IT UNIVERSITY OF COPENHAGEN

Big Data Management
Data Streaming

Björn Þór Jónsson

Outline

Lecture Hours (14-16)

- Streaming Layer
  - Requirements
  - Event Queues
  - Streaming Systems
  - Revisit Kappa Architecture
- Practical Concerns
  - Cluster & Project 3
  - Course Evaluation
  - Exam

Exercise Hours (16-18)

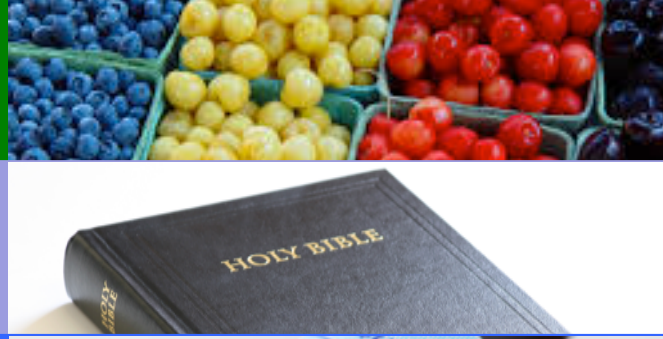
- Do one or more of:
  - Work on Project 3
  - Look at Exam
  - Play with Flink

The Three “V”s

Volume

Velocity

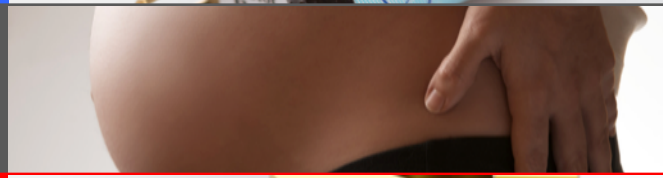
Variety



Veracity

Validity

Viability



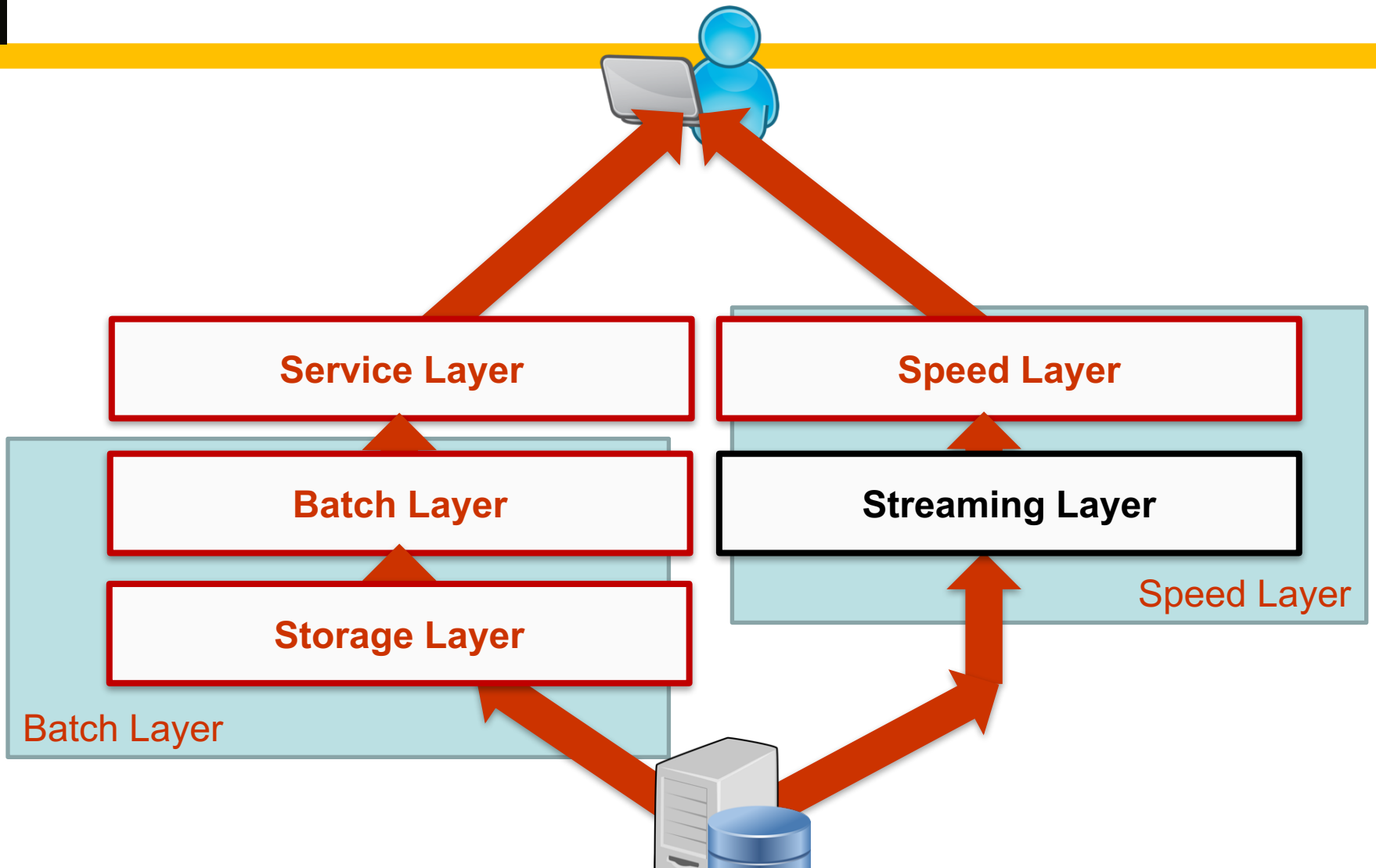
Value

Velocity ?= Real-Time

- Projects = Batch Layer + Analytics
  - What are related real-time applications?
- Other domains?

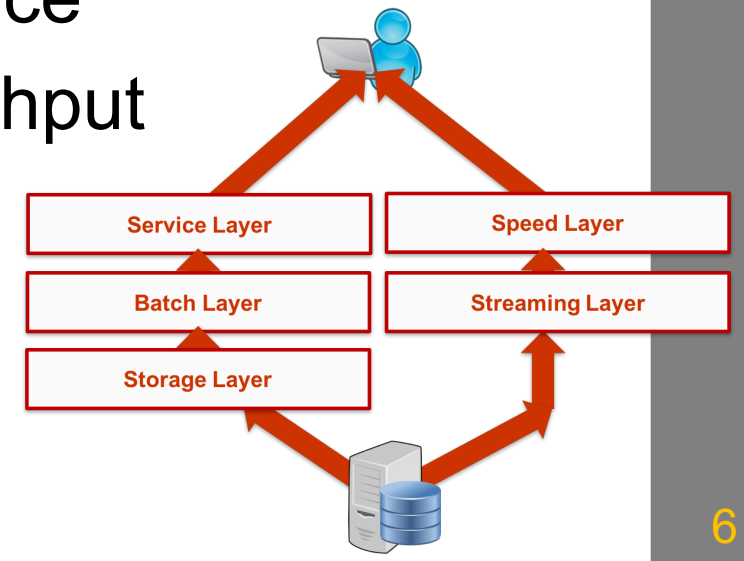
http://ieeexplore.ieee.org/document/7881376/

Framework
Lambda Architecture



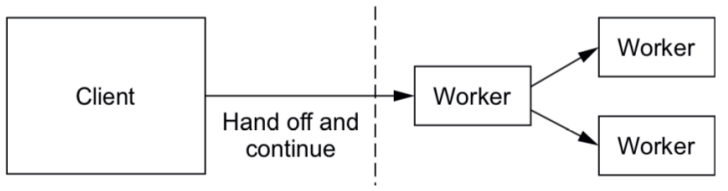
Streaming Layer

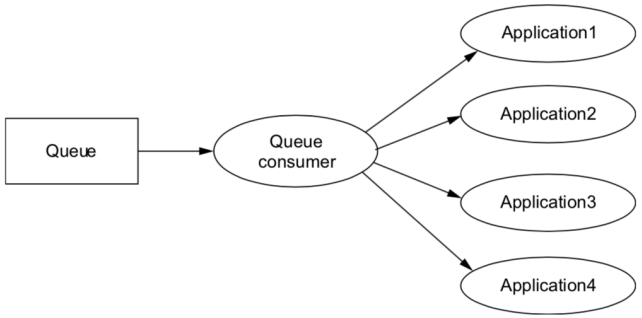
- Input: Stream of input records
- Output: Updates to Speed Layer views
- Conflicting Requirements:
  - Scaling out vs Fault tolerance
  - Low latency vs High throughput
- Most difficult part of Lambda Architecture

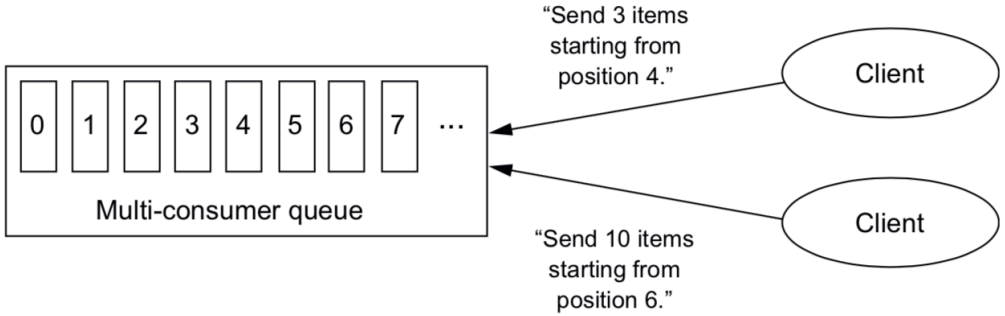


Delivering Data

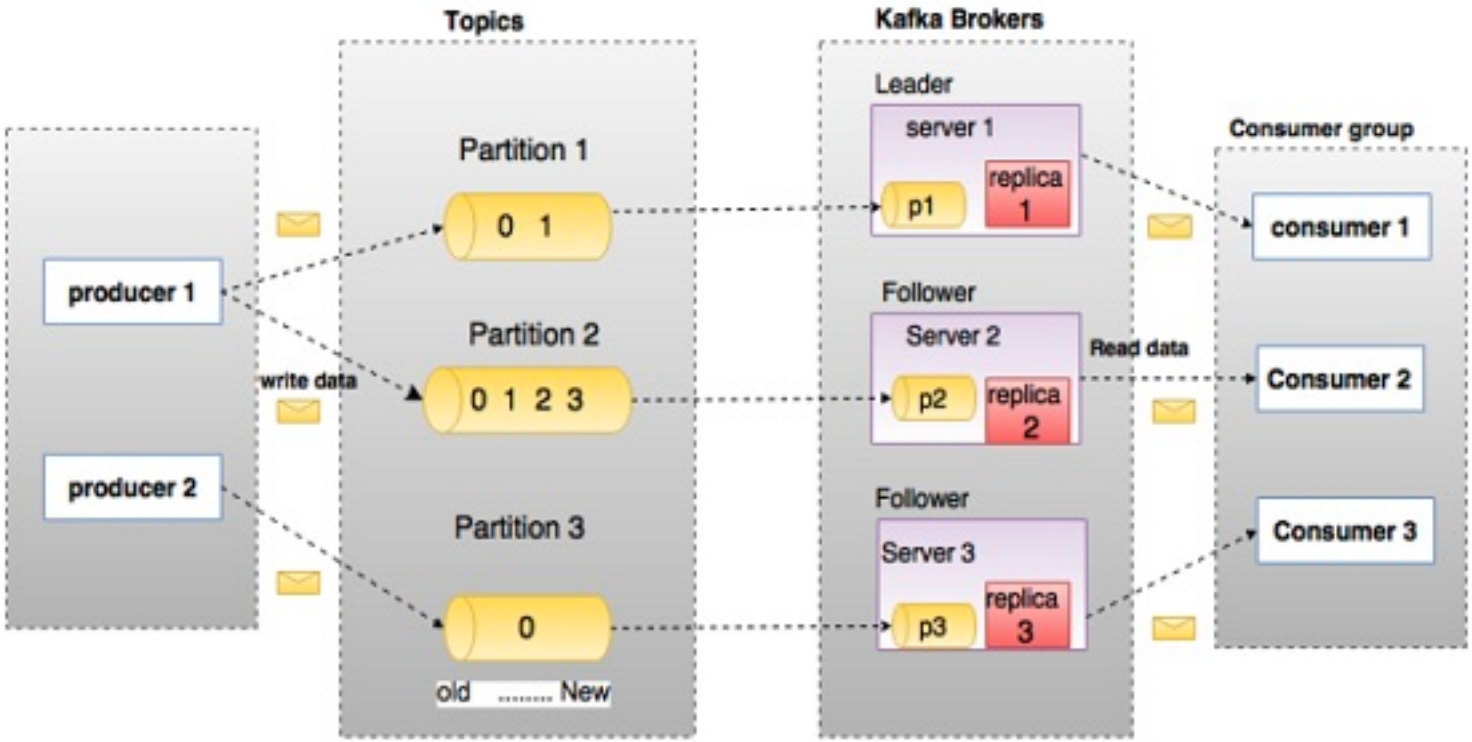
- No queue:
  Direct handoff, no control
- Single consumer:
  Complex management
- Multiple consumers:
  Separation of concerns





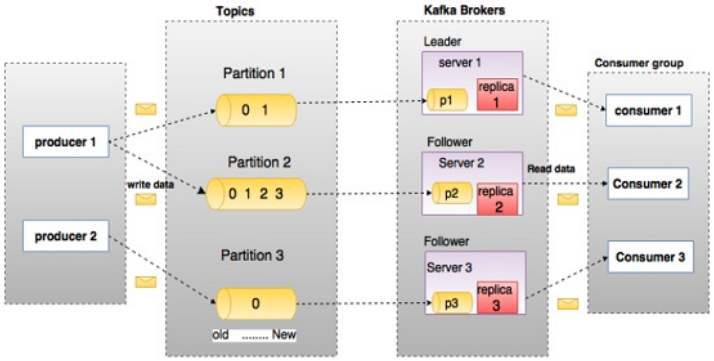


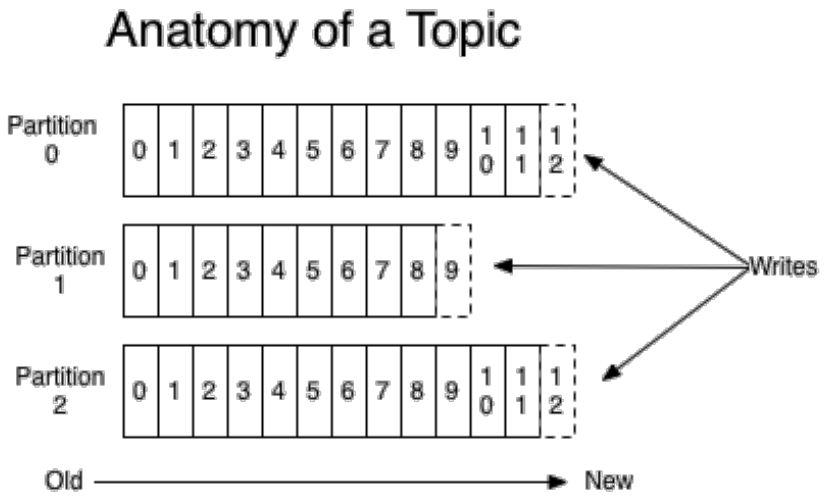
Kafka

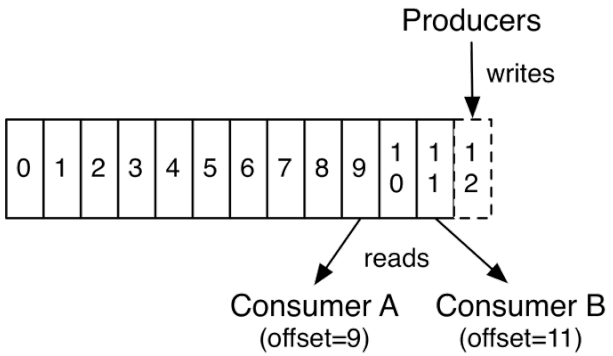


https://www.tutorialspoint.com/apache_kafka/apache_kafka_fundamentals.htm

Kafka

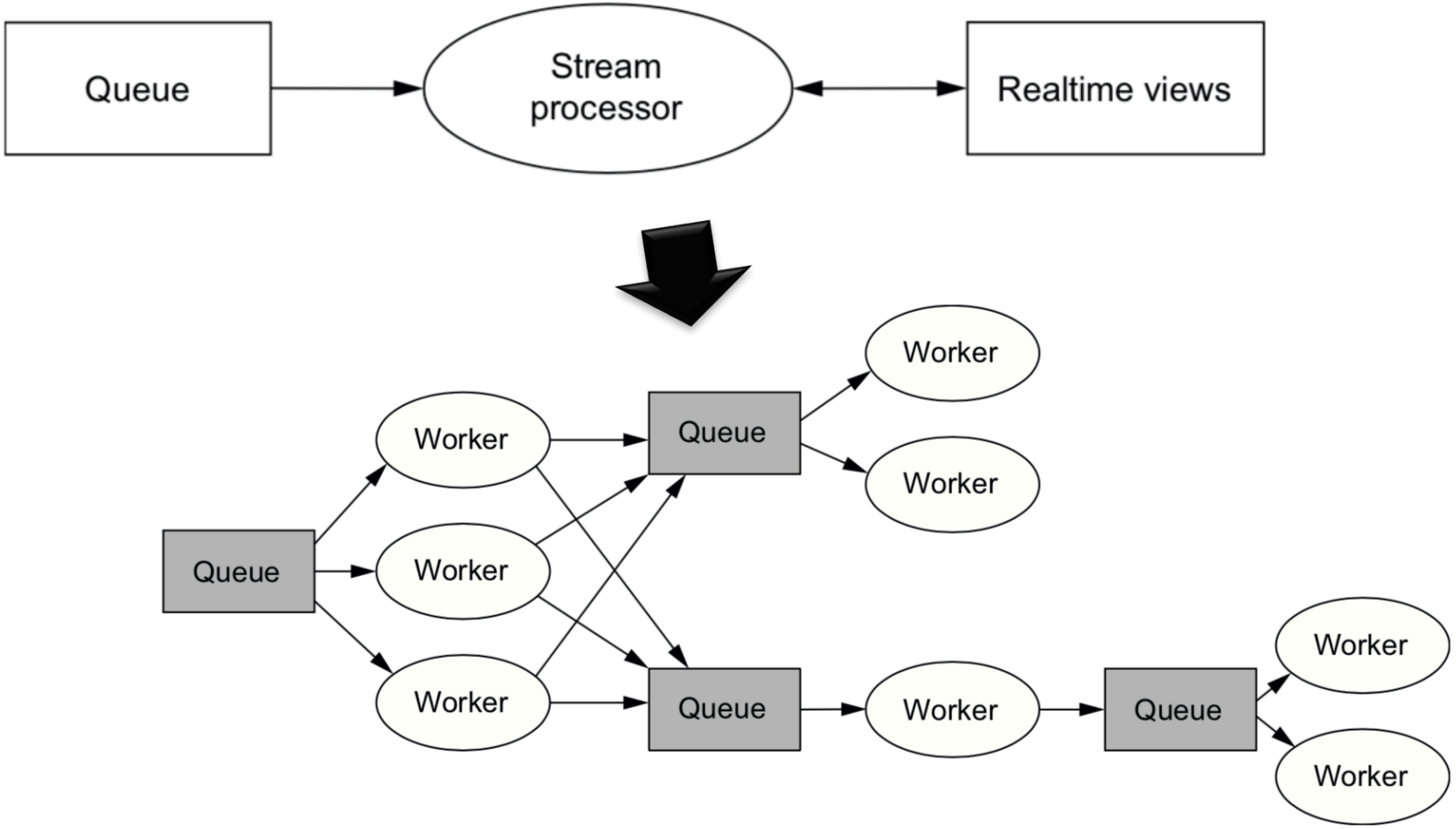




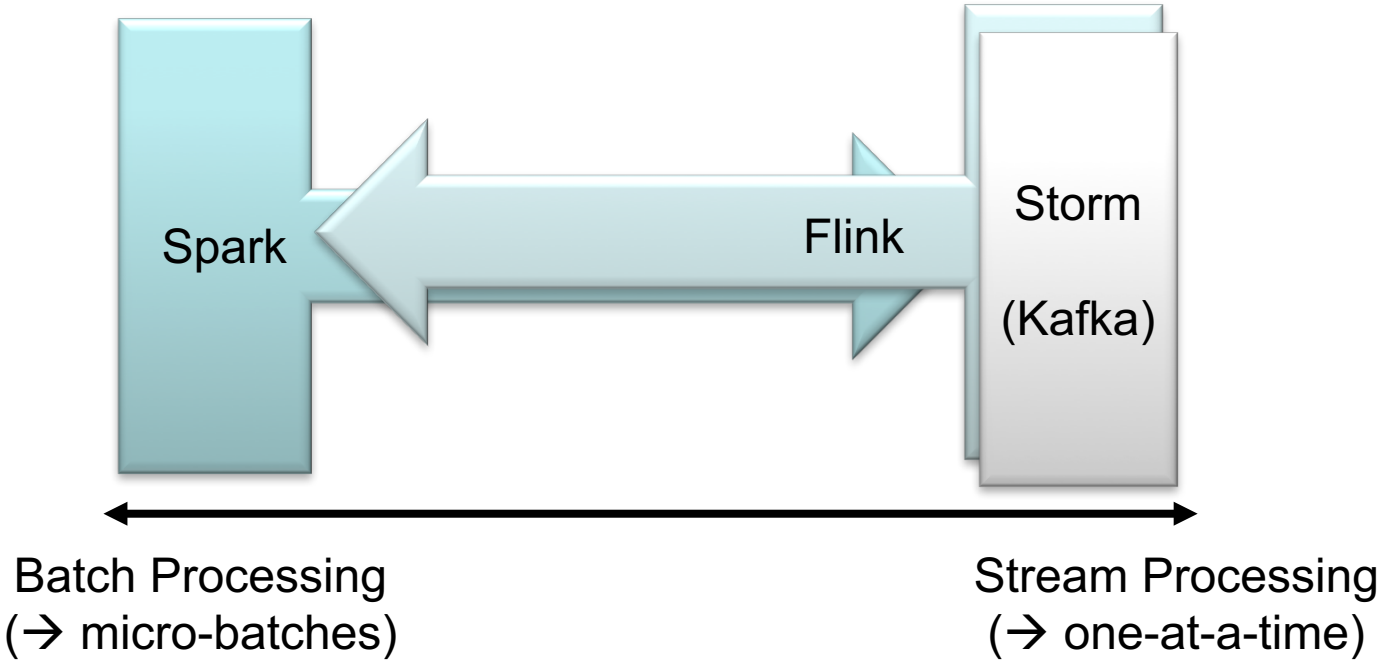


https://kafka.apache.org/intro

Stream Processing



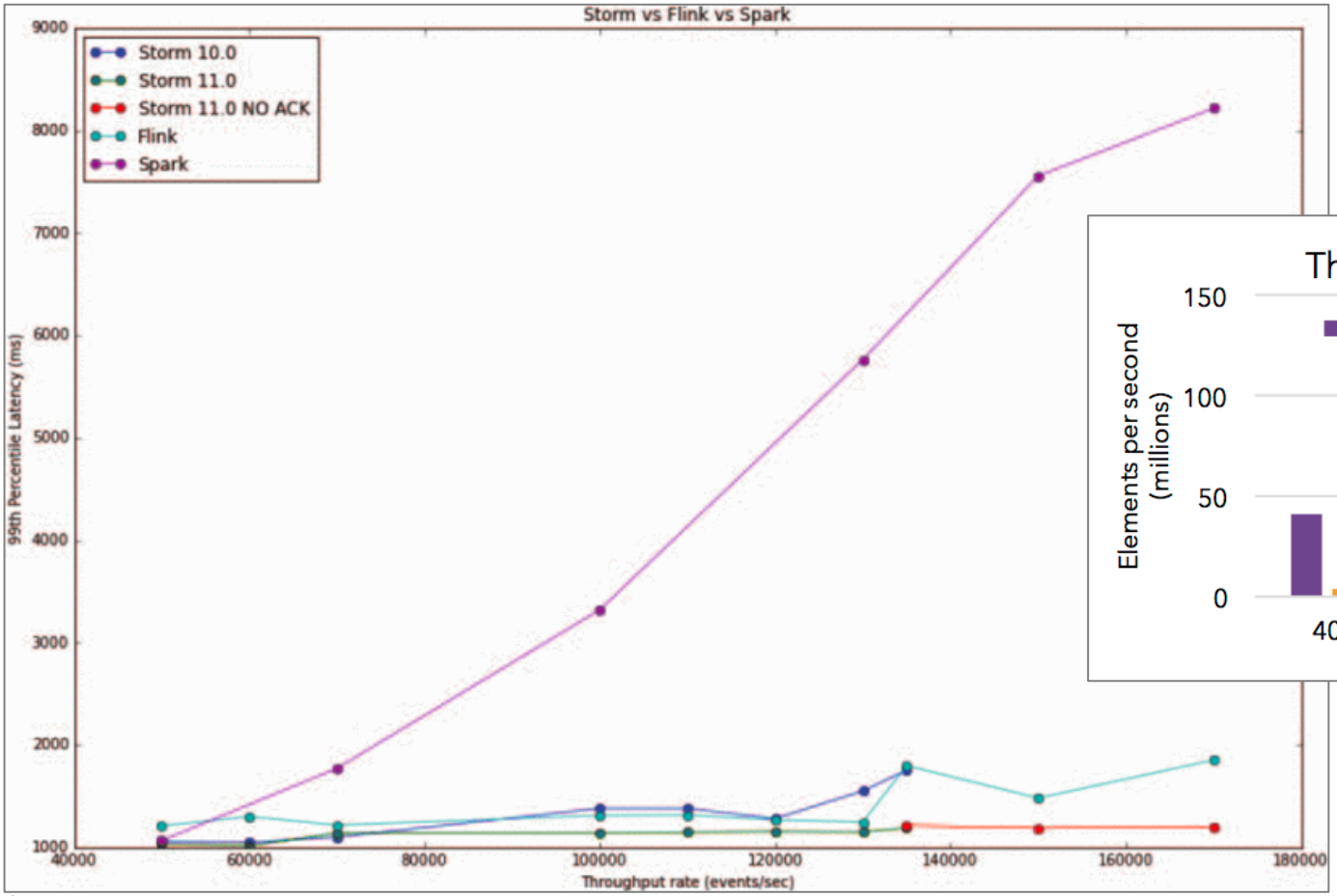
Stream Processing Paradigms

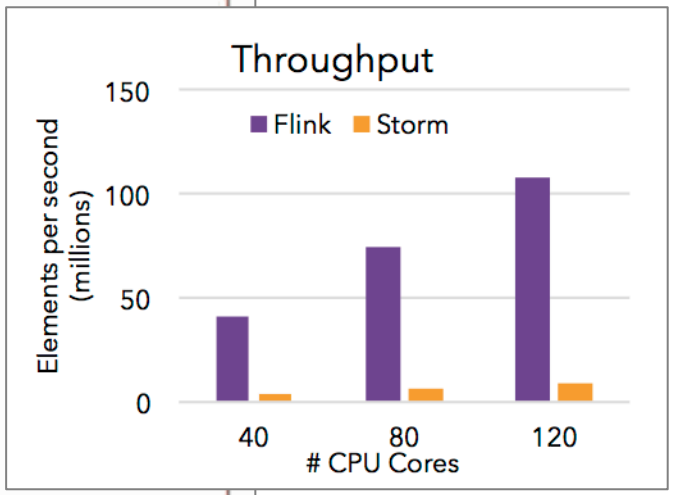


Comparison

	One-at-a-time	Micro-batched
Lower latency	✓	
Higher throughput		✓
At-least-once semantics	✓	✓
Exactly-once semantics	In some cases	✓
Simpler programming model	✓	

Latency over Throughput



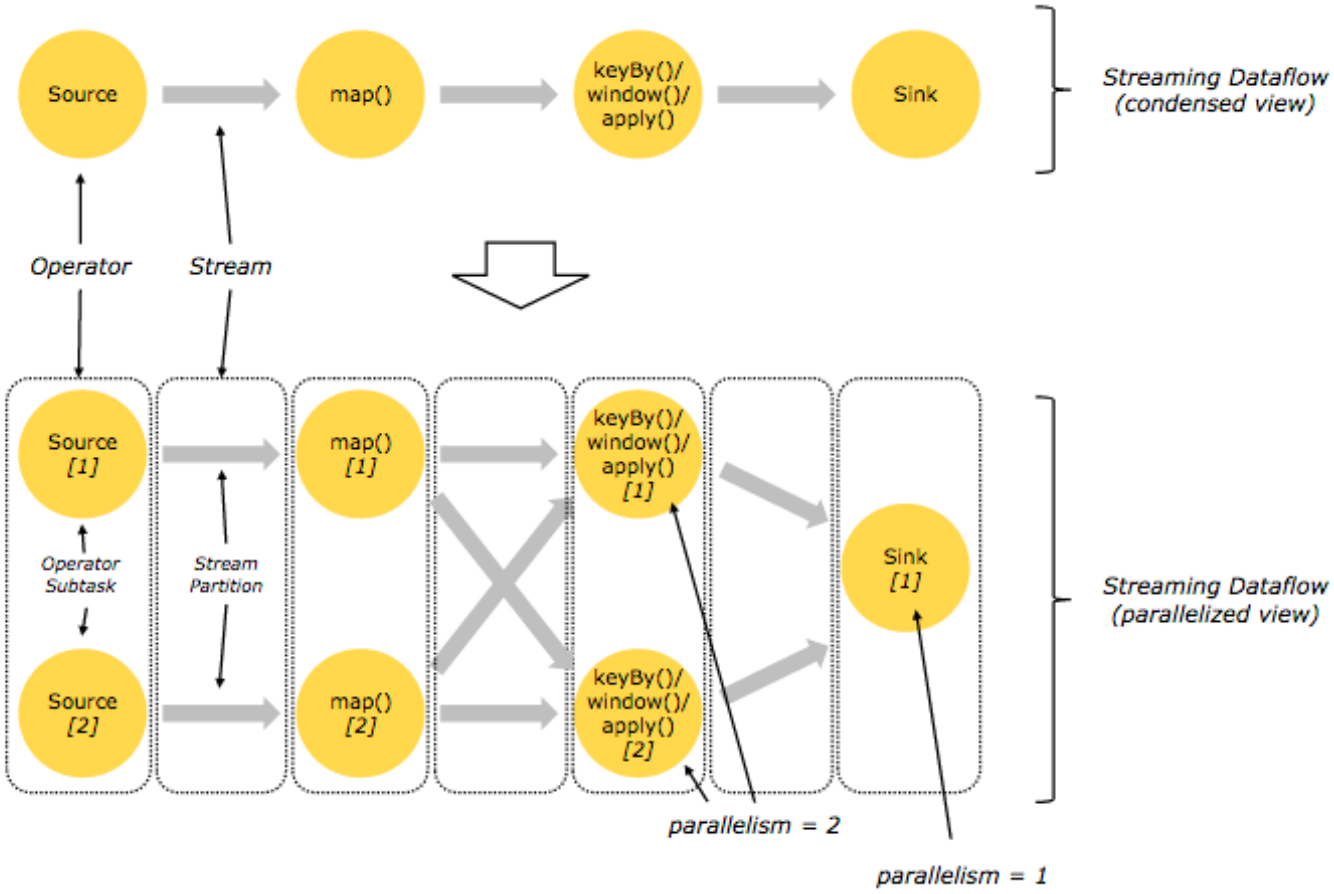


Simple pipeline
http://ieeexplore.ieee.org/document/7530084/

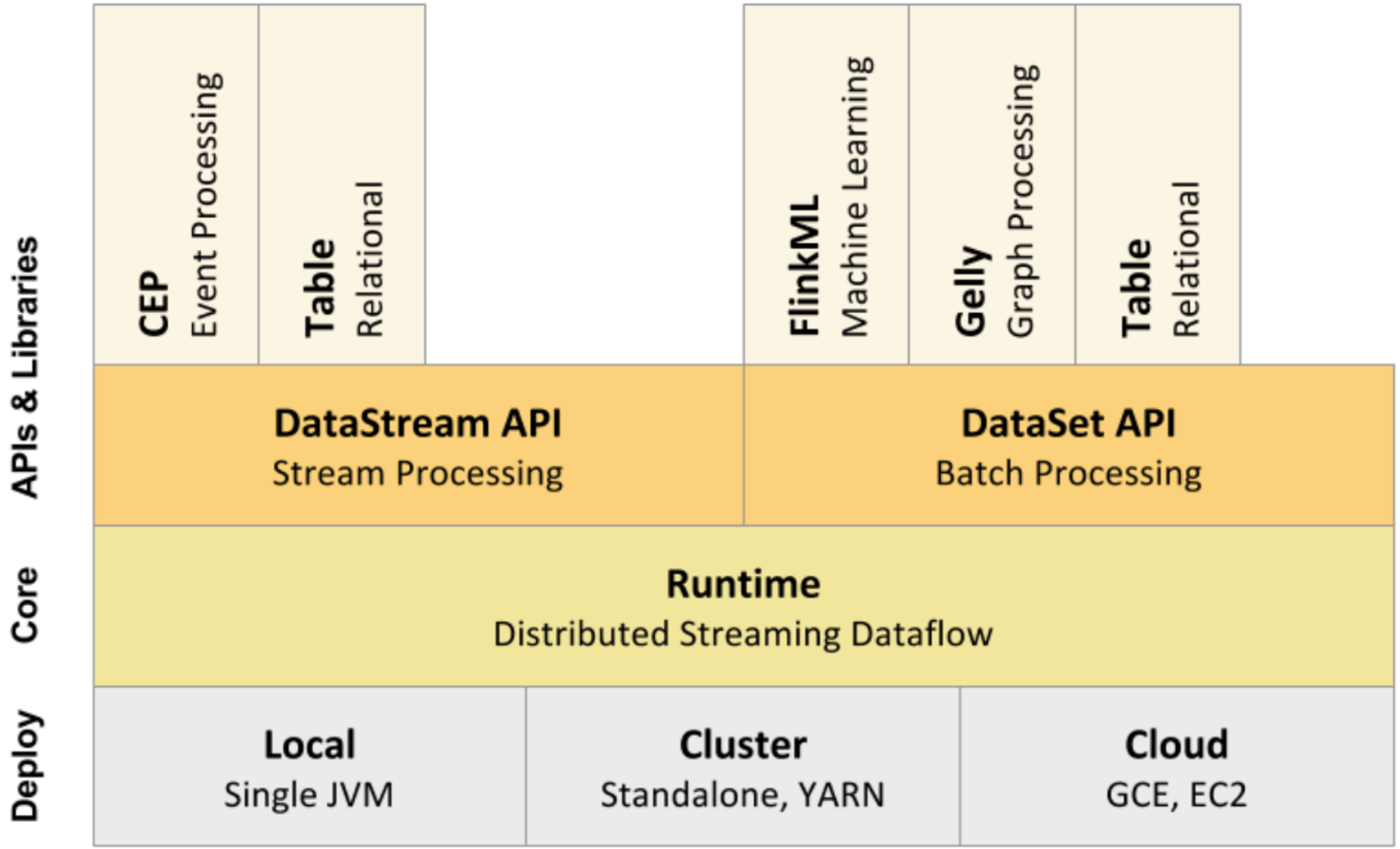
Shuffling pipeline
https://flink.apache.org/introduction.html

Flink


Flink


Source
map()
keyBy()/
window()/
apply()
Sink
Streaming Dataflow
(condensed view)
Operator
Stream
Source
[1]
Source
[2]
Operator
Subtask
Stream
Partition
map()
[1]
map()
[2]
keyBy()/
window()/
apply()
[1]
keyBy()/
window()/
apply()
[2]
Sink
[1]
Streaming Dataflow
(parallelized view)
parallelism = 2
parallelism = 1

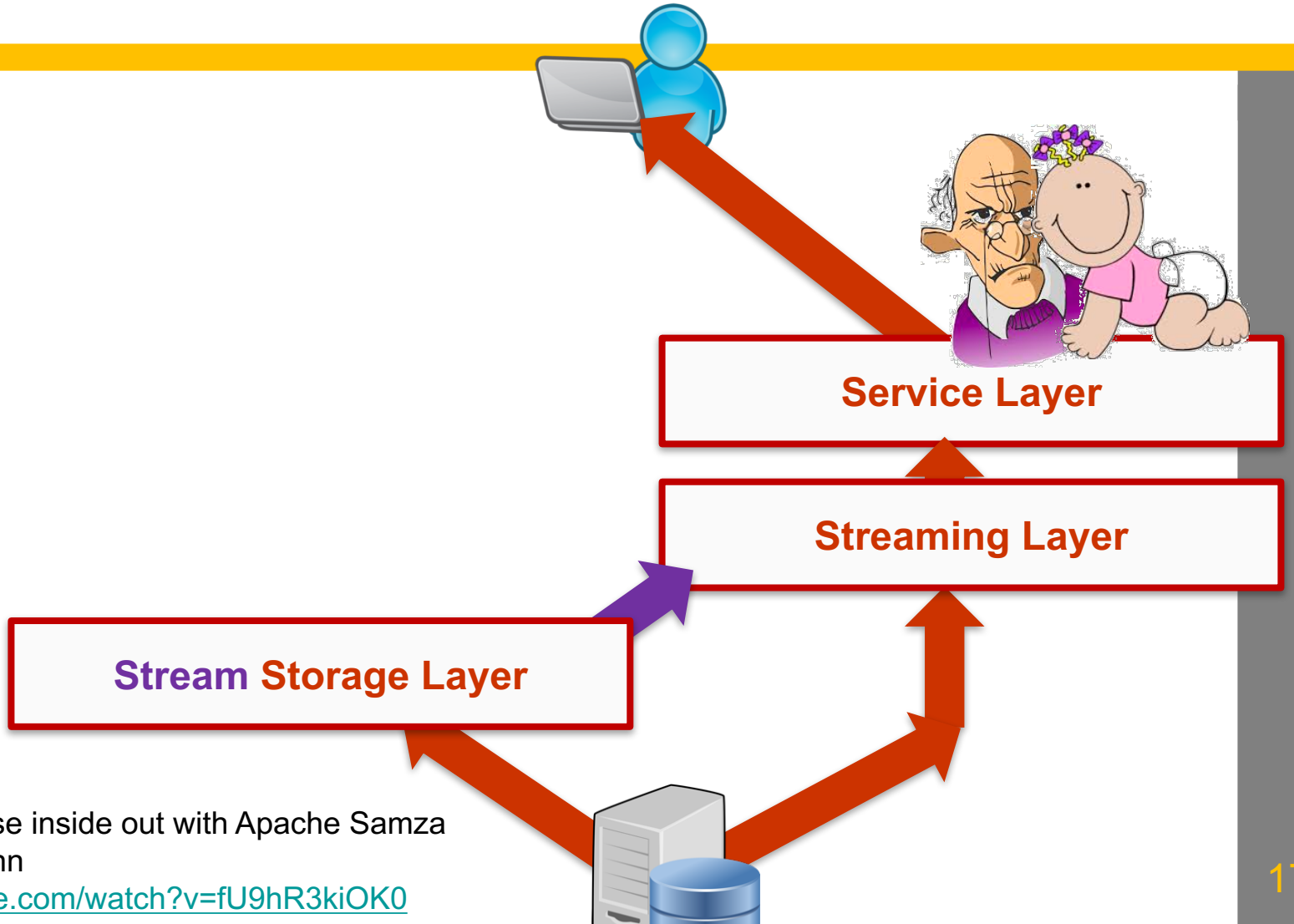
Flink Ecosystem



Small Demo: Streaming Word Count

- https://ci.apache.org/projects/flink/flink-docs-release-1.3/quickstart/setup_quickstart.html
  - Finding the right directory to be in was tricky
  - On my Mac (Flink installed using Homebrew):
    - `cd /usr/local/Cellar/apache-flink/1.3.2/libexec`

Kappa Architecture Revisited



Turning the database inside out with Apache Samza
by Martin Kleppmann
https://www.youtube.com/watch?v=fU9hR3kiOK0

Take Away Points

- Streaming Layer
  - Input: Stream of input records
  - Output: Updates to Speed Layer views
  - Conflicting goals:
    - Scaling out vs. Fault tolerance
    - Latency vs. Throughput
- Spark Streaming, Flink, Storm, Kafka, …
  - Storm + Flink towards Kappa architecture

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- Practical concerns
  - Cluster & Project 3
  - Course Evaluation
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Exercise Hours (16-18)

- Do one or more of:
  - Play with Flink
  - Work on Project 2
  - Look at exam…

Cluster & Project 3

- New cluster: hq.itu.dk (thanks to Sebastian!)
- Configured (thanks to Omar!)
  - Original password – ssh keys were lost!
    - Please set up again…
  - Memory for ~4 concurrent (full) pipelines
    - Hopefully sufficient due to staggered executions
    - Don't start late!
  - Project 3 data files are available in HDFS under the /sumo-data/ directory
    - `hdfs dfs -ls /sumo-data/`

Cluster & Project 3

- spark-shell / spark-submit:
  - include SPARK_MAJOR_VERSION=2
  - to use cluster add option: --master yarn
- hive:
  - alias for 'hive -hiveconf hive.execution.engine=mr'.

Course Evaluation

Count	Suggestion Category
14	Disjoint between theory and practice, exercises are unfocused / too much installation work, tools different from book
9	Problems with integration with critical course (also 4 positive mentions)
2	Overlap with SoWS
2	Practice exam not provided
2	Piazza
1	Cluster
1	Assignment 1 not useful

Exam

- Available on LearnIT “now”
- Deadline on December 20
  - Directions on LearnIT!

Exam Outline

This exam assignment is a written work based on a) the learning outcomes of the course and b) the three projects given throughout the semester. You should submit this written work individually. You can reuse work that was done as a group on these three projects, but *the text of the written work must be your own*.

This exam is composed of four questions. Your answers should be insightful, clear and concise. The document should be in a question-answer format, and must fit within (maximum) 10 normal pages. The written work must be submitted via LearnIT, where you will find all instructions related to submission. The deadline is managed by study administration, and cannot be changed in any way.

Course Outline

Calendar Week	Calendar Date	Course Week	Reading Materials	Lecture Topics	Exercise Topics
35	29.08	1	Papers	TECH: Relational model; DB systems; Big data motivation	
36	05.09	2	Papers	CRIT: Raw vs cooked data; Data valence; Personal data; Data walk	CRIT: Data walk
37	12.09	3	Papers	CRIT: Social aspects; Immutability and certainty; Perils of interpretation and bias	CRIT: Bias Project 1
38	19.09	4	Ch 1-3	TECH: Lambda Architecture: Overview; Layers and roles; Data properties	TECH: Intro to Spark Shell
39	26.09	5	M&W: Ch 4-5	Batch Layer: Storage; High volume; DHT	Project 1
40	03.10	6	Papers	Intro to data cleaning CRIT: Andrew Clement guest lecture	Project 2
41	10.10	7	M&W: Ch 6-9	Batch Layer: Batch processing; Spark	Spark; HDFS; Cluster
42					
43	24.10	8	M&W: Ch 10-13	Serving/Speed Layer: NoSQL; CAP theorem	Drill
44	31.10	9	M&W: Ch 18 + Papers: TBA	Data pipeline management; Metadata	Project 2
45	07.11	10	Papers	Data quality exercise	Project 3
46	14.11	11			
47	21.11	12	M&W: Ch 14-17	Speed Layer: Data streaming	Streaming / Project / Exam
48	28.11	13			Project 3
49	05.12	14			Portfolio Work
50	12.12	15			Portfolio Work
Exam report due 20.12					

No Class
Joint Class with DIM Students

Big Data Landscape

Vertical Apps

PREDICTIVE POLICING
bloomreach
MYRRIX

Log Data Apps

splunk> loggly sumologic

Ad/Media Apps

rocketfuel
collective[i]
bluefin
Recorded Future
LuckySort
Media Science
TURN
DataXu

Business Intelligence

ORACLE | Hyperion
SAP Business Objects RJMetrics
Microsoft | Business Intelligence
IBM COGNOS birst
MicroStrategy
Autonomy
bime
QlikView
Chart.io
GoodData

Analytics and Visualization

tableau
Palantir
OPERA
metaLayer
METAMARKETS
dataspora
centrifuge
TERADATA ASTER
SAS TIBCO
KARMASPHERE
panopticon
Real-Time Visual Data Analysis
pentaho
Datameer
platfora
ClearStory
CIRRO
alteryx
visual.ly
AYATA

Data As A Service

factual
kaggle
knoema
GNIP
DATASIFT
Windows Azure Marketplace
INRIX
LexisNexis
LOQATE

Analytics Infrastructure

Hortonworks
VERTICA
MAPR
cloudera
INFOBRIGHT
ParAccel
EMC²
GREENPLUM
NETEZZA
kognitio
DATASTAX
EXASOL
calpont

Operational Infrastructure

CouchBase
10gen
TERADATA
HADAPT
TERRACOTTA
VoltDB
MarkLogic
INFORMATICA

Infrastructure As A Service

amazon web services
Windows Azure
infochimps
Google BigQuery

Structured Databases

ORACLE
MySQL
Microsoft SQL Server
PostgreSQL
IBM DB2
SYBASE
memsql

Technologies

hadoop
hadoop MapReduce
mahout
APACHE HBASE
Cassandra

dave@vcdave.com
blogs.forbes.com/davefeinleib

THE BIG DATA LANDSCAPE

JANUARY 2014

Apps

Vertical

knewton, ellucian, practice fusion, SurveyMonkey, Predictive Policing

Operational Intelligence

splunk>, New Relic, AppDynamics, sumologic, VITRIA

Data As A Service

factual, FICO, kaggle, INRIX, GNIP, apigee, Placed, LOGATE, DATASIFT, TOPSY, LexisNexis

Consumer

Google, amazon, @WalmartLabs, ebay, NETFLIX

Ad/Media

METAMARKETS, collective[i], rocketfuel, FLURRY, collective, DataXu, Media Science, TURN, bloomreach

Business Intelligence

ORACLE | Hyperion, SAP, Business Objects, BJMetrics, Microsoft | Business Intelligence, NGDATA, IBM, JASPERSOFT, birst, MicroStrategy, pentaho, RECOMMIND, Autonomy, bime, Chart.io, GoodData, ATTIVIO, Recorded Future

Analytics and Visualization

tableau, QlikView, Palantir, OPERA, TRIFACTA, knoema, TERADATA ASTER, centrifuge, sas, TIBCO, panopticon, UFORA, Datameer, infoData, CIRRO, platfora, ClearStory, alteryx, visual.ly, AVATA, metaLayer, Atigeo, Alpine, SiSense

Infrastructure

Analytics

cloudera, Hortonworks, MAPR, Action, HADAPT, Pivotal, INFOBRIGHT, NETEZZA, VERTICA, EXASOL, kognitio, ENCORE

Operational

Couchbase, mongoDB, AEROSPIKE, splice machine, DATASTAX, TERRACOTTA, VoltDB, MarkLogic, INFORMATICA

As A Service

Qubole, amazon web services, Windows Azure, MORTAR, CSC, Google BigQuery

Structured DB

ORACLE, MySQL, SQL Server, PostgreSQL, IBM DB2, SYBASE, memsql, TERADATA

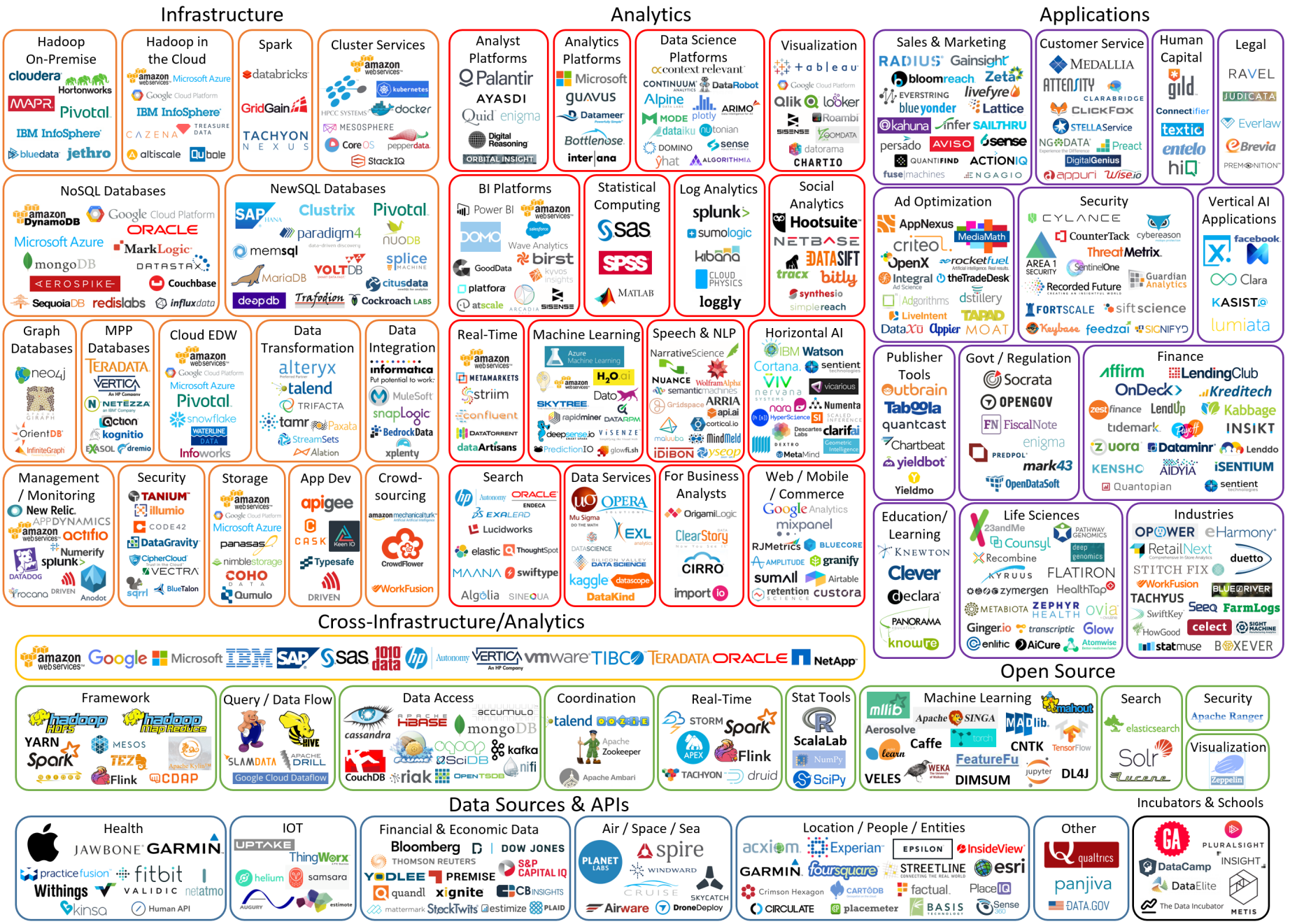
Technologies

hadoop, hadoop MapReduce, mahout, APACHE HBASE, Cassandra

dave@thebigdatagroup.com

bigdatalandscape.com

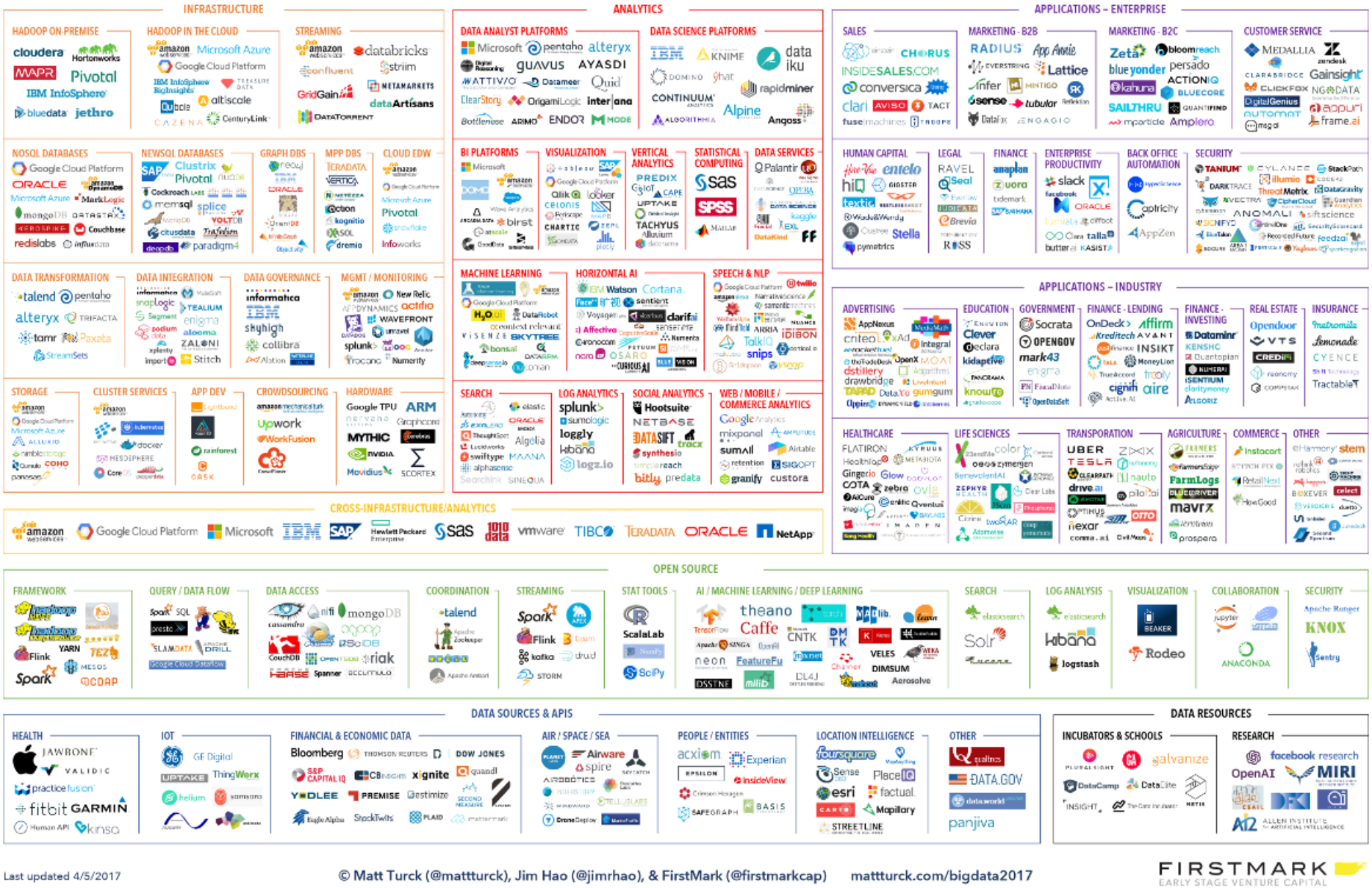
Big Data Landscape 2016 (Version 3.0)



Last Updated 3/23/2016

FIRSTMARK

BIG DATA LANDSCAPE 2017



mattturck.com/bigdata2017

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EARLY STAGE VENTURE CAPITAL