A License

The YouTube-News-Timeline dataset is under the CC BY 4.0 International license. Please refer to `https://creativecommons.org/licenses/by/4.0/legalcode` for license details.

B Data Format Example

A data format example is shown below.

Listing 1: A data example

```
{"https://apnews.com/article/japan-accidents-tsunamis-earthquakes-42
    ↪d4947609becd7f141e9524a8c98937":  # The URL link of the webpage
    ↪where we crawl the timeline.
    [
      [
        "0hEbGK4PnZg",
        "cl19tfn33hI",
        "R0l6z0HaUAM",
        "5QhCsR-t-qM",
        "ev3FBIoHMX8"
      ],
      [
        "psAuFr8Xeqs",
        "BsRd7WQuBHc",
        "Dp_8rLL1Y18",
        "h1m7GFPAq3o"
      ],
      [
        "f4TaKPKe1gg",
        "DLlsKd-QC2o"
      ],
      [
        "ocluW1Vhvcg",
        "vusthiUFx_0",
        "vGHzuZQLYtg",
        "7XpLbhQxpLw",
        "UsPFUzXisq4"
      ],
      [
        "hA3fNK0rxcs"
      ]
    ] # The URL links of the retrieved YouTube news videos. Each list
       ↪in the nested list corresponds to one node on the timeline.
       ↪These nodes are ordered in the nested list.
}
```

C More Dataset Characteristics

We include more details on the dataset's characteristics here. As demonstrated in Figure 8, the reference timelines are curated from a diverse set of more than $1,000$ publishers. The primary topics, each recurring more than 30 times, are depicted in In Figure 9. The topic annotations are given by an in-house proprietary entity linking algorithm. Moreover, the distribution of the event date, corresponding to each node on timelines, is shown in Figure 10.

D More Experimental Studies

To assess the impact of video duration on our model's performance, in Figure 11, we present a correlation between the video length and the corresponding video-level Euclidean distance, based

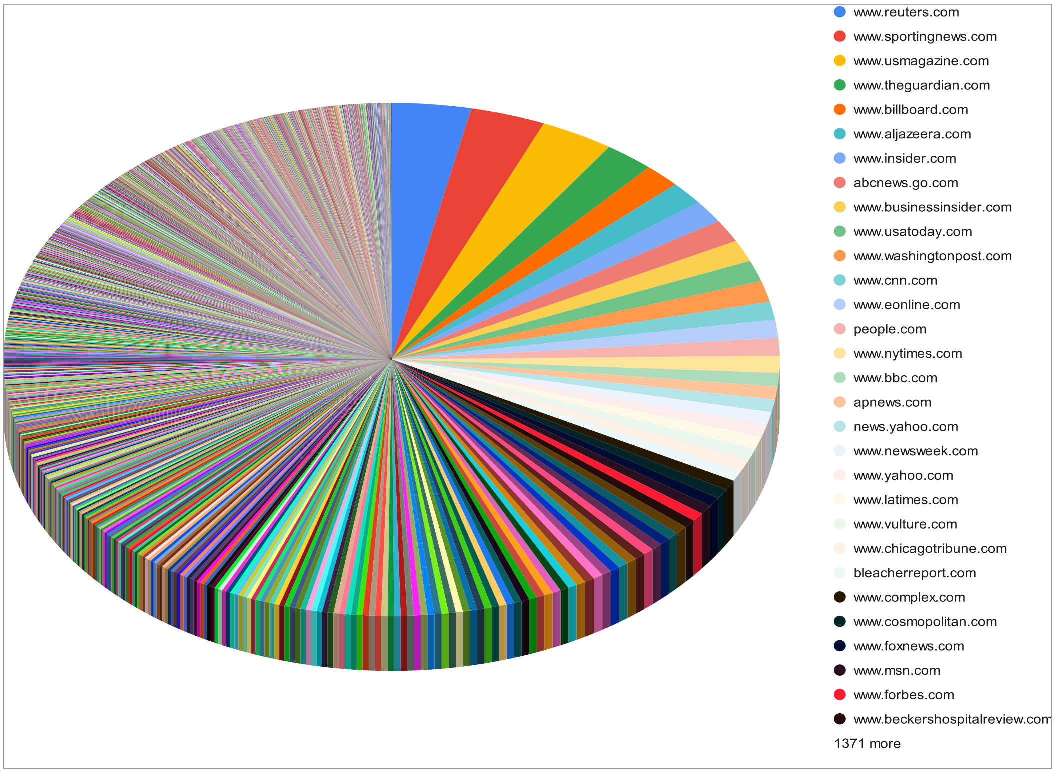

Figure 8: Pei chart of the news publishers.

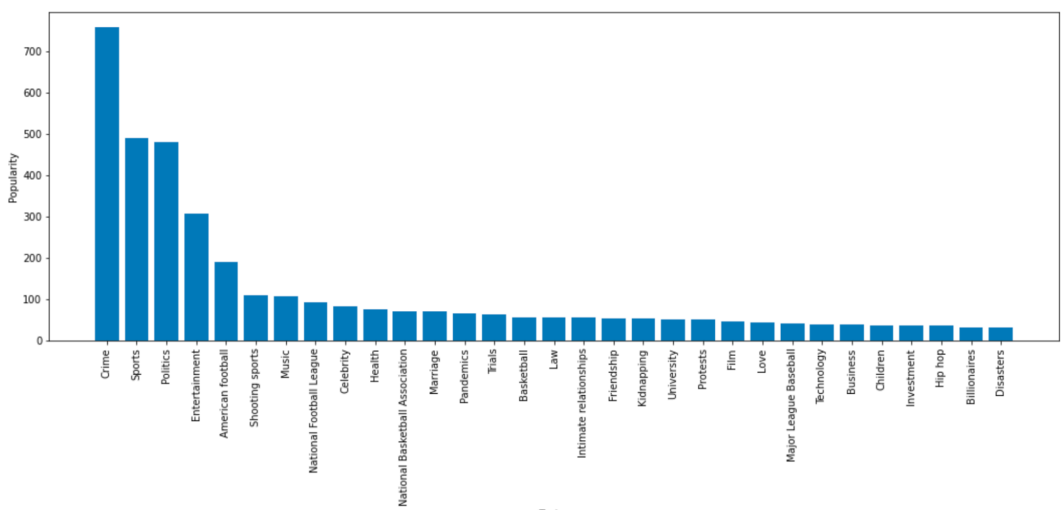

Figure 9: Distribution of the covered main topics.

on our Tri-Transformer model over the test set. The video-level Euclidean distance is not sensitive to video length. It can be observed that the variance becomes large for longer videos as the longer videos are less in both the training and test sets.

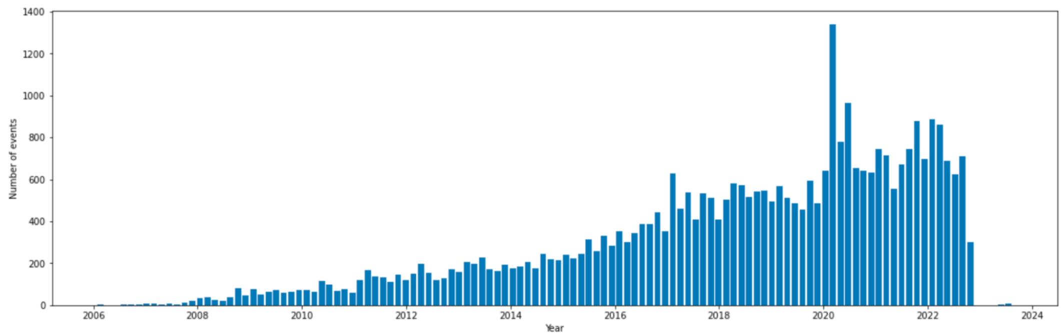

Figure 10: Distribution of the event date.

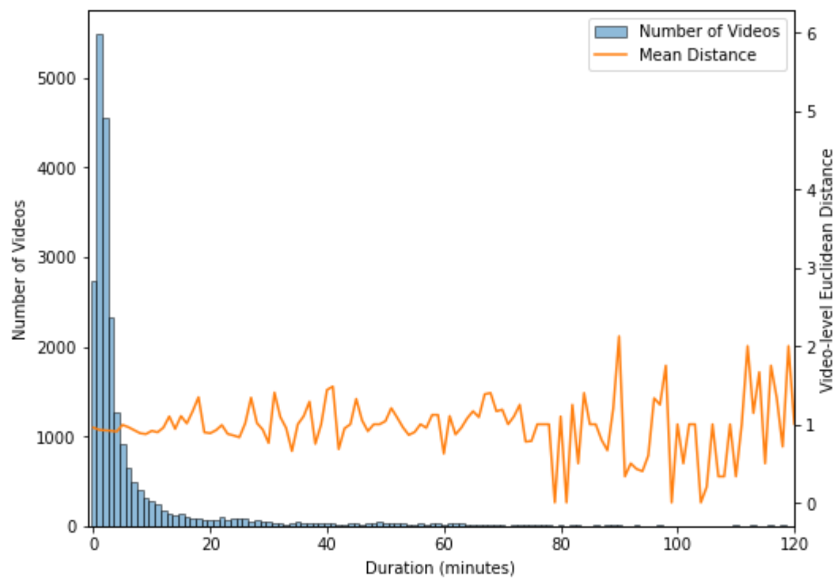

Figure 11: Number of videos and average video-level Euclidean distances in relation to video duration.

E Examples of Predicted Timelines

we present two examples of timelines predicted by our Tri-Transformer model in Table 4 and 5. The videos that have been assigned to incorrect nodes are highlighted for clarity.

F Societal Impacts

We expect that the proposed benchmark dataset and methods will facilitate future advancements in video timeline modeling. On the positive side, it offers a helpful tool for understanding and navigating large volumes of news video data, enabling more efficient news consumption and ensuring a more comprehensive understanding of events.

One the negative side, the crawled timelines might not always reflect absolute precision. They might be mistakenly used as evidence in some situations. This highlights the importance of using and interpreting these timelines carefully. In addition, while we have taken steps to diversify our data sources, news content can inherently carry biases based on various factors. We acknowledge this challenge and emphasize the future need for more diverse data sourcing to capture a broad spectrum of perspectives and reduce inherent biases. Also, there could be potential misuse if the technology were applied unethically. Specifically, the construction of timelines could be manipulated to present

#ground truth nodes = 8, #predicted nodes = 8, #videos = 29
node-level precision/recall= 100.0%/100.0%, video-level Hamming distance= 0.103, video-level Euclidean distance= 0.103, video pairwise agreement accuracy= 96.6%

Node ID	Ground truth videos (titles)	Predicted videos (titles)
1	tT_AWx7dgjg ("China Rocket Launches, Spacewalk Next") YJrnfvQZNYo ("China Launches Its Third Manned Space Mission")	tT_AWx7dgjg ("China Rocket Launches, Spacewalk Next") YJrnfvQZNYo ("China Launches Its Third Manned Space Mission")
2	UIcL9aXpOYE ("LIFT OFF: China launches space module rocket Tiangong 1") 8zK8jHpLV9c ("China launches first module for space station") 2CU0RKMW2n8 ("China launches first stage of space station plan")	UIcL9aXpOYE ("LIFT OFF: China launches space module rocket Tiangong 1") 8zK8jHpLV9c ("China launches first module for space station")
3	MAx8UrCm5Cg ("SPACE MISSION: China's Shenzhou-8 carries out first docking") 1j1zGxShID4 ("Success as China passes its first space docking test")	2CU0RKMW2n8 ("China launches first stage of space station plan") MAx8UrCm5Cg ("SPACE MISSION: China's Shenzhou-8 carries out first docking") 1j1zGxShID4 ("Success as China passes its first space docking test")
4	3A6pvG676aM ("China Lands Spacecraft on Moon") l-XYRQWGEZM ("China's Chang'e3 unmanned spacecraft lands on the moon") BxdBFCwqlGw ("State TV in China broadcasts Moon landing") oEHniKlucL0 ("China lands rover on the moon") PGrf1_IpjH0 ("Chinese lunar rover lands on moon")	3A6pvG676aM ("China Lands Spacecraft on Moon") l-XYRQWGEZM ("China's Chang'e3 unmanned spacecraft lands on the moon") BxdBFCwqlGw ("State TV in China broadcasts Moon landing") oEHniKlucL0 ("China lands rover on the moon") PGrf1_IpjH0 ("Chinese lunar rover lands on moon")
5	RodztOlgZW0 ("China launches Tiangong-2 space lab") euBlfv9S-ZE ("China successfully launches 2nd space laboratory Tiangong-2") goRzJM4PIEI ("China successfully launches Tiangong-2 space lab") Dw9RHNVmswE ("The launch of Tiangong-2 space lab") 1stYgsn19Zs ("Cina, lanciato in orbita il laboratorio spaziale Tiangong-2")	RodztOlgZW0 ("China launches Tiangong-2 space lab") euBlfv9S-ZE ("China successfully launches 2nd space laboratory Tiangong-2") goRzJM4PIEI ("China successfully launches Tiangong-2 space lab") Dw9RHNVmswE ("The launch of Tiangong-2 space lab") 1stYgsn19Zs ("Cina, lanciato in orbita il laboratorio spaziale Tiangong-2")
6	kQrLjgvIXEc ("Chinese probe Chang'e 4 lands on far side of moon") A2AXeRN-7Uk ("China's Chang'e-4 lands on moon's far side") WpzJblVRdO4 ("China lands Chang'e-4 space probe on the far side of the moon") apVqFquXYIg ("Chang'e-4 Probe Takes Panoramic Photos on Moon's Far Side") iEThGnpwAxU ("Chang'e-4 Probe Takes First Photo of Moon's Far Side")	kQrLjgvIXEc ("Chinese probe Chang'e 4 lands on far side of moon") A2AXeRN-7Uk ("China's Chang'e-4 lands on moon's far side") WpzJblVRdO4 ("China lands Chang'e-4 space probe on the far side of the moon") apVqFquXYIg ("Chang'e-4 Probe Takes Panoramic Photos on Moon's Far Side") iEThGnpwAxU ("Chang'e-4 Probe Takes First Photo of Moon's Far Side")
7	J7M-nEJnr4k ("China puts final satellite for Beidou into orbit") JCa9UPHMaWE ("China launches 100% domestically produced final satellite to complete Beidou system")	J7M-nEJnr4k ("China puts final satellite for Beidou into orbit") JCa9UPHMaWE ("China launches 100% domestically produced final satellite to complete Beidou system") WSkCBaN$_C LM$ ("China launches unmanned probe in first independent Mars mission") fwuWTd0NScc ("China launches its first unmanned mission to Mars")
8	WSkCBaN$_C LM$ ("China launches unmanned probe in first independent Mars mission") fwuWTd0NScc ("China launches its first unmanned mission to Mars") sCiwZTnxBvo ("Tianwen 1: China launches first independent mission to Mars") UqzBbubHtvc ("Beijing launches unmanned interplanetary mission to Mars") 0OCPNfGrrcQ ("China launches unnamed Mars probe")	sCiwZTnxBvo ("Tianwen 1: China launches first independent mission to Mars") UqzBbubHtvc ("Beijing launches unmanned interplanetary mission to Mars") 0OCPNfGrrcQ ("China launches unnamed Mars probe")

Table 4: A timeline of "Major milestones in Chinese space exploration".

#ground truth nodes = 10, #predicted nodes = 12, #videos = 40
node-level precision/recall= 58.3%/70.0%, video-level Hamming distance= 0.525, video-level Euclidean distance= 0.575, video pairwise agreement accuracy= 91.2%

Node ID	Ground truth videos (titles)	Predicted videos (titles)
1	aUs-BkqMLAM ("Schools Respond To U.S. Department of Ed Letter on Transgender Students") oZpYA8v5PRI ("Local reaction to school transgender guidelines") w7jeruoR0PM ("Local school divisions, and the public, react to transgender announcement")	aUs-BkqMLAM ("Schools Respond To U.S. Department of Ed Letter on Transgender Students") oZpYA8v5PRI ("Local reaction to school transgender guidelines")
2	rghWbw4DKwg ("Protections pulled from transgender school restrooms") TNmDduNrsZY ("How scrapping transgender bathroom guidelines impacts schools") kPFx_FkEx2s ("Rights and Recourse, 26 February 2017") za2hWMaef6U ("CI Bitesize: Trans bathroom guidance revoked")	w7jeruoR0PM ("Local school divisions, and the public, react to transgender announcement") rghWbw4DKwg ("Protections pulled from transgender school restrooms") TNmDduNrsZY ("How scrapping transgender bathroom guidelines impacts schools") kPFx_FkEx2s ("Rights and Recourse, 26 February 2017")
3	rX9qHJngRPk ("Vanderbilt kicker Sarah Fuller becomes first woman to score in a Power 5 game") -8MfQM9PAxk ("Sarah Fuller Becomes First Female Player To Kick Extra Point") IfgwDHOHbCI ("Tennessee vs. Vanderbilt: Sarah Fuller makes history") 9CaIF7nY6F8 ("Women's Football Highlight Show")	za2hWMaef6U ("CI Bitesize: Trans bathroom guidance revoked") rX9qHJngRPk ("Vanderbilt kicker Sarah Fuller becomes first woman to score in a Power 5 game")
4	j8kudE06p08 ("President Biden Delivers Remarks and Signs Executive Orders") 5xlSQ34b5bA ("President Joe Biden signs executive orders as 1st official act") IX9nMUn2lIY ("Biden delivers remarks, signs exec order on racial equity agenda") NTus5FevWhM ("President Joe Biden signs his first executive orders") Es_SMG8b3sI ("Unpacking Biden's first Executive Orders")	-8MfQM9PAxk ("Sarah Fuller Becomes First Female Player To Kick Extra Point") IfgwDHOHbCI ("Tennessee vs. Vanderbilt: Sarah Fuller makes history") 9CaIF7nY6F8 ("Women's Football Highlight Show") j8kudE06p08 ("President Biden Delivers Remarks and Signs Executive Orders")
5	IDkDrTvxsLY ("Presidential address: Watch Biden's full speech from March 11, 2021") tjVaIdsYekk ("Education announcement - March 12, 2021")	5xlSQ34b5bA ("President Joe Biden signs executive orders as 1st official act") IX9nMUn2lIY ("Biden delivers remarks, signs exec order on racial equity agenda") NTus5FevWhM ("President Joe Biden signs his first executive orders") Es_SMG8b3sI ("Unpacking Biden's first Executive Orders") IDkDrTvxsLY ("Presidential address: Watch Biden's full speech from March 11, 2021")
6	3s9He2qdb8w ("Supreme Court rules in favor of transgender student Gavin Grimm") ZvYRB7kAfpE ("Supreme Court refuses case for transgender bathroom rule")	tjVaIdsYekk ("Education announcement - March 12, 2021")
7	8GwdG2qunIY ("U.S. women soccer players reach $24 million settlement in fight for equal pay") HCSkjU16tH0 ("U.S. Soccer and women's national team players settle equal pay lawsuit for $24 million") zMxP6HxfKqU ("US women soccer players settle equal pay suit for $24M") EAZB29f8w5k("US Women's Soccer players reach landmark $24 million settlement with Soccer Federation") 3–vxNT1jrU ("'A win for everyone:' U.S. women's soccer settles equal pay dispute")	3s9He2qdb8w ("Supreme Court rules in favor of transgender student Gavin Grimm") ZvYRB7kAfpE ("Supreme Court refuses case for transgender bathroom rule") 8GwdG2qunIY ("U.S. women soccer players reach $24 million settlement in fight for equal pay") HCSkjU16tH0 ("U.S. Soccer and women's national team players settle equal pay lawsuit for $24 million") zMxP6HxfKqU ("US women soccer players settle equal pay suit for $24M") 3–vxNT1jrU ("'A win for everyone:' U.S. women's soccer settles equal pay dispute")
8	kAnbWxtiddA ("Lia Thomas Becomes 1st Transgender Athlete To Win NCAA championship") jHXgde2IZJg ("Reaction to trans swimmer Lia Thomas' NCAA Championship") HLCNg4ISygU ("Making Waves: Transgender Swimmer Lia Thomas' NCAA Win Sparks Public Protest") i5pvCVL1DNk ("Lia Thomas competes in Division") rZj76yicEaE("WATCH: Lia Thomas Swims 4:33.82 in 500 Free Prelims at NCAA Championships")	EAZB29f8w5k("US Women's Soccer players reach landmark $24 million settlement with Soccer Federation") kAnbWxtiddA ("Lia Thomas Becomes 1st Transgender Athlete To Win NCAA championship") jHXgde2IZJg ("Reaction to trans swimmer Lia Thomas' NCAA Championship")
9	2lS2WYD9fk8("2021-22 Women's Basketball Season Recap") a8rsZikLagE("Locked on Women's Basketball, March 24, 2022: 68 to the Sweet 16!") aV0yBBopnnI("NCAA Women's Basketball Tournament comes to Spokane and other top stories at 8 a.m.") AzqRk3HOeK8("Women's Basketball Weekly Update (03.29.2022)") K6Z7UsHUe_k("NAU Women's Basketball Championship Update")	HLCNg4ISygU ("Making Waves: Transgender Swimmer Lia Thomas' NCAA Win Sparks Public Protest") i5pvCVL1DNk ("Lia Thomas competes in Division") rZj76yicEaE("WATCH: Lia Thomas Swims 4:33.82 in 500 Free Prelims at NCAA Championships") 2lS2WYD9fk8("2021-22 Women's Basketball Season Recap") a8rsZikLagE("Locked on Women's Basketball, March 24, 2022: 68 to the Sweet 16!") aV0yBBopnnI("NCAA Women's Basketball Tournament comes to Spokane and other top stories at 8 a.m.") K6Z7UsHUe_k("NAU Women's Basketball Championship Update")
10	XHEAZkiObYw ("UConn vs. South Carolina | Full Game Highlights") tuDTa9On1IA ("South Carolina vs. UConn - Women's NCAA tournament championship highlights") hb7e6vh71p4 ("South Carolina vs. UConn: 2022 NCAA women's national championship") zoaApnfmIqc ("Press Conference: South Carolina vs. UConn Postgame - 2022 NCAA Tournament") JXpzJ20jJZY ("South Carolina women's basketball national championship celebration")	AzqRk3HOeK8("Women's Basketball Weekly Update (03.29.2022)") XHEAZkiObYw ("UConn vs. South Carolina | Full Game Highlights")
11		tuDTa9On1IA ("South Carolina vs. UConn - Women's NCAA tournament championship highlights") hb7e6vh71p4 ("South Carolina vs. UConn: 2022 NCAA women's national championship")
12		zoaApnfmIqc ("Press Conference: South Carolina vs. UConn Postgame - 2022 NCAA Tournament") JXpzJ20jJZY ("South Carolina women's basketball national championship celebration")

Table 5: A timeline of "50 Years of Title IX: The Defining Moments of Women's Sports".

events in a way that supports a particular opinion, thereby distorting the truth. To alleviate this potential concern, regular validation and fact-checking mechanisms can help ensure the constructed timelines align with factual occurrences.

G Discussions on Future Directions

Here, we highlight several promising directions, including more principle exploration for problems and methodologies, for future research in this field.

On one hand, more effective and principle methodologies are highly desired. First, as demonstrated in the experiments, we can develop more effective strategies to leverage textual information during training. Second, while our current method, as an exploratory work, treats the problem as a multi-class classification problem, it would be more principle to consider the problem as a ranking problem and use differentiable ranking models. Third, our algorithms assign a set of videos simultaneously, which may result in different assignments for the same video if we add or delete a video in the set. It remains challenging to model video interactions while keeping the prediction of videos less dependent. This aspect presents a potential avenue for enhancement.

In addition, future research can also be made from a problem-oriented perspective. Given that our defined problem and evaluation standard concentrate solely on assigning input video sets to ordered nodes, one possible extension is to integrate the event summarization step with our defined problem to construct a timeline with both associated videos and event information. The event information can be in the form of text, key frames, *etc*. Although our YouTube-News-Timeline dataset can be used to evaluate the generated event text descriptions, the evaluation protocol and algorithms need to be dedicatedly redesigned. In addition, extending the single linear timeline to more complex relationship modeling, such as multiple timelines [Yu et al., 2021] and graphs, can be a promising future direction to enhance the understanding of news stories