DialogueGAT: A Graph Attention Network For Financial Risk Prediction by Modeling the Dialogues in Earnings Conference Calls

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Outline

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Financial Risk Prediction

Financial risk prediction is an essential task for risk management in capital markets:

1. **hard information**: the historical stock return volatility [1]
2. **soft information**: Annual Report [2], **Earnings conference call**

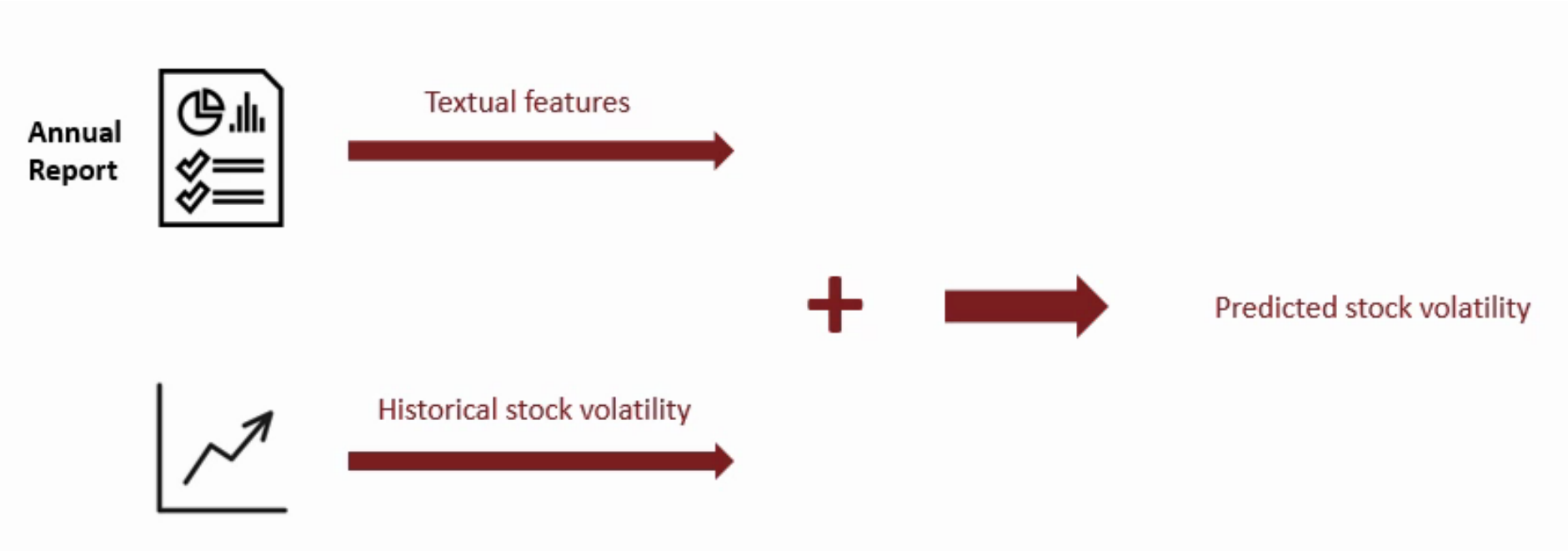


Figure: Financial Risk Prediction

Earnings Conference Call

The earnings conference call is a way for companies to relay information to all interested parties.

- **Time**: Typically at the end of each quarter
- **Participants**: Executives, analysts
- **Part**: Presentation, Question and Answer
- **Advantages**:
  1. Less constrained fashion
  2. Direct interaction

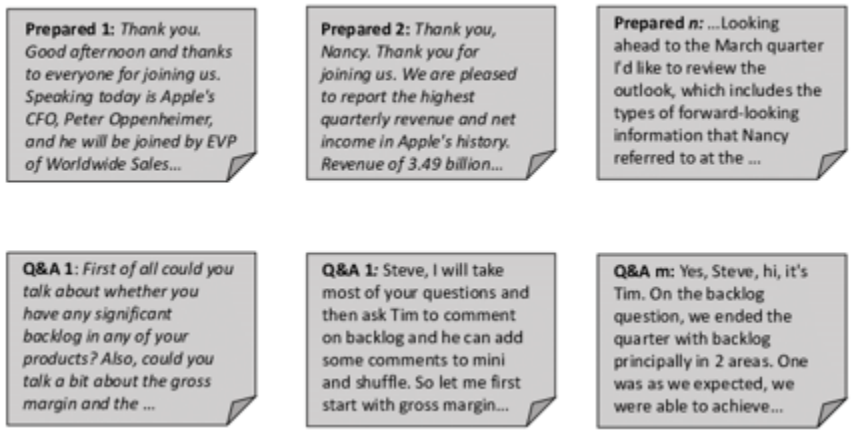


Figure: Example

Limitations

Most existing models [3, 4, 5] cast the risk prediction task as a standard text regression problem:

- Without considering the dialogue structures
- Without considering the speaker's information

Figure: Speaker information is important for a dialogue

Outline

Problem Definition

Financial risk prediction can be seen as **a supervised regression task**:

- **Input**: A dialogue with M speakers and N utterances.
- **Output**: The firm's future stock return volatility $v_{[t,t+\tau]}$ [1]
- **Metric**: Mean Squared Error

Definition

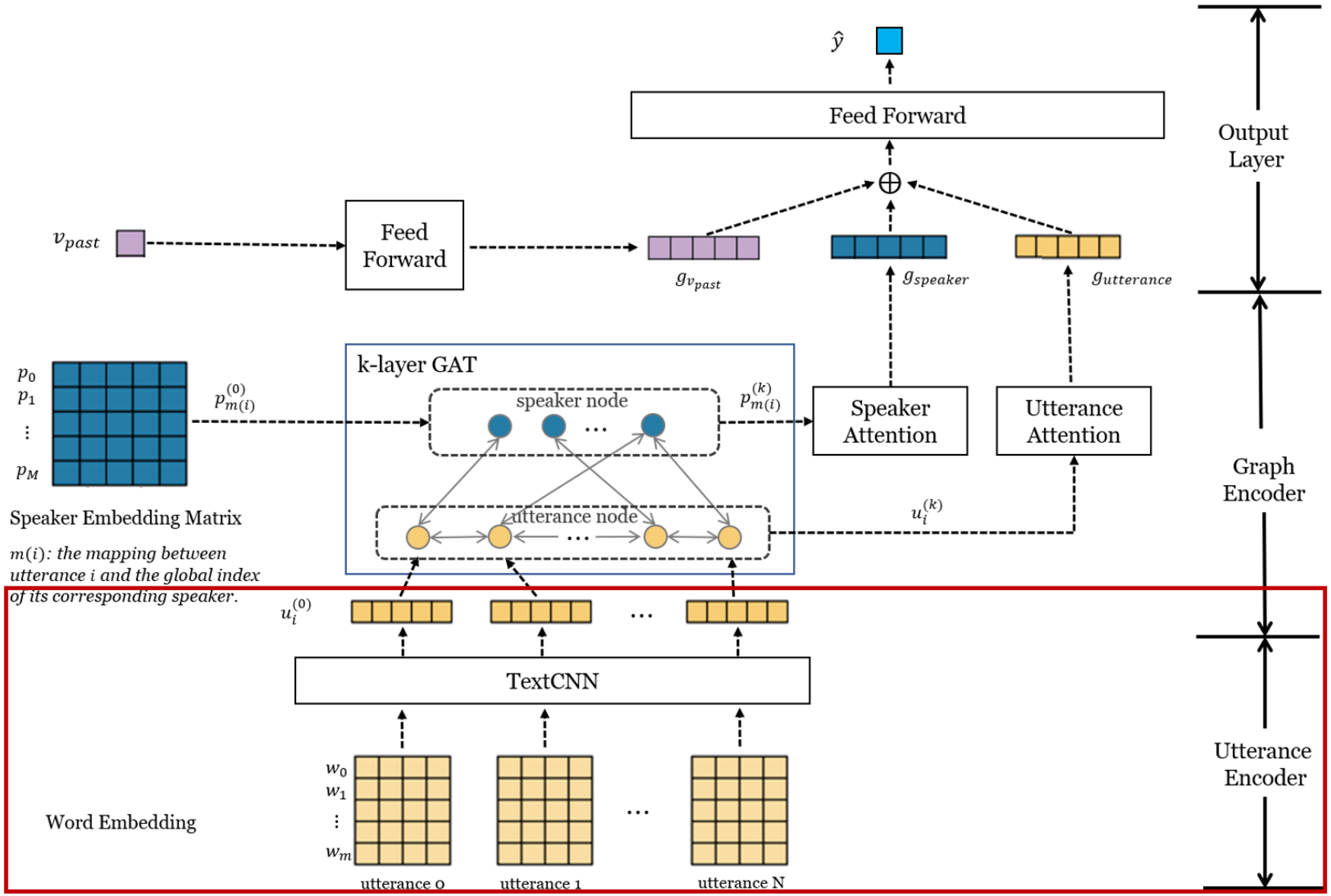
The stock return volatility $v_{[t,t+\tau]}$ reflects the degree of variation of stock prices:

$$v_{[t,t+\tau]} = \sqrt{\sum_{i=0}^{\tau} \left(r_{t+i} - \bar{r}\right)^2 / \tau}$$

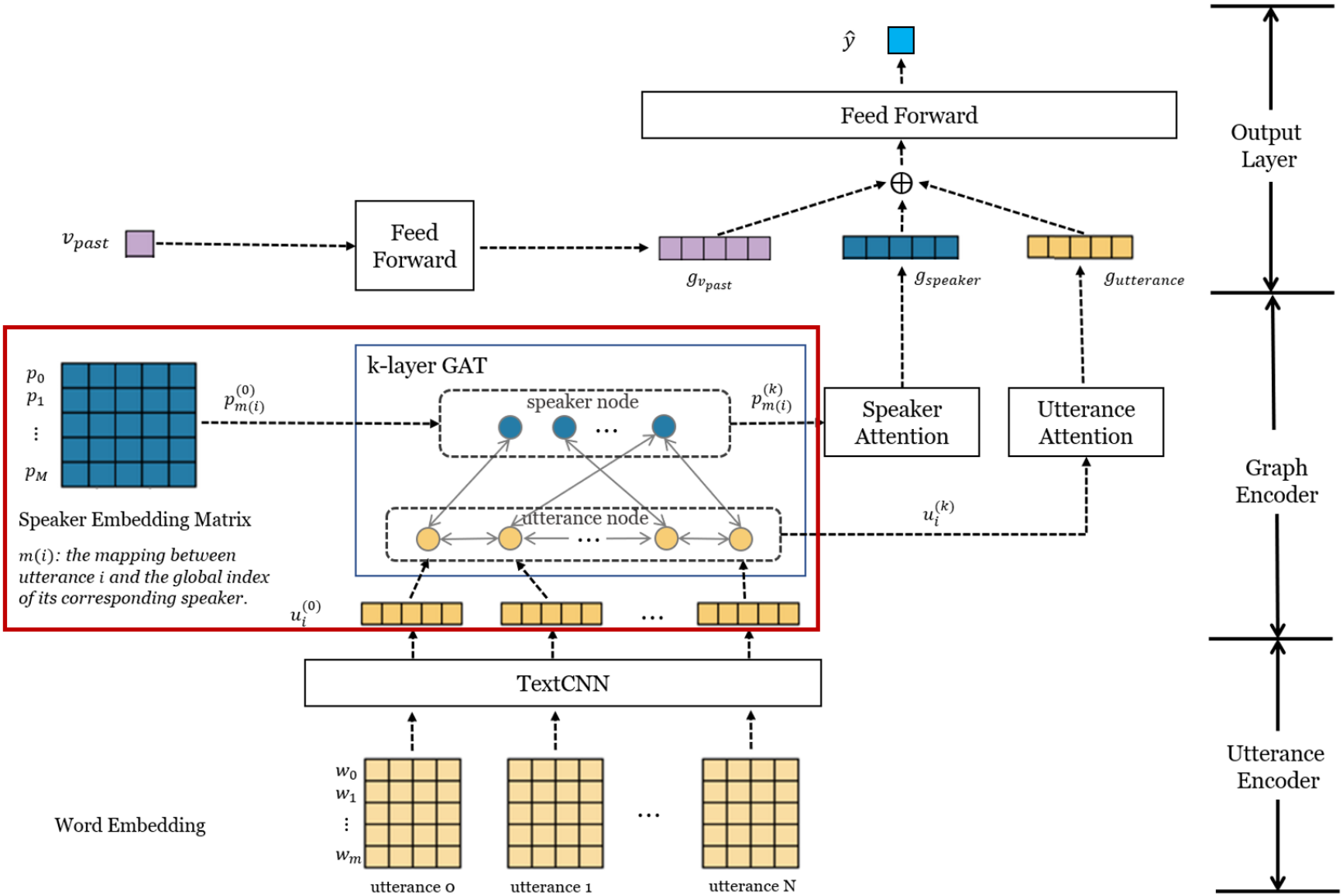
where r is the dividend-adjusted return of a specific stock.

[1] We set the time window size τ to 3, 7, and 15 days based on the PEAD. theory

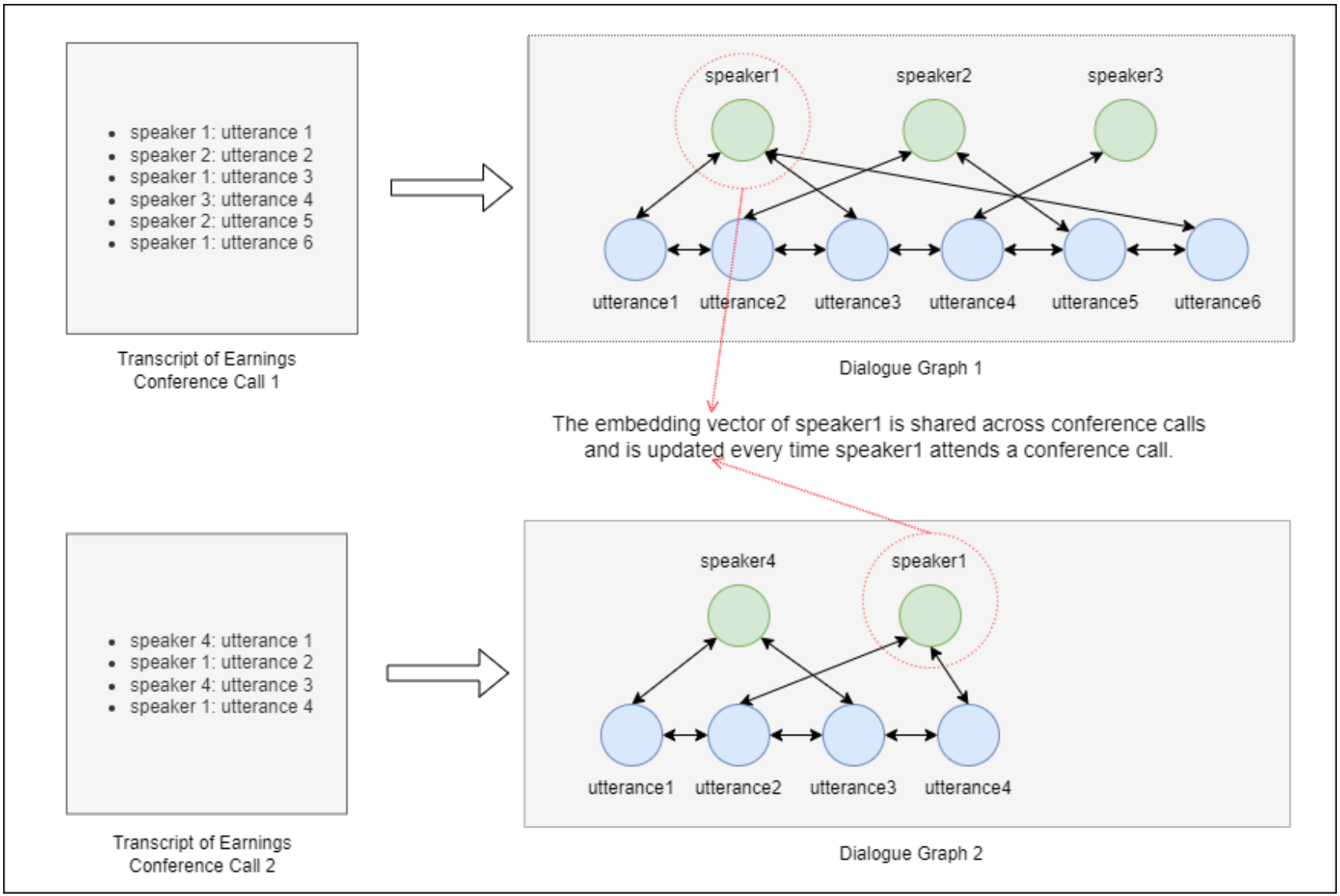
Utterance Encoder



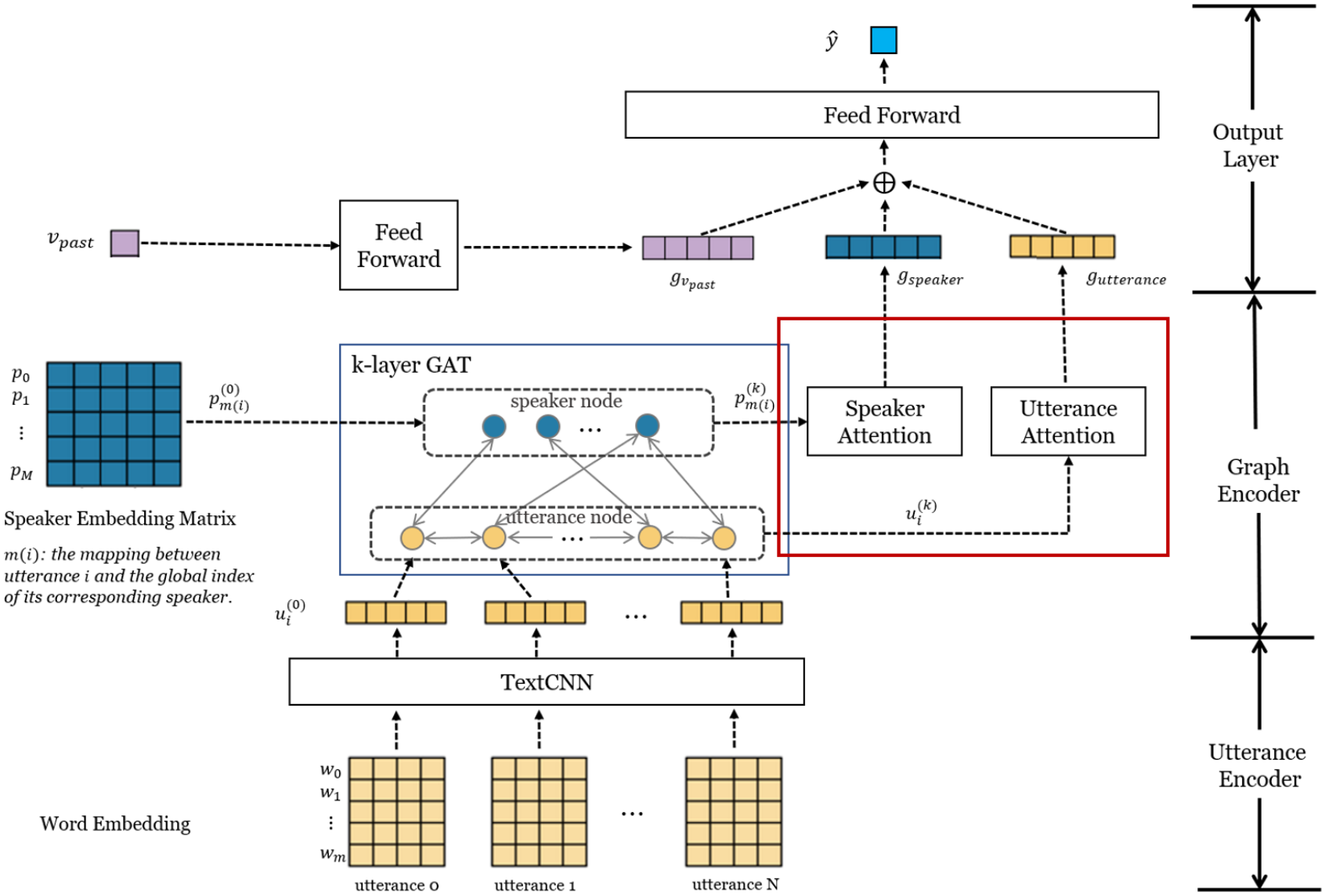
Graph Encoder: Dialogue Graph



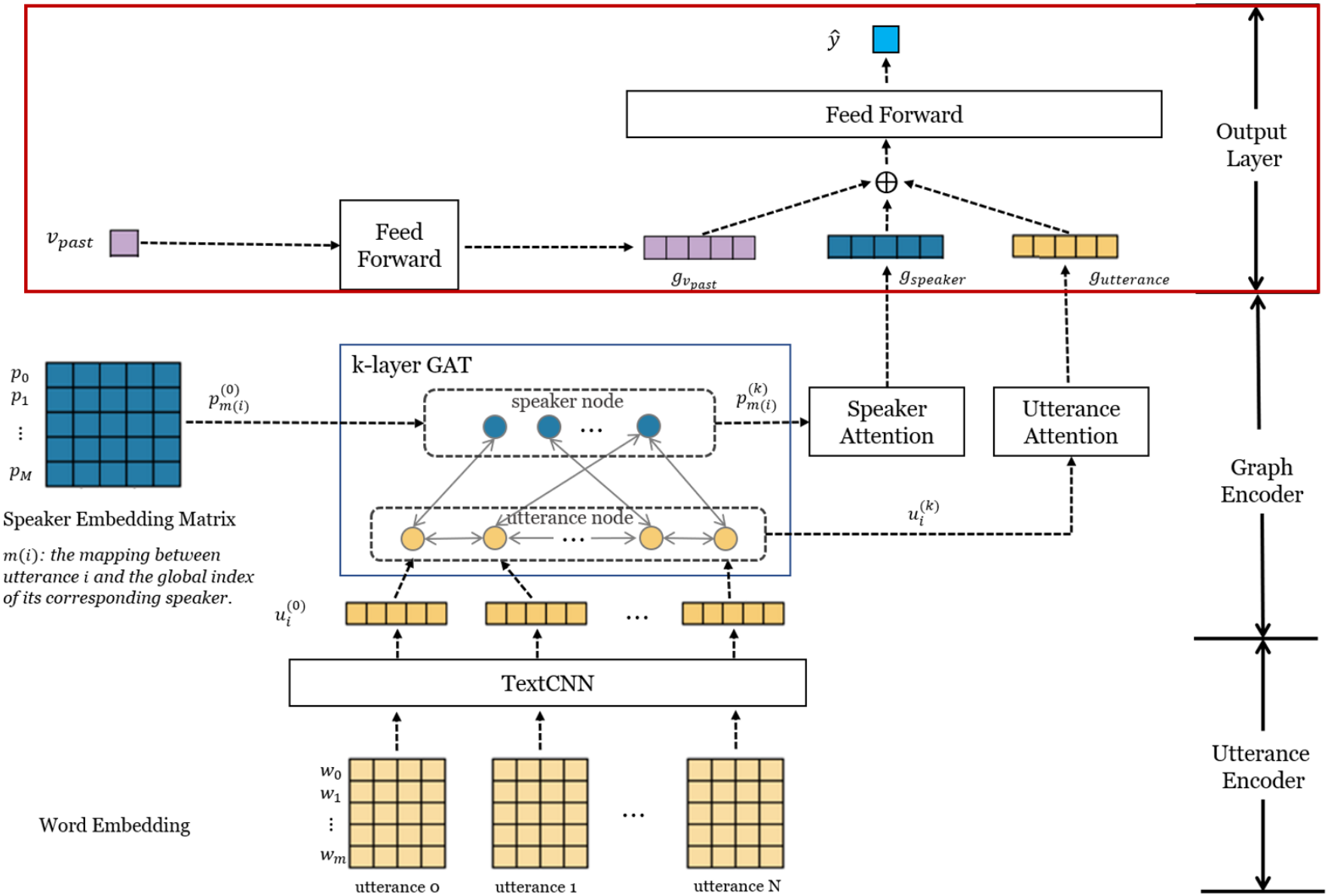
Graph Encoder: Example



Graph Encoder: Contextual Attention Layers



Output Layer



Outline

Dataset

- **Base Dataset**: MAEC dataset [5]
- **Supplement**: SeekingAlpha
- **Companies**: S&P1500
- **Split**: 7:1:2 on a yearly basis

Table: Descriptive statistics of our extended dataset.

Year	2015	2016	2017 - 2018
Training set (#Samples)	531	968	890
Validation set (#Samples)	75	138	127
Testing set (#Samples)	153	278	255
#Companies	523	897	736
#Speakers	5,840	8,768	7,006
#Utterances	59,549	108,714	79,253
#Sentences	102,142	184,936	145,206

Result

Table: Model performance in terms of MSE by varying the window size τ.

Year	2015			2016			2017-2018		
Methods	$\tau = 3$	$\tau = 7$	$\tau = 15$	$\tau = 3$	$\tau = 7$	$\tau = 15$	$\tau = 3$	$\tau = 7$	$\tau = 15$
v_{past} [1]	1.0905	0.5441	0.2744	1.3542	0.7300	0.4465	1.1739	0.5681	0.2723
SVR$_{v_{past}}$ [1]	0.6576	0.4393	0.2503	0.6440	0.3810	0.2714	0.5643	0.3634	0.2273
HAN [6]	0.5421	0.4259	0.2516	0.5272	0.3390	0.2501	0.5186	0.3554	0.2231
ProFET [4]	0.5902	0.4297	0.2471	0.5737	0.3717	0.2502	0.5341	0.3605	0.2270
DialogueGCN [7]	0.5376	0.4138	0.2462	0.5209	0.3343	0.2472	0.5019	0.3494	0.2204
MRQA [8]	0.5174	0.4126	0.2407	0.5162	0.3314	0.2286	0.4966	0.3443	0.2240
DialogueGAT	**0.4530**	**0.3236**	**0.1898**	**0.4549**	**0.2884**	**0.1810**	**0.4090**	**0.2886**	**0.2036**

- +Speaker Info > +Dialogue Structure > +Textual > Numerical [2]
- DialogueGAT is effective for modeling dialogue

[2] Numerical: v_{past}, SVR$_{v_{past}}$; +Textual: HAN, ProFET; +Dialogue Structure: DialogueGCN, MRQA; +Speaker Info: DialogueGAT

Model Interpretability

Case: AMD's 2015 Q2 earnings conference call [3]

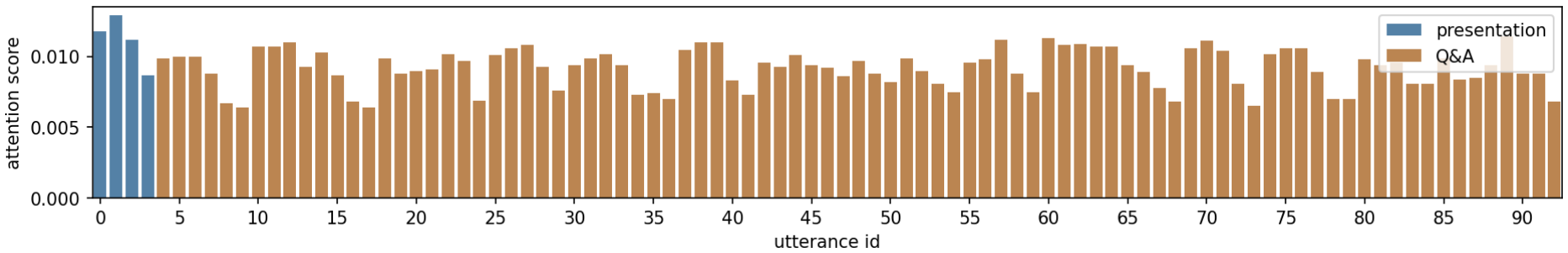


Figure: Utterance Attention

- The utterances in the presentation segment are generally more important than Q&A segment.
- Managers' presentation usually holds more private information and is more informative.

[3] Since AMD's financial performance in 2015 Q2 is below the market expectation, its stock price dropped significantly after the release of the earnings conference call.

Model Interpretability

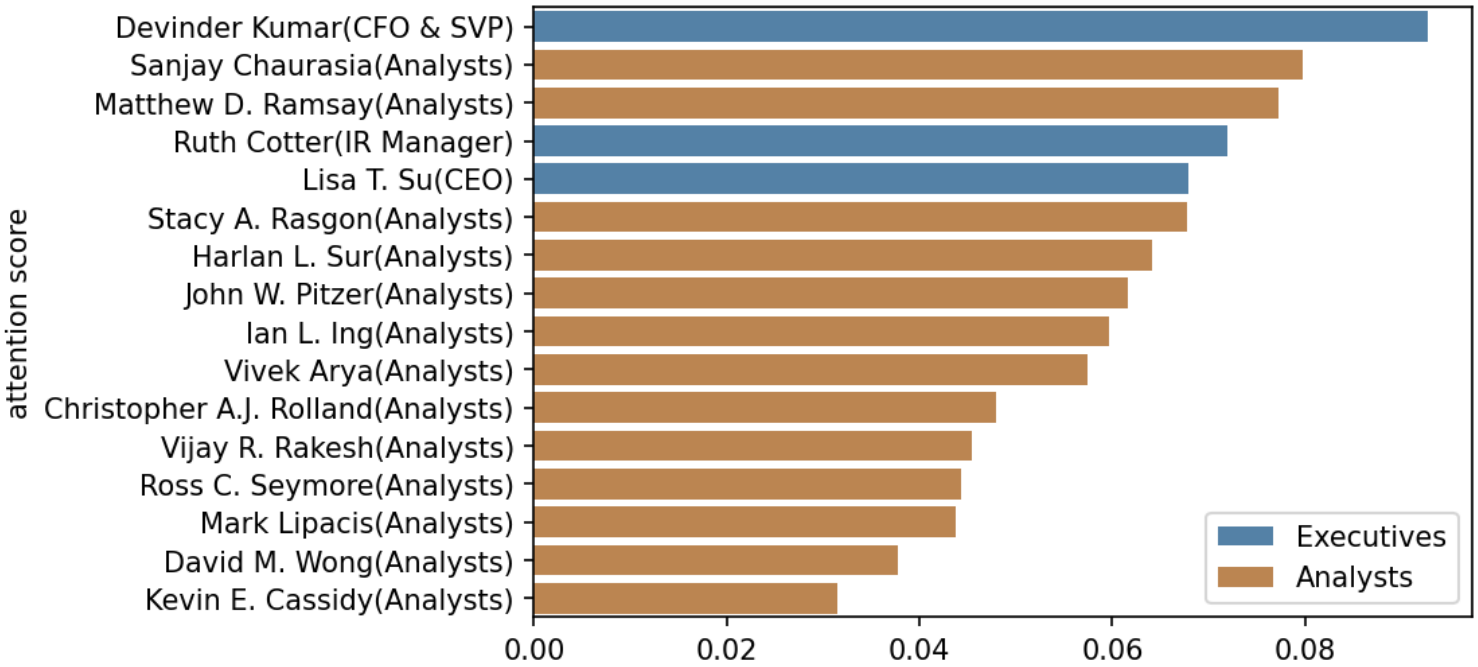


Figure: Speaker Attention

- Managers and analysts who ask harsh questions on behalf of public investors are usually more important than the rest analysts.

References I

Shimon Kogan, Dimitry Levin, Bryan R Routledge, Jacob S Sagi, and Noah A Smith.

Predicting risk from financial reports with regression.

In *Proceedings of Human Language Technologies: The 2009 Annual Conference of the North American Chapter of the Association for Computational Linguistics (NAACL)*, pages 272–280, 2009.

Yang Bao and Anindya Datta.

Simultaneously discovering and quantifying risk types from textual risk disclosures.

Management Science, 60(6):1371–1391, 2014.

Yu Qin and Yi Yang.

What you say and how you say it matters: Predicting stock volatility using verbal and vocal cues.

In *Proceedings of the 57th Annual Meeting of the Association for Computational Linguistics (ACL)*, pages 390–401, 2019.

Christoph Kilian Theil, Samuel Broscheit, and Heiner Stuckenschmidt.

Profet: Predicting the risk of firms from event transcripts.

In *Proceedings of the 28th International Joint Conference on Artificial Intelligence (IJCAI)*, pages 5211–5217, 2019.

Jiazheng Li, Linyi Yang, Barry Smyth, and Ruihai Dong.

Maec: A multimodal aligned earnings conference call dataset for financial risk prediction.

In *Proceedings of the 29th ACM International Conference on Information & Knowledge Management (CIKM)*, pages 3063–3070, 2020.

Zichao Yang, Diyi Yang, Chris Dyer, Xiaodong He, Alex Smola, and Eduard Hovy.

Hierarchical attention networks for document classification.

In *Proceedings of the 2016 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies (NAACL)*, pages 1480–1489, 2016.

References II

Deepanway Ghosal, Navonil Majumder, Soujanya Poria, Niyati Chhaya, and Alexander Gelbukh.
Dialoguegcn: A graph convolutional neural network for emotion recognition in conversation.
In *Proceedings of the 2019 Conference on Empirical Methods in Natural Language Processing and the 9th International Joint Conference on Natural Language Processing (EMNLP-IJCNLP)*, pages 154–164, 2019.

Zhen Ye, Yu Qin, and Wei Xu.
Financial risk prediction with multi-round q&a attention network.
In *Proceedings of the 29th International Joint Conference on Artificial Intelligence (IJCAI)*, pages 4576–4582, 2020.

Thanks!