



Learning-To-Rank Framework

How to create an army of models?

30.09.2024

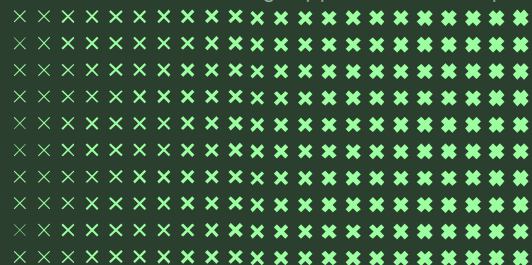
HAYSTACK

Catarina Goncalves
Data Scientist, OLX Group

Marcin Gumkowski
ML Engineer, OLX Group



Image by [pch.vector](#) on Freepik



About us



From **Olhão**, Portugal



BSc and MSc in **Computer Science and Engineering**

@ Instituto Superior Técnico (2017-2022)



Catarina Gonçalves

Junior Data Scientist

Lisbon, Portugal



About us



From **Poznań**, Poland



BSc and MSc in **Computer Science**

@ Poznań University of Technology
(2009-2014)



Marcin Gumkowski

Senior Machine
Learning Engineer

Poznań, Poland



LTR framework

Meet the team



Ilan Dubois

Senior Machine
Learning Engineer



Marcin Gumkowski

Senior Machine
Learning Engineer



**Catarina
Gonçalves**

Junior Data Scientist



**Katarzyna
Wagner-Wojciska**

Senior Data
Product Manager



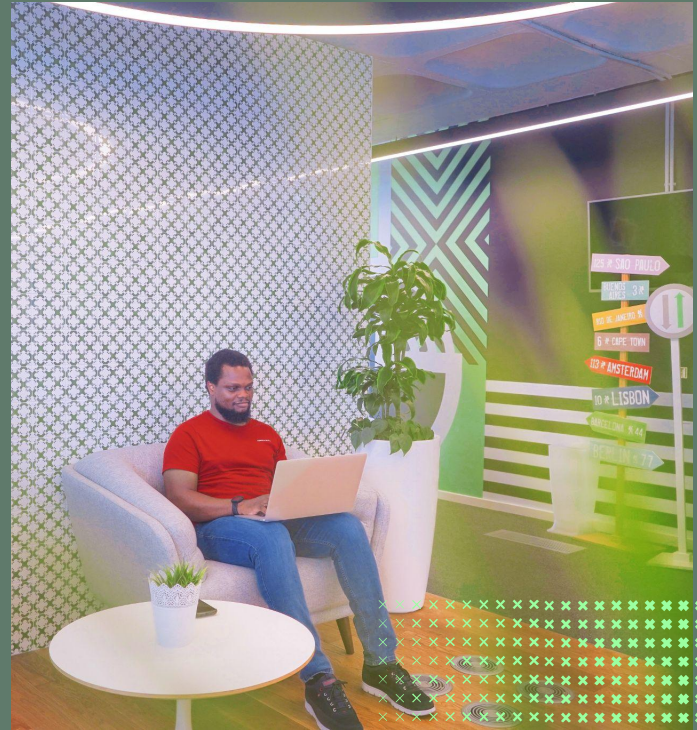
Cristian Martinez

Data Science
Manager



Agenda

- OLX Group
- Learning to rank - algorithm intro (OLX use case)
- OLX Group challenges
- LTR Framework
- Status Quo
- Next Steps and Q&A





We are

OLX



OLX TODAY



1

*Source: CEB - C-Sat with users (buyers and C2 sellers) on OLX EU Platforms from April 23 - April 24



Associates:

OLX Brasil

dubizzle
group

OfferUp

We empower millions of people in making **key life decisions***

>11M
found a
new home
with our
platforms



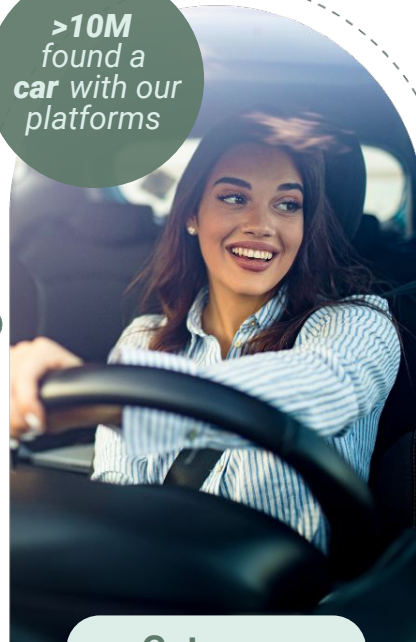
Moves away

Starts their career



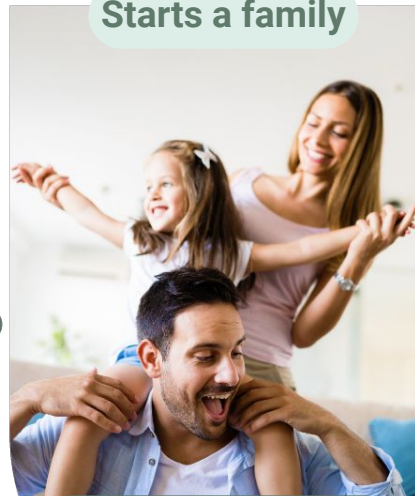
>4M
found a
job on OLX

>10M
found a
car with our
platforms



Get a car

Starts a family



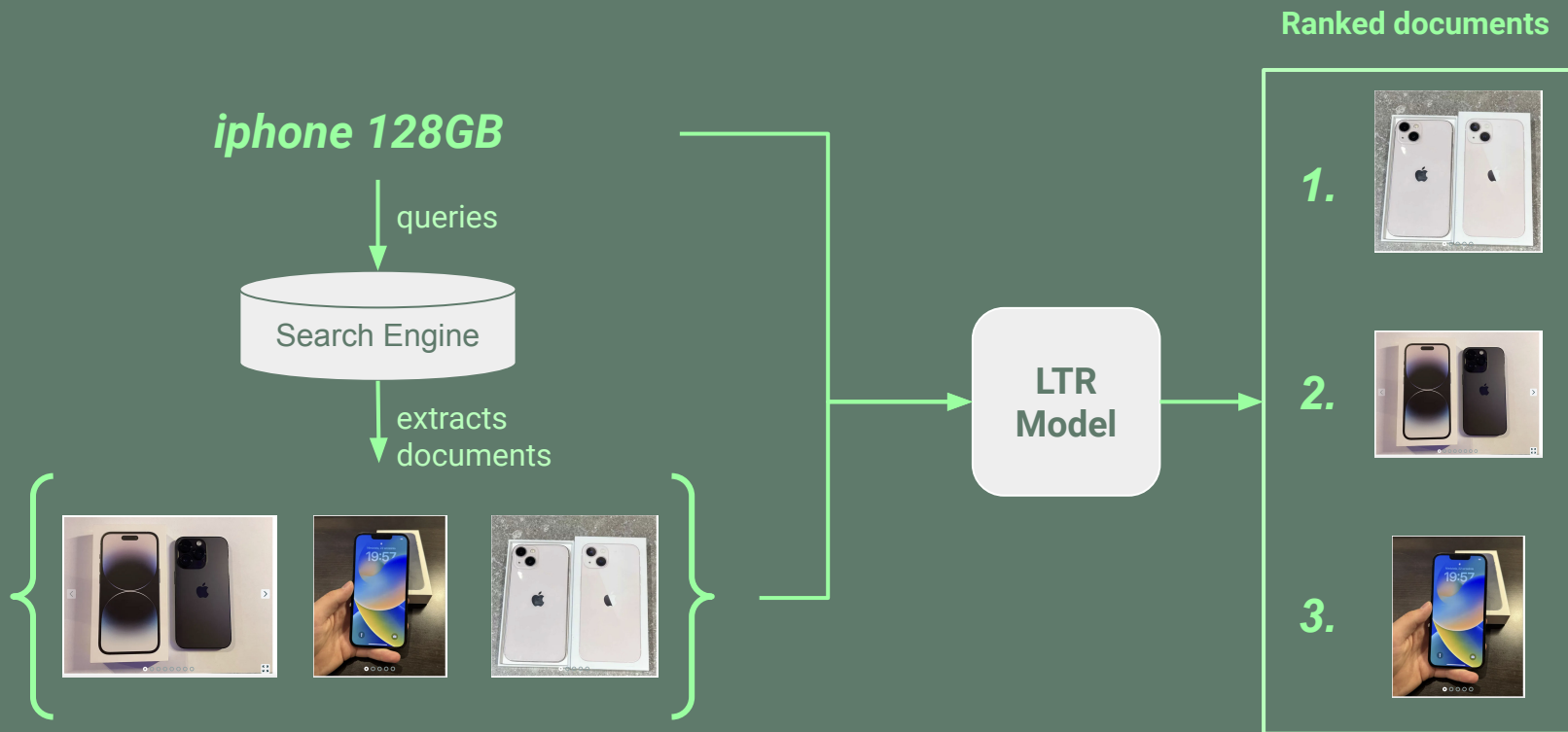
0.5M found a
Wedding planner on
.....OLX.....
0.6M found
baby stroller on OLX
.....
>2M found a **video game**
or console on OLX

01

Learning to Rank Algorithm Introduction



Learning to Rank



We could ask our users what ads are relevant for each query

Is it relevant for you?



Image	Title	Price	Condition	Location & Time
	iPhone 15 pro 256gb	3,900 PLN	Used	Warsaw, Białołęka - Today at 08:37
	iPhone 15 Pro Natural Titanium Warranty 2025	1,300 PLN for negotiation	Used	Warsaw, Mokotów - Today at 11:53
	iPhone 15 Pro Max, 256GB, PL Showroom + accessories	3,800 PLN for negotiation	Used	Warsaw, Mokotów - Today at 15:19
	Apple iPhone 15 Pro 256GB Black	3,800 PLN for negotiation Service with OLX Shipping	New	Warsaw, Białołęka - September 20, 2024



We could ask our users what ads are relevant for each query

Is it relevant for you?



no

yes

yes

no

Image	Title	Price	Condition	Location/Time
	iPhone 15 pro 256gb	3,900 PLN	Used	Warsaw, Białoleka - Today at 08:37
	iPhone 15 Pro Natural Titanium Warranty 2025	1,300 PLN for negotiation	Used	Warsaw, Mokotów - Today at 11:53
	iPhone 15 Pro Max, 256GB, PL Showroom + accessories	3,800 PLN for negotiation	Used	Warsaw, Mokotów - Today at 15:19
	Apple iPhone 15 Pro 256GB Black	3,800 PLN for negotiation	New	Warsaw, Białoleka - September 20, 2024



We could ask our users what ads are relevant for each query

Is it relevant for you?



no

yes

yes

no

Image	Title	Price	Condition	Location/Time
	iPhone 15 pro 256gb	3,900 PLN	Used	Warsaw, Białoleka - Today at 08:37
	iPhone 15 Pro Natural Titanium Warranty 2025	1,300 PLN for negotiation	Used	Warsaw, Mokotów - Today at 11:53
	iPhone 15 Pro Max, 256GB, PL Showroom + accessories	3,800 PLN for negotiation	Used	Warsaw, Mokotów - Today at 15:19
	Apple iPhone 15 Pro 256GB Black	3,800 PLN for negotiation	New	Warsaw, Białoleka - September 20, 2024



What are the characteristics that make an ad relevant?



Search bar: Iphone

Item listing: Iphone 14 128GB 95% battery MIDNIGHT BLACK

Price: PLN 1,900 (to negotiate)

Service: Service service with OLX Parcel

Location: Zabrze - June 5, 2024

Buttons: Buy, Send a message, Call

User Signals - clickstream events

Just an item

PLN 3,249

Price with OLX Shipping

PLN 3,274 + delivery from PLN 12 [Price details](#)

Buttons: Buy, Send a message, Call



Learning to Rank

How we build the dataset



Learning to Rank

How we build the dataset



Search bar: 1

Featured: iPhone 15 pro 256gb **3,900 PLN**
Used
Warsaw, Białoleka - Today at 08:37

iPhone 15 Pro Natural Titanium | Warranty 2025 **1,300 PLN**
for negotiation
Used
Warsaw, Mokotów - Today at 11:53

iPhone 15 Pro Max, 256GB, PL Showroom + accessories **3,800 PLN**
for negotiation
Used
Warsaw, Mokotów - Today at 15:19

query_id

1

1

1

Learning to Rank

How we build the dataset



Search results for "iphone 15 pro" in Warszawa, Mazowieckie, +0km.

Image	Title	Price	Rank
	iPhone 15 pro 256gb Used Warsaw, Białoleka - Today at 08:37	3,900 PLN	1
	iPhone 15 Pro Natural Titanium Warranty 2025 Used Warsaw, Mokotów - Today at 11:53	1,300 PLN for negotiation	2
	iPhone 15 Pro Max, 256GB, PL Showroom + accessories Used Warsaw, Mokotów - Today at 15:19	3,800 PLN for negotiation	3

query_id	doc_id
----------	--------

1	1
---	---

1	2
---	---


1	3
---	---

Learning to Rank

How we build the dataset



Search bar:




FEATURED

iPhone 15 pro 256gb

Used

Warsaw, Białoleka - Today at 08:37

3,900 PLN




iPhone 15 Pro Natural Titanium | Warranty 2025

Used

Warsaw, Mokotów - Today at 11:53

1,300 PLN
for negotiation



iPhone 15 Pro Max, 256GB, PL Showroom + accessories

Used

Warsaw, Mokotów - Today at 15:19

3,800 PLN
for negotiation

query_id	doc_id	features
----------	--------	----------

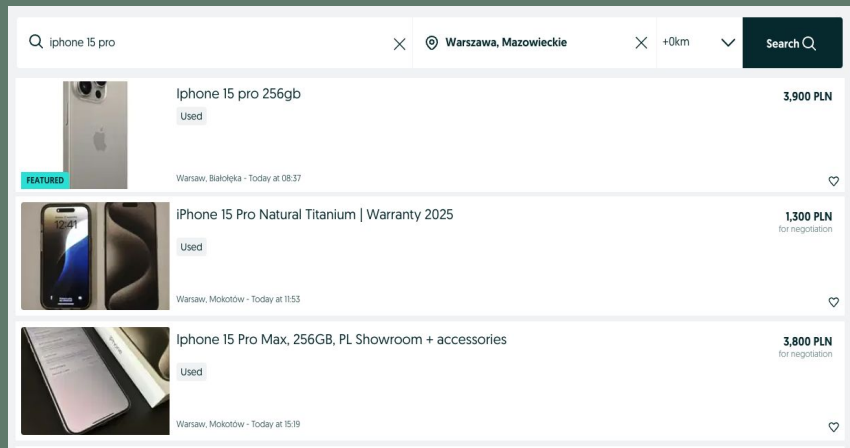
1	1
---	---

1	2
---	---

1	3
---	---

Learning to Rank

How we build the dataset



query_id	doc_id	features
----------	--------	----------

1	1	f0
---	---	----

1	2	f0
---	---	----

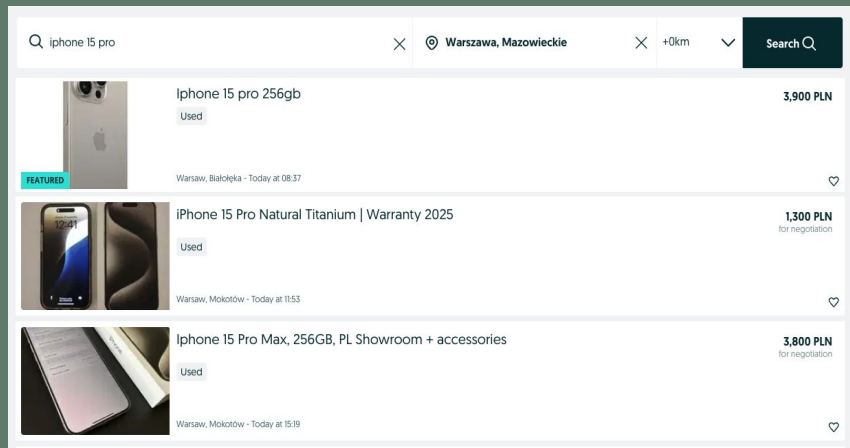
1	3	f0
---	---	----

e.g. ad price



Learning to Rank

How we build the dataset



query_id	doc_id	features	
----------	--------	----------	--

1	1	f0	f1
---	---	----	----

1	2	f0	f1
---	---	----	----

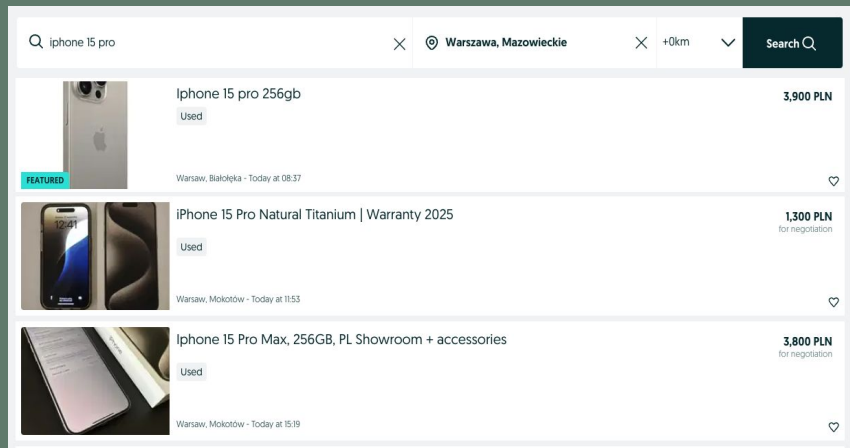
1	3	f0	f1
---	---	----	----

e.g. ad freshness



Learning to Rank

How we build the dataset



query_id	doc_id	features		
1	1	f0	f1	f2
1	2	f0	f1	f2
1	3	f0	f1	f2



e.g. Click Through Rate



Learning to Rank

How we build the dataset



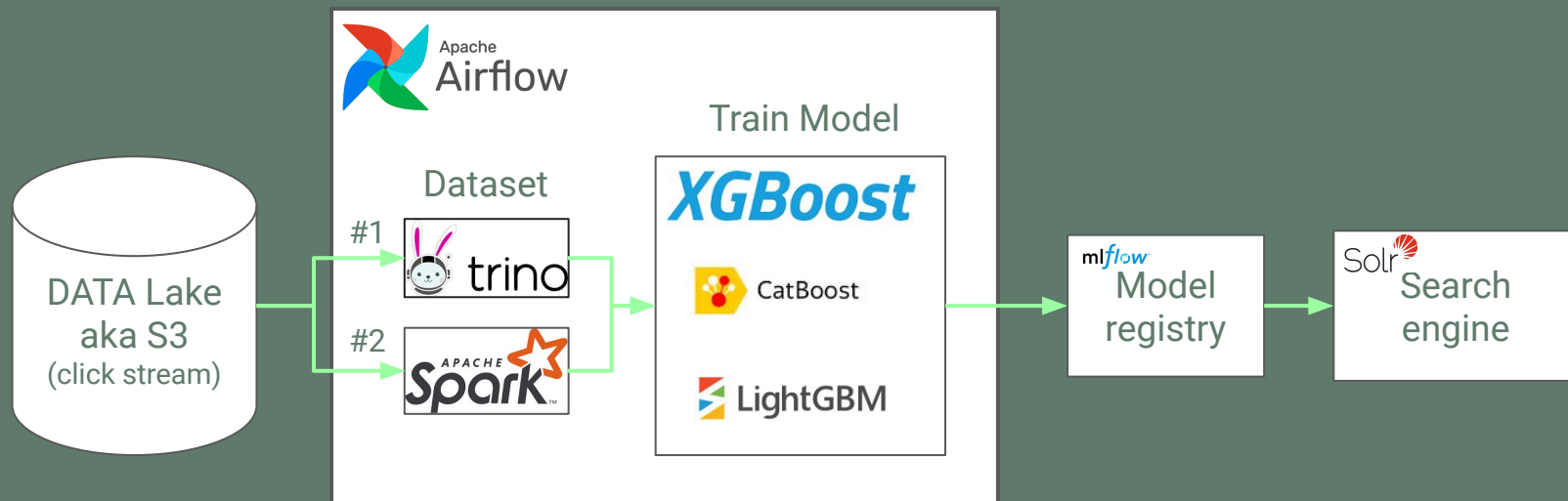
Search interface showing results for "iphone 15 pro" in "Warszawa, Mazowieckie" with a radius of "+0km".

Results list:

- Featured:** iPhone 15 pro 256gb, Used, 3,900 PLN, Warsaw, Białołęka - Today at 08:37
- iPhone 15 Pro Natural Titanium | Warranty 2025, Used, 1,300 PLN for negotiation, Warsaw, Mokotów - Today at 11:53
- iPhone 15 Pro Max, 256GB, PL Showroom + accessories, Used, 3,800 PLN for negotiation, Warsaw, Mokotów - Today at 15:19

query_id	doc_id	features			relevance
1	1	f0	f1	f2	0
1	2	f0	f1	f2	1
1	3	f0	f1	f2	0

Usual LTR pipeline



02

Challenges in OLX Group



Core

otodom

Real Estate

OTOMOTO

Motors



#1 challenge


Many Targets to optimize...

Delivery ad



VAS type #1





iphone 14 pro max 512GB idream insurance gold gold set

Used


Łódź, Białuty - Refreshed on June 9, 2024

PLN 4,500

Service service with OLX Parcel

FEATURED

Heart icon



iPhone 14 pro black, battery 92%, proof of purchase

Used

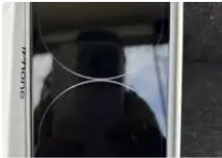
Scarves - June 9, 2024

PLN 3,300

Service service with OLX Parcel

FEATURED

Heart icon



I will sell an iPhone 14 pro max, 256GB memory, Space Black

New

Brenna - June 10, 2024

PLN 1,800

Heart icon

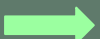


VAS type #2

VAS type #1



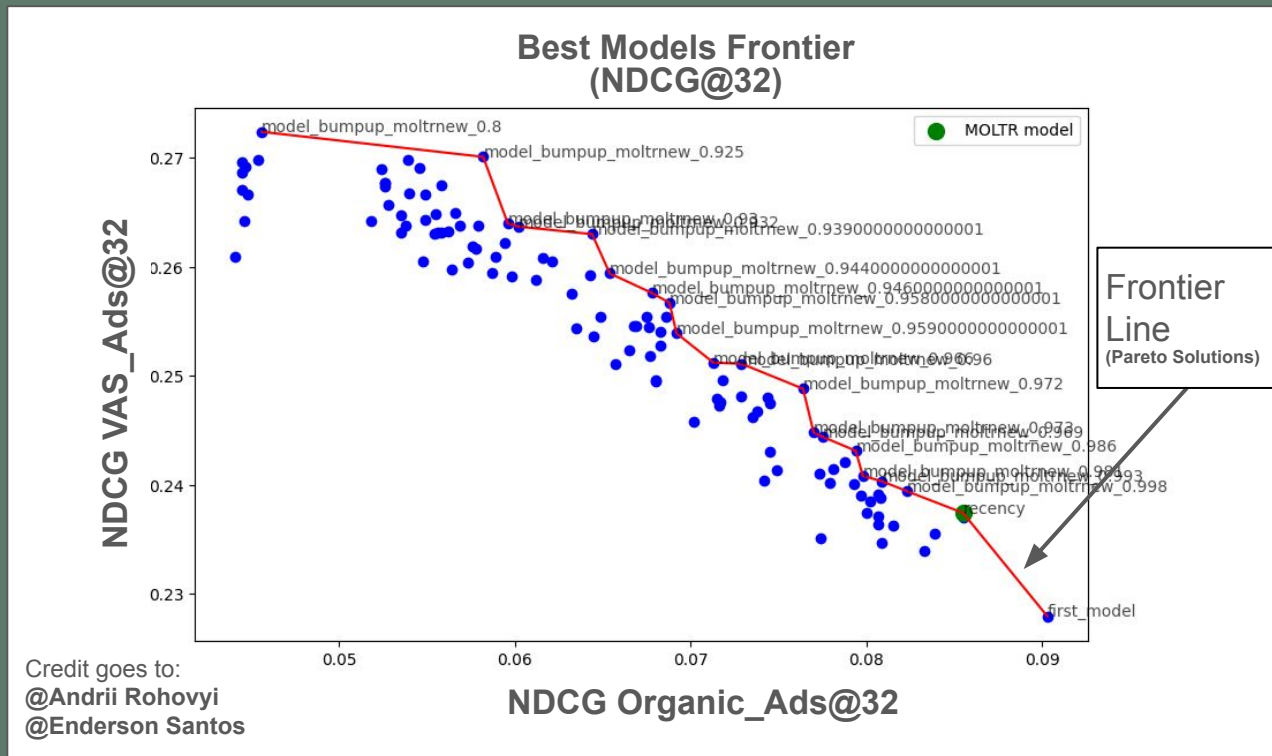
Organic ad



*VAS - value added-service

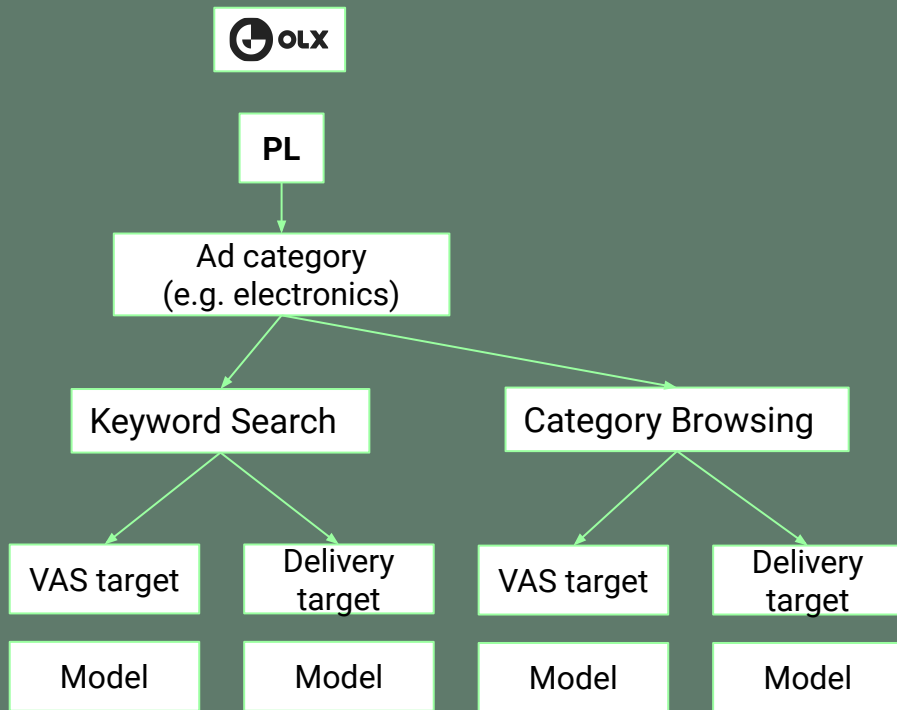
#1 challenge

Multi objective-optimization



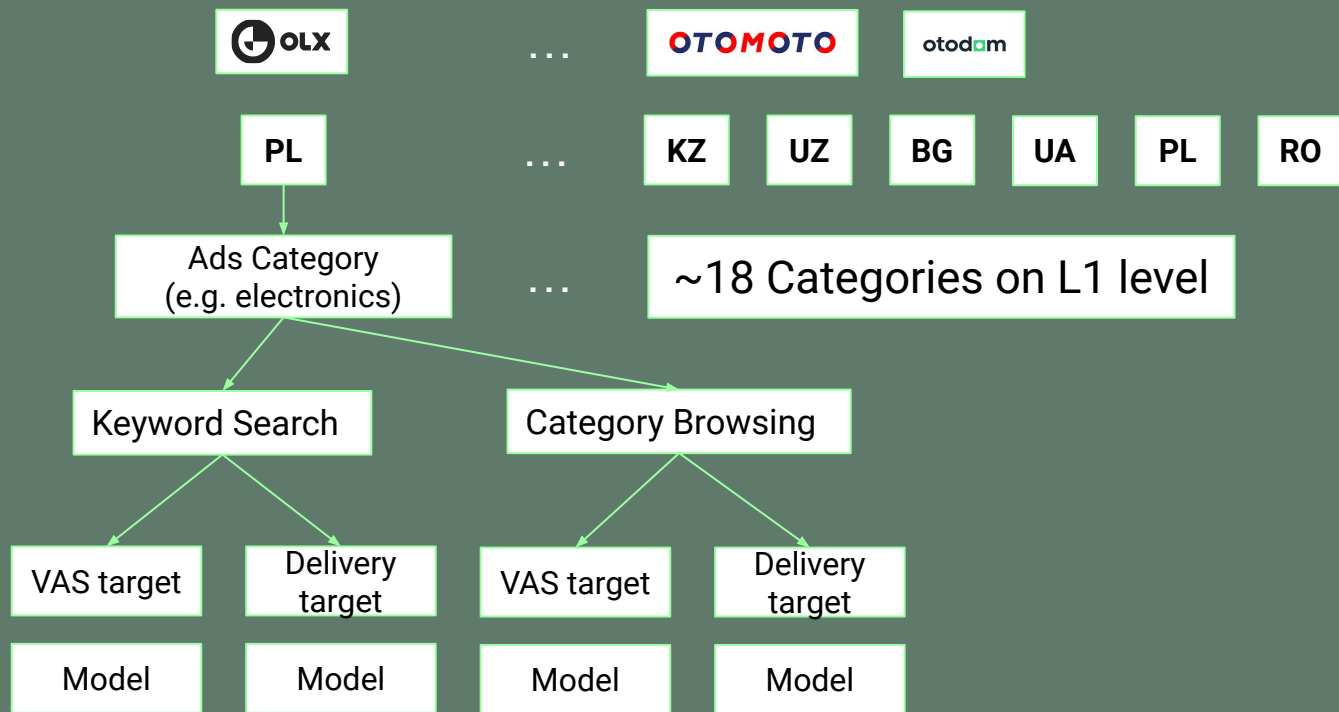
#2 challenge

Multiple models



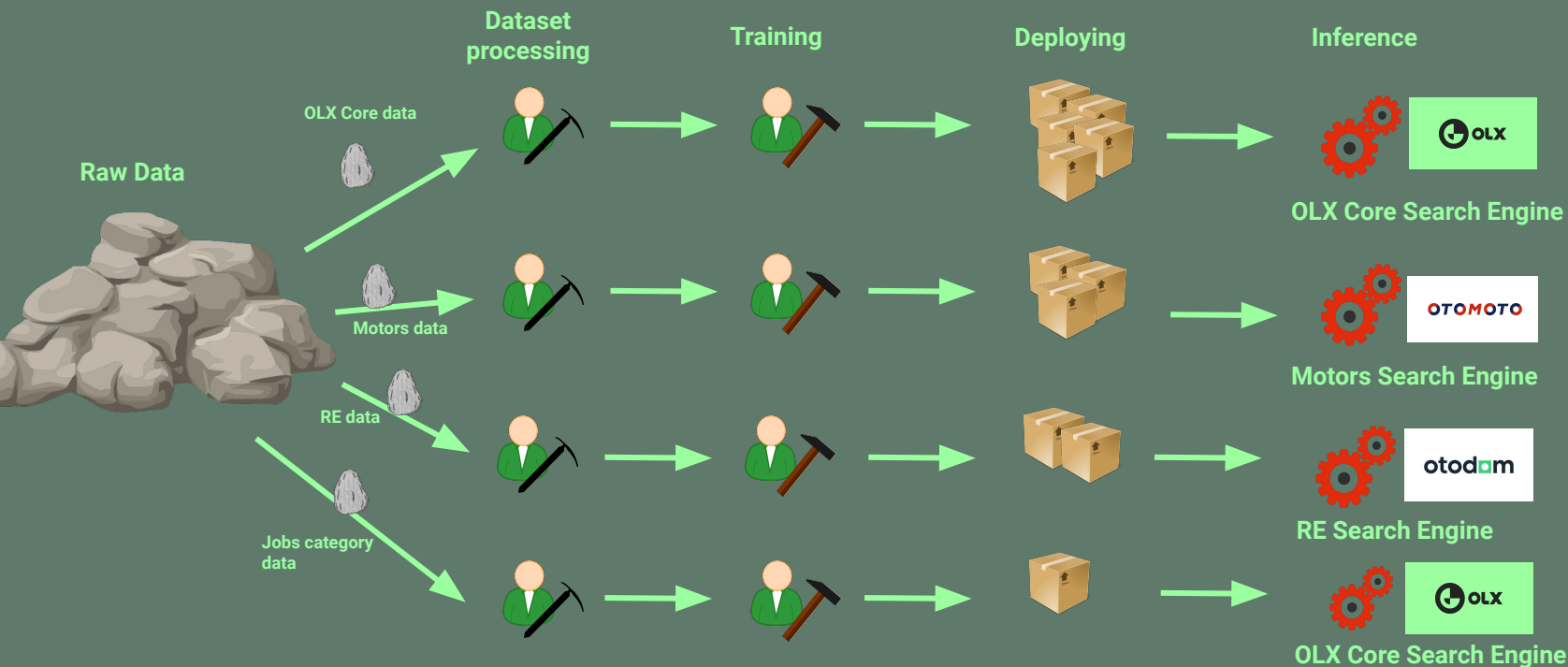
#2 challenge

Multiple models



#3 challenge

The pipelines hell





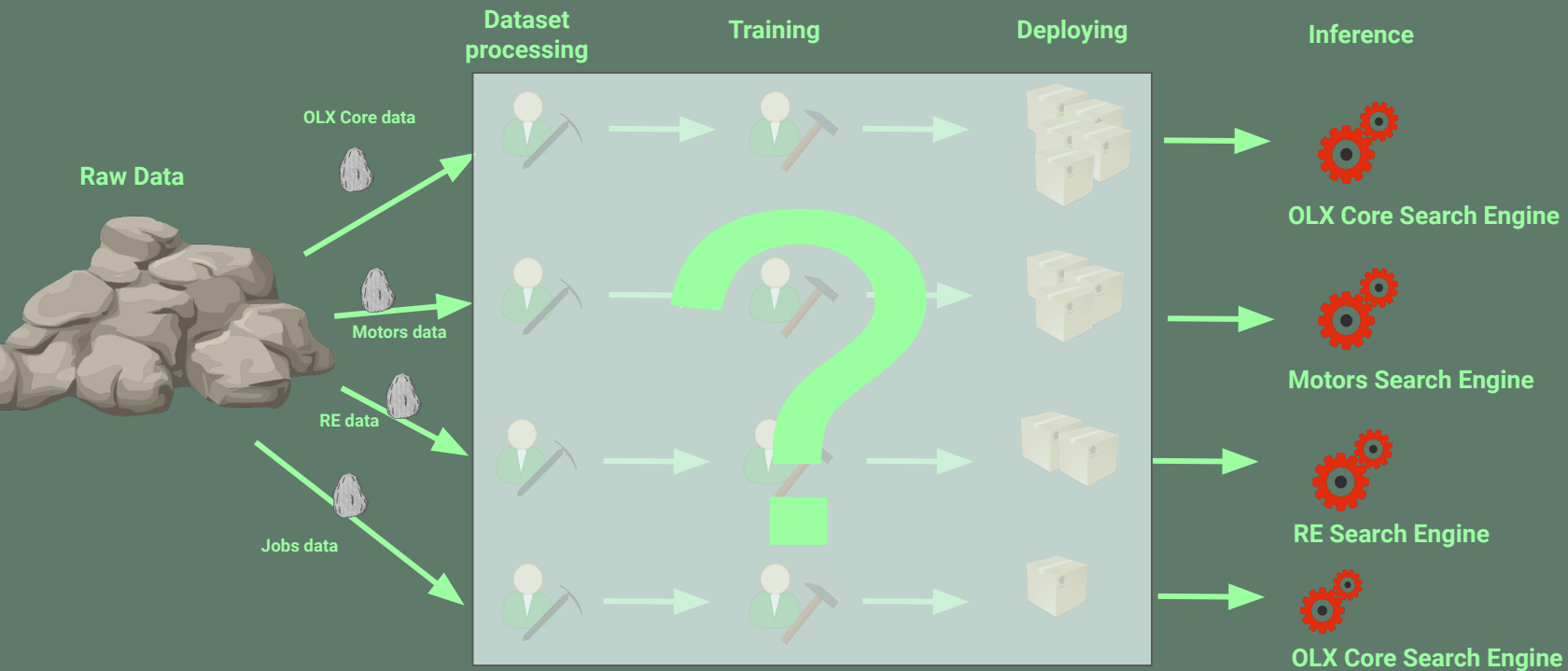
Problems summary

	OLX Core	Motors	Real Estate	Jobs in OLX
countries	7 (3 P&S, 4 non P&S)	3	3	7
repos to maintain	3	1	1	1
optimization targets	Delivery, VASes, Successful Events	VASes, Successful Events	VASes, Successful Events	VASes, Successful Events
models to maintain	11+	3+	3+	7+
OLX duplicated code	YES	YES	NOT YET	NOT YET

Ctrl+C, Ctrl+V



Can we do better?





LTR Framework **motivation**

- stop **duplicating efforts** for rankings



- stop growing **technical debt** 

- add **synergy** to the LTR projects 

- enable **rapid experimentation** 

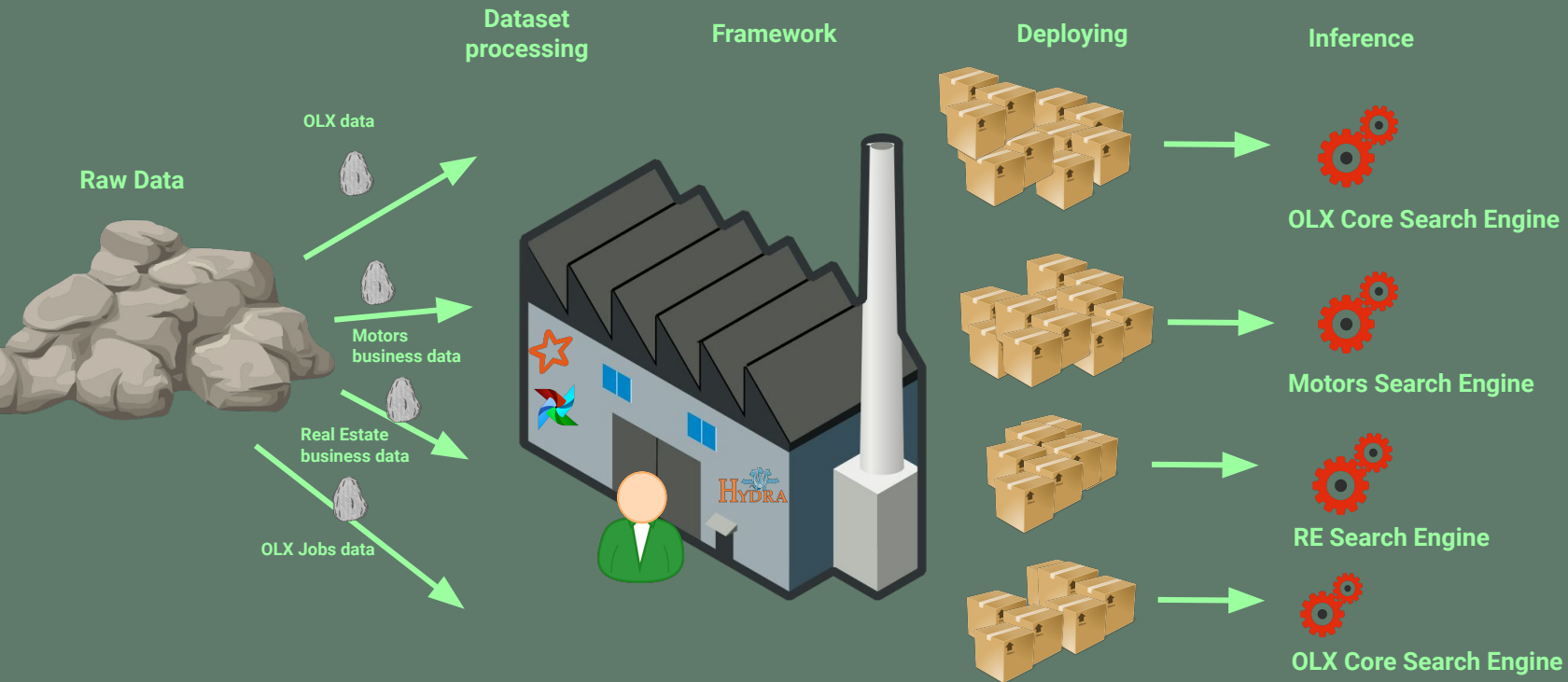
- **reduce costs** across teams 

03

LTR Framework



LTR Framework





Dataset unification

Query ID	Doc ID	Rank	f_*	r_*	e_*	Partition
Unique identifier of the user query	ID of the ad displayed to the user	Position of the ad on the result page	Features relative to the document or the user	Relevance signals (# clicks, # replies, ...)	Extra features not previously classified	country, platform, date, ...
<i>Required</i>	<i>Required</i>	<i>Required</i>	<i>At least 1</i>	<i>At least 1</i>	<i>Optional</i>	<i>At least 1</i>

Dataset
Example

q_id	doc_id	rank	f_price	f_ctr	r_replied	r_click	e_source	country	year	month	day
42	19	0	10	0.98	true	true	promoted	pl	2024	09	30
42	57	1	89	0.95	false	false	promoted	pl	2024	09	30
42	102	2	43	0.95	false	true	organic	pl	2024	09	30

features

relevance

extra

Configuration Setup



3 units   

1+ model

3+ countries

1+ target

3 environments

GOAL

Increase Flexibility

Enhance Experimentation

Better Organization



Configuration Setup

Scaling with Hydra



Hierarchical Configuration

- Modularity
- Scalability
- Reusability



Hydra

```
defaults:
  - environment: another environment
  - model_type: another model
  - target: another target
  - evaluation: another eval metric
  - _self_

brand: another_unit
country: another_country
```



Configuration Setup

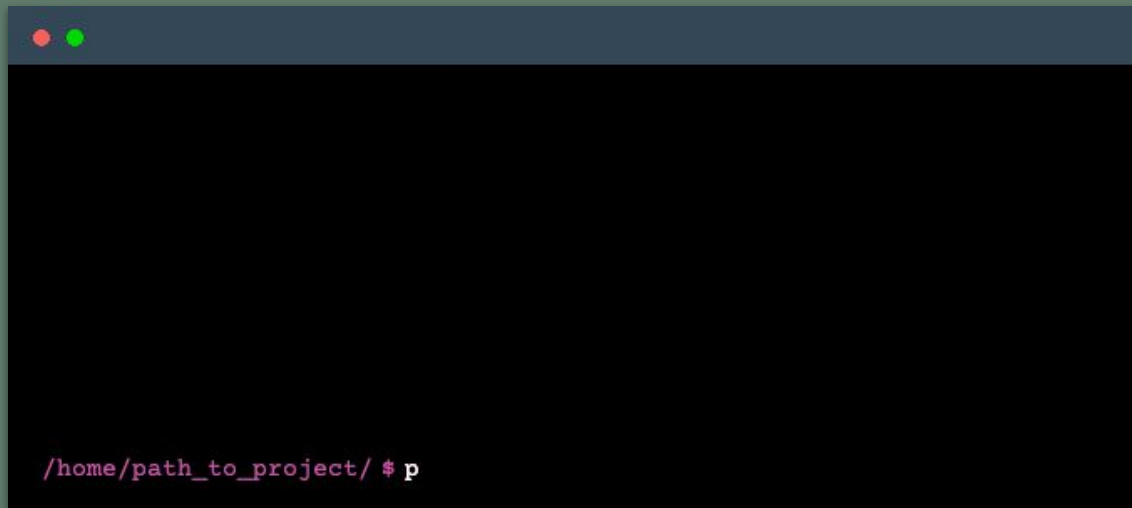
Scaling with Hydra



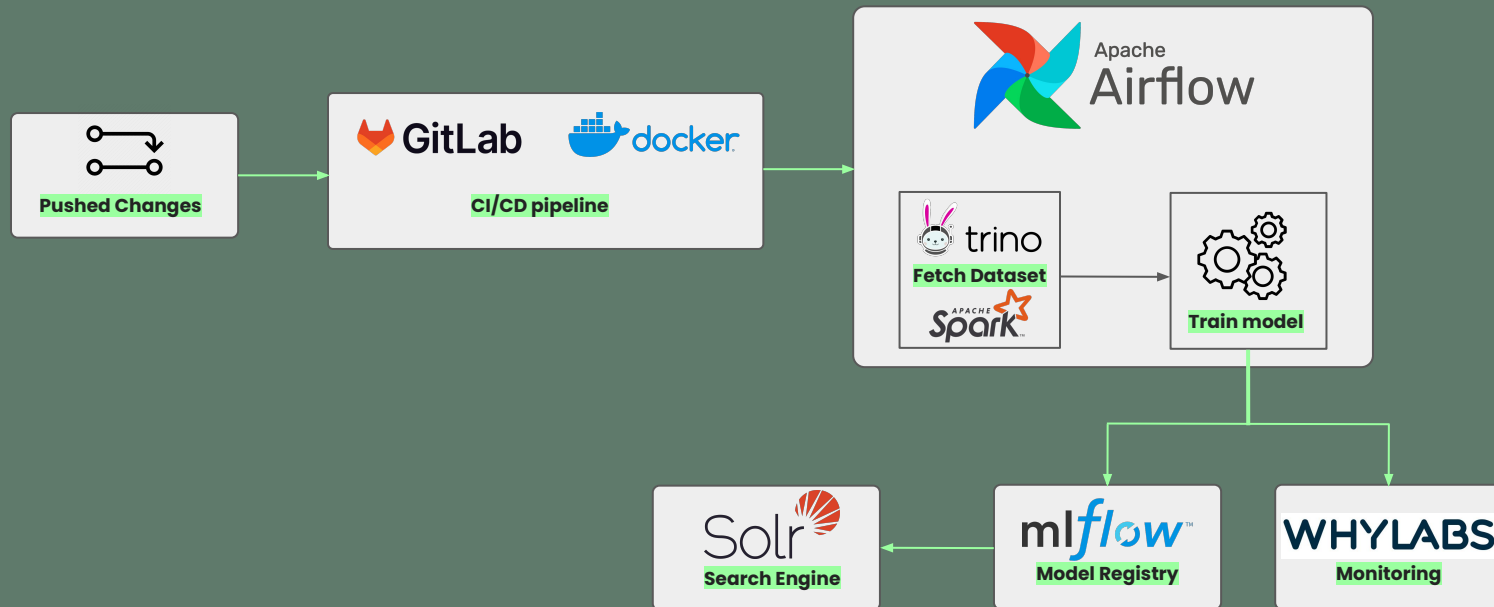
Runtime CLI Overrides

*Overriding, appending,
removing*

- Flexibility
- Customization
- Dynamic Adjustments

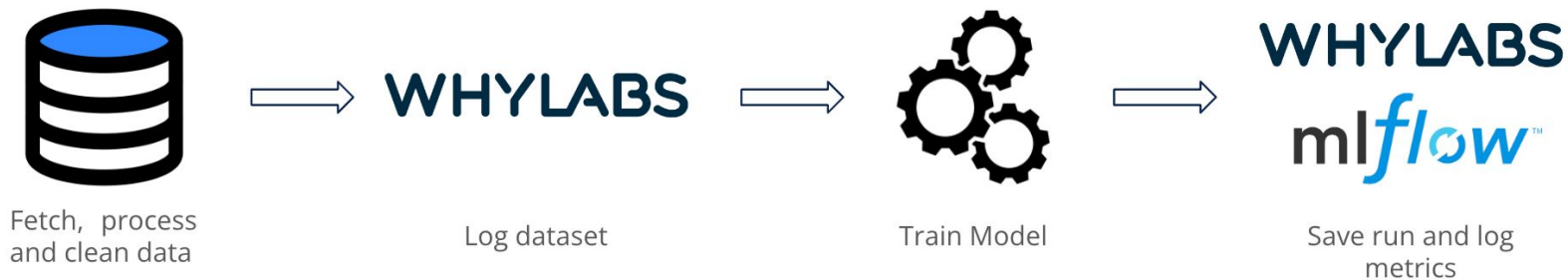


Deployment Logic



Monitoring

LTR Framework's setup



Monitoring

WHYLABS

Established nomenclature

LTR_FWK_{unit}_{country}

Key Features

- **Data Quality** Observation
- **Performance** Monitoring
- **Customizable Dashboards**
- **Detect** and root cause **ML issues**
- **Supports Ranking Projects**

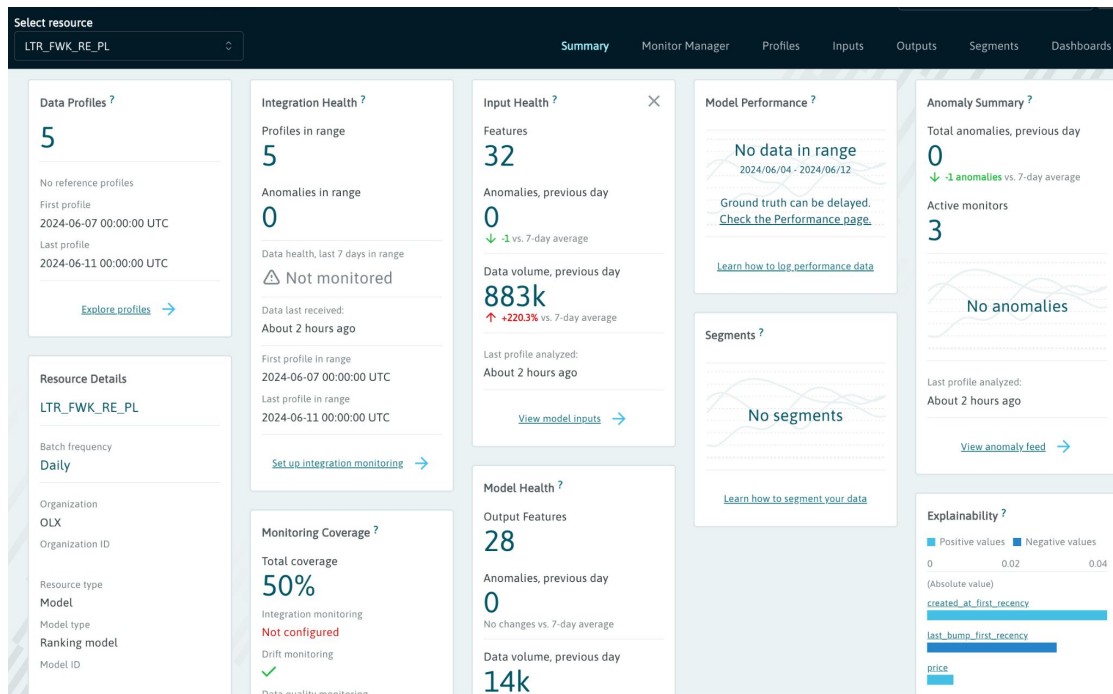
Benefits

- Enhanced **Project Organization**
- Improve **Model Reliability**
- **Reduce Downtime**

Monitoring

WHYLABS

Overview



Monitoring

WHYLABS

Monitors

New monitor: famous-blue-hawk-3562

Monitor ID: famous-blue-hawk-3562

1. Select the use case

2. Select the type of analysis

3. Set the baseline

4. Actions

Monitor type

- ☒ Drift
- ☐ Data quality
- ☐ Model performance

Group:

- ☐ Both input and output columns
- ☒ Input columns
- ☐ Output columns

Next

Preset monitors

Enable monitoring with one-click

Drift

Data drift in model inputs



All discrete inputs
Compared to a trailing
7-day baseline

Enable with one click

Configure

Data drift in model inputs



All non-discrete inputs
Compared to a trailing
7-day baseline

Enable with one click

Configure

Data quality

Missing values



Outlier detection (stddev)
Compared to a trailing
7-day baseline

Enable with one click

Configure

Unique value



Duplicate changes
Compared to a trailing
7-day baseline

Enable with one click

Configure

Data type



Detect mixed schema
Compared to a trailing
7-day baseline

Enable with one click

Configure

Missing values

Missing values



Monitoring

WHYLABS

Monitors Alerts

DS Buyer notification app APP 7:03 PM

Alert: Your monitor Eval-Train NDCGs Drift Check on dataset has detected low severity issues

[LTR FWK RE_PL](#) - 6 alerts

Top Alerted Features

- [output_eval_ndcg_10](#) - 1 alerts
- [output_train_ndcg_10](#) - 1 alerts
- [output_eval_ndcg_32](#) - 1 alerts
- [output_train_ndcg](#) - 1 alerts
- [output_eval_ndcg](#) - 1 alerts
- [output_train_ndcg_32](#) - 1 alerts

Top Alerted Segments

- [Overall segment](#) - 6 alerts

[LTR_FWK_RE_PL](#) [Monitor Manager](#) [Notification Settings](#)

Example of message received in dedicated slack channel

Model
[LTR](#) Overview with detected anomalies
ID: mo

Freshness
2024-09-11

Resource type
Ranking model

Anomalies in range

Last profile with anomalies
2024-09-11 00:00:00 UTC

Batch frequency
Daily

Shortcuts
[35 inputs](#) | [28 outputs](#) | [0 segments](#)

Reference profiles
0

Batch profile lineage
[2024-06-07 to 2024-09-11](#)

[View summary dashboard](#) →

2024-09-11

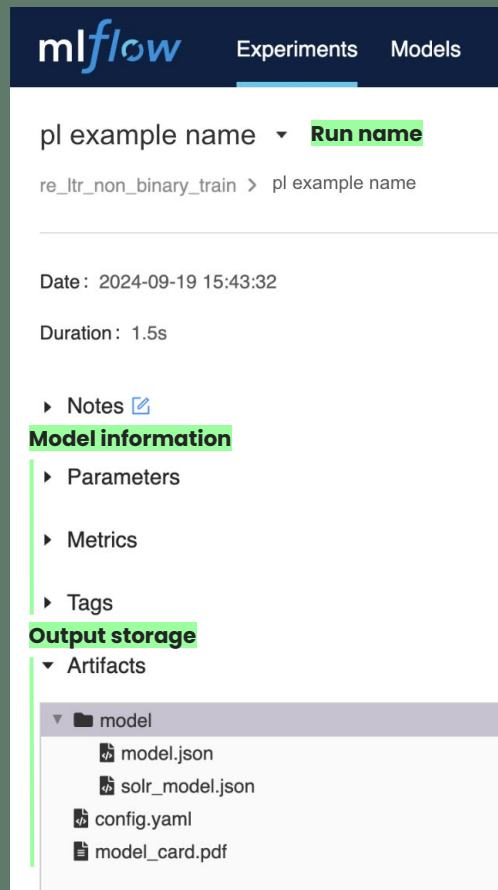
Ingestion:	0
Data quality:	0
Data drift:	6
Performance:	0
Total	6



Monitoring mlflow

Key Features

- Experiment **Tracking**
- **Reproducibility**
- Up-to-date **Model Storage**
- **Customizable**



The screenshot shows the mlflow web interface. At the top, there's a dark blue header with the "mlflow" logo and two tabs: "Experiments" (active) and "Models". Below the header, the breadcrumb navigation shows "re_itr_non_binary_train" > "pl example name". The main content area displays the details for the selected run. It includes the "Run name" as "pl example name", the "Date" as "2024-09-19 15:43:32", and the "Duration" as "1.5s". There is a "Notes" section with a link icon. Below this, the "Model information" section is expanded, showing "Parameters", "Metrics", and "Tags". The "Output storage" section is also expanded, showing a list of artifacts under the "model" folder: "model.json", "solr_model.json", "config.yaml", and "model_card.pdf".



Monitoring

Model Cards mlflow

Ranking insights

Avg position Before After

Bumped ads	14.6	14.0
Clicks	14.6	13.9
Replies	14.1	13.0

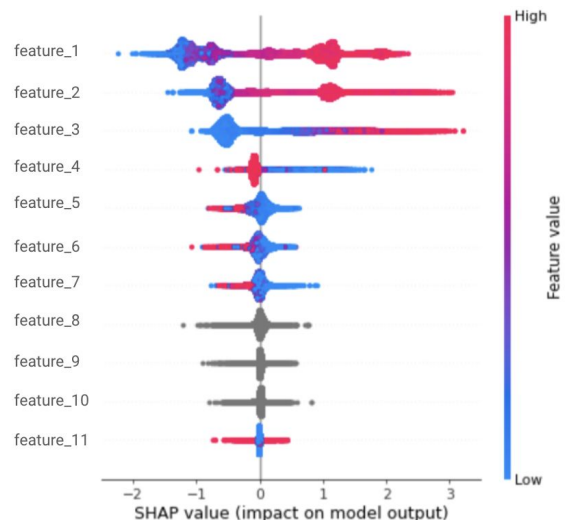
We present here the offline [NDCG](#) metrics.

Dataset figures are the performance that actually happened. Evaluation values represent the theoretical performance on new data.

	NDCG@10	NDCG@32
Dataset	0.277	0.396
Evaluation	0.317 [14.6%]	0.424 [7.0%]

example

Target: **Non-tech people**



06

Status Quo



Releases

Motors **Planned**

OLX Core **30% Progress**



All 7 countries

Real Estate **Integrated**

storia
Romania

otodom
Poland

imovirtual
Portugal

10
LTR Models



Real Estate Release



Automated Pipelines



MLFlow Integration

WHYLABS

WhyLabs Monitoring

storia

Romania

otodom

Poland

imovirtual

Portugal



Real Estate Release



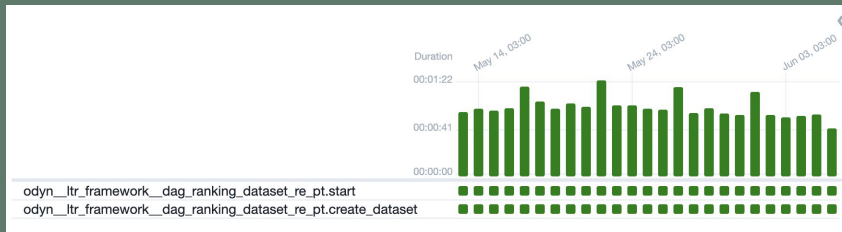
Automated Pipelines

Daily automated pipelines for efficient **dataset creation** and **model training**, ensuring continuous tracking and up-to-dateness of models.

DAG for each Country



Example



Real Estate Release



MLflow Integration & Automation

After training, the resulting **trained models**, **features**, **parameters**, and **performance metrics**, all complemented by **detailed model cards**, are stored in the desired MLflow experiment.

Trained model				Performance Metrics				Model Parameters			
				Metrics >				Parameters >			
	Start Time	Run Name	Us Sc Ve M	eval_ndcg	eval_ndcg_10	eval_ndcg_32	allow_writing_f	boosting_type	bootstrap_type	developer	Tags
<input type="checkbox"/>	3 hours ago	pl v0.5	i -	0.451	0.332	0.444	False	Plain	Bernoulli	python_scr...	
<input type="checkbox"/>	3 hours ago	ro v0.5	i -	0.441	0.331	0.433	False	Plain	Bernoulli	python_scr...	
<input type="checkbox"/>	1 day ago	pl v0.5	i -	0.446	0.333	0.44	False	Plain	Bernoulli	python_scr...	
<input type="checkbox"/>	1 day ago	ro v0.5	i -	0.429	0.322	0.424	False	Plain	Bernoulli	python_scr...	
<input type="checkbox"/>	2 days ago	pl v0.5	i -	0.434	0.316	0.426	False	Plain	Bernoulli	python_scr...	

Artifacts	
<div><div>model</div><div><div>model.json</div><div>solr_model.json</div><div>config.yaml</div><div>model_card.pdf</div></div></div>	<div>Full Path: Size: 50.95KB</div> <div>Model files</div> <div>Model card pl v0.9</div> <div>This ranking model was trained for OTODOM in PL.</div> <div>Dataset</div> <div>Some insights about the dataset used:</div> <div><div>Dates 2024-09-18 for 7 days</div><div>Dataset unique queries 6603</div><div>Avg clicked per search 4.15</div><div>Avg reply per search 2.00</div></div> <div>Model</div> <div>Type: CatBoostRanker</div>





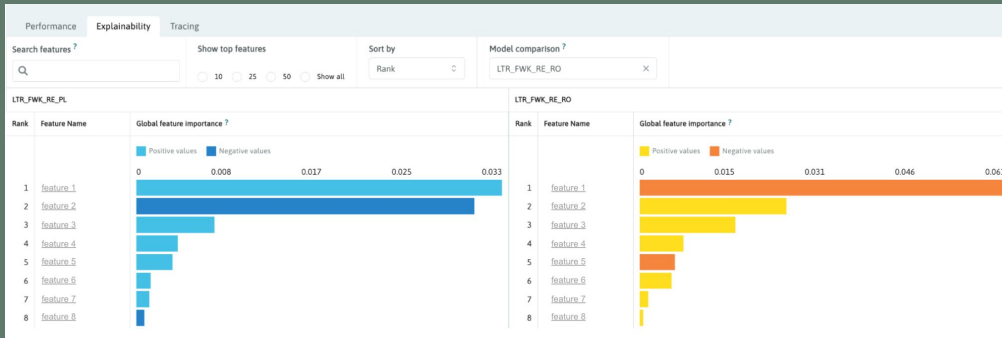
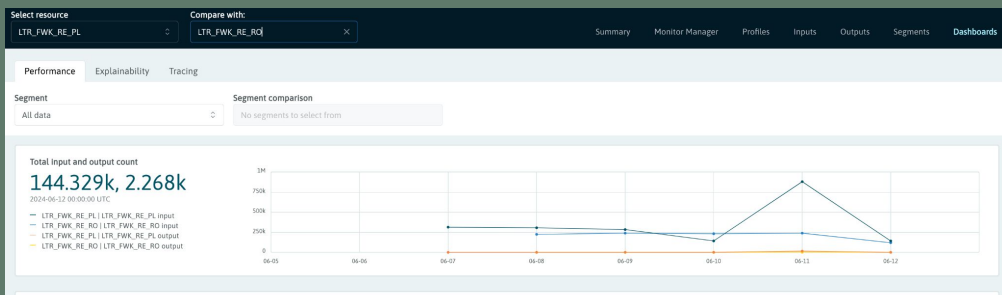
Real Estate Release

WHYLABS

WhyLabs Monitoring

For each country, there is a WhyLabs resource to track **training data** and **model outputs**, utilizing both WhyLabs' and **custom metrics** for comprehensive performance evaluation and data quality observation.

Comparison with other WhyLabs resources



LTR framework **speeding up the development**



Nr of weeks needed to conduct each step	OLD WAY		FRAMEWORK	
	adding new feature	scaling features to other country	adding new feature	scaling features to other country
Calculate new feature				
Add new feature to the dataset				
Train new models and select the best one				
Run AB test				
Analyse results & evaluate acceptance criteria				
TOTAL # weeks				

Adding new features
~25% faster
(ENTIRE PROCESS)

Training a model
~50-75% faster

LTR framework **speeding up the development**



Adding **new features**
to dataset

75%
faster

Adding new features
(ENTIRE PROCESS)

25%
faster

Model Training

UP TO
75%
faster

OLD WAY VS **LTR FRAMEWORK**

Percentual impact on **time needed** to conclude each step

LTR framework

Motivation

Overview



MOTIVATION 🚀	Status
Stop duplicating efforts	✓
Stop growing technical debt	✓
Add synergy to the LTR projects	✓
Enable rapid experimentation	✓
Reduce costs across teams	✓



07

Next Steps





What's Next?



Migrations

Migrate the remaining units into the Framework.



Feature Engineering

Take advantage of cross-project synergies to identify features that proved value in other contexts.



Scaling Up

Accommodate growth, ensure performance, and meet the increasing demands of the system.

Open-Source It



Q&A

Any questions?





OLX