Despite sequences being core to NLP, scant work has considered how to handle noisy sequence labels from multiple anno- tators for the same text. Given such anno- tations, we consider two complementary tasks: (1) aggregating sequential crowd la- bels to infer a best single set of consen- sus annotations; and (2) using crowd an- notations as training data for a model that can predict sequences in unannotated text. For aggregation, we propose a novel Hid- den Markov Model variant. To predict se- quences in unannotated text, we propose a neural approach using Long Short Term Memory. We evaluate a suite of meth- ods across two different applications and text genres: Named-Entity Recognition in news articles and Information Extraction from biomedical abstracts. Results show improvement over strong baselines. Our source code and data are available online1.

We present a Bayesian method for combining sequence classifications from multiple annotators with different levels of noise and class bias. Sequential classification is an important problem in fields such as NLP, where many tasks involve annotating spans of text.

In such tasks, crowdsourcing is often used to obtain training data for automated classifiers. However, individual human annotators have highly variable error rates and different automated classifiers often produce different patterns of errors. In both cases, errors can be reduced by combining multiple annotators.

However, while Bayesian methods have proved effective in combining unreliable classifiers, they have not previously taken into account the sequence of classifications and are therefore unable to incorporate rules that restrict which labels may follow each other, such as with BIO encoding. We propose a new method that incorporates sequence information using hidden Markov models, and show how the priors can be set to capture sequence rules. We analyse performance against established classifier combination methods on synthetic data to show the effects of annotator accuracy, bias and crowd size on performance. We further evaluate the methods on two NLP datasets: crowdsourced annotations of argument components; and predictions of argument components from an ensemble of neural network classifiers. The results show the advantage of modelling sequential dependencies between labels. We make our source code and data available online.

Bayesian classifier combination methods can be used both to obtain reliable classifications from crowdsourced annotations and to combine an ensemble of automated classifiers to reduce overall error rates.