Annotation of Tense & Aspect Semantics for Sentential AMR

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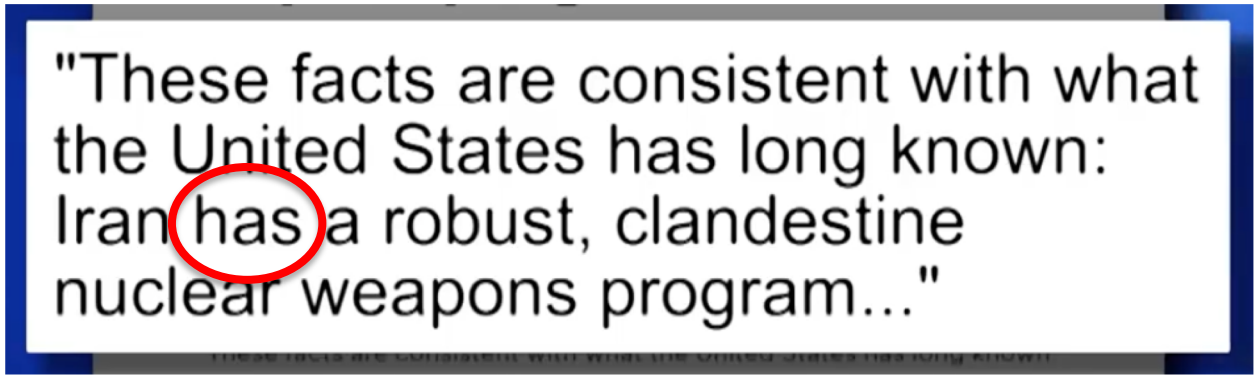
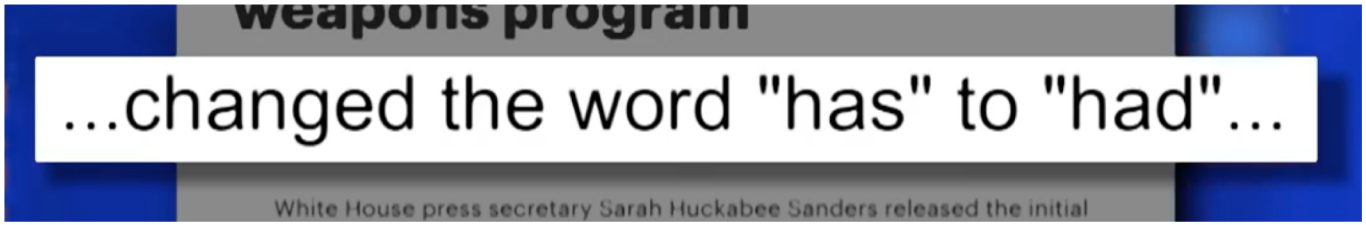
THE UNIVERSITY OF NEW MEXICO

GEORGETOWN UNIVERSITY

Why tense and aspect?

https://www.youtube.com/embed/W6E_Pjayhl8?start=139&end=166





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.

PAST TENSE

Snoopy cycled to work *yesterday*.

ONE-TIME, GOAL-ACHIEVED EVENT

Snoopy cycled to work *before* *he got a moped*.

HABITUAL, RECURRING EVENT

Why tense and aspect?

TENSE

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

ASPECT

- The ***how*** 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.**

Why tense and aspect?

Carr Fire in California Claims a Seventh Victim as It Continues to Grow

*"**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**?

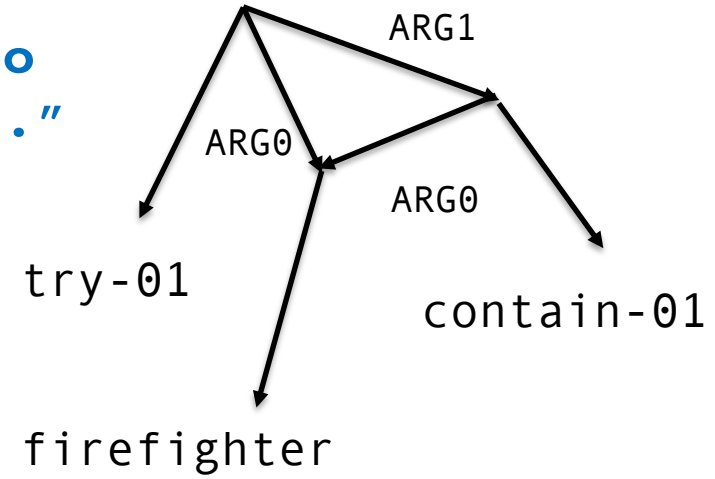
ABSTRACT MEANING REPRESENTATION (AMR)

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

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

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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

PRESENT TENSE | PROGRESSIVE ASPECT

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** leav**ing** for Boston tomorrow.

FUTURE TIME, COMPLETABLE ACTION

2. I **am** eat**ing** a sandwich.

PRESENT TIME, PROGRESS TO GOAL

3. I **am** lov**ing** be**ing** in Santa Fe.

PRESENT TIME, STATIVE

Design principles

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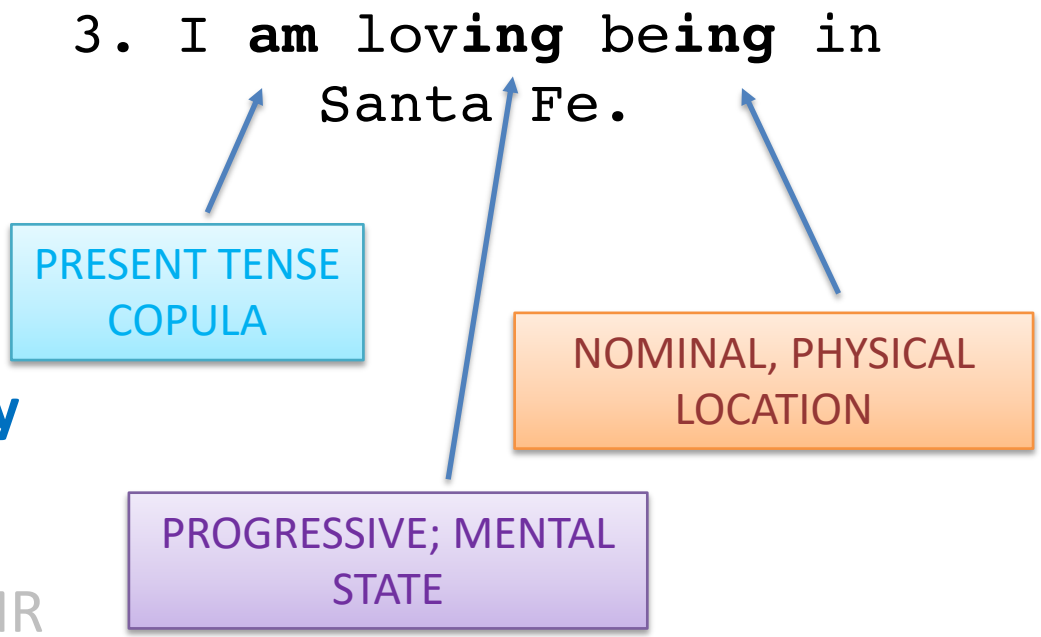


Design principles

1. Capture *semantics* (vs. morphosyntax) of tense and aspect
2. **Balance complexity of tense/aspect & simplicity for annotation**
3. Integrate into current AMR annotation practices

3. I **am** lov**ing** be**ing** in Santa Fe.

Time = now
Aspect = temporary state

Design principles

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

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

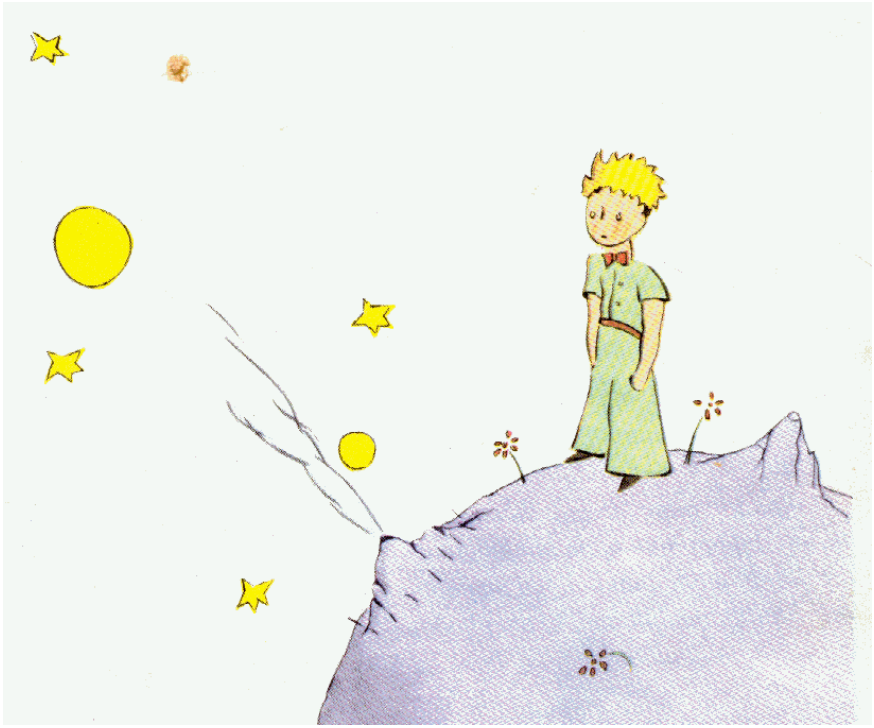
3. **Integrate into current AMR annotation practices**

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)))
```

PROPOSED ANNOTATION SCHEME

Proposed approach

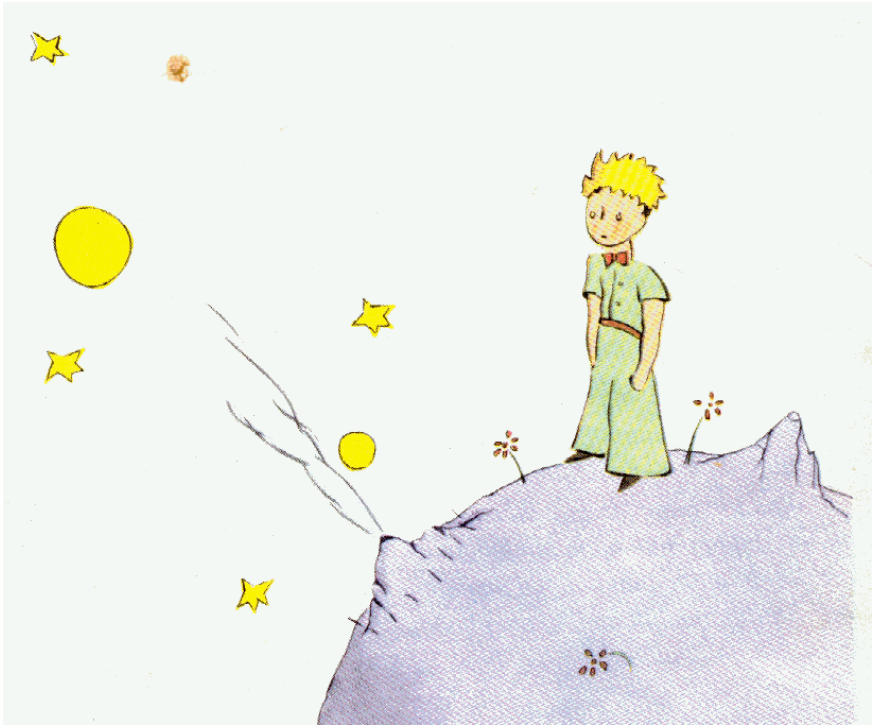


"I **have flown** a little over all parts of the world."

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

(Langacker, 1987)

Proposed approach



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        :op1 (p2 / part
          :part-of (w / world)))
      :quant (l / little)
   :ASPECT
   :TENSE)
```

AMR treats meaning at the **sentence level**.
We do the same with tense & aspect.
(cf. O'Gorman et al., 2018).

(Langacker, 1987)

Time annotation

- Present time

```
:time (n / now)
```

- Past time

```
:time (b / before
     :op1 (n / now))
```

- Future time

```
:time (a / after
     :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))
```

"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)))
```


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

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**

```
:time (u / up-to
      :op1 (n / now))
```

- Existential time

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:time (b / before
      :mod (e / ever)
      :op1 (n / now))
```

- Recent time

```
:time (b / before
      :mod (j / just)
      :op1 (n / now))
```

"Heavens, where **has** she **been living**?"

```
(l / live-01
   :time (u / up-to
         :op1 (n / now)))
```

(Klein, 1994; Portner, 1998)

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))
```

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

```
(f / fly-01
   :time (b / before
         :mod (e / ever)
         :op1 (n / now)))
```

(Klein, 1994; Portner, 1998)

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))
```

"I **have come** on a long journey."

```
(c / come-01
   :time (b / before
         :mod (j / just)
         :op1 (n / now)))
```

(Klein, 1994; Portner, 1998, 2009)

Aspect annotation

:stable +/-

✓ **States**

\+ inherent or permanent

– temporary

STATES

: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

EVENTS

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

Aspect annotation

:stable +/-

✓ **States**

\+ inherent or permanent

– temporary

"It **was** a picture of a boa constrictor."

:stable +

"He **was** in Turkish costume."

:stable -

: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

"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."

```
(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)))
```

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

```
(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)))
```

PILOT ANNOTATION STUDY

	TIME	
1	**Present**	:time (n / now)
2	**Past**	:time (b / before :op1 (n / now))
3	*Existential*	:time (b / before :mod (e / ever) :op1 (n / now))
4	*Recent*	:time (b / before :mod (j / just) :op1 (n / now))
5	**Future**	:time (a / after :op1 (n / now))
6	**Continuous**	:time (u / up-to :op1 (n / now))

	ASPECT		
1	**Stative**	:stable -	*Temporary*
2		:stable +	*Permanent**
3	**Eventive *(episodic)***	:ongoing +	*Atelic, in progress*
4		:ongoing + :complete -	*telic, in progress*
5		:ongoing -	*Atelic, done*
6		:ongoing - :complete -	*Telic, incomplete & done*
7		:ongoing - :complete +	*Telic, complete & done*
8		:completable -	*Non-real, atelic*
9		:completable +	*Non-real, telic*
10	***(habitual)***	:habitual +	*Habitual eventive*
11		:habitual + :stable -	*Habitual stative*

Pilot Annotation Study

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

	E & N1	E & N2	N1 & N2
Time	80%	61%	55.2%
Aspect	72.1%	73.8%	64.5 %

- **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)

Pilot Annotation Study

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
  :op1 (n / now))
```

7/26/18
[fire **grew** to 20,000 acres]
```
:ongoing -
:complete +
:time (b / before
  :op1 (n / now))
```

7/27/18
[crews **continue to build** containment lines]
```
:ongoing +
:complete -
:time (b / before
  :op1 (n / now))
```

8/20/18
[gullies **are hard** to reach]
```
:stable +
:time (u / up-to
  :op1 (n / now))
```

8/24/18
[fire **has burned** 229,658 acres]
```
:ongoing ?
:complete +
:time (u / up-to
  :op1 (n / now))
```

8/26/18
[fire **may be** 100% **contained** by next week]
```
:completable +
:time (a / after
  :op1 (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!

APPENDIX

Example Guideline Table

	States		Dynamic Events
	`:stable +`	`:stable -`	
Episodic	`:time ▪ now` if salient *He lives/lived/used to live in Paris.*	`:time ▪ now` *He was/is living in Paris.*	`: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 `: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))
```

Example: co-occurrent time annotation

"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."

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

"They were in a great hurry."

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

Example

:stable-

"The little prince **looked** everywhere to find a place to sit down; but the entire planet **was crammed** 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))))
```

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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