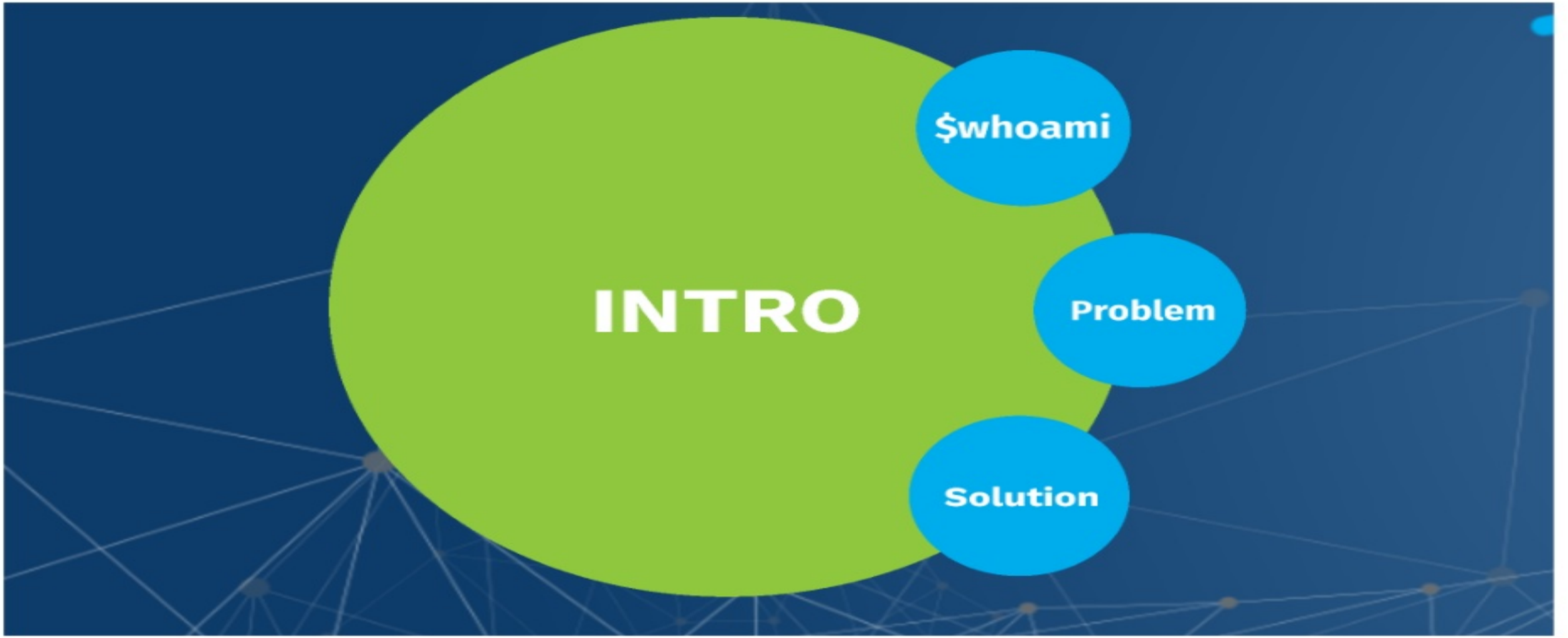

STREAMING
DIGITAL
FINGERPRINTS
INTRO
GOALS
CASE
STUDY
THANKS
Sebastian Czarnota
Digital Fingerprints


INTRO
$whoami
Problem
Solution

$whoami

Sebastian Czarnota

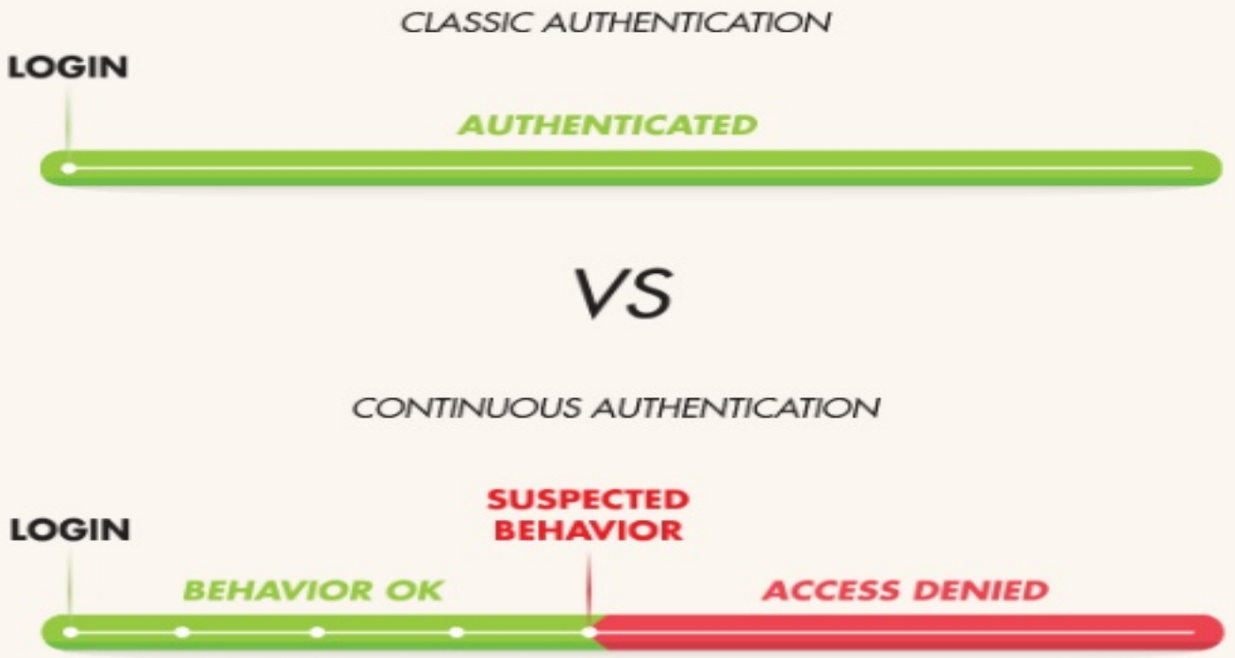
Principal Streaming Architect

sebastian@fingerprints.digital

https://fingerprints.digital/

Problem

Solution


CLASSIC AUTHENTICATION
LOGIN
AUTHENTICATED
VS
CONTINUOUS AUTHENTICATION
LOGIN
SUSPECTED BEHAVIOR
BEHAVIOR OK
ACCESS DENIED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GOALS
User Anonymity
User Experience
Simple Integration
Fast reaction time

User Anonymity as First Citizen Feature

User Anonymity as First Citizen Feature

- We **care** for users

User Anonymity as First Citizen Feature

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- GDPR **compliant**

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- Personal information **free**

User Anonymity as First Citizen Feature

- We **care** for users
- GDPR **compliant**
- Personal information **free**
- **Limited** consent requirements

We still remember "Don't be evil"...

Seamless User experience

Seamless User experience

- No visible changes in **UI**

Seamless User experience

- No visible changes in **UI**
- **Low** memory footprint

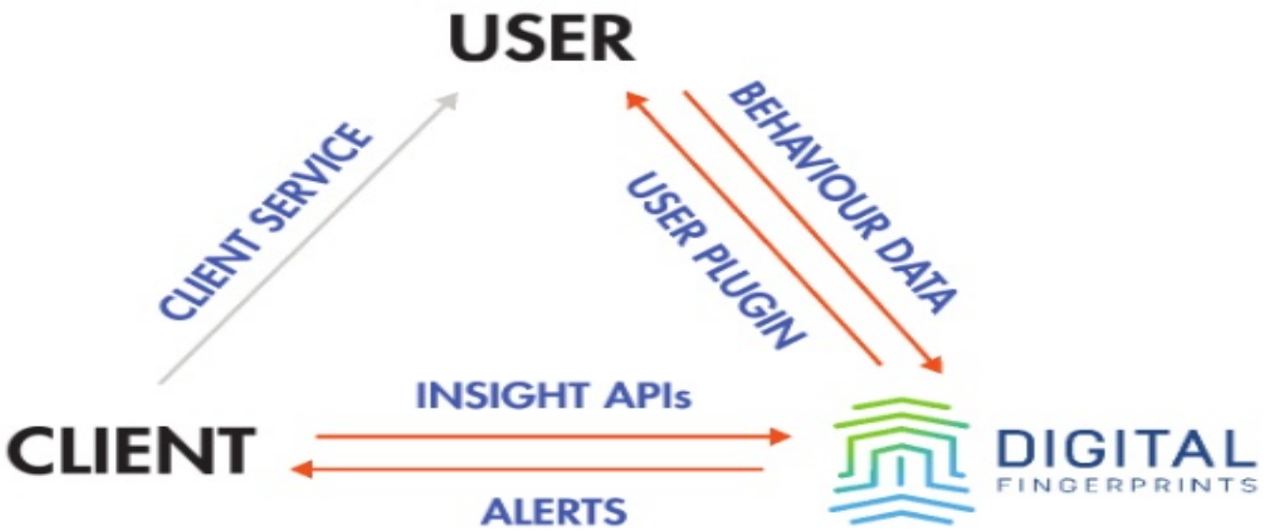
Seamless User experience

- No visible changes in **UI**
- **Low** memory footprint
- **Optimized** network traffic

Seamless User experience

- No visible changes in **UI**
- **Low** memory footprint
- **Optimized** network traffic
- Handle **wide** range of systems

Simple integration



Provide fast reaction time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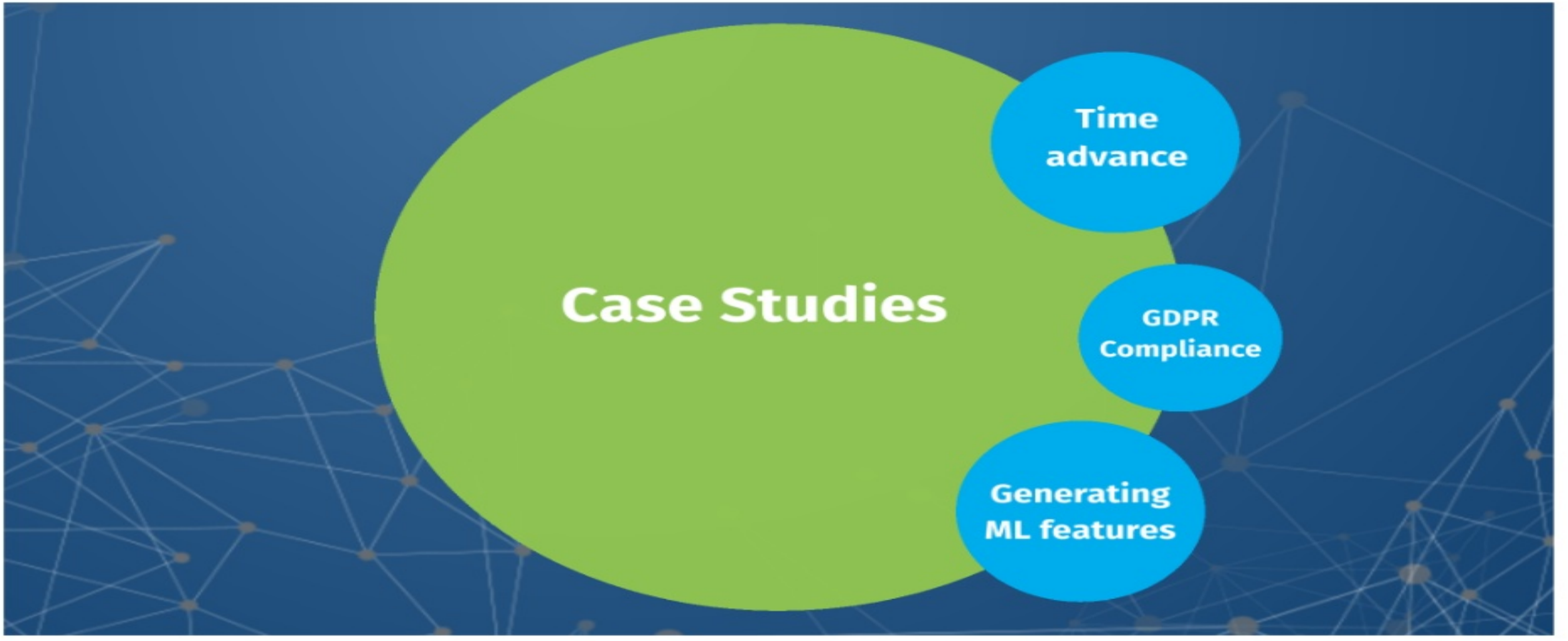
Case Studies
Time advance
GDPR Compliance
Generating ML features

How to advance time?

- Background
- Processing time
- Event time
- Ingestion time
- Our approach

Key requirements

Key requirements

- **Low** latency -> **Fast** reaction time

Key requirements

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- **Scalability** to met growing load

Key requirements

- **Low** latency -> **Fast** reaction time
- **Scalability** to met growing load
- Reprocessing and **time-travel**

Reprocessing

Reprocessing

- Process **lots** of stored data **fast**

Reprocessing

- Process **lots** of stored data **fast**

Reprocessing

- Process **lots** of stored data **fast**

- For **experimenting** and machine learning model **improvement**

Message lifetime

Processing Time Characteristic

Time advances according to system's time

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Time advances according to system's time

+ Simplicity - wall clock for processing

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- Non-deterministic results!!!

Processing Time Characteristic

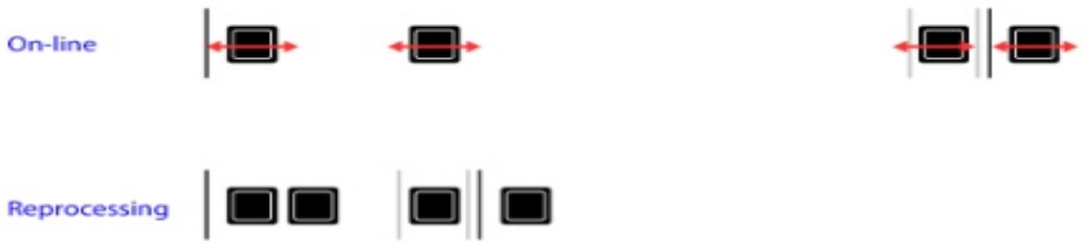
Time advances according to system's time

+ Simplicity - wall clock for processing
+ Low latency footprint

- Non-deterministic results!!!
- Hard to test processing time timers

Event Time Characteristic

Time advances according to external timestamps - event time



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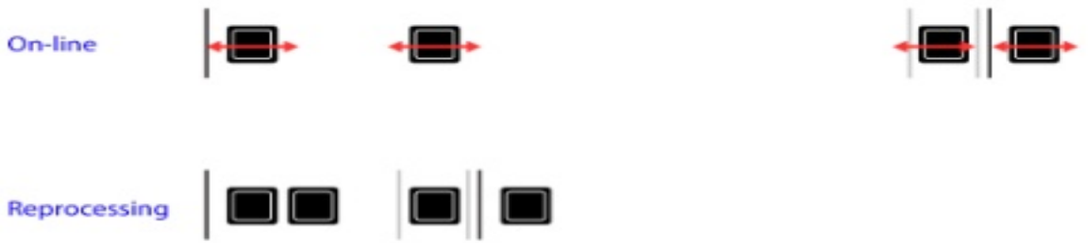

+ Deterministic results

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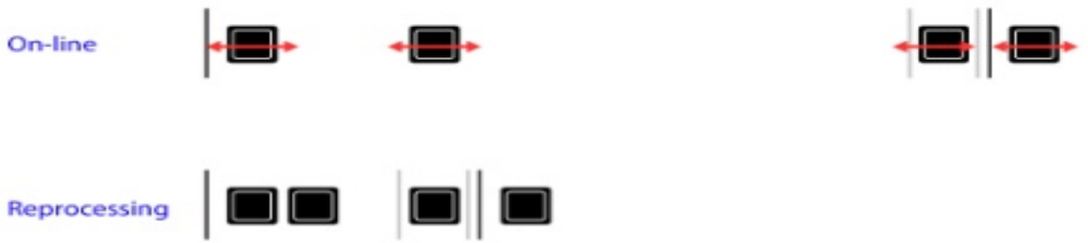

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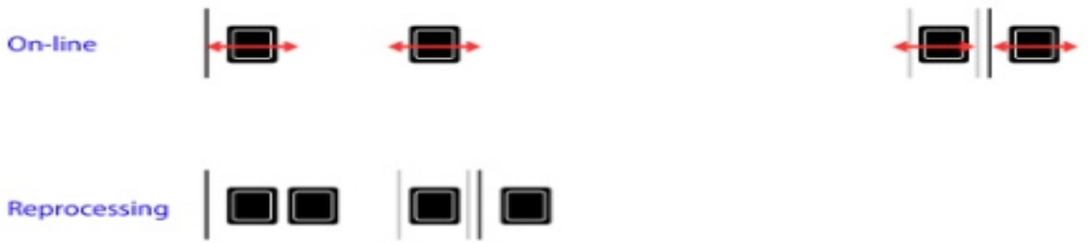

+ Deterministic results
+ Easy to test

- Every user may have different time...

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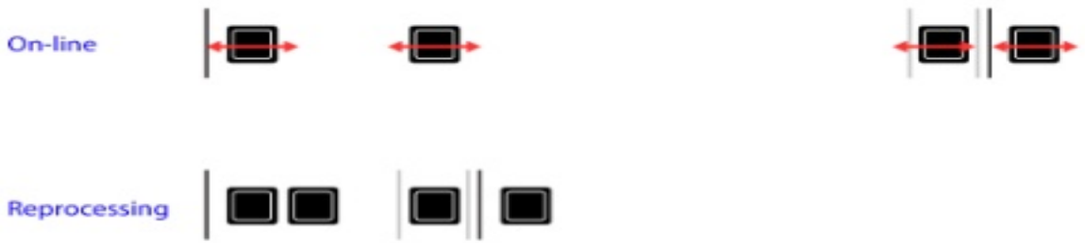

+ Deterministic results
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  which requires delaying time advance by lag...

Event Time Characteristic

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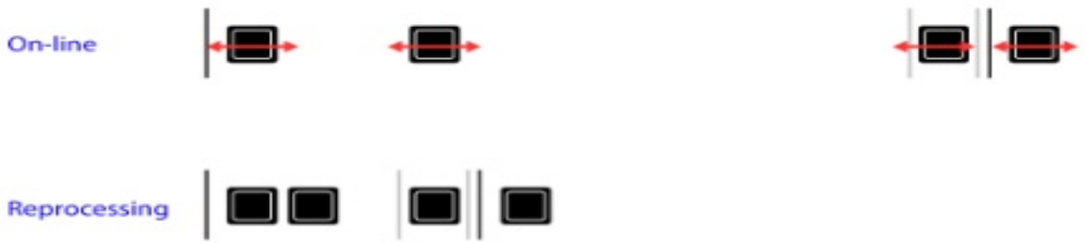

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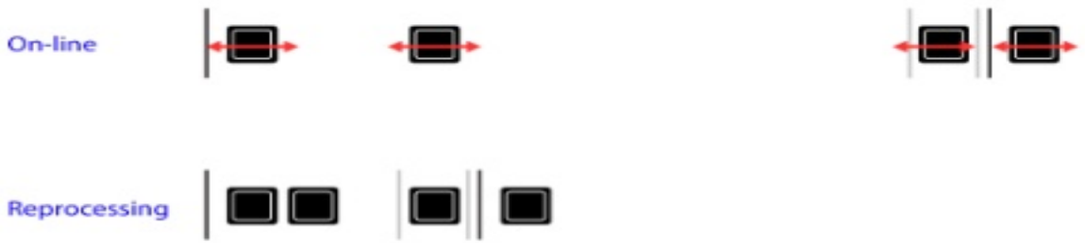

+ Deterministic results
+ Easy to test

- Every user may have different time...
  which requires delaying time advance by lag...
  thus increases latency and reaction time
- Risks due to timestamp tampering

Ingestion Time Characteristic

Time advances according to message's ingestion time

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+ We control source of time

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- Non-deterministic reprocessing

Ingestion Time Characteristic

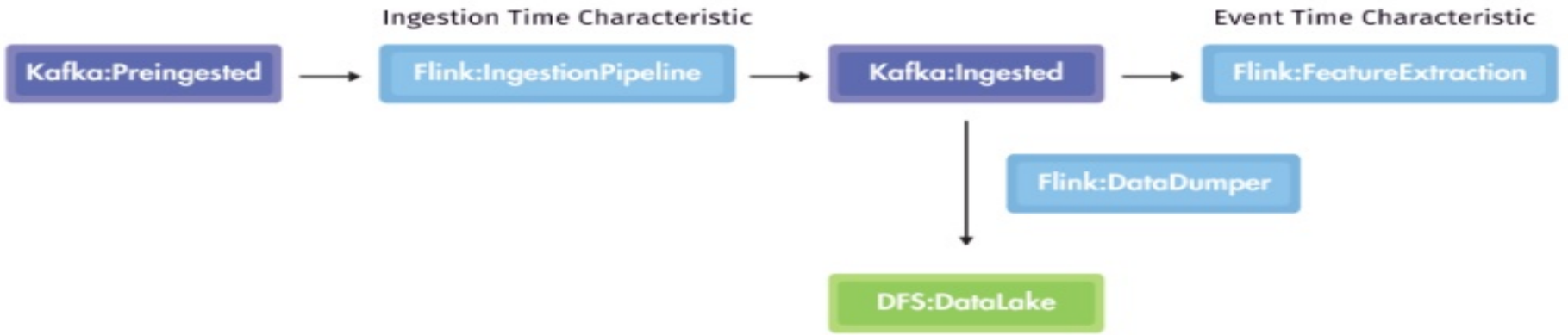
Time advances according to message's ingestion time

+ We control source of time

- Non-deterministic reprocessing
- Whole pipeline tests are hard

Our approach to time advancing

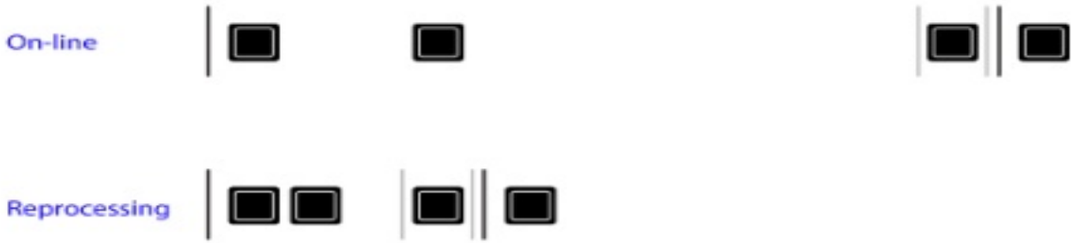
Time advances according to message's arrival time on boundary system



- We **combined** two time characteristics to achieve desired result

Our approach to time advancing

Time advances according to message's arrival time on boundary system



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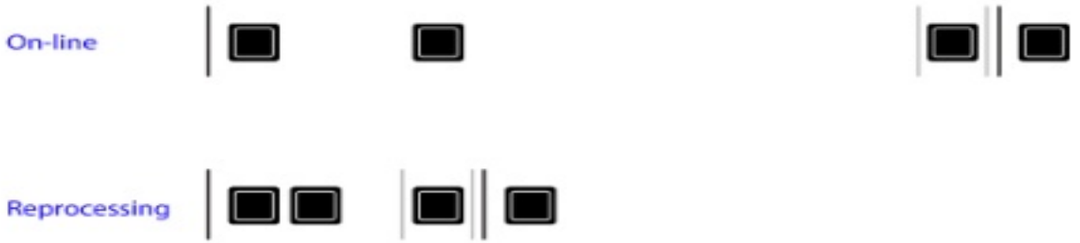

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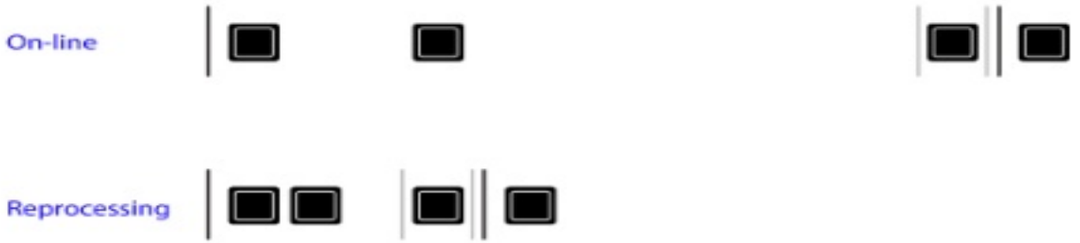

+ We control source of time
+ Stable reprocessing

Our approach to time advancing

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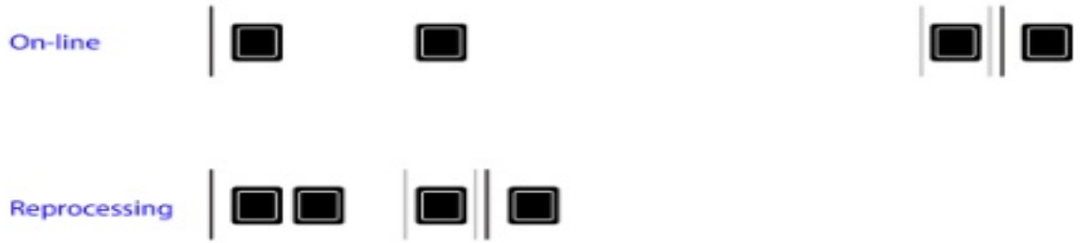

+ We control source of time
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+ Archive data with fixed timestamps

Our approach to time advancing

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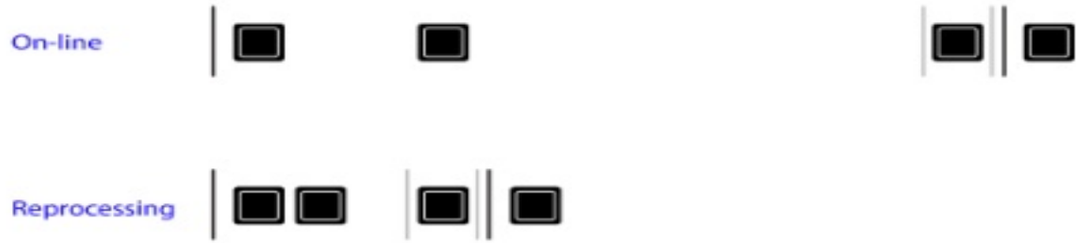

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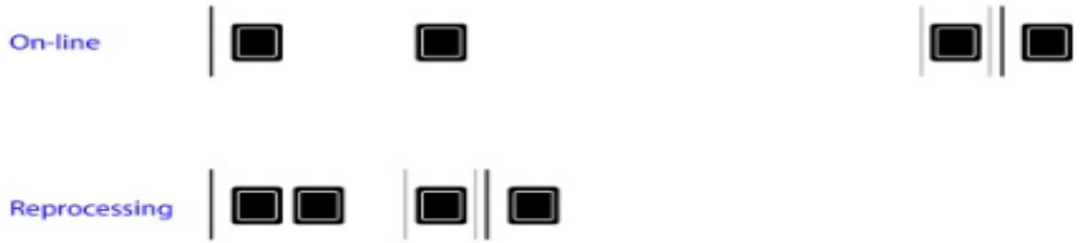

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– Reprocessing reaction time incorrect

Advancing Time Summary

- Always keep in mind your **requirements**
- **Know** drawbacks of each time characteristic
- You can **combine** time characteristics to fit your needs
- You can (and **should**!) unittest Flink applications

- **Watch out** for checkpointing interval!


Technical aspects of GDPR compliance
EU GDPR COMPLIANT
Requirements
Anonymization
Flink state weeding
Data lake
Machine Learning

GDPR Requirements

GDPR imposes requirements to:
- **delete** every bit of user's data when asked
- **move** user's data to another service provider
- **hold** raw data for extended time
- have **consent** for behaviour data processing

Anonymization

The less personal data you process the less consent you need...

NO! We are not gathering user's logins or passwords

Flink state weeding

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- Remember **clearing** operator state!

Flink state weeding

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- Use **timers** and inactivity markers

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- We can't wait for **Time-to-live** option on state variables

Flink state weeding

- Remember **clearing** operator state!
- Use **timers** and inactivity markers
- We can't wait for **Time-to-live** option on state variables
- It would be nice to have timer **unregistering**

GDPR and data lake

GDPR and data lake

- We **gather** behavioral data for:
  - ML methods research
  - Model training
  - Legal purposes - automatic decision making

GDPR and data lake

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GDPR and data lake

- We **gather** behavioral data for:
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  - Model training
  - Legal purposes - automatic decision making
- **Index** data by user_id
- **Remove** it when asked
- You need **indexable** data lake

GDPR and Machine Learning models

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- We are building Machine Learning models **per user**

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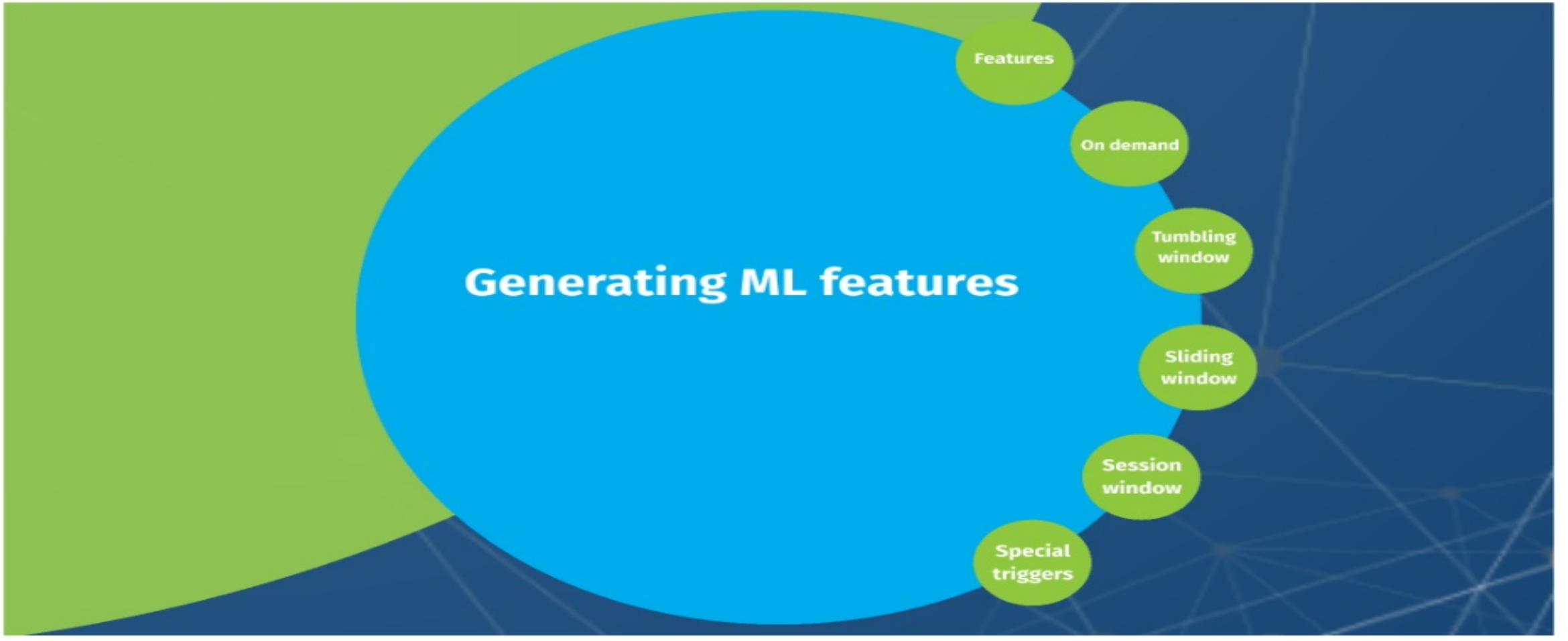
  - **Residual** impact on other user's models
- Residual impact **cannot** help find user
- Residual impact **fades** with time
- Residual impact are **NOT** against GDPR

Summary

- Index your data by user ID
- Be able to move and remove data by user Id


Generating ML features
Features
On demand
Tumbling window
Sliding window
Session window
Special triggers

Generating Machine Learning Features

- Low latency
- Deterministic response time
- Catch behaviour dynamics

Generating features on demand

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Generating features on demand

+ Cheap computationally

Generating features on demand

+ Cheap computationally

- High latency

Generating features on demand

+ Cheap computationally

- High latency
- Non deterministic latency

Generating features on demand

+ Cheap computationally

- High latency
- Non deterministic latency
- Cannot do pushing mode

Tumbling window

Tumbling window

+ Quite light computationally

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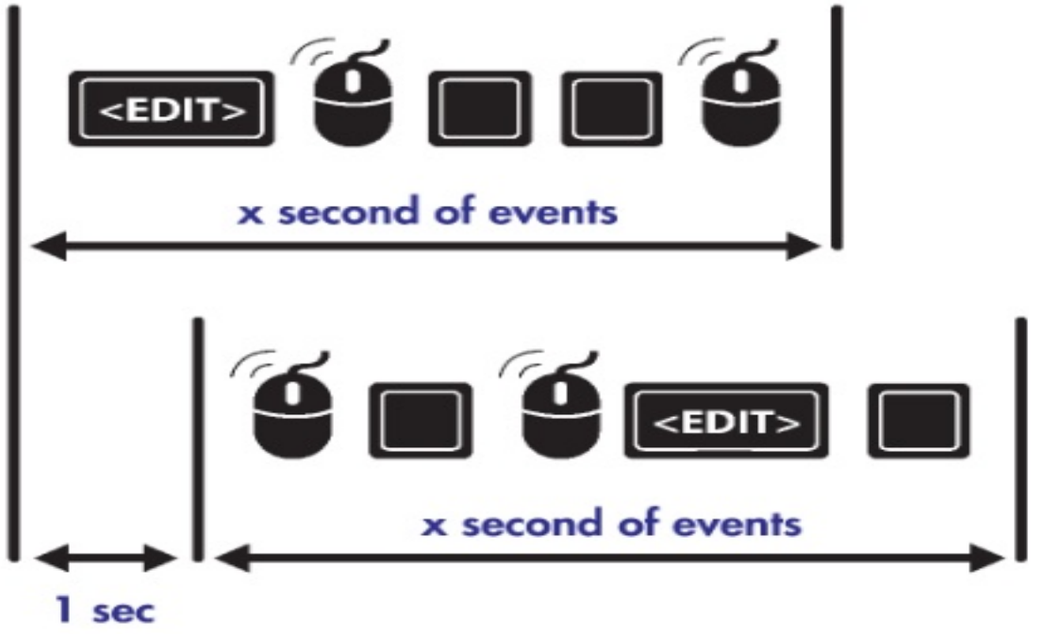
- Variable events in feature - poor ML models

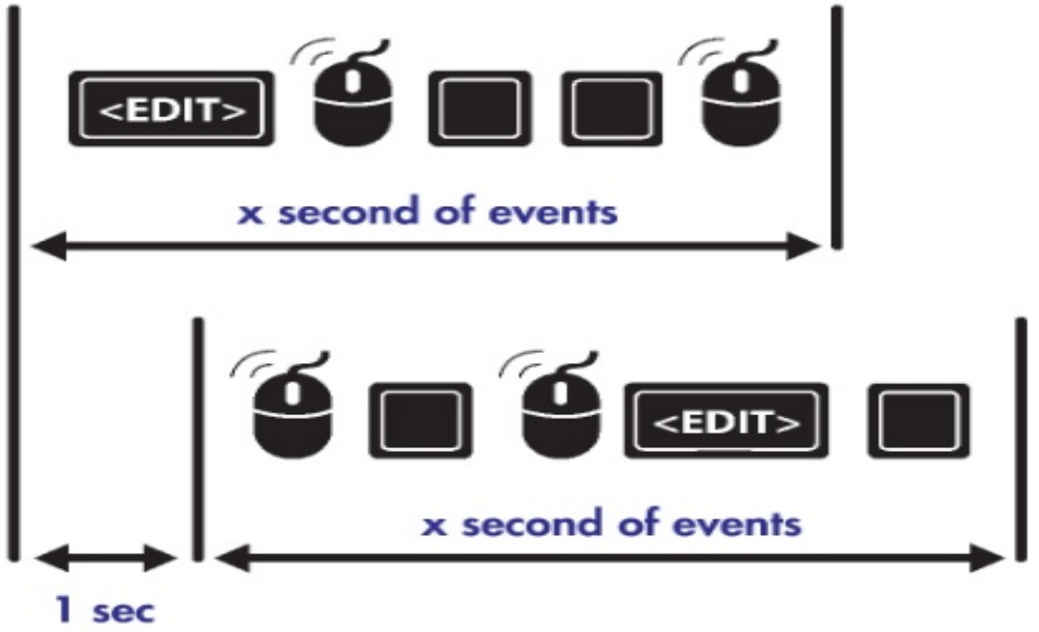
Tumbling window

+ Quite light computationally
- Variable events in feature - poor ML models
- Very few features

Sliding window

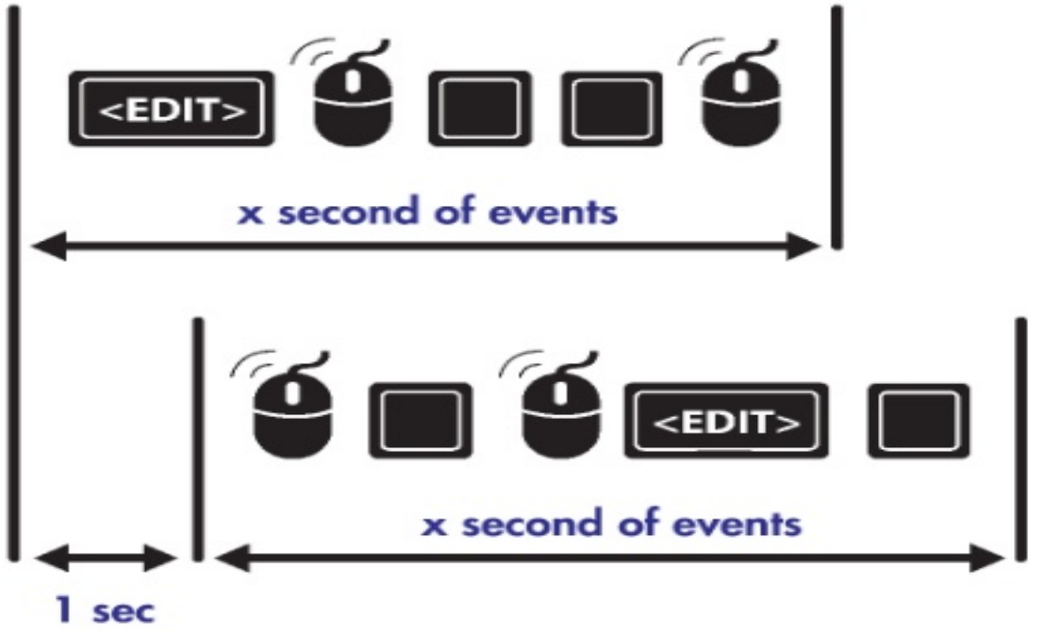


Sliding window



+ More features

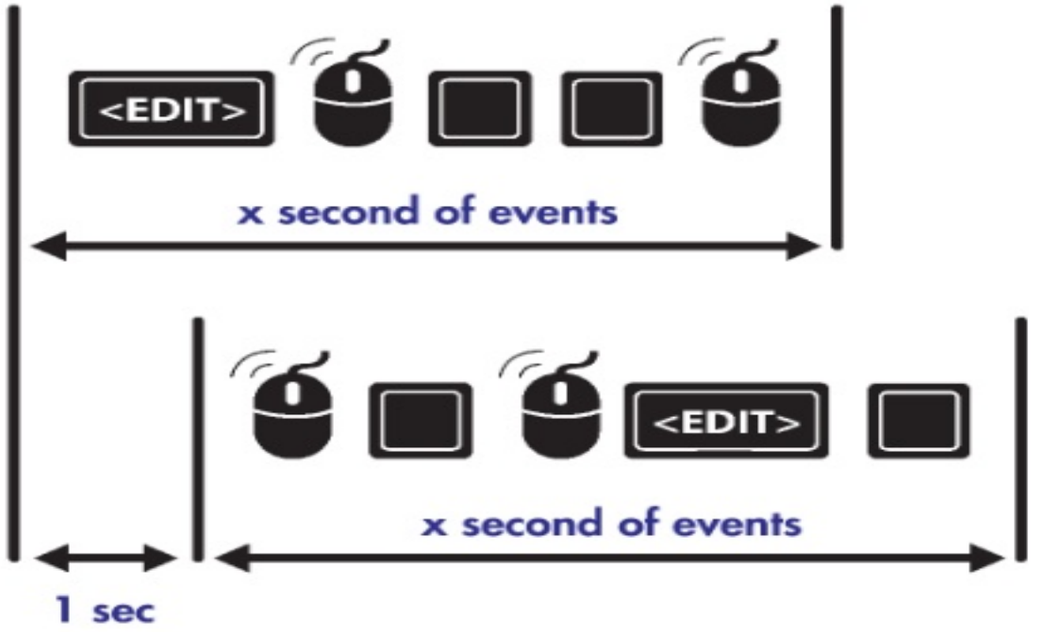
Sliding window



+ More features

- Computationally more intensive

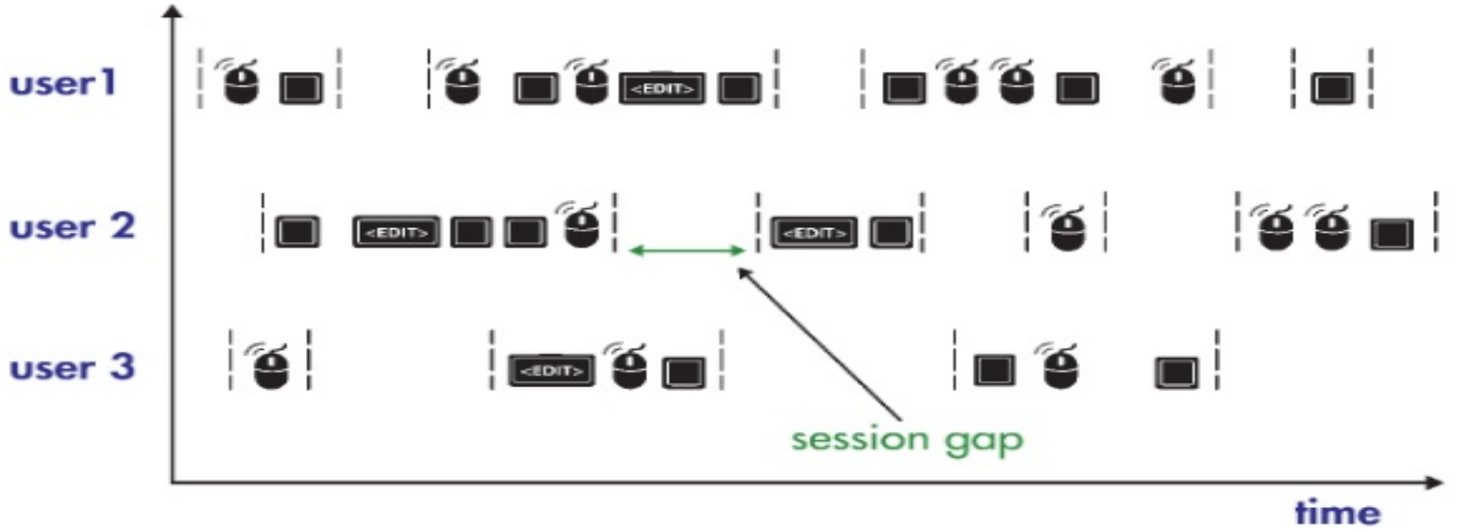
Sliding window



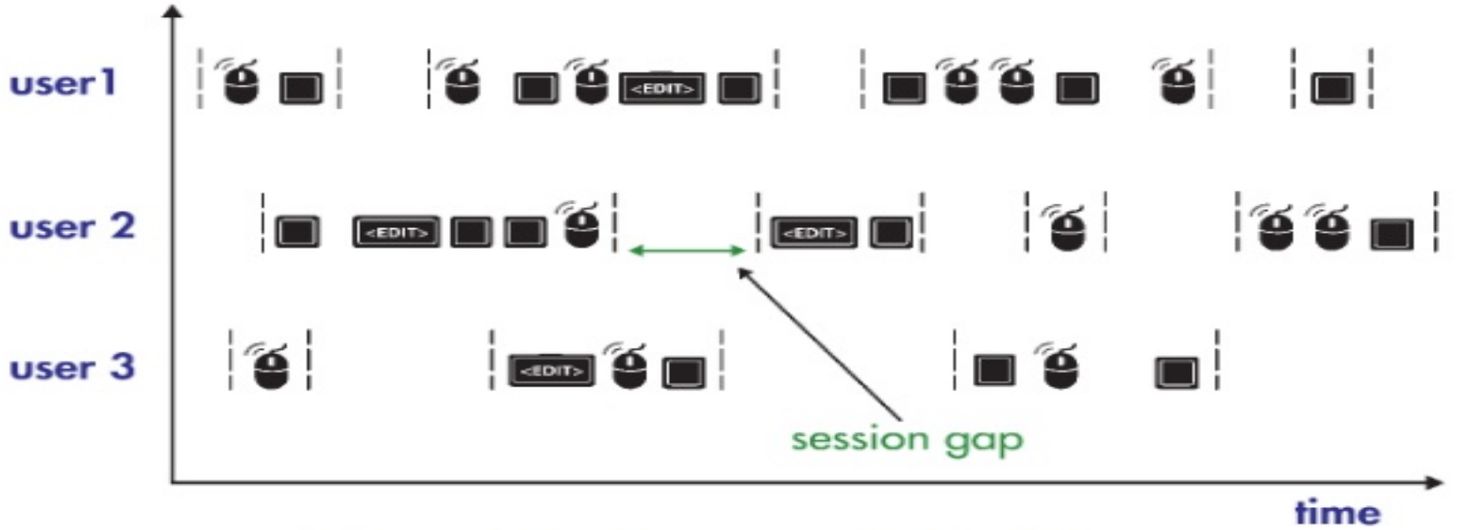
+ More features

- Computationally more intensive
- As poor results as in tumbling window

Session window

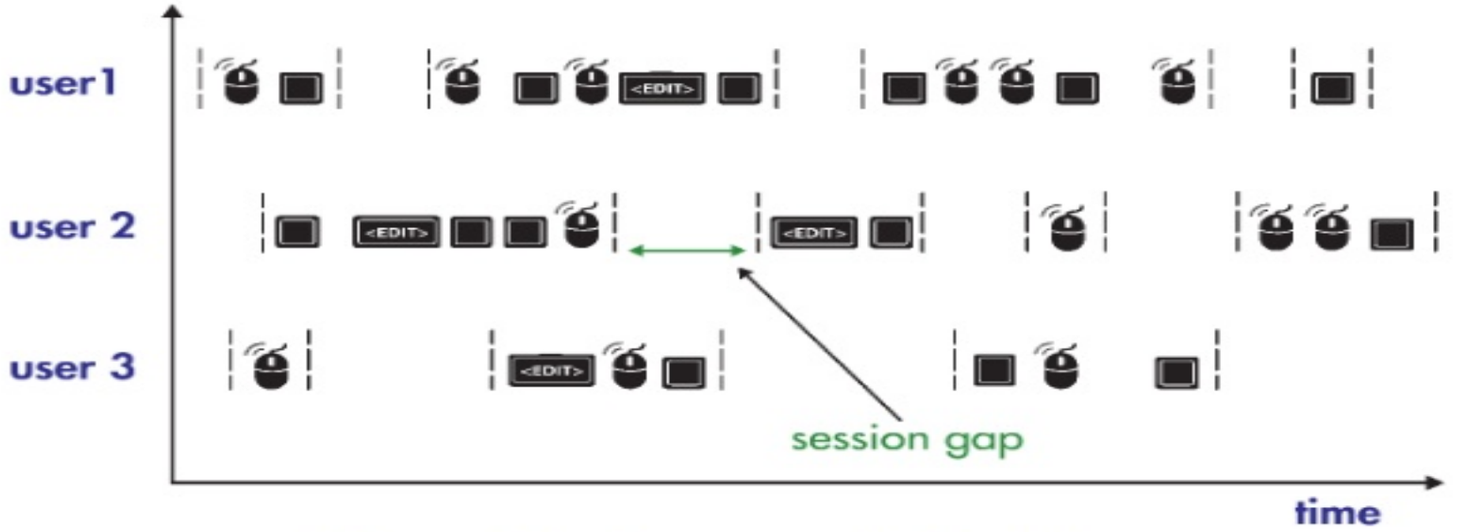


Session window



+ Not so intensive computationally

Session window



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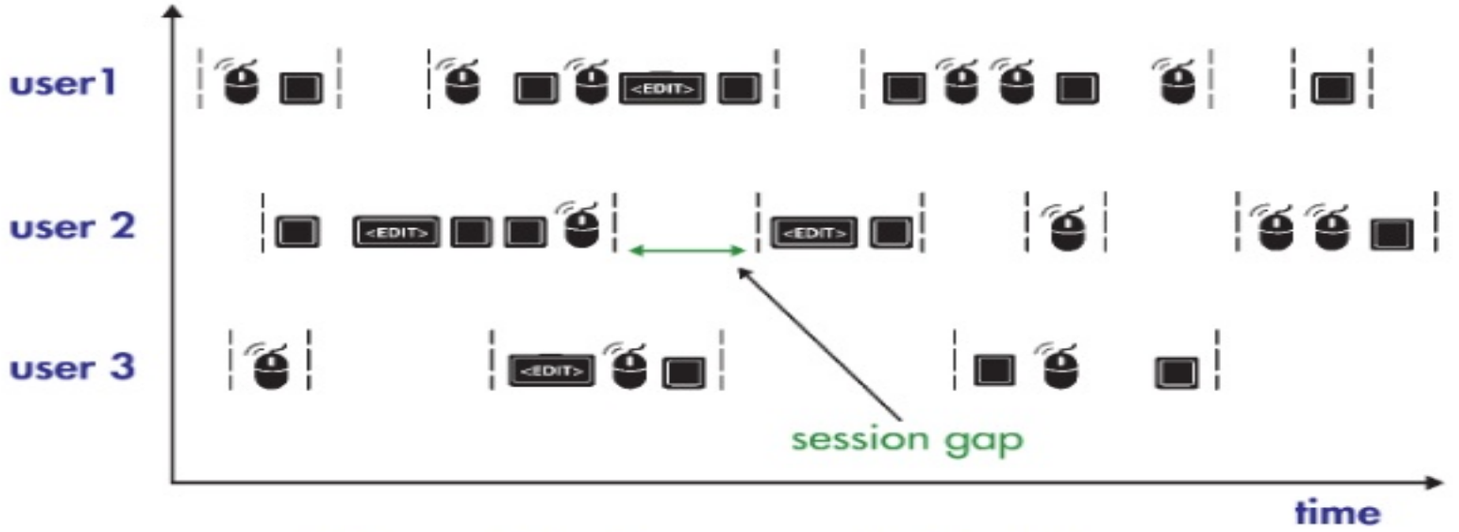
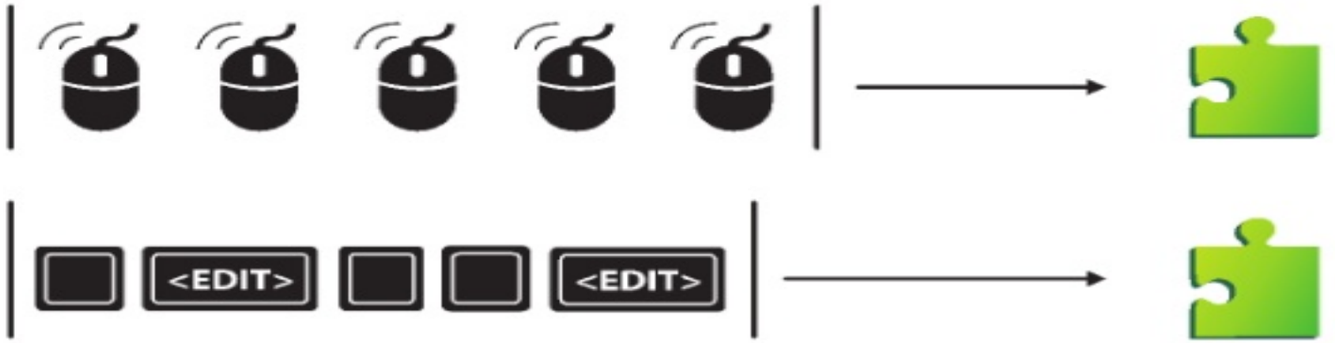
Session window



+ Not so intensive computationally
- Extends latency by session gap (sic!)
- Again variable number of events

Special triggers



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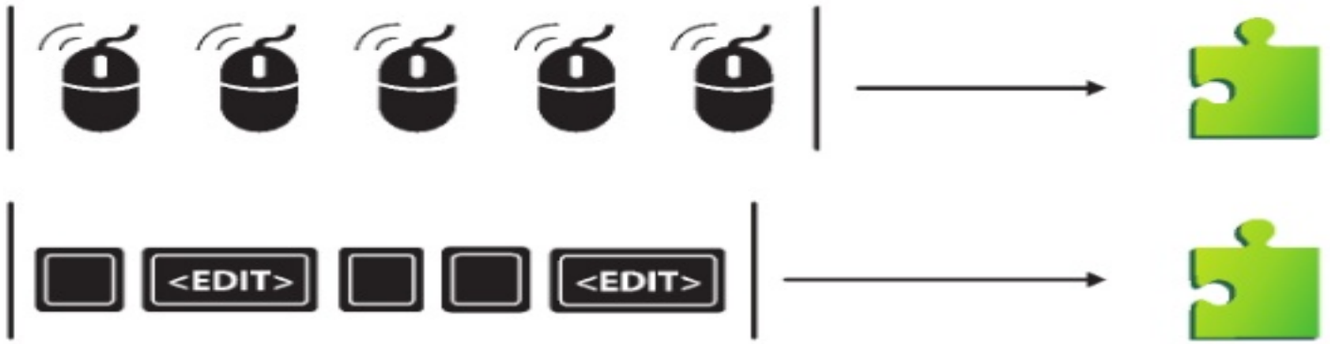
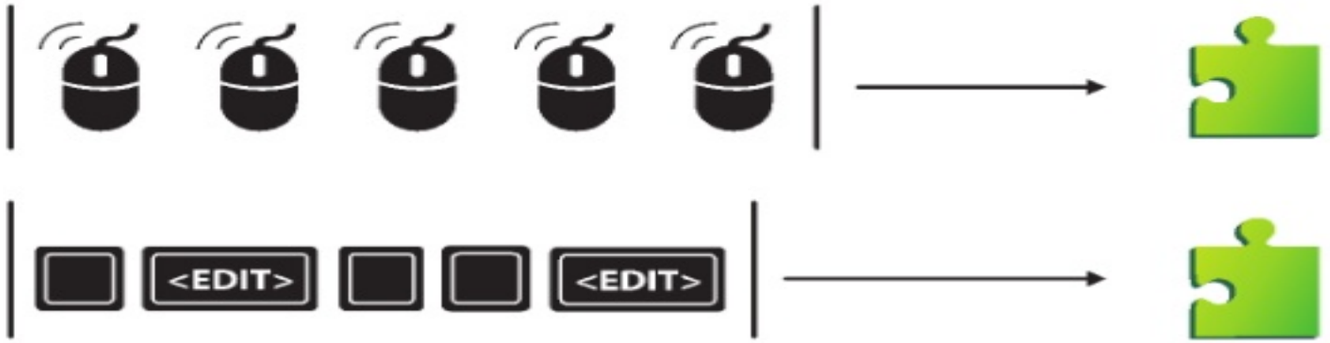


- Computationally intensive

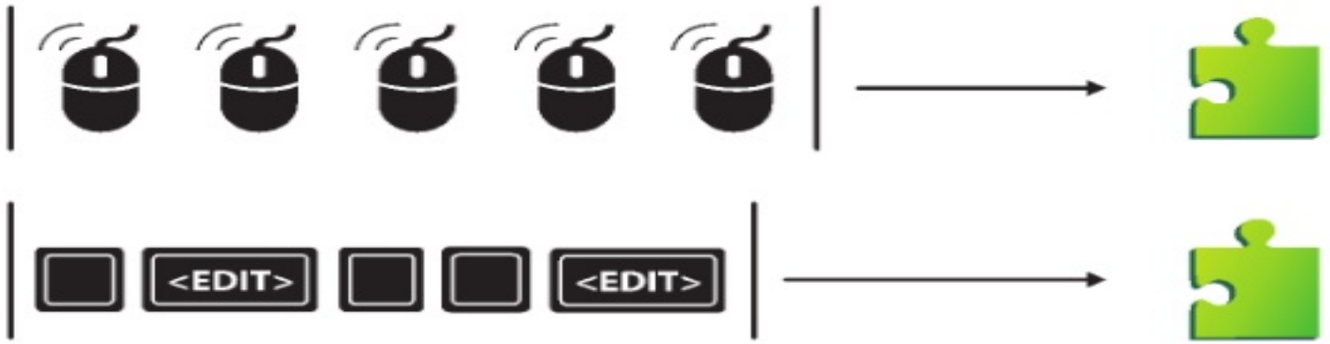
Special triggers



- Computationally intensive

+ Constant number of events

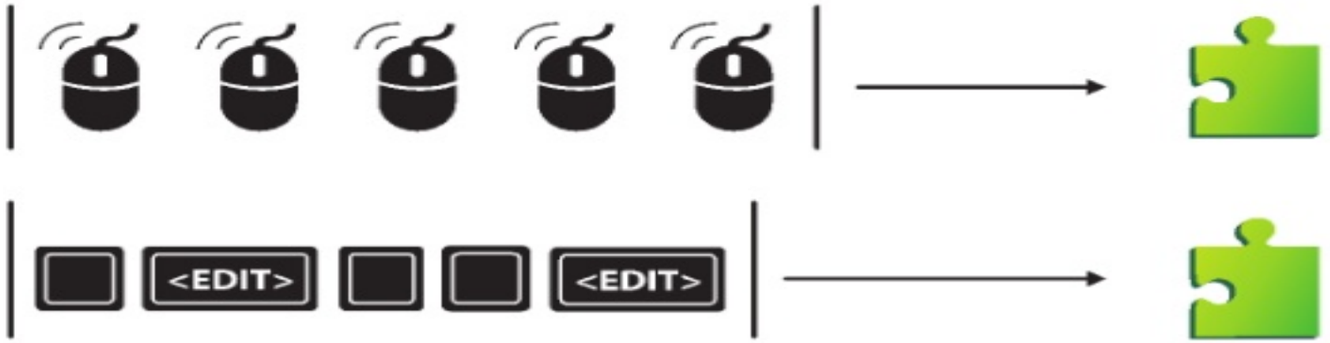
Special triggers



- Computationally intensive

+ Constant number of events
+ No latency slow downs

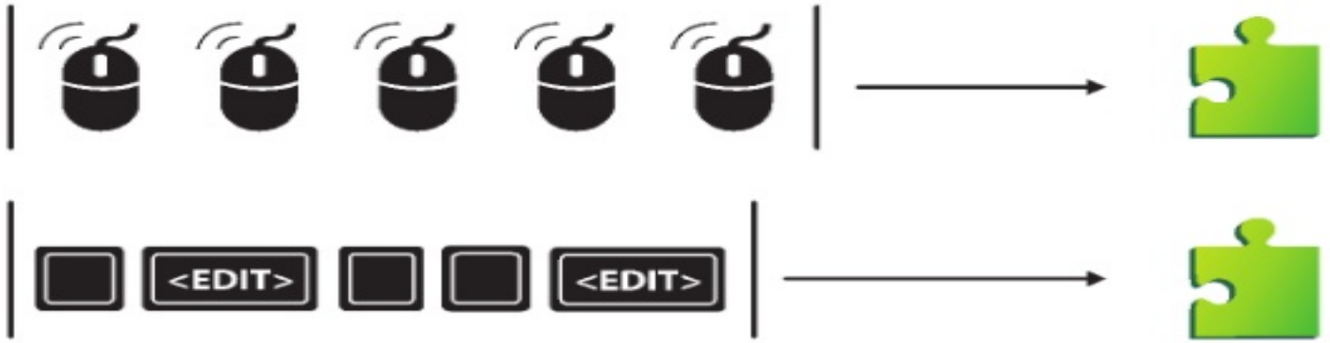
Special triggers



- Computationally intensive

+ Constant number of events
+ No latency slow downs
+ Lots of features

Special triggers



- Computationally intensive

+ Constant number of events
+ No latency slow downs
+ Lots of features
+ Good ML results

Generating ML Features Summary

- Event grouping doesn't end at standard Flink windows
- Test everything - results more then often are surprising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Thanks and wishes

- Deployment much improved!
- Waiting for state Time-To-Live
- Nice to have: efficient unregistering of many timers
- Need to have: testing utilities for processing time applications

- Conquer the world


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