[544] BigQuery: Complex Types

Meenakshi Syamkumar

Learning Objectives

- authenticate on a GCP VM to gain access to BiqQuery datasets
- execute BiqQuery queries in a variety of settings (console, Jupyter with extension, Python call)
- query complex data types (arrays and structs) using correlated cross joins

Demos...

Outline

Types: Simple and Arrays/Structs

Cross Joining

Unnesting, Correlated Cross Join

Geographic Data

Types

Basics

- BOOL, INT64, FLOAT64
- STRING, BYTES
- DATE, DATETIME
- etc.

Nesting

- **ARRAY** (repeated): `myarray[OFFSET(5)]`
- **STRUCT** (record) `mystruct.some_attribute`

example from https://cloud.google.com/bigquery/docs/nested-repeated

```
+-------------------+---------------------------------+-----------+
| title             | authors                         | num_pages |
+-------------------+---------------------------------+-----------+
| Example Book One  | [{123, Alex, 01-01-1960},       | 487       |
|                   |  {789, Kim, 01-01-1980}]        |           |
| Example Book Two  | [{456, Rosario, 01-01-1970}]    | 89        |
+-------------------+---------------------------------+-----------+
```

array of structs

struct

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Cross Joins

Previously covered JOIN types (they each specify "ON" to filter row pairings):

- INNER, LEFT, RIGHT

CROSS JOIN: every row in table 1 with every row in table 2

format 1

```
SELECT *
FROM tbl1
CROSS JOIN tbl2
```

format 2

```
SELECT *
FROM tbl1, tbl2
```

same meaning as format 1
(comma means "cross join")

tbl1

A	B
1	2
3	4

tbl2

C
X
Y

A	B	C
1	2	X
1	2	Y
3	4	X
3	4	Y

Cross Joins: Filtering

Predicates

- don't use "ON" as in other JOINs
- can optionally use "WHERE"

Naive version: get every combination of pairs, then filter down after.
Can we do better?

Sometimes query engines can optimize certain WHERE filters with CROSS JOIN.

BigQuery implements optimized spatial JOINs for INNER JOIN and CROSS JOIN operators with the following GoogleSQL predicate functions:

- `ST_DWithin`
- `ST_Intersects`
- `ST_Contains`
- `ST_Within`
- `ST_Covers`
- `ST_CoveredBy`
- `ST_Equals`
- `ST_Touches`

BigQuery Documentation

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Unnesting and Correlated Cross Join

```
SELECT x,y,z
FROM tbl
CROSS JOIN UNNEST(tbl.coord)
```

x	coord
1	[{2,3}, {4,5}]
6	[{7,8}, {9,10}]

unnest

y	z
2	3
4	5

y	z
7	8
9	10

different logical table for each row

Unnesting and Correlated Cross Join

SELECT x,y,z
FROM **tbl**
CROSS JOIN UNNEST(**tbl.coord)**

x	coord
1	[{2,3}, {4,5}]
6	[{7,8}, {9,10}]

unnest

y	z
2	3
4	5

y	z
7	8
9	10

x	y	z
1	2	3
1	4	5
6	7	8
6	9	10

"correlated" means we only cross against table unnested from row. No output row contains 5 and 6 for example.

TopHat

Outline

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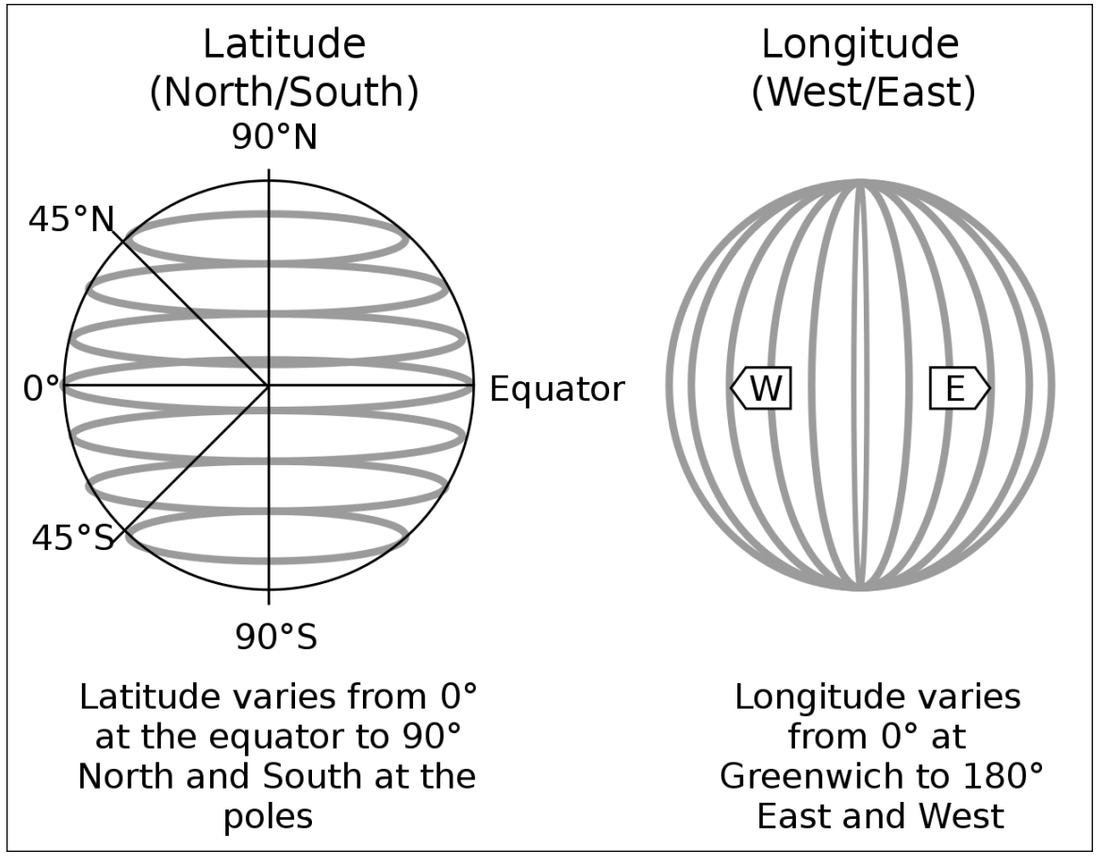
Geographic Data

Coordinate reference systems

- way to associate coordinates with a point on earth
- latitude/longitude (used by GPS) is most famous
- some systems incorporate altitude too (3D coordinate system)



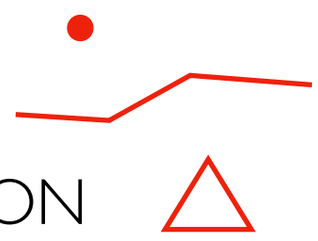
https://en.wikipedia.org/wiki/Geographic_coordinate_system#/media/File:FedStats_Lat_long.svg

BigQuery support

- common geo operations (e.g., geographic joins)
- uses lat/lon by default (no altitude)

Shape constructors

- ST_GEOGPOINT
- ST_MAKELINE
- ST_MAKEPOLYGON



other shape (e.g., multi-polygons) are possible with operations on these

Demos...

[544] BigQuery: Data Sources and Geographic Data

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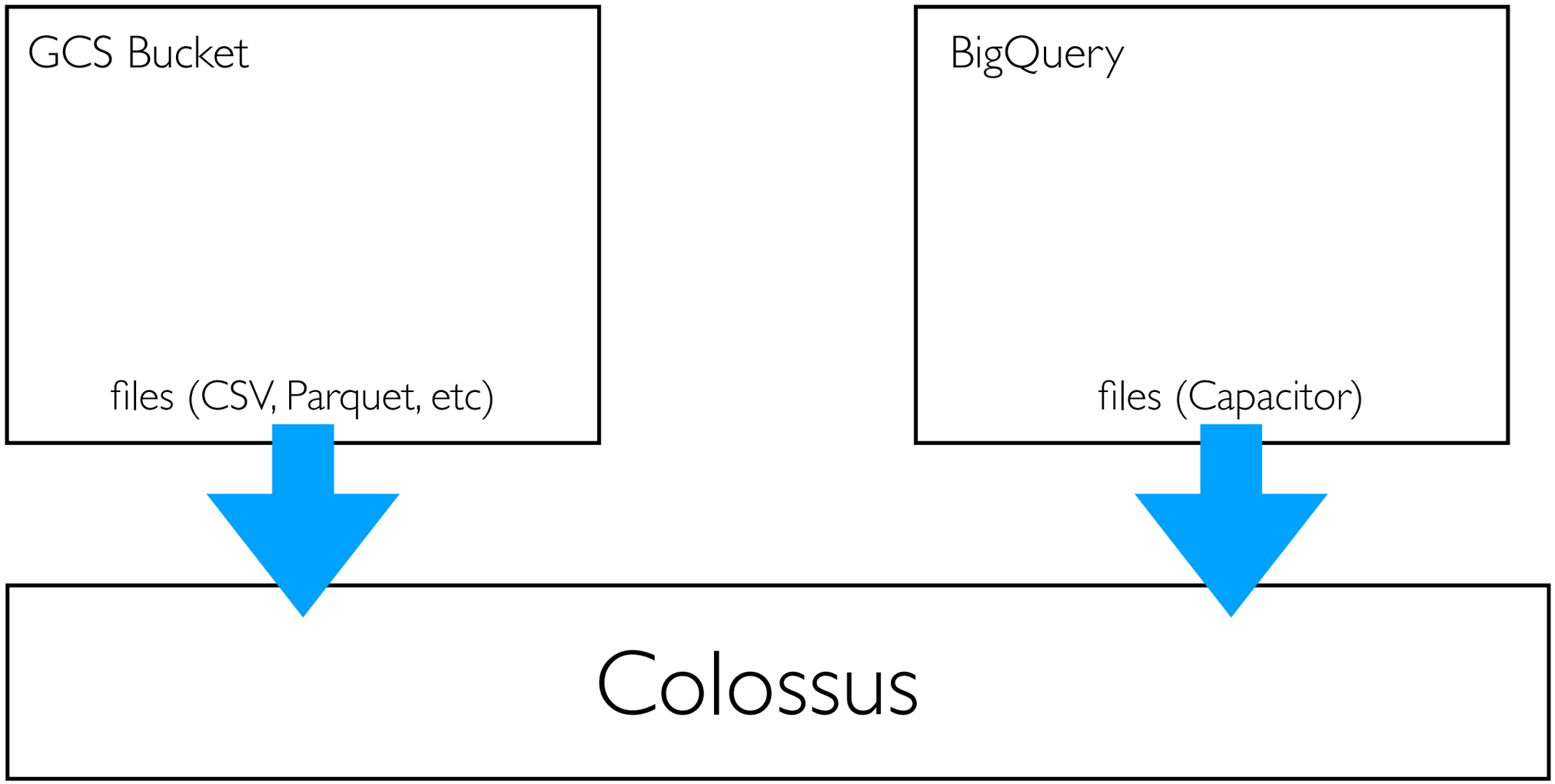
Learning Objectives

- interact with a GCS bucket
- write load queries to bring data from various sources into BigQuery
- create Dataform pipelines to populate BigQuery datasets:
- perform spatial operations on geographic data

Table Types: Standard Tables, External Tables, and Views



https://cloud.google.com/bigquery/docs/tables-intro
https://cloud.google.com/blog/products/bigquery/inside-capacitor-bigquerys-next-generation-columnar-storage-format

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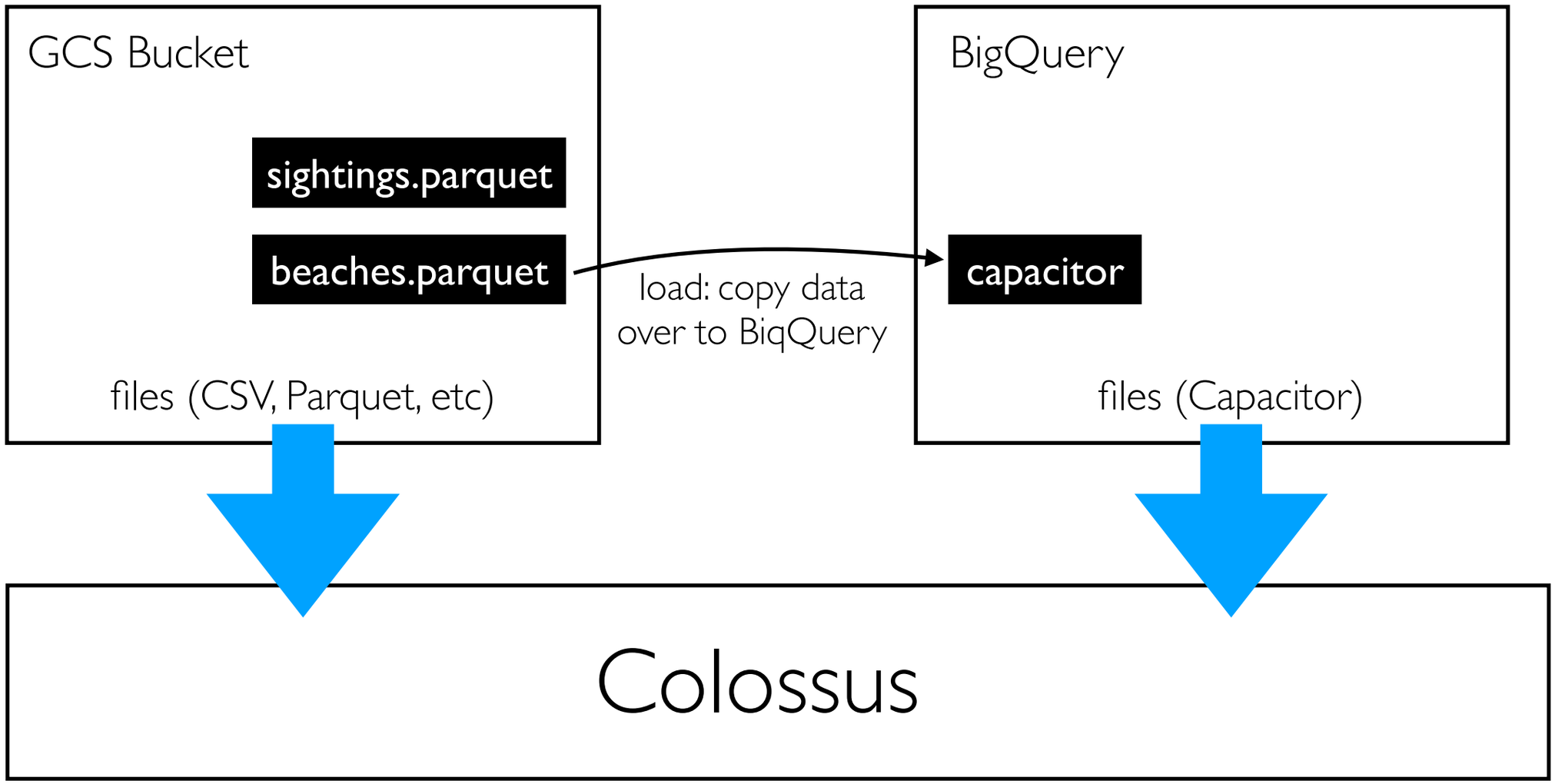

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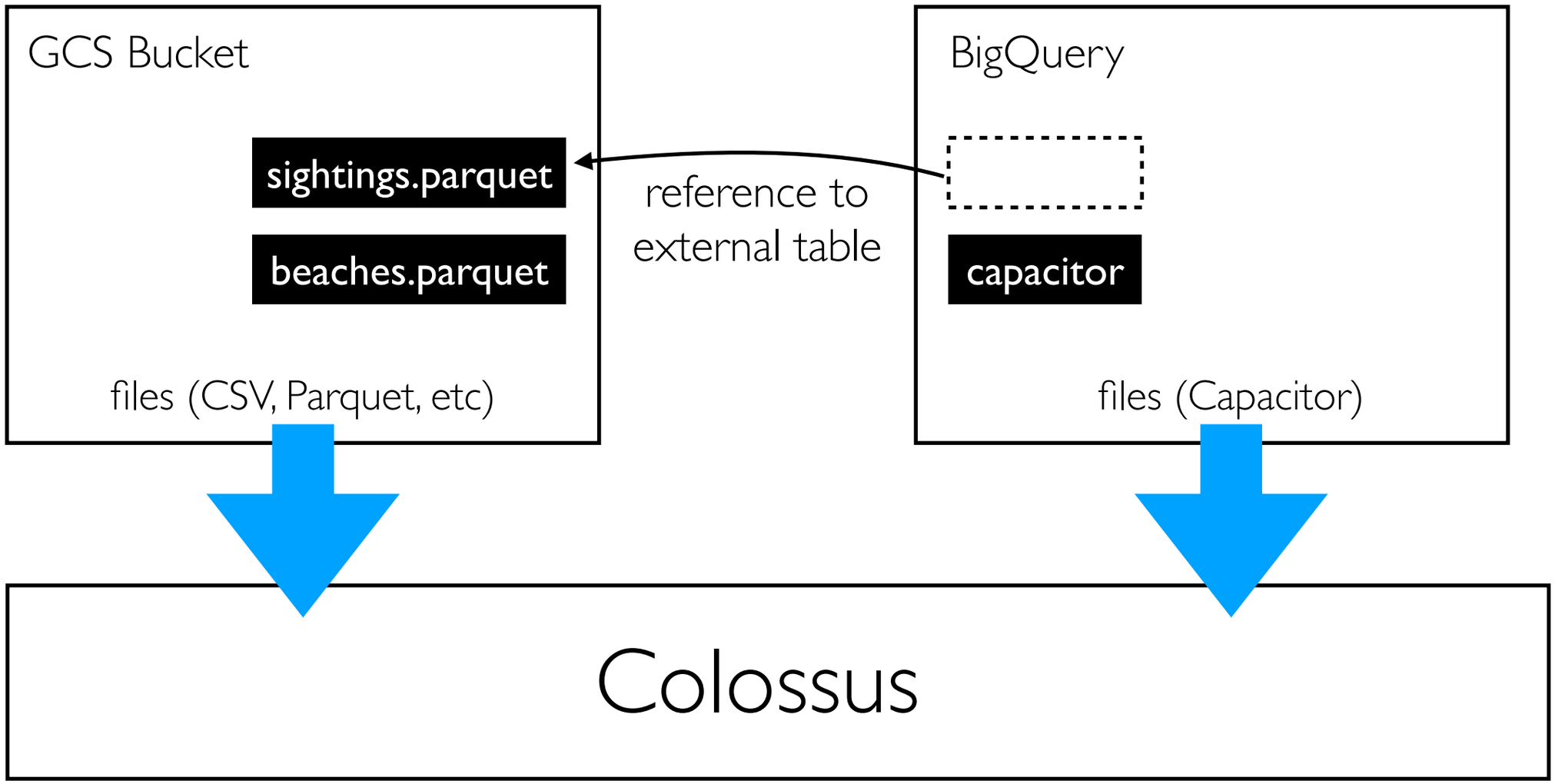

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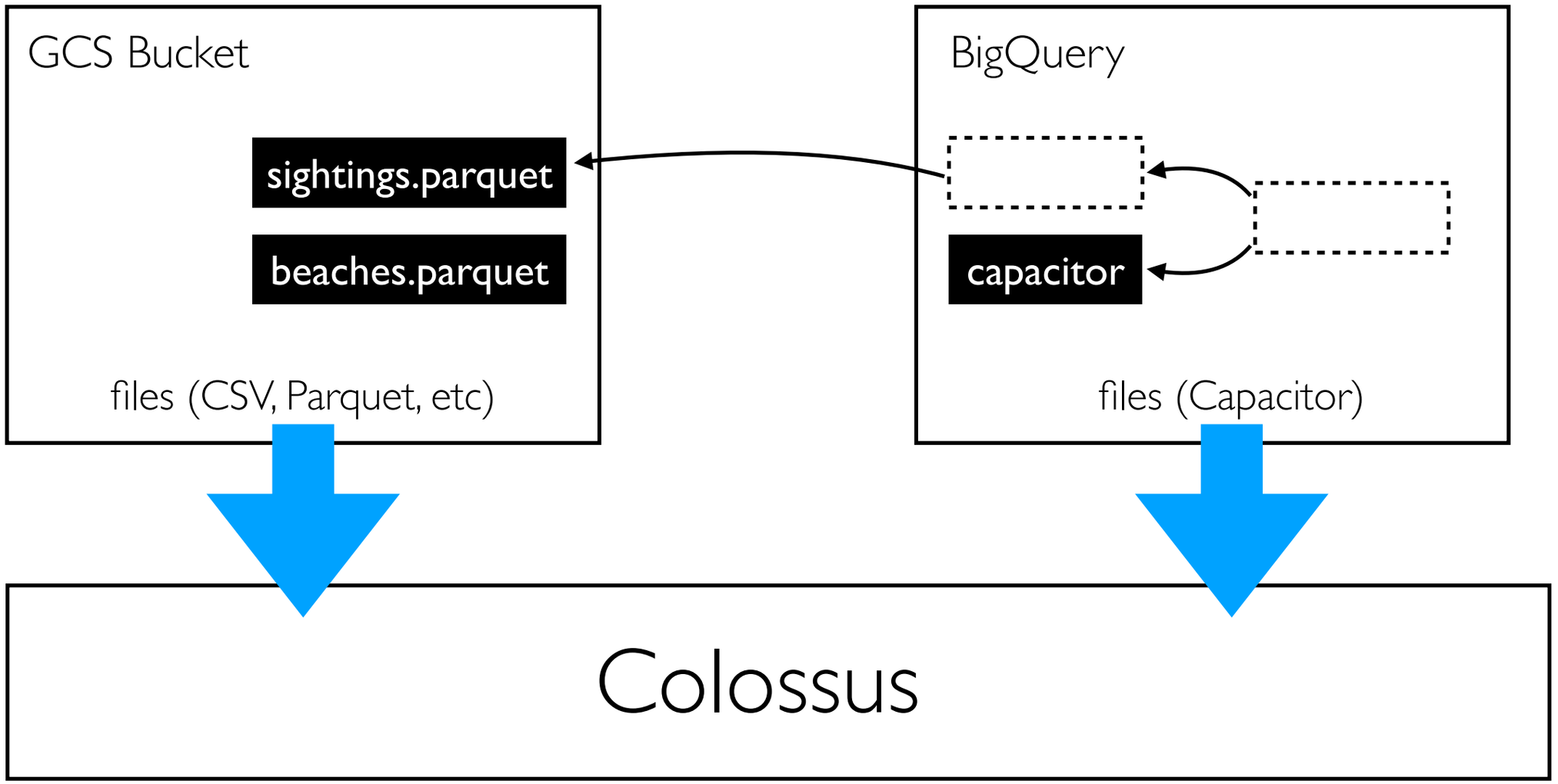
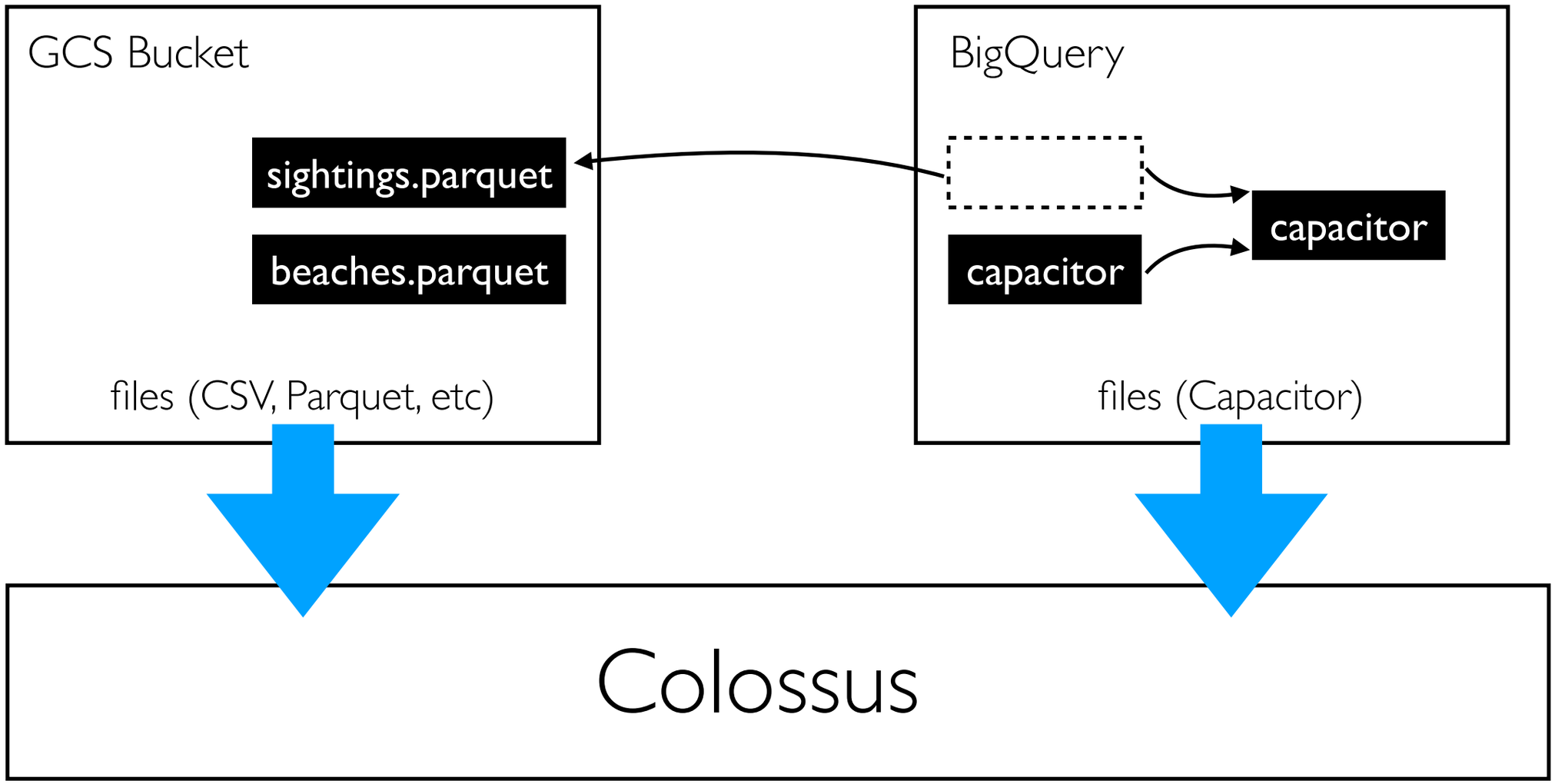
Table Types: Standard Tables, External Tables, and Views



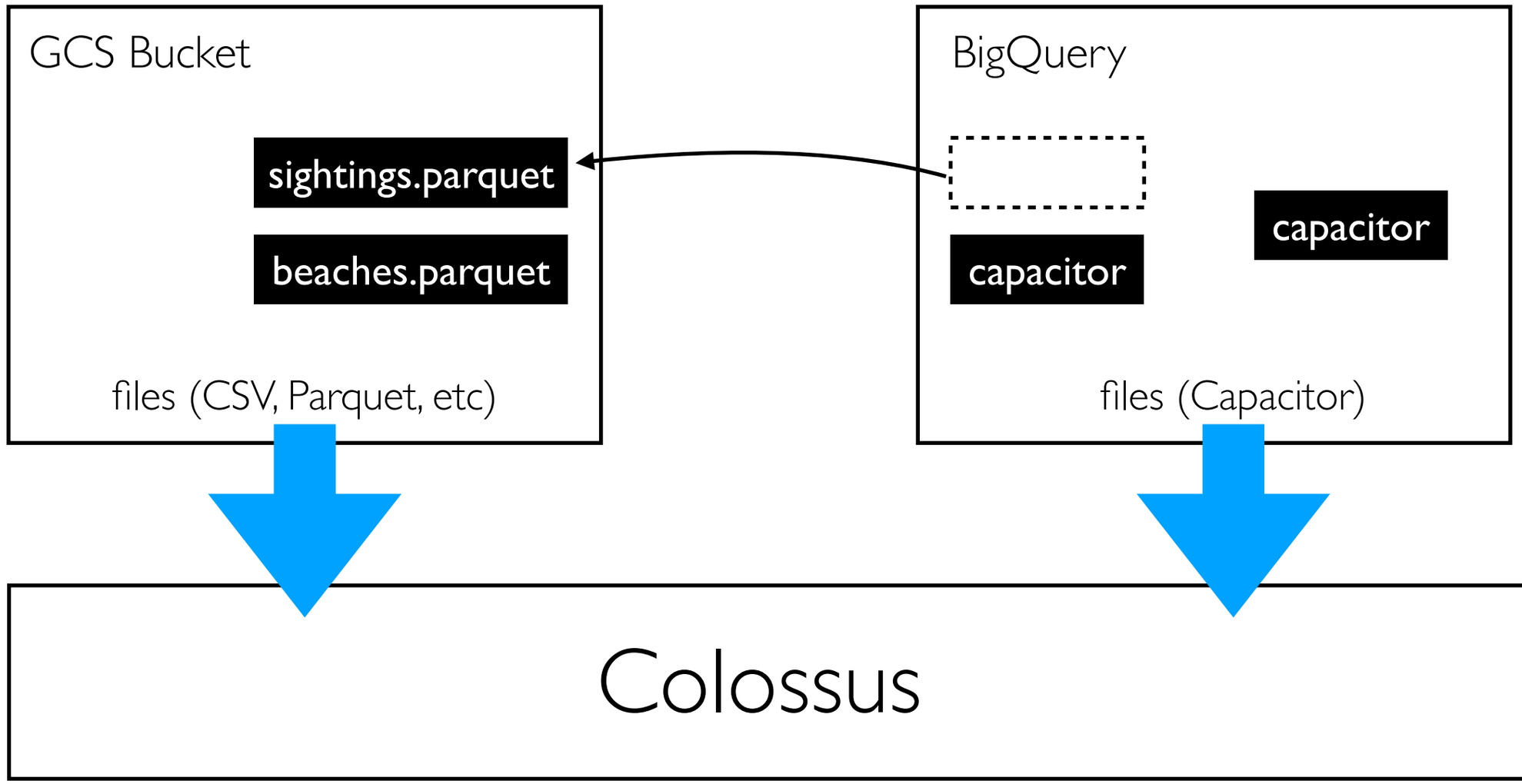

```
CREATE VIEW beach_animals
AS
SELECT s.*
FROM sightings s
JOIN beaches b ON s.beach_id = b.beach_id
ON b.name = "Bernies Beach";
```

Using a Standard Table as a Materialized "View"




```
CREATE TABLE beach_animals
AS
SELECT s.*
FROM sightings s
JOIN beaches b ON s.beach_id = b.beach_id
ON b.name = "Bernies Beach";
```

Performance

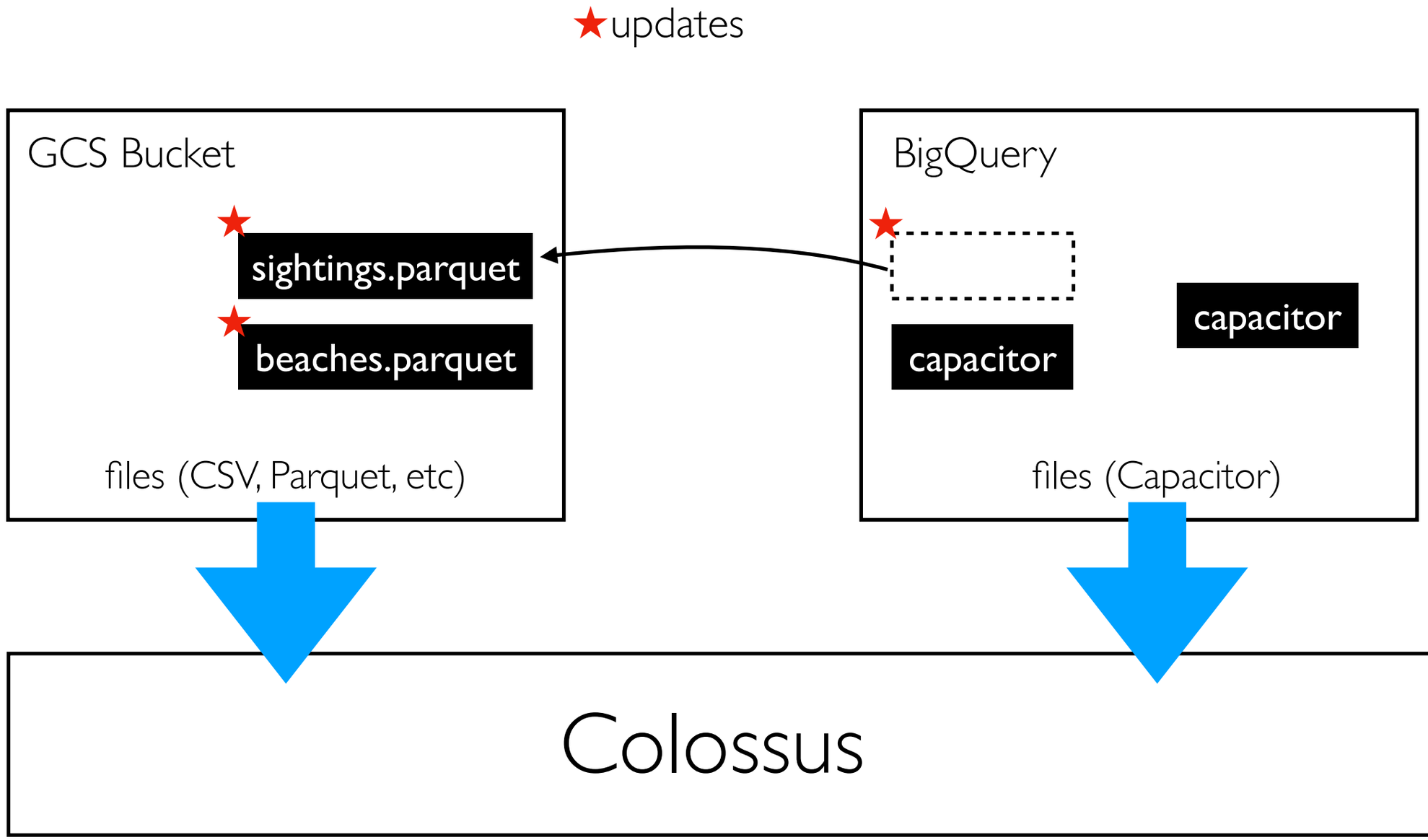


which approach will give us better performance and lower cost when querying beach_animals?

```
CREATE VIEW beach_animals
AS
...
```

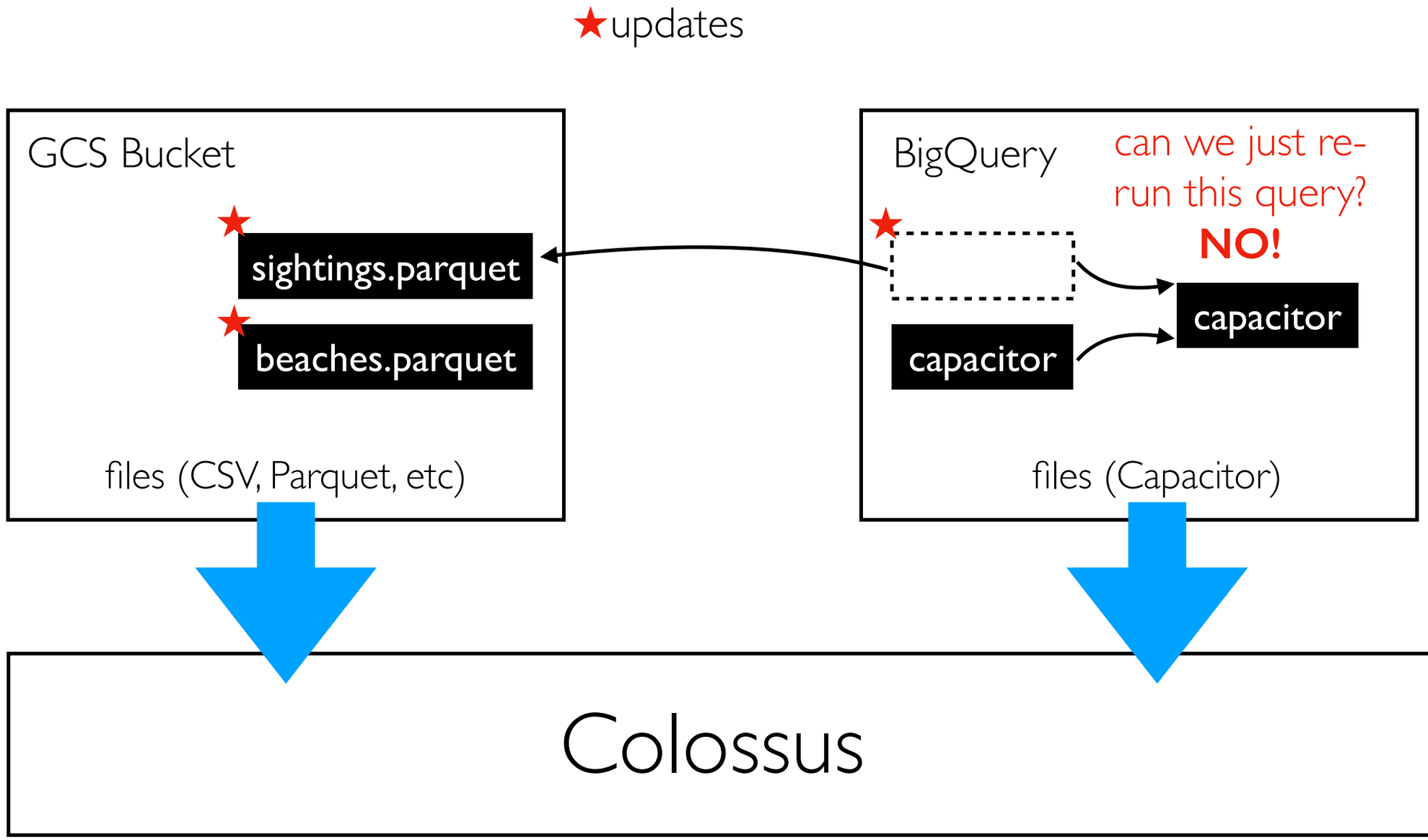
```
CREATE TABLE beach_animals
AS
...
```

Update Visibility



even though tables usually give the best performance and lowest cost, up-stream updates aren't immediately reflected (like they are with external tables and views)

Refreshing Materialized Data




```
CREATE TABLE beach_animals
AS
SELECT s.*
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ON b.name = "Bernies Beach";
```
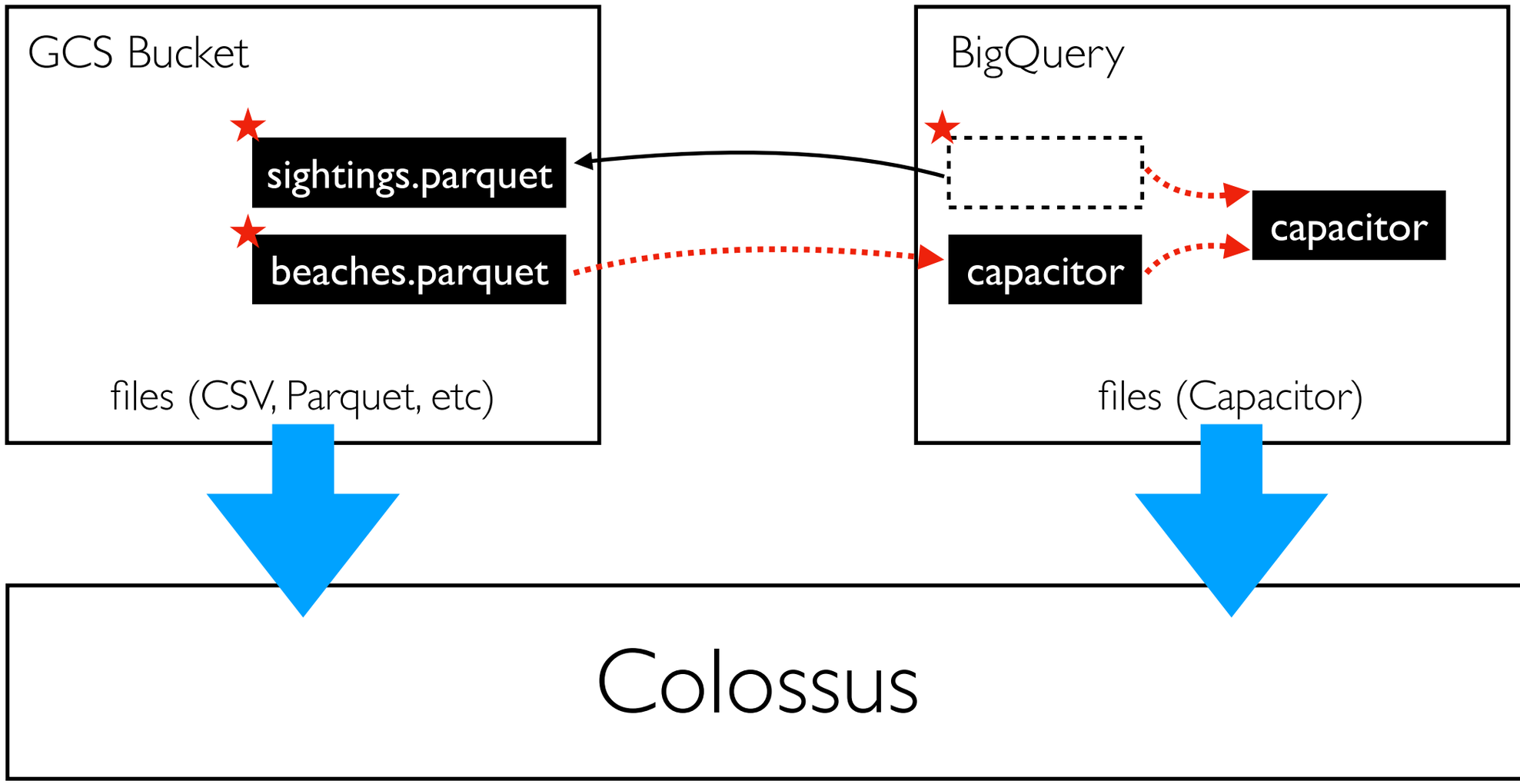

Dependency DAGs (Directed Acyclic Graphs)

★updates



we want to keep track of the graph of data dependencies so we can re-run the necessary operations in order to update a specific data resource.

very important for big DAGs (think 100s of nodes!)

Dataform

Key features

- version control on pipeline/DAG code (integrates with Git)
- adds syntax to SQL for specifying references to data objects
- infers DAG structure, enabling runs with dependencies
- scheduler integration

our focus

Cost

- free, because you end up paying for BigQuery when you use Dataform

Demos...