**Paper 11: Are Online Reviews of Physicians Biased Against Female Providers?**

Patients increasingly seek out information regarding their healthcare online. Online reviews of caregivers in particular may influence from whom patients seek treatment. Are these sources biased against female providers? To address this question we analyze a new dataset of online patient reviews of male and female healthcare providers with respect to numerical ratings and language use. We perform both regression and (data-driven) qualitative analyses of language via neural embedding models induced over review texts. In both cases we account for provider specialty. To do so while learning embeddings, we explicitly induce specialty, sex, and rating embeddings from review meta-data via a ‘matched-sampling’ training regime.

We find that females consistently receive less favorable numerical ratings overall, even after adjusting for specialty. To analyze language use in reviews of male versus female providers, we induce neural embeddings (distributed representations) of gender and qualitatively characterize the ‘distributional semantics’ that this induces. We observe differences in language use, e.g., analysis of average vector similarities over repeated runs reveal that many of the words closest to the coordinates in embedding space associated with positive sentiment and female providers describe interpersonal characteristics (sweet, considerate, caring, personable, compassionate): such descriptions do not seem as similar to the point corresponding to positive sentiment regarding male providers. To facilitate research in this direction we publicly release data, embeddings, and all code (including Jupyter notebooks) to reproduce our analyses and further explore the data: https://github.com/avi-jit/RateMDs.

<https://static1.squarespace.com/static/59d5ac1780bd5ef9c396eda6/t/5d4733b1583292000112852b/1564947398860/Thawani.pdf>

## **paper 12: Automatic Classification of Online Doctor Reviews: Evaluation of Text Classifier Algorithms**

**Background:** An increasing number of doctor reviews are being generated by patients on the internet. These reviews address a diverse set of topics (features), including wait time, office staff, doctor’s skills, and bedside manners. Most previous work on automatic analysis of Web-based customer reviews assumes that (1) product features are described unambiguously by a small number of keywords, for example, battery for phones and (2) the opinion for each feature has a positive or negative sentiment. However, in the domain of doctor reviews, this setting is too restrictive: a feature such as visit duration for doctor reviews may be expressed in many ways and does not necessarily have a positive or negative sentiment.

**Objective:**This study aimed to adapt existing and propose novel text classification methods on the domain of doctor reviews. These methods are evaluated on their accuracy to classify a diverse set of doctor review features.

Methods: We first manually examined a large number of reviews to extract a set of features that are frequently mentioned in the reviews. Then we proposed a new algorithm that goes beyond bag-of-words or deep learning classification techniques by leveraging natural language processing (NLP) tools. Specifically, our algorithm automatically extracts dependency tree patterns and uses them to classify review sentences.

**Results:**We evaluated several state-of-the-art text classification algorithms as well as our dependency tree–based classifier algorithm on a real-world doctor review dataset. We showed that methods using deep learning or NLP techniques tend to outperform traditional bag-of-words methods. In our experiments, the 2 best methods used NLP techniques; on average, our proposed classifier performed 2.19% better than an existing NLP-based method, but many of its predictions of specific opinions were incorrect.

**Conclusions:** We conclude that it is feasible to classify doctor reviews. Automatically classifying these reviews would allow patients to easily search for doctors based on their personal preference criteria.

<https://www.jmir.org/2018/11/e11141/>

**Paper 13: Effects of Online Physician Reviews and Physician Gender on Perceptions of Physician Skills and Primary Care Physician (PCP) Selection**

Physician review websites have become more relevant and important in people’s selection of physicians. The current study experimentally examined how online physician reviews endorsing a primary care physician’s (PCP’s) technical or interpersonal skills, along with a physician’s gender, may influence people’s perceptions of the physician’s skills and their willingness to choose the physician. Participants were randomly assigned to view a mockup physician review web page and to imagine that they needed to find a new PCP in a new city. They were then asked to report their perceptions of the physician and willingness to choose the physician as their PCP. The results suggested that people’s willingness to choose a PCP was affected by physician reviews through their influence on people’s perceptions of the PCP’s technical and interpersonal skills. More importantly, this study found that when physician reviews endorsed a PCP’s technical skills people perceived a female PCP to be more interpersonally competent than a male PCP and thus were more likely to choose the female PCP. The gendered perception, however, was not extended to a PCP’s technical skills. Practical implications for health providers and consumers are discussed.

<https://www.tandfonline.com/doi/abs/10.1080/10410236.2018.1475192>

**Paper 14: Catch Me If You Can — Detecting Fraudulent Online Reviews of Doctors Using Deep Learning**

Fake online reviews are becoming more prevalent and are a significant concern for consumer protection groups and regulatory authorities. However, identifying fake reviews has been a challenge in IS, marketing, and computer science. In this study, we design a deep learning approach to capture the linguistic traits that differentiate between genuine and fake reviews. Our deep learning model is evaluated on a dataset of 181,951 doctor reviews, 8% of which are fake. Since a natural honeypot existed at one point on the platform that hosted these reviews, we are able to label the reviews that exploited the natural honeypot as fraudulent, thus overcoming the major challenge in constructing the ground truth for training the model. Our model shows a significant improvement in accuracy when compared to traditional machine learning algorithms such as logistic regression and random forest. Interestingly, we also find that human evaluators perform much worse than machine learning approaches. Compared to 200 human evaluators, our deep learning approach has a true positive rate (14.29% vs. 8.70%) that is twice as high, and it also achieves a much lower false positive rate (0.63% vs. 11.68%). We also observe that these evaluators are susceptible to human bias, as they are more likely to label fake reviews as genuine than they are to label genuine reviews as genuine. Our study offers further explanations for the advantages of deep learning and is the first to construct a deep learning model to detect fraudulent online reviews, an approach that can help curb fake reviews and increase information quality and market efficiency.

<https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3320258>

**Paper 15: Sentiment Independent Topic Detection in Rated Hospital Reviews**

We present a simple method to find topics in user reviews that accompany ratings for products or services. Standard topic analysis will perform sub-optimal on such data since the word distributions in the documents are not only determined by the topics but by the sentiment as well. We reduce the influence of the sentiment on the topic selection by adding two explicit topics, representing positive and negative sentiment. We evaluate the proposed method on a set of over 15,000 hospital reviews. We show that the proposed method, Latent Semantic Analysis with explicit word features, finds topics with a much smaller bias for sentiments than other similar methods.

<https://www.aclweb.org/anthology/W19-0509/>

**Article : What Do Patients Say About Doctors Online? A Systematic Review of Studies on Patient Online Reviews**

**Background.** The number of patient online reviews (PORs) has grown significantly, and PORs have played an increasingly important role in patients’ choice of health care providers.

**Objective.** The objective of our study was to systematically review studies on PORs, summarize the major findings and study characteristics, identify literature gaps, and make recommendations for future research.

**Methods.** A major database search was completed in January 2019. Studies were included if they (1) focused on PORs of physicians and hospitals, (2) reported qualitative or quantitative results from analysis of PORs, and (3) peer-reviewed empirical studies. Study characteristics and major findings were synthesized using predesigned tables.

**Results.** A total of 63 studies (69 articles) that met the above criteria were included in the review. Most studies (n=48) were conducted in the United States, including Puerto Rico, and the remaining were from Europe, Australia, and China. Earlier studies (published before 2010) used content analysis with small sample sizes; more recent studies retrieved and analyzed larger datasets using machine learning technologies. The number of PORs ranged from fewer than 200 to over 700,000. About 90% of the studies were focused on clinicians, typically specialists such as surgeons; 27% covered health care organizations, typically hospitals; and some studied both. A majority of PORs were positive and patients’ comments on their providers were favorable. Although most studies were descriptive, some compared PORs with traditional surveys of patient experience and found a high degree of correlation and some compared PORs with clinical outcomes but found a low level of correlation.

### **Conclusions.** PORs contain valuable information that can generate insights into quality of care and patient-provider relationship, but it has not been systematically used for studies of health care quality. With the advancement of machine learning and data analysis tools, we anticipate more research on PORs based on testable hypotheses and rigorous analytic methods.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6475821/>

**Article : A large-scale quantitative analysis of latent factors and sentiment in online doctor reviews**

Online physician reviews are a massive and potentially rich source of information capturing patient sentiment regarding healthcare. We analyze a corpus comprising nearly 60 000 such reviews with a state-of-the-art probabilistic model of text. We describe a probabilistic generative model that captures latent sentiment across aspects of care (eg, interpersonal manner). We target specific aspects by leveraging a small set of manually annotated reviews. We perform regression analysis to assess whether model output improves correlation with state-level measures of healthcare. We report both qualitative and quantitative results. Model output correlates with state-level measures of quality healthcare, including patient likelihood of visiting their primary care physician within 14 days of discharge (p=0.03), and using the proposed model better predicts this outcome (p=0.10). We find similar results for healthcare expenditure. Generative models of text can recover important information from online physician reviews, facilitating large-scale analyses of such reviews.

<https://academic.oup.com/jamia/article/21/6/1098/787675>