Foundations for Successful Data Projects

Strata Data Conference, San Francisco 2019

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About the presenters

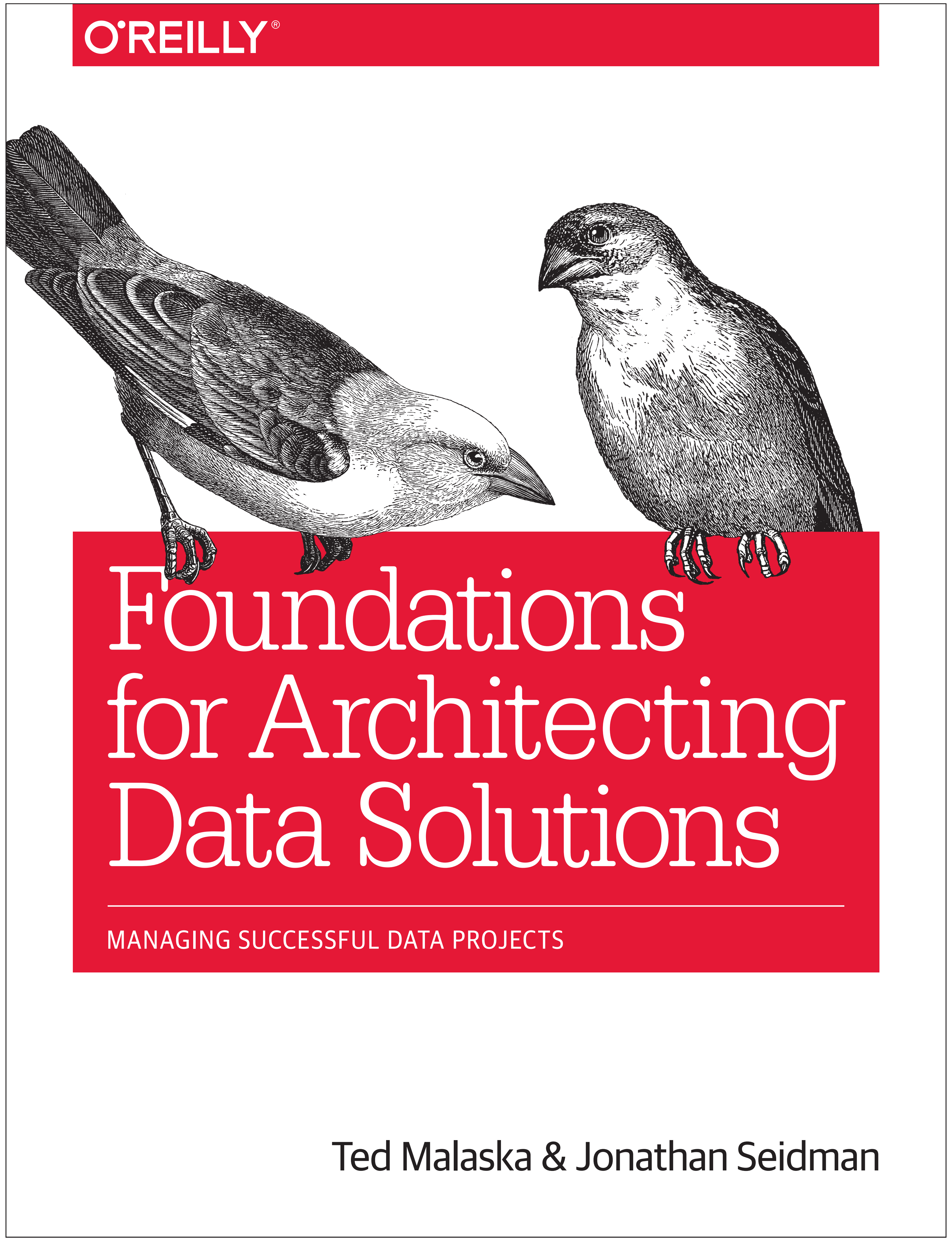
Ted Malaska

- **Capital One:** Director of Enterprise Architecture
- **Blizzard Ent:** Director of Engineering of Global Insights
- **Cloudera:** Principal Solution Architect
- **FINRA:** Lead Architect
- **Contributor:** Apache Spark, Hadoop, Hive, Sqoop, Yarn, Flume, others

About the presenters

Jonathan Seidman

- Software Engineer at Cloudera
- Previously Technical Lead on the big data team at Orbitz
- Co-founder of the Chicago Hadoop User Group and Chicago Big Data



O'REILLY®

Foundations for Architecting Data Solutions

MANAGING SUCCESSFUL DATA PROJECTS

Ted Malaska & Jonathan Seidman

Foundations of Successful Data Projects

Understand the problem

Select software

Manage risk

Build effective teams

Build maintainable architectures

Agenda

- Understanding the key data project types
- Selecting data management solutions
- Building effective teams
- Managing risk in projects
- Ensuring data integrity
- Metadata management
- Using abstractions

Understanding the Key Data Project Types

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Understanding the key data project types

- Major Data Project Types
- Primary Considerations & Risk Management
- Team Makeup

Major Data Project Types

- Data Pipelines and Data Staging
- Data Processing and Analysis
- Application Development

Data Pipelines and Data Staging

- Sourcing Data
- Transmitting Data
- Staging Data
- Accessibility Options
- Discovery

Data Processing and Analysis

- Curating Data
- Cultivating Ideas
- Data Product Generation
  - Reports, Models, Insight, Charts, ...

Application Development

- Traditional or Model Serving
- Inner Loop
- Outer Loop

Primary Considerations

- Data Pipelines and Data Staging
- Data Processing and Analysis
- Application Development

Primary Considerations

Data Pipelines and Data Staging

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Data Pipelines and Data Staging – Considerations

- On boarding paths for Data Suppliers
  - Files
  - Embedded code
  - APIs (Rest, WebSocket, GRPC, Syslog, ...)
  - Agents

Data Pipelines and Data Staging – Considerations

- Transmission
  - At Least Once, Duplication, Latency, and Ordering
- Tokenization & Auditing & Governance
  - GDPR, CA Protection Laws, Misuse, Data Breach
- Quality
  - Schema Validation, Rules Validation, Carnality Verance
- Access
  - Security, Matching the use case to the storage system

Data Pipelines and Data Staging – Considerations

- Meta Management
  - New and mutated Datasets
  - Security
- Access
  - Matching the use case to the storage system
  - SQL is King
  - No one tool
  - Trade Offs
    - Cost vs Time to Value vs Value of Data

Primary Considerations

Data Processing and Analysis

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Data Processing and Analysis – Considerations

- Curating Data
  - Working with Producers
  - Joining
  - Time series
  - CDC
- Undering Quality of Data
  - SLAs
  - Correctness of the Data
  - Stability of the Data
    - Coupling

Data Processing and Analysis – Considerations

- Cultivating Ideas
  - Defining Real Goals
  - Evaluating ROI
- Productionization of Pipelines
  - Service Reliability Engineering
- Culture
  - ML vs AI vs Engineer

Data Processing and Analysis – Considerations

- Understanding
  - Explainable Outcomes
  - Defendable Solutions
- Promotion Paths
  - Deploying Products
  - Historical Evaluation
  - Up to Date Auditing

Primary Considerations

Application Development

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Application Development – Considerations

- Availability and Failure
  - How will it fail
  - How will failure impact customers
  - What level of fail should be tested for
  - Levels of failure design
- State Locality and Consistency
  - What are the requirements
  - Speed, cost, or truth
  - Transactions and Locking

Application Development

- Latency and Throughput
  - Expectations and Throughput
  - Is it really big data?
  - Inner and Outer Looping
- Granularity of Deployments
  - Monolith single deployment
  - Monolith microservices
- Culture
  - Development Towers
  - Over the wall
  - Development Granularity

Team Makeup

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Team Makeup

- Data Pipelines and Data Staging
- Data Processing and Analysis
- Application Development

Data Pipelines and Data Staging – Team Makeup

- Data Engineers
- Site Reliability Engineers (SRE)
- Application Engineers
- Data Architects
- Governance
- Solution Engineers/Architects

Data Processing and Analysis – Team Makeup

- Visionaries
- The Brains
- Problem Seekers
- Engineers
- Duct Tapers
- Tech Debt Payers
- Site Reliability Engineers (SRE)

Application Development – Team Makeup

- Web Developers
- Front end Developers
- Data Engineers (DBAs)
- Performance Focused Engineers
- SOA / Queue Engineers
- Site Reliability Engineers (SRE)

Evaluating and Selecting Data Solutions

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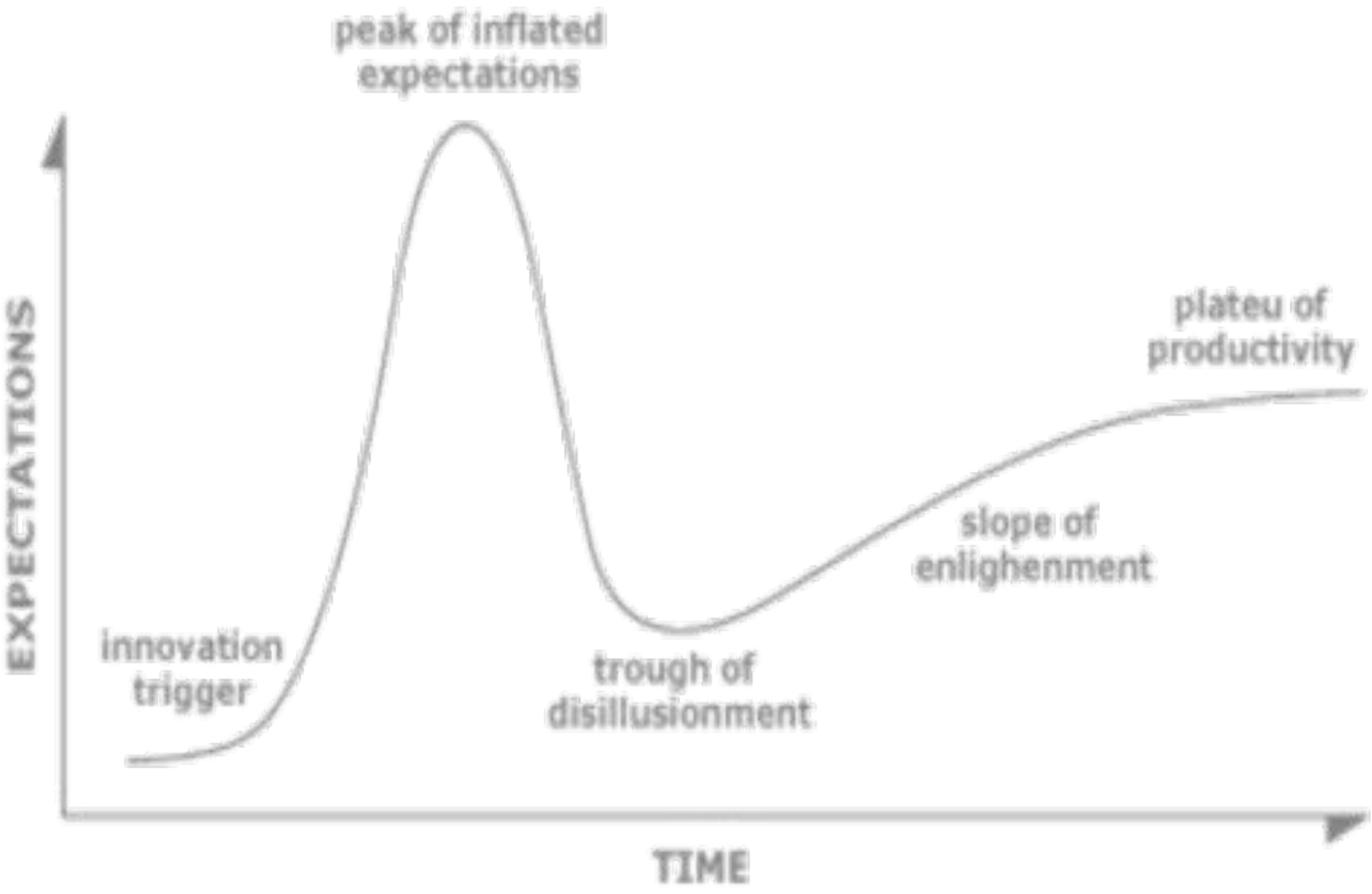
Evaluating and Selecting Data Solutions

- Solution Life Cycles
- Tipping Point Considerations
- Considerations for Technology Selection

Solution Life Cycles

- Private Incubation Stage
- Release Stage
- “Curing Cancer” Stage
- Broken Promises Stage
- Hardening Stage
- Enterprise Stage
- Decline and Slow Death Stage



Private Incubation Stage

- Technology Trigger
- Vision

Release Stage

- Changes
  - Inviting People In
  - Documentation
  - Marketing
- Reasons for Releasing
  - Money
  - Hiring
  - Culture
  - Future Building
- Big Promises

“Curing Cancer” Stage

- Big Promise
- Maybe outside area of expertise
  - Promise to push internally
  - Promises to gain influence
  - Promises to get attriations
- Promises can be good and bad

Broken Promises Stage

- Cracks in the Dream
  - Scale
  - Usability
  - Use Case
  - Security
  - Practicality
  - Skill Requirements
  - Auditability
  - Maintainability
  - Integration
  - Quality
  - Lies

Hardening

- Balance Features
- Technical Debt
- Partnering
- Corp Partnerships
- Leadership Stories
- Easy Success Paths

Enterprise Stage

- Stable
- Predictable
- Easy to hire for
- Supportable / Maintainable
- Pragmatists outnumber innovators
- No longer cool, but still very lucrative

Slow Decline Stage

- Not Worth Retiring
- Not worth Investing In
- Good Enough

Tipping Point Considerations

- Mavericks
- Connectors
- Salesman
- Stickiness
- Context

Mavericks

- Passion Driven
- Helpful
- Bottom Up Power
- They see the future or may see shadows

Connectors

- High triangles
- Trusted weak ties
- Gateways for pain, needs, and opportunities
- Considering the towered companies

Sales Man

- Make the Deal Happen
- Right or wrong doesn’t matter as much as action
- Momentum starters

Stickiness

- Think about gravity
  - Data
  - Code
  - User’s Favor
  - Results

Context

- Where is the company
- Looking for Opportunities
  - Holding down the fort
  - Lower cost
  - Play around
- The Swing Pendulum Effort
  - Where is the ball now and where is it heading

Tipping Point Considerations

- Mavericks
- Connectors
- Salesman
- Stickiness
- Context

Considerations for Technology Selection

- Demand
- Fit
- Visibility
- Risks

Evaluating the Demand

- Business Needs
- Internal Demand
- Desire to live on the edge

Evaluating the Fit

- Primary Capability
- Skill Sets
- Level of Commitments
- Level of Alignment

Evaluating the Visibility

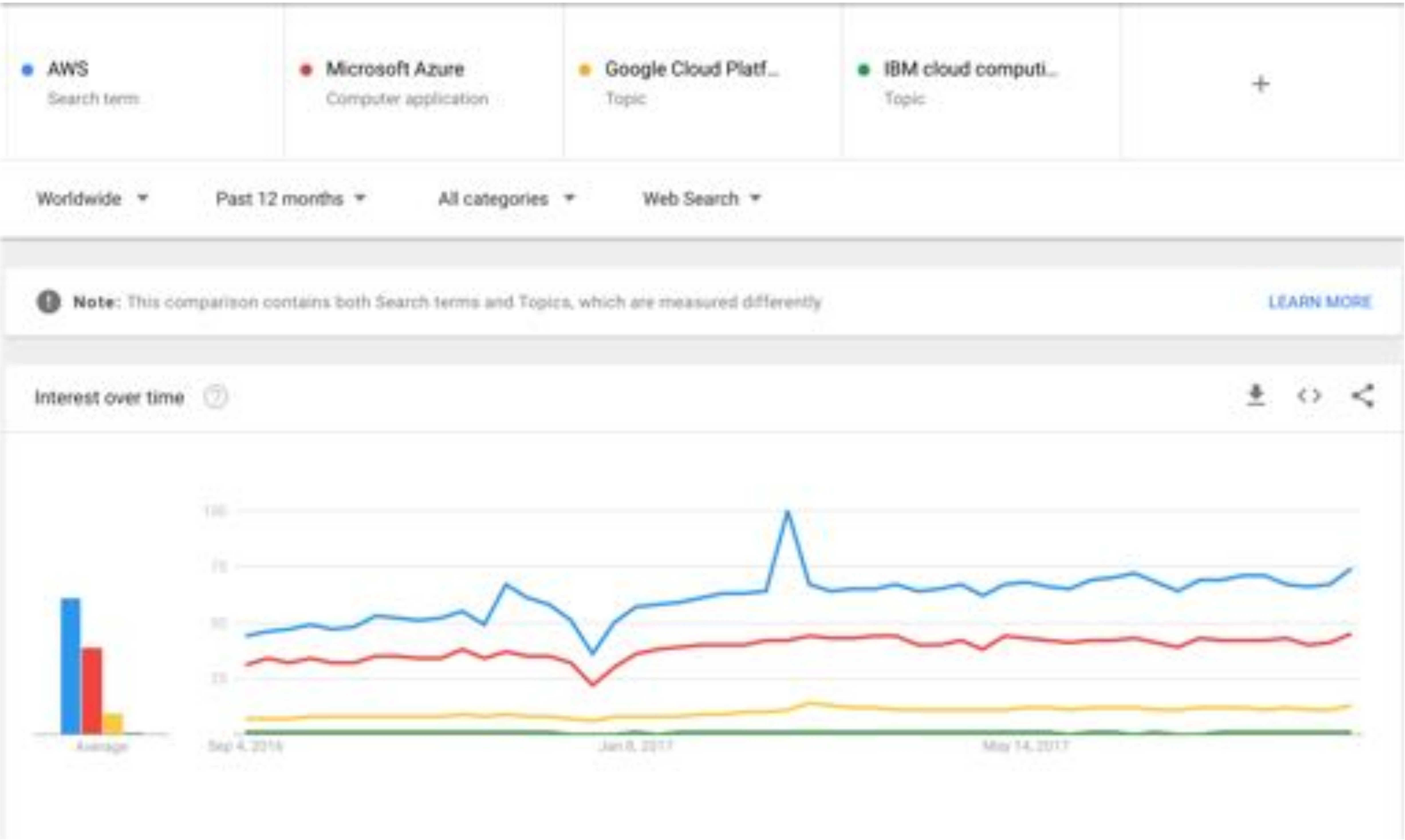
- Benchmarks
  - Hidden biases, Motivated Biases, Unfair Comparisons
- Fundamentals
  - There is no magic
- Leaders Success
- Market Trends

Reviewing Fundamentals

- Relative Location of Data to Readers
- Compression formats and rates
- Data Structures
- Partitioning, Replication, and Failure
- API and Interfaces
- Resource Allocations and Tuning

Reviewing Market Trends

Google Trends



● AWS
Search term

● Microsoft Azure
Computer application

● Google Cloud Platf...
Topic

● IBM cloud computi...
Topic

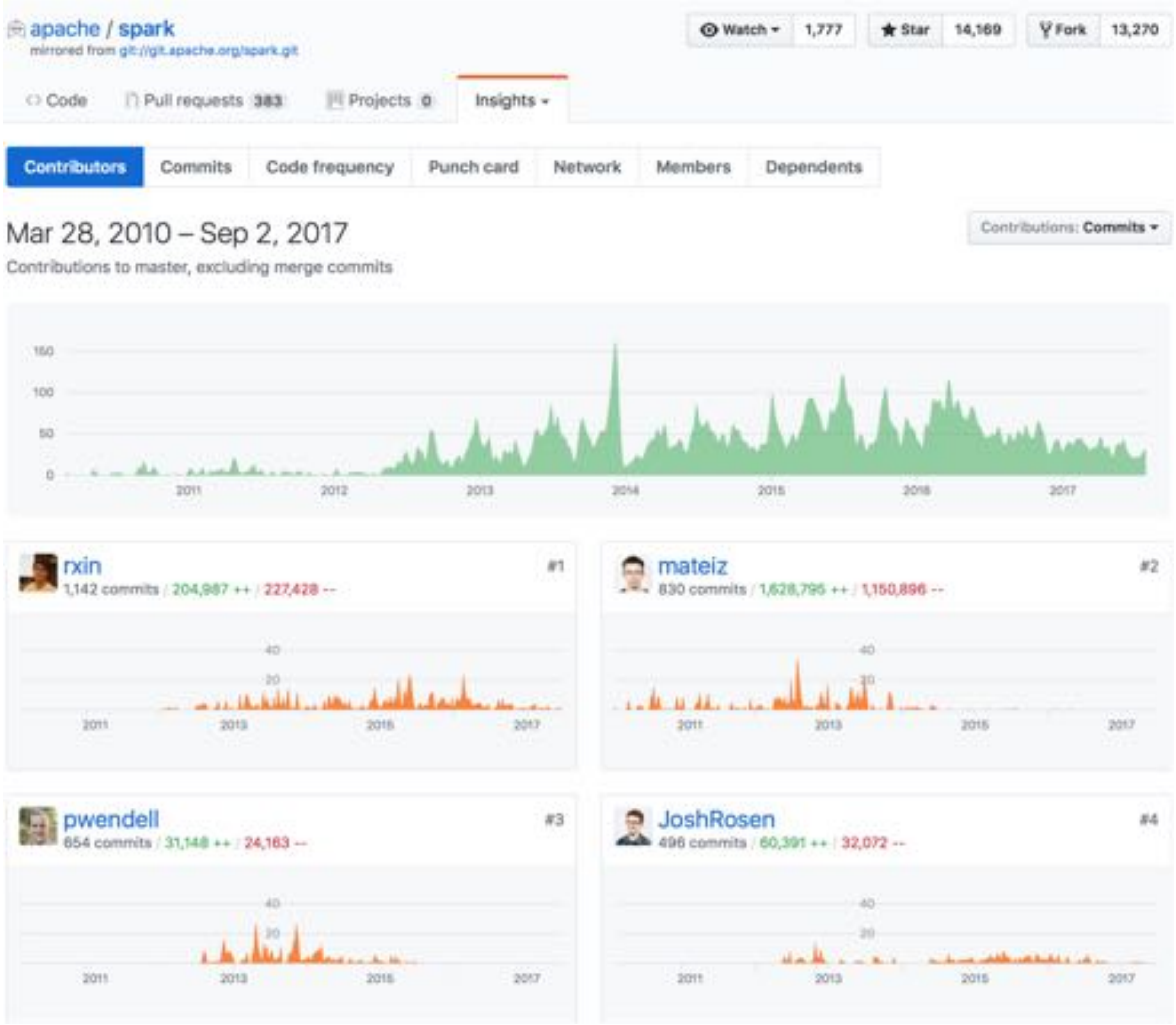
Worldwide ▾ Past 12 months ▾ All categories ▾ Web Search ▾

Note: This comparison contains both Search terms and Topics, which are measured differently

Interest over time

Reviewing Market Trends

Github activity



apache / spark
mirrored from git://git.apache.org/spark.git

Watch 1,777 | Star 14,169 | Fork 13,270

Code | Pull requests 383 | Projects 0 | Insights

Contributors | Commits | Code frequency | Punch card | Network | Members | Dependents

Mar 28, 2010 – Sep 2, 2017

Contributions to master, excluding merge commits

Contributions: Commits

rxin #1
1,142 commits / 204,987 ++ / 227,428 --

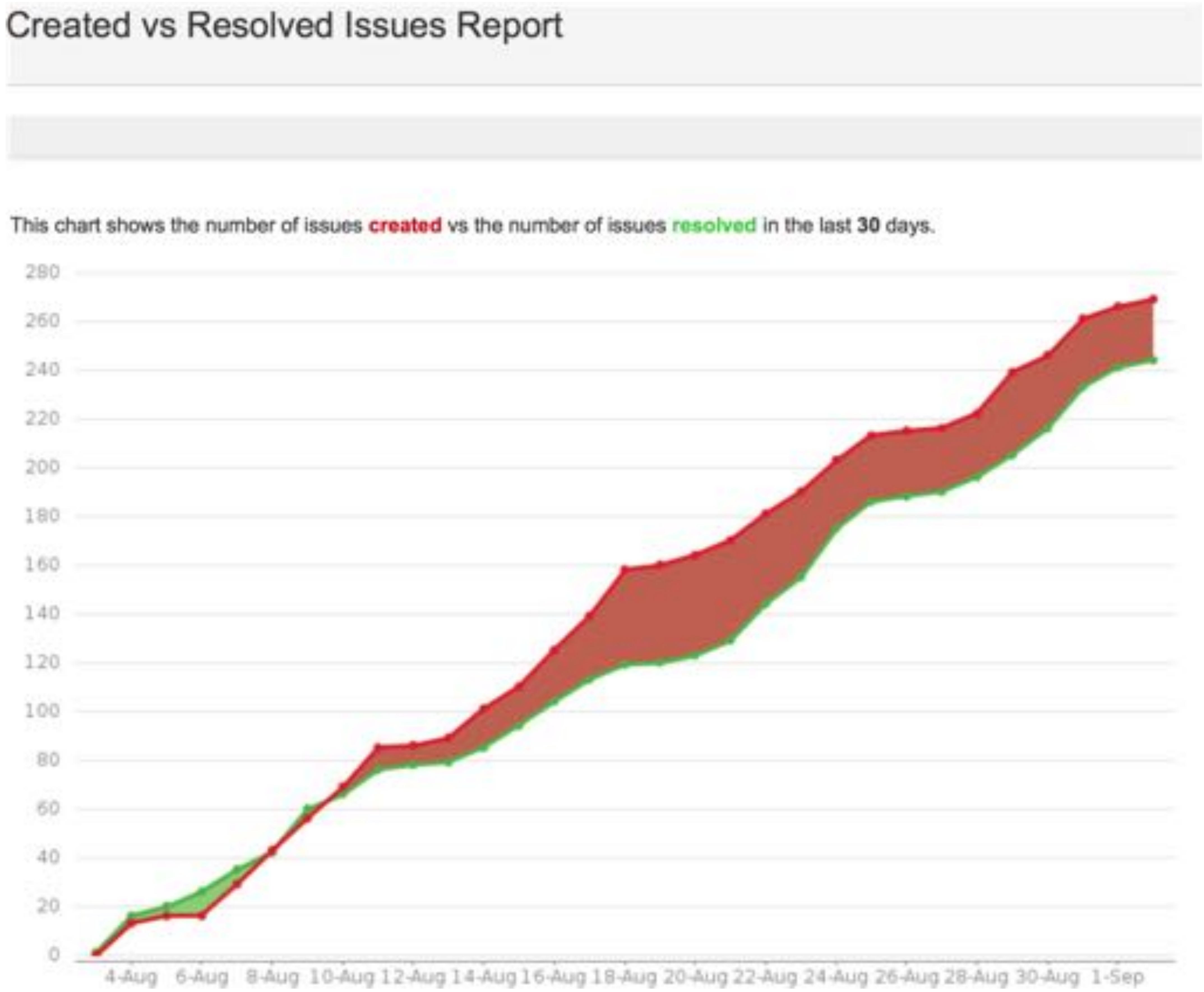
mateiz #2
830 commits / 1,628,795 ++ / 1,150,896 --

pwendell #3
654 commits / 31,148 ++ / 24,163 --

JoshRosen #4
496 commits / 60,391 ++ / 32,072 --

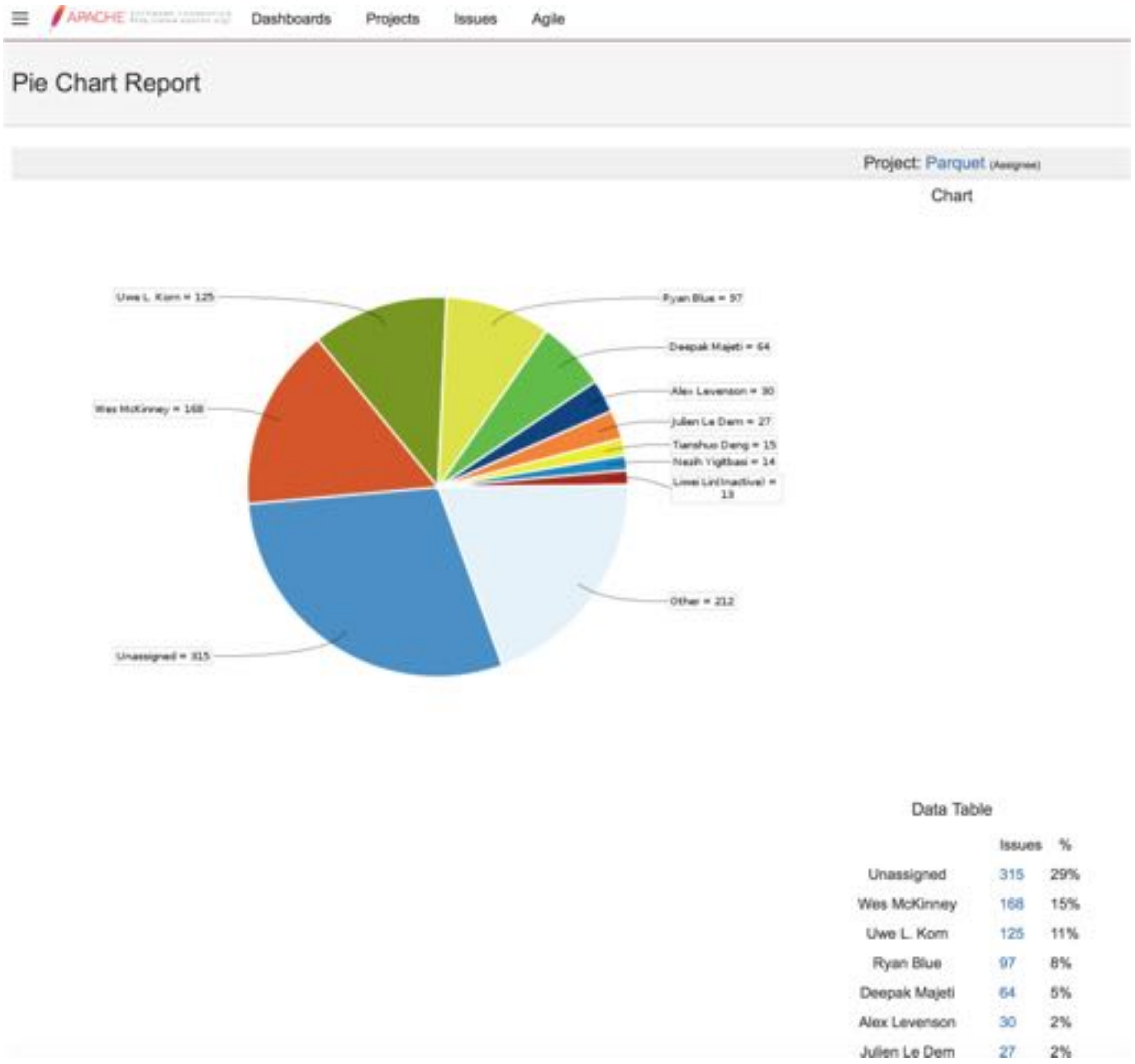
Reviewing Market Trends

Jira Counts and Charts



Created vs Resolved Issues Report

This chart shows the number of issues **created** vs the number of issues **resolved** in the last **30** days.



Pie Chart Report

Project: Parquet (Assignee)

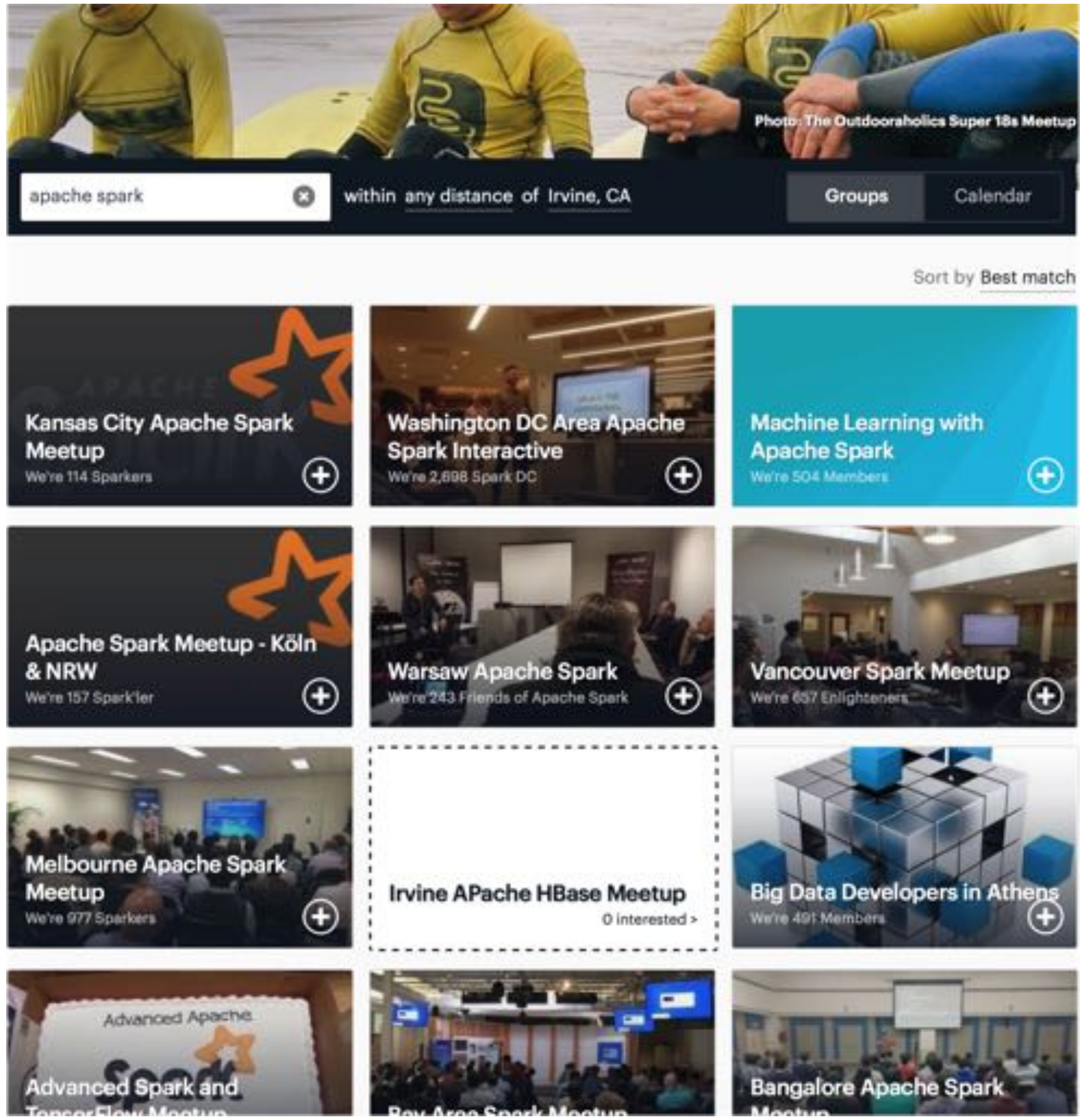
Chart

Data Table

	Issues	%
Unassigned	315	29%
Wes McKinney	168	15%
Uwe L. Korn	125	11%
Ryan Blue	97	8%
Deepak Majeti	64	5%
Alex Levenson	30	2%
Julien Le Dem	27	2%

Reviewing Market Trends

Conferences and meetups



apache spark ⊗ within any distance of Irvine, CA

Sort by Best match

Kansas City Apache Spark Meetup
We're 114 Sparkers

Washington DC Area Apache Spark Interactive
We're 2,698 Spark DC

Machine Learning with Apache Spark
We're 504 Members

Apache Spark Meetup - Köln & NRW
We're 157 Spark'ler

Warsaw Apache Spark
We're 243 Friends of Apache Spark

Vancouver Spark Meetup
We're 657 Enlighteners

Melbourne Apache Spark Meetup
We're 977 Sparkers

Irvine APache HBase Meetup
0 interested >

Big Data Developers in Athens
We're 491 Members

Advanced Spark and TensorFlow Meetup

Bay Area Spark Meetup

Bangalore Apache Spark Meetup

Reviewing Market Trends

- Also:
  - Community Interest
  - Email Lists and Forums
  - Contributors
  - Follow the Money $$$

Evaluating the Risks

- Risk Tolerance
- Stress Tolerance
- Leader vs follower

Future Proofing

- Assume Change
- Interface Design
- Producer & Consumer Experience

Assume Change

- Remember the Logic and Physical
- Think Logical and Implementation

Interface Design

- Standards
- SQL
- DataFrames / DataSets
- REST, GRPC
- AVRO, Parquet, Protobuf, Thrift, JSON, CSV

Building Successful Teams

Lessons Learned Building Big Data Teams

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Build well rounded teams

Sysadmins

Developers

Analysts

Data Scientists

Other roles:

Data Protection Officer

Product Managers

Network/Systems Engineers

SRE

How to find people?

Start with people you already have, but make sure you invest in training…

- Linux, network, DBAs –> sysadmins
- Developers –> developers
  - Easy if you're at a company like Orbitz, otherwise maybe not so much
- Analysts –> analysts
- It's not an easy path though
  - Set goals instead of micro-managing development
  - Be prepared to iterate, don't be afraid to fail

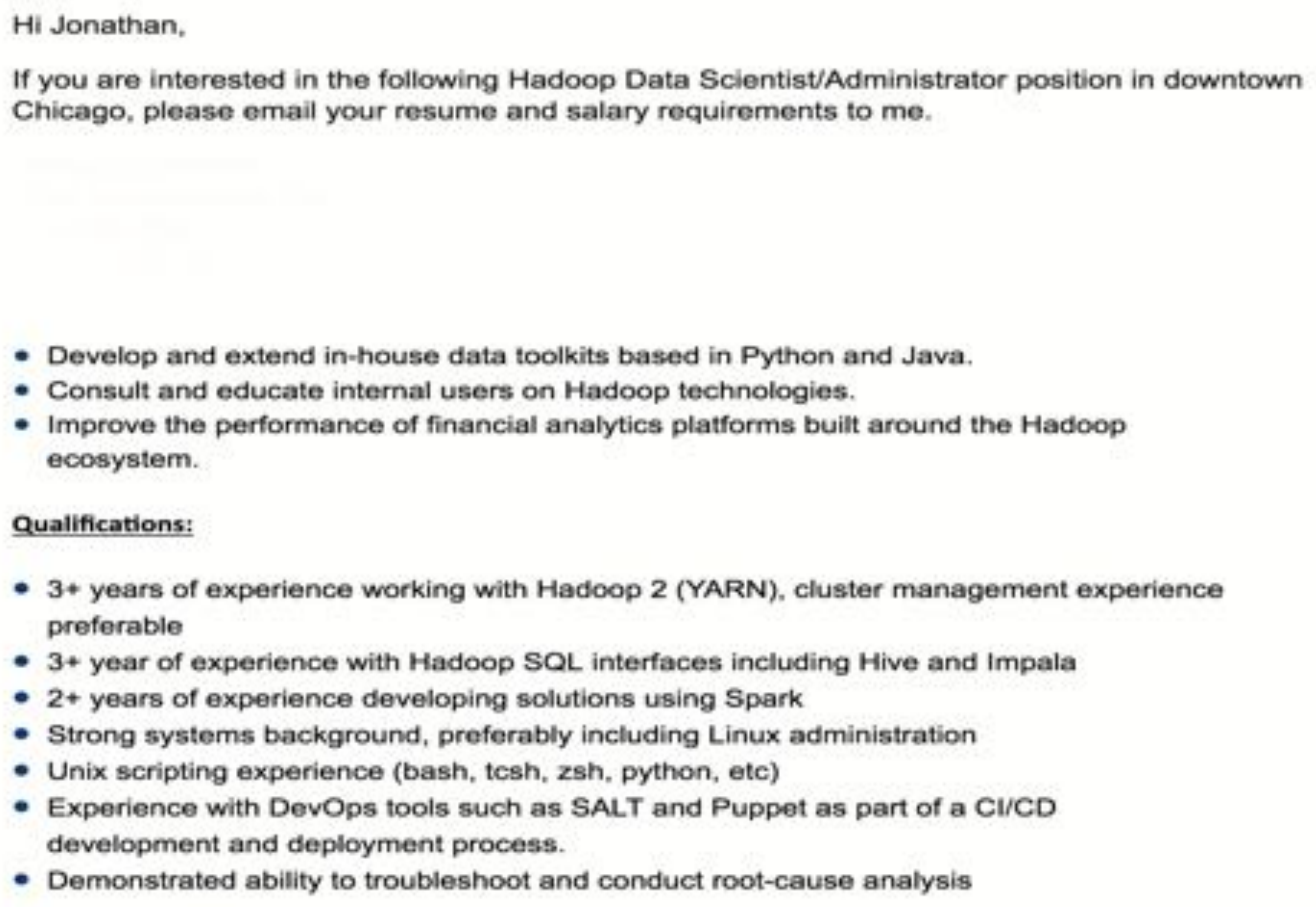
Also don’t forget other teams

Communication is key

DBAs

Other Project Teams

Also, don’t do this:



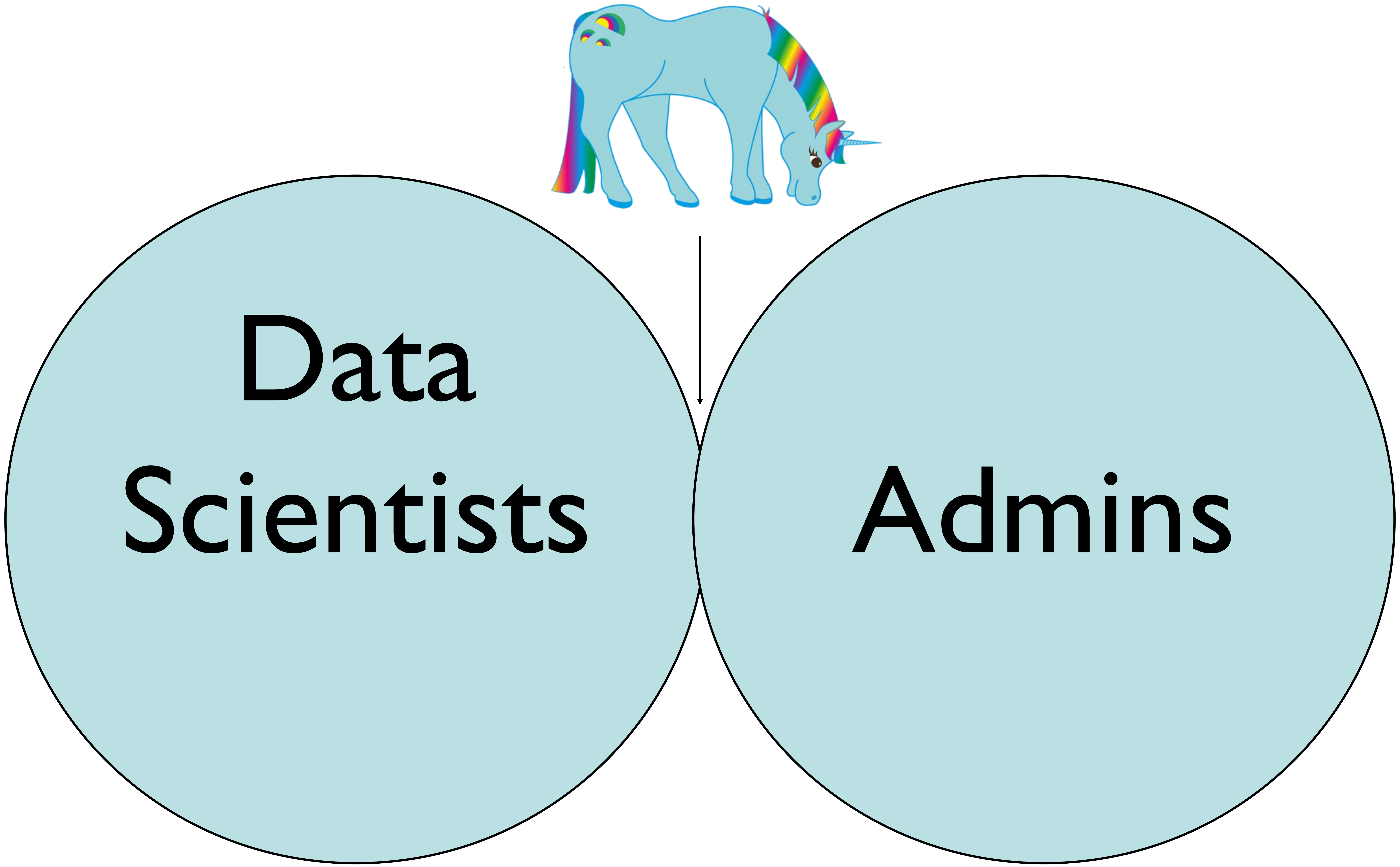
Hi Jonathan,

If you are interested in the following Hadoop Data Scientist/Administrator position in downtown Chicago, please email your resume and salary requirements to me.

- Develop and extend in-house data toolkits based in Python and Java.
- Consult and educate internal users on Hadoop technologies.
- Improve the performance of financial analytics platforms built around the Hadoop ecosystem.

Qualifications:

- 3+ years of experience working with Hadoop 2 (YARN), cluster management experience preferable
- 3+ year of experience with Hadoop SQL interfaces including Hive and Impala
- 2+ years of experience developing solutions using Spark
- Strong systems background, preferably including Linux administration
- Unix scripting experience (bash, tcsh, zsh, python, etc)
- Experience with DevOps tools such as SALT and Puppet as part of a CI/CD development and deployment process.
- Demonstrated ability to troubleshoot and conduct root-cause analysis



Data Scientists

Admins

Differing Skill Sets

- Detail-Oriented
- Experimental
- The Communicator
- …

Think beyond just skills

- Also look for complementary personalities
- And avoid toxic personalities
  - But what if they're really talented?
  - See above.

Customer Engagement

- Your teams should work closely with your customers, whether they're external or internal

Managing Project Risk

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Managing Risk

1 in 11.5 million

1 in 4292

Shark photo: http://www.travelbag.co.uk/

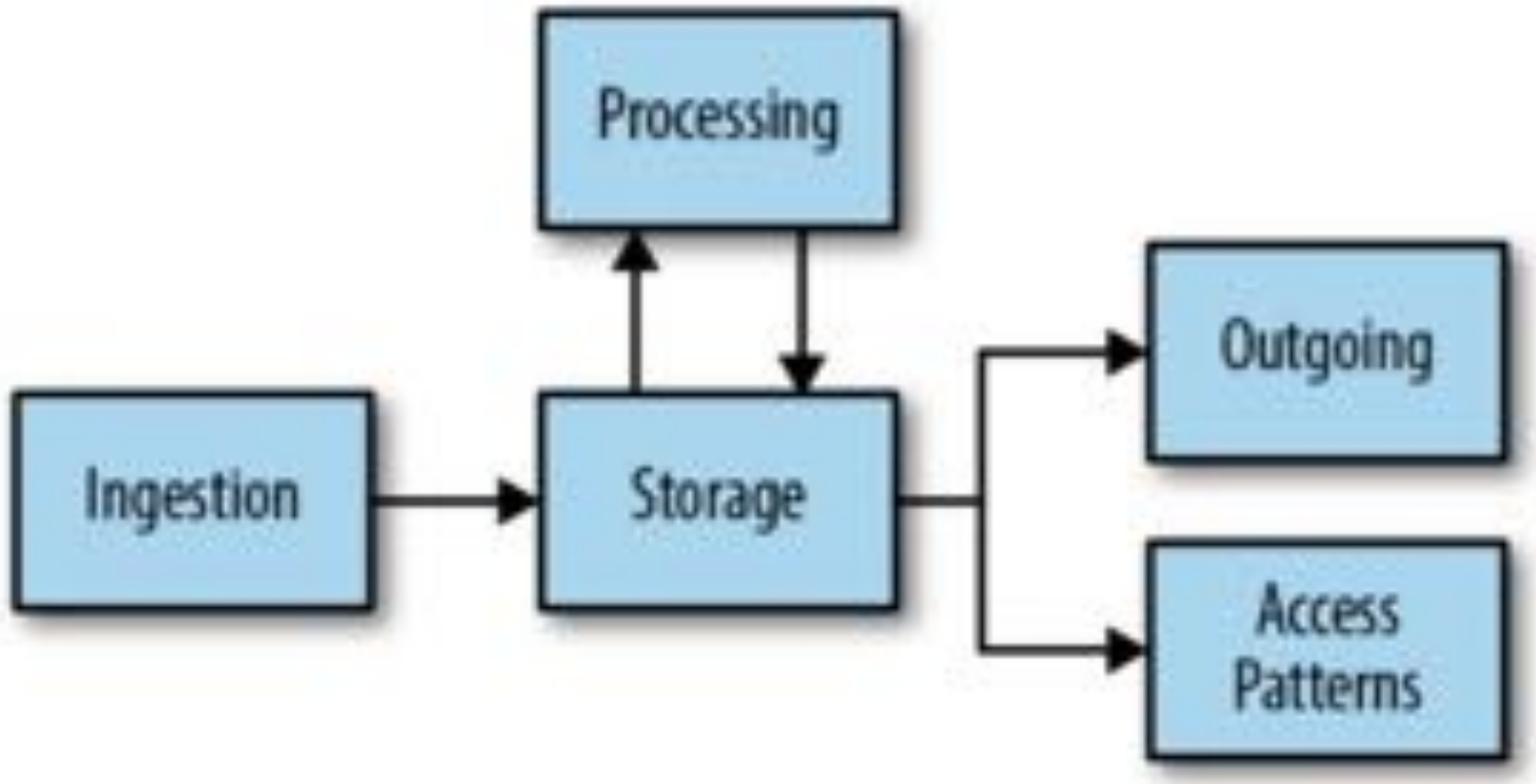
Managing Risk – Risk Categories

Technology Risk

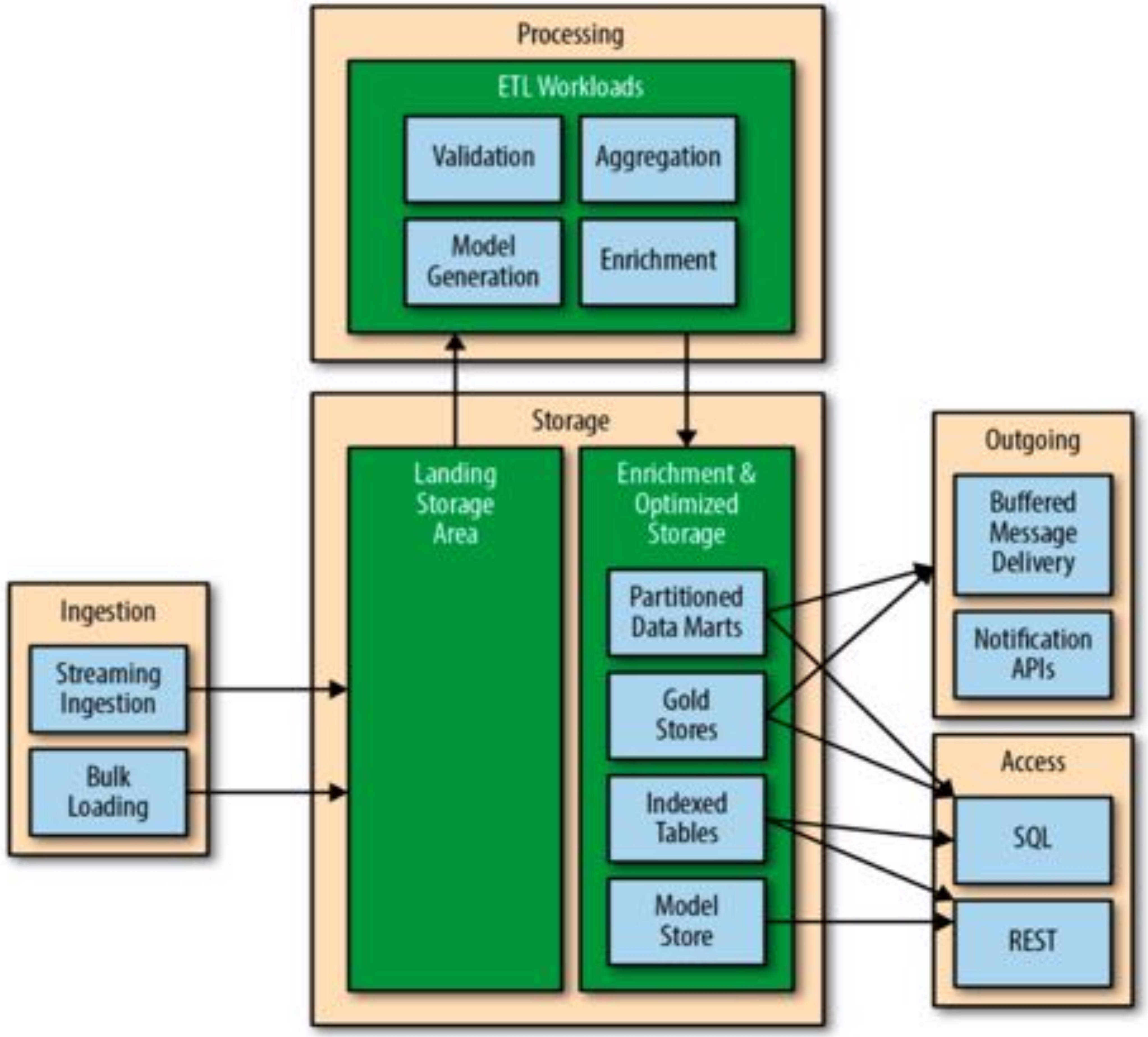
Team Risk

Requirements Risk

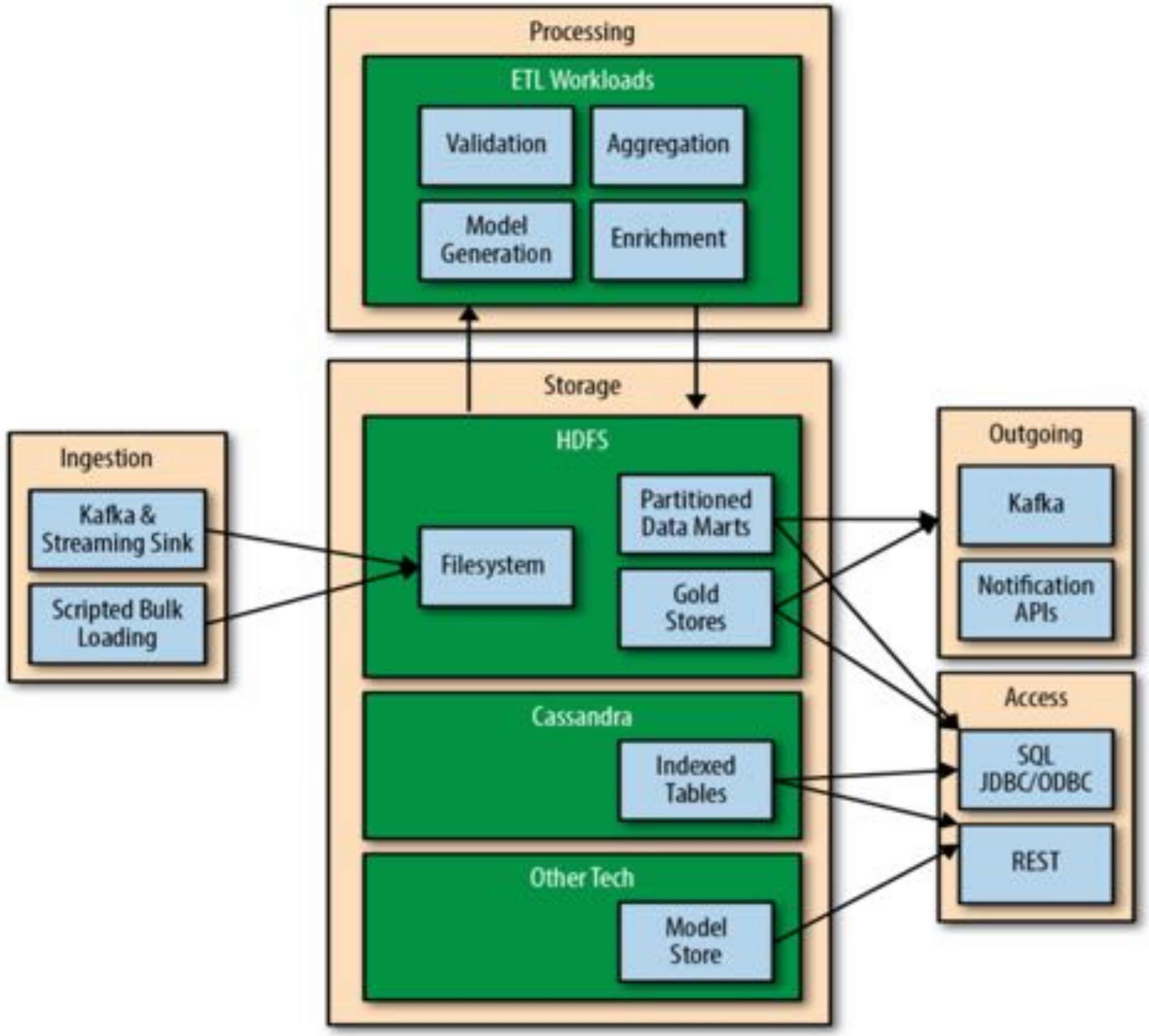
Managing Risk – Categorizing Risk



Managing Risk – Categorizing Risk



Managing Risk – Categorizing Risk



Risk Weighting

- Technology Risk
  - How much experience do we have with this technology?
  - Do we have production experience with the technology?
  - We know SQL, but what about Cassandra CQL?
  - …

Risk Weighting

- Team Risk
  - Experience level of team members
  - Team skill sets
  - Size of team
  - …

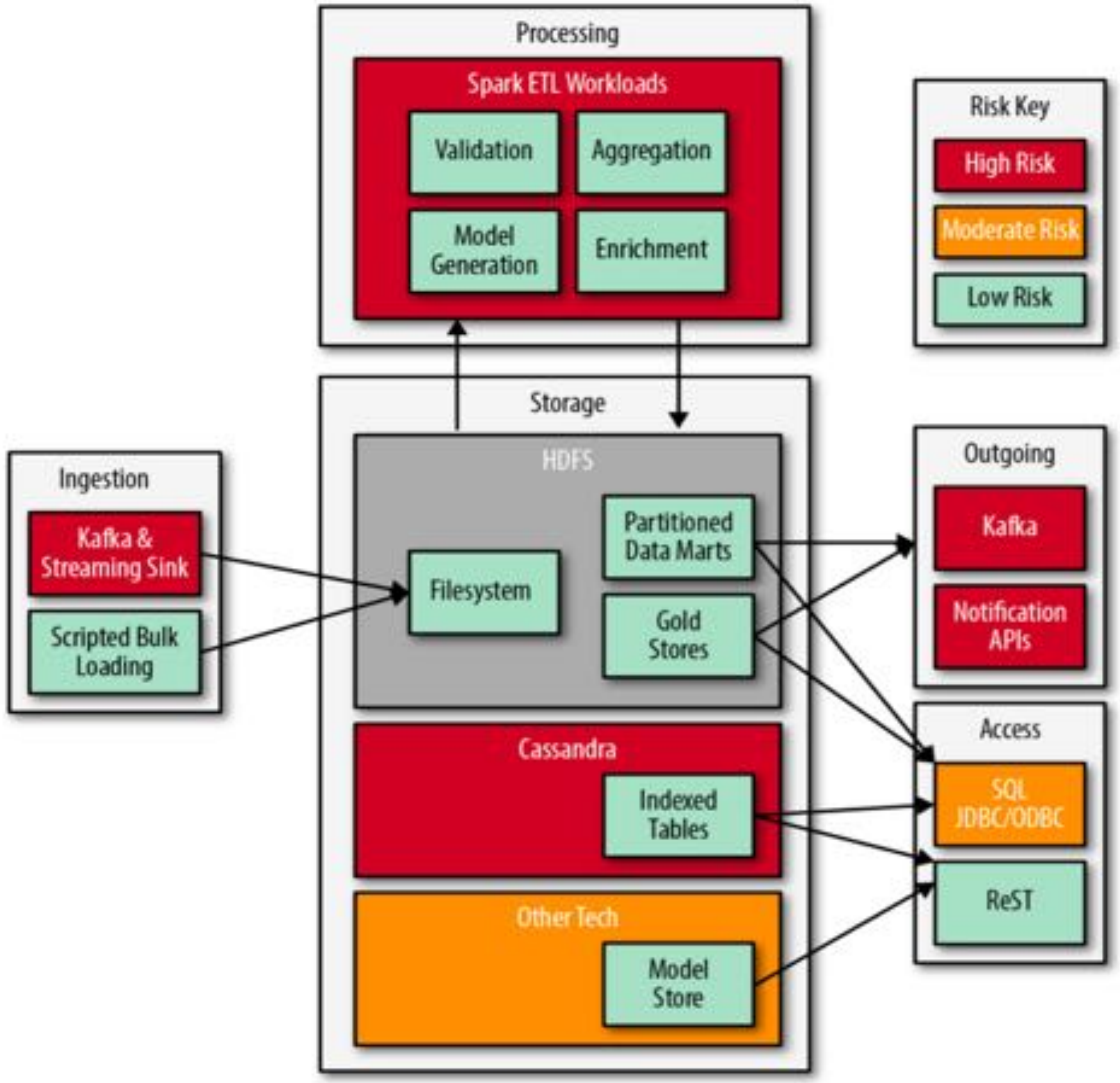
- Don’t forget about other teams
  - System dependencies
  - …

Risk Weighting

- Requirements Risk
  - Vaguely defined requirements
  - Novel requirements (e.g. stringent latency requirements)

Managing Risk – Categorizing Risk

- Cassandra
  - Limited technical experience (team risk)
  - Need to validate data model (reqs risk)
  - Stringent uptime requirements (tech risk)



Mitigating Risk

- Requirements Risk
  - Ensure good functional requirements
  - Break requirements up – don’t boil the ocean
  - Share requirements and get buy-in from all stakeholders
  - Get agreement on scope

Mitigating Risk

- Technology Risk
  - Tackle important/complex components first
  - Use external resources to help fill knowledge gaps
  - Consider replacing riskier technologies with more familiar ones

Mitigating Risk

- Technology Risk
  - Use proofs of concept
    - Than throw them away

Mitigating Risk

- Technology Risk
  - Use abstractions to minimize dependencies
  - Ensure repeatable build, deployment, monitoring processes

Mitigating Risk

- Technology Risk
  - Start building early

Mitigating Risk

- Team Risk
  - Build well rounded teams
  - Ensure communication with other teams
    - But work to reduce coupling

Communicating Risk

- Make sure stakeholders are aware of risks
  - But remember there can be risks to overstating risk
- Collaborate and get buy-in
- Share risk
- Risk can be a negotiation tool

Ensuring Data Integrity

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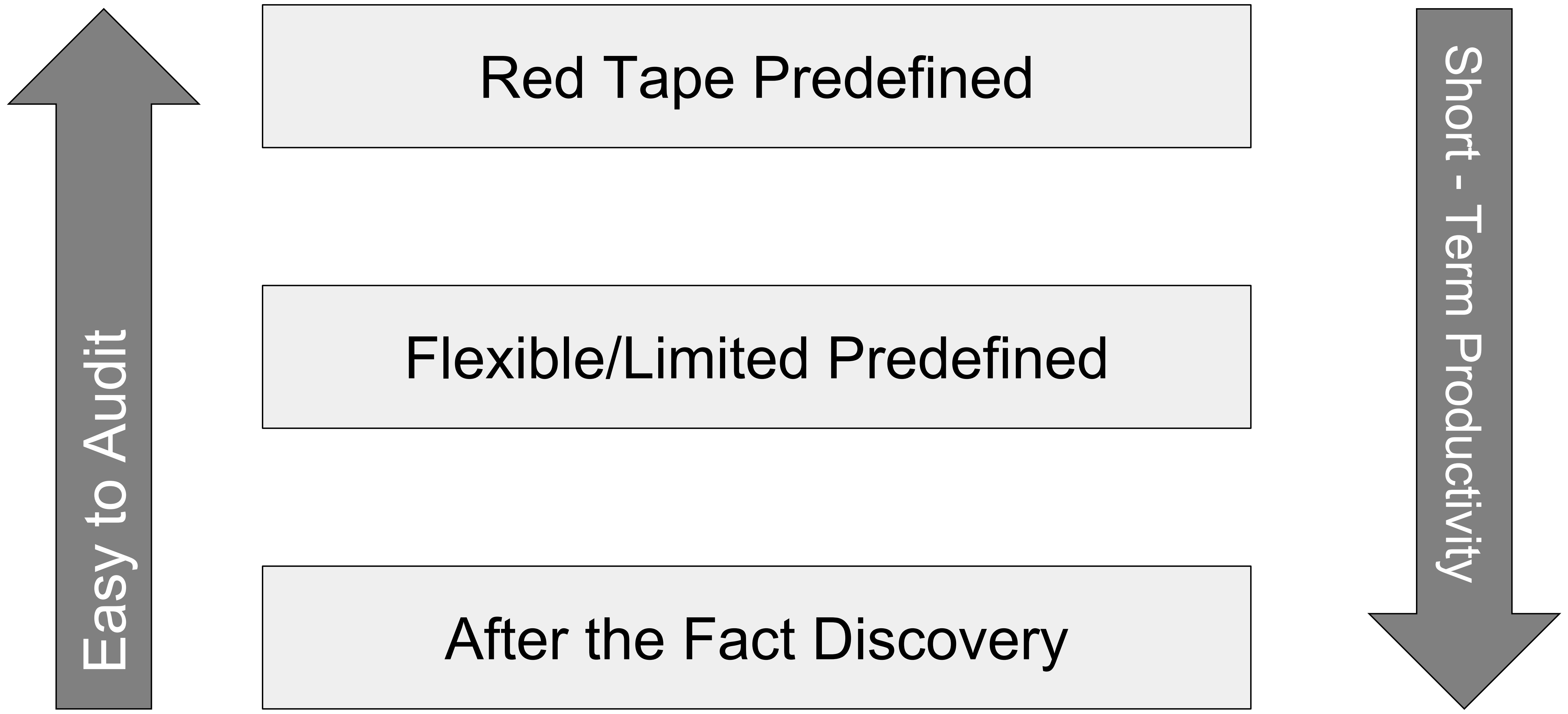
Ensuring Data Integrity

- Pre-defined vs Derived via Discovery
- Path of Fidelity
- Validation of Quality

Pre-Defined vs Derived via Discovery

- Producer - Productivity vs Audit
- Consumer - Consistency

Producer - Productivity vs Audit



Predefined Traps

- Centralized Reviewing Org
- High bar to on board
- Unclear schema evolution paths

Discovery Traps

- Uncommon output
- Data quality standards
- Uncommon SLAs
- The balloon problem

Consumers Point of View

- Consistency is Key
- Access to Powerful Tools
- Multiple Landing Areas is Key
  - Long Term
  - Indexed
  - Lucene Indexed
  - Streams
- Future Proofing

Path of Fidelity

- What is Fidelity
- What can we mutate

What is Full Fidelity

- The cells and their values are preserved
- Field names and definitions are preserved
- No matter where or how you access the data
- No Filtering
- No Irreversible Mutations

What can we mutate

- Tokenization
- Underlining files structions
- Storage system
- Access Path

Validate Quality

- Validation of Fidelity
- Validation of Quality

Validation of Fidelity

- Row Counts
- Check Sums
- Reversible byte by byte check

Validation of Quality

- Column level rules
- Null counts
- Field carnality
- Record counts

Metadata Management

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Metadata Management

- What do we mean?
  - Understanding what data you have
  - Knowing what the data is
  - Knowing where the data is
- This is complex
  - Large number of data sources, storage systems, processing…
  - Ease of data access and creation of new data sets
  - Start planning at the beginning of your project!

Why Do We Care?

- Visibility – know what data you collect and how to access it
  - Faster time to market
  - Avoid duplication of work
  - Derive more value from data
  - Identify gaps

Why Do We Care?

- Relationships

Why Do We Care?

Regulations

GDPR, etc.

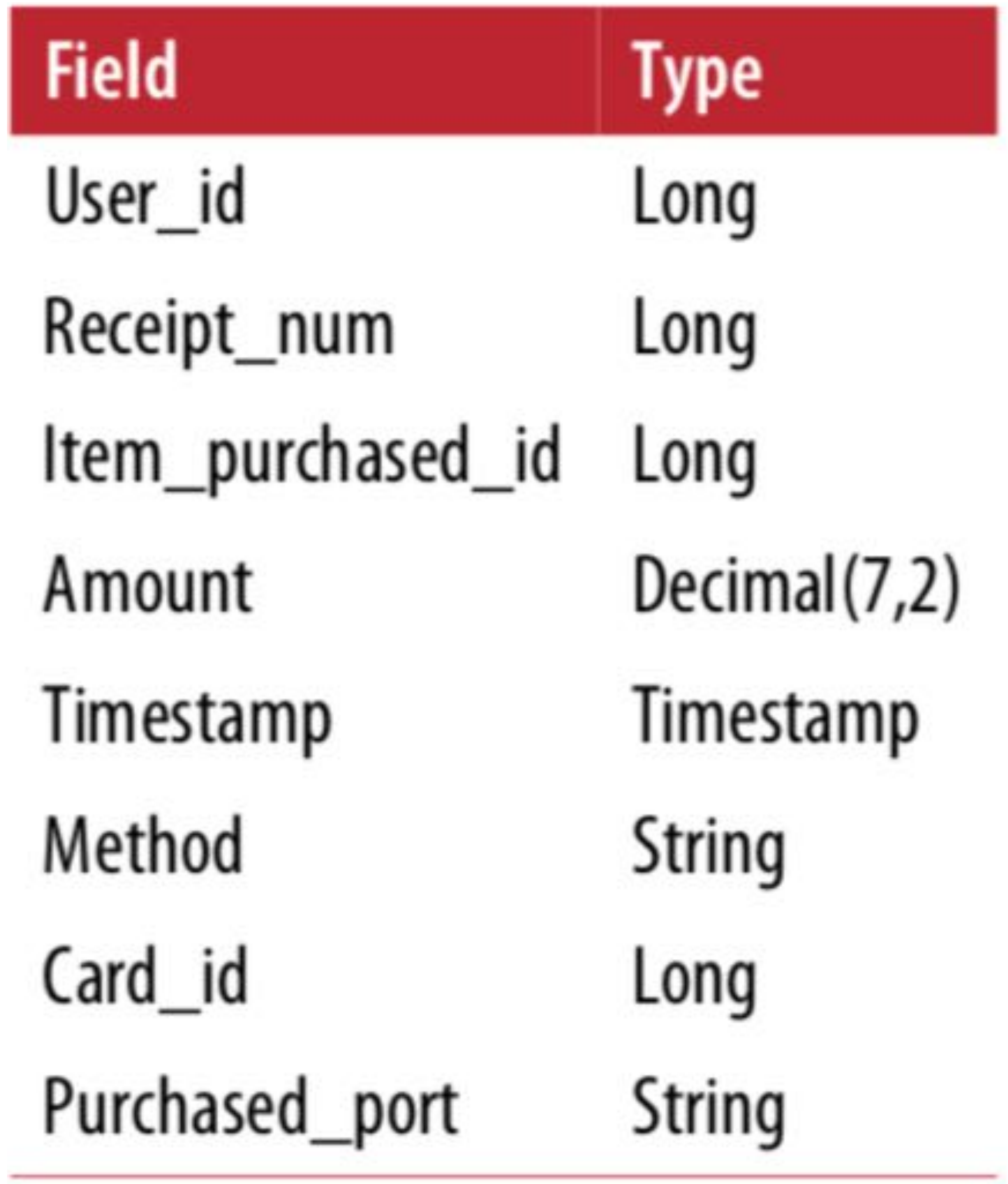
Types of Metadata

- Data at rest
- Data in motion
- Source data
- Data processing
- Reports, dashboards, etc.

Data At Rest

- Files, database tables, Lucene indexes, etc.

Data At Rest – Database Table Example



Field	Type
User_id	Long
Receipt_num	Long
Item_purchased_id	Long
Amount	Decimal(7,2)
Timestamp	Timestamp
Method	String
Card_id	Long
Purchased_port	String

Data At Rest – Other Metadata Types

Audit Logs

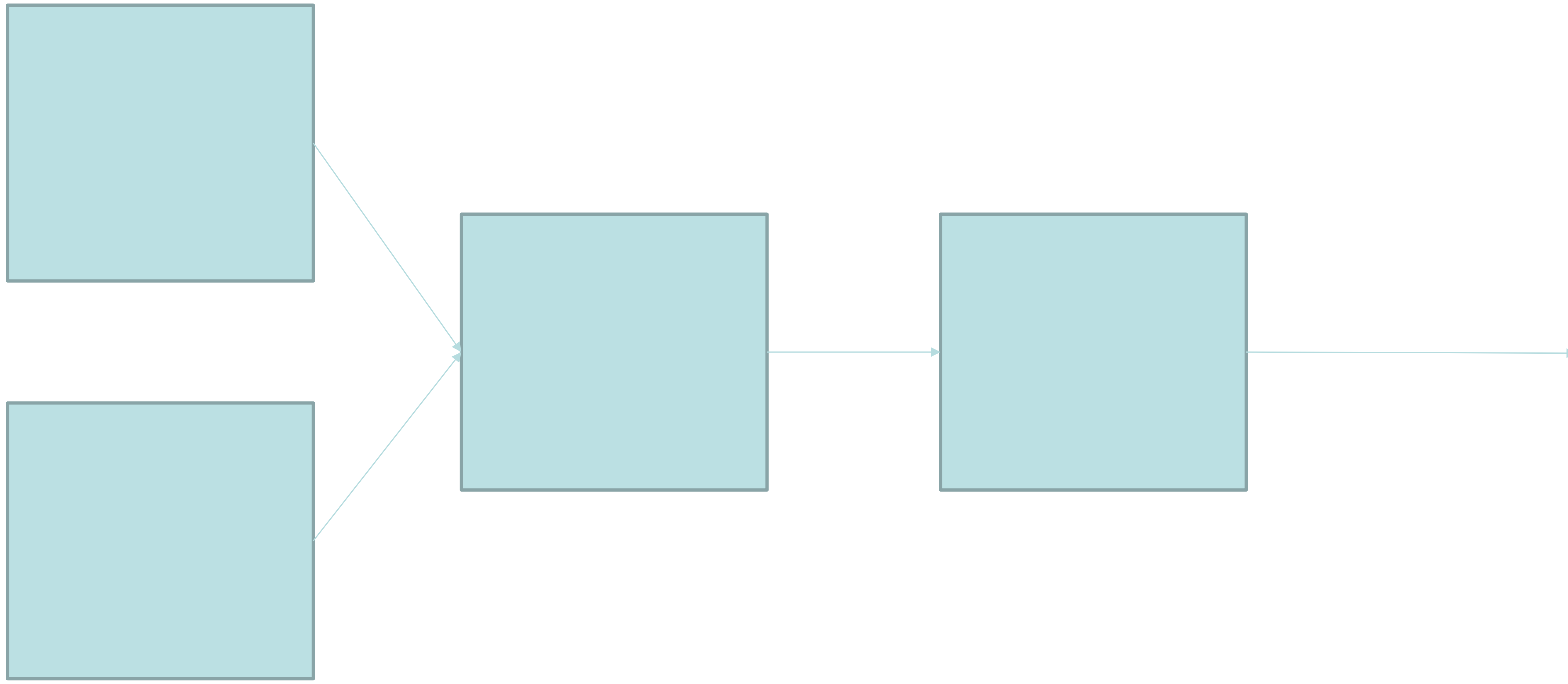
Data At Rest – Other Metadata Types

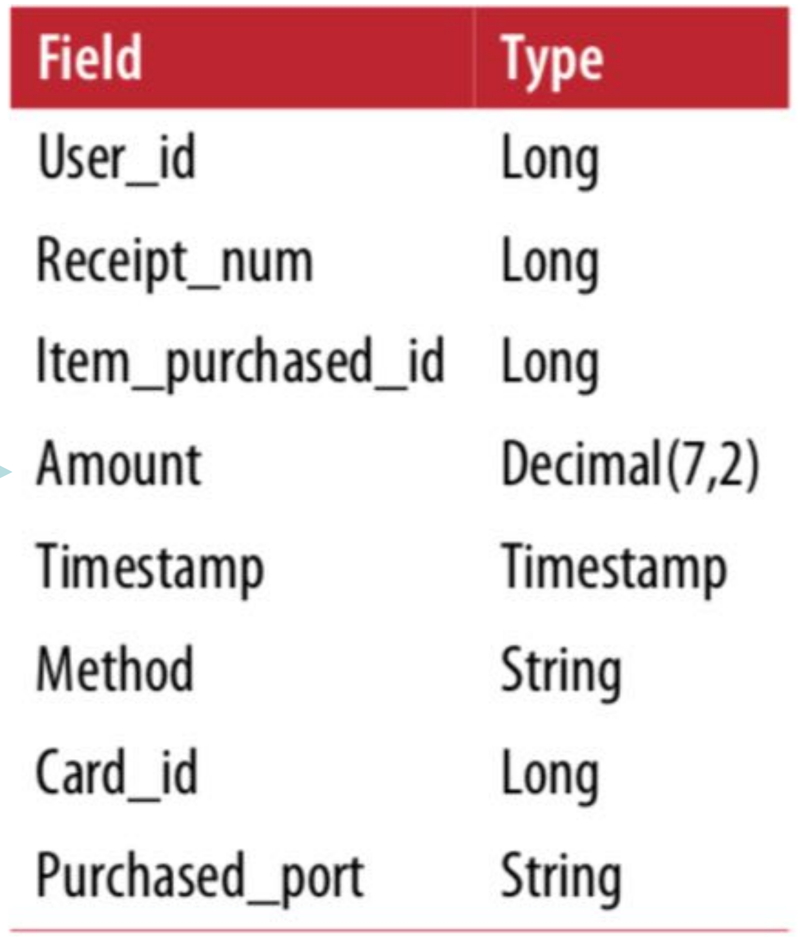
Comments

Data At Rest – Other Metadata Types

Tags

Data At Rest – Other Metadata Types





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User_id	Long
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Amount	Decimal(7,2)
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Method	String
Card_id	Long
Purchased_port	String

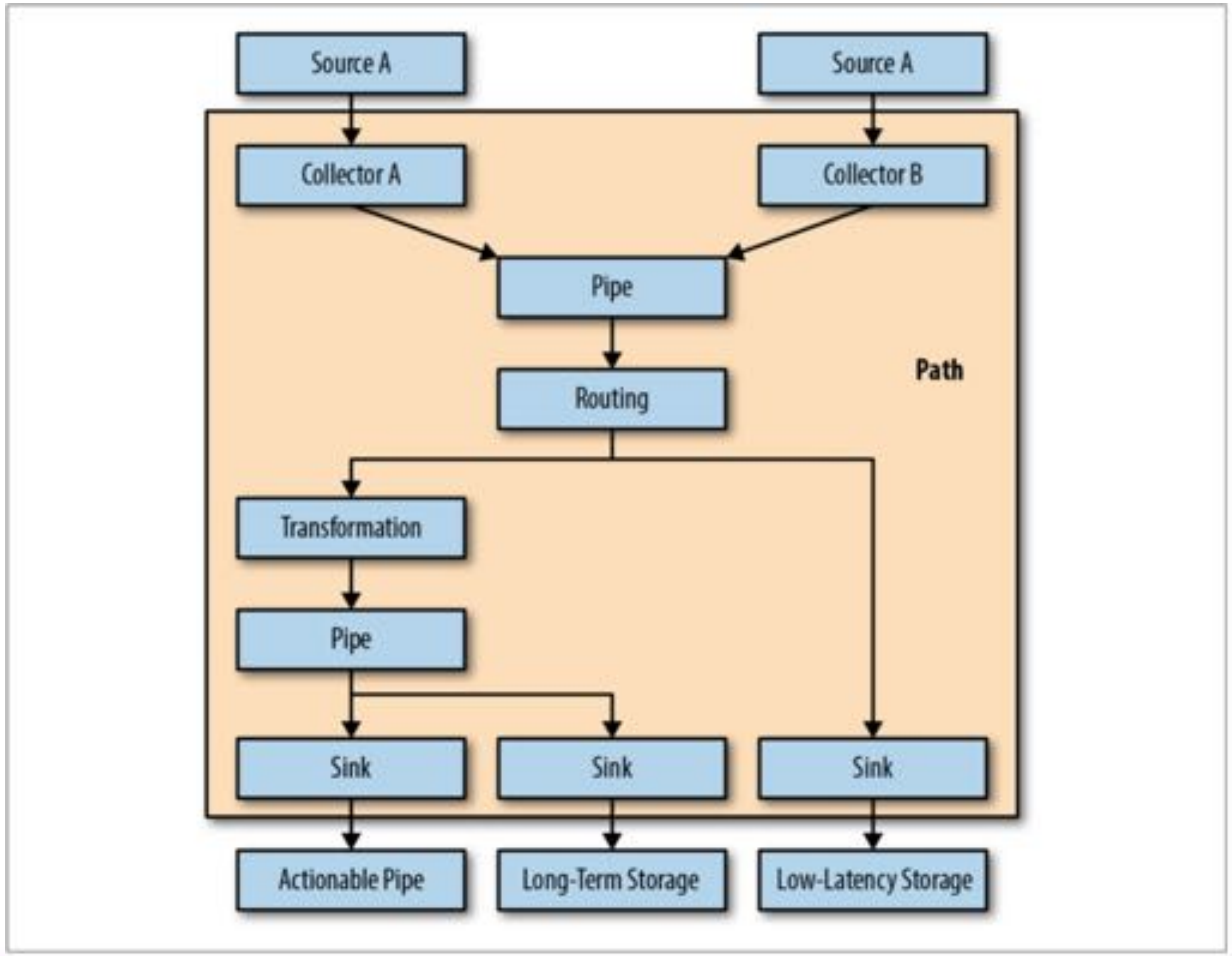
Lineage

Data In Motion

- This is data that's moving through the system
  - Batch or streaming ingestion
  - Data processing
  - Derived data

Data in Motion – What to Capture

- Paths
- Sources
- Transformations
- Destinations
- Reports/Dashboards



Data in Motion – Paths

- How does the data move through the system?
  - Source systems
  - Data collection systems
  - Routing
  - Transformations
  - Etc.

Source Data

- External systems
- Internal systems

Data In Motion – Transformations

- Data format changes, for example JSON to protocol buffers
- Data fidelity – is the data filtered or changed?
- Metadata about processing – job names, technologies, inputs, outputs, etc.

Data Processing – Machine Learning

- More complex algorithms can require special considerations
  - Purpose of a model
  - Technologies, algorithms, etc.
  - Features
  - Datasets – training, test, etc.
  - Goals of the model
  - Who owns the model?

Reports and Dashboards

- Data sources
- Any data transformations
- Information on the report’s creator
- Log of modifications
- Purpose of report
- Tags

Approaches to Metadata Collection

- Declarative
  - Require and enable metadata to be created as data is added to the system
- Discovery
  - After the fact cataloging of data

How?

- Create your own solution
- Use tools provided by your vendor
- Use third party tools

Thank you!

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Jonathan Seidman | @jseidman

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