

Using AI models to improve User experience at eBay Search

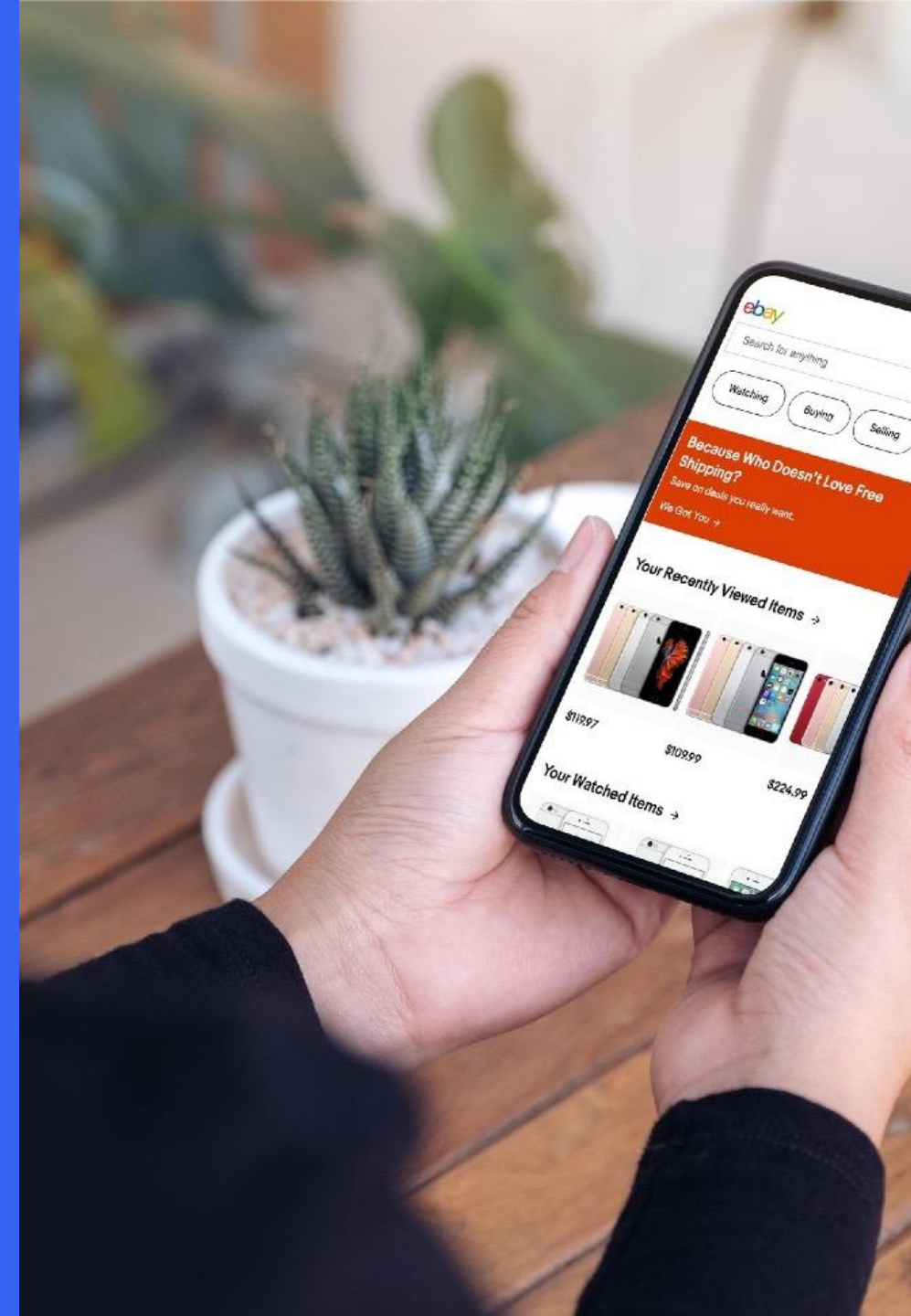
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Overview

- AI at eBay
- Search at eBay
- Spell correction in Search
- Fine-tuning pre-trained LM for Spell correction



eBay today

1.8B live listings

133M active buyers worldwide

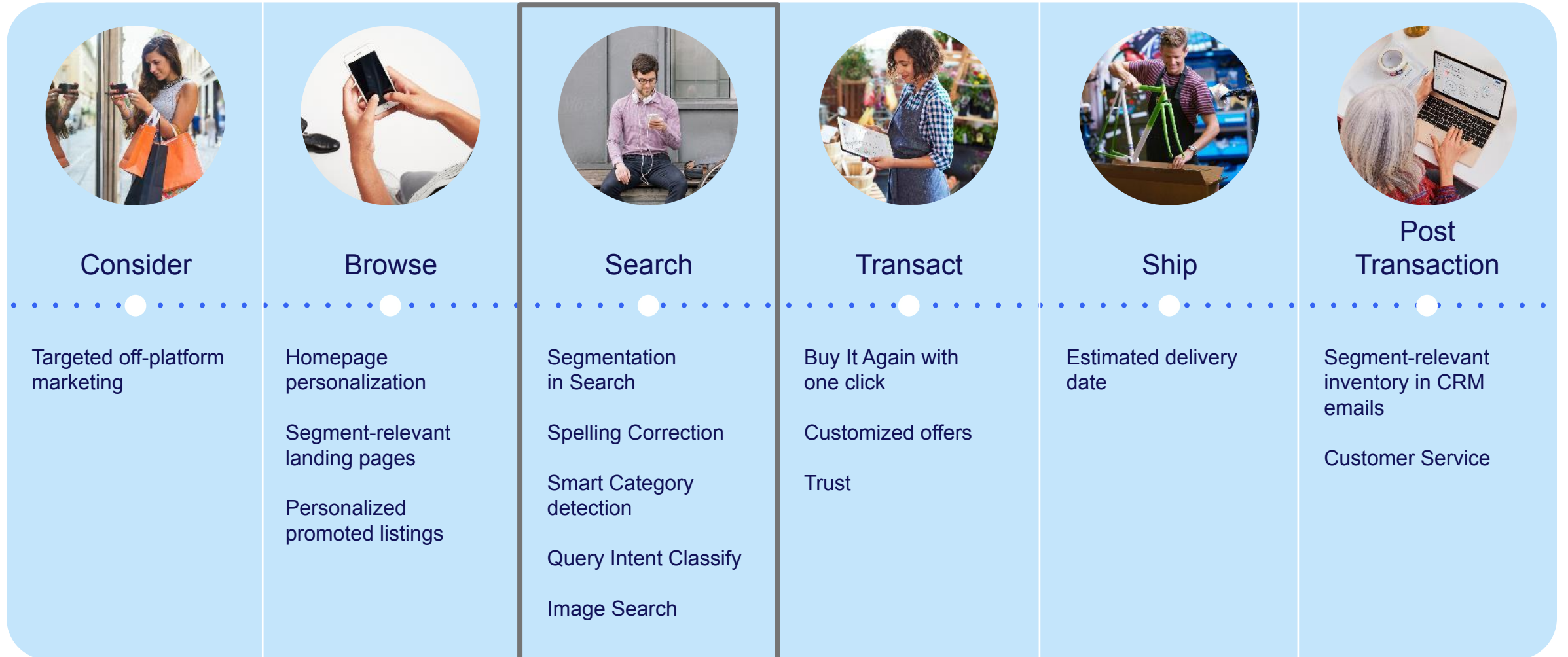
190 markets

\$11.6B mobile volume

As of Q1 2023



eBay AI at Every Step of the Shopping Journey



Search Science at eBay



Search at eBay

Drives a lion's share of the business



400 Million searches/day



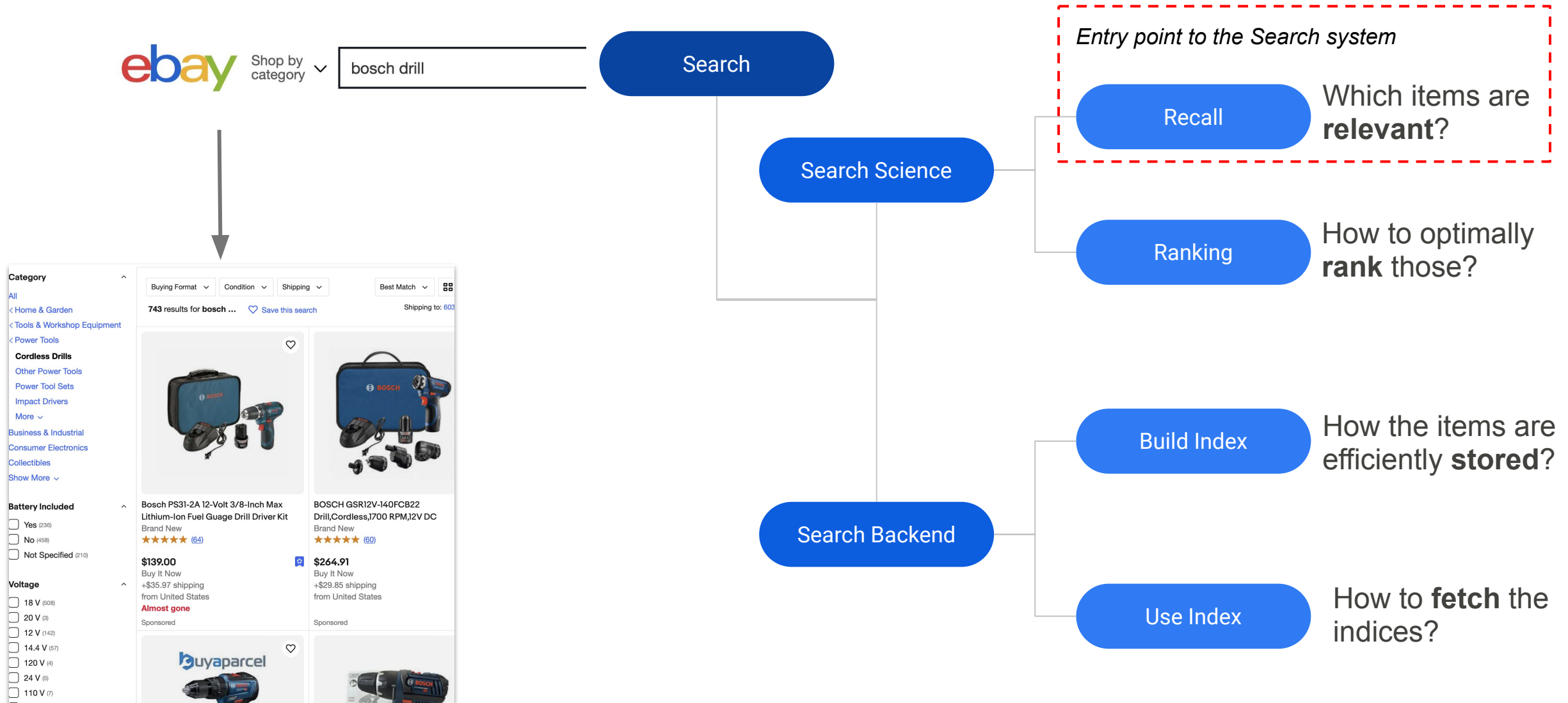
>99% availability



Largest scale ML application



Search Ecosystem at eBay



Spell Correction at eBay



Queries with misspelled words



Shop by category

ipone

All Categories

Price

\$ Min to \$ Max

[See all](#)

Buying Format

- All Listings
- Auction
- Buy It Now

All Listings

Auction

Buy It Now

Condition

Shipping

Local

0 results for ipone [Save this search](#)

Shipping to: 10041

No exact matches found

Save this search to receive email alerts and notifications when new items are available.

[Save this search](#)

[Tell us what you think](#)

Why is Spell Correction important

- ~**10%** of search traffic contains spelling mistakes
- Spelling correction **directly impacts** the *null and low* search results
- Leads to a **more relevant item** set retrieval
- Users expect that search should be **robust** towards erroneous queries

Spell correction approaches at eBay

Dictionaries

Manually created dictionary with popular mistakes for limited amount of entities

ipone 13	Cell Phones & Sm... ▾	Search
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Showing results for ipone 13 and iphone 13. Search instead for **your original query**



Apple iPhone 13, A2482, 128GB, Unlocked, Good Condition (Free Ship)

Good - Refurbished

★★★★★ [7 product ratings](#)

\$543.40

Buy It Now

Free 2 day shipping

Free returns

✓ **eBay Refurbished**

472+ sold

★ Top Rated Plus

ML model

Machine learning model capable of improving spelling mistakes in the rest of queries

bottle holder	All Categories ▾	Search
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Showing results for bottle holder and bottle holder. Search instead for **your original query**



Cycling Bike Water Bottle Holder Mount Handlebar Bicycle Drink Cup Bottle Cage

Brand New

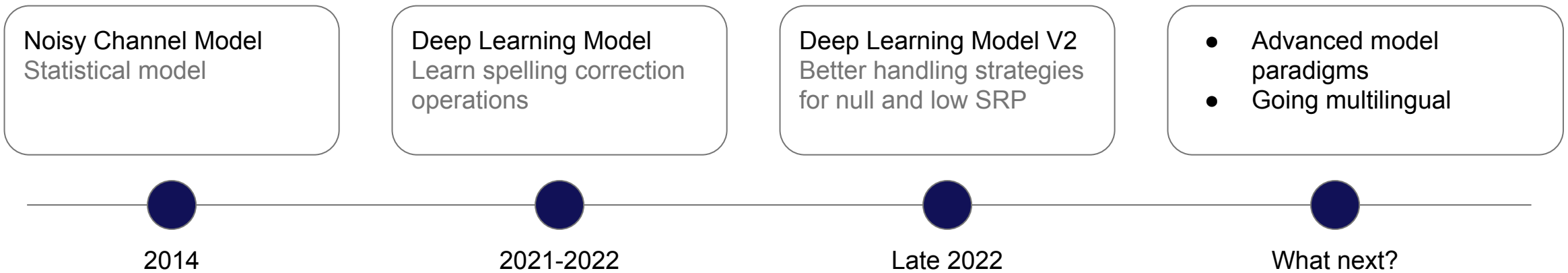
\$6.79 to \$6.99

Buy It Now

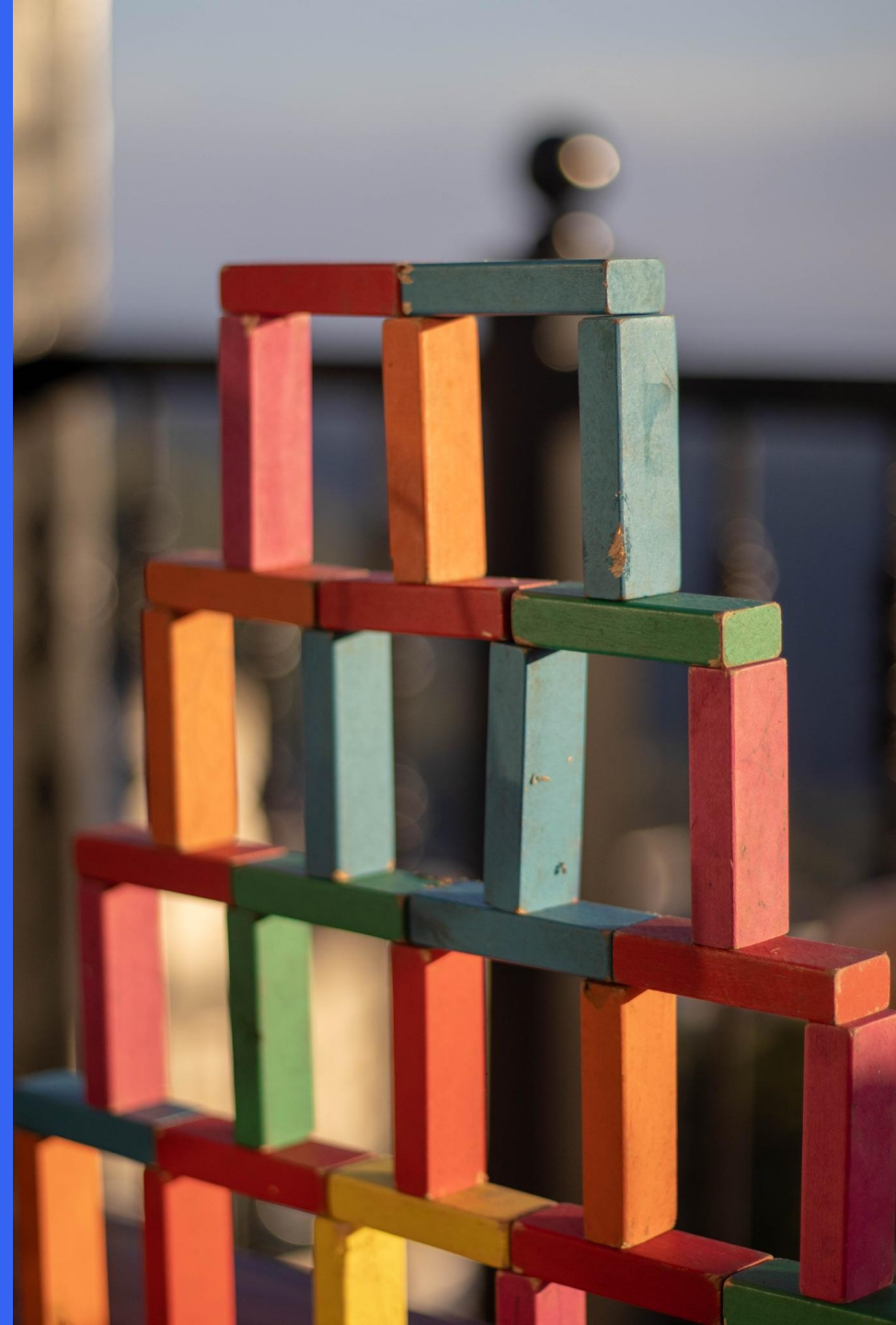
Free 3 day shipping

350+ sold

History of Spell Correction at eBay



Technical Background



General Spell Correction approach

Seq2label models

- Input: a **Sequence** of tokens
- Output: a sequence of corresponding **labels**
- aka **Sequence** → **Labels**

Seq2seq models

- Input: a **sequence** of tokens
- Output: a **sequence** of tokens
- aka **Sequence** → **Sequence**

Seq2Label models

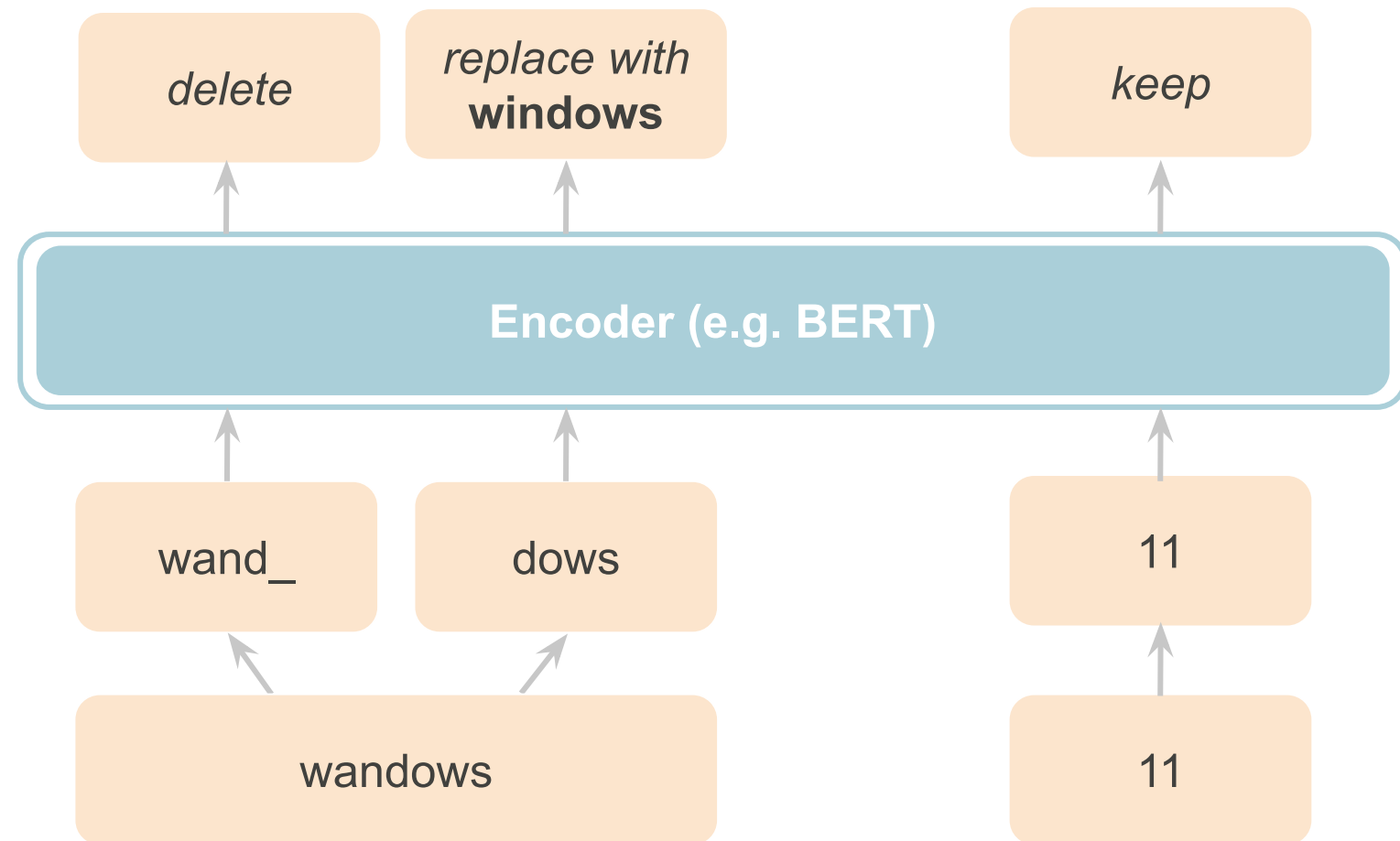
edit operations

keep, delete,
replace with {token},
insert {token}

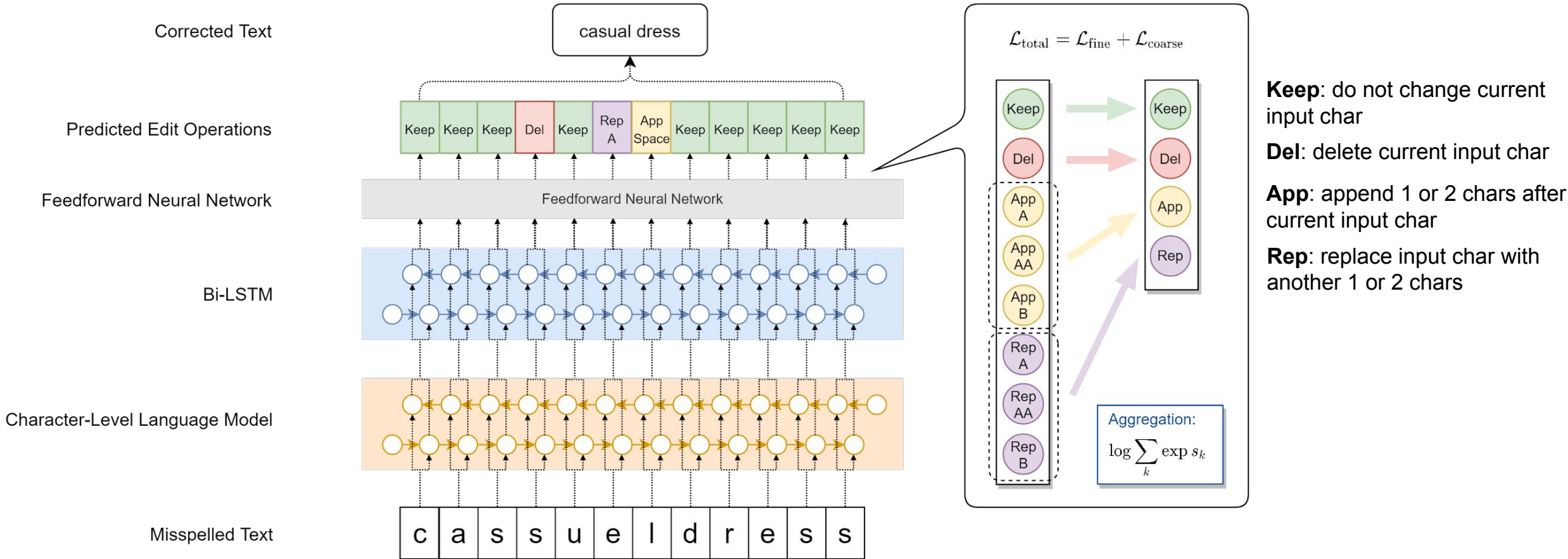
model

tokenized query

user query

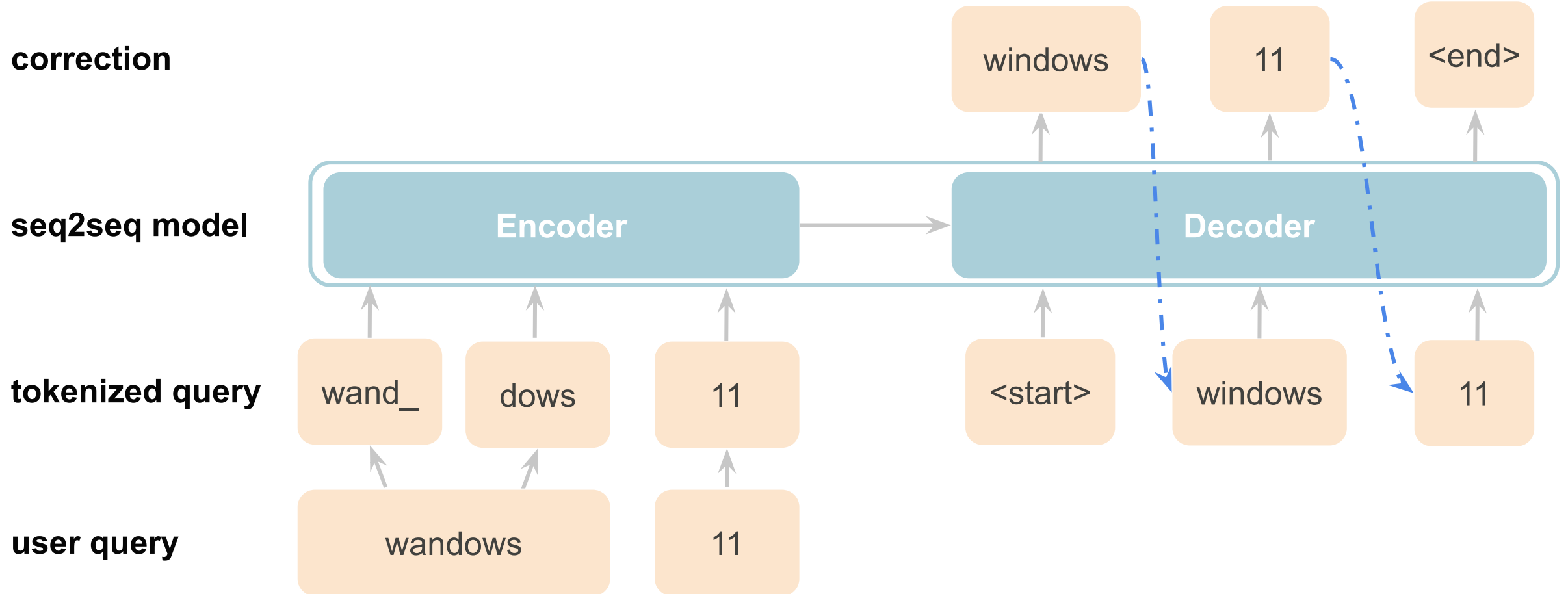


Character-level Seq2Label model at eBay



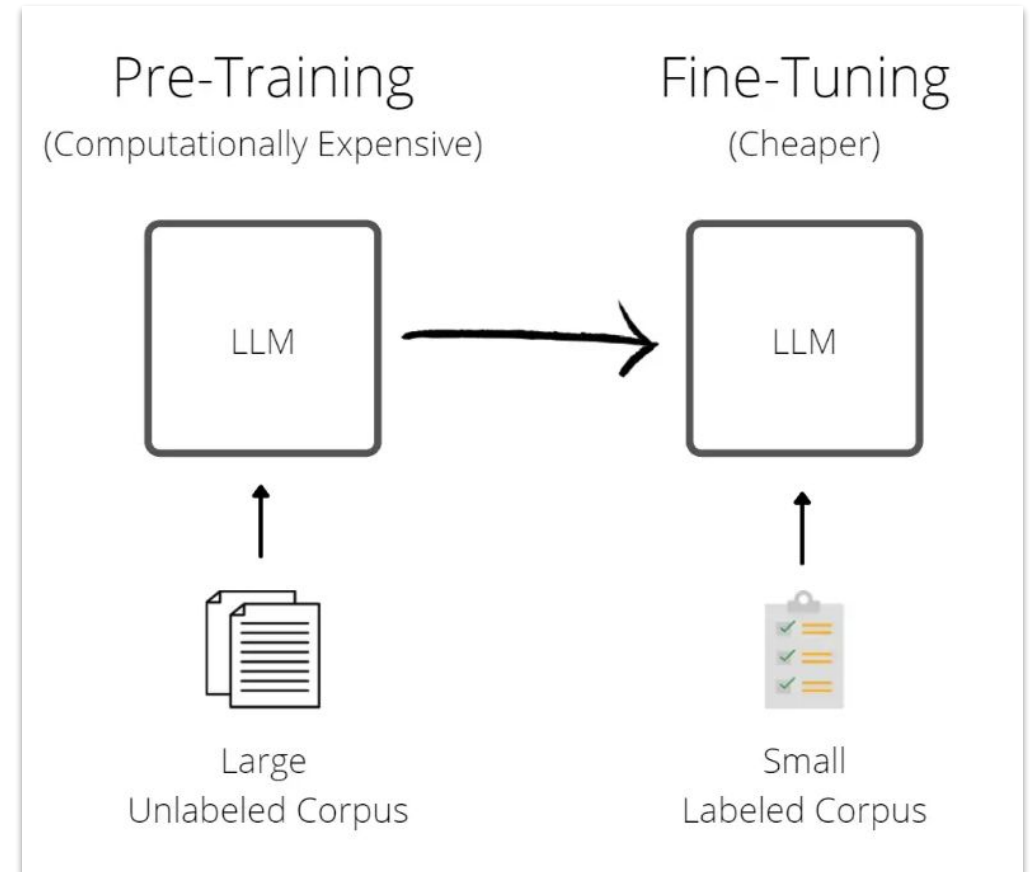
* Mengyi Gao, Canran Xu, and Peng Shi. 2021. Hierarchical character tagger for short text spelling error correction <https://arxiv.org/abs/2109.14259>

Seq2Seq models



What is Fine-tuning Paradigm

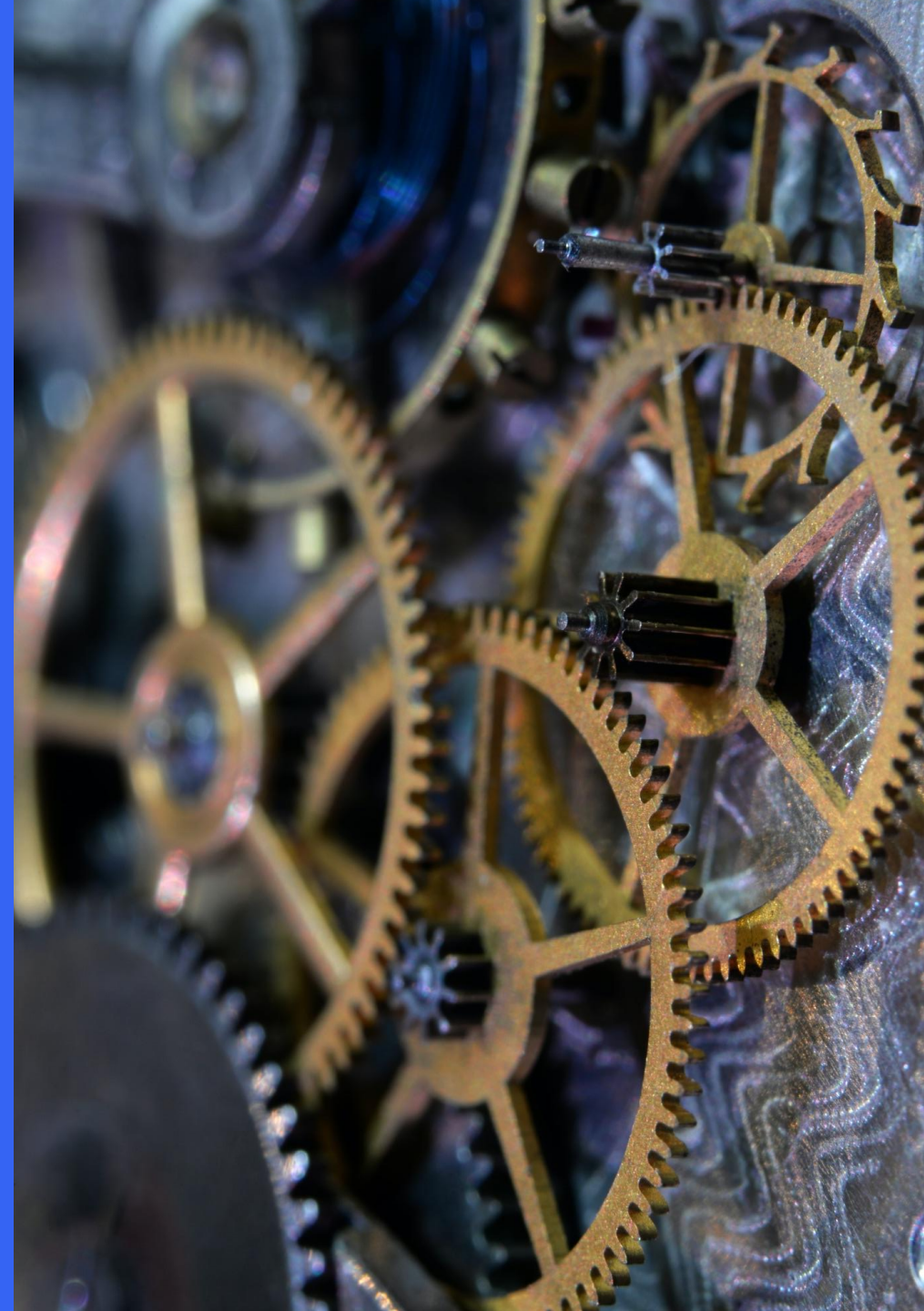
- A *Language Model (LM)*, is a type of DL model capable of generating human language. Informally, models with over 1B parameters are considered *Large LMs*.
- *Pre-training* is a technique used in natural language processing to train a language model on a large amount of unlabeled text data.
- *Fine-tuning* is to “tweak” (unfreeze model and re-learn task specific params) for specific use cases. Taking advantage of model’s previous knowledge.



Why Seq2Seq Pre-trained models?

	Less Customization Overhead	Understands longer context	Has open domain knowledge	Easy Multilingual adaptation	Only Few Samples Required to train	Fast Inference Speed
Seq2Label Custom Model	✗	✗	✗	✗	✗	✓
Seq2Label Pretrained Model	✗	✗	✓	✓	✓	✓
Seq2seq Custom model	✓	✓	✗	✗	✗	✗
Seq2seq Pretrained model	✓	✓	✓	✓	✓	✗

Models and Evaluations



Model Choices

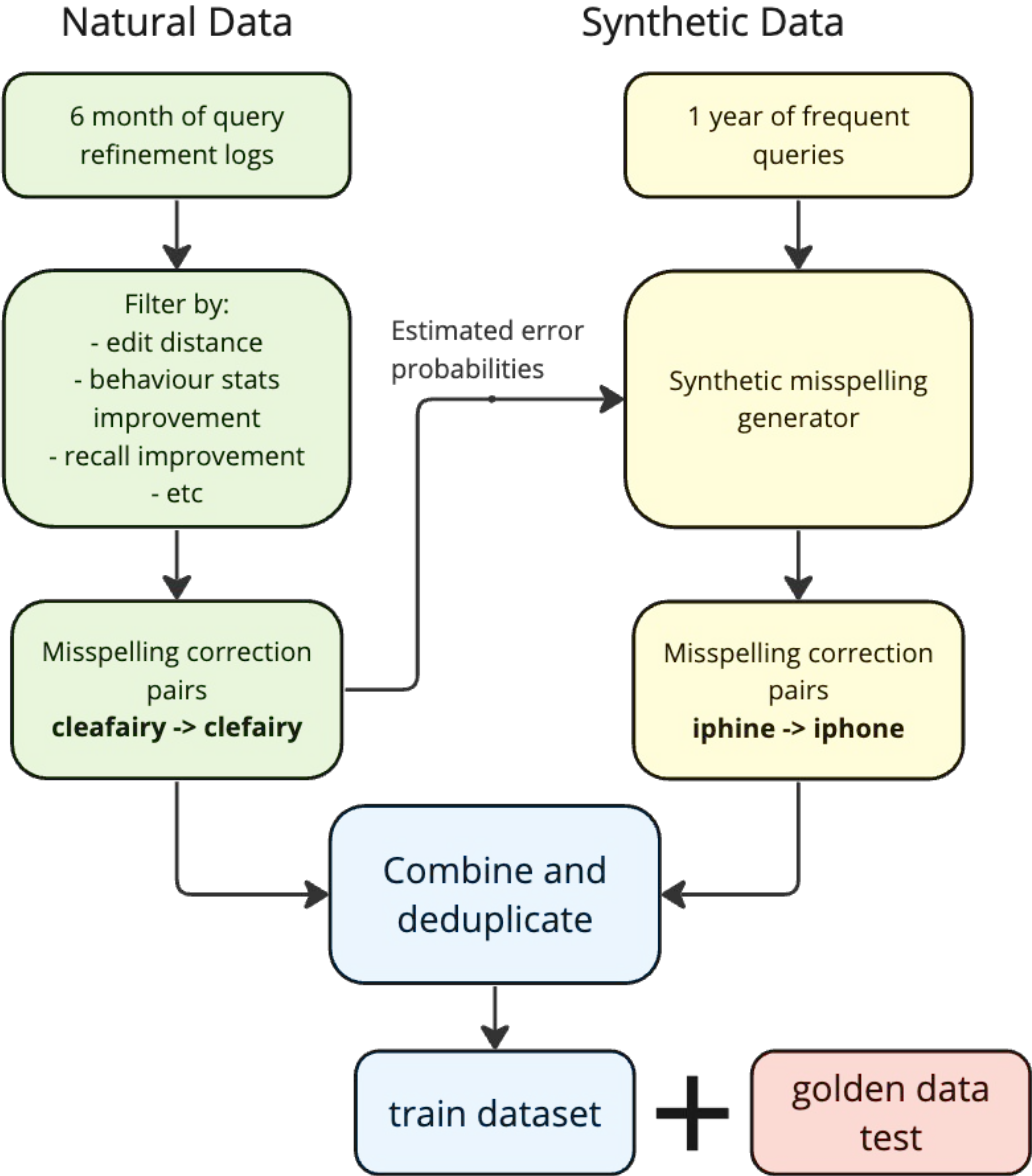
How we choose these models?

- Pretrained from multiple NLP tasks: summarization, translation, denoising, etc.
- Preferably with multi-lingual variants

What models did we choose?

Class of models	Model	# params (millions)	Pretrained languages
T5	T5-small	60	English, French, Romanian, German
	T5-large	738	English, French, Romanian, German
	mT5-small	300	101 languages: English, Spanish, German, French, etc
BART	BART-base	139	English
	mBART-large	611	53 languages: English, German, Spanish, French, etc

Data collection strategy



Training Data Samples

Source	Target	Type
camo cargo mens	camo cargo mens	correct
power srering pump parts	power steering pump parts	synthetic
vibtage boxing cards	vintage boxing cards	natural
bmw e30 mirror	bmw e30 mirror	correct
higo boss mens shoes	hugo boss mens shoes	synthetic
sonyw670	sony w670	natural
detroit tigets hat	detroit tigers hat	natural
old lego star wars sets	old lego star wars sets	correct
chaeger 1968	charger 1968	synthetic

Models' performance

Different fine-tuned seq2seq models,
(Numbers *relative* to the current seq2label model for English language)

Model	#Params, M	$\Delta F1$, %	$\Delta Accuracy$, %	Inference time
T5-small	60	+2	+2	9x
T5-large	74	+21	+22	31x
Flan-T5-base	247	+19	+18	15x
Flan-T5-large	783	+30	+32	29x
BART-base	139	+23	+24	5x
BART-large	406	+23	+24	11x
Seq2label (current)	28	-	-	1x

One Multilingual **mT5-small** fine-tuned on a mix of 5 languages
(Relative to a seq2label model trained for each language separately)

Language	$\Delta F1$, %	$\Delta Accuracy$, %
English	+20	+21
German	+14	+16
Spanish	+21	+23
French	+21	+20
Italian	+19	+25

Empirical Results

Original input	Seq2label	BART-base	Comment
christine dior sunglasses	✗ christine dior sunglasses	✓ christian dior sunglasses	<i>Better entity handling</i>
large disney seven drawfs	✗ large disney seven drfs	✓ large disney seven dwarfs	
32x32 abercrombie jeans diressed	✗ 32x32 abercrombie jeans dressed	✓ 32x32 abercrombie jeans distressed	<i>Better context handling</i>
skippers fur inside	✗ skippers fur inside	✗ skippers fur inside	<i>slippers fur inside</i>
philips x-treame gen 2	✓ philips x-treme gen 2	✗ philips x-traume gen 2	

Summary

- Overview of eBay Search
- Deep dive into Speller functionality
- Usage of pretrained model for eCommerce

Future Work

- Inference Optimizations
- Using LLMs

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- Mengyi Gao
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Questions