Text Generation from Meaning Representations

Yannis Konstas

Joint work with
Mark Yatskar, Luke Zettlemoyer and Yejin Choi (UW)

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Yonatan Bisk and Daniel Marcu (ISI)
Motivation
Motivation

Machine-generated Representation
Motivation

Machine-generated Representation
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Machine-generated Representation
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Machine-generated Representation

<table>
<thead>
<tr>
<th>source</th>
<th>block:</th>
<th>hk</th>
</tr>
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<tbody>
<tr>
<td>target</td>
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<td>ms</td>
</tr>
<tr>
<td>pos</td>
<td>RP:</td>
<td>W</td>
</tr>
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Motivation

Machine-generated Representation

Place the heineken block west of the mercedes block.

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<td>big</td>
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**Motivation**

Machine-generated Representation

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Place the heineken block in the first open space to the left of ups block.
Motivation
Motivation

Machine-generated Representation
Motivation

Machine-generated Representation

Sentence Compression
Motivation

Machine-generated Representation

Sentence Compression

Sentence Fusion
Motivation

- Machine-generated Representation
- Sentence Compression
- Sentence Fusion
- Paraphrasing
NLG Pipeline

Input

Content Planning
- Content Selection
- Document Planning

Sentence Planning
- Lexicalization
- Reordering/Linearization
- Splitting/Aggregation

Surface Realisation

Text

Communicative Goal

Framework
NLG Pipeline

Framework
- Neural Encoder
- RNN Decoder
- Graph Alignment
Cloudy, with temperatures between 10 and 20 degrees. South wind around 20 mph.

Cloudy, with temperatures between 10 and 20 degrees. South wind around 20 mph.

<table>
<thead>
<tr>
<th>Time</th>
<th>Min</th>
<th>Mean</th>
<th>Max</th>
</tr>
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<tbody>
<tr>
<td>06:00-21:00</td>
<td>9</td>
<td>15</td>
<td>21</td>
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</table>

Cloud Sky Cover

<table>
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<tr>
<th>Time</th>
<th>Percent (%)</th>
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<tr>
<td>06:00-09:00</td>
<td>25-50</td>
</tr>
<tr>
<td>09:00-12:00</td>
<td>50-75</td>
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</tbody>
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Wind Direction

<table>
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<th>Mode</th>
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<tbody>
<tr>
<td>S</td>
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(1) PCFG Grammar

S → R(start)
R(r,t) → FS(r_j, start) R(r,t)
R(r,t) → FS(r_j, start)
FS(r,r_f_i) → F(r,r_f_j) FS(r,r_f_j)
FS(r,r_f_i) → F(r,r_f_j)
F(r,r_f) → W(r,r_f) F(r,r_f)
F(r,r_f) → W(r,r_f)
W(r,r_f) → α
W(r,r_f) → g(f,v)

Testing

(2) Hypergraph Representation

(3) k-best decoding via integration

Cloudy, with temperatures between 10 and 20 degrees. South wind around 20 mph.

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F0_1(temp1/start)

F0_1(temp1/min)

F0_1(temp1/max)

F0_2(temp1/min)

F0_2(temp1/max)

FS0_1(temp1,start)

FS0_2(temp1,start)

FS1_2(temp1,start)

(1) PCFG Grammar

S → R(start)
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F(r,r_f) → W(r,r_f) F(r, r_f)
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(2) Hypergraph Representation

(3) k-best decoding via integration

More Complex Structure
More Complex Structure

Input (Graph or Tree)
More Complex Structure

Input (Graph or Tree)

- `know-01`
  - `ARG0`
  - `ARG1`
  - `ARG1-of`
  - `inhabit-01`
    - `ARG0`
    - `man`
      - `mod`
      - `lazy`

<table>
<thead>
<tr>
<th>AMR</th>
<th>DAG</th>
</tr>
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</table>

Graph or Tree representation of the AMR structure.
More Complex Structure

Input (Graph or Tree)

```
know-01
  \_ ARG0
    \_ I

  \_ ARG1
    \_ planet
      \_ ARG1-of
        \_ inhabit-01
          \_ ARG0
            \_ man
              \_ mod
                \_ lazy

\begin{tabular}{|c|c|}
\hline
AMR & DAG \\
\hline
\lambda-calculus Expression & Tree \\
\hline
\end{tabular}
```
More Complex Structure

Input (Graph or Tree)

```
know-01
  ARG0
  ARG1
    I
  planet
    ARG1-of
      inhabit-01
        ARG0
          man
            mod
              lazy

λ-calculus Expression

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```
I know a planet that is inhabited by a lazy man.
More Complex Structure

Input (Graph or Tree)

Output (Text)

I know a planet that is inhabited by a lazy man.

I knew a planet that was inhabited by a lazy man. (lpp_1943.249)

I have known a planet that was inhabited by a lazy man.

I know about a planet. It is inhabited by a lazy man.

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NeuGEN Framework
NeuGEN Framework

G \rightarrow \text{Encoder} \rightarrow \text{Decoder} \rightarrow w
Encoder
- Bag of Words: Concepts and roles
- Attention mechanism
**NeuGEN Framework**

**Encoder**
- Bag of Words: Concepts and roles
- Attention mechanism

**Decoder**
- Left-to-right word LSTM
- Greedy beam search
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**Reranker**
NeuGEN Framework

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- Bag of Words: Concepts and roles
- Attention mechanism

Decoder
- Left-to-right word LSTM
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Reranker
- CCG parser -> semantics
**NeuGen Framework**

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- Partial propositions graph $E_{incr}$
NEUGEN Framework

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**Aligner**
- Feed-forward NN with attention

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**NeuGEN Framework**

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- Bag of Words: Concepts and roles
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**Aligner**
- Feed-forward NN with attention
- \( S_{\text{align}} = \text{fit}(G, E_{\text{incr}}) \)

**Decoder**
- Left-to-right word LSTM
- Greedy beam search

**Reranker**
- CCG parser -> semantics
- Partial propositions graph \( E_{\text{incr}} \)
Alignment
Alignment

w: A man inhabited a planet
Alignment

**w**: A man inhabited a planet

![Diagram showing the alignment of terms in the sentence: inhabit as the verb, man as the agent, and planet as the patient.]

\[ E_{\text{incr}} \]
Alignment

\( w: \) A man inhabited a planet

\[ E_{\text{incr}} \]
Alignment

\( w \): A man inhabited a planet

\( G \)

\( E_{\text{incr}} \)

\( \text{fit}(G, E_{\text{incr}}) \)
Alignment

**w**: A man inhabited a planet

\[ \text{E}_{\text{incr}} \]

<inhabit, man, agent>
<inhabit, planet, patient>

\[ \text{fit}(G, E_{\text{incr}}) \]

\[ G \]

<know-01, I, A0>
<know-01, planet, A1>
<planet, inhabit-01, A1-of>
<inhabit-01, man, A0>
<man, lazy, mod>
Alignment

$G$

$<\text{know, I, A0}>$

$<\text{know, planet, A1}>$

$<\text{planet, inhabit, A1-of}>$

$<\text{inhabit, man, A0}>$

$<\text{man, lazy, mod}>$

$E_{\text{incr}}$

$E_1: <\text{inhabit, man, agent}>$

$<\text{inhabit, planet, patient}>$

fitness score

$[0..1]$
Alignment

\[ fit(G, E_{incr}) = \frac{1}{n} \sum_{i=0}^{n} fit(G, E_i) \]
Decoding

encoder(G)

I know planet

ARG0

ARG1

inhabit

ARG1-of

ARG0

man

mod

lazy

G
Decoding

encoder(G)

ARG0

know

ARG1

planet

ARG1-of

inhabit

ARG0

man

mod

ARG0

lazy

∅
Decoding

I
The
A
...

encoder(G)

know
ARG0
I
planet
ARG1-of
inhabit
ARG0
man
mod
lazy

G
Decoding

I know I planet lazy

encoder(G)

The man

 ARG0

 ARG1

 ARG1-of

inhabit

 ARG0

 man

 mod

 lazy

 w_{11}: I

 w_{12}: The

 w_{13}: Man

 w_{14}: Tree

 ...
Decoding

encoder(G)

I
The
A
...

know
planet
inhabit
man
lazy

w₁₁: I
w₁₂: The
w₁₃: Man
w₁₄: Tree
...

re-score: S_LSTM
Decoding

encoder(G)

I
The
A
...

know
knew
planet
...

\( w_{11}: \) I

\( w_{12}: \) The

\( w_{13}: \) Man

\( w_{14}: \) Tree

...

re-score: \textbf{SLSTM}
Decoding

encoder(G)

 ARG0
 know
 I
 planet
 man
 lazy
 ARG1
 inhabit
 ARG1-of

re-score: $S_{LSTM} + S_{align}$
Decoding

encoder(G)

I know
The knew
A planet

w11: I know
w12: The knew
w13: Man knew
w14: Tree knew
w21: I know
w22: I knew
w23: The planet
w24: Man planet

re-score: $S_{\text{LSTM}} + S_{\text{align}}$
Decoding

encoder(G)

I
The
A

... 

know
knew
planet

... 

w_{11}: I
w_{12}: The
w_{13}: Man
w_{14}: Tree

w_{21}: I know
w_{22}: I knew
w_{23}: The planet
w_{24}: Man planet

G

know
planet
inhabit
man

... 

re-score: \textbf{S}_{LSTM} + \textbf{S}_{align}
Decoding

encoder(G)

G

I know a planet

w_{11}: I
w_{12}: The
w_{13}: Man
w_{14}: Tree

w_{21}: I knew
w_{22}: The planet
w_{23}: Man
w_{24}: Man planet

w_{41}: I know a planet
w_{42}: I knew planets that
w_{43}: The planet I knew
w_{44}: Man know a planet that

re-score: SLSTM + Salign
Decoding

encoder(G)

re-score: $S_{LSTM} + S_{align}$
Decoding

encoder(G)

I
The
A

know
knew
planet
man

... ...

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w41: I know a planet
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ARG0
ARG1
ARG1-of

know
planet
inhabit
mod

w12: The
w13: Man
w14: Tree

w23: The planet
w24: Man planet

G

re-score: \textbf{S}LSTM + \textbf{S}align
Decoding

I know a planet inhabited was

encoder(G)

ARG0

ARG1

ARG1-of

ARG0

know

planet

inhabit

man

lazy

G

w_{11}: I know
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re-score: $\textbf{S}_{\text{LSTM}} + \textbf{S}_{\text{align}}$
Preliminary Results
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Experimental Setup
Preliminary Results

Experimental Setup
- Baseline RNN w/o alignment
- NeuGen
Preliminary Results

Experimental Setup
- Baseline RNN w/o alignment
- NeuGen

Dataset
Preliminary Results

Experimental Setup
- Baseline RNN w/o alignment
- NeuGen

Dataset
- AMR LDC2015E86
- Train: 15k, Dev: 1.2k, Test: 1.2k
Preliminary Results

Experimental Setup
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- Train: 15k, Dev: 1.2k, Test: 1.2k

![Bar Chart](image)
Example Output
Example Output

Gallardo found-01 Tijuana Drug Cartel

domain ARG0-of

person ARG0-of

flee-01 ARG1

Tijuana Drug Cartel
Example Output

Gold: Gallardo is the fugitive founder of Tijuana Drug Cartel.
Baseline: Gallardo is the founder of Tijuana Drug Cartel.
NeuGen: Tijuana Drug Cartel is the founder of Gallardo.
Example Output

**Gold:** Gallardo is the fugitive founder of Tijuana Drug Cartel.

**Baseline:** Gallardo is the founder of Tijuana Drug Cartel.

**NeuGen:** Tijuana Drug Cartel is the founder of Gallardo.

Gallardo
Tijuana Drug Cartel
State
Country
...
Example Output

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Next Steps
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- “Machine-generated” representations
  - $\lambda$-calculus (ATIS)
  - Blocks World complex descriptions (from ISI)
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- Downstream Text-to-Text Applications
Thank You