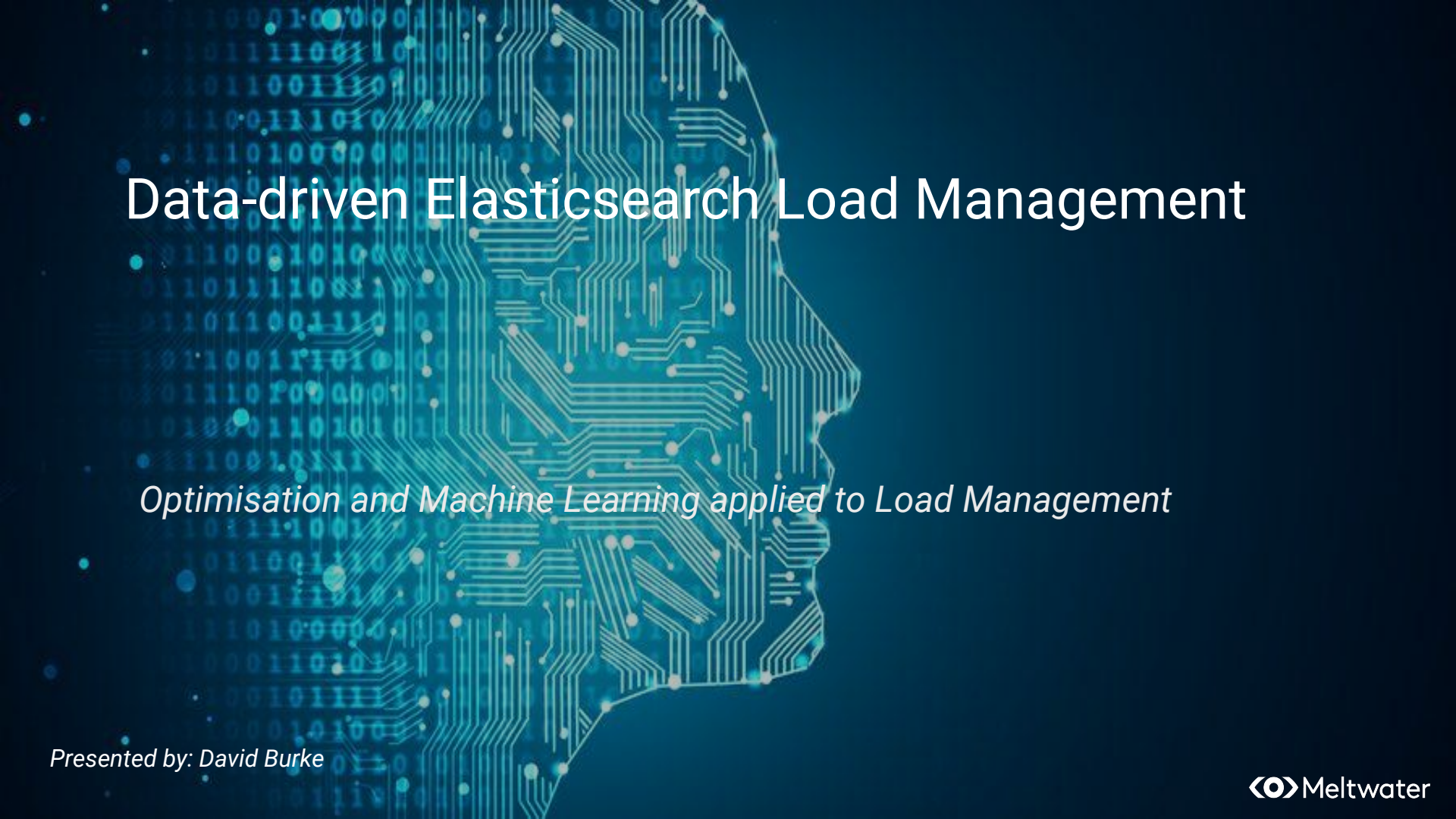


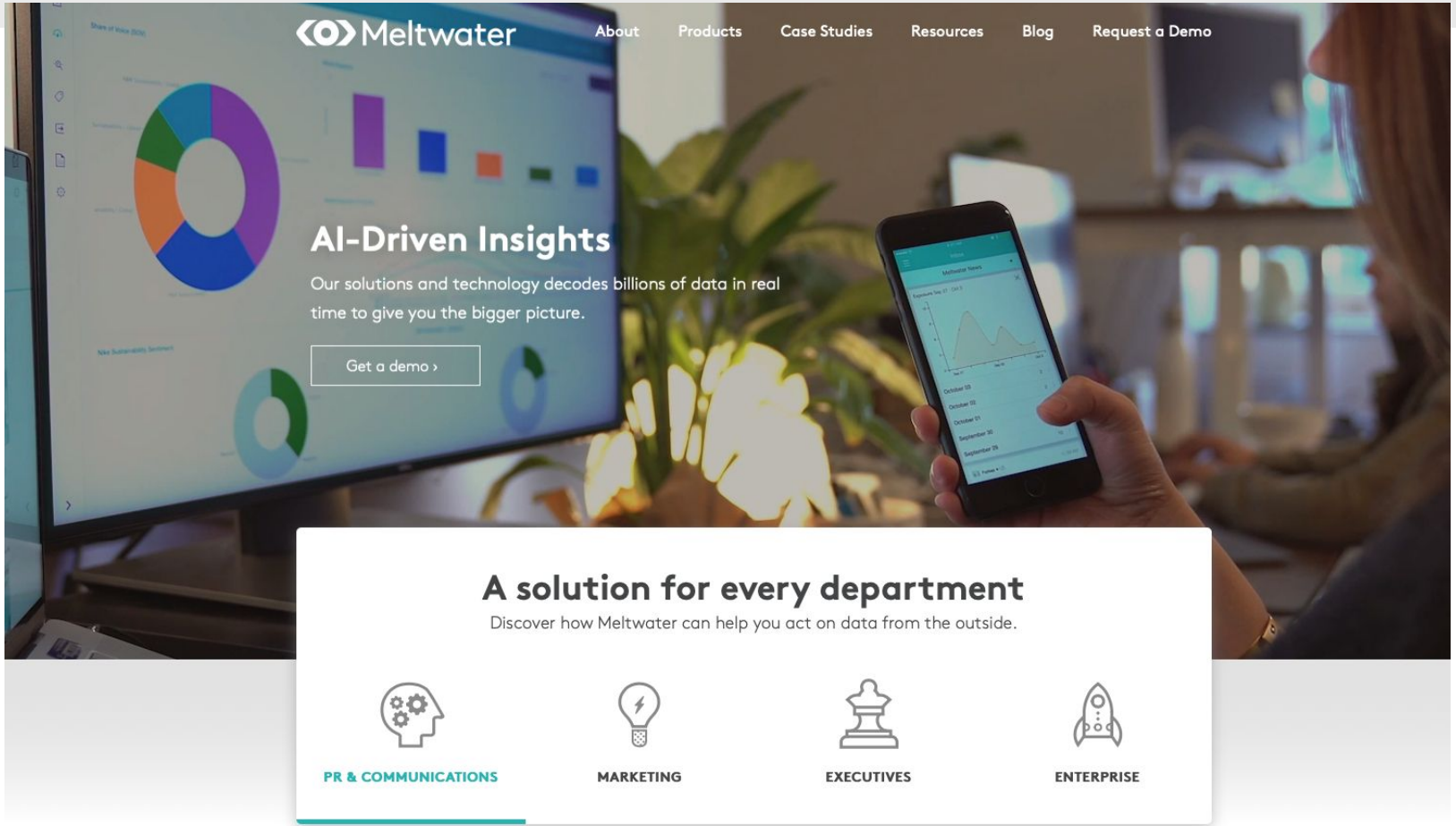
Data-driven Elasticsearch Load Management

Optimisation and Machine Learning applied to Load Management

Presented by: David Burke

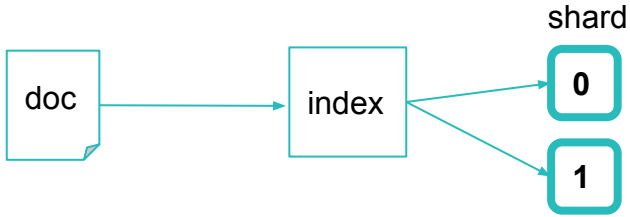
Meltwater

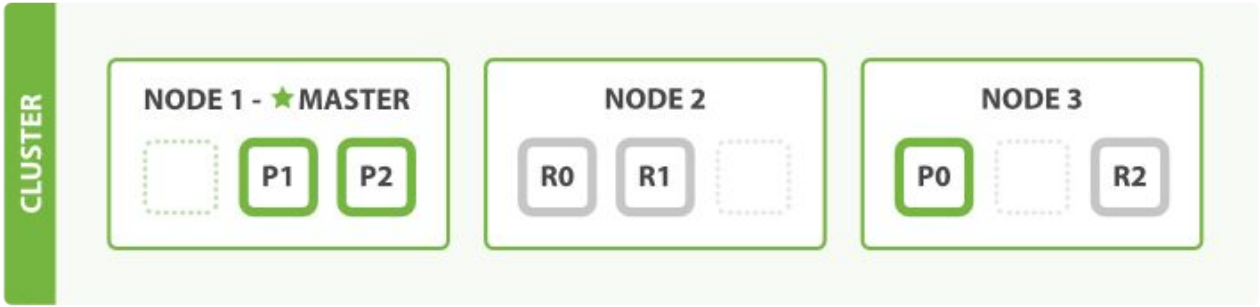
Who are Meltwater?



Elasticsearch

elasticsearch - scalable, distributed search



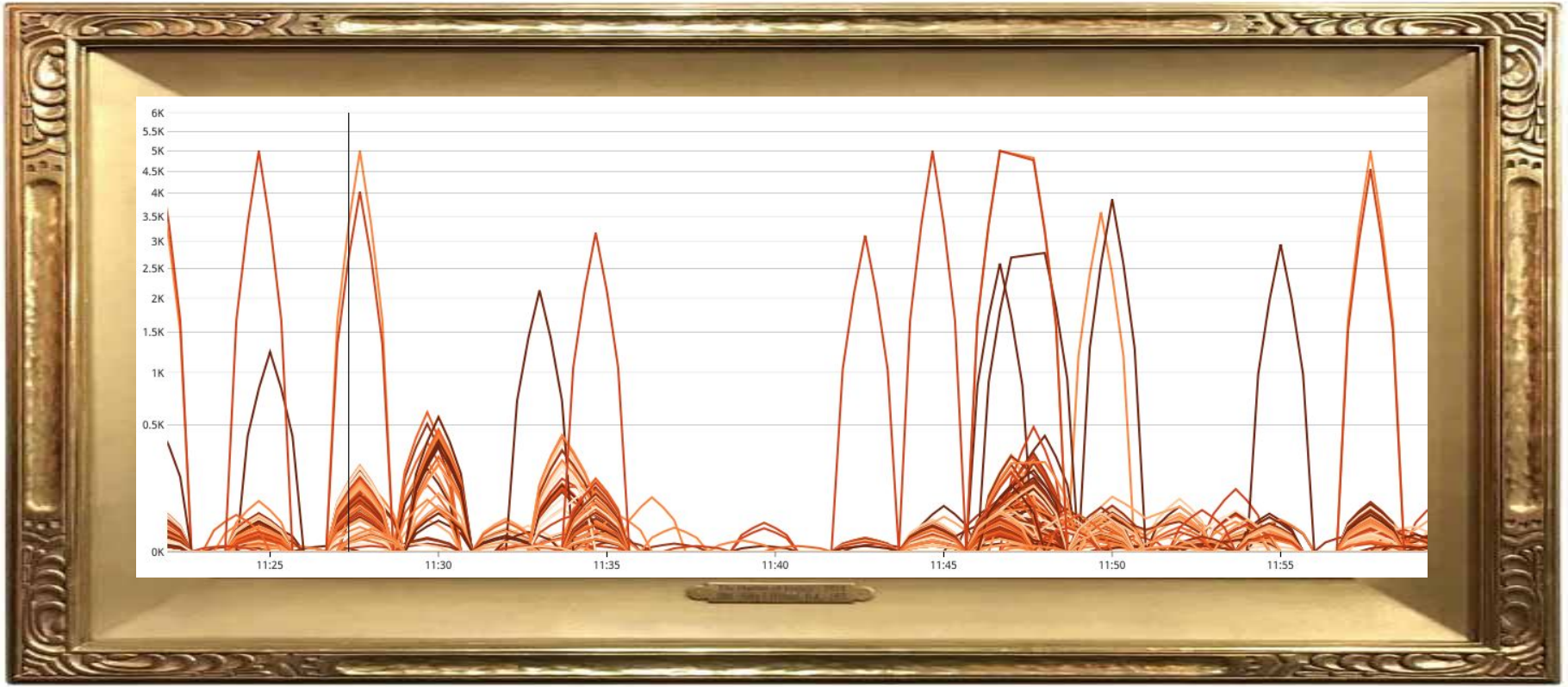


132.4B
AVAILABLE DOCUMENTS

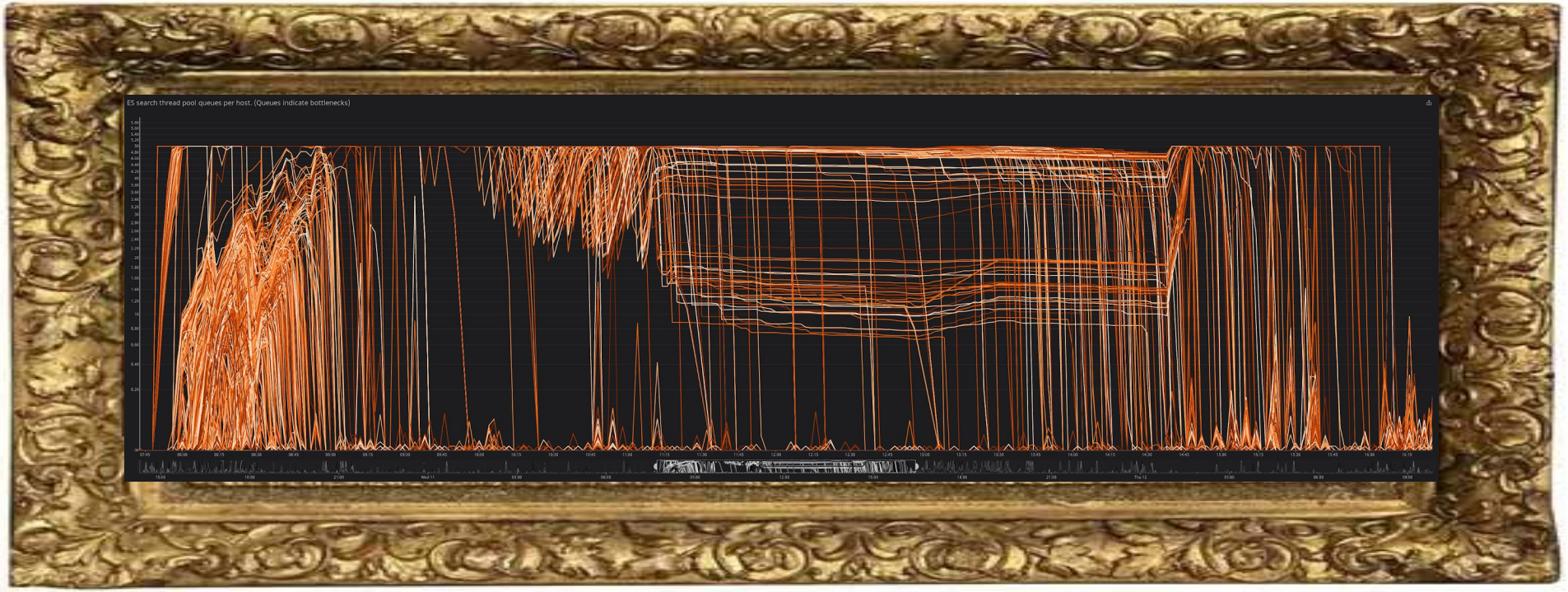
3.3M
SEARCHES/DAY

720
DATA NODES

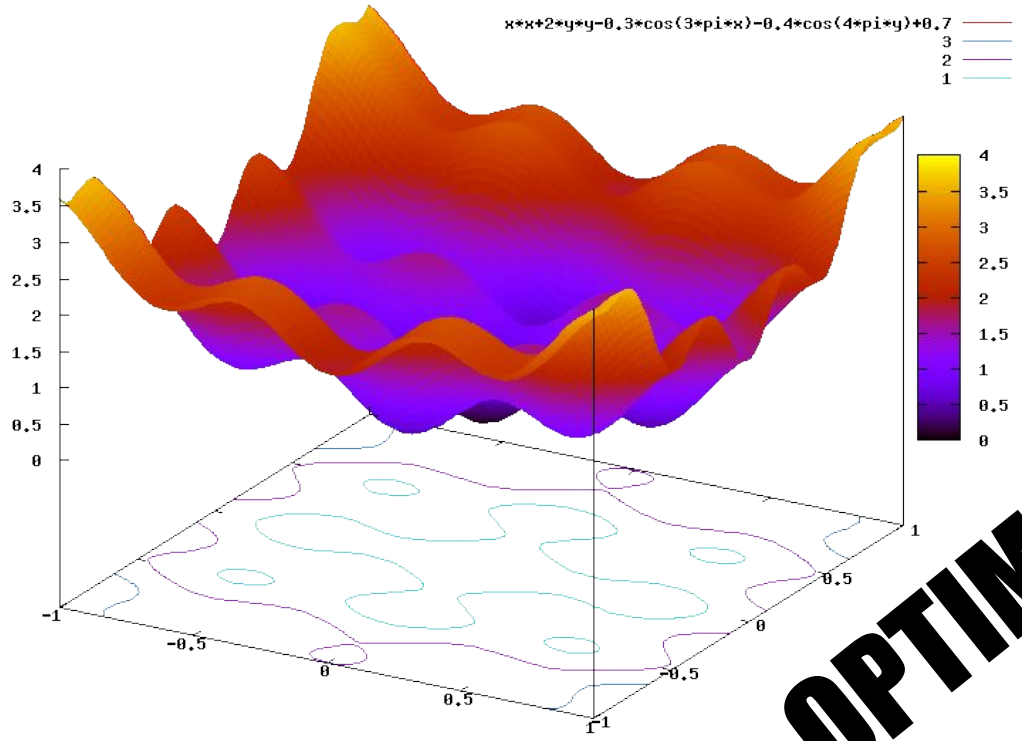
The Art Gallery



The Art Gallery



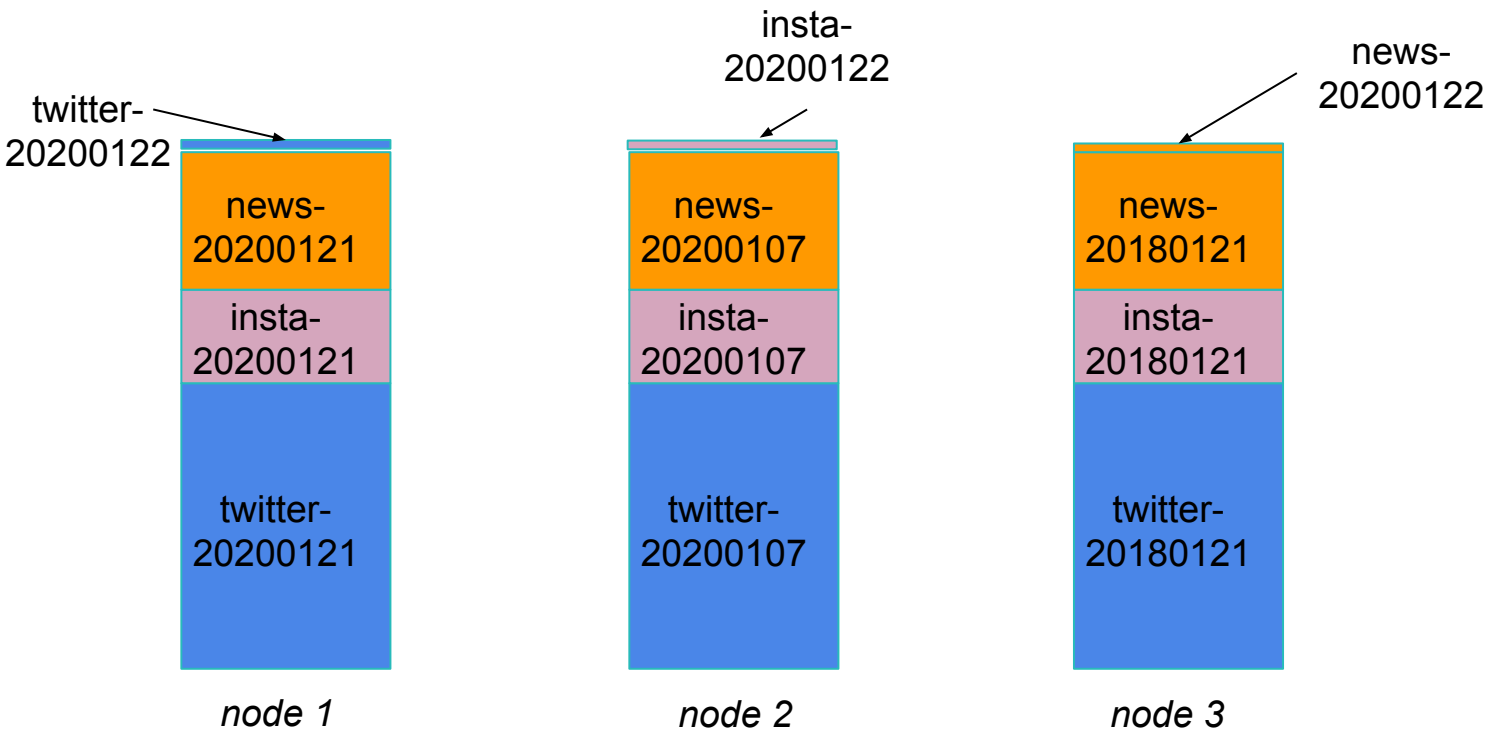
APPLICATION 1



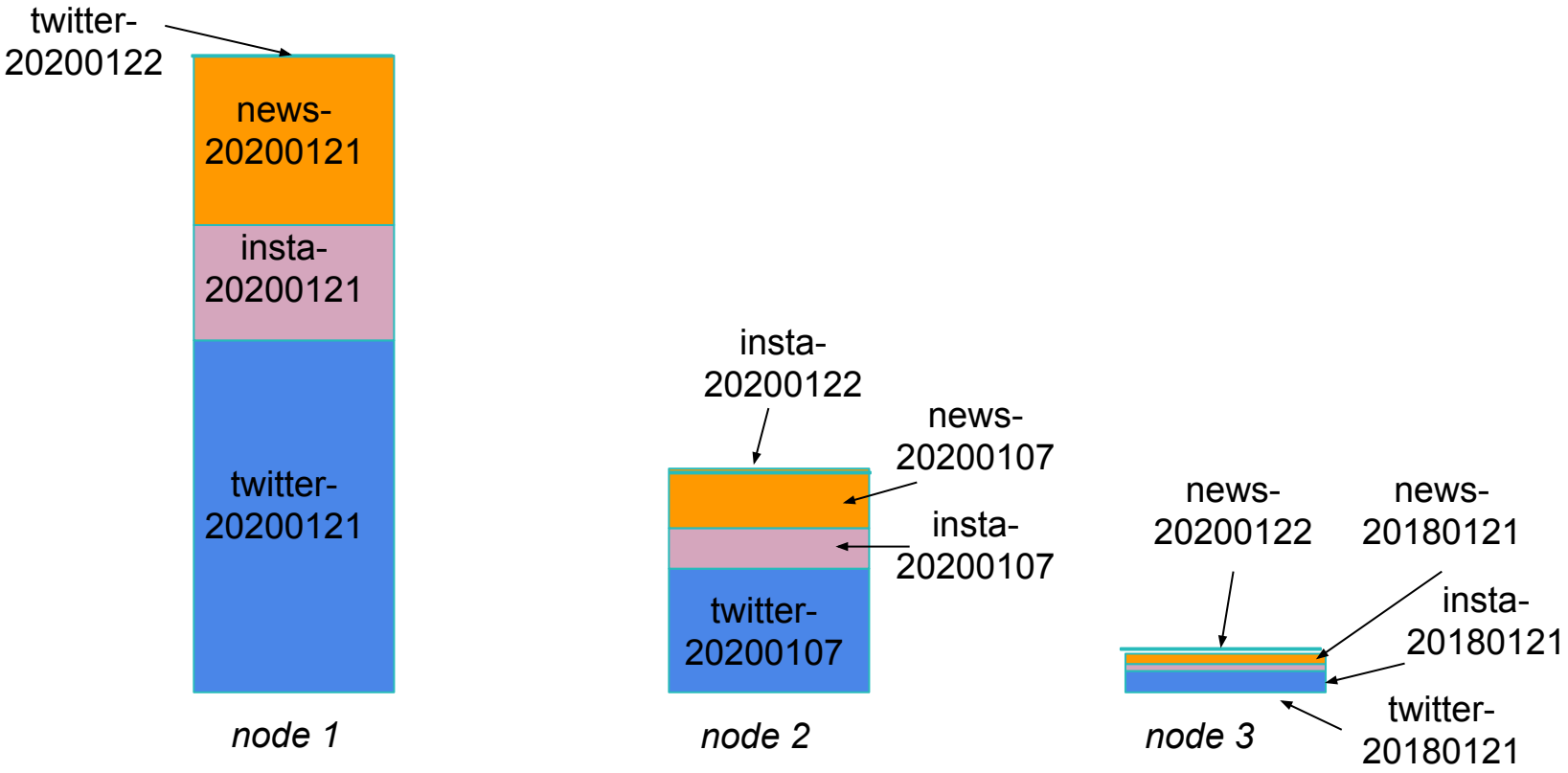
OPTIMISATION

Meltwater

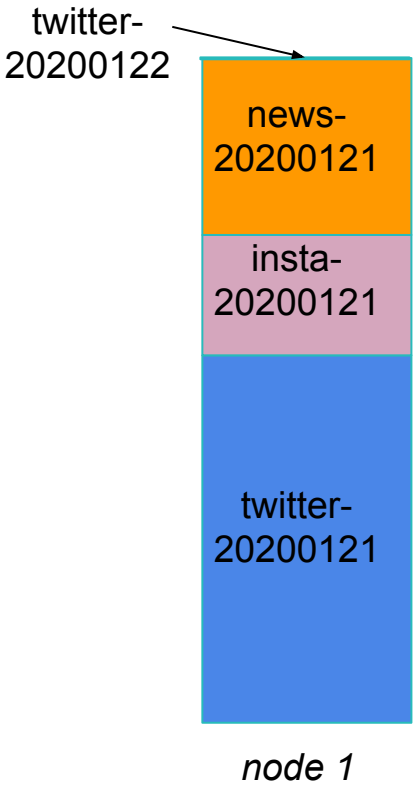
Balanced disk?



Balanced load?

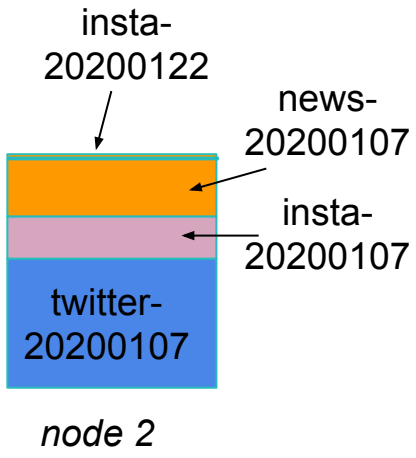


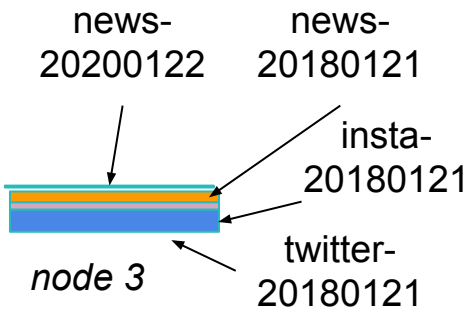
Balanced load?



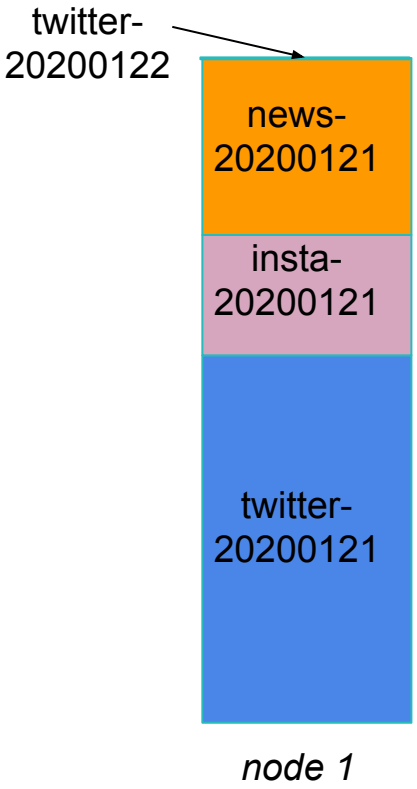
Minimize

- Variance in disk usage
- Variance in total load
- Variance in search load
- Variance in indexing load



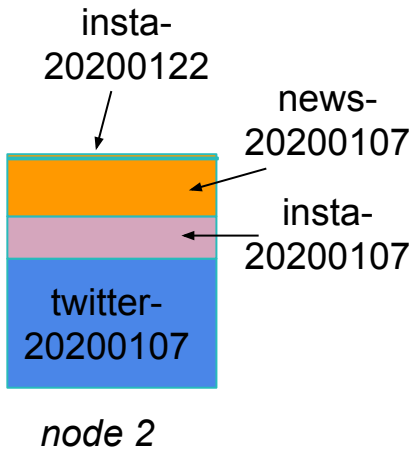


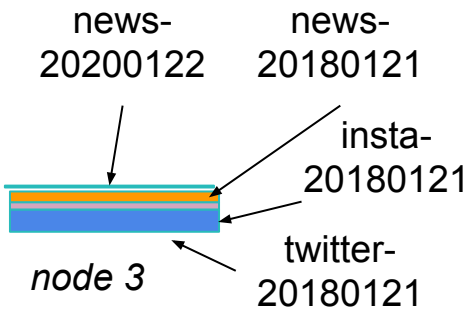
Balanced load?



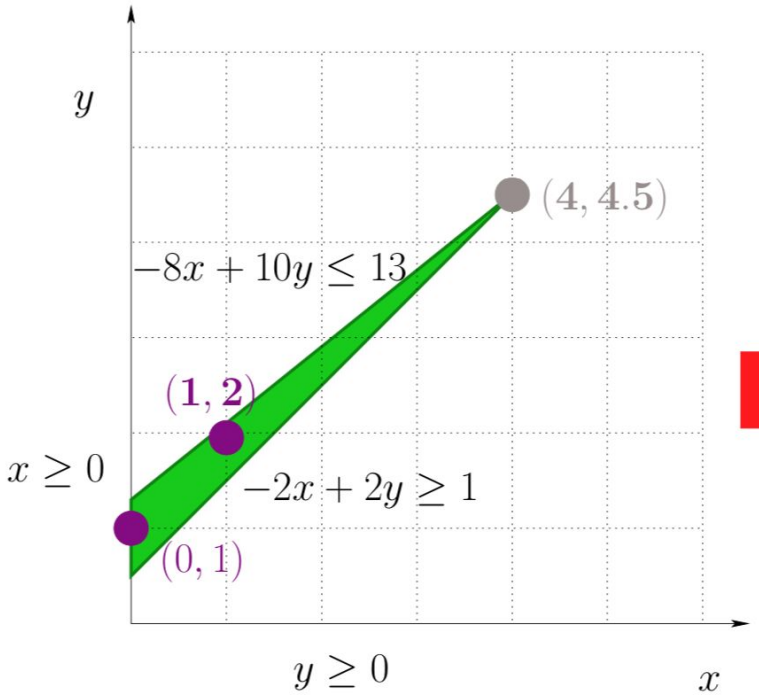
Minimize

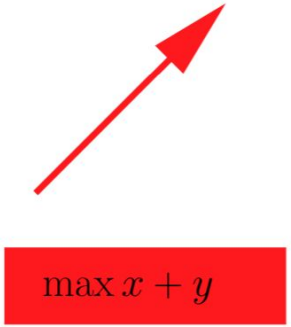
- Variance in disk usage
- Variance in total load
- Variance in search load
- Variance in indexing load
- *Variance in future load?*





Mixed Integer Linear Program (MILP)





$$
\begin{aligned}
\max \; & x + y \\
-2x + 2y &\geq 1 \\
-8x + 10y &\leq 13 \\
x, y &\geq 0 \\
x, y &\in \mathbb{Z}
\end{aligned}
$$

Variables

Objective

Constraints

Example taken from: https://www.cs.upc.edu/~erodri/webpage/cps/theory/lp/milp/slides.pdf

Mixed Integer Linear Program (MILP)

shard copy (82441)

nodes (720)

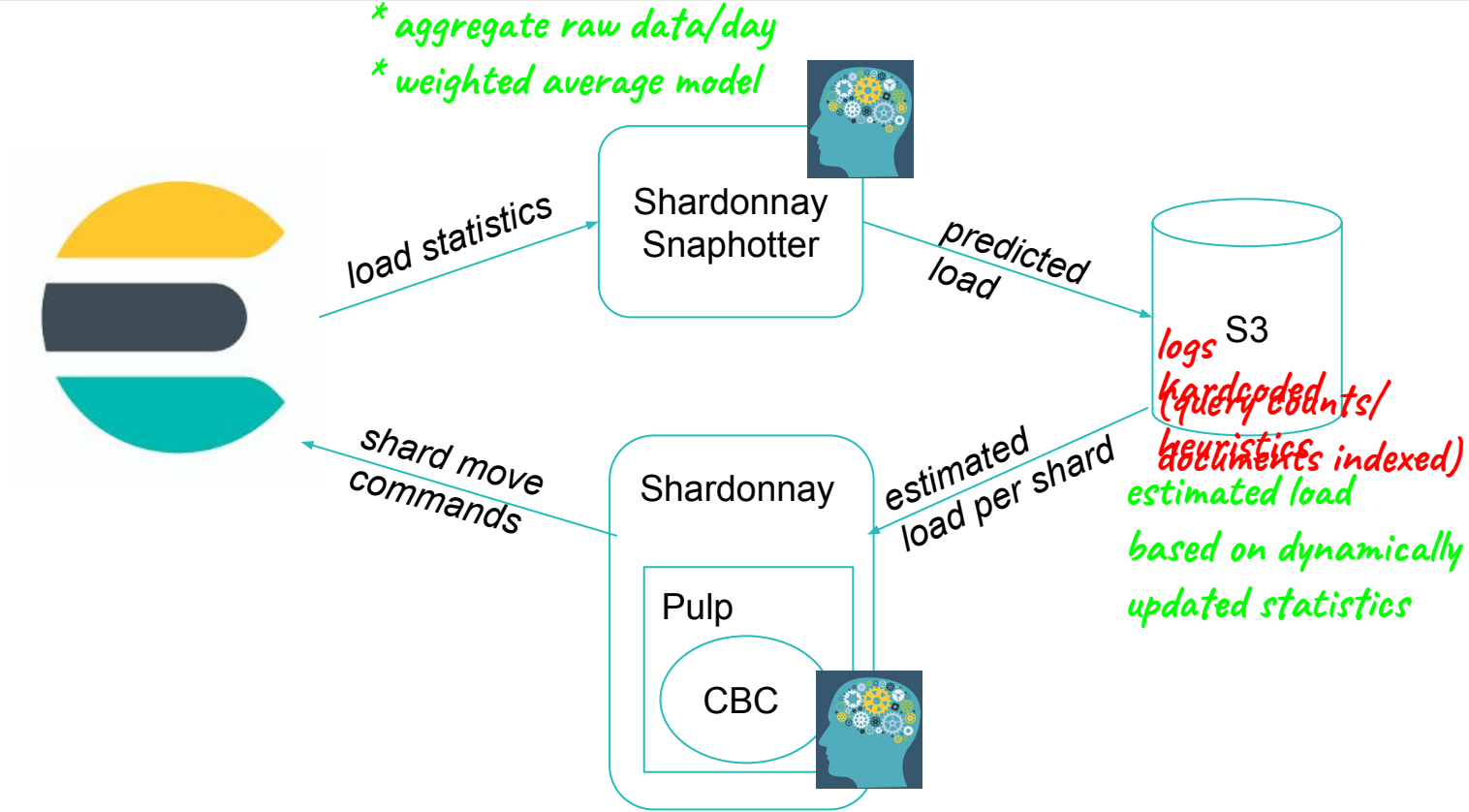
0	1	0	0	0	0	0	0	0	…
0	0	0	0	0	0	0	0	0	…
1	0	0	0	0	0	0	0	0	…
0	0	0	0	0	0	0	0	1	…
0	0	0	0	0	0	0	1	0	…
0	0	1	0	0	0	0	0	0	…
0	0	0	0	0	0	1	0	0	…
…	…	…	…	…	…	…	…	…	…

```
min today_weight * sum(
          disk_var_today,
          load_var_today,
          search_load_var_today,
          indexing_load_var_today)
     +
     (1 - today_weight) * sum(
          disk_var_tomorrow +
          load_var_tomorrow +
          search_load_var_tomorrow +
          indexing_load_var_tomorrow)
```

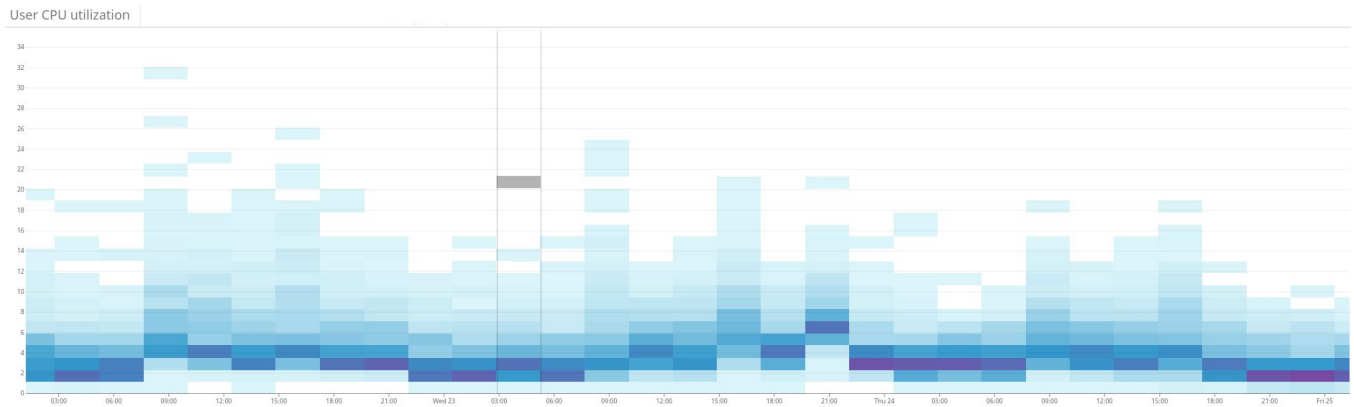
```
constraints: don’t exceed disk watermark
             don’t allow two replicas of the same shard on a node
             don’t move todays indices
             don’t exceed N moves
             ...
```

Meltwater

Shardonnay

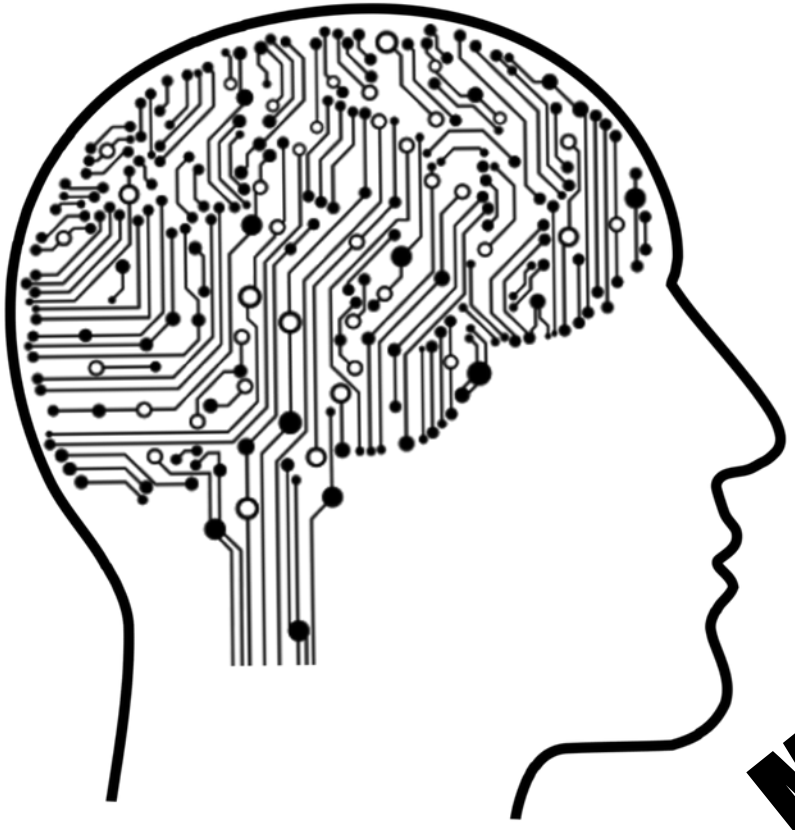

* aggregate raw data/day
* weighted average model
load statistics
Shardonnay
Snaphotter
predicted
load
S3
logs
(query counts/
documents indexed)
hardcoded
heuristics
shard move
commands
Shardonnay
estimated
load per shard
Pulp
CBC
estimated load
based on dynamically
updated statistics


ES node hotness
16
15
14
13
12
11
10
9
8
7
6
5
4
04:00
04:30
05:00
05:30
06:00
06:30
07:00
07:30
08:00
08:30
09:00
09:30
10:00
10:30
11:00
11:30
12:00
12:30
13:00
13:30
14:00
14:30
15:00
15:30


User CPU utilization
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
03:00
06:00
09:00
12:00
15:00
18:00
21:00
Wed 23
03:00
06:00
09:00
12:00
15:00
18:00
21:00
Thu 24
03:00
06:00
09:00
12:00
15:00
18:00
21:00
Fri 25

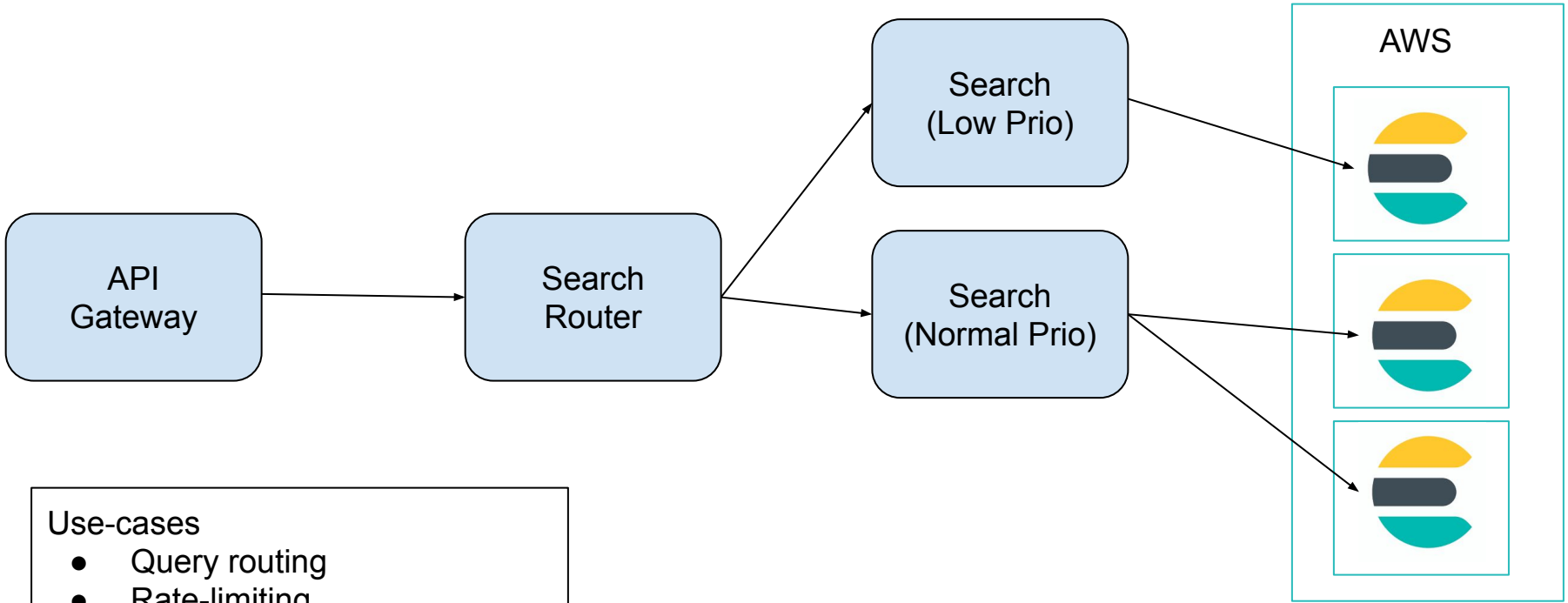
Meltwater

APPLICATION 2



MACHINE LEARNING

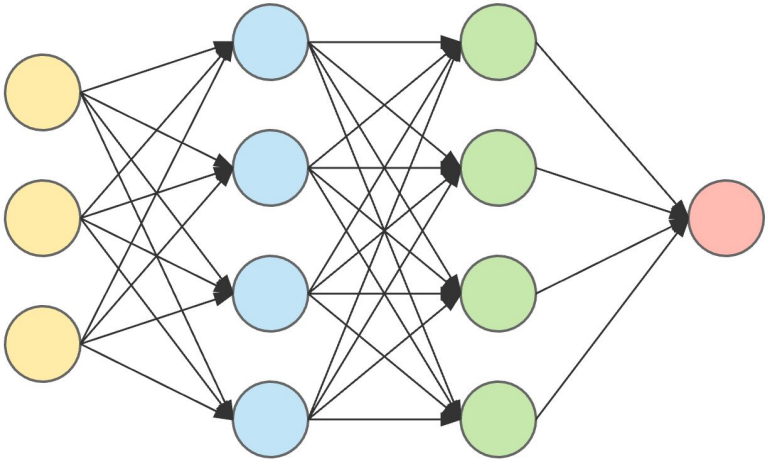
Predicting Query Resource Usage



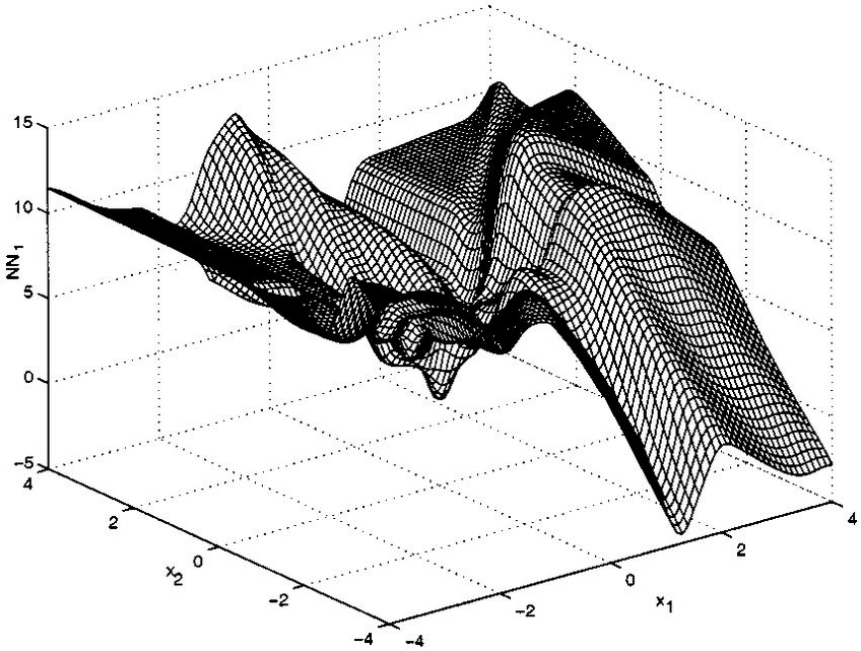
Use-cases

- Query routing
- Rate-limiting
- Load shedding
- Blocking queries

Deep Neural Network



input layer hidden layer 1 hidden layer 2 output layer

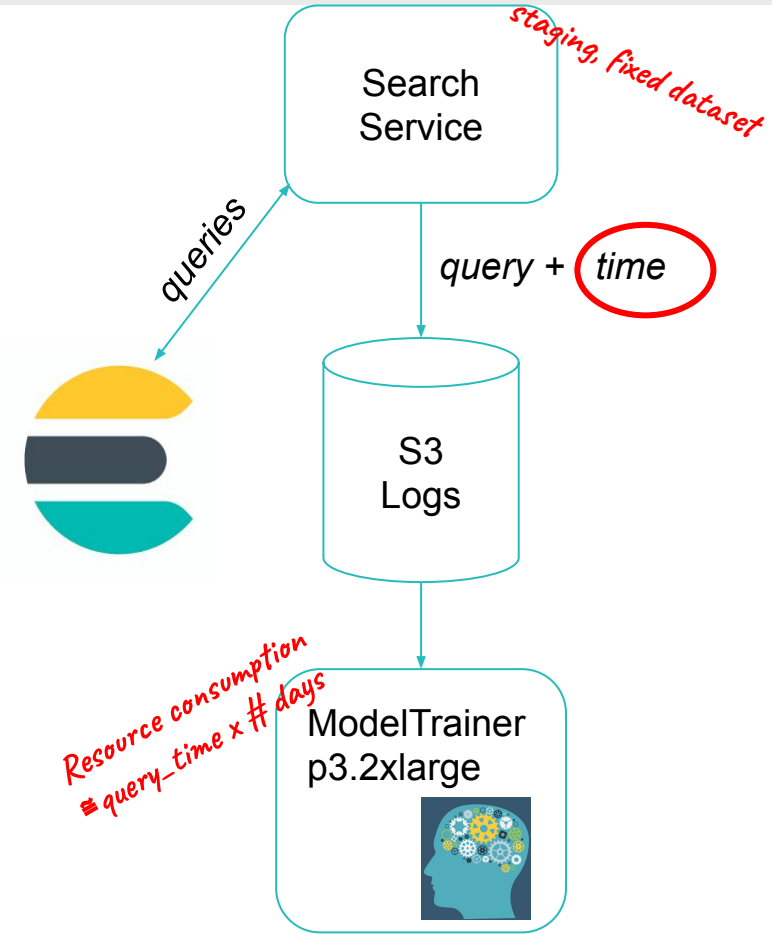


Meltwater

- number_of_terms
- number_of_wildcards
- length_of_query
- number_of_days
- …
- …
- is_result_list
- is_count
- is_date_aggregation
- is_significant_terms_aggregation
- …
- ...

Meltwater

Predicting Query Resource Usage

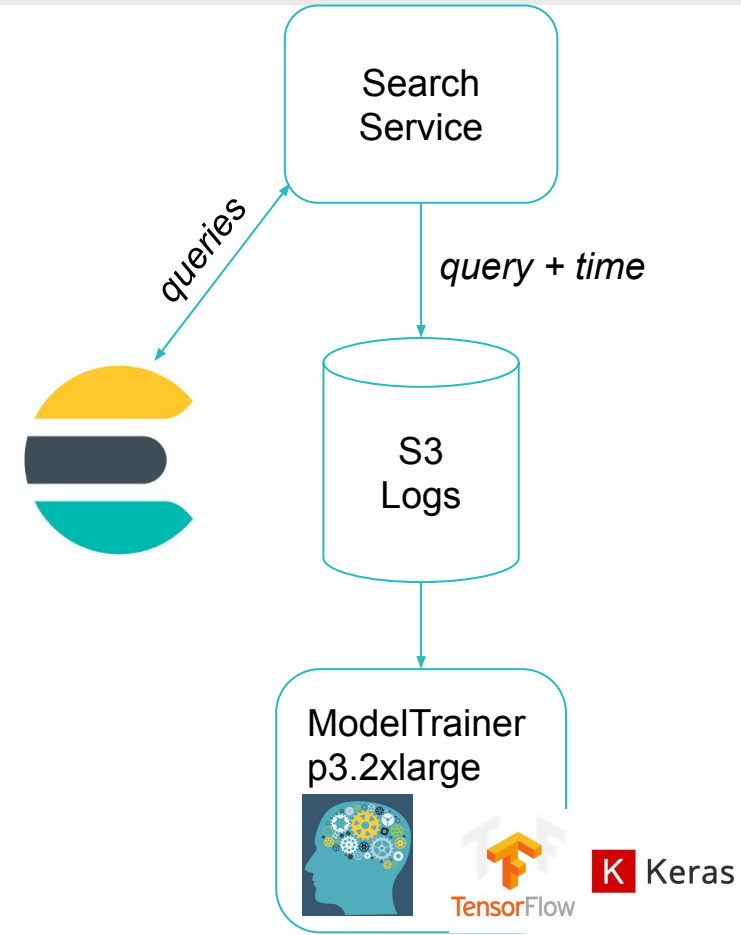


What can we predict?
vs
What do we want to predict?

Resource consumption
≅query_time x # days

Production vs Staging

Predicting Query Resource Usage



Train a model

Data pre-processing

- Data sampling
- Extract features
- Transformations
- Scaling

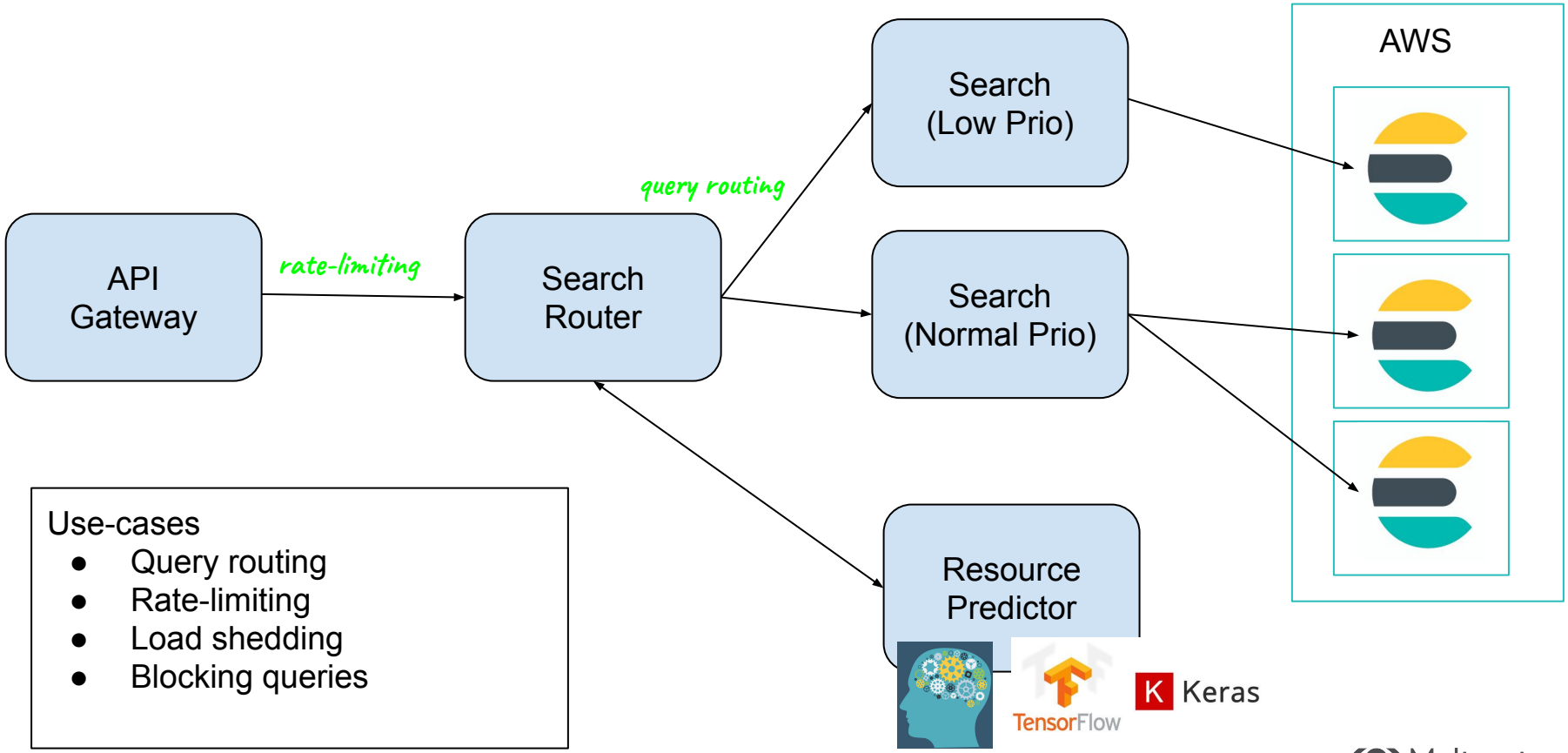
Data exploration

- Data visualisation
- Statistical analysis

Model evaluations

- ML techniques (Linear vs DNN vs RF)
- Hyperparameter tuning

Predicting Query Resource Usage

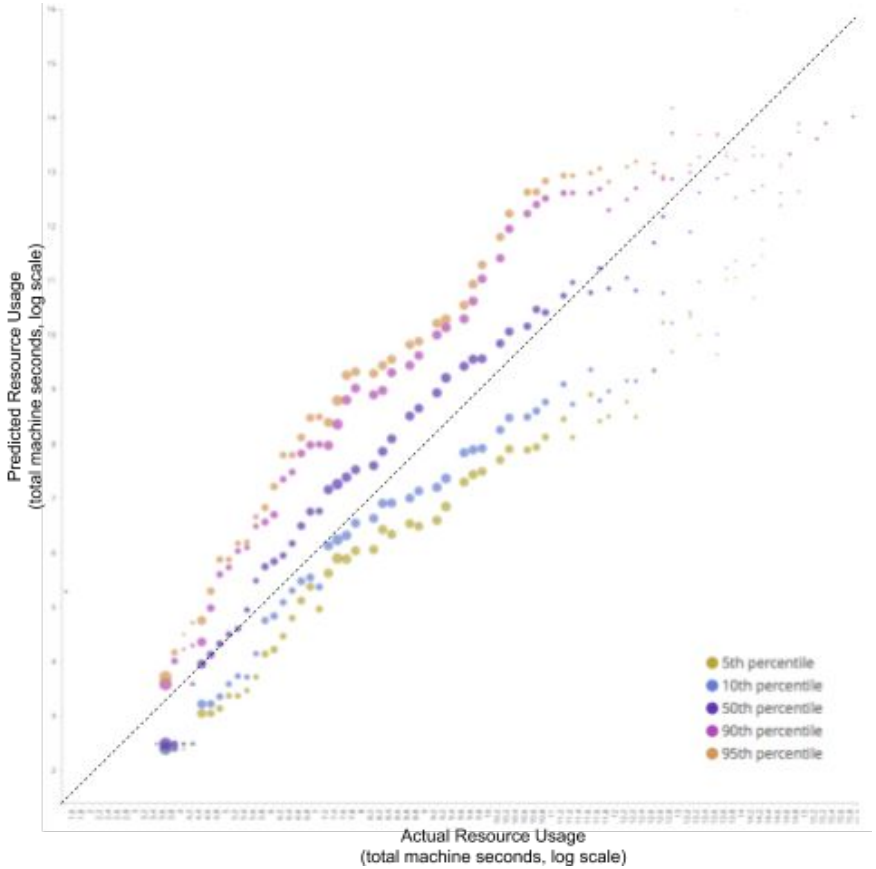


Use-cases

- Query routing
- Rate-limiting
- Load shedding
- Blocking queries

Meltwater

Predicting Query Resource Usage

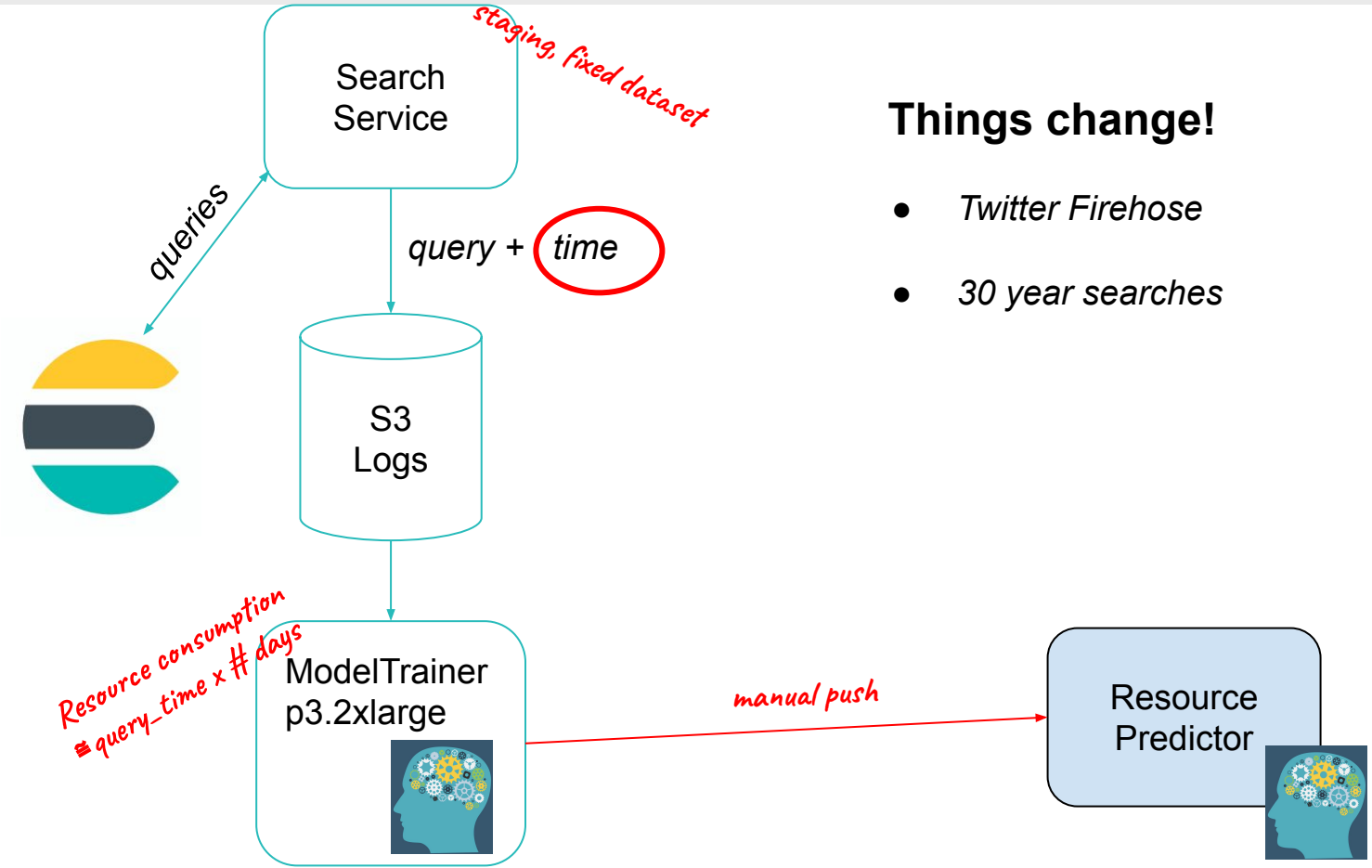


Predictive routing: can we successfully predict the top N% (heaviest resource consumption) queries?

If we take the top 1% of predicted heaviest queries **77%** of these were correctly identified as being ‘heavy’ queries.

Meltwater

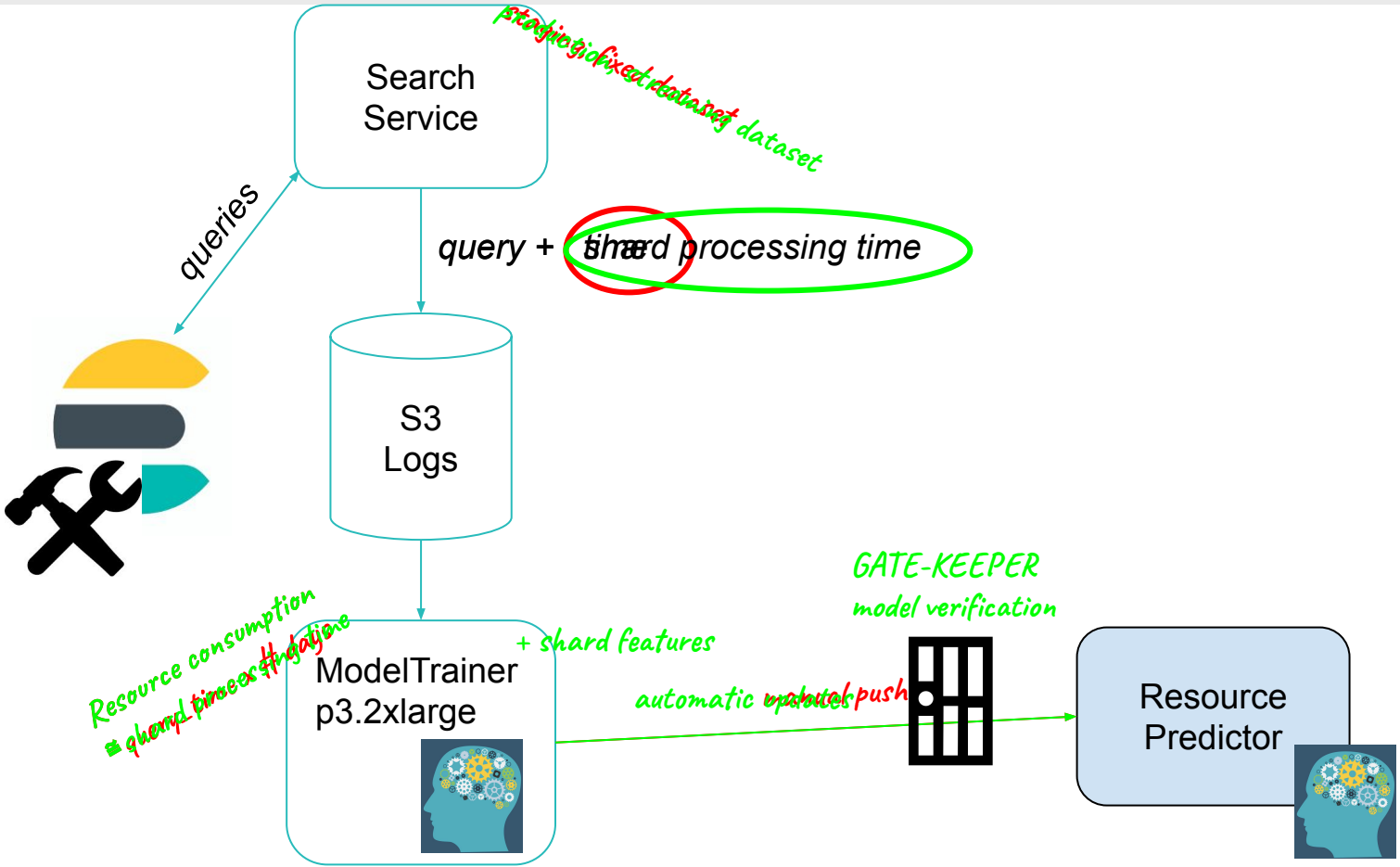
Predicting Query Resource Usage



Things change!

- *Twitter Firehose*
- *30 year searches*

Predicting Query Resource Usage



Data-driven Elasticsearch Load Management

- Optimisation and Machine Learning (and related Data Science disciplines) enable advanced data driven strategies for managing load
- Getting the ´right´ data can be challenging, but is key to being successful
- Things change, models must reflect this

Acknowledgements

Special thanks to:

- Meltwater Gothenburg
- Team Horace

Q and A

Contact: david.burke@meltwater.com

Meltwater