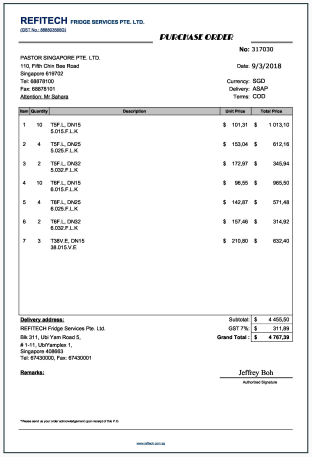
Improving Information Extraction on Business Documents with Specic Pre-Training Tasks

Thibault Douzon, Stefan Duffner, Christophe Garcia and Jérémy Espinas

May 23, 2022

DAS 2022 – Oral Session

Business Documents



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3	2	TBF.L, DN32 5.032/F.L/K	$ 172,97	$ 345,94
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7	3	TBFV.E, DN15 38.015/V.E	$ 210,80	$ 632,40

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ROC NO: 538358-H
NO 2 & 4, JALAN BAYU 4,
BANDAR SERI ALAM,
81750 MASAI, JOHOR
Tel:07-388 2218 Fax:07-388 8218
Email: ng@ojcgroup.com

TAX INVOICE

Invoice No : PEGIV-1030765
Date : 15/01/2019 11:05:16 AM
Cashier : NG CHUAN MIN
Sales Persor : FATIN
Bill To : **THE PEAK QUARRY WORKS**
Address : .

Description	Qty	Price	Amount
000000111	1	193.00	193.00 SR
KINGS SAFETY SHOES KWD 805			

Qty: 1	Total Exclude GST:	193.00
	Total GST @6%:	0.00
	Total Inclusive GST:	193.00
	Round Amt:	0.00
	TOTAL:	**193.00**
	VISA CARD	193.00
	xxxxxxxxxxxx4318	
	Approval Code:000	

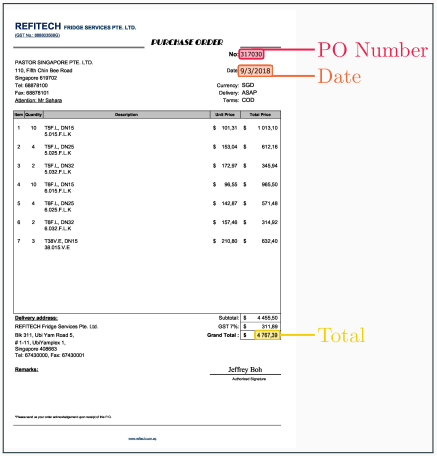
193.00

Goods Sold Are Not Returnable & Refundable
****Thank You. Please Come Again.****

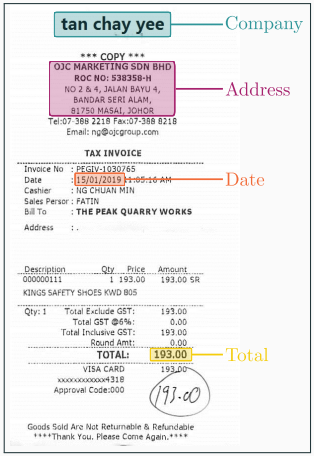
(b) Receipt

Figure 1: Document samples from private and public [3] datasets

Information Extraction



(a) Purchase order



(b) Receipt

Figure 1: The aim is to extract specific information for each document type

Architectures for Information Extraction

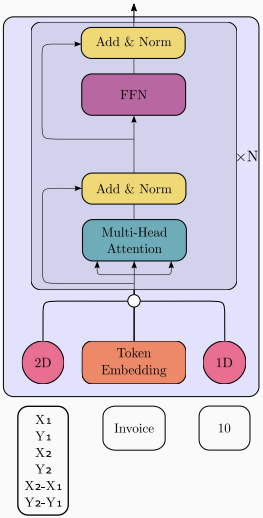
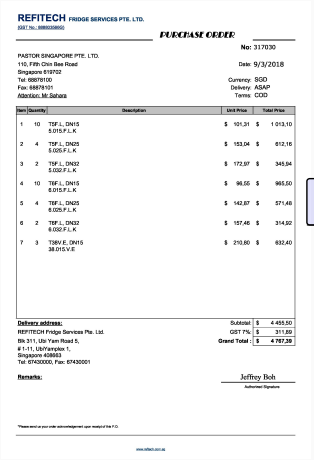


Figure 2: Transformer [4] architecture used for LayoutLM [5, 6] model

Pre-Training Language Models



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7	3	T38V E. DN15 38.015.V.E	$ 210,80	$ 632,40

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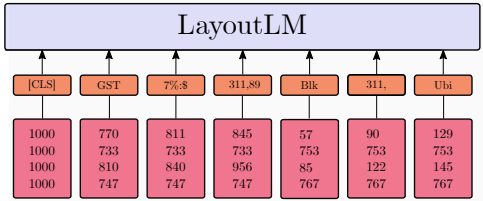
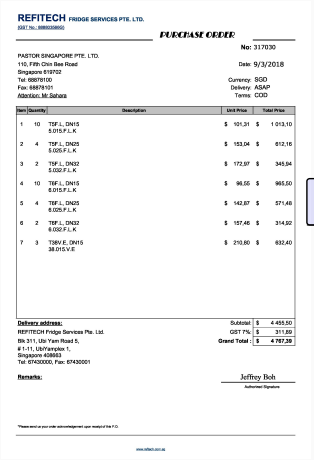


Figure 3: Masked Language Modeling (MLM) [1] diagram. Only part of the sequence is represented.

Pre-Training Language Models



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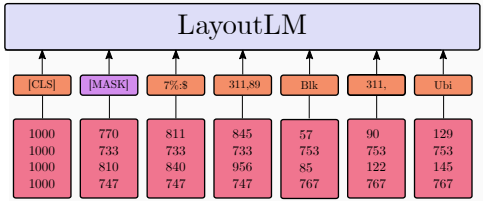


Figure 3: Some tokens are randomly replaced by a special token.

Pre-Training Language Models

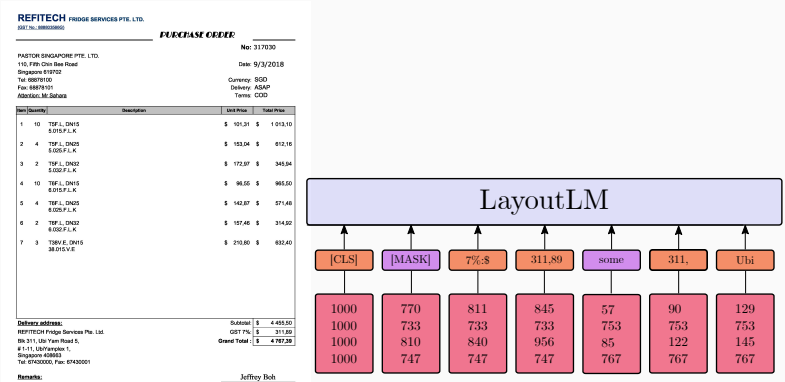
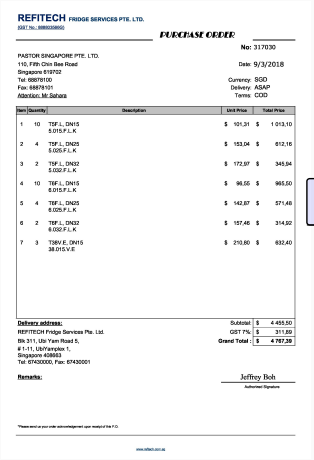


Figure 3: Some other tokens are randomly replaced by other random tokens.

Pre-Training Language Models



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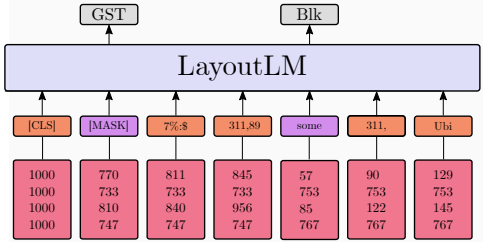
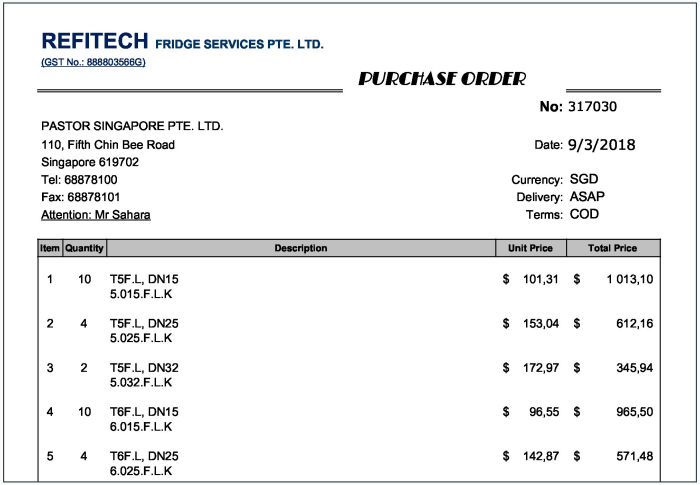


Figure 3: Finally, model is pre-trained by the cross-entropy between prediction logits and intial document's tokens.

Pre-Training Language Models



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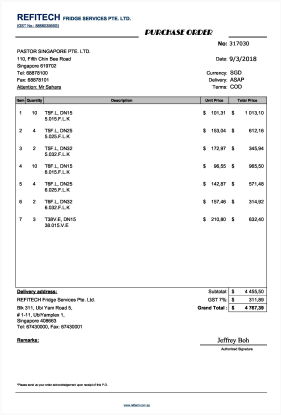
Item	Quantity	Description	Unit Price	Total Price
1	10	T5F.L, DN15 5.015.F.L.K	$ 101,31	$ 1 013,10
2	4	T5F.L, DN25 5.025.F.L.K	$ 153,04	$ 612,16
3	2	T5F.L, DN32 5.032.F.L.K	$ 172,97	$ 345,94
4	10	T6F.L, DN15 6.015.F.L.K	$ 96,55	$ 965,50
5	4	T6F.L, DN25 6.025.F.L.K	$ 142,87	$ 571,48

Figure 4: Zoom on a purchase order

Numeric Ordering



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Item	Quantity	Description	Unit Price	Total Price
1	10	TBF L, DN15 S.015.F.L.K	$ 101,31	$ 1 013,10
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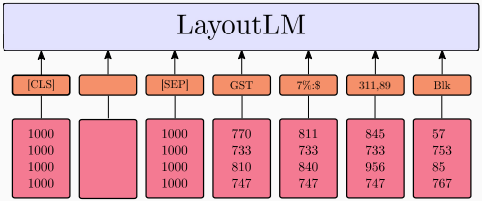


Figure 5: Numeric Ordering (NO) focuses on figures' relative magnitude. Only part of the sequence is represented.

Numeric Ordering

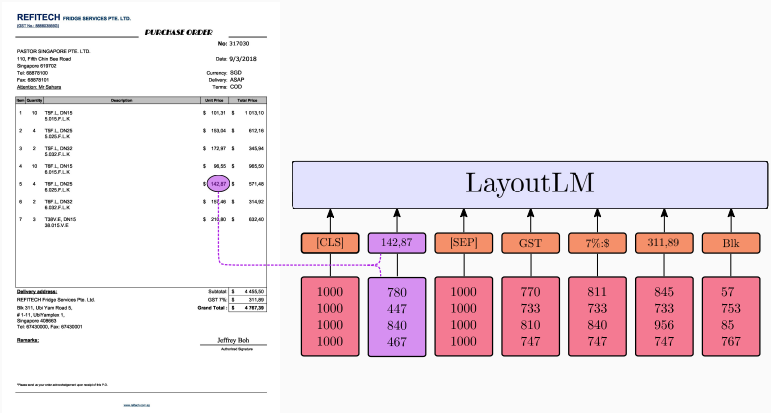


Figure 5: A figure in the document is randomly selected.

Numeric Ordering

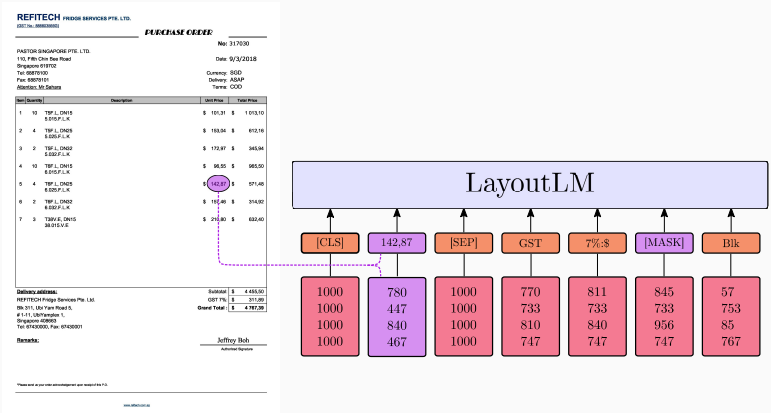


Figure 5: Some tokens and / or positions are randomly masked or replaced.

Numeric Ordering

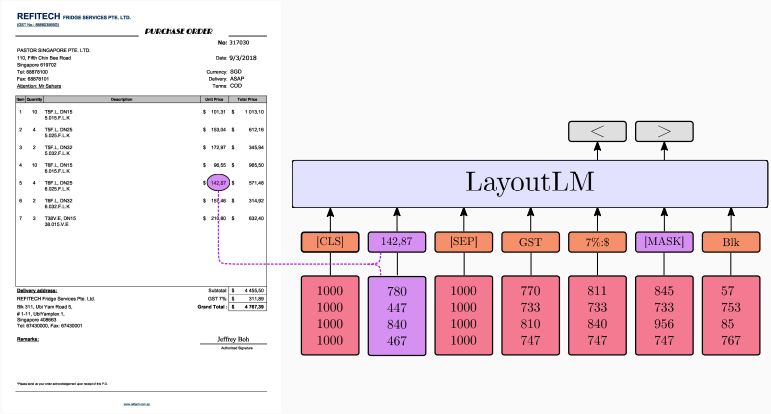
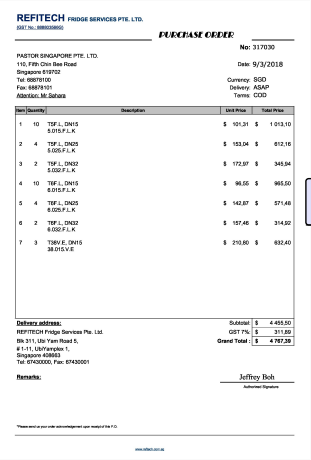


Figure 5: Model is pre-trained on the prediction of relative order between each number and the chosen one.

Layout Inclusion



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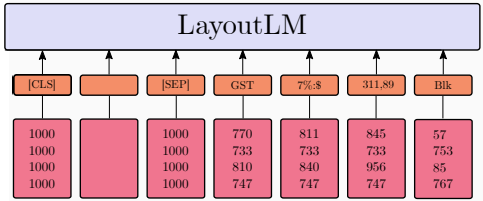

Figure 6: Layout Inclusion (LI) teaches the relative position of tokens. Only part of the sequence is represented.

Layout Inclusion

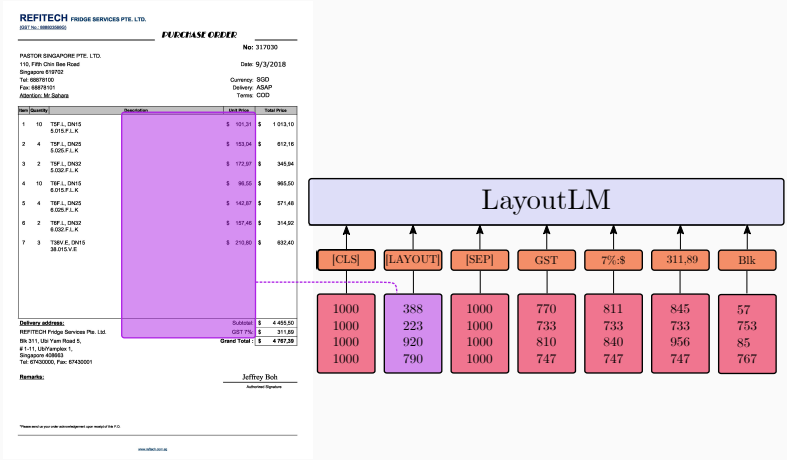

Figure 6: A rectangle zone is randomly chosen inside the document's boudaries. It is represented by a *[LAYOUT]* token.

Layout Inclusion

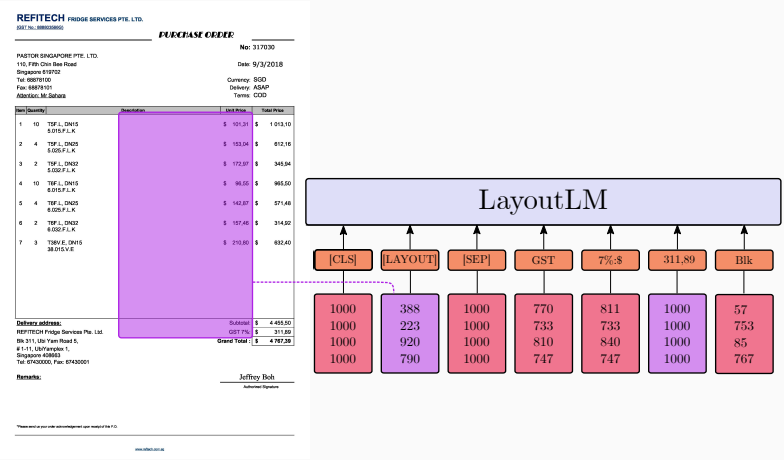

Figure 6: Some tokens and / or positions are randomly masked or replaced.

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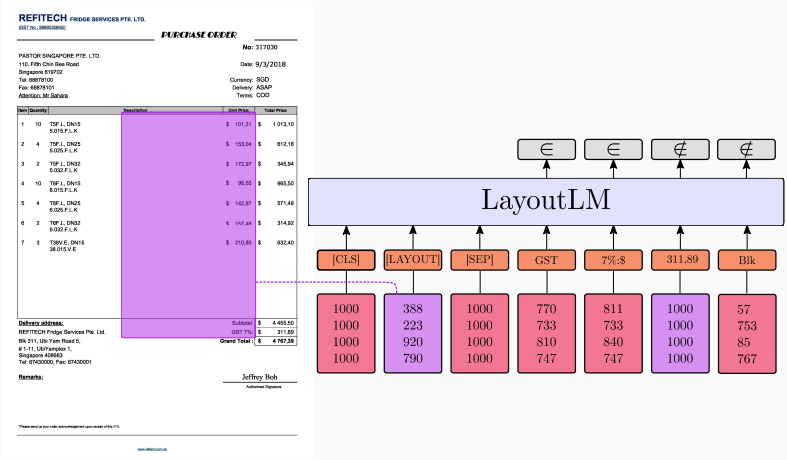

Figure 6: Model predicts for each token if its center is inside or outside the random rectangle.

Pre-Training Datasets

Pre-training datasets

- RVL-CDIP [2], collection of 10M business documents. Pre-trained models available online ;

Pre-Training Datasets

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- RVL-CDIP [2], collection of 10M business documents. Pre-trained models available online ;
- Business Document Collection (BDC), 500k invoices and purchase orders from 2018 to today.

Experiments

All experiments evaluated those 3 pre-trained models

- **Masked Language Modeling** (MLM) on **RVL-CDIP**. This model was available online ;

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Experiments

All experiments evaluated those 3 pre-trained models

- **Masked Language Modeling** (MLM) on **RVL-CDIP**. This model was available online ;
- **Masked Language Modeling** on the **Business Document Collection** (BDC) ;
- **Masked Language Modeling, Numeric Ordering and Layout Inclusion** (MLM+NO+LI) tasks on **BDC**.

Results

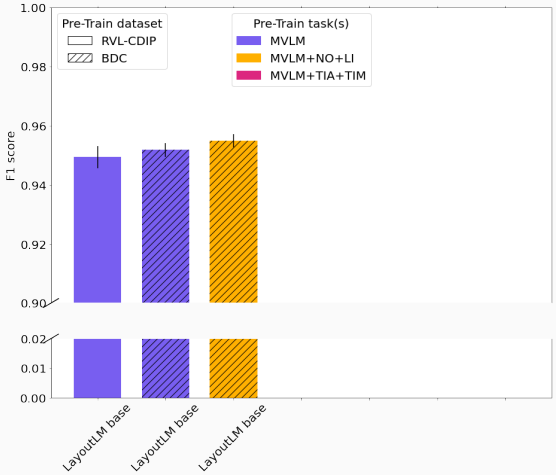

Figure 7: Results on SROIE fine-tuning. Both BDC and the new pre-training tasks improve model performance.

Results

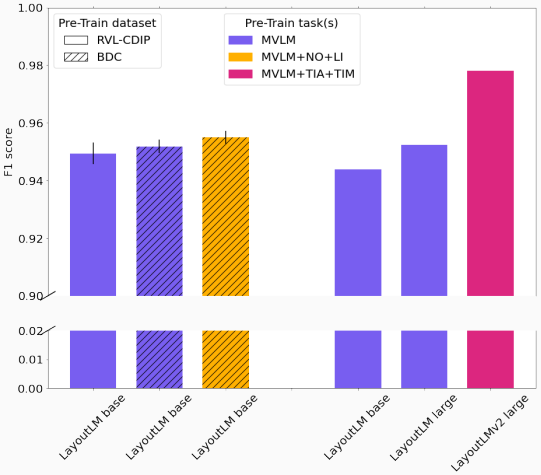

Figure 7: Our pre-trained models (left) outperform original LayoutLM [5, 6] base and large models (right).

Conclusions

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- Language model sizes could be reduced – without any performance loss – by elaborating better pre-training adapted to downstream tasks ;
- More work is needed in order to process very long documents, as current language models are not adapted.

Thanks everyone !

Any questions ?

Paper & contact information

Any in-depth question about this work ? Please contact me !

Thibault Douzon, Stefan Duffner, Christophe Garcia and Jérémy Espinas

thibault.douzon@esker.com

Code and models are available on
github.com/thibaultdouzon/business-document-pre-training.git

References i

[1] J. Devlin, M.-W. Chang, K. Lee, and K. Toutanova.
BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding.
arXiv:1810.04805 [cs], May 2019.
arXiv: 1810.04805.

[2] A. W. Harley, A. Ufkes, and K. G. Derpanis.
Evaluation of deep convolutional nets for document image classification and retrieval.
In *International Conference on Document Analysis and Recognition (ICDAR)*.

References ii

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