

# The Problem of Reference

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## Entity-Parse Semantics

Two claims:

- Converting unstructured text to structured data — structuring text — is equivalent to semantics.
- Entity parsing — joint parsing and coreference — is a (nearly) adequate structuring of text.

These claims together constitute Entity-Parse semantics.

These claims suggest that we may be closer to effective conversational agents (operational sentience) than people realize.

## The Cutting Edge of Structured Data

- Google Scholar
- Freebase
- The Google Knowledge Graph
- Fusion Tables (Google) — agglomerating billions of web tables.
- Biperpedia (Google) — millions of class names with associated attribute names automatically extracted from web tables.
- The Santori Knowledge Base (Microsoft, not released)
- Proprietary “big data” databases of personal information.

# Reference as Structuring

Consider FACC from Google.

ClueWeb Corpora

Freebase Entities

**Karen Spärck Jones lecture**

The **Karen Spärck Jones** lecture is an annual event that honours women in computing research.

This lecture series builds on the activities to celebrate, inform and support women engaged in computing. These include the annual [London Hopper](#), providing networking opportunities for early career researchers, and the [Lovelace Colloquium](#), for women undergraduates in computing and related subjects.

Freebase Find...

**Karen Spärck Jones** <sup>nm</sup>

mid: /m/02698nt notable type: /computer/computer...

Karen Spärck Jones FBA was a British computer scient...

Name of the annotated document

clueweb12-filename3572.html

→ Karen Spärck Jones 19318 19336 0.99955487 1.3374945e-05 /m/02698nt

→ Karen Spärck Jones 19389 19407 0.99768384 1.5958393e-05 /m/02698nt

Entity mention text

Beginning Offset

End Offset

Confidence levels

Freebase identifier (mid)

## Coreference vs. Reference: Text vs. Reality

Wikipedia —[Malaysia Airlines Flight 370 (MH370/MAS370)] was a scheduled international passenger flight from Kuala Lumpur to Beijing [that] ... (disappeared) ...

KUALA LUMPUR, May 1 (Reuters) - Malaysia released a preliminary report on [missing Flight MH370] on Thursday in which it recommended that the U.N. body overseeing global aviation consider introducing a system for tracking commercial aircraft in real time.

The document, dated April 9, also provided fresh details of attempts the authorities in Kuala Lumpur made to locate [the Malaysia Airlines plane] and of the exact flight path [it] is believed to have taken.

## Coreference vs. Reference: Text vs. Reality

[The secrecy-shrouded, botched execution] in Oklahoma on Tuesday couldn't happen the same way in [California], where [state laws and regulations] require public disclosure of the drugs used in lethal injections.

As [pro-Russian forces] extended their control over parts of [eastern Ukraine], [the country's interim authorities] ordered the expulsion of [a naval attach] at Moscow's embassy in Kiev.

## Event Reference

V. Stiviano says [Donald Sterling's racist comments] on an audio recording [leaked to the public] were not the first by the Los Angeles Clippers owner in conversations with her.

:

[Sterling told Stiviano] in the recording that she should not post online photos of herself with black people.

:

The recording, which an attorney for Stiviano said [was leaked] by a third party, led to public outcry across the country and the NBA.

## Sampling

The first sentence of the lead story at [news.google.com](https://news.google.com) as of 8:00 this morning was:

Russian President Vladimir Putin said Friday that Russia wants peace and order to be restored in Ukraine and will “respect” the outcome of Ukraine’s presidential election on Sunday.



## Some Current Work on Reference

The CoNLL shared tasks in 2011 and 2012 were both on coreference.

Two papers of note:

Heeyong Lee, Marta Recasens, Angel Chang, Mihai Surdeanu, Dan Jurafsky “Joint Entity and Event Coreference across Documents”, EMNLP 2012

Greg Durrett and Dan Klein, “Easy Victories and Uphill Battles in Coreference Resolution”, EMNLP 2013

## Parsing as Structuring

( ( Authorities  
    (in Ukraine)  
    (on Sunday))  
said  
( (government forces)  
reclaimed  
(a television tower)  
( during  
  ( (a security operation)  
    (to ( quell  
        pro-Russian  
        rebel  
        activity  
    ( in (the eastern town of Kramatorsk))))))

## Entity Parsing: Joint Parsing and Reference Resolution

Each syntax node is treated as a mention.

In an entity parse each syntax node is reference-resolved to an entity (equivalence class of mentions).

Each dependency arc is treated as a relationship between entities. Dependency arcs should be labeled with semantic roles when appropriate.

## Entity Parsing: An Example

Authorities in Ukrain said Government forces reclaimed a television tower during [a security operation] to quell pro-Russian rebel activity in the eastern town of Kramatorsk.

Interior Minister Arsen Avakov said that [a new assault] to reclaim control over the town ... began at dawn.

## An Entity Parse

the-tower: head: television tower

the-forces: head: government forces

Kramatorsk: head: the eastern town of Kramatorsk

the-activity: nmod: pro-Russian  
                  nmod: rebel  
                  head: activity  
                  nmod: in <Kramatorsk>

## Entity Parse Continued

the-control: head: control

nmod: of <Kramatorsk>

the-operation: head: a security operation

objective: to quell <the-activity>

head: a new assault

objective: to gain <the-control>

nmod: began at dawn

the-reclaiming: agent: <the-forces>

head: reclaimed

patient: <the-tower>

vmod: during <the-operation>

## Different Views of Semantics

- Entity-Parse semantics.
- Compositional Tarskian semantics. Type-Logical semantics. Truth-condition semantics. Formal language semantics (programming languages and mathematical logic).
- Grounding.
- Vector semantics.

## Compositional Semantics Ignores Reference

```
( ( ((1) Ohio)'s
  ban
  (on ((2) same-sex marriage)))
was challenged
(in (federal court))
(by (((3) six gay couples)
  (((3) who)
  (seek
  (to (make
      ((1) the state)
      (join
      (21
      others
      (that
      (have legalized
      ((2) such unions)))))))))))))
```

“join 21 others ...” seems coreferential with “legalize same-sex marriage”.



## Visual Grounding Ignores Non-Physical Speech

To truly understand language, an intelligent system must be able to connect words, phrases, and sentences to **its perception of** objects and events in the world.

— Ray Mooney

By “perception” advocates of grounding typically mean images or videos.

But most concepts in news sentences are not physical.

Hiring surprisingly surged last month as the economy added 288,000 net new jobs – the best performance in more than two years – and the unemployment rate dropped to 6.3 percent, its lowest level since September 2008, the Labor Department said Friday.

## Vector Semantics Obscures Entities

Ohio's ban on same sex marriage was challenged by [x] in [y].

What are the differences between “challenged”, “contested”, “threaten” and “protested”? Perhaps vectors can help here.

However, the relation “x challenged y” in a news story seems to be a relational triple, in the sense of freebase or the Google knowledge graph, with **particular entities** x and y.

Would we really want to replace all SQL databases with vector-processing systems? Should all of freebase be reduced to a single vector?

## Entity Grammars

An entity grammar consists of

- an edge label set  $\mathcal{L}$
- a word vocabulary  $\mathcal{V}$
- a set of entities  $\mathcal{E}$
- a set of productions  $X \xrightarrow{\ell} Y \quad X, Y \in \mathcal{E} \quad \ell \in \mathcal{L}$
- a set of productions  $X \xrightarrow{\text{head}} w \quad X \in \mathcal{E} \quad w \in \mathcal{V}.$

## Stochastic Entity Grammars

Each production is associated with a probability.

$$P(X \xrightarrow{\ell} Y) \in [0, 1]$$

$$P(X \xrightarrow{\text{head}} w) \in [0, 1]$$

$$\sum_{w \in \mathcal{V}} P(X \xrightarrow{\text{head}} w) = 1$$

## Unsupervised Learning of Entity Grammars

Note that an entity grammar generates an entity parse of a dependency tree.

Given a set  $D$  of dependency parses we heuristically find the entity grammar  $G$  and entity parse  $S$  of  $D$  maximizing  $P(G)P(S|G)$ .

We evaluate on a joint NP-VP coreference data set from Lee et al. (Dan Jurafsky's group at Stanford). Using the same metric as Lee et al. we get:

Lee et al.	35.4
Our current system	35.5

## Summary and Research Directions

- Entity-Parses may be (nearly) adequate semantic representations.
- Semantic “understanding” by computers may be closer than many people think.
- We should (must?) find a way to train these systems without supervision.