Supplementary Materials for A Case Study on Neural Headline Generation for Editing Support

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A Details of Compared Models

A.1 Multimodal Model

The multimodal model (Hori et al., 2017) is defined by the following equations:

$$d_{k,t} = W_{Ak}c_{k,t} + b_{Ak} \tag{1}$$

$$v_{k,t} = w_B^\top \tanh\left(W_B \hat{h}_t + V_{Bk}c_{k,t} + b_{Bk}\right) \tag{2}$$

$$\beta_{k,t} = \frac{\exp\left(v_{k,t}\right)}{\sum_{k=1}^{K} \exp\left(v_{k,t}\right)} \tag{3}$$

$$c_t = \sum_{k=1}^{K} \beta_{k,t} d_{k,t} \tag{4}$$

where K is the number of modalities, $c_{k,t}$ is the context vector, W_{Ak}, W_B, V_{Bk} are weight matrices, b_{Ak} and b_{Bk} are bias vectors, w_B is a weight vector, and $v_{k,t}$ is a scalar.

A.2 Query-based Model

The query-based model (Nema et al., 2017) is defined by the following equations:

$$w_t = V[c_t'; \hat{h}_t] \tag{5}$$

$$a_t(s) = \frac{\exp(w_t^\top h_s)}{\sum_{s=1}^{S} \exp(w_t^\top h_s)} \tag{6}$$

$$c_t = \sum_{s=1}^{S'} a_t(s) h_s \tag{7}$$

where c_t' is the context vector of a lead and V is a weight matrix.

B Details of Crowdsourcing Results

Table 1 lists the detailed results of the crowdsourcing task of readability and usefulness for two subsets: simple and complex. The simple subset included only triples where the characters in each

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[*]Both authors contributed equally to this work.

	Simple subset			Complex subset		
	R	U	A	R	U	A
Editor	3.64	3.38	3.51	3.62	3.12	3.37
Prefix	2.85	2.50	2.67	2.67	2.35	2.51
OpenNMT	3.61	3.27	3.44	3.51	3.12	3.32
MultiModal	3.60	3.23	3.42	3.49	3.09	3.29
QueryBased	3.60	3.29	3.45	3.50	3.06	3.28
GateFusion	3.61	3.32	3.46	3.46	**3.19**	3.33
HybridFusion	**3.64**	**3.37**	**3.51**	**3.53**	3.18	**3.35**

Table 1: Details of crowdsourcing results for simple and complex subsets. R, U, and A are the abbreviations of Readability, Usefulness, and Average, respectively.

short title were completely matched by those in the corresponding headline. The complex subset included only non-simple triples, i.e., the complement of the simple subset.

C Full Examples of Outputs

Table 2 lists the output examples generated with the best model OpenNMT among the three baselines and our best model HybridFusion.

References

Chiori Hori, Takaaki Hori, Teng-Yok Lee, Ziming Zhang, Bret Harsham, John R. Hershey, Tim K. Marks, and Kazuhiko Sumi. 2017. Attention-based multimodal fusion for video description. In *ICCV*.

Preksha Nema, Mitesh M. Khapra, Anirban Laha, and Balaraman Ravindran. 2017. Diversity driven attention model for query-based abstractive summarization. In *ACL*, pages 1063–1072.

Generated title (Japanese)	English translation
Headline	Evolution of Darvish: turning adversity into opportunity.
Lead 29 28 1 9 1 10 90 81 5 7 3 1 158 158 145	Yu Darvish (29) of the Rangers took the mound for the first time in 1 year and 9 months with the Pirates at home and won the return game for the first time in 1 year and 10 months. For a while the number of throws has been restricted to 90 balls so he dropped at the 5th inning when reaching 81 balls, but he gathered 3 hits and 1 run with 7 strikeouts each time, and the maximum speed of the straight marked 158 kilometers. Wilson, acting his buddy, said, "It was a wonderful pitch, the straight was 158 kilos and the sinker was over 145 kilos". Baxter, the team coach, also played tribute to the "real Dar", which he saw for the first time since taking over as director, "Pitching as I remember".
Editor	Dar sculpted his body better than before surgery.
OpenNMT	Evolution of turning adversity into opportunity.
HybridFusion	Dar turned adversity into opportunity.
Headline 10	With the first profit decline in ten years, Lawson is at a crossroads . Does Lawson have any secret plan?
Lead 2 9 3	Lawson, a major convenience store, is at a crossroads. Lawson was second in the number of stores so far, but Uni FamilyMart Holdings was founded in September and Lawson fell to third place. They are struggling to perform, evidenced by the recent decline in their profits. Although they would like to rebuild by becoming a subsidiary of Mitsubishi Corporation, Mitsubishi Corporation is having management problems. Does Lawson have any secret plan?
Editor 10	The first profit decline in ten years. Lawson is at a crossroads.
OpenNMT ?	Lawson. Does Lawson have any secret plan?
HybridFusion 10	Lawson is at a crossroads with the first profit decline in ten years.
Headline	SHARP headquarters moved from its home for many years in Abeno in Osaka to Sakai.
Lead 1 6 30	Even though I knew about it, I still feel lonely —. SHARP, which is in the process of restructuring, moved its headquarters from Osaka-shi Abeno-ku to Osaka Prefecture Sakai-shi Sakai-ku on the 1st. On June 30, the former headquarters in Abeno-ku, which was the last business day of the headquarters, seemed unchanged as usual, but occasionally there were also many people taking pictures of building signs, and a local man said, "Since childhood, SHARP was here, even though I knew about it, I still feel lonely".
Editor	SHARP headquarters moved from Abeno to Sakai.
OpenNMT	SHARP headquarters moved from Abeno.
HybridFusion	SHARP headquarters moved from Abeno to Sakai.
Headline	Surpassing "Frozen"? What is the reason for the popularity of "Zootopia", which is also popular among adults?
Lead 5 22 350 45 2016 ?	The latest Disney animated movie "Zootopia" has gained in popularity. As of May 22, the total number of moviegoers exceeded 3.5 million, and the box office exceeded 4.5 billion yen. We will examine the charm of "Zootopia", which people are already saying that " It might become the box-office champion of 2016 " .
Editor	The charm of "Zootopia" is beyond our expectation.
OpenNMT ?	Surpassing "Frozen"? It is popular among adults.
HybridFusion	What is the reason for the popularity of "Zootopia" among adults?
Headline	Munich shooting incident. Are suspects interested in indiscriminate shootings? What is the impact of the incident on German society?
Lead 22 9 1	On the afternoon of the 22nd, a shooting incident occurred in a crowded shopping center in Munich part of southern Germany and 9 people were killed. The suspect was found dead at a place about 1 kilometer away from the shopping center and the authorities announced that the suspect had killed himself after escaping. Although the motive is unknown, there is information that the suspect was planning a shooting. What will the impact of the incident be on German society?
Editor	Germany, known for having many immigrants, was shocked by a shooting rampage.
OpenNMT	Was the shooting incident in Munich indiscriminate?
HybridFusion	The impact on German society of a shooting incident in Munich.

Table 2: Examples of generated titles. Headline and Lead denote headline and lead as input. Editor is reference title created by an editor. OpenNMT and HybridFusion are the default OpenNMT model and our hybrid model.