engineered), we believe that such an augmentation might result in the construction of higher performing machine learning and data analysis systems.

Following the theoretical modeling, we suggest quantitative measures to assess the framework's utility to machine learning systems. Especially we focused on quantifying how well the ontology can represent domain data, and how the features from an influence network could be integrated into machine learning systems.

Future work will instantiate concrete machine learning problems into the proposed approach. For instance, an example can be quantifying fuzzy influence networks in social media opinions [15]. In this way we will validate our theoretical assumptions by incarnating and materializing different influence functions, distance and quality measures, scales and other parameters for our model assessment and evaluation in different machine learning problems. Ultimately, this will help refining the model's capability to effectively quantify influence and subjectivity in fashion and style.

6. ACKNOWLEDGMENTS

We thank Jay B. Martin for his generous editorial assistance.

7. REFERENCES

- S. Ajmani, H. Ghosh, A. Mallik, and S. Chaudhury. An ontology based personalized garment recommendation system. In Web Intelligence (WI) and Intelligent Agent Technologies (IAT), 2013 IEEE/WIC/ACM International Joint Conferences on, volume 3, pages 17–20. IEEE, 2013.
- [2] K. Bollacker, C. Evans, P. Paritosh, T. Sturge, and J. Taylor. Freebase: A collaboratively created graph database for structuring human knowledge. In Proceedings of the 2008 ACM SIGMOD International Conference on Management of Data, SIGMOD '08, pages 1247–1250, New York, NY, USA, 2008. ACM.
- [3] J. G. Breslin, A. Harth, U. Bojars, and S. Decker. Towards semantically-interlinked online communities. In *The Semantic Web: Research and Applications*, pages 500–514. Springer, 2005.
- [4] N. Díaz-Rodríguez, M. P. Cuéllar, J. Lilius, and M. D. Calvo-Flores. A survey on ontologies for human behavior recognition. ACM Comput. Surv., 46(4):43:1–43:33, Mar. 2014.
- [5] R. Guha, D. Brickley, and S. Macbeth. Schema. org: Evolution of structured data on the web. Communications of the ACM, 59(2):44–51, 2016.
- [6] M. Hepp. Goodrelations: An ontology for describing products and services offers on the web. In *Knowledge Engineering: Practice and Patterns*, pages 329–346. Springer, 2008.
- [7] J. Li and Y. Li. Cognitive model based fashion style decision making. Expert Systems with Applications, 39(5):4972 – 4977, 2012.
- [8] J. Miller. Fashion and Music. Bloomsbury Publishing,
- [9] I. Novalija and G. Leban. Applying NLP for building domain ontology: Fashion collection. A:147–150, 2013.
- [10] Y. Raimond, S. A. Abdallah, M. B. Sandler, and F. Giasson. The music ontology. In ISMIR, 2007.

- [11] Y. Raimond and M. Sandler. Evaluation of the music ontology framework. In *The Semantic Web: Research* and Applications, pages 255–269. Springer, 2012.
- [12] A. Steinfeld, S. R. Bennett, K. Cunningham, M. Lahut, P.-A. Quinones, D. Wexler, D. Siewiorek, J. Hayes, P. Cohen, J. Fitzgerald, O. Hansson, M. Pool, and M. Drummond. Evaluation of an integrated multi-task machine learning system with humans in the loop. In NIST Performance Metrics for Intelligent Systems Workshop (PerMIS), 2007.
- [13] D. Vogiatzis, D. Pierrakos, G. Paliouras, S. Jenkyn-Jones, and B. J. H. H. A. Possen. Expert and community based style advice. *Expert Syst. Appl.*, 39(12):10647–10655, Sept. 2012.
- [14] C. Wah, S. Branson, P. Perona, and S. Belongie. Multiclass recognition and part localization with humans in the loop. In *Computer Vision (ICCV)*, 2011 IEEE International Conference on, pages 2524–2531. IEEE, 2011.
- [15] L. Wang and J. M. Mendel. Fuzzy opinion networks: A mathematical framework for the evolution of opinions and their uncertainties across social networks. CoRR, abs/1602.06508, 2016.
- [16] L. Wang, X. Zeng, L. Koehl, and Y. Chen. Intelligent fashion recommender system: Fuzzy logic in personalized garment design. *Human-Machine* Systems, IEEE Transactions on, 45(1):95–109, 2015.
- [17] S. Zoghbi, G. Heyman, J. C. Gomez, and M.-F. Moens. Cross-modal fashion search. In *MultiMedia Modeling*, pages 367–373. Springer International Publishing, 2016.
- [18] S. Zoghbi, I. Vulić, and M.-F. Moens. I pinned it. where can I buy one like it?: Automatically linking pinterest pins to online webshops. In Proceedings of the 2013 workshop on Data-driven user behavioral modelling and mining from social media, pages 9–12. ACM, 2013.