

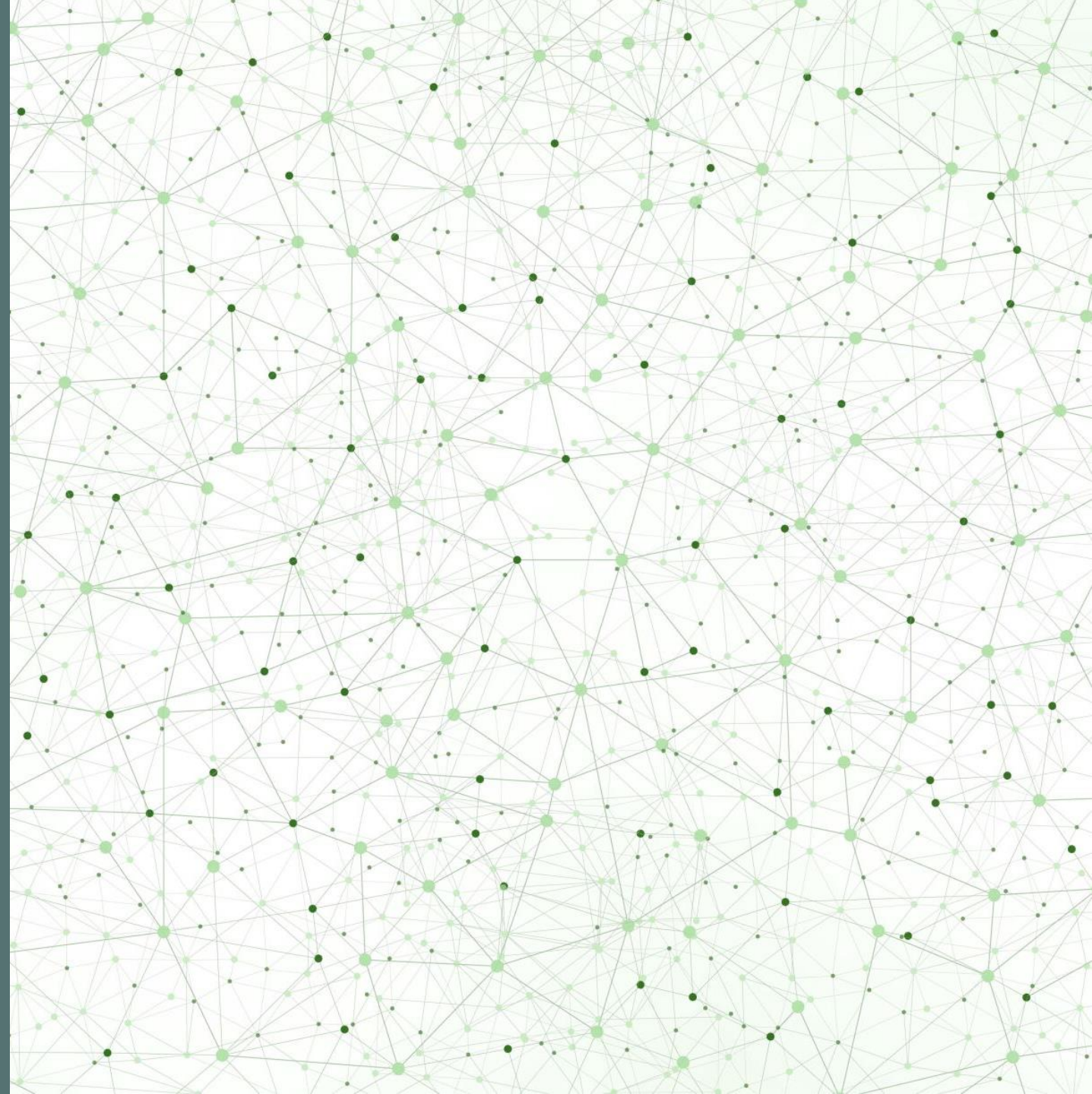
FTT: FORECASTING TEMPORAL TRENDS FOR FAKE NEWS DETECTION

Hu et al.

Diachronic LMs

By Amir Ghadanfar

PS (6 LP)



OVERVIEW

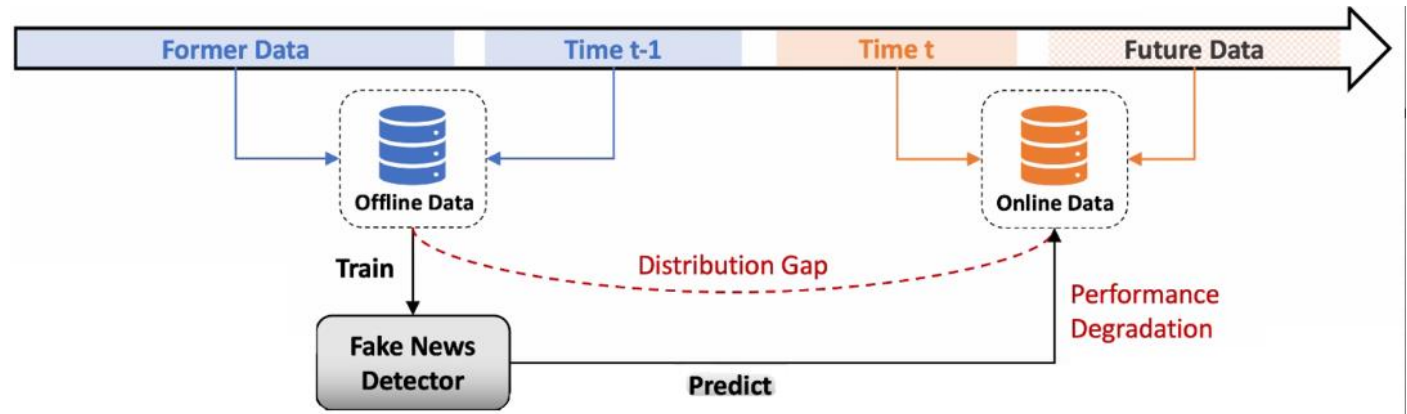
- I. Introduction
- II. Framework
- III. Evaluation
- IV. Conclusion

INTRODUCTION

Motivation

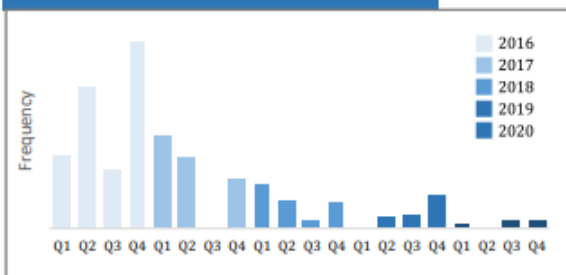
- Trust in news publication
- Importance of fake news detection
- Rapid evolution of news data
- Importance of temporal aspect
- Field of study is lacking

Challenging Data



- Temporal shift
- Offline vs. Online data
- Attributes of Consecutive data:
 - Temporal dependencies
 - No clear distributional boundaries
- Models make faulty assumption

Topic 1: Child Trafficking

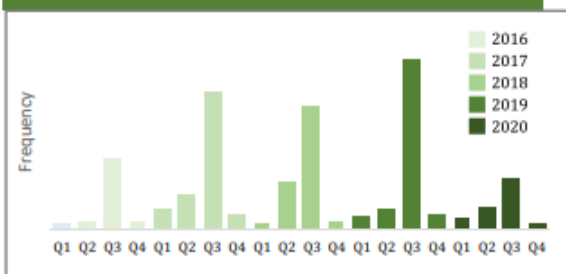


2016Q1 Text: Over 100 people have arrived around Funing County to steal children. More than 20 children have been lost in Funing County.

2017Q1 Text: Over 100 foreigners have come from Sanya and have arrived in Baoding City, Hebei Province. They specialize in children trafficking.

2018Q1 Text: Over 10,000 foreigners from Sanya and have arrived in Shulan, Jilin, Changchun, more than 2,000 children was lost.

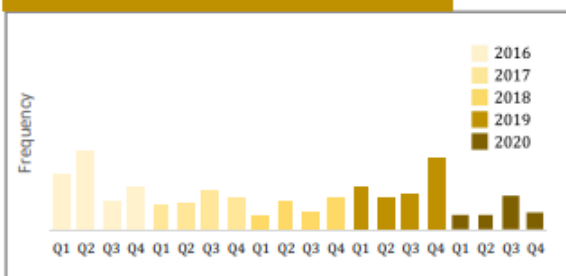
Topic 2: College Entrance Exam



2019Q3 Text: Yang Guilan, whose admission letter was forgotten on the No. 818 bus, and now it is placed at the dispatching booth of Xinxi Station, please forward (from Suiyang County).

2020Q3 Text: Anyone in Lanzhou know Yang Guilan? Her admission ticket was lost on the No.104 bus, and is currently at the dispatching booth of Xinxi Station. (please forward if you see it)

Topic 3: Falling Accident



2016Q2 Text: Netizens reported that this morning a girl fell from the apartment building of ...

2017Q4 Text: A girl fell from the 11th floor of a hotel because of a broken relationship.

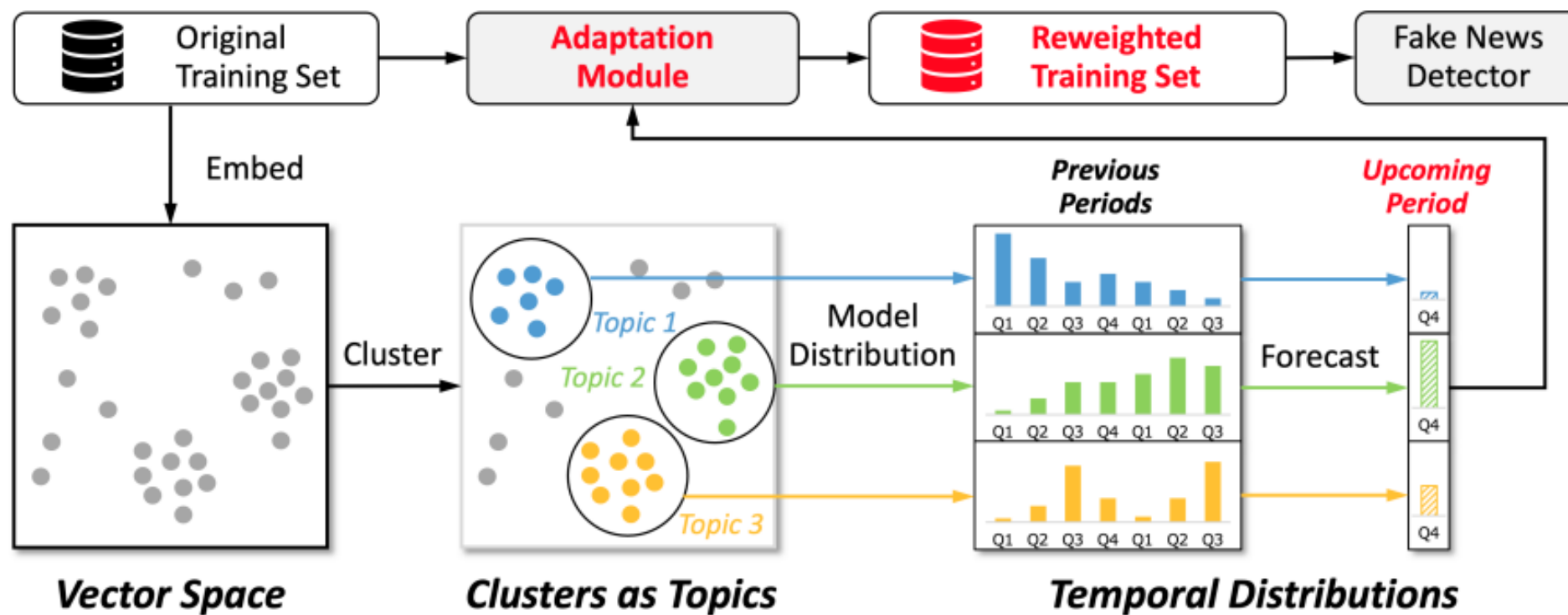
2020Q1 Text: A tragedy occurred in Longgang! Yesterday, a man accidentally fell from ...

The “Solution”

- Temporal patterns in same-topic news data
- Improve generalization and adaptation
- Patterns in Figure:
 - Decrease
 - Periodicity
 - Approximate Stationary

FTT: FORECAST TEMPORAL TRENDS

First look



Data Representation

- Consecutive data
- Data representation in vector space
- Sentence BERT
- Single step incremental clustering
- Similarity threshold

Math
notation:

$$D = \{D_q\}_{q=1}^Q$$

$\theta_{similarity}$

Temporal Distribution: Modeling

- Threshold for datapoints in a cluster
- Organize data for analysis
- Quarterly frequency sequence
- Break down time series
- Using decomposable time series model

Math
notation:

$$\theta_{\text{count}}$$

$$f = \frac{N_{T,q}}{Nq}$$

Temporal Trends

- Non-periodic trends:
 - k = growth rate
 - m = offset
 - a, m = parameters
 - δ = Rate Adjustment Term
 - γ = Smoothing Term
- Periodic trend:
 - s = sum up of 4 regression models
- Trend modeling function: p

Math notation: $g_i(f_{i,q}) = k_i f_{i,q} + m_i$

$$k_i = k + a(q)^T \delta$$

$$m_i = m + a(q)^T \gamma$$

$$s_i = (f_{i,q})$$

$$p_i(f) = g_i(f) + s_i(f)$$

Forecast Based Adaptation

- Fit model using forecast tool
- Create new train set with updated weights
- Mean absolute percentage error
- New weights correspond to forecast

Math notation:

$$\theta_{MAPE}$$

$$D_{Q'}$$

$$w_{i,Q} = \text{Bound}\left(\frac{p_i(f_{i,Q})}{\sum_{i \in D_{Q'}} p_i(f_{i,Q})}\right)$$

Fake News Detection Training

- Incorporate framework into model
- Compatible with any NN
- Include weights in loss function
- Learn during backpropagation

Math
notation:

$$\hat{y} = \textit{sigmoid}(\textit{MLP}(o_i))$$

$$\mathcal{L} = -\frac{1}{N} \sum_{i=1}^N w_{i,Q} * \textit{Crossentropy}(y_i, \hat{y}_i)$$

EVALUATION

Dataset

- Data extracted from Chinese fake-news detection model
- Data from January 2016 – December 2020
 - Divided into 4 subsets pro year
- Imbalanced dataset
 - Under sampled every subset
- Testing on every subset from 2020

1. Experiment: Can FTT Help?

Comparison
with 5
methods:

Baseline: instances weighted
equally

EANN: neural network using
adversarial training

Same period weighting

Previous period weighting

Combined weighting

1. Experiment: Can FTT Help?

2020	Metric	Baseline	EANN _T	Same Period Reweighting	Prev. Period Reweighting	Combined Reweighting	FTT (Ours)
Q1	macF1	0.8344	0.8334	0.8297	0.8355	0.8312	0.8402
	Accuracy	0.8348	0.8348	0.8301	0.8359	0.8315	0.8409
	F1 _{fake}	0.8262	0.8181	0.8218	0.8274	0.8237	0.8295
	F1 _{real}	0.8425	0.8487	0.8377	0.8435	0.8387	0.8509
Q2	macF1	0.8940	0.8932	0.8900	0.9004	0.8964	0.9013
	Accuracy	0.8942	0.8934	0.8902	0.9006	0.8966	0.9014
	F1 _{fake}	0.8894	0.8887	0.8852	0.8953	0.8915	0.8981
	F1 _{real}	0.8986	0.8978	0.8949	0.9055	0.9013	0.9046
Q3	macF1	0.8771	0.8699	0.8753	0.8734	0.8697	0.8821
	Accuracy	0.8776	0.8707	0.8759	0.8741	0.8707	0.8827
	F1 _{fake}	0.8696	0.8593	0.8670	0.8640	0.8582	0.8743
	F1 _{real}	0.8846	0.8805	0.8836	0.8829	0.8812	0.8900
Q4	macF1	0.8464	0.8646	0.8464	0.8429	0.8412	0.8780
	Accuracy	0.8476	0.8647	0.8476	0.8442	0.8425	0.8784
	F1 _{fake}	0.8330	0.8602	0.8330	0.8286	0.8271	0.8707
	F1 _{real}	0.8598	0.8690	0.8598	0.8571	0.8553	0.8853
Average	macF1	0.8630	0.8653	0.8604	0.8631	0.8596	0.8754
	Accuracy	0.8636	0.8659	0.8610	0.8637	0.8603	0.8759
	F1 _{fake}	0.8546	0.8566	0.8518	0.8538	0.8501	0.8682
	F1 _{real}	0.8714	0.8740	0.8690	0.8723	0.8691	0.8827

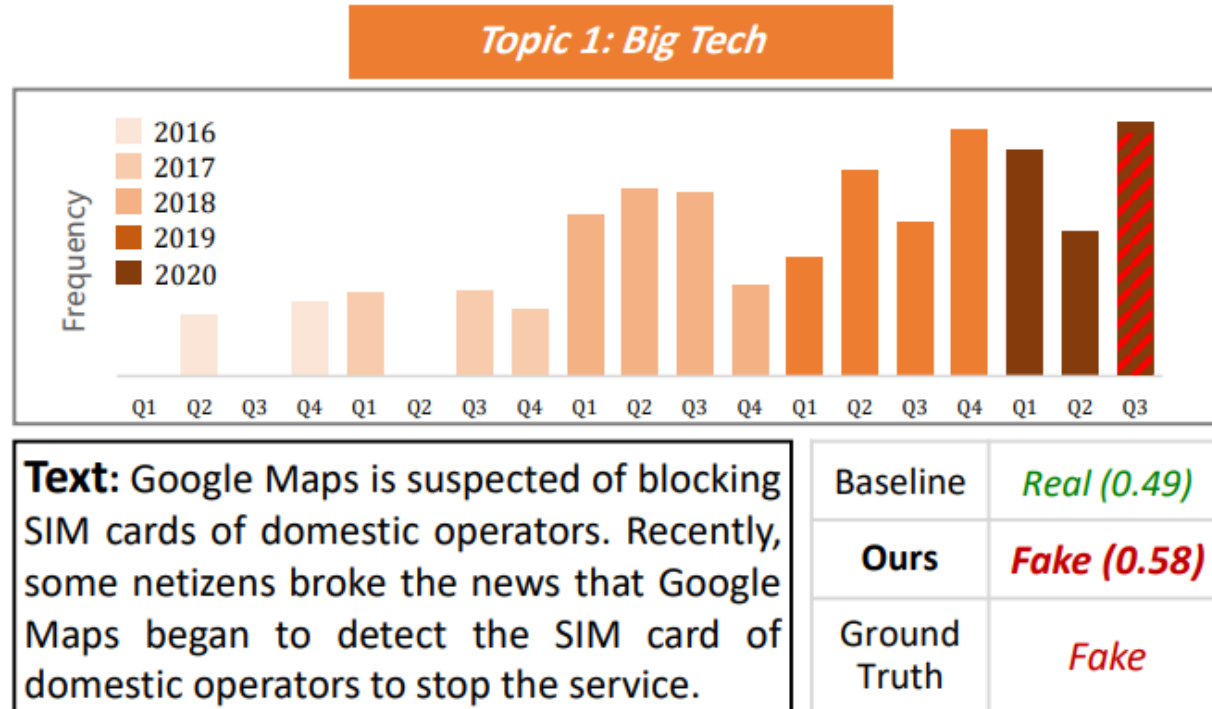
- FTT outperforms every other metric
- F1-fake higher on average than F1-real
- Heuristic methods are inconsistent

2. Experiment: How Does FTT Help

- Cluster the Test-set
- Instances in same/new clusters = old/new topics
- FTT outperforms regarding both topic types
- Reweighting improves FTT:
 - Recognizing existing topics
 - Generalizing new topics

Subset of the test set	Metric	Baseline	FTT (Ours)
Existing Topics	macF1	0.8425	0.8658
	Accuracy	0.8589	0.8805
	F1 _{fake}	0.7997	0.8293
	F1 _{real}	0.8854	0.9023
New Topics	macF1	0.8728	0.8846
	Accuracy	0.8729	0.8846
	F1 _{fake}	0.8730	0.8849
	F1 _{real}	0.8727	0.8843

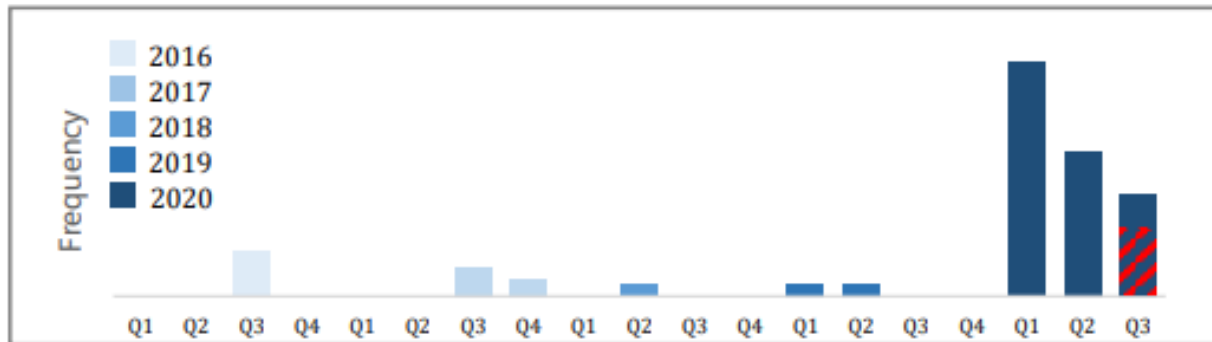
CASE STUDY



- Red dashed bars represents FTT forecast
- Texts are translated from Chinese
- FTT corrects model prediction
- Pattern of increase captured by FTT

CASE STUDY

Topic 2: Infectious Diseases



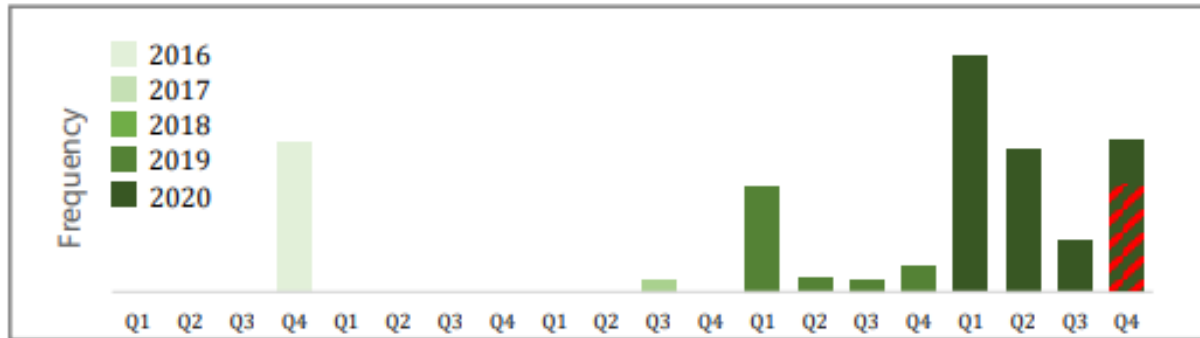
Text: Barcelona officially confirmed that Umtiti's COVID-19 test result was positive. As an asymptomatic patient he has begun home isolation. Umtiti did not follow the team to the UCL due to injury.

Baseline	<i>Fake (0.67)</i>
Ours	<i>Real (0.37)</i>
Ground Truth	<i>Real</i>

- FTT corrects model prediction
- Explosive trend fading over time
- Temporal pattern correctly forecasted

CASE STUDY

Topic 3: Medication Safety



Text: The Second Xiangya Hospital and Huaxi Hospital all issued documents refusing the admission of traditional Chinese medicine because of the frequent occurrence of quality problems.

Baseline	Real (0.34)
Ours	Fake (0.55)
Ground Truth	Fake

- FTT corrects model prediction
- “Smiling curve” pattern
- Successfully captured by framework

CONCLUSION

Sum-up

- Temporal shift as a common fake news detection challenge
- Modeling and forecasting temporal patterns as a solution
- Math behind FTT
- FTT outperforms other metrics
- Case study showcases the power of FTT

Limitations

Data:

- Only Chinese text data
- No details on how they got the data

In-topic prison:

- Difficulties on new topics

Scarce temporal patterns:

- Can't capture diverse temporal patterns

QUESTIONS ?