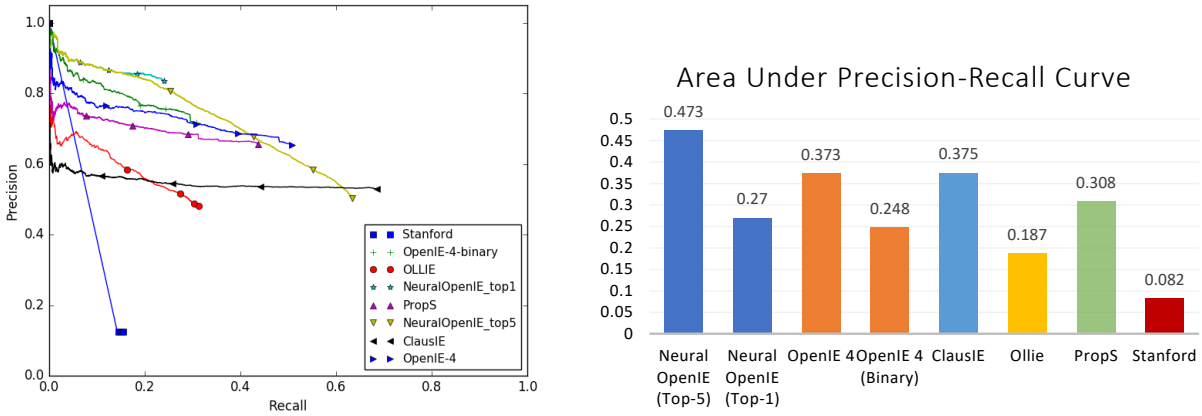

Figure 2: The Precision-Recall (P-R) curve and Area under P-R curve (AUC) of Open IE systems

neural Open IE is learned from the bootstrapped outputs of OPENIE4's extractions, only 11.4% of the extractions from neural Open IE agree with the OPENIE4's extractions, while the AUC score is even better than OPENIE4's result. We believe this is because the neural approach learns arguments and relations across a large number of highly confident training instances. This also indicates that the generalization capability of the neural approach is better than previous methods. We observed many cases in which the neural Open IE is able to correctly identify the boundary of arguments but OpenIE4 cannot, for instance:

Input	Instead , much of numerical analysis is concerned with obtaining approximate solutions while maintaining reasonable bounds on errors .
Gold	much of numerical analysis ||| concerned ||| with obtaining approximate solutions **while maintaining reasonable bounds on errors**
OpenIE4	much of numerical analysis ||| is concerned with ||| obtaining approximate solutions
Neural Open IE	much of numerical analysis ||| is concerned ||| with obtaining approximate solutions **while maintaining reasonable bounds on errors**

This case illustrates that the neural approach reduces the limitation of hand-crafted patterns from other NLP tools. Therefore, it reduces the error propagation effect and performs better than other systems especially for long sentences.

We also investigated the computational cost of different systems. For the baseline systems, we obtained the Open IE extractions using a Xeon 2.4 GHz CPU. For the neural Open IE, we evaluated performance based on an M60 GPU. The running time was calculated by extracting Open IE tuples from the test dataset that contains a total of 3,200 sentences. The results are shown in Table 1. Among the aforementioned conventional systems, Ollie is the most efficient approach which takes around 160s to finish the extraction. By using GPU, the neural approach takes 172s to extract the tuples from the test data, which is comparable with conventional approaches. As the neural approach does not depend on other NLP tools, we can further optimize the computational cost in future research efforts.

System	Device	Time
Stanford	CPU	234s
Ollie	CPU	160s
ClausIE	CPU	960s
PropS	CPU	432s
OpenIE4	CPU	181s
Neural Open IE	GPU	172s

Table 1: Running time of different systems

4 Related Work

The development of Open IE systems has witnessed rapid growth during the past decade (Mausam, 2016). The Open IE system was introduced by TEXTRUNNER (Banko et al., 2007) as the first generation. It casts the argument and relation extraction task as a sequential labeling problem. The system is highly scalable and extracts facts from large scale web content. REVERB (Fader et al., 2011) improved over TEXTRUNNER with syntactic and lexical constraints on binary relations expressed by verbs, which more than doubles the area under the