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Extracting Synonyms from Bilingual Dictionaries

Mustafa Jarrar
Birzeit University

Eman Karajah
Birzeit University

Muhammad Khalifa
Cairo University

Khaled Shaalan
British University in Dubai

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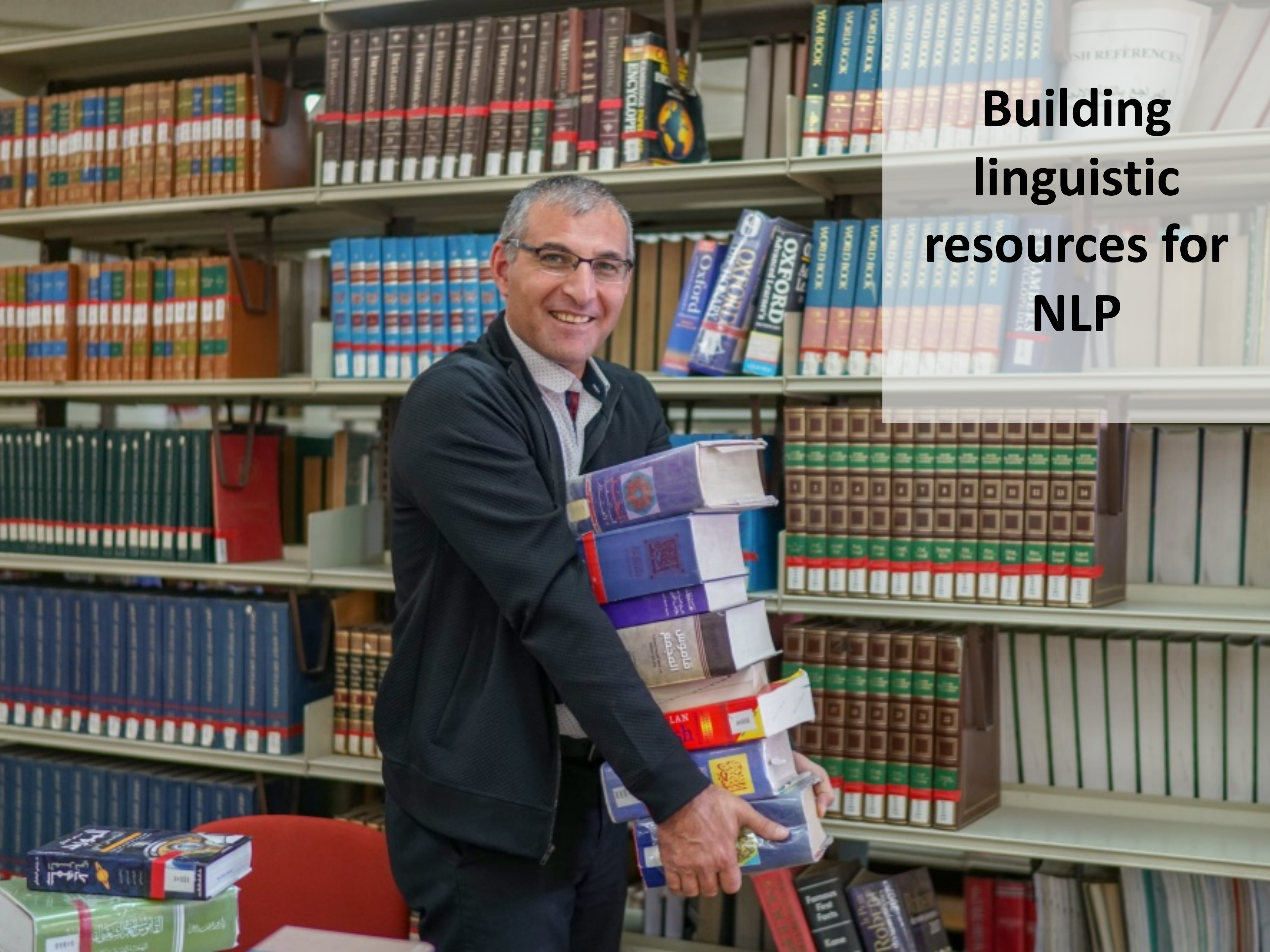
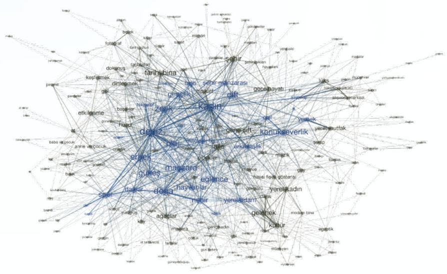


Building linguistic resources for NLP

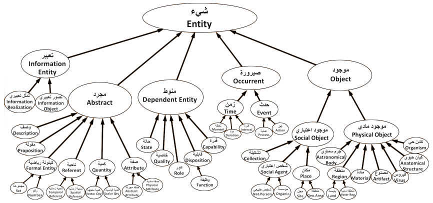
Lexical Resources at Birzeit University

Lexicographic Database



150 lexicons
largest Arabic-multilingual database

Arabic Ontology



Formal Arabic Wordnet
with ontologically clean content

Dialect Corpus

Curras كراس
Corpus for Palestinian Arabic
مدونة اللهجة العامية الفلسطينية

Search [Search]

☑ Stem ☑ MSA ☑ Surface ☑ Gloss
● Whole Word ○ Substring

Annotated dialectal corpus,
each word is annotated with 16 features

Big Linguistic Data Graph

https://ontology.birzeit.edu

Why do we need Synonyms

The importance of synonyms is growing:

- Application areas: computational linguistics, information retrieval, question answering, and machine translation.
- Essential parts in thesauri, wordnets (Miller et al., 1990), and linguistic ontologies (Jarrar, 2021).

Notions of Synonymy

- **Word embeddings:** words appearing in similar contexts.

- **Thesauri:** closely related words.

- **Wordnets:** based on substitutionablity: “two expressions are synonymous in a linguistic context *c* if the substitution of one for the other in *c* does not alter the truth value” (Miller et al., 1990).

- **Linguistic Ontology**: equivalence relation (i.e., reflexive, symmetric, and transitive). Two terms are synonyms *iff* they have the exact same concept (i.e., refer, intentionally, to the same set of instances). Thus, $T_1 =_{Ci} T_2$. (Jarrar, 2021)

Related Work

Three main tasks related to synonyms extraction:

Wordnet construction

Using other wordnets, machine translation, corpora, emeddings,
(Oliveira and Gomes, 2014), (Ercan and Haziyev, 2019), (Khodak et al., 2017)
(Wu and Zhou, 2003), (Al-Tarouti et al., 2016)

Discovering new translations

Using multilingual translation graphs
(Villegas et al., 2016), (Torregrosa et al., 2019)

Improving existing dictonaries

Analyzing the Ragazzini-Biagi English-Italian dictionary
(Flati and Navigli, 2012)

The Algorithm – Extract Synonyms from bilingual dictionary

- ***Input:*** set of bilingual translation pairs (a_i, e_j)
- ***Do:*** Extract bilingual synonyms, of the form $\{a_1,..,a_k\} = \{e_1,..,e_l\}$.

Step 1: Extract cyclic paths

- Build undirected translation graph, from a dictionary: keep expanding until:
  1) The root node is found, i.e., cycle,
  2) No more translations are found,
  3) The max *k* level is reached.
- *Output:* Nodes participating in the same path are considered candidate synonyms, and converted into bilingual synsets, e.g., $\{a_1, a_2\} = \{e_1, e_2\}$.

Step 2: Consolidation

- Arabic synsets are consolidated (i.e., unioned) if they have the same English synsets
- Similarly, English synsets are consolidated if they have the same Arabic synsets.
- Repeated until no more consolidations are found.

- ***Output:*** the final sets of bilingual synonyms.

Example

Synsets extracted from AWN

أدْغَال | غَاب | غَابَة	forest | wood | woods
غأبَة	forest | timber | timberland | woodland
خَشَب	wood
آلَة نَفْخ	wood | woodwind | woodwind instrument
أَحْرَاش | أدْغَال | حِرْش | دَغْل | غابَة	jungle
نَغْمَة	quality | timber | timbre | tone
نَوْعِيَّة	quality
صَبْغَة | صِبْغَة | دَرَجَة لَوْن | لَوْن خَفِيف	shade | tincture | tint | tone

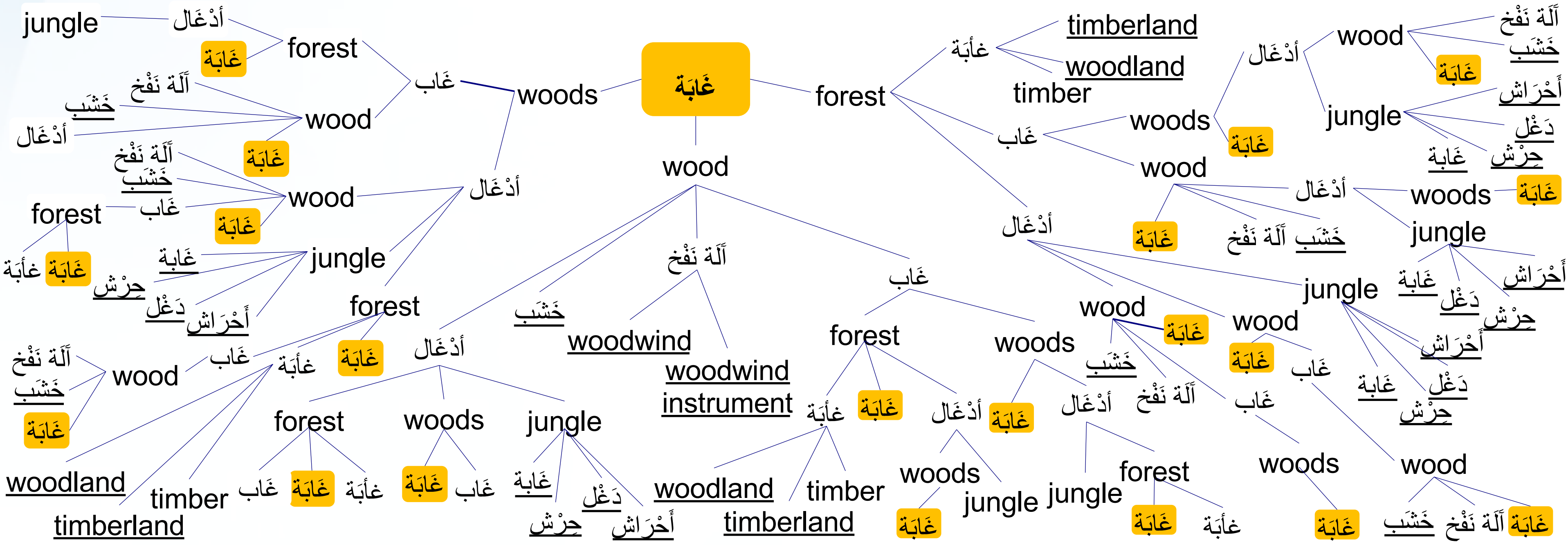
synsets into a flat translation pairs

Bilingual dictionary

آلَة نَفْخ	wood
آلَة نَفْخ	woodwind
آلَة نَفْخ	woodwind instrument
أَحْرَاش	jungle
أدْغَال	forest
أدْغَال	jungle
أدْغَال	wood
أدْغَال	woods
حِرْش	jungle
خَشَب	wood
خَفِيف	shade
خَفِيف	tincture
خَفِيف	tint
خَفِيف	tone
دَرَجَة	shade
دَرَجَة	tincture
دَرَجَة	tint
دَرَجَة	tone
دَغْل	jungle
صَبْغَة	shade
صَبْغَة	tincture
صَبْغَة	tint
صَبْغَة	tone
صِبْغَة	shade
صِبْغَة	tincture
صِبْغَة	tint
صِبْغَة	tone
غأبَة	forest
غأبَة	timber
غأبَة	timberland
غأبَة	woodland
غَاب	forest
غَاب	wood
غَاب	woods
غابَة	jungle
غَابَة	forest
غَابَة	wood
غَابَة	woods
لَوْن	shade
لَوْن	tincture
لَوْن	tint
لَوْن	tone
نَغْمَة	quality
نَغْمَة	timber
نَغْمَة	timbre
نَغْمَة	tone
نَوْعِيَّة	quality

Example (Step 1: Extract cyclic paths)

Translation Graph for ġābaẗ (غَابَة), *k*=7



Build undirected translation graph, from a dictionary: keep expanding until:

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➔ Cyclic paths are Candidate bilingual synsets

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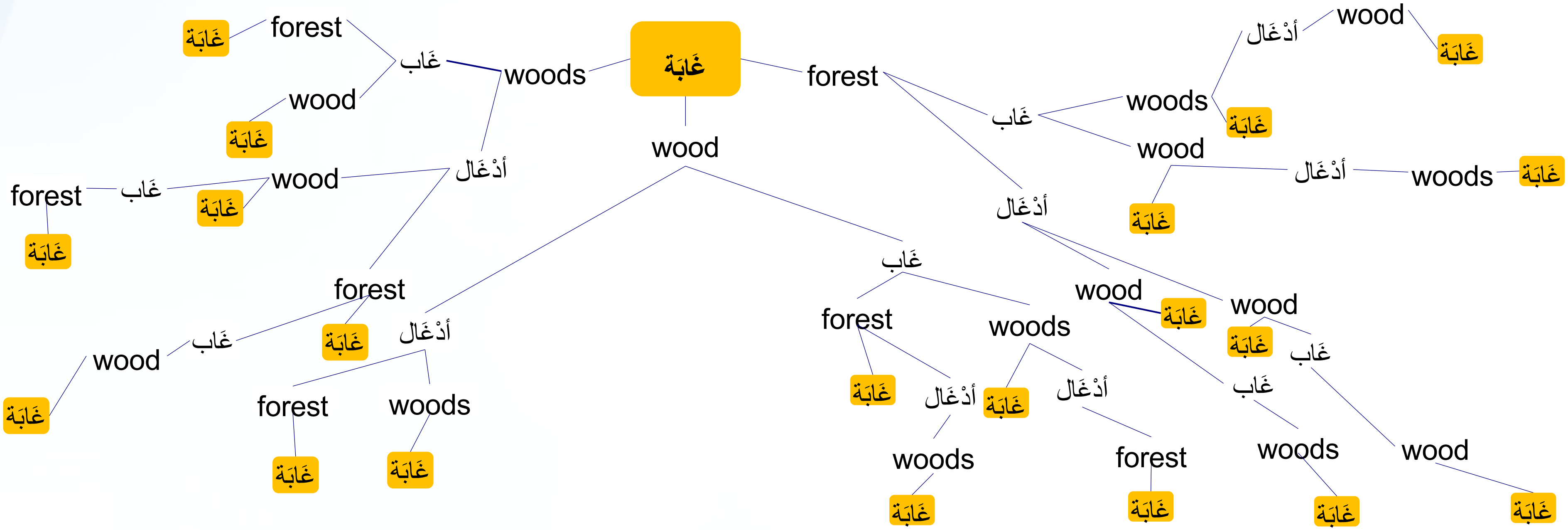

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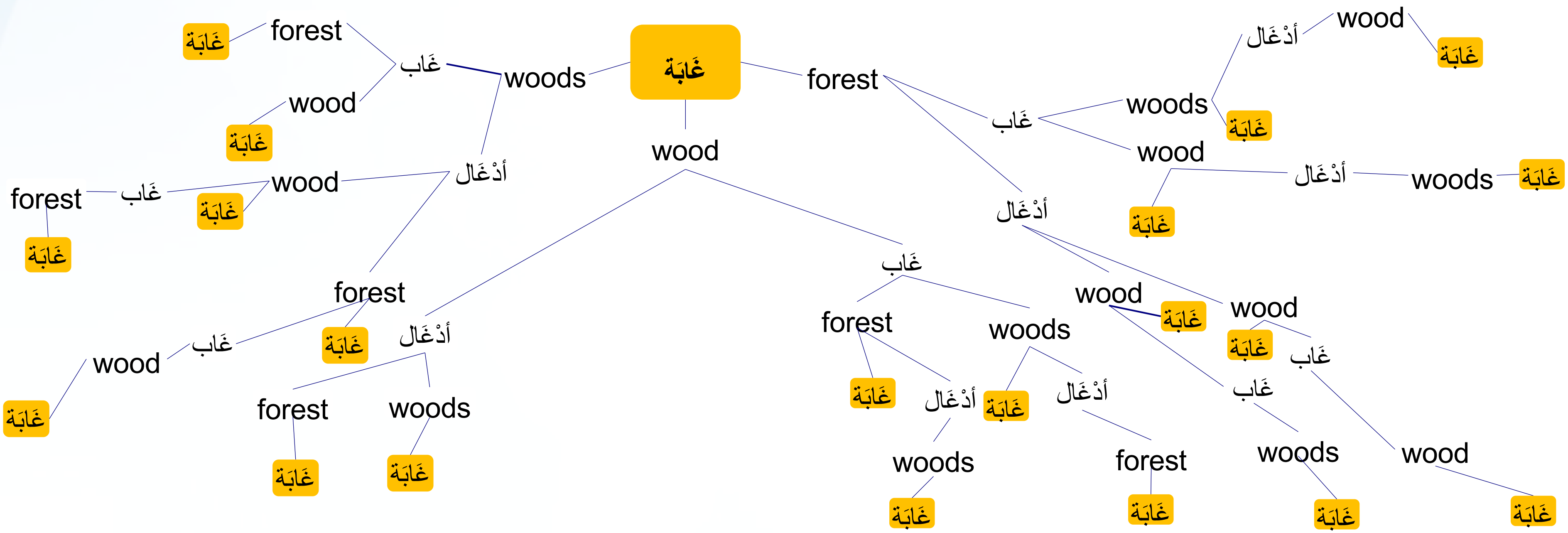

Output: nodes participating in cyclic paths are **candidate bilingual synsets**:

غَاب | غَابَة	Forest | woods
غَاب | أدْغَال | غَابَة	wood | woods | forest
غَاب | غَابَة	wood | woods
أدْغَال | غَابَة	wood | woods
أدْغَال | غَابَة	woods | forest
أدْغَال | غَابَة	wood | forest
غَاب | غَابَة	wood | forest

🡸 duplicates are removed

Example (Step 2: Consolidation)

- Arabic synsets are consolidated (i.e., unioned) if they have the same English synsets
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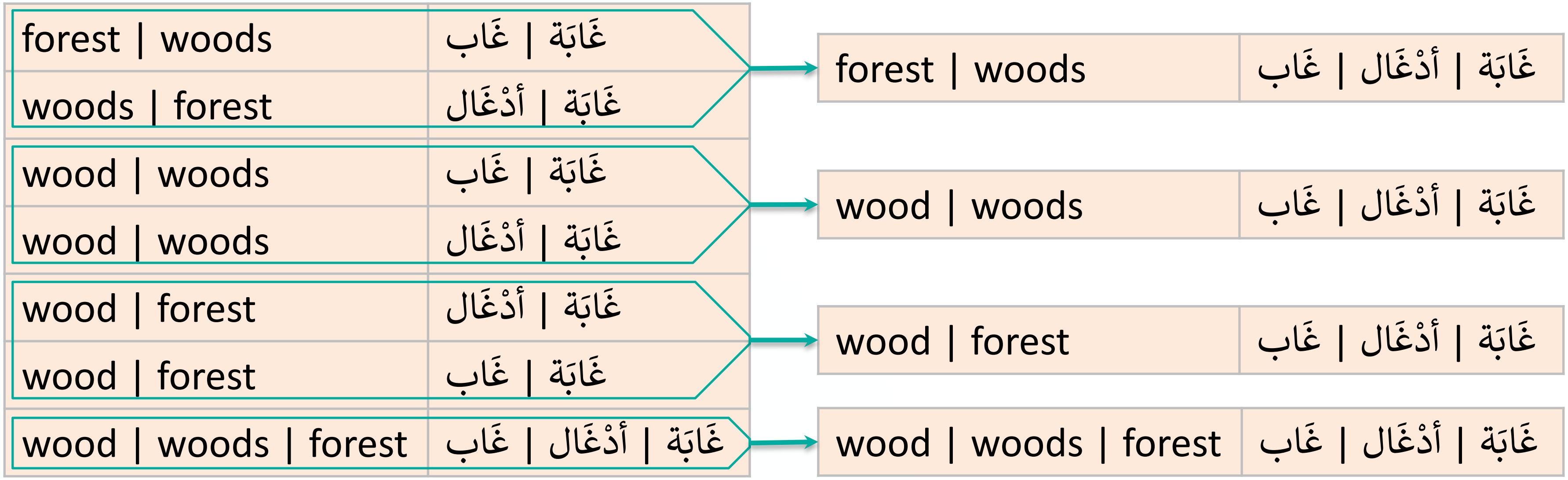
  - *Output:* the final sets of bilingual synonyms.



Candidate Synsets

forest | woods	غَابَة | غَاب
woods | forest	غَابَة | أَدْغَال
wood | woods	غَابَة | غَاب
wood | woods	غَابَة | أَدْغَال
wood | forest	غَابَة | أَدْغَال
wood | forest	غَابَة | غَاب
wood | woods | forest	غَابَة | أَدْغَال | غَاب

Consolidating Arabic Using English

forest | woods	غَابَة | أَدْغَال | غَاب
wood | woods	غَابَة | أَدْغَال | غَاب
wood | forest	غَابَة | أَدْغَال | غَاب
wood | woods | forest	غَابَة | أَدْغَال | غَاب

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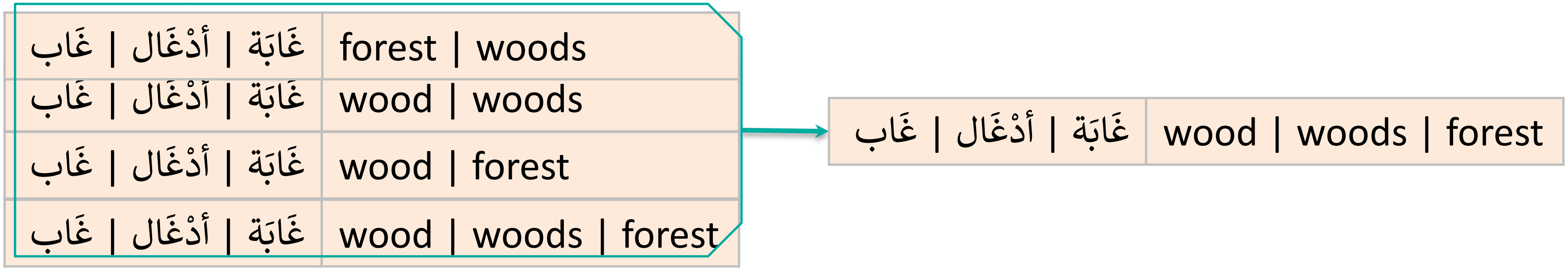
Consolidating English Using Arabic



غَابَة | أدْغَال | غَاب	forest | woods
غَابَة | أدْغَال | غَاب	wood | woods
غَابَة | أدْغَال | غَاب	wood | forest
غَابَة | أدْغَال | غَاب	wood | woods | forest

غَابَة | أدْغَال | غَاب	wood | woods | forest

no more consolidations needed

Example (Step 2: Consolidation)

- Arabic synsets are consolidated (i.e., unioned) if they have the same English synsets
- Similarly, English synsets are consolidated if they have the same Arabic synsets.
- Repeated until no more consolidations are found.

Output: the final sets of bilingual synonyms.

Final output:

غَابَة | أدْغَال | غَاب	wood | woods | forest

Consolidation Heuristics

The consolidation is designed based on the following **heuristics**:

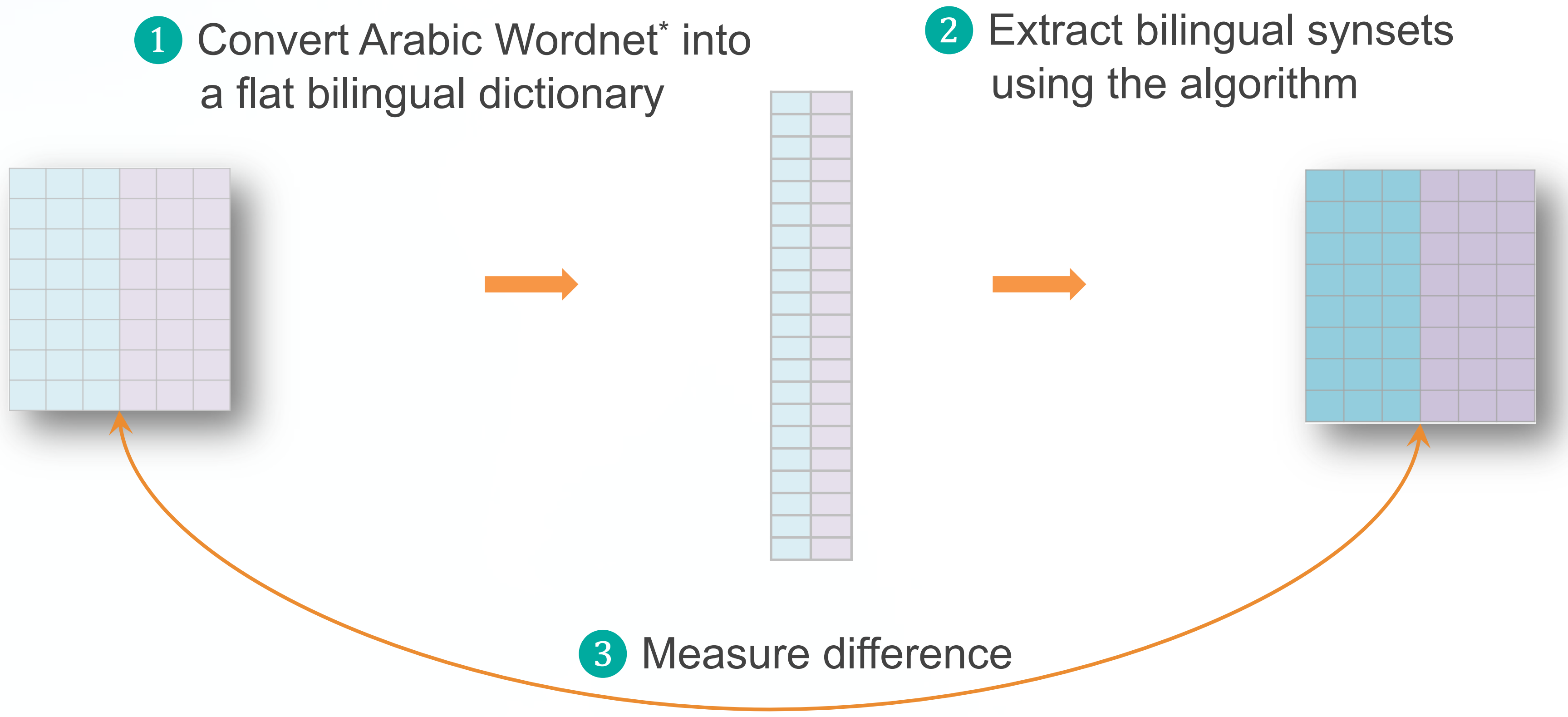
1. It is less likely for bilingual synsets to refer to multiple concepts.

2. It is less likely that a synset is a subset of another synset. Cases like $\{a, b, c, d\}$ and $\{a, b, c\}$ may affect our accuracy.

3. It is less likely for the same English synset, to be translated into multiple Arabic synsets.

Evaluation

- Evaluation of synonyms is known to be difficult (Wu et al., 2003).
- Proposed **Evaluation Methodology**:



1 Convert Arabic Wordnet* into a flat bilingual dictionary

2 Extract bilingual synsets using the algorithm

3 Measure difference

* Arabic Wordnet is very challenging – contains polysemous synsets.

Evaluation

Evaluation matrices:

$$Precision = \frac{\sum_{x \in extracted} max_{y \in AWN} Cosine(x,y)}{|Extracted\ synsets|}$$

$$Recall = \frac{\sum_{y \in AWN} max_{x \in Extracted} Cosine(x,y)}{|AWN|}$$

$$F\text{-}Measure = 2 * \frac{Precision\ .Recall}{Precision + Recall}$$

Results:

	Precision	Recall	F-Measure
k=6, no consolidation	62.5	91.9	74.4
k=6, with consolidation	80.5	84.2	**82.3**
k=8, with consolidation	64.4	84.3	73.0

Remarks: (i) no tuning or any language-specific treatment, (ii) AWN is polysemous

Summary

Conclusions:

- Algorithm to extract synonyms from flat bilingual dictionaries.
- No tuning, No language-specific treatments.
- Good accuracy - although AWN is very polysemous.

Proposed Improvements:

- Fine tuning
- Use part-of-speech, and other morphological features
- Combine words with compatible diacritics or inflections
- Use the algorithm to enrich the Arabic Ontology

Thank You

Mustafa Jarrar
mjarrar@birzeit.edu

→ Email me questions

→ Email me dictionaries to extract you the synonyms

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