Language Acquisition of Multiword Expressions

from language technology to language learners

Aline Villavicencio

Institute of Informatics

Federal University of Rio Grande do Sul, Brazil

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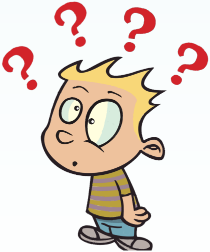
Multiword expressions (MWE)

1. What are they?
2. Why are they important?
3. What happens when we ignore them?



Multiword expressions (MWE)

Jumping the Shark

1. The moment when an established TV show changes in a significant manner in an attempt to stay fresh.

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Jumping the Shark

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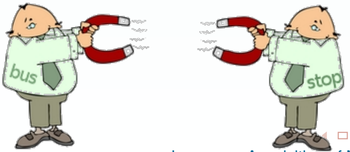
What are MWEs?

- *loan shark*
- *French kiss*
- *open mind*
- *vacuum cleaner*
- *voice mail*
- *high heel shoe*
- *make sense*
- *good morning*
- *take a shower*
- *upside down*
- . . .

- *es pan comido*
- *estiró la pata*
- *traer por la calle de la amargura*
- *dar gato por liebre*
- *alucinar en colores*
- *calcular a ojímetro*
- *dejar plantado*
- *meter la pata*
- . . .

- *quebrar um galho*
- *lavar roupa suja*
- *cara de pau*
- *amigo da onça*
- *aspirador de pó*
- *fazer sentido*
- *tomar banho*
- *dar-se conta*
- *nem te conto*
- *depois de amanhã*
- . . .



MWE: definition(s)

What is a word? What is a MWE? [Church, 2011]

- A unit whose exact meaning cannot be derived directly from the meaning of its parts [Choueka, 1988]
- Arbitrary and recurrent word combinations [Smadja, 1993]
- Idiosyncratic interpretations that cross word boundaries (or spaces) [Sag et al., 2002]

Multiword expression

A combination of words that must be treated as a unit at some level of linguistic processing.

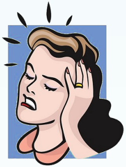
[Calzolari et al., 2002]

Characteristics I

1. **Arbitrariness and Institutionalisation**: *salt and pepper*, *?pepper and salt* [Smadja, 1993]
2. **Frequency**: 50% to 70% of the lexicon [Jackendoff, 1997, Krieger and Finatto, 2004, Ramisch, 2009]
3. **Limited lexical, syntactic and semantic variability**:*kick the bucket/?pail/?container* [Sag et al., 2002]

Why are MWEs important for NLP?

Because they are. . .



- Frequent [Sag et al., 2002]
- A marker of fluency
- Between lexicon and syntax [Calzolari et al., 2002]
- Hard to translate, parse, disambiguate, etc.
- An open problem in NLP [Schone and Jurafsky, 2001]

What happens if we ignore them?

We may get lost in translation:

From Greek to English

1. **Money laundering** represents between 2 and 5% ...
   - **The rinsing of dirty money** represents the 2 until 5%
2. as seen from the human **point of view**
   - as this is fixed by the human **optical corner**

What happens if we ignore them?

- MWEs are not as present in NLP applications as in languages
- Lexical resources construction is onerous

However

- Corpora are rich information sources
- MWE integration can improve the quality of NLP systems

Tasks [Anastasiou et al., 2009]

- **Acquisition**:

  [Silva and Lopes, 1999, Frantzi et al., 2000, Fazly et al., 2009, Seretan and Wehrli, 2009, Pecina, 2010, Kim and Baldwin, 2010]
- **Interpretation and disambiguation**:

  [Baldwin, 2006, Fazly et al., 2007, McCarthy et al., 2007, Nakov, 2008].
- **Representation**: [Laporte and Voyatzi, 2008, Grégoire, 2010, Graliński et al., 2010, Izumi et al., 2010, Schuler and Joshi, 2011]
- **Applications**:
  - Parsing: [Wehrli et al., 2010, Hogan et al., 2011]
  - IR: [Acosta et al., 2011, Xu et al., 2010]
  - WSD: [Finlayson and Kulkarni, 2011]
  - MT: [Ren et al., 2009, Pal et al., 2010, Carpuat and Diab, 2010]

Zoom on acquisition

1. Develop techniques for automatic acquisition of MWEs from corpora
2. Evaluate the usefulness of MWEs in NLP applications.
3. Investigate the application of MWE identification techniques for language acquisition studies.

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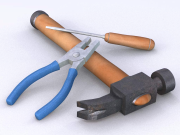
4. Machine Translation
5. VPCs in English Child Language
6. Conclusions and Future work

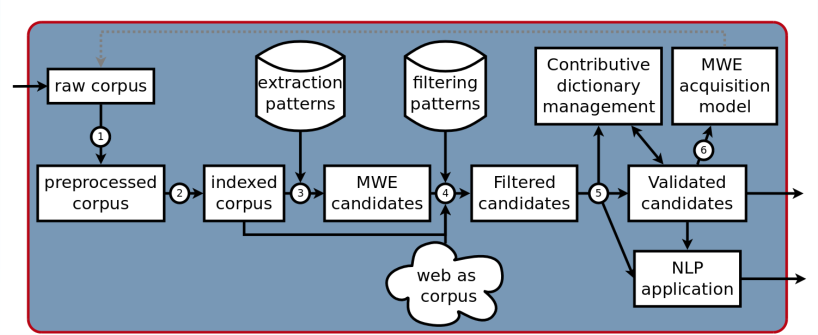
Tools for monolingual acquisition

- LocalMaxs – `hlt.di.fct.unl.pt/luis/multiwords/`
- Text::NSP – `search.cpan.org/dist/Text-NSP`
- UCS – `www.collocations.de/software.html`
- jMWE – `projects.csail.mit.edu/jmwe`
- Varro – `sourceforge.net/projects/varro/`
- Web services like Yahoo! terms
- Terminology extraction tools



A MWE processing framework

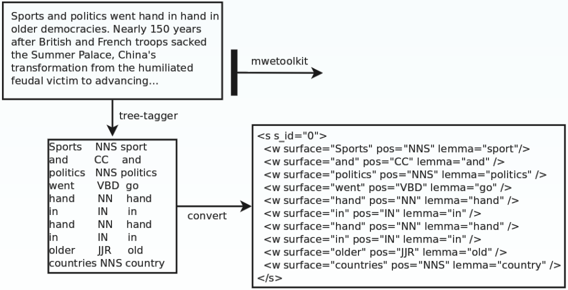
[Ramisch et al., 2010d, Ramisch et al., 2010b, Ramisch et al., 2012]



1. Preprocessing (external)

External tools for

1. Tokenisation, Lemmatisation, POS tagging, Dependency parsing



Sports and politics went hand in hand in older democracies. Nearly 150 years after British and French troops sacked the Summer Palace, China's transformation from the humiliated feudal victim to advancing...

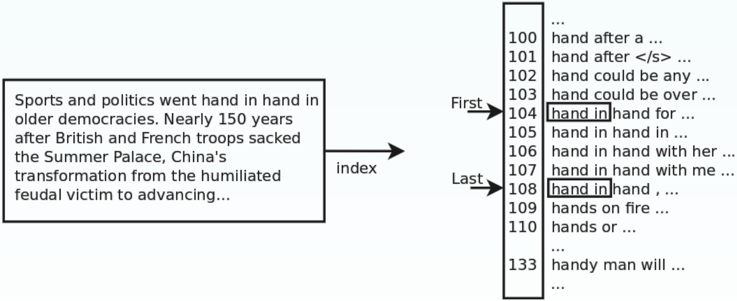
```
Sports    NNS politics
```

```
Sports    NNS sport
and       CC  and
politics  NNS politics
went      VBD go
hand      NN  hand
in        IN  in
hand      NN  hand
in        IN  in
older     JJR old
countries NNS country
```

```
<s s_id="0">
  <w surface="Sports" pos="NNS" lemma="sport"/>
  <w surface="and" pos="CC" lemma="and" />
  <w surface="politics" pos="NNS" lemma="politics" />
  <w surface="went" pos="VBD" lemma="go" />
  <w surface="hand" pos="NN" lemma="hand" />
  <w surface="in" pos="IN" lemma="in" />
  <w surface="hand" pos="NN" lemma="hand" />
  <w surface="in" pos="IN" lemma="in" />
  <w surface="older" pos="JJR" lemma="old" />
  <w surface="countries" pos="NNS" lemma="country" />
</s>
```

2. Corpus Indexing

- Suffix array

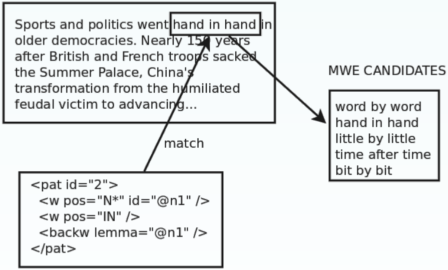


Sports and politics went hand in hand in older democracies. Nearly 150 years after British and French troops sacked the Summer Palace, China's transformation from the humiliated feudal victim to advancing...

		...
	100	hand after a ...
	101	hand after </s> ...
	102	hand could be any ...
	103	hand could be over ...
First	104	hand in hand for ...
	105	hand in hand in ...
	106	hand in hand with her ...
	107	hand in hand with me ...
Last	108	hand in hand , ...
	109	hands on fire ...
	110	hands or ...
		...
	133	handy man will ...
		...

3. Candidate extraction

- Linguistic Patterns



Sports and politics went hand in hand in older democracies. Nearly 150 years after British and French troops sacked the Summer Palace, China's transformation from the humiliated feudal victim to advancing...

```
<pat id="2">
  <w pos="N*" id="@n1" />
  <w pos="IN" />
  <backw lemma="@n1" />
</pat>
```

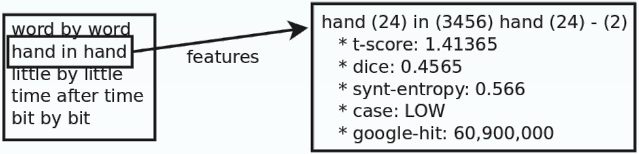
word by word
hand in hand
little by little
time after time
bit by bit

4. Candidate filtering

Features:

- Association measures, Variation entropy

[Ramisch et al., 2008]



word by word
hand in hand
little by little
time after time
bit by bit

features

hand (24) in (3456) hand (24) - (2)
* t-score: 1.41365
* dice: 0.4565
* synt-entropy: 0.566
* case: LOW
* google-hit: 60,900,000

Some association measures:

$$\text{t-score} = \frac{c(w_1^n) - E(w_1^n)}{\sqrt{c(w_1^n)}} \qquad \text{pmi} = \log_2 \frac{c(w_1^n)}{E(w_1^n)}$$

$$\text{dice} = \frac{n \times c(w_1^n)}{\sum_{i=1}^{n} c(w_i)} \qquad \text{ll} = \sum_{w_i w_j} \log \left[\frac{c(w_i w_j)}{E(w_i w_j)} \right]^{c(w_i w_j)}$$

5. Validation

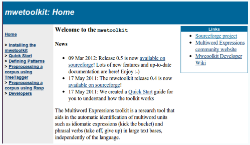
- Intrinsic using dictionaries, experts' or native speakers' judgements
- Extrinsic within NLP application

6. Machine Learning

- Export to WEKA machine learning toolkit
- Learn classifiers
- Apply to new data

The `mwetoolkit`

`mwetoolkit.sf.net`



mwetoolkit: Home

Home

> Installing the mwetoolkit
> Quick Start
> Defining Patterns
> Preprocessing a corpus using TreeTagger
> Preprocessing a corpus using Rasp
> Developers

Welcome to the `mwetoolkit`

News

- 09 Mar 2012: Release 0.5 is now available on sourceforge! Lots of new features and up-to-date documentation are here! Enjoy :-)
- 17 May 2011: The mwetoolkit release 0.4 is now available on sourceforge!
- 17 May 2011: We created a Quick Start guide for you to understand how the toolkit works

The Multiword Expressions toolkit is a research tool that aids in the automatic identification of multiword units such as idiomatic expressions (kick the bucket) and phrasal verbs (take off, give up) in large text bases, independently of the language.

Links

- Sourceforge project
- Multiword Expressions community website
- Mweoolkit Developer Wiki

- Target users: computational linguists
- Modular, customisable system
- Independent of language, n-gram length , adjacency, formalism, preprocessing tool

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For creating lexical resources

- The `mwetoolkit` can be used for identifying and suggesting MWE entries

Creating MWE resources

- English MWE lexicon extension for parsing

  [Zhang et al., 2006, Villavicencio et al., 2007]
- Compositionality detection of English VPCs

  [Ramisch et al., 2008]
- Greek nominal expressions lexicon

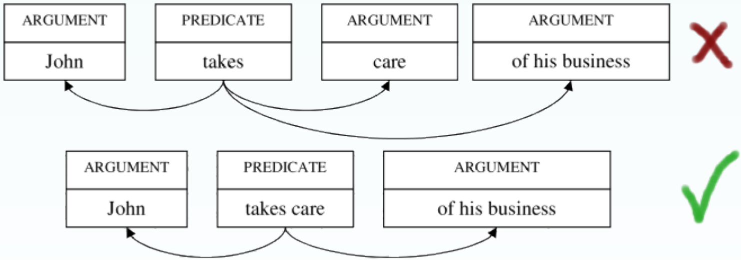
  [Linardaki et al., 2010]
- Portuguese Light Verb lexicon [Duran et al., 2011]

Portuguese Light Verb lexicon

[Duran et al., 2011]

Portuguese Light Verb lexicon

Light Verb + Noun: *take care, take shower, take walk, tomar cuidado, tomar banho, dar caminhada*



Problem: coverage of light verbs in lexical resources

Portuguese Light Verb lexicon

Corpus

PLN-BR-Full: 29M words, news, POS tagged

Patterns:

1. V + N + P: *abrir mão de* (*give up*, lit. *open hand of*)
2. V + P + N: *deixar de lado* (*ignore*, lit. *leave at side*)
3. V + DT + N + P: *virar as costas para* (*ignore*, lit. *turn the back to*)
4. V + DT + ADV: *dar o fora* (*get out*, lit. *give the out*)
5. V + ADV: *ir atrás* (*follow*, lit. *go behind*)
6. V + P + ADV: *dar para trás* (*give up*, lit. *give to back*)
7. V + ADJ: *dar duro* (*work hard*, lit. *give hard*)

Portuguese Light Verb lexicon I

pattern	acquired	analysed	− idiom.	+ idiom.
V + N + P	69,264	2,140	327	8
V + P + N	74,086	1,238	77	8
V + DT + N + P	178,956	3,187	131	4
V + DT + ADV	1,537	32	0	0
V + ADV	51,552	3,626	19	41
V + P + ADV	5,916	182	0	2
V + ADJ	25,703	2,140	145	11
Total	407,014	12,545	699	74

Portuguese Light Verb lexicon

Traditional (*take, make, do*), and more unusual (*provide*) light verbs

- *dar tratamento = tratar*

  give treatment= treat

- *dar medo = amedrontar*

  give fear = frighten

- *tornar responsável = responsabilizar*

  hold responsible = responsibilise

- *prestar atenção = atentar?*

  pay attention = attend?

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MWEs and machine translation (MT)

- MWEs introduce cross-lingual asymmetries
- Pilot study of their impact on MT quality
- Introduction in MT systems $\Longrightarrow$ +quality

Source: English verb-particle constructions (VPCs) *(give up, take off)*

Target: Portuguese verbs *(desistir, decolar)*

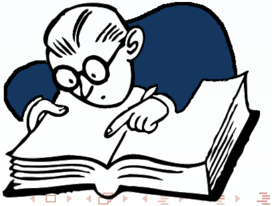
Verb-particle constructions (VPCs) in English

Semantic variability:

- *give back*
- *give up*
- *look up*

Syntactic variability:

- *She gave up*
- *She gave it up*
- *She gave up smoking*



Experimental context

- Baseline: Moses with WMT 2011 parameters on fragment of Europarl v6
- 660-sentences test set

Integration strategy 1/3: TOK

Concatenate verb and particle to treat them as a unit

*Europe will **give** it **up***

⇓

*Europe will **give_up** it*

Integration strategy 2/3: VPC?

Extra binary feature in translation model that flags VPCs

Source s	**Target** t	$p(t\|s)$	$lex(t\|s)$	$p(s\|t)$	$lex(s\|t)$	***VPC?***
a backward step .	de uma regressão .	1	0.0280	0.5	0.0025	***0***
a backward step .	uma regressão .	1	0.0280	0.5	0.0278	***0***
a backward step	de uma regressão	1	0.0287	0.5	0.0026	***0***
a backward step	uma regressão	1	0.0287	0.5	0.0288	***0***
. . .						
give up	desistimos	1	0.0187	0.5	0.0266	***1***
has ***given up*** the	desistiu da	1	0.0227	0.8	0.0654	***1***
has never ***given up***	nunca desistiu	1	0.0287	0.1	0.0022	***1***

Integration strategy 3/3: BILEX

Add bilingual lexicon of VPCs

Manual evaluation

- Scoring scheme:
  - 3 - good
  - 2 - acceptable
  - 1 - bad
  - 0 - untranslated

Translation quality

	% 3	% 2	% 1	% 0	Score
Baseline	59.88	9.58	***30.54***	0.00	***383***
TOK	47.31	6.59	17.37	***28.74***	288
VPC?	59.88	10.78	***29.34***	0.00	***385***
BILEX	64.07	8.38	***27.54***	0.00	***395***

3 - good, 2 - acceptable, 1 - bad, 0 - untranslated

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VPCs in English Child Language

[Villavicencio et al., 2012a]

Why Verb-Particle Constructions (VPCs)?

- Profiling of VPCs in English and their usage in child-produced and child-directed sentences
- Ground work for computational models of VPC learning

Corpus

English CHILDES [MacWhinney, 1995]

- child-produced and child-directed speech
- annotated with POS-tags, parses, verb semantic classes and psycholinguistic information [Villavicencio et al., 2012b]

VPCs in CHILDES

Sentences	Children Set	Adults Set
Parsed	482,137	988,101
with VPCs	38,326	82,796
% with VPCs	7.95	8.38

Children's Age in months	VPC Sentences
0-24	2,799
24-48	26,152
48-72	8,038
72-96	1,337
>96	514

VPCs in CHILDES

Rank	Chidren VPC	Adult VPC	Child Rank
1	put on	come on	7
2	go in	put on	1
3	get out	go on	9
4	take off	get out	3
5	fall down	take off	4
6	put in	put in	6
7	come on	sit down	8
8	sit down	go in	2
9	go on	come out	10
10	come out	pick up	18

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Summary

- Develop techniques for automatic acquisition of MWEs from corpora
- Evaluate the usefulness of MWEs in language technology applications.
- Investigate the application of MWE identification techniques for language acquisition studies.

Future work

- Clustering methods
- Further investigate use of entropy
- Explore cross lingual (a)symmetries
- Classification (interpretation and disambiguation)

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- *It is partly funded by CNPq Projects 551964/2011-1, 202007/2010-3, 305256/2008-4 and 309569/2009-5 and CAPES/COFECUB 707/11*

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Language Acquisition of Multiword Expressions

from language technology to language learners

Aline Villavicencio

Institute of Informatics

Federal University of Rio Grande do Sul, Brazil

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