

# MultiLexBATS: Multilingual Dataset of Lexical Semantic Relations

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NexusLinguarum COST Action (CA18209)  
European network for Web-centred linguistic data science

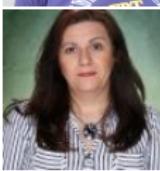
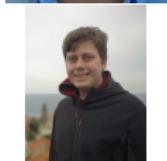
May, 2024



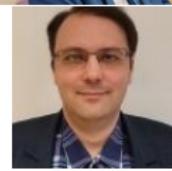
# Team



Chiara Cantone



Chaya Liebeskind



Letizia Granata



- **New test set of lexico-semantic relations**
  - Based on the translation of such relations in the **Bigger Analogy Test Set** (Gladkova et al., 2016) to 15+ languages (and counting)

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  - **10 files**, each with covering a different **relation**:

L01 [hypernyms – animals]	L02 [hypernyms – misc]	L03 [hyponyms – misc]
L04 [meronyms – substance]	L05 [meronyms – member]	L06 [meronyms – part]
L07 [synonyms – intensity]	L08 [synonyms – exact]	
L09 [antonyms – gradable]	L10 [antonyms – binary]	

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  - Restricted to **lexico-semantic relations**
  - More languages
  - **Manual** and **parallel** translations
- Useful for assessing **word embeddings** and **language models** in the covered languages
  - Independently or in a **cross-language** scenario

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  - Independently or in a **cross-language** scenario
- Large community effort in the scope of **NexusLinguarum COST Action, Use Case 4.1.3**, also involving other tasks (**T2.1, T3.2**)

# BATS

## Bigger Analogy Test Set (English)

academia college/university/institute  
apartment bedroom/room/bathroom/kitchen/kitchenette/living\_room/pantry/toilet/shower\_room  
bird feathers/plume/preen/croup/calamus/fowl/drumstick/syrinx/bill/rump/vane/barb/quill/shaft/pecker/pennon/feet  
brush bristle/hold/shank/grip/handgrip/handle/head/stem  
bus seats/conductor/window/driver/roof  
byte bit  
car engine/armrest/headrest/grille/hinge/tailpipe/suspension/hood/horn/hooter/petrol/pintle/trunk/floorboard/ba  
castle donjon/tower/turret/gate/dungeon/moat/keep/great\_hall  
cat whiskers/coat/paw/paws/fur/eyes/back/claws/tail/teeth  
chair seat/armrest/headrest/armrests/rest/pad/back/leg/backrest/legs  
church altar/choir/vestry/transept/apse/sanctuary/rood/screen/bema/nave/tower/sacristy/corner/chancel/amen/chapel/  
comb teeth/shaft/grip/tooth/handle  
day hour/forenoon/eventide/nanosecond/noonday/femtosecond/hr/minutes/microsecond/msec/time/midnight/sec/nightti  
deer antler/antlers/withers(flag/scut  
dollar cent  
door hinge/keyhole/threshold/doorframe/bolt/deadbolt/doorjamb/tumbler/doorpost/doorstep/doorcase/case/lock/casin  
dress sleeve/slide/plastron/zip/zipper/fastener/hemline/bodice/neckline/waistline/belt/slides\_fastener/zip\_fastene  
filename extension/name  
flower petal/leaf/anther/style/perianth/placenta/stamen/pistil/ovary/corolla/carpel/envelope/sepal/calyx/stigma/ch  
gigabit megabit/kbit/kb/kilobit/mb/mbit  
gramm milligram/mg/grain/milligram/mcg/carat/microgram/ng/dg/decigram/nanogram/metric\_grain/obolus  
guitar string/deck/pegs/fret/strings/frets/peg/fingerboard  
gun trigger/holder/safety/extractor/clip/magazine/barrel/hammer/viewfinder/gunsight/stock/cartridge/remover/cha  
harbor dock/facility/anchorage/landing/docking/dockage/anchorage\_ground/docking\_facility/landing\_place/landing\_st  
jail cell/cellblock/guard/police/prison\_cell/jail\_cell  
jewellery bead/stone/wire/beads/gemstone/gem/metal/gold/silver/platina/bead/beads/jewel  
litre millilitre/cc/ml/millilitter/cl/dl/deciliter/ml/cubic\_centimetre/centiliter/decilitre/cubic\_centimeter/cent  
movie scene/subtitles/footage/credit/episode/shot/sequence/credits/caption  
orthography hyphenation/punctuation/punctuation\_mark/word\_division/spelling  
piano keyboard/clavier/loud/hammer/sounding/pedal/sustaining/soft/fingerboard/soundboard/action/board/key/fallboa  
pie crust/cheese/filling/fruit/apple/berries/glazing/pastry/icing  
poem stanza/canto/prosody/rime/line/rhyme/verse/poetic\_rhythm/rhythmic\_pattern/verse\_line/line\_of\_verse/line\_of\_  
pub bar/barroom/taproom/saloon/ginmill  
radio receiver/tuner/radio/demodulator/transmitter/detector/receiving/set/amplifier/wireless/radio\_transmitter/re  
railcar suspension/cushion/shock/shock\_absorber/suspension\_system  
seafront harbor/seaport/dock/haven/anchorage/landing/harbour/dockage/anchorage\_ground/docking\_facility/landing  
shilling pence  
shirt button/dickey/collar/dickey/sleeve/buttons/dickey/pocket/chirttail/chirtleeeve/chirtfront/chirt\_button  
Gromann et al. (NexusLinguarum) MultiLexBATS May, 2024 4 / 15

# BATS

## Manual translation to different languages

ID	Relation	Source Words	Target Words	DE	Comments
L06_7	meronyms - part	car		Auto	-
		engine		Motor	-
		horn		Hupe	-
		hooter		DUPLICATE_Hupe	-
		trunk		Kofferraum	-
		gun		NO_TRANSLATION	unclear link to car
		armrest		Armlehne	-
		...		..	-
				Bremse, Beleuchtung, ...	-

# MultiLexBATS

## Parallel dataset

ID	Relation	Source	Target	AL	BM	DE	EL	ES	FR	HE	HR	IT	LT	MK	PT	RO	SK	SL	
L06_6	meronyms	byte	byte	byte	NO_TRANSI	Byte	μπάτι	byte	octet	בִּיט	bajt	byte	baitas	bajt	byte	octet	bajt	bajt	
		bit	bit	bit	NO_TRANSI	Bit	δυόδιο	bit	bit	בִּיט	bit	bit	bitas	bit	bit	bit	bajt	bit	
L06_7	meronyms	car	makinē	mobili	Auto	αυτοκίνητο	coche	voiture	מכונית	auto	macchina	машина	auto	carro	automobil	auto	avtomobil		
		engine	motor	motore	Motor	μηχανή	motor	motor	מַוְתֵּאָר	motor	motore	variklis	motor	motor	motor	motor	motor	motor	
		armrest	mbéshteté	bolokoniw	Armliehne	טֶמֶלָּהָרְכֶּה	reposa_bra	accoudoir	שְׁנָעָרָתְּצָה	nasion_za	bracciolino	atrama_rankai	apolo_de_icoterā	opierka_na_naslonjalo_za_roke					
		headrest	mbéshteté	kungolodi	Kopfstütze	מַחְלָאָרְקָה	reposacabe	appui-tête	שְׁנָעָרָתְּצָה	nasion_za	poggiatesta	atrama_galval	encosto_de_tatierā	opierka_na_naslonjalo_za_glavlo					
		grille	grilé	da	Kühlergrill	ירלאם	rejilla	grille	סְגֻּוָּר	relektka	griglia	grotelés	grilha	grilaj	maska_chiz	rešetka			
		hinge	menteshé	NO_TRANSI	Scharnier	מְנֻחָאָרְךָ	bisagra	charnière	ירְכָּה	šárka	cardine	šarnyras	dobradica	balama	pánt	tečaj			
		tailpipe	tub_shark	tylo	Auspuffroh	נוֹזְלָה	tubo_de_e	pot_d'echelle	הַטְּלָבָה	auspuff	tubo_di_sc	išmetamasis_vamzdzi	tubo_de_e_teavá_de_e	výfukové_pízpuňa_cev					
		suspension	peullim	DUPPLICATE	Aufhängung	ונְדָרְתָּן	suspension	suspension	שְׁנָעָרָתְּצָה	oyjes	suspension	pakaba	suspensão	suspensiō	pruženje	vzmetenje			
		hood	kofano	kapo	Motorhaut	קוֹנוֹתָה	capó	capot	נוֹנָה	hauba	cofano	kapotas	capota	kapotă	kapota	pokrov_motorja			
		horn	bori	kalaksóni	Hupe	קוֹרְפָּה	bocina	klaxon	רְזֵרְזָה	sirena	clacson	DUPPLICATE_garso_sign	buzina	claxon	klaksón	hupa			
		hooter	sirené	DUPPLICATE	DUPPLICATE	קלקסון	claxon	DUPPLICATE	DUPPLICATE	DUPPLICATE	DUPPLICATE	DUPPLICATE	DUPPLICATE	DUPPLICATE	DUPPLICATE	sireñā	DUPPLICATE_trobija		
		petrol	benziné	petorol	Benzin	בְּנִזְיָן	gasolina	essence	עַמְּדָה	gorivo	benzina	benzinás	gasolina	benzină	benzin	gorivo			
		paintle	gilipré_	ki	borszi	Achse	κοσσαδόρο	pivote	broche	נוֹנָה	kuka	perno_di_si	jkašas	píno	ax_vertical	NO_TRANSI_kijuka			
		trunk	portbagazh	kesu	Kofferraum	נוֹרְטָה	maletero	coffre	נוֹנָה	prtljažnik	bagaglijao	bagaziñé	bagageira	portbagaj	kufor	prtlažnik			
		floorboard	tapet_maki	duguma_d	Fussraum	נוֹתָאמָה	cuere_suel	plancher	נוֹנָה	pod	pianale	dugnas	čão	podea	podlaha	talna_obloga			
		bar	shufér_	shi	dlszminyrs	Stange	μπάρα	barra	בָּרָה	šípkā	bar	strypas	barra	bará	tyč	drog			
		gas	gaz	DUPPLICATE	DUPPLICATE	gas	gaz	DUPPLICATE	DUPPLICATE	DUPPLICATE	DUPPLICATE	DUPPLICATE	DUPPLICATE	DUPPLICATE	DUPPLICATE	DUPPLICATE	DUPPLICATE	DUPPLICATE	
		buffer	NO_TRANSI	dampen	Stoßdämpf	պարուօք	búfer	tampon	պָגָן	odbojník	lucidatrice	buferis	DUPPLICATE_combustib	DUPPLICATE_plin	pára-choqu	amortizer	DUPPLICATE_loščenik		
		door	dere	da_ia	Tür	נוֹרְטָה	puerta	porte	נוֹנָה	vratna	sportello	durelés	porta	ušá	dvere	vratá			
		stabilizer	stabiliżes	sabatillan	Stabilisator	σταθερόποντο	estabilizadore	stabilisator	נוֹנָה	stabilizator	stabilizato	stabilizatorius	estabilizadi	stabilizator	stabilizator	stabilizator	stabilizator		
		seat	vend_	sedil	sigilan	Sitz	Θέση	asiento	siège	נוֹנָה	sjedalo	sédyné	assento	scăun	sedadlo	sedēž			
		window	dritare	finstirliw	Scheibe	nopáðþupo	ventana	fenêtre	נוֹנָה	prozor	finestra	langas	janela	fereastră	okno	okno			
		exhaust	marmite	boli	Auspuff	DUPPLICATE	escape	échappement	הַנְּפָרָה	ispusña_cij	DUPPLICATE	išmetimas	escape	esapamento	výfuk	izphu			
		taillift	DUPPLICATE	DUPPLICATE	Heckflosse	πτερύγιο	alero_trase	empennage	DUPPLICATE	kobilica	pinna	išmetimo_vamzdzi	aleta	ariplorá_a_plutva	NO_TRANSLATION				
		back	mbrapa	ko	Fond	πίσω	među	parte_de_a_arrière	נוֹנָה	stražnji_dic	dietro	uzpakanliné_dalis	traseira	spate	zadná_čast	zadék			
		luggage	bagazh	minen	Gepäck	βαλίτσα	equipaje	bagage	נוֹנָה	DUPPLICATE	bagaglio	bagážas	bagagem	bagaj	batožina	prijava			
		pedal	pedale	pedali	Pedal	nevntál	pedal	pédale	נוֹנָה	pedala	pedale	pedalas	pedal	pedală	pedál	pedal			

# MultiLexBATS

## Figures

Lang	Translators	$\kappa$	Sources	Targets	NoTrans	Duplicate	Alternative
AL	3	0.51	500	4665	62	1042	0
BM	1	–	451	3355	174	1156	32
DE	1	–	500	5159	36	550	582
EL	1	–	500	4722	78	966	248
ES	3	0.55	500	5184	58	525	405
FR	1	–	500	4905	10	778	19
HE	1	–	500	4676	11	1027	130
HR	1	–	500	4382	98	1325	219
IT	2	0.50	500	4807	26	902	1354
LT	3	0.77	500	4506	44	1206	552
MK	1	–	423	2414	122	635	44
PT	4	0.62	500	4572	50	1136	451
RO	2	0.97	500	5054	63	650	0
SK	1	–	500	4395	225	1304	477
SL	2	0.48	500	4775	54	932	38

# Experimentation

Tasks, to be performed by Language Models

## • Monolingual Analogy Completion

Language	Prompt
EN	"<a>" is to "<b>" as "<c>" is to "<d>".
AL	"<a>" është për "<b>" ashtu si "<c>" për "<d>".
BM	"<a>" ye "<b>" ye i n'a fo "<c>" ye "<d>"
DE	"<a>" ist so zu "<b>" wie "<c>" zu <d> ist.
EL	Το "<a>" είναι προς το "<b>" ό,τι το "<c>" προς το "<d>".
ES	"<a>" es a "<b>" como "<c>" es a "<d>".
FR	"<a>" est à "<b>" ce que "<c>" est à "<d>".
HE	"<a>" ה "ב" כ "<c>" ה "ד"
HR	Odnos između riječi "<a>" i "<b>" jednak je odnosu između riječi "<c>" i "<d>".
IT	"<a>" sta a "<b>" come "<c>" sta a "<d>".
LT	"<a>" yra "<b>" taip, kaip "<c>" yra "<d>".
MK	Односот меѓу зборовите "<a>" и "<b>" е еднаков со односот меѓу зборовите "<c>" и "<d>".
PT	"<a>" está para "<b>" assim como "<c>" está para "<d>"-
RO	"<a>" este pentru "<b>" cum "<c>" este pentru "<d>".
SK	Slovo "<a>" sa má k slovu "<b>" ako slovo "<c>" k slovu "<d>".
SL	Beseda "<a>" je besedi "<b>" enako, kot je beseda "<c>" besedi "<d>".

- If  $a = \text{byte}$ ,  $b = \text{bit}$ ,  $c = \text{car}$ : byte is to bit as car is to ... (engine, armrest, ...)

# Experimentation

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DE	"<a>" ist so zu "<b>" wie "<c>" zu <d> ist.
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## • Analogy-Based Translation:

- i.e., with the first part in one language and the second in another.
- Example for EN→ES:  
apple is to fruit as manzana es como ... (fruta).

# Experimentation

## Setup: pretrained Language Models

- Multilingual **Masked Language Models** (MMLM):
  - mBERT (Devlin et al., 2019), XLM-RoBERTa (Conneau et al., 2020)
  - Zero- vs Five-shot
  - MultiLexBATS vs MATS (Mickus et al., 2023)

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Setup: pretrained Language Models

- Multilingual **Masked Language Models** (MMLM):
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  - Zero- vs Five-shot
  - MultiLexBATS vs MATS (Mickus et al., 2023)
- Comparison with **generative** multilingual model BLOOM (BigScience Workshop, 2023)
  - 30 random analogy pairs

# Results

## Monolingual Analogy Completion

- Average accuracy in analogy completion in full datasets

Lang	mBERT (MultiLexBATS)		XLM-R (MultiLexBATS)		mBERT (MATS) 0-shot
	0-shot	5-shot	0-shot	5-shot	
DE	0.196	0.215	0.202	<b>0.217</b>	0.186
EN	0.214	0.233	0.183	<b>0.243</b>	0.233
ES	0.186	<b>0.236</b>	0.176	0.188	0.170
FR	0.223	0.219	0.221	<b>0.254</b>	0.208
IT	0.203	<b>0.260</b>	0.119	0.166	0.178

# Results

## Monolingual Analogy Completion

- Average accuracy in analogy completion in 30 random analogy pairs

Lang	mBERT		XLM-R		BLOOM
	0-shot	5-shot	0-shot	5-shot	0-shot
AL	0.08	0.15	0.10	<b>0.22</b>	0.20
BM	0.08	<b>0.30</b>	0.07	0.26	0.12
DE	0.03	0.10	0.03	0.09	<b>0.24</b>
EL	0.00	0.00	0.10	<b>0.18</b>	0.16
EN	0.17	0.36	0.12	0.25	<b>0.41</b>
ES	0.16	0.29	0.13	0.28	<b>0.34</b>
FR	0.20	0.29	0.19	<b>0.41</b>	0.35
HE	0.08	0.21	0.14	<b>0.24</b>	0.11
HR	0.20	0.45	0.15	<b>0.41</b>	0.16
IT	0.18	<b>0.39</b>	0.11	0.26	0.28
LT	0.05	<b>0.24</b>	0.08	<b>0.24</b>	0.13
*MK	0.18	<b>0.39</b>	0.13	0.20	0.20
PT	0.16	0.33	0.12	0.27	<b>0.36</b>
RO	0.10	<b>0.26</b>	0.11	0.31	0.17
SK	0.11	0.21	0.13	<b>0.28</b>	0.20
SL	0.11	<b>0.28</b>	0.14	0.26	0.17

# Results

## Monolingual Analogy Completion

- Average accuracy in analogy completion in 30 random analogy pairs

Lang	mBERT		XLM-R		BLOOM
	0-shot	5-shot	0-shot	5-shot	0-shot
AL	0.08	0.15	0.10	<b>0.22</b>	0.20
BM	0.08	<b>0.30</b>	0.07	0.26	0.12
DE	0.03	0.10	0.03	0.09	<b>0.24</b>
EL	0.00	0.00	0.10	<b>0.18</b>	0.16
EN	0.17	0.36	0.12	0.25	<b>0.41</b>
ES	0.16	0.29	0.13	0.28	<b>0.34</b>
FR	0.20	0.29	0.19	<b>0.41</b>	0.35
HE	0.08	0.21	0.14	<b>0.24</b>	0.11
HR	0.20	0.45	0.15	<b>0.41</b>	0.16
IT	0.18	<b>0.39</b>	0.11	0.26	0.28
LT	0.05	<b>0.24</b>	0.08	<b>0.24</b>	0.13
*MK	0.18	<b>0.39</b>	0.13	0.20	0.20
PT	0.16	0.33	0.12	0.27	<b>0.36</b>
RO	0.10	<b>0.26</b>	0.11	0.31	0.17
SK	0.11	0.21	0.13	<b>0.28</b>	0.20
SL	0.11	<b>0.28</b>	0.14	0.26	0.17

- Some languages easier to handle than others, relations as well
- Best performance with BLOOM for languages in its pretraining data (EN, FR, ES, PT)

# Results

## Analogy-based Translation

- Accuracy of analogy-based translation in a selection of language pairs.

L1→L2	mBERT		XLM-R	
	0-shot	5-shot	0-shot	5-shot
EN→DE	0.064	<b>0.092</b>	0.046	0.058
EN→FR	<b>0.125</b>	0.116	0.051	0.080
FR→EN	<b>0.188</b>	0.170	0.046	0.081
FR→RO	0.073	<b>0.099</b>	0.029	0.050
ES→PT	0.117	<b>0.149</b>	0.068	0.119
ES→IT	0.070	<b>0.156</b>	0.027	0.040
SK→HR	0.074	<b>0.126</b>	0.052	0.050
HR→SL	0.161	<b>0.224</b>	0.124	0.141
HR→SK	0.081	<b>0.123</b>	0.065	0.105
EN→BM	0.007	<b>0.030</b>	0.002	0.019
EN→AL	0.021	0.047	0.019	<b>0.048</b>
EN→EL	0.001	0.001	0.019	<b>0.032</b>
EN→HE	0.007	<b>0.033</b>	0.005	0.025
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- More challenging task
  - Performance higher for languages of the same family (e.g., HR→SL)
  - Lower for EN → low-resourced languages.

# Conclusions & Future

- MultiLexBATS is new **benchmark for multilingual and cross-lingual tasks** that may benefit from relational knowledge
  - Code and **data** available from:  
<https://github.com/dgromann/MultiLexBATS>
  - Presented baselines have room for improvement
    - Other models, prompt engineering, fine-tuning

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  - Code and **data** available from:  
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  - Presented baselines have room for improvement
    - Other models, prompt engineering, fine-tuning
- **Future work:**
  - Include other languages
  - Convert to RDF format
  - Analyse cross-lingual gaps

# Thank you. For more details and results...

## Acknowledgements

This paper was based upon work in COST Action CA18209 NexusLinguarum, supported by COST (European Cooperation in Science and Technology). <http://www.cost.eu/>.

Hugo Gonçalo Oliveira and Ricardo Rodrigues are partially supported by national funds through FCT, within the scope of the project CISUC (UID/CEC/00326/2020). C.O. Truică and E.S. Apostol are supported in part by project DECIP ("Dezvoltarea Capacitatii Institutionale a Universitatii POLITEHNICA din Bucuresti", contract no. PFE57/2022) and by the National University of Science and Technology Politehnica Bucharest through the PubArt program. This paper has been also partially supported by the Spanish project PID2020-113903RB-I00 (AEI/FEDER, UE), by DGA/FEDER, by the *Agencia Estatal de Investigación* of the Spanish Ministry of Economy and Competitiveness and the European Social Fund through the "Ramón y Cajal" program (RYC2019-028112-I).

Work developed in the scope of:



Funded by  
the European Union

Hugo Gonçalo Oliveira supported by:



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Thank you. For more details and results...

**See you at the poster!**

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