Solving Price Per Unit Problem Around the World: Formulating Fact Extraction as Question Answering

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India Machine Learning

Price Per Unit (PPU)

- What is PPU at Amazon?
- How does it help the customer?

PPU in Amazon Catalog

Featured from our brands

AmazonFresh Colombia Ground Coffee, Medium Roast, 12 Ounce

Ground · 12 Ounce (Pack of 1)

4.5 out of 5 stars ~ 1,573

$5.30 ($0.44/Ounce)

Save more with Subscribe & Save

prime **Today 1PM - 6PM**

Sponsored

Gevalia Colombian Medium Roast Ground Coffee (12 oz Bags, Pack of 6)

Colombian · Ground · 12 Ounce (Pack of 6)

4.8 out of 5 stars ~ 580

$35.88 ($0.50/Ounce)

Save 5% more with Subscribe & Save

Sponsored

Gevalia Colombian Blend Medium Roast K-Cup Coffee Pods (72 Pods,12 Count (Pack of 6))

Pods · 12 Count (Pack of 6)

4.5 out of 5 stars ~ 337

$48.55 ($0.67/Count)

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Featured from our brands

Amazon Brand - 100 Ct. Solimo Dark Roast Coffee Pods, Compatible with Keurig 2.0 K-Cup Brewers

Dark Roast · Pods · 100 Count (Pack of 1)

4.5 out of 5 stars ~ 26,987

$29.99 ($0.30/Count)

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Ground · 12 Ounce (Pack of 1)

4.4 out of 5 stars 1,573

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Save more with Subscribe & Save

prime **Today 1PM - 6PM**

Sponsored

Gevalia Colombian Medium Roast Ground Coffee (12 oz Bags, Pack of 6)

Colombian · Ground · 12 Ounce (Pack of 6)

4.7 out of 5 stars 580

$35.98 ($0.50/Ounce)

Save 5% more with Subscribe & Save

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Challenge with PPU

- What are the challenges with PPU?
- How does we tackle them?

Challenges with PPU

- Sellers put wrong PPU info
- Specify it in free-text
- Unstructured
- Extracting only relevant values
- Computing total quantity
- PPU on product image

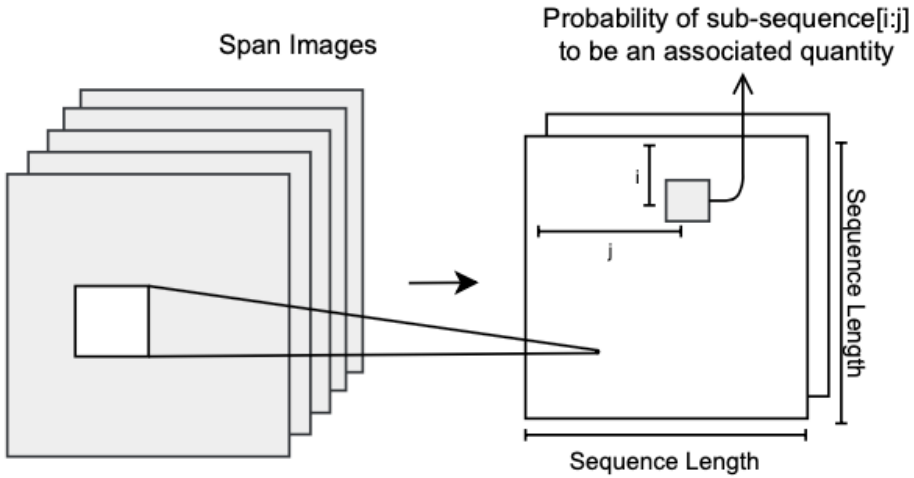
Product Title	UoM	Total Quantity
Maxwell House Original Roast Ground Coffee K Cups, Caffeinated, 6 ct - 12.4 oz Box - PACK OF 2	Count	12
Maxwell House Original Roast Ground Coffee, Caffeinated, 6 ct - 60 g Box - PACK OF 2	Weight	720
Tansukh Panchkol Powder for Hyperacidity and Digestion, red 60 gm (Pack of 2),(total 120 gm)	Weight	120
Niconi Advanced Hand Sanitizer with 8 Hour Germ Protection Lemon - 200 ml (pack of 2), (100 ml each)	Volume	200
Nutratech Creatine Monohydrate Micronized - 200 g (Blueberry Flavor), 5000 mg Amino powder, 100 g extra	Weight	300

Problem Formulation

Problem Formulation

- Named Entity Recognition (NER) is a de-facto solution to fact extraction. However, it does not allow to couple start and end indices explicitly to check for their compatibility while training and are prone to small variations, for e.g., "*fluid ounce*" or "*fl oz*", which need to be tagged.

- To overcome these limitations, we introduce a span-image architecture that works at a character-level and employ a QA approach to quantity extraction which conditions the extractor model with UoM type specific question (*eg. "What is the total volume?"*).



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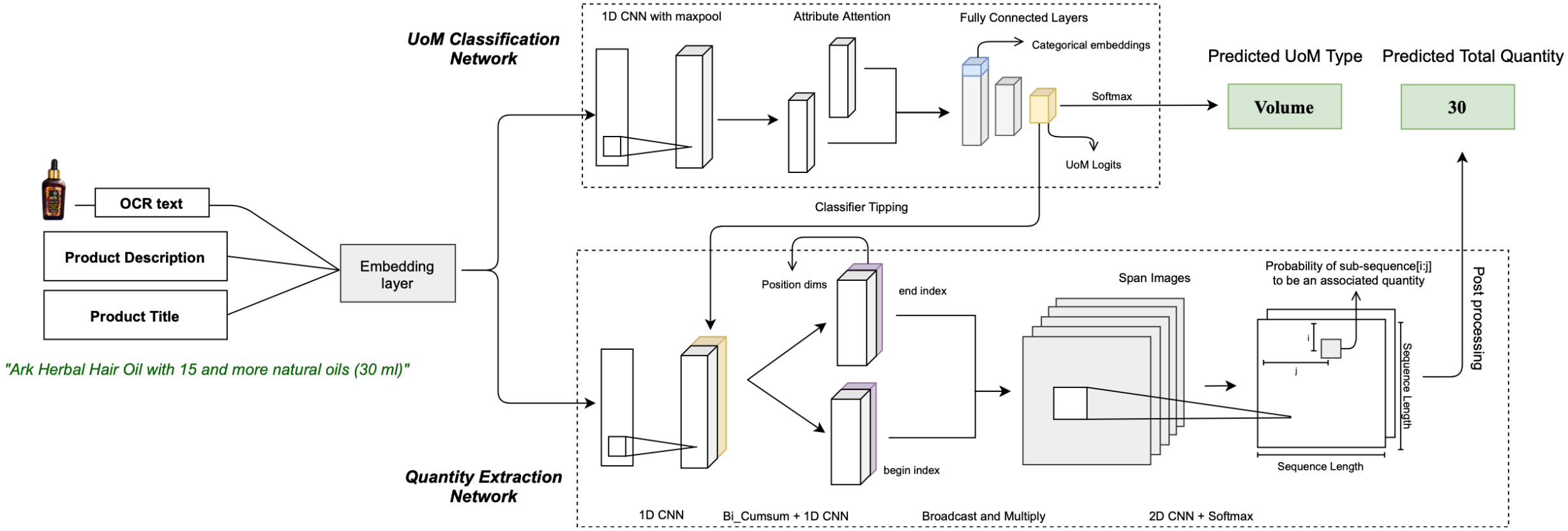
- Formally, for a product P with set of N text attributes - $\{a_1^P, a_1^P, \dots a_N^P\}$, with character sequences $x^i = \{x_1^i, x_2^i, \dots x_{n_i}^i\}$, where $x_j^i \in \mathbb{R}^k$ are k-dimensional character embedding for j^{th} character in the sequence of length n_i for attribute a_i^P, task is to predict UoM type and use it to predict the begin and end indices of all relevant quantities in each x^i.

Model Architecture

UoM Classification and Quantity Extraction Networks



Results

- How did we obtain training dataset?
- How does our model fare with the baselines?
- How does we deploy our model?

Dataset

- We used auditors for UoM type and total quantity
- Tag parts of the title using some heuristics
- Add noise
  - adding, deleting, changing characters
  - adding gibberish words
- We trained US, EU-5 and IN models with training dataset of sizes 430k, 270k and 150k respectively and used 10% held-out set.

Table 2: Distribution of products by number of spans

Span length	Count	Percentage
0	311,248	54.09%
1	198,200	34.45%
2	64,811	11.26%
3	1,127	0.20%

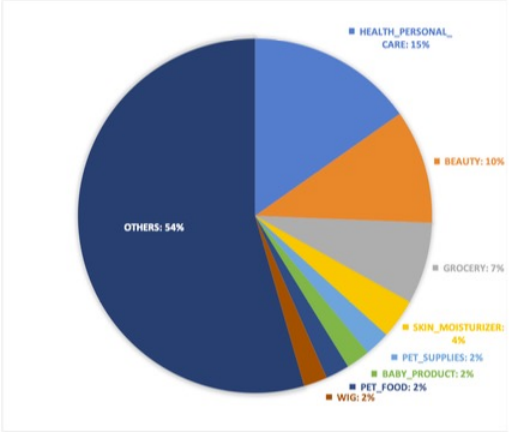


Figure 3: Distribution of product categories in the Amazon catalog

Comparison with Rule-based models

Table 3: PR comparison between our PPU model with the rule-based model in US marketplace

Task		Rule-Based				PPU Model			
		Volume	Weight	Count	Overall	Volume	Weight	Count	Overall
UoM Classification	P	90.0	61.9	79.1	77.2	91.6	87.9	97.0	93.6
	R	24.3	38.3	4.8	17.2	88.3	95.2	94.8	93.5
	F1	38.3	47.3	9.1	28.1	**89.9**	**91.4**	**95.9**	**93.5**
Quantity Extraction	P	83.6	57.7	52.8	60.6	**95.1**	**95.1**	**95.0**	**95.0**
	R	22.5	35.7	3.2	15.3	41.6	35.9	30.9	34.4
	F1	35.5	44.1	6.0	24.4	57.9	52.1	46.6	50.5

Comparison with BERT models

Table 5: Problem formulation - Comparative results between Fact Extraction approach using BERT and Question Answering approach using our PPU model across all marketplaces.

Marketplace		Fact Extraction				Question Answering			
		Volume	Weight	Count	Overall	Volume	Weight	Count	Overall
EU-5	P	93.3	93.9	86.8	89.9	**95.0**	**95.1**	**87.1**	**90.8**
	R	45.3	34.4	37.0	38.8	18.0	14.2	21.7	19.2
	F1	61.0	50.4	51.9	54.1	30.3	24.7	34.7	31.7
IN	P	**95.0**	95.0	**90.9**	93.1	95.0	**95.1**	89.7	**93.2**
	R	83.5	76.4	33.7	61.2	69.4	69.0	45.0	60.7
	F1	88.9	84.7	49.1	71.7	80.2	80.0	59.9	73.5
US	P	**95.4**	**95.2**	75.2	84.4	95.1	95.1	**95.0**	**95.0**
	R	49.9	40.7	22.4	32.8	41.6	35.9	30.9	34.4
	F1	65.5	57.1	34.6	46.7	57.9	52.1	46.6	50.5

Latency Scaling

Table 7: Latency scaling (in milliseconds) with respect to number of CPU cores for different models

Number of CPU cores	BERT		PPU model		PPU model - IN	
	Mean	P90	Mean	P90	Mean	P90
2	126	150	104	205	12	21
4	73	89	56	105	8	13
8	69	86	33	56	7	9
16	56	66	21	32	6	7

Thank You!