A long hard look at Multiword Expressions in the age of Language Models

Vered Shwartz
MWE Workshop, August 2021
A long hard look at **Multiword Expressions** in the age of **Language Models**

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Representing Phrases
Representing Phrases

$$f(\vec{v}_{w_1}, \vec{v}_{w_2}) \approx \vec{v}_{w_1w_2}$$
Representing Phrases
Representing Phrases

\[ f(\vec{v}_{w_1}, \vec{v}_{w_2}, \ldots, \vec{v}_{w_k}) \rightarrow \vec{v}_{w_{1\ldots k}} \]

2013 Pre-trained Word Embeddings

2015 RNNs
Representing Phrases

\[ f(\vec{v}_{w_1}, \vec{v}_{w_2}, \ldots, \vec{v}_{w_k}) \rightarrow \vec{v}_{w_{1:k}} \]

\[ f(\vec{v}_{w_1}, \vec{v}_{w_2}) \approx \vec{v}_{w_1w_2} \]

2013 Pre-trained Word Embeddings

2015 RNNs

2018 Pre-trained Language Models
Representing Phrases

\[ f(\vec{v}_{w_1}, \vec{v}_{w_2}, \ldots, \vec{v}_{w_k}) \rightarrow \vec{v}_{w_{1..k}} \]

2013 Pre-trained Word Embeddings

2015 RNNs

2018 Pre-trained Language Models
Representing MWEs

Compositional: $f(\vec{v}_{w_1}, \vec{v}_{w_2}, \ldots, \vec{v}_{w_k})$
Representing MWEs

Compositional: $f(\vec{v}_{w_1}, \vec{v}_{w_2}, \ldots, \vec{v}_{w_k})$

Implicit Meaning

IF OLIVE OIL IS MADE FROM OLIVES...
THEN THAT MUST MEAN BABY OIL IS MADE FROM...
Representing MWEs

Compositional: $f(\vec{v}_{w_1}, \vec{v}_{w_2}, \ldots, \vec{v}_{w_k})$

1 Implicit Meaning
2 Meaning Shift
In this Talk

1. Interpreting implicit meaning
2. Recognizing meaning shift
3. Interpreting figurative language
1. Interpreting implicit meaning
2. Recognizing meaning shift
3. Interpreting figurative language
Implicit Meaning in MWEs

**Noun Compounds**

- Oil *made of* olives
- Oil *used for* babies

**Adjective-Noun Compositions**

- Heated water
  - (high temperature)
- Heated debate
  - (anger or passion)
Implicit Meaning in MWEs

Noun Compounds

Oil made of olives  Oil used for babies

Adjective-Noun Compositions

Heated water
(high temperature)

Heated debate
(anger or passion)

Do text representations capture implicit meaning?
Noun Compound Paraphrasing

The township is served by three **access roads**

Road that makes access possible

Noun Compound Paraphrasing

The township is served by three *access roads*  

Road that makes access possible
Noun Compound Paraphrasing

The township is served by three *access roads*  
Road that makes access possible

Embedding

Encoding

biLSTM  
Self-Attention  
None

Noun Compound Paraphrasing

The township is served by three **access roads**

Road that makes access possible

---

Noun Compound Paraphrasing

The township is served by three *access roads*  
Road that makes access possible

Embedding

Encoding

Pooling

Classification

Noun Compound Paraphrasing

Noun Compound Paraphrasing

Noun Compound Paraphrasing

Noun Compound Paraphrasing

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Noun Compound Paraphrasing

Accuracy

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Adjective Noun Composition

To-go cocktails triggers **heated** debate during legislative hearing
Adjective Noun Composition

To-go cocktails triggers **heated** debate during legislative hearing

**Embedding**

**Encoding**

**Pooling**

Adjective Noun Composition

To-go cocktails triggers **heated** debate during legislative hearing

- **Embedding**
- **Encoding**
- **Pooling**
- **Classification**

Adjective Noun Composition
Adjective Noun Composition

Accuracy

100
75
50
25
0

Majority  Static  Contextualized  Human

Adjective Noun Composition

Accuracy

Majority
Static
Contextualized
GPT-3
Human

50
53.8
65.1
51.89
86.4

100
75
50
25
0

Adjective Noun Composition

It kind of works in practice…
It kind of works in practice...

for common phrases.
It kind of works in practice...

for common phrases.

Can you train models to handle uncommon phrases?
Interpreting New Noun Compounds

parsley cake
Interpreting New Noun Compounds

parsley cake

I've baked a parsley cake, would you like a piece?
Interpreting New Noun Compounds

parsley cake

I've baked a parsley cake, would you like a piece?

Cakes can be made from fruit.

Parsley is an herb.

Herbs are similar to fruit.

Cake made of parsley!
Interpreting New Noun Compounds

parsley cake

Cakes can be made from fruit.

Parsley is an herb.

Herbs are similar to fruit.

Cake made of parsley!

I’ve baked a parsley cake, would you like a piece?

Hmm... no, thanks.
parsley cake

I've baked a parsley cake, would you like a piece?
parsley cake

I've baked a parsley cake, would you like a piece?

Yes, please!

Noun Compound Paraphrasing

Produce a ranked list of paraphrases expressing the relationship between the constituents:

- oil used for babies
- oil for babies
- oil made for babies
- oil made of olives
- oil from olives
- oil extracted from olives

(Nakov and Hearst, 2006; Hendrickx et al., 2013)
Multi-task Learning for Noun Compound Paraphrasing

Input
\( w_1 = \text{olive}, w_2 = \text{oil} \)

Output
\{ [w_2] \text{ made of } [w_1], [w_2] \text{ extracted from } [w_1], \ldots \}
Paraphrasing Model
Paraphrasing Model
Paraphrasing Model

Instance: \( w_1 = \text{olive}, \ w_2 = \text{oil}, \ p = [w_2] \text{ made of } [w_1] \)
Paraphrasing Model

Instance: \( <w_1 = \text{olive}, w_2 = \text{oil}, p = [w_2] \text{ made of } [w_1]> \)

Main:

1. What is the relation between \textit{olive} and \textit{oil}?
Paraphrasing Model

Instance: \(<w_1 = \text{olive}, w_2 = \text{oil}, p = [w_2] \text{ made of } [w_1]\)>

Main:

What is the relation between \textit{olive} and \textit{oil}?
Paraphrasing Model

Instance: \(<w_1 = \text{olive}, w_2 = \text{oil}, p = [w_2] \text{ made of } [w_1]\)>

Main:

1 What is the relation between \text{olive} and \text{oil}?
Paraphrasing Model

Instance: $<w_1 = \text{olive}, w_2 = \text{oil}, p = [w_2] \text{ made of } [w_1]>$

**Main:**
1. What is the relation between *olive* and *oil*?
Paraphrasing Model

Instance: \(<w_1 = \text{olive}, w_2 = \text{oil}, p = [w_2 \text{ made of } w_1]\>\)

Main:
1. What is the relation between \text{olive} and \text{oil}?
Paraphrasing Model

Instance: \(<w_1 = \text{olive}, w_2 = \text{oil}, p = [w_2] \text{ made of } [w_1]\)>

Main:
1. What is the relation between \textit{olive} and \textit{oil}?
What is the relation between olive and oil?
Paraphrasing Model

Instance: \( <w_1 = \text{olive}, w_2 = \text{oil}, p = [w_2] \text{ made of } [w_1]> \)

Main:

1. What is the relation between *olive* and *oil*?

\[ \hat{p} = 78 \ldots \]

MLP

\[ \text{oil} \rightarrow \hat{p} \rightarrow \text{olive} \]

\[
\begin{align*}
(28) \text{ made} & \\
(121) \text{ olive} & \\
(712) \text{ oil} & \\
\ldots & \\
(10) \text{ of} & \\
(1) [w_1] & \\
(2) [w_2] & \\
(3) [p] & \\
(78) [w_2] \text{ containing } [w_1] & \\
\ldots & \\
(131) [w_2] \text{ made of } [w_1] & \\
\ldots & \\
\end{align*}
\]
Paraphrasing Model

Instance: $<w_1 = \textit{olive}, w_2 = \textit{oil}, p = [w_2] \text{ made of } [w_1]>$

Loss: $\text{CE}(\hat{p}, p)$

Main:

1. What is the relation between \textit{olive} and \textit{oil}?

Loss: $\text{CE}(\hat{p}, p)$
Paraphrasing Model

Instance: \(<w_1 = \text{olive}, \ w_2 = \text{oil}, \ p = \[w_2]\ \text{made of} \ [w_1]\>\)

Loss: \(\text{CE}(\hat{p}, p)\)

**Main:**

1. What is the relation between *olive* and *oil*?

2. What can *oil* be made of?

**Auxiliary:**

- (28) made
- (121) olive
- (712) oil
- (10) of
- (1) \([w_1]\)
- (2) \([w_2]\)
- (3) \([p]\)
- (78) \([w_2]\) containing \([w_1]\)
- (131) \([w_2]\) made of \([w_1]\)
- ...
Paraphrasing Model

Instance: \(<w_1 = \text{olive}, w_2 = \text{oil}, p = [w_2] \text{ made of } [w_1]>\)

Loss: \(CE(\hat{p}, p)\)

**Main:**
1. What is the relation between \textit{olive} and \textit{oil}?

2. What can \textit{oil} be made of?

3. What can be made of \textit{olive}?

**Auxiliary:**

- \(\hat{p} = 78\)
Paraphrasing Model

Instance: \(<w_1 = \text{olive}, w_2 = \text{oil}, p = [w_2] \text{ made of } [w_1]>\)
Loss: \(CE(\hat{p}, p)\)

Main:
1. What is the relation between \text{olive} and \text{oil}?

Auxiliary:
2. What can \text{oil} be made of? / 3. What can be made of \text{olive}?
Paraphrasing Model

Instance: \( w_1 = \text{olive}, w_2 = \text{oil}, p = [w_2] \text{ made of } [w_1] \rangle \)

Loss: \( \text{CE}(\hat{p}, p) + \text{CE}(\hat{w}_1, w_1) + \text{CE}(\hat{w}_2, w_2) \)

**Main:**
1. What is the relation between \text{olive} and \text{oil}?

**Auxiliary:**
2. What can \text{oil} be made of?
3. What can be made of \text{olive}?

**Paraphrasing Model**

\[
\text{Loss} = \text{CE}(\hat{p}, p) + \text{CE}(\hat{w}_1, w_1) + \text{CE}(\hat{w}_2, w_2)
\]

\[
\hat{p} = \text{MLP}_p\(\text{oil}, [p], \text{olive}\)
\]

\[
\hat{w}_1 = \text{MLP}_w\(\text{oil}
\text{made of } [w_1]\)
\]

\[
\text{(28) made}
\]

\[
\text{(121) olive}
\]

\[
\text{(712) oil}
\]

\[
\text{(10) of}
\]

\[
\text{(1) } [w_1]
\]

\[
\text{(2) } [w_2]
\]

\[
\text{(3) } [p]
\]

\[
\text{(78) } [w_2] \text{ containing } [w_1]
\]

\[
\text{(131) } [w_2] \text{ made of } [w_1]
\]

\[
\text{...}
\]

\[
\text{(1) } [w_1]
\]

\[
\text{(2) } [w_2]
\]

\[
\text{(3) } [p]
\]
Multi-task Learning for Noun Compound Paraphrasing

Instance: \(<w_1 = \text{olive}, w_2 = \text{oil}, p = [w_2] \text{ made of } [w_1]>\)

Loss: \( \text{CE}(\hat{p}, p) + \text{CE}(\hat{w}_1, w_1) + \text{CE}(\hat{w}_2, w_2) \)

Main:

1. What is the relation between \text{olive} and \text{oil}?

Generalizes similar noun compounds: \text{avocado oil} expected to predict similar paraphrases
Multi-task Learning for Noun Compound Paraphrasing

Instance: \(<w_1 = \text{olive}, w_2 = \text{oil}, p = [w_2 \text{ made of } w_1] >\)
Loss: \(CE(\hat{p}, p) + CE(\hat{w_1}, w_1) + CE(\hat{w_2}, w_2)\)

Generalizes similar paraphrases: 
[\(w_2\)] from [\(w_1\)] expected to predict the same constituent nouns

Auxiliary:
(2) What can \(\text{oil}\) be made of? / (3) What can be made of \(\text{olive}\)?

\[
\begin{align*}
(28) \text{ made} & \\
(121) \text{ olive} & \\
(712) \text{ oil} & \\
\ldots & \\
(10) \text{ of} & \\
(1) [w_1] & \\
(2) [w_2] & \\
(78) [w_2] \text{ containing } [w_1] & \\
\ldots & \\
(131) [w_2] \text{ made of } [w_1] & \\
\ldots & \\
\end{align*}
\]
Multi-task Learning for Noun Compound Paraphrasing

Instance: \(<w_1 = \text{olive}, w_2 = \text{oil}, p = [w_2] \text{ made of } [w_1]\)>

Loss: \(\text{CE}(\hat{p}, p) + \text{CE}(\hat{w}_1, w_1) + \text{CE}(\hat{w}_2, w_2)\)

Main:

1. What is the relation between \(\text{olive}\) and \(\text{oil}\)?

2. What can \(\text{oil}\) be made of?

3. What can be made of \(\text{olive}\)?

Auxiliary:

Self-supervised with corpus co-occurrences!
Multi-task Learning for Noun Compound Paraphrasing

Input
\( w_1 = \text{olive}, w_2 = \text{oil} \)

Output
\{ [w_2] \text{ made of } [w_1], [w_2] \text{ extracted from } [w_1], ... \}
Evaluation Results

SemEval 2013 Task 4 (Hendrickx et al., 2013)
Evaluation Results

SemEval 2013 Task 4 *(Hendrickx et al., 2013)*

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SemEval 2013 Task 4 (Hendrickx et al., 2013)

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</table>
Error Analysis
Error Analysis

False Positive
Error Analysis

False Positive

Valid 44%

“discussion by group”
Error Analysis

False Positive

- Valid 44%
- “discussion by group”
- “life of women in community”
- Too specific 15%
Error Analysis

False Positive

- Other: 14%
- Borderline grammatical: 5%
- Syntactic errors: 8%
- Incorrect prepositions: 14%
- Too specific: 15%
- Valid: 44%

Examples:
- Force of coalition forces
- Discussion by group
- Life of women in community
Error Analysis

**False Positive**
- Other: 14%
- Borderline grammatical: 5%
- Syntactic errors: 8%
- Incorrect prepositions: 14%

**False Negative**
- Valid: 44%
- "force of coalition forces"
- "discussion by group"
- "life of women in community"

"Too specific": 15%
Error Analysis

False Positive

- Other: 14%
- Borderline grammatical: 5%
- Syntactic errors: 8%
- Incorrect prepositions: 14%
- "force of coalition forces"
- "discussion by group"
- "life of women in community"
- Too specific: 15%
- Valid: 44%

False Negative

- Long paraphrase: 30%
- Invalid: 44%
Error Analysis

**False Positive**
- Other: 14%
- Borderline grammatical: 5%
- Syntactic errors: 8%
- Incorrect prepositions: 14%
- “force of coalition forces”
- “discussion by group”
- “life of women in community”
- Too specific: 15%
- Valid: 44%

**False Negative**
- Determiners: 25%
- Long paraphrase: 30%
- “mutation of a gene”
Error Analysis

**False Positive**
- Other: 14%
- Borderline grammatical: 5%
- Syntactic errors: 8%
- Incorrect prepositions: 14%
- "force of coalition forces"
- "discussion by group"
- "life of women in community"
- Too specific: 15%

**False Negative**
- Long paraphrase: 30%
- Determiners: 25%
- "holding of shares"
- Inflected constituents: 10%
- "mutation of a gene"
Error Analysis

**False Positive**
- Other: 14%
- Borderline grammatical: 5%
- Syntactic errors: 8%
- Incorrect prepositions: 14%
- “life of **women** in community”
- “force of coalition forces”
- “discussion by group”

**False Negative**
- Long paraphrase: 30%
- Inflected constituents: 10%
- Determiners: 25%
- Other: 35%
- “holding of shares”
- “mutation of a gene”
New Results

SemEval 2013 Task 4 (Hendrickx et al., 2013)
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bus conductor

BART
- conductor of a bus
- conductor who is bus conductor
- conductor who works as bus conductor
- conductor of bus

T5
- conductor of a bus
- conductor working in a bus
- conductor who works in bus
- conductor who works on bus
- conductor of bus

GPT-2
- conductor of a bus
- conductor who drives a bus
- conductor who drives the bus
- conductor who works for a bus
- conductor who works for a bus

GPT-3
- conductor working in a bus
- conductor in charge of bus
- conductor who works on a bus
- conductor in a bus
- conductor of the bus
parsley cake

**BART**
cake made with parsley
cake made from parsley
cake with parsley
cake with parsley in it
cake containing parsley

**T5**
cake made with parsley
cake made of parsley
cake made from parsley
cake that is made from parsley
cake that is made with parsley

**GPT-2**
cake made with parsley
cake made from parsley
cake made of parsley
cake with parsley
cake with parsley in it

**GPT-3**
cake made with parsley
cake made up of parsley
cake made of parsley
cake made from parsley
cheeseburger stabbing

BART
- stabbing of cheeseburger
- stabbing that occurs in cheeseburger
- stabbing of cheeseburger
- stabbing that occurs in cheeseburger
- stabustake that results from cheeseb

T5
- spokesman for the cheeseburger
- stabbing of cheese
- spokesman for the cheese business
- spokesman for cheese
- stabbing for cheese

GPT-2
- stabbing of the cheeseburgers
- stabbing of a cheeseburgers
- stabbing with a cheeseburgers
- stabbing of the cheeseburgers by the
- slicing of a cheeseburgers

GPT-3
- stabbing of a cheeseburger
- stabbing made from cheeseburger
- stabbing caused by the cheeseburger
- stabbing done with a cheeseburger
- stabbing done by a cheeseburger
Context-Dependent Implicit Meaning

Milk *for* cats

Milk *from* cats
Context-Dependent Implicit Meaning

Milk for cats

Milk from cats
Furious Meghan Markle says she won’t fall for dad’s *crocodile tears* after he claimed ‘she’d be better off if he were dead’
Do representations “know” it’s not actually about a crocodile?
1. Interpreting implicit meaning
2. Recognizing meaning shift
3. Interpreting figurative language
Noun Compound Literality

The crash course in litigation made me a better lawyer
Noun Compound Literality

The crash course in litigation made me a better lawyer

Embedding

Encoding

Pooling

crash

Noun Compound Literality

The **crash** course in litigation made me a better lawyer

Embedding

Encoding

Pooling

Classification

Noun Compound Literality

Verb-Particle Constructions

We did **get on** together

<table>
<thead>
<tr>
<th>Method</th>
<th>Accuracy</th>
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<tbody>
<tr>
<td>Majority</td>
<td>23.6</td>
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<tr>
<td>Static</td>
<td>60.5</td>
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<tr>
<td>Contextualized</td>
<td>90</td>
</tr>
<tr>
<td>Human</td>
<td>93.8</td>
</tr>
</tbody>
</table>
Verb-Particle Constructions

We did **get** **on** together

<table>
<thead>
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<th></th>
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<td>23.6</td>
<td>60.5</td>
<td>90</td>
<td>93.8</td>
</tr>
</tbody>
</table>

Light-Verb Constructions

Jamie **made** **on decision** to drop out of college.

<table>
<thead>
<tr>
<th></th>
<th>Majority</th>
<th>Static</th>
<th>Contextualized</th>
<th>Human</th>
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<tbody>
<tr>
<td>Accuracy</td>
<td>43.7</td>
<td>74.6</td>
<td>82.5</td>
<td>83.8</td>
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</table>
Detecting meaning shift → modeling meaning?
The Queen and her husband were on a train trip from Sydney to Orange.

- ride ✓
- carriage ✓
- journey ✓
- heading ✓
- carrying ×

- travelling ✓
- running ✓
- journey ✓
- going ✓
- headed ✓

- to ×
- headed ✓
- heading ✓
- that ×
- and ×
The Queen and her husband were on a train trip from Sydney to Orange.
Creating a guilt trip in another person may be considered to be psychological manipulation.
Creating a guilt trip in another person may be considered to be psychological manipulation.
GPT-3
GPT-3

Hello, how are you?
Hello, how are you?

I’m an AI created by OpenAI. How can I help you today?
Hello, how are you?

I'm an AI created by OpenAI. How can I help you today?

Are there fleas in the flea market?
Hello, how are you?

I’m an AI created by OpenAI. How can I help you today?

Are there fleas in the flea market?

If you’re referring to a flea market, then yes, there are bound to be some fleas.
1. Interpreting implicit meaning
2. Recognizing meaning shift
3. Interpreting figurative language
Everyone smiles. You should probably tell your parents about the wedding tomorrow, Carmen suggests. What about you? I ask, not thinking that she will be okay. I’ll be fine. Since Dominic isn’t up for grabs anymore, I figure that I will concentrate on something else, Carmen declares.
Everyone smiles. You should probably tell your parents about the wedding tomorrow, Carmen suggests. What about you? I ask, not thinking that she will be okay. I’ll be fine. Since Dominic isn’t up for grabs anymore, I figure that I will concentrate on something else, Carmen declares.
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**up for grabs**

Informal
available; obtainable.
Everyone smiles. You should probably tell your parents about the wedding tomorrow, Carmen suggests. What about you? I ask, not thinking that she will be okay. I’ll be fine. Since Dominic isn’t up for grabs anymore, I figure that I will concentrate on something else, Carmen declares.

**up for grabs**

*informal*

available; obtainable.

**Plausible**

- Carmen will find someone new to be with.
Everyone smiles.
You should probably tell your parents about the wedding tomorrow, Carmen suggests.
What about you? I ask, not thinking that she will be okay.
I’ll be fine. Since Dominic isn’t _up for grabs_ anymore, I figure that I will concentrate on something else, Carmen declares.

**Plausible**

✅ Carmen will find someone new to be with.

**Implausible**

❌ Carmen will continue to pursue Dominic since he is available.
They have a work meeting.

Everyone smiles. You should probably tell your parents about the wedding tomorrow, Carmen suggests. What about you? I ask, not thinking that she will be okay. I’ll be fine. Since Dominic isn’t up for grabs anymore, I figure that I will concentrate on something else, Carmen declares.

Determine which of the continuations is the plausible one.

<table>
<thead>
<tr>
<th>Everyone smiles. You should probably tell your parents about the wedding tomorrow, Carmen suggests. What about you? I ask, not thinking that she will be okay. I’ll be fine. Since Dominic isn’t up for grabs anymore, I figure that I will concentrate on something else, Carmen declares.</th>
<th>(1) Carmen will find someone new to be with.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2) Carmen will continue to pursue Dominic since he is available.</td>
<td>(1)</td>
</tr>
</tbody>
</table>
Zero-Shot Models

Everyone smiles. You should probably tell your parents about the wedding tomorrow, Carmen suggests. What about you? I ask, not thinking that she will be okay. I’ll be fine. Since Dominic isn’t up for grabs anymore, I figure that I will concentrate on something else, Carmen declares.

Option 1
Carmen will find someone new to be with.

Option 2
Carmen will continue to pursue Dominic since he is available.

Which continuation yields a higher LM score?
Zero-Shot Models

Everyone smiles. You should probably tell your parents about the wedding tomorrow, Carmen suggests. What about you? I ask, not thinking that she will be okay. I’ll be fine. Since Dominic isn’t up for grabs anymore, I figure that I will concentrate on something else, Carmen declares. Carmen will find someone new to be with.

Which continuation yields a higher LM score?

Option 1

Option 2

+ transfer learning from UnifiedQA (Khashabi et al., 2021)
Interpreting Idioms

Discriminative

<table>
<thead>
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<th>Model</th>
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<tr>
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</tr>
<tr>
<td>Human</td>
<td>92</td>
</tr>
</tbody>
</table>

Zero-shot
Few-Shot Models

Prompt

Q: Cup of tea, Gia? Rose asked. Gia nodded absently, still watching the bike as it became as small as a matchbox toy cresting the hill. I'll be off then, Paul leaned over and kissed Rose's cheek. She nodded. We'll get cracking on the shop.

(1) There is a lot to be done so we better get started.
(2) You can all rest there is still time.

A: (1)
Everyone smiles. You should probably tell your parents about the wedding tomorrow, Carmen suggests. What about you? I ask, not thinking that she will be okay. I’ll be fine. Since Dominic isn’t up for grabs anymore, I figure that I will concentrate on something else, Carmen declares.

A: (1)

There is a lot to be done so we better get started.
(2) You can all rest there is still time.

A: (1)
Few-Shot Models

Prompt

Q: Cup of tea, Gia? Rose asked. Gia nodded absently, still watching the bike as it became as small as a matchbox toy cresting the hill. I'll be off then, Paul leaned over and kissed Rose's cheek. She nodded. We’ll get cracking on the shop.

(1) There is a lot to be done so we better get started.
(2) You can all rest there is still time.

A: (1)

Instance

Q: Everyone smiles. You should probably tell your parents about the wedding tomorrow, Carmen suggests. What about you? I ask, not thinking that she will be okay. I’ll be fine. Since Dominic isn’t up for grabs anymore, I figure that I will concentrate on something else, Carmen declares.

(1) Carmen will find someone new to be with.
(2) Carmen will continue to pursue Dominic since he is available.

A:
**Few-Shot Models**

**Prompt**

Q: Cup of tea, Gia? Rose asked. Gia nodded absently, still watching the bike as it became as small as a matchbox toy cresting the hill. I'll be off then, Paul leaned over and kissed Rose's cheek. She nodded. We’ll get cracking on the shop. 

(1) There is a lot to be done so we better get started. 
(2) You can all rest there is still time.

A: (1)

**Instance**

Q: Everyone smiles. You should probably tell your parents about the wedding tomorrow, Carmen suggests. What about you? I ask, not thinking that she will be okay. I’ll be fine. Since Dominic isn’t up for grabs anymore, I figure that I will concentrate on something else, Carmen declares.

(1) Carmen will find someone new to be with.
(2) Carmen will continue to pursue Dominic since he is available.

A:

Also: PET *(Schick and Schütze, 2021)*
Interpreting Idioms

**Discriminative**

![Bar chart showing accuracy for different models and human performance.

- **GPT2-XL**: 53.6
- **GPT3**: 60.3
- **UnifiedQA**: 67.7
- **GPT3**: 55.5
- **PET**: 69.2
- **Human**: 92

The chart compares zero-shot and few-shot performance.]
Everyone smiles. […] Dominic isn’t up for grabs anymore, […], Carmen declares. [SEP] Carmen will find someone new to be with.

Everyone smiles. […] Dominic isn’t up for grabs anymore, […], Carmen declares. [SEP] Carmen will continue to pursue Dominic since he is available.
Interpreting Idioms

Discriminative

<table>
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<th>Few-shot</th>
<th>Supervised</th>
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Knowledge-Enhanced Model

Cooper (1999): L2 English speakers interpret unknown idioms based on the context and the literal meaning of the constituents.

(1) I took a deep breath [...] and ran full-speed away from the cliff.
(2) I took a deep breath [...] and ran full-speed towards the edge of the cliff.
Isaac yelled across the cliff face to me. The rush of beating the tempest had his adrenaline pumping. I could see he was scared, yet invigorated. Ok man, You're up next, he yelled out to me. A sick feeling swept over me. It was indeed my turn to run the gauntlet.

Cooper (1999): L2 English speakers interpret unknown idioms based on the context and the literal meaning of the constituents.

(1) I took a deep breath [...] and ran full-speed away from the cliff.
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(1) I took a deep breath [...] and ran full-speed away from the cliff.
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Run is used to get exercise
Run has the property found on gym
Gauntlet is used as a weapon
Isaac yelled across the cliff face to me. The rush of beating the tempest had his adrenaline pumping. I could see he was scared, yet invigorated. Ok man, You're up next, he yelled out to me. A sick feeling swept over me. It was indeed my turn to **run the gauntlet**.

Cooper (1999): L2 English speakers interpret unknown idioms based on the context and the *literal meaning* of the constituents.

(1) I took a deep breath [...] and ran full-speed **away** from the cliff.
(2) I took a deep breath [...] and ran full-speed **towards** the edge of the cliff.
**Knowledge-Enhanced Model**

*Cooper (1999):* L2 English speakers interpret unknown idioms based on the *context* and the *literal meaning* of the constituents.

$$S_1 = \sum_{i=1}^{k} S_{1,i}$$

The sentence includes a known idiom: "run the gauntlet." Cooper (1999) notes that L2 English speakers interpret unknown idioms based on the context and the literal meaning of the constituents. The idiomatic phrase "run the gauntlet" is used to mean running full-speed away from a cliff or a dangerous situation. The model suggests that the interpretation of the idiom is influenced by the surrounding context and the literal meaning of the words involved.

---

The diagram illustrates the process of scoring the interpretation of the idiom. The first sentence, "Isaac yelled [...] run the gauntlet." is scored with the context: "Run is used to get exercise" and the literal meaning: "full-speed away from the cliff." The second sentence, "Isaac yelled [...] run the gauntlet." is scored with the context: "Gauntlet is used as a weapon" and the literal meaning: "full-speed away from the cliff." The scorer then combines these scores to generate the overall score for the interpretation of the idiom.
Knowledge-Enhanced Model

**Cooper (1999):** L2 English speakers interpret unknown idioms based on the context and the *literal meaning* of the constituents.

Isaac yelled across the cliff face to me. The rush of beating the tempest had his adrenaline pumping. I could see he was scared, yet invigorated. Ok man, You're up next, he yelled out to me. A sick feeling swept over me. It was indeed my turn to *run the gauntlet*.

\[
S_1 = \sum_{i=1}^{k} S_{1,k}
\]

I took a deep breath [...] and ran full-speed *away* from the cliff.
Knowledge-Enhanced Model

**Cooper (1999):** L2 English speakers interpret unknown idioms based on the context and the *literal meaning* of the constituents.

1. I took a deep breath [...] and ran full-speed *away* from the cliff.
2. I took a deep breath [...] and ran full-speed *towards* the edge of the cliff.

**Para-COMET** *(Gabriel et al., 2021)*

The narrator sweats from nerves
The narrator feels scared
The narrator wants to feel better.
...
Isaac yelled across the cliff face to me.
The rush of beating the tempest had his adrenaline pumping.
I could see he was scared, yet invigorated.
Ok man, You're up next, he yelled out to me. A sick feeling swept over me.
It was indeed my turn to **run the gauntlet**.

(1) I took a deep breath [...] and ran full-speed away from the cliff.
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---

**Knowledge-Enhanced Model**

**Cooper (1999):** L2 English speakers interpret unknown idioms based on the context and the *literal meaning* of the constituents.

---

Para-COMET

*Gabriel et al., 2021*

---

The narrator sweats from nerves
The narrator feels scared
The narrator wants to feel better.
...
Results

Discriminative

<table>
<thead>
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<td>81.5</td>
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<tr>
<td>Context</td>
<td>82.8</td>
</tr>
<tr>
<td>Literal</td>
<td>83.5</td>
</tr>
<tr>
<td>Human</td>
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</tr>
</tbody>
</table>

- **Zero-shot**
- **Few-shot**
- **Supervised**
Everyone smiles. You should probably tell your parents about the wedding tomorrow, Carmen suggests. What about you? I ask, not thinking that she will be okay. I’ll be fine. Since Dominic isn’t up for grabs anymore, I figure that I will concentrate on something else, Carmen declares.

Carmen will find someone new to be with.
Automatic Evaluation Results

Generative

<table>
<thead>
<tr>
<th>Model</th>
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<th>Few-shot</th>
<th>Supervised</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPT3</td>
<td>28.8</td>
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<td>54.2</td>
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<tr>
<td>GPT2-XL</td>
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<td>49</td>
<td></td>
</tr>
<tr>
<td>GPT3</td>
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<td>49</td>
<td></td>
</tr>
<tr>
<td>Bart-L</td>
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<td></td>
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</tr>
<tr>
<td>T5-L</td>
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<td></td>
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</tr>
<tr>
<td>GPT2-XL</td>
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<td></td>
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</table>

Bar chart showing BERT scores for different models and training scenarios.
Knowledge-Enhanced Models

Training

- **Inference**: Run is used to get exercise
- **Narrative**: Isaac yelled [...] run the gauntlet.
  - Generator
  - [...] full-speed towards the edge of the cliff.

- **Inference**: Gauntlet is used as a weapon
- **Narrative**: Isaac yelled [...] run the gauntlet.
  - Generator
  - [...] full-speed towards the edge of the cliff.
Knowledge-Enhanced Models

Training

[Inference] Run is used to get exercise  [Narrative] Isaac yelled [...] run the gauntlet.  Generator  [...] full-speed towards the edge of the cliff.

... [Inference] Gauntlet is used as a weapon  [Narrative] Isaac yelled [...] run the gauntlet.  Generator  [...] full-speed towards the edge of the cliff.

Inference
Knowledge-Enhanced Models

Training

[Inference] Run is used to get exercise [Narrative] Isaac yelled [...] run the gauntlet. Generator [...] full-speed towards the edge of the cliff.

[Inference] Gauntlet is used as a weapon [Narrative] Isaac yelled [...] run the gauntlet. Generator [...] full-speed towards the edge of the cliff.

Inference

[Inference] Run is used to get exercise [Narrative] Isaac yelled [...] run the gauntlet. Generator \( \text{logits}_{1,1} \ldots \text{logits}_{1,n} \)

[Inference] Gauntlet is used as a weapon [Narrative] Isaac yelled [...] run the gauntlet. Generator \( \text{logits}_{k,1} \ldots \text{logits}_{k,n} \)
Knowledge-Enhanced Models

Training

[Inference] Run is used to get exercise [Narrative] Isaac yelled [...] run the gauntlet. Generator [...] full-speed towards the edge of the cliff.

... ...

[Inference] Gauntlet is used as a weapon [Narrative] Isaac yelled [...] run the gauntlet. Generator [...] full-speed towards the edge of the cliff.

Inference

[Inference] Run is used to get exercise [Narrative] Isaac yelled [...] run the gauntlet. Generator \( \text{logits}_{k,1} \ldots \text{logits}_{k,n} \)

... ...

[Inference] Gauntlet is used as a weapon [Narrative] Isaac yelled [...] run the gauntlet. Generator \( \text{logits}_{k,1} \ldots \text{logits}_{k,n} \)

Sample text from \( \text{logits}_t = \sum_{i=1}^{k} \text{logits}_{t,i} \)
Automatic Evaluation Results

Generative

- GPT3: 28.8
- GPT2-XL: 46.2
- GPT3: 48.6
- Bart-L: 48
- T5-L: 49
- GPT2-XL: 54.2
- Literal: 51.4
- Context: 52.6

Zero-shot | Few-shot | Supervised
Human Evaluation Results

Generative

- Equally bad: 18%
- Equally good: 8%
- Baseline: 16%
- Literal: 14%
- Context: 44%
Everyone smiles. You should probably tell your parents about the wedding tomorrow, Carmen suggests. What about you? I ask, not thinking that she will be okay. I’ll be fine. Since Dominic isn’t up for grabs anymore, I figure that I will concentrate on something else, Carmen declares.
Everyone smiles.
You should probably tell your parents about the wedding tomorrow, Carmen suggests.
What about you? I ask, not thinking that she will be okay. I’ll be fine. Since Dominic isn’t up for grabs anymore, I figure that I will concentrate on something else, Carmen declares.

References:
Dominic is in a relationship with someone else.
The goods were available for anyone who wanted them.
Carmen will find someone new to be with.
Examples

Everyone smiles.
You should probably tell your parents about the wedding tomorrow, Carmen suggests.
What about you? I ask, not thinking that she will be okay.
I’ll be fine. Since Dominic isn’t up for grabs anymore, I figure that I will concentrate on something else,
Carmen declares.

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Carmen will find someone new to be with.

GPT2: I’m not up for grabs anymore, so I can focus on something that I’m good at.
Everyone smiles.
You should probably tell your parents about the wedding tomorrow, Carmen suggests. What about you? I ask, not thinking that she will be okay. I’ll be fine. Since Dominic isn’t up for grabs anymore, I figure that I will concentrate on something else, Carmen declares.

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X GPT2: I’m not up for grabs anymore, so I can focus on something that I’m good at.
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❌ GPT2: I’m not up for grabs anymore, so I can focus on something that I’m good at.

Bart: I know that she will be okay.
Examples

Everyone smiles. You should probably tell your parents about the wedding tomorrow, Carmen suggests. What about you? I ask, not thinking that she will be okay. I’ll be fine. Since Dominic isn’t up for grabs anymore, I figure that I will concentrate on something else, Carmen declares.

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❌ GPT2: I'm not up for grabs anymore, so I can focus on something that I'm good at.

❌ Bart: I know that she will be okay.
Everyone smiles.
You should probably tell your parents about the wedding tomorrow, Carmen suggests.
What about you? I ask, not thinking that she will be okay.
I’ll be fine. Since Dominic isn’t up for grabs anymore, I figure that I will concentrate on something else, Carmen declares.

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Refererences:
Dominic is in a relationship with someone else.
The goods were available for anyone who wanted them.
Carmen will find someone new to be with.

❌ GPT2: I’m not up for grabs anymore, so I can focus on something that I’m good at.

❌ Bart: I know that she will be okay.

✓ T5: He was ready to take his time.
Everyone smiles. You should probably tell your parents about the wedding tomorrow, Carmen suggests. What about you? I ask, not thinking that she will be okay. I’ll be fine. Since Dominic isn’t up for grabs anymore, I figure that I will concentrate on something else, Carmen declares.

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Examples

References:
Dominic is in a relationship with someone else.
The goods were available for anyone who wanted them.
Carmen will find someone new to be with.

GPT2: I’m not up for grabs anymore, so I can focus on something that I’m good at.
Bart: I know that she will be okay.
T5: He was ready to take his time.
GPT3 zero-shot: I just need to find a new date. You’re coming, right? I ask her.
Everyone smiles.
You should probably tell your parents about the wedding tomorrow, Carmen suggests.
What about you? I ask, not thinking that she will be okay.
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Recap
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Interpreting implicit meaning:
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- By generalizing existing knowledge about similar noun compounds.
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1. By generalizing existing knowledge about similar noun compounds.
2. Pre-trained LMs are not bad at this.
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Recognizing meaning shift
Recap

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   - Pre-trained LMs are really good at this.
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   - Context and the constituents’ literal meaning helps.
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Thank You!

@VeredShwartz  vereds@allenai.org
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