Partial Annotation Learning for Biomedical Entity Recognition: Supplementary Materials

This supplementary material provides more experimental details and results. And due to page limit, more details such as full experimental results are exposed at our GitHub Page.

1. SUPPLEMENTARY MATERIALS

A. Dataset Distribution

Fig. S1 shows the distribution of the number of tokens in sentences among the training corpora for five entity types and the figure has used a base-10 logarithmic transformation on the x axis.

B. Partial Annotation Scenarios

The pseudo-code for RAR algorithm is shown in Algorithm 1.

Algorithm 1 Remove Annotations Randomly (RAR)

Require: r for the removal ratio; Train_Instances for the instance list in the original training set, in which each instance is a collection of (TOKEN, LABEL) pairs, formatted as Instance(TOKEN, LABEL); Entity_Spans for entity span list in the original training set, in which each entity annotation is formatted as Span(NAME, LABEL, START, END, Ins_ID))

Ensure: Partial_Instances

```
Num_Removal ← round(r * length(Entity_Spans))
flag ← 0
Shuffle Entity_Spans
for each entity ∈ Entity_Spans do
    if flag < Num_Removal then
        Train_Instances[Ins_ID][START : END].LABEL ← "O"
        flag ← flag + 1
    end if
end for
Partial_Instances ← Train_Instances
```

The pseudo-code for RSFR algorithm is shown in Algorithm 2.

C. Evaluation metrics

In named entity recognition, we concentrate on entity-level evaluation instead of token-level evaluation, which means that the model performance is measured by its ability to correctly identify the boundary of entities and classify them in their category, rather than evaluating individual tokens in isolation. This makes entity-level evaluation a more accurate representation of the model's real-world performance.

To evaluate the performance of a named entity recognition model, three standard machine learning evaluation indicators are typically used: precision (P), recall (R), and F1-score (F1). Precision measures the proportion of entities that the model correctly identified and classified out of all the entities it predicted. Recall measures the proportion of entities that the model correctly identified and classified among all the golden truth entities. F1-score combines both precision and recall into a single metric, representing a balance between the two. These metrics provide a comprehensive evaluation of the model's performance, allowing for a detailed analysis of its strengths and weaknesses.

D. Experimental settings

For the baseline models, we follow the officially released implementation from the authors and made a few modifications to fit our tasks. All experiments are implemented on an NVIDIA A100 GPU. For models based on PubMedBERT pre-trained language model, we use the Huggingface

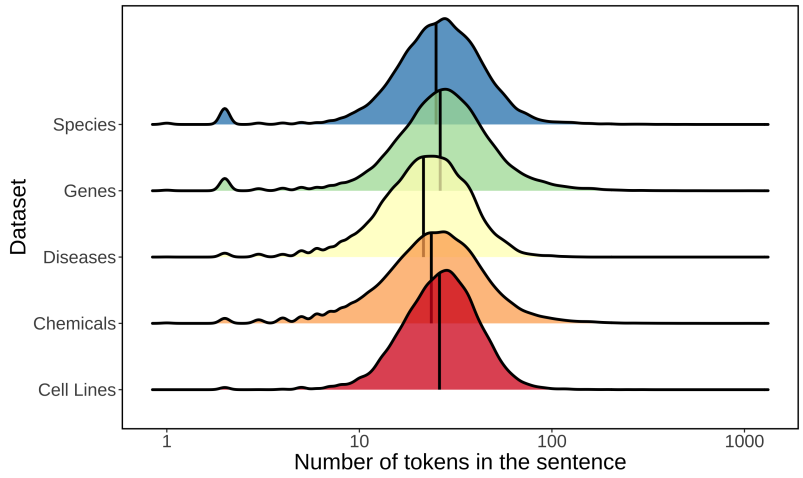

Fig. S1. Distribution of the number of tokens in sentences among the training corpora.

Algorithm 2 Remove All Annotations for Randomly Selected Surface Forms (RSFR)

Require: r for the removal ratio; Train_Instances for the instance list in the original training set, in which each instance is a collection of (TOKEN, LABEL) pairs, formatted as Instance(TOKEN, LABEL); Entity_Spans for entity span list in the original training set, in which each entity annotation is formatted as Span(NAME, LABEL, START, END, Ins_ID)); Removal_Name for an empty set to store the removal surface forms

Ensure: Partial_Instances

Num_Removal $\leftarrow$ round($r *$ length(Entity_Spans)) $* 0.99$
$flag \leftarrow 0$
Shuffle Entity_Spans
for each $entity \in$ Entity_Spans **do**
  Surface_Form $\leftarrow$ $entity$.NAME
  TYPE $\leftarrow$ $entity$.LABEL
  if $flag <$ Num_Removal **and** Surface_Form $\notin$ Removal_Name **then**
    Add Surface_Form to Removal_Name
    for each $span \in$ Entity_Spans **do**
      if $span$.NAME $=$ Surface_Form **and** $span$.LABEL $=$ TYPE **then**
        Ins_ID $\leftarrow$ $span$.Ins_ID
        START $\leftarrow$ $span$.START
        END $\leftarrow$ $span$.END
        LABEL $\leftarrow$ $span$.LABEL
        Train_Instances[Ins_ID][START : END].LABEL $\leftarrow$ "O"
        $flag \leftarrow flag + 1$
      end if
    end for
  end if
end for
Partial_Instances $\leftarrow$ Train_Instances

implementation of PubMedBERT [1]. As shown in Fig. S1, majority of sentence lengths are less than 100, so we set the maximum length of the sentence as 128 for the pre-trained transformer models to ensure optimal performance.

For the BiLSTM-Partial-CRF model, we use the Pytorchimplementation[2] and employ 100-dimensional pre-trained word embeddings GloVe to initialize the lookup table. We train the model for 100 epochs using the stochastic gradient descent optimizer on all compiled datasets for five entity types. We use grid search to tune learning rate in values {0.1, 0.05, 0.001} for each entity type, and results showed that learning rate of 0.001 achieved the best model performance for all entity types. So the learning rate is set to 0.001, and the batch size varies among different entity types due to memory constraints. The remaining hyperparameters are left as their default value in the authors' implementations.

For the PubMedBERT-based models including the PubMedBERT tagger, the EER-PubMedBERT model, and our proposed TS-PubMedBERT-Partial-CRF model, training is done by mini-batch stochastic gradient descent (SGD) with exponential learning rate decay and the initial learning rate is set to $5e-5$. The model is trained for 50 epochs for the entity types of diseases, species, and cell lines, and 20 epochs for the entity types of chemicals and genes with early stopping. For the EER-PubMedBERT model, the default value of the hyperparameter expected entity ratio is 0.25, which can't make the model converge. So, we use grid search to tune this hyperparameter for values in {0.01, 0.05, 0.15, 0.25, 0.5, 0.75}. We find that setting the expected entity ratio as 0.01 achieves the best model performance for all five entity types. For the TS-PubMedBERT-Partial-CRF model, to keep consistent with the baseline models, especially EER-PubMedBERT-CRF model for a fair comparison, we use the same hyperparameter expected entity ratio, uncertainty margin γ, and also the same balancing coefficient of EER loss λ_B. We only tune the begging step of self-training, the balancing coefficient λ_O in overall EER loss, and the coefficient λ_S, and then report the best performance. Note that in the hyperparameter searching process, we select the hyperparameters based on the best performance on the development set of the fully annotated corpora and apply these hyperparameters to the partially annotated corpora of the corresponding entity type.

It should be also noted that selecting a single set of hyperparameters to tune the model may not be the optimal choice, as each compiled dataset may have a distribution that differs from the fully annotated dataset. Ideally, each compiled dataset should be tuned separately. However, given the size of our experimental setup, which consists of 1,800 experiments, it is not feasible to tune each dataset separately. To gain a comprehensive understanding of the comparison between partial annotation learning methods and full annotation learning methods, we have opted for a compromise approach, in which we apply one set of hyperparameters from the corresponding model to all combinations of entity removal rate and entity removal scheme for the same entity type. Nevertheless, model parameters can be further tuned to achieve even higher performance.

E. Experimental Results

To provide detailed insights into the model's performance on each entity type, we also record the corresponding F1-score, precision, and recall, erosion rate and misguidance rate, as shown in Fig. S2, Fig. S3, Fig. S4, Fig. S5 and Fig. S6 respectively. The layouts of Fig. S3, Fig. S4, Fig. S5 and Fig. S6 are the same as that of Fig. S2, except for the vertical axis, denoting precision, recall, erosion rate and misguidance rate respectively. Table. S1 presents the full results.

Table S1. Main Results averaged over all random seeds

Dataset	Scheme	Rate	Model	P	R	F1
CellLine	RAR	0.1	BiLSTM-Partial-CRF	64.22±1.18	63.97±1.70	64.08±1.12
CellLine	RAR	0.1	EER-PubMedBERT	51.55±1.44	82.09±0.51	63.32±1.17
CellLine	RAR	0.1	PubMedBERT	71.06±1.23	67.39±1.85	69.15±0.84
CellLine	RAR	0.1	TS-PubMedBERT-Partial-CRF	49.31±11.00	80.56±3.64	60.13±8.21
CellLine	RAR	0.2	BiLSTM-Partial-CRF	63.15±1.52	61.65±1.82	62.36±0.87
CellLine	RAR	0.2	EER-PubMedBERT	48.92±3.01	81.43±0.72	61.06±2.24

[1] https://huggingface.co/microsoft/BiomedNLP-PubMedBERT-base-uncased-abstract-fulltext
[2] https://github.com/allanj/ner_incomplete_annotation

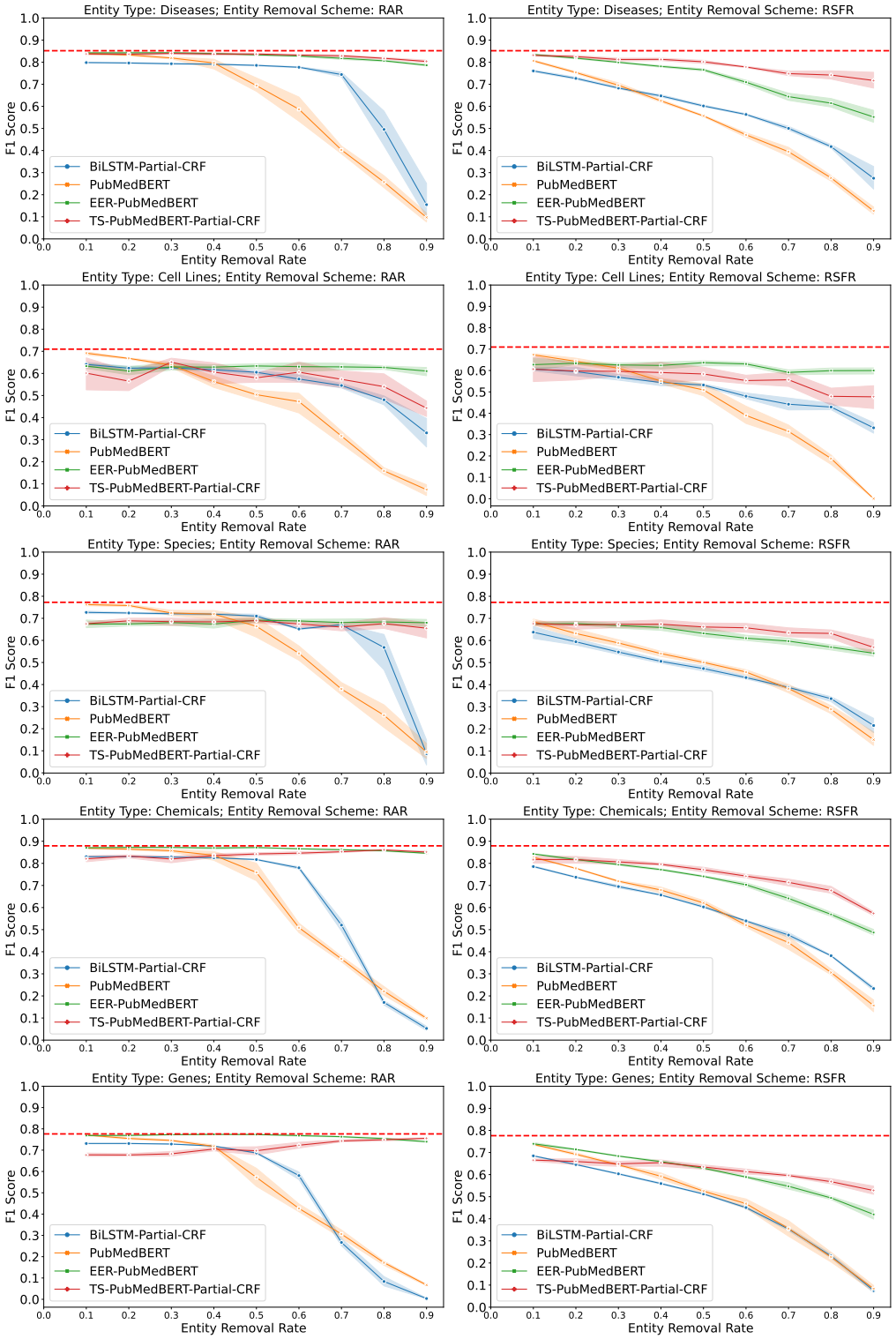

Fig. S2. The F1-score on the test set. The whole figure contains 10 (5 rows × 2 columns) subplots, where each row of subplots reflects the curves of each entity type and each column of subplots reflects the curves of each entity removal scheme. In each subplot, the horizontal axis denotes the entity removal rate, the vertical axis denotes the F1-score, and the red dotted line denotes the upper bound F1-score, which is the F1-score of PubMedBERT tagger on fully annotated dataset.

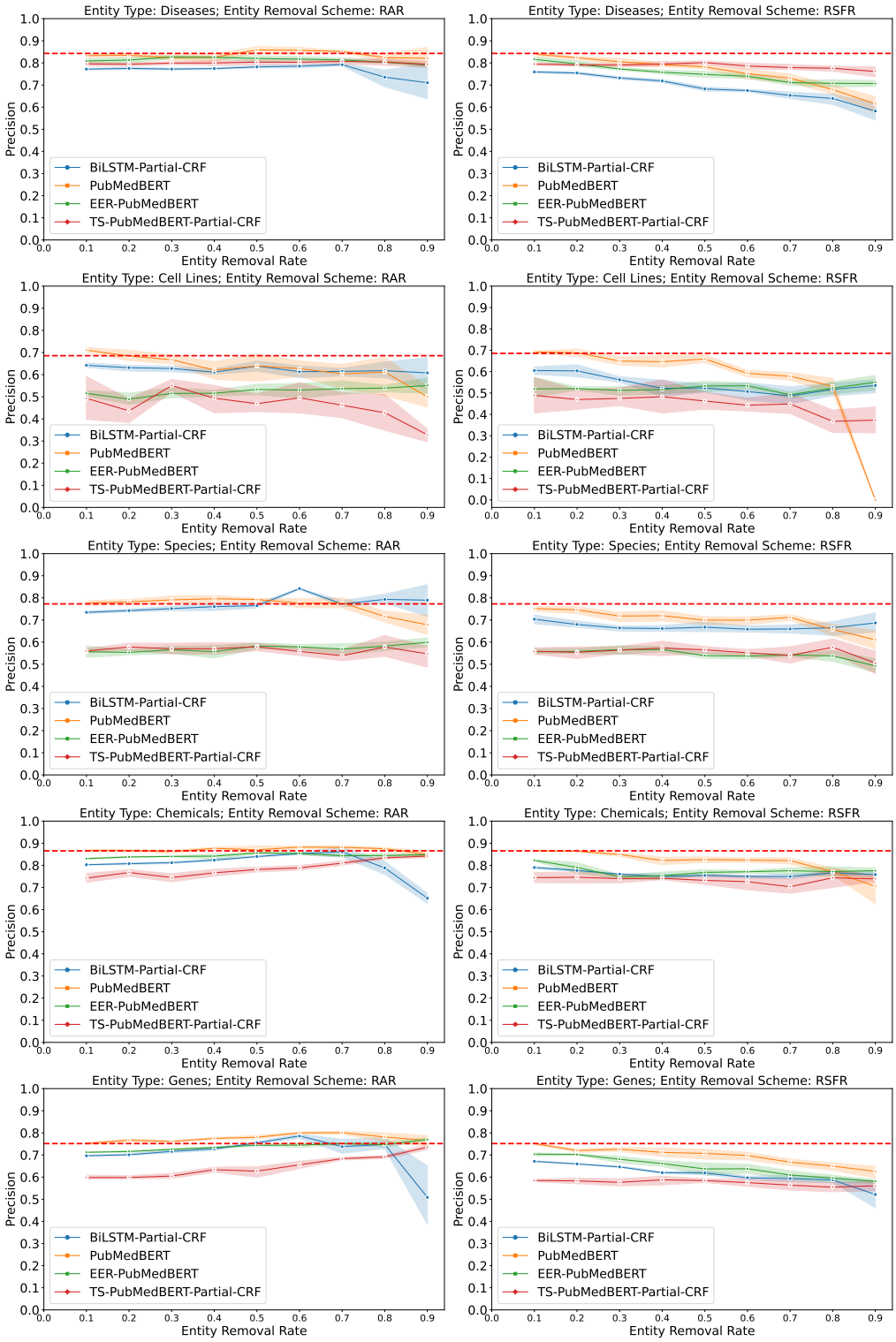

Fig. S3. The Precision on the test set

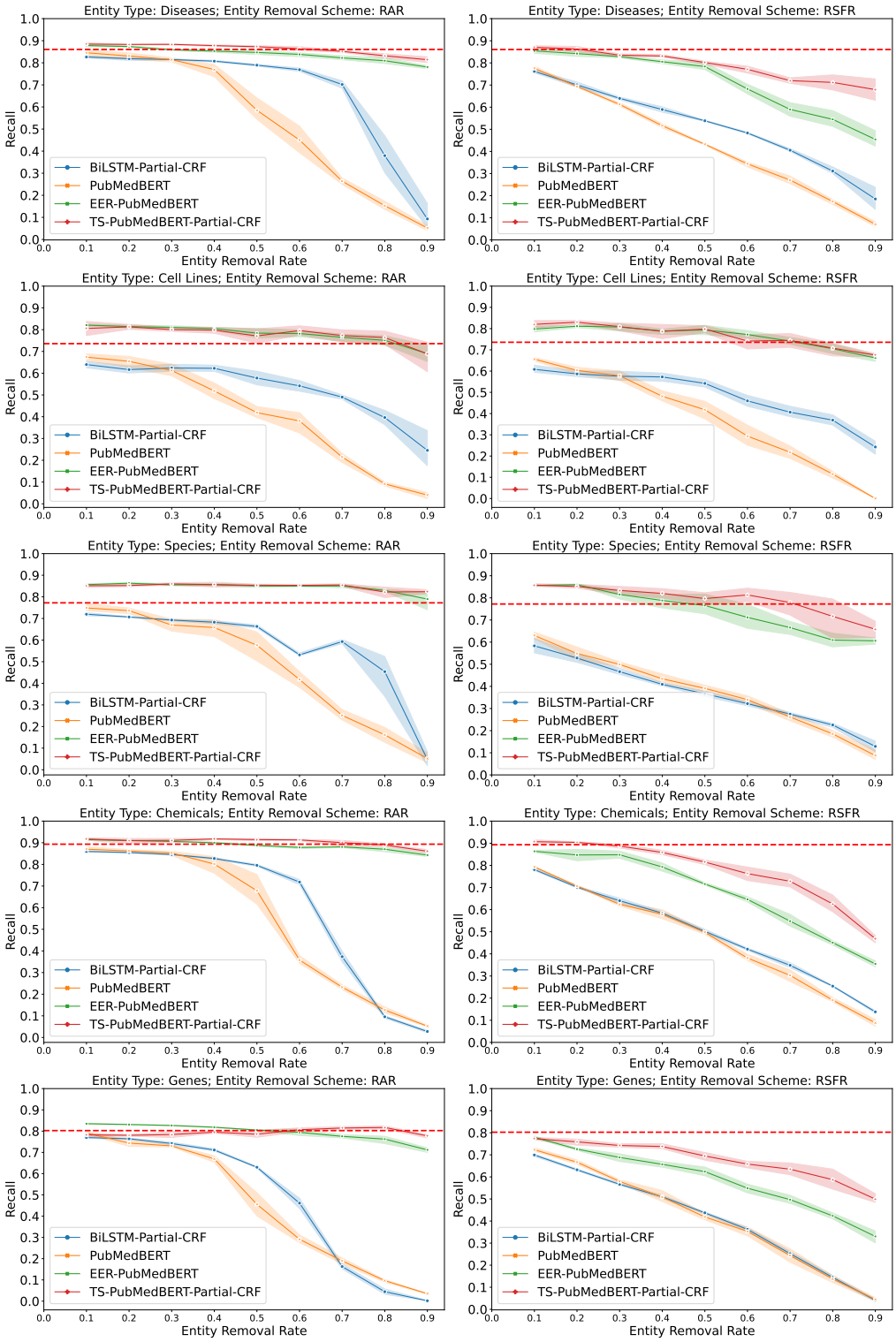

Fig. S4. The Recall on the test set

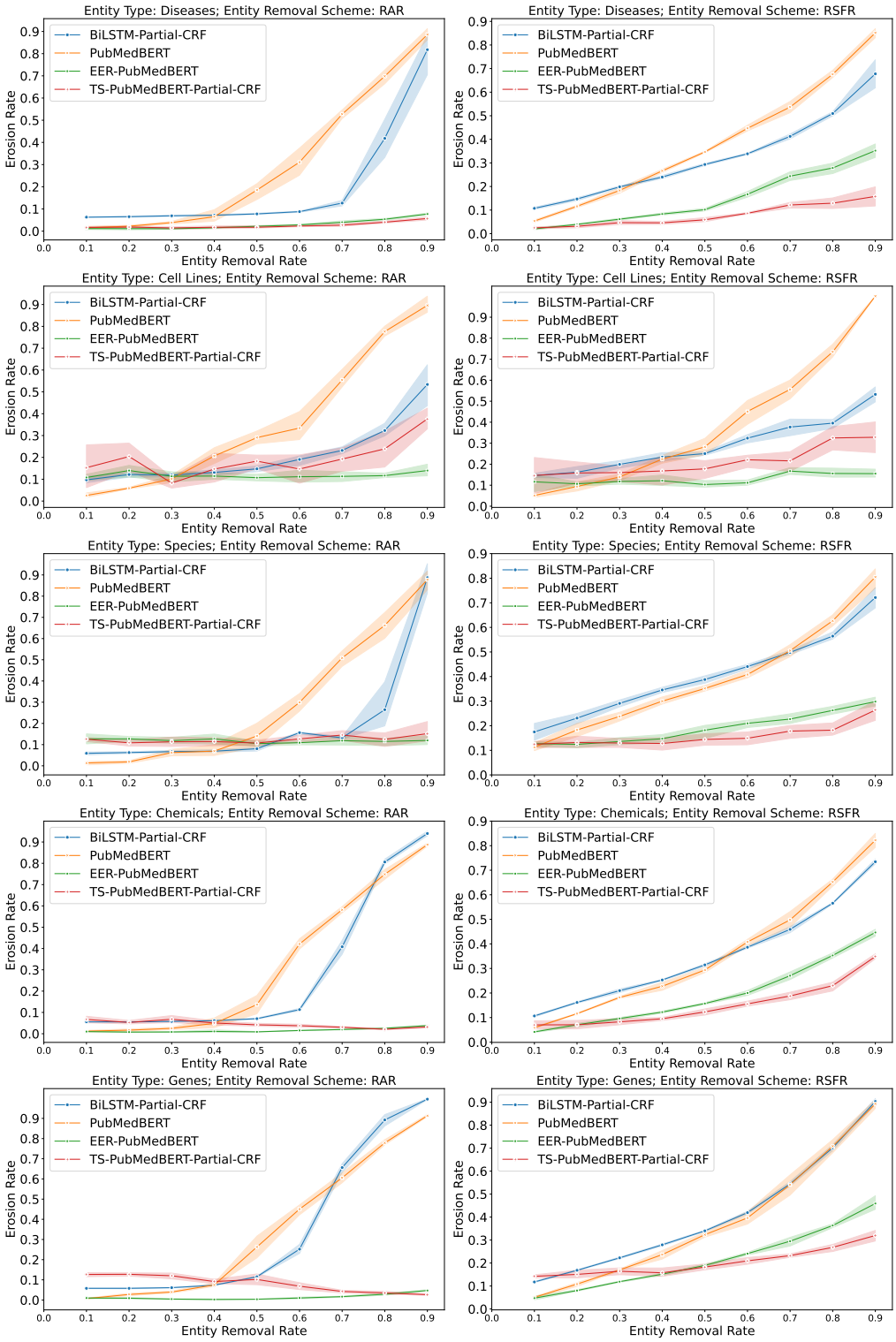

Fig. S5. The Erosion rate on the test set

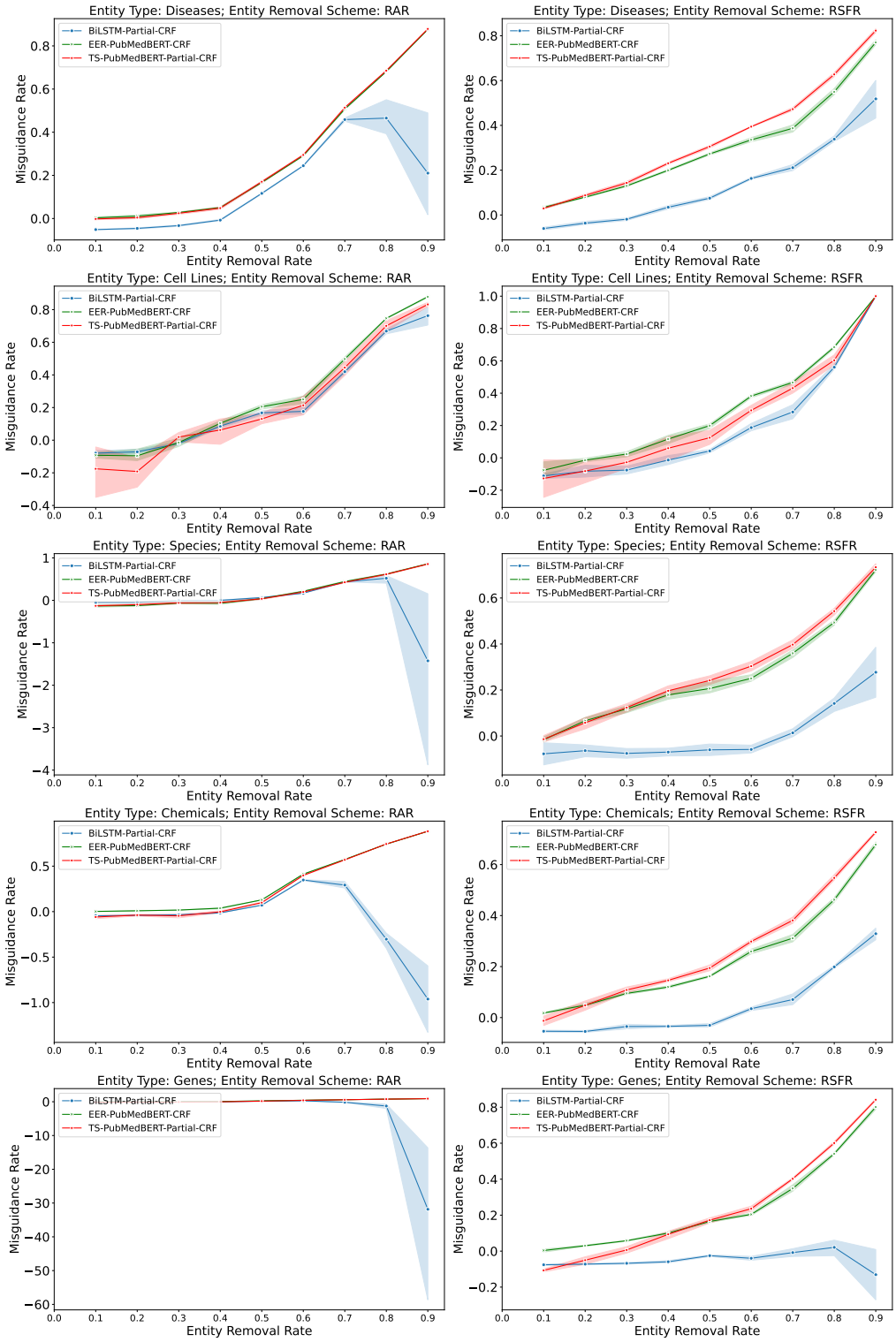

Fig. S6. The Misguidance rate compared to PubMedBERT NER tagger on the test set

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Dataset	Scheme	Rate	Model	P	R	F1
CellLine	RAR	0.2	PubMedBERT	68.45±2.75	65.45±2.83	66.79±0.30
CellLine	RAR	0.2	TS-PubMedBERT-Partial-CRF	43.65±6.05	81.29±1.30	56.50±4.93
CellLine	RAR	0.3	BiLSTM-Partial-CRF	62.78±1.43	62.39±1.79	62.54±0.59
CellLine	RAR	0.3	EER-PubMedBERT	51.51±2.67	81.01±0.88	62.92±1.81
CellLine	RAR	0.3	PubMedBERT	66.73±2.11	61.24±2.94	63.79±1.39
CellLine	RAR	0.3	TS-PubMedBERT-Partial-CRF	55.03±3.35	80.02±1.15	65.12±2.10
CellLine	RAR	0.4	BiLSTM-Partial-CRF	61.13±1.39	62.24±1.75	61.66±0.96
CellLine	RAR	0.4	EER-PubMedBERT	51.59±1.59	80.48±0.78	62.86±1.20
CellLine	RAR	0.4	PubMedBERT	62.10±4.53	51.84±4.23	56.33±3.09
CellLine	RAR	0.4	TS-PubMedBERT-Partial-CRF	49.36±7.13	79.78±1.61	60.58±5.24
CellLine	RAR	0.5	BiLSTM-Partial-CRF	63.88±2.59	57.77±3.60	60.51±1.07
CellLine	RAR	0.5	EER-PubMedBERT	53.32±2.62	78.39±2.41	63.38±1.19
CellLine	RAR	0.5	PubMedBERT	63.95±6.72	41.88±2.81	50.36±2.51
CellLine	RAR	0.5	TS-PubMedBERT-Partial-CRF	46.87±4.71	77.12±3.79	58.01±2.53
CellLine	RAR	0.6	BiLSTM-Partial-CRF	61.34±3.06	54.18±2.74	57.45±1.91
CellLine	RAR	0.6	EER-PubMedBERT	53.02±3.65	78.22±1.77	63.07±2.12
CellLine	RAR	0.6	PubMedBERT	62.71±4.08	38.07±5.34	47.26±5.17
CellLine	RAR	0.6	TS-PubMedBERT-Partial-CRF	49.54±7.72	79.57±2.43	60.56±5.13
CellLine	RAR	0.7	BiLSTM-Partial-CRF	61.45±1.90	49.02±1.07	54.53±1.23
CellLine	RAR	0.7	EER-PubMedBERT	53.66±3.49	76.50±1.89	62.96±1.82
CellLine	RAR	0.7	PubMedBERT	60.37±6.56	21.46±2.42	31.64±3.39
CellLine	RAR	0.7	TS-PubMedBERT-Partial-CRF	46.17±6.71	77.30±3.07	57.33±4.43
CellLine	RAR	0.8	BiLSTM-Partial-CRF	61.81±4.21	39.63±3.86	48.05±2.42
CellLine	RAR	0.8	EER-PubMedBERT	53.92±1.76	75.10±2.39	62.72±0.83
CellLine	RAR	0.8	PubMedBERT	61.15±10.55	9.16±1.03	15.89±1.84
CellLine	RAR	0.8	TS-PubMedBERT-Partial-CRF	42.79±9.23	76.40±3.44	54.01±6.79
CellLine	RAR	0.9	BiLSTM-Partial-CRF	60.80±8.15	24.55±9.29	33.08±7.46
CellLine	RAR	0.9	EER-PubMedBERT	55.10±3.95	69.00±4.33	61.06±2.20
CellLine	RAR	0.9	PubMedBERT	50.00±5.39	4.02±1.57	7.38±2.80
CellLine	RAR	0.9	TS-PubMedBERT-Partial-CRF	32.82±3.21	68.87±7.73	44.28±3.86
CellLine	RSFR	0.1	BiLSTM-Partial-CRF	60.51±2.01	60.82±1.88	60.61±0.85
CellLine	RSFR	0.1	EER-PubMedBERT	51.92±5.17	79.81±1.58	62.73±3.42
CellLine	RSFR	0.1	PubMedBERT	69.21±0.55	65.59±1.05	67.35±0.78
CellLine	RSFR	0.1	TS-PubMedBERT-Partial-CRF	48.90±9.19	82.01±2.06	60.59±6.81
CellLine	RSFR	0.2	BiLSTM-Partial-CRF	60.35±3.21	58.69±1.53	59.49±2.31
CellLine	RSFR	0.2	EER-PubMedBERT	52.06±0.92	81.12±0.69	63.42±0.76
CellLine	RSFR	0.2	PubMedBERT	68.90±2.11	60.32±1.84	64.31±1.70

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Dataset	Scheme	Rate	Model	P	R	F1
CellLine	RSFR	0.2	TS-PubMedBERT-Partial-CRF	46.94±5.29	83.02±0.99	59.75±4.14
CellLine	RSFR	0.3	BiLSTM-Partial-CRF	56.19±1.45	57.56±2.49	56.84±1.44
CellLine	RSFR	0.3	EER-PubMedBERT	51.22±2.16	80.76±1.87	62.62±1.14
CellLine	RSFR	0.3	PubMedBERT	64.95±2.25	57.82±2.60	61.10±1.25
CellLine	RSFR	0.3	TS-PubMedBERT-Partial-CRF	47.47±4.79	80.93±2.06	59.62±3.01
CellLine	RSFR	0.4	BiLSTM-Partial-CRF	52.16±4.41	57.24±2.21	54.38±1.68
CellLine	RSFR	0.4	EER-PubMedBERT	51.59±2.15	78.89±1.59	62.37±1.95
CellLine	RSFR	0.4	PubMedBERT	64.64±3.03	48.13±2.75	55.06±1.50
CellLine	RSFR	0.4	TS-PubMedBERT-Partial-CRF	48.25±8.80	78.68±3.93	59.06±5.43
CellLine	RSFR	0.5	BiLSTM-Partial-CRF	52.38±2.20	54.21±1.93	53.21±0.65
CellLine	RSFR	0.5	EER-PubMedBERT	53.30±2.71	79.36±2.53	63.66±1.37
CellLine	RSFR	0.5	PubMedBERT	65.92±2.01	41.80±4.65	50.93±3.09
CellLine	RSFR	0.5	TS-PubMedBERT-Partial-CRF	46.24±4.58	79.79±1.76	58.37±3.35
CellLine	RSFR	0.6	BiLSTM-Partial-CRF	50.67±4.41	45.98±2.70	47.98±1.55
CellLine	RSFR	0.6	EER-PubMedBERT	53.37±1.79	77.22±2.11	63.07±0.99
CellLine	RSFR	0.6	PubMedBERT	59.20±1.71	29.37±5.36	38.96±4.66
CellLine	RSFR	0.6	TS-PubMedBERT-Partial-CRF	44.27±3.38	74.14±3.88	55.29±2.52
CellLine	RSFR	0.7	BiLSTM-Partial-CRF	48.62±4.46	40.64±2.81	44.23±3.19
CellLine	RSFR	0.7	EER-PubMedBERT	49.20±1.51	74.09±1.69	59.11±1.32
CellLine	RSFR	0.7	PubMedBERT	57.81±2.11	21.80±3.28	31.51±3.50
CellLine	RSFR	0.7	TS-PubMedBERT-Partial-CRF	44.87±5.57	74.46±3.74	55.66±3.70
CellLine	RSFR	0.8	BiLSTM-Partial-CRF	51.66±3.37	36.91±2.68	42.91±1.67
CellLine	RSFR	0.8	EER-PubMedBERT	52.26±3.25	70.54±2.56	59.91±1.65
CellLine	RSFR	0.8	PubMedBERT	53.19±4.13	11.52±1.82	18.82±2.52
CellLine	RSFR	0.8	TS-PubMedBERT-Partial-CRF	36.74±6.01	70.80±3.61	47.91±4.46
CellLine	RSFR	0.9	BiLSTM-Partial-CRF	53.54±3.52	24.26±3.24	33.18±3.00
CellLine	RSFR	0.9	EER-PubMedBERT	55.06±3.73	66.18±1.85	59.97±1.58
CellLine	RSFR	0.9	PubMedBERT	0.00±0.00	0.00±0.00	0.00±0.00
CellLine	RSFR	0.9	TS-PubMedBERT-Partial-CRF	37.33±7.12	67.57±0.78	47.68±5.98
Chemical	RAR	0.1	BiLSTM-Partial-CRF	80.29±0.15	85.96±0.07	83.03±0.09
Chemical	RAR	0.1	EER-PubMedBERT	83.06±0.35	91.43±0.11	87.04±0.15
Chemical	RAR	0.1	PubMedBERT	86.71±0.53	87.02±1.18	86.86±0.33
Chemical	RAR	0.1	TS-PubMedBERT-Partial-CRF	74.21±2.22	91.75±0.71	82.04±1.55
Chemical	RAR	0.2	BiLSTM-Partial-CRF	80.78±0.51	85.47±0.31	83.06±0.17
Chemical	RAR	0.2	EER-PubMedBERT	83.81±0.25	91.01±0.12	87.26±0.12
Chemical	RAR	0.2	PubMedBERT	86.71±0.47	86.20±0.76	86.45±0.53
Chemical	RAR	0.2	TS-PubMedBERT-Partial-CRF	76.79±1.75	91.02±1.41	83.28±0.86

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Dataset	Scheme	Rate	Model	P	R	F1
Chemical	RAR	0.3	BiLSTM-Partial-CRF	81.21±0.45	84.57±0.18	82.85±0.17
Chemical	RAR	0.3	EER-PubMedBERT	84.05±0.28	90.61±0.22	87.20±0.11
Chemical	RAR	0.3	PubMedBERT	86.17±0.80	85.28±1.09	85.71±0.58
Chemical	RAR	0.3	TS-PubMedBERT-Partial-CRF	74.50±2.23	91.11±1.03	81.96±1.67
Chemical	RAR	0.4	BiLSTM-Partial-CRF	82.37±0.56	82.72±0.40	82.54±0.10
Chemical	RAR	0.4	EER-PubMedBERT	84.18±1.43	90.00±0.46	86.98±0.63
Chemical	RAR	0.4	PubMedBERT	87.71±0.60	80.15±4.39	83.68±2.34
Chemical	RAR	0.4	TS-PubMedBERT-Partial-CRF	76.63±1.83	91.77±0.33	83.51±1.04
Chemical	RAR	0.5	BiLSTM-Partial-CRF	84.00±0.34	79.56±0.53	81.72±0.23
Chemical	RAR	0.5	EER-PubMedBERT	85.61±0.38	88.77±0.50	87.16±0.10
Chemical	RAR	0.5	PubMedBERT	87.04±1.98	67.83±7.83	75.92±4.42
Chemical	RAR	0.5	TS-PubMedBERT-Partial-CRF	78.13±1.30	91.45±0.58	84.26±0.66
Chemical	RAR	0.6	BiLSTM-Partial-CRF	85.31±0.64	71.83±1.41	77.98±0.58
Chemical	RAR	0.6	EER-PubMedBERT	85.41±0.57	87.82±0.59	86.59±0.12
Chemical	RAR	0.6	PubMedBERT	88.26±0.73	35.79±2.15	50.89±2.18
Chemical	RAR	0.6	TS-PubMedBERT-Partial-CRF	78.87±1.27	91.31±0.35	84.62±0.72
Chemical	RAR	0.7	BiLSTM-Partial-CRF	86.15±2.61	37.35±2.89	52.04±2.96
Chemical	RAR	0.7	EER-PubMedBERT	84.37±0.59	88.08±0.29	86.18±0.21
Chemical	RAR	0.7	PubMedBERT	88.14±0.86	23.23±1.17	36.75±1.47
Chemical	RAR	0.7	TS-PubMedBERT-Partial-CRF	81.00±1.11	90.04±1.57	85.26±0.40
Chemical	RAR	0.8	BiLSTM-Partial-CRF	78.85±3.34	9.57±0.70	17.06±1.17
Chemical	RAR	0.8	EER-PubMedBERT	84.46±0.95	87.01±1.37	85.70±0.25
Chemical	RAR	0.8	PubMedBERT	87.55±0.64	12.68±1.58	22.11±2.37
Chemical	RAR	0.8	TS-PubMedBERT-Partial-CRF	83.42±0.69	88.97±0.57	86.10±0.22
Chemical	RAR	0.9	BiLSTM-Partial-CRF	65.16±2.69	2.76±0.60	5.29±1.10
Chemical	RAR	0.9	EER-PubMedBERT	84.85±0.45	84.30±0.85	84.57±0.21
Chemical	RAR	0.9	PubMedBERT	84.96±1.72	5.25±0.37	9.89±0.67
Chemical	RAR	0.9	TS-PubMedBERT-Partial-CRF	84.21±0.85	86.07±0.89	85.12±0.55
Chemical	RSFR	0.1	BiLSTM-Partial-CRF	79.02±0.56	78.09±0.64	78.55±0.33
Chemical	RSFR	0.1	EER-PubMedBERT	82.28±0.52	86.37±0.42	84.27±0.26
Chemical	RSFR	0.1	PubMedBERT	86.58±0.23	79.26±0.44	82.76±0.31
Chemical	RSFR	0.1	TS-PubMedBERT-Partial-CRF	74.46±2.59	90.70±0.94	81.76±1.70
Chemical	RSFR	0.2	BiLSTM-Partial-CRF	77.71±0.42	70.14±0.46	73.73±0.28
Chemical	RSFR	0.2	EER-PubMedBERT	79.10±2.55	84.71±2.90	81.72±0.67
Chemical	RSFR	0.2	PubMedBERT	86.37±0.25	70.68±0.30	77.74±0.19
Chemical	RSFR	0.2	TS-PubMedBERT-Partial-CRF	74.62±2.89	90.38±0.29	81.72±1.77
Chemical	RSFR	0.3	BiLSTM-Partial-CRF	76.01±0.32	64.02±1.32	69.49±0.71

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Dataset	Scheme	Rate	Model	P	R	F1
Chemical	RSFR	0.3	EER-PubMedBERT	74.81±1.12	84.78±1.83	79.46±0.46
Chemical	RSFR	0.3	PubMedBERT	84.93±1.05	62.39±0.98	71.92±0.44
Chemical	RSFR	0.3	TS-PubMedBERT-Partial-CRF	74.00±2.33	88.73±0.90	80.67±1.21
Chemical	RSFR	0.4	BiLSTM-Partial-CRF	75.01±1.08	58.42±0.91	65.67±0.26
Chemical	RSFR	0.4	EER-PubMedBERT	75.27±1.92	79.29±2.13	77.18±0.44
Chemical	RSFR	0.4	PubMedBERT	82.22±1.92	57.94±2.30	67.93±1.58
Chemical	RSFR	0.4	TS-PubMedBERT-Partial-CRF	74.15±0.72	85.84±1.10	79.56±0.62
Chemical	RSFR	0.5	BiLSTM-Partial-CRF	75.49±0.73	50.19±1.00	60.28±0.49
Chemical	RSFR	0.5	EER-PubMedBERT	76.85±1.29	71.56±0.64	74.10±0.35
Chemical	RSFR	0.5	PubMedBERT	82.61±1.41	49.76±1.05	62.11±1.10
Chemical	RSFR	0.5	TS-PubMedBERT-Partial-CRF	73.23±2.29	81.50±1.19	77.11±1.23
Chemical	RSFR	0.6	BiLSTM-Partial-CRF	74.99±0.75	42.14±0.62	53.96±0.42
Chemical	RSFR	0.6	EER-PubMedBERT	77.12±0.66	64.64±1.34	70.32±0.96
Chemical	RSFR	0.6	PubMedBERT	82.38±1.20	38.11±1.66	52.08±1.35
Chemical	RSFR	0.6	TS-PubMedBERT-Partial-CRF	72.62±3.65	76.28±3.28	74.24±0.99
Chemical	RSFR	0.7	BiLSTM-Partial-CRF	74.98±1.32	34.84±1.33	47.55±1.26
Chemical	RSFR	0.7	EER-PubMedBERT	77.57±1.57	54.80±2.87	64.15±1.53
Chemical	RSFR	0.7	PubMedBERT	82.13±1.59	30.29±2.97	44.16±3.22
Chemical	RSFR	0.7	TS-PubMedBERT-Partial-CRF	70.35±3.82	72.82±3.51	71.41±1.61
Chemical	RSFR	0.8	BiLSTM-Partial-CRF	76.64±0.54	25.43±0.24	38.19±0.28
Chemical	RSFR	0.8	EER-PubMedBERT	77.21±2.53	45.08±1.18	56.90±1.05
Chemical	RSFR	0.8	PubMedBERT	77.16±1.82	19.09±1.08	30.60±1.49
Chemical	RSFR	0.8	TS-PubMedBERT-Partial-CRF	74.37±4.58	62.55±4.15	67.72±1.84
Chemical	RSFR	0.9	BiLSTM-Partial-CRF	75.85±1.63	13.81±0.68	23.35±0.93
Chemical	RSFR	0.9	EER-PubMedBERT	77.61±1.38	35.46±1.44	48.66±1.45
Chemical	RSFR	0.9	PubMedBERT	70.53±7.73	8.83±1.78	15.64±2.90
Chemical	RSFR	0.9	TS-PubMedBERT-Partial-CRF	73.89±1.53	46.85±1.84	57.30±1.02
Disease	RAR	0.1	BiLSTM-Partial-CRF	77.19±0.37	82.62±0.56	79.81±0.12
Disease	RAR	0.1	EER-PubMedBERT	80.87±1.20	87.81±0.59	84.19±0.44
Disease	RAR	0.1	PubMedBERT	83.32±0.75	84.54±1.79	83.91±0.54
Disease	RAR	0.1	TS-PubMedBERT-Partial-CRF	79.51±1.11	88.48±0.65	83.75±0.35
Disease	RAR	0.2	BiLSTM-Partial-CRF	77.50±0.59	81.87±0.78	79.62±0.23
Disease	RAR	0.2	EER-PubMedBERT	81.31±1.37	87.36±0.41	84.22±0.71
Disease	RAR	0.2	PubMedBERT	83.50±0.84	83.08±1.53	83.27±0.38
Disease	RAR	0.2	TS-PubMedBERT-Partial-CRF	79.39±0.85	88.31±0.20	83.61±0.45
Disease	RAR	0.3	BiLSTM-Partial-CRF	77.21±0.46	81.48±0.28	79.28±0.27
Disease	RAR	0.3	EER-PubMedBERT	82.67±0.93	85.89±0.48	84.24±0.26

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Dataset	Scheme	Rate	Model	P	R	F1
Disease	RAR	0.3	PubMedBERT	82.39±1.34	81.42±1.04	81.89±0.57
Disease	RAR	0.3	TS-PubMedBERT-Partial-CRF	79.94±0.81	88.35±0.29	83.93±0.47
Disease	RAR	0.4	BiLSTM-Partial-CRF	77.44±0.43	80.75±0.43	79.06±0.26
Disease	RAR	0.4	EER-PubMedBERT	82.53±0.75	85.30±0.56	83.89±0.28
Disease	RAR	0.4	PubMedBERT	82.58±1.99	76.94±3.24	79.64±2.55
Disease	RAR	0.4	TS-PubMedBERT-Partial-CRF	79.98±1.34	87.78±0.36	83.69±0.61
Disease	RAR	0.5	BiLSTM-Partial-CRF	78.19±0.52	78.93±0.49	78.55±0.27
Disease	RAR	0.5	EER-PubMedBERT	82.01±1.52	84.70±1.10	83.31±0.27
Disease	RAR	0.5	PubMedBERT	85.86±1.56	58.51±5.58	69.40±3.52
Disease	RAR	0.5	TS-PubMedBERT-Partial-CRF	80.36±1.31	87.30±0.43	83.68±0.61
Disease	RAR	0.6	BiLSTM-Partial-CRF	78.54±0.86	76.88±0.85	77.69±0.25
Disease	RAR	0.6	EER-PubMedBERT	81.74±1.12	83.83±1.01	82.76±0.24
Disease	RAR	0.6	PubMedBERT	85.68±1.62	45.03±6.91	58.69±5.80
Disease	RAR	0.6	TS-PubMedBERT-Partial-CRF	80.28±1.09	86.39±1.00	83.21±0.28
Disease	RAR	0.7	BiLSTM-Partial-CRF	79.20±0.67	70.18±1.98	74.40±1.19
Disease	RAR	0.7	EER-PubMedBERT	81.35±1.10	82.22±1.01	81.77±0.56
Disease	RAR	0.7	PubMedBERT	85.16±0.45	26.40±1.68	40.27±1.96
Disease	RAR	0.7	TS-PubMedBERT-Partial-CRF	80.72±1.27	85.18±0.48	82.88±0.66
Disease	RAR	0.8	BiLSTM-Partial-CRF	73.55±4.45	37.96±9.51	49.55±8.71
Disease	RAR	0.8	EER-PubMedBERT	80.32±0.82	80.94±1.51	80.61±0.39
Disease	RAR	0.8	PubMedBERT	82.40±1.90	15.28±2.13	25.71±3.03
Disease	RAR	0.8	TS-PubMedBERT-Partial-CRF	80.38±1.70	83.19±1.06	81.73±0.42
Disease	RAR	0.9	BiLSTM-Partial-CRF	71.04±8.76	9.29±6.82	15.50±9.36
Disease	RAR	0.9	EER-PubMedBERT	79.13±0.85	78.09±0.75	78.60±0.43
Disease	RAR	0.9	PubMedBERT	82.07±4.90	5.19±1.33	9.73±2.36
Disease	RAR	0.9	TS-PubMedBERT-Partial-CRF	79.32±1.60	81.41±1.55	80.32±0.64
Disease	RSFR	0.1	BiLSTM-Partial-CRF	75.91±0.50	76.15±0.81	76.03±0.46
Disease	RSFR	0.1	EER-PubMedBERT	81.61±1.10	85.43±1.25	83.46±0.43
Disease	RSFR	0.1	PubMedBERT	83.99±1.07	77.54±1.15	80.62±0.49
Disease	RSFR	0.1	TS-PubMedBERT-Partial-CRF	79.44±0.58	87.07±0.81	83.08±0.40
Disease	RSFR	0.2	BiLSTM-Partial-CRF	75.44±0.62	70.07±1.32	72.65±0.58
Disease	RSFR	0.2	EER-PubMedBERT	79.57±1.43	84.22±1.53	81.80±0.28
Disease	RSFR	0.2	PubMedBERT	82.31±0.80	69.39±0.52	75.29±0.51
Disease	RSFR	0.2	TS-PubMedBERT-Partial-CRF	79.08±0.63	86.28±1.29	82.51±0.53
Disease	RSFR	0.3	BiLSTM-Partial-CRF	73.19±0.72	63.97±0.71	68.27±0.42
Disease	RSFR	0.3	EER-PubMedBERT	77.25±0.57	82.83±0.64	79.94±0.37
Disease	RSFR	0.3	PubMedBERT	80.54±1.95	61.22±0.85	69.56±1.10

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Dataset	Scheme	Rate	Model	P	R	F1
Disease	RSFR	0.3	TS-PubMedBERT-Partial-CRF	79.02±0.96	83.50±0.70	81.20±0.75
Disease	RSFR	0.4	BiLSTM-Partial-CRF	71.83±0.79	58.94±1.38	64.73±0.62
Disease	RSFR	0.4	EER-PubMedBERT	75.79±1.02	80.53±0.97	78.08±0.44
Disease	RSFR	0.4	PubMedBERT	79.21±0.99	51.62±1.11	62.49±0.63
Disease	RSFR	0.4	TS-PubMedBERT-Partial-CRF	79.49±1.18	83.13±0.67	81.26±0.59
Disease	RSFR	0.5	BiLSTM-Partial-CRF	68.23±1.08	53.84±0.32	60.18±0.47
Disease	RSFR	0.5	EER-PubMedBERT	74.80±1.58	78.37±1.84	76.51±0.57
Disease	RSFR	0.5	PubMedBERT	78.19±1.00	43.21±0.34	55.65±0.35
Disease	RSFR	0.5	TS-PubMedBERT-Partial-CRF	80.14±0.86	80.18±0.82	80.16±0.81
Disease	RSFR	0.6	BiLSTM-Partial-CRF	67.50±0.65	48.32±0.39	56.32±0.34
Disease	RSFR	0.6	EER-PubMedBERT	73.96±1.16	68.23±2.49	70.93±1.05
Disease	RSFR	0.6	PubMedBERT	75.11±2.37	34.38±1.30	47.13±1.19
Disease	RSFR	0.6	TS-PubMedBERT-Partial-CRF	78.60±1.49	77.10±1.78	77.81±0.30
Disease	RSFR	0.7	BiLSTM-Partial-CRF	65.33±1.77	40.54±0.75	50.03±1.06
Disease	RSFR	0.7	EER-PubMedBERT	71.10±1.33	58.98±3.43	64.40±1.82
Disease	RSFR	0.7	PubMedBERT	73.14±2.26	27.05±2.06	39.45±2.30
Disease	RSFR	0.7	TS-PubMedBERT-Partial-CRF	77.88±1.40	72.00±1.41	74.81±1.15
Disease	RSFR	0.8	BiLSTM-Partial-CRF	63.93±2.80	31.13±1.80	41.77±0.93
Disease	RSFR	0.8	EER-PubMedBERT	70.78±1.86	54.49±4.10	61.45±2.26
Disease	RSFR	0.8	PubMedBERT	67.93±2.45	17.36±1.24	27.62±1.52
Disease	RSFR	0.8	TS-PubMedBERT-Partial-CRF	77.58±1.39	71.18±3.85	74.18±2.11
Disease	RSFR	0.9	BiLSTM-Partial-CRF	58.21±4.42	18.51±5.61	27.46±5.89
Disease	RSFR	0.9	EER-PubMedBERT	70.67±1.51	45.43±3.96	55.19±2.89
Disease	RSFR	0.9	PubMedBERT	61.52±4.37	7.07±1.21	12.64±1.92
Disease	RSFR	0.9	TS-PubMedBERT-Partial-CRF	76.12±2.52	67.92±5.52	71.71±3.94
Gene	RAR	0.1	BiLSTM-Partial-CRF	69.66±0.33	76.97±0.42	73.13±0.12
Gene	RAR	0.1	EER-PubMedBERT	71.22±0.23	83.48±0.31	76.86±0.23
Gene	RAR	0.1	PubMedBERT	75.22±0.47	79.05±0.64	77.08±0.16
Gene	RAR	0.1	TS-PubMedBERT-Partial-CRF	59.81±1.06	78.24±0.90	67.79±0.86
Gene	RAR	0.2	BiLSTM-Partial-CRF	70.12±0.44	76.41±0.38	73.13±0.16
Gene	RAR	0.2	EER-PubMedBERT	71.60±0.42	83.10±0.17	76.92±0.29
Gene	RAR	0.2	PubMedBERT	76.67±0.90	74.37±1.83	75.48±0.56
Gene	RAR	0.2	TS-PubMedBERT-Partial-CRF	59.83±0.83	78.03±0.49	67.73±0.68
Gene	RAR	0.3	BiLSTM-Partial-CRF	71.64±0.79	74.17±0.77	72.87±0.14
Gene	RAR	0.3	EER-PubMedBERT	72.54±0.38	82.65±0.22	77.26±0.14
Gene	RAR	0.3	PubMedBERT	76.13±0.59	73.05±0.63	74.56±0.44
Gene	RAR	0.3	TS-PubMedBERT-Partial-CRF	60.49±1.22	78.39±1.54	68.28±1.24

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Dataset	Scheme	Rate	Model	P	R	F1
Gene	RAR	0.4	BiLSTM-Partial-CRF	72.76±0.74	71.10±0.59	71.92±0.14
Gene	RAR	0.4	EER-PubMedBERT	73.44±0.44	81.82±0.22	77.41±0.19
Gene	RAR	0.4	PubMedBERT	77.50±0.47	66.93±1.64	71.81±0.76
Gene	RAR	0.4	TS-PubMedBERT-Partial-CRF	63.36±1.29	79.51±0.59	70.52±0.96
Gene	RAR	0.5	BiLSTM-Partial-CRF	75.47±0.59	63.00±0.40	68.67±0.22
Gene	RAR	0.5	EER-PubMedBERT	74.39±0.15	80.49±0.27	77.32±0.06
Gene	RAR	0.5	PubMedBERT	78.02±1.00	45.55±6.39	57.22±4.87
Gene	RAR	0.5	TS-PubMedBERT-Partial-CRF	62.69±2.70	78.54±1.79	69.71±2.25
Gene	RAR	0.6	BiLSTM-Partial-CRF	78.61±1.13	46.12±2.73	58.06±1.98
Gene	RAR	0.6	EER-PubMedBERT	74.48±1.18	79.42±1.73	76.84±0.35
Gene	RAR	0.6	PubMedBERT	80.00±0.51	29.11±2.13	42.65±2.23
Gene	RAR	0.6	TS-PubMedBERT-Partial-CRF	65.56±1.88	80.64±1.09	72.31±1.52
Gene	RAR	0.7	BiLSTM-Partial-CRF	73.79±3.63	16.29±1.28	26.67±1.90
Gene	RAR	0.7	EER-PubMedBERT	75.14±0.53	77.54±0.92	76.32±0.22
Gene	RAR	0.7	PubMedBERT	80.06±0.83	18.95±1.58	30.61±2.12
Gene	RAR	0.7	TS-PubMedBERT-Partial-CRF	68.35±0.73	81.45±0.83	74.32±0.57
Gene	RAR	0.8	BiLSTM-Partial-CRF	74.76±3.01	4.46±1.40	8.37±2.48
Gene	RAR	0.8	EER-PubMedBERT	74.69±1.31	76.24±2.09	75.42±0.51
Gene	RAR	0.8	PubMedBERT	78.17±2.32	9.66±0.76	17.19±1.22
Gene	RAR	0.8	TS-PubMedBERT-Partial-CRF	69.15±0.82	81.70±0.78	74.90±0.62
Gene	RAR	0.9	BiLSTM-Partial-CRF	50.85±14.60	0.18±0.13	0.36±0.25
Gene	RAR	0.9	EER-PubMedBERT	76.99±0.78	71.18±1.16	73.96±0.30
Gene	RAR	0.9	PubMedBERT	76.55±2.71	3.52±0.23	6.72±0.43
Gene	RAR	0.9	TS-PubMedBERT-Partial-CRF	73.52±1.22	77.76±1.04	75.56±0.35
Gene	RSFR	0.1	BiLSTM-Partial-CRF	67.13±0.32	69.92±0.66	68.49±0.24
Gene	RSFR	0.1	EER-PubMedBERT	70.36±0.86	77.95±0.57	73.96±0.71
Gene	RSFR	0.1	PubMedBERT	75.16±0.49	72.29±0.97	73.69±0.31
Gene	RSFR	0.1	TS-PubMedBERT-Partial-CRF	58.47±0.56	77.31±0.62	66.59±0.57
Gene	RSFR	0.2	BiLSTM-Partial-CRF	65.96±0.25	63.21±0.50	64.56±0.19
Gene	RSFR	0.2	EER-PubMedBERT	70.23±0.31	72.58±0.66	71.38±0.30
Gene	RSFR	0.2	PubMedBERT	71.98±0.84	66.67±1.07	69.22±0.74
Gene	RSFR	0.2	TS-PubMedBERT-Partial-CRF	58.30±1.41	75.87±1.54	65.93±1.45
Gene	RSFR	0.3	BiLSTM-Partial-CRF	64.59±0.40	56.63±0.56	60.35±0.30
Gene	RSFR	0.3	EER-PubMedBERT	68.07±1.57	68.80±1.89	68.39±0.23
Gene	RSFR	0.3	PubMedBERT	72.58±1.09	57.95±0.92	64.43±0.29
Gene	RSFR	0.3	TS-PubMedBERT-Partial-CRF	57.65±1.83	74.23±0.88	64.88±1.34
Gene	RSFR	0.4	BiLSTM-Partial-CRF	62.01±0.48	50.99±0.82	55.95±0.38

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Dataset	Scheme	Rate	Model	P	R	F1
Gene	RSFR	0.4	EER-PubMedBERT	66.09±1.48	65.70±1.39	65.87±0.45
Gene	RSFR	0.4	PubMedBERT	71.20±2.01	50.85±2.82	59.25±1.60
Gene	RSFR	0.4	TS-PubMedBERT-Partial-CRF	58.77±2.30	73.76±1.26	65.40±1.68
Gene	RSFR	0.5	BiLSTM-Partial-CRF	61.89±1.02	43.72±0.54	51.23±0.26
Gene	RSFR	0.5	EER-PubMedBERT	63.70±3.10	62.38±2.39	62.91±0.52
Gene	RSFR	0.5	PubMedBERT	70.70±2.54	41.86±1.61	52.52±0.91
Gene	RSFR	0.5	TS-PubMedBERT-Partial-CRF	58.44±0.96	69.47±2.01	63.47±1.18
Gene	RSFR	0.6	BiLSTM-Partial-CRF	59.70±0.81	36.23±0.92	45.08±0.50
Gene	RSFR	0.6	EER-PubMedBERT	63.78±2.28	54.88±2.23	58.91±0.54
Gene	RSFR	0.6	PubMedBERT	69.76±1.97	35.32±2.43	46.86±2.45
Gene	RSFR	0.6	TS-PubMedBERT-Partial-CRF	57.52±1.85	65.80±1.73	61.36±1.31
Gene	RSFR	0.7	BiLSTM-Partial-CRF	59.34±1.71	25.22±1.13	35.36±0.88
Gene	RSFR	0.7	EER-PubMedBERT	60.96±2.24	49.71±2.08	54.73±1.68
Gene	RSFR	0.7	PubMedBERT	66.75±1.74	24.39±3.41	35.62±3.93
Gene	RSFR	0.7	TS-PubMedBERT-Partial-CRF	56.37±2.54	63.49±2.89	59.60±0.66
Gene	RSFR	0.8	BiLSTM-Partial-CRF	58.71±1.36	14.47±0.86	23.19±1.06
Gene	RSFR	0.8	EER-PubMedBERT	59.55±1.87	42.34±1.56	49.44±0.76
Gene	RSFR	0.8	PubMedBERT	64.97±1.97	13.76±1.84	22.65±2.52
Gene	RSFR	0.8	TS-PubMedBERT-Partial-CRF	55.44±2.39	58.74±5.04	56.81±1.34
Gene	RSFR	0.9	BiLSTM-Partial-CRF	52.14±6.95	4.08±0.69	7.53±1.12
Gene	RSFR	0.9	EER-PubMedBERT	58.08±1.00	33.03±3.13	42.00±2.52
Gene	RSFR	0.9	PubMedBERT	62.60±3.09	4.48±0.93	8.33±1.61
Gene	RSFR	0.9	TS-PubMedBERT-Partial-CRF	56.08±2.59	49.94±2.42	52.79±2.05
Species	RAR	0.1	BiLSTM-Partial-CRF	73.45±0.74	71.96±0.85	72.69±0.62
Species	RAR	0.1	EER-PubMedBERT	55.67±2.80	85.64±0.41	67.43±2.01
Species	RAR	0.1	PubMedBERT	77.69±1.15	74.87±1.97	76.22±0.71
Species	RAR	0.1	TS-PubMedBERT-Partial-CRF	56.01±1.04	85.13±0.78	67.56±0.82
Species	RAR	0.2	BiLSTM-Partial-CRF	74.25±0.67	70.67±0.21	72.42±0.35
Species	RAR	0.2	EER-PubMedBERT	55.35±1.42	86.30±0.46	67.43±1.03
Species	RAR	0.2	PubMedBERT	78.19±1.40	73.60±1.43	75.80±0.57
Species	RAR	0.2	TS-PubMedBERT-Partial-CRF	57.83±1.95	85.23±0.60	68.88±1.33
Species	RAR	0.3	BiLSTM-Partial-CRF	75.16±1.16	69.26±0.43	72.08±0.45
Species	RAR	0.3	EER-PubMedBERT	56.55±1.80	85.56±0.54	68.07±1.19
Species	RAR	0.3	PubMedBERT	79.10±1.97	66.96±3.34	72.43±1.28
Species	RAR	0.3	TS-PubMedBERT-Partial-CRF	56.99±2.81	85.97±0.59	68.49±1.94
Species	RAR	0.4	BiLSTM-Partial-CRF	76.04±1.86	68.27±0.83	71.93±0.55
Species	RAR	0.4	EER-PubMedBERT	55.70±3.13	85.63±0.57	67.43±2.16

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Dataset	Scheme	Rate	Model	P	R	F1
Species	RAR	0.4	PubMedBERT	79.59±1.83	65.79±4.52	71.89±2.25
Species	RAR	0.4	TS-PubMedBERT-Partial-CRF	57.03±2.80	85.65±1.26	68.40±1.65
Species	RAR	0.5	BiLSTM-Partial-CRF	76.48±1.19	66.32±0.89	71.03±0.84
Species	RAR	0.5	EER-PubMedBERT	58.27±1.47	85.09±0.75	69.16±0.98
Species	RAR	0.5	PubMedBERT	79.26±0.94	57.61±7.44	66.40±4.97
Species	RAR	0.5	TS-PubMedBERT-Partial-CRF	57.91±1.88	85.30±0.60	68.96±1.17
Species	RAR	0.6	BiLSTM-Partial-CRF	84.19±0.38	53.16±0.88	65.17±0.54
Species	RAR	0.6	EER-PubMedBERT	57.85±1.36	84.99±0.24	68.83±0.96
Species	RAR	0.6	PubMedBERT	77.64±2.34	41.73±4.14	54.15±3.58
Species	RAR	0.6	TS-PubMedBERT-Partial-CRF	55.79±2.18	85.33±0.48	67.44±1.48
Species	RAR	0.7	BiLSTM-Partial-CRF	77.22±1.56	59.29±1.08	67.06±0.49
Species	RAR	0.7	EER-PubMedBERT	56.86±2.89	85.05±0.92	68.09±1.83
Species	RAR	0.7	PubMedBERT	77.75±2.76	25.17±2.66	37.95±3.08
Species	RAR	0.7	TS-PubMedBERT-Partial-CRF	53.87±2.74	85.45±0.68	66.03±1.98
Species	RAR	0.8	BiLSTM-Partial-CRF	79.31±2.39	45.40±10.71	56.81±9.81
Species	RAR	0.8	EER-PubMedBERT	58.18±2.32	82.97±0.60	68.37±1.55
Species	RAR	0.8	PubMedBERT	71.62±2.65	16.16±3.95	26.10±5.35
Species	RAR	0.8	TS-PubMedBERT-Partial-CRF	57.78±5.39	82.24±2.72	67.62±2.81
Species	RAR	0.9	BiLSTM-Partial-CRF	78.96±8.18	4.74±3.51	8.72±6.18
Species	RAR	0.9	EER-PubMedBERT	59.94±2.41	78.96±4.71	68.01±1.76
Species	RAR	0.9	PubMedBERT	67.87±5.36	5.20±2.59	9.46±4.20
Species	RAR	0.9	TS-PubMedBERT-Partial-CRF	54.72±5.83	82.40±1.14	65.53±4.31
Species	RSFR	0.1	BiLSTM-Partial-CRF	70.34±2.21	58.33±3.62	63.75±2.99
Species	RSFR	0.1	EER-PubMedBERT	55.66±1.26	85.59±0.32	67.44±0.84
Species	RSFR	0.1	PubMedBERT	75.18±1.19	62.98±1.82	68.53±1.39
Species	RSFR	0.1	TS-PubMedBERT-Partial-CRF	55.85±1.76	85.76±0.67	67.62±1.11
Species	RSFR	0.2	BiLSTM-Partial-CRF	67.98±1.63	52.81±2.28	59.41±1.66
Species	RSFR	0.2	EER-PubMedBERT	55.79±1.29	85.95±0.30	67.66±1.01
Species	RSFR	0.2	PubMedBERT	74.57±1.72	54.87±3.42	63.15±2.40
Species	RSFR	0.2	TS-PubMedBERT-Partial-CRF	55.42±2.94	85.14±1.03	67.08±2.04
Species	RSFR	0.3	BiLSTM-Partial-CRF	66.37±1.36	46.66±1.68	54.77±1.30
Species	RSFR	0.3	EER-PubMedBERT	56.61±2.23	81.55±2.36	66.76±1.20
Species	RSFR	0.3	PubMedBERT	71.79±2.53	49.93±1.27	58.88±1.51
Species	RSFR	0.3	TS-PubMedBERT-Partial-CRF	56.38±1.82	83.36±2.16	67.24±1.53
Species	RSFR	0.4	BiLSTM-Partial-CRF	66.13±1.50	40.93±0.85	50.56±0.93
Species	RSFR	0.4	EER-PubMedBERT	56.66±1.32	78.84±3.35	65.89±1.50
Species	RSFR	0.4	PubMedBERT	71.94±2.56	43.43±2.17	54.08±1.25

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Dataset	Scheme	Rate	Model	P	R	F1
Species	RSFR	0.4	TS-PubMedBERT-Partial-CRF	57.34±3.54	82.03±2.43	67.38±2.19
Species	RSFR	0.5	BiLSTM-Partial-CRF	66.75±2.52	36.66±1.45	47.29±1.27
Species	RSFR	0.5	EER-PubMedBERT	53.89±1.58	76.57±5.06	63.21±2.56
Species	RSFR	0.5	PubMedBERT	69.93±1.97	39.10±1.71	50.10±1.02
Species	RSFR	0.5	TS-PubMedBERT-Partial-CRF	56.52±1.75	79.69±2.98	66.12±1.97
Species	RSFR	0.6	BiLSTM-Partial-CRF	65.83±1.74	32.20±1.17	43.21±0.78
Species	RSFR	0.6	EER-PubMedBERT	53.71±1.44	71.20±6.12	61.04±1.34
Species	RSFR	0.6	PubMedBERT	69.93±2.00	34.03±1.76	45.73±1.32
Species	RSFR	0.6	TS-PubMedBERT-Partial-CRF	55.18±1.77	81.33±3.44	65.74±2.31
Species	RSFR	0.7	BiLSTM-Partial-CRF	65.95±2.09	27.47±0.92	38.76±0.79
Species	RSFR	0.7	EER-PubMedBERT	54.18±0.71	66.57±3.27	59.71±1.67
Species	RSFR	0.7	PubMedBERT	71.19±1.45	26.16±1.94	38.21±2.11
Species	RSFR	0.7	TS-PubMedBERT-Partial-CRF	53.99±4.10	77.92±5.81	63.50±2.30
Species	RSFR	0.8	BiLSTM-Partial-CRF	66.51±3.37	22.56±1.10	33.65±1.26
Species	RSFR	0.8	EER-PubMedBERT	53.77±2.73	60.94±3.52	56.99±1.37
Species	RSFR	0.8	PubMedBERT	65.73±2.86	18.54±1.68	28.84±1.93
Species	RSFR	0.8	TS-PubMedBERT-Partial-CRF	57.67±4.05	71.64±9.56	63.20±2.19
Species	RSFR	0.9	BiLSTM-Partial-CRF	68.68±4.78	12.88±2.70	21.52±3.71
Species	RSFR	0.9	EER-PubMedBERT	49.28±3.44	60.60±1.66	54.24±1.52
Species	RSFR	0.9	PubMedBERT	61.03±4.84	8.73±2.43	15.09±3.44
Species	RSFR	0.9	TS-PubMedBERT-Partial-CRF	50.58±5.85	65.81±4.18	56.88±3.53