

# A scalable system to identify adverse events from consumer reviews



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# We are Reckitt

43,000+ employees

**200**+ yrs heritage

Global Business Units

20m+ products sold daily

countries over six continents













































# Detecting Adverse Events using Al to improve product safety

### **MOTIVATION**

# Value that inspired us to work on this

~ 1.3 m

emergency
department visits
each year caused by
adverse events

Source: cdc.gov

~ 300 k

patients **each year** need to be hospitalized for further treatment

Source: cdc.gov

~ 1.5 m

consumer reviews across 49 ecommerce platforms & 28 markets (approx. 25 000 monthly)



# What are (drug) adverse events?

- Adverse event an untoward medical occurrence after exposure to a medicine, which is not necessarily caused by that medicine. \*
- Adverse drug reactions (ADRs) unintended, harmful events attributed to the use of medicines – occur as a cause of and during a significant proportion of unscheduled hospital admissions. \*\*
- An adverse drug event (ADE) is when someone is harmed by a medicine. \*\*\*





<sup>\*</sup> https://www.ema.europa.eu/en/glossary/adverse-event (European Medicine Agency)

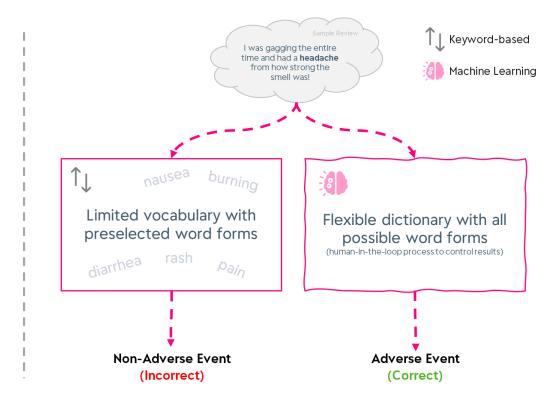
<sup>\*\*</sup> https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6297296/ (US National Library of Medicine)

<sup>\*\*\*</sup> https://www.cdc.gov/medicationsafety/adult\_adversedrugevents.html (CDC)

# Why ML is better than the legacy approach?

ML-based models demonstrate superior performance comparing to rule-bales approaches

- √ Scalable architecture
- ✓ Built-in multi-language support
- ✓ Automated updates
- √ Robust design





The sample review is made up for this illustrative example and does not refer to any actual products.



# Adapting existing solutions to our product portfolio and monitored domains

### LANGUAGE STYLE CONSIDERATIONS

# Formal vs. colloquial language modeling

### **ADE Corpus**

"We describe the side effects of 5-FU in a colon cancer patient who suffered severe mucositis, desquamating dermatitis, prolonged myelosuppression, and neurologic toxicity that required admission to the intensive care unit."

### **Online Review**

"This is horrible and after using i had a reaction. I struggled to breathe and could not stop coughing. I have had reactions to fragrances like this in the past with perfumes and fragrances"



# We build in-house to fit our unique product potrfolio

**Health products** 

**Hygiene products** 





Strepsils (S)

















# Adjusting definitions to our specificity

- Incident means any malfunction or deterioration in the characteristics or performance of a device made available on the market, including use-error due to ergonomic features, as well as any inadequacy in the information supplied by the manufacturer and any undesirable side-effect. \*
- Undesirable effect means an adverse reaction for human health attributable to the normal or reasonably foreseeable use of a cosmetic product. \*\*





### **DATA ACQUISITION**

# Internal drug safety data

### **✓** Pros:

In house data, collected and processed by specialists. More than 100k records available.

# X Cons:

Heavily processed to fit the legal reporting framework.

This data can only be used to supplement the dataset, not to form the core of it.

### **Examples:**

It was reported that on an unknown date; an adult female aged 35-44, began taking Condoms. Patient stated that after sexual intercourse they found out that there was no sperm in the condom. When they looked closely, they saw that the top of the condom was torn off. A thick centimetre was off. After a few days, it turned out to be in her vagina just like the semen.

A HCP reported on the \* Regulatory Health Authority website on 00-Jan-0000 about a female consumer who suffered from chemical meningitis after taking some Ibuprofen, which prolonged or involved inpatient hospitalization. The patient was recovering at the time of the report.



### **DATA ACQUISITION**



Data in Brief

The PsyTAR dataset: From patients generated arratives to a corpus of adverse drug events and

D

# Narrative-based open-source data



Open-source data available for research and modeling. Collected from patient narratives, so much more naturally sounding

# X Cons:

Dataset have only around a 1k narratives available. Focuses on drug side effects and does not cover other domains of interest.

### **Examples:**

I had diarrhea for a whole week;bad uterine cramps followed by heavy menstrual bleeding two weeks after my period. Alot of gas and nausea. This pill stopped my pain, but cause me more pain. The side effects are much worst than the pain itself.

headaches within 2 hrs of taking it. Low sex drive.

I have been on Lipitor 40mg. for 2 years. GREAT results. Went from 256 to 135 and LDL from 201 to 65. In the past 3 weeks, I have been experiancing TERRIBLE abdominal pain, shortness of breath, and EXTREME muscle pains. I'm a pharmacist, so I know all to well what these side effects are from. I've stopped taking it, but the effects are a slow go. I would NOT recommend lipitor to anyone.



### **DATA ACQUISITION**

# **Consumer Relations & Social Listening**

## **✓** Pros:

Taken directly from sources of interest – eCommerce and social media. Available in large quantities collected from customer relations processes.

# X Cons:

Data is labeled only for classification.

To unlock its full potential, we're partnering with external vendors to label the data for named entity recognition purpose.

### **Examples:**

Good packing. First time i bought this for cockroaches. The mosquitoes version was also efficitibe to kill cockroaches.

Chemical mixture not essential oil. Stopped using after 1 hour as eye and mouth irritation is occurring. Had to open all the windows in the 4 bedroom house with fans at full speed to send the chemical vapors out.

Liked that they made joints feel less stiff, but one side effect I had was the pills gave me bad gas!





# Leveraging transformer-based architectures for domain adaptation and NER

# **Technologies & base architectures**



### **Transformers**

Our modeling approach is based on State-of-the-art transformer-based architectures.



### **TensorFlow**

We use tensorflow as our main DL framework for ease of switching between high-level Keras API and lower-level APIs

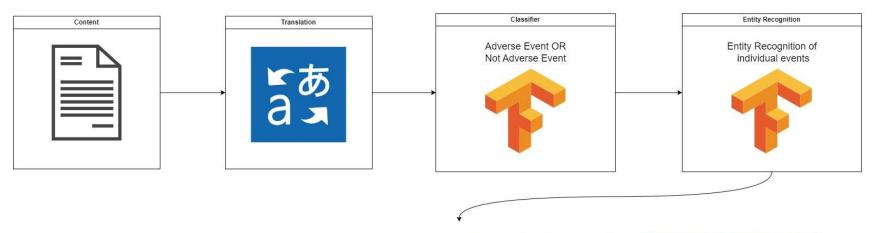


# HuggingFace

We use HuggingFace as the source of pre-trained models we fine-tune as well as for reading model classes



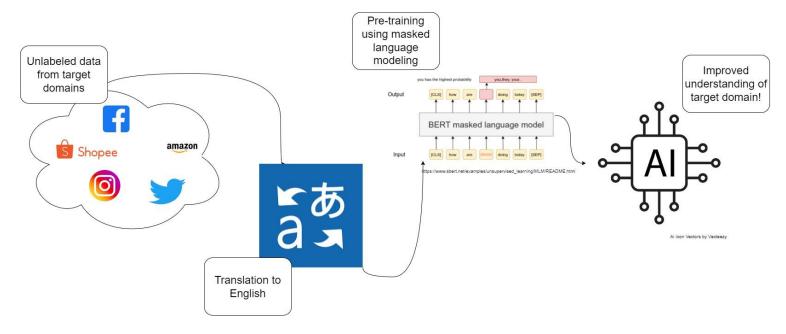
# Two step modeling pipeline



Yesterday I was having a headache (INDICATION), so I took some Nurofen (DRUG). Unfortunately, it made me feel nauseous (ADE)! Never happened to me before.



# **Pre-training for domain adaptation**

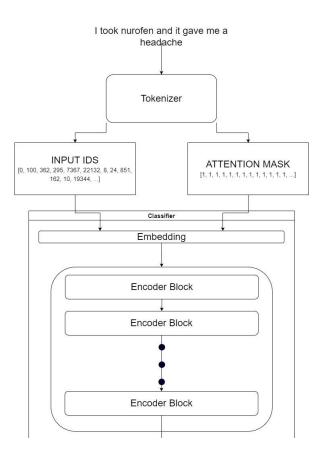




# **Base Model**

## Main tunable parameters:

- 1. Transformer type
- 2. Number of trainable Transformer layers
- 3. Number of dense layers processing Transformer output
- 4. Dropout value
- 5. Learning rate + optimizer function

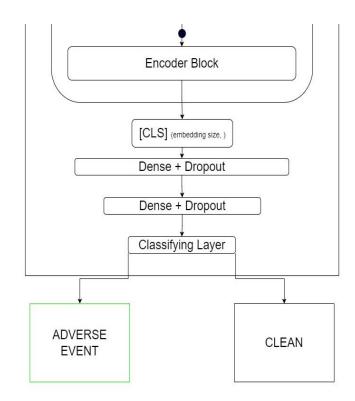




# **Classification Model**

### **Encoder output processed:**

[CLS] token of the last hidden state for representation of the entire sequence.

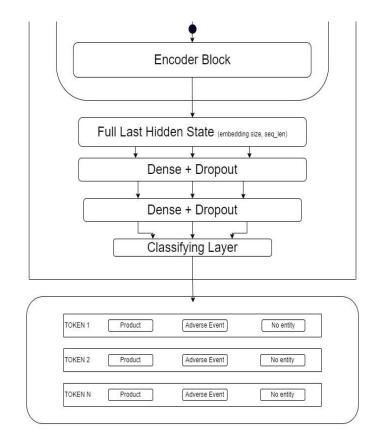




# **NER Model**

## **Encoder output processed:**

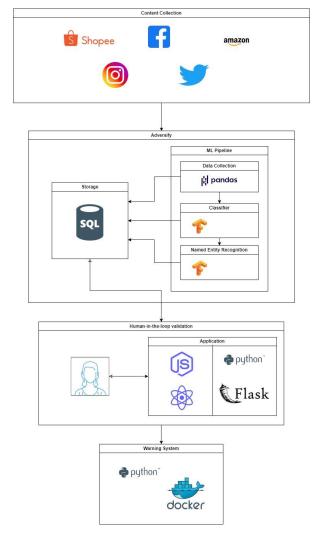
Full last hidden state to allow for individual token classification.







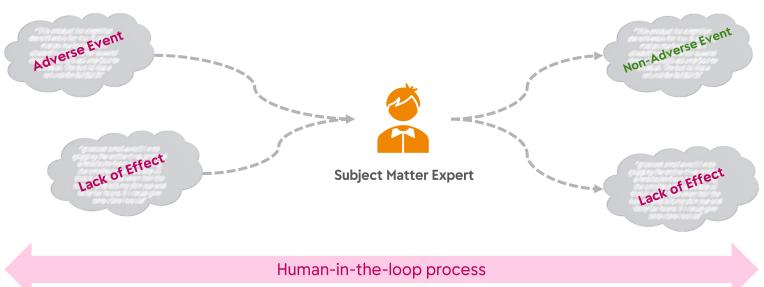
High-level overview of planned architecture





# We apply human-in-the-loop process to improve data

Consumer reviews classified by ML





# **Adversify App**

### **Functionalities:**

- Building trust of users by giving them control over predictions.
- Evaluating model performance.
- Logging feedback from users for retraining

Actions

