AND OTHER THINGS

Counting Koalas with Kafka

@SimonAubury

@saubury

Apache Kafka Meetup - December 2023

Simple Machines

Simon Aubury

Director of data platforms

💗 Kafka enthusiast
🤗 Confluent Community Catalyst
🏠 Sydney, Australia

Baz

Southern koala

💗 Endangered
🤗 Eucalyptus trees
🏠 Australia

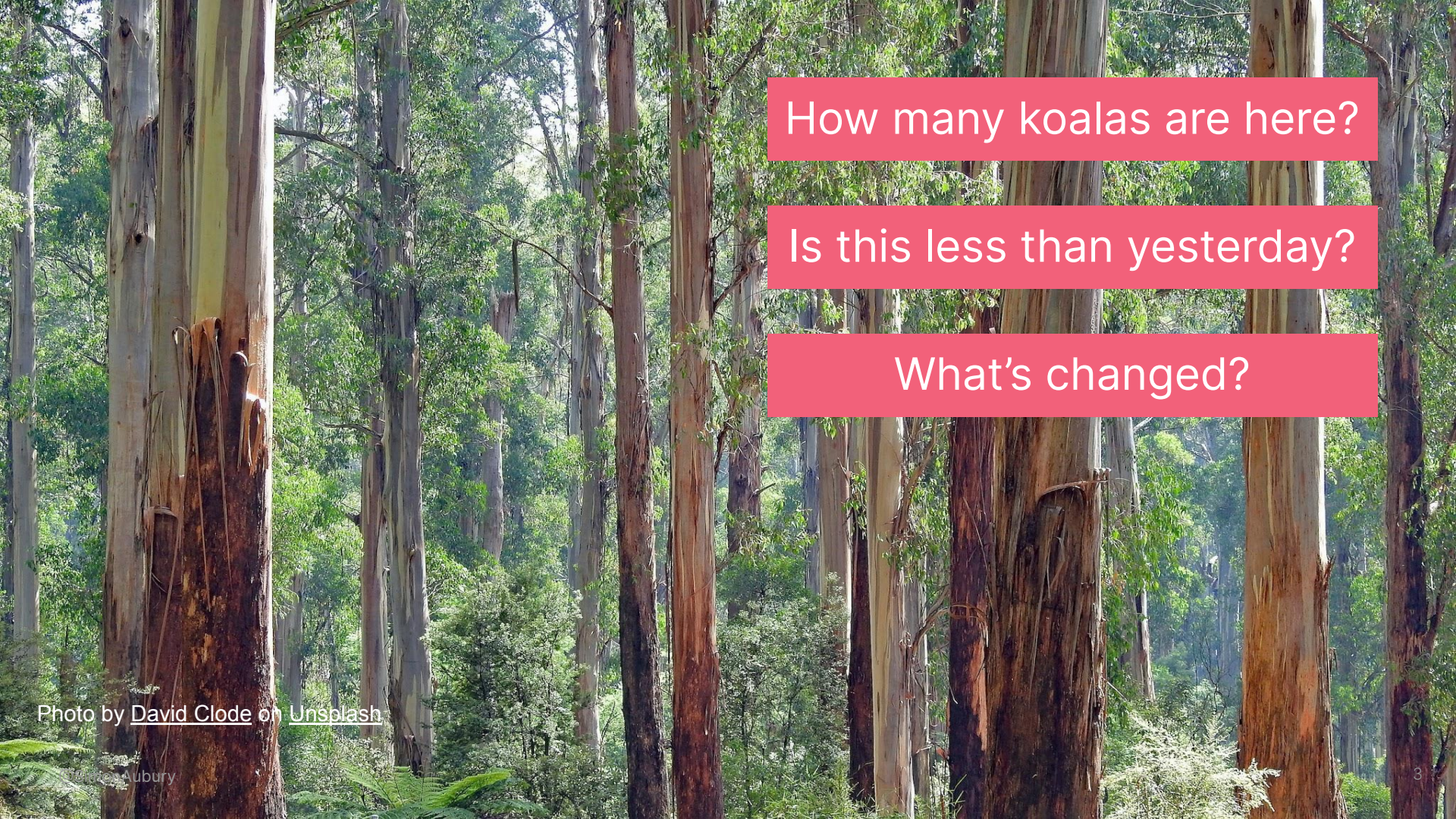
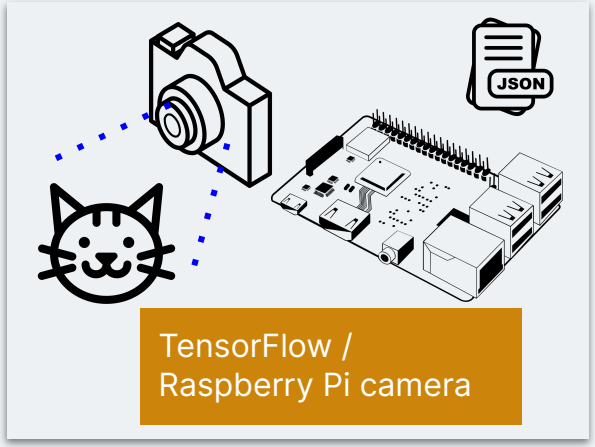


Photo by David Clode on Unsplash



1. Kafka-Cat

Raspberry Pi

Cameras in the wilderness

Raspberry Pi is a **low cost** credit-card sized computer

With an attached camera they have sufficient processing power for edge ML detection with TensorFlow Lite

TensorFlow

TensorFlow Lite object detection

Identify which of a known set of objects might be present and provide information about their positions within the image.


```
{ "cat": 0.82 }
```

```
{"cat":1, "koala":0}
```

Open Camera

Load model

Single image

Object detect

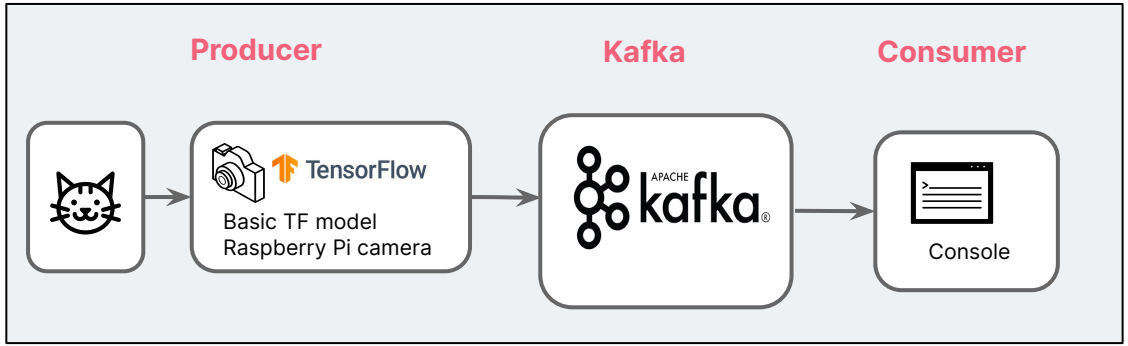
Kafka produce

```
# Start capturing video input from the camera
cap = cv2.VideoCapture()

# Load model efficientdet_lite0.tflite, set threshold
detector = vision.ObjectDetector.create_from_options(70%)

# Continuously capture camera images
while True:
    image = cap.read()

    # Run object detection estimation using the model
    detection_result = detector.detect(image)

    # Produce to objects topic
    kafka_producer.produce( detection_result )
```

https://github.com/saubury/wildlife-watch/blob/main/detect.py

Architecture

MVP version



-zsh

Python ⌘1 -zsh

```
saubury:wildlife-watch % kafka-console-consumer --bootstrap-server localhost:9092 --topic objects
{"camera_name": "raspberry-pi", "objects_found": [{"class_name": "cat", "probability": 0.74}], "objects_count": {"cat": 1}}
{"camera_name": "raspberry-pi", "objects_found": [{"class_name": "cat", "probability": 0.74}], "objects_count": {"cat": 1}}
{"camera_name": "raspberry-pi", "objects_found": [{"class_name": "cat", "probability": 0.74}], "objects_count": {"cat": 1}}
{"camera_name": "raspberry-pi", "objects_found": [{"class_name": "cat", "probability": 0.76}], "objects_count": {"cat": 1}}
{"camera_name": "raspberry-pi", "objects_found": [{"class_name": "cat", "probability": 0.76}], "objects_count": {"cat": 1}}
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{"camera_name": "raspberry-pi", "objects_found": [{"class_name": "cat", "probability": 0.72}], "objects_count": {"cat": 1}}
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{"camera_name": "raspberry-pi", "objects_found": [{"class_name": "cat", "probability": 0.71}], "objects_count": {"cat": 1}}
```
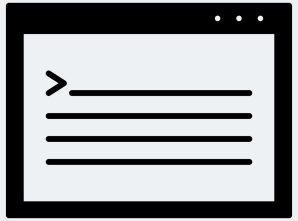

TensorFlow / Zoo Livestream

APACHE kafka

KSQL

Console



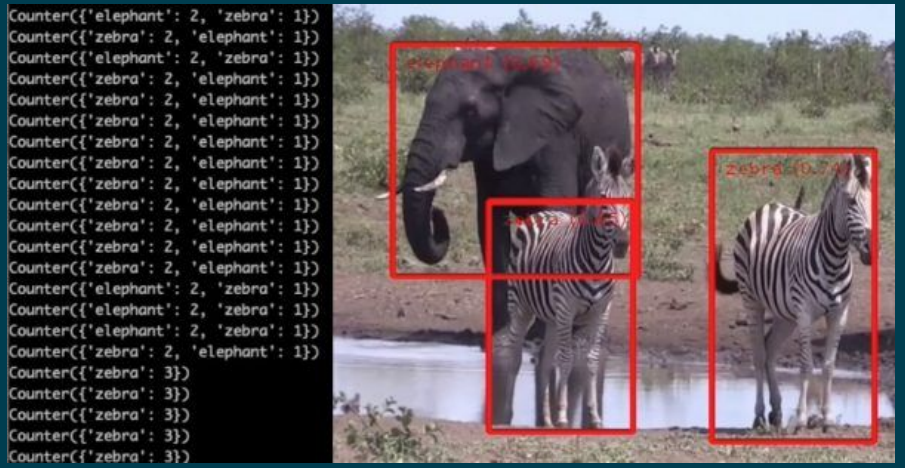
2. Zoo-keeping with ksqlDB

Zoo camera feed

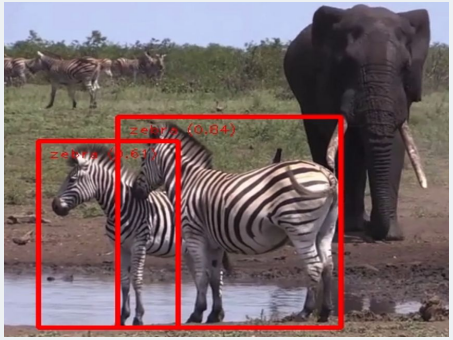
Expanding the animal collection

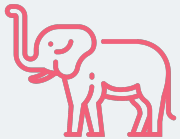
More animals from the zoo

- Additional Kafka producer
- Laptop based
- Source video webcam feed from local zoo (Pyautogui & OpenCV)



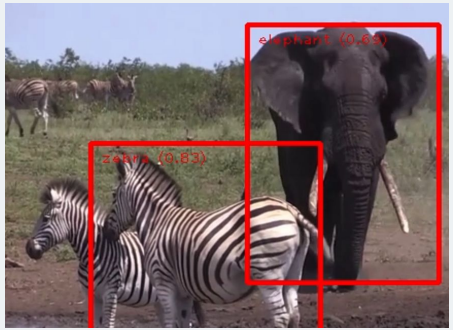

```
{
  "camera_name": "zoo-webcam",
  "objects_count": {
    "elephant": 1,
    "zebra": 2
  }
}
```

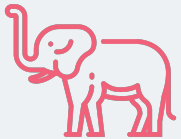




0

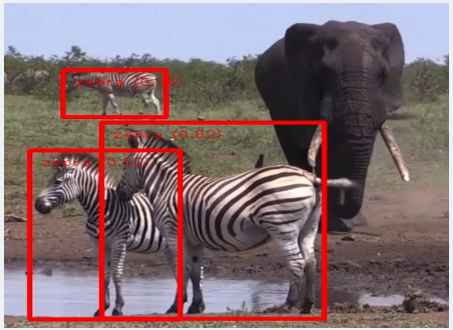
2

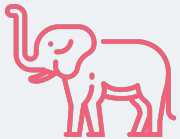




1

1





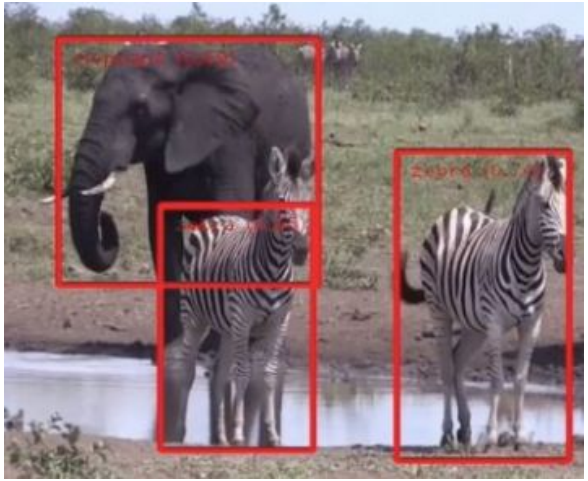
0

3

Payload extraction

Payload

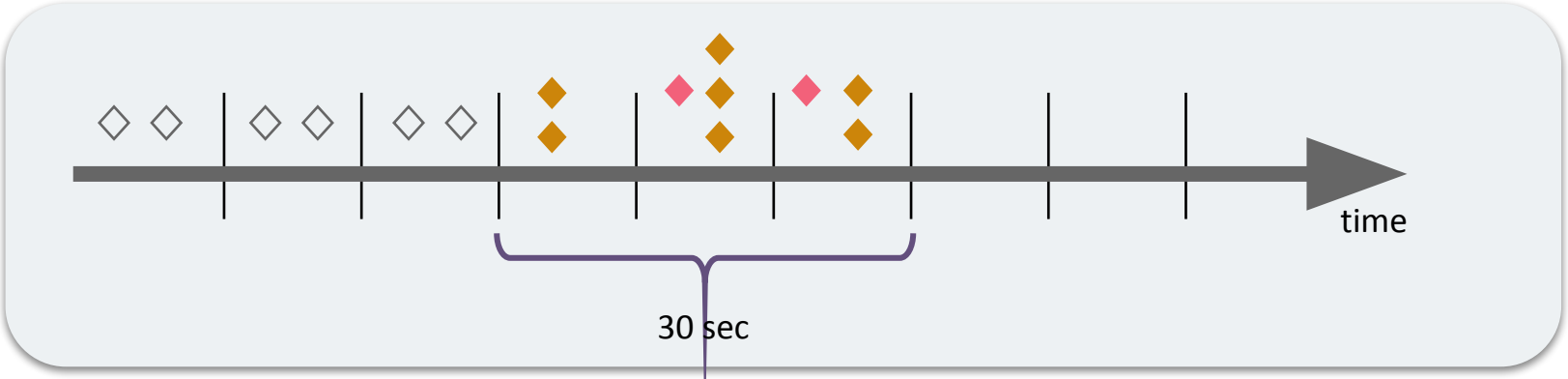
```
{
  "camera_name": "zoo-webcam",
  "objects_count": {
    "elephant": 1,
    "zebra": 2
  }
}
```



KSQL pivot

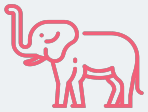
```
create stream animals as
select extractjsonfield(objects_count, '$.elephant') as elephant
, extractjsonfield(objects_count, '$.zebra') as zebra
, < many more animals >
from objects;
```

ksqlDB



KSQL table

```
create table zoo as
select max(elephant), max(zebra)
from animals window tumbling (size 30 seconds)
group by camera_name
emit changes;
```

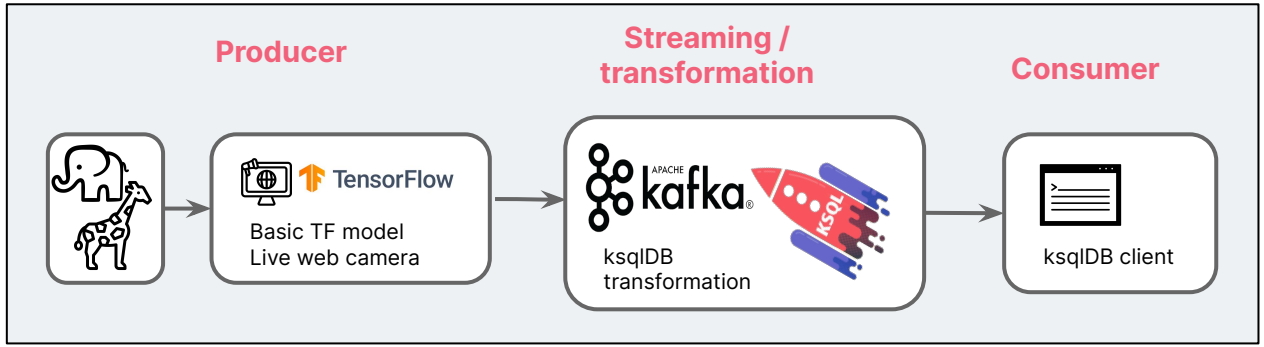


1

3

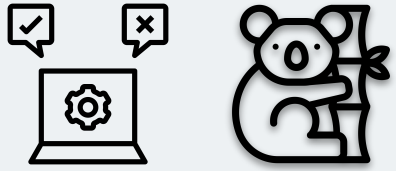
Architecture

Zoo-keeper version




```
ksql> select camera_name, max_elephant, max_zebra from zoo emit changes;
+-----------------------------------+-----------------------------------+-----------------------------------+
|CAMERA_NAME                        |MAX_ELEPHANT                       |MAX_ZEBRA                          |
+-----------------------------------+-----------------------------------+-----------------------------------+
|mylaptop                           |null                               |1                                  |
|mylaptop                           |null                               |2                                  |
|mylaptop                           |null                               |3                                  |
|mylaptop                           |1                                  |3                                  |
|mylaptop                           |1                                  |3                                  |
|mylaptop                           |1                                  |3                                  |
```

TensorFlow / Zoo Livestream



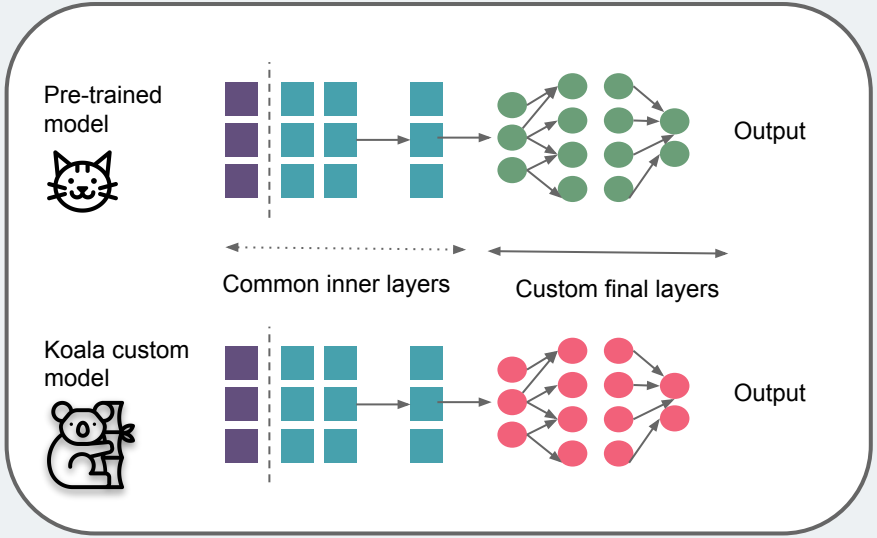
Transfer learning / koala training data

3. Transfer learning with Koalas

Transfer learning

Custom Koala object detection model

ℹ️ Transfer learning is an ML technique that focuses on using knowledge gained while solving one problem ... and applying it to a different but related problem.

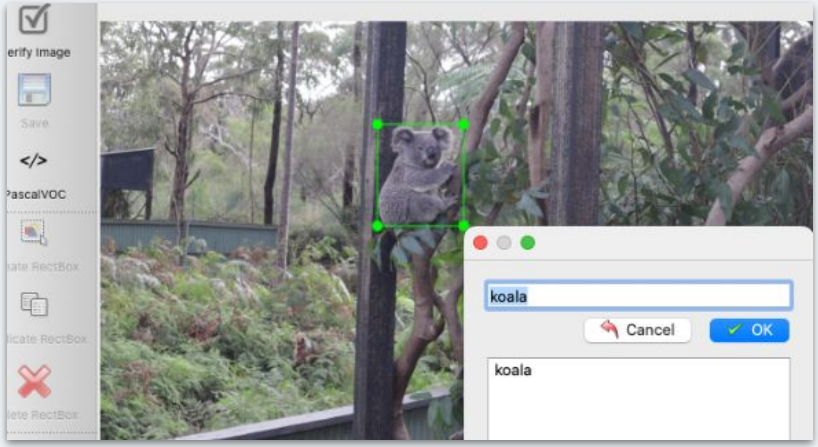


Transfer learning

Custom Koala object detection model

⚠ EfficientDet TensorFlow Lite trained on COCO 2017 dataset ... over 200K labeled images

🎯 Goal - retrain an model with koala dataset to train a custom object detection model



Edges, shapes, outlines, contrasts

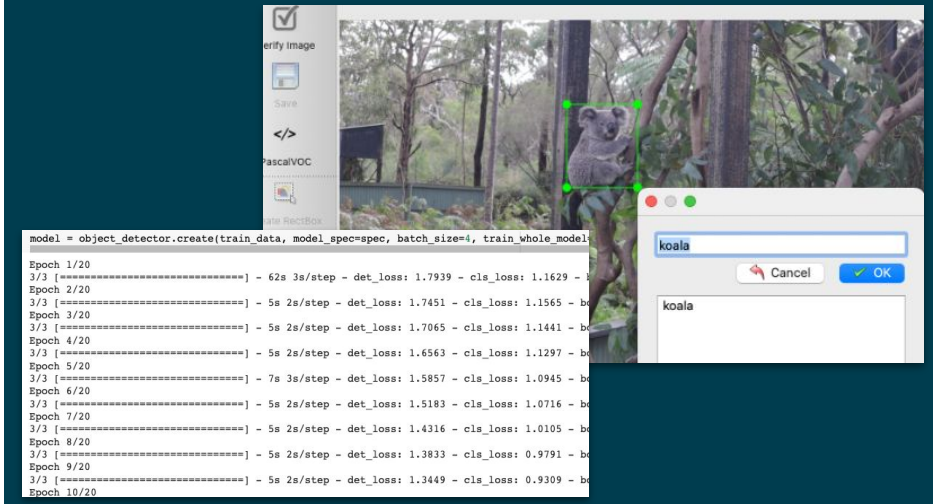
Koala specific data set

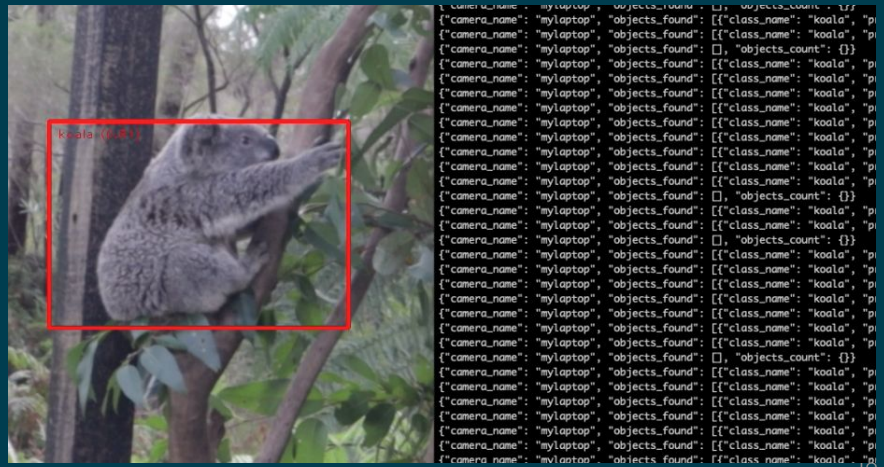
Koala model

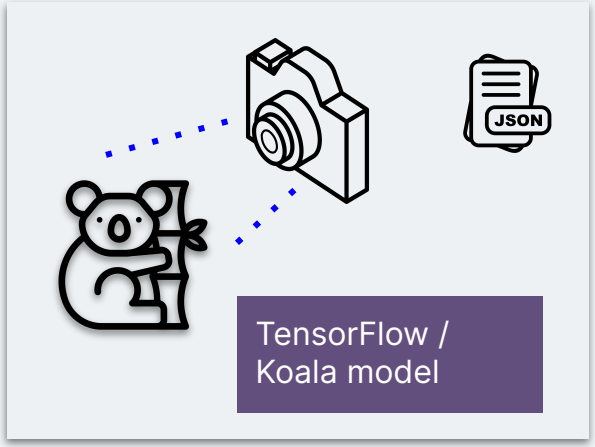
Retraining a TensorFlow Lite model

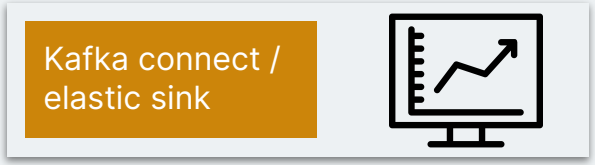
🔧 TensorFlow Lite Model Maker

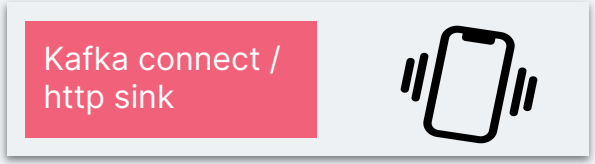
- Koala dataset with Labellmg
- Train the TensorFlow model
- Export as a TensorFlow Lite model.
- Evaluate model
- Deploy model to RaspberryPi











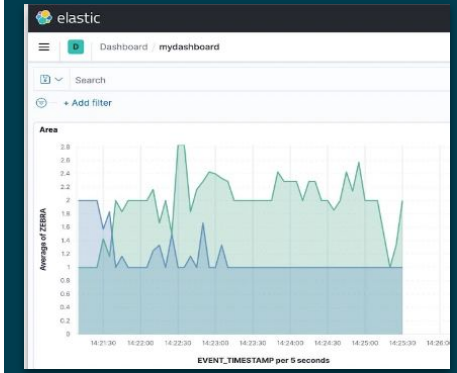
4. Analysis and alerting

Analysis and alerting

Command line is cool, but ...

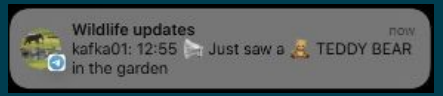
- Real-time dashboard with Kibana
- Phone alerts with Telegram

Kafka Connect is a framework for connecting Kafka with external systems



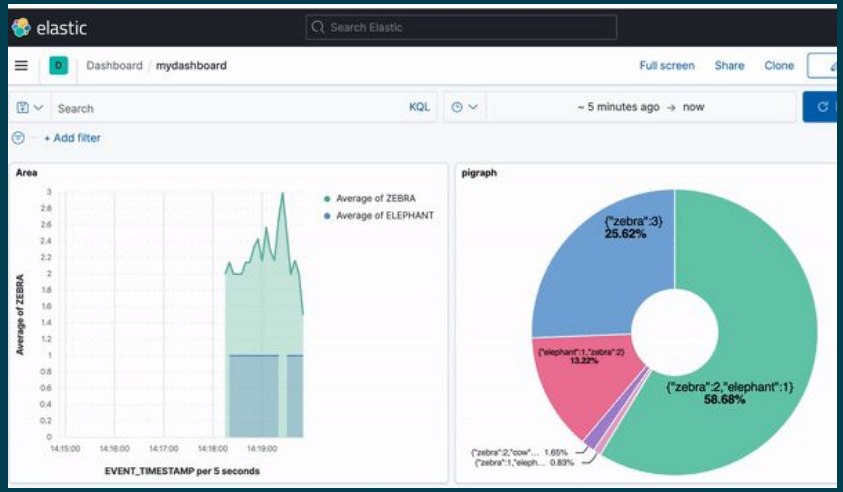
Dashboard

Alerts



Kibana dashboard

Kafka Connect with Kafka Connect Elasticsearch connector to send both the animals and zoo Kafka topics to Elasticsearch indexes.



Building the dashboard

Kafka connect / elastic sink

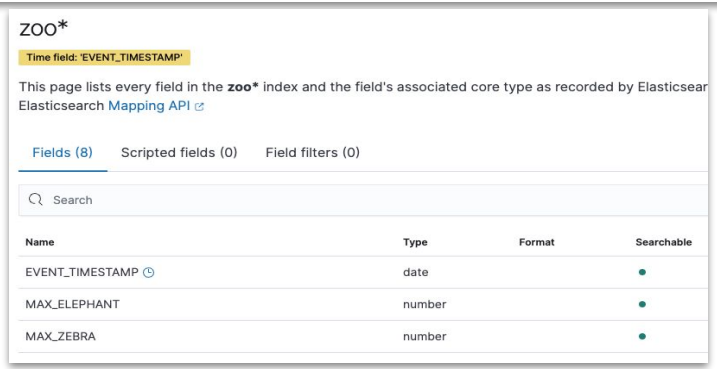
Kafka Topic

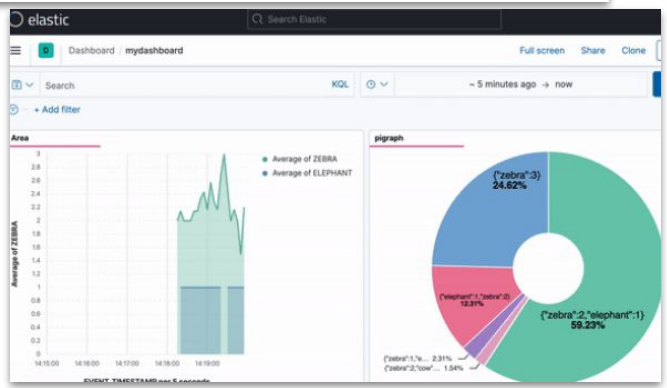
Elastic sink class

Index name

Timestamp

```
{
"topics": "ZOO",
"key.converter": "org.apache.kafka.connect.storage.StringConverter",
"value.converter.schemas.enable": "false",
"connector.class": "io.confluent.connect.elasticsearch.ElasticsearchSinkConnector",
"key.ignore": "true",
"value.converter": "org.apache.kafka.connect.json.JsonConverter",
"type.name": "type.name=kafkaconnect",
"topic.index.map": "ZOO:zoo",
"connection.url": "http://elasticsearch:9200",
"transforms": "ExtractTimestamp",
"transforms.ExtractTimestamp.type": "org.apache.kafka.connect.transforms.InsertField$Value",
"transforms.ExtractTimestamp.timestamp.field": "EVENT_TIMESTAMP"
}
```





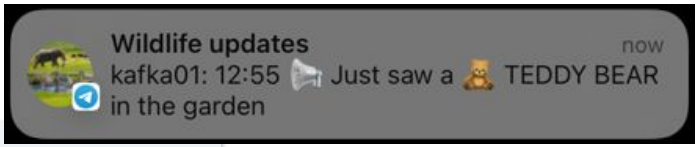
Telegram bot

Created wildlife Telegram bot with exposed HTTP-based interface

Telegram bot alert for each record in teddybear-telegram-topic Kafka

Teddy bear alerts

Kafka connect / http sink



KSQL stream

```
create stream teaddybear-telegram-topic
as
select '🦕 Just saw a 🧸 TEDDY BEAR in the garden' as message
from animals
where teddybear > 0 ;
```

Kafka topic

Telegram API

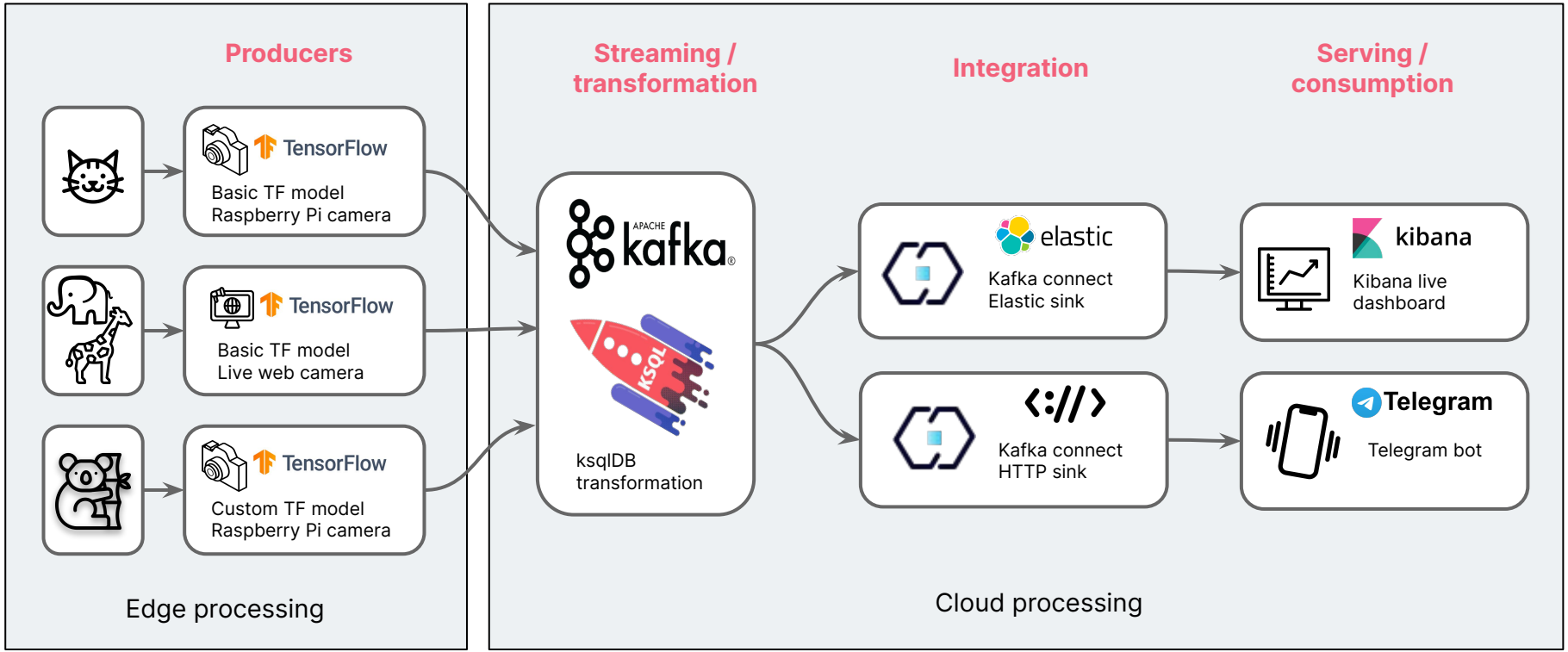
Chat ID

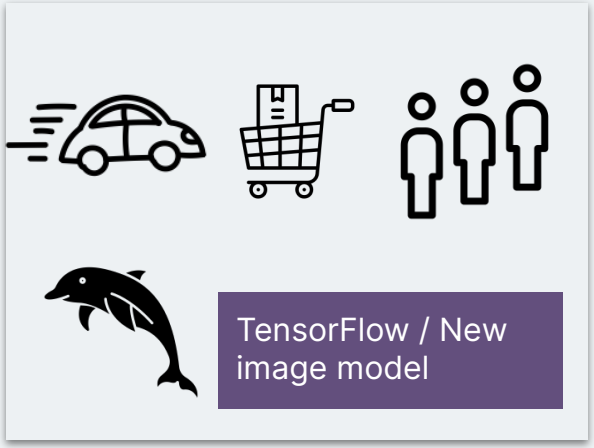
Regular expression

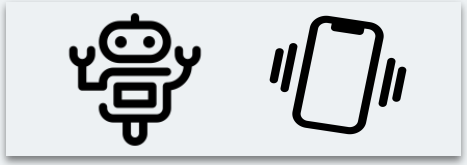
```
{
  "topics": "teaddybear-telegram-topic",
  "input.data.format": "JSON",
  "connector.class": "HttpSink",
  "confluent.topic.bootstrap.servers": "broker:29092",
  "confluent.topic.replication.factor": "1",
  "reporter.bootstrap.servers": "broker:29092",
  "reporter.result.topic.name": "success-responses",
  "reporter.result.topic.replication.factor": "1",
  "reporter.error.topic.name": "error-responses",
  "reporter.error.topic.replication.factor": "1",
  "http.api.url": "https://api.telegram.org/botXXXXXX/sendMessage",
  "request.method": "POST",
  "headers": "Content-Type: application/json",
  "request.body.format": "string",
  "batch.max.size": "1",
  "batch.prefix": "{\"chat_id\":\"-123456\", ",
  "batch.suffix": "}",
  "regex.patterns": ".*MESSAGE=(.*)",
  "regex.replacements": "\"text\":\"$1\"",
  "regex.separator": "~",
  "tasks.max": "1",
  "value.converter": "org.apache.kafka.connect.storage.StringConverter",
  "name": "teaddybear-telegram-sink"
}
```

Architecture

Final version







5. How does this help me?

Events are everywhere

Coffee queue wait times

Shopping trolley usage

Car park occupancy

Understand streams that matter - object detection plus stream processing

Photo by Marcus Wallis on Unsplash

That which is measured improves.

That which is measured and reported improves exponentially

Karl Pearson

Thanks / Any questions?

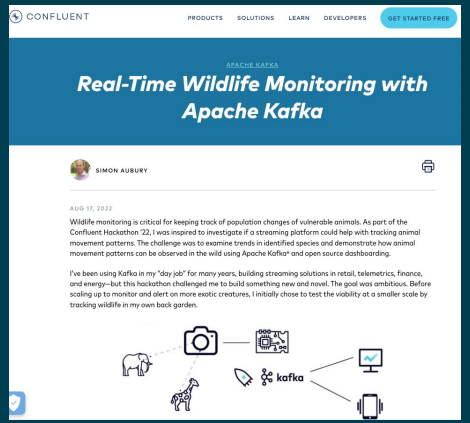


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Photo by David Clode on Unsplash