## NewsStories: Illustrating articles with visual summaries

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Abstract. Recent self-supervised approaches have used large-scale imagetext datasets to learn powerful representations that transfer to many tasks without finetuning. These methods often assume that there is a one-to-one correspondence between images and their (short) captions. However, many tasks require reasoning about multiple images paired with a long text narrative, such as photos in a news article. In this work, we explore a novel setting where the goal is to learn a self-supervised visual-language representation from longer text paired with a set of photos, which we call visual summaries. In addition, unlike prior work which assumed captions have a literal relation to the image, we assume images only contain loose illustrative correspondence with the text. To explore this problem, we introduce a large-scale multimodal dataset called NewsStories containing over 31M articles, 22M images and 1M videos. We show that state-of-the-art image-text alignment methods are not robust to longer narratives paired with multiple images, and introduce an intuitive baseline that outperforms these methods, e.g., by 10% on on zero-shot image-set retrieval in the GoodNews dataset<sup>1</sup>.

Keywords: vision-and-language, image-and-text alignment

#### 1 Introduction

State-of-the-art image-and-text representation learning approaches generally focus on learning a one-to-one correspondence between an image and one [20,30,15] or more captions [6,32,35], such as a photo with a caption "An airplane is flying in the sky" (Figure 1a). While existing datasets such as MSCOCO [23] and Flickr30K [40] contain multiple captions for an image, the aforementioned approaches still learn a one-to-one correspondence between an image and a short caption that generally has a strong literal relation to it. However, this is unrealistic for longer text narratives containing multiple images (e.g. news articles, Wikipedia pages, blogs). To challenge such constraints, Kim et al. [18] first introduce the problem of retrieving image sequences based on blog posts that may

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<sup>&</sup>lt;sup>1</sup> Project page: https://github.com/NewsStoriesData/newsstories.github.io



Fig. 1. Unlike prior work (a) which aligns a single image with one or more captions, we study the problem of learning the multiplicity of correspondences between an unordered set of visually diverse images and longer text sequences (b). (c) shows an example story from our NewsStories dataset. For each story, we cluster articles from different media channels and collect images that are used in the articles. In contrast to conventional literal caption datasets such as MSCOCO and Flickr30K, the images and text narratives in NewsStories only have illustrative relationships

be composed of multiple paragraphs, using the assumption that the image sequence and the paragraphs have the same weak temporal ordering. However, this assumption is quite restrictive due to the prevalence of long narrative texts and groups of relevant images without information about their temporal order, e.g., in the news domain and Wikipedia. More importantly, they do not consider semantically related text narratives that may use similar groups of images.

Motivated by recent representation learning approaches which leverage largescale data [30,15], we seek to address the important problem of learning visualsemantic representations from text narratives of varying lengths and groups of complementary images from publicly available data. In this paper, we address this research problem in the news domain due to the prevalence of related articles and their corresponding images on the same story from different media channels. However, this is a general problem inherent in other domains including Wikipedia and social media posts on similar events. We define a story as an event associated with a visual summary consisting of images that illustrate it and articles that describe it, or videos depicting it. In contrast to prior work, this problem requires the capability to reason about the multiplicity of correspondences between sets of complementary images and text sequences of varying lengths. For example, in (Figure 1b), we aim to identify the story that is jointly illustrated by images of an airplane, flags of the European Union (EU) and a nurse preparing a vaccine. Here, one possibility is about traveling to the EU during a pandemic. A story could contain a variety of photos that illustrate a particular concept, and conversely, stock images of an airplane or EU flags could illustrate different stories.

We formulate the problem of visual summarization as a retrieval task, where the image sets are given and the goal is to retrieve the most *relevant* and *illustrative* image set for an article. Our proposed research problem is distinguished from prior work in two ways. First, we must be able to reason about the *many-to-many* correspondences between multiple images and linguistically diverse text

**Table 1. Dataset statistics comparison.** Our NewsStories dataset is significantly larger than existing datasets with diverse media channels and story clusters that indicate related articles, images and news videos

	GoodNews	NYTimes	Visual News	NewsStories	NewsStories
	[4]	800K [36]	[24]	Unfiltered	Filtered
# Media channels	1	1	4	28,215	46
# Story clusters	-	-	-	-	350,000
# Articles	257,033	444,914	623,364	31,362,735	931,679
# Images	462,642	792,971	1,080,595	22,905,000	754,732
# Videos	0	0	0	1,020,363	333,357
Avg article length	451	974	773	446	584

narratives in a story. Second, the images in our problem setting often only have *illustrative* correspondences with the text rather than *literal* connections (e.g. "travel" or "vacation" rather than "airplane flying"). Extracting complementary information from images and relating them to the concepts embodied by the story is a relatively under-explored problem, especially when the images and text only have loose and symbolic relationships. While existing work such as Visual Storytelling [14] aims to generate a coherent story given a set of images, the images have a temporal ordering and exhibit *literal* relations to the text.

To facilitate future work in this area, we introduce **NewsStories**, a large-scale multimodal dataset (Fig. 1-c and Table 1). It contains approximately 31M articles in English and 22M images from more than 28k news sources. Unlike existing datasets, NewsStories contains data consisting of three modalities - natural language (articles), images and videos. More importantly, they are loosely grouped into *stories*, providing a rich test-bed for understanding the relations between text sequences of varying lengths and visually diverse images and videos. With an expanding body of recent work on joint representation learning from the language, visual, and audio modalities, we hope that our NewsStories dataset will pave the way for exploring more complex relations between multiple modalities.

Our primary goal is to learn robust visual-semantic representations that can generalize to text narratives of varying lengths and different number of complementary images from uncurated data. We benchmark the capabilities of state-of-the-art image-text alignment approaches to reason about such correspondences in order to understand the challenges of this novel task. Additionally, we compare them to an intuitive Multiple Instance Learning (MIL) approach that aims to maximize the mutual information between the images in a set and the sentences of a related articles. We pretrain these approaches on our NewsStories dataset before transferring the learnt representations to the downstream task of article-to-image-set retrieval on the GoodNews dataset under 3 challenging settings, without further finetuning. Importantly, we empirically demonstrate the utility of our dataset by showing that training on it improves significantly on CLIP and increases the robustness of its learnt representations to text with different numbers of images. To summarize, our contributions are as follows:

- 1. We propose the novel and challenging problem of aligning a story and a set of illustrative images *without temporal ordering*, as an important step towards advancing general vision-and-language reasoning, and with applications such as automated story illustration and bidirectional multimodal retrieval.
- 2. We introduce a large-scale news dataset NewsStories that contains over 31M articles from 28K media channels as well as data of three modalities. The news stories provide labels of relevance between articles and images.
- 3. We experimentally demonstrate that existing approaches for aligning images and text are ineffective for this task and introduce an intuitive MIL approach that outperforms state-of-the art methods as a basis for comparisons. Finally, we show that training on the NewsStories dataset significantly improves the model's capability to transfer its learned knowledge in zero-shot settings.

#### 2 Related Work

To the best of our knowledge, there has been limited work that directly address our problem of learning many-to-many correspondence between images and texts. Wang et al. [38] propose to learn an alignment between image regions and its set of related captions. However, the images and captions in their setting have strong literal relationships instead of illustrative correspondences. Current vision-language models have other applications including text-based image retrieval [40], visual question answering [2,42] and visual reasoning [33], and as a tool for detection of anomalous image-text pairing in misinformation [1,?].

Recent vision-language models [30,15] demonstrate excellent zero-shot performance on various downstream tasks, sometimes exceeding the performance of bespoke models for these tasks. This advancement has relied on very large-scale datasets consisting simply of images and their associated captions. Such datasets require little or no curation, whereas the need for training labels has limited the size of datasets in the past [13]. These image-caption datasets are paired with a natural contrastive learning objective, that of associating images with their correct captions [41,30,15]. Previous work has demonstrated that improved visual representations can be learned by predicting captions (or parts of them) from images [16,21,31,8]. Captions provide a semantically richer signal [8] than the restricted number of classes in a dataset such as ImageNet – for example, a caption such as "my dog caught the frisbee" mentions two objects and an action.

Closer to our work are methods that learn one-to-many correspondences from images or videos to captions [6,32,35], or vice-versa. Polysemous Instance Embedding Networks (PVSE) [32] represents a datum from either modality with multiple embeddings representing different aspects of that instance, resulting in  $n \times n$  possible matches. They use multiple instance learning (MIL) [9] align a image-sentence pair in a joint visual-semantic embedding [11,17,10] while ignoring mismatching pairs. PCME [6] explicitly generalizes the MIL formulation from a single best match to represent the set of possible mebeddings as a normal distribution, and optimize match probabilities using a soft contrastive loss [28]. In contrast to prior work, in our setting both the visual and text modalities con-

tain semantically distinct concepts that are not appropriately represented with a unimodal probability density.

Finally, while there exist news datasets including GoodNews [4], NYT800k [36] and VisualNews [24], they are only sourced from a single (GoodNews and NYT800K) or four (VisualNews) media channels. Additionally, the VMSMO dataset [22] contains news articles and videos that are downloaded from Weibo, but it does not contain images. Compared to these datasets, our NewsStories dataset not only contains articles from over 28K sources, but also has story labels to indicate related articles and images. Related to our work, [12] released the NewSHead dataset for the task of News Story Headline generation, containing 369k stories and 932k articles but no images. However, ours contains a much larger corpus of stories and associated articles. Last but not least, the aforementioned datasets generally only contain either images and articles or videos and articles. In contrast, ours provides data from all 3 modalities.

#### 3 The NewsStories Dataset

Our NewsStories dataset comprises the following modalities: 1. news articles and meta data including titles and dates 2. images 3. news videos and their corresponding audio. As mentioned above, NewsStories has three main differences from existing datasets. First, it is significantly larger in scale and consists of data from a much wider variety of news media channels. Second, unlike a significant percentage of multimodal datasets, it contains three different modalities – text, image and videos. Third, the text, images, and videos are grouped into stories. This provides story cluster labels that not only help to identify related articles but also create sets of multiple corresponding images for each story.

#### 3.1 Data collection

Learning the multiplicity of correspondences between groups of complementary images and related text narratives requires a dataset that contains multiple relevant but different images that correspond to a given text sequence and vice versa. Curating a large-scale dataset with these characteristics is an extremely expensive and time-consuming process. In contrast, the news domain provides a rich source of data due to the proliferation of online multimedia information. We collected news articles and associated media links spanning the period between October 2018 and May 2021<sup>2</sup>. The articles from a filtered subset (Section 3.2) are grouped into stories by performing agglomerative clustering on learned document representations [25], similar to [12], which iteratively loads articles published in a recent time window and groups them based on content similarity. We merge clusters that can possibly share similar images via a second round of clustering based on named entities. Specifically, we begin by extracting the named entities in the articles using Spacy and their contextualized representations with a pretrained named-entity aware text encoder [39]. To obtain a single

<sup>&</sup>lt;sup>2</sup> CommonCrawl [7] can be used to fetch web articles.

vector for the story cluster, we perform average-pooling over all named entity representations across all articles. Finally, these representations are merged into a slightly smaller number of clusters. We extracted video links, however only the text and images are used for alignment in Section 4.

#### 3.2 Dataset filtering

We observed that there is a large amount of noise in the collected datasets due to the prevalence of smaller media channels. To address this, we removed articles and links that do not belong to a curated list of 46 news media channels<sup>3</sup> selected by an independent organization rating media biases. The list contains major news sources including BBC, CNN, and Fox News.

Curated evaluation set. Due to the sparsity of suitable datasets for this task, we curate a subset of the story clusters and use it as our evaluation set for the proxy task of retrieving image sets based on long narrative textual queries. Out of the 350,000 story clusters in the filtered story clusters, we randomly select 5000 clusters with at least 5 images. In the news domain it is common that articles on the same story may use similar photos. For example, different articles on the covid vaccinations may use the same image of a vaccination shot. To ensure that we can visually discriminate between two stories, we adopt a heuristic to ensure that the images are as diverse as possible. We begin by computing a set of detected entities for each image using the Google Web Detection API  $^4$ .

To generate a visually diverse image set for a story, we compute all possible combinations of five images from the entire set of images present in the story and compute the intersection set of all detected entities over the images within a combination. Finally, we select the combination with the smallest intersection set as the ground-truth (GT) image set for a story. During training, each set of images is randomly sampled from all available images in the story cluster.

#### 3.3 Quality of story clusters

To evaluate the quality of these story clusters, we use qualified human raters to judge three aspects of our NewsStories dataset. Each data sample is rated by three humans and the rating with the most votes is selected as the final score. We provide the instructions for these evaluations in the supplementary.

Relatedness of articles in a story cluster. For an approach to learn a meaningful alignment between groups of images and groups of related text, it is necessary that the articles in a story cluster are mostly relevant to each other. We randomly sample 100 stories and provide each rater with up to 10 articles from each story. A story is rated as of good quality if at least 80% of the articles are related to each other. Out of 100 randomly selected story clusters, raters determine that 82% of them are of good quality. Note that we do not try to eliminate all noise in the story clusters since we do not have ground-truth targets.

<sup>&</sup>lt;sup>3</sup> https://www.allsides.com/media-bias/media-bias-chart

<sup>&</sup>lt;sup>4</sup> https://cloud.google.com/vision/docs/detecting-web

Relevance of images in a story cluster. To rate the semantic relevance of the images to the story, each rater is provided with a maximum of 10 articles and 20 images from each cluster. The image set is labeled as relevant to the articles if at least 80% of the images are plausible in the context of the story. 76% of the randomly selected sets are rated as relevant. Some possible sources of irrelevant images may come from links to other articles or advertisements.

Ambiguity of ground-truth image sets in the evaluation set. A well-known problem of existing bidirectional sentence-to-image retrieval datasets is that some sentences can be relevant to other images in the dataset that are not in the ground truth, which results in inherent noise in the evaluation metrics. We use raters to determine if humans are able to discriminate between the ground-truth image set and others that can potentially be relevant. We randomly sample 150 stories and use the pretrained CLIP model to rank the image sets given the query article. A rater is provided with the GT image set as well as the top-5 sets retrieved by the CLIP model and is asked to select the most relevant image set. 86% of GT sets are selected by at least 2 out of 3 raters as the most relevant, indicating that our annotations are of high quality.

#### 3.4 Data statistics

We compare our NewsStories dataset to existing news datasets such as Good-News, NYT800K and VisualNews [4,24] in Table 1. We present statistics of both unfiltered and filtered sets. In contrast to existing datasets, the entire dataset contains articles from approximately 28K news media channels, which significantly increases its linguistic diversity. Additionally, it contains over 31M articles and 22M images. We compute the story clusters over articles from the filtered set due to computational constraints, but we release the entire dataset. The articles, images, and videos in the final filtered set are grouped into approximately 350K fine-grained story clusters. The number of articles per story cluster varies greatly across different clusters, ranging from a minimum of 1 to a maximum of about 44,000 (see suppl. for frequency histograms). We observe that story clusters that contain unusually high number of articles tend to come from the entertainment domain, e.g., reality television shows. These story clusters are removed from the final filtered set to eliminate noise. Additionally, we observe that most story clusters contain about 1 to 20 images. This is indicative of the challenges faced in obtaining sufficient data to study the novel problem of learning multiple correspondences between images and text. Finally, please refer to the supplementary material for details on the video statistics.

#### 4 Illustrating articles with visual summaries

The primary objective of this work is to explore the problem of illustrating articles with visual summaries that comprise a varying number of images. By reasoning about the multiplicity of correspondences between longer text sequences and multiple image illustrations, we hope to jointly learn visual-semantic representations that are robust to text narratives of different lengths as well as a

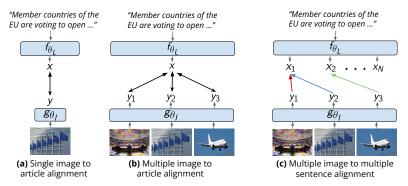


Fig. 2. Comparison of image-and-text alignment objectives. The images and text are encoded by encoders  $g_{\theta_I}$  and  $f_{\theta_L}$ , respectively. x and y denote the representations of the encoded article and image respectively. In (c), x is also labeled with a subscript to indicate that it is the representation for a sentence in the article

varying number of images. Specifically, given a set of visually different images, the goal is to learn an aggregated and contextualized representation for the images such that it is able to infer the relevant story, regardless of the exposition styles in the articles. To address this goal, we formulate the task of retrieving the most relevant set of images given a query article.

In this task, given a story consisting of a set of related articles  $\mathcal{A}$ , and a corresponding set of images  $\mathcal{I}$ , where  $|\mathcal{I}| = N_I$ , we aim to maximize the semantic similarity between each article  $L \in \mathcal{A}$ , and the entire image set  $\mathcal{I}$ . A language encoder  $f_{\theta_L}$  is used to encode the entire text sequence L into its representation  $x \in \mathbb{R}^{N_L \times D}$ . Depending on the number of text segments  $N_L$ , L can be used to denote an article-level representation or a set of sentence representations. Each image is encoded to obtain its base representation  $y_i$  with an image encoder  $g_{\theta_I}$  parameterized by weights  $\theta_I$ , where  $i \in \{1, \dots, N_I\}$ .

We describe several existing image-text alignment objectives that can be applied to our task in Sec. 4.1. We then present a Multiple Instance Learning approach for maximizing the correspondence between an image and specific sentences in the article to determine the importance of fine-grained alignment for this problem in Sec. 4.2. See Figure 2 for a high level comparison of these objectives. An effective visual summarization of an article requires the set of retrieved images to be *coherent* and *complete*. Since negative image sets may only overlap with the story partially, we enforce coherence by constraining the models to rank them lower than the positive set for an article. Additionally, our proposed approach seeks to enforce completeness by maximizing the semantic alignment between articles and the sets of relevant images via an article-level loss.

#### 4.1 Existing alignment objectives

Single image-text contrastive loss: We first explore an objective that aligns an image with a caption. Contrastive learning and its variants (InfoNCE and triplet loss) are commonly used to align an image with its corresponding text

sequence by maximizing the similarity score between their respective representations [30,15,3]. We use the popular InfoNCE [5,29] loss, formulated as  $\mathcal{L}_{\text{InfoNCE}}(x,y)$ :

$$-\log \frac{\exp\left(sim(x,y)/\tau\right)}{\exp\left(sim(x,y)/\tau\right) + \sum_{x'} \exp\left(sim(x',y)/\tau\right) + \sum_{y'} \exp\left(sim(x,y')/\tau\right)} \tag{1}$$

where x', y' denote the non-corresponding text and image representations with respect to a ground-truth pair in a given batch,  $\tau$  is a temperature value, and sim(.) is a similarity function.

Multiple Instance Learning for Noise Contrastive Estimation: The MIL-NCE formulation [27] provides a natural and intuitive extension to the regular InfoNCE objective by allowing for comparisons between a text sequence and multiple images, formulated as  $\mathcal{L}_{\text{MIL-NCE}}(x, y)$ :

$$-\log \frac{\sum_{i \in N_I} \exp\left(sim(x, y_i)/\tau\right)}{\exp\left(sim(x, y)/\tau\right) + \sum_{x'} \exp\left(sim(x', y)/\tau\right) + \sum_{y'} \exp\left(sim(x, y')/\tau\right)} \tag{2}$$

When evaluating with sets of images for both the InfoNCE and MIL-NCE baselines, we first compute the similarity score between the text query and each image before taking their average as the final similarity score.

Soft contrastive loss: PCME [6] models each image or text instance as a probability distribution. The probability that an image and a text match (m = 1) is computed as:

$$\frac{1}{K^2} \sum_{k}^{K} \sum_{k'}^{K} p(m|z_I^k, z_L^{k'}) \tag{3}$$

where  $z_I^k$  is the k-th sampled embedding from the image distribution and K is the number of sampled embeddings from each modality. The probability that two sampled embeddings match is computed using:  $p(m|z_I^k, z_L^{k'}) = \sigma(-\alpha ||z_I^k - z_L^{k'}|| + \beta)$ , where  $\sigma$  is the sigmoid function and  $\alpha$  and  $\beta$  are learnable parameters. Finally, the loss for a given pair of image I and text L is formulated as:

$$\mathcal{L}_{\text{soft}} = \begin{cases} -\log p(m|I,L), & \text{if } I \text{ corresponds to } L\\ -\log(1-p(m|I,L)), & \text{otherwise} \end{cases}$$
 (4)

During training and evaluation, multiple representations are computed for each image and caption. The final similarity score between a {image, caption} pair is computed from the highest-scoring pair of image and caption representations.

#### 4.2 Multiple Instance Learning - Sentence To Image (MIL-SIM)

Inspired by [18], we assume that each image in a given set should correspond to at least one sentence in the the article. Consequently, we adopt a Multiple Instance Learning framework where a bag of image and sentence instances is

labeled as positive if most of the instances are from the same story cluster and negative otherwise. The MIL-NCE loss formulation is a smooth approximation of the max function, thus it learns an alignment between the entire article and the most representative image in a set. In contrast, MIL-SIM tries to learn the illustrative correspondence between each image and the most relevant sentence.

We segment the text article into individual sentences and encode them as  $L = \{x_1, \dots, x_{N_L}\}$ . Given a positive pair of image set  $I = \{I_1, \dots, I_{N_I}\}$  and text article L, we aim to maximize the mutual information between them:

$$\max_{\theta} \mathbb{E}[\log \frac{p(I, L)}{p(I)p(L)}], \tag{5}$$

where p(I), P(L) and P(I, L) are the marginal distributions for the images and articles as well as their joint distribution, respectively.

In this setting, we do not have the ground-truth target labels which indicate the sentence that a given image should correspond to. This problem is compounded by the fact that some of the images may not originate from the same text source but from related articles. Consequently, we generate pseudo-targets by selecting the best matching sentence in an article for an image (colored arrows in Figure 2(c)). Then we use Equation 1 to maximize the lower bound of the mutual information between them. Given an image representation  $y_i$  and an article L, we compute their similarity as  $\max_l x_l^T y_i$  where l denotes the index of the sentence representation. In this formulation, multiple sentences in a corresponding article may be related to the image but will be treated erroneously as irrelevant. We circumvent this by selecting the highest-scoring sentences, with respect to the image, in articles from other clusters as negatives. Additionally, we mitigate the possibility of a different cluster containing a related sentence by reducing the weight of the image-sentence loss.

However, this may introduce a lot of noise to the learning process, especially if an image originates from a weakly-related article. To alleviate this problem, we impose an article-level loss that aims to maximize the general semantic similarity between the entire article and image set. We compute a single representation for the entire article  $L_f$  as well as image set  $I_f$  by mean-pooling over the sentence and image representations, respectively. Finally, we learn an alignment between them by minimizing the value of InfoNCE( $I^f, L^f$ ), where their similarity is computed as:  $sim(I^f, Y^f) = (I^f)^T Y^f$ . Our final objective function is formulated as:

$$\mathcal{L}_{\text{MIL-SIM}} = \sum_{b=1}^{B} L_{\text{InfoNCE}}(I_b^f, L_b^f) + \lambda * \sum_{b=1}^{B} \sum_{i=1}^{N_I} L_{\text{InfoNCE}}(I_{b,i}, L_b),$$
 (6)

where B and  $\lambda$  are the batch size and trade-off weight, respectively.

#### 5 Experiments

#### 5.1 Implementation details

We use the visual and text encoders of CLIP [30] as a starting point and finetune them using the image-and-text alignment objectives described above. The orig-

**Table 2.** Comparison on the task of article-to-image-set retrieval on the test split of our NewsStories dataset, which contains 5000 unseen stories with image sets of size 5. Higher R@K values and lower median rank indicate more accurate retrievals

Method	Alignment	R@1	R@5	R@10	Median
	Type				Rank
Pretrained CLIP [30]	Single	31.03	53.87	63.53	4
Single Image	Single	35.88	63.58	74.12	3
MIL-NCE [27]	Single	32.84	59.60	70.92	3
PVSE [32]	Single	36.09	64.26	74.90	3
PCME [6]	Single	35.18	65.52	75.65	3
Transformer [37]	Multiple	50.08	78.79	86.10	2
Mean	Multiple	49.12	76.04	85.18	2
MIL-SIM	Multiple	<b>54.24</b>	82.76	90.38	1

**Table 3.** Zero-shot evaluations of article-to-image-set retrieval approaches on our test splits of the GoodNews [4] dataset. Each test split has 3, 4, or 5 images in each article

	R@1				R@5			R@10				Rank
Method	3	4	5	3	4	5	3	4	5	3	4	5
CLIP [30]	22.29	21.13	20.90	41.14	39.25	38.83	49.94	47.33	47.41	11	13	13
Single Image	17.27	16.27	15.61	34.84	32.57	32.55	43.94	41.47	40.95	16	19	20
MIL-NCE [27]	13.75	13.87	13.30	30.14	29.06	28.33	38.30	37.40	36.40	24	26	29
PVSE [32]	19.21	20.29	20.17	38.52	37.72	39.21	47.72	48.04	49.17	14	14	13
PCME [6]	20.08	20.65	20.14	39.36	39.72	39.91	48.12	48.56	49.03	14	14	13
Transformer [37]	29.06	28.69	29.41	51.15	50.77	51.61	59.83	59.71	60.57	5	5	5
Mean	28.73	28.01	28.77	50.22	49.11	50.24	58.80	58.64	59.39	5	6	5
MIL-SIM	29.42	30.59	30.23	52.07	49.82	51.44	60.51	61.73	62.58	4	4	5

inal CLIP model is trained end-to-end using 400 million image-and-text pairs. Due to the scale of the pretraining dataset, its representations have been demonstrated to be transferable to downstream tasks without further finetuning on the target datasets. During training, we finetune the projection layers of the CLIP encoders on the train split of our NewsStories dataset. We extend the max input text length in CLIP from 77 to 256 in our experiments. We set an initial learning rate of 1e-5 and optimize the model using the Adam [19] optimizer, with a linear warm-up of 20,000 steps. The learning rate is gradually annealed using a cosine learning rate scheduler. We tune the hyperparameter settings by averaging the validation performance over 5 splits of 1000 articles that are randomly selected from the entire training set. In the MIL-SIM objective, we use the NLTK [26] library to tokenize the articles into sentences and set the value of  $\lambda$  to 0.1.

#### 5.2 Evaluation Datasets and Metrics

We conduct an evaluation of article-to-image set retrieval on both our proposed NewsStories dataset and the GoodNews [4] dataset, which contains approximately 250K articles from the New York Times. For our evaluation on the GoodNews dataset, we create three different evaluation sets of 5000 articles

**Table 4.** Evaluation of retrieval models on article-to-image-set retrieval on the Good-News dataset, where the candidate image sets do not contain a fixed number of images

Method	Alignment Type	R@1	R@5	R@10	Median Rank
Pretrained CLIP [30]	Single	18.43	36.59	46.92	12
Single Image [30]	Single	17.14	33.77	43.56	17
MIL-NCE [27]	Single	15.50	28.96	37.60	24
PVSE	Single	18.57	37.70	47.78	12
PCME	Single	19.37	39.19	48.04	12
Mean	Multiple	21.30	41.56	51.66	9
Transformer	Multiple	20.30	40.88	49.24	11
MIL-SIM	Multiple	25.12	46.17	56.16	7

with 3, 4 and 5 images with no overlapping articles or images between the sets and evaluate on each separately. Note that compared to [35] which retrieves the ground-truth image from a set of five images, our evaluation setup is more challenging and arguably more realistic for real-world applications. We use two metrics: recall at top-K (R@1, R@5, R@10), where higher recall is better, and Median Rank of the correct sample, where lower is better.

#### 5.3 Quantitative results

NewsStories. Table 2 reports the Recall@K retrieval accuracies and median rank on the test split of our NewsStories dataset. In this setting, each image set has a fixed size of 5 images. As demonstrated by Radford et al.[30], the learnt representations of the pretrained CLIP model transfer effectively to the GoodNews dataset without further finetuning, obtaining a R@1 accuracy of 31.03%. We observe that approaches that align a single image with a text sequence generally perform worse than variants that learn an aggregation function over the images.

In contrast to the video variant of the MIL-NCE approach [27] which reports that aligning a video clip to multiple narrations leads to better performance on downstream tasks, applying such an approach on images and text that only have loose topical relationships does not work out-of-the-box. The retrieval accuracies obtained by MIL-NCE show that maximizing the similarity between the text representation and the most representative image in the set performs worse than training with single images. Despite using a simple average-pooling function, the mean images baseline outperforms the single image and MIL-NCE baselines significantly. This suggests that context between images is crucial.

Although transformers have been shown to be effective at reasoning about context, using an image transformer to compute contextual information across the images only improves 1% over the mean baseline. This indicates that the self-attention mechanism alone is insufficient to capture the complementary relations between related but visually different images. Last but not least, the significant improvements obtained by MIL-SIM over other alignment objectives highlight the importance of maximizing the alignment between an image and the most relevant segment in an article, despite not having access to the ground-truth pairings during training. We also provide results of an ablation study over the length of the input text sequence in the supplementary.



Fig. 3. Qualitative results showing the three top-ranked image sets per query on the test split of our NewsStories dataset. The ground-truth and incorrect image sets, as determined by the cluster labels, are outlined with green and red boxes, respectively

Zero-shot evaluation on GoodNews. Next, we compare the effectiveness of our finetuned models on the curated test splits of the GoodNews dataset without further finetuning. We verify that none of the images and articles are present in our NewsStories train split. Since GoodNews does not group articles into stories, the images in a set are obtained from the same article, instead of related articles as done in NewsStories. Similar to the evaluation results on our NewsStories dataset, Table 7 shows that the pretrained CLIP model already performs well on all 3 test splits of the GoodNews dataset, achieving an average of approximately 21% Recall@1 accuracy without any finetuning on the target dataset. Additionally, finetuning the CLIP model on NewsStories using the standard single image-and-text and MIL-NCE objectives actually leads to significant drops in performance from the pretrained CLIP model. These results suggest that learning a one-to-one correspondence is not optimal for allowing a model to reason about correspondences with multiple related images. This is corroborated by the observation that models trained to learn a one-to-one correspondences between images and text generally perform worse as the number of images increases. In contrast, we observe that training the models to align text with varying numbers of images helps them to generalize to sets of images better.

By finetuning the CLIP model on our dataset, the mean baseline shows significantly improved retrieval accuracies despite not observing any articles and images from the GoodNews dataset during training. The much improved performances obtained by the mean images and transformer approaches demonstrate the importance of understanding the complementary relationships between images even in this setting, where all ground-truth images originate from the same text narrative. Similar to the results in the first setting, the results of the best-performing MIL-SIM approach suggests that being able to learn a mapping between each image and specific parts of the text narrative is crucial during training for this research problem, even if the images and text are only weakly-related.

**Zero-shot with multiple set sizes on GoodNews.** Finally, we evaluate on images sets of variable size in Table 4, where the number of images in a set varies from 3 to 5. This requires a model to not only reason about the general semantic similarity between the query article and images but also determine if

the number of images in a given set provides enough complementary information to discriminate one story from another. To this end, we randomly select 1500 articles from each of the above-mentioned GoodNews evaluation sets to create an evaluation split with different number of images per set.

Despite the inherent noise in obtaining positive text and image pairs using unsupervised clustering, the results suggest that aligning text narratives with varying numbers of complementary images during training is beneficial for learning more robust representations. These learnt representations are better able to discriminate between articles with different number of images.

#### 5.4 Qualitative results

Figure 3 provides an example of correct and incorrect retrievals on the test split of our NewsStories dataset. For each query article, the top 3 retrieved images are displayed in row order from top to bottom. Interestingly, in Figure 3a, our mean image model is able to retrieve other set of images that are relevant to the notion of "fire", despite the fact that they belong to relatively different stories. Figure 3b shows a hard example since the other two retrieved image sets are related to the query article, with the exception of not containing the image of the easter eggs. We include more retrieval visualizations in the supplementary.

#### 5.5 Practical application of retrieving sets of images

While we formulate the evaluation of this research problem as an article-toimage-set retrieval task, it may be impractical to find suitable images that have already been grouped into sets. Hence, we present an algorithm to find individual candidate images before grouping them into sets and ranking them using our trained models. We refer interested readers to the supplementary for more details as well as visualizations of the retrieval results.

#### 6 Conclusion

In this work, we propose the important and challenging problem of illustrating stories with visual summarizes. This task entails learning many-to-many *illustrative* correspondences between relevant images and text. To study this problem in detail, we introduce a large-scale multimodal news dataset that contains over 31M news articles and 22M images. Finally, we benchmark the effectiveness of state-of-the-art image-and-text alignment approaches at learning the many-to-many correspondences between the two modalities and draw useful insights from our empirical results for future research in this direction.

Limitations and societal impact. Data and algorithms dealing with media can potentially be repurposed for misinformation. The selection of media channels in NewsStories reflects the judgment of an independent organization. Our models are trained on top of the CLIP model and may inherit its bias (if any).

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In this supplementary material, we provide the following:

- 1. Additional statistics of the images, articles and videos included in our NewsStories dataset.
- 2. Ablation experiments over the length of the input text sequence using the best-performing MIL-SIM model.
- An algorithm for generating suitable image sets to describe any text narrative or article.
- 4. Additional qualitative retrieval results on the test splits of the GoodNews dataset.

To begin, we compute and present histograms over the number of articles, images and videos that are present in the computed story clusters in Section A. Next, we conduct an ablation study in Section B over the length of the input text sequences in the MIL-SIM approach to determine the importance of using additional context for learning the correspondences between text narratives and groups of complementary images. In Section C, we describe an algorithm that an author may use to leverage the finetuned models to select a visually illustrative set of images for a given text narrative. Finally, we provide additional qualitative retrieval results of the MIL-SIM model on the test splits of the NewsStories and GoodNews datasets in Section D.

#### A Additional statistics of the NewsStories dataset

Article and images statistics. Figure 4 shows the histograms of the number of images and articles that are contained in each news story cluster. Note that we only show the first n bins that contain 95% of all images and articles for conciseness. As mentioned in the main paper, the number of articles per story cluster varies greatly across different clusters. Story clusters with unusually high numbers of articles are generally very noisy and tend to revolve around the theme of entertainment such as reality television updates or music videos. Additionally, a high percentage of story clusters contain between 1 and 20 images, where some of the images sourced from different media channels on the same story may be near-duplicates of each other. However, we note that such noise is prevalent in uncurated real-world data and being able to leverage these publicly available data to address the proposed research problem effectively remains an open question.

News videos statistics. We provide a histogram of the number of videos contained in each story cluster of our unfiltered NewsStories dataset in Figure 5. As corroborated by the data in Table 5, we observe that a large percentage of news story clusters do not contain any videos at all. Additionally, the number of videos in a news story cluster varies considerably, from a minimum of zero to a maximum of 4005 videos. However, with over 450K stories containing at least one corresponding video, our NewsStories dataset still provides a rich environment for learning to reason about multimodal correspondences between text, images, videos and audio.

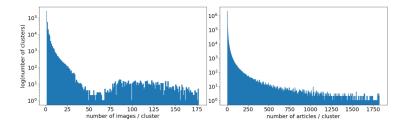


Fig. 4. Histogram of the number of images / articles that are contained in each news story cluster. For improved visualization, we show first n bins that capture 95% of total image / articles

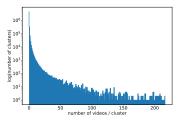


Fig. 5. Histogram of number of videos per story cluster.

#### B Input text length ablation

To evaluate the importance of the number of input word tokens in retrieving the most relevant image set, we conduct an ablation study over the length of the input text sequences for the best-performing MIL-SIM approach and report the results in Table 6. In our experiments, we use both article-level and sentence-level alignment objectives. In the former objective, we begin from the start of an article and limit the number of words to the desired lengths. Since the pretrained CLIP model accepts a maximum of 77 word tokens, we modify the original model by zero-padding the pretrained positional embeddings for the additional word positions and finetune the entire set of positional embeddings during training.

 Table 5. Video story cluster statistics

	Unfiltered	Filtered
Min. # videos in a cluster	0	0
Max. # videos in a cluster	4005	2255
Std. dev. # videos per cluster	4.22	6.79
Mode # videos per cluster	0	0
# clusters with $\geq 1$ video	451,228	81,957

**Table 6.** Ablation of our best-performing MIL-SIM approach over the length of the input text sequences for the MIL-SIM approach on the validation split of our NewsStories

Input Text		R@1			R@5			R@10		Μe	edian	Rank
Length	3	4	5	3	4	5	3	4	5	3	4	5
32	34.28	36.46	38.08	56.66	60.19	62.64	65.11	68.52	70.43	3	3	3
64	41.10	45.31	48.04	65.78	70.02	73.37	74.36	78.42	81.10	2	2	2
128	39.96	45.48	48.58	67.01	72.15	75.74	76.47	80.65	84.02	2	2	2
256	41.06	45.91	49.23	67.16	73.09	76.35	77.22	81.60	84.70	2	2	2
512	39.44	44.88	48.73	66.39	72.29	75.74	76.50	81.44	84.69	2	2	2

**Table 7.** Ablation of MIL-SIM over the length of input text sequences on zero-shot evaluations of article-to-image-set retrieval approaches on the GoodNews [4] dataset. Each test split has 3, 4, or 5 images in each article.

Input Text	R@1			R@5			R@10				Median Rank		
Length	3	4	5	3	4	5	3	4	5	3	4	5	
32	26.36	26.18	25.46	49.53	47.64	46.96	59.06	57.10	56.47	6	7	7	
64	27.73	27.82	27.13	50.87	50.19	49.85	61.29	59.16	59.02	5	6	7	
128	28.23	29.89	28.86	51.76	52.90	51.72	62.24	62.28	60.96	5	5	6	
256	29.42	30.59	30.23	52.07	49.82	51.44	60.51	61.73	62.58	4	4	5	
512	28.26	28.14	27.06	50.97	50.54	49.27	59.26	59.94	58.52	5	5	6	

In the latter objective, we split each article into sentences and limit the number of sentences by the selected number of words. In Table 7, we observe that using more input words generally helps to improve retrieval accuracy.

Interestingly, the best retrieval performance is obtained when 256 input word tokens are used. One possible reason is that there are more redundant sentences, which do not really contribute to the overall semantics of the story. The performance drop when 512 word tokens are used also suggests that a solution to this problem has to be able to better filter out non-salient sentences.

### C Algorithm for selecting multiple images for text narratives

More often than not, a journalist seeking to obtain suitable images to visually illustrate their article may not be able to find suitable images that have already been grouped into sets. With this in mind, we present a general algorithm below that allows an author to search for individual candidate images before grouping them and using our finetuned models to select the best set.

1: Given a text narrative, extract a set of named entities  $E = \{e_1, \dots, e_n\}$ 

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2: images \leftarrow set()
 3: for k in range(n) do
       look up a suitable image in an image database using e_k
 4:
       images.append(I_k) where I_k is the looked-up image
 5:
 6: end for
 7: Generate all possible combinations C of images of size X where X is the
   desired number of images
 8: max\_similarity \leftarrow \inf
 9: best set \leftarrow None
10: for k in range(C) do
       compute similarity between text representation and image set represen-
   tations score
12:
       if score > max\_similarity then
           max\_similarity = score
13:
           best set \leftarrow C_k
14:
       end if
15:
16: end for
17: return best set
```

#### D Retrieval results using the image search algorithm

We present visual examples of the top-ranked image sets for randomly selected articles from the GoodNews dataset using the proposed image set search algorithm and the finetuned MIL-SIM model. For each detected named entity in an article, we search for suitable images using Google Search and select the top 5 results as candidates images. To provide a basis of comparison, we put ourselves in the shoes of a journalist and create image sets for the selected articles using a naive approach. Specifically, we randomly select 5 named entities present in each article and select the top-ranked image returned by the Google Search API for each named entity. While this is a simplistic alternative approach, it can be easily adopted by any journalist without considering one's aesthetic preferences. Compared to these randomly selected image sets, the image sets selected by the MIL-SIM model appear to be more visually descriptive. It is possible that the image sets may be more diverse if a user increases the number of candidate images for each query named entity. However, there is a trade-off between increasing the diversity of the image sets and inference time since the time required to compute the combinations of images increases significantly with more candidate images.

Finally, we conduct a qualitative analysis of the correspondences between individual images in a set and specific sentences in an article. Recall that the MIL-SIM approach relies on the assumption that each image should be related to at least one sentence in an article, even if their relationship is loose and illustrative at best rather than literal. We compute the similarity scores between each sentence in an article and the image set selected by the MIL-SIM model. Each image and its best matching sentence are outlined and highlighted in the same color.

#### FedEx's Price Rise Is a Blessing in Disguise for Amazon

No. 1 on the list of chores the Internet has done away with: dragging yourself to the store to stock up on unwieldy items and carting them home. Many e-commerce companies -- led by Amazon.com and the sites it owns, like Diapers.com and Soap.com -- have made it easy to order even items like toilet paper and diapers without paying a cent for shipping. So when FedEx announced last week that it would change its shipping prices to charge for the space a package occupies in a truck, not just its weight, many analysts suggested that Amazon would be the biggest victim. Shipping costs already eat into its slim profits, and as any Internet shopper knows, Amazon has a habit of mailing items from a single order in multiple oversize boxes, often with free two-day shipping. But FedEx needs Amazon more than Amazon needs FedEx ...

#### MIL-SIM retrieved image set:



Fig. 6. Example of retrieved image sets given a query article using our algorithm.

#### FedEx's Price Rise Is a Blessing in Disguise for Amazon

No. 1 on the list of chores the Internet has done away with: dragging yourself to the store to stock up on unwieldy items and carting them home. Many e-commerce companies – led by Amazon.com and the sites it owns, like Diapers.com and Soap.com – have made it easy to order even items like toilet paper and diapers without paying a cent for shipping. So when FedEx announced last week that it would change its shipping prices to charge for the space a package occupies in a truck, not just its weight, many analysts suggested that Amazon would be the biggest victim. Shipping costs already eat into its slim profits, and as any Internet shopper knows, Amazon has a habit of mailing items from a single order in multiple oversize boxes, often with free two-day shipping. But FedEx needs Amazon more than Amazon needs FedEx. Instead, FedEx's price increase – which happens in January and which analysts say U.P.S. is likely to match — could further cement Amazon's power over retailing by striking a bigger blow to small Internet retailers, the same ones that are already losing the battle with Amazon.



Fig. 7. Example of the most relevant sentences for each image in the top-ranked image set, as determined by the MIL-SIM model.

#### Rebuilt Iraq Mosque Buoys Spirits, but New Sectarian Splits Loom

"The plan for improving the shrine is to tear down everything around it," said Mohammed al-Mashqor, a member of Iraq's Parliament who sits on a committee that deals with religious affairs and holy sites. "It will be a great entertainment and tourism area." Some of the area's Sunni residents see their patrimony at risk. They say the Shiite Endowment, an Iraqi council that oversees the country's Shiite shrines, has been making generous offers to buy out homeowners, with the aim of taking control of the old city. "What's happening now is a challenge to the people," said the head of Samarra's city council, Omar Mohammed Hassan. "If they take this area, the economy of Samarra will die. I think Samarra will explode one day in protests after suffering for so long." Officials from Unesco, which designated Samarra as one of three World Heritage Sites in Iraq, said they were trying to negotiate an accord between the central government ...

MIL-SIM retrieved image set:



Fig. 8. Example of retrieved image sets given a query article using our algorithm.

## Rebuilt Iraq Mosque Buoys Spirits, but New Sectarian Splits Loom "The plan for improving the shrine is to tear down everything around it," said Mohammed al-Mashqor, a member of Iraq's Parliament who sits on a committee that deals with religious affairs and holy sites, "It will be a great entertainment and tourism area." Some of the area's Sunni residents see their patrimony at risk. They say the Shitte Endowment, an Iraqi council that oversees the country's Shitte shrines, has been making generous offers to buy out homeowners, with the aim of taking control of the old city." What's happening now is a challenge to the people, "said the head of Samarra's city council, Omar Mohammed Hassan." If they take this area, the economy of Samarra will die. I think Samarra will explode one day in protests after suffering for so long." Officials from Unesco, which designated Samarra as one of three World Heritage Sites in Iraq, said they were trying to negotiate an accord between the central government and provincial officials to balance preservation against development. IM: Mashqor, the member of Parliament, said that the Shitte Endowment planned to spend the next three years buying houses ...











Fig. 9. Example of the most relevant sentences for each image in the top-ranked image set, as determined by the MIL-SIM model.

#### Cyprus: Why One of the World's Most Intractable Conflicts Continues

LONDON -- It is home to the longest-serving peacekeeping mission in United Nations history. It has been called a diplomatic graveyard, having frustrated generations of negotiators. It has been compared -- in complexity and duration, not bloodshed -- to the Israeli-Palestinian conflict. Cyprus has effectively been partitioned since 1974, its Greek and Turkish communities -- and its capital, Nicosia -- separated by a buffer zone known as the Green Line. But unlike most conflict zones, Cyprus is more or less at peace, and a popular tourist destination. Hundreds of thousands of people have crossed the line since travel restrictions were eased in 2003. The following year, the country joined the European Union. So why has the conflict defied so many efforts at resolution? The answer has as much to do with domestic politics on both sides of the island as with pressures from Turkey and Greece as well as Britain, the colonial-era ruler of Cyprus, James Ker-Lindsay, a scholar at the London School of Economics ...

MIL-SIM retrieved image set:



Fig. 10. Example of retrieved image sets given a query article using our algorithm.

#### Cyprus: Why One of the World's Most Intractable Conflicts Continues

LONDON — It is home to the longest-serving peacekeeping mission in United Nations history. It has been called a diplomatic graveyard, having frustrated generations of negotiators. It has been compared — in complexity and duration, not bloodshed — to the Israeli-Palestinian conflict. Cyprus has effectively been partitioned since 1974, its Greek and Turkish communities — and its capital, Nicosia — separated by a buffer zone known as the Green Line. But unlike most conflict zones, Cyprus is more or less at peace, and a popular tourist destination. Hundreds of thousands of people have crossed the line since travel restrictions were eased in 2003. The following year, the country joined the European Union. So why has the conflict defied so many efforts at resolution? The answer has as much to do with domestic politics on both sides of the island as with pressures from Turkey and Greece as well as Britain, the colonial-era ruler of Cyprus, James Ker-Lindsay, a scholar at the London School of Economics and the author of several books on the Cyprus conflict, said in a phone interview. On Monday, the Greek Cypriot leader, Micos Anastsaidees, and the Turkish Cypriot leader, Mustafa Akinci, began five days of talks brokered by the United Nations at Mont Pèlerin, a Swiss resort ...











Fig. 11. Example of the most relevant sentences for each image in the top-ranked image set, as determined by the MIL-SIM model.

#### Leslie Modlin, Frederick Bartholomew

Leslie Ann Modlin and Frederick Benjamin Bartholomew are to be married Sunday evening by the Rev. Robin Renteria, a Unitarian Universalist minister, at the Fearrington Inn in Pittsboro, N.C. The couple, both 27, met at Duke, from which they graduated. They are medical students at Stanford, she in her third year, he in his fourth. Next month, the groom is to begin an M.B.A. program there. The bride is a daughter of Barbara T. Modlin and Jeffrey L. Modlin, who live and work in Lake Forest, Ill. Her father is an independent investment manager; her mother is a mortgage banker for JPMorgan Chase. The groom is a son of Randi S. Bartholomew and Frederick R. Bartholomew of Lakewood Ranch, Fla. His father is an operations director at Gettel Automotive Management, a group of car dealerships in Bradenton, Fla. The groom is the namesake of his paternal grandfather, the late Freddie Bartholomew, who as a child actor starred in films such as "David Copperfield" (1935), "Little Lord Fauntleroy" (1936) ...

MIL-SIM retrieved image set:



Fig. 12. Example of retrieved image sets given a query article using our algorithm.

#### Leslie Modlin, Frederick Bartholomew

Leslie Ann Modlin and Frederick Benjamin Bartholomew are to be married Sunday evening by the Rev. Robin Renteria, a Unitarian Universalist minister, at the Fearrington Inn in Pittsboro, N.C. The couple, both 27, met at Duke, from which they graduated. They are melical students at Stanford, she in her third year, he in his fourth, Next month, the groom is to begin an M.B.A. program there. The bride is a daughter of Barbara T. Modlin and Jeffrey L. Modlin, who live and work in Lake Forest, III. Her father is an independent investment manager, her mother is a mortgage banker for JPMorgan Chase. The groom is a son of Randi S. Bartholomew and Frederick R. Bartholomew of Lakewood Ranch, Fla. His father is an operations director at Gettel Automotive Management, a group of car dealerships in Bradenton, Fla. The groom is the namesake of his paternal grandfather, the late Freddie Bartholomew, who as a child actor starred in films such as "David Copperfield" (1935), "Little Lord Fauntleroy" (1936) and "Captains Courageous" (1937).



Fig. 13. Example of the most relevant sentences for each image in the top-ranked image set, as determined by the MIL-SIM model.

#### Jameis Winston Suspended for First Half of Florida State-Clemson Game

Florida State said Wednesday that quarterback Jameis Winston, last season's Heisman Trophy winner, would be suspended for the first half of the top-ranked Seminoles' home game Saturday against No. 22 Clemson after he shouted an obscene statement in the student union Tuesday. "As a result of his comments yesterday, which were offensive and vulgar, Jameis Winston will undergo internal discipline and will be withheld from competition for the first half of the Clemson game," Florida State's interim president, Garnett S. Stokes, and Athletic Director Stan Wilcox said in a joint statement. The university declined to comment further. At a news conference Wednesday, just after the suspension was issued, Winston said he wanted to apologize "to the university, to my coaches and to my teammates" and called his behavior "selfish." "I did something," he said, "so I've got to accept my consequences." He added, "We're going to think about moving forward and winning the game." ...



Fig. 14. Example of retrieved image sets given a query article using our algorithm.

# Jameis Winston Suspended for First Half of Florida State-Clemson Game Florida State said Wednesday that quarterback Jameis Winston, last season's Heisman Trophy winner, would be suspended for the first half of the top-ranked Seminoles' home game Saturday against No. 22 Clemson after he shouted an obscene statement in the student union Tuesday. 'Rs a result of his comments yesterday, which were offensive and vulgar, Jameis Winston will undergo internal discipline and will be withheld from competition for the first half of the Clemson game," Florida State's interim president, Garnett S. Stokes, and Athletic Director Stan Wilcox said in a joint statement. The university declined to comment further. At a news conference Wednesday, just after the suspension was issued, Winston said he wanted to apologize "to the university, to my coaches and to my teammates" and called his behavior "selfish." "I did something," he said, "so I've got to accept my consequences." He added, "We're going to think about moving forward and winning the game." It is the latest episode involving Winston, who was accused in late 2012 of raping a fellow student. Prosecutors declined to file charges in that case.



Fig. 15. Example of the most relevant sentences for each image in the top-ranked image set, as determined by the MIL-SIM model.

#### Image set retrievals for articles

#### D.1 Additional qualitative retrieval results

In this section, we provide additional qualitative retrieval results obtained by our best-performing MIL-SIM approach on our test splits of the NewsStories and GoodNews datasets. For each query article, we show the ground-truth set of corresponding images as well as the top five retrieved image sets. In the visualizations, we also provide the corresponding article titles that correspond to the retrieved image sets. The ground-truth and incorrect image sets are also outlined in green and red boxes, respectively. The retrieved image sets for a query article are ordered from top to bottom.

Query article: "NEW YORK (Thomson Reuters Foundation) - Climate campaigners unveiled a huge countdown clock on Saturday, showing how little time is left before global temperatures hit a critical high, to kick off a week of climate action in New York. The digital installation shows seven years and 102 days remain before average global temperatures, at current emission rates, reach 1.5 degrees Celsius above pre-industrial levels. There's good news. That number isn't zero, said Gan Golan, an artist and activist who co-created the display. We can meet this challenge, but we don't have any time to lose, he told the Thomson Reuters Foundation.

The United Nations has warned of huge global changes, such as the loss of coral reefs and Arctic sea ice, if the 1.5 degree threshold is crossed. Countries in the 2015 Paris Agreement agreed on measures to limit emissions to stay below the critical temperature mark. The clock's installation will take over what is known as the Metronome, where 15 spinning LED digits tell the time of day and the time remaining in a day, down to a hundredth of a second..."

#### **Ground-truth images:**





"Spinning clock in New York counts down time until climate devastation ..."



"Artes Mundi 9 review wide-ranging show dominated by one devastating work " ories dataset.



"Van Gogh spectacle aims to move New Yorkers "



"Scientific American announces it is replacing term 'climate change' with 'climate emergency' "









one-third of heat deaths blamed on climate change"

Query article: "The hedge fund that staged a revolt at Exxon last month is now recruiting an army of mom-and-pop investors for future battles. Every week, our lead climate reporter brings you the big ideas, expert analysis, and vital guidance that will help you flourish on a changing planet. Sign up to get The Weekly Planet, our guide to living through climate change, in your inbox. Last month, a tiny hedge fund called Engine No. 1 staged a coup of sorts at ExxonMobila shareholders' revolt that unseated three members of the oil company's board of directors and replaced them with more climate-concerned candidates. The putsch was the first centered on climate change at an American oil company. Now the financial group is ready to recruit ordinary investors people with 401(k)s, Robinhooders, the macro prudentially curious into its army. Tomorrow it is launching an exchange-traded fund, or ETF, that will track the performance of the 500 largest public companies in America, the firm told The Atlantic. The new Engine No. 1 Transition 500 Fund is, in other words, a low-fee, diversified index fund of the type that now dominates the American stock market. ..."

#### **Ground-truth images:**











#### Retrieved images:











"A Climate-Focused Index Fund Will Fight Skeptical CEOs"























" Billionaire Xavier Niel's French Victory at Westfield Has a Snag"











"Somalia's Jubbaland region rejects national president's inclusion in election talks"











"Rising oil price will draw response from consumers: Kemp" Query article: "Former President Barack Obama announced Saturday that the family's dog Bo, who lived with the Obamas while they were in the White House, passed away. "Today our family lost a true friend and loyal companion. For more than a decade, Bo was a constant, gentle presence in our liveshappy to see us on our good days, our bad days, and everyday in between," Obama wrote on Twitter, along with a photo of him running alongside the Portuguese water dog. Bo joined the Obama family in April 2009. He was a gift from the late Sen. Edward M. Kennedy, D-Mass., a key supporter of Obama's 2008 presidential campaign who became close to the family. Bo helped Obama keep a promise to daughters Malia and Sasha that they could get a dog after the election. BIDENS BRINGING CAT INTO WHITE HOUSE The Obamas also adopted another Portuguese water dog while they were in the White House, Sunny. The first pets were highly popular in the Obama White House and even had their own schedules along with the rest of the family. "Everybody wants to see them and take pictures," Michelle Obama said in 2016. "I get a memo at the beginning of the month with a request for their schedules, and I have to approve their appearances." ..."

#### **Ground-truth images:**











#### Retrieved images:











"Obamas Mourn Death Of 'True Friend,' Beloved 'First Dog' Bo"











"'This isn't a game': Michelle Obama urges Republicans to honor election results"













"Obama sold record-breaking 1.7 million copies of memoir in first week"























"Obama on Merkel, Putin and other leaders in 'A Promised Land'" Query article: "A recent Gallup poll shows 62% of Americans believe transgender athletes should only compete on sports teams of the sex they were assigned at birth The study also found that a majority of Americans support transgender individuals serving in the military, but support has waned since 2019 Those who knew someone who is transgender were more likely to support transgender athletes and military members The percentage of Democrats and liberals who support these movements was also higher than the percentage of support from Republicans and conservatives The survey comes as eight states have already passed a ban on transgender athletes playing on the team of the gender they identify with Only a third of Americans believe transgender athletes should be allowed to compete on teams that don't match the sex they were assigned at birth, a new poll found. Advertisement Gallup's annual Values and Beliefs survey conducted May 3 - 18 by telephone interviews with 1,016 randomly selected adults living in the US showed that 62 percent said transgender athletes should only be allowed to play on sports teams that correspond with the sex they were assigned at birth, while 34 percent said they should be allowed to play on teams that match their gender identity ..."

#### **Ground-truth images:**











#### Retrieved images:











"Mixed Views Among Americans on Transgender Issues"









"'GOP seizes on women's sports as unlikely wedge issue"



































"Transgender sports debate heads to the Louisiana House floor " Query article: "Wendy's Co. may not give permission for Flynn Restaurant Group to become a franchisee of the Frosty seller, creating a potential roadblock for a \$816 million bankruptcy sale, a lawyer for the chain said in court Friday. Flynn, the largest eatery franchisee in the US, was approved Friday as the so-called stalking horse bidder to buy about 1,300 Pizza Hut and Wendy's restaurants from bankrupt restaurant operator NPC International Inc. We are not hopeful that we can grant consent to Flynn, lawyer Sean O'Neal of law firm Cleary Gottlieb Steen & Hamilton said on behalf of Wendy's. The burger chain hasn't consented to Flynn buying the 394 locations in part because Flynn operates hundreds of competing restaurants including Arby's Restaurant Group Inc. and Panera Bread Co. locations. Wendy's and Pizza Hut have both asked for the right to vet potential franchisees in the bankruptcy sale. O'Neal said Wendy's and Flynn are in talks about the issue and Wendy's would give an answer by Thursday. He added that regional Wendy's franchisees are forming a consortium that could make a competing bid for the locations. Wendy's is trying to put together a competing bid, NPC lawyer Ray Schrock of law firm Weil Gotshal & Manges said in court ..."

#### **Ground-truth images:**











#### Retrieved images:











"Wendy's May Withhold Franchise Permission From Flynn in NPC Sale"





















"Chipotle Increases Wages Resulting In \$15 Per Hour Average Wage And Provides Path To Six Figure Compensation In ~3 Years"











"Americans hungry for Burger King, sales improve in Q1"











"Black franchisee files racial discrimination lawsuit against McDonald's" Query article: "President Tayyip Erdogan said on Friday he had reminded China's foreign minister during talks in Ankara on Thursday that Turkey expects to receive 50 million doses of COVID-19 vaccines from Sinovac Biotech (SVA.O) as per a deal between the two countries. Turkey has until now been using COVID-19 vaccines developed by Sinovac, received as part of an agreement to procure a total of 100 million doses, and has administered 14.6 million shots, with 8.2 million people having received a first dose, since Jan. 14 when the nationwide rollout began. On Thursday, Turkey said it has begun initial talks to procure Russia's Sputnik-V shot. read more Erdogan told reporters in Istanbul after Friday prayers that he had told Chinese Foreign Minister Wang Yi that Turkey had not received the 50 million doses by the end of February as pledged in the agreement and was therefore expecting them. He said Wang told him he would bring the issue up with China's president. Our Standards: The Thomson Reuters Trust Principles. ..."

#### **Ground-truth images:**











#### Retrieved images:











"A mobster's allegations rock Turkey's government"











"Turkish delegation to visit Egypt as Ankara seeks to repair ties "













Turkey records 44756 new coronavirus cases, highest level yet"











Erdogan says he reminded Chinese minister that Turkey expects 50 mln doses of COVID-19 vaccines "











"Biden, Erdogan upbeat about ties but disclose no breakthrough"

Query article: "BARCELONA, Spain (AP) Barcelona said Tuesday it reached a deal to sign defender Eric Garcia, bringing the 20-year-old defender home after he left the club in 2017 to join Manchester City. Barcelona said Garcia's five-year contract will begin July 1 after his City deal expires. A buyout clause in his contract is set at 400 million euros (\$490 million). Garcia joins Sergio Agero in leaving City days after losing the Champions at 400 million euros (\$490 million), Gat Cid Jonis Sergio Agerto in leaving City days are nosing the Champons League final to join financially troubled Barcelona as free agents without a transfer fee. Garcia will first join up with Spain's squad for the European Championship. He is a regular member of the national squad despite not establishing himself in coach Pep Guardiola's City team. Accomplished on the ball, Garcia seemed to struggled to adapt to the typically physical side of playing in the Premier League. Garcia's career path follows one of his mentors at Barcelona, veteran defender Gerard Piqu. Piqu left Barcelona as a teenager for Manchester United and returned four years later at the start of the Catalan club's dominating era under Guardiola. ..."

#### **Ground-truth images:**











#### Retrieved images:















"Barcelona 'want to SELL Samuel Umtiti with AC Milai



















































"FC Barcelona Versus Dynamo Kiev Champions League"

Query article: "CARACAS, May 10 (Reuters) - Venezuela's main academy of medicine has asked the United States to add the South American nation to its international donor list for millions of doses of COVID-19 vaccines, despite a political freeze between the two countries. Enrique Lopez-Loyo, president of the politically independent National Academy of Medicine, made the request to US Ambassador to Venezuela James Story at a meeting on May 2, the academy said in a statement on Monday. "To control the pandemic in our country, we need to vaccinate around 70% of the adult population, nearly 15 million people, in as little time as possible," the academy said in the statement. "The amount of vaccines that have arrived to Venezuela ... represents less than 10%. of what Venezuela needs." Venezuela has received around 1.4 million vaccines from China and Russia, according to the Health Ministry, and hopes to receive doses for about 5 million people from the World Health Organization's (WHO) COVAX program. The academy is a member of the Venezuelan government's round table developing a response to the coronavirus crisis for its 30 million people. The academy's plea, however, for US supplies of AstraZeneca PLC (AZN.L) vaccines runs contrary to the government's refusal in March to authorize the vaccine because of reports of blood clotting in some recipients. ...."

#### **Ground-truth images:**











#### Retrieved images:











"You May Not Speak if You Use an 'Aggressive Tone'"











"WaPo under fire for 'pseudoreligious' video urging "

wsStories dataset.











"Opinion: Believe in conspiracy theories? How about these, instead?"











"The Miseducation of America's Elites "











"Diversity Is An Outcome"

Query article: "Regardless of industry, job hunting remains a competitive process. Potential employees often look for out-of-the-box ways to distinguish themselves from other candidates; however, they still need to remain true to themselves and demonstrate their value to the prospective employer. Below, 15 members of Forbes Human Resources Council share their tips for applicants looking to stand out to a company during the interview process. Follow their advice the next time you're applying for a competitive job. 1. Be Your Authentic Self I believe that the way you will stand out to organizations is by being your most authentic self. Don't be afraid to bring your ideas forward and to question or challenge the status quo in the most respectful way. Organizations need your uniqueness; you add value by showing what makes you different! Don't be afraid to show how you can help them achieve their goals and reach new audiences and cultures. - Darlene Slaughter, March of Dimes 2. Personalize Your Introductions Personalize your introductions. I am always impressed when a candidate looks for an opportunity to customize their introduction through due diligence on the hiring manager, the company's mission, values or social media posts anything beyond the standard cover letter ..."

### **Ground-truth images:**











Retrieved images:







"Managers, Here Are 4 Way You Can Create Better One-On-Ones With Your Employees"







"Four Tips For Matching Your Sales Style With A Prospect's Personality"

wsStories dataset.











"15 HR Experts Explain How Job Applicants Can Stand Out"











"How To Register Your Premium Domain Name "











"Why Healthy Competition Is Key To Cultivating Happiness At Work" Query article: "MEXICO CITY, Jan 16 (Reuters) - Mexico has registered its worst week yet of the pandemic, with a record number of infections from the new coronavirus and more than 7,000 COVID-19 deaths, government data showed on Saturday. There were 20,523 new coronavirus cases and 1,219 more fatalities on Saturday, pushing total confirmed infections to 1,630,258 and deaths to 140,241, the Health Ministry said. For the week ending Saturday, Mexico recorded more than 7,000 deaths for the first time, while posting over 106,200 new cases. Mexico's real number of infected people and deaths is likely significantly higher than the official count, the government has said, because of a lack of widespread testing ..."

# **Ground-truth images:**











### Retrieved images:











"Mexico's death toll from COVID-19 set to pass grim milestone of 150,000"











"Spain's health minister to resign as COVID-19 cases hit new daily high "











"One of the nations hardesthit by COVID-19, Chile now outpaces most of the world in vaccinations"











"Mexico records deadliest coronavirus week yet with 7000 deaths "











"Pharma firm in India to make Russia's Sputnik V COVID-19 vaccine" <u>**Query article:**</u> "KANDEL, Germany -- It happened between neatly stacked rows of shampoo and organic baby food: A teenage boy walked up to his ex-girlfriend in the local drugstore, pulled out a kitchen knife with an eight-inch blade and stabbed her in the heart.

The death in Kandel, in southwestern Germany, on Dec. 27 has traumatized this sleepy town of barely 10,000 inhabitants, not just because both the suspect and the victim were only 15 years old and went to the local school, but also because the boy is an Afghan migrant and the girl was German. From the moment Germany opened its doors to more than a million migrants two years ago, prominent episodes like the Berlin Christmas market attack and the New Year's molestation and rapes in Cologne have stoked German insecurities. From the moment Germany opened its doors to more than a million migrants two years ago, prominent episodes like the Berlin Christmas market attack and the New Year's molestation and rapes in Cologne have stoked German insecurities ..."

## **Ground-truth images:**





















"A Girl's Killing Puts Germany's Migration Policy on Trial ..."











"Europäisch werden ... "

























For Some, the Slopes. For Her, the Cheese.











Tracing Jewish History Along the Rhine

<u>Query article</u>: "I call it organic because I didn't even ask for it," Mr. Halvorson said, after the primary's surprise. "Some of Halvorson's own voters may abandon him, because they can't stomach voting for a Democrat," said David Wasserman, who tracks House races for the nonpartisan Cook Political Report. "But he'll win some Democrats, who don't know he's a Tea Party candidate."

A defense lawyer, Joseph D. Morrissey, 59, lost his law license for most of the 2000s after a series of reprimands and suspensions over ethics and conduct issues. And in 2014, Mr. Morrissey was sentenced to jail time -- he spent nights there for three months -- after having a sexual relationship with a teenager employed in his law office. The woman, now 20, became his wife. Mr. Morrissey, a former Virginia state lawmaker, is running for mayor of Richmond. He has been able to draw from a strong base of support among black and working-class voters, driven by his charisma and familiarity, and is a top contender in a crowded field

## **Ground-truth images:**











## Retrieved images:











"The Drama Down the Ballot: 2016's Other Wild Races ..."













" Big Names in New York Real Estate Figure Into Skelos and Silver Cases ... "























Footsteps to Follow in the Coming Year  $\underline{\textbf{Ouery article}}\text{: "IThe woods this fall, these books imply, will be crawling with iPad-owning, J. Crew-wearing Natty Bumppos. Be prepared to duck.}$ 

Typical among them is Lily Raff McCaulou, the author of "Call of the Mild: Learning to Hunt My Own Dinner" (Grand Central). When she was in her mid-20s, her book explains, she lived in New York City and worked as a personal assistant to a movie director. She grew tired of urban life. Like a character in a Diane Keaton film she moved to rural Oregon. Ms. McCaulou had never hunted. Once in Oregon, she says, and wanting to feel more connectioned to her meals and to the land, she purchased a Benelli Nova pump-action shotgun in the youth size for \$419. She took a hunting safety course. She began shooting larger and larger game. "Elk guts," one hunter tells her, "are the real test." Her friends and "hippie, blue-state parents" were dumbfounded. "Won't you be the darling of the right wing?" her father says. To her, it was "a bizarre version of coming out."

## **Ground-truth images:**











Retrieved images:











"A New Breed of Hunter Shoots, Eats and Tells ..."





































After a Homecoming, a Son Finds His Muse











An Artist Explores the Lives of Girls Labeled Difficult

Query article: ""In my house, growing up in Piedmont, West Virginia, we collected Mother Goose and Joel Chandler Harris," he said. "My father used to tell Brer Rabbit stories to my brother and me all the time." These conversations led to "a much deeper understanding of the larger stakes in the project," Ms. Tatar said. Like the history of America, the history of folklore is messy and complicated. In the late 19th century and early 20th century, African-Americans debated whether these folk tales were worth preserving. Some people considered the stories remnants of slavery rather than evidence of ingenuity.

The novelist Toni Morrison, however, has played an important role in validating these stories by integrating them into her writing, Ms. Tatar said." While Ms. Morrison's novels contain traces of innovative uses of folklore, "Tar Baby" is the most obvious and the one Mr. Gates was particularly eager to include in this collection. Not only is it one of his favorite stories but he also finds the appearance of the tar baby in many cultures "haunting." ...

## **Ground-truth images:**











## Retrieved images:











"From Two Scholars, African-American Folk Tales for the Next Generation ..."

























" How the Author of 'Madeline' Created His Most Famous Character ... "























"American Indian Narratives in Picture Form ..." Query article: "Virginia Lee, a senior research analyst at Euromonitor International, a market research company in London, said the company's tracking of the category "other facial makeup," which includes face primers, jumped 73 percent from 2006 to 2011, with sales in the United States going to \$46.6 million, from \$26.9 million. And primers (or correctors, as they are sometimes called) are regularly discussed, rated and traded on review sites like makeupalley.com.

"Since face primers have been a success and have been endorsed by beauty editors, makeup companies are taking advantage and coming up with niche ones for the face and also going beyond the facial category," Ms. Lee said. Indeed. Smashbox has developed primers for the lid, under the eyes and the lashes, and is introducing one for the lips in 2013, according to the company. Urban Decay and MAC each offer eye, lip and lash primers that claim to help eye shadow, lipstick and mascara last longer after application. According to Nick Gavrelis, the vice president for global product development for MAC, the company's primer ..."

## **Ground-truth images:**





















"A Primer on Primers ..."











"How to Get the Bright, Matte Lips From the Runways ... "











" A Guide for Those Lost in the Aisles ... "











"Molly Ringwald Shares Her Beauty Routine, and Likes Her Freckles ..."











"Someone Just Like Me Said, 'Buy It' …"

Query article: "Ms. Faigenbaum and Mr. Griffiths met through friends last year, and in the fall decided to find a place of their own. "Amie comes along and ruins my plan, and I have to move out of the city," Mr. Griffiths said. "I wasn't ready for the suburban thing, and she wasn't able to move to Manhattan" because of her job in New Jersey. So they decided to meet in the middle, hunting in and around Hoboken, N.J.

The couple wanted a one-bedroom with a washer-dryer and a parking spot. When Ms. Faigenbaum drove into the city to visit Mr. Griffiths, she scheduled her trips around street parking, which was prohibited until 7 p.m. They planned to adopt a dog, so they looked only at dog-friendly buildings. "When I lived in the city I was never home enough, because why stay home?" Mr. Griffiths said. But in New Jersey, "I knew we would be able to care for a dog better." The couple intended to keep their rent, including parking costs, below \$2,500 a month. ..."

## **Ground-truth images:**











## Retrieved images:









"A Bed-Stuy Rental via FaceTime ..."

























" Bargains With a 'But' ... "











"What Pet Owners Must Do to Get New York Apartments ..."











"Warm Nights, Cold Noses ..." Query article: "Seau had wanted his daughter, Sydney, to give the speech introducing him if he were ever enshrined in the Hall. But a rule enacted in 2010 ended the practice of letting relatives or close associates speak because, a Hall spokesman said last week, their remarks often repeated what was said in the videos highlighting the inductees' careers. After his death, Seau was found to have a traumatic brain injury that doctors believe was brought on by hits to his head. His family later filed a lawsuit against the N.F.L.

Sydney Seau said last week that it was "painful" knowing that she could not speak for her father and that she had no intention of using her speech, were she able to make one, as a platform to discuss the lawsuit or his death. The policy of the football Hall -- which will welcome seven new members in addition to Junior Seau -- differs from the open door to family members at the baseball and hockey Halls. The Naismith Memorial Basketball Hall of Fame once permitted relatives to speak for dead inductees but switched in 2012 to allow family members to deliver videotaped messages shown at the annual ceremony in Springfield, Mass. ..."

## **Ground-truth images:**





















"The One-Day Contract, a Last Hurrah for Athletes ..."











"JJunior Seau's Family Silenced by a Policy Not Found at Other as∉talls of Fame... "











" From Undrafted to Unforgettable in the N.F.L. ... "











"For Matthews Clan, N.F.L. Is All in the Family ..."











"In N.F.L. Locker Rooms, Reflecting on the Turmoil..."

Query article: "Name-brand programs can excite existing fan bases, reduce marketing costs and appeal to an increasingly important international market. (The French, it turns out, are big fans of "Prison Break," Mr. Madden said.) But there are no guarantees. Fox's revival of "The X-Files" was among this season's best-rated new shows, but the network canceled "Minority Report," based on the Tom Cruise sci-fi movie, after dismal ratings. ABC is axing its revival of "The Muppets," and on Monday, CBS said it was canceling the low-rated "Rush Hour."

"It is irresistible in a world that has 60 or 80 makers of original programming to have something that has pre-existing awareness," said Mr. Nevins of Showtime. "Still, at the end of the day, it's going to rise and fall based on its quality." And not all revivals are created equal. Mr. Nevins said he pursued a new "Twin Peaks" only because Mr. Lynch agreed to participate. ("We've persuaded the original creators to complete their mission," he said.) David Duchovny and Gillian Anderson signed on for "The X-Files," ..."

## **Ground-truth images:**





















"Times Critics' Guide: What to Do This Week

























"In Hollywood, a Year of Mining the Past for Box-Office











"Matthew Weiner, the Creator of Mad Men, Prepares for Another Fade to Black











"South by Southwest: 5 Titles to Watch For

Query article: "And she did not come sweeping into power at SAG-Aftra, which represents roughly 160,000 actors, broadcasters and voice-over artists. She was named union president after the elected one, Ken Howard, died in the middle of his term. Most studios figured that Ms. Carteris would leave the sluggish union on cruise control. But that view is changing. In August, Ms. Carteris proved herself an effective advocate for age-discrimination legislation, since signed into California law, which forces Hollywood databases like IMDb to remove birthdays upon request. Then, this month, her union pulled the trigger on a long-authorized strike against 11 video game makers, including Electronic Arts, Activision and Warner Bros., in a pay dispute.

"Hey, hey -- shut it down!" she yelled last week through a bullhorn outside Electronic Arts' offices in Playa del Rey. "L.A. is a union town!" As strikes go, it's a baby one. Only about 5,000 performers who record game dialogue (and groans and other gruesome sounds humans make when hit by bullets) are affected. ..."

## **Ground-truth images:**





















"California Today: A Final State of the State From Jerry Brown ..."





















" How Sumner Redstone Went From Army Cryptographer to Media Mogul ... "











"Oscar 2017 Nominees React ..."











"An Indie Champion and His Life's Labors ..."

Query article: "The Miller archive, comprising 322 linear feet of material, is certainly a rich one. It documents the whole of his public career, including the development of classic plays like "Death of a Salesman" and "The Crucible" and his showdown with the House Un-American Activities Committee and advocacy against censorship arround the world. There is also intensely personal material, including early family letters and drafts of an essay about the death of Marilyn Monroe, Miller's second wife, begun the day of her funeral and revised over many years but never published. But the richest vein may be the journals, which span more than 70 years, often mixing fragments of works in progress with intimately diaristic reflections.

"Arthur wrote about everything in his journals," said Julia Bolus, Miller's longtime assistant and director of the Arthur Miller Trust, who is coediting a volume of selections. "They were the place where all the elements of his life came together." ..."

## **Ground-truth images:**











## Retrieved images:











"Richard Pipes, Historian of Russia and Reagan Aide, Dies at 94 ..."





































"His Music, Entwined With His Faith ..."











"The Sound of Spirit..."