

Overcoming catastrophic forgetting

SciELO dataset

The SciELO dataset contains monolingual and parallel texts from scientific publications in English, Spanish, Portuguese and French.

This dataset was used in WMT16 for Biomedical Translation Task, with the aims to evaluate systems on the translation of scientific publications for the biological and health domains. [more \(https://www.statmt.org/wmt16/biomedical-translation-task.html\)](https://www.statmt.org/wmt16/biomedical-translation-task.html)

Preprocessing

Parallel corpus

This dataset is available in the [BioC XML format \(http://bioc.sourceforge.net/\)](http://bioc.sourceforge.net/) and require some preprocessing and alignment in order to end up with a usable parallel corpora.

Although we have preprocessed and aligned this dataset from scratch, we have ended up using the aligned corpora provided by the WMT in order to reuse the test sets from the WMT15 challenge.

Working format

To ease the work with this dataset, we have converted it to a CSV file (UTF-8),

Cleaning

We have cleaned every corpus using the following steps:

1. Since Remove repeated whitespaces
2. Convert text to NFD to avoid encoding problems
3. Strip whitespace
4. Removing all pairs where one of the languages didn't have a translation

Since both, the health and biological domain can make a heavy use of Chemical formulas and drugs names, we have considered that lowering the text was not convenient.

Also, we do not differentiate between texts from titles or abstracts.

In addition to this, we have prepared two versions of the dataset:

- **Unconstrained:** Datasets that use all the available data
- **Constrained:** Datasets limited to a maximum number of pairs. This limit corresponds to the number of pairs of the smallest dataset

Cleaning output (UNCONSTRAINED)

Train (tr+val):

```
/home/salvacarrion/anaconda3/envs/mltests/bin/python /home/salvacarrion/Documents/Programming/Python/mltests/paper1/code/preprocess/clean.py
Processing training files...
Reading file... (es-en-gma-biological.csv)
100%|██████████| 125828/125828 [00:10<00:00, 11960.31it/s]
Stats for: es-en-gma-biological.csv *****
- Documents: 17672
- Sentences: 123597
  - Removed: 2231 (1.77%)
- Titles/Abstracts: 8867/114730 (7.73%)
File saved!

Reading file... (es-en-gma-health.csv)
100%|██████████| 587299/587299 [00:48<00:00, 12119.58it/s]
Stats for: es-en-gma-health.csv *****
- Documents: 75856
- Sentences: 580482
  - Removed: 6817 (1.16%)
- Titles/Abstracts: 44508/535974 (8.30%)
File saved!

Reading file... (fr-en-gma-health.csv)
100%|██████████| 9127/9127 [00:00<00:00, 11951.10it/s]
Stats for: fr-en-gma-health.csv *****
- Documents: 1135
- Sentences: 9040
  - Removed: 87 (0.95%)
- Titles/Abstracts: 740/8300 (8.92%)
File saved!

Reading file... (pt-en-gma-biological.csv)
100%|██████████| 121874/121874 [00:10<00:00, 12057.78it/s]
Stats for: pt-en-gma-biological.csv *****
- Documents: 18180
- Sentences: 120301
  - Removed: 1573 (1.29%)
- Titles/Abstracts: 5766/114535 (5.03%)
File saved!

Reading file... (pt-en-gma-health.csv)
100%|██████████| 512564/512564 [00:42<00:00, 12043.31it/s]
Stats for: pt-en-gma-health.csv *****
- Documents: 65659
- Sentences: 507987
  - Removed: 4577 (0.89%)
- Titles/Abstracts: 48986/459001 (10.67%)
File saved!
```

Done!

Process finished with exit code 0

Test:

```
/home/salvacarrion/anaconda3/envs/mltests/bin/python /home/salvacarrion/Documents/Programming/Python/mltests/paper1/code/preprocess/l_clean.py
Processing test files...
Reading file... (test-gma-en2es-biological.csv)
100%|██████████| 4003/4003 [00:00<00:00, 12253.74it/s]
Stats for: test-gma-en2es-biological.csv *****
***
- Documents: 500
- Sentences: 3933
  - Removed: 70 (1.75%)
- Titles/Abstracts: 513/3420 (15.00%)
File saved!

Reading file... (test-gma-en2es-health.csv)
100%|██████████| 4854/4854 [00:00<00:00, 12497.96it/s]
Stats for: test-gma-en2es-health.csv *****
- Documents: 500
- Sentences: 4816
  - Removed: 38 (0.78%)
- Titles/Abstracts: 506/4310 (11.74%)
File saved!

Reading file... (test-gma-en2fr-health.csv)
100%|██████████| 5268/5268 [00:00<00:00, 11930.75it/s]
Stats for: test-gma-en2fr-health.csv *****
- Documents: 500
- Sentences: 5023
  - Removed: 245 (4.65%)
- Titles/Abstracts: 510/4513 (11.30%)
File saved!

Reading file... (test-gma-en2pt-biological.csv)
100%|██████████| 4100/4100 [00:00<00:00, 12347.91it/s]
Stats for: test-gma-en2pt-biological.csv *****
***
- Documents: 500
- Sentences: 4055
  - Removed: 45 (1.10%)
- Titles/Abstracts: 502/3553 (14.13%)
File saved!

Reading file... (test-gma-en2pt-health.csv)
100%|██████████| 3694/3694 [00:00<00:00, 12371.66it/s]
Stats for: test-gma-en2pt-health.csv *****
- Documents: 500
- Sentences: 3676
  - Removed: 18 (0.49%)
- Titles/Abstracts: 504/3172 (15.89%)
```

File saved!

Reading file... (test-gma-es2en-biological.csv)

100%|██████████| 4028/4028 [00:00<00:00, 12156.61it/s]

Stats for: test-gma-es2en-biological.csv *****

- Documents: 500
- Sentences: 3982
 - Removed: 46 (1.14%)
- Titles/Abstracts: 511/3471 (14.72%)

File saved!

Reading file... (test-gma-es2en-health.csv)

100%|██████████| 5027/5027 [00:00<00:00, 11226.09it/s]

Stats for: test-gma-es2en-health.csv *****

- Documents: 500
- Sentences: 4961
 - Removed: 66 (1.31%)
- Titles/Abstracts: 508/4453 (11.41%)

File saved!

Reading file... (test-gma-fr2en-health.csv)

100%|██████████| 5356/5356 [00:00<00:00, 11859.21it/s]

Stats for: test-gma-fr2en-health.csv *****

- Documents: 500
- Sentences: 5072
 - Removed: 284 (5.30%)
- Titles/Abstracts: 506/4566 (11.08%)

File saved!

Reading file... (test-gma-pt2en-biological.csv)

100%|██████████| 3914/3914 [00:00<00:00, 10782.80it/s]

Stats for: test-gma-pt2en-biological.csv *****

- Documents: 500
- Sentences: 3871
 - Removed: 43 (1.10%)
- Titles/Abstracts: 506/3365 (15.04%)

File saved!

Reading file... (test-gma-pt2en-health.csv)

100%|██████████| 3757/3757 [00:00<00:00, 12287.98it/s]

Stats for: test-gma-pt2en-health.csv *****

- Documents: 500
- Sentences: 3738
 - Removed: 19 (0.51%)
- Titles/Abstracts: 506/3232 (15.66%)

File saved!

Done!

Process finished with exit code 0

Cleaning output (CONSTRAINED)

Train (tr+val):

```
/home/salvacarrion/anaconda3/envs/nmt/bin/python /snap/pycharm-professional/230/plugins/python/helpers/pydev/pydevd.py --multiproc --qt-support=auto --client 127.0.0.1 --port 33541 --file /home/salvacarrion/Documents/Programming/Python/mltests/paper1/code/preprocess/1_clean.py
```

Connected to pydev debugger (build 203.7148.72)

Processing training files...

Reading file... (es-en-gma-biological.csv)

100%|██████████| 125828/125828 [00:27<00:00, 4642.78it/s]

Stats for: es-en-gma-biological.csv *****

- Documents: 17672
- Sentences: 123597
 - Removed: 2231 (1.77%)
- Titles/Abstracts: 8867/114730 (7.73%)

File saved!

Reading file... (es-en-gma-health.csv)

100%|██████████| 587299/587299 [02:05<00:00, 4671.29it/s]

Limiting size to 123597

Stats for: es-en-gma-health.csv *****

- Documents: 59237
- Sentences: 123597
 - Removed: 463702 (78.96%)
- Titles/Abstracts: 9548/114049 (8.37%)

File saved!

Reading file... (fr-en-gma-health.csv)

100%|██████████| 9127/9127 [00:01<00:00, 4570.30it/s]

Stats for: fr-en-gma-health.csv *****

- Documents: 1135
- Sentences: 9040
 - Removed: 87 (0.95%)
- Titles/Abstracts: 740/8300 (8.92%)

File saved!

Reading file... (pt-en-gma-biological.csv)

100%|██████████| 121874/121874 [00:26<00:00, 4654.42it/s]

Stats for: pt-en-gma-biological.csv *****

- Documents: 18180
- Sentences: 120301
 - Removed: 1573 (1.29%)
- Titles/Abstracts: 5766/114535 (5.03%)

File saved!

Reading file... (pt-en-gma-health.csv)

100%|██████████| 512564/512564 [01:49<00:00, 4699.29it/s]

Limiting size to 120301

Stats for: pt-en-gma-health.csv *****

- Documents: 54294

- Sentences: 120301
 - Removed: 392263 (76.53%)
- Titles/Abstracts: 11662/108639 (10.73%)

File saved!

Done!

Process finished with exit code 0

Test:

These files are the same as the ones used in unconstrained dataset

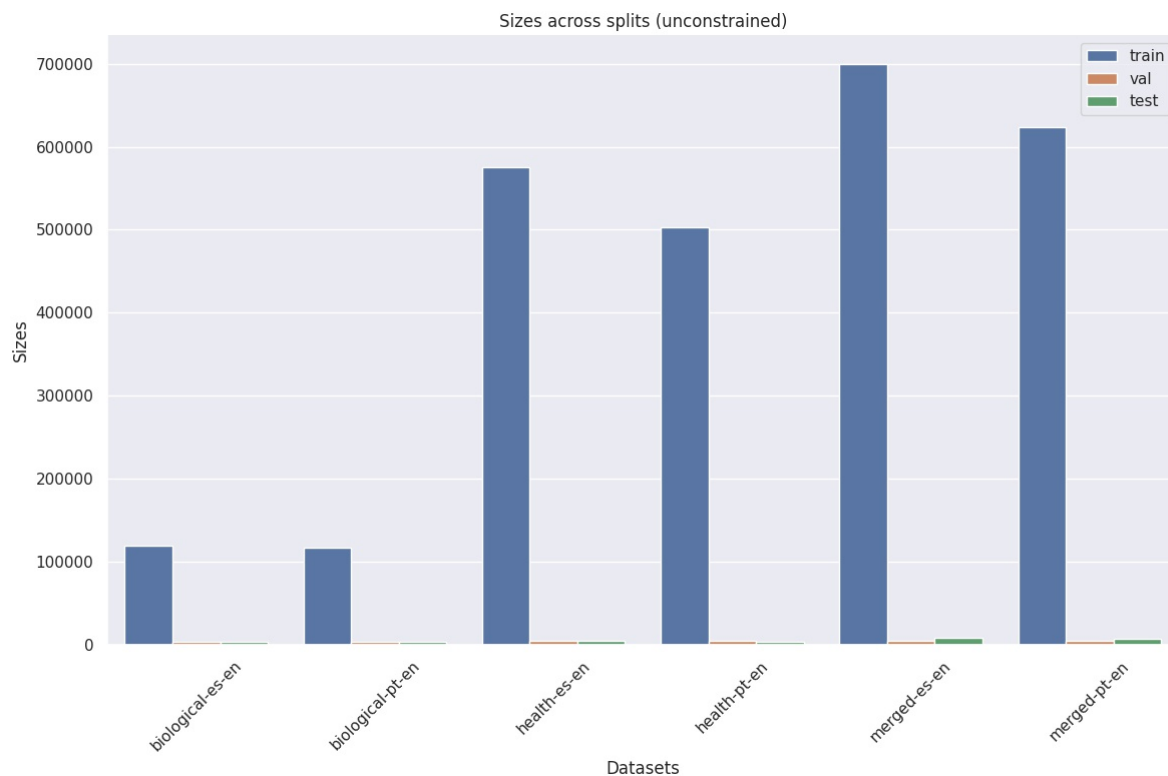
Splits

Since no validation set was provided, we have create our owns (from the training set), using the following formula: $\min(5000, \max(3000, \text{TRAININGSET_LEN} * 0.03))$. This formula is arbitrary and was used to have a validation set similar in size to the test set but not too large.

Split sizes: (UNCONSTRAINED)

#Command: `wc -l $(ls)`
 (Values indicate the number of sentences)

	Dataset	Split	Size
0	biological-es-en	train	119890
1	biological-es-en	val	3707
2	biological-es-en	test	3982
3	biological-pt-en	train	116692
4	biological-pt-en	val	3609
5	biological-pt-en	test	3871
6	health-es-en	train	575482
7	health-es-en	val	5000
8	health-es-en	test	4961
9	health-pt-en	train	502987
10	health-pt-en	val	5000
11	health-pt-en	test	3738
12	merged-es-en	train	699079
13	merged-es-en	val	5000
14	merged-es-en	test	8943
15	merged-pt-en	train	623288
16	merged-pt-en	val	5000
17	merged-pt-en	test	7609



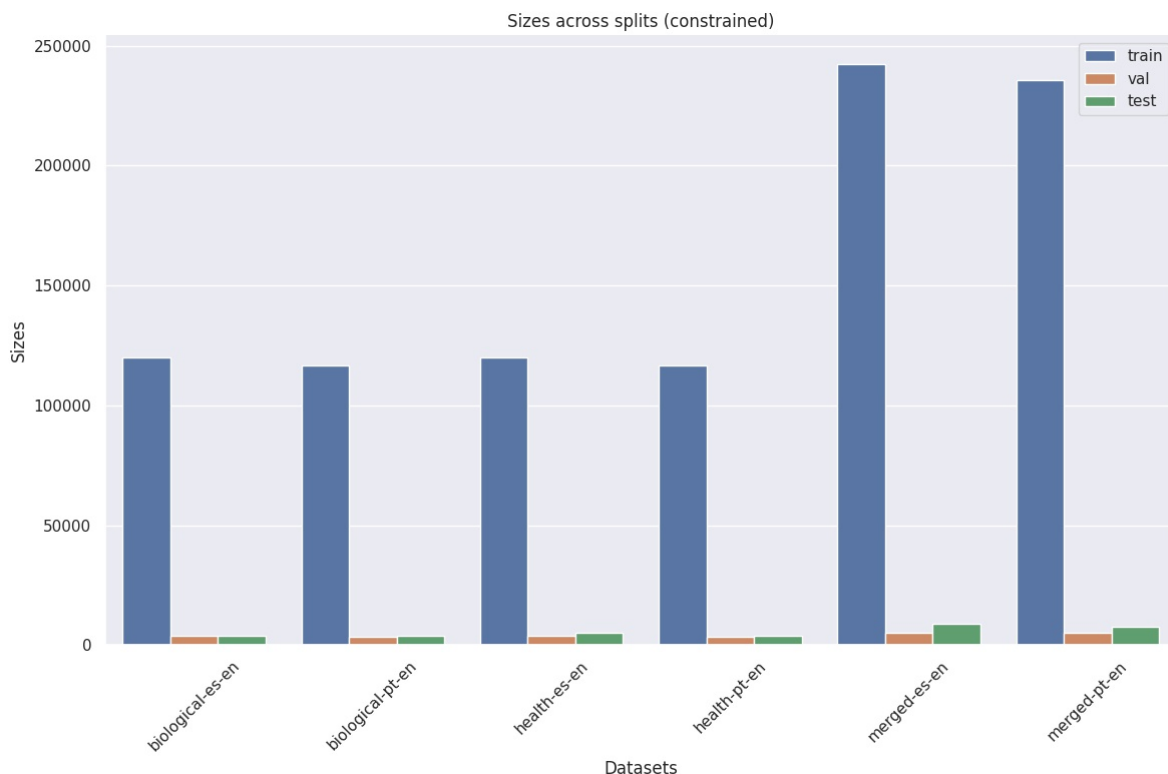
Split sizes: (CONSTRAINED)

#Command: `wc -l $(ls)`

(Values indicate the number of sentences)

0	biological-es-en	train	119890
1	biological-es-en	val	3707
2	biological-es-en	test	3982
3	biological-pt-en	train	116692
4	biological-pt-en	val	3609
5	biological-pt-en	test	3871
6	health-es-en	train	119890
7	health-es-en	val	3707
8	health-es-en	test	4961
9	health-pt-en	train	116692
10	health-pt-en	val	3609
11	health-pt-en	test	3738
12	merged-es-en	train	242194
13	merged-es-en	val	5000
14	merged-es-en	test	8943
15	merged-pt-en	train	235602
16	merged-pt-en	val	5000
17	merged-pt-en	test	7609

Figure saved!



Tokenization and BPE

Finally, we have tokenized the dataset using Moses, and fastBPE to learn and apply the subword tokenization with a maximum dictionary size of 32,000 tokens.

Examples

Health

Translation pair #1:

- DE@@ TEC@@ CIÓN R@@ Á@@ P@@ ID@@ A DEL VI@@ R@@ US DE LA G@@ AS@@ TR@@ O@@ EN@@ T@@ ERI@@ TI@@ S TR@@ AN@@ SM@@ I@@ SI@@ B@@ LE EN C@@ ER@@ DO A TR@@ AV@@ É@@ S DE LA RE@@ AC@@ CIÓN EN C@@ AD@@ ENA DE LA PO@@ LI@@ MER@@ ASA
- R@@ AP@@ ID DE@@ TEC@@ TION OF SW@@ INE TR@@ AN@@ SM@@ IS@@ SI@@ B@@ LE G@@ AS@@ TR@@ O@@ EN@@ T@@ ERI@@ TI@@ S VI@@ R@@ US BY N@@ EST@@ ED P@@ OL@@ Y@@ MER@@ AS@@ E CH@@ A@@ IN RE@@ AC@@ TION

Translation pair #2:

- Una ingestión excesiva de calorías , combinada con una vida sedent@@ aria , promueve la expresión fenotípica de este síndrome en individuos con predisposición genética .
- Ex@@ ces@@ sive intake of calories together with lack of exercising leads to phen@@ otyp@@ ical expression of this syndrome in individuals with genetic predisposition .

Translation pair #3:

- Pacientes : catorce pacientes con una edad media de 60 años diagnosticados de cirrosis hepática en estadios A y B que se les practicó colecistectomía laparoscópica .
- Patients : we studied 14 patients (mean age 60 years) with Child 's Class A and Class B hepatic cirrhosis who underwent laparoscopic cholecystectomy .

Biological**Translation pair #1:**

- La caracterización de los extractos purificados se realizó por barrido espectrofotométrico , pruebas bioquímicas de electroforesis SDS @-@ PAGE , ensayo Pur@@ pal@@ d y la prueba crom@@ génica de L@@ AL .
- The characterization of the purified extracts was performed by spectrophotometric scanning , SDS @-@ PAGE biochemical tests , Pur@@ pal@@ d assay and chrom@@ genic L@@ AL test .

Translation pair #2:

- Se utilizó un diseño experimental completamente al azar , con arreglo factorial , con cinco repeticiones .
- A completely randomized experimental design with a factorial arrangement and five replications was used .

Translation pair #3:

- Y su relación con el desarrollo de Bemisia tabaci Gen@@ n .
- And their relationship to the development of Bemisia tabaci Gen@@ n .

Merge**Translation pair #1:**

- Clínicamente muestran aspecto sol@@ ap@@ ables con las forma ex@@ trat@@ es@@ ticulares .
- Clin@@ ically they show features overl@@ apping the ex@@ trat@@ esticular types .

Translation pair #2:

- Estrategias como la coordinación e investigación pueden optim@@ iz@@ arse para alcanzar sus objetivos .
- Strategies such as coordination and research could be optim@@ ised so that their objectives can be reached .

Translation pair #3:

- Los resultados obtenidos fueron muy satisfactorios .
- The results obtained were satisfactory .

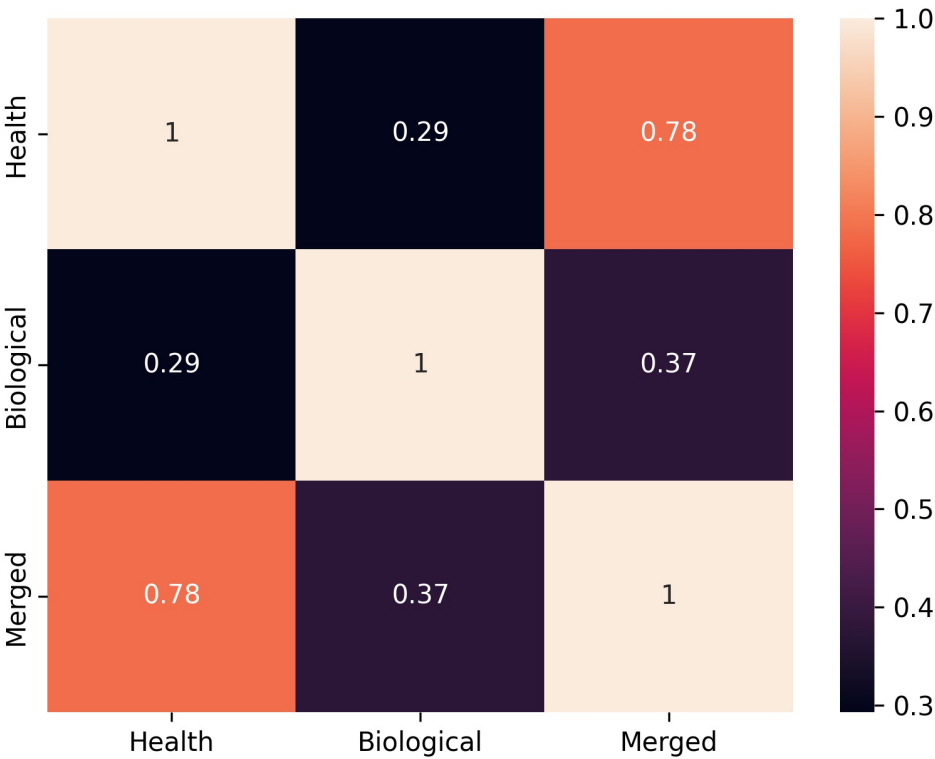
Dataset overlapping

With the objective to visualize the vocabulary overlap among domains, we have plot two matrices: one with IoU values, and another with the overlapping between domain1 and domain2:

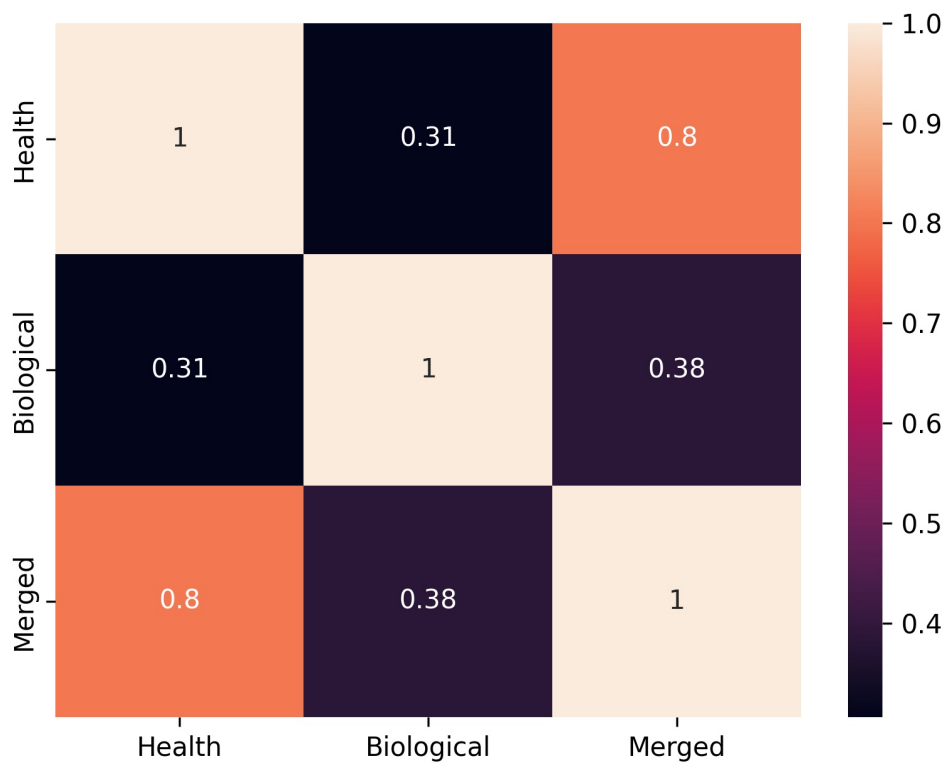
Intersection Over Union (unconstrained)

Formula:
iou=vocab1.intersection(vocab2)/len(vocab1.union(vocab2))

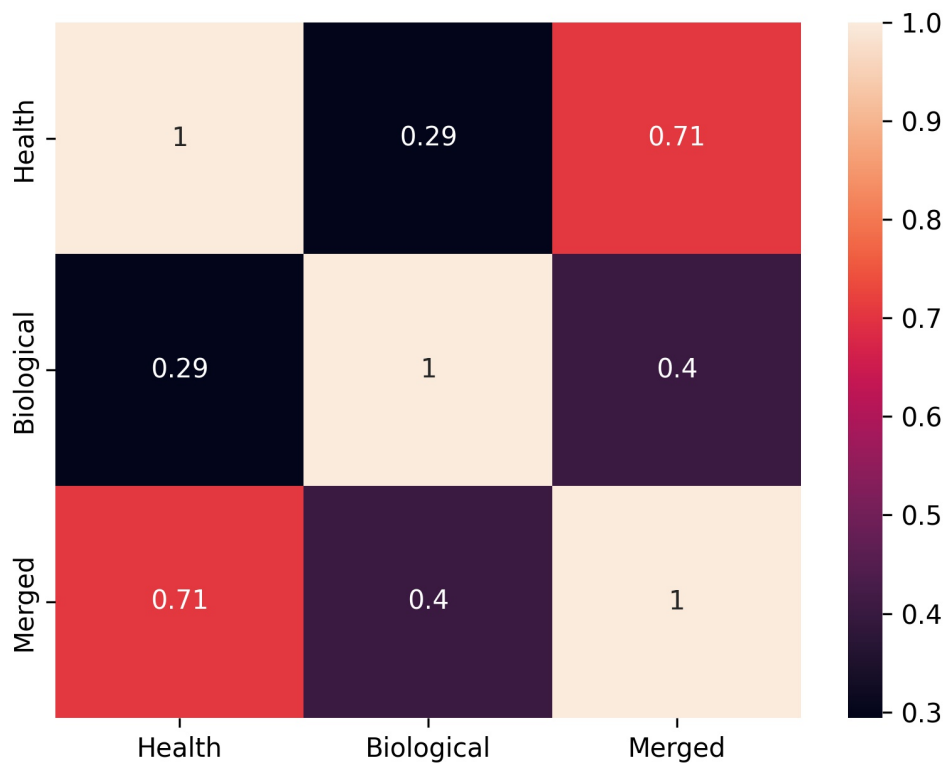
es-en | data: es

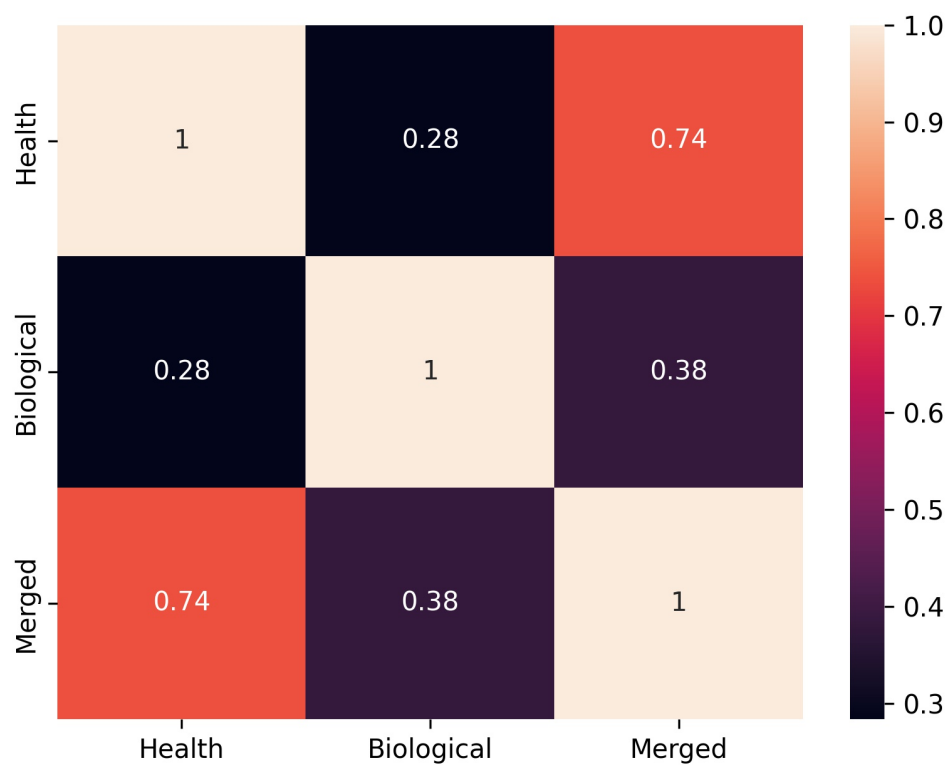


es-en | data: en



pt-en | data: pt



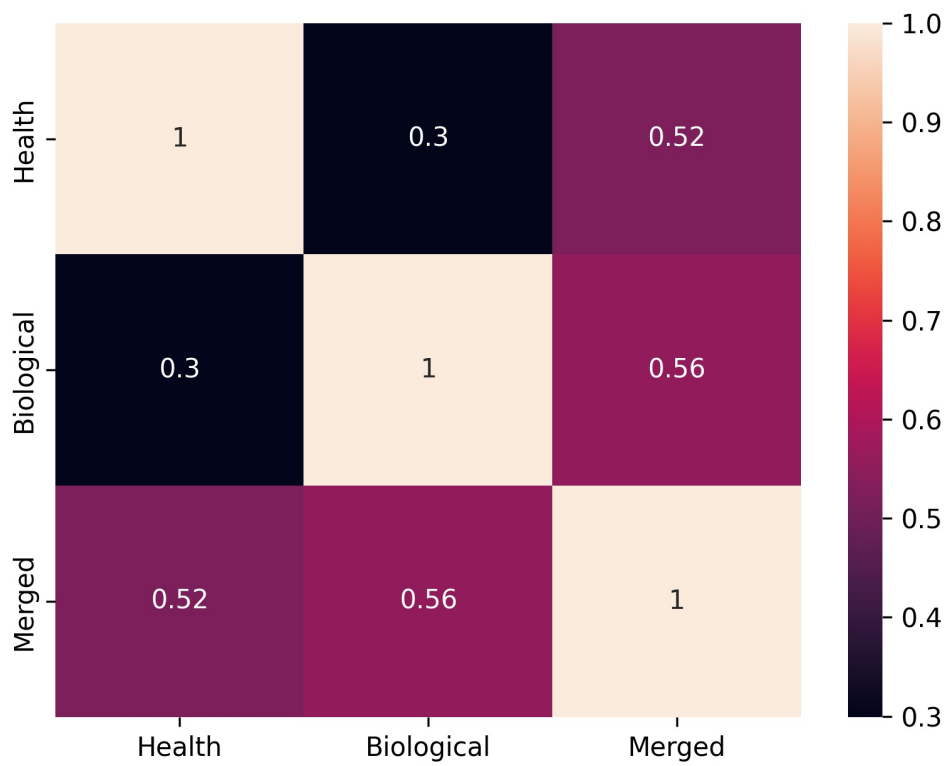
pt-en | data: en

Intersection Over Union (constrained)

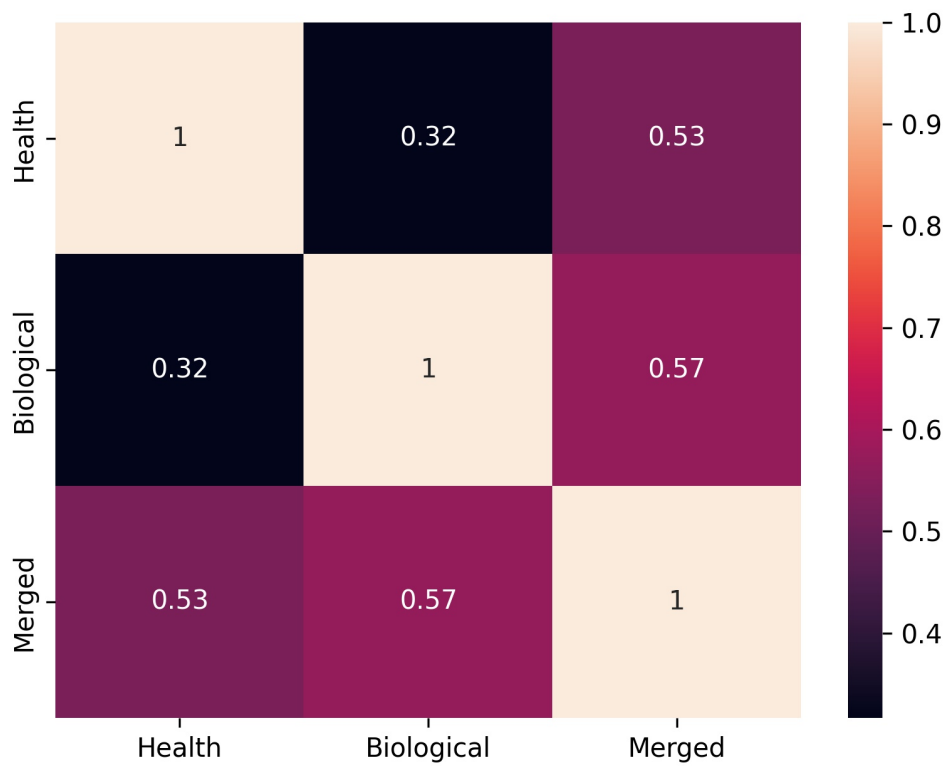
Formula:

```
iou=vocab1.intersection(vocab2)/len(vocab1.union(vocab2))
```

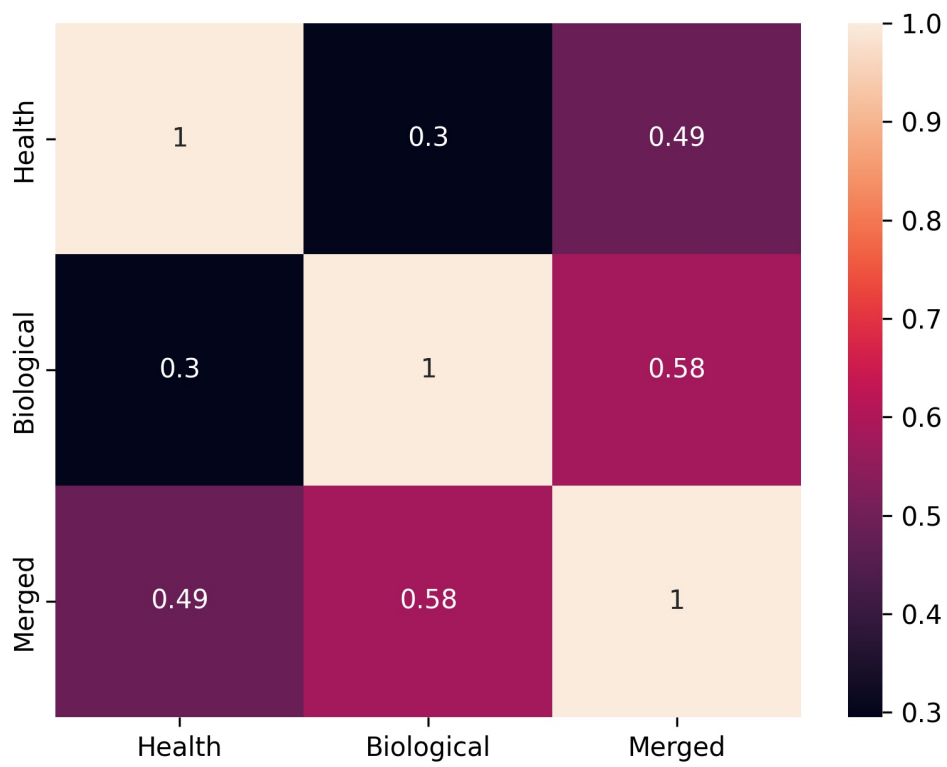
es-en | data: es



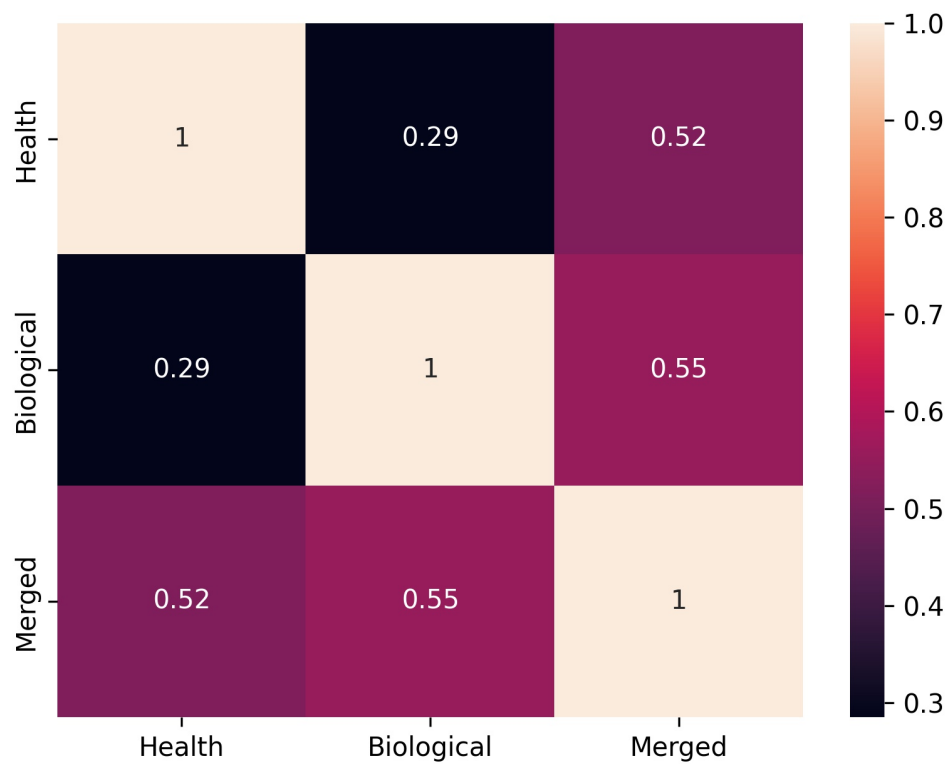
es-en | data: en



pt-en | data: pt



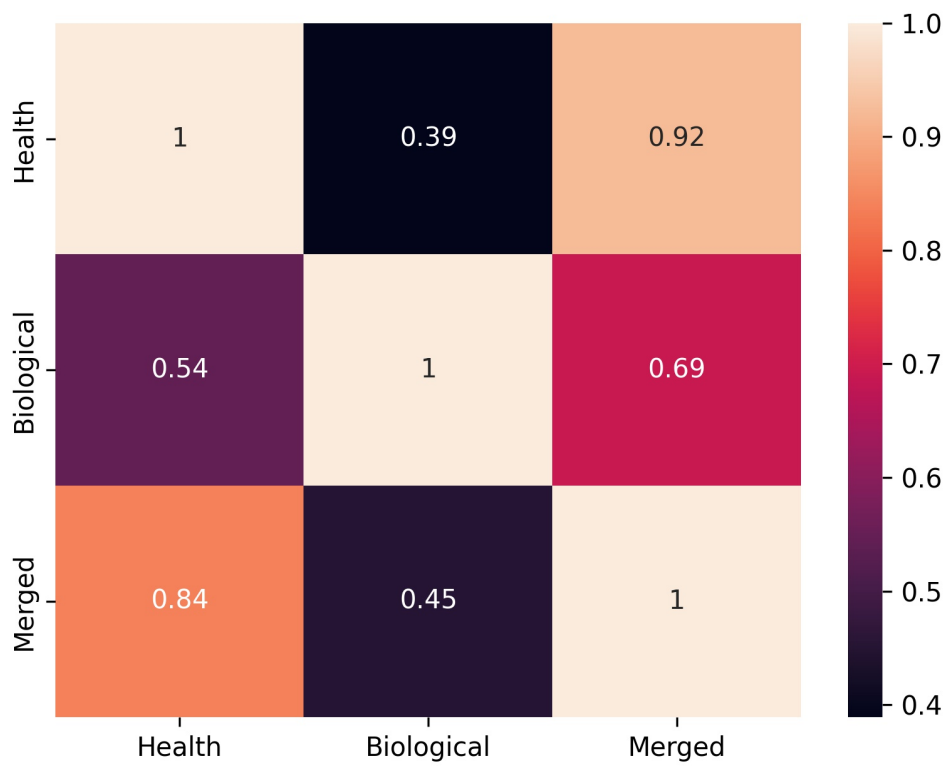
pt-en | data: en



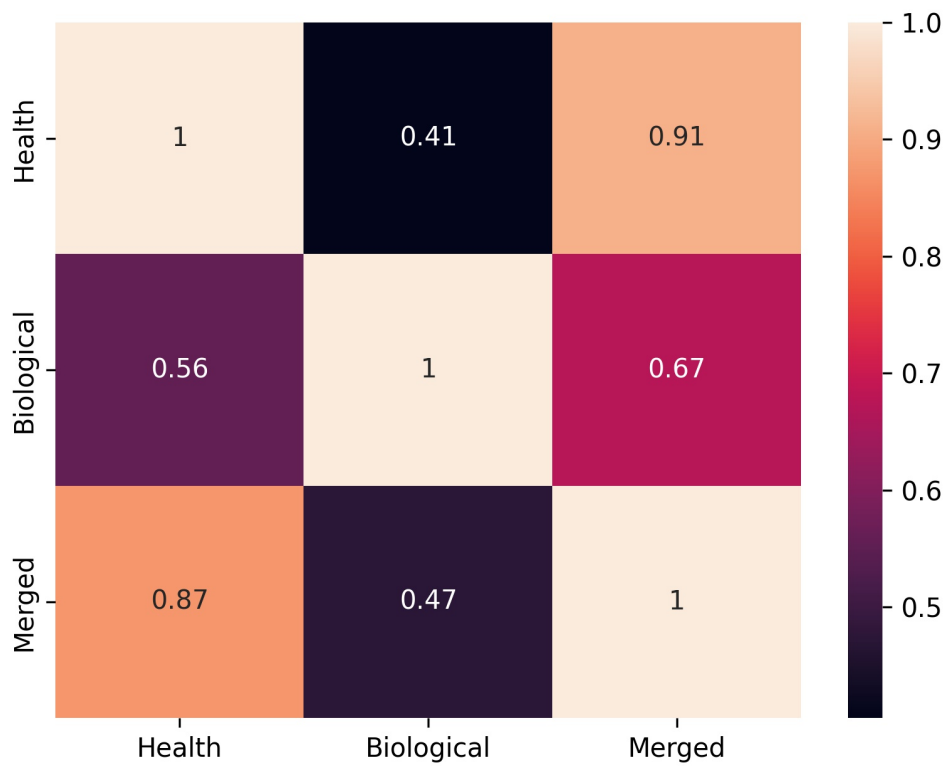
Overlapping (domain1 - domain2) (unconstrained)

```
Formula: overlap=vocab1.intersection(vocab2)/len(vocab1)
```

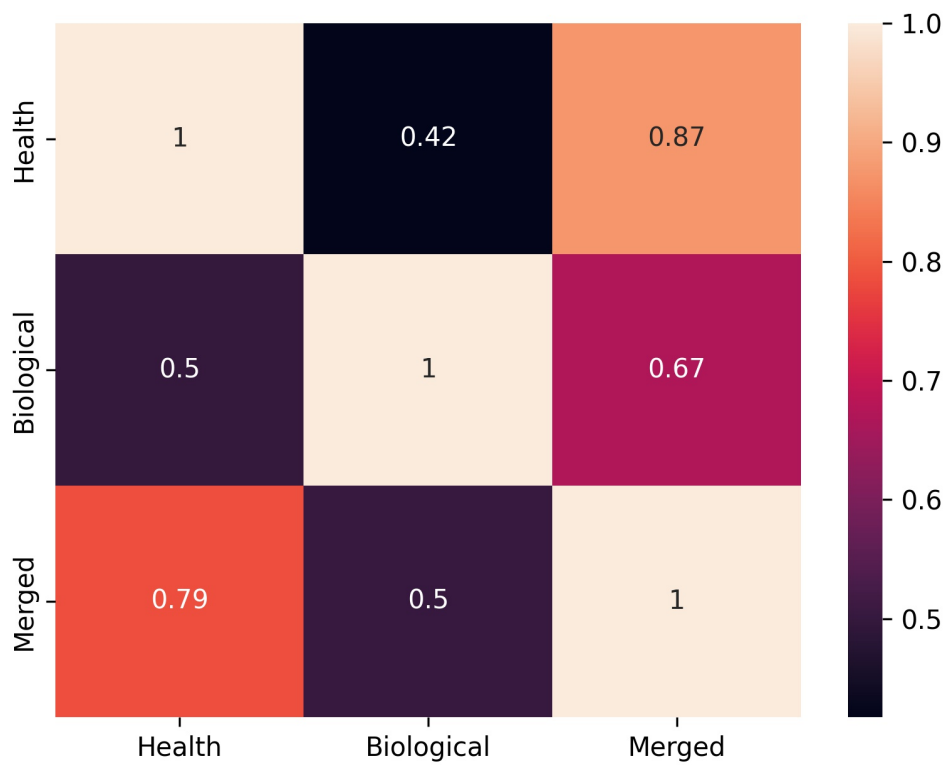
es-en | data: es



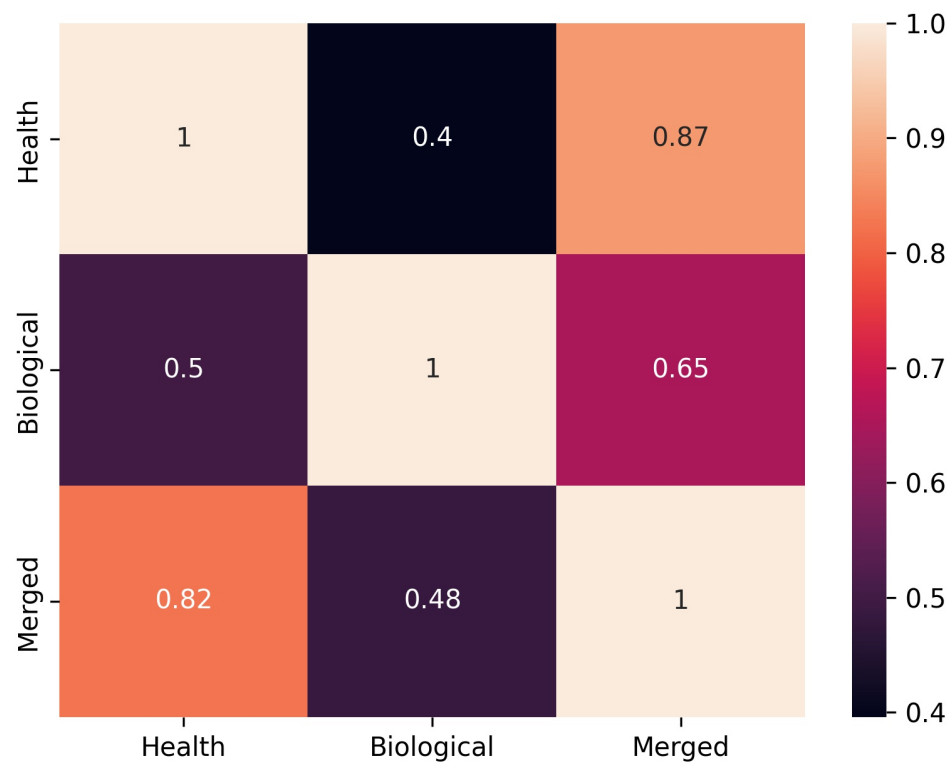
es-en | data: en



pt-en | data: pt



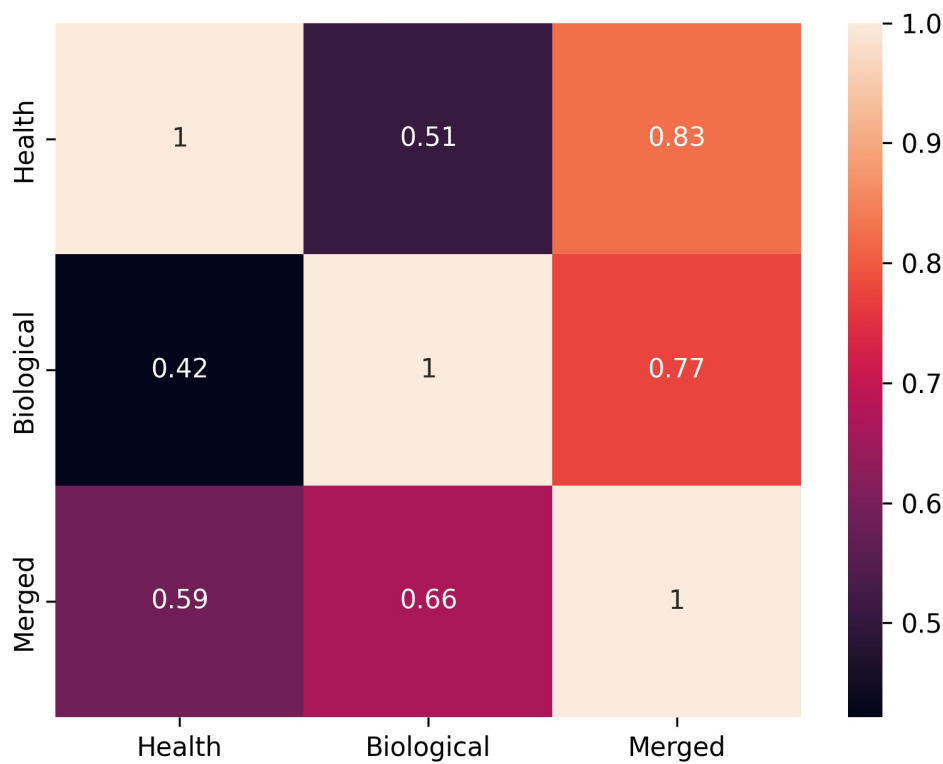
pt-en | data: en



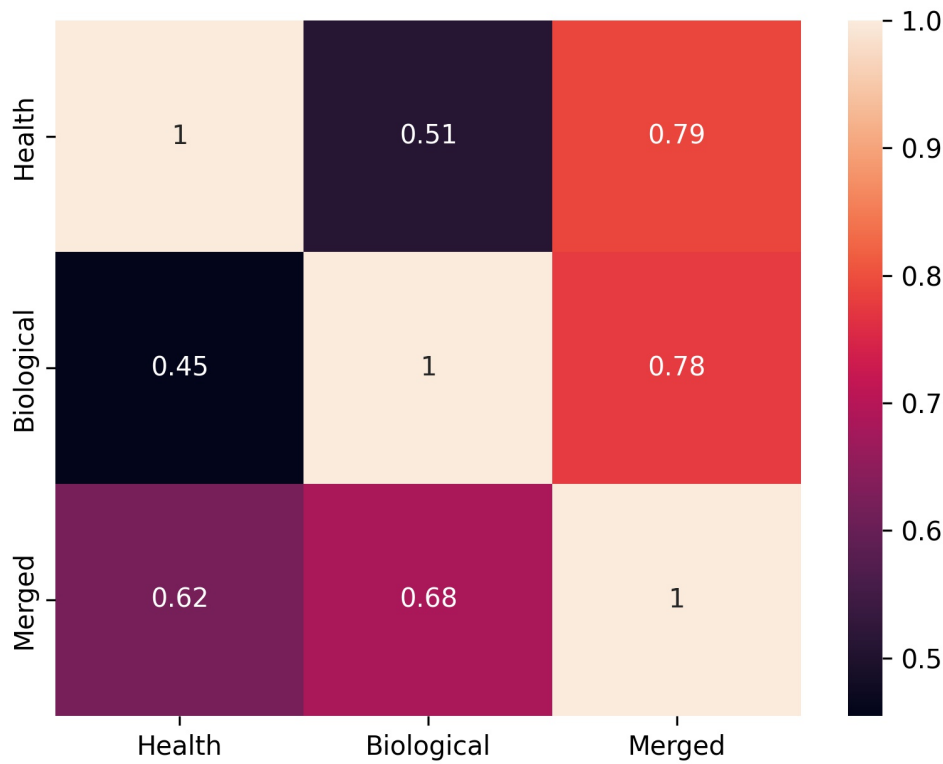
Overlapping (domain1 - domain2) (constrained)

```
Formula: overlap=vocab1.intersection(vocab2)/len(vocab1)
```

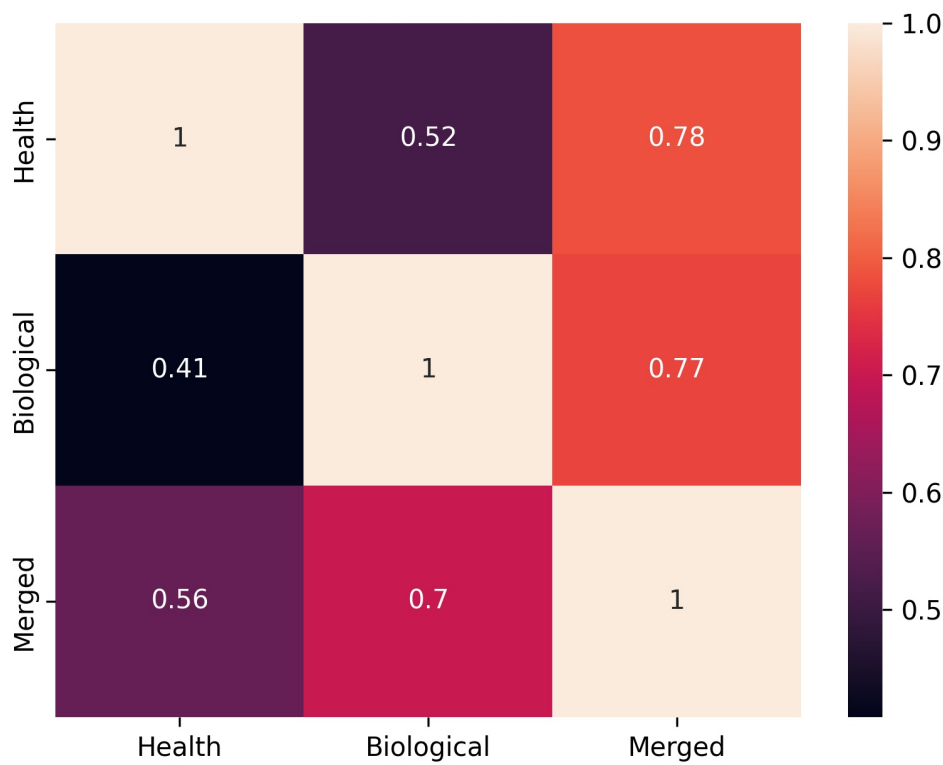
es-en | data: es



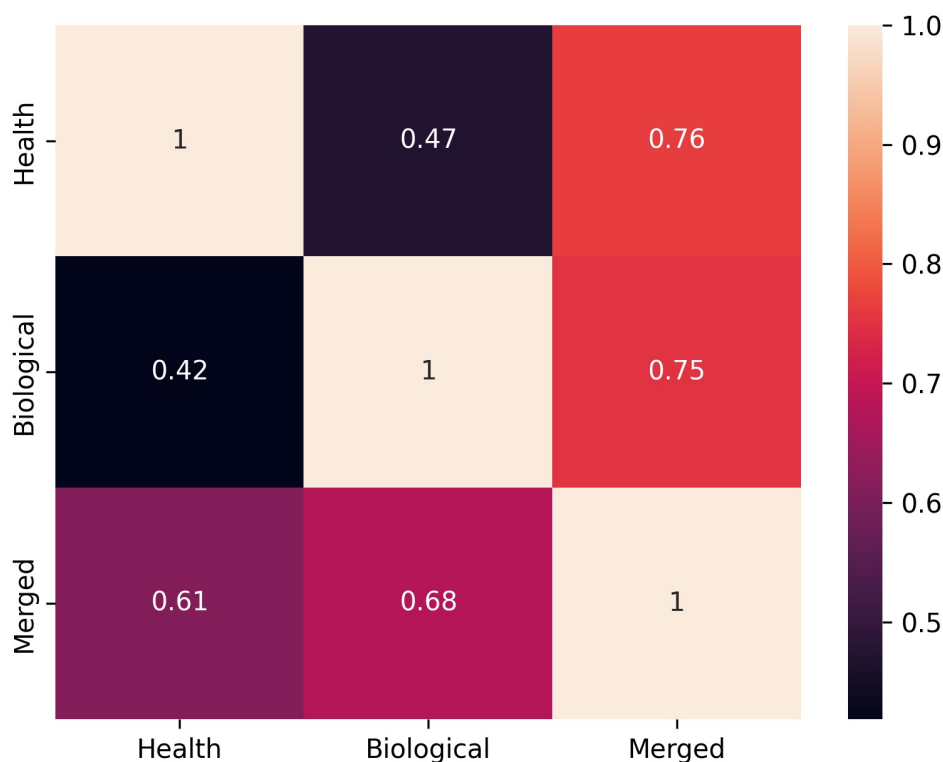
es-en | data: en



pt-en | data: pt



pt-en | data: en



Methodology

Baseline #1: Naive training

- Train one model per language and domain (2 language pairs x 3 domains).
 - Example: (es-en) and (pt-en) for (health, biological and health+biological)

Baseline #2: Sequential training

- Evidence of the catastrophic forgetting problem

Baseline #3: Approaches for mitigating catastrophic forgetting

- Fixed/Bayesian Interpolation
- Elastic Weight Consolidation

Proposal: Freeze architecture, extend, and train extension

- Fine tuning
- Model surgery
- Reinforcement learning

Training

We have trained 6 models* using the same base architecture for all of them, and the same configuration. (*Toolkit: fairseq 0.10.2*)

Trained models:

- **es-en:** health, biological, health+biological, health->biological
- **pt-en:** health, biological, health+biological, health->biological

Main parameters:

```
--arch transformer \
--optimizer adam \
--criterion label_smoothed_cross_entropy --label-smoothing
0.1 \
--max-tokens 4096 \
--num-workers $(nproc) \
--max-epoch 50 \
--seed 1 \
--save-dir $BASE_PATH/checkpoints \
--log-format simple \
--no-epoch-checkpoints \
--tensorboard-logdir $BASE_PATH/logdir \
--update-freq 8 \
--eval-bleu \
--eval-bleu-args '{"beam": 5, "max_len_a": 1.2, "max_len_b":
10}' \
--eval-bleu-detok moses \
--eval-bleu-remove-bpe \
--eval-bleu-print-samples \
--best-checkpoint-metric bleu --maximize-best-checkpoint-met
ric \
--clip-norm 1.0 \
--lr 1e-3 \
--lr-scheduler reduce_lr_on_plateau \
--warmup-updates 4000 \
--dropout 0.1 --weight-decay 0.0001 \
--patience 5 \
--wandb-project "mltests"
```

Progress (unconstrained)

Training:



Validation:

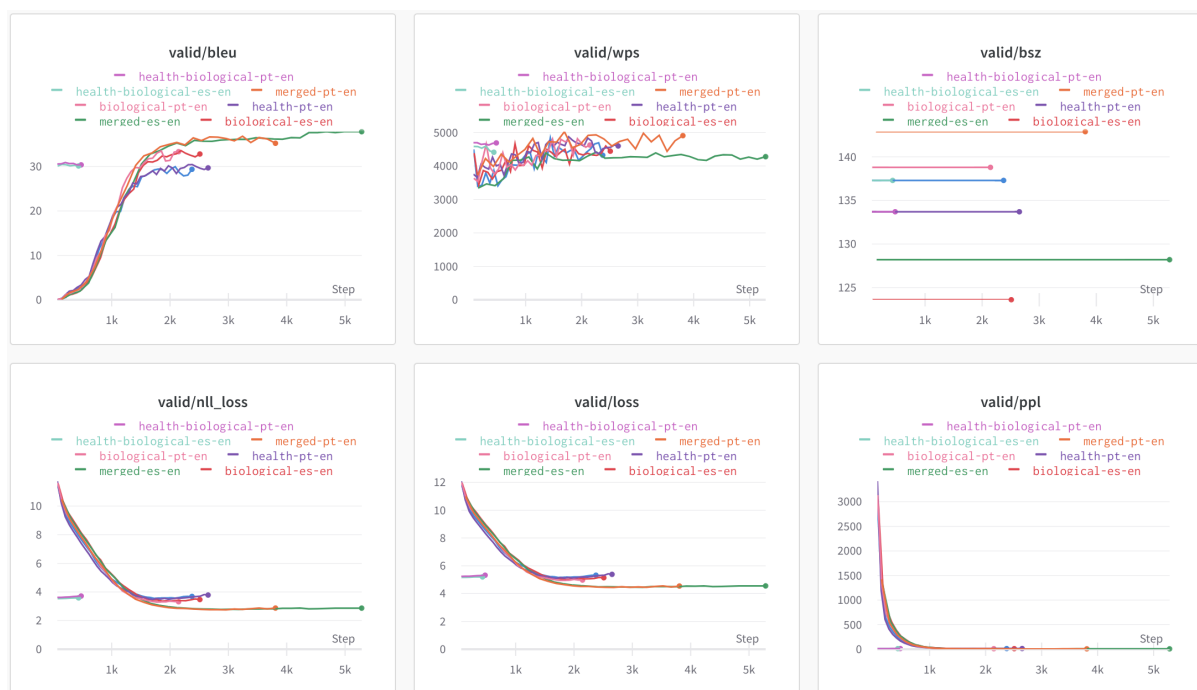


Progress (constrained)

Training:



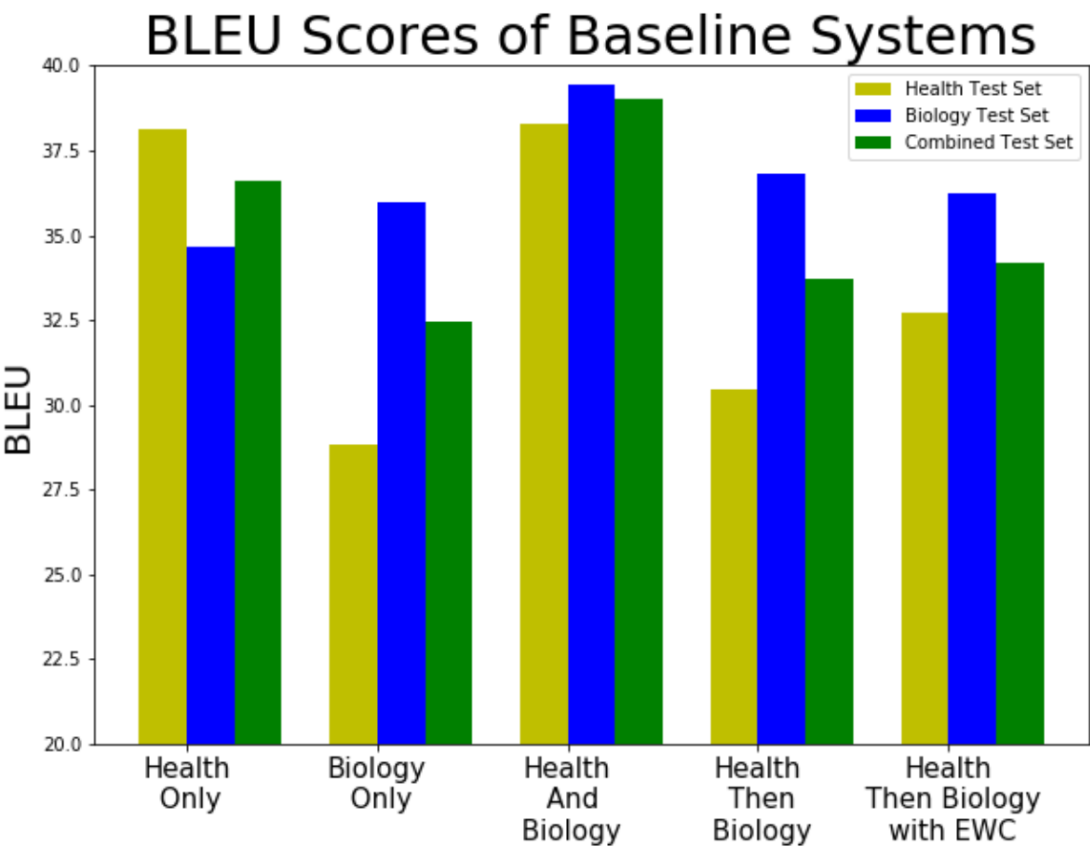
Validation:



Evaluation

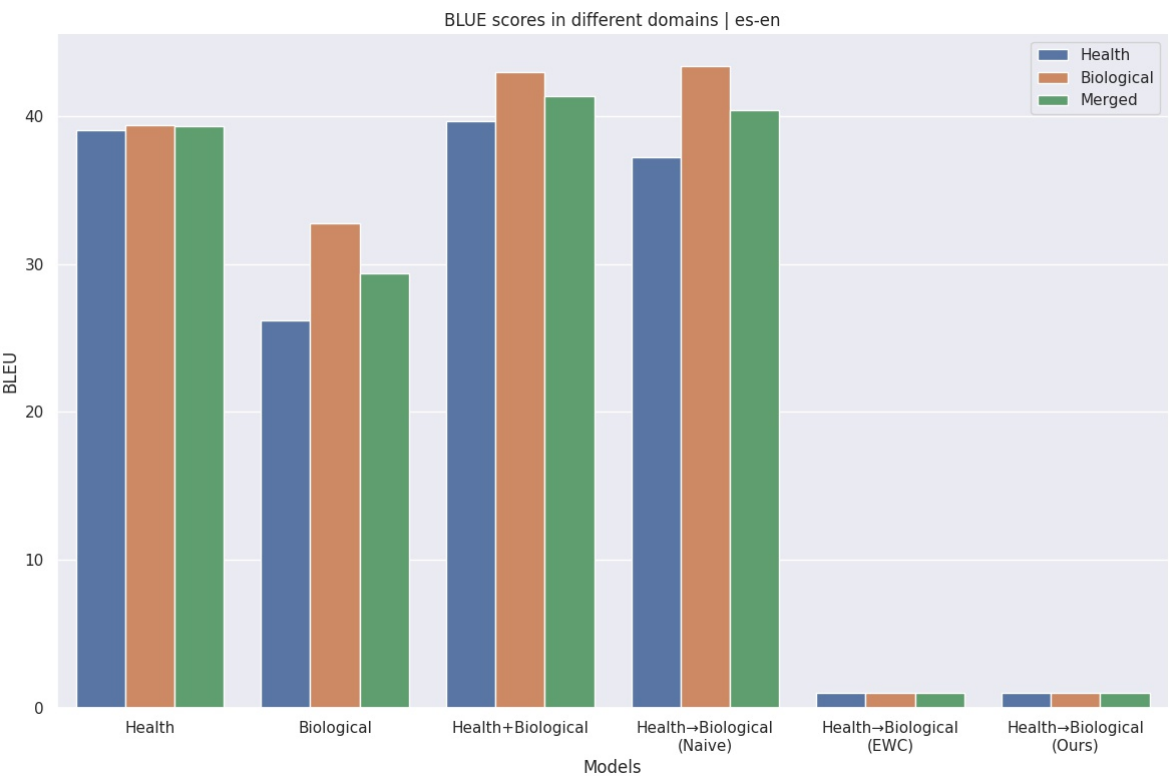
Each one of the 6 trained models has been evaluated on each domain, using the BLEU score from Fairseq (used for the WMT).

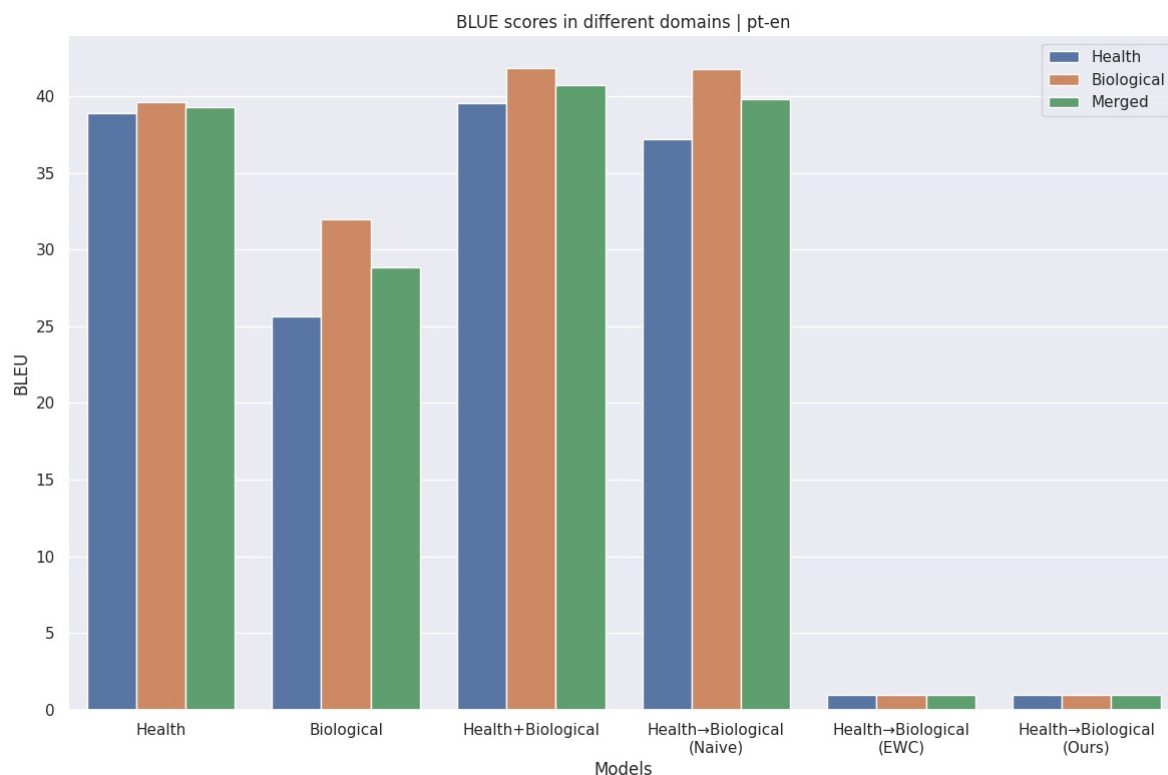
Reference (kell master thesis)



Unconstrained

Spanish-English:



Portuguese-English:**Comments:**

- The results from es-en and pt-en are pretty similar across all tested domains. Therefore, the comments below can apply to both of them.
- **Health model:** This model is trained on the health domain exclusively. However, this case is interesting since we expect the health model to perform very well on its domain (health), then to perform reasonably well on the merged domain (as there is more data), and finally, to perform worse on the biology domain. However, the health model performs very well in all domains with no significant differences among them. We argue that this could be related to the amount of data available for each domain. The training set from the health domain contains around ~550k sentences, while the biological domain has only 100k sentences. This imbalance in terms of data could lead to inadvertently train more performant models when using the health domain. To test this hypothesis, we have trained a new model but using the same amount of data as it is available for the biological domain (later).
- **Biological model:** This model is trained on the biological domain exclusively. It performs well in its domain, a little worse in the merged domain and finally, the health domain is the one with the worst results as expected.
- **Health+Biological:** This model is trained on the health and biological domain at once. Here, we observed a consistent increase in performance for all domains. As the amount of data in the biology domain is significantly smaller than the health domain, the improvements are only slightly better than the health domain.
- **Health→Biological:** This model is trained sequentially. First on the health domain, and then fine-tuned on the biological domain. As a result of this sequential training, the performance in the fine-tuned domain increased but at expense of worsen its performance on a previously learned domain (health). This phenomenon is known as "catastrophic forgetting" and it is the one we will try to mitigate.

Table:

```
In [4]: import pandas as pd
df = pd.read_csv("../data/unconstrained/test_data.csv")
print(df)
```

	Unnamed: 0	Model	Test domain	lang	BLEU
0	0	Health	Health	es-en	39.02
1	1	Health	Biological	es-en	39.38
2	2	Health	Merged	es-en	39.34
3	3	Biological	Health	es-en	26.19
4	4	Biological	Biological	es-en	32.76
5	5	Biological	Merged	es-en	29.36
6	6	Health+Biological	Health	es-en	39.63
7	7	Health+Biological	Biological	es-en	42.95
8	8	Health+Biological	Merged	es-en	41.32
9	9	Health→Biological\n(Naive)	Health	es-en	37.20
10	10	Health→Biological\n(Naive)	Biological	es-en	43.35
11	11	Health→Biological\n(Naive)	Merged	es-en	40.38
12	12	Health→Biological\n(EWC)	Health	es-en	1.00
13	13	Health→Biological\n(EWC)	Biological	es-en	1.00
14	14	Health→Biological\n(EWC)	Merged	es-en	1.00
15	15	Health→Biological\n(Ours)	Health	es-en	1.00
16	16	Health→Biological\n(Ours)	Biological	es-en	1.00
17	17	Health→Biological\n(Ours)	Merged	es-en	1.00
18	18	Health	Health	pt-en	38.86
19	19	Health	Biological	pt-en	39.61
20	20	Health	Merged	pt-en	39.26
21	21	Biological	Health	pt-en	25.67
22	22	Biological	Biological	pt-en	31.94
23	23	Biological	Merged	pt-en	28.86
24	24	Health+Biological	Health	pt-en	39.54
25	25	Health+Biological	Biological	pt-en	41.80
26	26	Health+Biological	Merged	pt-en	40.74
27	27	Health→Biological\n(Naive)	Health	pt-en	37.16
28	28	Health→Biological\n(Naive)	Biological	pt-en	41.78
29	29	Health→Biological\n(Naive)	Merged	pt-en	39.77
30	30	Health→Biological\n(EWC)	Health	pt-en	1.00
31	31	Health→Biological\n(EWC)	Biological	pt-en	1.00
32	32	Health→Biological\n(EWC)	Merged	pt-en	1.00
33	33	Health→Biological\n(Ours)	Health	pt-en	1.00
34	34	Health→Biological\n(Ours)	Biological	pt-en	1.00
35	35	Health→Biological\n(Ours)	Merged	pt-en	1.00

Translated examples

Legend: Source (S), Target (T), Hypothesis (H), Detokenized (D), Probabilities (P)

Translations not cherry picked

Trained on: Health, Tested on: Health (es-en)

S-4762 Algunos b @-@ bloque@@ adores son , también , vasodila
t@@ adores .

T-4762 Some b @-@ blockers are also vasodi@@ l@@ ators .

H-4762 -0.2545783817768097 Some b @-@ blockers are also va
sodi@@ l@@ ators .

D-4762 -0.2545783817768097 Some b @-@ blockers are also va
sodi@@ l@@ ators .

P-4762 -0.2415 -0.0850 -0.1610 -0.1649 -0.3808 -0.3433 -0.750
6 -0.0631 -0.3405 -0.1388 -0.1310

S-858 Dis@@ función miccional post @-@ bra@@ quit@@ erapia en
el cáncer prostático

T-858 Objectives :

H-858 -0.656700849533081 Post @-@ brachy@@ therapy voiding
dysfunction in prostate cancer

D-858 -0.656700849533081 Post @-@ brachy@@ therapy voiding
dysfunction in prostate cancer

P-858 -4.2436 -0.1390 -0.2959 -0.0589 -0.4146 -0.2406 -0.1419
-0.6925 -0.1862 -0.1538

S-2323 La tomografía computadorizada mostró imágenes con aspe
cto de embol@@ ia pulmonar .

T-2323 CT images suggested pulmonary embolism .

H-2323 -0.556445837020874 Computed tomography showed image
s with aspect of pulmonary embolism .

D-2323 -0.556445837020874 Computed tomography showed image
s with aspect of pulmonary embolism .

P-2323 -1.0355 -0.0882 -0.9586 -0.1854 -0.5684 -2.6379 -0.134
8 -0.1575 -0.0706 -0.1530 -0.1310

S-3812 Consumo de alcohol en la consulta de una sala de emerg
encia .

T-3812 Alcohol consumption in the emergency room .

H-3812 -0.5013466477394104 Alcohol consumption in an emerg
ency room .

D-3812 -0.5013466477394104 Alcohol consumption in an emerg
ency room .

P-3812 -0.1431 -0.2048 -0.5730 -1.4506 -0.2033 -0.1445 -1.148
6 -0.1427

Trained on: Health, Tested on: Biological (es-en)

S-3944 Las técnicas de fecundación artificial siguen desarrollándose día a día .

T-3944 Artificial reproductive technology (ART) is improving constantly .

H-3944 -0.7757904529571533 Artificial fertilization techniques continue to develop a day to day .

D-3944 -0.7757904529571533 Artificial fertilization techniques continue to develop a day to day .

P-3944 -0.8396 -0.0449 -0.8764 -0.3654 -1.3506 -0.7778 -1.5505 -0.9983 -0.2864 -2.3688 -0.3376 -0.1536 -0.1354

S-1367 El intervalo de tiempo promedio entre aportes de presa fue de 7@ 98 s .

T-1367 The mean time interval between pre@ y deliveries was 7@ 98 s .

H-1367 -0.6061871647834778 The average time interval between pre@ y contributions was 7@ 98 .

D-1367 -0.6061871647834778 The average time interval between pre@ y contributions was 7@ 98 .

P-1367 -0.4470 -0.7220 -0.2297 -0.5246 -0.3596 -3.0708 -0.9708 -0.1361 -0.1207 -0.0876 -0.0675 -0.9636 -0.1805

S-727 El Her@ b@ ario US@ J de Costa Rica : trayectoria y contribuciones .

T-727 US@ J Her@ bari@ um of Costa Rica : history and contributions .

H-727 -0.3842181861400604 The Her@ bari@ um US@ J of Costa Rica : trajectory and contributions .

D-727 -0.3842181861400604 The Her@ bari@ um US@ J of Costa Rica : trajectory and contributions .

P-727 -0.3028 -1.3042 -0.4261 -0.3853 -0.3091 -0.1093 -1.2289 -0.0751 -0.0860 -0.1367 -0.8913 -0.1663 -0.0718 -0.1423 -0.1280

Trained on: Biological, Tested on: Health (es-en)

S-3629 Un paciente HIV positivo falleció debido a epidermolisis .

T-3629 One HIV positive patient died of epidermolysis .

H-3629 -1.3282438516616821 A HIV infection caused HIV infection due to epidermolysis .

D-3629 -1.3282438516616821 A HIV infection caused HIV infection due to epidermolysis .

P-3629 -0.5730 -1.2475 -1.7452 -2.2903 -2.1050 -1.4641 -0.7367 -0.1582 -3.7445 -0.0702 -1.6936 -2.5032 -0.0915 -0.1726

S-916 Indicaciones médicas y quirúrgicas de los potenciales evocados .

T-916 Medical and surgical indications of evoked potentials .

H-916 -1.0327579975128174 medical and surgical approach of the potential evoked potentials .

D-916 -1.0327579975128174 medical and surgical approach of the potential evoked potentials .

P-916 -2.9271 -0.3403 -0.2766 -3.6245 -0.2752 -2.0038 -0.3977 -0.1251 -1.9874 -0.1362 -0.1323 -0.1669

S-3544 Este estudio tiene por objetivo presentar una revisión sobre el asunto .

T-3544 This study aimed at reviewing this subject .

H-3544 -0.6708385348320007 This study aims to present a review on the matter of the matter .

D-3544 -0.6708385348320007 This study aims to present a review on the matter of the matter .

P-3544 -0.3408 -0.2574 -2.1074 -0.2635 -1.2550 -0.7099 -0.0190 -0.8654 -0.2694 -0.4990 -0.3849 -1.1015 -1.6698 -0.1248 -0.1949

S-4839 Los valores plasmáticos del sodio y del potasio no se alteraron .

T-4839 Plasma sodium and potassium were not changed .

H-4839 -0.45692428946495056 Plasma and potassium values were not altered .

D-4839 -0.45692428946495056 Plasma and potassium values were not altered .

P-4839 -2.8977 -0.1235 -0.3627 -0.0258 -0.2182 -0.1091 -0.1709 -0.4268 -0.0846 -0.1500

Trained on: Biological, Tested on: Biological (es-en)

S-1782 Los experimentos fueron llevados a cabo usando el músculo aislado de ambas especies .

T-1782 Both species experiments were carried out using the isolated muscles .

H-1782 -0.43383994698524475 The experiments were carried out using the isolated muscle of both species .

D-1782 -0.43383994698524475 The experiments were carried out using the isolated muscle of both species .

P-1782 -0.5694 -0.3670 -0.1327 -0.4449 -0.0903 -0.2822 -0.1545 -2.4607 -0.0882 -0.4919 -0.5733 -0.1386 -0.1103 -0.1698

S-1071 Los invertebrados que habitan el suelo son actores importantes en los procesos edáficos .

T-1071 Soil @-@ inhabiting invertebrates play an important role in soil processes .

H-1071 -0.7320635914802551 The invertebrates that inhabit the soil are important actors in the edaphic processes .

D-1071 -0.7320635914802551 The invertebrates that inhabit the soil are important actors in the edaphic processes .

P-1071 -2.1574 -0.2994 -2.4002 -0.5484 -0.6102 -0.0960 -0.0561 -0.2094 -0.1566 -0.5941 -0.8326 -2.4657 -0.3104 -0.0811 -0.1634

S-768 Lo último podría limitar el restablecimiento de poblaciones de especies herbívoras .

T-768 The later prevent the re @-@ establishment of herbivore species populations .

H-768 -0.8204675316810608 Finally , the latter could limit the recovery of herbivorous species .

D-768 -0.8204675316810608 Finally , the latter could limit the recovery of herbivorous species .

P-768 -1.6022 -0.3679 -2.0152 -1.0818 -1.2024 -0.3188 -0.1867 -1.2975 -0.1059 -0.4300 -1.1682 -0.6948 -0.1946

S-296 Mis resultados los comparo con la información existente para el planeta .

T-296 I compared my results against information for the entire Planet .

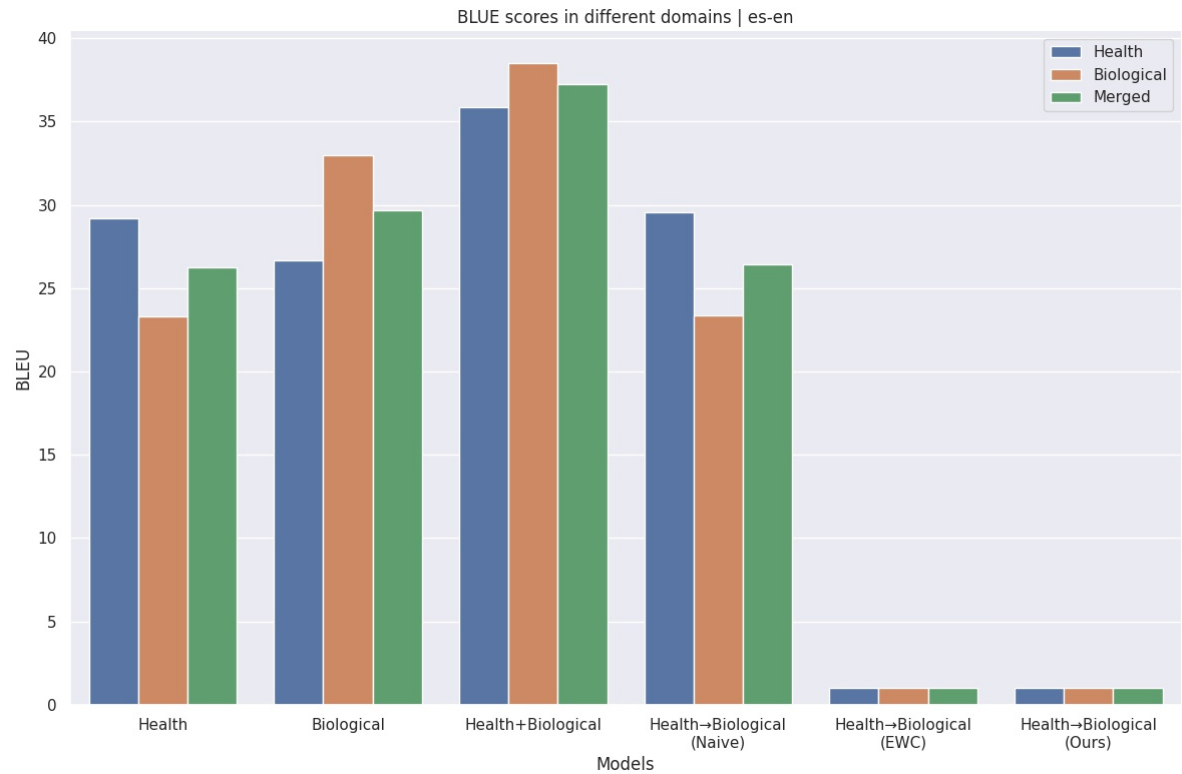
H-296 -0.7367602586746216 The results are compared with the existing information for the planet .

D-296 -0.7367602586746216 The results are compared with the existing information for the planet .

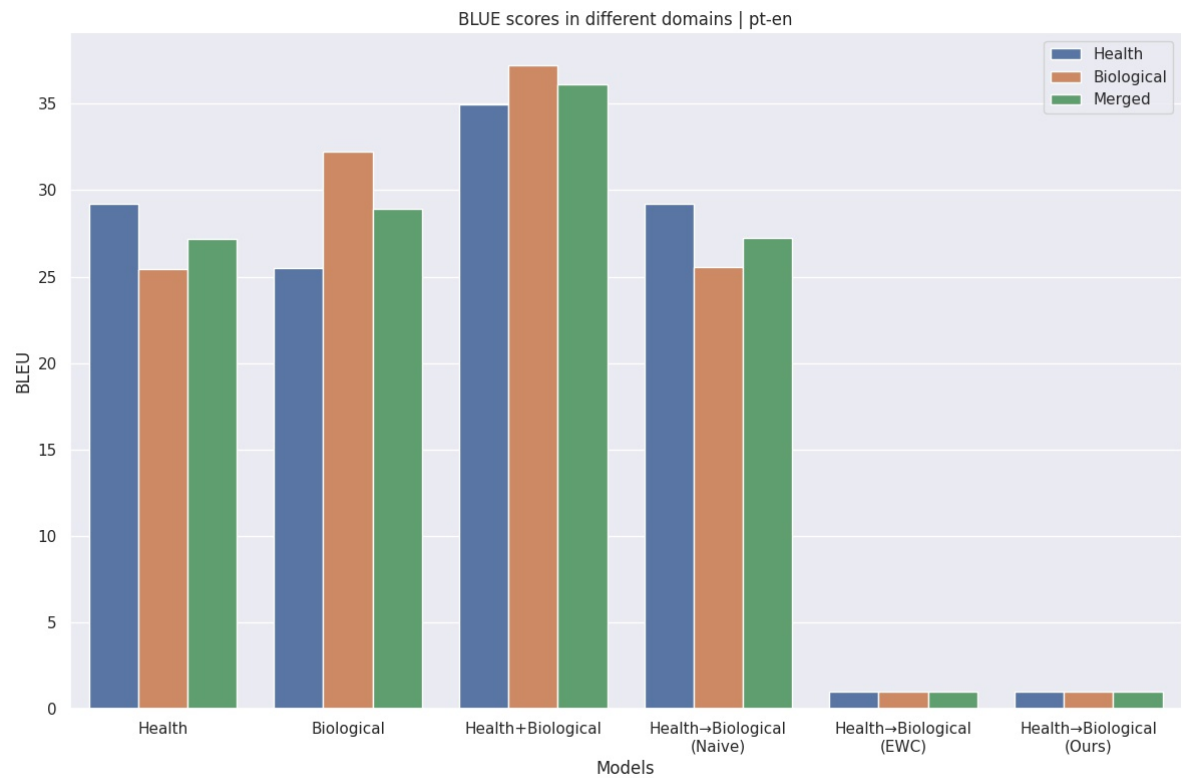
P-296 -4.1590 -0.0544 -1.3278 -0.6892 -0.4899 -0.4855 -0.9092 -0.0514 -0.6784 -0.1990 -0.2870 -0.0653 -0.1818

Constrained

Spanish-English:



Portuguese-English:



Comments:

- The results from es-en and pt-en are pretty similar across all tested domains. Therefore, the comments below can apply to both of them.

- **Health model:** This model is trained on the health domain exclusively. This time, with a balanced dataset the health model performs as expected. Very well in its domain, reasonably well on the merged domain, and poorly on the biological domain.
- **Biological model:** This model is trained on the biological domain exclusively. It performs well in its domain, a little worse in the merged domain and finally, the health domain is the one with the worst results as expected.
- **Health+Biological:** This model is trained on the health and biological domain at once. First, we observed a consistent increase in performance for all domains. This is expected, since as usual: "the more data, the better". However, this additional (balanced) data makes the model more robust to unknown domains and the gap in terms of performance across domains is slightly decreased.
- **Health->Biological:** This model is trained sequentially. First on the health domain, and then fine-tuned on the biological domain. => MARGINAL INCREMENTS. NO SIGNS OF CATASTROPHICAL FORGUEING!!!!!!!!!!!!!! (REVIEW)

Table:

```
In [2]: import pandas as pd
df = pd.read_csv("../data/constrained/test_data.csv")
print(df)
```

	Unnamed: 0	Model	Test domain	lang	BLEU
0	0	Health	Health	es-en	29.17
1	1	Health	Biological	es-en	23.28
2	2	Health	Merged	es-en	26.25
3	3	Biological	Health	es-en	26.65
4	4	Biological	Biological	es-en	32.98
5	5	Biological	Merged	es-en	29.67
6	6	Health+Biological	Health	es-en	35.86
7	7	Health+Biological	Biological	es-en	38.49
8	8	Health+Biological	Merged	es-en	37.26
9	9	Health→Biological\n(Naive)	Health	es-en	29.55
10	10	Health→Biological\n(Naive)	Biological	es-en	23.34
11	11	Health→Biological\n(Naive)	Merged	es-en	26.45
12	12	Health→Biological\n(EWC)	Health	es-en	1.00
13	13	Health→Biological\n(EWC)	Biological	es-en	1.00
14	14	Health→Biological\n(EWC)	Merged	es-en	1.00
15	15	Health→Biological\n(Ours)	Health	es-en	1.00
16	16	Health→Biological\n(Ours)	Biological	es-en	1.00
17	17	Health→Biological\n(Ours)	Merged	es-en	1.00
18	18	Health	Health	pt-en	29.19
19	19	Health	Biological	pt-en	25.42
20	20	Health	Merged	pt-en	27.18
21	21	Biological	Health	pt-en	25.48
22	22	Biological	Biological	pt-en	32.24
23	23	Biological	Merged	pt-en	28.92
24	24	Health+Biological	Health	pt-en	34.98
25	25	Health+Biological	Biological	pt-en	37.21
26	26	Health+Biological	Merged	pt-en	36.15
27	27	Health→Biological\n(Naive)	Health	pt-en	29.20
28	28	Health→Biological\n(Naive)	Biological	pt-en	25.55
29	29	Health→Biological\n(Naive)	Merged	pt-en	27.25
30	30	Health→Biological\n(EWC)	Health	pt-en	1.00
31	31	Health→Biological\n(EWC)	Biological	pt-en	1.00
32	32	Health→Biological\n(EWC)	Merged	pt-en	1.00
33	33	Health→Biological\n(Ours)	Health	pt-en	1.00
34	34	Health→Biological\n(Ours)	Biological	pt-en	1.00
35	35	Health→Biological\n(Ours)	Merged	pt-en	1.00

Translated examples

Legend: Source (S), Target (T), Hypothesis (H), Detokenized (D), Probabilities (P)

Translations not cherry picked

Trained on: Health, Tested on: Health (es-en)

S-4277 Todas , menos una , evolucionaron favorablemente independientemente del tratamiento utilizado .

T-4277 All of them , but one , evolved successfully .

H-4277 -0.9211965203285217 All , at least one evolved favorably independently of the treatment .

D-4277 -0.9211965203285217 All , at least one evolved favorably independently of the treatment .

P-4277 -0.1193 -3.0150 -1.8813 -0.1571 -0.3179 -1.0666 -1.3487 -0.0061 -3.1623 -0.1907 -0.5136 -0.3611 -0.6346 -0.1223

S-342 Disfunción miccional post braquiterapia en el cáncer prostático

T-342 Objectives :

H-342 -0.8363382816314697 Post brachytherapy function in prostate cancer

D-342 -0.8363382816314697 Post brachytherapy function in prostate cancer

P-342 -4.2303 -0.1559 -2.0284 -0.5584 -0.1517 -0.1784 -0.1890 -0.0128 -0.0221

S-244 La tomografía computarizada mostró imágenes con aspecto de embolia pulmonar .

T-244 CT images suggested pulmonary embolism .

H-244 -0.3998290002346039 The computed tomography showed images with pulmonary embolism .

D-244 -0.3998290002346039 The computed tomography showed images with pulmonary embolism .

P-244 -0.9179 -1.2668 -0.1386 -0.1885 -0.3406 -0.0906 -0.8390 -0.0500 -0.0671 -0.0993

S-1075 Consumo de alcohol en la consulta de una sala de emergencia .

T-1075 Alcohol consumption in the emergency room .

H-1075 -0.4401593506336212 Alcohol consumption in the emergency room visits .

D-1075 -0.4401593506336212 Alcohol consumption in the emergency room visits .

P-1075 -0.0470 -0.1664 -0.8801 -0.3831 -1.0671 -0.0174 -1.2277 -0.0822 -0.0905

Trained on: Health, Tested on: Biological (es-en)

-2781 Las dietas de har@@ inas mezcl@@ adas mostraron los mejores resultados en longitud .

T-2781 The mixed meal @-@ based diets showed better production results .

H-2781 -0.6066553592681885 The diets of mixed diets showed the best results in length .

D-2781 -0.6066553592681885 The diets of mixed diets showed the best results in length .

P-2781 -1.9708 -0.1460 -0.5205 -1.3207 -1.2588 -0.7932 -0.6821 -0.2032 -0.1533 -0.4996 -0.0840 -0.1498 -0.1047

S-1315 El intervalo de tiempo promedio entre aportes de presa fue de 7@@ 98 s .

T-1315 The mean time interval between pre@@ y deliveries was 7@@ 98 s .

H-1315 -0.8942710757255554 The average time interval between contributions was 7@@ 98 .

D-1315 -0.8942710757255554 The average time interval between contributions was 7@@ 98 .

P-1315 -0.3406 -0.8814 -0.3741 -0.8798 -0.3730 -3.1739 -1.8025 -0.1505 -0.0582 -1.7010 -0.1020

S-1161 El factor m@@ ór@@ fico para la especie fue de 0.7@@ 60@@ 41 .

T-1161 The form @-@ factor for the species was of 0.7@@ 60@@ 41 .

H-1161 -0.6691439747810364 The morphic factor for the species of the species was 0.7@@ 41 .

D-1161 -0.6691439747810364 The morphic factor for the species of the species was 0.7@@ 41 .

P-1161 -0.5770 -1.9056 -0.9096 -0.2214 -0.1486 -0.8225 -0.8401 -0.7356 -1.0623 -0.0298 -1.6293 -0.2767 -0.0661 -0.1434

S-1051 El análisis de los resultados se hizo mediante una prueba t pare@@ ada .

T-1051 The analysis of results was done by a paired t @-@ test .

H-1051 -0.5913573503494263 The analysis of the results was performed using a paired t @-@ test .

D-1051 -0.5913573503494263 The analysis of the results was performed using a paired t @-@ test .

P-1051 -0.6477 -1.3748 -0.1423 -0.5766 -0.0618 -0.5341 -2.1491 -0.6055 -0.5726 -0.0360 -0.4455 -1.4269 -0.0169 -0.1689 -0.1117

Trained on: Biological, Tested on: Health (es-en)

S-3484 Un paciente HIV positivo falleció debido a epidermolisis .

T-3484 One HIV positive patient died of epidermolysis .

H-3484 -0.6549513339996338 HIV positive patient died due to epidermolysis .

D-3484 -0.6549513339996338 HIV positive patient died due to epidermolysis .

P-3484 -0.2747 -0.6397 -1.1379 -0.5288 -0.4474 -0.1497 -3.0308 -0.1033 -0.6284 -0.1305 -0.1334

S-3556 Este estudio tiene por objetivo presentar una revisión sobre el asunto .

T-3556 This study aimed at reviewing this subject .

H-3556 -0.5915473699569702 This study aims to present a review on the matter .

D-3556 -0.5915473699569702 This study aims to present a review on the matter .

P-3556 -0.7122 -0.3697 -0.6416 -0.6107 -0.5905 -0.1485 -0.1984 -1.1848 -0.4627 -1.4014 -0.6620 -0.1160

S-4888 Los valores plasmáticos del sodio y del potasio no se alteraron .

T-4888 Plasma sodium and potassium were not changed .

H-4888 -0.38854897022247314 Plasma values of sodium and potassium were not altered .

D-4888 -0.38854897022247314 Plasma values of sodium and potassium were not altered .

P-4888 -0.9361 -1.3466 -0.8944 -0.2965 -0.0703 -0.1775 -0.0474 -0.1599 -0.3272 -0.1757 -0.1317 -0.0993

S-11 Indicaciones médicas y quirúrgicas de los potenciales evocados .

T-11 Medical and surgical indications of evoked potentials .

H-11 -1.183539867401123 Dental and surgical indicators of the potential evoking .

D-11 -1.183539867401123 Dental and surgical indicators of the potential evoking .

P-11 -3.3431 -0.3797 -0.0375 -2.9420 -0.2289 -2.6478 -0.4204 -0.1158 -1.3230 -1.9889 -0.6540 -0.1213

Trained on: Biological, Tested on: Biological (es-en)

S-2258 Isla Fuerte es un complejo arrecifal holocénico parcialmente emergido .

T-2258 Isla Fuerte is a partially emerged Holocene reef complex .

H-2258 -0.5470016598701477 Isla Fuerte is a partial reef complex that emerged .

D-2258 -0.5470016598701477 Isla Fuerte is a partial reef complex that emerged .

P-2258 -0.2208 -0.1517 -0.0103 -0.1791 -0.5054 -0.1410 -0.5372 -0.0172 -3.8636 -0.0996 -0.7024 -0.1356

S-513 Se registraron seis especies en la comunidad de Cerro Tule .

T-513 Six species of carnivorous were recorded .

H-513 -0.965829074382782 We recorded six species in the Cerro El Density community .

D-513 -0.965829074382782 We recorded six species in the Cerro El Density community .

P-513 -1.2235 -0.4278 -0.5862 -0.2635 -0.7154 -1.2146 -0.1618 -1.6539 -4.5431 -0.4244 -0.2450 -0.1308

S-1573 Meantodo para montar permanente de huevos de helmintos enteroparasitos .

T-1573 Definitive preservation of helminthic eggs .

H-1573 -1.3171203136444092 Meant while for permanent culture of enteroparasites were observed .

D-1573 -1.3171203136444092 Meant while for permanent culture of enteroparasites were observed .

P-1573 -1.7694 -0.6177 -0.4050 -1.4824 -1.9134 -3.8539 -0.6741 -0.7958 -1.4900 -0.9137 -2.1089 -1.6854 -0.5953 -0.1348

S-1520 Sin embargo , falleció debido a neumonía intrahospitalaria .

T-1520 However , he died due to intrahospital pneumonia .

H-1520 -1.145051121711731 However , died due to intrahospital stay .

D-1520 -1.145051121711731 However , died due to intrahospital stay .

P-1520 -0.5008 -0.1761 -3.0102 -0.5419 -0.1582 -3.2985 -0.6363 -2.8702 -0.1446 -0.1138

In []: