

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

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Outline

1. Introduction
2. Proposed Model
3. Experiment

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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**

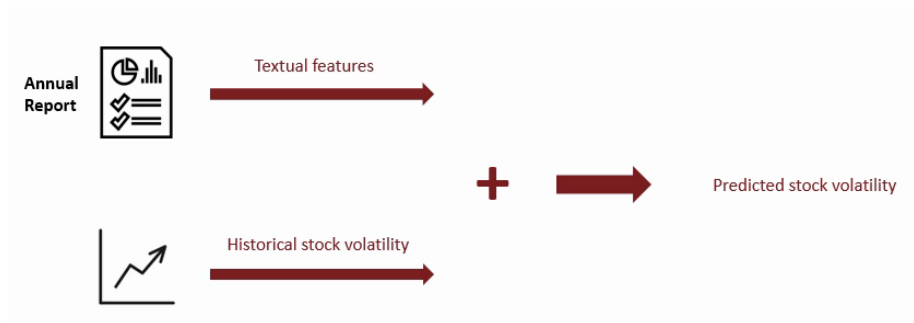


Figure: Financial Risk Prediction

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

Prepared 1: Thank you. Good afternoon and thanks to everyone for joining us. Speaking today is Apple's CFO, Peter Oppenheimer, and he will be joined by EVP of Worldwide Sales...

Prepared 2: Thank you, Nancy. Thank you for joining us. We are pleased to report the highest quarterly revenue and net income in Apple's history. Revenue of 3.49 billion...

Prepared n: ...Looking ahead to the March quarter I'd like to review the outlook, which includes the types of forward-looking information that Nancy referred to at the ...

Q&A 1: First of all could you talk about whether you have any significant backlog in any of your products? Also, could you talk a bit about the gross margin and the ...

Q&A 1: Steve, I will take most of your questions and then ask Tim to comment on backlog and he can add some comments to mini and shuffle. So let me first start with gross margin...

Q&A m: Yes, Steve, hi, it's Tim. On the backlog question, we ended the quarter with backlog principally in 2 areas. One was as we expected, we were able to achieve...

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

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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

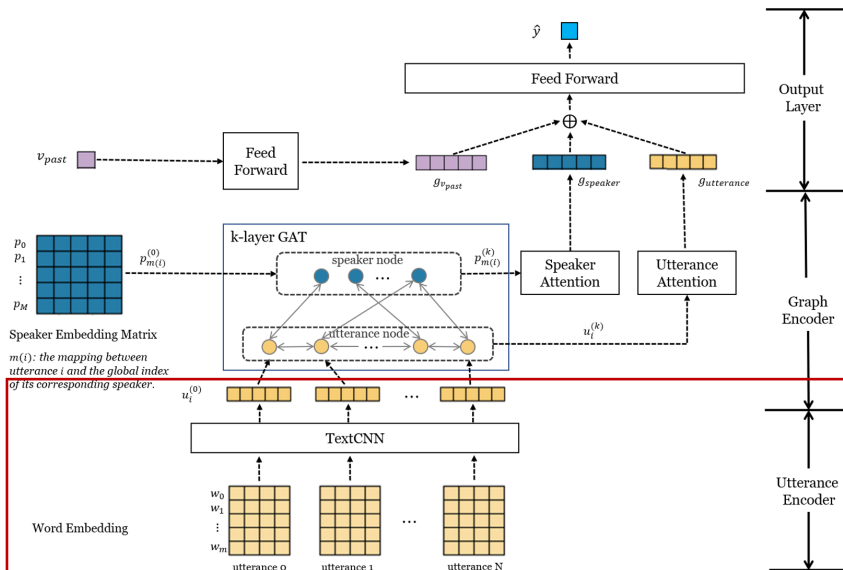
The stock return volatility $v_{[t,t+\tau]}$ reflects the degree of variation of stock prices:

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

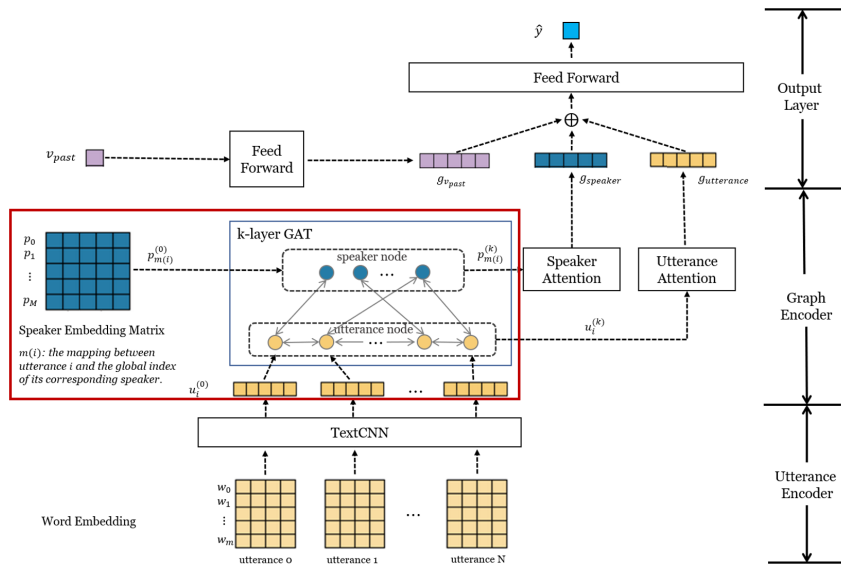
where r is the dividend-adjusted return of a specific stock.

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

Utterance Encoder



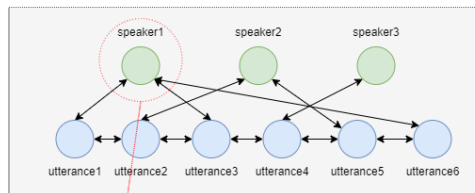
Graph Encoder: Dialogue Graph



Graph Encoder: Example

- speaker 1: utterance 1
- speaker 2: utterance 2
- speaker 1: utterance 3
- speaker 3: utterance 4
- speaker 2: utterance 5
- speaker 1: utterance 6

Transcript of Earnings
Conference Call 1

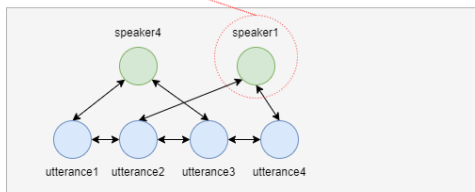


Dialogue Graph 1

The embedding vector of speaker1 is shared across conference calls and is updated every time speaker1 attends a conference call.

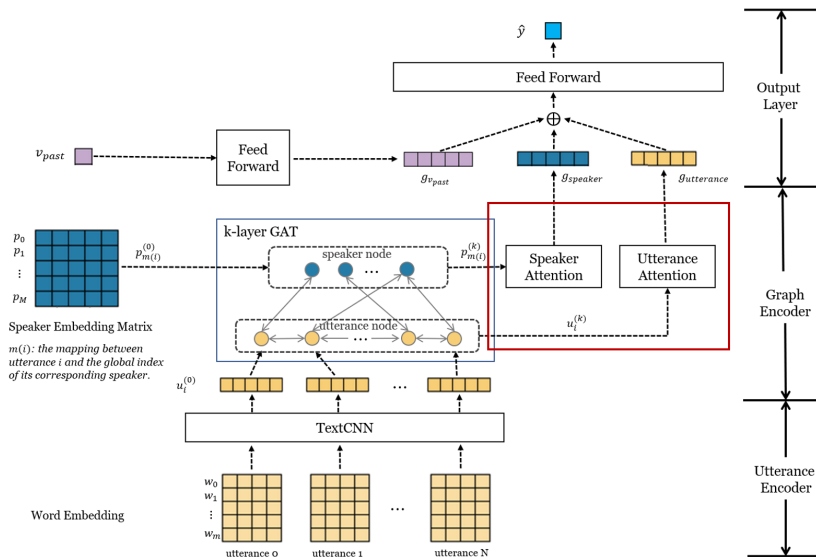
- speaker 4: utterance 1
- speaker 1: utterance 2
- speaker 4: utterance 3
- speaker 1: utterance 4

Transcript of Earnings
Conference Call 2

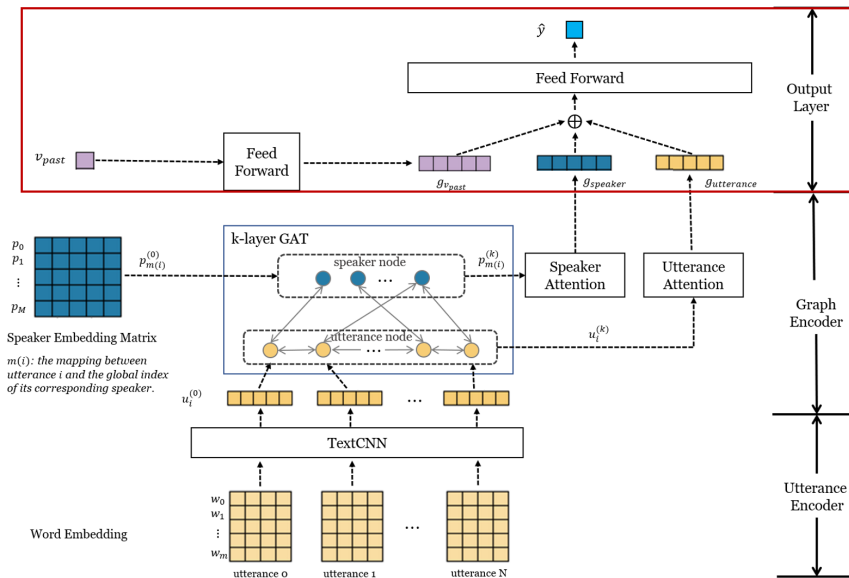


Dialogue Graph 2

Graph Encoder: Contextual Attention Layers



Output Layer



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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 > Numerical²
- DialogueGAT is effective for modeling dialogue

²Numerical: 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

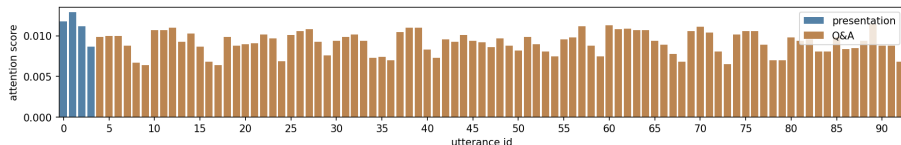


Figure: Utterance Attention

- 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.

³Since 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

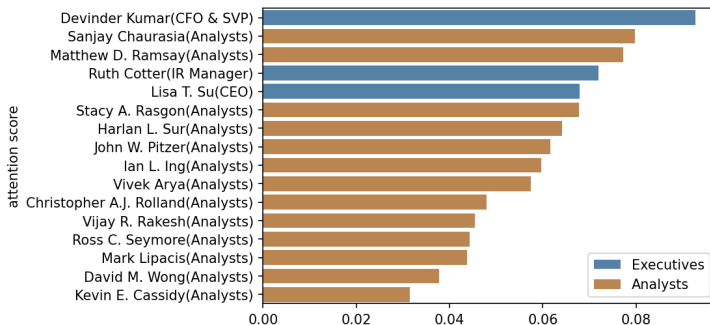


Figure: Speaker Attention

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

References I



Shimon Kogan, Dmitry 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.

Dialoguegc: 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!