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DeepLearning.AI

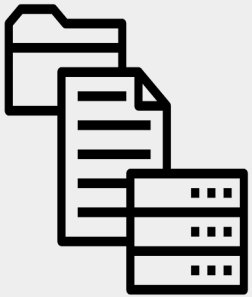
Transform Raw Data into Features for Model Training

Machine Learning Workflow

Ingest & Analyze	Prepare & Transform	Train & Tune	Deploy & Manage
			
Data exploration	Feature engineering	Automated ML	Model deployment
Bias detection	Feature store	Model train and tune	Automated pipelines
			
Amazon S3 & Amazon Athena	Amazon SageMaker Data Wrangler	Amazon SageMaker Autopilot	Amazon SageMaker Endpoints
AWS Glue	Amazon SageMaker Processing Jobs	Amazon SageMaker Training & Debugger	Amazon SageMaker Batch Transform
Amazon SageMaker Data Wrangler & Clarify	Amazon SageMaker Feature Store	Amazon SageMaker Hyperparameter Tuning	Amazon SageMaker Pipelines

Feature Engineering

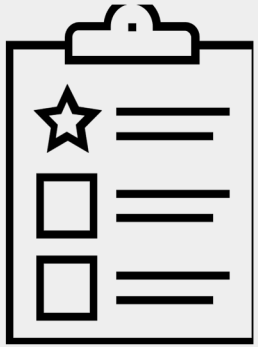
Feature Engineering



RAW DATA

Domain Knowledge

Statistics

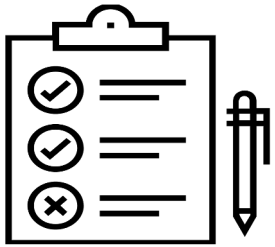


FEATURES

Feature Engineering

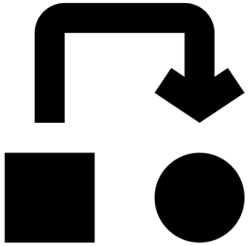
- Dataset best fits the algorithm
- Improve ML model performance

Feature Engineering - Components



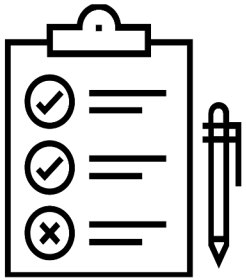
Selection

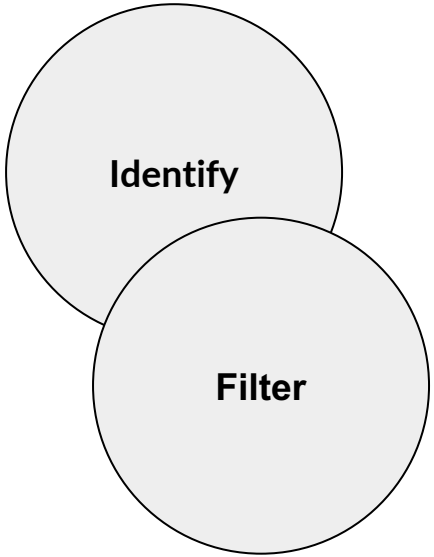
Creation



Transformation

Feature Engineering - Selection

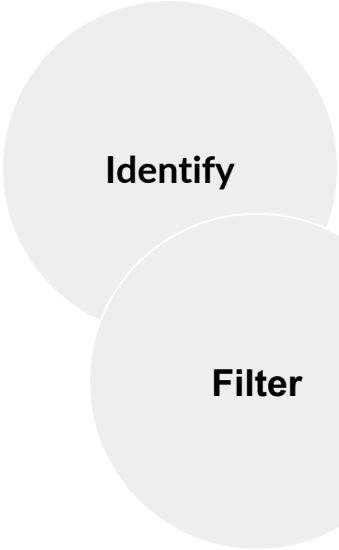




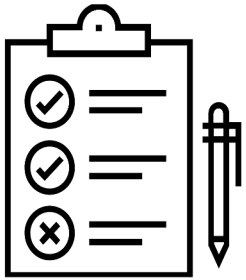
Data attributes

Irrelevant and redundant attributes

Feature Engineering - Selection



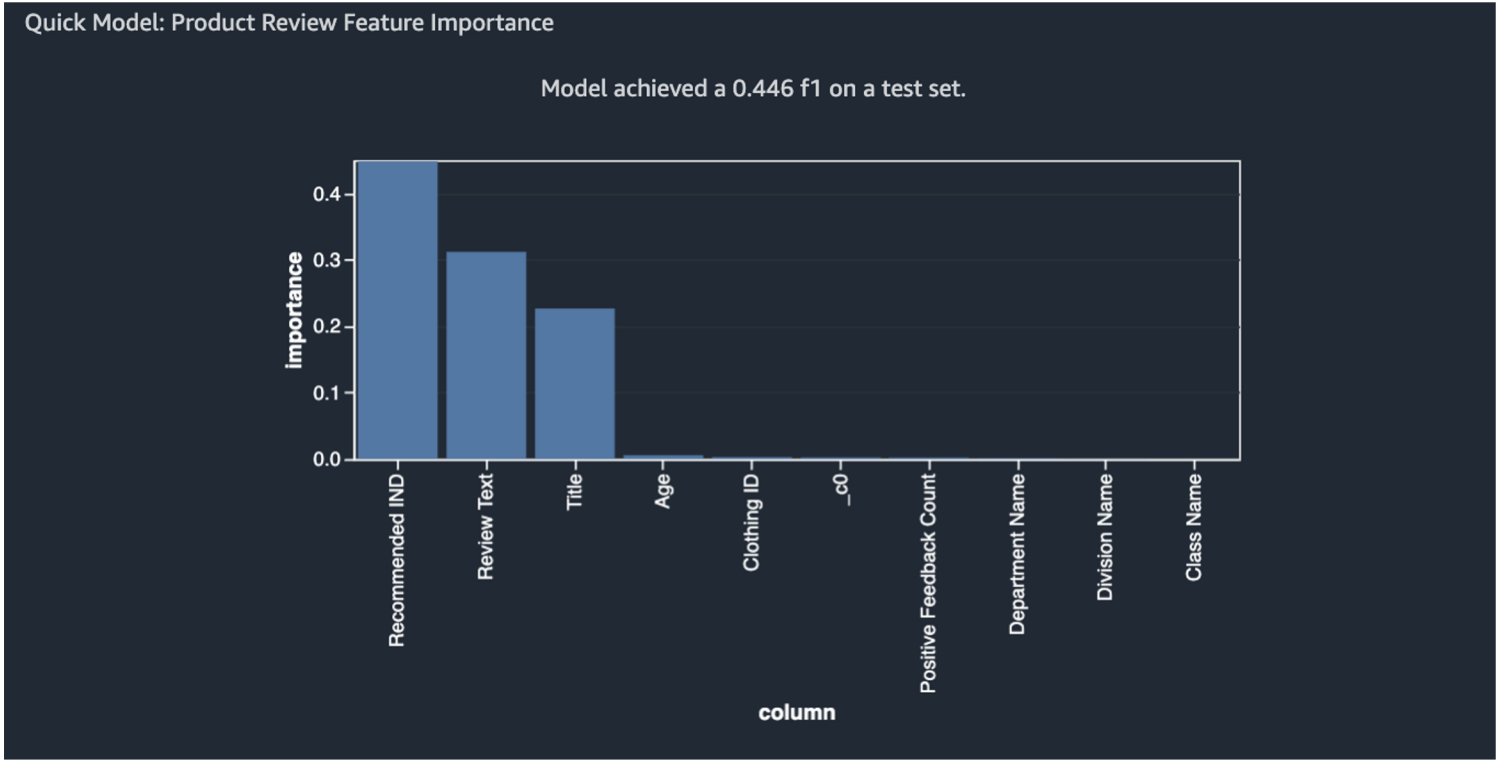
Data attributes



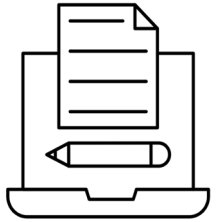
Irrelevant and redundant attributes

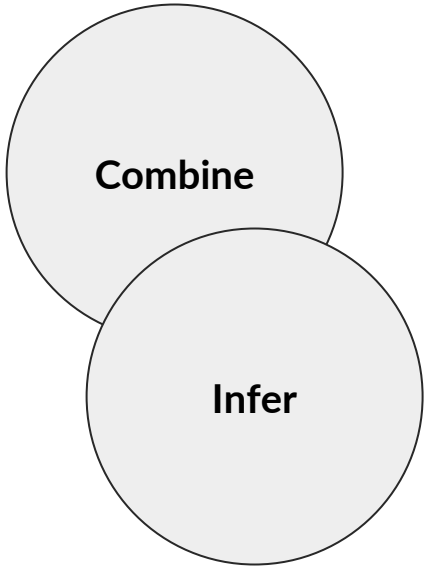
- Reduce feature dimensionality
- Train models faster

Feature Importance Report



Feature Engineering - Creation



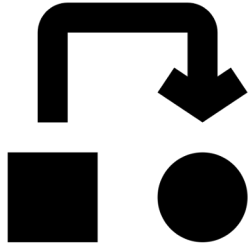


Existing data points into new features

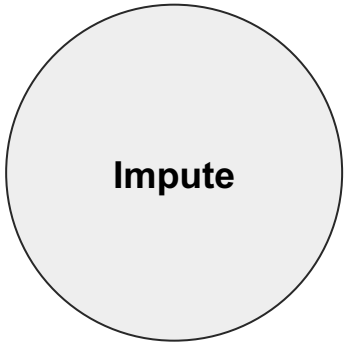
New attributes

- Lead to more accurate predictions

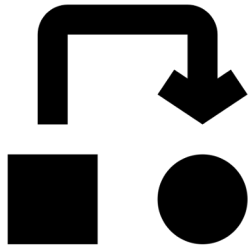
Feature Engineering - Transformation



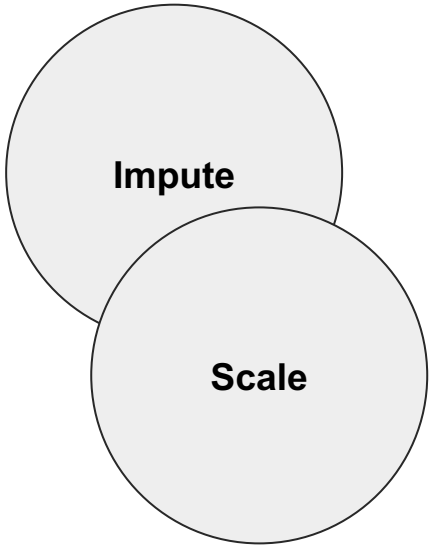
Feature Engineering - Transformation



Missing feature values

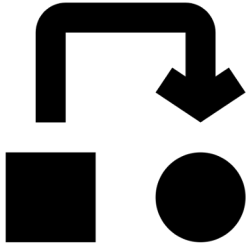


Feature Engineering - Transformation

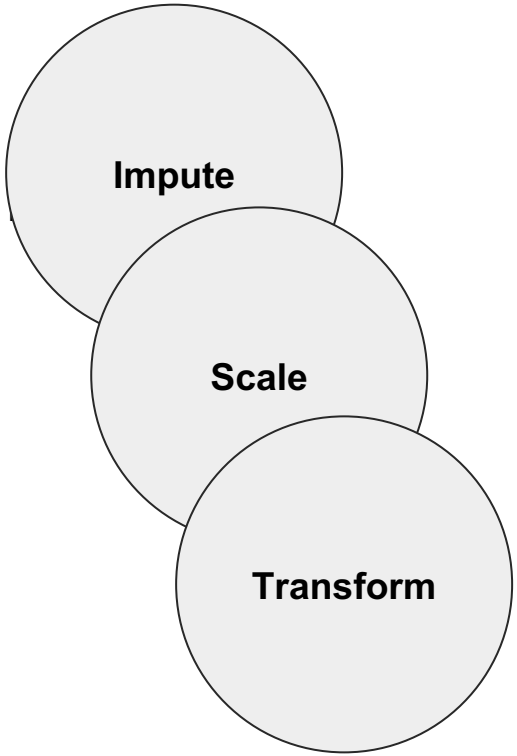


Missing feature values

Numerical features



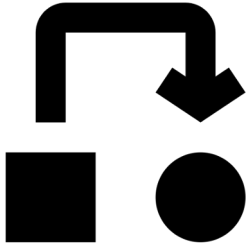
Feature Engineering - Transformation



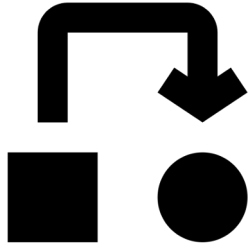
Missing feature values

Numerical features

Non Numerical features

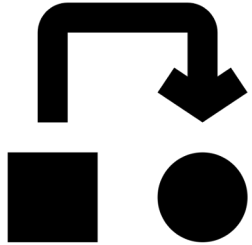


Feature Engineering - Transformation



Class Name	Review Text
Blouses	“I simply love it!”
Pants	“It's ok.”
Dresses	“It arrived damaged. Going to return.”

Feature Engineering - Transformation



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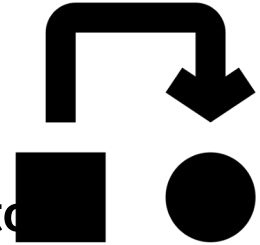
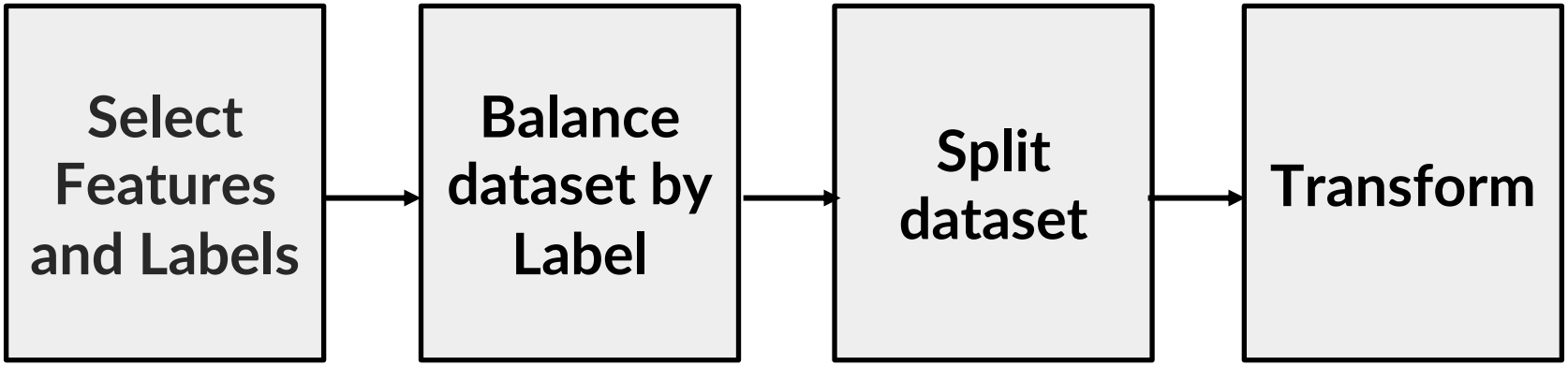
Feature Transformation



Review Text	BERT vecto		
“I simply love it!”	101	2023	...	...
“It's ok.”	3319	1012	...	...
“It arrived damaged. Going to return.”	2003	2307	...	...

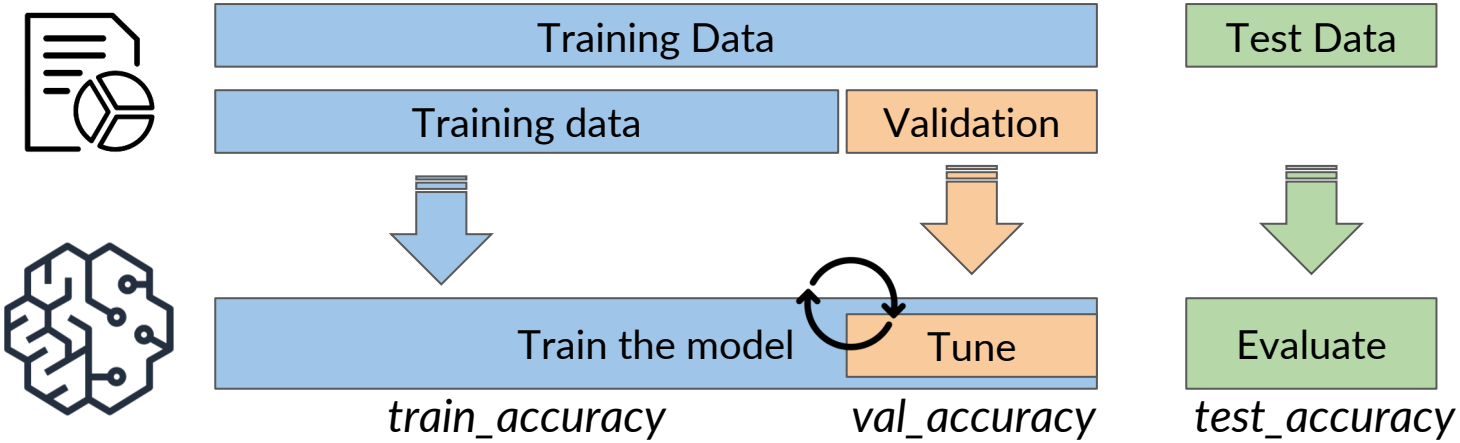
Feature Engineering Pipeline

Feature engineering pipeline

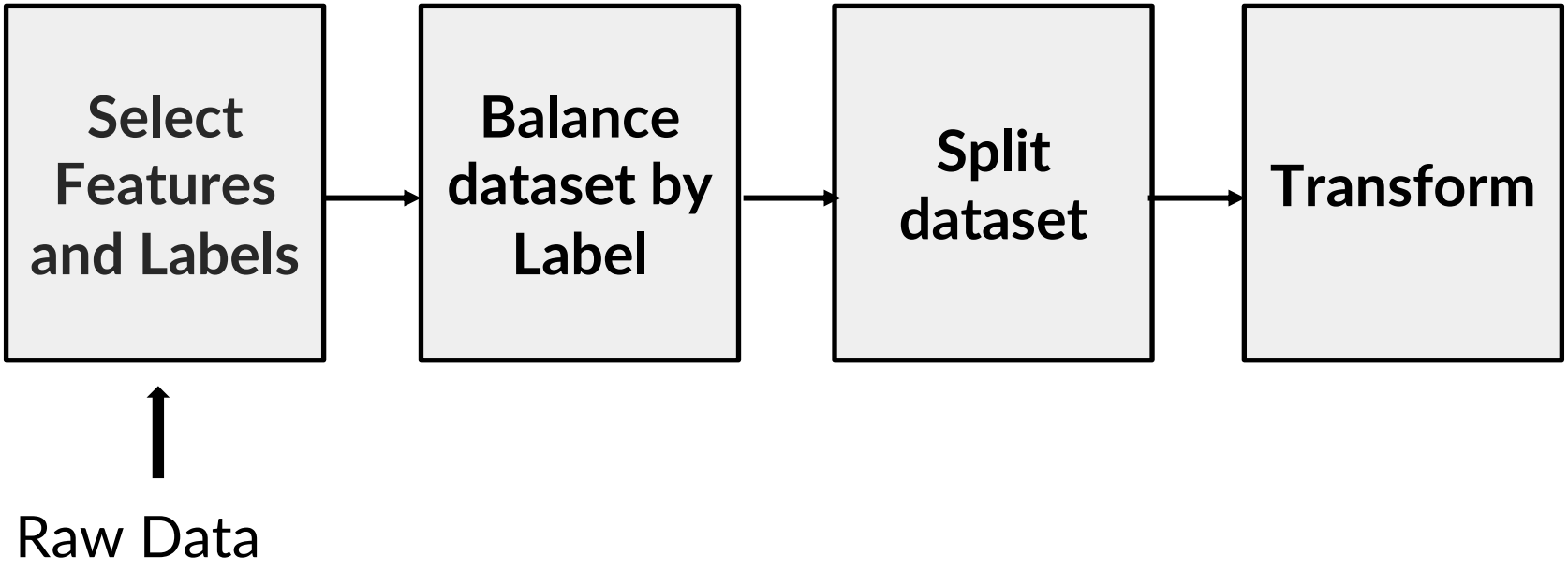


Split Dataset

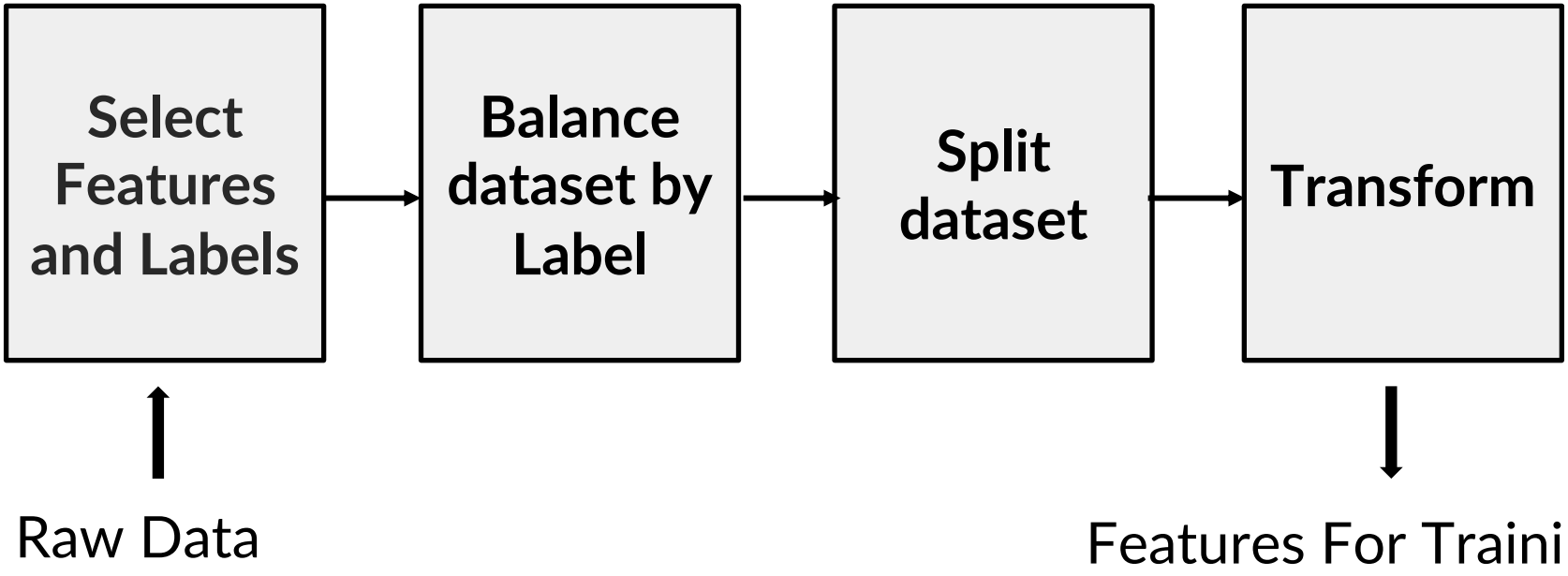
- Training, validation and test data



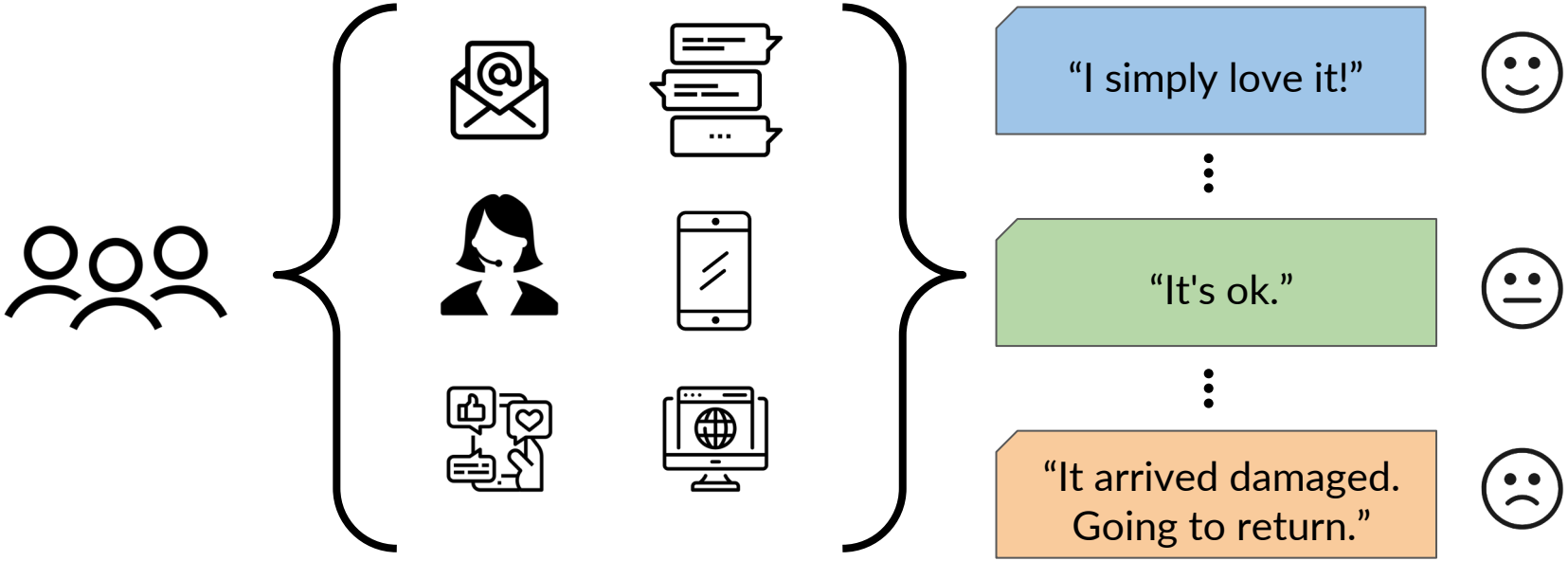
Feature Engineering Pipeline



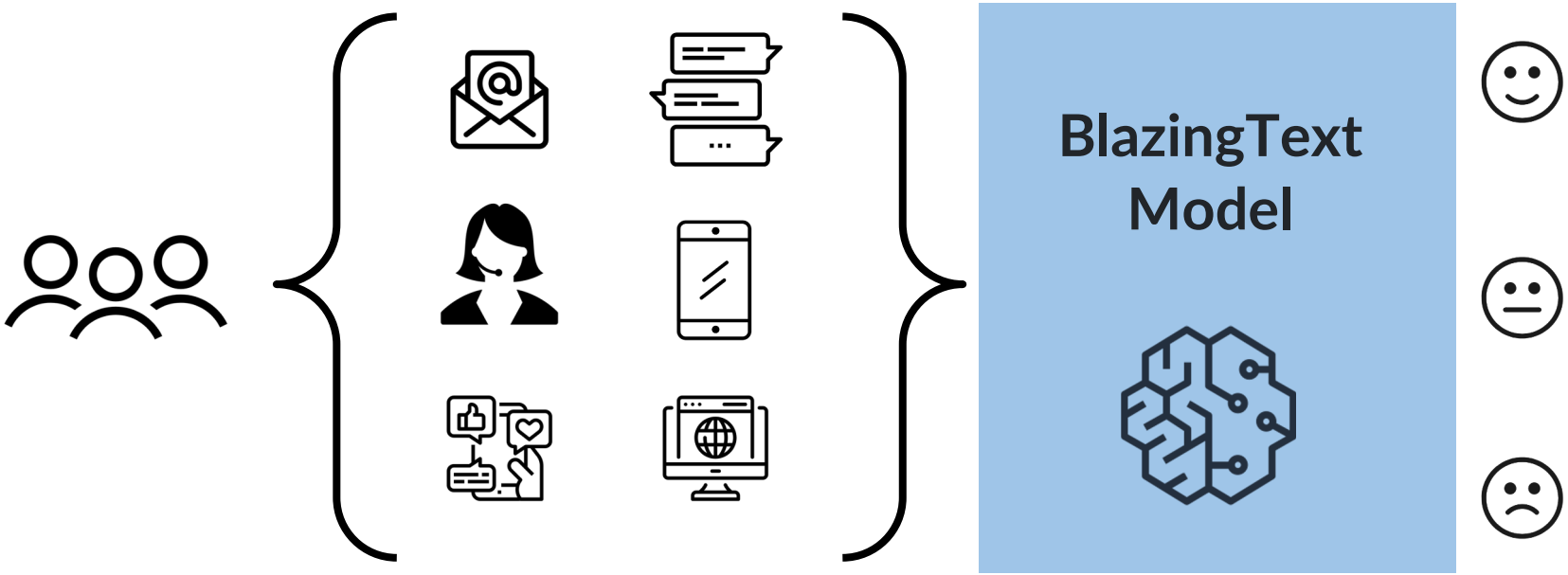
Feature Engineering Pipeline



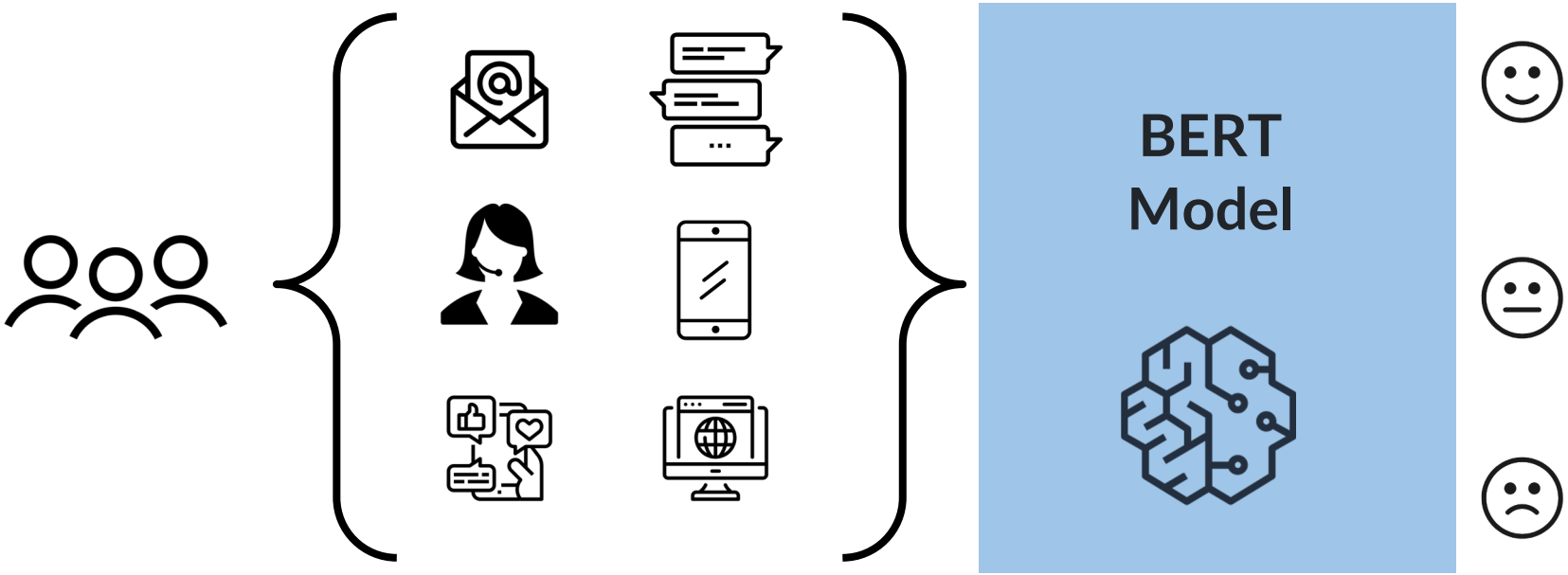
Multi-class Classification for Sentiment Analysis of Product Reviews



Multi-class Classification for Sentiment Analysis of Product Reviews



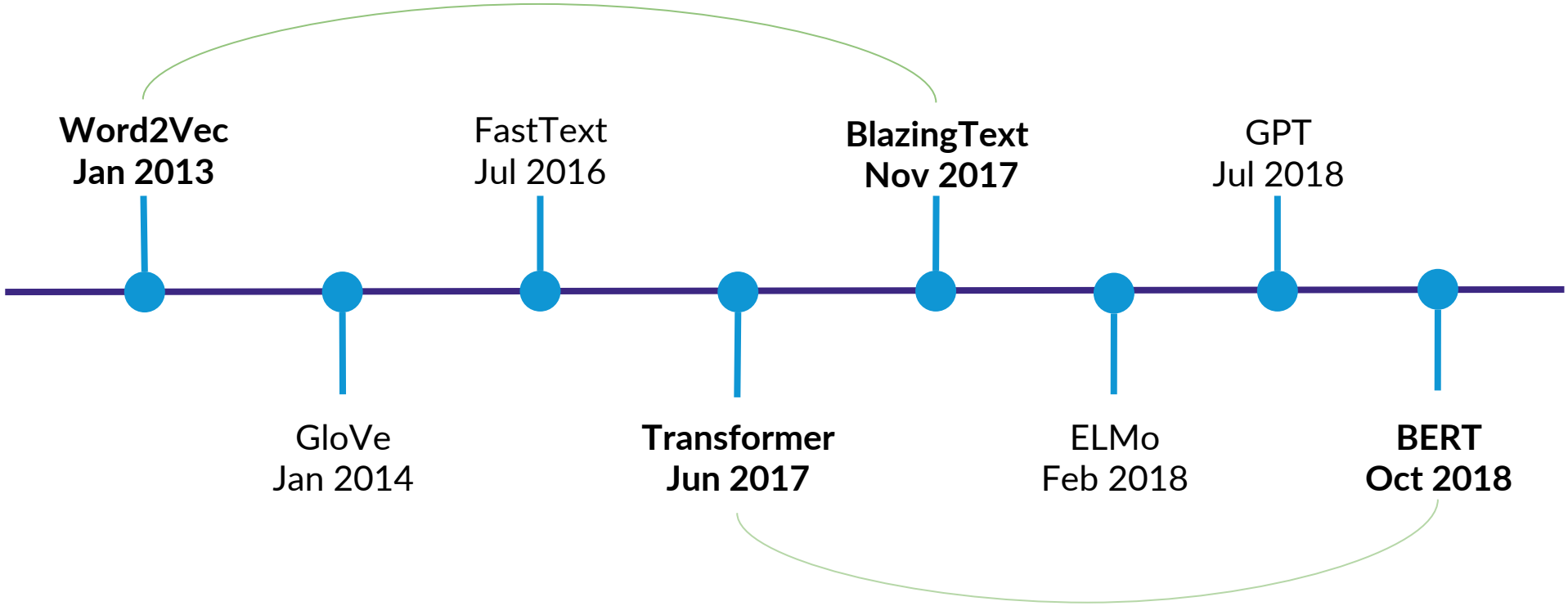
Multi-class Classification for Sentiment Analysis of Product Reviews



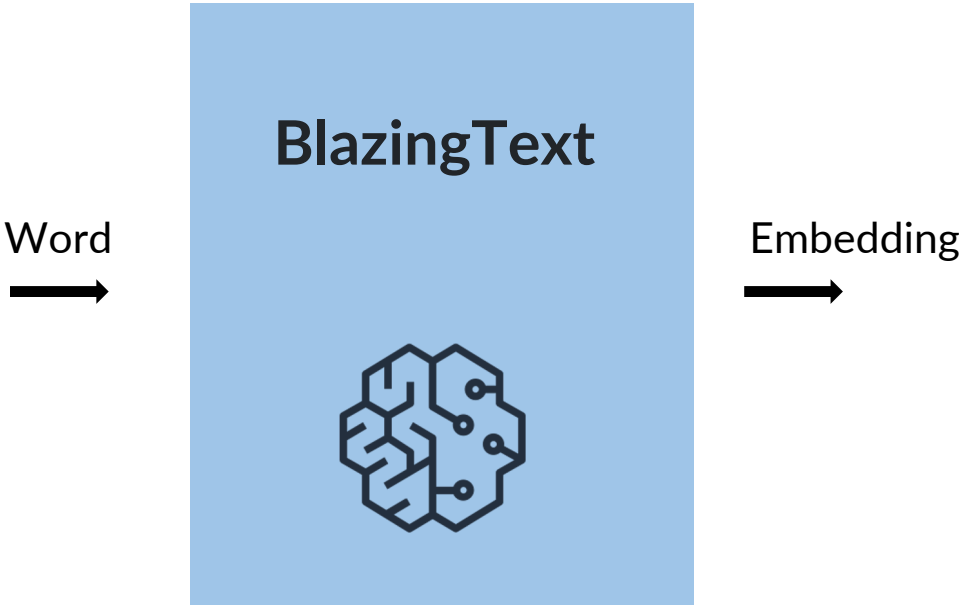
BERT

Bidirectional Encoder
Representations
from Transformers

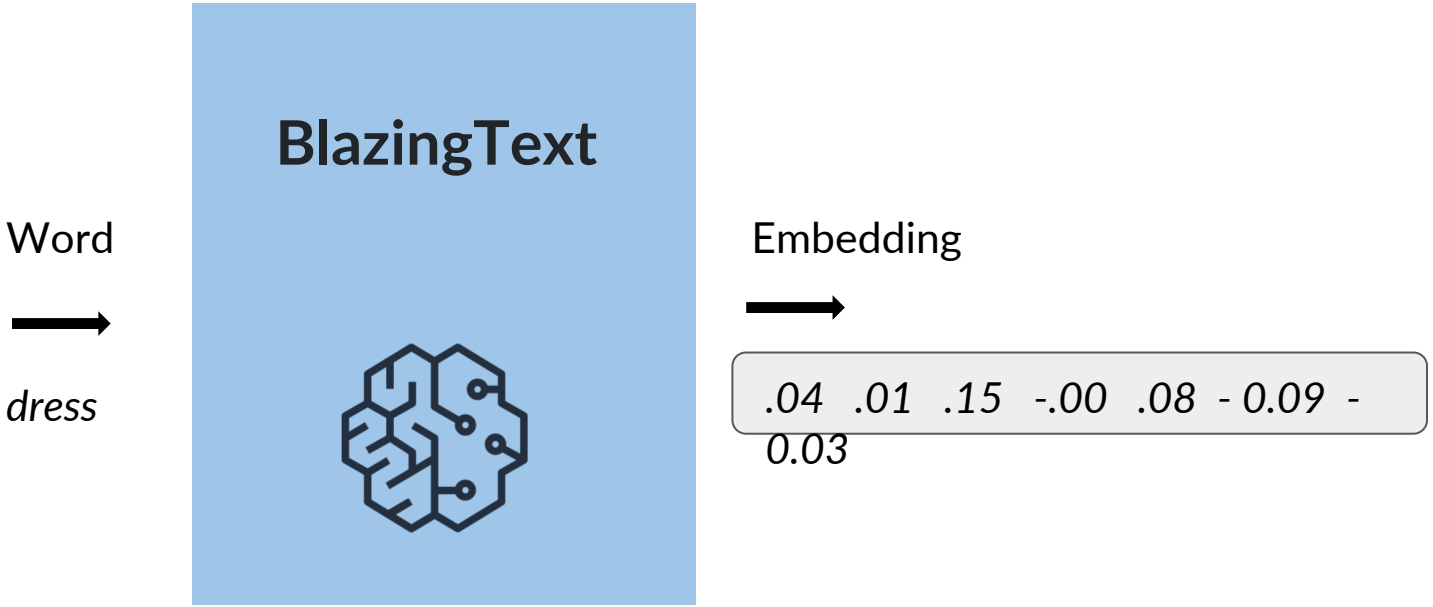
BlazingText vs BERT



BlazingText - Word Level Embeddings

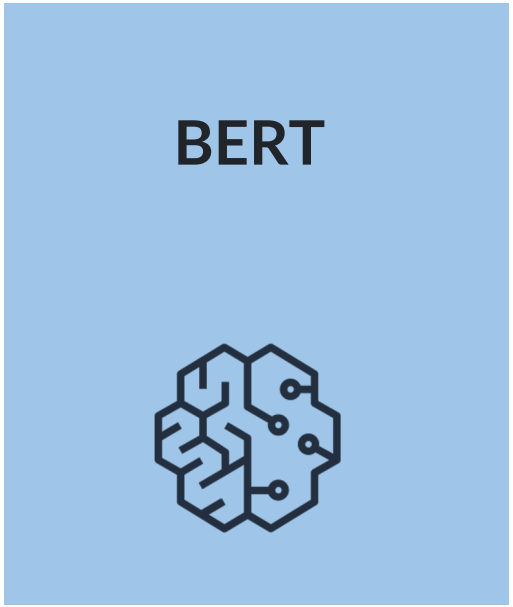


BlazingText - Word Level Embeddings



BERT - Contextual Embeddings

Sentence

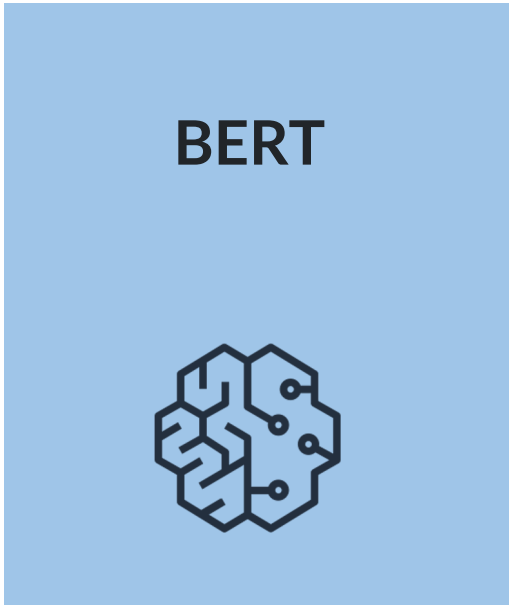


Embedding (Token + Segment + Position)

BERT - Contextual Embeddings

Sentence

I love the dress



Embedding (Token + Segment + Position)

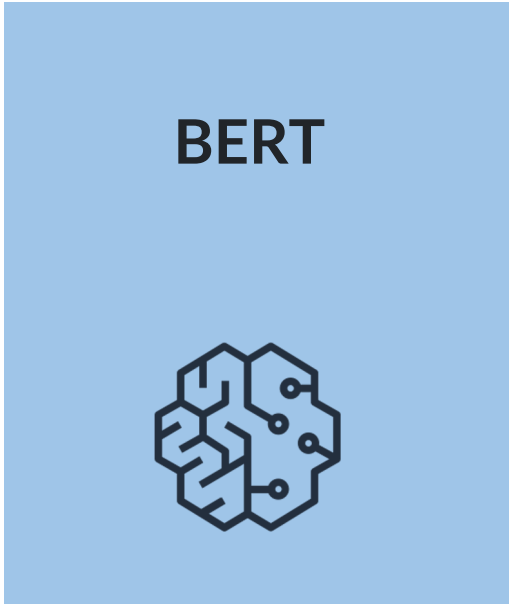
Fixed length embedding

BERT - Contextual Embeddings

Sentence

I love the dress

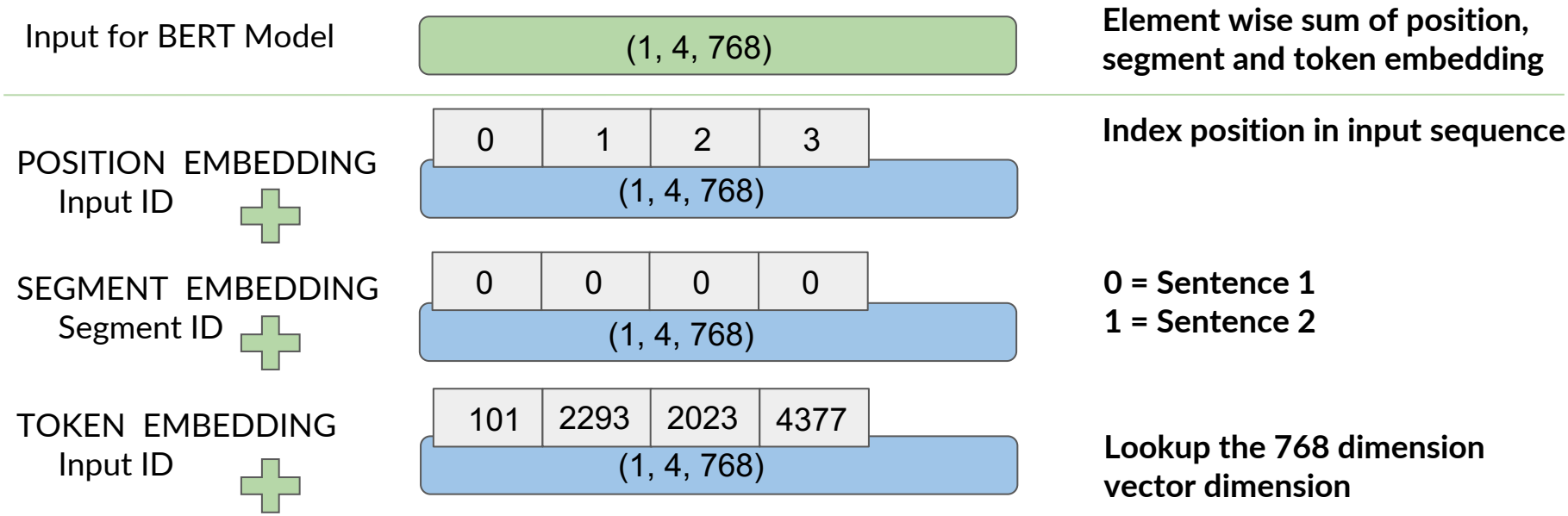
I love the dress, but not the price



Embedding (Token + Segment + Position)

Fixed length embedding

BERT Embeddings



BERT Embeddings

Raw Input
sequence

Love this dress

1 input

BERT Embeddings

Word Piece Tokenization

[CLS], Love, this, dress

1 input sequence (consisting of 4 tokens)

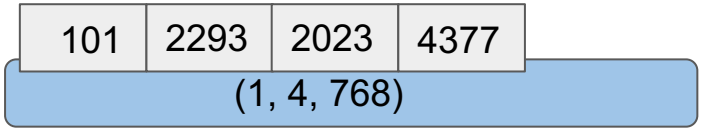
Raw Input **sequence**

Love this dress

1 input

BERT Embeddings

TOKEN EMBEDDING
Input ID



Lookup the 768 dimension vector dimension

Word Piece Tokenization

[CLS], Love, this, dress

1 input sequence (consisting of 4 tokens)

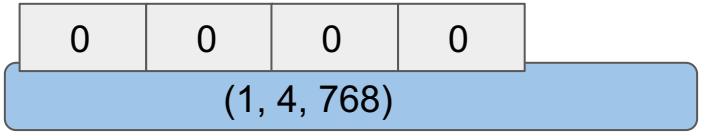
Raw Input **sequence**

Love this dress

1 input

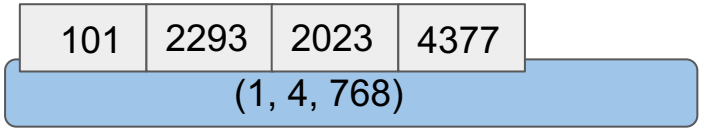
BERT Embeddings

SEGMENT EMBEDDING
Segment ID



0 = Sentence 1
1 = Sentence 2

TOKEN EMBEDDING
Input ID



Lookup the 768 dimension vector dimension

Word Piece Tokenization

[CLS], Love, this, dress

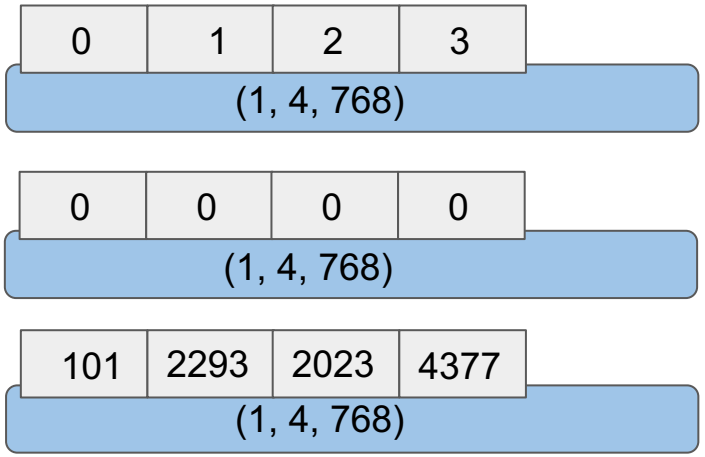
1 input sequence (consisting of 4 tokens)

Raw Input **sequence**

Love this dress

1 input

BERT Embeddings



Index position in input sequence

0 = Sentence 1
1 = Sentence 2

Lookup the 768 dimension vector dimension

Word Piece Tokenization

[CLS], Love, this, dress

1 input sequence (consisting of 4 tokens)

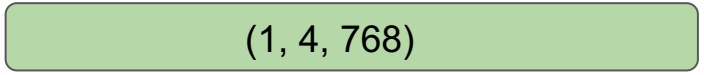
Raw Input **sequence**

Love this dress

1 input

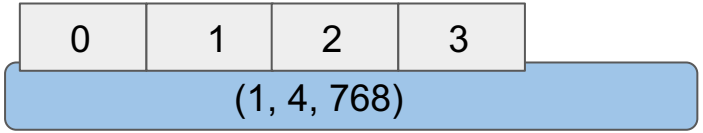
BERT Embeddings

Input for BERT Model



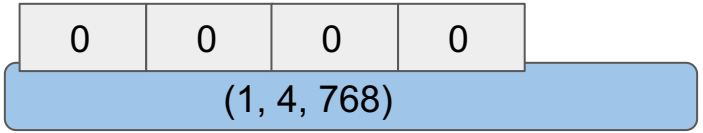
Element wise sum of position, segment and token embedding

POSITION EMBEDDING
Input ID



Index position in input sequence

SEGMENT EMBEDDING
Segment ID



0 = Sentence 1
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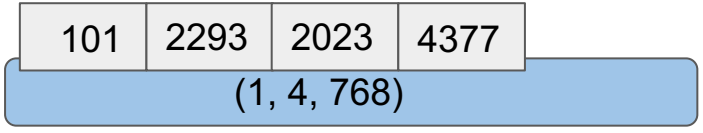
TOKEN EMBEDDING
Input ID



Lookup the 768 dimension vector dimension

Word Piece Tokenization

[CLS], Love, this, dress

1 input sequence (consisting of 4 tokens)

Raw Input **sequence**

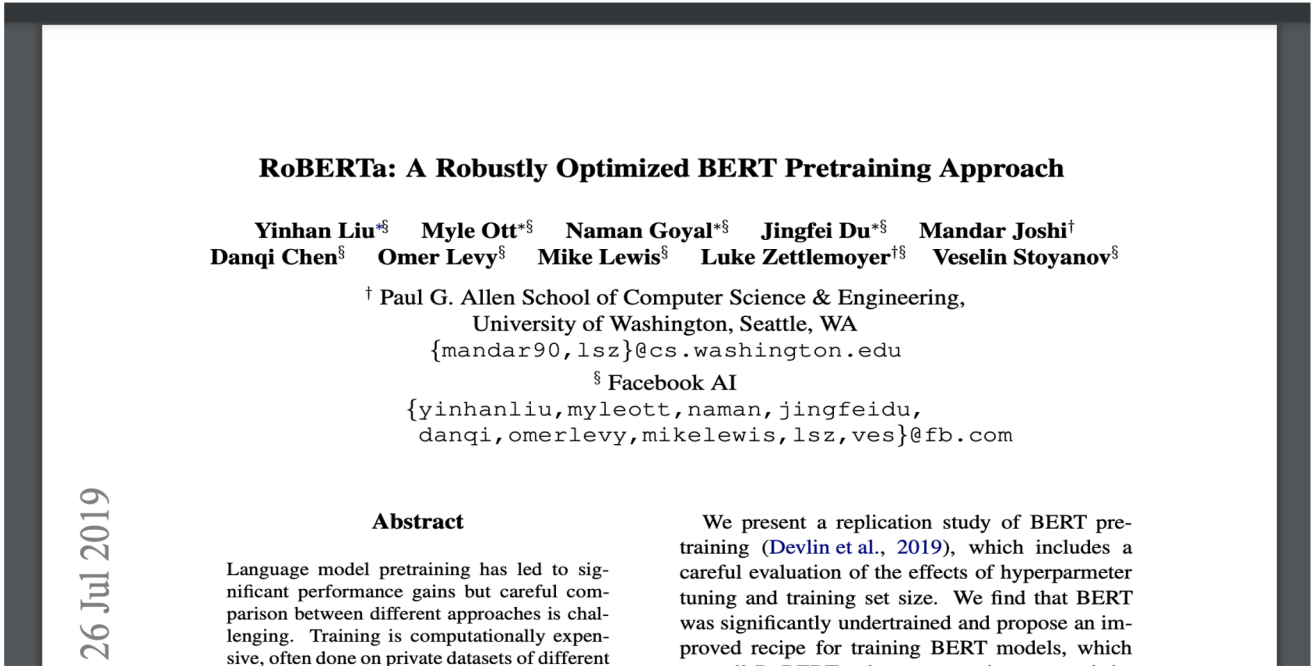
Love this dress

1 input

Feature Engineering

At scale with Amazon SageMaker Processing Jobs

RoBERTa model



RoBERTa: A Robustly Optimized BERT Pretraining Approach

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Abstract

Language model pretraining has led to significant performance gains but careful comparison between different approaches is challenging. Training is computationally expensive, often done on private datasets of different

We present a replication study of BERT pretraining (Devlin et al., 2019), which includes a careful evaluation of the effects of hyperparmeter tuning and training set size. We find that BERT was significantly undertrained and propose an improved recipe for training BERT models, which

BERT Embeddings with RoBERTa

```
from transformers import RobertaTokenizer

PRE_TRAINED_MODEL_NAME = 'roberta-base'



tokenizer =
RobertaTokenizer.from_pretrained(PRE_TRAINED_MODEL_NAME)
```

Import the Tokenizer class

Create the tokenizer to use based on pre trained model

BERT Embeddings with scikit-learn

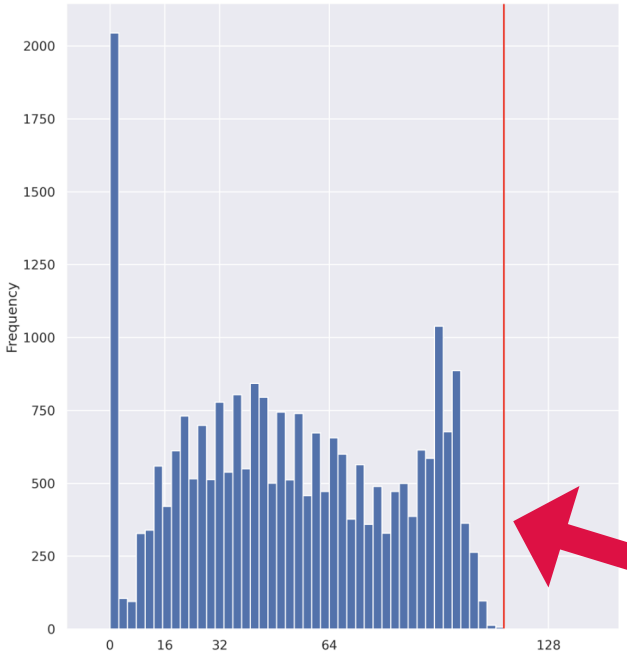
```
def convert_to_bert_input_ids(...):
    encode_plus = tokenizer.encode_plus(
        review,
        add_special_tokens=True,
        max_length=128,
        return_token_type_ids=False,
        padding='max_length',
        return_attention_mask=True,
        return_tensors='pt',
        truncation=True

    return encode_plus['input_ids'].flatten().tolist()
```

Review to be encoded

Max sequence length

Special tokens

BERT hyper-parameter: **max_seq_length**



mean	52.51
std	31.38
min	1.00
10%	10.00
20%	22.00
30%	32.00
40%	41.00
50%	51.00
60%	61.00
70%	73.00
80%	88.00
90%	97.00
100%	**115.00**

BERT Embeddings with scikit-learn

```
def convert_to_bert_input_ids(...):
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        truncation=True

    return encode_plus['input_ids'].flatten().tolist()
```
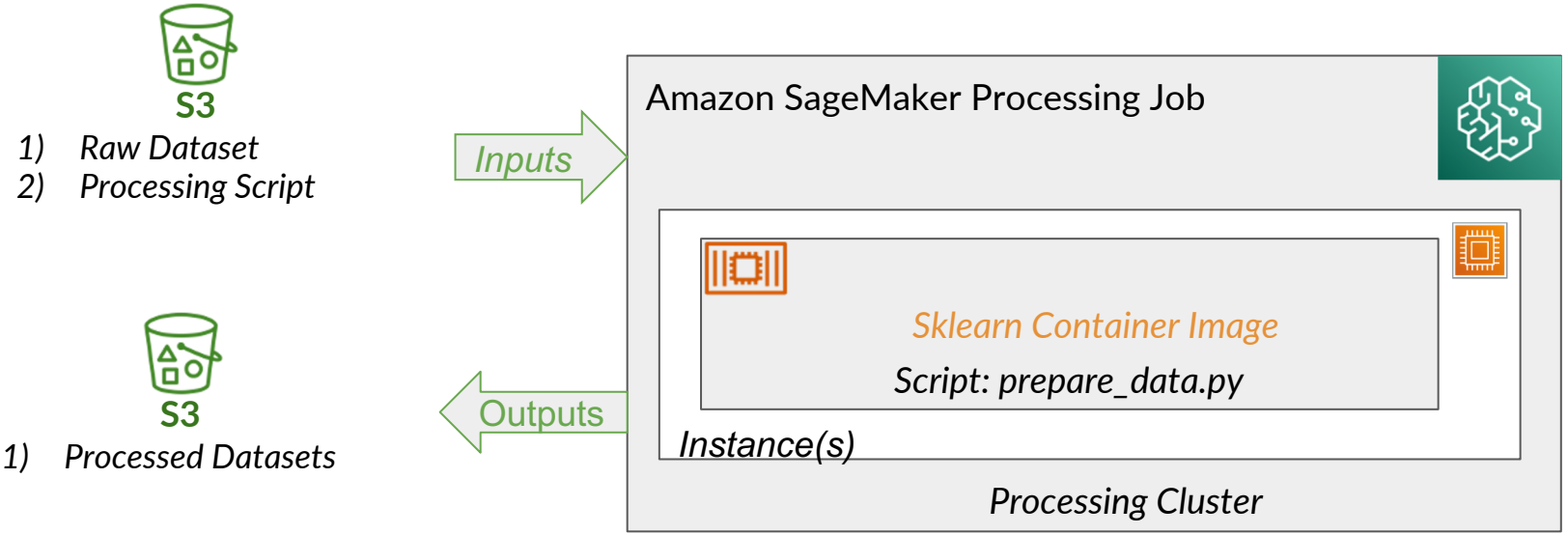

Review to be encoded

Max sequence length

Special tokens

Amazon SageMaker Processing

Execute preprocessing, post processing, model evaluation



Amazon SageMaker Processing with scikit-learn

```
from sagemaker.sklearn.processing import SKLearnProcessor
from sagemaker.processing import ProcessingInput, ProcessingOutput


processor = SKLearnProcessor(
        framework_version='<SCIKIT_LEARN_VERSION',
        role=role,
        instance_type='ml.c5.4xlarge',
        instance_count=2)

processor.run(<parameters>)
```

Setup processing cluster

Run the processing job

Amazon SageMaker Processing with scikit-learn

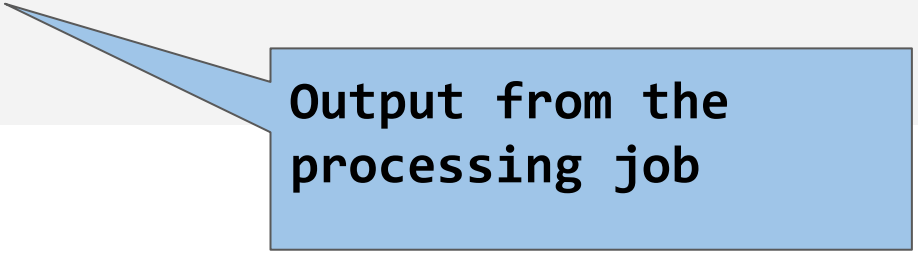
```
...
code='preprocess-scikit-text-to-bert.py',

inputs=[
    ProcessingInput(
        input_name='raw-input-data',
        source=raw_input_data_s3_uri,
        ...)
],
```

Scikit-learn script to execute

Input data to transform

Amazon SageMaker Processing with scikit-learn

```
...
outputs=[
    ProcessingOutput(
        output_name='bert-train',
        s3_upload_mode='EndOfJob',
        source='/opt/ml/processing/output/bert/train'),
    ...,
],
```



Amazon SageMaker Processing with scikit-learn

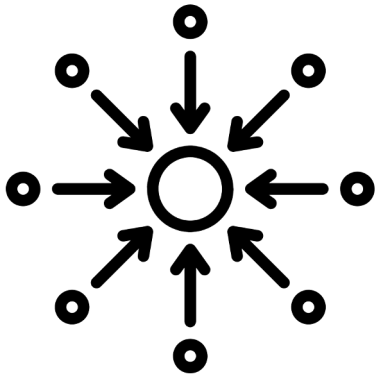
Sentiment	Review
1	*this is a great item!*
-1	*not a good product.*
0	*dress is ok*
-1	*do not use! awful. blah*

SageMaker Processing

label_id	input_ids		
1	*101*	*2023*	...
-1	*3319*	*1012*	...
0	*2003*	*2307*	...
-1	*102*	*3212*	...

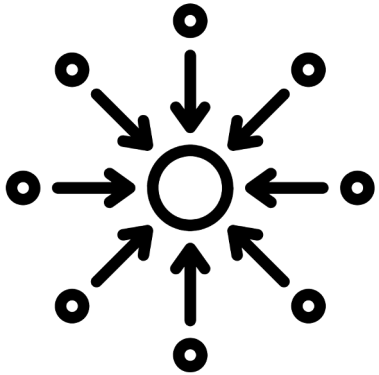
Feature Store

Feature Store

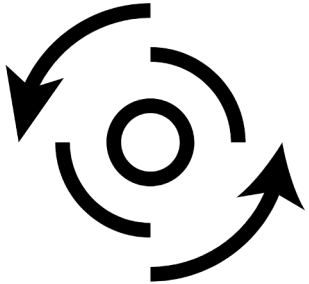


Centralized

Feature Store

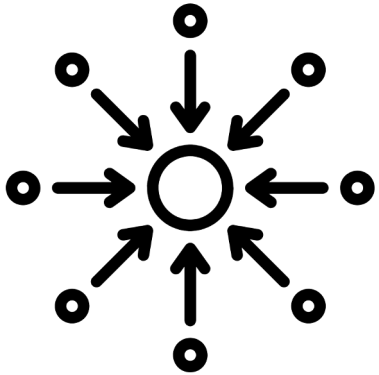


Centralized

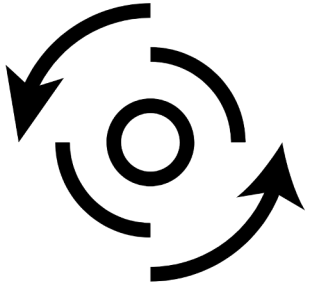


Reusable

Feature Store



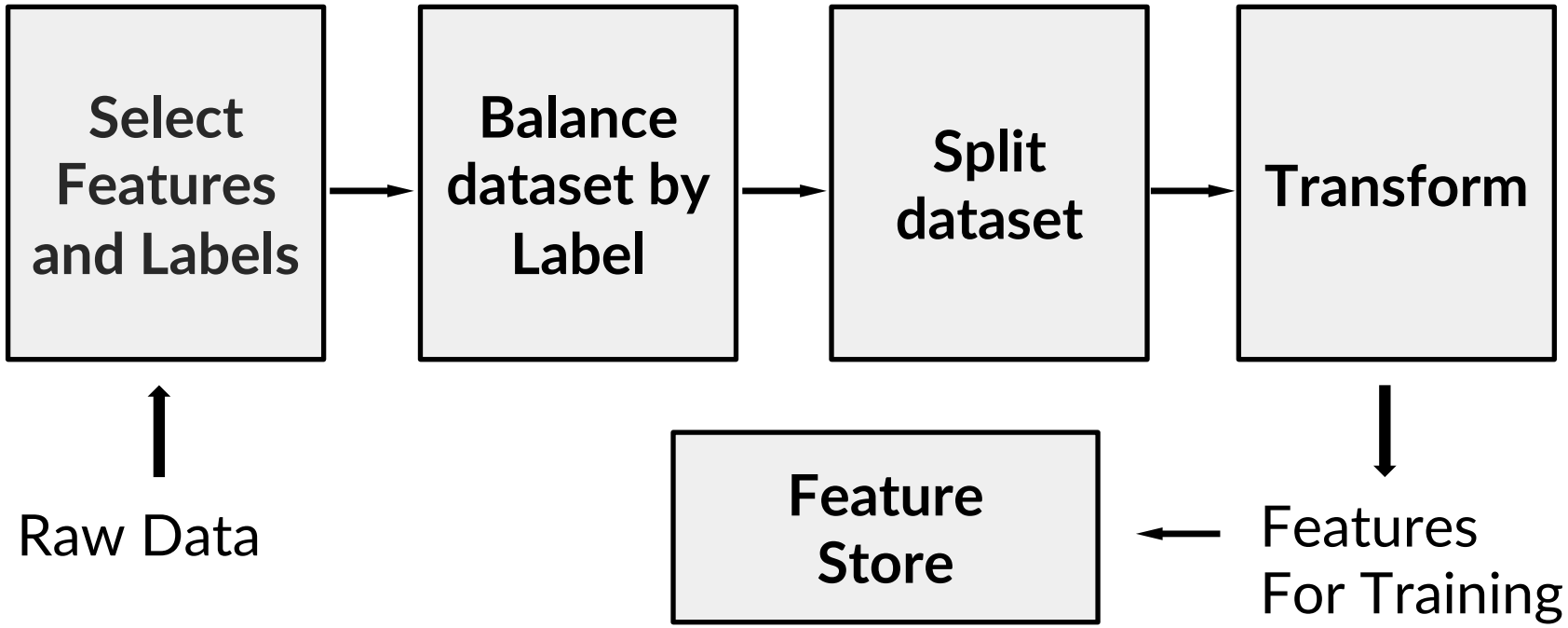
Centralized



Reusable

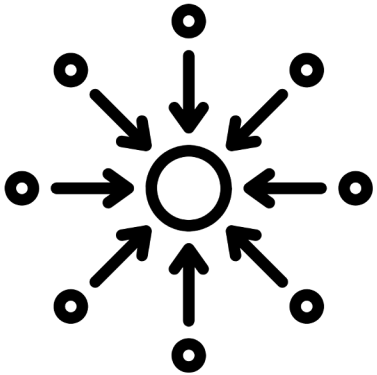
Discoverable

Feature Engineering Pipeline Extended



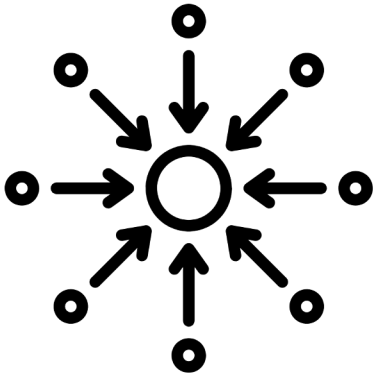
Amazon SageMaker Feature Store

Amazon SageMaker Feature Store

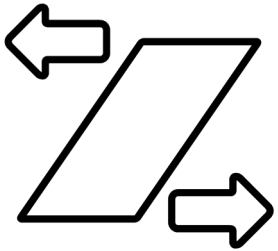


Store and Serve Features

Amazon SageMaker Feature Store

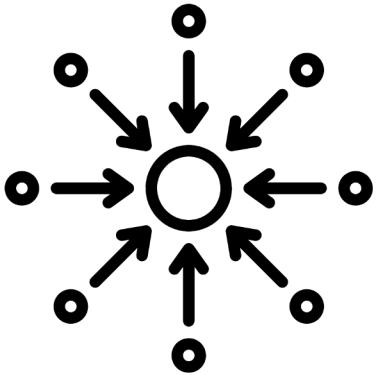


Store and Serve Features

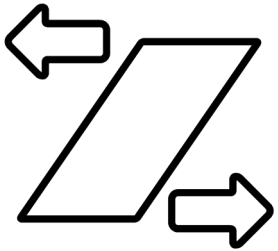


Reduce skew

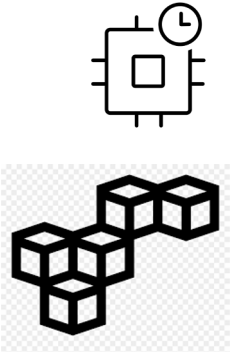
Amazon SageMaker Feature Store



Store and Serve Features



Reduce skew



Real time & Batch

Amazon SageMaker Feature Store - Create

```
from sagemaker.feature_store.feature_group import FeatureGroup

reviews_feature_group_name = "reviews_distilbert_max_seq_length_128"

reviews_feature_group = FeatureGroup(
     name=...,
     feature_definitions=...,
     sagemaker_session=sagemaker_session)

reviews_feature_group.create(
    s3_uri="s3://{}/{}".format(bucket, prefix),
    record_identifier_name=record_identifier_feature_name,
    event_time_feature_name=event_time_feature_name,
    role_arn=role)
```

Name

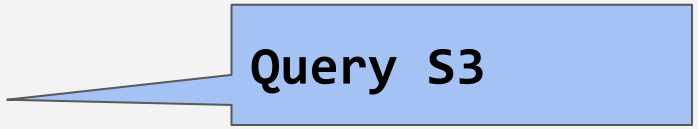
Create

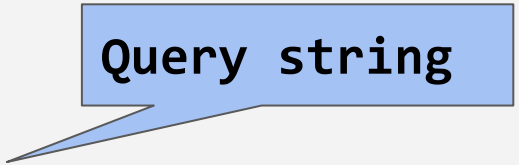
Amazon SageMaker Feature Store - Ingest

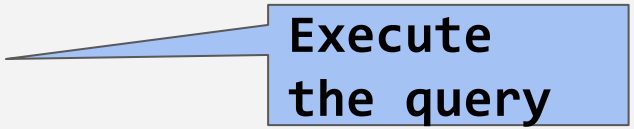
```
reviews_feature_group.ingest(
    data_frame=df_records,
    max_workers=3,
    wait=True)
```

Amazon SageMaker Feature Store - Retrieve

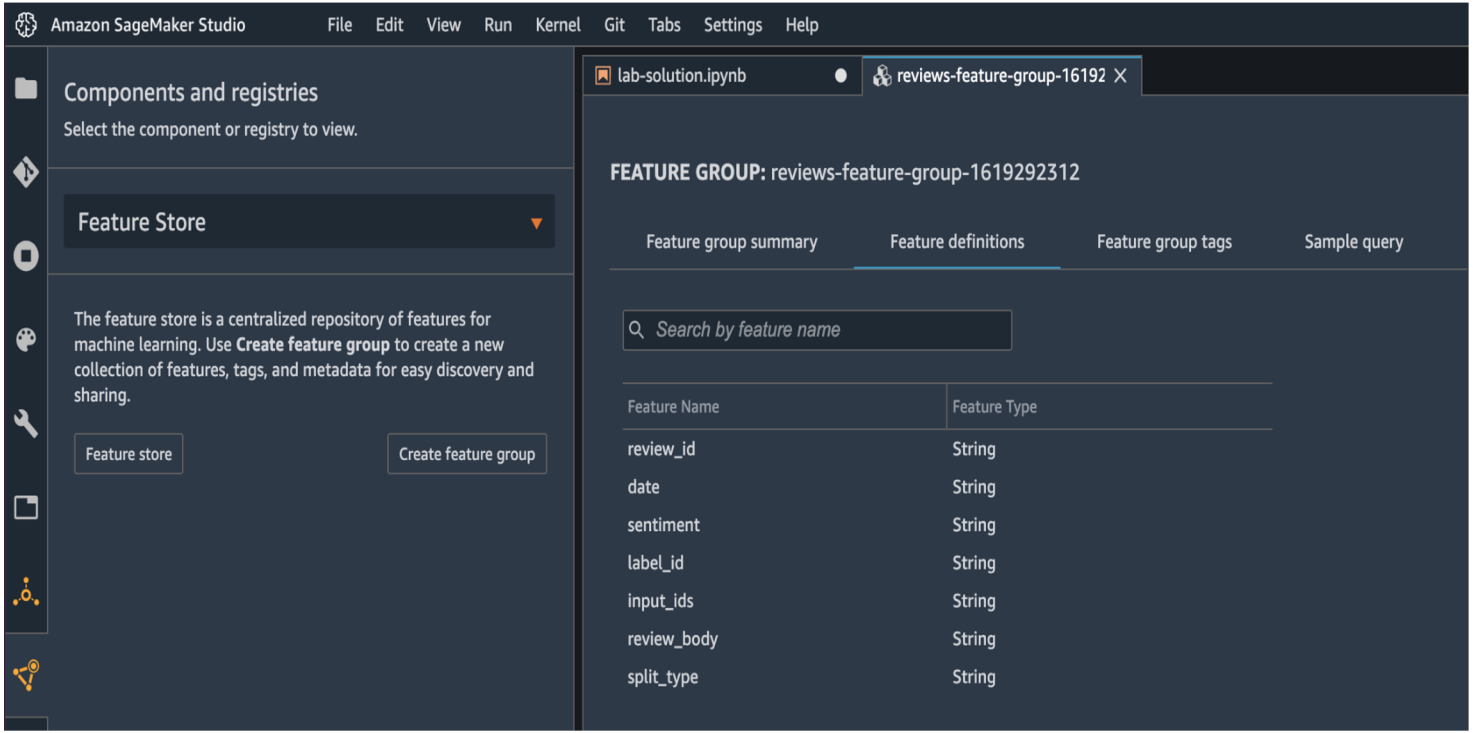
```
reviews_feature_store_query =
    reviews_feature_group.athena_query()

reviews_feature_store_table =
    reviews_feature_store_query.table_name

query_string = 'SELECT review_body, input_ids, input_mask, segment_ids,
label_id FROM "{}" LIMIT 5'.format(reviews_feature_store_table)

reviews_feature_store_query.run(
    query_string=..., ...)
```



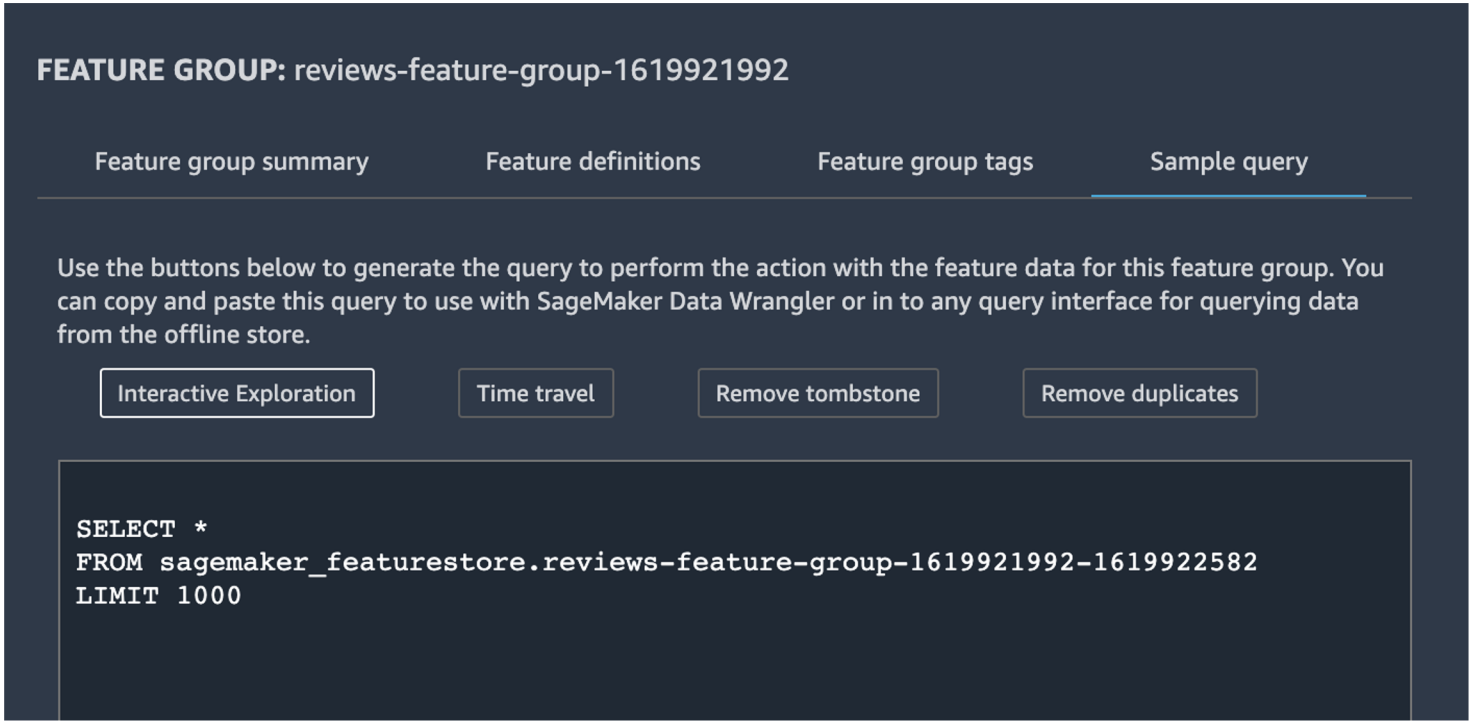




Amazon SageMaker Feature Store In SageMaker Studio



Amazon SageMaker Feature Store In SageMaker Studio



Amazon SageMaker Feature Store In SageMaker Studio

	date	review_id	sentiment	label_id	input_ids	review_body
0	2021-04-29T18:34:07Z	14136	1	2	[0, 713, 16, 10, 182, 22, 4903, 3760, 254, 22, 2125, 4, 939, 657, 24, 328, 939, 2813, 6215, 74, ...	This is a very "retailer " piece. i love it! i wish retailer would bring back more pieces like t...
1	2021-04-29T18:34:07Z	4026	0	1	[0, 100, 1432, 5, 6173, 8, 2162, 10, 2514, 1836, 11, 5, 2440, 33953, 4, 939, 524, 2333, 10, 1836...	I followed the reviews and bought a larger size in the blue stripe. i am usually a size 8 but or...
2	2021-04-29T18:34:07Z	7522	-1	0	[0, 713, 8443, 16, 98, 11962, 8, 10698, 1969, 8, 939, 657, 5, 32847, 4, 959, 1437, 24, 24232, 90...	This jacket is so cute and fits perfect and i love the motif. however it deposited black linty ...
3	2021-04-29T18:34:07Z	7618	-1	0	[0, 133, 19111, 738, 8, 1421, 738, 32, 2198, 430, 4, 24, 18, 101, 45, 190, 5, 276, 3588, 4, 5, 5...	The catalog shot and model shot are completely different. it's like not even the same dress. the...
4	2021-04-29T18:34:07Z	11942	1	2	[0, 100, 269, 101, 5, 356, 9, 42, 8443, 1437, 53, 939, 206, 24, 1237, 650, 8, 939, 531, 671, 5, ...	I really like the look of this jacket but i think it runs small and i must return the one i rec...