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:

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

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

$$\beta_{k,t} = \frac{\exp(v_{k,t})}{\sum_{k=1}^{K} \exp(v_{k,t})}$$
(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:

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

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

	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
${\tt HybridFusion}$	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.

^{*}Both authors contributed equally to this work.

	Generated title (Japanese)	English translation
Headline	逆境をチャンスに変えたダルビッシュの進化	Evolution of Darvish: turning adversity into opportunity.
Lead	レンジャーズのダルビッシュ有 (29) が 28 日、本拠地で行	Yu Darvish (29) of the Rangers took the mound for the first time in 1 year
	われたパイレーツ戦で1年9か月ぶりのマウンドを踏み、1	and 9 months with the Pirates at home and won the return game for the
	年 10 か月ぶりの白星で復帰戦を飾った。しばらくは 90 球	first time in 1 year and 10 months. For a while the number of throws has
	の球数制限があるため、81球に達した5回に降板したが、	been restricted to 90 balls so he dropped at the 5th inning when reaching
	毎回の7奪三振で3安打1失点にまとめ、ストレートのマッ	81 balls, but he gathered 3 hits and 1 run with 7 strikeouts each time,
	クスは 158 キロをマーク。女房役のウイルソンは、「素晴ら	and the maximum speed of the straight marked 158 kilometers. Wilson,
	しい投球だった。ストレートは158キロだったし、シンカー	acting his buddy, said, "It was a wonderful pitch, the straight was 158
	も 145 キロを超えていた」と絶賛。自軍のバクスター監督	kilos and the sinker was over 145 kilos". Baxter, the team coach, also
	も、監督就任以来、初めて見る"生ダル"に「私が記憶に	played tribute to the "real Dar", which he saw for the first time since
		• •
	あるままのピッチング」と賛辞を惜しまなかった。	taking over as director, "Pitching as I remember".
Editor	術前より進化ダルの肉体改造	Dar sculpted his body better than before surgery.
OpenNMT	逆境をチャンスに変えた進化	Evolution of turning adversity into opportunity.
HybridFusion	ダル 逆境をチャンスに変えた	Dar turned adversity into opportunity.
Headline	10 年ぶりの減益でローソンが岐路に ローソンに秘策はあ	With the first profit decline in ten years, Lawson is at a crossroads. Does
	るのか	Lawson have any secret plan?
Lead	コンビニ大手のローソンが岐路に立たされています。これ	Lawson, a major convenience store, is at a crossroads. Lawson was sec-
	までローソンは店舗数で2位でしたが、9月にユニー・ファ	ond in the number of stores so far, but Uni FamilyMart Holdings was
	ミリーマートホールディングスが発足したことで3位に転	founded in September and Lawson fell to third place. They are struggling
	落してしまいました。最新の決算では減益に転じるなど業	to perform, evidenced by the recent decline in their profits. Although
	績面でも苦戦を強いられています。三菱商事の子会社にな	they would like to rebuild by becoming a subsidiary of Mitsubishi Cor-
	ることで立て直しを図りたいところですが、台所事情が苦	poration, Mitsubishi Corporation is having management problems. Does
	しいのは三菱商事の方で、ローソンはむしろ頼られる側で	Lawson have any secret plan?
		Lawson have any secret plan:
TAKE	す。果たしてローソンに秘策はあるのでしょうか。	The first seed dealine in the seed of the
Editor	10年ぶり減益 岐路のローソン	The first profit decline in ten years. Lawson is at a crossroads.
OpenNMT	ローソン ローソンに秘策ある?	Lawson. Does Lawson have any secret plan?
HybridFusion	ローソン 10 年ぶり減益で岐路	Lawson is at a crossroads with the first profit decline in ten years.
Headline	シャープ本社 長年親しまれた大阪・阿倍野から堺へ移転	SHARP headquarters moved from its home for many years in Abeno in
		Osaka to Sakai.
Lead	わかってても、なんか寂しい 。経営再建中のシャープ	Even though I knew about it, I still feel lonely —. SHARP, which is in the
	は1日、本社を大阪市阿倍野区から大阪府堺市堺区へ移転	process of restructuring, moved its headquarters from Osaka-shi Abeno-
	した。6月30日、本社最後の営業日となった阿倍野区の旧	ku to Osaka Prefecture Sakai-shi Sakai-ku on the 1st. On June 30, the
	本社前はいつもと変わらない様子だったが、時折、建物看	former headquarters in Abeno-ku, which was the last business day of the
	板の写真を撮る人の姿も多くみられ、看板を撮っていた地	headquarters, seemed unchanged as usual, but occasionally there were
	元の男性は「子供の時から、シャープここにあって当たり	also many people taking pictures of building signs, and a local man said,
	前だった。わかってても寂しい」などと話していた。	"Since childhood, SHARP was here, even though I knew about it, I still
	have size is a second of the control	feel lonely".
Editor	シャープ本社 阿倍野から堺へ	SHARP headquarters moved from Abeno to Sakai.
	シャープ本社阿倍野から移転	-
OpenNMT		SHARP headquarters moved from Abeno.
HybridFusion	シャープ本社 阿倍野から堺へ	SHARP headquarters moved from Abeno to Sakai.
Headline	アナ雪を超える? 大人にも好評、映画『ズートピア』の	Surpassing "Frozen"? What is the reason for the popularity of
	大ヒットのワケは?	"Zootopia", which is also popular among adults?
Lead	ディズニーアニメーション映画最新作『ズートピア』が、ジ	The latest Disney animated movie "Zootopia" has gained in popularity.
	ワジワと広がりをみせ、大きな話題になっている。5月22	As of May 22, the total number of moviegoers exceeded 3.5 million, and
	日現在、累計動員 350 万人を突破し、興行収入も 45 億円を	the box office exceeded 4.5 billion yen. We will examine the charm of
	超えた。早くも「2016年の興行収入はこの作品がトップな	"Zootopia", which people are already saying that " It might become the
	のでは?」とささやかれている『ズートピア』の魅力を検証	box-office champion of 2016 ".
	する。	
Editor	ブートピア 予想外の内容魅力	The charm of "Zootopia" is beyond our expectation.
OpenNMT	アナ雪超える? 大人にも好評	Surpassing "Frozen"? It is popular among adults.
-		
HybridFusion	大人にも好評ズートピアの訳	What is the reason for the popularity of "Zootopia" among adults?
Headline	ミュンヘン銃撃 容疑者は無差別乱射に関心? 事件の独	Munich shooting incident. Are suspects interested in indiscriminate
	社会への影響は	shootings? What is the impact of the incident on German society?
Lead	22 日の午後、多くの人で賑わうドイツ南部ミュンヘンの	
Lead		
Lead	22 日の午後、多くの人で賑わうドイツ南部ミュンヘンの	shopping center in Munich part of southern Germany and 9 people were
Lead	22 日の午後、多くの人で賑わうドイツ南部ミュンヘンの ショッピングセンターで9人が死亡する銃撃事件が発生し	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
Lead	22 日の午後、多くの人で賑わうドイツ南部ミュンヘンのショッピングセンターで9人が死亡する銃撃事件が発生した。容疑者はショッピングセンターから約1キロ離れた場所で死亡しているのを発見され、警察当局は逃走後に自ら	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
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Editor	22 日の午後、多くの人で賑わうドイツ南部ミュンヘンのショッピングセンターで9人が死亡する銃撃事件が発生した。容疑者はショッピングセンターから約1キロ離れた場所で死亡しているのを発見され、警察当局は逃走後に自ら命を絶ったと発表している。犯行の動機については不明だが、容疑者が以前から銃撃を計画していたとの情報もある。事件がドイツ社会に与える影響について考えてみたい。銃乱射 移民大国ドイツに衝撃	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? Germany, known for having many immigrants, was shocked by a shooting rampage.
Lead Editor OpenNMT HybridFusion	22 日の午後、多くの人で賑わうドイツ南部ミュンヘンのショッピングセンターで9人が死亡する銃撃事件が発生した。容疑者はショッピングセンターから約1キロ離れた場所で死亡しているのを発見され、警察当局は逃走後に自ら命を絶ったと発表している。犯行の動機については不明だが、容疑者が以前から銃撃を計画していたとの情報もある。事件がドイツ社会に与える影響について考えてみたい。銃乱射 移民大国ドイツに衝撃	Germany, known for having many immigrants, was shocked by a shooting

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.