

SpotFake+: A Multimodal Framework for Fake News Detection via Transfer Learning



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Motivation

Online news platforms are becoming exceedingly popular amongst consumers due to their ease of access and their vast selection of disparate sources.

News obtained from such platforms are generally of full length as compared to the one present on any social media.

Previous studies have solved the problem of multimodal fake news detection on datasets consisting of news in the form of tweets (Boididou and others 2015).

In this paper, we study the problem of detecting fake news on full length articles along with associated images.

We present SpotFake+, a multimodal approach that leverages transfer learning to capture semantic and contextual information from the news articles and its associated images and achieves the better accuracy for fake news detection.

Dataset

In this paper, we consider the FakeNewsNet repository (Shu et al. 2018) for multimodal fake news detection.

FakeNewsNet consists of full length articles rather than short claims or news in the form of tweets.

The repository consists of two datasets from two different domains-politics and entertainment. Each news article has text and an image associated with it.

The ground-truth labels for the political and entertainment domain were collected from Politifact and Gossipcop and E! Online, respectively.

Dataset	Politifact	GossipCop
Real	624 (321)	16817 (10529)
Fake	432 (164)	5223 (2581)

Table 1: The number of samples in the FakeNewsNet repository. The values in the brackets indicate samples fit to use after data pre-processing.

Dataset Pre-processing

We manually remove logos from the articles, and dropped samples that either lacked images or contained GIFs.





Figure 1: Image samples from FakeNewsNet repository that were discarded after the cleaning process.

Model Architecture

The schematic diagram of the model is shown in Figure 2.

Textual Feature Extractor

This is a sub-module of SpotFake+ that is responsible of extracting the contextual text features from the posts.

It uses pre-trained XLNet that represent words and sentences in a way that best captures underlying semantic and contextual meaning.

Visual Feature Extractor

We employ the pre-trained VGG-19. We extract the output of the second last layer of VGG-19 convolutional network pre-trained on ImageNet dataset.

Multimodal Eugion

Multimodal Fusion
The two feature vectors obtained via different modalities are fused together using simple concatenation technique to obtain the desired news representation.

This news representation is then passed through a fully connected neural network for fake news classification.

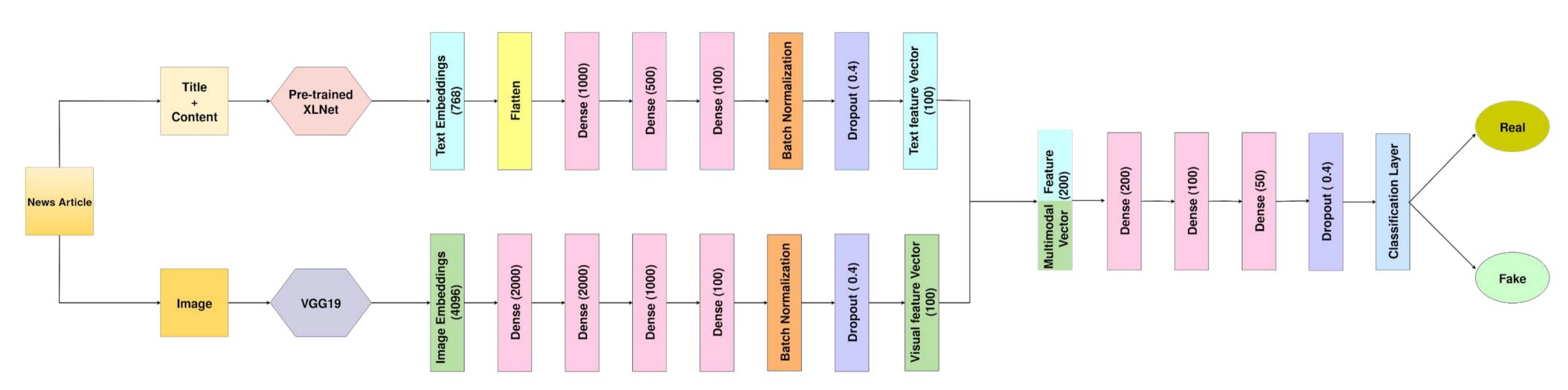


Figure 2: Our proposed SpotFake+ for Fake News Detection

Results

SpotFake+ is compared against current state of the art text and other multiple-modality models (Wang et al. 2018; Khattar et al. 2019; Singhal et al. 2019) on the same dataset. The detailed analysis of the results are shown in Table 2. The loss function graphs are also plotted in Figure 3.

Modality	Models	Politifact	GossipCop
Text	SVM	0.58	0.497
	Logistic Regression	0.642	0.648
	Naive Bayes	0.617	0.624
	CNN	0.629	0.723
	SAF (Social Article Fusion)	0.691	0.689
	XLNet + Dense Layer	0.74	0.836
	XLNet + CNN	0.721	0.84
	XLNet + LSTM	0.721	0.807
Image	VGG19	0.654	0.80
	EANN (Wang et al. 2018)	0.74	0.86
Text + Image	MVAE (Khattar et al. 2019)	0.673	0.775
	SpotFake (Singhal et al. 2019)	0.721	0.807
	SpotFake+ (XLNet + dense + VGG19)	0.846	0.856

Table 2: Comparison of accuracy on FakeNewsNet dataset. SpotFake+ is our proposed multimodal approach.

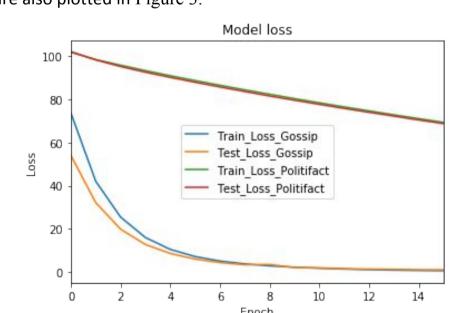


Figure 3: Loss function graphs on GossipCop and Politifact datasets by SpotFake+.

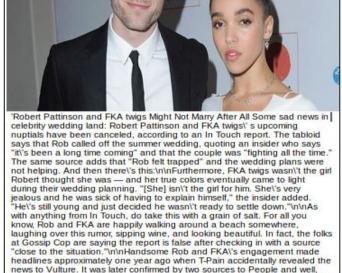
Parameters	Unimodal Text Models (XLNet + dense layer)	Image Models (VGG)
Input feature dim	768	4096
# of dense layers	3 (100,500,100)	3 (2000,1000,100)
Output feature dim	100	100
Dropout	0.4	0.4
Activation	ReLu	ReLu
Optimizer	SGD	SGD
Batch Size	32	32

Table 3: List of Hyperparameters used in SpotFake+.

Samples identified by proposed SpotFake+



Kim Kardashian, Kanye West Snubbed By Kate Middleton And Prince William Report Debunked Kate Middleton and Prince William are not spared from rumors and malicious reports despite their stature. But the rumors of them snubbing Kim Kardashian and Kanye West was debunked. (Photo: Chris Jackson/Getty Images)/ninKate Middleton and Prince William despite their stature in the world are not spared from rumors and unfounded reports that put the royal couple in a bad light. One of them is the report that they snubbed the power couple Kim Kardashian and Kanye West. ninThe report said that Kardashian feels that Middleton and Prince William are snubbing or disinterested in meeting her and her husband. The royal couple allegedly turned down the invitation to attend West's concert a couple of times. The "Keeping up with the Kardashians" star feels that it is snobbery towards net. In International Prince William are snubbing or disinterested in meeting her and her husband. The royal couple and the foliation of the state of the world of the royal couple met with her during a Nets game with her husband Jay Z. Kardashian feels that Beyonce has an edge over her. Kim Kardashian was allegedly hurt especially that Middleton is her idol. Inthososip Cop debunked the above-mentioned report as fake news because it was not from a reliable source. Knowing the Duke and the Duchess of Cambridge are busy people, missing an invitation is unlikely but if not done beforehand, the possibility is that it cannot be accommodated into their schedules. Intho Princes of Cambridge are busy people, missing an invitation is unlikely but if not done beforehand, the possibility is that it cannot be accommodated into their schedules. Intho Princes of Cambridge are busy people, missing an invitation has her husband as a has-been. In 2015, a report has mentioned that Kim and her husband has been inviting the royal couple but were turned down again and again. Ninkim sent Princess Charlotte a custom-made dress from Karnye's clothing line but it was returned. One



this is the ring, apparently:\n\nGetty Images\n\nRob and FKA have not been spotted in public since last Novemben's GO Campaign Gala in Beverly Hills but then again, their relationship has been generally private this whole time.\n\nFollow Peggy on Twitter.'

Figure 4: Samples of fake data from GossipCop that were incorrectly predicted as real by Unimodal text models but were correctly predicted as fake by SpotFake+.



'Cairlyn Jenner Says It's s'Tough't to Keep a Close Relationship With All Her Children: 'They've All Moved On't Cairlyn Jenner'tis having a hard time keeping up with the kids.'htn'' spend a lot of time by myself here in the house,' she revealed in an in-depth interview with Broadly published Tuesday, "I have a lot of children, but sometimes just because of circumstances, maintaining a close relationship with your kids is very tough. They all have lives. They've all moved on. "Inh' We'tre just human beings; we'tre going to be here for a very short time." Jenner added. "We come and we go and at the end, when it's all said and done, hopefully your family is going to be there." In'nCaiflyn shares son Burt Jenner, 39, and daughter Cassandra Marino, 37, with first wife Chrystie Crownoves. She also shares sons Brandon and Brody Jenner with second wife Linda Thompson ... and, most famously, daughters Kendall Jenner and Kylie Jenner with most recent ex-wife Kris Jenner. "In'nJenner also played an important role in raising krist' four children with the late Robert Kardashian. - Kourtney Kardashian, Kim Kardashian, Khloe Kardashian, and Rob Kardashian - which was chronicled on the family's Et reality show.'hinShe spent a lot of 2017 in a war of words with Kris and the Kardashian children who believed Jenner's memoir "The Secrets of My Life" was filled with lies - and the trans community, who took issue with her initial support of Donald Trump. "I got the trans community, who took issue with her initial support of Donald Trump." got the trans community out there bashing on me, I got the Kardashians out there bashing on me, I got the Kardashians out there bashing on me, I got the Kardashians out there bashing on me, I got the trans community, who took issue with her initial support of Donald Trump." 1901 the trans community out there bashing on the publication, which noted the interview was done back in October. "All I do is is there in the house and try to stay out of trouble." "In tho pe when I get up there to the pearly

said. "And it would shock everybody. Screw 'em."n\nin a more recent interview Jenner did with Piers Morgan

she said she doesn't "talk to the Kardashians anymore."n'n"The only ones I am concerned about are Kenda and Kylie," she added. "They are my biological kids. I spent 23 years carting them around."n'nInstagram



ommy Lee Claims He Paid \$130,000 For Brandon's Rehab Following Son's Threatening Post It doesn toming bee claims he had \$150,000 For Brahdom's Rehab Pollowing out a Threatening Post hobestrict book think things are getting better between Tommy Lee and his son, Brandon Lee hin/On Monday night, the 55-year-old rocker took to Instagram once again to call out his oldest child after Brandon, 22, insisted in a social media post earlier that day that they stop airing out their grievances on social media. "If you want to bad mouth me, do it to my face," Brandon declared in a lengthy post. "You post something for the world to see, saying I'm a bad kid and my mom is a bad mother, what do you expect? Seriously, who'ts the fkn adult here: How would you even know if firm a bad kid, you're not even around enough to know what kind of person I am."n'nThe message came after Brandon -- who allegedly assaulted Tommy back in March -- shared a video of his seemingly unconscious dad on social media, which appeared to be in response to Tommy's Instagram rant on Father's Day about the lack of respect he receives from his son. In In The feud continued when Tommy started listing all of the money he'rs allegedly spent on Brandon. "Rehlab for son: \$130,000, Party for son's 21 birthday last year: \$40,000," he wrote. "Medical Bills after son knocks his father unconscious and uses alcoholism as scapegoat: \$10,000. Son acting like a victim on social media on father's day: Priceless. "In'n Th Notley Crue drummer concluded the post, writing: "I'm out [mic] drop!"In\nAs for Pamela Anderson, Tommy\s revivile and Brandon's mother, she's still siding with her son, who "amela stands by Brandon's reaction to his father's post," a source tells ET. "She believes Brandon has the right to protect himself and the family, in Pam! 's eyes, while Brandon is Tommyl's biological son, that doesn't make Tommy a real father." (a)nEarlier this month, Anderson opened up to ET's Nischelle Turner about the alleged assault and feud.\n\n"tf(s between them. I wish the best for everybody, but, you know, we're all growing and learning and this is part of it," the 50-year-old actress said at the time. "It's too bad, but like I said, it's the past."n'inFor more from the feud, watch he clip below:\n\nRELATED CONTENT:\n\nTommy Lee's Son Brandon Shares Video Of His Ur After Threatening Postion\nPamela Anderson Says Son Brandon is \'More\' of an Adult Than Ex Tommy Lee After Their Altercation (Exclusive)InInPamela Anderson Opens Up On Family Drama With Tommy Lee and

Figure 5: Samples of real data from GossipCop that were incorrectly predicted as fake by Unimodal text models but were correctly predicted as real by SpotFake+.

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Code and dataset is available at: https://github.com/shiivangii/SpotFakePlus