

意見要旨把握問題の自動解答手法に関する研究

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自然言語処理学研究室 久保 大輝

概要

- 取り組んだタスク
- 手法
- 実験
- 結果
- 考察
- まとめ

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取り組んだタスク

- 意見要旨把握問題 (Center test 3C)
 - 議題のテーマが設定されている
 - テーマに従って、登場人物が意見を述べ合う

C 次の会話は、「迷信」をテーマとして、日本のある大学において行われた公開講座でのやりとりの一部である。32 ~ 34 に入れるのに最も適当なものを、それぞれ下の①~④のうちから一つずつ選べ。

Moderator: The title of today's discussion is "Superstitions — what they are, and why people believe in them." Our guest speakers are Joseph Grant, a university professor who lives here in Japan, and Lily Nelson, a visiting professor from Canada. Joseph, can you explain what a superstition is?

Joseph: Superstitions are beliefs for which there is no obvious rational basis. For example, there are various dates and numbers that people are superstitious about. In many places, "Friday the 13th" is thought to be unlucky, and here in Japan, 4 and 9 are also considered unlucky. In contrast, 7 is known as "Lucky 7." A superstitious person believes that actions such as choosing or avoiding certain numbers can influence future events even though there is no direct connection between them. Believing in superstitions is one of the ways humans can make sense of a set of unusual events which cause someone to feel lucky or unlucky. This seems to have been true throughout history, regardless of race or cultural background.

Moderator: So, it is your view that 32 .

- ① superstitions are rationally based on certain dates and numbers
- ② superstitions can be used to explain strange happenings around us
- ③ superstitious people believe race and culture are related to luck
- ④ superstitious people tend to have identical beliefs regarding history

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▪ Josephさんの意見

▪ 選択肢

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⇒4つの選択肢の中から、
登場人物の意見の要約となる選択肢を当てる問題

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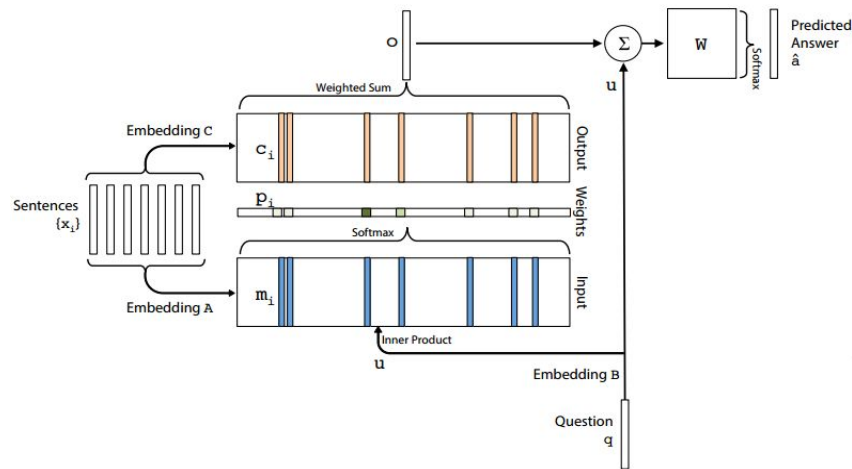
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ベースとなる手法

- End-To-End Memory Networks [Sukhbaatar 15]



ベースとなる手法

- End-To-End Memory Networks [Sukhbaatar 15]

- 与えられたストーリー(文脈)を記憶し、
質問に対して回答するフレームワーク

- タスク: QA (20 Toy task)

- Task1 : Single Supporting Fact

- Task 20: Agent's Motivations

e.g. Task1

Story:

Mary went to the bathroom.
John moved to the hallway.
Mary travelled to the office.

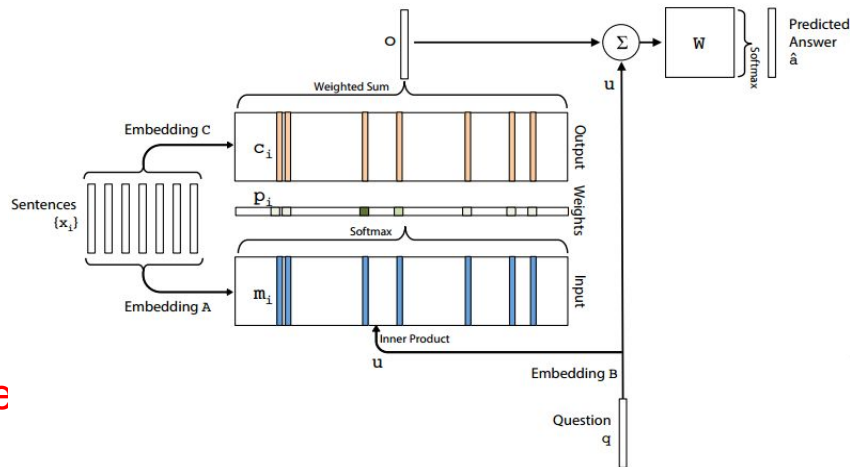
Question:

Where is Mary?

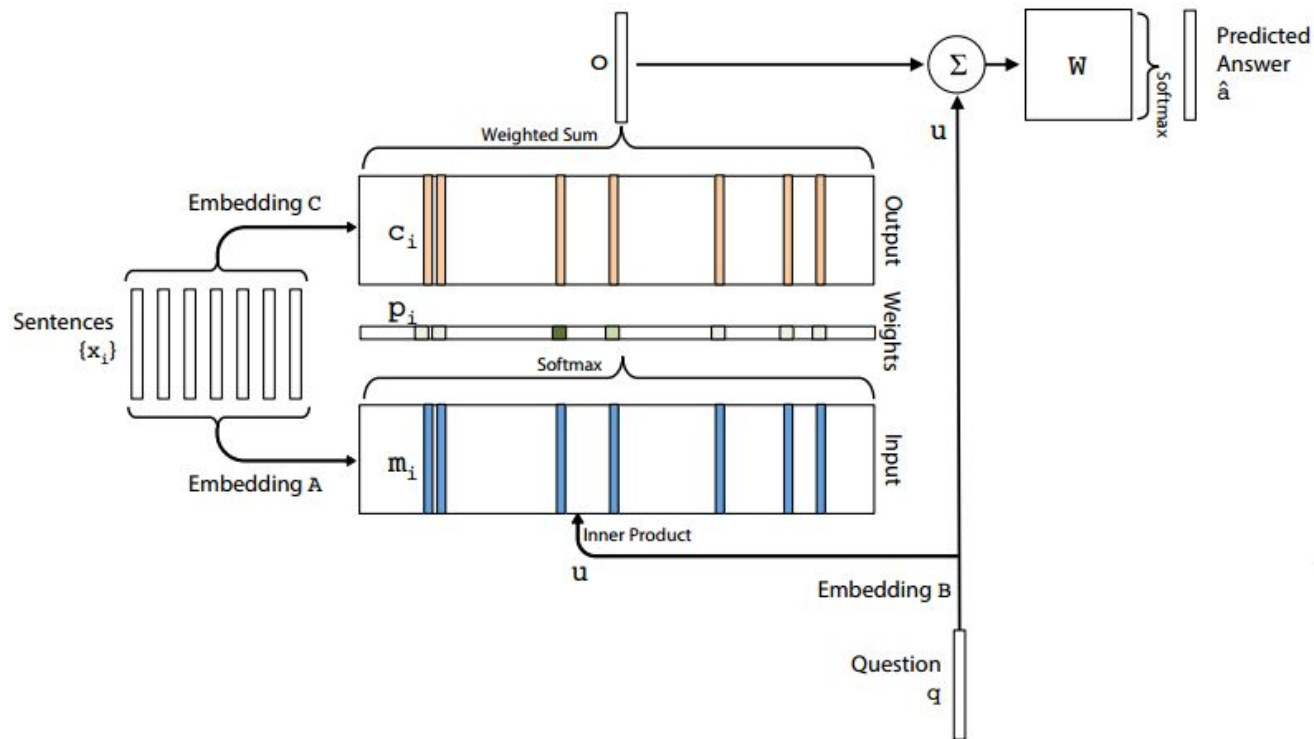
A: office

- 文脈を把握することができる

⇒今回のタスク(意見要旨把握)でも
適用できそう?

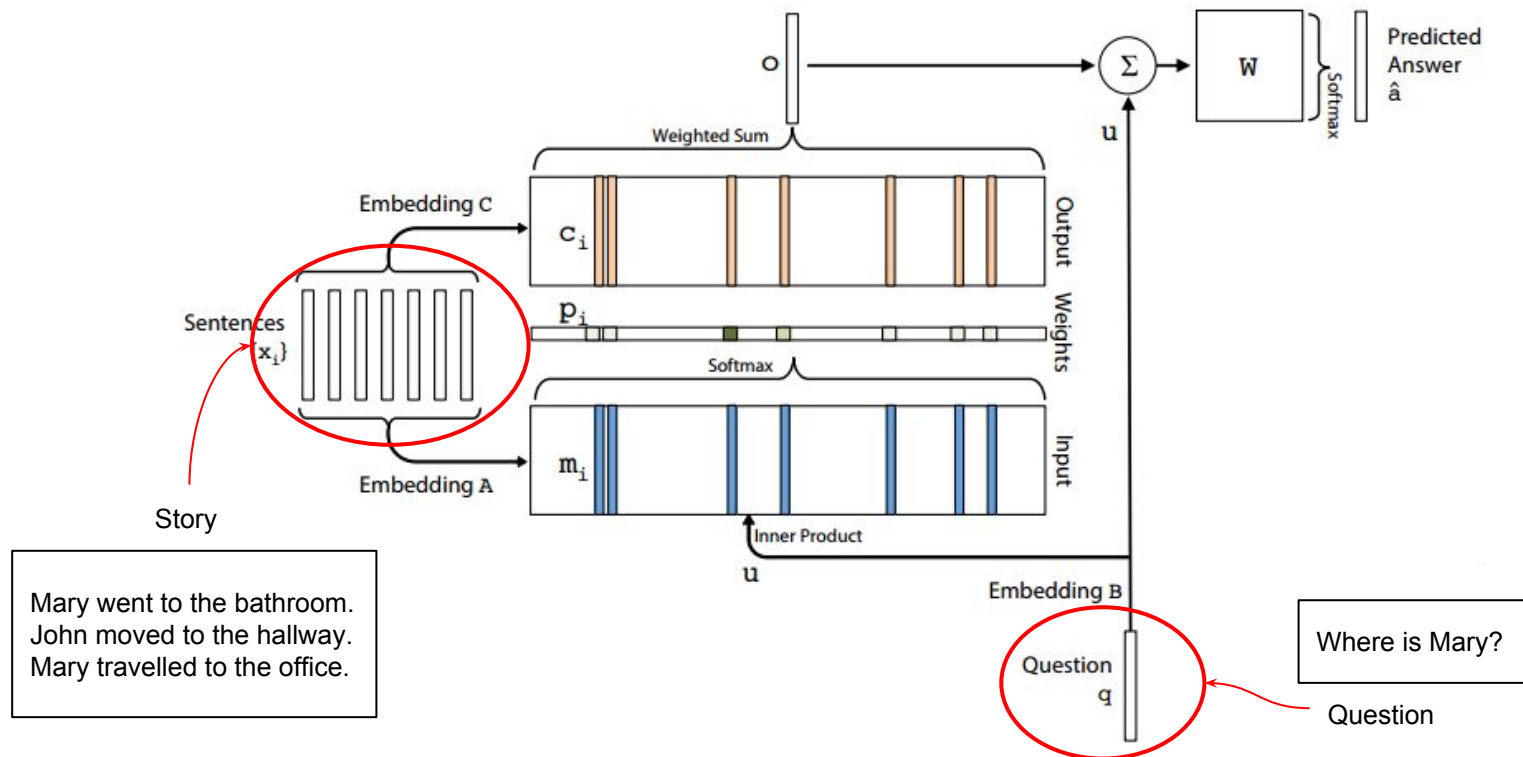


モデル概要



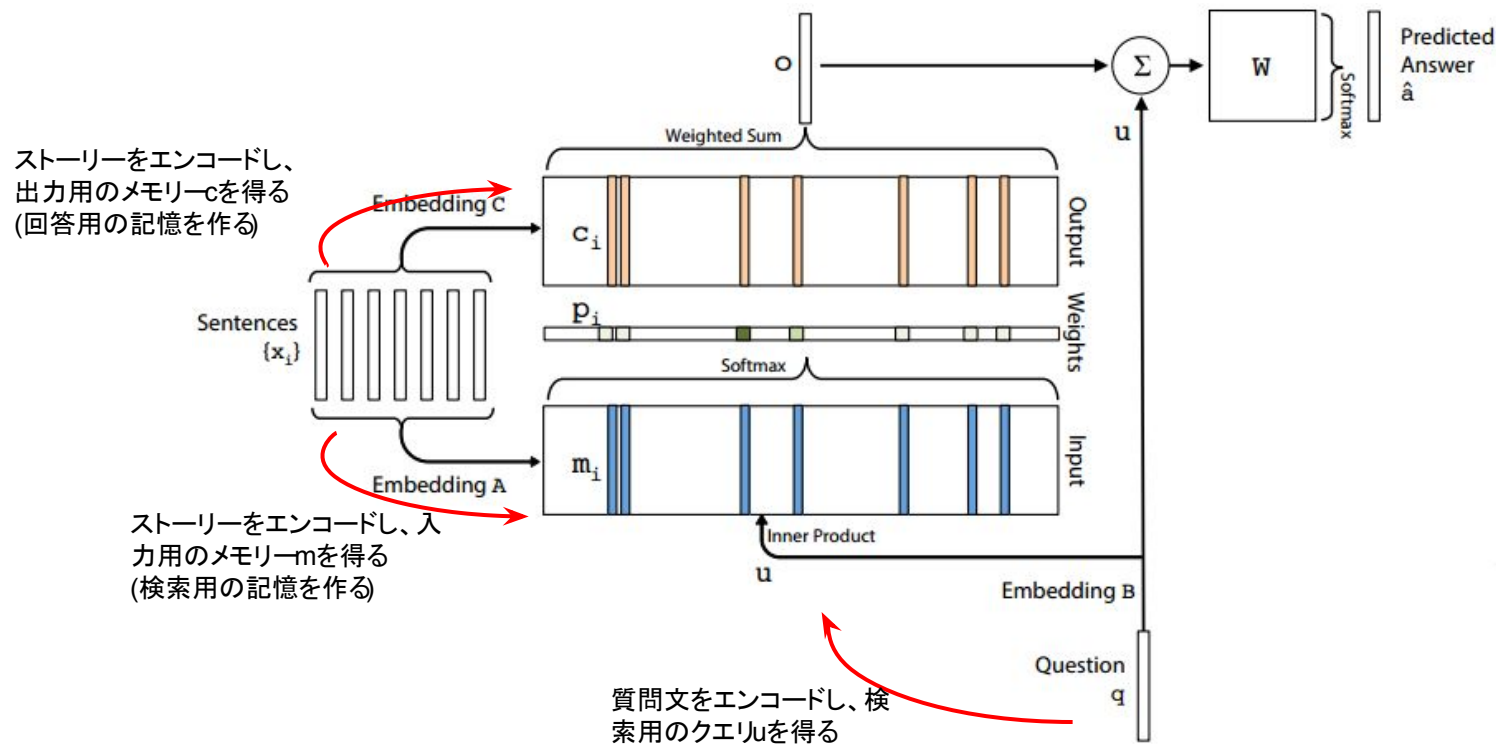
(図は論文から引用)

モデル概要



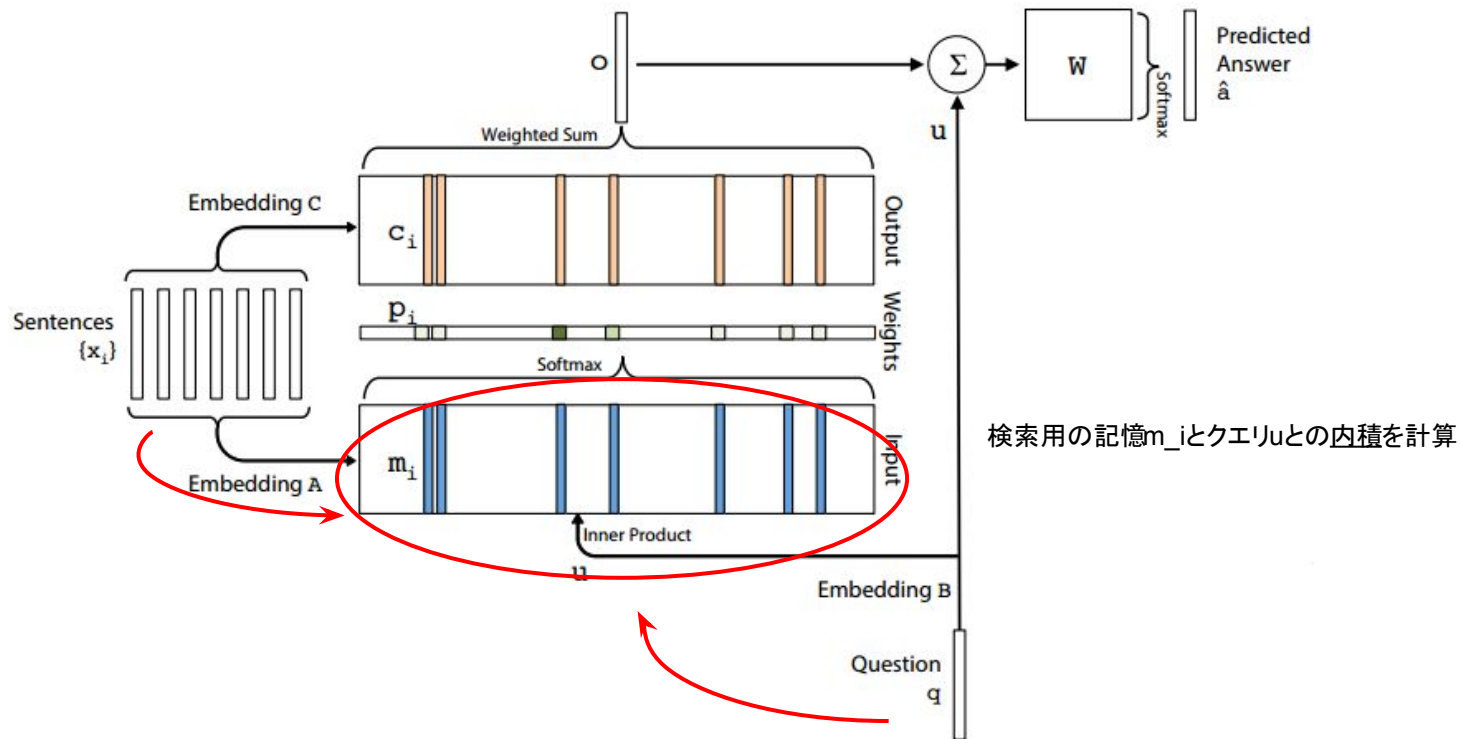
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モデル概要



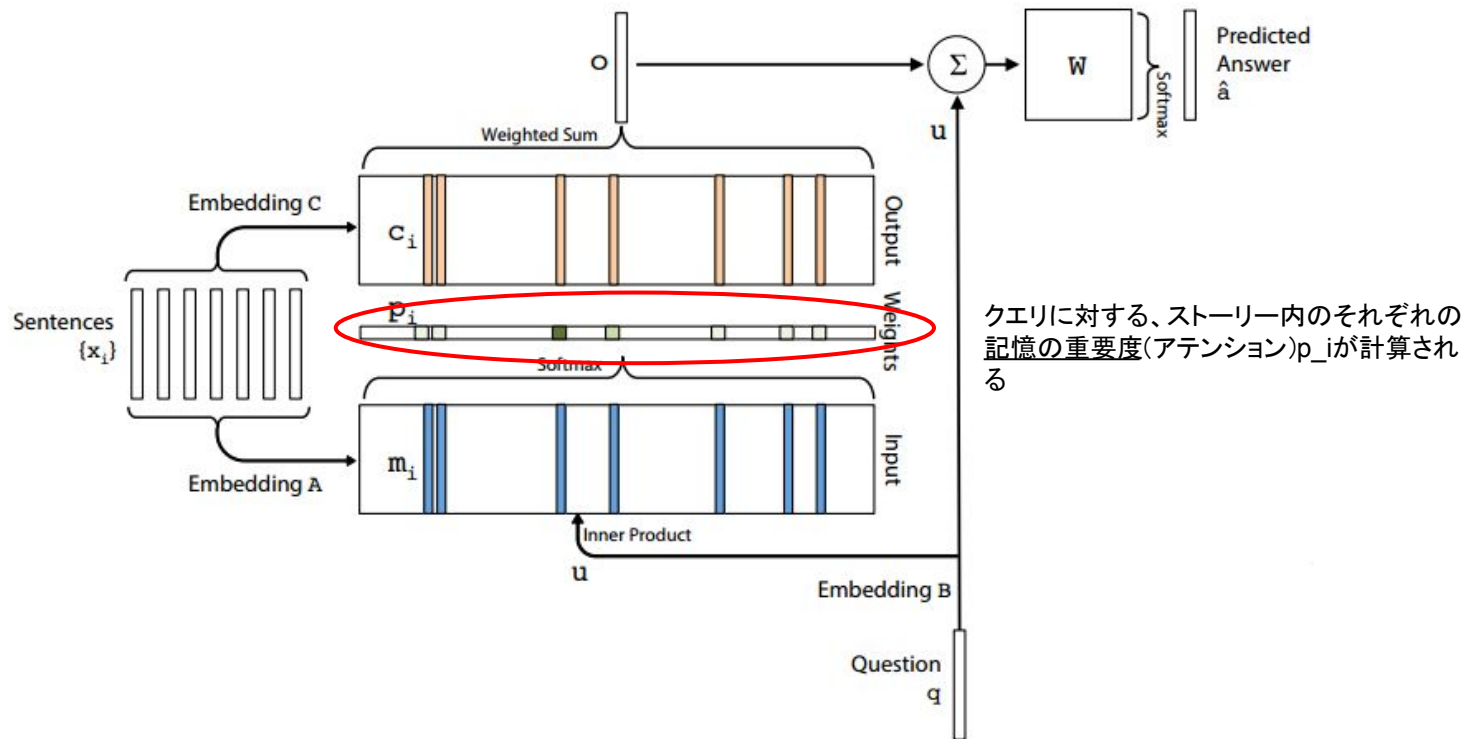
(図は論文から引用)

モデル概要



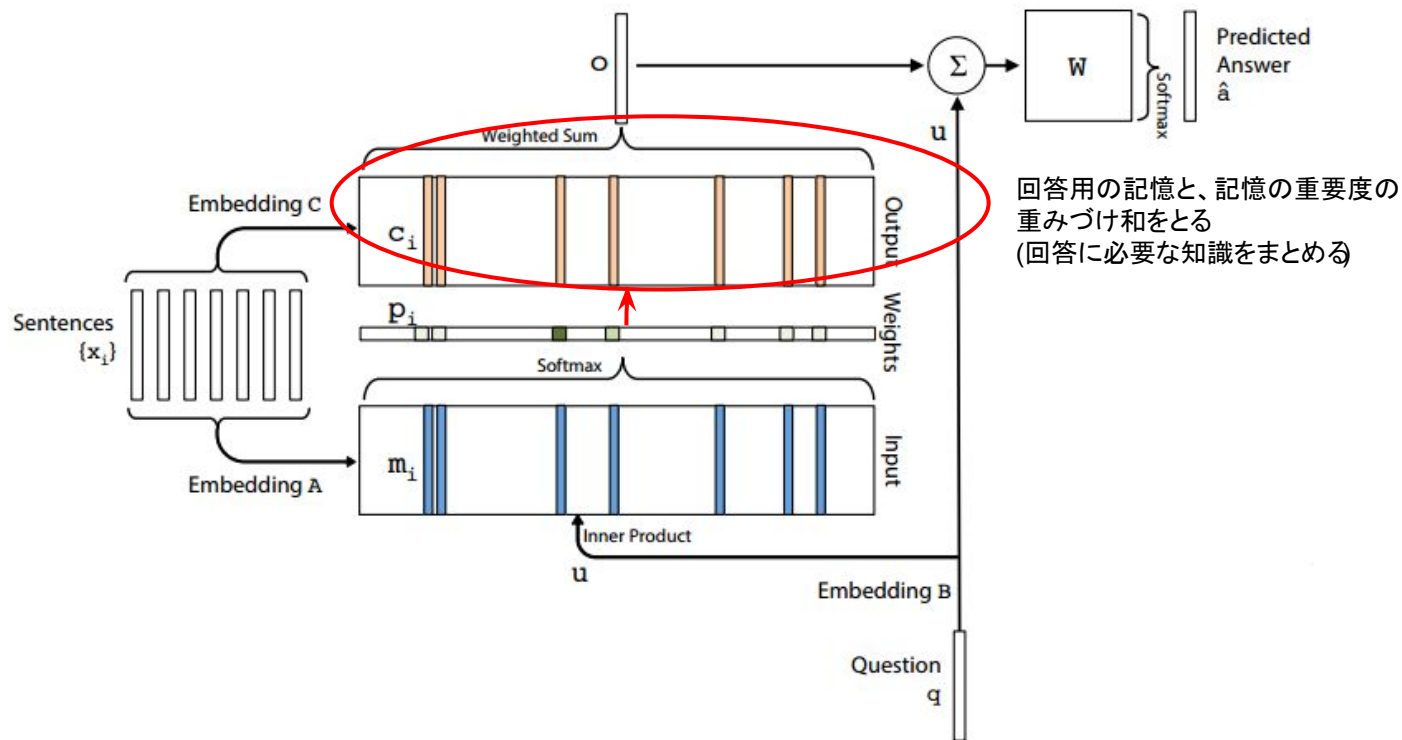
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モデル概要



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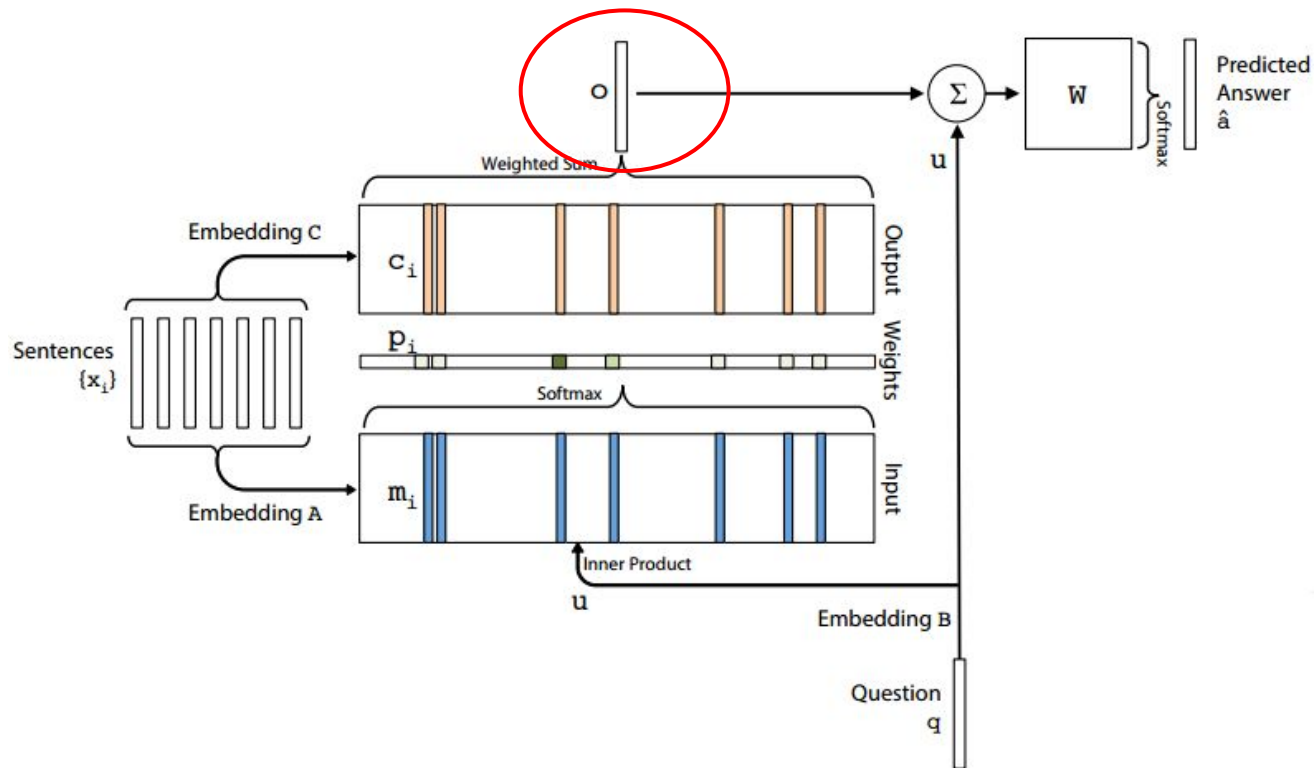
モデル概要



(図は論文から引用)

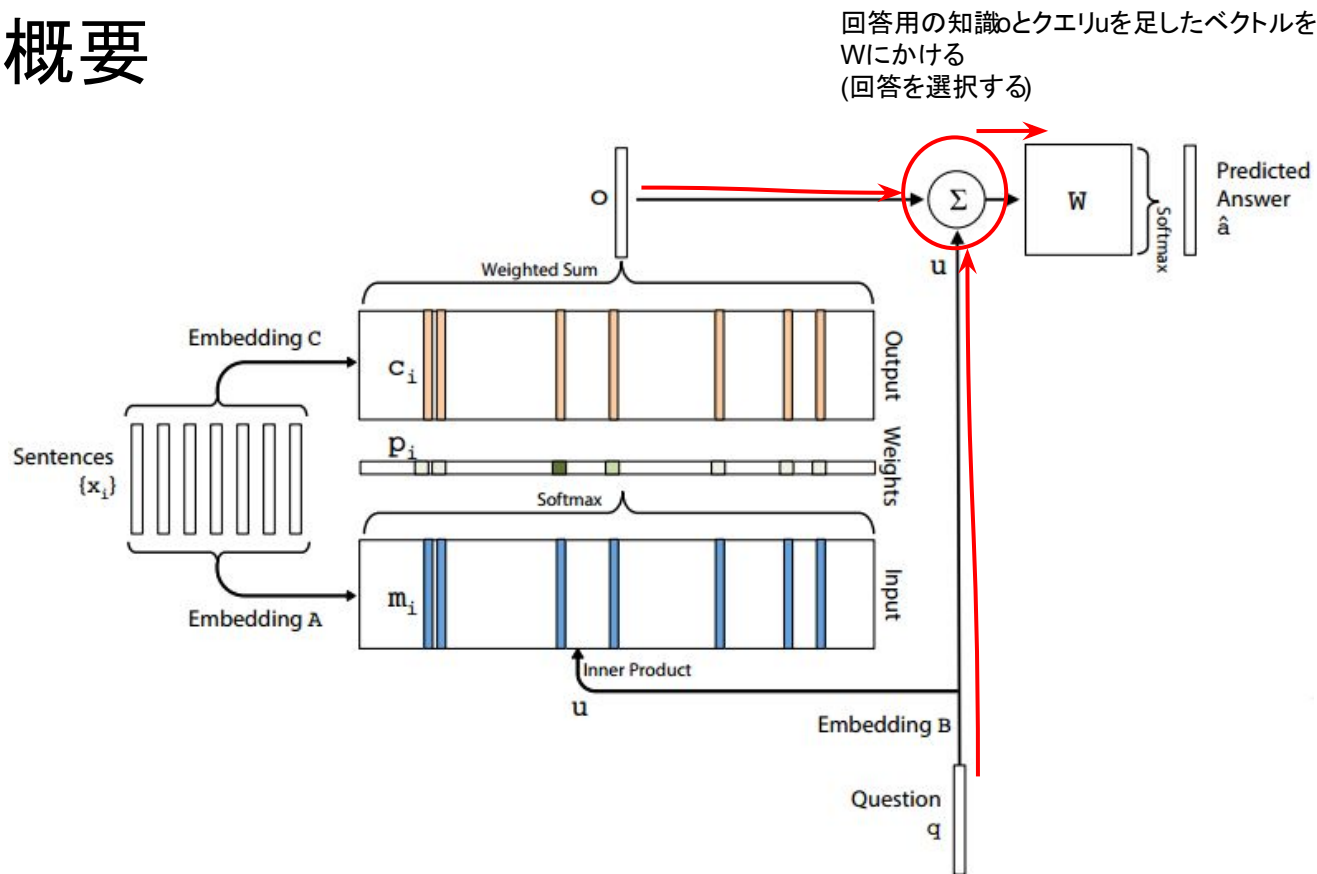
モデル概要

回答に必要な知識がまとまっている
ベクトル u を得る

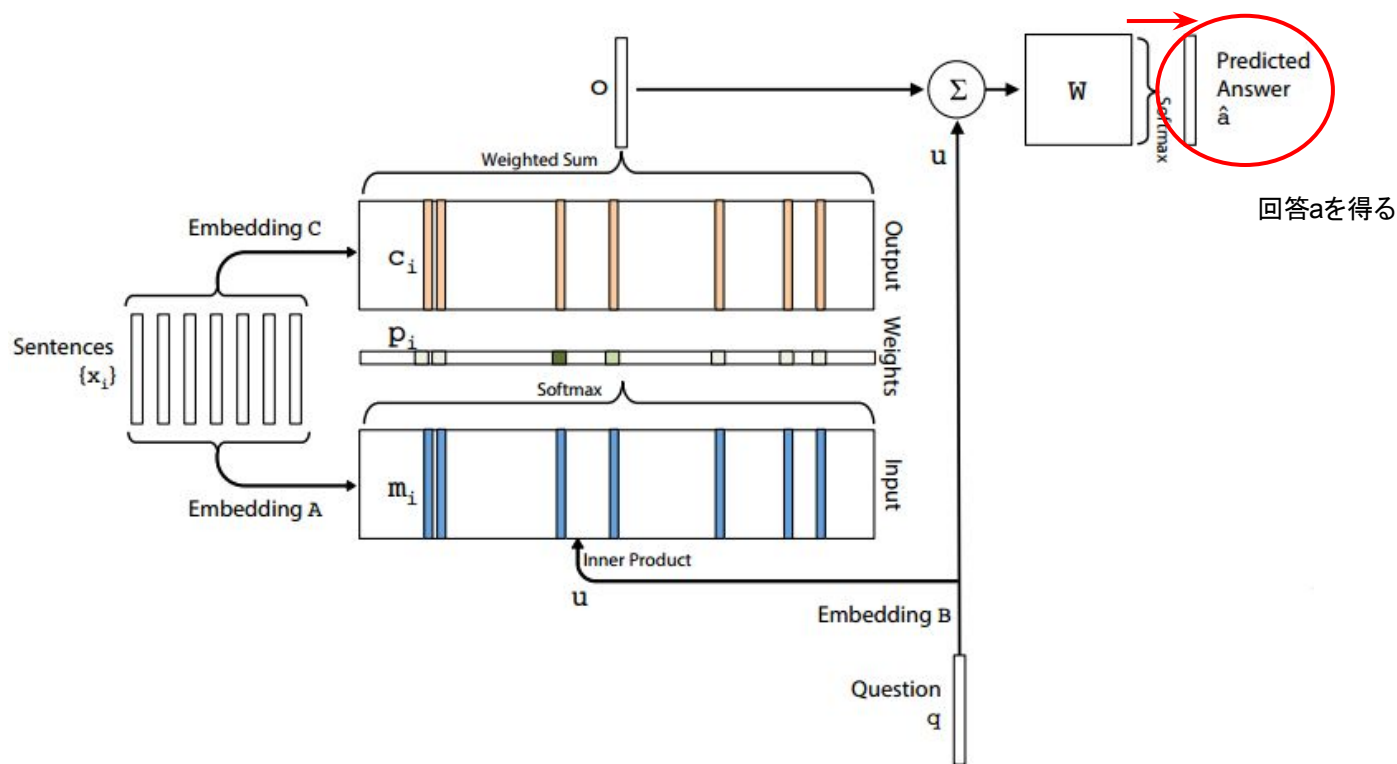


(図は論文から引用)

モデル概要



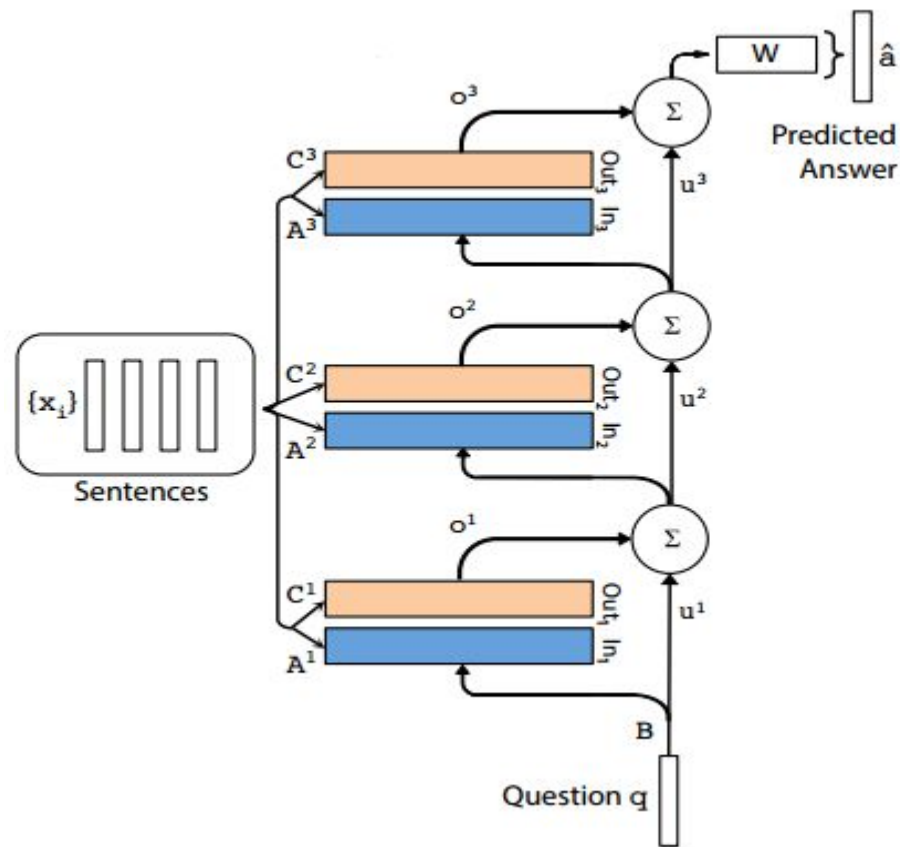
モデル概要



(図は論文から引用)

モデル図

- 多層化 (3層)
 - 前の層の出力を入力に使う
- このモデルを実装
 - chainer



(図は論文から引用)

#	Task	paper	Implementation (on chainer)	#	Task	paper	Implementation (on chainer)
1	Single supporting fact	0.999	0.963	11	Basic coreference	0.7	0.863
2	Two supporting facts	0.572	0.303	12	Conjunction	0.899	0.9
3	Three supporting facts	0.236	0.24	13	Compound coreference	0.803	0.926
4	Two argument relations	0.597	0.674	14	Time Reasoning	0.817	0.333
5	Three argument relations	0.837	0.691	15	Basic deduction	0.352	0.485
6	Yes/No questions	0.49	0.498	16	Basic induction	0.495	0.486
7	Counting	0.639	0.748	17	Positional reasoning	0.491	0.503
8	Lists/Sets	0.622	0.686	18	Size reasoning	0.487	0.516
9	Simple Negation	0.641	0.605	19	Path finding	0	0.097
10	Indefinite Knowledge	0.313	0.462	20	Agent's motivations	0.964	0.915

意見要旨把握問題への適用

- 4つの選択肢を意見に対する質問と考える

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選択肢の内容と意見(記憶)
との一致性を学習する

意見(記憶)

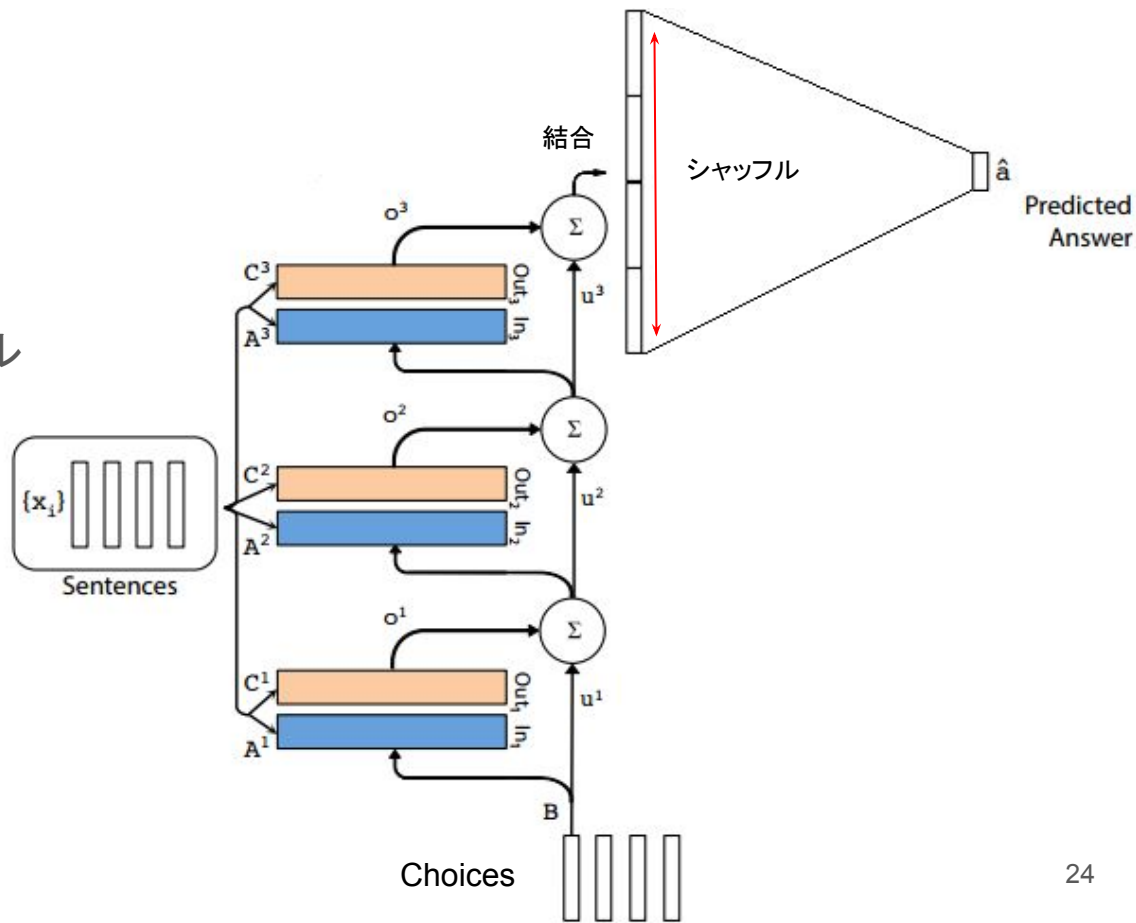
クエリ

ベースモデルの適用

選択肢4つを順番にモデルに入力



モデルの出力として、4つのベクトル
が得られる



ベースモデルの適用

選択肢4つを順番にモデルに入力



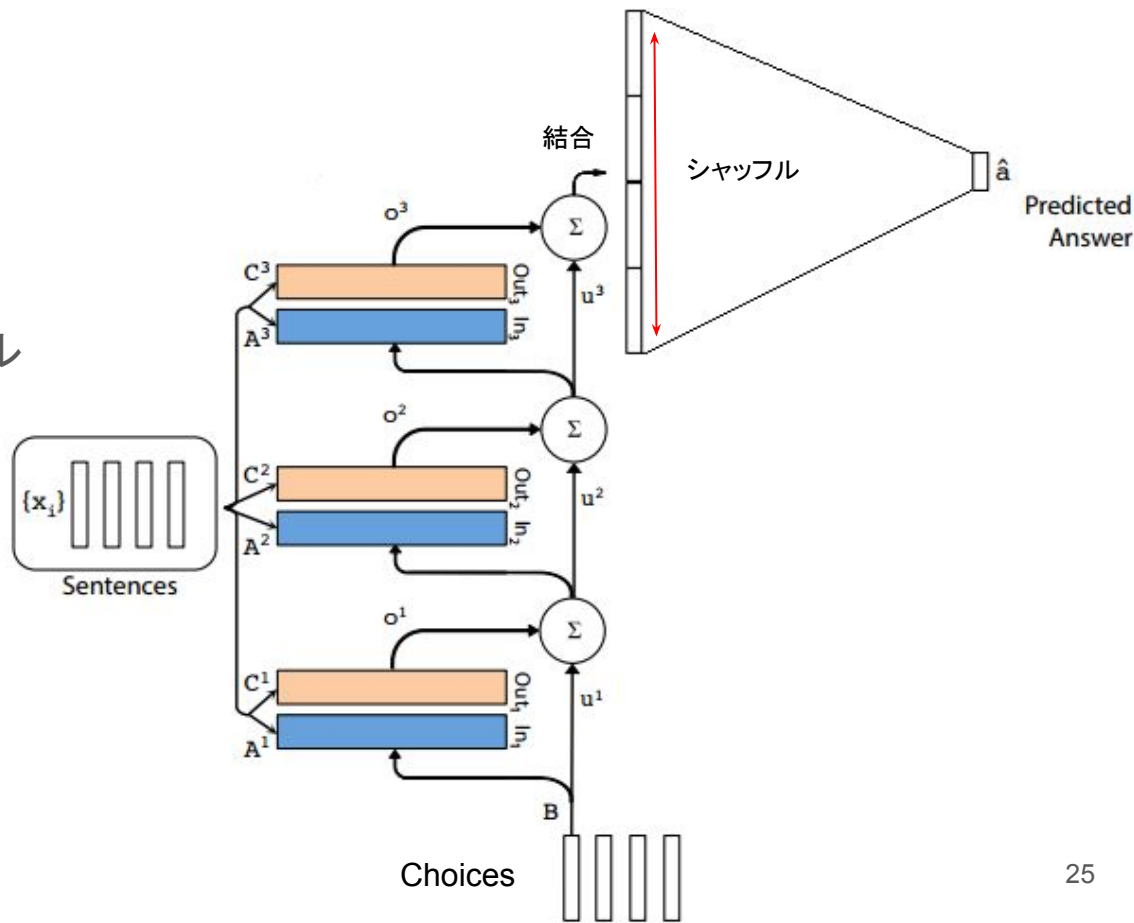
モデルの出力として、4つのベクトル
が得られる



4つのベクトルをシャッフルして
結合(選択肢の順番{1,2,3,4}を
学習に影響させないようにする)



1層のFFNNに入力し、4値分類



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実験設定

- 開発データ
 - 120 paragraph
 - Vocab: 2599
- method
 - Shuffle model
 - Embedding initialization
 - Randomly from a standard normal distribution: 100 dim
 - Pre-train word2vec: 300 dim
 - Dropout 有/無
- Evaluation
 - 10-fold cross validation

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Results

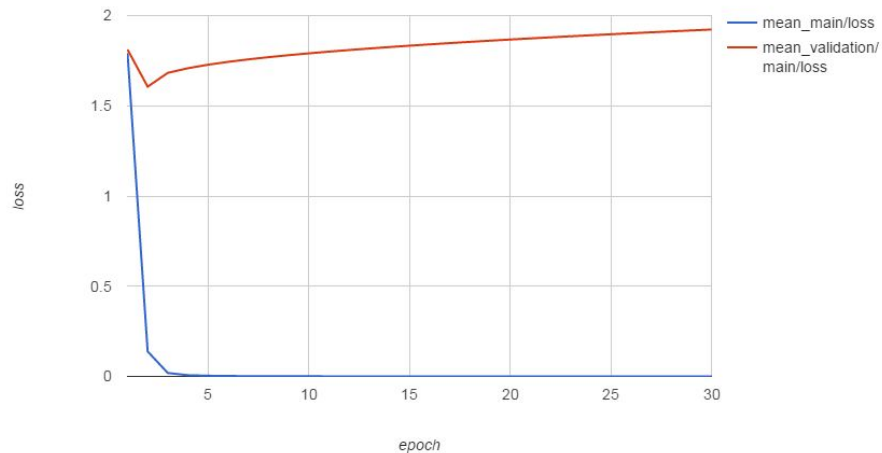
	embedding	
	random	word2vec
正則化なし	0.308	0.267
正則化あり(dropout)	0.225	0.317

Accuracy

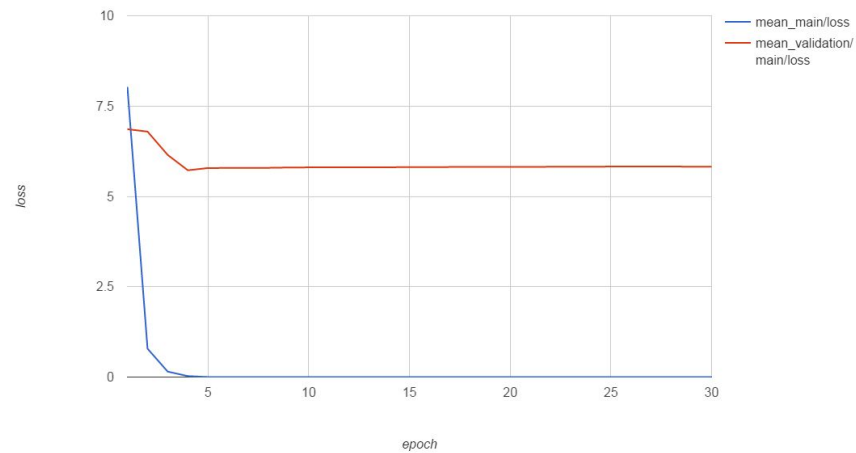
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考察 (正則化)

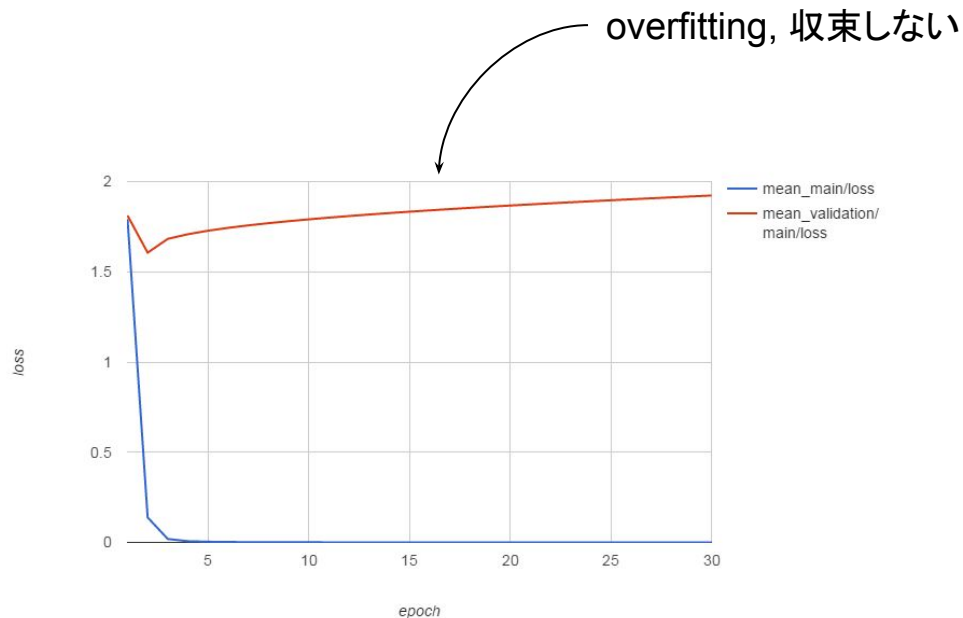


shuffle model, word2vec, 正則化なし

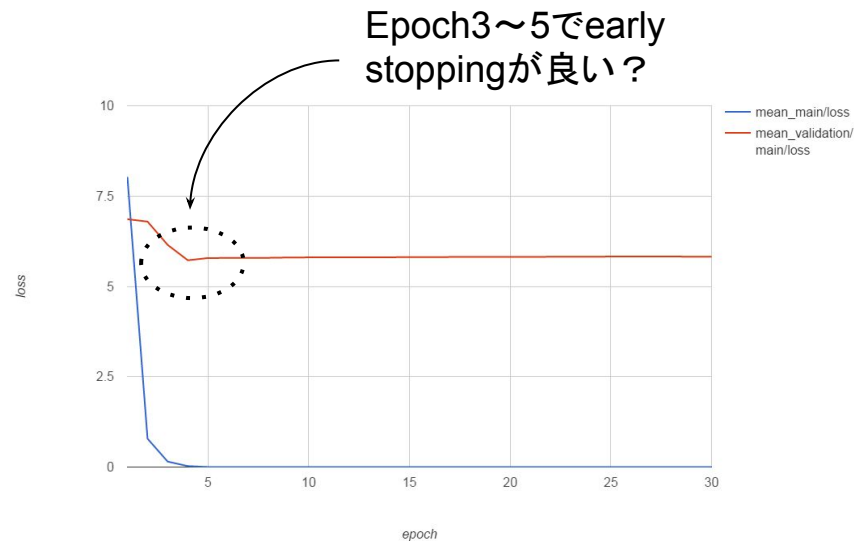


shuffle model, word2vec, ratio=0.2

考察 (正則化)



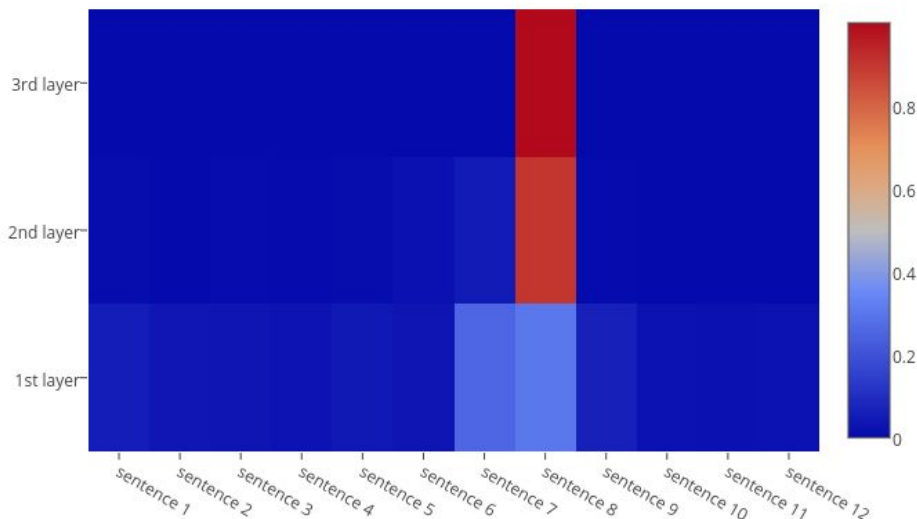
shuffle model, word2vec, 正則化なし



shuffle model, word2vec, ratio=0.2

考察 (attention)

- 回答が正解した例
(入力: 正解の選択肢
モデル: word2vec, dropout)



Sentence 1: Today it's said that reading is an old fashioned way to

spend your time or find information .

Sentence 2: But is this true ?

Sentence 3: I'd like you to state your opinion frankly .

Sentence 4: Jason, would you like to start ?

Sentence 5: Reading is a joy and there 's nothing like settling down with a good book .

Sentence 6: As more and more child of the digital age grow up, e book are likely to be more popular .

Sentence 7: However, there's a big disadvantage to reading book on computer screen: they need power to function .

Sentence 8: A power cut in a desktop computer or just running out of battery power for a notebook computer or e reader will make it impossible for you to keep reading .

Sentence 9: In that sort of situation, a paper book would be preferable, because you don't need any power other than the ability to lift your hand and turn a page .

Sentence 10: Thank you , Jason .

Sentence 11: He point out that % % A % % .

Sentence 12: What do you think , Holly ?

(問題番号が記号で記されている部分)

考察 (attention)

<Choices>

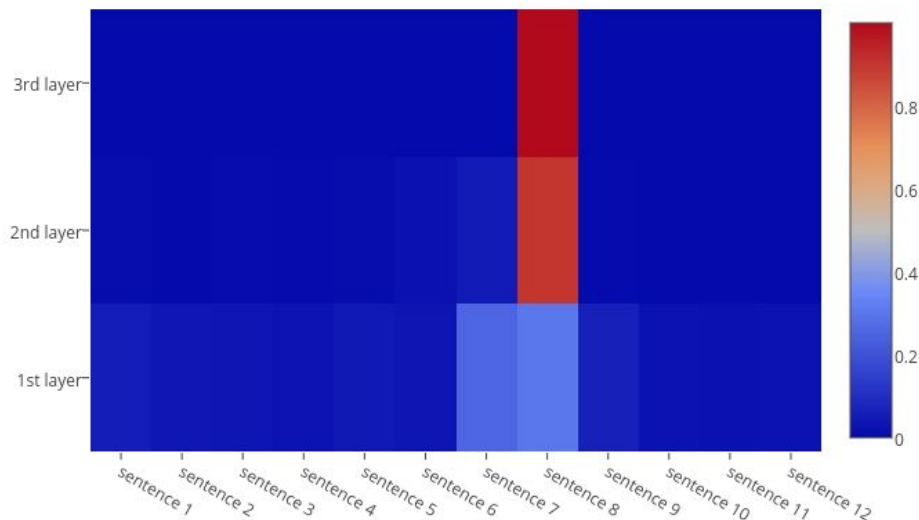
Gold: 3, Predict: 3

1: e book need no electric power .

2: fewer people will use e book or e reader in future year .

3: paper book are better because they don't rely on electric power .

4: paper book will be more popular in future year .



Input: Choice 3

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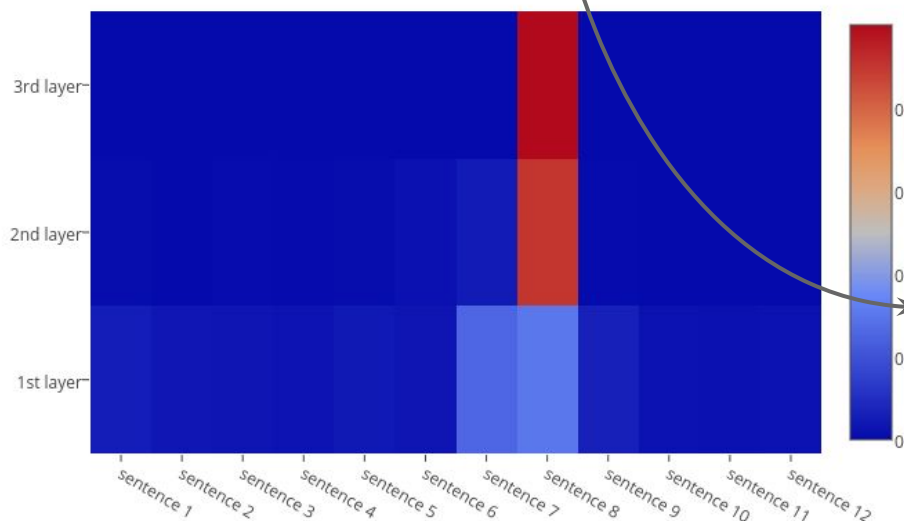
Sentence 11: He point out that % % A % % .

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考察 (attention)

回答に必要な
ない部分

Jasonが意見を
述べている部分



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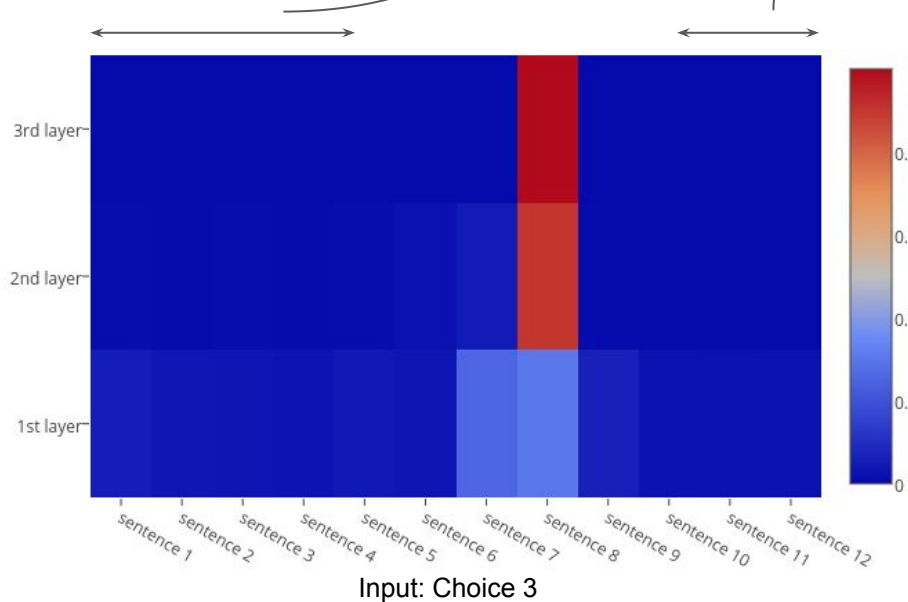
Sentence 11: He point out that % % A % % .

Sentence 12: What do you think , Holly ?

Input: Choice 3

考察 (attention)

回答に必要な部分のアテンションは小さく
なっている
⇒ 選択肢と意味の近い単語が無いため？



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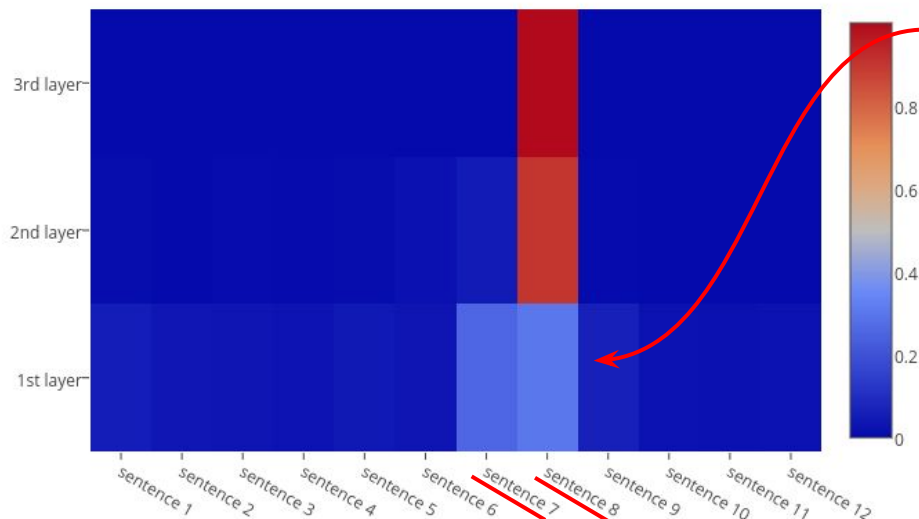
<Choices>

Gold: 3, Predict: 3

(和訳)3: 紙の本は、電力に頼らなくてよいので良い

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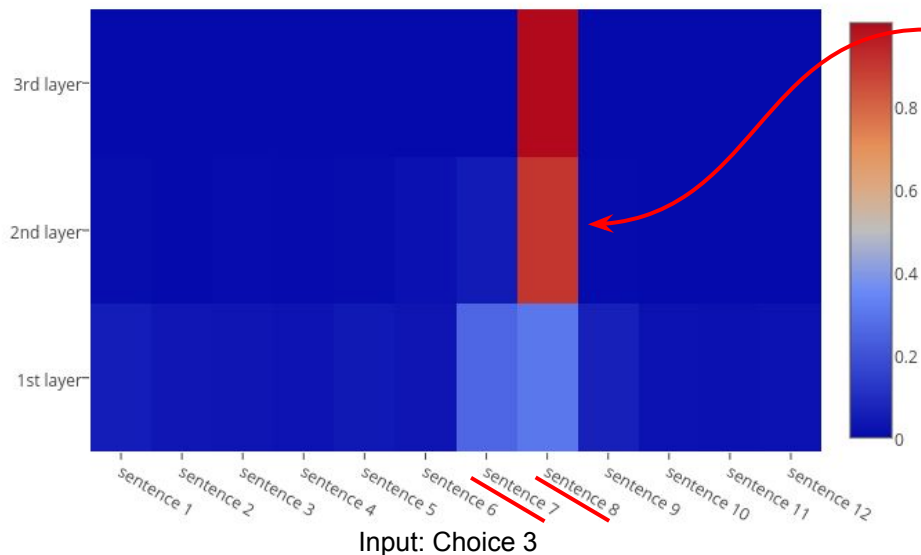
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文7だけの情報でも答えられないことはないが、情報量が不十分
⇒ しかし、文8の情報の方が確実
⇒ 文8のattentionが増加?

考察 (attention)

<Choices>

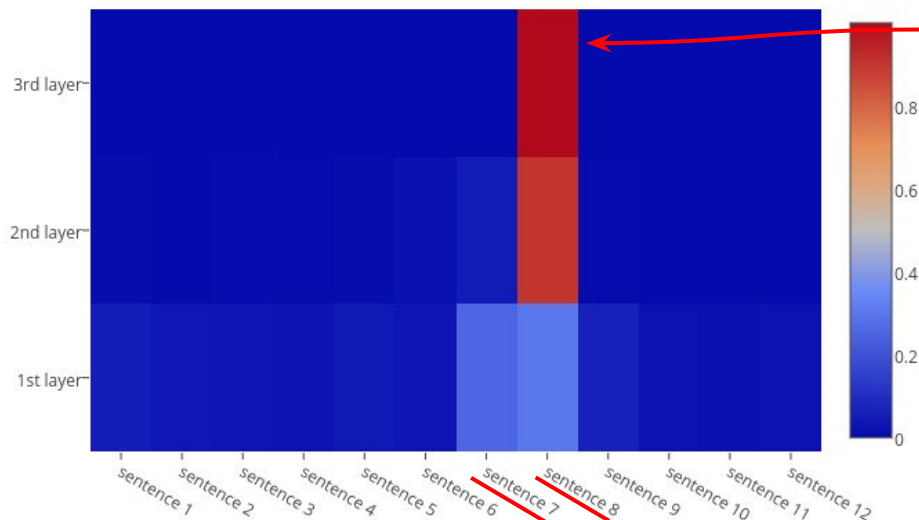
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4: paper book will be more popular in future year .



Input: Choice 3

Sentence 1: Today it's said that reading is an old fashioned way to

spend your time or find information .

Sentence 2: But is this true ?

Sentence 3: I'd like you to state your opinion frankly .

Sentence 4: Jason, would you like to start ?

Sentence 5: Reading is a joy and there 's nothing like settling down with a good book .

Sentence 6: As more and more child of the digital age grow up, e book are likely to be more popular .

Sentence 7: However, there's a big disadvantage to reading book on computer screen: they need power to function .

Sentence 8: A power cut in a desktop computer or just running out of battery power for a notebook computer or e reader will make it impossible for you to keep reading .

Sentence 9: In that sort of situation, a paper book would be preferable, because you don't need any power other than the ability to lift your hand and turn a page .

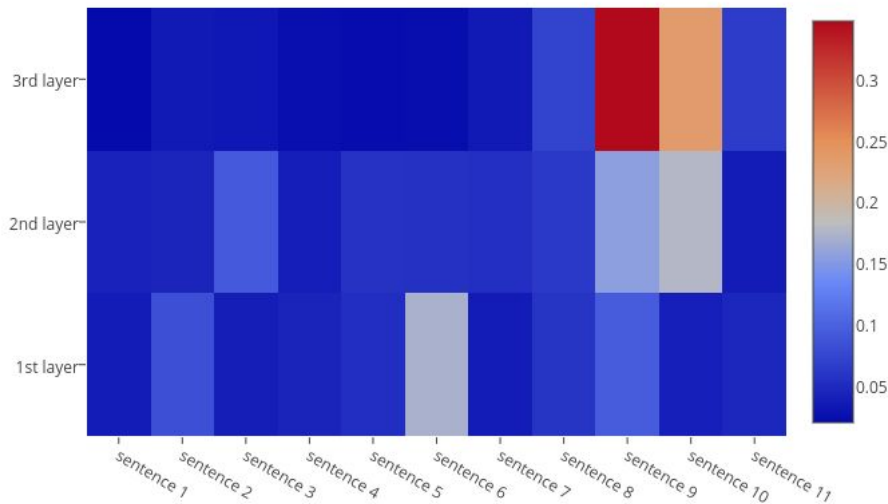
Sentence 10: Thank you , Jason .

Sentence 11: He point out that % % A % % .

Sentence 12: What do you think , Holly ?

考察 (attention)

- 回答が不正解した例
(入力: モデルが正解と判断した選択肢
モデル: word2vec, dropout)



Sentence 1: I agree with Terry .

Sentence 2: Also, we can get a lot out of participating in sporting activity .

Sentence 3: We work at what challenge u and master it .

Sentence 4: We endure the hard training .

Sentence 5: Such experience give u a sense of accomplishment .

Sentence 6: There is meaning in having all the student participating .

Sentence 7: Well, it's just a you say .

Sentence 8: However, there must be student like me who feel inferior at sporting activity .

Sentence 9: I know the most important thing in amateur sport is not the result, but I sometimes play badly under pressure, even if I try to do my best .

Sentence 10: If sport at school become a torture and make u wish to escape from them, we won't be able to enjoy physical activity at school .

Sentence 11: So Lynn, you want to say that % % A % % .

考察 (attention)

- 不正解した例

(入力: モデルが正解と判断した選択時)

```
In [1]: from nltk import stem
In [2]: lemmatizer = stem.WordNetLemmatizer()
In [3]: lemmatizer.lemmatize('us')
Out[3]: u'u'
In [4]: lemmatizer.lemmatize('as')
Out[4]: u'a'
```

3rd layer

2nd layer

1st layer

Sentence 1 Sentence 2 Sentence 3 Sentence 4 Sentence 5 Sentence 6 Sentence 7 Sentence 8 Sentence 9 Sentence 10 Sentence 11

Sentence 1: I agree with Terry .

Sentence 2: Also, we can get a lot out of participating in sporting activity .

Sentence 3: We work at what challenge u and master it .

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Sentence 10: If sport at school become a torture and make u wish to escape from them, we won't be able to enjoy physical activity at school .

Sentence 11: So Lynn, you want to say that % % A % % .

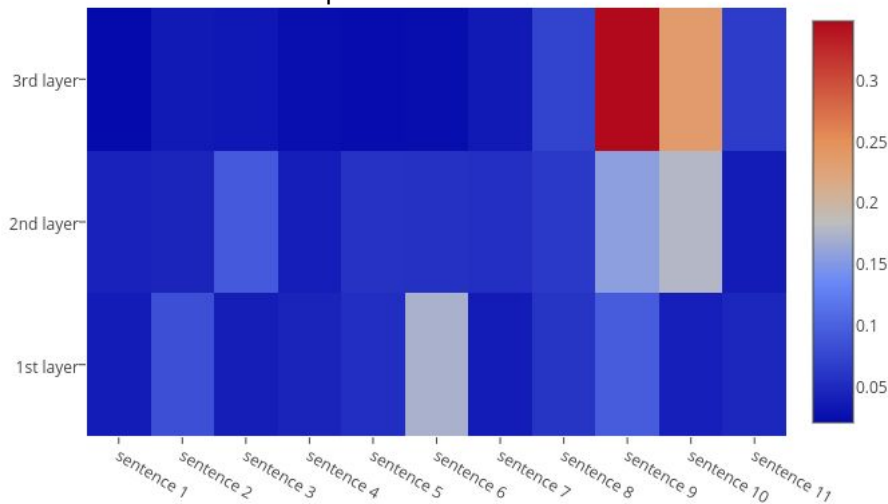
考察 (attention)

<Choices>

Gold: 1, Predict: 2

- 1: participating in sport can be painful to some student .
- 2: participating in sport has no benefit for student .
- 3: sport at school produce unnecessary competition .
- 4: the pressure to win at sport is unhealthy for student .

Input: Choice 2



Sentence 1: I agree with Terry .

Sentence 2: Also, we can get a lot out of participating in sporting activity .

Sentence 3: We work at what challenge us and master it .

Sentence 4: We endure the hard training .

Sentence 5: Such experience give us a sense of accomplishment .

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Sentence 11: So Lynn, you want to say that % % A % % .

考察 (attention)

<Choices>

Gold: 1, Predict: 2

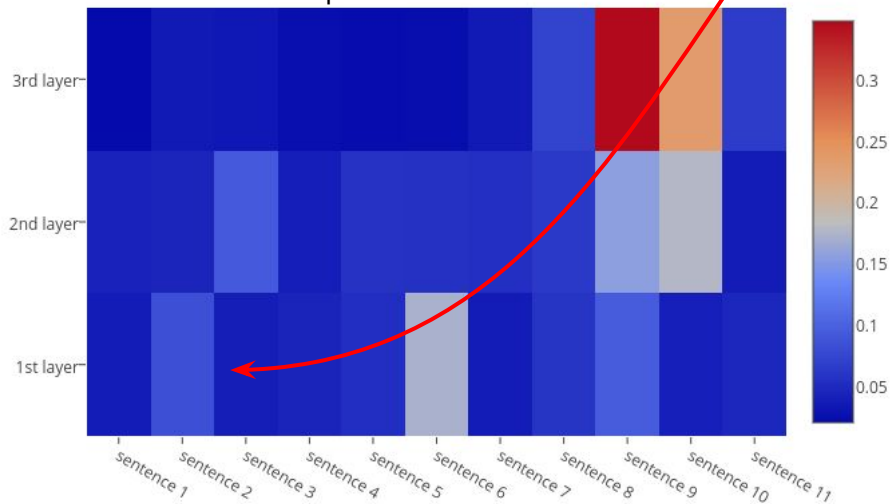
1: participating in sport can be painful to some student .

2: participating in sport has no benefit for student .

(和訳)2: スポーツに参加することは、すべての学生にとって何の利益もない

against

Input: Choice 2



Sentence 1: I agree with Terry .

Sentence 2: Also, we can get a lot out of participating in sporting activity .

(和訳)文2: 私たちは、スポーツ活動に参加することでたくさんのことを得ることができます

Sentence 5: Such experience give us a sense of accomplishment .

Sentence 6: There is meaning in having all the student participating .

Sentence 7: Well, it's just as you say .

Sentence 8: However, there must be student like me who feel inferior at sporting activity .

Sentence 9: I know the most important thing in amateur sport is not the result, but I sometimes play badly under pressure, even if I try to do my best .

Sentence 10: If sport at school become a torture and make u wish to escape from them, we won't be able to enjoy physical activity at school .

Sentence 11: So Lynn, you want to say that % % A % % .

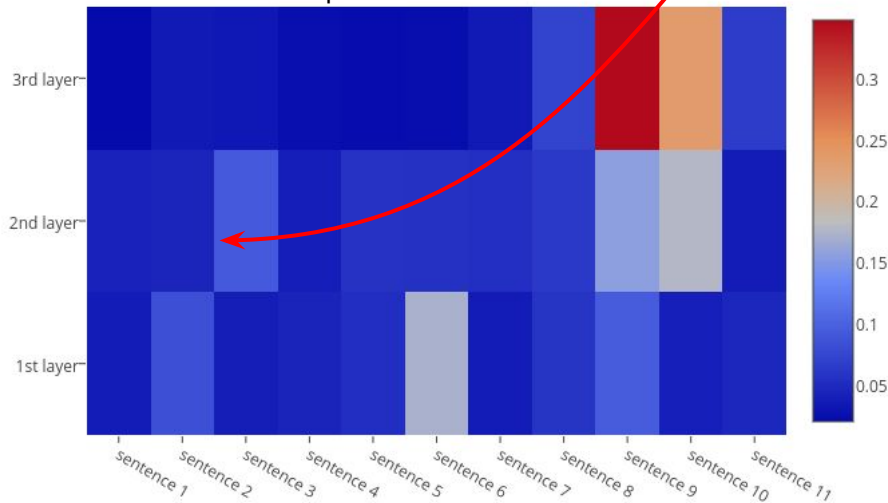
考察 (attention)

<Choices>

Gold: 1, Predict: 2

- 1: participating in sport can be painful to some student .
- 2: participating in sport has no benefit for student .
- 3: sport at school produce unnecessary competition .
- 4: the pressure to win at sport is unhealthy for student .

Input: Choice 2



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Sentence 11: So Lynn, you want to say that % % A % % .

考察 (attention)

<Choices>

Gold: 1, Predict: 2

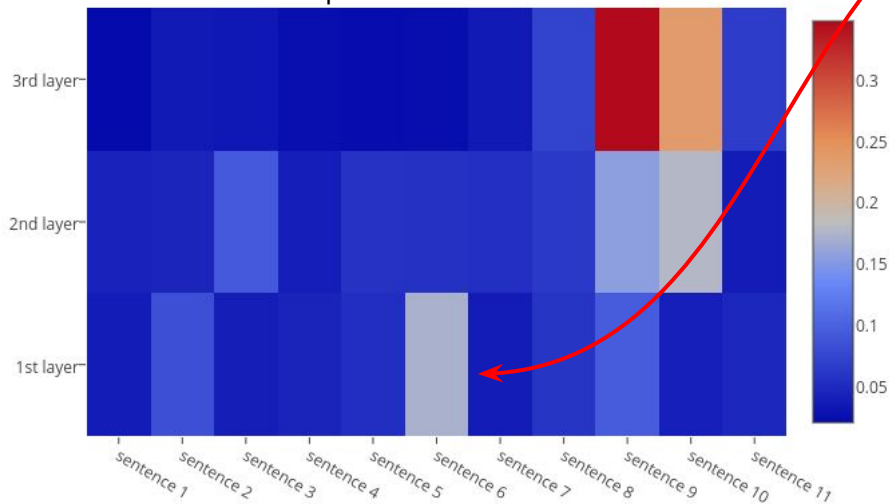
1: participating in sport can be painful to some student .

2: participating in sport has no benefit for student .

(和訳)2: スポーツに参加することは、すべての学生にとって何の利益もない

against

Input: Choice 2



Sentence 1: I agree with Terry .

Sentence 2: Also, we can get a lot out of participating in sporting activity .

Sentence 3: We work at what challenge us and master it .

Sentence 4: We endure the hard training

(和訳)文6: すべての学生が参加することに意味を持ちます

Sentence 6: There is meaning in having all the student participating .

Sentence 7: Well, it's just as you say .

Sentence 8: However, there must be student like me who feel inferior at sporting activity .

Sentence 9: I know the most important thing in amateur sport is not the result, but I sometimes play badly under pressure, even if I try to do my best .

Sentence 10: If sport at school become a torture and make u wish to escape from them, we won't be able to enjoy physical activity at school .

Sentence 11: So Lynn, you want to say that % % A % % .

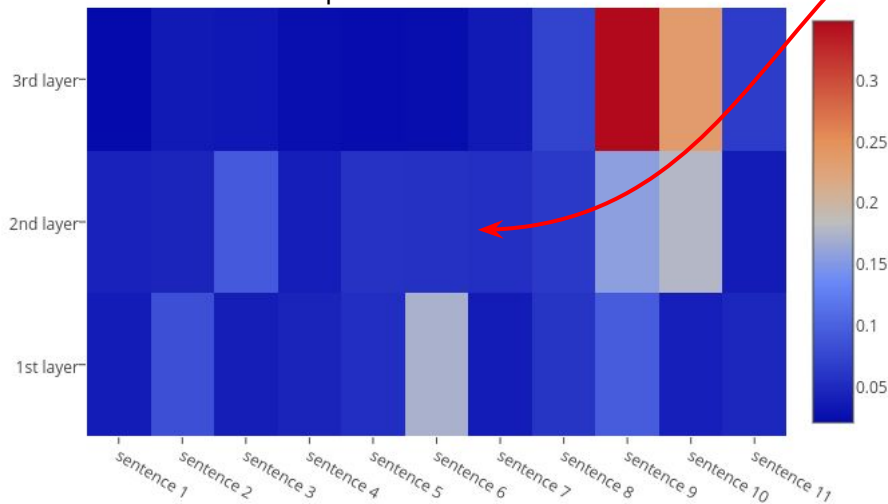
考察 (attention)

<Choices>

Gold: 1, Predict: 2

- 1: participating in sport can be painful to some student .
- 2: participating in sport has no benefit for student .
- 3: sport at school produce unnecessary competition .
- 4: the pressure to win at sport is unhealthy for student .

Input: Choice 2



Sentence 1: I agree with Terry .

Sentence 2: Also, we can get a lot out of participating in sporting activity .

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Sentence 10: If sport at school become a torture and make u wish to escape from them, we won't be able to enjoy physical activity at school .

Sentence 11: So Lynn, you want to say that % % A % % .

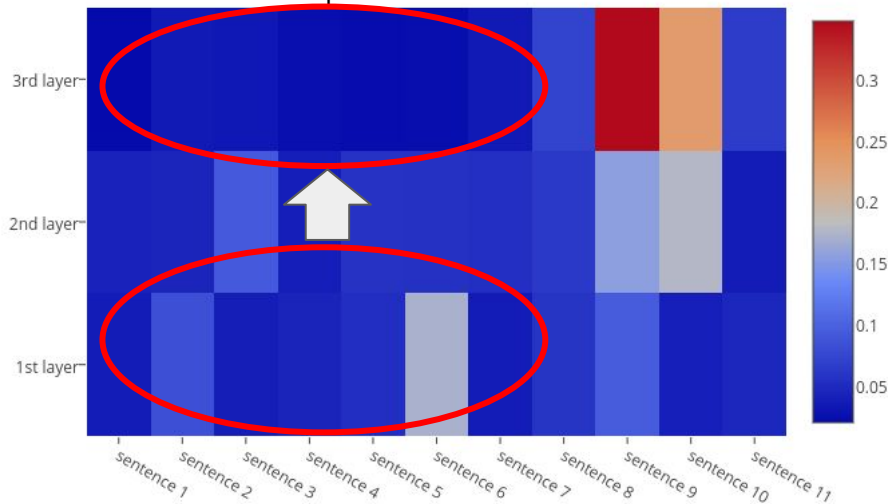
考察 (attention)

<Choices>

Gold: 1, Predict: 2

- 1: participating in sport can be painful to some student .
- 2: participating in sport has no benefit for student .
- 3: sport at school produce unnecessary competition .
- 4: the pressure to win at sport is unhealthy for student .

Input: Choice 2



Sentence 1: I agree with Terry .

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Sentence 10: If sport at school become a torture and make u wish to escape from them, we won't be able to enjoy physical activity at school .

Sentence 11: So Lynn, you want to say that % % A % % .

Sentence 1～6 はchoice 2の内容と矛盾している

⇒ attentionが小さくなるべき

⇒ 正しく学習できている

考察 (attention)

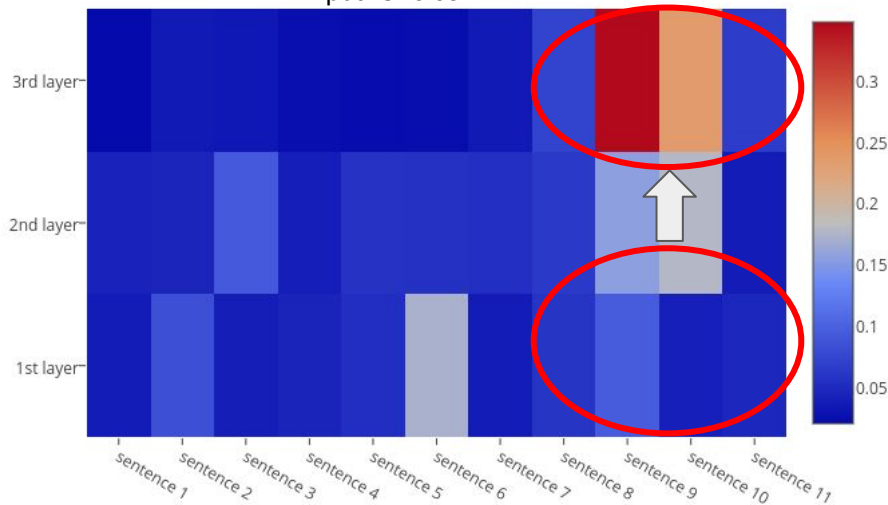
<Choices>

Gold: 1, Predict: 2

- 1: participating in sport can be painful to some student .
- 2: participating in sport has no benefit for student .
- 3: sport at school produce unnecessary competition .
- 4: the pressure to win at sport is unhealthy for student .

スポーツに参加すること: 否定的

Input: Choice 2



Sentence 1: I agree with Terry .

Sentence 2: Also, we can get a lot out of participating in sporting activity .

Sentence 3: We work at what challenge us and master it .

Sentence 4: We endure the hard training .

Sentence 5: Such experience give us a sense of accomplishment .

Sentence 6: There is meaning in having all the participating .
as you say .

Sentence 8: However, there must be student like me who feel inferior at sporting activity .

Sentence 9: I know the most important thing in amateur sport is not the result, but I sometimes play badly under pressure, even if I try to do my best .

Sentence 10: If sport at school become a torture and make u wish to escape from them, we won't be able to enjoy physical activity at school .

Sentence 11: So Lynn, you want to say that % % A % % .

Sentence 8~10 はchoice 2の内容と一致している

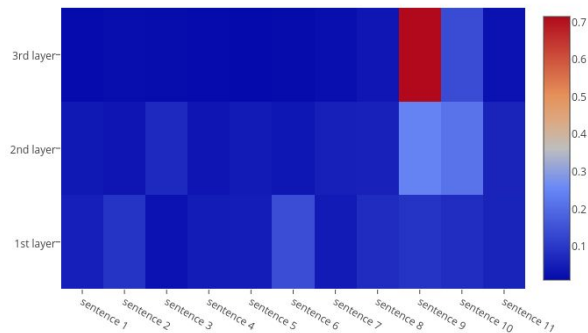
⇒ attentionが大きくなっている

⇒ 正しく学習できている

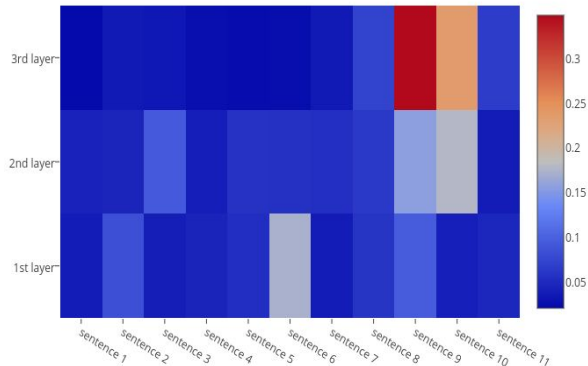
⇒ なぜ回答を間違えたのか？

考察 (attention)

Input: Choice 1



Input: Choice 2



•
•
Sentence 8: However, there must be student like me who feel inferior at sporting activity .

Sentence 9: I know the most important thing in amateur sport is not the result, but I sometimes play badly under pressure, even if I try to do my best .

Sentence 10: If sport at school become a torture and make us wish to escape from them, we won't be able to enjoy physical activity at school .

<Choices>

Gold: 1, Predict: 2

1: participating in sport can be painful to some student .

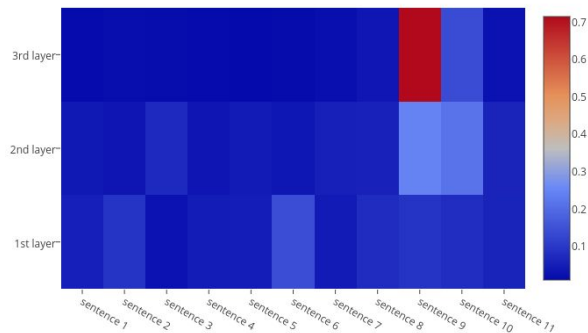
2: participating in sport has no benefit for student .

○ 意見との一致性: choice1 < choice2 とモデルが判断

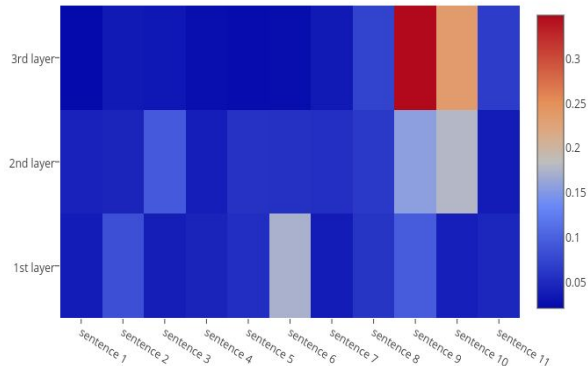
○ なぜ?

考察 (attention)

Input: Choice 1



Input: Choice 2



•
•
Sentence 8: However, there must be student like me who feel inferior at sporting activity .

Sentence 9: I know the most important thing in amateur sport is not the result, but I sometimes play badly under pressure, even if I try to do my best .

Sentence 10: If sport at school become a torture and make u wish to escape from them, we won't be able to enjoy physical activity at school .

•
•

<Choices>

Gold: 1, Predict: 2

1: participating in sport can be painful to some student .

2: participating in sport has no benefit for student .

○ 意見との一致性: choice1 < choice2 とモデルが判断

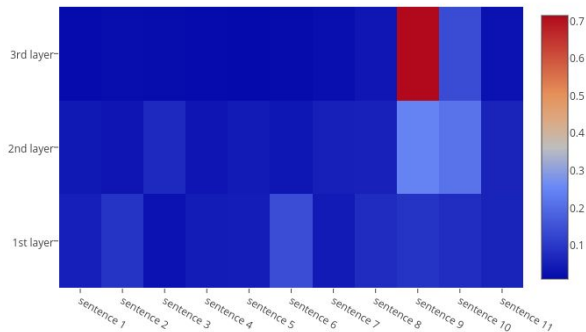
○ なぜ?

⇒ participating in sport can be painful と participating in sport has no benefit はそもそも意味が近い

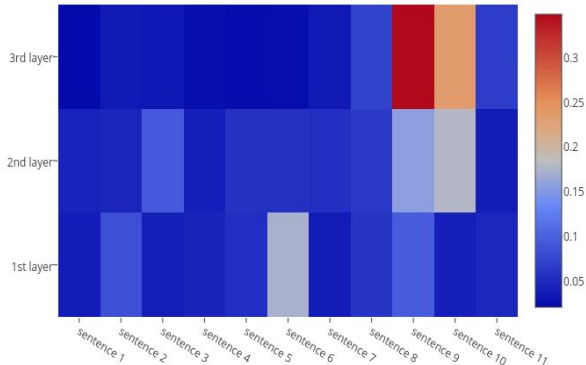
⇒ to some student と for student が選択肢の差異

考察 (attention)

Input: Choice 1



Input: Choice 2



⋮
Sentence 8: However, there must be student like me who feel inferior at sporting activity .

Sentence 9 (和訳)文8: しかしながら、私のようなスポーツ活動を苦手に感じる学生もきっといるに違いありません。

Sentence 10: If sport at school become a torture and make u wish to escape from them, we won't be able to enjoy physical activity at school .

⋮
sentence 8 を見れば、to some student であると答えられるはず

<Choices>

Gold: 1, Predict: 2

1: participating in sport can be painful to some student .

2: participating in sport has no benefit for student .

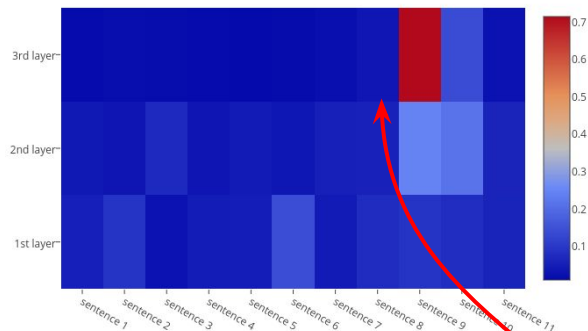
○ 意見との一致性: choice1 < choice2 とモデルが判断

○ なぜ?

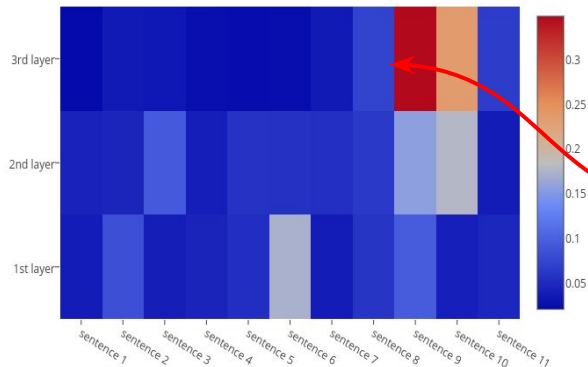
⇒ to some student と for student が選択肢の差異

考察 (attention)

Input: Choice 1



Input: Choice 2



⋮
Sentence 8: However, there must be student like me who feel inferior at sporting activity .

Sentence 9: I know the most important thing in amateur sport is not the result, but I sometimes play badly under pressure, even if I try to do my best .

Sentence 10: If sport at school become a torture and make u wish to escape from them, we won't be able to enjoy physical activity at school .
⋮

<Choices>

Gold: 1, Predict: 2

1: participating in sport can be painful to some student .

2: participating in sport has no benefit for student .

○ 意見との一致性: choice1 < choice2 とモデルが判断

○ なぜ?

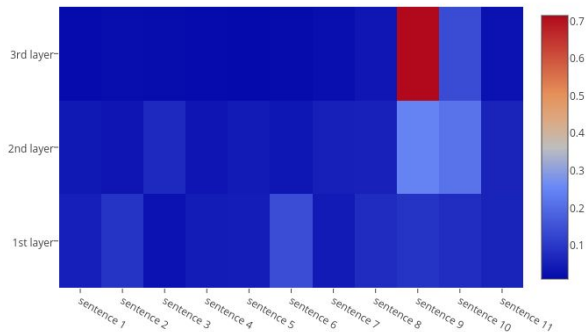
⇒ choice 1, 2ともに、sentence 8 に対するattentionが小さくなっている

⇒ フレーズレベルの表現までは学習できない?

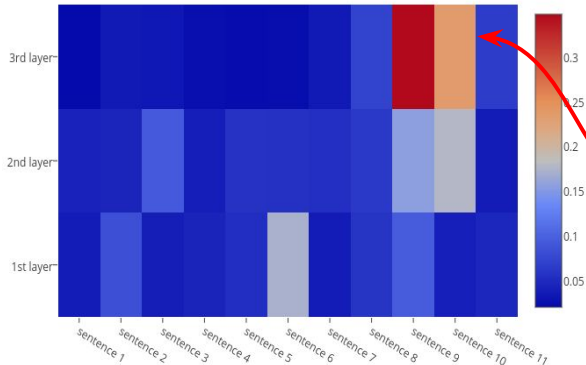
(There must be ~: きっといるに違いない)

考察 (attention)

Input: Choice 1



Input: Choice 2



(和訳)文9: アマチュアスポーツにおいて結果は重要なことではないが、たとえベストを尽くしたとしても、時々、プレッシャーによってひどいプレーをしてしまう

Sentence

Sentence 9: I know the most important thing in amateur sport is not the result, but I sometimes play badly under pressure, even if I try to do my best .

Sentence 10: If sport at school become a torture and make u wish to escape from them, we won't be able to enjoy physical activity at school .

(和訳)文10: もし、学校でのスポーツが拷問になり、それらから逃げだしたいと私たちが思うのなら、私たちはおそらく学校での体を動かす活動を楽しむことができないだろう。

<Cho
Gold:

1: participating in sport can be painful to some student .

2: participating in sport has no benefit for student .

○ 意見との一致性: choice1 < choice2 とモデルが判断

○ なぜ?

⇒ sentence 9, 10 のみを見ると、for student の意味である

⇒ モデルは choice 2 を正解と判断してしまった?

概要

- 取り組んだタスク
- 手法
- 実験
- 結果
- 考察
- まとめ

まとめ

- 最も精度がよかったモデル
 - Pre-trained word2vec, dropout model (acc: 0.317)
- Pre-trained word2vecを、埋め込み行列の初期重みとして用いたモデルが正解率が良い
 - Random initializationの場合は、ランダムに回答する場合の正解率 (0.25)よりも、低くなってしまう
- 学習データ数が少ない(120 paragraph)
 - Pre-trainされた分散表現を初期化に用い、さらにモデルに正則化を入れる必要あり
- Future work
 - Lemmatizer の変更
 - 意見要旨選択枝データを使って、正例を増やし、2値分類のモデルにしてみる
 - データの正則化
 - embedding後のベクトル に予測分布が最も変わる方向にノイズを加え、データの分布を滑らかにする (virtual adversarial training)
⇒選択枝間の微妙な差異を学習できるのではないか？

参考文献

- Sukhbaatar, Sainbayar, Jason Weston, and Rob Fergus. "End-to-end memory networks." *Advances in neural information processing systems*. 2015.
- NIPS2015読み会「End-To-End Memory Networks」, “<http://www.slideshare.net/unnonouno/nip2015endtoend-memory-networks>”

ご清聴ありがとうございました

- Task example
 1. Single Supporting Facts · 単一の情報の認識
 2. Two or Three Supporting Facts · 複数の情報の関連付け
 3. Two or Three Argument Relations · 複数の引数をとる述語の理解
 4. Yes/No Questions · Yes/No 疑問文の理解
 5. Counting and Lists/Sets · 事物の数え上げ、事物の列挙
 6. Simple Negation and Indefinite Knowledge · 否定の理解、選言の理解
 7. Basic Coreference, Conjunctions and Compound Coreference · 曖昧さのない単純な照応の解決 · 連言の理解、連言を含む照応の解決
 8. Time Reasoning · 時間指標詞による順序関係の把握
 15. Basic Deduction and Induction · 基礎的な演繹・帰納推論
 17. Positional and Size Reasoning · 空間指標詞による位置関係の把握 · 量的性質の比較推論
 19. Path Finding · 方角的な位置関係と移動の推論
 20. Agent's Motivations · 人物の状態の追跡

ベースモデルの適用2

選択肢4つを順番にモデルに入力



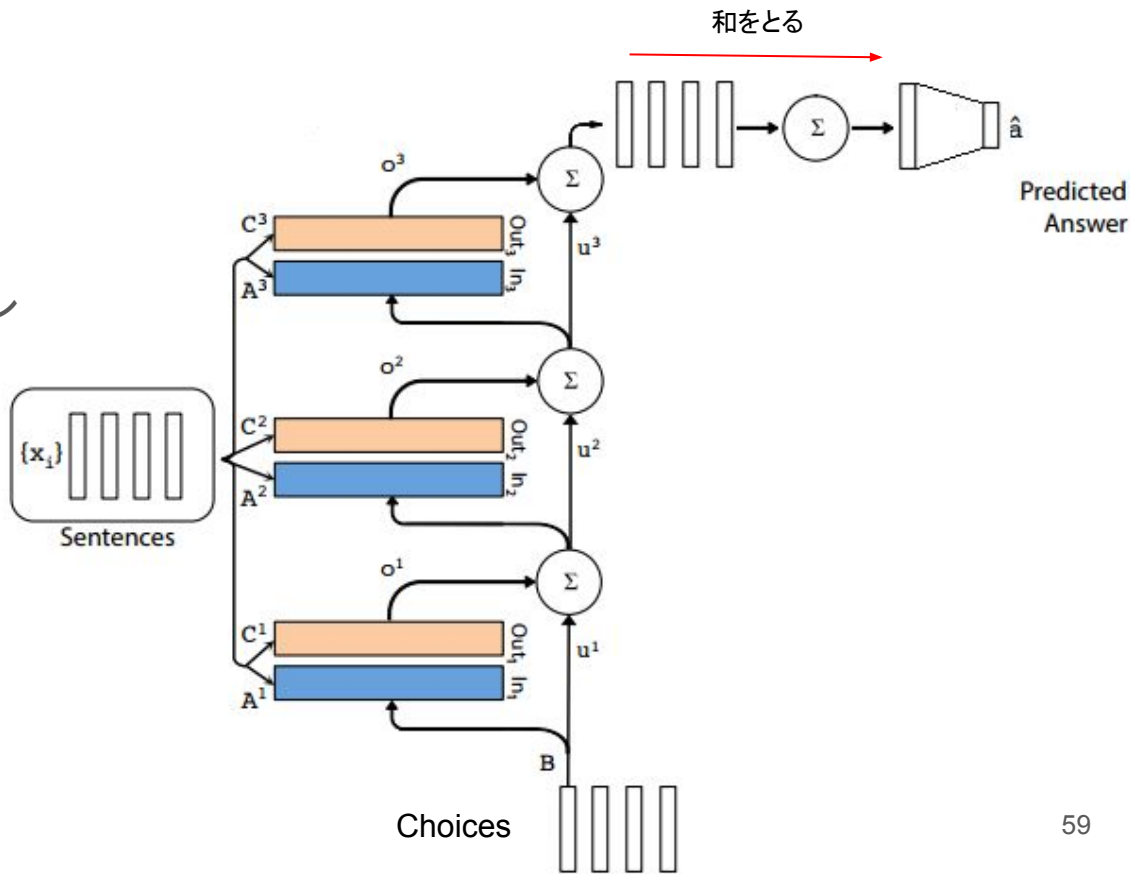
モデルの出力として、4つのベクトル
が得られる



4つのベクトルの和を取り、1つの
ベクトルにする



1層のFFNNに入力し、4値分類



モデルの定式化

- 入力

- 意見: $\{X_1, X_2, \dots, X_n, \dots, X_N\}$ (X_n : n 番目の文)
- 選択肢: q_1, q_2, q_3, q_4

- 出力

- 4つの選択肢に対する意見の分類結果: a (4値分類)

- パラメータ

- 埋め込み行列: $A_1, A_2, A_3, C_1, C_2, C_3, B$ ($d \times V$ 次元)
 - d : embeddingベクトルの次元数
 - V : 語彙数
- 回答用の行列: W ($V \times d$ 次元)

Results

		embedding	
		random	word2vec
plus	正則化なし	0.275	0.283
	正則化あり(dropout)	0.233	0.300
shuffle	正則化なし	0.308	0.267
	正則化あり(dropout)	0.225	0.317

Accuracy