SASI, Cassandra on the full text search ride

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4	Query planner
5	Some benchmarks
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SASI introduction

What is SASI ?

- **S**STable-**A**ttached **S**econdary **I**ndex → new 2nd index impl that follows SSTable life-cycle

- Objective: provide more performant & capable 2nd index

Who created it ?

Open-source contribution by an engineers team

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- Joined on May 17, 2010

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- Joined on May 11, 2012

Why is it better than native 2nd index ?

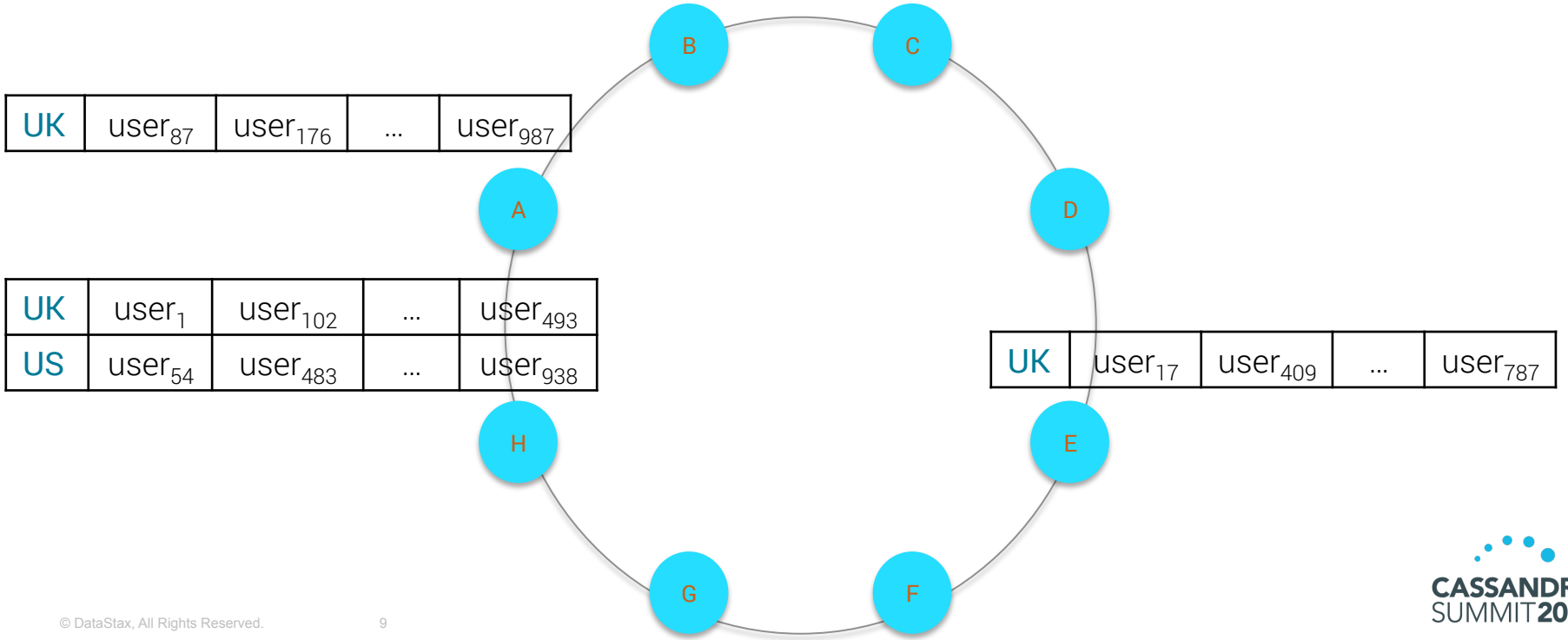
- follow SSTable life-cycle (flush, compaction, rebuild …) → more optimized
- new data-strutures
- range query (<, ≤, >, ≥) possible
- full text search options

Demo

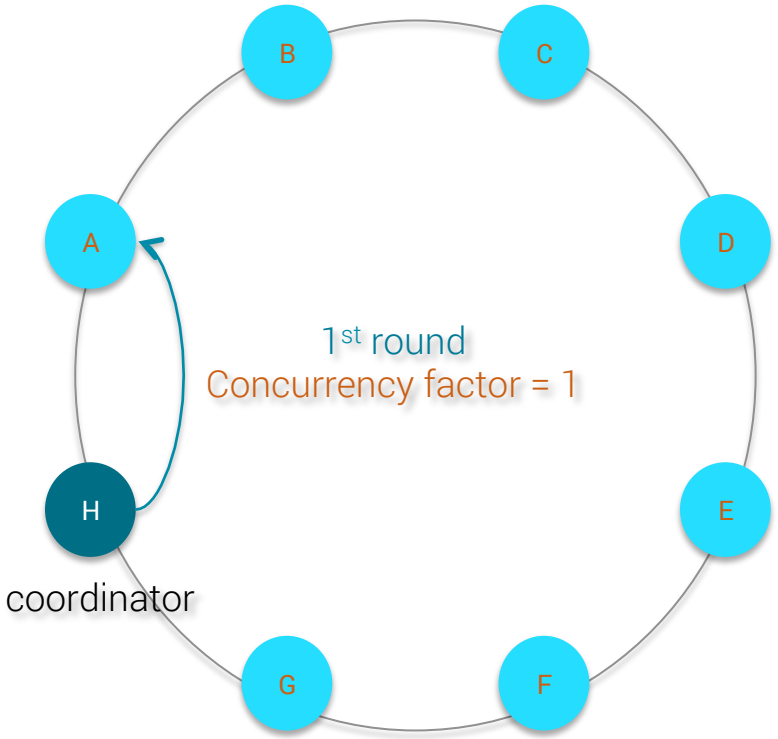
SASI cluster-wide

Distributed index

On cluster level, SASI works exactly like native 2nd index



Distributed search algorithm



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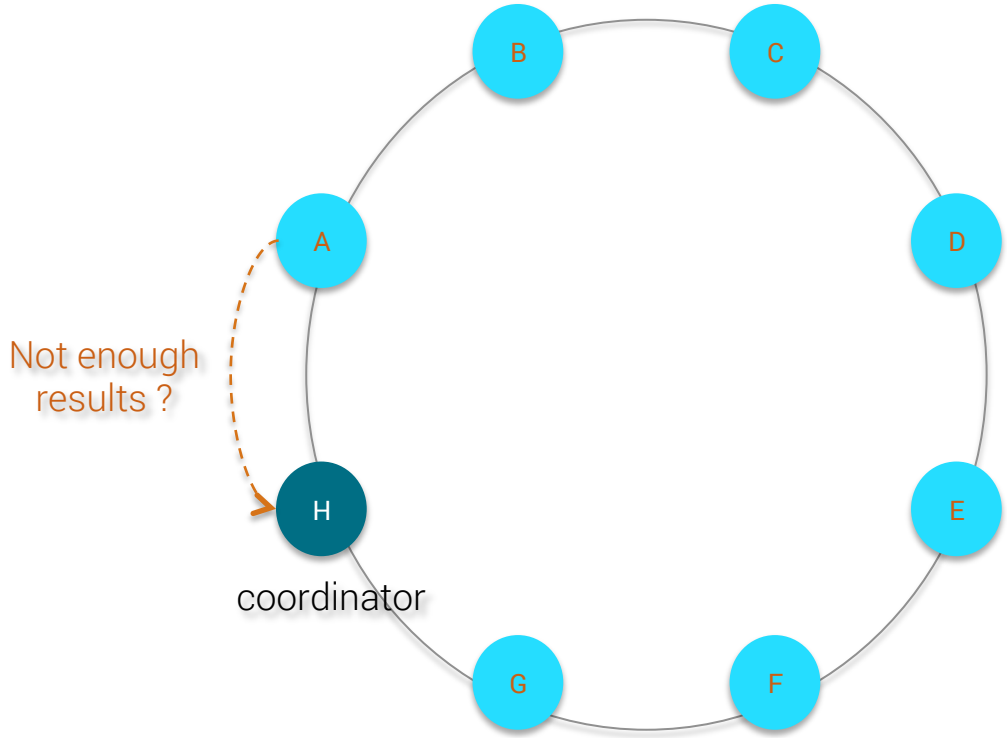
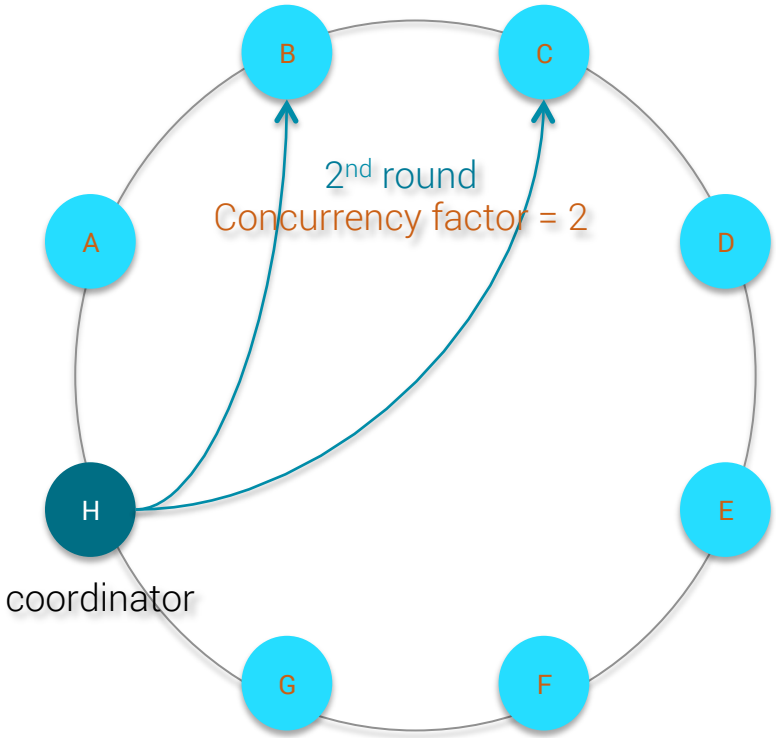
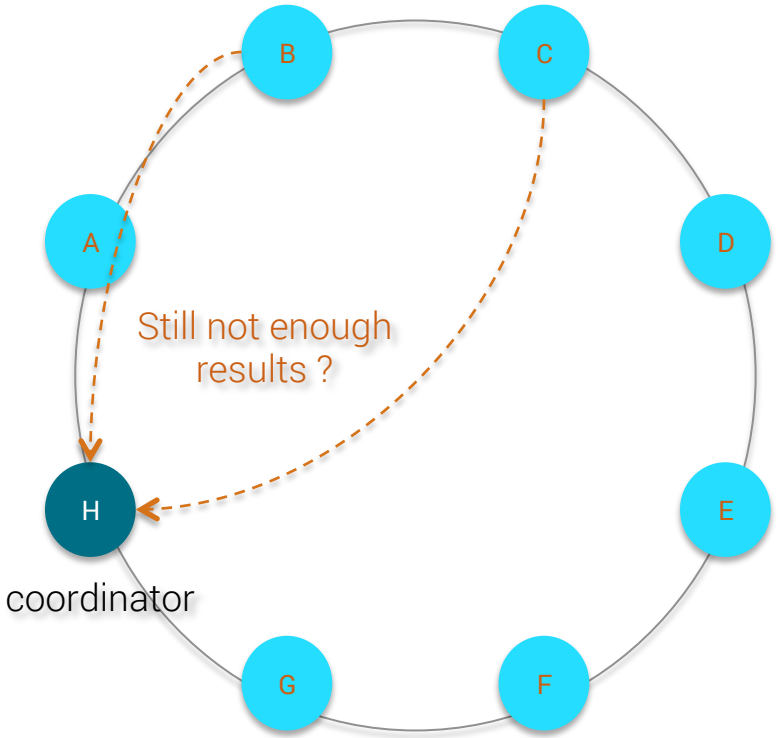


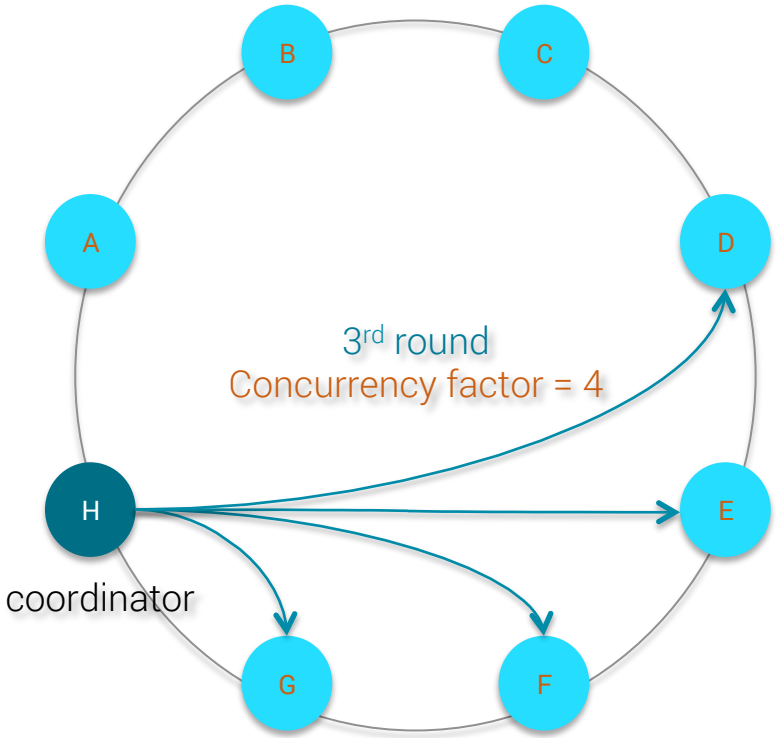
Distributed search algorithm



Distributed search algorithm



Distributed search algorithm



Concurrency factor formula

$$\text{CONCURRENCY\_FACTOR} = \max\left(1, \min\left(token\_range\_count, \left\lceil \frac{requested\_LIMIT}{estimate\_rows\_by\_token\_range} \right\rceil\right)\right)$$

$$estimate\_rows\_by\_token\_range = \frac{estimate\_rows}{token\_range\_count \times replication\_factor}$$

- more details at: http://www.planetcassandra.org/blog/cassandra-native-secondary-index-deep-dive/

Concurrency factor formula

But right now …

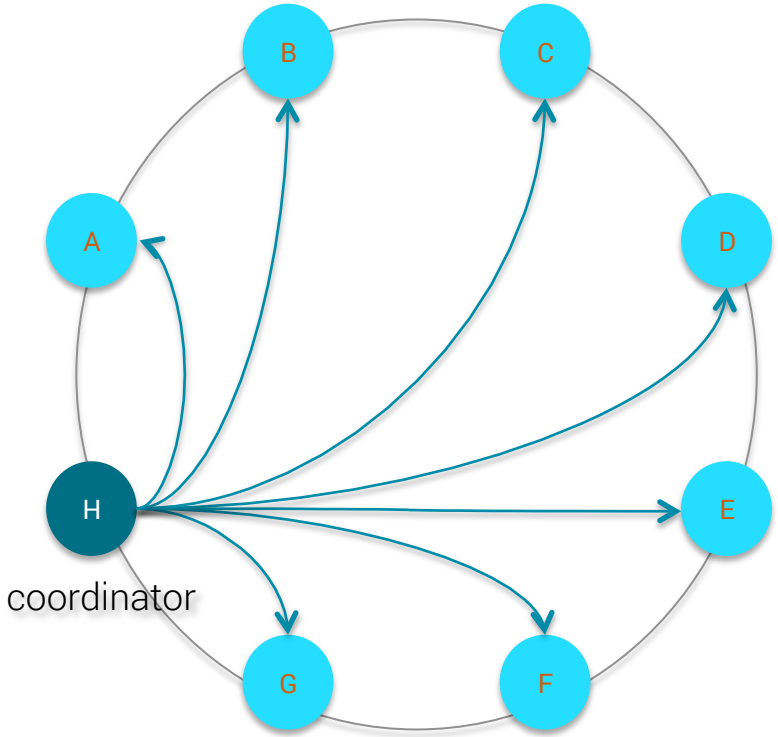
SASIIndex.getEstimatedResultRows()

```
1  public long getEstimatedResultRows()
2  {
3      // this is temporary (until proper QueryPlan is integrated into Cassandra)
4      // and allows us to priority SASI indexes if any in the query since they
5      // are going to be more efficient, to query and intersect, than built-in indexes.
6      return Long.MIN_VALUE;
7  }
```

So initial concurrency factor always = *max(1, negative number)* = 1 for 1st query round with SASI …

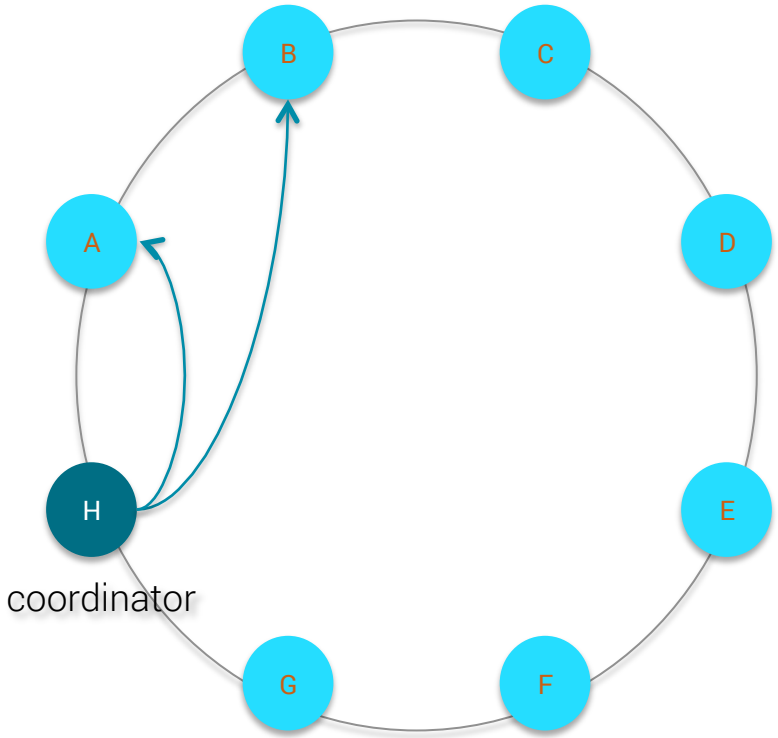
Caveat 1: non restrictive filters

Hit all nodes eventually ☹

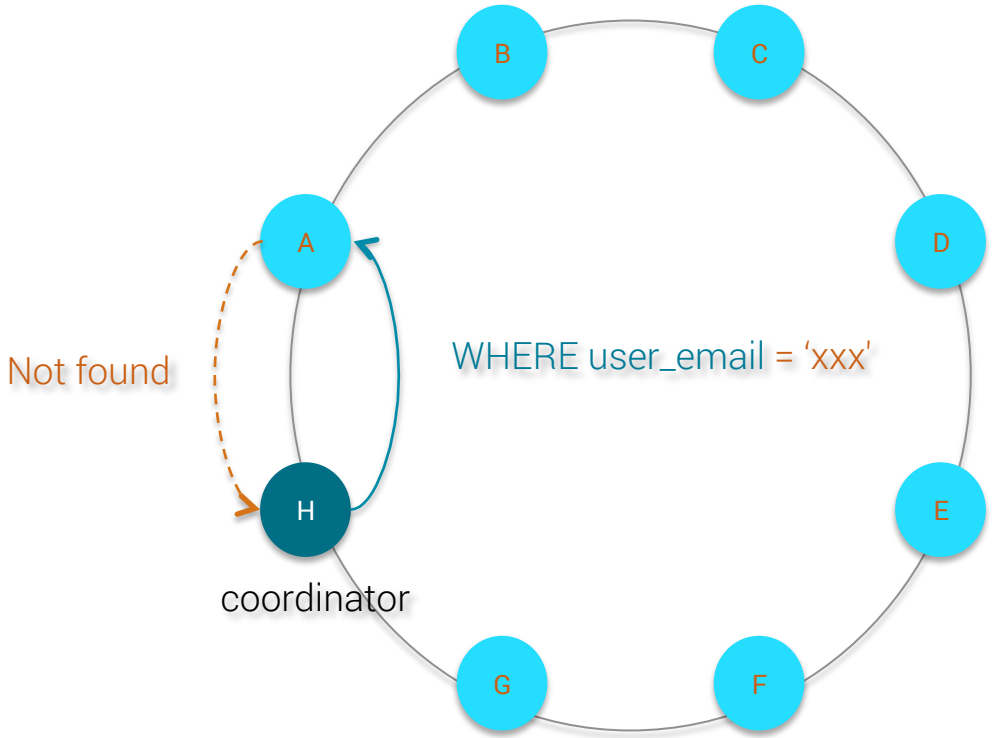


Caveat 1 solution : always use LIMIT

SELECT *
FROM …
WHERE …
LIMIT 1000



Caveat 2: 1-to-1 index (*user_email*)



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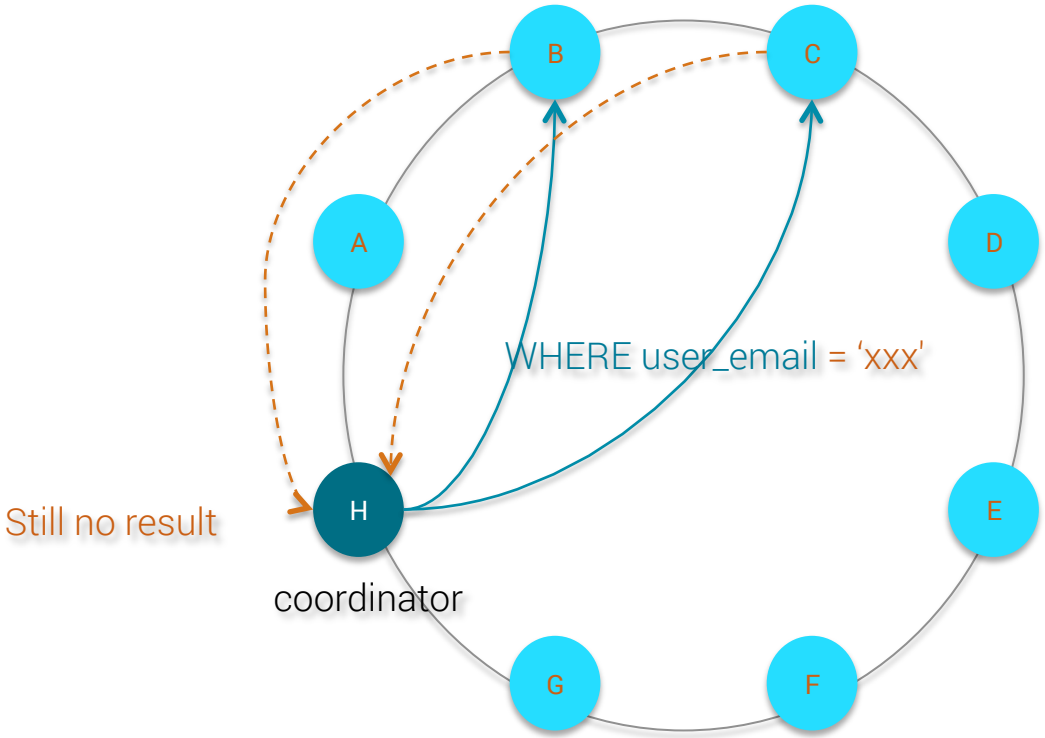

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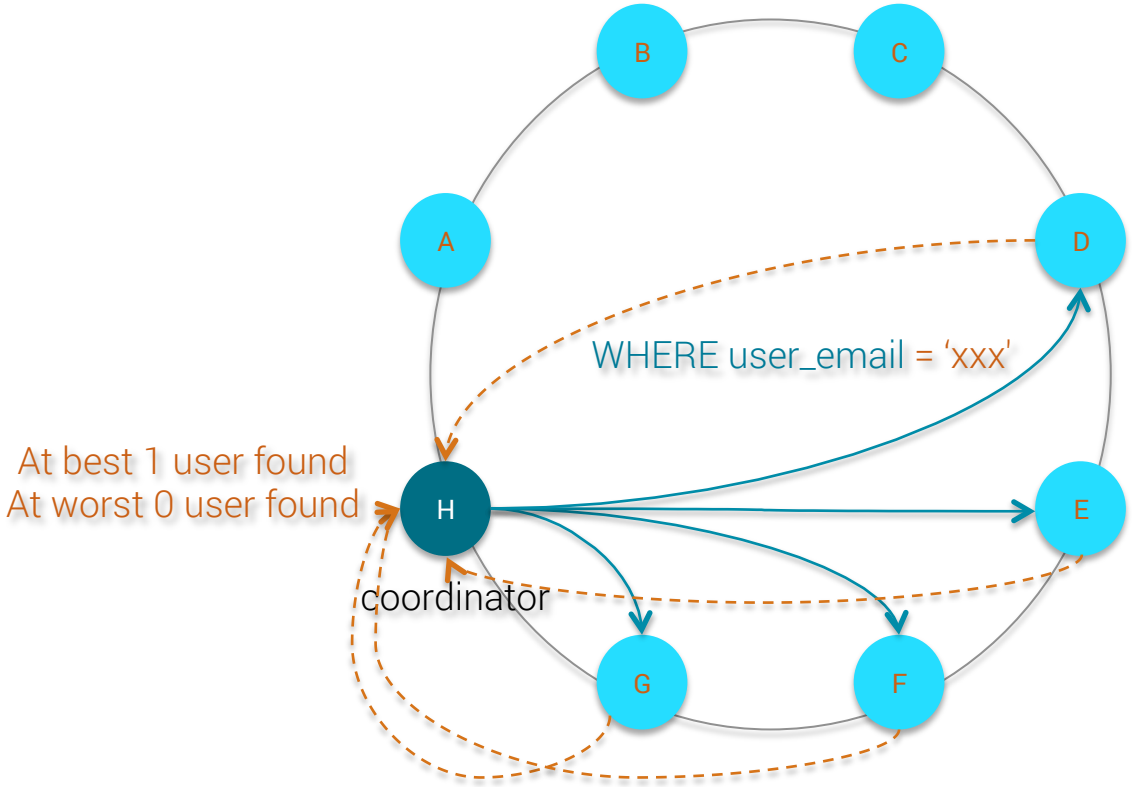


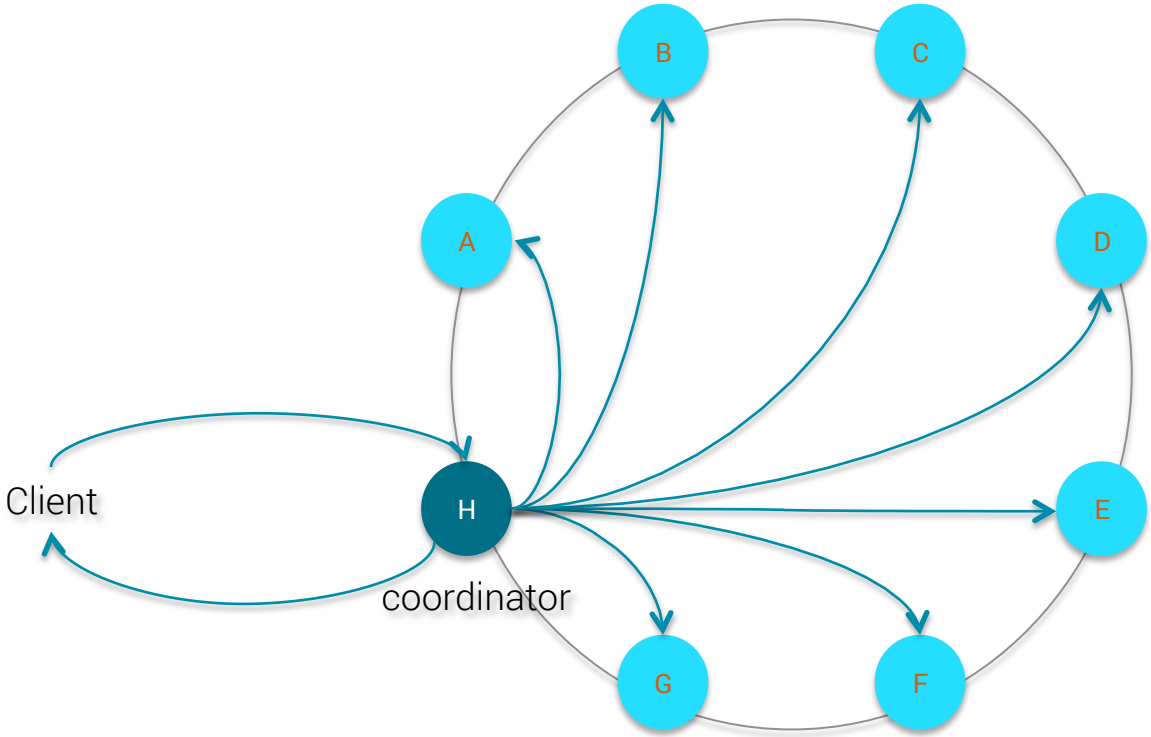
Caveat 2 solution: materialized views

For 1-to-1 index/relationship, use materialized views instead

```
CREATE MATERIALIZED VIEW user_by_email AS
SELECT * FROM users
WHERE user_id IS NOT NULL and user_email IS NOT NULL
PRIMARY KEY (user_email, user_id)
```

But range queries (<, >, ≤, ≥) not possible …

Caveat 3: fetch all rows for analytics use-case



Caveat 3 solution: use co-located Spark

Local index query

SASI local read/write path

Local write path

Index files are built

- on memtable flush
- on compaction flush

To avoid OOM, index files are split into chunk of

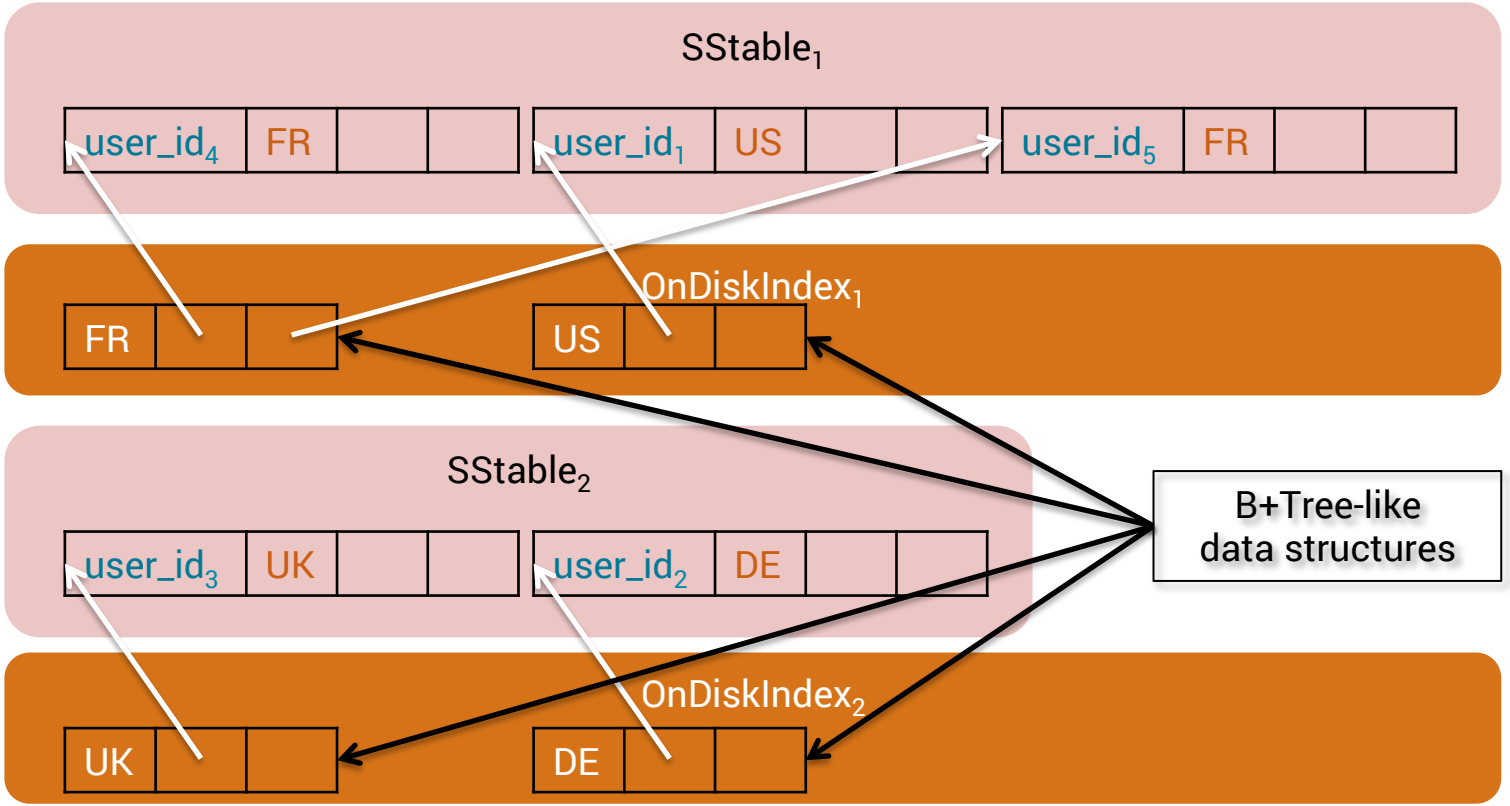
- 1Gb for memtable flush
- *max_compaction_flush_memory_in_mb* for compaction flush

Local write path data structures

Index mode, data type	Data structure	Usage
PREFIX, text	Guava *ConcurrentRadixTree*	name LIKE 'John%'
CONTAINS, text	Guava *ConcurrentSuffixTree*	name LIKE '%John%' name LIKE '%ny'
PREFIX, other	JDK *ConcurrentSkipListSet*	age = 20 age >= 20 AND age <= 30
SPARSE, other	JDK *ConcurrentSkipListSet*	age = 20 age >= 20 AND age <= 30

suitable for 1-to-N index with N ≤ 5

OnDiskIndex files

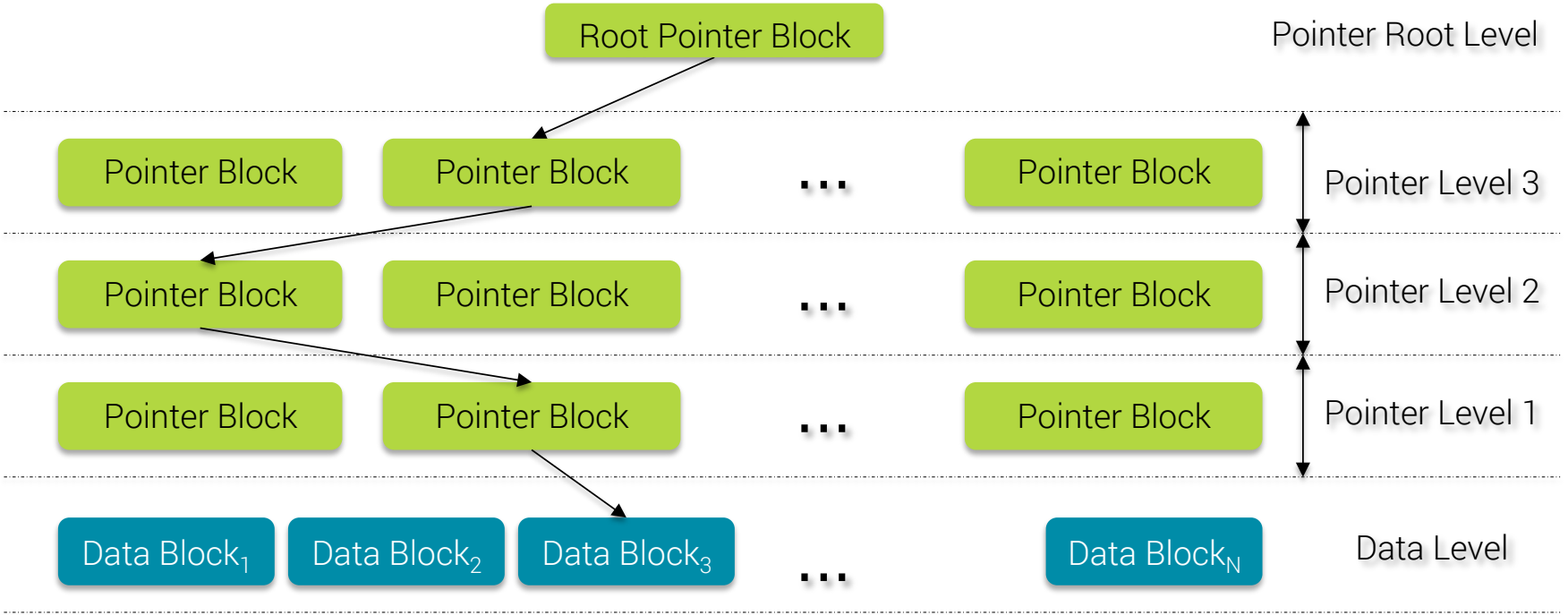


Local read path

- first, optimize query using Query Planer (see later)
- then load chunks (4k) of index files from disk into memory
- perform binary search to find the indexed value(s)
- retrieve the corresponding **partition keys** and push them into the **Partition Key Cache**

→ Yes, **currently** SASI only keep partition key(s) so on wide partition it's not very optimized ...

Binary search using OnDiskIndex files



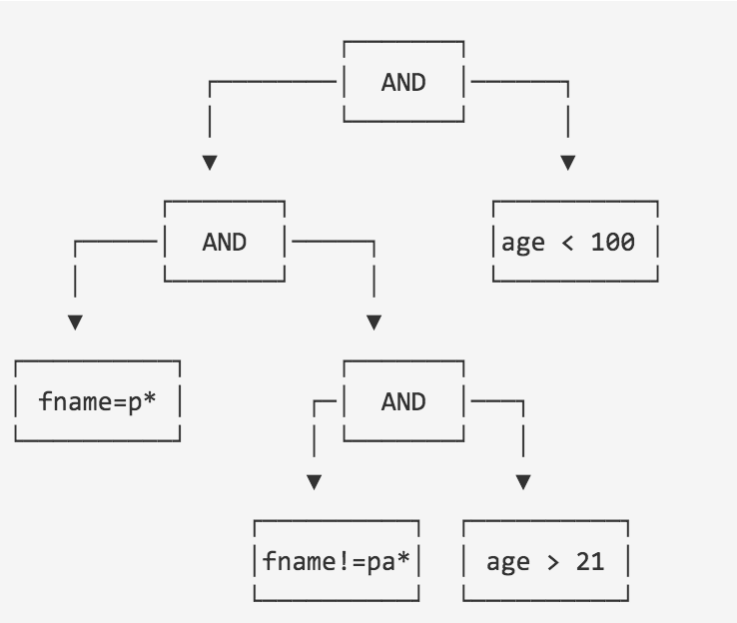
Query Planner

Query planner

- build predicates tree
- predicates push-down & re-ordering
- predicate fusions for != operator

Query optimization example

WHERE age < 100 AND fname LIKE 'p%' AND fname != 'pa%' AND age > 21



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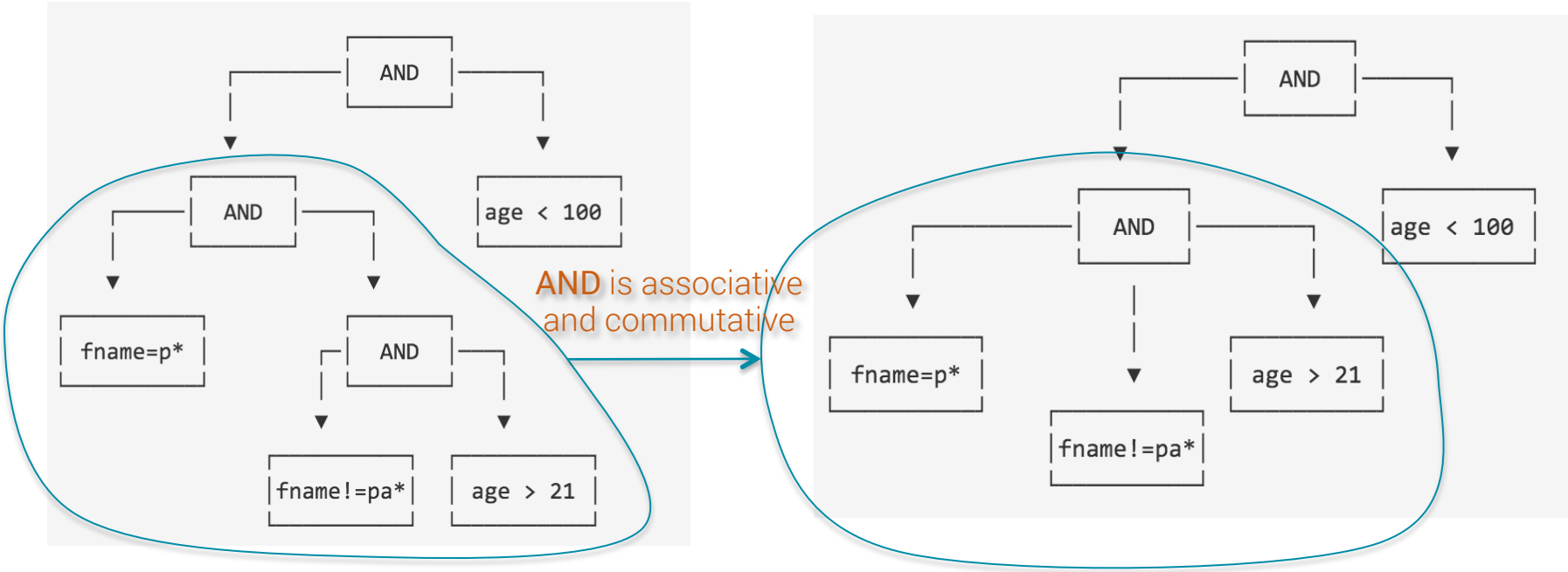

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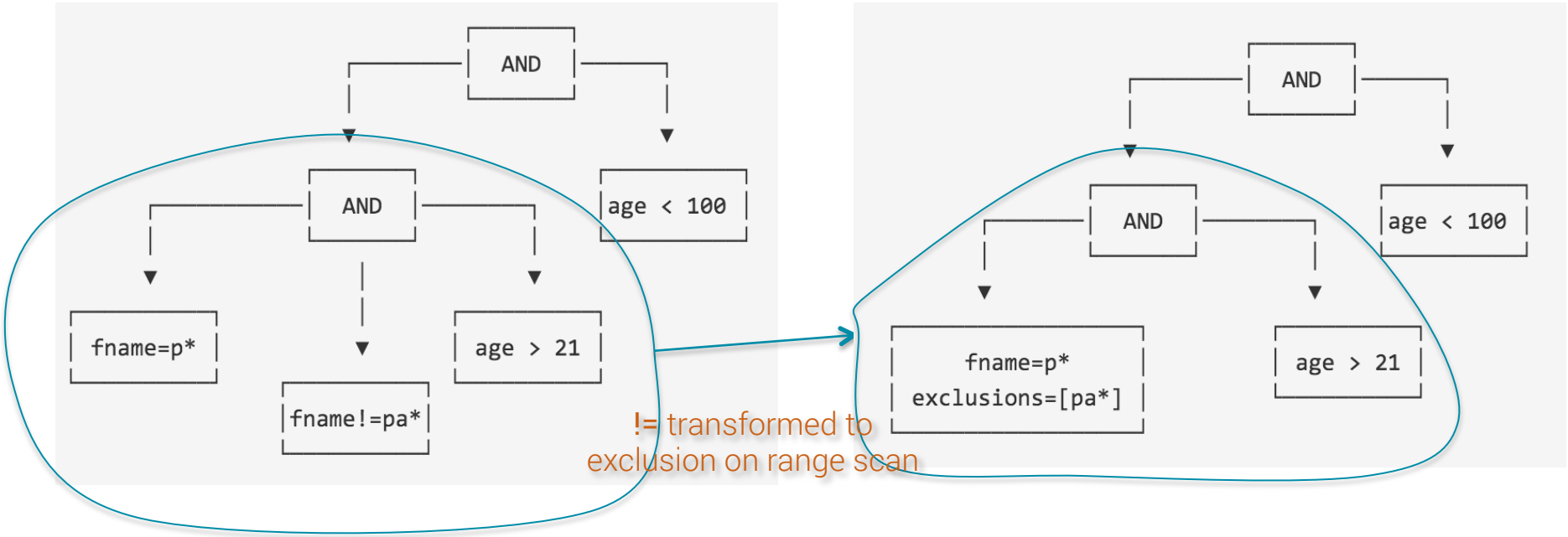

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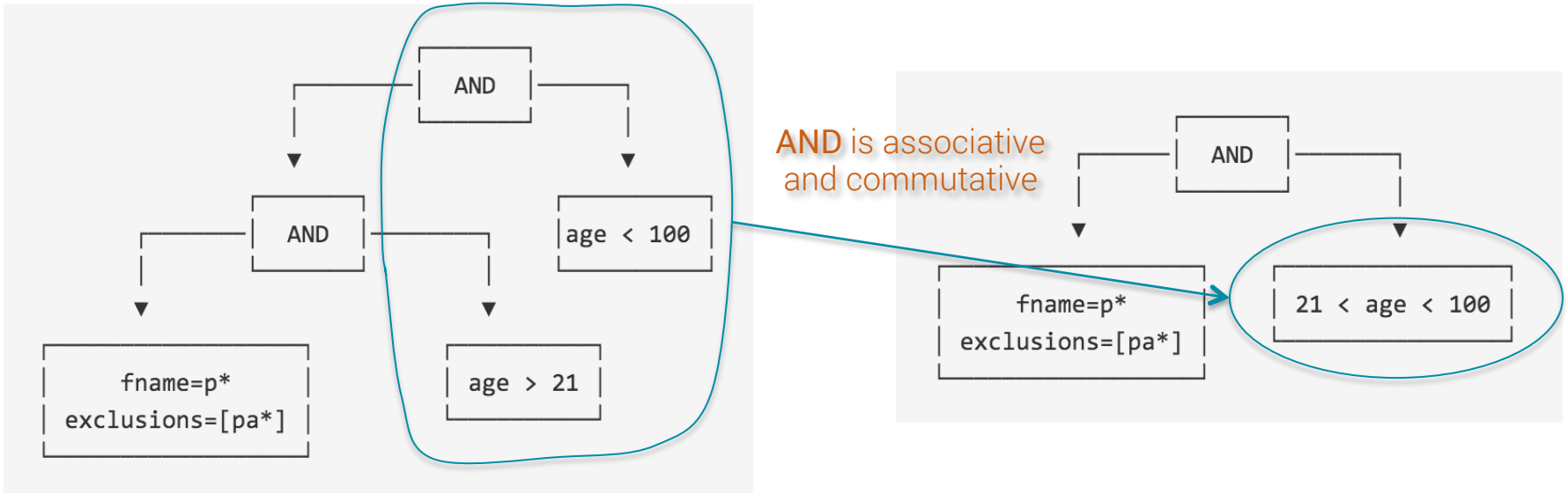

Some benchmarks

Hardware specs

13 bare-metal machines

- 6 CPU HT (12 vcores)
- 64Gb RAM
- 4 SSDs in RAID0 for a total of 1.5Tb

Data set

- 13 billions of rows
- 1 numerical index with 36 distinct values
- 2 text index with 7 distinct values
- 1 text index with 3 distinct values

Benchmark results

Full table scan using co-located Spark (no LIMIT)

Predicate count	Fetched rows	Query time in sec
1	36 109 986	609
2	2 781 492	330
3	1 044 547	372
4	360 334	116

Benchmark results

Full table scan using co-located Spark (no LIMIT)

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Benchmark results

Beware of disk space usage for full text search !!!

Table *albums* with ≈ 110 000 records, 6.8Mb data size

Index Name	Index Mode	Analyzer	Index Size	Index Size/SSTable Size Ratio
albums_country_idx	**PREFIX**	**`NonTokenizingAnalyzer`**	2Mb	0.29
albums_year_idx	**PREFIX**	N/A	2.3Mb	0.34
albums_artist_idx	**CONTAINS**	**`NonTokenizingAnalyzer`**	**30Mb**	**4.41**
albums_title_idx	**CONTAINS**	**`StandardAnalyzer`**	**41Mb**	**6.03**

Take Away

SASI vs search engines

SASI vs Solr/ElasticSearch ?

- Cassandra is not a search engine !!! (database = durability)
- always slower because 2 passes (SASI index read + original Cassandra data)
- no scoring
- no ordering (~~ORDER BY~~)
- no grouping (~~GROUP BY~~) → Apache Spark for analytics

If you don't need the above features, SASI is for you!

SASI sweet spots

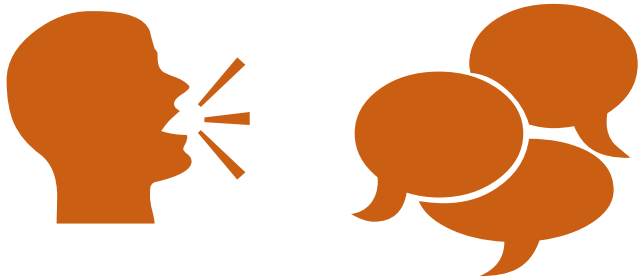
SASI is a relevant choice if

- you need **multi criteria search** and you don't need ordering/grouping/scoring
- you mostly need **100 to 10000** of rows for your search queries
- you **always know the partition keys** of the rows to be searched for (this one applies to native secondary index too)
- you want to index **static columns** (**SASI** has no penalty since it indexes the whole partition)

SASI blind spots

SASI is a poor choice if

- you have **very wide partitions** to index, SASI only indexes the partition offset (but it will change with **CASSANDRA-11990** merged to trunk)
- you have **strong SLA on search latency**, for example few millisecs requirement
- **ordering of the search results** is important for you



Q & A

Thank You

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