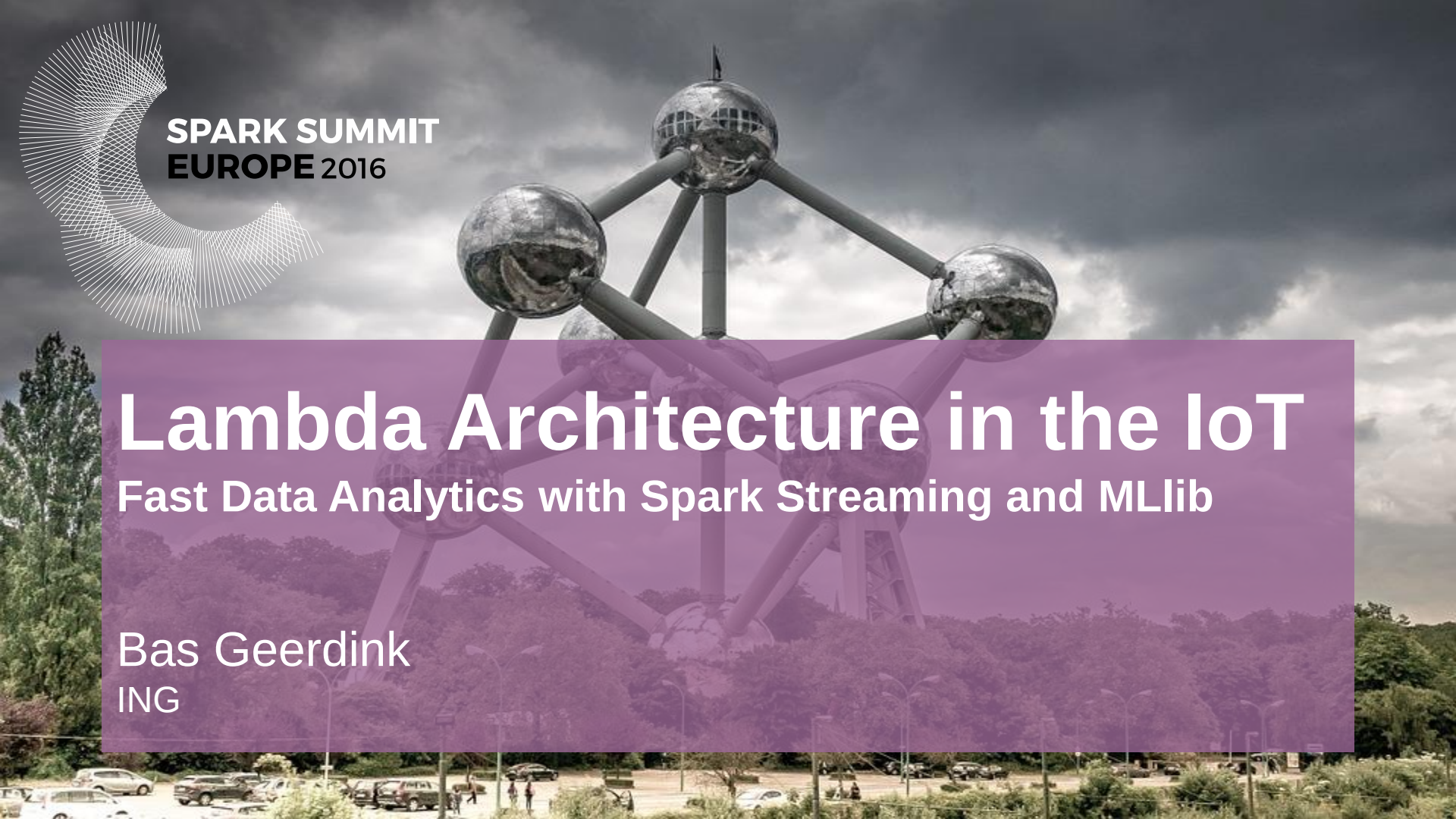


Lambda Architecture in the IoT

Fast Data Analytics with Spark Streaming and MLlib

Bas Geerdink
ING

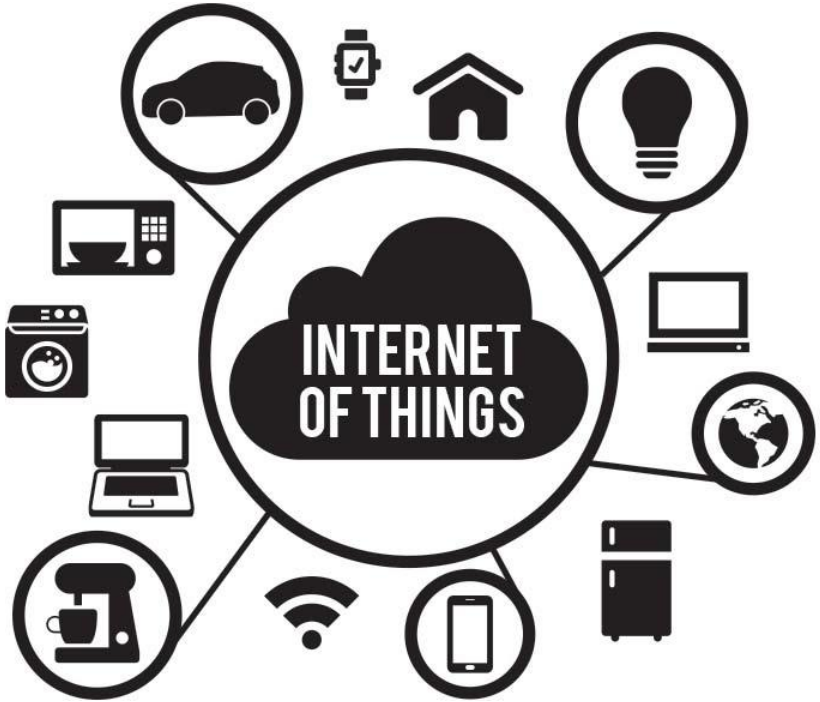
Who am I?

Bas Geerdink

- Chapter Lead in Analytics area at ING
- Master degree in Artificial Intelligence and Informatics
- Spark Certified Developer

- @bgeerdink
- https://www.linkedin.com/in/geerdink

The Internet of …



What's new in the IoT?

- Data
  - Streaming data from more sources
- Use cases
  - Combining data streams
- Technology
  - Fast processing and scalability
- Challenges
  - Security: encrypt the sensors/network/server

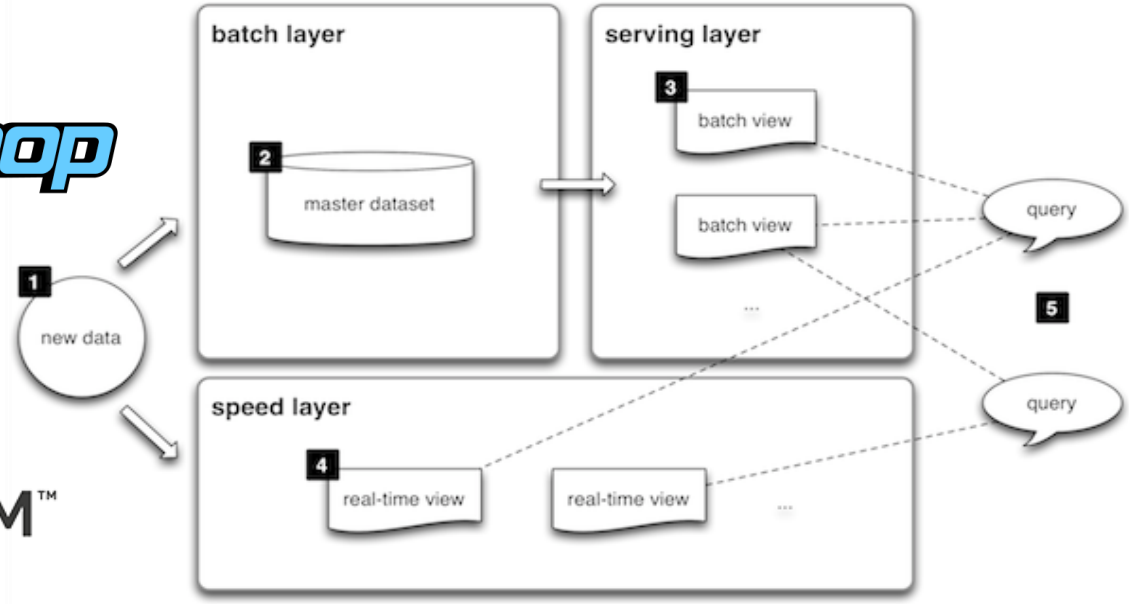
What do we want in the IoT?

- FAST data: process stream of events (sensory data)
- BIG data: process files/tables in batches (static data)

- ONE analytics engine
- ONE querying/visualization tool

- Scalable environment
- Reactive software

Lambda Architecture



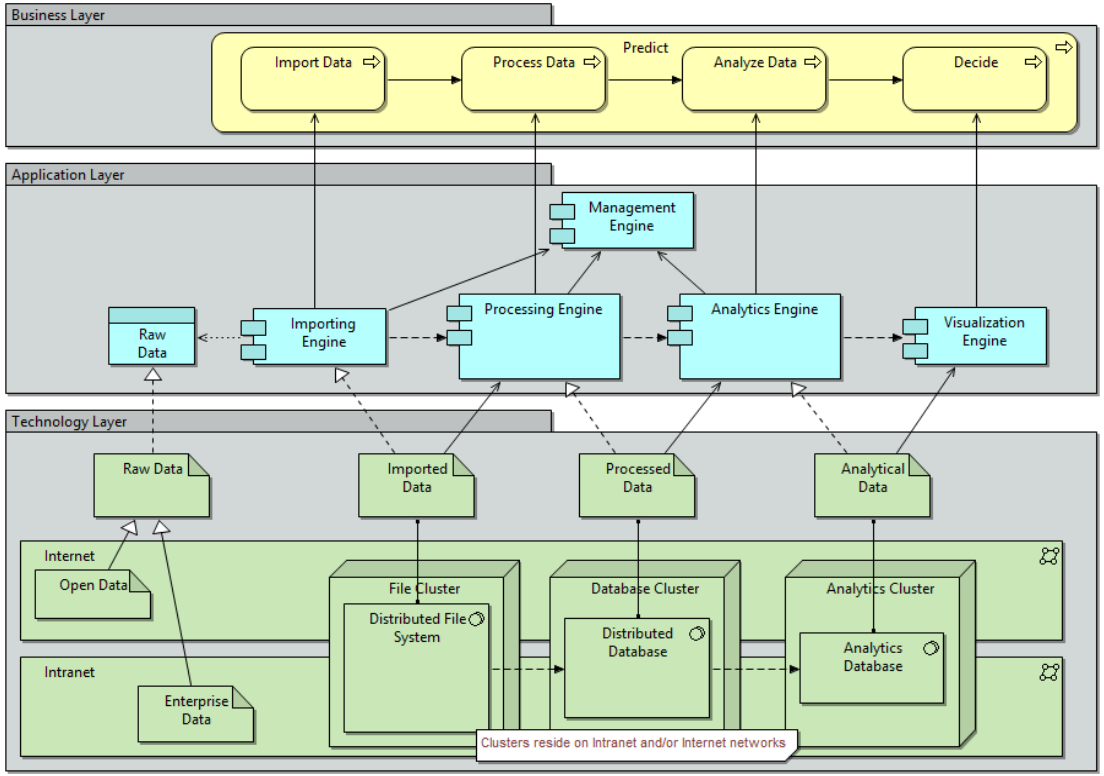
Source: Nathan Marz (2013)

Gamma/Kappa/Omega/… Architecture

- Lambda Criticism:
  - Too complex
  - Two code bases
  - Two data stores

- Alternatives:
  - Treat a stream as a mini-batch
  - Treat a batch as a stream of records
  - Combine batch and stream within one system

Big Data Reference Architecture



Source: Geerdink (2013)

Use case: Smart Parking

Recommend the best car park when driving to Amsterdam

→ Show the car park with the highest score, determined by

- Batch (every x minutes), data from car parks
- Stream (every x seconds), GPS data of cars

Gemeente Amsterdam

Wonen
Werken
Vrije tijd
Buurten

Actueel
Veelgevraagd
Bestuur en organisatie
Alle onderwerpen

Contact
English
Adressengids
Nieuwsbrief

Home > Parkeren & verkeer > Parkeren + Reizen (P+R)

Zoeken...

Parkeren + Reizen (P+R)

Parkeer uw auto voor € 8,00 per 24 uur (na 10.00 uur voor € 1,00 per 24 uur) aan de rand van Amsterdam en reis met openbaar vervoer naar het centrum.

P+R locaties

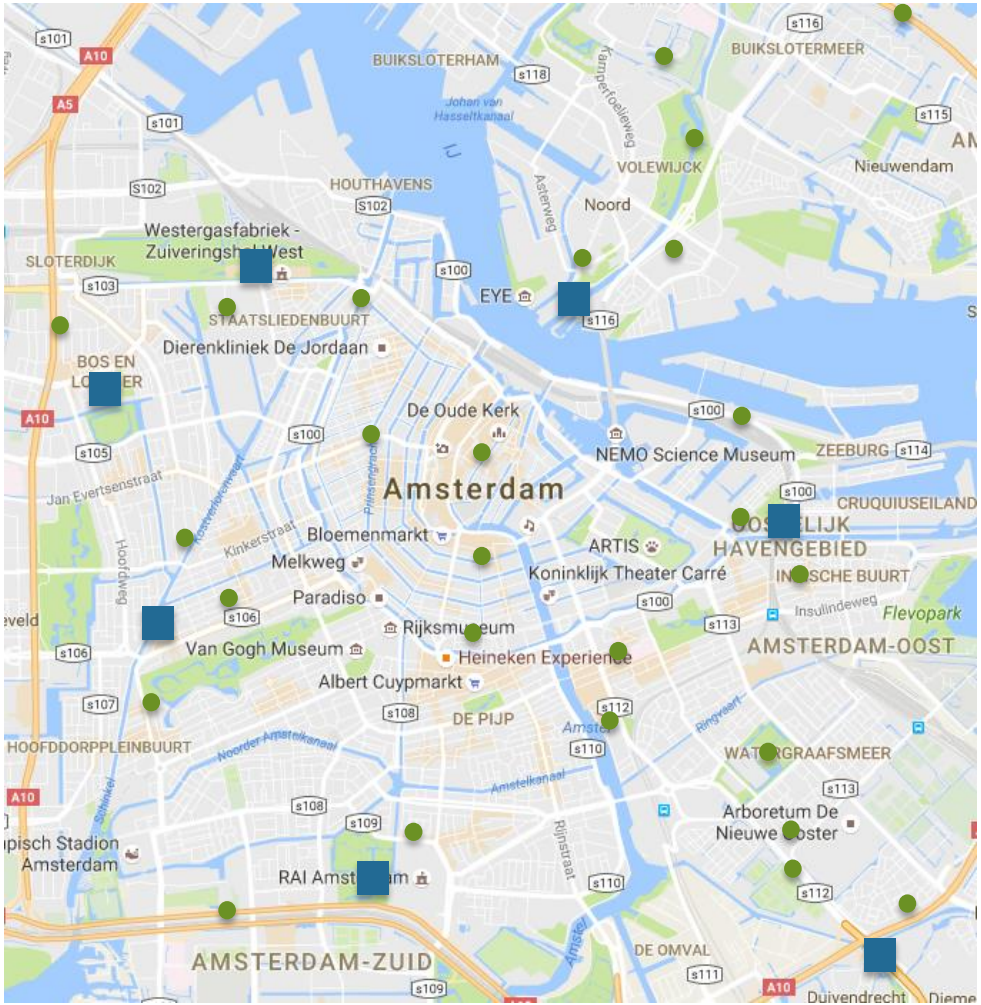
Meer informatie per P+R locatie en uitleg hoe het werkt:

- P+R ArenA
- P+R Zeeburg I en II
- Weekend P+R VUmc
- P+R Bos en Lommer
- P+R RAI
- P+R Sloterdijk
- P+R Olympisch Stadion
- Welke P+R kies ik?

Actuele beschikbaarheid P + R parkeerplekken

Laatste update: 25-okt-2016 00:21 (elke minuut)

P+R locatie	Beschikbaarheid	Parkeerplekken
P+R ArenA	Vrij	1.440
P+R Zeeburg 2	Vrij	322
P+R Olympisch Stadion	Vrij	161
P+R Zeeburg 1	Vrij	60
P+R Sloterdijk	Geen informatie	
P+R Bos en Lommer	Vrij	21
Weekend P+R VUmc	Gesloten	



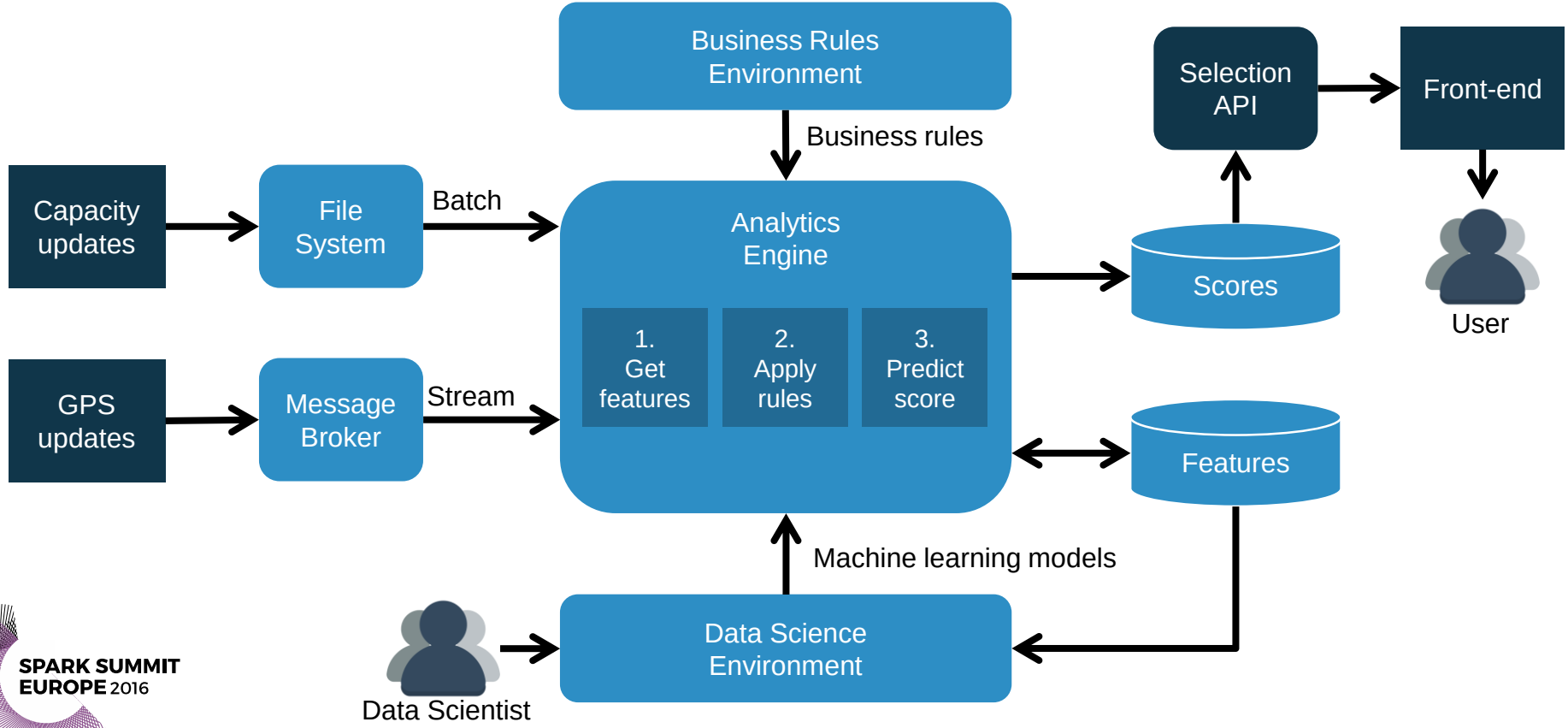
Stream Process

- Get car events (GPS data)
- Filter events (business rules)
- Store events
- For each car park in the neighborhood:
  - Get feature set (location, capacity, usage, …)
  - Combine event with previous events (running sum)
  - Update feature set
  - Predict score (machine learning) and update database

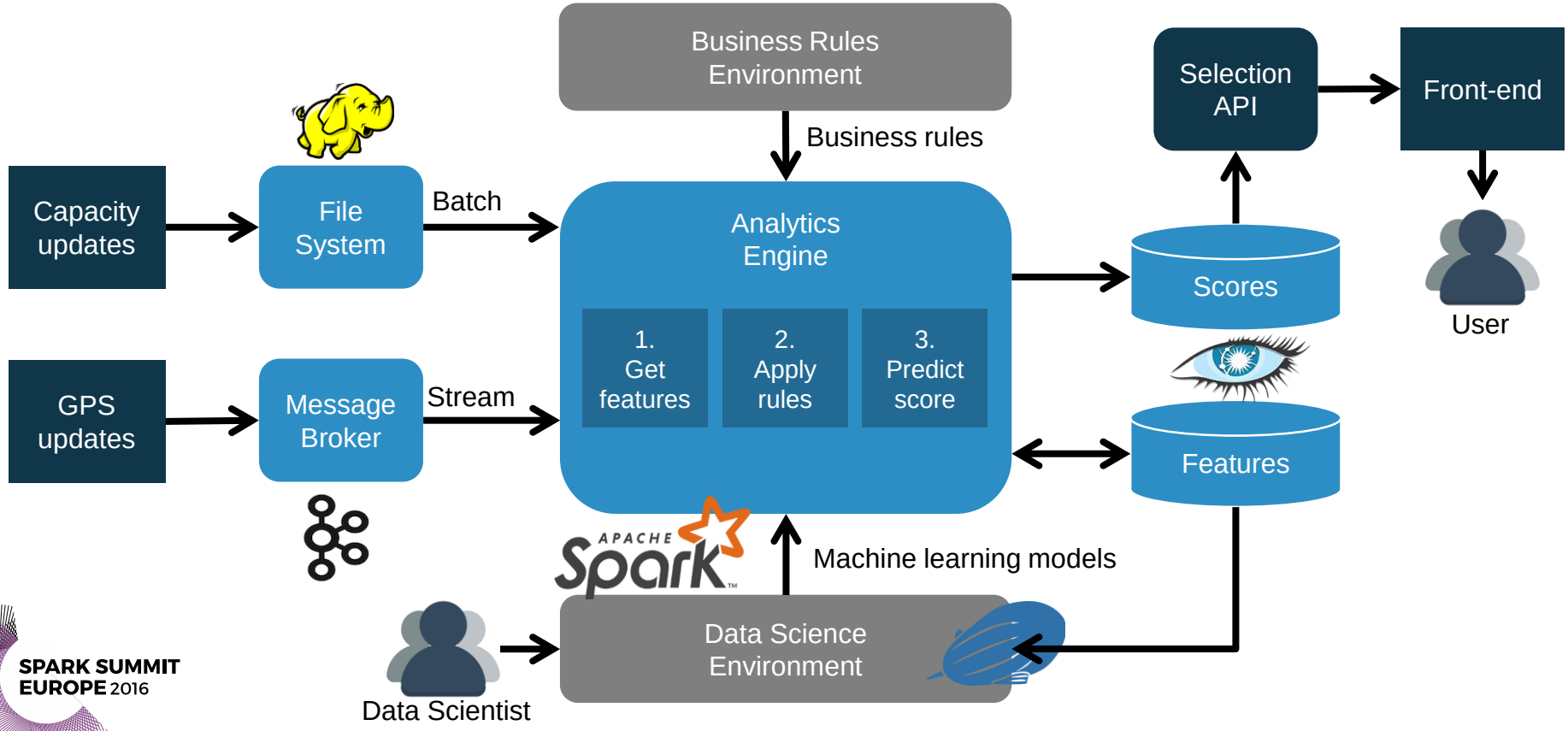
Batch Process

- Get car park data
- Clean up (remove old car data)
- For each car park in the data set:
  - Get recent set of car data (running sum)
  - Update feature set
  - Predict score (machine learning) and update database

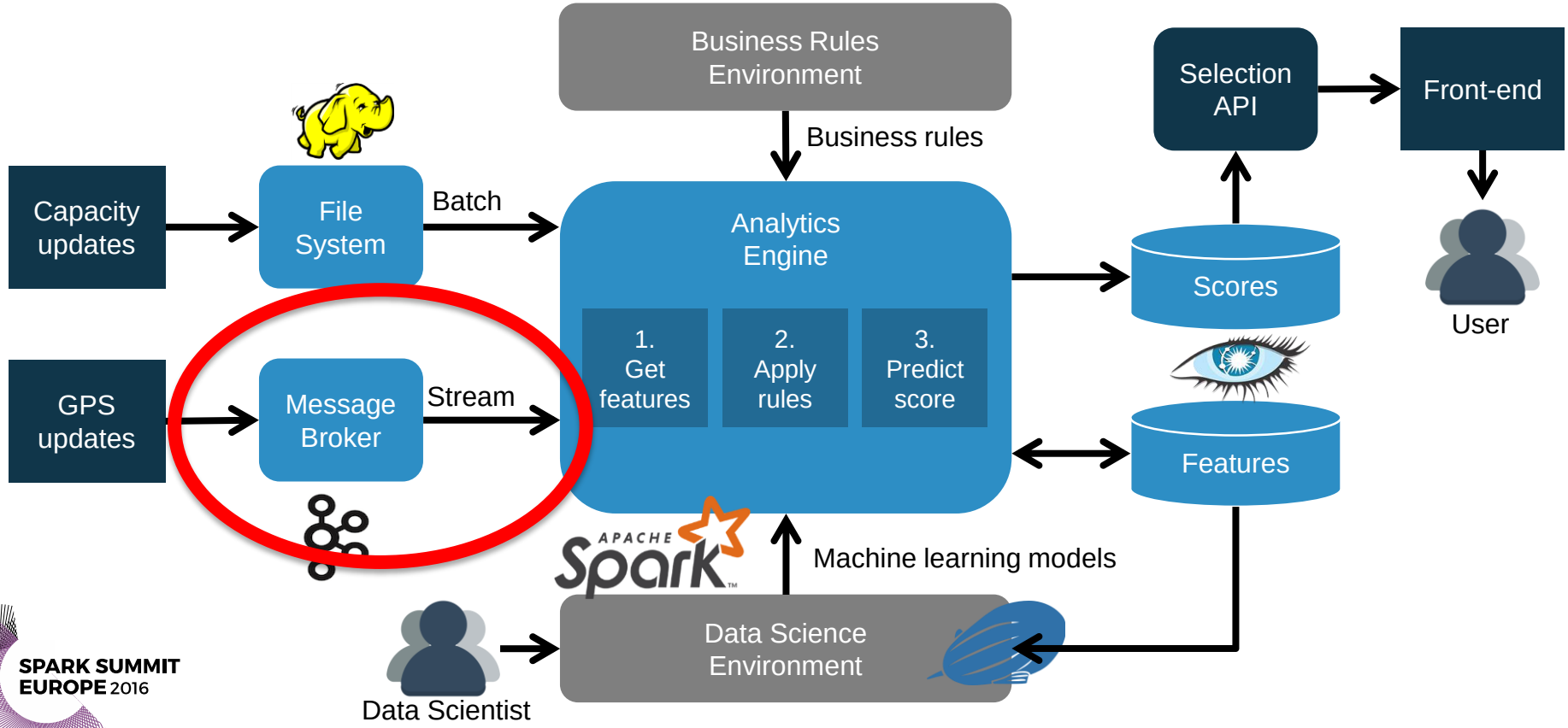
Lambda Architecture



Lambda Architecture



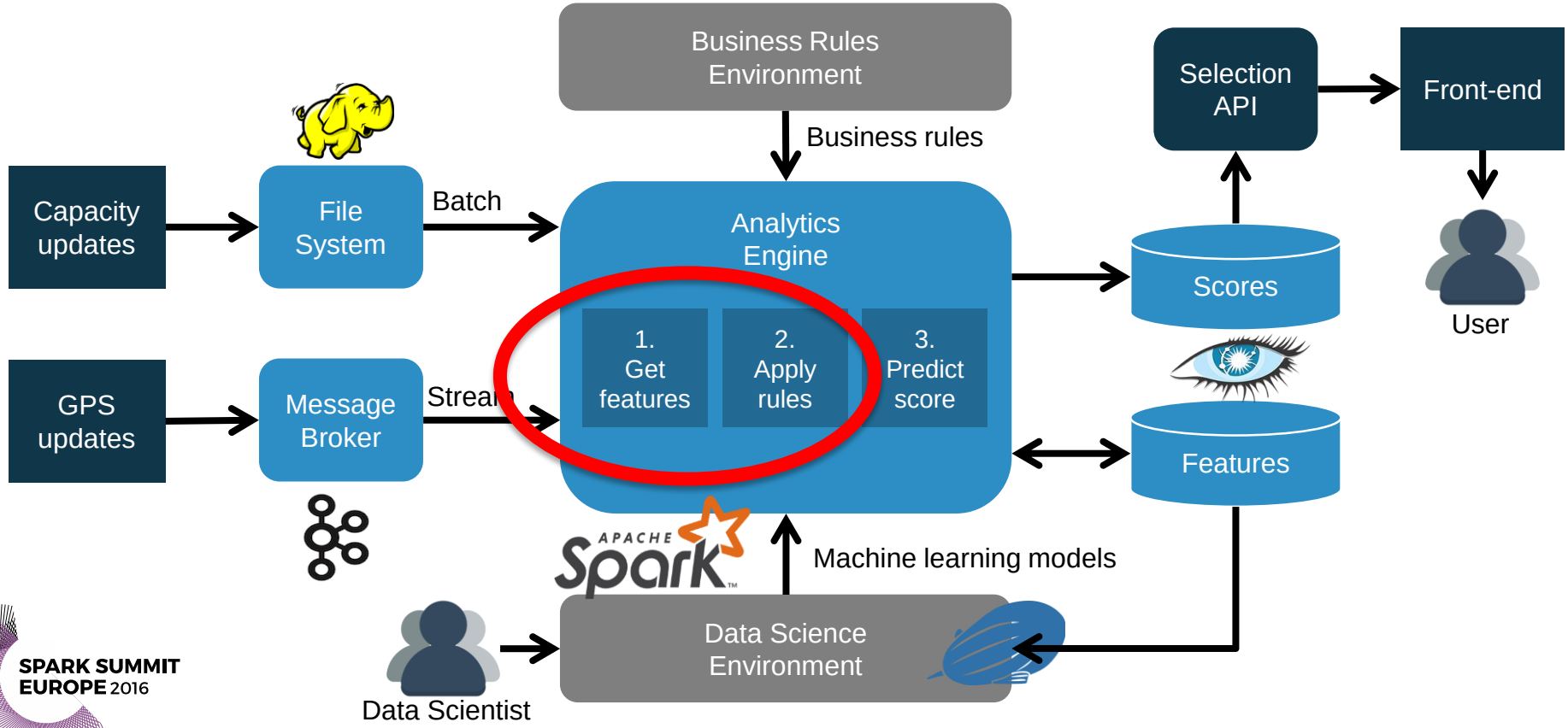
Lambda Architecture



Event Processing with Kafka

```
import org.apache.spark.streaming.{Seconds, StreamingContext}
import org.apache.spark.streaming.kafka010._
import org.apache.spark.streaming.kafka010.LocationStrategies.PreferConsistent
import org.apache.spark.streaming.kafka010.ConsumerStrategies.Subscribe

// initialize Spark Streaming
val conf = new SparkConf().setAppName("fast-data").setMaster("local[*]")
val ssc = new StreamingContext(conf, Seconds(1)) // batch interval = 1 sec

// set parameters for Kafka connection
val topics = Array("cars")
val kafkaParams = Map[String, Object]("bootstrap.servers" -> "localhost:9092")

// subscribe to stream -> create Spark DStream
val stream = KafkaUtils.createDirectStream[String, String](
  ssc,
  PreferConsistent,
  Subscribe[String, String](topics, kafkaParams))
```

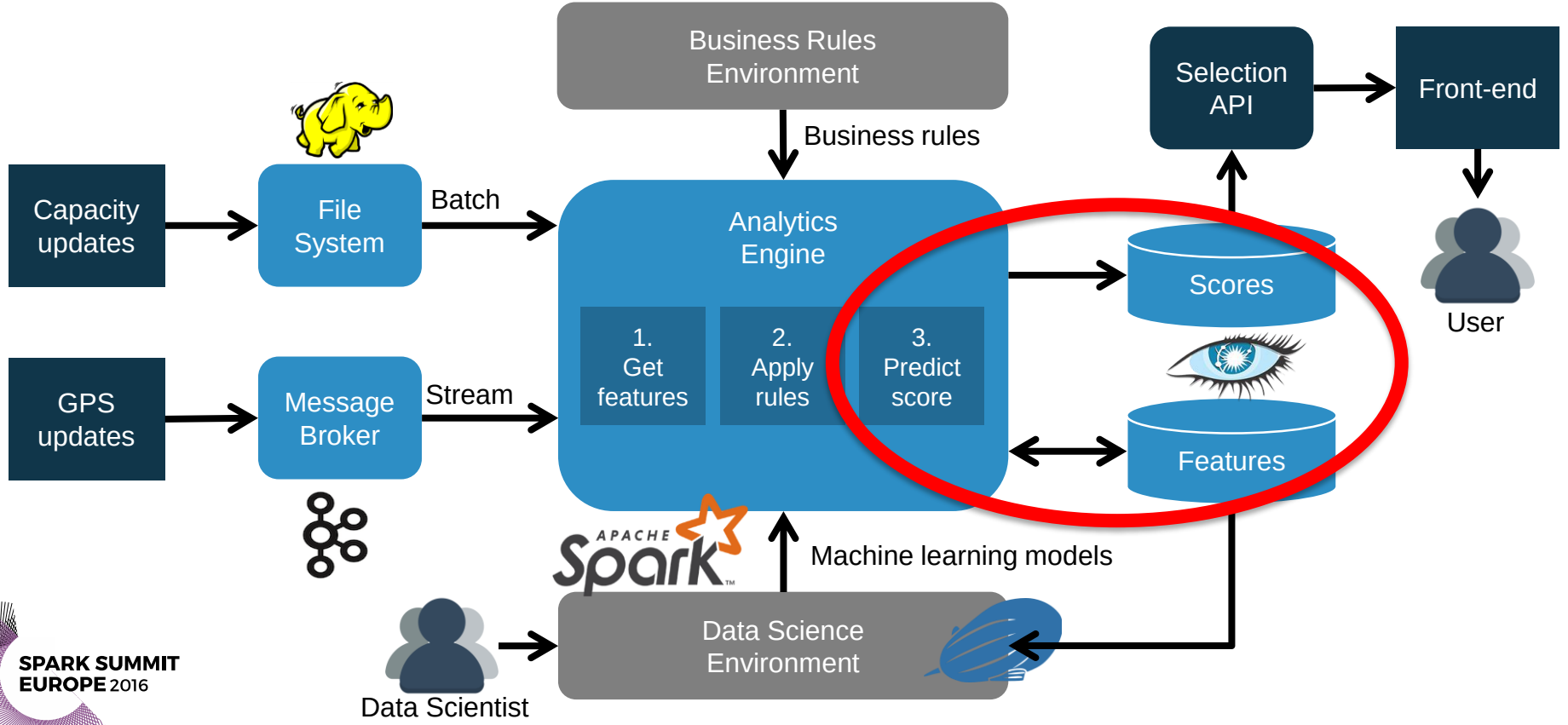
Lambda Architecture



Stream: Data Preparation

```
// change raw data to business events
val events = stream
  .map(event => CarLocationHelper.createCarLocation(event.value))

// apply business rules
val filtered = events
  .filter(Location.filterLocalArea)    // only select cars in local area

// store car locations (update or create)
filtered
  .foreachRDD(rdd => rdd.foreach(cle => { CassandraHelper.insertCarLocation(cle) }))
```

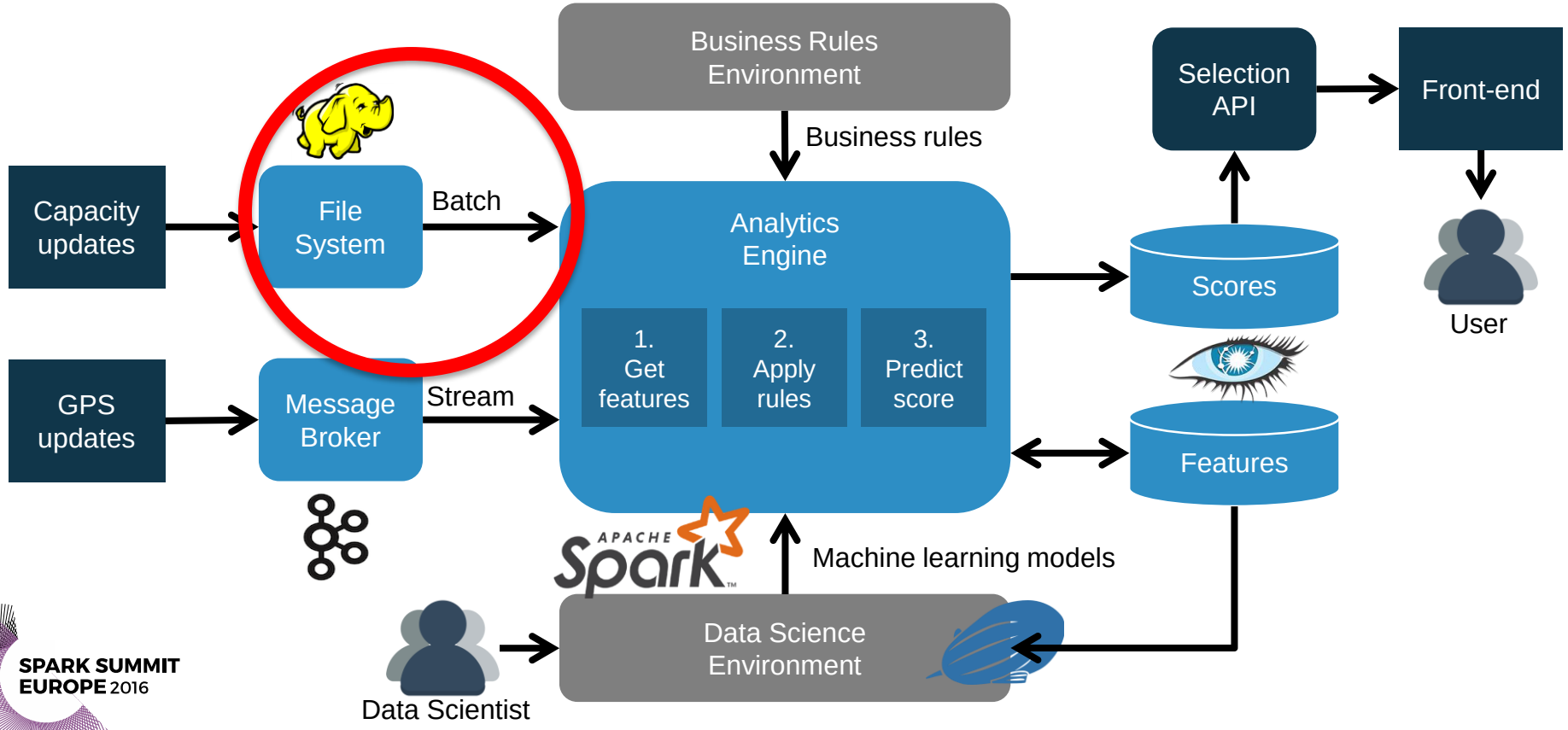
Lambda Architecture



Stream: Create Recommendation

```
// recalculate the distribution of each car park in the neighborhood
filtered
  // get feature set
  .map(cl => Location.getLocalCarParks(cl))
  .foreachRDD(rdd => rdd.foreach(carParks => carParks.foreach { cp =>
    // combine event with previous events (running average)
    val carsInNeighborhood = DensityCalculator.calculateDensity(cp, getCarsInNeighborhood(cp))
    val updatedCarPark = cp.setCarsInNeighborhood(carsInNeighborhood)

    // predict score (machine learning)
    val vector = new DenseVector(updatedCarPark.featureVectorArray)
    val score = model.predict(vector)

    // update feature set and score
    val scoredCarPark = updatedCarPark.setScore(score)
    updateCarParkFeatures(updatedCarPark)
  }
))
```

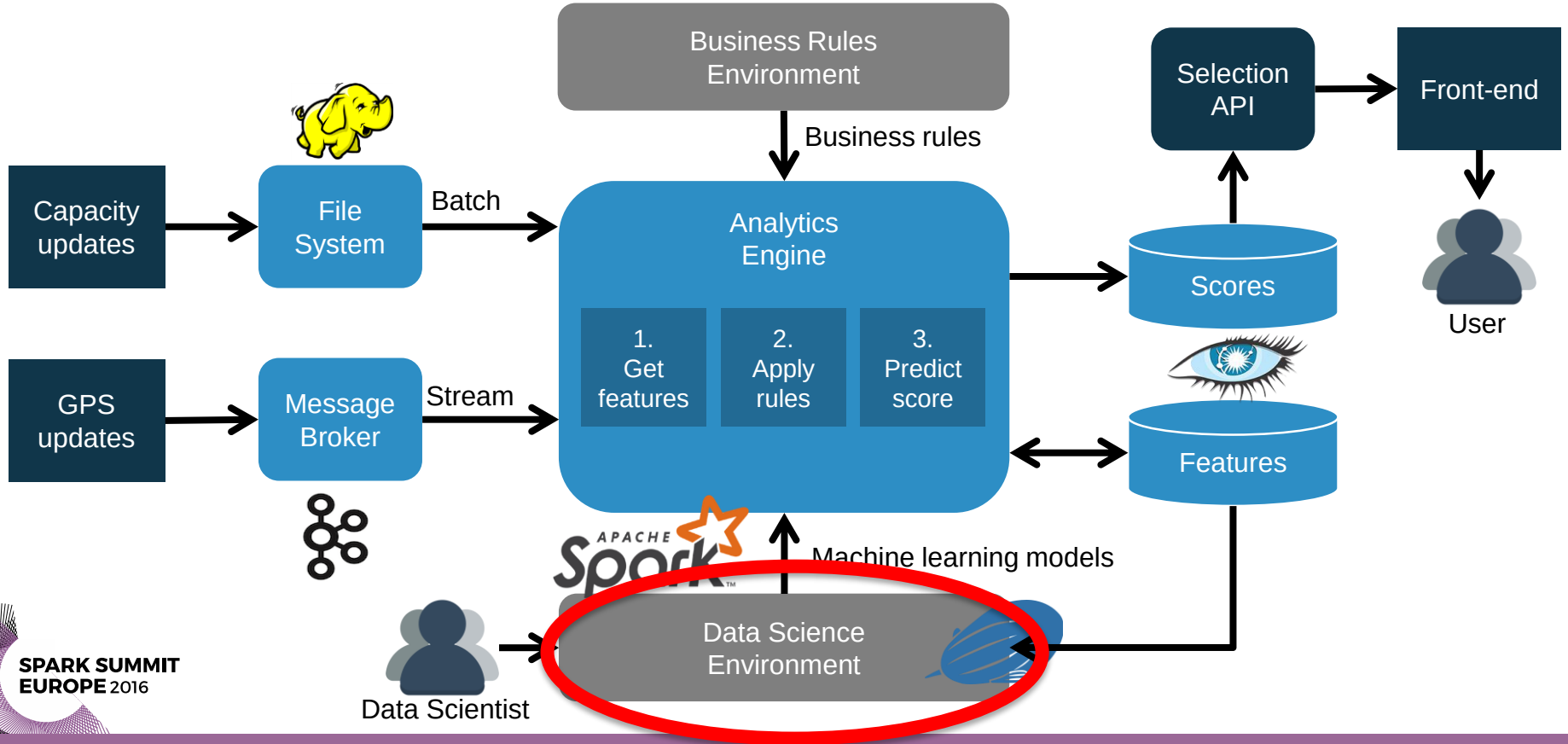
Lambda Architecture



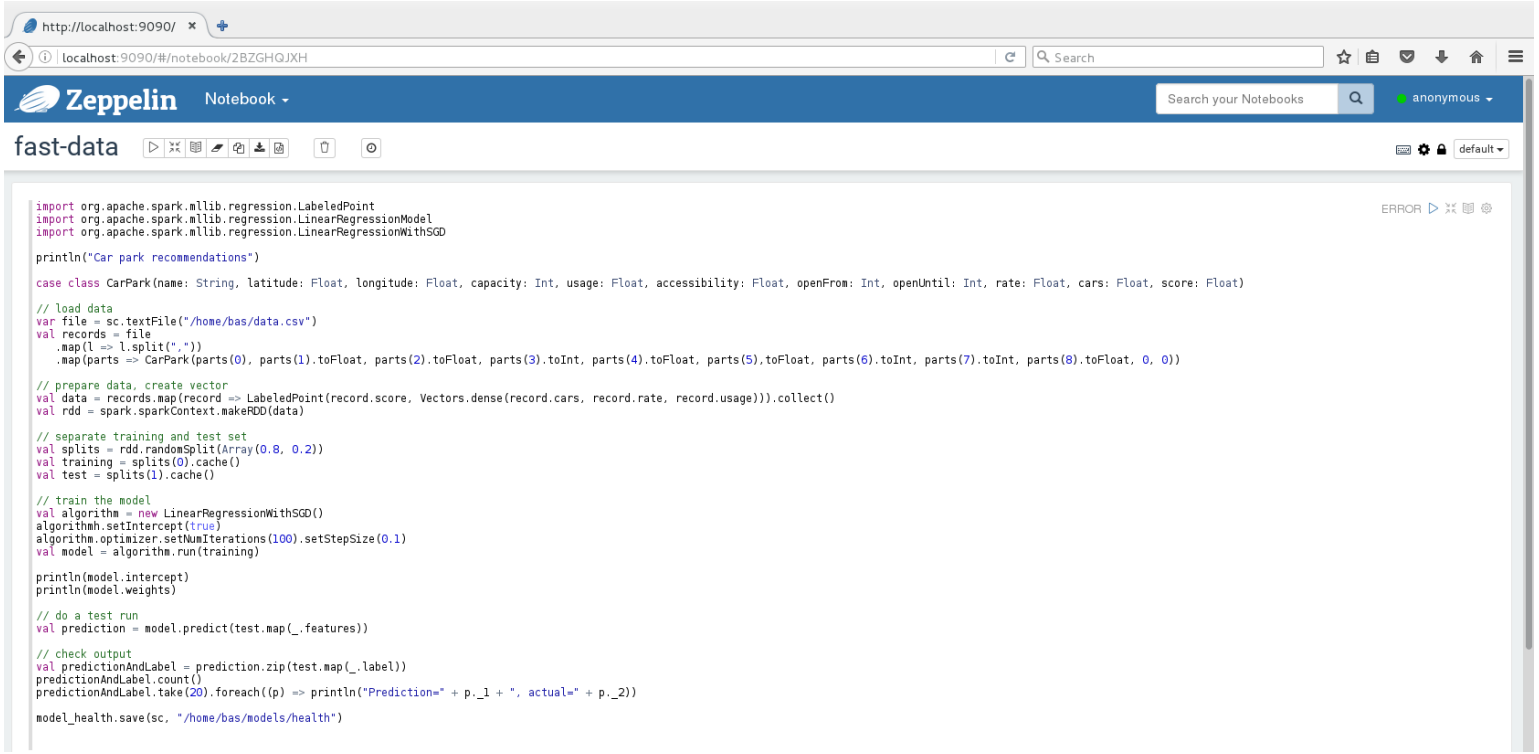
Batch Processing

```
// initialize Spark for batch processing
val spark = SparkSession.builder.appName("batch-data").master("local[*]")
  .getOrCreate()

// clean up (remove car data older than 60 seconds)
CassandraHelper.removeOldCarLocations(60)

// get car park data
val textFile = spark.sparkContext.textFile("hdfs://data/latest.csv")

// iterate over all car parks in the data set
textFile.map(line => CarParkHelper.createCarPark(line)).map{cp =>
  // get recent set of car data (running average)
  val carsInNeighborhood = DensityCalculator.calculateDensity(cp, getCarsInNeighborhood(cp))
  val updatedCarPark = cp.setCarsInNeighborhood(carsInNeighborhood)

  // predict score (machine learning)
  val vector = new DenseVector(updatedCarPark.featureVectorArray)
  val score = model.predict(vector)

  // update feature set and score
  val scoredCarPark = updatedCarPark.setScore(score)
  updateCarParkFeatures(updatedCarPark)
}
```

Lambda Architecture



Data Science with Zeppelin



Summary

- The IoT requires new architecture principles: in-memory, distributed, reactive and scalable are the new normal
- Lambda/Kappa/Omega reference architectures are designed for combining batch and streaming data flows
- Open source tooling such as Kafka, Cassandra, and Spark adhere to these principles and design patterns


SPARK SUMMIT
EUROPE 2016
#SparkSummit
THANK YOU!
ING is hiring ☺