Selected Advanced Data Visualizations: "The UX-Machine", Cultural Visualisation, Cognitive Big Data, and Communication of Health and Wellness Data

Artur Lugmayr
Curtin University
Visualisation and Interactive Media Lab. (VisMedia)
Perth, WA, AUSTRALIA
artur.lugmayr@artur-lugmayr.com

Adam Greenfeld
Curtin University
Visualisation and Interactive Media Lab. (VisMedia)
Perth, WA, AUSTRALIA
adam.greenfeld@graduate.curtin.edu.au

Danjing Joy Zhang
Curtin University
Digital China Lab.
Perth, WA, Australia
joy.zhang@curtin.edu.au

ABSTRACT
The goal of this set of this demonstration presentation is to describe a set of visualizations that underline the importance of appropriate data visualizations in particular contexts. The goal is to showcase different types of visualizations, and illustrate how emerging media technology can be utilized for this purpose. First, we showcase 'The UX-Machine', which is a tool for visualizing bio-feedback data; second, we illustrate a visualization of a cultural photographic collection; third, we present Cognitive Big Data as emerging new technology in the domain of Big Data, and fourth present visualization as a matter of communication and culture. The goal of this paper is to introduce and describe the key aspects of visualization on some concrete examples. The demonstrators should also illustrate the use of emerging media technology as part of advanced concepts for data visualization.

Keywords
Cognitive Big Data, Big Data, Emotional Computation, Affective Computation, Visualization, User-Experience, Bio-Feedback.

1. INTRODUCTION
The main goal of this paper is to introduce the set of demonstrations to be presented during the WWW 2017 conference. One of the aims of this series of demonstrations is to showcase the different stages of a typical visualization pipeline as illustrated in Figure 1. Each demonstration fits to a different visualization stage of a typical visualization pipeline. We especially focused on the aspects of data presentation, interaction, cognition & perception, and communication, rather than the data analysis part itself.

WWW 2017 Companion, April 3-7, 2017, Perth, Australia.
ACM 978-1-4503-4914-7/17/04.
http://dx.doi.org/10.1145/3041021.3059213

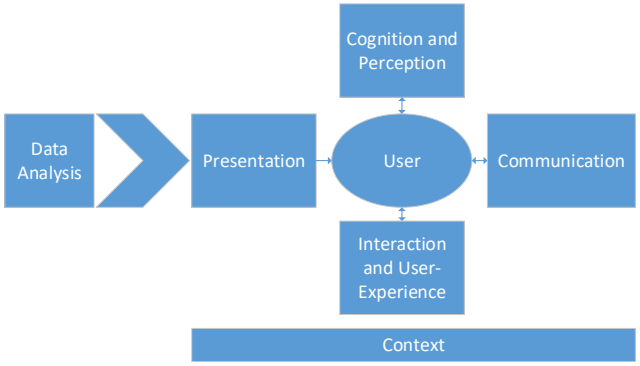

Figure 1. Visualisation Pipeline (extended from [1]).

The demonstrations have been developed by the authors during the past years, and range over a wide set of application areas:

- **Visualization of a Cultural Photographic Collection in 3D:** cultural visualization which visualizes historical photographs from the digital archives of the *State Library Western Australia (SLWA)*. Users can explore different aspects of the images, such as location, author, theme, or time-period. The application was firstly published in [2], and should illustrate an example for presenting media archives in an interactive way to enable an easier information exploration;
- **The "UX-Machine":** demo of a freely available software platform to collect, analyze, manage, and visualize emotional bio-feedback data from distributed physiological sensor network connected to a human body (published in [3], and freely downloadable from [4]). This demonstration should illustrate the possibility of this technology in terms of advanced feedback and interaction processing through user-experience, and visualization of emotional concepts;
- **Bio-Feedback Visualization to Communicate Health Data:** on the example of the fitness tracker Xiaomi Miband (China), we illustrate the importance of communication – especially how communication is utilized to reconfigure Big Data collection, socialization, communication, and stipulation of wellbeing activities;

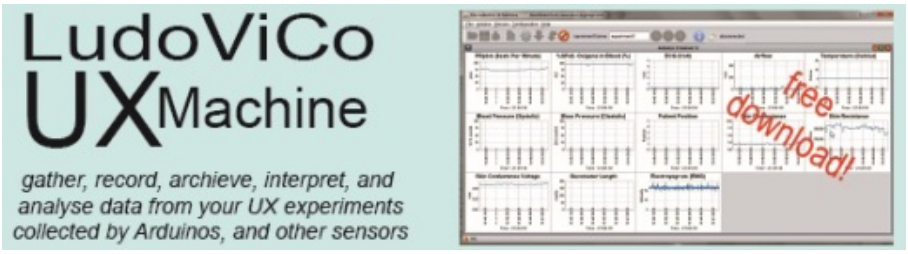

Figure 2. The "UX-Machine" (freely downable from [4] and firstly published in [3].

- **Cognitive Big Data:** Cognitive Big Data is a framework for merging ideas from cognitive computation, Big Data, and psychology under the aspect of Big Data. It has been firstly mentioned in [5], and a complete framework has been developed in [6]. Cognitive Big Data presents advanced models for cognitive processes in the domain of Big Data. We illustrate how this can be supported through visualization;

Today much research is focused on Big Data, rather than improving human understandability of the results of the analysis, and the data itself. These types of have been selected to underline the importance of the phases of *presentation, cognition and perception, communication,* and *interaction and user-experience*. The visualization of a cultural photographic archive is an example for presenting large scale media archive, and providing a sophisticating method to interact with the archive. The UX-Machine is an example how emotional and biofeedback data can be utilized to visualize human responses in UX experiments. The importance of communication as part of the visualization pipeline is illustrated on the example of a fitness tracker in China. The visualization of biological data illustrates the use of visualizations in a professional context.

1.1 Related Works

Various different basic theories and ideas contributed to the ideas of these demonstrators. Most of these are described in the original works, where the applications have been described in the first place.

Digital Humanities deal with exploration of computational technology in humanities areas [7]. The *3D Photographic Archive Visualization* demo illustrates how 3D and immersive technologies can be utilized to visualize large scale image archives [8] as a virtual reality application [7]. Previous work e.g. illustrate the possibility of advertising in [9] on interactive displays.

The large field of *Emotional Computation* and *Affective Computation* deal with the recognition and simulation of human emotions with computer systems (see e.g. [10]). Affective interaction [11] and perceptual user-interfaces [12] have been introduce in previous research work. A media viewpoint towards emotional computation has been presented in [13], and [14] attempts to link user-interaction, media research, and emotional computation (see also e.g. [15], and [14]).

Cognitive Big Data merges is situated at the intersection of *Big Data* research (see e.g. [16], [17]), *Cognitive Computation*, and *Neurosciences* [13], and can be seen as new way how to think about Big Data [6] and [5], in particular in the field of knowledge management.

We also would like to emphasize other trends that enable far more complex media visualisations by integrating aspects of e.g. serious storytelling [19], cultural insights [20], personalization techniques (e.g. [21] and [22]), user-behavior models [23], smart sensor networks [24], IoT technology [25], tangible interaction [26], new immersive visual displays [9], or health analysis [27].

2. THE "UX-MACHINE"

The "UX-Machine" is a freely available software platform to collect, analyze, manage, and visualize biofeedback data from physiological sensors (see Figure 2). The goal of the tool is to introduce an opened platform for emotional analysis within the scope of user-experience experiments. The UX-Machine's primary goal is to provide a tool to analyze multi-sensor time-series data from a distributed sensor network to visualize emotional user data. The platform has been firstly presented within the SEACHI workshop during CHI 2016 [3] and can be found on http://www.ux-machine.com [4].

The UX-Machine addresses the following features:

- Philological data acquisition, management, storage, interpretation, and visualization;
- Simple and advanced time-series analytics based on extensible plug-ins;
- Suited for any Arduino based sensor platform including a sensor communication protocol;
- Current sensor types support: accelerometers, body-motion sensors, medical sensors (ECG, EMG, breath, pulse, temperature, position, GSR), etc.

3. 3D PHOTOGRAPHIC ARCHIEVE VISUALISATION

The prototype has been developed to illustrate the power of new 3D technologies in creating an interactive 3D visualisation of the large scale historic photographic image database of the *Stage Library of Western Australia (SLWA)*. The library contained over 1 Million photographs since the 1850s, and single images were annotated with metadata. We have been developing an explorative prototype for large scale 3D displays, which enables the exploration of the photographic achieve according author, location, time-period, and subject [2]. One example sketch is depicted in Figure 3.

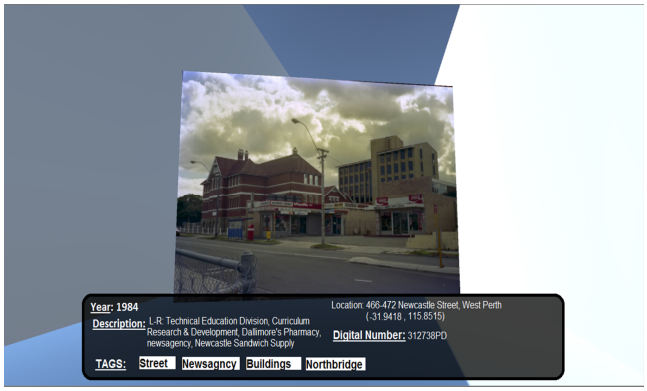

Figure 3. Cultural Visualisation of a Photographic Collection in Interactive 3D Environments.

4. COGNITIVE BIG DATA

The basic idea of cognitive data relates to create "human understandable data supporting mental capabilities as socio-technical system, in the right application context, right granularity with knowledge and wisdom processing in the foreground" [6]. In contrast to the common thoughts in Big Data, the framework includes 5 traits:

- Big Data as socio-technical system to support and extend human cognition;
- Data spaces consisting of unknown, unavailable, available and the analysis data;
- Data richness in form of wisdom, knowledge, information, and data;
- Features supporting knowledge management and decision making;
- Characteristics for visualization and sensory presentation.

The key-issue in Cognitive Big Data is the creation of an equilibrium between the knowledge and information that can be created through machine learning, and human understanding. Visualization is the key to enable the understanding of the complexities in underlying data.

5. COMMUNICATION OF HEALTH AND WELLBEING ACTIVITIES

As last, we would like to present an advanced media based visualisation for health self-management and communication through online visualisations. Health care self-management is gaining global traction, and appealing to globalized, individualistic, self-cultivating, and empowered consumers. In this case, we present Xiaomi, as second largest wearable technology provider in the world with a market share of 24.6%, following Fitbit's market share of 34.2% [28]. Xiaomi enables individuals to access and visualize their wellness data (e.g. steps, heart rate, weight, sleep data) and share the data with their social peers through online networking sites like WeChat Power of Running, and Mi Community. With this example, we investigate the importance of visualisation to communicate personal health data, and understand the effects of community engagement on fitness self-management on socio-cultural level.

This example illustrates the importance of visualisations through online portals and as a matter of technology which is in line with the cultural transformation of China. Thus, the traditional Chines culture of 'yang sheng' meaning nourishing life through physical exercises and collective community action are employed to adopt this new wearable technology as well as to enhance the UX of the Mi Band, which is a collaborative online community [29].

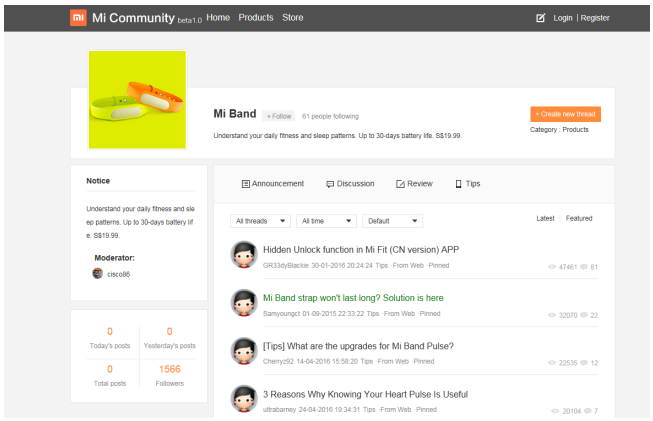

Figure 4. Communication of Health and Wellbeing Activities within the Me Community.

Mi Club and Mi Community (see Figure 4) are the unique means to combine culture and communication in forgoing unnecessary features and addressing customer complaints. As mobile networking is embedded in traditional kinship ties and guanxi networks [30], wearables connected with mobile communication is an extension of engagement bodily experience is central to one's motivation to participate in community. It emphasizes both the individualistic initiatives on bodily improvement and more in the community engagement and hence more appealing and culturally and socially acceptable.

6. CONCLUSIONS

The goal of this paper, was to present five different demonstrations of visualisations during the demo track at WWW2017 to illustrate a typical data visulisation pipeline. The demos range from various different domains, and are an example for one of the phases of: *presentation, cognition and perception, communication,* and *interaction and user-experience*.

7. REFERENCES

[1] R. Spence, *Information Visualization*, vol. 1. Springer-Verlag, 2001.

[2] A. Lugmayr, A. Greenfeld, A. Woods, and P. Joseph, "Cultural Visualisation of a Cultural Photographic Collection in 3D Environments – Development of 'PAV 3D' (Photographic Archive Visualisation)," in *Entertainment Computing - ICEC 2016: 15th IFIP TC 14 International Conference, Vienna, Austria, September 28-30, 2016, Proceedings*, G. Wallner, S. Kriglstein, H. Hlavacs, R. Malaka, A. Lugmayr, and H.-S. Yang, Eds. Cham: Springer International Publishing, 2016, pp. 272–277 [Online]. Available: http://dx.doi.org/10.1007/978-3-319-46100-7_29

[3] A. Lugmayr and S. Bender, "Free UX Testing Tool: The LudoVico UX Machine for Physiological Sensor Data Recording, Analysis, and Visualization for User Experience

Design Experiments," in *Proceedings of the SEACHI 2016 on Smart Cities for Better Living with HCI and UX*, 2016, pp. 36–41 [Online]. Available: http://doi.acm.org/10.1145/2898365.2899801

[4] A. Lugmayr, "The UX-Machine." 2017 [Online]. Available: www.ux-machine.com

[5] A. Lugmayr, B. Stockleben, C. Scheib, M. Mailaparampil, N. Mesia, and H. Ranta, "A Comprehensive Survey on Big Data Research and It's Implications - What is really 'new' in Big Data? It's Cognitive Big Data," in *Proceedings of the 20th Pacific-Asian Conference on Information Systems (PACIS 2016)*, 2016 [Online]. Available: http://www.pacis2016.org/abstract/Index

[6] A. Lugmayr, B. Stockleben, C. Scheib, and M. Mailaparampil, "Cognitive Big Data. Survey and Review on Big Data Research and its Implications: What is Really 'New'? Cognitive Big Data!," *Journal of Knowledge Management (JMM)*, vol. 21, no. 1, 2017 [Online]. Available: http://www.emeraldgrouppublishing.com/products/journals/call_for_papers.htm?id=5855k, Journal of Knowledge Management/Emerald

[7] A. B. David Kim Iman Salehian Johanna Drucker, *Introduction to Digital Humanities*. Online: dh.101.humanities.ucla.edu, 2014 [Online]. Available: http://dh.101.humanities.ucla.edu

[8] A. Lugmayr and M. Teras, "Immersive Interactive Technologies in Digital Humanities: A Review and Basic Concepts," in *Proceedings of the 3rd International Workshop on Immersive Media Experiences*, 2015, pp. 31–36 [Online]. Available: http://doi.acm.org.dbgw.lis.curtin.edu.au/10.1145/2814347.2814354

[9] I. Rakkolainen and A. Lugmayr, "Immaterial Display for Interactive Advertisements," in *ACM Conference on Advances in Computer Entertainment Technology*, 2007, pp. 95–98.

[10] L. F. Barrett, B. Mesquita, K. N. Ochsner, and J. J. Gross, "The Experience of Emotion," *Annual review of Psychology*, vol. 58, pp. 373–403, 2007.

[11] P. Maja, S. Nicu, F. C. Jeffrey, and H. Thomas, "Affective multimodal human-computer interaction," *Proceedings of the 13th Annual ACM International Conference on Multimedia*, 2005.

[12] W. P. Rosalind, "Perceptual user interfaces: affective perception," *Commun. ACM*, vol. 43, no. 3, pp. 50–51, 2000.

[13] M. Grabowski, *Neuroscience and Media: New Understandings and Representations*. Routledge, 2014 [Online]. Available: https://books.google.com.au/books?id=74vooAEACAAJ

[14] A. Lugmayr, "Emotive Media - Implicit Interaction Through Human Emotions," in *28th Australian Conference on Human-Computer Interaction (HCI) (OzCHI)*, 2016 [Online]. Available: http://www.ozchi.org/2016/

[15] A. Lugmayr, T. Dorsch, and P. R. Humanes, "Emotional Ambient Media," in *Handbook of Research on Synthetic Emotions and Sociable Robotics: New Applications in Affective Computing and Artificial Intelligence*, IGI Global, 2009.

[16] M. M. Gobble, "Big Data: The Next Big Thing in Innovation.," *Research Technology Management*, vol. 56, no. 1, pp. 64–66, 2013 [Online]. Available: http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=84694731&site=ehost-live

[17] R. Kitchin, "Big Data, new epistemologies and paradigm shifts," *Big Data & Society*, vol. 1, no. 1, 2014 [Online]. Available: http://bds.sagepub.com/content/1/1/2053951714528481

[18] I. Kuznetsova, S. J. Siira, A. J. Shearwood, J. A. Ermer, A. Filipovska, and O. Rackham, "Simultaneous processing and degradation of mitochondrial RNAs revealed by circularized RNA sequencing," *Nucleic Acids Res*, 2017 [Online]. Available: http://www.ncbi.nlm.nih.gov/pubmed/28201688

[19] A. Lugmayr, E. Sutinen, J. Suhonen, C. I. Sedano, H. Hlavacs, and C. S. Montero, "Serious storytelling – a first definition and review," *Multimedia Tools and Applications*, pp. 1–27, 2016 [Online]. Available: http://dx.doi.org/10.1007/s11042-016-3865-5

[20] M. Keane, "Online Entertainment| Disconnecting, Connecting, and Reconnecting: How Chinese Television Found Its Way Out of the Box," *International Journal of Communication*, vol. 10, p. 18, 2016.

[21] G. Getto and J. Labriola, "iFixit Myself: User-Generated Content Strategy in The Free Repair Guide for Everything," *IEEE Transactions on Professional Communication*, vol. 59, no. 1, pp. 37–55, Mar. 2016.

[22] Z. Yu, M. Tian, Z. Wang, B. Guo, and T. Mei, "Shop-Type Recommendation Leveraging the Data from Social Media and Location-Based Services," *ACM Trans. Knowl. Discov. Data*, vol. 11, no. 1, pp. 1:1–1:21, Jul. 2016 [Online]. Available: http://doi.acm.org/10.1145/2930671

[23] I. H. Sarker, M. A. Kabir, A. Colman, and J. Han, "Predicting How You Respond to Phone Calls: Towards Discovering Temporal Behavioral Rules," in *Proceedings of the 28th Australian Conference on Computer-Human Interaction*, 2016, pp. 421–425 [Online]. Available: http://doi.acm.org/10.1145/3010915.3010979

[24] B. Pogorelc, R.-D. Vatavu, A. Lugmayr, B. Stockleben, T. Risse, J. Kaario, E. Lomonaco, and M. Gams, "Semantic ambient media: From ambient advertising to ambient-assisted living," *Multimedia Tools and Applications*, vol. 58, no. 2, pp. 399–425, 2012.

[25] A. Lugmayr, Y. Zou, B. Stockleben, K. Lindfors, and C. Melakoski, "Categorization of ambient media projects on their business models, innovativeness, and characteristicsâ??evaluation of Nokia Ubimedia MindTrek Award Projects of 2010," *Multimedia Tools and Applications*, vol. 66, no. 1, pp. 33–57, 2013 [Online]. Available: http://dx.doi.org/10.1007/s11042-012-1143-8

[26] B. Carden, J. Donovan, M. Rittenbruch, and M. Foth, “Exploring Tangible Interaction for Map-based Feedback,” in *Proceedings of the 28th Australian Conference on Computer-Human Interaction*, 2016, pp. 224–228 [Online]. Available: http://doi.acm.org/10.1145/3010915.3010974

[27] S. Xie, M. Helfert, A. Lugmayr, R. Heimgärtner, and A. Holzinger, “Influence of Organizational Culture and Communication on the Successful Implementation of Information Technology in Hospitals,” in *Cross-Cultural Design. Cultural Differences in Everyday Life*, vol. 8024, P. L. P. Rau, Ed. Springer Berlin Heidelberg, 2013, pp. 165–174 [Online]. Available: http://dx.doi.org/10.1007/978-3-642-39137-8_19

[28] S. Gibbs, “Xiaomi now world’s second-biggest wearables maker.” 2015 [Online]. Available: https://www.theguardian.com/technology/2015/jun/04/xiaomi-worlds-second-biggest-wearables-maker

[29] M. Community, Available: http://c.mi.com/

[30] C. Wallis, *Technomobility in China*. New York: New York University Press, 2013.