Annotation of Tense & Aspect Semantics for Sentential AMR

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Why tense and aspect?

NLP representations & tools should be able to capture these differences, but often don’t.

This work: AMR
In the context of MWEs & constructions...

1. Aspectual meaning of non-compositional expressions is systematic

   (1a) Hermione has been dying for years.
   (1b) *Hermione has been kicking the bucket for years.

2. Light verbs exist in part to express tense (& aspect)

   (2a) Nathan gives interesting talks.
   (2b) Nathan gave an interesting talk yesterday.

3. Some fixed expressions entail changes related to tense & aspect

   (3) The COLING audience is well-versed in MWEs by now...
       in fact, they were well versed before they arrived last week.

(McGinnis, 2002; Michaelis, 2006; Altshuler & Michaelis, 2018)


Contributions of this work

Extend existing AMR annotation to reflect tense/aspect contrasts in English

- Semantic tense/aspect categories & criteria
- Pilot annotation results
- Open challenges
MOTIVATION FOR TENSE AND ASPECT
Why tense and aspect?

**TENSE**
- The *when* of an event

**ASPECT**
- The *how* of an event

Snoopy cycles.

**PRESENT TENSE**
**ACTIVITY; CHARACTERISTIC**

Snoopy cycles *to work*.

**PRESENT TENSE**
**GOAL-ORIENTED ACTIVITY; CHARACTERISTIC / HABITUAL EVENT**
Why tense and aspect?

TENSE
• The when of an event

ASPECT
• The how of an event

Snoopy cycled to work.

Snoopy cycled to work yesterday.

Snoopy cycled to work before he got a moped.

ONE-TIME, GOAL-ACHIEVED EVENT

HABITUAL, RECURRING EVENT
Why tense and aspect?

TENSE
• The *when* of an event

Snoopy *cycled* to work *yesterday* *but got a flat tire.*

Snoopy *never cycles to work.*

Snoopy *ought to cycle to work, but he doesn’t want to.*

ASPECT
• The *how* of an event

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“As of Sunday morning, the Carr Fire had destroyed more than 1,600 buildings and consumed more than 154,000 acres.”

“The fire was 41 percent contained but Ms. Bain said it was spreading along deep drainage gullies, which are hard to reach for firefighters.”
Existing tense/aspect representations

- **TimeML**
  (Pustejovsky et al., 2003; Pustejovsky, 2017)

- **Situation Entity (SE) Labeling**
  (Friedrich & Palmer, 2014; Friedrich et al., 2016)

- **Richer Event Description (RED)**
  (O’Gorman et al., 2016)

- **Causal & Temporal Relation Scheme (CaTeRS)**
  (Mostafazadeh et al., 2016)

- **Tense Sense Disambiguation**
  (Reichart and Rappoport, 2010)

1. How to separate **grammatical** tense/aspect from **semantic** tense/aspect?

2. How to create **event types** that are understandable for non-linguist annotators?

3. How to reason with **context**?
ABSTRACT MEANING REPRESENTATION (AMR)
Abstract Meaning Representation  
(Banarescu et al. 2013)

• Broad-coverage, **sentence-level** semantic representation for **English**
• **Abstracts** away from morphosyntactic variation
  • Predicate-argument structure, named entities, coreference, modality, ...
• Aspires to be the “Penn Treebank” for semantics to spur work in **natural language understanding and generation**

“The firefighters are trying to contain the spread of the fire.”

(t / try-01
  :ARG0 (f / firefighter)
  :ARG1 (c / contain-02
    :ARG0 f
    :ARG1 (s / spread-02
      :ARG1 (f2 / fire)))))

(Matthiessen & Bateman, 1991; Palmer et al., 2005)
Abstract Meaning Representation (Banarescu et al. 2013)

- Broad-coverage, **sentence-level** semantic representation for English
- **Abstracts** away from morphosyntactic variation
  - Predicate-argument structure, named entities, coreference, modality, ...
- Aspires to be the “Penn Treebank” for semantics to spur work in **natural language understanding and generation**

Leaves out much important, functional information, **tense** and **aspect** included
“As of **Sunday**, the fire **had destroyed** more than 1,600 buildings but **was spreading** quickly.”

=  

“On **Sunday**, the fire **destroyed** more than 1,600 buildings and **spread** quickly.”

=  

“By **Sunday**, the fire **will have destroyed** more than 1,600 buildings and **will be spreading** quickly.”
Design principles

1. Capture *semantics* (vs. morphosyntax) of tense and aspect

2. Balance *complexity* of tense/aspect & *simplicity* for annotation

3. Integrate into *current* AMR annotation practices
Design principles

1. Capture *semantics* (vs. morphosyntax) of tense and aspect

2. Balance complexity of tense/aspect & simplicity for annotation

3. Integrate into current AMR annotation practices

1. I am leaving for Boston tomorrow.

2. I am eating a sandwich.

3. I am loving being in Santa Fe.
Design principles

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**Design principles**

1. Capture *semantics* (vs. morphosyntax) of tense and aspect

2. **Balance complexity of tense/aspect & simplicity** for annotation

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**Example:**

3. *I am loving being in Santa Fe.*
Design principles

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3. I am *loving being in Santa Fe.*

Time = now

Aspect = temporary state
Design principles

1. Capture *semantics* (vs. morphosyntax) of tense and aspect

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The dinosaurs became extinct *millions of years ago.*

:time (b / before
  :op1 (n / now)
  :quant (m / multiple
    :op1 (t / temporal-quantity
      :quant 1000000
      :unit (y / year)))


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PROPOSED ANNOTATION SCHEME
Proposed approach

“I have flown a little over all parts of the world.”

(Langacker, 1987)
Proposed approach

“I have flown a little over all parts of the world.”

(\texttt{f / fly-01}
  
  \texttt{:ARG0 i}
  
  \texttt{:location (o / over}
  
  \texttt{:op1 (p2 / part}
  
  \texttt{:part-of (w / world))}
  
  \texttt{:quant (l / little)}
  
  \texttt{:ASPECT}
  
  \texttt{:TENSE})

AMR treats meaning at the \textit{sentence level}. We do the same with tense & aspect. (cf. O’Gorman et al., 2018).

(Langacker, 1987)
Time annotation

- **Present time**
  
  \[ :\text{time} \ (n \ / \ \text{now}) \]

- **Past time**

  \[ :\text{time} \ (b \ / \ \text{before} \  \\
  \quad :\text{op1} \ (n \ / \ \text{now})) \]

- **Future time**

  \[ :\text{time} \ (a \ / \ \text{after} \  \\
  \quad :\text{op1} \ (n \ / \ \text{now})) \]

(Reichenbach, 1947; Klein, 1994; Moens & Steedman, 1998; Allen et al., 2008)
Time annotation

• Present time
  :time (n / now)

• Past time
  :time (b / before
   :op1 (n / now))

• Future time
  :time (a / after
   :op1 (n / now))

"Here is a copy of the drawing."

(b / be-located-at-91
 :time (n / now))

(Reichenbach, 1947; Klein, 1994; Moens & Steedman, 1998; Allen et al., 2008)
Time annotation

- **Present time**
  :time (n / now)

- **Past time**
  :time (b / before
  :op1 (n / now))

- **Future time**
  :time (a / after
  :op1 (n / now))

“I pondered over the adventures of the jungle.”

(p / ponder-01
 :time (b / before
  :op1 (n / now)))

(Reichenbach, 1947; Klein, 1994; Moens & Steedman, 1998; Allen et al., 2008)
Time annotation

- **Present time**
  :time (n / now)

- **Past time**
  :time (b / before
  :op1 (n / now))

- **Future time**
  :time (a / after
  :op1 (n / now))

“I will try to make my portraits.”

(t / try-01
 :time (a / after
 :op1 (n / now)))
Time annotation

- Continuous time
  \[ :time (u / up-to
       :op1 (n / now)) \]

- Existential time
  \[ :time (b / before
         :mod (e / ever)
         :op1 (n / now)) \]

- Recent time
  \[ :time (b / before
         :mod (j / just)
         :op1 (n / now)) \]

(Klein, 1994; Portner, 1998)
Time annotation

- **Continuous time**
  
  \[
  \text{time (u / up-to} \\
  \text{op1 (n / now)})
  \]

- **Existential time**
  
  \[
  \text{time (b / before} \\
  \text{mod (e / ever)} \\
  \text{op1 (n / now)})
  \]

- **Recent time**
  
  \[
  \text{time (b / before} \\
  \text{mod (j / just)} \\
  \text{op1 (n / now)})
  \]

“Heavens, where **has** she **been** living?”

(l / live-01
  
  \[
  \text{time (u / up-to} \\
  \text{op1 (n / now)})
  \]

(Klein, 1994; Portner, 1998)
Time annotation

- **Continuous time**
  \[\text{time} (u / \text{up-to})\]
  \[: \text{op1} (n / \text{now})\]

- **Existential time**
  \[\text{time} (b / \text{before})\]
  \[: \text{mod} (e / \text{ever})\]
  \[: \text{op1} (n / \text{now})\]

- **Recent time**
  \[\text{time} (b / \text{before})\]
  \[: \text{mod} (j / \text{just})\]
  \[: \text{op1} (n / \text{now})\]

"I have flown a little over all parts of the world."

(f / fly-01
  \[\text{time} (b / \text{before})\]
  \[: \text{mod} (e / \text{ever})\]
  \[: \text{op1} (n / \text{now})\])

(Klein, 1994; Portner, 1998)
Time annotation

- **Continuous time**
  \[\text{time} (u / \text{up-to}) \quad : \text{op1} (n / \text{now})\]

- **Existential time**
  \[\text{time} (b / \text{before}) \quad : \text{mod} (e / \text{ever}) \quad : \text{op1} (n / \text{now})\]

- **Recent time**
  \[\text{time} (b / \text{before}) \quad : \text{mod} (j / \text{just}) \quad : \text{op1} (n / \text{now})\]

“I have come on a long journey.”

\[(c / \text{come-01})\]

(Klein, 1994; Portner, 1998, 2009)
Aspect annotation

:stable +/-
✓ States
  + inherent or permanent
  - temporary

:ongoing +/-?
✓ Real events (all)
  + viewed from inside
  - viewed from outside
  ? may or may not continue

:complete +/-
✓ Real, goal-oriented events
  + goal achieved
  - goal not achieved

(Vendler, 1947; Dowty 1986; Partee, 1999; Rothstein, 2008; Croft, 2012)
Aspect annotation

:stable +/-
✓ States
+ inherent or permanent
− temporary

ongoing +/-?
✓ Real events (all)
+ viewed from inside
− viewed from outside
? may or may not continue

:complete +/-
✓ Real, goal-oriented events
+ goal achieved
− goal not achieved

“It was a picture of a boa constrictor.”
:stable +

“He was in Turkish costume.”
:stable -

(Vendler, 1947; Dowty 1986; Partee, 1999; Rothstein, 2008; Croft, 2012)
Aspect annotation

:stable +/-
✓ States
+ inherent or permanent
- temporary

:ongoing +/-?
✓ Real events (all)
+ viewed from inside
- viewed from outside
? may or may not continue

:complete +/-
✓ Real, goal-oriented events
+ goal achieved
- goal not achieved

“He was looking for a sheep.”
:ongoing +

“He looked for a sheep.”
:ongoing -

“He has been looking for a sheep.”
:ongoing ?

(Vendler, 1947; Dowty 1986; Partee, 1999; Rothstein, 2008; Croft, 2012)
**Aspect annotation**

:stable +/-
- States
  - inherent or permanent
  - temporary

:ongoing +/-?
- Real events (all)
  - viewed from inside
  - viewed from outside
- may or may not continue

:complete +/-
- Real, goal-oriented events
  - goal achieved
  - goal not achieved

“**He was looking** for a sheep.”
:ongoing +

“**He looked** for a sheep.”
:ongoing -

“I **jumped** to my feet, completely thunderstruck.”
:ongoing -
:complete +

“I **was jumping** to my feet when...”
:ongoing +
:complete -

(Vendler, 1947; Dowty 1986; Partee, 1999; Rothstein, 2008; Croft, 2012)
Aspect annotation

:completable +/-
✓ hypothetical or non-real events
+ goal-oriented
- non-goal oriented

:habitual +
✓ regularly recurrent

“If you please, draw me a sheep!”
:completable +

“I may read poetry instead of the news today.”
:completable -

(Mathew & Katz, 2009)
Aspect annotation

:completable +/-
✓ hypothetical or non-real events
+ goal-oriented
- non-goal oriented

:habitual +
✓ regularly recurrent

"Boa constrictors **swallow** their prey whole."
  :habitual +

"But whoever it was, he or she **would** always **say**, ‘That is a hat’."
  :habitual +

(Mathew & Katz, 2009)
“As of Sunday, the fire had destroyed more than 1,600 buildings but was spreading quickly.”

“By Sunday, the fire will have destroyed more than 1,600 buildings and will be spreading quickly.”

(a / and
  :op1 (d / destroy-01 :ongoing - :complete +)
  :op2 (s / spread-03 :ongoing +)
  :time (b / before
    :op1 (d / date-entity :weekday (s2 / sunday)))
  :time (b / before
    :op1 (n / now)))

(a / and
  :op1 (d / destroy-01 :completable +)
  :op2 (s / spread-03 :ongoing +)
  :time (b / before
    :op1 (d / date-entity :weekday (s2 / sunday)))
  :time (a / after
    :op1 (n / now)))
<table>
<thead>
<tr>
<th>TIME</th>
<th>ASPECT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Present</strong></td>
<td><strong>Stative</strong></td>
</tr>
<tr>
<td>Past</td>
<td>:time (b / before :op1 (n / now))</td>
</tr>
<tr>
<td><strong>Existential</strong></td>
<td><strong>Eventive (episodic)</strong></td>
</tr>
<tr>
<td>Recent</td>
<td>:time (b / before :mod (e / ever) :op1 (n / now))</td>
</tr>
<tr>
<td>Future</td>
<td>:time (a / after :op1 (n / now))</td>
</tr>
<tr>
<td>Continuous</td>
<td>:time (u / up-to :op1 (n / now))</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>habitual</strong></td>
<td><strong>Habitual</strong></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Pilot Annotation Study

- 1 expert (E), 2 novice annotators (N1, N2)
  - 50 sentences from *The Little Prince*
  - Novice annotators were given thorough annotation guidelines

<table>
<thead>
<tr>
<th></th>
<th>E &amp; N1</th>
<th>E &amp; N2</th>
<th>N1 &amp; N2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time</strong></td>
<td>80%</td>
<td>61%</td>
<td>55.2%</td>
</tr>
<tr>
<td><strong>Aspect</strong></td>
<td>72.1%</td>
<td>73.8%</td>
<td>64.5 %</td>
</tr>
</tbody>
</table>

- 86 possible targets for both tense and aspect
  - Inter-annotator agreement (IAA) similar to comparable tense/aspect annotation tasks
Pilot Annotation Study

1. How do we apply: time (n / now)?

“That is funny!”

One never knows.

Where I live, everything is very small.

These disagreements most often occurred with:

- **Generic** statements in the present tense
- Time within **quotations**

(Reichenbach, 1947; Klein, 1994)
Pilot Annotation Study

2. Inceptive and cognitive states

I reached the top of the mountain and suddenly saw the river below.

:stable -  ?  :ongoing -  :complete +

For those who are concerned with matters of great importance.

:stable +  ?  :stable -

(Croft, 2012)
3. Conditional and modal constructions

When an astronomer discovers one of these, he does not give it a name, but only a number.

:habitual +

And if I forget him, I may become like the grown-ups...

:completable +

:time (a / after
:op1 (n / now))

(Portner, 2009)
SUMMARY & FUTURE WORK
Contributions of this work

Extend existing AMR annotation to reflect tense/aspect contrasts in English

• Semantic tense/aspect categories & criteria
• Pilot annotation results
• Open challenges
Example (Future work)

When did the Carr fire occur?

7/23/18
[fire reported]
:ongoing -
:complete +
:time (b / before
:opl (n / now))

7/26/18
[fire grew to 20,000 acres]
:ongoing -
:complete +
:time (b / before
:opl (n / now))

7/27/18
[crews continue to build containment lines]
:ongoing +
:complete -
:time (b / before
:opl (n / now))

8/20/18
[gullies are hard to reach]
:stable +
:time (u / up-to
:opl (n / now))

8/24/18
[fire has burned 229,658 acres]
:ongoing ?
:complete +
:time (u / up-to
:opl (n / now))

8/26/18
[fire may be 100% contained by next week]
:completable +
:time (a / after
:opl (n / now))
Future work

• Linguistic refinement
  – Temporal relations between events
  – Troubleshooting areas from pilot annotation
  – Modality!
  – Cross-linguistic data

• NLP applications
  – Scale up annotation scheme to large corpora
  – AMR parsers
  – Timeline extraction, narrative understanding, dialogue for human-agent collaboration...
Many thanks to all members of the AMR tense and aspect working group for their contributions to this project.

THANK YOU!
# Example Guideline Table

<table>
<thead>
<tr>
<th>States</th>
<th>Dynamic Events</th>
</tr>
</thead>
</table>
| **:stable +**| :time ■ now if salient  
*He lives/lived/used to live in Paris.* |
| **:stable -**| :time ■ now  
*He was/is living in Paris.* |
| **Episodic** | :time ■ now,  
:ongoing +/-/?, and  
:complete +/- if telic and realized  
:completable - if atelic and hypothetical  
:completable + if telic and hypothetical  
*He went/is going/will go to Paris.*  
*He has been to Paris (ever, recently).*  
*He has been touring Paris for the past week.*  
*He may/should/could go to Paris.* |
| **Habitual** | :habitual +, and  
:time ■ now if salient  
*He is in Paris often.* |

| **:habitual +, and** | :habitual +, and  
:time ■ now if salient  
*He goes to Paris often.* |

Table 1: Overview of tense/aspect annotation scheme by stativity and habituality. Aspectual features are in bold. :time ■ now is short for one of: :time now, :time before now, :time after now, :time up-to now. For habituals and stable states, :time is only annotated if there is a clear relation to the present time, e.g. past time expressed by *used to.*
Example: finite verb targets

“The firefighters are trying to contain the spread of the fire.”

(t / try-01 :ongoing + :complete -
 :ARG0 (f / firefighter)
 :ARG1 (c / contain-02
  :ARG0 f
 :ARG1 (s / spread-02
   :ARG1 (f2 / fire)))
 :time (n / now))
"In the course of this life, I have had a great many encounters with a great many people who have been concerned with matters of consequence."

(e / encounter-01 :ongoing - :complete +
 :ARG0 (i / i)
 :ARG1 (p / person
 :quant (m2 / many
 :mod (g2 / great))
 :ARG1-of (c / concern-01 :stable +
 :ARG0 (m3 / matter
 :ARG1-of (c2 / consequential-01))))
:quant (m / many
 :mod (g / great))
 :time (c3 / course
 :poss (l / life
 :mod (t / this)))
 :time (b / before
 :mod (e / ever)
 :op1 (n / now))
**Example: ongoing + without -ing**

“I ask your forgiveness.”

“I was in a great hurry.”

(a / ask-02 :ongoing + :complete -
 :ARG0 (i / i)
 :ARG1 (f / forgive-01
 :ARG0 y
 :ARG1 i
 :ARG2 (y / you)
 :time (n / now))

(h / hurry-01 :ongoing +
 :ARG1 (t / they
 :degree (g / great)
 :time (b / before
 :op1 (n / now)))
Example

"The little prince looked everywhere to find a place to sit down; but the entire planet was cramming and obstructed by the king's magnificent ermine robe."

(a / and
:op1 (c / cram-01 :stable -
   :ARG1 (r2 / robe
      :mod (e2 / ermine)
      :mod (m / magnificent)
      :poss (k / king))
   :ARG2 (p3 / planet
      :extent (e3 / entire))
   :time (b2 / before
      :op1 (n2 / now)))
:op2 (o / obstruct-01 :stable -
   :ARG0 r2
   :ARG1 p3
   :time (b3 / before
      :op1 (n3 / now)))
:concession (l / look-01 :ongoing - :complete +
   :ARG0 (p / prince
      :mod (l2 / little))
   :ARG1 (p2 / place
      :purpose (s / sit-down-02
         :ARG1 p))
   :location (e / everywhere)
   :time (b / before
      :op1 (n / now)))

Example


Design principles

1. Capture *semantics* (vs. morphosyntax) of tense and aspect

2. Balance complexity of tense/aspect & simplicity for annotation

3. Integrate into current AMR annotation practices

I am leaving for Boston tomorrow. == *Estoy yendo a Boston mañana.*

Voy a Boston mañana. == I leave for Boston tomorrow.

FUTURE TIME, COMPLETABLE ACTION