Research Assessment Exercise 2020
Impact Case Study

University: Hong Kong Baptist University

Unit of Assessment (UoA): 11 Mathematics & Statistics

Title of case study: MultiRank for Adaptive Learning Engine in Social Media

(1) Summary of the impact

In online social media, networked data consists of multiple dimensions/entities such as users (learners and teachers), tags, photos, videos, and comments. Our research has provided a community discovery scheme in a multi-dimensional network for data mining applications. The algorithms have been implemented (starting from June 2015) in ShowMuse's adaptive learning engine where ShowMuse (http://showmuse.so/) is an interactive learning platform created by entrepreneur at Hong Kong. With a video-based interactive learning approach, users are able to learn with new knowledge from the contents created by teachers. Personalized feedback can be delivered to users, which encourage participation and interaction from both teachers and other like-minded users. The impacts include (i) the technology provided to a local entrepreneur company so that the company can be raised to the funding HK$ 15 million from Hong Kong Science Park and venture capital; (ii) the technology provided to give an investment opportunity for online social media from venture capital; (iii) the technology provided to support users on a new learning platform based on videos and (iv) the training of postgraduate students for the application of mathematical algorithms to the technology used in a social media company.

(2) Underpinning research

The impact is based on research that took place in the unit of assessment with five publications in 2011-2016. The key researcher was M. Ng (Working at Department of Mathematics, Hong Kong Baptist University from 2005-2019)

The algorithm on which this case study is based is to employ a ranking scheme for multi-dimensional entities to identify a community in a multi-dimensional network by evaluating the affinity between two items in the same type of entity (same dimension) or different types of entities (different dimensions) from the network. The high-dimensional Markov chain equations are set up and the ranking solution can be determined by solving such high-dimensional Markov chain equations. The idea and algorithm are successfully implemented and used in ShowMuse's adaptive learning engine.

(3) References to the research

The research has been published in international conferences and journals and has been cited. Citations are shown for the Web of Science (WOS), the Scopus (SC) and Google Scholar (GS) as of 11 June 2019.

[P1] X. Li, Y. Ye and M. Ng, MultiVCRank with applications to image retrieval, IEEE Transactions on Image Processing, V25 (2016), pp. 1396-1409.
https://doi.org/10.1109/TIP.2016.2522298
[WOS: 3, SC: 4, GS: 12]

[P2] X. Li, M. Ng, and Y. Ye, MultiComm: Finding Community Structure in Multi-Dimensional Networks, IEEE Transactions on Knowledge and Data Engineering, V26 (2014), pp. 929-941.
https://doi.org/10.1109/TKDE.2013.48
[WOS: 30, SC: 38, GS: 54]

[P3] X. Li and M. Ng, Solving Sparse non-negative tensor equations: algorithms and applications, Frontiers of Mathematics in China, V10 (2015), pp. 649-680.
https://link.springer.com/article/10.1007/s11464-014-0377-3
[WOS: 16, SC: 17, GS: 24]

[P4] X. Li, M. Ng and Y. Ye, HAR: hub, authority and relevance scores in multi-relational data for query search, 2012 SIAM International Conference on Data Mining, CA, pp. 141-152.
https://doi.org/10.1137/1.9781611972825.13
[SC: 34, GS: 48]

[P5] M. Ng, X. Li and Y. Ye, MultiRank: co-ranking for objects and relations in multi-relational data, 17th ACM SIGKDD Conference on Knowledge Discovery and Data Mining (KDD-2011) August 21-24, 2011, San Diego, CA, pp. 1217-1225.
https://doi.org/10.1145/2020408.2020594
[SC: 63, GS: 85]

(4) Details of the impact

The main research in this case is to develop a community discovery scheme in a multi-dimensional network for data mining applications. For example, we are interested to find a group of learners, teachers, videos, comments, stories, and questions in an adaptive learning platform so that both the effectiveness of user learning and the efficiency of learning platform can be enhanced. Because of multi-dimensional network and multiple entities involved and their multiple relationships, the main research is to study multi-dimensional Markov chain, formulate such Markov chain equations, and solve these equations to obtain the usage probabilities of each item in the multi-dimensional network. According to their probability values, the ranking scheme can be established so that learners, teachers, videos, comments, stories, and questions can be identified and used in the adaptive learning process set up by ShowMuse's platform.

ShowMuse (http://showmuse.so/) created by entrepreneur Dennis Cheung to help adults in their short period of time keep learning outside the classroom, received an investment of HK$ 15 million from Hong Kong Science and Technology Parks's Corporate Venture Fund and other venture capital. ShowMuse is an incubatee of Hong Kong Science and Technology Parks's Incu-Tech programme for technology start-ups. It applied for the fund after securing investment of an equal value from a private investor. Cheung's start-up was selected from a pool of around 50 companies [S1]. It was chosen for its potential market and strong team in social media. This is the first impact of the mathematical research provided to a local entrepreneur company so that the company can be raised to the funding. The second impact is that the mathematical research can be transferred to technology used in a social medial company to create an investment opportunity from venture capital.

ShowMuse is an education platform which allows people with different skills to film tutorials and post on their website. Users can learn different skills from the videos and elevate themselves and equip themselves with new skills. The platform is unconventional with a wide range of tutorials from daily life to career tips, from beauty suggestions to cooking tutorials. The general public can easily access the tutorials at any point in time to enhance their abilities.

The third impact is that the mathematical research can provide a technology to support users on a new learning platform based on videos. At September 2018, there are already 2 million downloads, 70,000 DAU (Daily Active Users) and over 60 celebrities in ShowMuse and also around 50,000 videos are used for learning purpose. It is stated the research results would be definitely useful to ShowMuse's learning platform.

Pathways to Impact

Michael Ng has a keen interest in the development of data science, and has been a driving force in bringing together disparate groups with a common interest in the development of data science. He plays a leading role in knowledge and research transfer. The UoA and its alumni organized a one-day industry research sharing activity (June 2015) where companies can present an open research problem and students and staffs can get feedback about how mathematical and statistical research could be used to tackle it. The purpose is to develop new contacts with end-users. Dennis Cheung is one of the presenter and show the development of ShowMuse and the requirement of adaptive learning engine in ShowMuse.

After the activity, Dennis and Michael arranged two post-graduate students to work for the adaptive learning engine based on the research results in [P1,P2,P3,P4,P5] done by Michael. Michael was invited to be the consultant for this adaptive learning project. Two postgraduate students can be trained how to use mathematical algorithms to build an adaptive learning engine used in a social media company. The fourth impact is that the training of postgraduate students how to apply for mathematical research to the technology in real world applications.

(5) Sources to corroborate the impact

[S1] https://www.scmp.com/tech/innovation/article/1915618/kiss-and-tell-learning-app-showmuse-gets-hk3-mln-hong-kong-science