# Weakly-Supervised Opinion Summarization by Leveraging External Information



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7"

#### Overview

Opinion summarization from online product reviews is a challenging task involving identifying opinions related to various aspects of the product. In this work,

• We address this task without human supervision – by incorporating domain

#### **Customer Reviews**

Charles Nordlande

🖕 🚖 🖕 🏠 🔿 THIS OASIS CRITIC HAS TO ADMIT: NEW LIGHT IS A TOTAL GAME CHANGE viewed in the United States on July 29, 2019

wrote a lengthy critical review of the 2017 Oasis, which was the first Kindle that I've ever returned out of every nainly criticized the cold and slippery aluminum shell for intruding on, rather than disappearing from eading experience. But along with those criticisms, I praised its bigger 7" screen as the one aspect that I would niss. And now, with the upgrade of that screen to one with adjustable color temperature, I decided to give the asis a try, even though its design was unchanged from 2017

eviewed in the United States on July 29, 2019 olor: Graphite | Digital Storage Capacity: 32 | Connectivity: Wi-Fi | Offer Type: With Special Offer

• It's small, provides basically two simple physical controls, and a sleek premium aluminum design that makes i peautiful to look at without showing off

## **Task Description**

#### **Feature descriptions**

- Our best 7", 300 ppi flush-front Paperwhite display. Adjustable warm light to shift screen shade from white to amber. • Waterproof (IPX8) so you can read in the bath or by the pool. Thin and light ergonomic design with page turn buttons. Reads like real paper with the latest e-ink technology for fast page Reads like real paper with the latest e-ink technology for fast page Instant access to millions of books, newspapers, and audiobooks. 0 Works with Audible - pair with Bluetooth headphones or speakers to switch

knowledge from external information;

- We propose ASPMEM, a generative approach for aspect identification that can use such knowledge effectively;
- We adopt a three-step pipeline to create summaries by identifying aspects, computing salience, and selecting opinions.

## **Aspect Identification**

ASPMEM contains an array of memory cells  $\mathcal{A} = \{a_1, a_2, \cdots, a_k\}$  to store aspect-related information. Similar to topic models, we assume the review segment s is generated from these aspect (topic) memories.

#### **Sentence Representation**

 $P(v_i|a_j) \propto \exp(\cos(v_i, a_j)),$  $P(v_i) = \sum P(v_i|a_j)P(a_j),$ 

• The screens warm temperature display works like a charm. You can either adjust it manually in the setting sectio or just set it to automatically active with sunrise and sunset. I just put in an automatic timer and overall found it a pleasure to use this feature at night. The warm effect doesn't bring in any eye irritation to me, at night or day, hich a computer screen does

Richard A. Nathan

★☆☆☆☆ Micro-USB is Not Acceptable eviewed in the United States on July 29, 201 olor: Graphite | Digital Storage Capacity: 32 | Connectivity: Wi-Fi | Offer Type: Without Special Offers

his is my 11th Kindle. Their last Oasis model should have been technology forward enough to have a USBharging. The lack of this charging port is totally unacceptable. I am angry over this. EVERY cell phone sold is either JSB-C or Lightning. Just a quick walk through a Best Buy will show numerous computers with USB-C charging. oing with a Micro USB port is an insult to the target users of this flagship device. The head of the Kindle project nd any engineer that advocated for it should be fired

#### Gwaredd Thomas

▶☆☆☆☆ Lower ppi - Not good viewed in the United States on April 15, 2019 olor: BLACK | Option: Without Kindle Unlimited | Offer Type: With Special Offers youldn't purchase this product for the following reason; my 3rd Gen. Kindle has 300 ppi and this supposed "new

ne has only 167 ppi so what gives?

★★★★☆ Pleasant updates to the "base" Kindl viewed in the United States on April 15, 2019 olor: WHITE Option: Without Kindle Unlimited Offer Type: With Special Offers Verified Purchas had a Kindle touch years ago and had stopped using it. But I want to be able to focus on reading and not pop-ups

om other apps so I bought this new Kindle to avoid the distractions of reading on my phone



seamlessly between reading and listening. Ì A single battery charge lasts weeks, not hours.

#### **Review Summary**

It looks and feels much **bigger** than you'd think. The **storage capability** is great. More storage, more books! Lighting to adaptive with 2 ambient sensors. One HUGE improvement is that the Oasis is waterproof! Overall it's a great e-reader, but abysmal battery life negates all the  $\bigcirc$ positive features. Shorter than Voyage or Original Oasis. Significantly short. Also, one cannot follow text with audio.

## **External Information**

Rather than estimating the aspect memory *a* by human-annotated data or unsupervised methods, we select the top K keywords with the highest TF-IDF value from external resources to initialize a.

• bag1 —	• bag2 —	• bag3 —
•	•	•
• tv1 —	• tv2 —	• tv3 —
	•	•

Keywords of TV input resolution ratio hdmi contrast tuner component atsc color ntsc speaker pixel picture brightness stereo stand comb sound audio angle connection

#### Results

#### **Evaluated by Rouge**

Methods	R-1 R-2
Lead	35.5 15.2
LexRank	37.7 14.1
MATE + MILNET [1]	44.1 21.8
ASPMEMSUM	46.6 25.7
w/o filtering	48.0 28.7
w/o Relevance	41.5 20.5
w/o Sentiment	40.5 18.2
w/o ILP	46.2 25.1



### **Sentence Generation**

 $P(s|a_i) \propto \exp(\cos(s, a_i)).$ 

## Likelihood Maximization

 $J(\theta) = -\sum_{s \in \mathcal{X}} \log P(s; \theta) + \lambda \left\| \mathbf{\hat{A}} \mathbf{\hat{A}}^{T} - \mathbf{I} \right\|_{2}.$ 

## **Aspect Prediction**

 $P(a_i|s) \propto P(s|a_i)P(a_i).$ 

## Results

Evaluated by multi-label micro  $F_1$ Modol

iviodei	Bags	B/ I	Boots	Keyb/s	I Vs	Vacs	Ave.
ABAE (2017)	41.6	48.5	41.0	41.3	45.7	40.6	43.2
MATE (2018)	48.6	54.5	46.4	45.3	51.8	47.7	49.1
bert (2019)	61.4	66.5	52.0	57.5	63.0	60.4	60.2
ASPMEM	52.4	58.1	54.5	51.4	53.9	54.6	54.2
w/ extra mem	60.0	62.0	55.8	61.8	60.0	61.8	60.2



## **Salience Computation**

#### Relevance

- "It looks and feels much bigger."
- "I love this one!" X  $\mathbb{S}_{rel}(s) = \frac{1}{|s|} \sum_{i \in j=\{1,\cdots,K\}} \max_{j \in \{1,\cdots,K\}} g(\cos(\boldsymbol{v}_i, \boldsymbol{a}_j) \cdot w_j).$

## Sentiment

- "The storage is great!"
- "Bought it for my daughter." ×  $\mathbb{S}_{senti}(s) = \mathbf{p}^T \operatorname{softmax}(\mathsf{MLP}(\mathsf{LSTM}(s)))$

## **Overall**

 $\mathbb{S}_{sal}(s) = \mathbb{S}_{rel}(s) \times \mathbb{S}_{senti}(s).$ 

#### Inter-annotator Agreement 54.7 36.6

## **Keywords distribution**



## Summary examples



So this is the **perfect size**. The **padding** is good and it is quite **stylish**. there is just **enough size** for a mouse, power cord, a fre CD's and a cell phone. Functionality wise : awesome! The **price** on Amazon is great. Unfortunately over the holidays the hand strap broke. As I stated above, getting the computer in and out is pain.

#### w/ and w/o extra memory

	Interface -	0.71	0.00	0.00	0.19	0.05	0.05	0.00	0.00	0.00	-	0.71	0.00	0.00	0.19	0.05	0.05	0.00	0.00	0.00
	Connectivity -	0.25	0.55	0.00	0.02	0.07	0.07	0.00	0.05	0.00	-	0.20	0.50	0.00	0.00	0.07	0.20	0.00	0.02	0.00
	Service -	0.04	0.04	0.54	0.11	0.00	0.14	0.00	0.07	0.07	-	0.04	0.04	0.50	0.07	0.00	0.29	0.00	0.07	0.00
bel	Ease_of_use -	0.04	0.04	0.04	0.86	0.04	0.00	0.00	0.00	0.00	-	0.04	0.04	0.00	0.71	0.04	0.18	0.00	0.00	0.00
e e	Image -	0.06	0.05	0.01	0.11	0.66	0.07	0.00	0.02	0.01	-	0.02	0.05	0.00	0.10	0.60	0.20	0.00	0.01	0.01
Irue	none -	0.05	0.07	0.14	0.07	0.06	0.44	0.03	0.08	0.06	-	0.03	0.06	0.09	0.06	0.03	0.60	0.02	0.07	0.03
	Price -	0.00	0.00	0.10	0.00	0.00	0.10	0.76	0.03	0.00	-	0.00	0.00	0.07	0.00	0.00	0.21	0.72	0.00	0.00
	Size & Look -	0.00	0.05	0.05	0.00	0.10	0.19	0.00	0.62	0.00	-	0.00	0.05	0.05	0.00	0.05	0.24	0.00	0.62	0.00
	Sound -											0.01	0.05	0.00	0.03	0.01	0.12	0.01	0.03	0.74
	Intert	ace No cil	inty ser	ile	use, /m	ade l	one	ince		und	Inter	ace No cil	jity Ser	ice.	use In	ade de	one		<sup>204</sup> So	bnu
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**Opinion Selection** 

An ideal summary would contain highsalience opinions, avoid redundant information, and meet the limit on the length. These goals can be formalized as an ILP problem:

 $\boldsymbol{\alpha} = \arg\max_{\boldsymbol{\alpha}} \sum_{i} \mathbb{S}_{sal}(s_i) \alpha_i - \sum_{i,j} sim_{ij} \beta_{ij},$ 

s.t.  $\alpha_i, \beta_{ij} \in \{0, 1\}$   $\forall i, j$  $\beta_{ij} \ge \alpha_i + \alpha_j - 1 \quad \forall i, j$  $\beta_{ij} \le \frac{1}{2}(\alpha_i + \alpha_j)$  $\forall i, j$  $\sum_i \alpha_i l_i < L$  $\forall i$ 

Fantastic **sound**, **great fit** and a simple practicle **set** up. i find this device very good. And with the additional purchase of some acustibud ear pieces the **sounds** is quite good. This is an awesome product. The design of the ear pieces did not fit my ear anatomy very well. the sound isn't as rich as other on ear Bluetooth.



[1] Angelidis, S., Lapata, M. (2018). Summarizing Opinions: Aspect Extraction Meets Sentiment Prediction and They Are Both Weakly Supervised. In EMNLP 2018.

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