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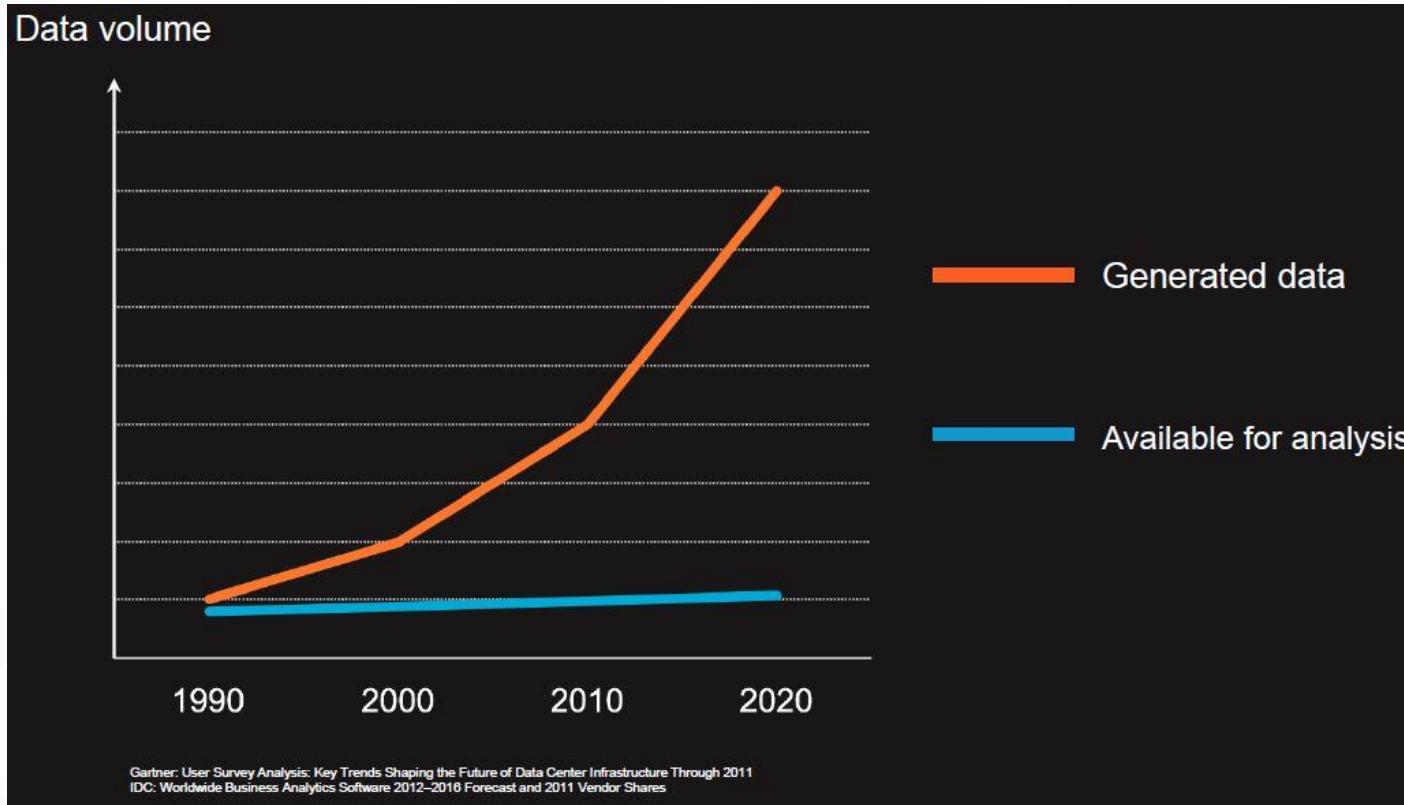
# Building Your Data Warehouse with Amazon Redshift

Vidhya Srinivasan, AWS ([vid@amazon.com](mailto:vid@amazon.com))

Guest Speaker: Justin Cunningham, Yelp (s)



# Data Warehouse - Challenges



**Cost**

**Complexity**

**Performance**

**Rigidity**

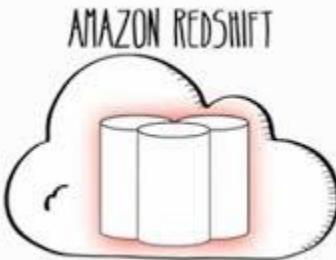


Amazon  
Redshift

Petabyte scale; massively parallel  
Relational data warehouse  
Fully managed; zero admin  
SSD & HDD platforms  
As low as \$1,000/TB/Year

# Clickstream Analytics for Amazon.com

- Web log analysis for Amazon.com
  - Over one petabyte workload
  - Largest table: 400TB
  - 2TB of data per day
- Understand customer behavior
  - Who is browsing but not buying
  - Which products / features are winners
  - What sequence led to higher customer conversion
- Solution
  - Best scale out solution – query across 1 week
  - Hadoop – query across 1 month



# Using Amazon Redshift

- Cost
  - 1.6 PB cluster
  - 100 node dw1.8xl (3-yr RI)
  - \$180/hr
- Complexity
  - 20% time of one DBA
    - Backup
    - Restore
    - Resizing
- Performance
  - Scan 2.25 trillion rows of data: **14 minutes**
  - Load 5 billion rows data: **10 minutes**
  - Backfill 150 billion rows of data: **9.75 hours**
  - Pig → Amazon Redshift: **2 days to 1 hr**
    - 10B row join with 700 M rows
  - Oracle → Amazon Redshift: **90 hours to 8 hrs**
    - Reduced number of SQLs by a factor of 3



# Who uses Amazon Redshift?

# Common Customer Use Cases



## Traditional Enterprise DW

- Reduce costs by extending DW rather than adding HW
- Migrate completely from existing DW systems
- Respond faster to business



## Companies with Big Data

- Improve performance by an order of magnitude
- Make more data available for analysis
- Access business data via standard reporting tools



## SaaS Companies

- Add analytic functionality to applications
- Scale DW capacity as demand grows
- Reduce HW & SW costs by an order of magnitude

# Selected Amazon Redshift Customers



BEACHMINT



NOKIA

foursquare®

Pinterest

FT.com  
FINANCIAL TIMES

sling®

latentview  
Actionable Insights • Accurate Decisions

NTT docomo

NASDAQ OMX



amazon

etix

4

scopely

has offers™

imshealth™  
INTELLIGENCE APPLIED.

euclid

SOUNDCLLOUD

Sansan

Schumachergroup

Albert  
Optimization technology

spuul

peak  
GAMES

CAKE

BookmyShow

vivaki

DataXU

MINICLIP



UMUC

University of Maryland University College

# Amazon Redshift Partners

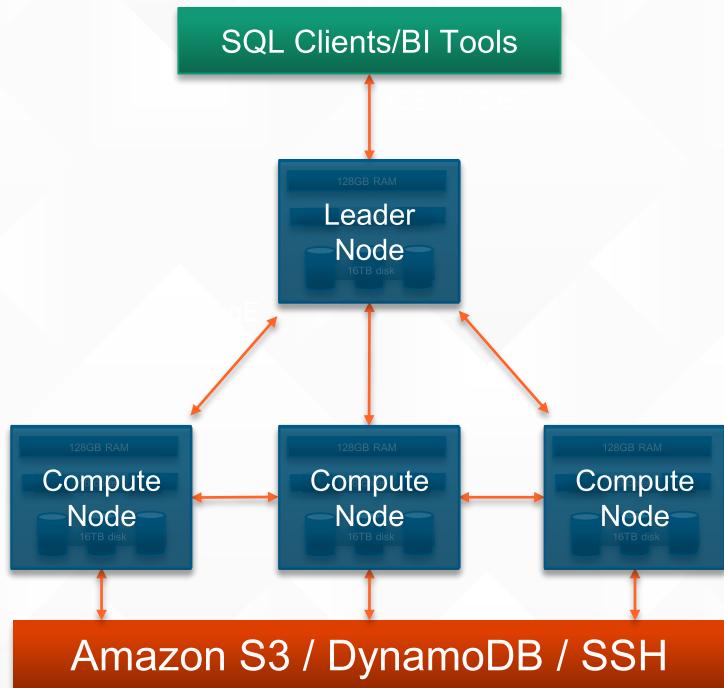


Segment



# Amazon Redshift Architecture

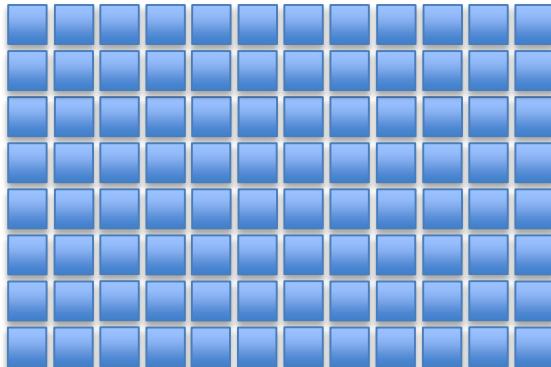
- Leader Node
  - SQL endpoint
  - Stores metadata
  - Coordinates query execution
- Compute Nodes
  - Local, columnar storage
  - Execute queries in parallel
  - Load, backup, restore via Amazon S3; load from Amazon DynamoDB or SSH
- Two hardware platforms
  - Optimized for data processing
  - DW1: HDD; scale from 2TB to 2PB
  - DW2: SSD; scale from 160GB to 326TB



# Amazon Redshift dramatically reduces I/O

- Column storage
- Data compression
- Zone maps
- Direct-attached storage
- Large data block sizes

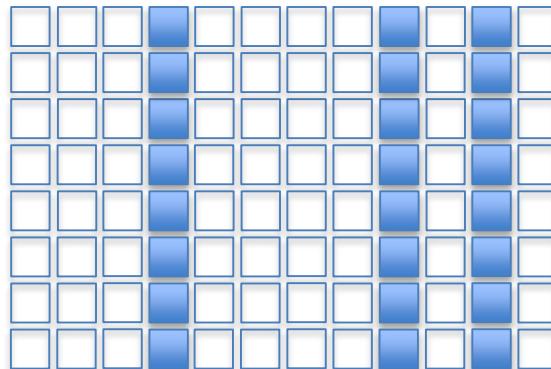
ID	Age	State	Amount
123	20	CA	500
345	25	WA	250
678	40	FL	125
957	37	WA	375



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ID	Age	State	Amount
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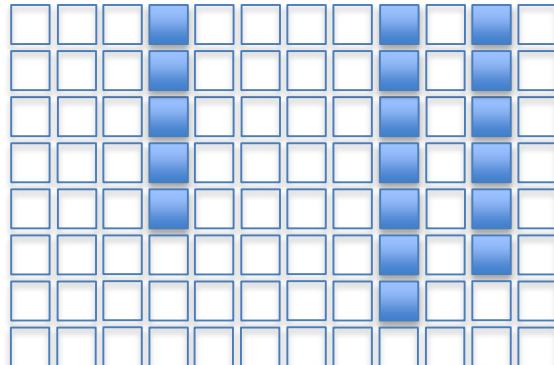


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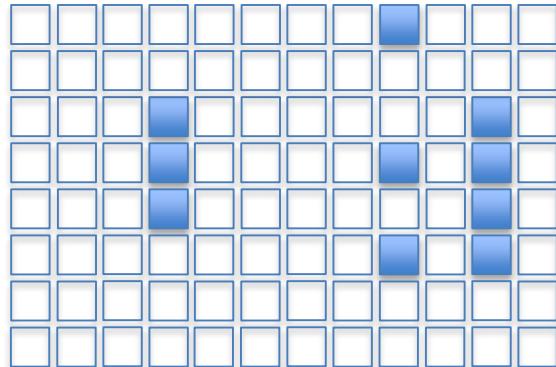
```
analyze compression listing;
```

Table	Column	Encoding
listing	listid	delta
listing	sellerid	delta32k
listing	eventid	delta32k
listing	dateid	bytedict
listing	numtickets	bytedict
listing	priceperticket	delta32k
listing	totalprice	mostly32
listing	listtime	raw



# Amazon Redshift dramatically reduces I/O

- Column storage
  - Data compression
  - Zone maps
  - Direct-attached storage
  - Large data block sizes
- Track of the minimum and maximum value for each block
  - Skip over blocks that don't contain the data needed for a given query
  - Minimize unnecessary I/O

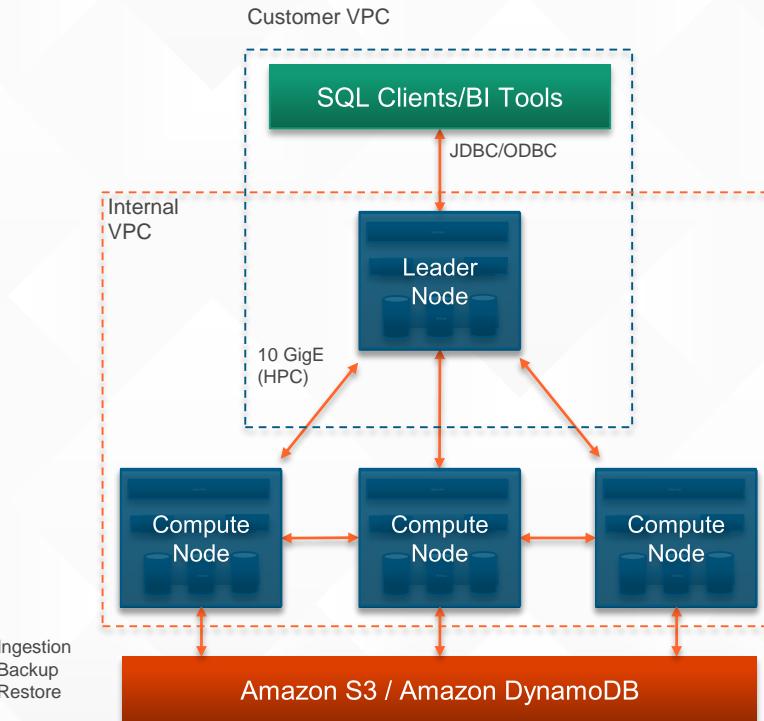


# Amazon Redshift dramatically reduces I/O

- Column storage
- Data compression
- Zone maps
- Direct-attached storage
- Large data block sizes
- Use direct-attached storage to maximize throughput
- Hardware optimized for high performance data processing
- Large block sizes to make the most of each read
- Amazon Redshift manages durability for you

# Amazon Redshift has security built-in

- SSL to secure data in transit
- Encryption to secure data at rest
  - AES-256; hardware accelerated
  - All blocks on disks and in Amazon S3 encrypted
  - HSM Support
- No direct access to compute nodes
- Audit logging & AWS CloudTrail integration
- Amazon VPC support
- SOC 1/2/3, PCI-DSS Level 1, FedRAMP, others



# Amazon Redshift is 1/10<sup>th</sup> the Price of a Traditional Data Warehouse

DW1 (HDD)	Price Per Hour for DW1.XL Single Node	Effective Annual Price per TB
On-Demand	\$ 0.850	\$ 3,723
1 Year Reserved Instance	\$ 0.215	\$ 2,192
3 Year Reserved Instance	\$ 0.114	\$ 999

DW2 (SSD)	Price Per Hour for DW2.L Single Node	Effective Annual Price per TB
On-Demand	\$ 0.250	\$ 13,688
1 Year Reserved Instance	\$ 0.075	\$ 8,794
3 Year Reserved Instance	\$ 0.050	\$ 5,498





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# Expanding Amazon Redshift's Functionality

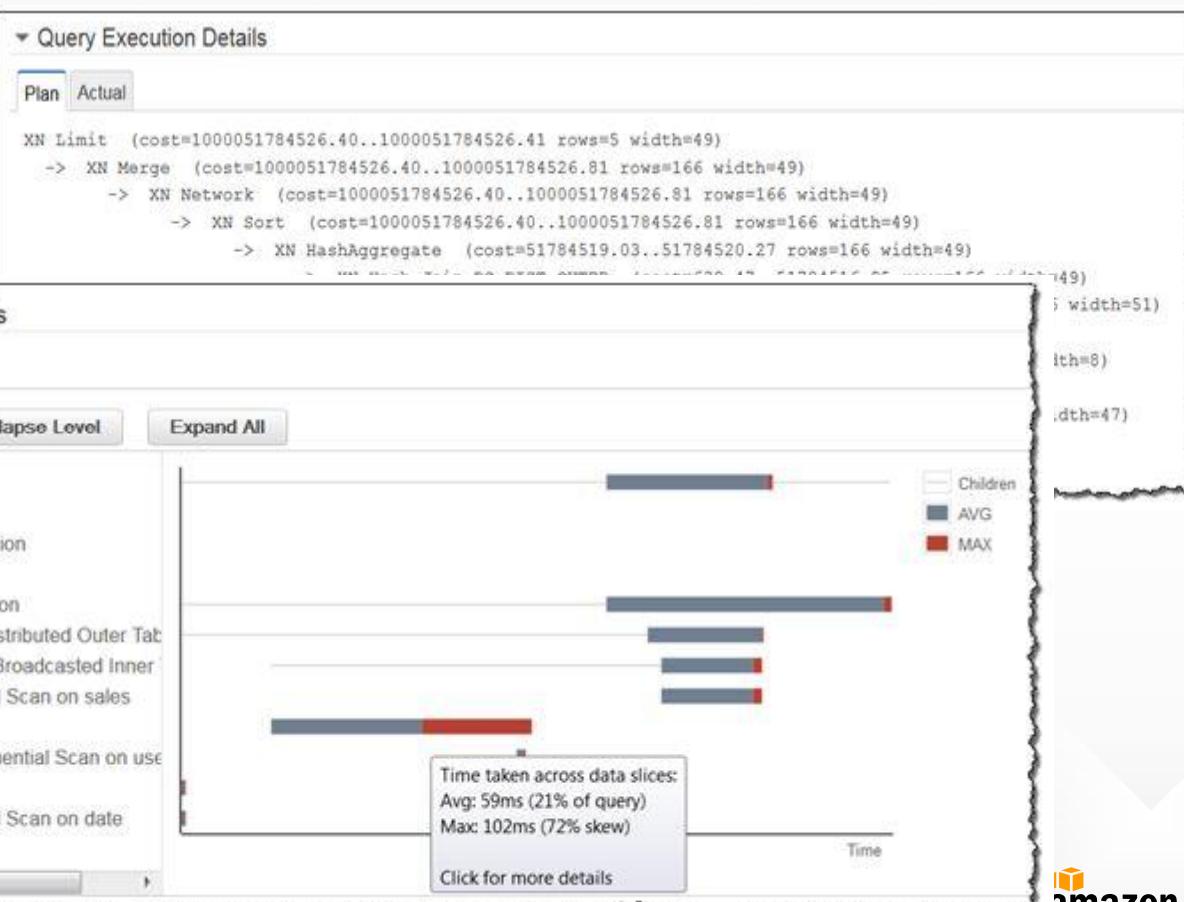


# Custom ODBC and JDBC Drivers

- Up to 35% higher performance than open source drivers
- Supported by Informatica, Microstrategy, Pentaho, Qlik, SAS, Tableau
- Will continue to support PostgreSQL open source drivers
- Download drivers from console

# Explain Plan Visualization

```
explain
select sellerid, username, (firstname || ' ' || l
city, sum(qtysold)
from sales, date, users
where sales.sellerid = users.userid
and sales.dateid = date.dateid
and year = 2008
and city = 'San Diego'
group by sellerid, userna
order by 5 desc
limit 5;
```



# User Defined Functions

- We're enabling User Defined Functions (UDFs) so you can add your own
  - Scalar and Aggregate Functions supported
- You'll be able to write UDFs using Python 2.7
  - Syntax is largely identical to PostgreSQL UDF Syntax
  - System and network calls within UDFs are prohibited
- Comes with Pandas, NumPy, and SciPy pre-installed
  - You'll also be able import your own libraries for even more flexibility



# Scalar UDF example – URL parsing

```
CREATE FUNCTION f_hostname (VARCHAR url)
    RETURNS varchar
IMMUTABLE AS $$

    import urlparse
    return urlparse.urlparse(url).hostname

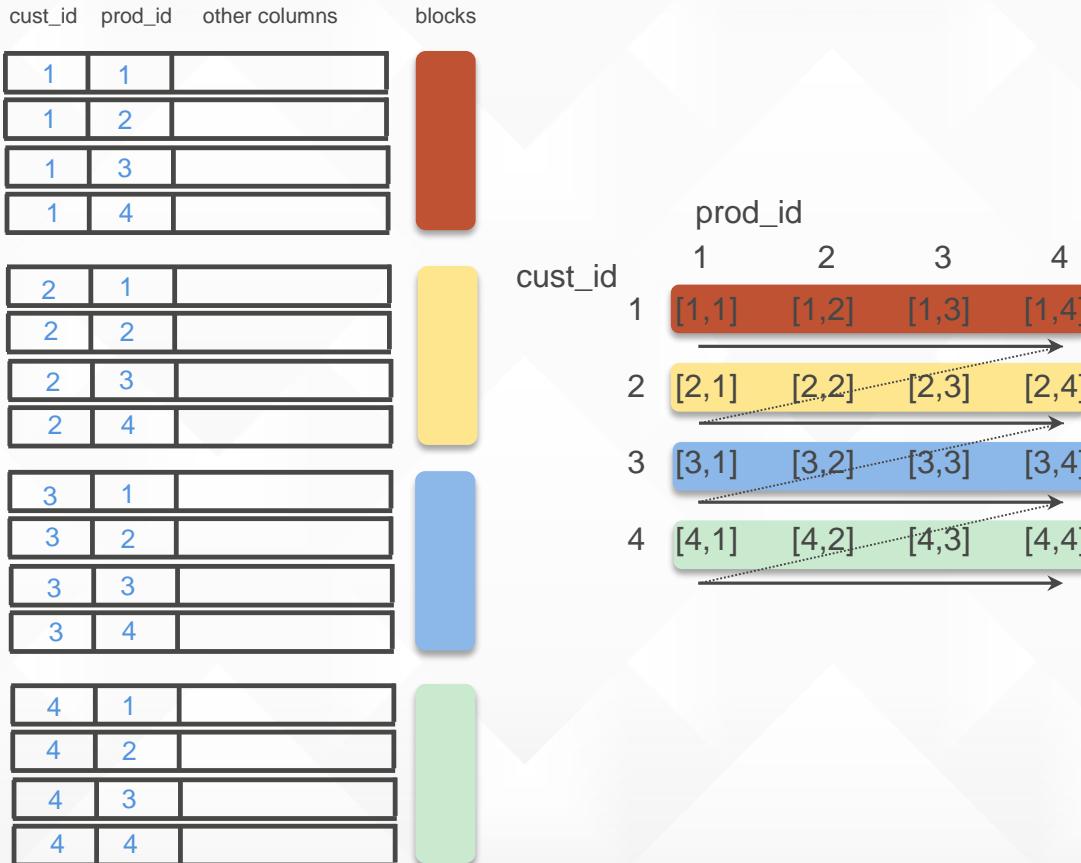
$$ LANGUAGE plpythonu;
```

Rather than using complex REGEX expressions, you can import standard Python URL parsing libraries and use them in your SQL

# Interleaved Multi Column Sort

- Currently support Compound Sort Keys
  - Optimized for applications that filter data by one leading column
- Adding support for Interleaved Sort Keys
  - Optimized for filtering data by up to eight columns
  - No storage overhead unlike an index
  - Lower maintenance penalty compared to indexes

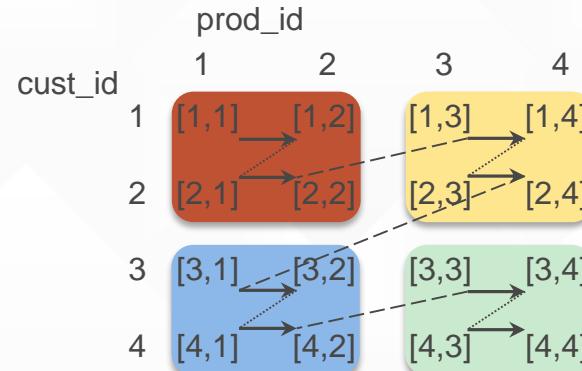
# Compound Sort Keys Illustrated



- Records in Redshift are stored in blocks.
- For this illustration, let's assume that four records fill a block
- Records with a given `cust_id` are all in one block
- However, records with a given `prod_id` are spread across four blocks

# Interleaved Sort Keys Illustrated

cust_id	prod_id	other columns
blocks		
1	1	
1	2	
2	1	
2	2	
1	3	
1	4	
2	3	
2	4	
3	1	
3	2	
4	1	
4	2	
3	3	
3	4	
4	3	
4	4	



- Records with a given cust\_id are spread across two blocks
- Records with a given prod\_id are also spread across two blocks
- Data is sorted in equal measures for both keys

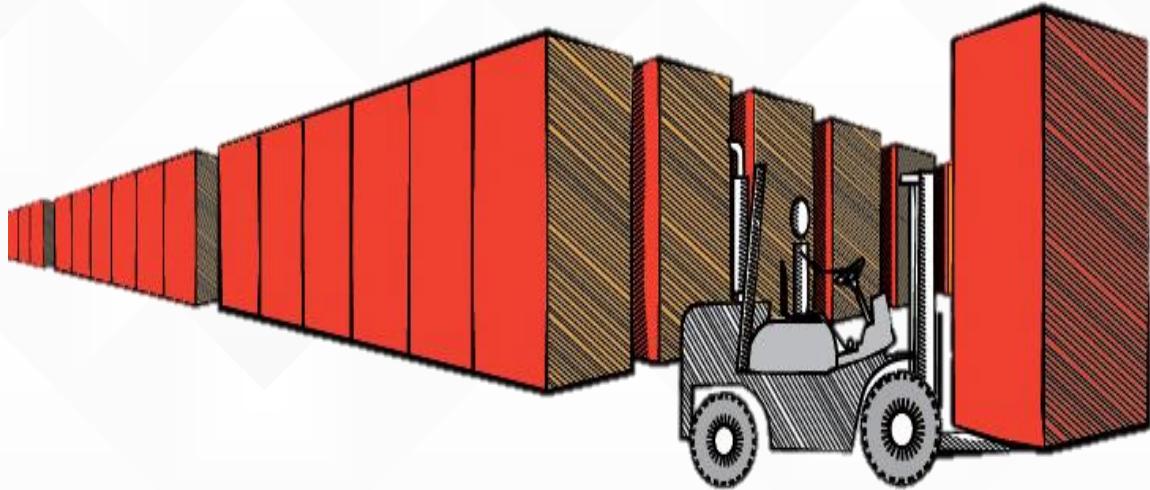
# How to use the feature

```
[ SORTKEY [ COMPOUND | INTERLEAVED ] ( column_name [, ...] ) ]
```

- New keyword ‘INTERLEAVED’ when defining sort keys
  - Existing syntax will still work and behavior is unchanged
  - You can choose up to 8 columns to include and can query with any or all of them
- No change needed to queries
- Benefits are significant

# Amazon Redshift

- *Cost*
- *Performance*
- *Simplicity*
- *Use Cases*



*Spend time with your **data**, not your database....*



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# Using Redshift at yelp

Justin Cunningham

Technical Lead – Business Analytics and Metrics

justinc@



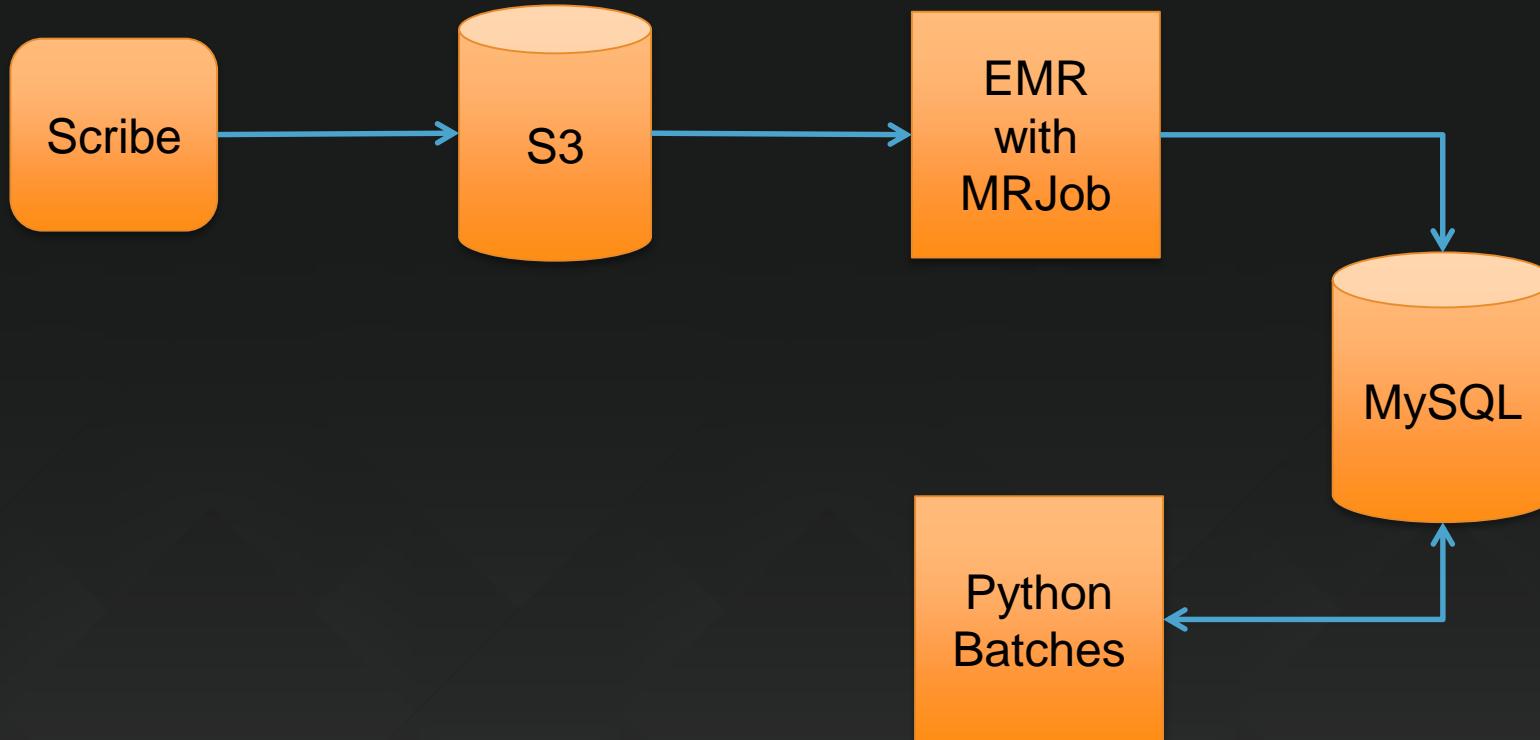


# Hidden gems in your neighborhood? We know just the place.

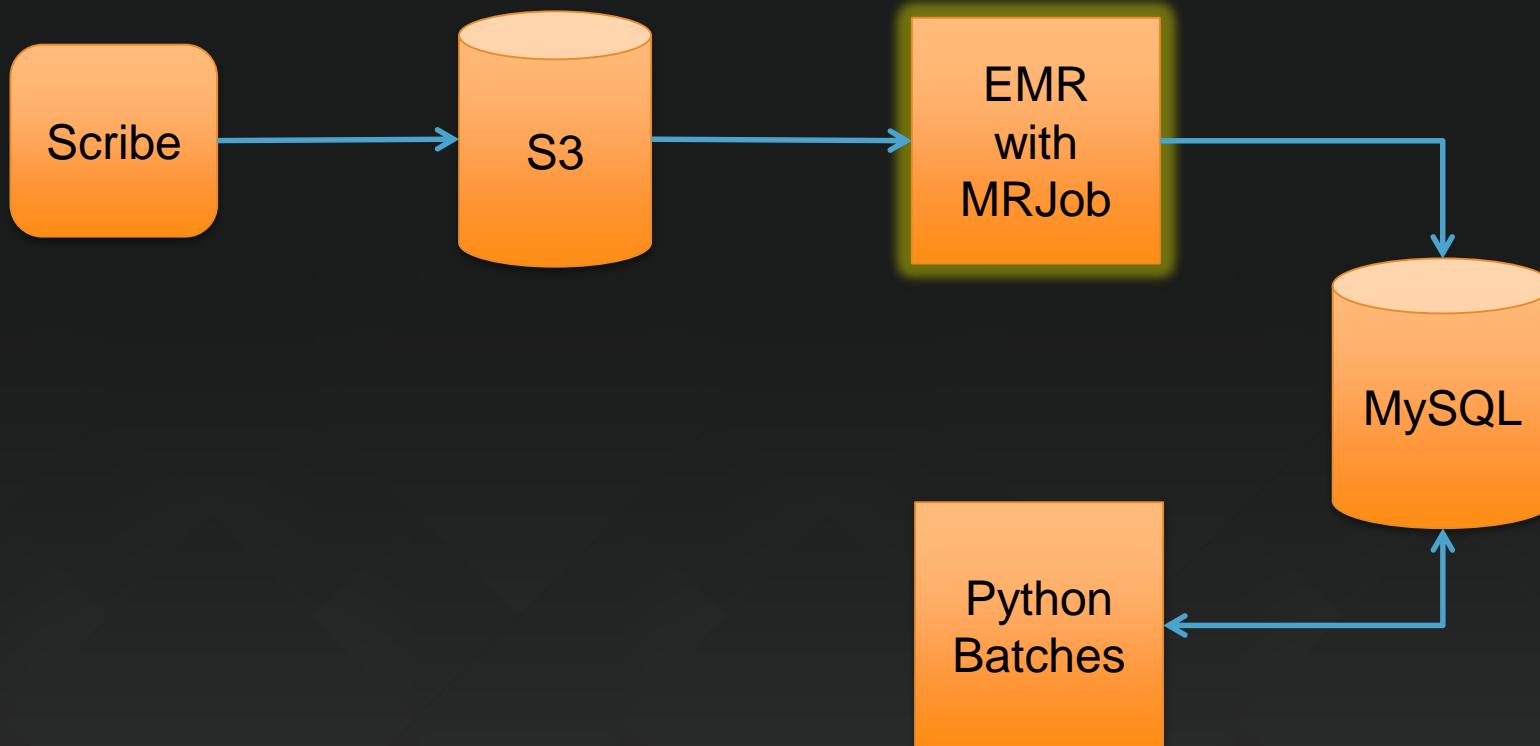
Most reviews on Yelp come from regular writers like Eliza D.  
They explore everything local... even around your corner.

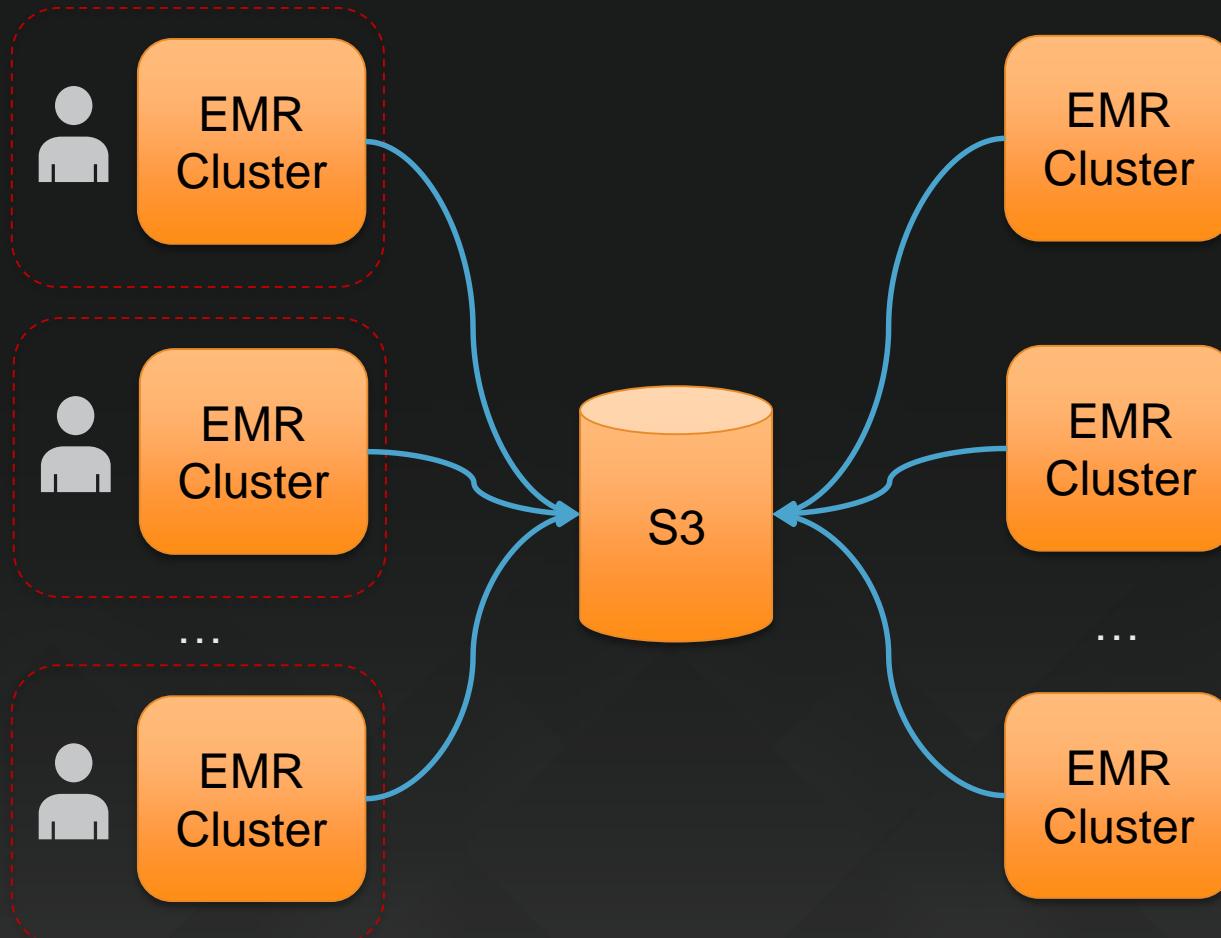


# Evolved Data Infrastructure



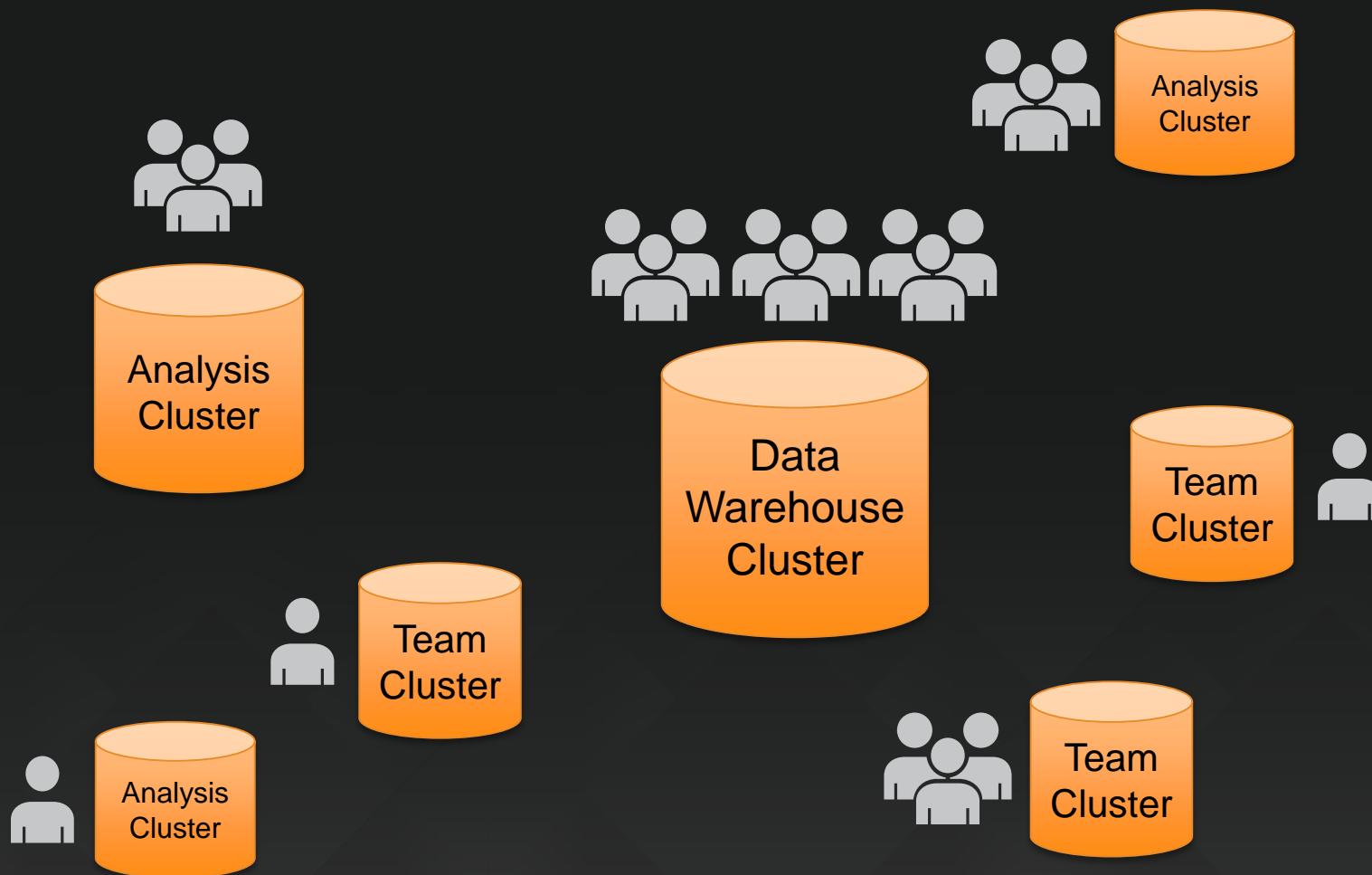
# Evolved Data Infrastructure





```
python my_job.py -r emr s3://my-inputs/input.txt
```





# Who Owns Clusters?



- Every Data Team – Front-end and Back-end Too
- Why so many?
  - Decouples Development
  - Decouples Scaling
  - Limits Contention Issues



**ads**

**Gary Danko**

Find tacos, cheap dinner, Max's

Near San Francisco, CA

Home About Me Write a Review Find Friends Messages Talk Events

Write a Review Add Photo Share Bookmarks

SSSS American (New)

Map city ©2014 Google. Screenshot

800 N Point St  
San Francisco, CA 94109  
Fisherman's Wharf, Russian Hill

Get Directions H1B; 749-2080 garydanko.com



See all 3266 photos

"For a "fancy" restaurant the place is not pretentious at all." in 202 reviews Ambience: Upscale

"I selected the Lemon Pepper Duck Breast with Duck Hash, and I am SO happy I did!" in 92 reviews

"Thankfully, the foie gras didn't overwhelm the stuffing combination and I felt it went very well w/ the quail." in 354 reviews Quail Salad - View the full menu

Show more review highlights

aliment 4.5 104 reviews 1.2 miles away from Gary Danko

Blake B. said "We had a great brunch at Aliment a few weeks back. We were the first to open and didn't have a reservation but were..." read more

Recommended Reviews

Search reviews

English 3768

Jessie N. 4.5 125 friends 39 reviews 4/21/2014 I check-in here Listed in MY ULTIMATE FAVORITE LIST!

AMAZINGLY SPECIAL! What a night of great food, attentive waitstaff and loving company.

Just as they claimed, we stepped foot into a world of



Today 5:30 pm - 12:00 am Open now

Full menu

Price range: Above \$61

Health score: 92 out of 100

Vegetarians go nuts for this spot. See other places they like.

Work here? Claim this business

Hours

Mon 5:30 pm - 12:00 am  
Tue 5:30 pm - 12:00 am  
Wed 5:30 pm - 12:00 am Open now  
Thu 5:30 pm - 12:00 am  
Fri Closed





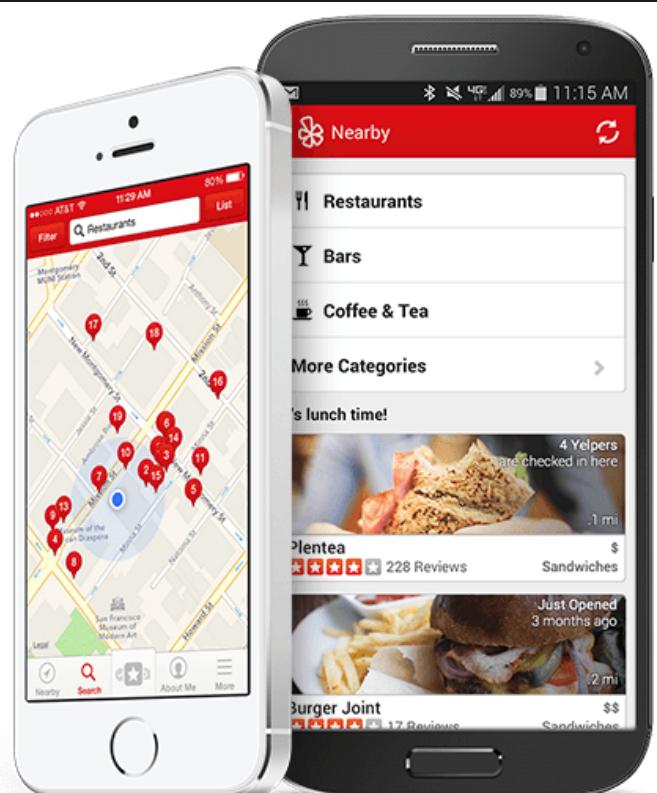
# Heading out? Bring Yelp with you.

The free Yelp mobile app is the fastest and easiest way to search for businesses near you. Download it now to get started.

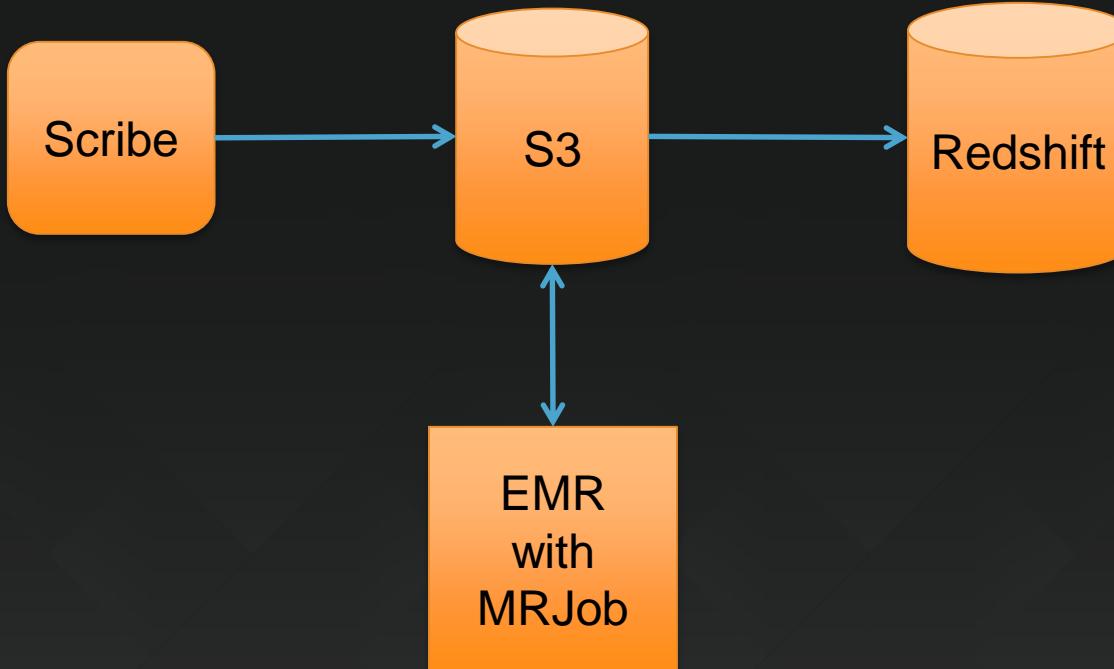
Enter your number and we'll send you a link to install the app.

[Send link to phone](#)

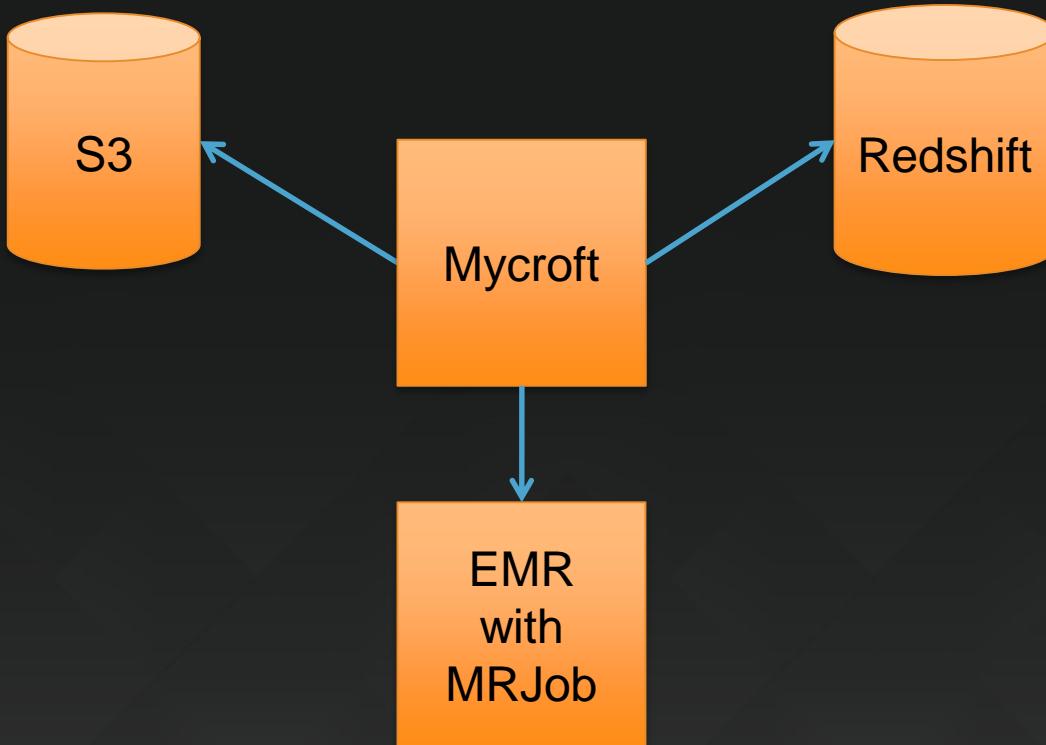
We don't charge for this service. Standard messaging rates apply.

 [Write & read reviews](#) [Get directions](#) [Browse nearby](#) [View menu](#) [Add & view photos](#) [Check-in](#)

# Data Loading Patterns - EMR



# Mycroft - Specialized EMR



[github.com/Yelp/mycroft](https://github.com/Yelp/mycroft)



# Mycroft - Specialized EMR



Start new job

**Redshift ID**  
pao-sq-vpc

**Schema** ranger      **Schema version** initial

**S3 path (Enter log name for instant search)**  
s3://yelp-sorted-logs-us-west-2/logs/sorted\_ranger/

**Start date** 2015-03-25      **End date (optional)**

Leave this field empty to have the Redshift cluster be updated daily after catching up from the start date

**Contact Emails**  
paloalto-dev@yelp.com, search@yelp.com

Comma-separated list of email addresses to associate with this job. These email addresses will be notified on completion or error.

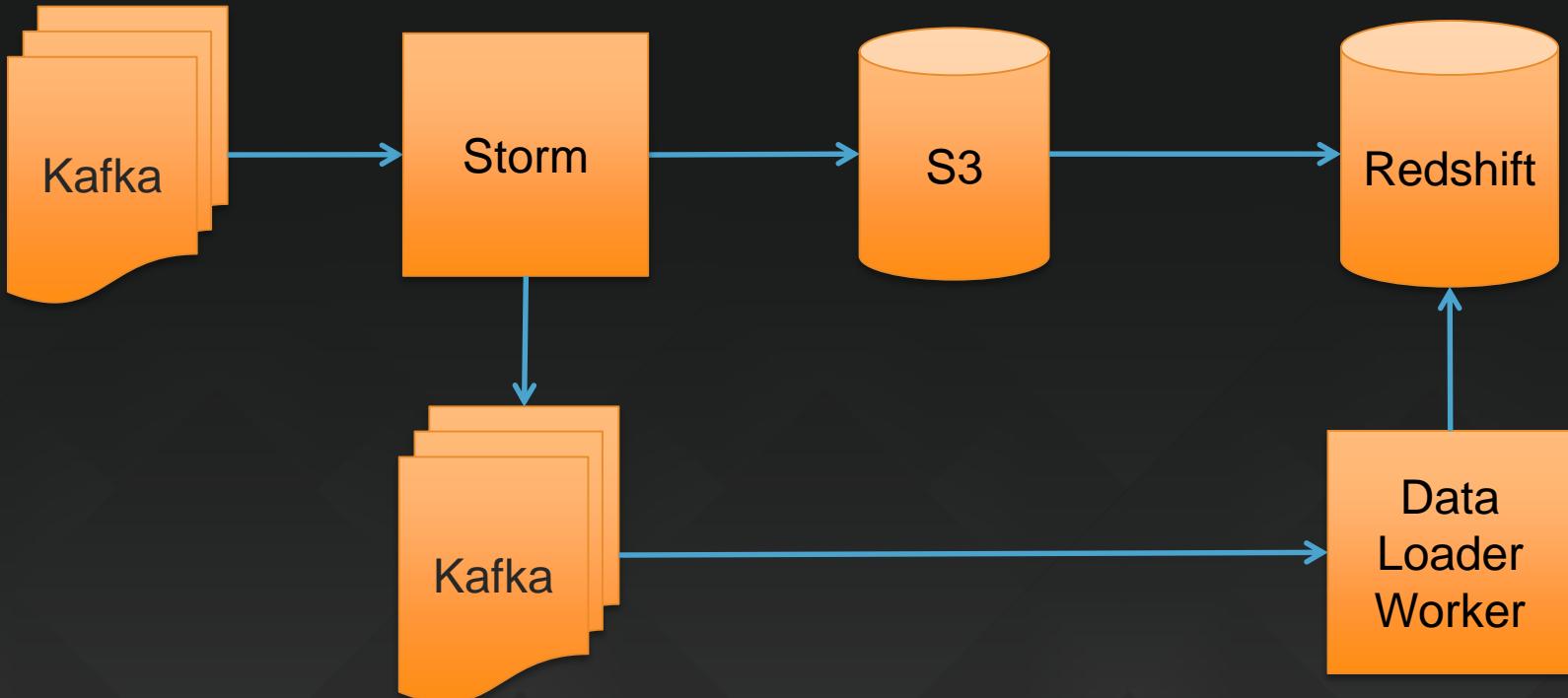
**Additional Arguments (extra for experts)**

**Create Job**

github.com/Yelp/mycroft



# Kafka and Storm



[github.com/Yelp/pyleus](https://github.com/Yelp/pyleus)



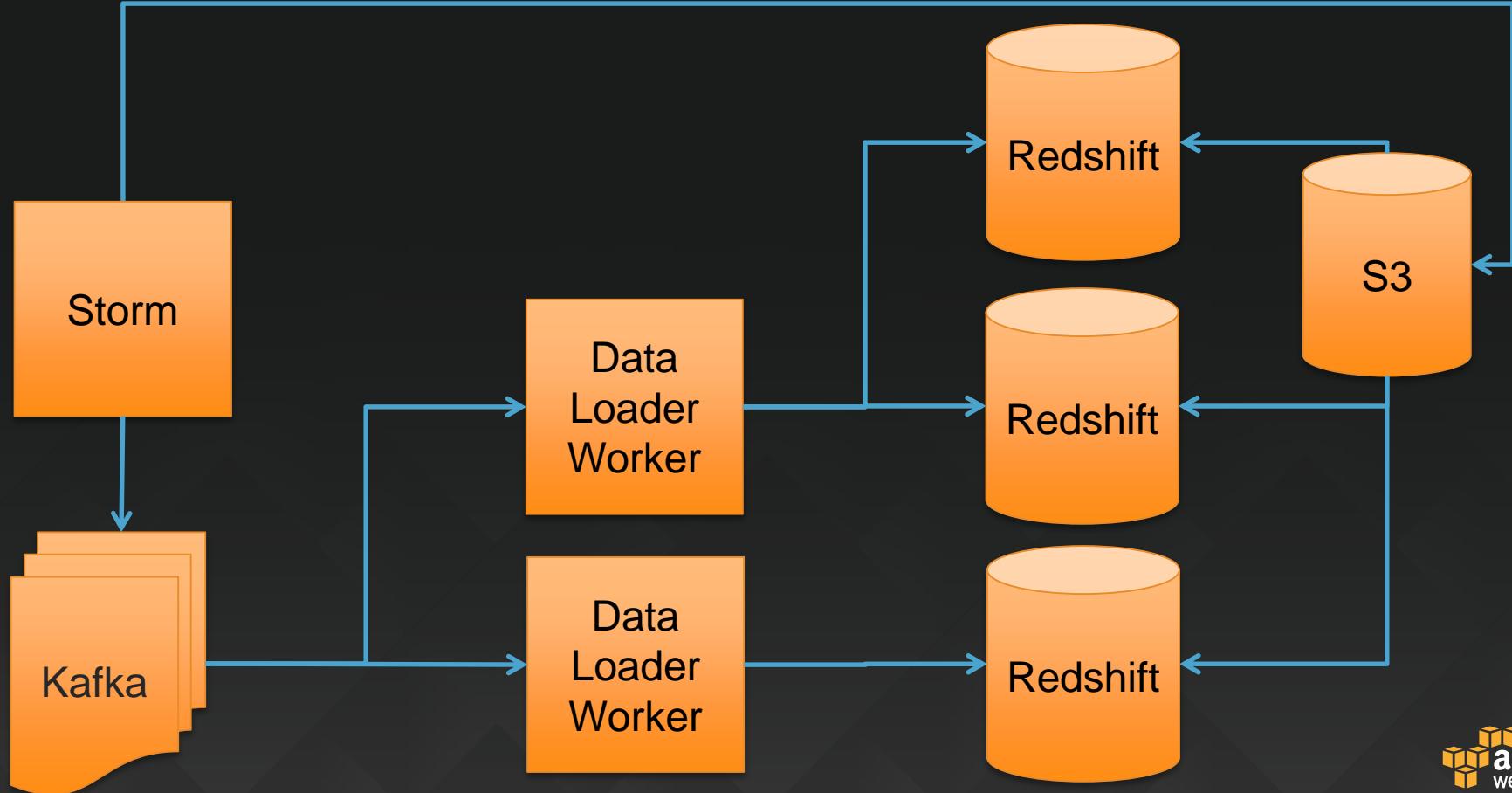
# Data Loading Best Practices



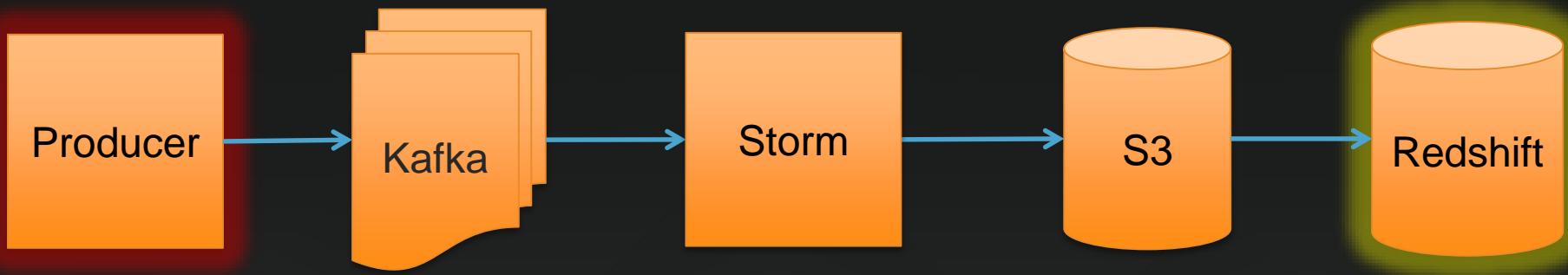
- Batch Updates
- Use Manifest Files
- Make Operations Idempotent
- Design for Autorecovery



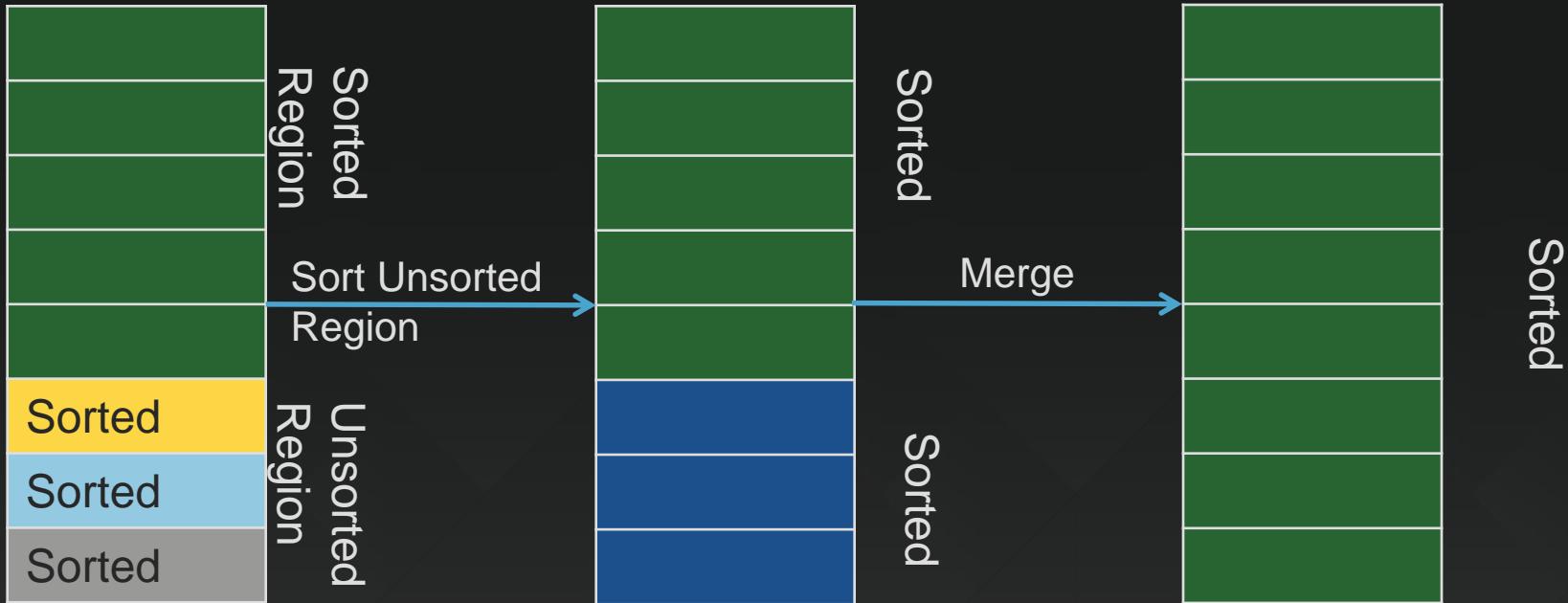
# Support Multiple Clusters



ETL -> ELT



# Time Series Data – Vacuum Operation



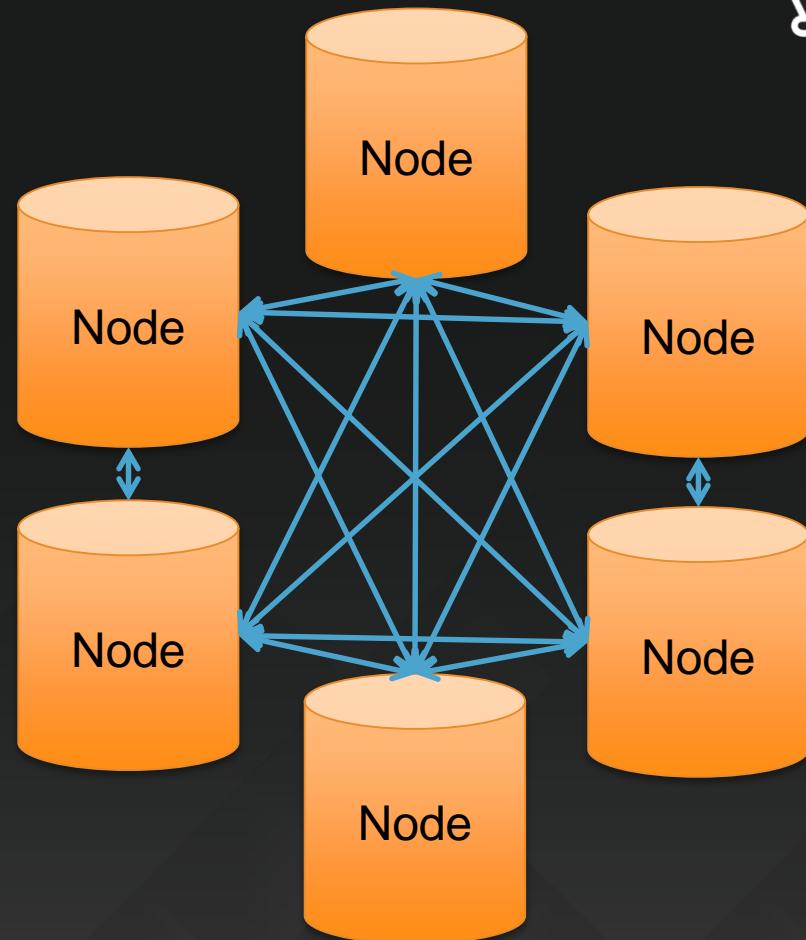
Append in Sort Key Order

# Distkeys



business
<b>id</b>
name
...

business_image
<b>id</b>
<b>business_id</b>
url
...



# Take Advantage of Elasticity



"The BI team wanted to calculate some expensive analytics on a few years of data, so we just restored a snapshot and added a bunch of nodes for a few days"

# Monitoring



**Whenever:** PercentageDiskSpaceUsed

**is:**

**for:**  consecutive period(s)

## Actions

Define what actions are taken when your alarm changes state.

Notification	Delete
<b>Whenever this alarm:</b> State is ALARM	<input type="button" value="Delete"/>
<b>Send notification to:</b> bam-dwv1	<input type="button" value="New list"/> <input type="button" value="Enter list"/>
<b>Email list:</b> justinc@yelp.com	<input type="button" value="Delete"/>

# Querying: Use Window Functions



```
SELECT AVG(event_count) OVER (
    ORDER BY event_timestamp ROWS 2 PRECEDING
) AS average_count, event_count, event_timestamp
FROM events_per_second ORDER BY event_timestamp;
```

average_count	event_count	event_timestamp
50	50	1427315395
53	57	1427315396
65	88	1427315397
53	14	1427315398
58	72	1427315399

More Information: <http://bit.ly/1FeqDp1>



# Open-Source Tools



- [github.com/Yelp/mycroft](https://github.com/Yelp/mycroft)
  - Redshift Data Loading Orchestrator
- [github.com/Yelp/mrjob](https://github.com/Yelp/mrjob)
  - EMR in Python
- [github.com/Yelp/pyleus](https://github.com/Yelp/pyleus)
  - Storm Topologies in Python



Thank You  
SAN FRANCISCO





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# AWS Summit

SAN FRANCISCO

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