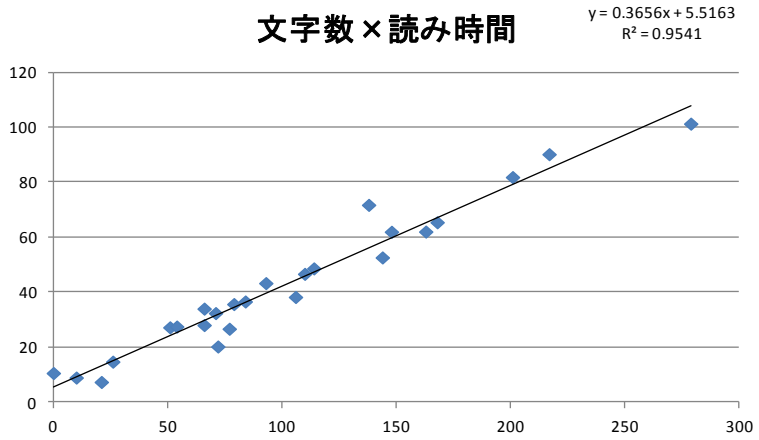
Fig.1 Interpolation Result of Subject 1 (The cumulating pupil size)

It is possible to predict the pupil size from the ratio of the power of the background activity.

※However, this R-square values is the maximum one among the 10-times learn, so there are also low R-square values.

Emotion analysis while reading comics using gaze, blinking, pupil size

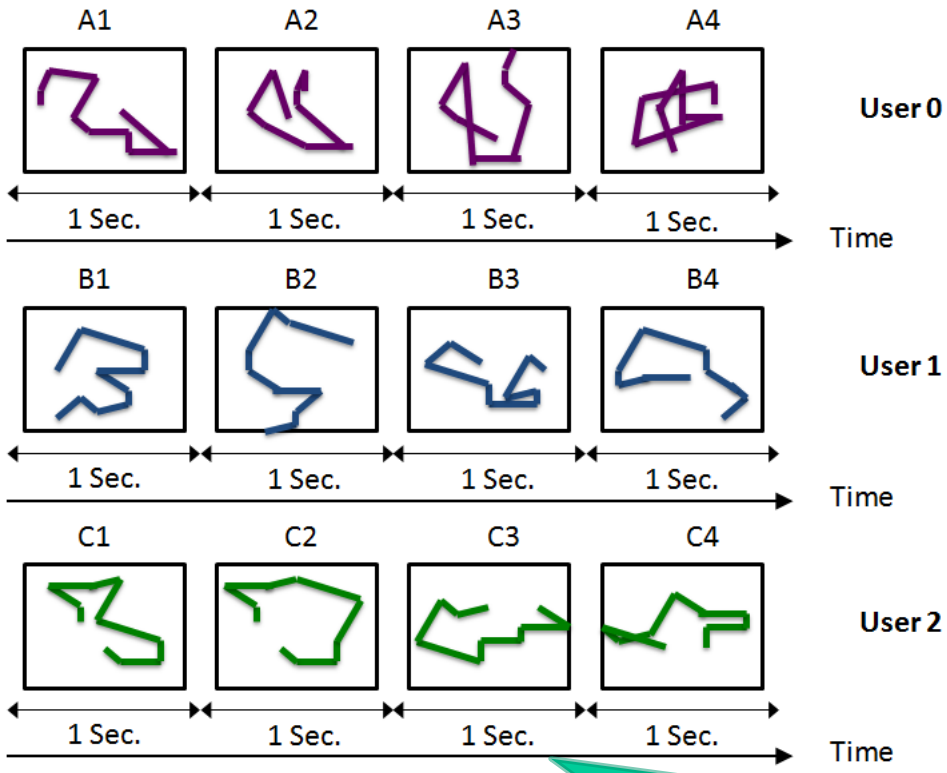




Y : number of characters in balloons per a page
X : time of reading one page in second
Test comics : The left is GOLGO 13, the right is Mr. Hoo

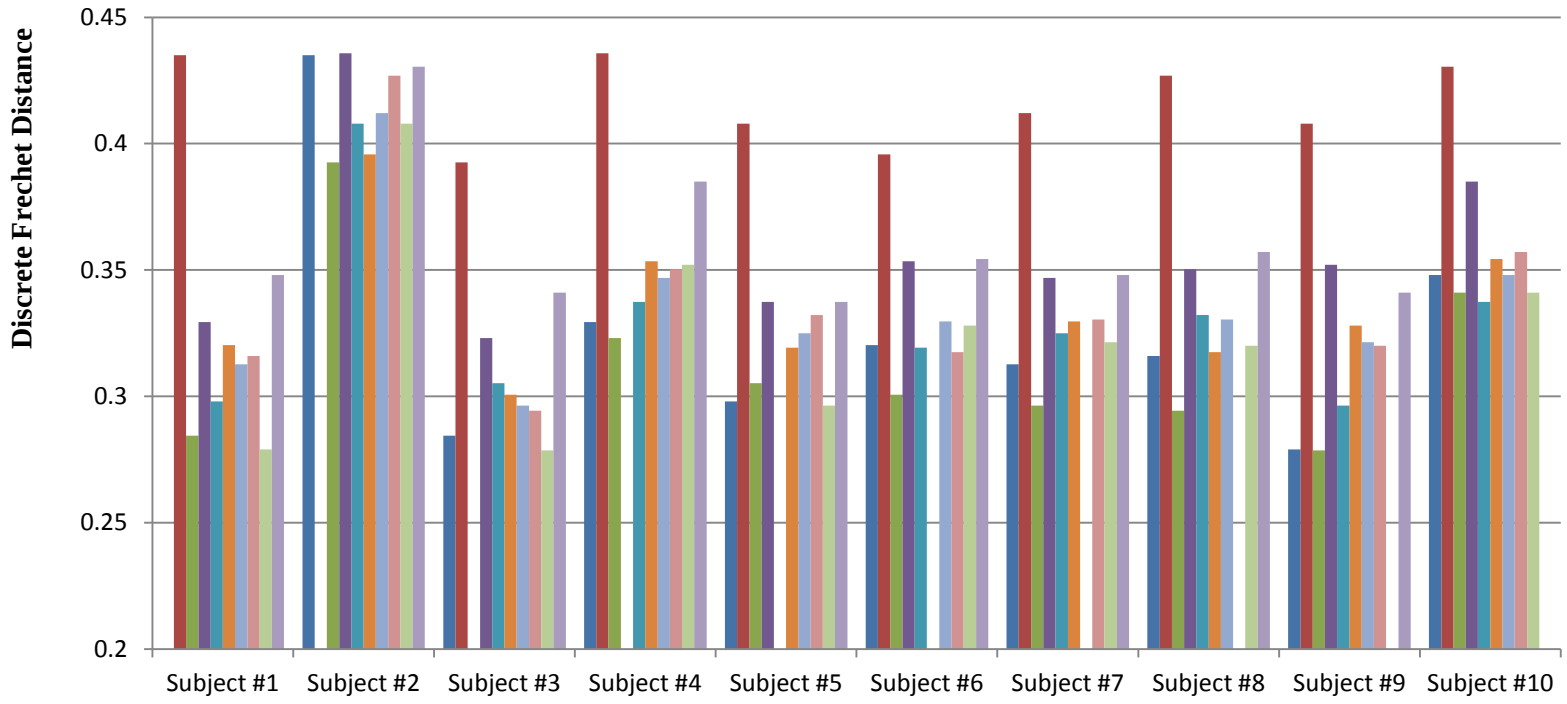
- There is strong relation between X and Y.
- Some points above and below lines may represent some strong or least level of interest.

User preference analysis and grouping of users based on the similarity of gaze (1/2)



If some users' trajectories of gazes are similar, their preferences could be same. Using Fretchet Distance, gaze similarity is analyzed.

User preference analysis and grouping of users based on the similarity of gaze (2/2)



Gaze similarity is observed between some users. It suggests that grouping users can be done based on it.

Some Applications

- Recommendation System
- Remote-control-less TV
- Automatic restaurant evaluation
- Life Log
- Personalization of movie genre
- Personalization of music genre
- Accurate user emotion feedback to any marketing applications
- And more