

Towards a Multilingual Medical Lexicon

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What matters for a multilingual dictionary ?

- Entries: Base forms + all lexical variants
- Morpho-syntactic information
 - POS, number, gender, case, tense, ...
- Coverage
 - With respect to a given domain
- Multilingualism
 - Translation dictionaries

Available Sources

	Lexical Information	Coverage	Multilingualism
WordNet	POS	•155,000 words •General language	English
EuroWordNet	POS	•30,000-50,000 words •General language	Dutch, Italian, Spanish, German, French, Czech, Estonian, ...
EuroDicAutum		•630,000 words and phrases •EU activities, finance, agriculture, legislation, transport,...	Dutch, French, German, Italian, Danish, English, Greek, Portuguese, Spanish, Finnish, Swedish
UMLS Metathesaurus	-	• > 1M words and phrases •Biomedicine	English, German, French, Spanish, French, Swedish, Russian, ...
UMLS Specialist Lexicon	POS, number, case, tense, person, inflection types, ...	•250,000 words and acronyms •Biomedicine	English

Multilingual Lexicon Creation

1. Create/Collect available (monolingual) resources
2. Define an interchange format
3. Convert resources to interchange format
4. Define a cross-lingual linking format
5. Define criteria for semantic linkage
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Collect Monolingual Lexical Resources with full lexical information

- **French** UMLF lexicon from different French health-related organizations and the University Hospitals of Geneva, Switzerland (**33,718** entries)
- **English** medical lexicon from Linköping University, Sweden (**22,686** entries)
- **Swedish** medical lexicon from Linköping University (**23,223** entries)
- **Swedish** medical lexicon from Göteborg University, Sweden (**6,786** entries)
- **German** Specialist Lexicon from Freiburg University Hospital, Germany (**41,316** entries)
- **English** Specialist Lexicon, which is part of the UMLS (**96,621** entries, avoiding acronyms and chemical names)
- A total of **224,351** entries

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- A total of 224,351 entries

Large variability in scope and granularity

Multilingual Lexicon Creation

- Collect available (monolingual) resources
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- Convert resources to that format
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Lexicon Interchange Format

(cf. Baud et al. AMIA 05)

Field	Description	Definition
ID	Unique Identifier	
Frm	Inflected Form	Inflection of Lem
Mfr	Morphosyntactic features of inflected form	Coded in MULTEXT
Lem	Lemma	The basic form of the entry
Mul	Morpho-syntactic features	Coded in MULTEXT
Lng	Language	EN,DE,FR,SW
Typ	Entry Type	•Basic entry (B) •Subword entry (S) •Compound entry (C) •Term entry (T)
Prt	Decomposition	Parts of a compound entry
Str	Head	Head of a compound/term entry
Ref	Reference lemma	ID of lemma's entry

MULTEXT Standard

Part-of-Speech

=====	
Noun	N
Verb	V
Adjective	A
Adverb	R
...	

Nouns (N)

=====			
P	ATT	VAL	C
=====			
1	Type	common proper	c p

2	Gender	masculine feminine neuter	m f n

3	Number	singular plural	s p

4	Case	nominative genitive dative accusative	n g d a

Verbs (V)

=====			
P	ATT	VAL	C
=====			
1	Type	main auxiliary modal	m a o

2	Mood/VForm	indicative subjunctive imperative conditional infinitive participle gerund supine base	i s m c n p g s b

3	Tense	present imperfect future past	p i f s

4	Person	first second third	1 2 3

5	Number	singular plural	s p

6	Gender	masculine feminine neuter	m f n

Adjectives (A)

=====			
P	ATT	VAL	C
=====			
1		indefinite possessive	i s

2	Degree	positive comparative superlative	p c s

3	Gender	masculine feminine neuter	m f n

4	Number	singular plural	s p

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Articles (T)

=====			
P	ATT	VAL	C
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1	Type	definite indefinite	d i

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MULTEXT Standard

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Articles (T)

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1	Type	definite indefinite	d i
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Lemma	MULTEXT
<i>nail</i> (EN)	Nc-sn
<i>doigt</i> (FR)	Ncmsn
<i>digital</i> (SW)	A-pfsn

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Monolingual Resources

EN|DIM:20501|B||abdomen|Ncns|||||||
EN|DIM:20502|B||abdominal|Afpsn|||||||
EN|DIM:20503|B||abduction|Ncns|||||||
EN|DIM:20504|B||abductor|Ncns|||||||

SV|LIU_SV142_A|B||buk|nc0sn|||||||
SV|LIU_SV143_A|B||abdominal|afpsn|||||||
SV|LIU_SV144_A|T||från buk|nc0sn|||||buk|||
SV|LIU_SV145_A|C||bukabscess|nc0sn|||||buk__abscess|||
SV|LIU_SV146_A|T||abdominell aktinomykos|nc0sn|||||aktinomykos|||
SV|LIU_SV147_A|C||bukaorta|nc0sn|||||buk__aorta|||

DE|UKLFR:1045|B||Atrophie|Ncfsn|||19|||||
DE|UKLFR:1046|B||Atropin|Ncnsn|||11|||||
DE|UKLFR:1047|B||Atropinvergiftung|Ncfsn|||20|||||
DE|UKLFR:1048|B||Attacke|Ncfsn|||19|||||
DE|UKLFR:1049|B||Attest|Ncnsn|||11|||||

FR|UMLF:10012|B||distiller|Vmn|||||||
FR|UMLF:10013|B||distinct|Afms|||||||
FR|UMLF:10014|B||distinguer|Vmn|||||||
FR|UMLF:10015|C||distocclusion|Ncfs|||||dist__occlusion|occlusion|||

POS: Common Noun

EN|DIM:20501|B| |abdomen|Ncns| | | | | | | |

EN|DIM:20502|B||abdominal|Afpps|||||

EN|DIM:20503|B|abduction|Ncns| | | | | | | |

EN|DIM:20504|B|abductor|Ncns| | | | | | | |

SV|LIU SV142 A|B||buk|nc0sn|||||

SV|LIU_SV143_A|B||abdominal|afpusn|||||

SV|LIU_SV144_A|T||från buk|nc0sn|||buk|||

SV|LIU_SV145_A|C||bukabscess|nc0sn||||buk__abscess|||||

SV|LIU_SV146_A|T|abdomine11 aktinomykos|nc0sn||||aktinomykos|||

SV|LIU_SV147_A|C||bukaorta|nc0sn||||buk__aorta|||||

DE|UKLFR:1045|B|Atrophie|Ncfsn||19|

DE|UKLFR:1046|B||Atropin|Ncnsn||11|||

DE|UKLFR:1047|B||Atropinvergiftung|Ncfsn||20|||

DE | UKLFR:1048 | B | | Attacke | Ncfsn | | | 19 | | | | |

DE|UKLFR:1049|B|Attest|Ncnsn||11|||

FR|UMLF:10012|B||distiller|vmn|||

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```
FR|UMLF:10015|C||distocclusion|Ncfs||||dist__occlusion|occlusion|||
```

POS: Adjective

EN|DIM:20501|B||abdomen|Ncns| || || || || ||

EN|DIM:20502|B||**abdominal**|Afps| || || || || || ||

EN|DIM:20503|B||abduction|Ncns| || || || || || ||

EN|DIM:20504|B||abductor|Ncns| || || || || || ||

SV|LIU_SV142_A|B||buk|nc0sn| || || || || || ||

SV|LIU_SV143_A|B||**abdominal**|afpusn| || || || || || ||

SV|LIU_SV144_A|T||från buk|nc0sn| || || || || buk| || ||

SV|LIU_SV145_A|C||bukabscess|nc0sn| || || || buk__abscess| || || ||

SV|LIU_SV146_A|T||abdominell aktinomykos|nc0sn| || || || aktinomykos| || ||

SV|LIU_SV147_A|C||bukaorta|nc0sn| || || || buk__aorta| || || ||

DE|UKLFR:1045|B||Atrophie|Ncfsn| ||19| || || || ||

DE|UKLFR:1046|B||Atropin|Ncnsn| ||11| || || || ||

DE|UKLFR:1047|B||Atropinvergiftung|Ncfsn| ||20| || || || ||

DE|UKLFR:1048|B||Attacke|Ncfsn| ||19| || || || ||

DE|UKLFR:1049|B||Attest|Ncnsn| ||11| || || || ||

FR|UMLF:10012|B||distiller|Vmn| || || || || || ||

FR|UMLF:10013|B||**distinct**|Afms| || || || || || ||

FR|UMLF:10014|B||distinguer|Vmn| || || || || || ||

FR|UMLF:10015|C||distocclusion|Ncfs| || || || dist__occlusion|occlusion| || ||

POS: Compound

EN|DIM:20501|B||abdomen|Ncns|||||||
EN|DIM:20502|B||abdominal|Afpsn|||||||
EN|DIM:20503|B||abduction|Ncns|||||||
EN|DIM:20504|B||abductor|Ncns|||||||

SV|LIU_SV142_A|B||buk|nc0sn|||||||
SV|LIU_SV143_A|B||abdominal|afpsn|||||||
SV|LIU_SV144_A|T||från buk|nc0sn|||||buk|||
SV|LIU_SV145_A|C||bukabscess|nc0sn|||||buk__abscess||||
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Multi Word Nouns

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Linking Format

Links represent possible translations.

Field	Description	Definition
Src	Source	Source ID to be linked with target entry
Tar	Target	Target ID to be linked with source entry
Lnk	Type of Relation	???

Relation Type:

- Language-specific characteristics of
 - number,
 - case,
 - gender
- Multiple derivations, e.g.
 - attributive or predicative adjectives,
 - definite or indefinite objects

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Simple Relation Types

- REL1
 - A and B share the same POS and MULTEXT features
- REL2
 - A and B share the same POS, but at least one MULTEXT feature differs
- REL3
 - A and B do not share same POS

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Linking using Subword Indexing

- MorphoSaurus engine extracts meaningful subwords from medical text
- Maps them to language-independent concept IDs
- Covers English, German, Portuguese, French, Spanish, Swedish
- Validated for cross-lingual text retrieval

Original Document	Orthographic Normalization	Morphological Segmentation	Semantic Normalization (MIDs)
High TSH values suggest the diagnosis of primary hypothyroidism while a suppressed TSH level suggests hyperthyroidism.	high tsh values suggest the diagnosis of primary hypothyroidism while a suppressed tsh level suggests hyperthyroidism.	high tsh value s suggest the diagnosis of primary hypo thyroidism while a suppressed tsh level suggest s hyper thyroidism.	#up# tsh #value# #suggest# #diagnost# #primar# #small# #thyre# #suppress# tsh #nivell# #suggest# #up# #thyre# .
Erhöhte TSH-Werte erlauben die Diagnose einer primären Hypothyreose, ein supprimierter TSH-Spiegel spricht dagegen für eine Schilddrüsenüberfunktion.	erhoehte tsh-werte erlauben die diagnose einer primaeren hypothyreose, ein supprimierter tsh-spiegel spricht dagegen fuer eine schilddruesenueberfunktion.	er hoehte tsh - wert e erlaub en die diagnosis einer primaeren hypothyre ose, ein supprim iert er tsh - spiegel spricht dagegen fuer eine schilddruesen ueber funktion.	#up# tsh - #value# #permit# #diagnost# #primar# #small# #thyre# , #suppress# tsh - {#mirror# #nivell#} #speak# #thyre# #up# #function# .
A presença de valores elevados de TSH sugere o diagnóstico de hipotireoidismo primário, enquanto níveis suprimidos de TSH sugerem hipertireoidismo.	a presenca de valores elevados de tsh sugere o diagnostico de hipotireoidismo primario, enquanto niveis suprimidos de tsh sugerem hipertireoidismo.	a presenc a de valor es elevad os de tsh suger e o diagnost ico de hipo tireoid ismo primari o, enquanto niveis suprimid os de tsh suger em hiper tireoid ismo.	#actual# #value# #up# tsh #suggest# #diagnost# #small# #thyre# #primar# , #nivell# #suppress# tsh #suggest# #up# #thyre# .

Semantic Enrichment

- All inflected forms (*Frm-field*, if available) or base forms (*Lem-field*) are processed with **MorphoSaurus**.
- Resulting representations are added to lexicon entries:
 - ...
 - EN|DIM:20501|B||abdomen|Ncns||||||| #abdom
 - DE|UKLFR:1383|B||Bauch|Ncmsn|||1u||||| #abdom
 - ...

Linking Algorithm

```
FOR EVERY lexeme  $i$  and its attributes in the list DO
  FOR EVERY lexeme  $j$  (starting from  $i$ ) and its attributes in
    the list DO
    IF MorphoSaurus-Representation of input is identical
      THEN
        IF POS and MUL-values of  $i$  and  $j$  are identical
          THEN  $type = REL1$  # synonymy/translation
        IF POS-values are identical, but not MUL-values
          THEN  $type = REL2$ 
        IF POS-values differ
          THEN  $type = REL3$  # derivation
        PRINT "ID( $i$ ) | ID( $j$ ) |  $type$ "
```

Results

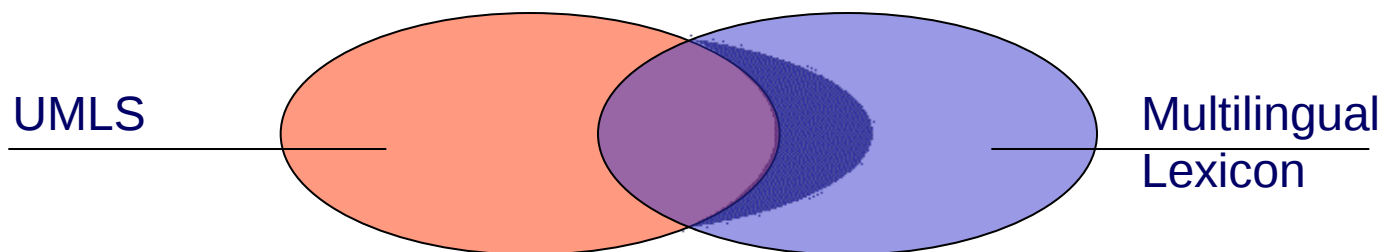
Language Pair	# Relations	Different Lemmas
English-German	126,504	31,544
English-French	70,680	24,368
English-Swedish	86,655	34,030
French-Swedish	21,604	8,312
French-German	32,659	10,458
German-Swedish	41,469	12,105
TOTAL	379,571	120,817

- Additional 271,971 intralingual synonymy relationships found (sums up to 651,542)
- REL1 (10%), REL2 (44%), REL3 (46%)

Preliminary Evaluation: Coverage

- Most comprehensive resource for medical terminology: UMLS Metathesaurus
- How many terms are covered?
- How many relations are covered?

Coverage: Terms



Language	UMLS *	Covered	Synonyms**	Additional**
English	122,035	32,668 (27%)	3,807	68,842
German	21,162	2,832 (13%)	1,269	23,379
French	10,260	3,590 (35%)	309	25,923
Swedish	12,012	8,520 (71%)	994	17,579
TOTAL	165,469	189,712		

* Only single-word preferred entries ** only REL1 and REL2 (no derivation)

Coverage: Relations

Language	UMLS	Covered	Synonyms*	Additional*
English-German	15,979	1,259 (8%)	8,801	21,484
English-French	12,589	1,783 (14%)	6,974	15,611
English-Swedish	9,554	3,403 (36%)	10,124	20,503
German-French	9,859	850 (9%)	773	8,835
German-Swedish	10,063	810 (8%)	1,699	9,596
French-Swedish	6,793	1,109 (16%)	1,911	5,292
TOTAL	64,837	120,817		

* only REL1 and REL2

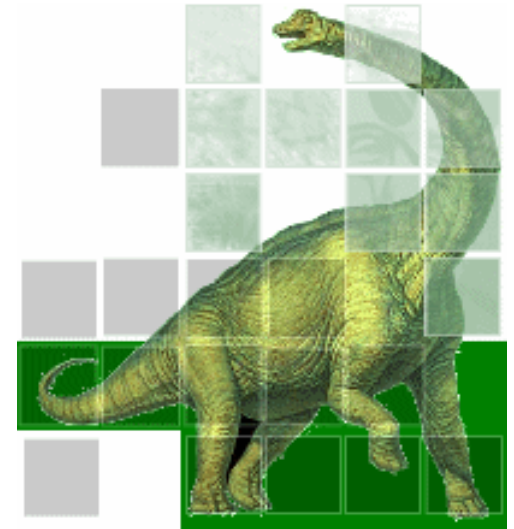
Conclusion

- Framework for integrating heterogeneous lexical resources
- Integration of English, German, French and Swedish sources
- Simple Linkage Format for coding lexical relations
- Generating substantial amount of synonym mappings and translations using MorphoSaurus subword indexing
- Partly validated using UMLS Metathesaurus
- Extensive evaluation is ongoing (presentation at MEDINFO)

www.morphosaurus.net

Morphosaurus Resources

- Subword-Lexicon:
 - Organizes subwords in several languages (English, German, Portuguese, Spanish, Fench, Swedish)
- Subword-Thesaurus:
 - Groups synonymous subwords (within and between languages)
- Subword-Segmeter:
 - Extraction of Subwords and Assignment of *Equivalence Classes*



Morphosaurus

**Morphosaurus-
Identifier (MID)**

Subword Approach

- Subwords are atomic, conceptual or linguistic units:
 - Stems: *stomach, gastr, diaphys*
 - Prefixes: *anti-, bi-, hyper-*
 - Suffixes: *-ary, -ion, -itis*
 - Infixes: *-o-, -s-*
- Equivalence classes contain synonymous subwords and their translations:
#derma = { **derm**, **cutis**, **skin**, **haut**, **kutis**, **pele**, **cutis**, **piel**, ... }
#inflamm = { **inflam**, **-itic**, **-itis**, **entzuend**, **-itis**, **-itisch**, **inflam**, **flog**, **inflam**, **flog**, **-iolitis**, ... }

Subwords: Lexicon & Thesaurus

Subword Lexicon:

gastr
stomach
magen

ventric
chamber

hepat,hepar
liver
leber

nephr
ren
kidney
nier

Subword Thesaurus:

groups synonymous subwords to
equivalence classes

#GASTR

#CHAMBER

#HEPAR

#NEPHR

Example

High TSH values suggest the diagnosis of primary hypothyroidism ...

Erhöhte TSH-Werte erlauben die Diagnose einer primären Schilddrüsenunterfunktion ...

Original

Interlingua

#up tsh #value #suggest
#diagnost #primar #small
#thyre

#up tsh #value #permit
#diagnost #primar #thyre
#hypo #function

**Orthographic
Normalization**

**Orthographic
Rules**

high tsh values suggest the diagnosis of primary hypothyroidism ...

erhoehte tsh werte erlauben die diagnose einer primaeren schilddruesenunterfunktion ...

**Segmenter
Subword-Lexicon**

**Semantic
Normalization**

**Subword-
Thesaurus**

high tsh value s suggest the
diagnos is of primar y hypo
thyroid ism

er hoeh te tsh wert e erlaub en
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**Orthographic
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**Segmenter
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Normalization**

**Subword-
Thesaurus**

high tsh value s suggest the diagnos is of primar y hypo thyroid ism

er hoeh te tsh wert e erlaub en die diagnos e einer primaer en schilddruese n unter funktion