RECURRENT NEURAL NETWORK APPROACH FOR TABLE FIELD EXTRACTION IN BUSINESS DOCUMENTS

PhD Student: Clément Sage

Supervisors: Alexandre Aussem, Haytham Elghazel, Véronique Eglin and Jérémy Espinas

Université Claude Bernard Lyon 1

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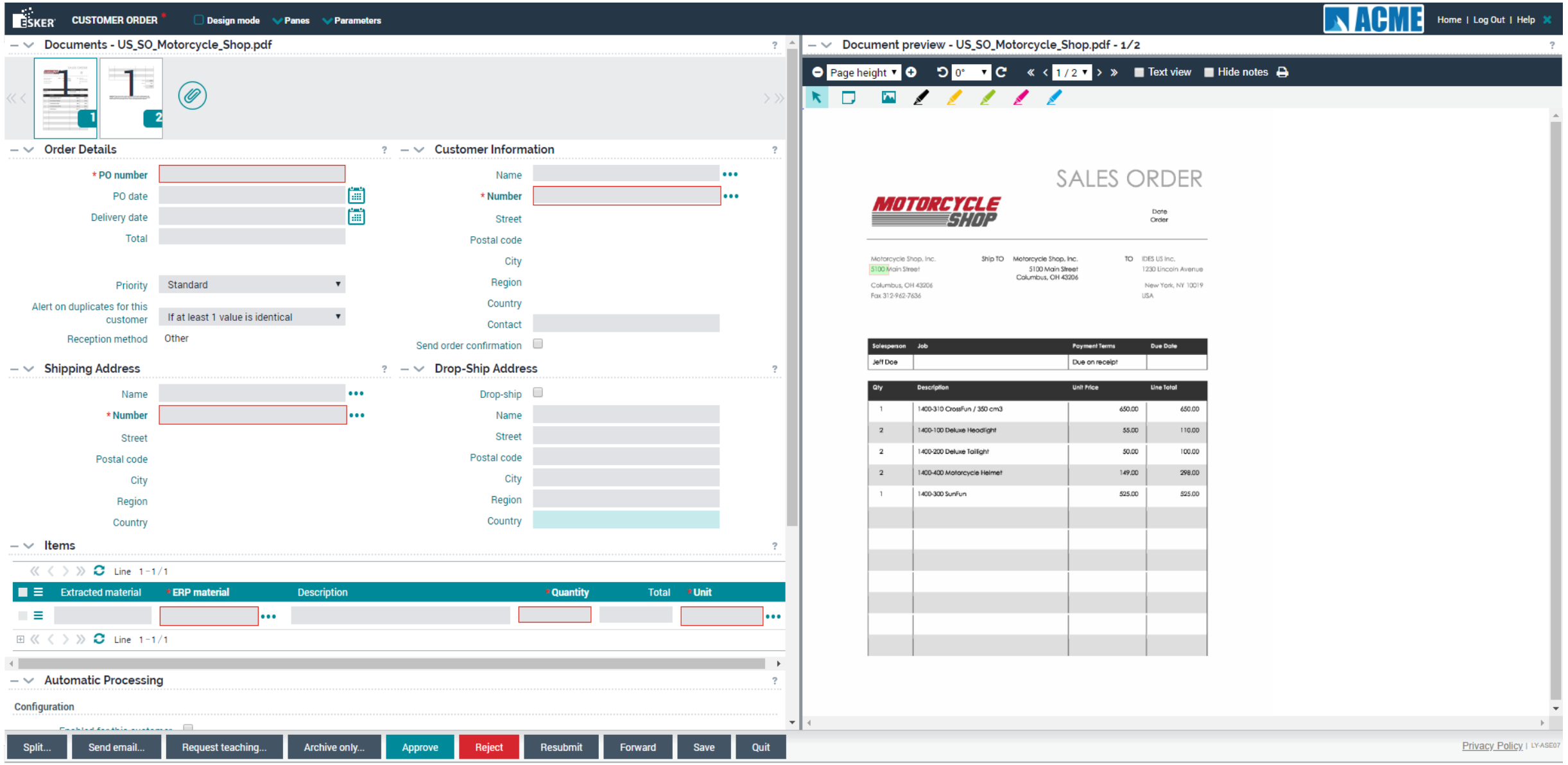
OUTLINE OF THE PRESENTATION

- Information extraction in business documents
- State of the art review
- Presentation of our method
- Dataset & experiments
- Results
- Conclusions & perspectives

INFORMATION EXTRACTION (IE) IN BUSINESS DOCUMENTS



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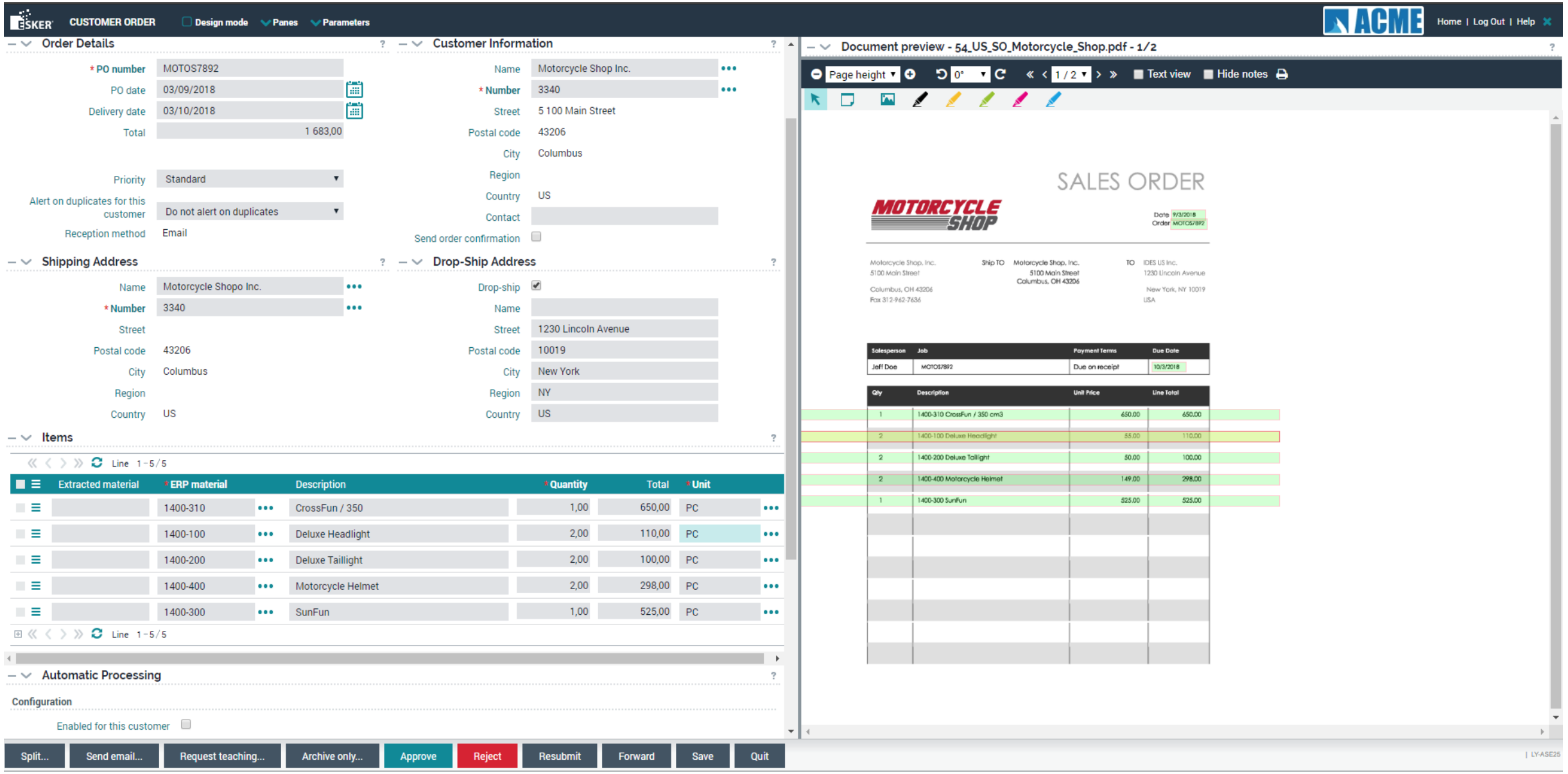

INFORMATION EXTRACTION CONSTRAINTS IMPOSED BY INDUSTRIAL CONTEXT

- Able to operate on both scanned and born-digital documents
- Should be generic enough to be easily adapted for any language, document class or information to extract
- Should accurately extract information even for a document layout (also called template) which has not already processed by the system
  - Structural Template Incremental Learning approaches such as in [1, 2, 3, 4, 5] cannot be employed
  - Should develop a template free method

STATE OF THE ART REVIEW OF TEMPLATE FREE IE APPROACHES

- Lot of recent works on the detection and physical structure recognition of tables in documents [6, 7, 8]
  - However, table structure in business documents is frequently ambiguous and may not provide enough knowledge for further field extraction

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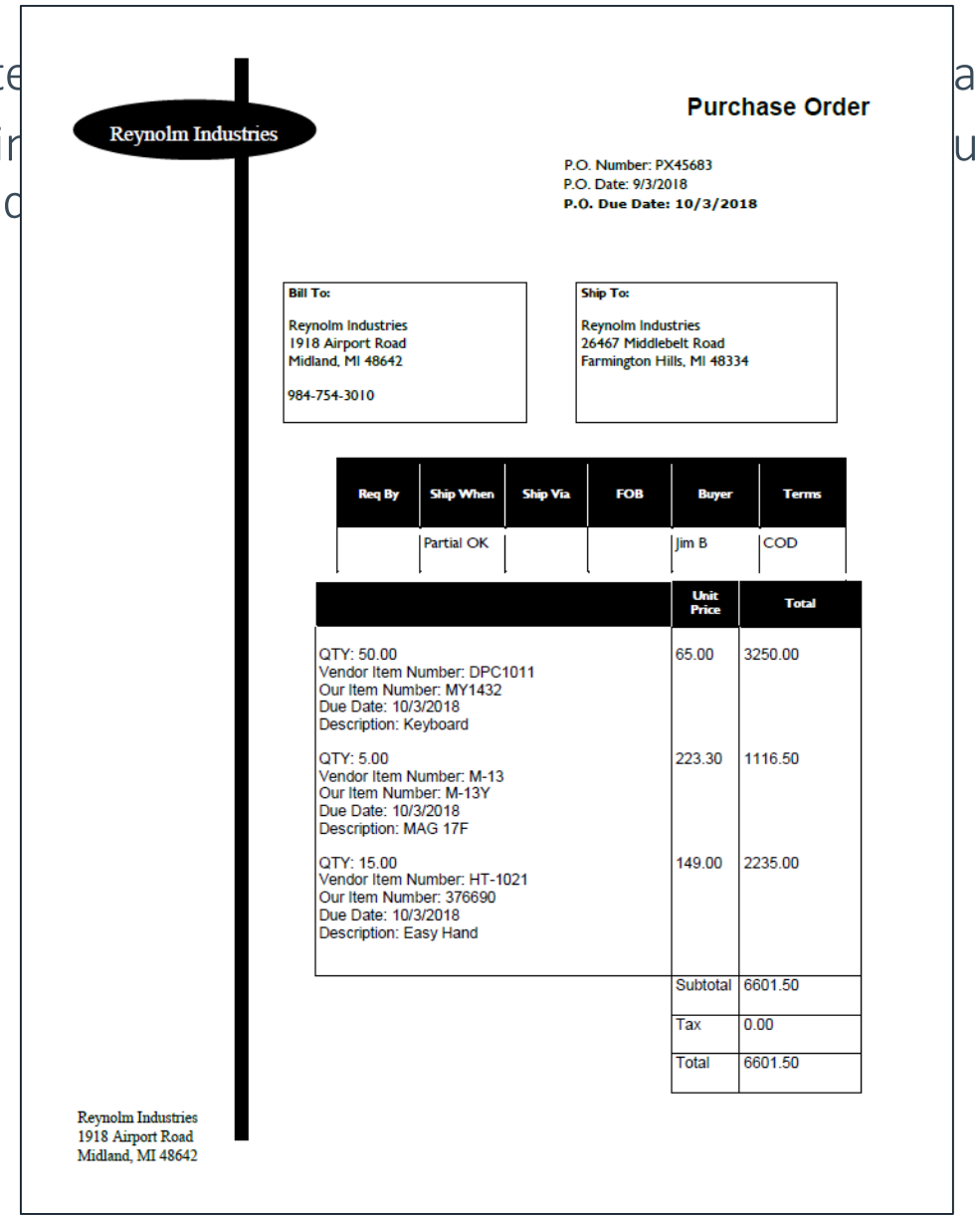

Reynolm Industries

Purchase Order

P.O. Number: PX45683
P.O. Date: 9/3/2018
P.O. Due Date: 10/3/2018

Bill To:

Reynolm Industries
1918 Airport Road
Midland, MI 48642

984-754-3010

Ship To:

Reynolm Industries
26467 Middlebelt Road
Farmington Hills, MI 48334

Req By	Ship When	Ship Via	FOB	Buyer	Terms
	Partial OK			Jim B	COD

	Unit Price	Total
QTY: 50.00 Vendor Item Number: DPC1011 Our Item Number: MY1432 Due Date: 10/3/2018 Description: Keyboard	65.00	3250.00
QTY: 5.00 Vendor Item Number: M-13 Our Item Number: M-13Y Due Date: 10/3/2018 Description: MAG 17F	223.30	1116.50
QTY: 15.00 Vendor Item Number: HT-1021 Our Item Number: 376690 Due Date: 10/3/2018 Description: Easy Hand	149.00	2235.00
	Subtotal	6601.50
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- Methods [9, 10, 11] that rely on significant domain specific knowledge and a number of handcrafted features or rules:
  - Showing troubles when tackling highly unstructured fields in documents with strong layout variability

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- IE is closely related with the Named Entity Recognition (NER) task which is actively studied [13, 14, 15]:
  - However, IE in business documents presents some specificities: word alignment and spacing, reading order, grammar

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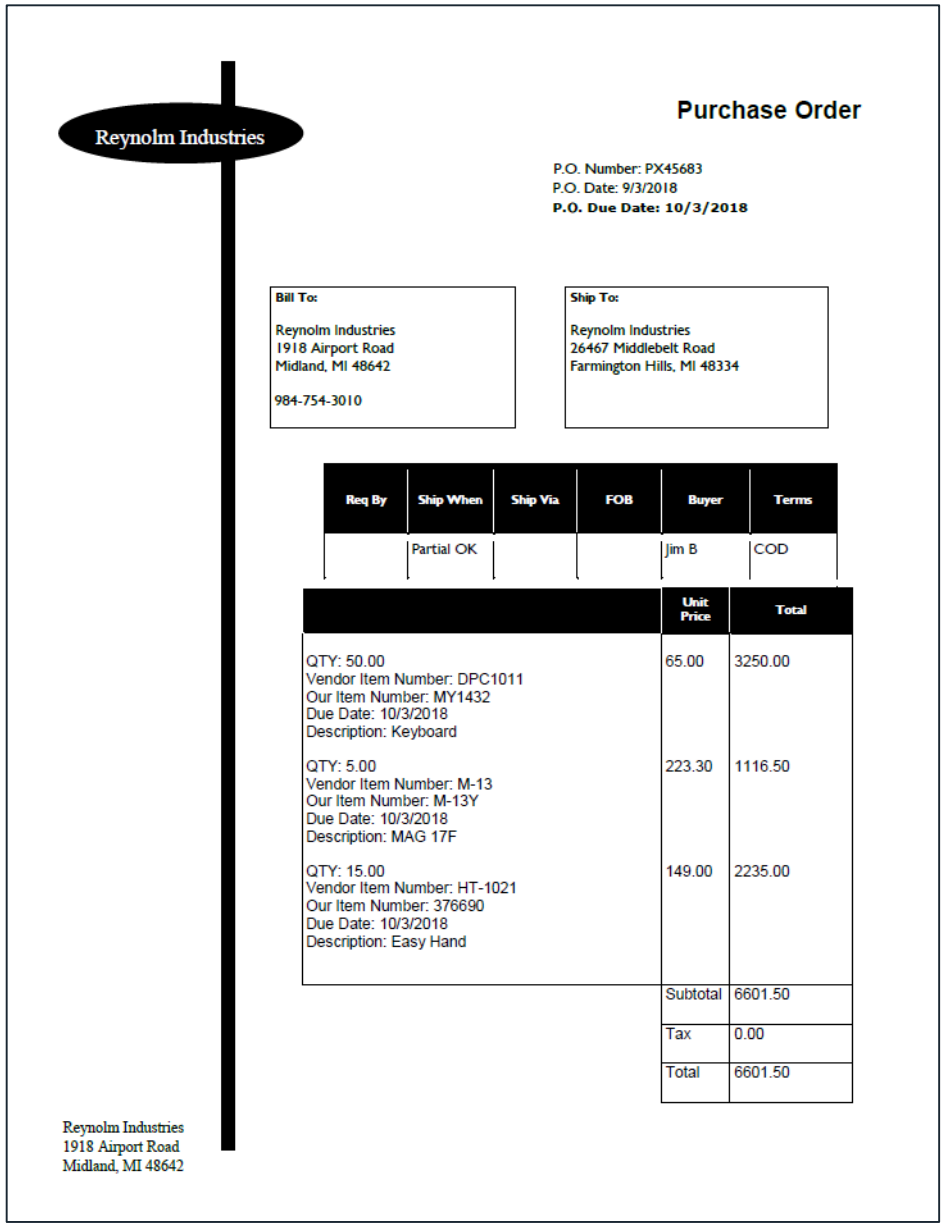
- Sequence labelling approach with recurrent neural network (RNN) [12] for extracting non tabular data in invoices:
  - Applying this approach to tabular data, which are more challenging to retrieve ?

TABLE FIELD EXTRACTION OBJECTIVE



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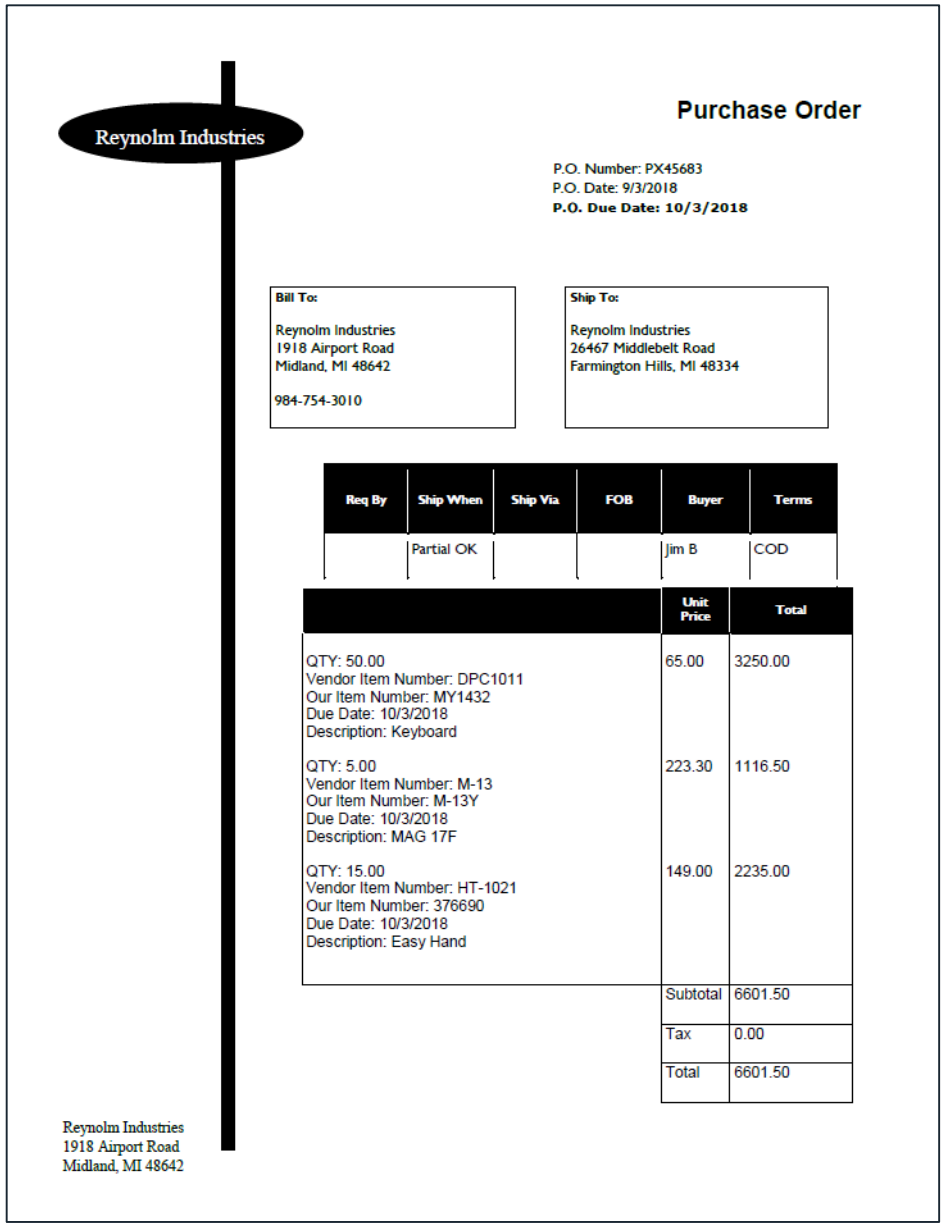

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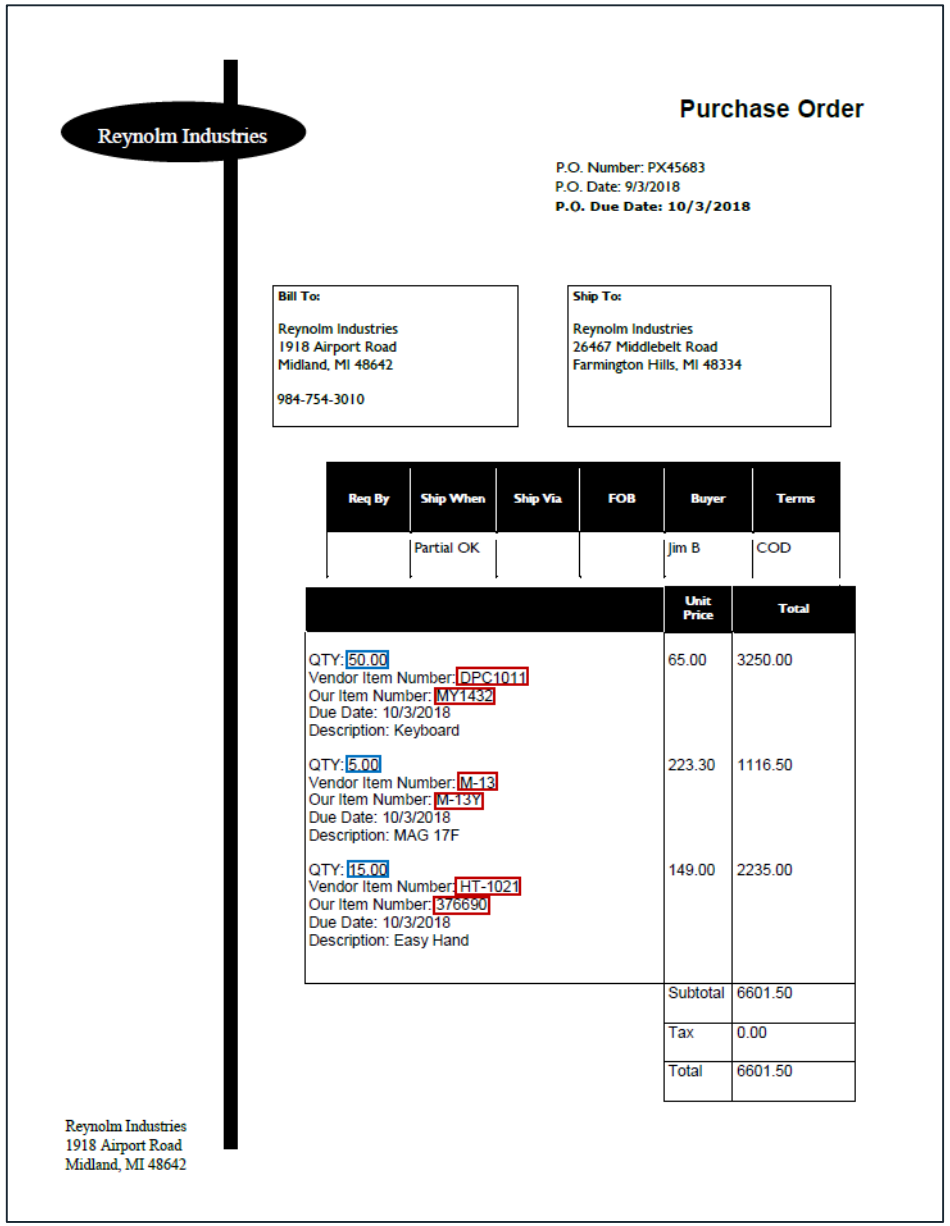

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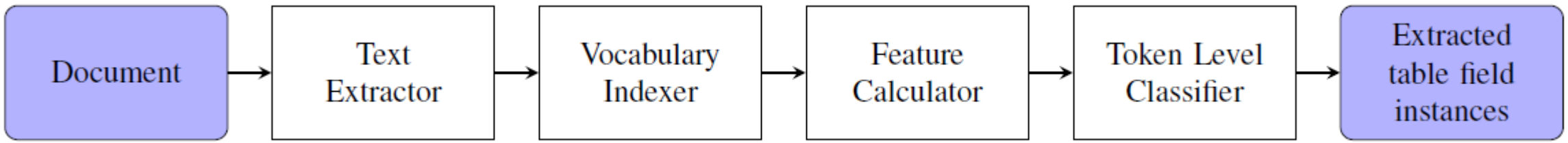
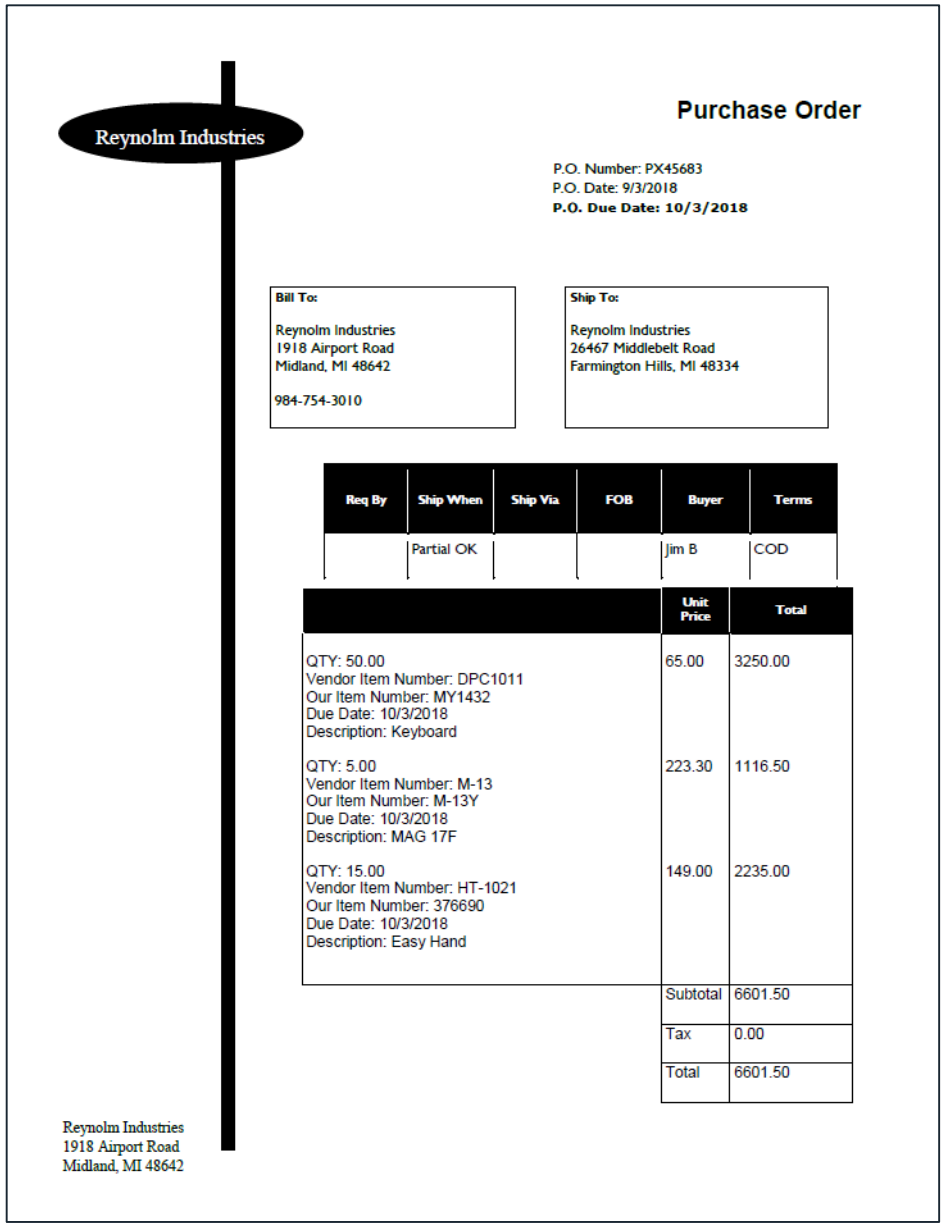
OVERVIEW OF OUR METHOD



STEP #1: TEXT EXTRACTOR



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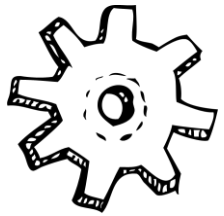
External OCR



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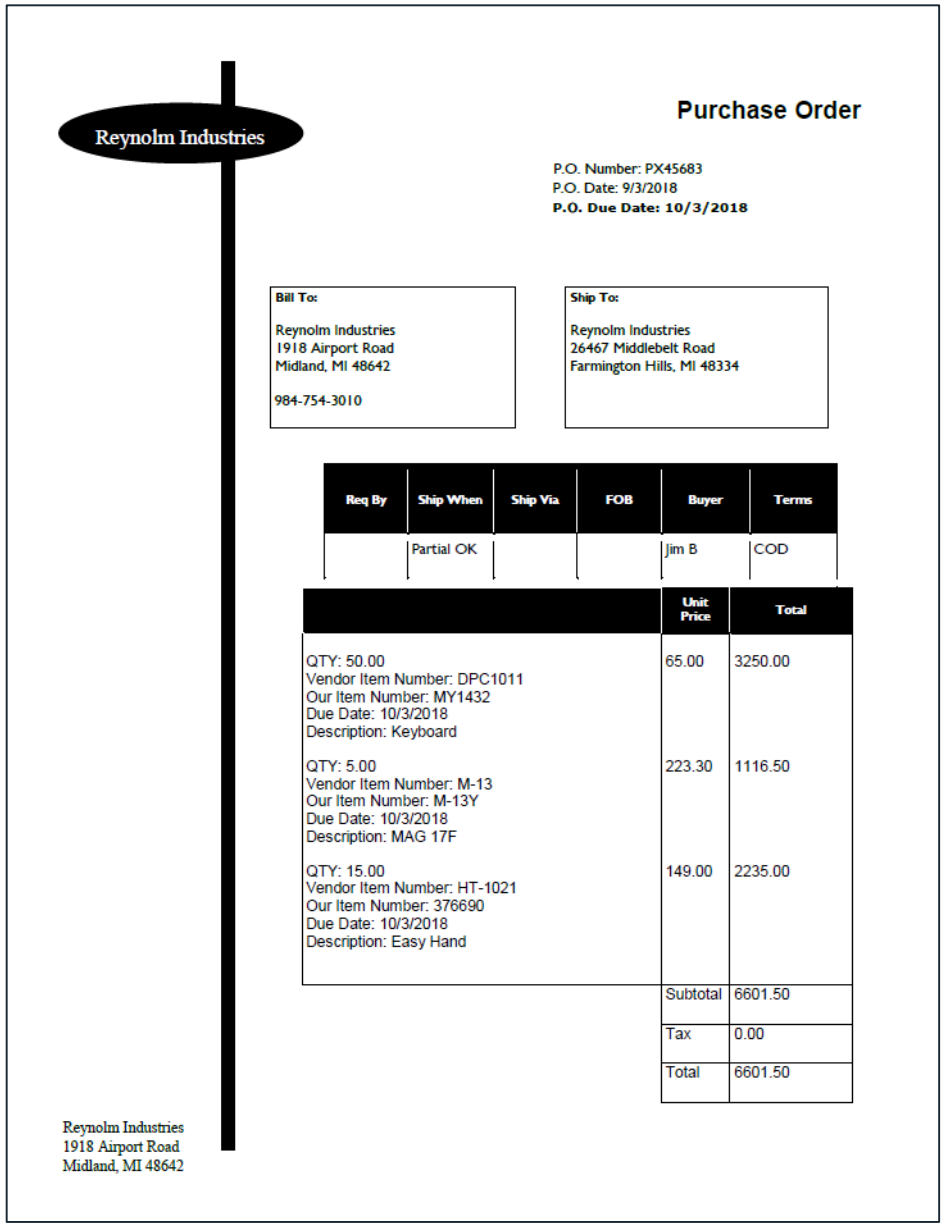

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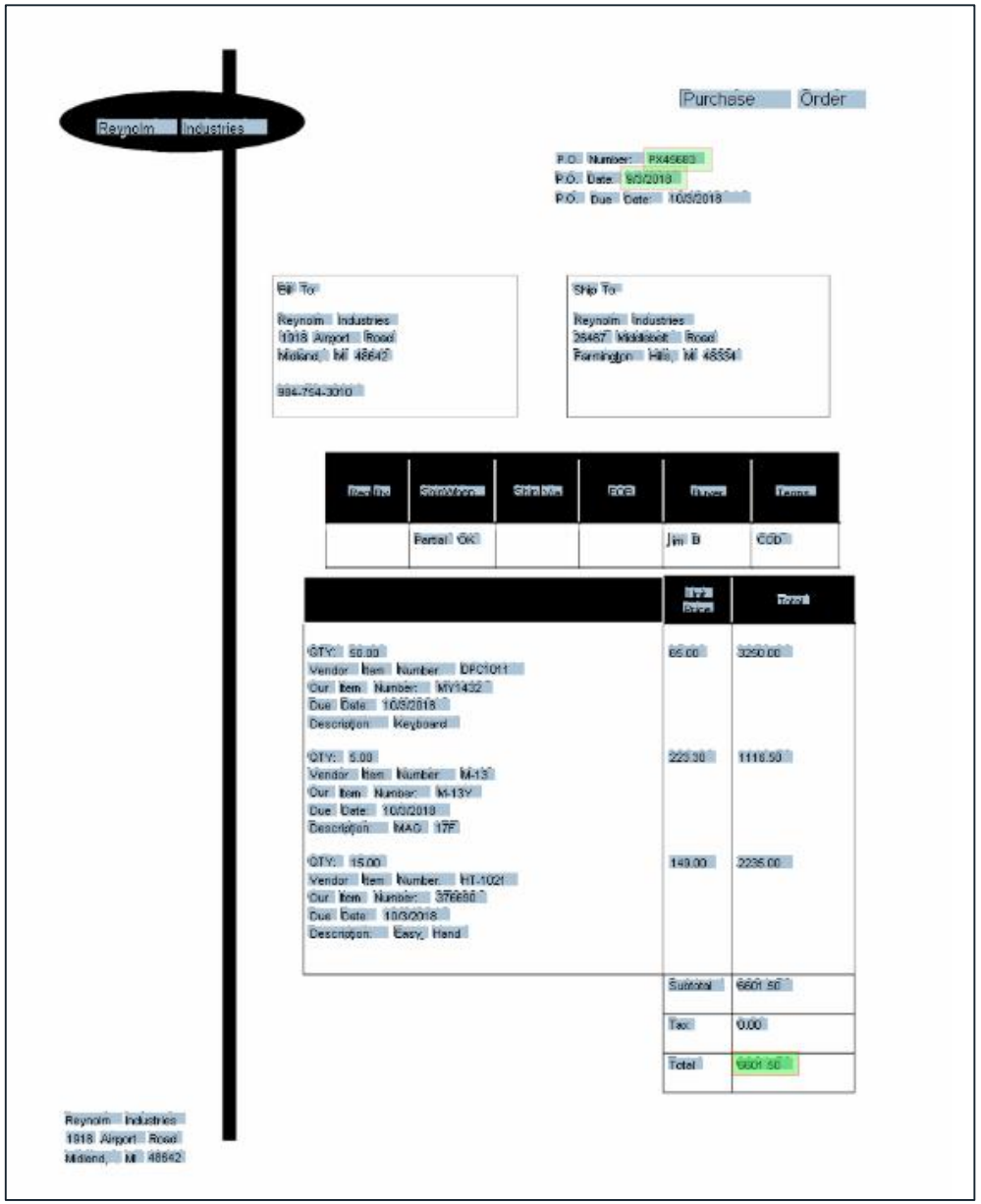
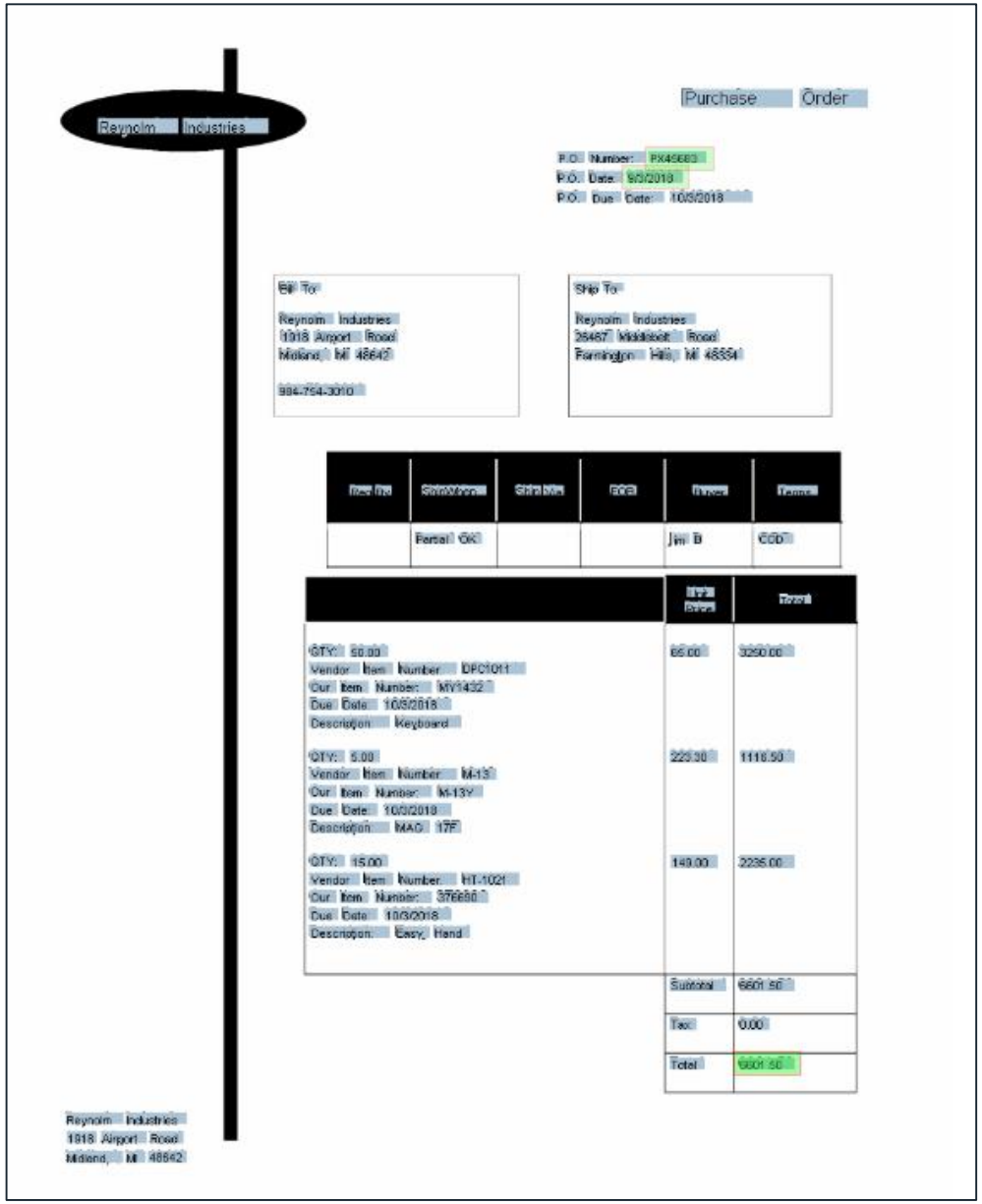


STEP #1: TEXT EXTRACTOR, ORDERING OF THE TOKENS IN Z ORDER



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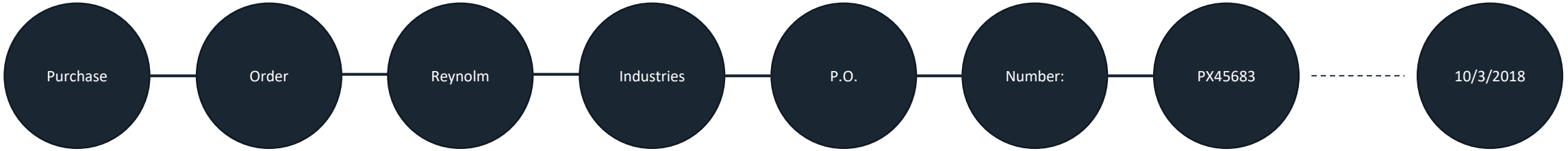
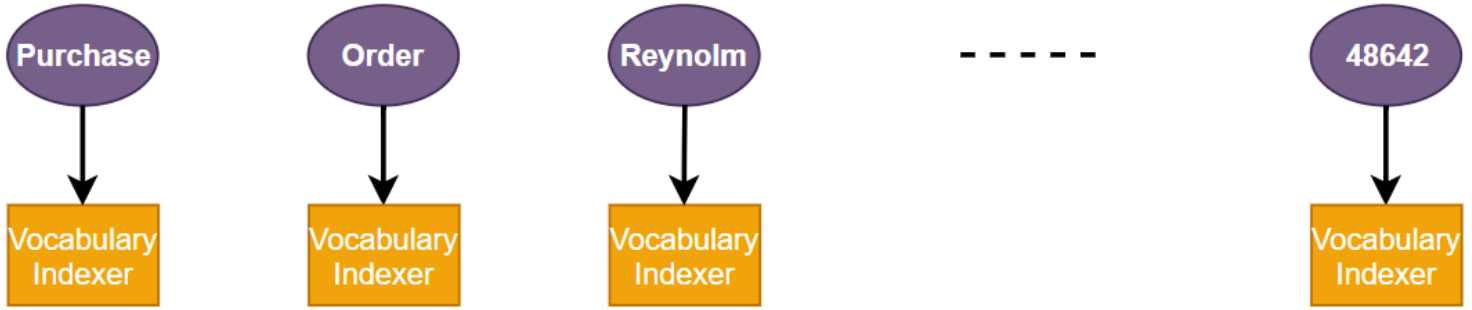


STEP #2: VOCABULARY INDEXER



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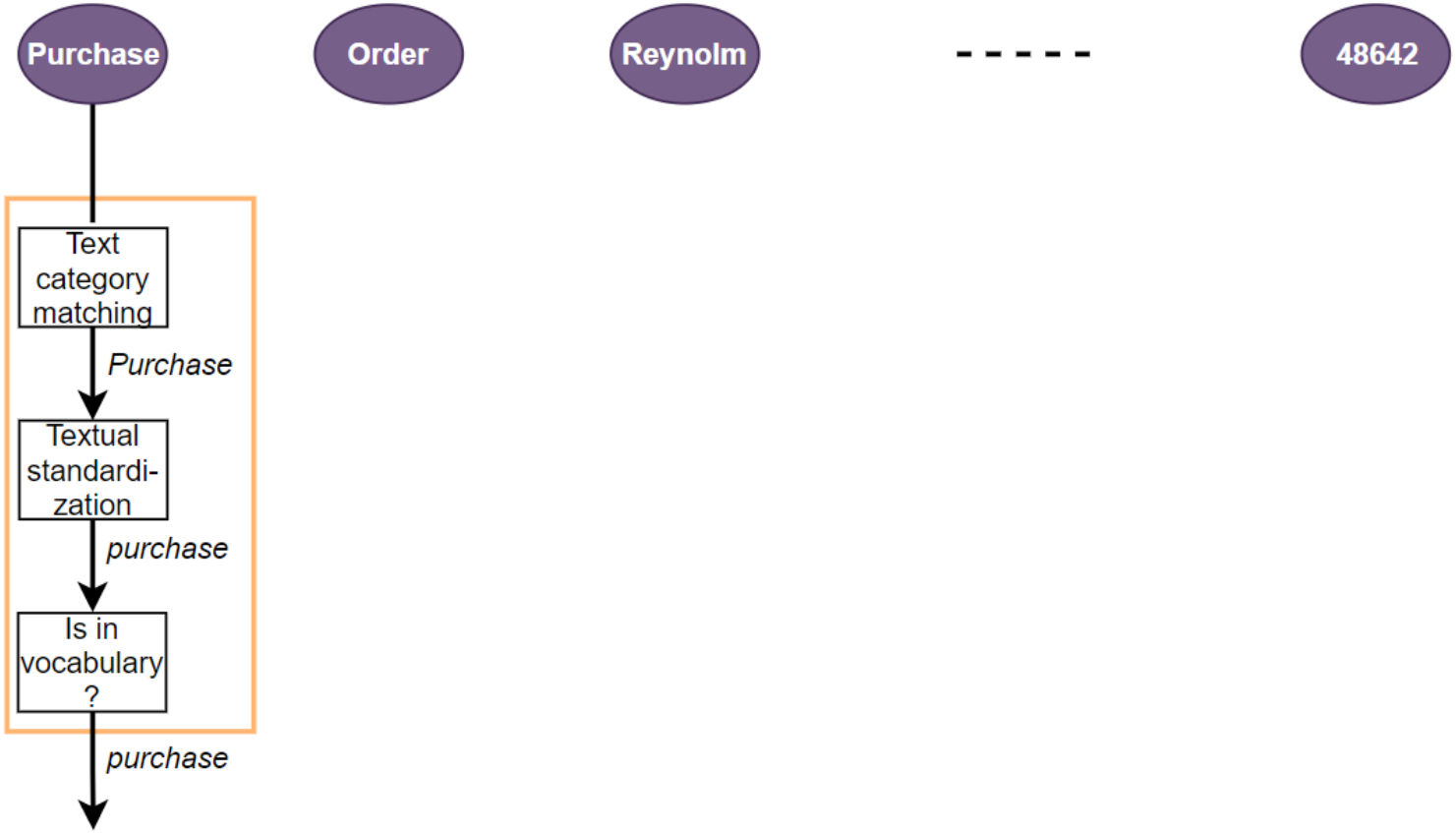

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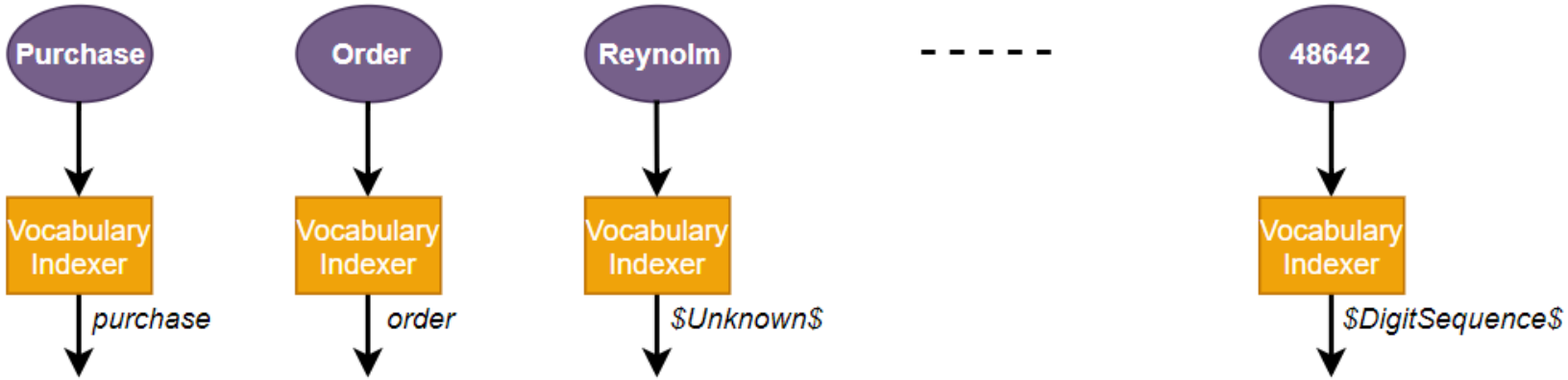
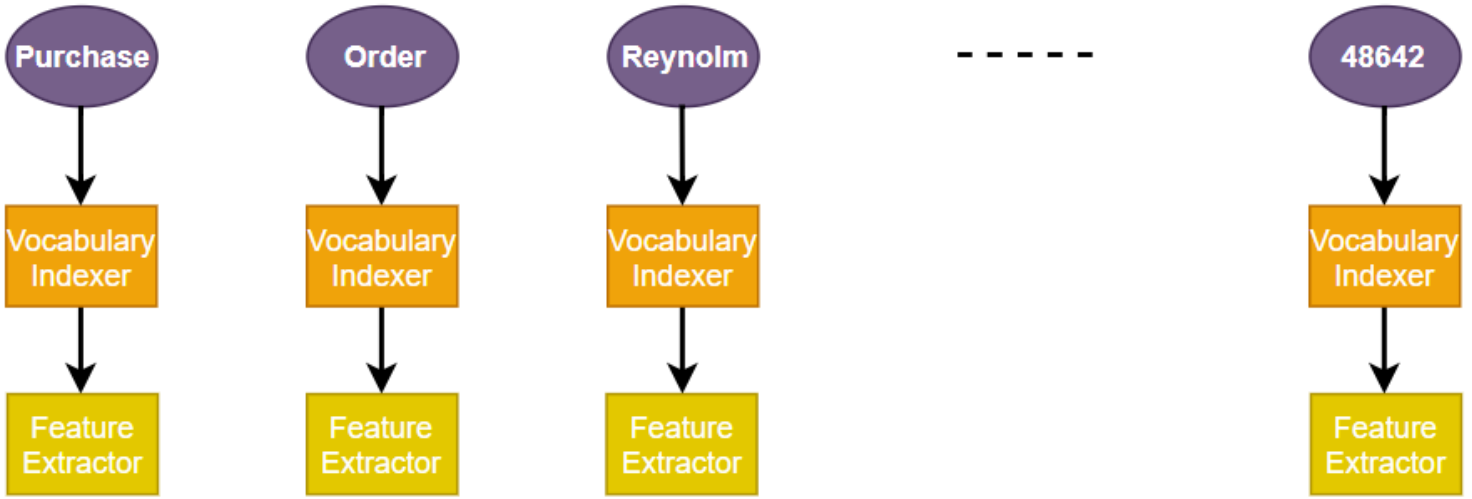


STEP #3: FEATURE EXTRACTOR



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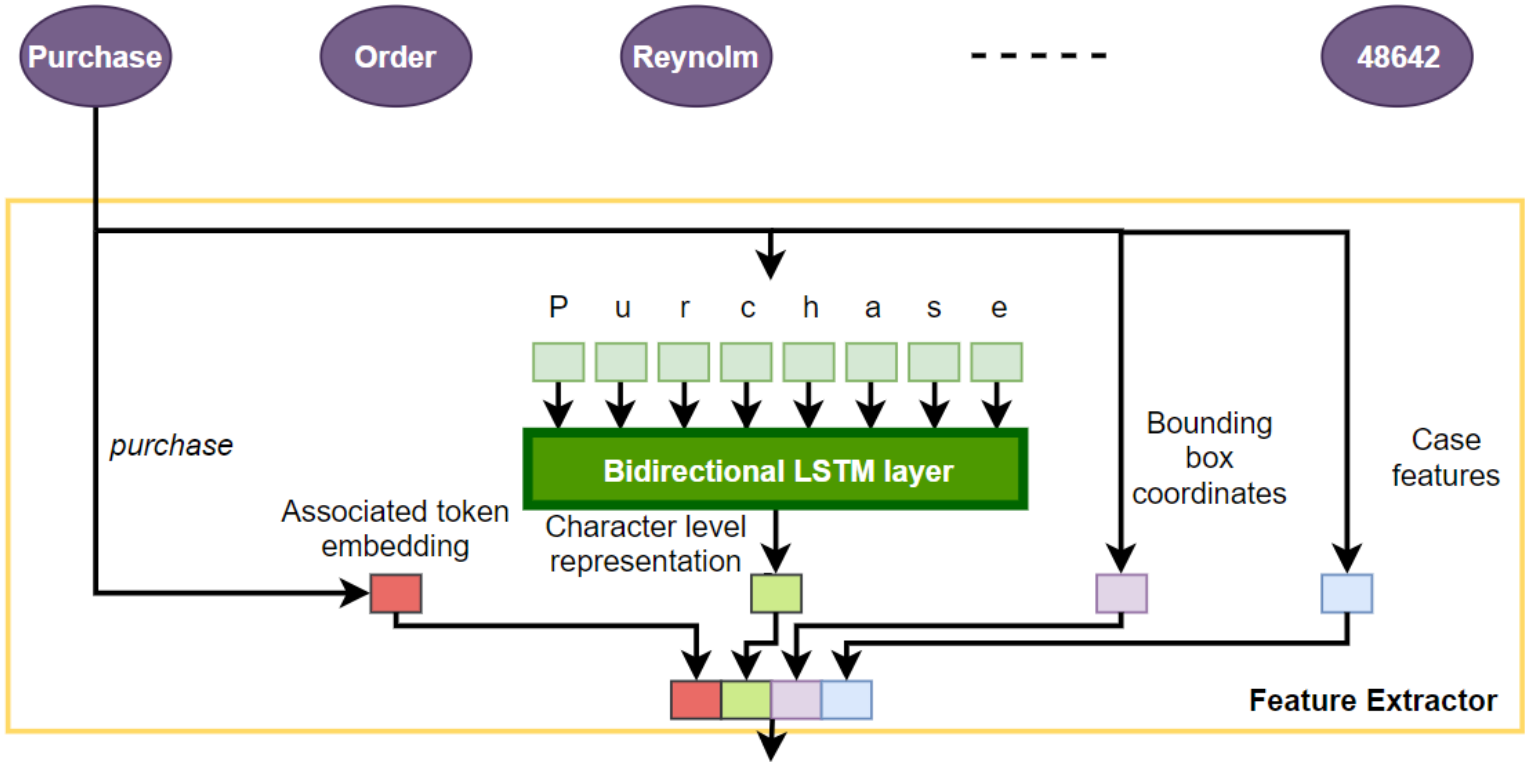
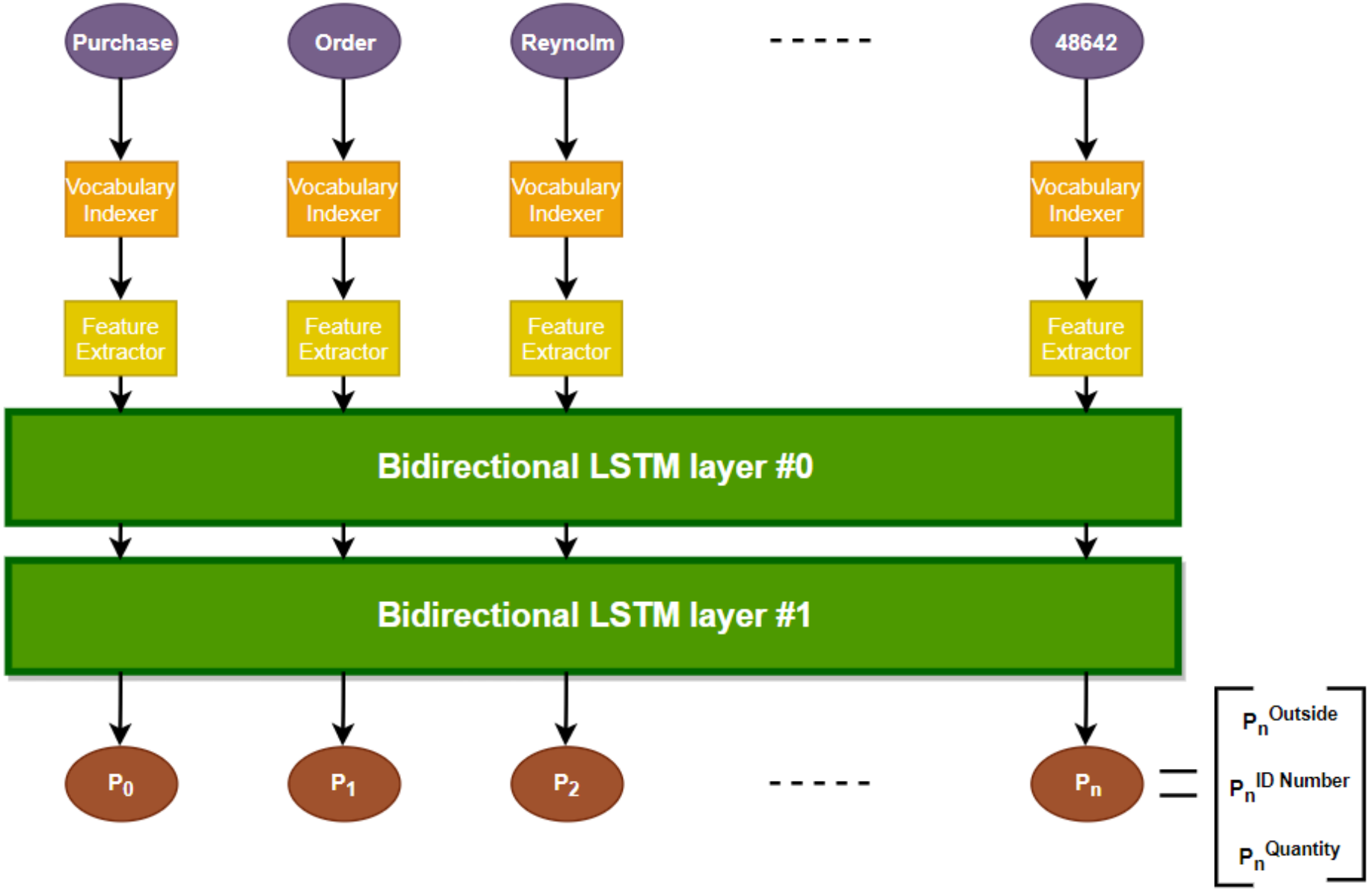


STEP #4: TOKEN LEVEL CLASSIFIER



BASELINE: FEEDFORWARD NEURAL NETWORK WITH LOCAL CONTEXT

- BLSTM layers are replaced by dense feed forward layers with equivalent number of parameters

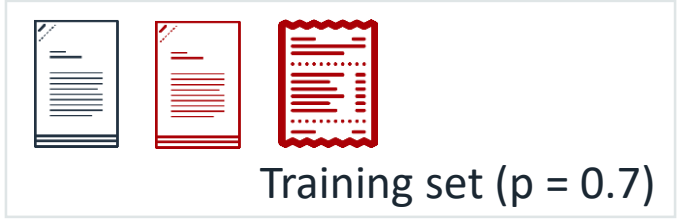
- For fair comparison, the baseline is enhanced with local context in its inputs:
  - For a given token, the feature vectors of its 4 closest tokens on the document - one in each direction - are concatenated with its own feature vector

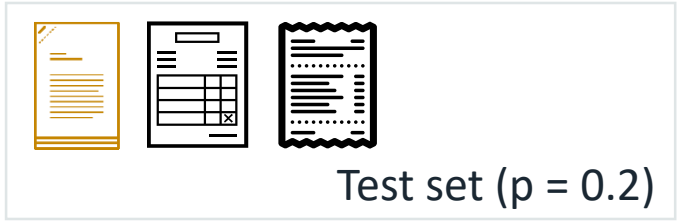
DATASET USED FOR EXPERIMENTS

- Dataset created with documents from Esker platform:
  - 28,570 purchase orders in English language
  - Originating from 2,818 distinct issuers, each having between 3 and 31 document instances
  - Within a document, there is on average more than 3 ordered products

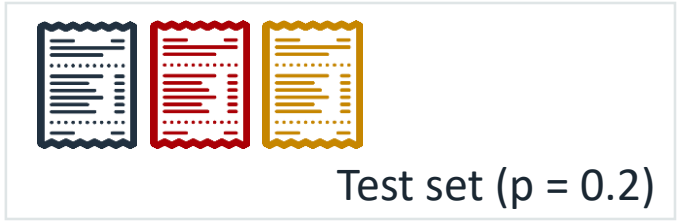
EXPERIMENTS DESCRIPTION

Splitting dataset at document level





Splitting dataset at issuer level



HYPER PARAMETERS VALUES BASED ON VALIDATION PERFORMANCES

- 64 dimensional textual embeddings
- RNN model is composed of two bidirectional LSTM layers of 1,300 cells each
- Baseline has two dense layers with 6,947 and 1,300 rectified linear units

EXPERIMENTS RESULTS

TABLE I
EXTRACTION PERFORMANCES FOR DOCUMENTLEVELSPLITTING EXPERIMENT.

	F1 score		Precision		Recall	
Field	Baseline	RNN	Baseline	RNN	Baseline	RNN
ID number	0.8532	**0.9064**	0.8633	**0.9083**	0.8435	**0.9051**
Quantity	0.9260	**0.9641**	0.9022	**0.9549**	0.9521	**0.9736**
Micro avg.	0.8889	**0.9343**	0.8825	**0.9309**	0.8956	**0.9380**

TABLE II
EXTRACTION PERFORMANCES FOR ISSUERLEVELSPLITTING EXPERIMENT.

	F1 score		Precision		Recall	
Field	Baseline	RNN	Baseline	RNN	Baseline	RNN
ID number	0.6851	**0.7522**	0.6887	**0.7694**	0.6870	**0.7380**
Quantity	0.8475	**0.8938**	0.8423	**0.9016**	0.8586	**0.8882**
Micro avg.	0.7640	**0.8207**	0.7625	**0.8338**	0.7692	**0.8102**

CONCLUSION

- Proposed a generic template-free approach for extracting table field in business documents that is able to deal with unknown layouts

- By experimenting on a large dataset of real world purchase orders, we showed that using recurrent connections is beneficial for the information extraction
  - On unknown templates, micro F1 score of 0.821 compared to 0.764 for the baseline

FUTURE WORK

- Experimenting model with character level textual representations generated by a RNN in order to provide a more granular parsing of the text

- Getting more structured predictions :
  - Conditional Random Field (CRF) layer on top of the RNN
  - Tackles end-to-end recognition of structured tabular entities

- Assess the behavior of our extraction models when confronted with a multilingual dataset

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