Intellectual Merit: The results of our project have already had a large impact on our ability to use combinations of neural and symbolic approaches to do semantic understanding of text, including novel models of discourse coherence, novel models of interpretability of embeddings and neural models, new ways of combining adversarial learning with text processing, and novel neural models that combine text and network structure. Particular achievements include the following. We introduced two deep learning algorithms for the task of developing lexicons that predict outcomes like human preferences or actions from text as a way of making these models transparent and interpretable. We investigated the role of linguistic context in an LSTM LM, through ablation studies, analyzing the increase in perplexity when prior context words are shuffled, replaced, or dropped, in order to understand how neural models are able to use much longer context than traditional language models in NLP. By using neural models that combine language and social networks to investigate conflict in communities online, we show that such conflicts tend to be initiated by a handful of communitiesless than 1% of communities start 74

Broader impacts: The project has trained 17 graduate students, postdocs, and undergraduates, including 6 women, who have received weekly mentoring from the PIs in various phases of the project, including training in research methodology, in career development, and in the research content described above. One woman postdoc from this project, Yulia Tsvetkov, has now begun her faculty career at CMU. Three graduate students have graduated: Will Hamilton is starting a faculty job at McGill this year. Raine Hoover received her MS and Jiwei Li received his PhD and both are now at startups. Finally, the undergraduate, Jon Gauthier, graduated and is now a PhD student at MIT.

The algorithms have been described in publications and talks to the community and in talks given by the PIs to computer science departments around the country. Several pieces of code have been incorporated into the Stanford CoreNLP software, which is used by research groups and companies around the country.

a summary of the results of the completed work, including accomplishments, supported by the award. The results must be separately described under two distinct headings: Intellectual Merit and Broader Impacts;

Publications: Understanding neural models: Li et al. (2015), coreference: Clark and Manning (2016a,b); events: Huang et al. (2016).

Research products: The algorithms have been described in publications and described in talks to the community and in talks given by the PIs to

computer science departments around the country. Several systems have been incorporated into the Stanford CoreNLP software, used by research labs and companies around the country, including in particular Kevin Clark's statistical and neural coreference systems: `https://stanfordnlp.github.io/coref.html` and Grace Muzny's quote annotator:

Various datasets have been made available: The SCONE dataset for learning models of context-dependent executable semantics at: `https://nlp.stanford.edu/projects/scone/`; the network model of Reddit interaction at: `http://snap.stanford.edu/data/web-RedditNetworks.html`.

a listing of the publications resulting from the NSF award (a complete bibliographic citation for each publication must be provided either in this section or in the References Cited section of the proposal); if none, state No publications were produced under this award.

evidence of research products and their availability, including, but not limited to: data, publications, samples, physical collections, software, and models, as described in any Data Management Plan; and

if the proposal is for renewed support, a description of the relation of the completed work to the proposed work.

If the project was recently awarded and therefore no new results exist, describe the major goals and broader impacts of the project. Note that the proposal may contain up to five pages to describe the results. Results may be summarized in fewer than five pages, which would give the balance of the 15 pages for the Project Description.

References

Clark, Kevin, and Christopher D. Manning. 2016a. Deep reinforcement learning for mention-ranking coreference models. In *Empirical Methods on Natural Language Processing*.

Clark, Kevin, and Christopher D. Manning. 2016b. Improving coreference resolution by learning entity-level distributed representations. In *Association for Computational Linguistics (ACL)*.

Huang, Ruihong, Ignacio Cases, Dan Jurafsky, Cleo Condoravdi, and Ellen Riloff. 2016. Distinguishing past, on-going, and future events: The eventstatus corpus. In *Empirical Methods in Natural Language Processing (EMNLP)*.

Li, Jiwei, Minh-Thang Luong, Dan Jurafsky, and Eudard Hovy. 2015. When are tree structures necessary for deep learning of representations? In *Empirical Methods in Natural Language Processing (EMNLP)*.