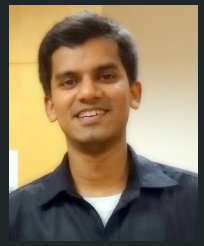
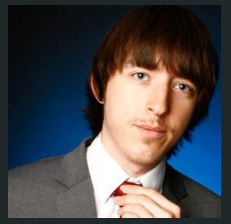
Modelling Human Factors in Perceptual Multimedia Quality: On The Role of Personality and Culture

Michael Scott
Sharath Chandra
Yang Huan
Weisi Lin
George Ghinea




NANYANG TECHNOLOGICAL UNIVERSITY

Brunel University London

Motivation - Background

‘Perceived Quality’ determines the success of
Multimedia Content and Service Providers

Content *depends on Creators*

Transmission *depends on ISPs*

Motivation - Background

‘Perceived Quality’ determines the success of
Multimedia Content and Service Providers

Content *depends on Creators*

Transmission *depends on ISPs*

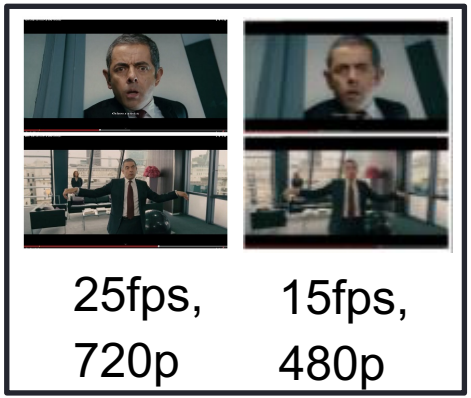
ISPs can stream content at the ‘right’ parameters to ensure viewers’ satisfaction

What are ‘right’ parameters? Highest?

Sometimes, tradeoff between quality and bandwidth is essential (mobile network)

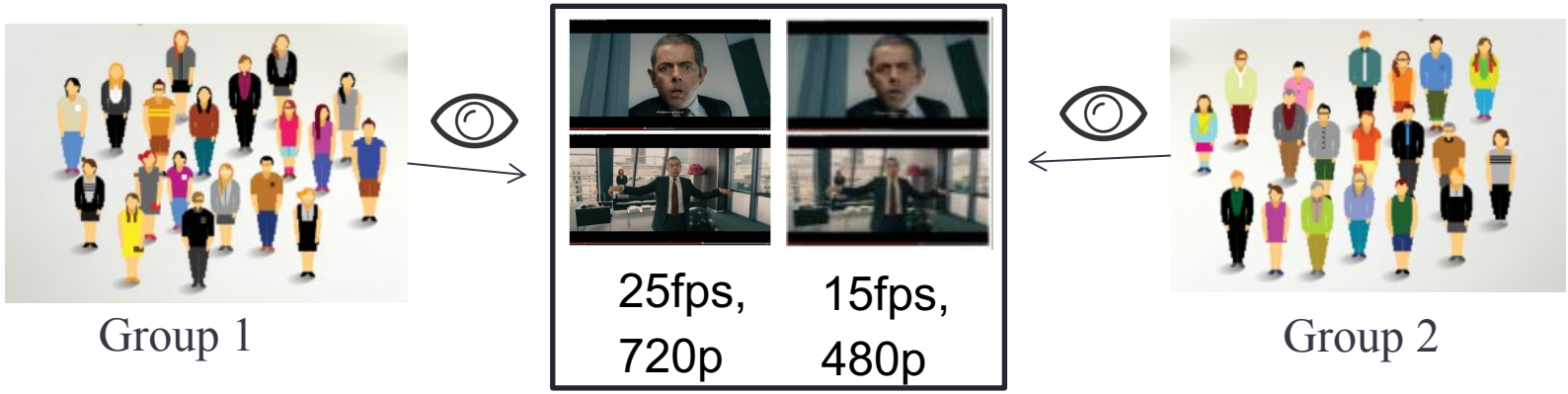
Motivation - Questions

Group 1



Group 2

Motivation - Questions



Group 1

Group 2

1. Can the lower parameter setting video have higher ‘perceived quality’?
2. What are the factors influencing perception of quality?
3. How are enjoyment and perceived quality related?

Service providers can then maintain adequate customer satisfaction in a personalized manner while optimally utilizing resources such as bandwidth.

Related Work

Perception of Quality and Enjoyment are influenced by:

a. System factors b. Contextual factors c. Human factors

Related Work

Perception of Quality and Enjoyment are influenced by:

a. System factors b. Contextual factors c. Human factors

Previous research focuses on system, contextual factors with limited consideration for human factors (mostly basic variables such as gender, age group etc.)

These are insufficient to generalize findings to a broader population because of idiosyncratic rater effects

Reiter, Ulrich, et al. "Factors influencing quality of experience." *Quality of Experience*. Springer International Publishing, 2014

Scullen, Steven E. et al. "Understanding the latent structure of job performance ratings." *Journal of Applied Psychology* 85.6 2000

Existing Challenges

Assumption in previous works:
Perceptual quality of different participants is averaged out.

Existing Challenges

Assumption in previous works:

Perceptual quality of different participants is averaged out.

What about human factors? *How to represent them?*

Differences at a micro-cosmic level: Personality

Differences at a macro-cosmic level: Culture

Studying the influence of such human factors needs *subjective data*

However, there are no such publicly available datasets!

Gosling, S. D.,et. al (2003). A very brief measure of the Big-Five personality domains. Journal of Research in personality, 37(6)

Hofstede, G., & Bond, M. H. (1984). Hofstede's culture dimensions an independent validation using rokeach's value survey. Journal of cross-cultural psychology, 15(4)

Studies in Psychology

Role of human factors

Americans have more analytical visual perception (inclined to pay attention to details), while Asians have a more holistic visual perception (likely to be more sensitive to context).

Similar studies were conducted on cross-cultural differences b/w Westerners, Japanese and Chinese etc., (on cognitive processes, visual attention, color perception and so on..)

Miyamoto, Yuri. "Culture and analytic versus holistic cognition: Toward multilevel analyses of cultural influences." *Advances in Experimental Social Psychology* 47 (2013): 131-188.

Setlock, Leslie D., Pablo-Alejandro Quinones, and Susan R. Fussell. "Does culture interact with media richness? The effects of audio vs. video conferencing on Chinese and American dyads." *System Sciences, HICSS 2007.*

Acar, Adam, et al. "Object vs. Relation: Understanding the Link between Culture and Cognition with the Help of WordNet." *Int. J. of Asian Lang. Proc.* 21.4 (2011): 199-208.

Recent Study on Perceptual Quality

Data: 59 users 6 YouTube videos covering sports, comedy and education genres.

User characteristics:
Gender, Cultural background (Asian/Western)
Personality, Immersive tendency

Social Context:
Every user sees the video individually and with friends.

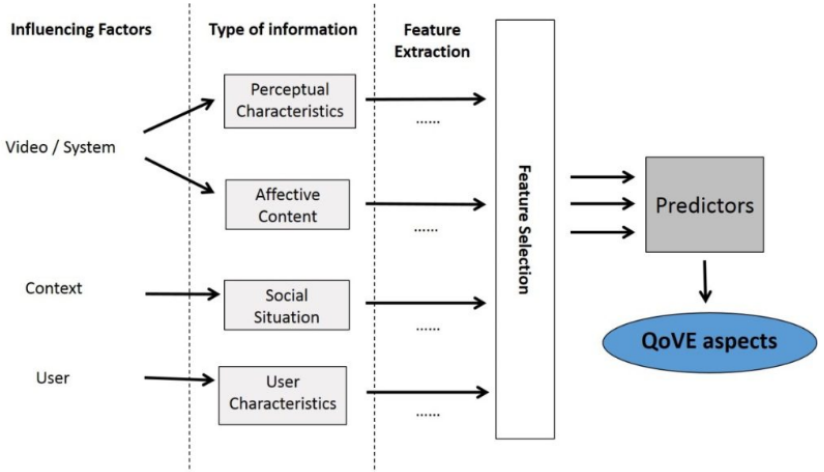
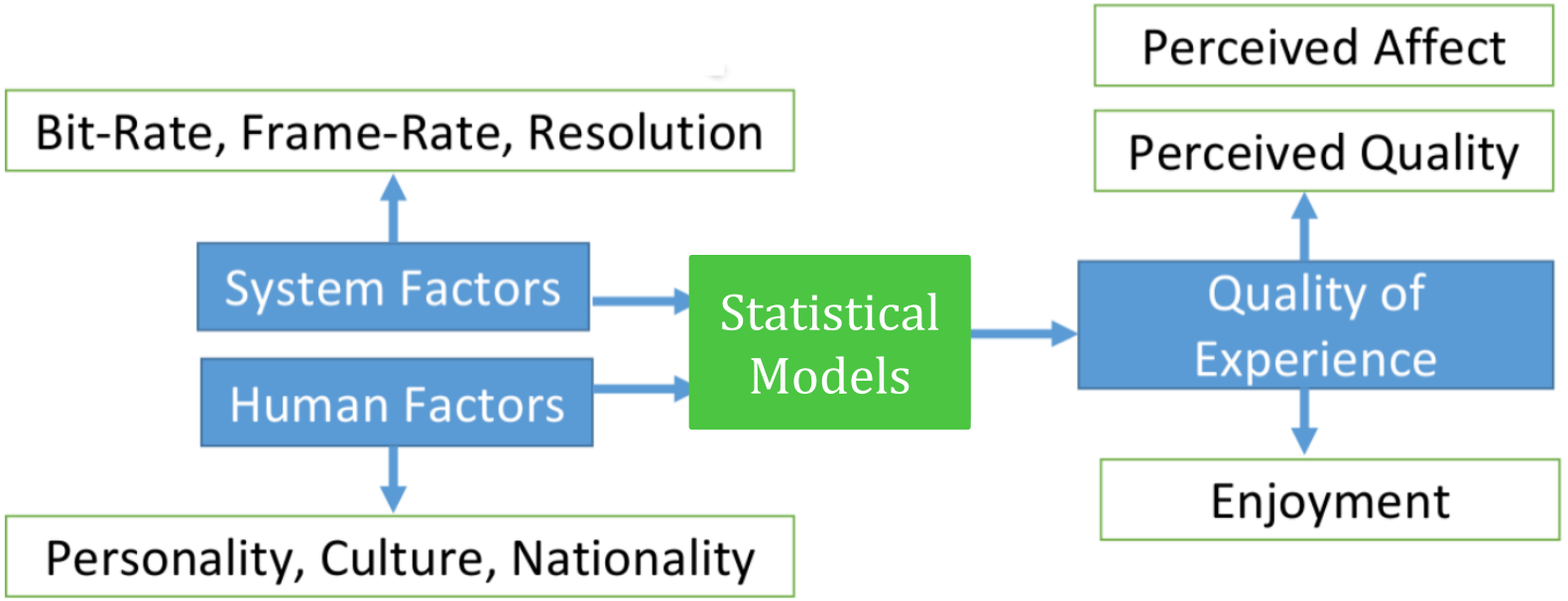


Figure source [Zhu et. al]

Zhu, Yi, et al. "Towards a comprehensive model for predicting the quality of individual visual experience." *IS&T/SPIE Electronic Imaging*. International Society for Optics and Photonics, 2015.

Overview of our work

Modeling the influence of personality and culture on quality and enjoyment and also the correlations b/w the responses.



Research Questions

1. To what extent do human factors predict variance in ratings of quality and enjoyment?
2. Which system characteristics and human factors influence quality and enjoyment the most?
3. What is the relationship between perception of quality and enjoyment across stimuli - how are they correlated?

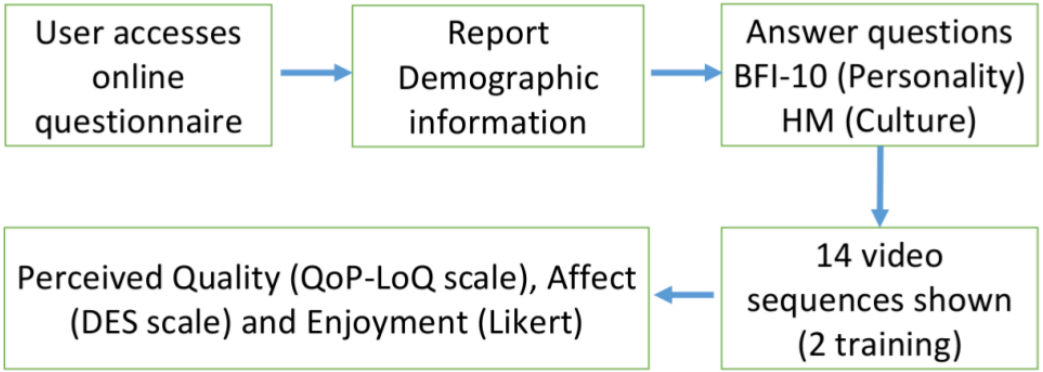
Dataset

144 video sequences (part of FilmStim#)

a. 1 nominal parameter: content (12 short movie clips of different emotions)

b. 3 ordinal parameters: bit-rate (384, 768 kbps); resolution (480, 720p); framerate (5, 15, 25 fps).

c. 12 quality conditions and 6*2 emotion conditions



Scan for dataset

#Assessing the effectiveness of a large database of emotion-eliciting films: A new tool for emotion researchers. Cognition and Emotion 24(7): 1153-1172.

Sample Descriptives

The participants were 114 university students drawn from NTU Singapore and Brunel University London. 50% of the sample was drawn from each institution.

Human Factors	$\bar{x}(NTU)$	$\bar{x}(BUL)$	$\bar{x}(Pool)$	σ
Extroversion	5.61	5.46	5.54	1.689
Agreeableness	7.33	7.31	7.22	1.533
Conscientiousness	6.40	6.70	6.55	1.523
Neuroticism	5.56	5.68	5.62	1.716
Openness	6.60	6.91	6.75	1.424
Power Distance	-35.61	-36.32	-35.96	53.219
Individualism	25.79	11.67	18.73	50.619
Masculinity	3.68	-6.14	-1.23	53.483
Uncertainty Avoidance	52.54	36.67	44.61	47.182
Pragmatism	16.14	17.54	16.84	58.090
Indulgence	-22.63	-11.32	-16.97	65.522

$\bar{x}$: Sample Mean; σ: Standard Deviaton

Cultural dimensions: http://geert-hofstede.com/national-culture.html

http://1drv.ms/1M1bnwU

Scan for dataset

Statistical Models

We build three computational models to investigate the influence of system factors (Bit-Rate, Frame-Rate and Frame-Size) and human factors (5 personality factors and 6 culture factors).

1. **Baseline:** Considers system factors (as factorial interactions) and the content parameter (to reflect differences in nature of content).

2. **Extended:** Adds human factors (as covariates) to the baseline model.

3. **Optimistic:** Each participant is modeled as a random effect, to take into consideration factors, other than system/personality/culture which we measured, that can play a role.

Results - Baseline Model

Parameter	df_{num}	Perceived Quality			Enjoyment		
		df_{den}	F	p	df_{den}	F	p
Movie Excerpt	11	191.387	8.880	.000	177.090	40.140	.000
Frame Rate (FR)	2	1152.788	23.540	.000	1131.230	5.173	.006
Frame Dimension (Dim)	1	1164.451	16.890	.000	1146.390	2.846	.092
Bit-Rate (BR)	1	1160.518	9.830	.002	1139.690	.474	.491
FR * Dim	2	1150.910	3.070	.047	1130.961	1.663	.190
FR * BR	2	1152.330	5.188	.006	1131.496	2.078	.126
Dim * BR	1	1165.993	8.240	.004	1137.742	1.364	.243
FR * Dim * BR	2	1154.080	5.714	.003	1130.448	.002	.998

Frame Rate had a statistically significant effect on enjoyment.
System factors alone do not make a huge impact
on how the content is perceived.

N. Yeung and A. G. Sanfey, “Independent coding of reward magnitude and valence in the human brain,” The Journal of Neuroscience, 2004.

Results - Extended Model

Parameter	df_{num}	Perceived Quality			Enjoyment		
		df_{den}	F	p	df_{den}	F	p
Movie Excerpt	11	191.490	9.070	.000	171.956	39.733	.000
Frame Rate (FR)	2	1142.880	24.075	.000	1136.577	4.695	.009
Frame Dimension (Dim)	1	1153.771	13.578	.000	1151.402	3.336	.068
Bit-Rate (BR)	1	1148.206	12.677	.000	1145.171	.257	.612
FR * Dim	2	1145.057	3.748	.024	1145.206	1.057	.348
FR * BR	2	1144.258	5.262	.005	1138.177	1.856	.157
Dim * BR	1	1154.877	9.876	.002	1146.873	2.424	.120
FR * Dim * BR	2	1146.555	5.981	.003	1138.844	.057	.945
Extroversion	1	1151.392	.130	.718	1150.401	.024	.877
Agreeableness	1	1151.909	2.672	.102	1152.475	2.001	.157
Conscientiousness	1	1141.817	7.126	.008	1141.249	5.271	.022
Neuroticism	1	1149.100	11.708	.001	1146.479	.050	.823
Openness	1	1150.056	1.168	.280	1145.365	4.344	.037
Power Distance	1	1154.125	.290	.590	1152.465	9.138	.003
Individualism	1	1149.721	5.519	.019	1150.026	.674	.412
Masculinity	1	1147.422	5.578	.018	1141.312	3.312	.069
Uncertainty Avoidance	1	1144.686	.333	.564	1144.106	5.751	.017
Pragmatism	1	1152.021	4.889	.027	1160.700	.604	.437
Indulgence	1	1140.461	2.321	.128	1149.178	2.206	.138

Results - Optimistic Model

Parameter	df_{num}	Perceived Quality			Enjoyment		
		df_{den}	F	p	df_{den}	F	p
Movie Excerpt	11	176.430	11.260	.000	179.877	46.990	.000
Frame Rate (FR)	2	1086.420	28.464	.000	1116.890	8.025	.000
Frame Dimension (Dim)	1	1100.669	17.950	.000	1120.818	3.130	.077
Bit-Rate (BR)	1	1092.200	13.052	.000	1121.960	.054	.816
FR $*$ Dim	2	1091.110	2.892	.056	1117.780	.719	.487
FR $*$ BR	2	1103.450	5.269	.005	1127.280	1.488	.226
Dim $*$ BR	1	1114.040	7.513	.006	1128.860	1.466	.226
FR $*$ Dim $*$ BR	2	1087.310	7.143	.001	1113.480	.020	.980

Frame-Size and frame rate has become non-significant.
The most notable difference, however, is a large increase in the variance explained as a result of including participants as random effects.

There are factors other than system, human and content factors which influence perception of affect and enjoyment.

Comparison of Models

Perceived Quality: Baseline and Optimisitc models predict 24.2 % and 37.9% of the overall variance resp. Extended model predicts approximately 9.3% of variance attributable to human factors

Models	$\Delta\bar{x}$	σ	$SE_{\bar{x}}$	95% CI		t	df	p
				Lower	Upper			
Baseline → Extended	.0325	.461	.013	.007	.058	2.472	1231	.014
Baseline → Optimistic	.3551	1.009	.029	.299	.412	12.350	1231	.000

Enjoyment: Baseline and Optimistic models predict 23% and 47.8% of the overall variance. Extended moel again predicts 9.3% of the variance attributable to human factors.

Models	$\Delta\bar{x}$	σ	$SE_{\bar{x}}$	95% CI		t	df	p
				Lower	Upper			
Baseline → Extended	.0394	.430	.012	.015	.063	3.219	1231	.001
Baseline → Optimistic	.4199	1.129	.032	.357	.483	13.069	1231	.000

Tables show paired t-test results on models' predictions

Perceived Quality and Enjoyment

Overall correlation between quality and enjoyment is significant (0.375, $p<0.05$), however not consistent across all movie excepts.

Additionally, the ‘highest' quality parameters do not consistently perform well. E.g: Violence

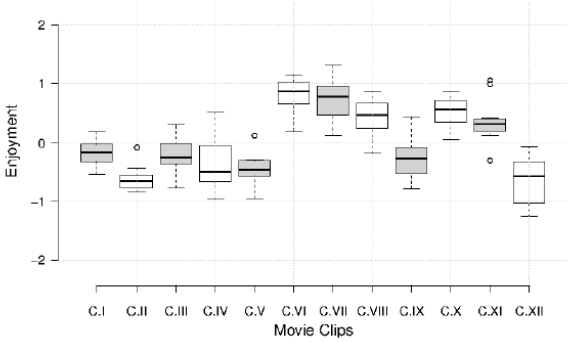


Figure 1: Box-Plot showing the distribution of Enjoyment of Each Movie Excerpt in the Dataset

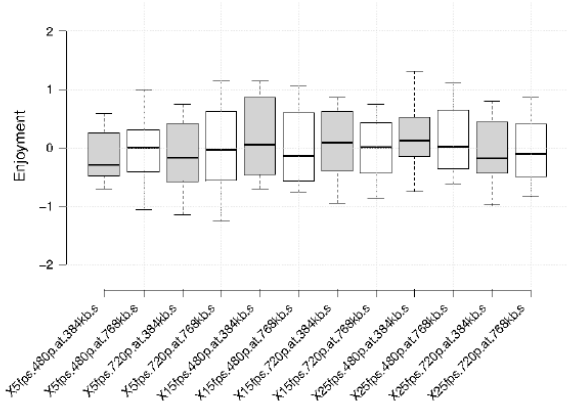


Figure 2: Box-Plot showing the distribution of Enjoyment of Each Parameter Setting in the Dataset

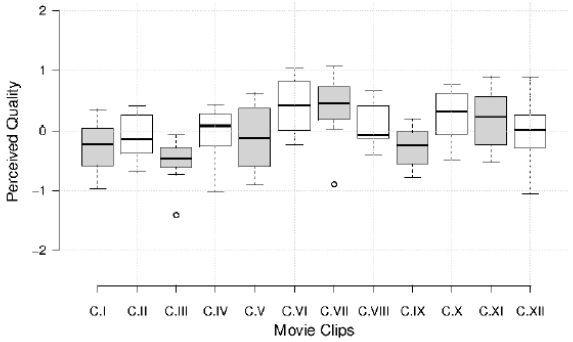


Figure 3: Box-Plot showing the distribution of Perceived Quality of Each Movie Excerpt in the Dataset

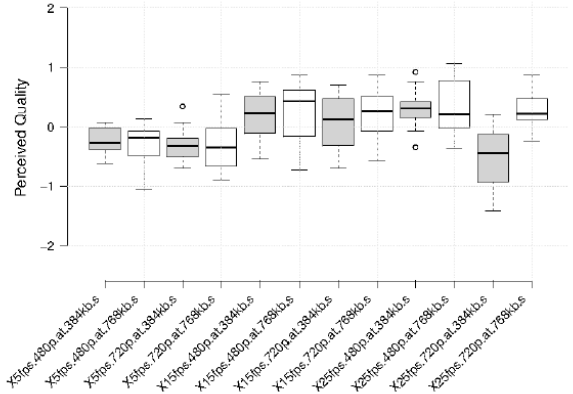


Figure 4: Box-Plot showing the distribution of Perceived Quality of Each Parameter Setting in the Dataset

Research Questions (Revisited):

1. To what extent do human factors predict variance in ratings of quality and enjoyment?
2. Which system characteristics and human factors influence quality and enjoyment the most?
3. What is the relationship between experience of quality and enjoyment across stimuli - how are they correlated?

Research Questions (Revisited):

1. To what extent do human factors predict variance in ratings of quality and enjoyment?

    Greater proportion of the variance can be predicted by human factors than by system factors (improvement of 13.7%).

    “Lower” system factors may not automatically entail lower quality or enjoyment. For instance, the parameter setting 25fps, 480p, 384k was ranked 4th for perceived quality and 1st for enjoyment, despite having a low bit-rate.

    Personality and Culture represent 9.3% of the variance attributed to human factors.

Research Questions (Revisited):

2. Which system and human factors influence quality and enjoyment the most?

Sig. Factors	Quality	Enjoyment
System	All	Frame-rate
Human	Con, Neu, PRG, MAS, IDV	Con, Ope, PDI

Culture: power distance (PDI); individualism (IDV); uncertainty avoidance (UAI); masculinity (MAS); pragmatism (PRG); and indulgence (IVR).
Personality: openness (O); conscientiousness (C); Extroversion (E); Agreeableness (A); Neuroticism (N).

Research Questions (Revisited):

3. What is the relationship between experience of quality and enjoyment across stimuli - how are they correlated?

A correlation analysis of the relationship between quality and enjoyment shows considerable inconsistency in effect size. It is interesting to note that the excerpts with objectionable content (i.e., graphic murders) had non-significant correlations while excerpts with widely acceptable content (i.e., romance) had much higher effect sizes.

Open Questions

What are the other human factors (apart from Personality and Culture) which influence perceived quality (and QoE)?

Only the main effects of personality and culture were explored in this study – how about their interactions with each other and with other factors?

Designing user-centered algorithms for optimal bandwidth utilization by taking parameters like personality and culture, and also individual preference for different generes.

This study considered university students (of diverse cultures), how to build large-scale and broader datasets?

Dataset can be downloaded from:
http://1drv.ms/1M1bnwU

Thank you!

Any Questions?