Catalyst

Objective

Understand the Catalyst query optimizer

For DataFrames, Datasets and Spark SQL
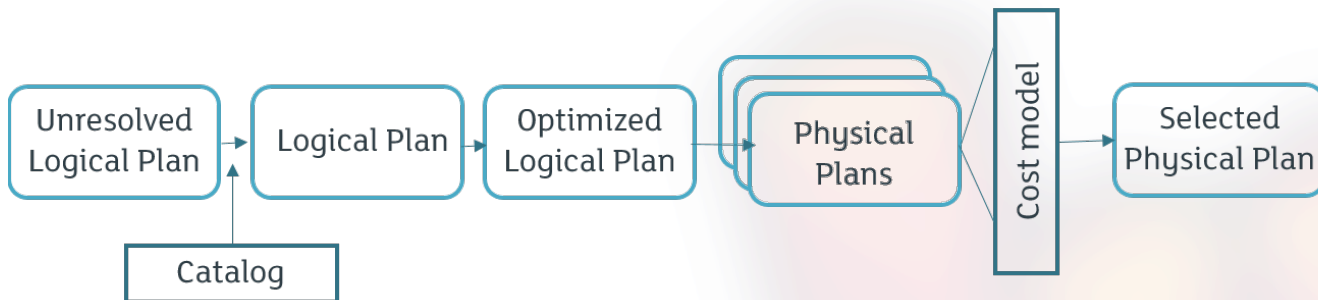
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	Analysis	Logical Optimization	Physical Planning		Code Generation

SQL Query → DataFrame → Unresolved Logical Plan → Logical Plan → Optimized Logical Plan → Physical Plans → Cost model → Selected Physical Plan → RDDs

Catalog

Catalyst query optimizer
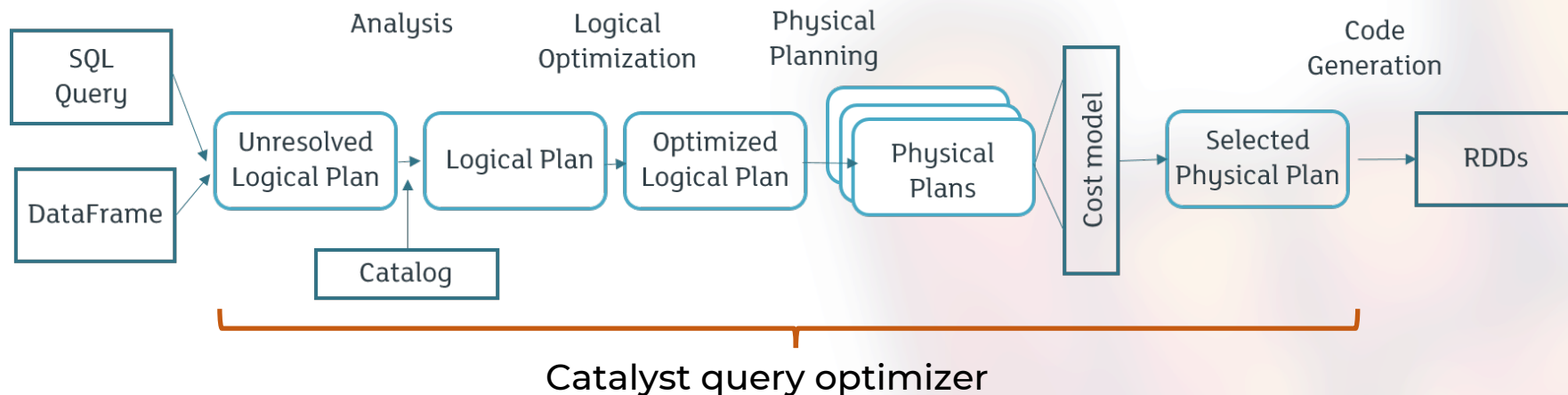
When you run a SQL job

- Spark knows the DF dependencies in advance – unresolved logical transformation plan
- Catalyst resolves references and expression types – resolved logical plan
- Catalyst compresses and pattern matches on the plan tree – optimized logical plan
- Catalyst generates physical execution plans

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Steps

- Analysis: unresolved plan => resolved plan
  - use Catalog to find where DataFrames, columns are coming from
  - resolves column types
- Optimization: resolved plan => optimized plan
  - processes the transformation tree
  - column pruning, predicate pushdown etc
- Physical planning: optimized (logical) plan => physical execution plans
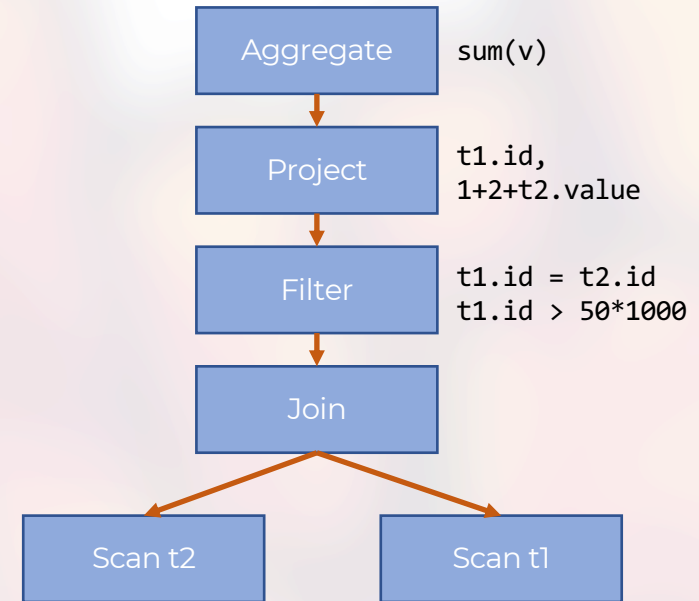- Code generation: generate Scala code from the execution plan

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```
t1 = (DF with numerical id and value)
t2 = (DF with numerical id)
```

```
t1.join(t2, "id")
  .where(col("id") > 50 * 1000)
  .select(col("id"), (lit(1) + lit(2) + col("value")).alias("v"))
  .agg(sum(col("v")))
```

```
SELECT sum(v)
FROM
  SELECT t1.id, 1 + 2 + t1.value as v
  FROM t1 join t2
  WHERE t1.id = t2.id AND t1.id > 50 * 1000
```
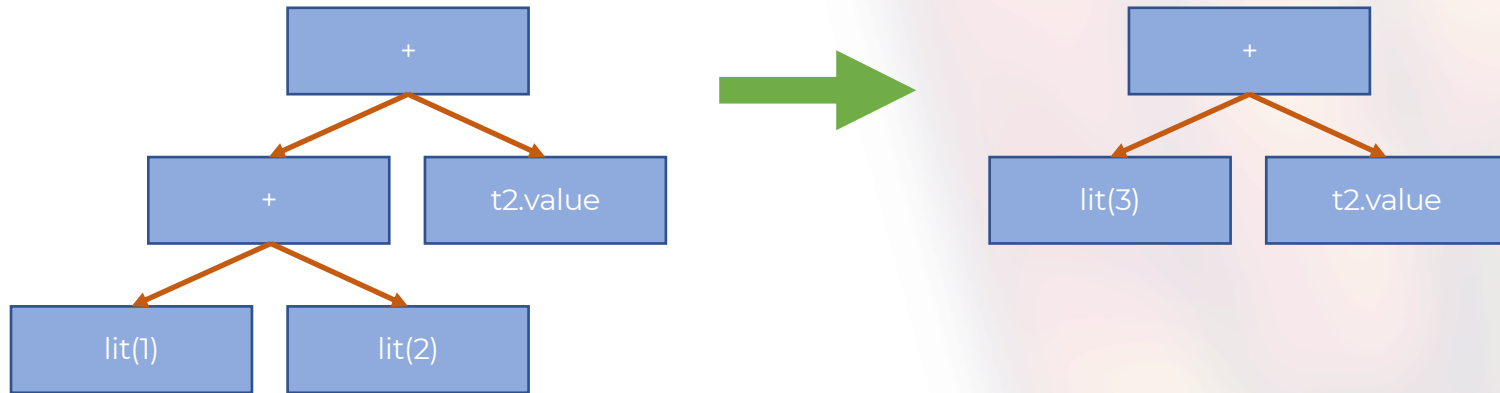

| Aggregate | sum(v) |

| Project | t1.id, 1+2+t2.value |

| Filter | t1.id = t2.id, t1.id > 50*1000 |

| Join |

| Scan t2 | Scan t1 |

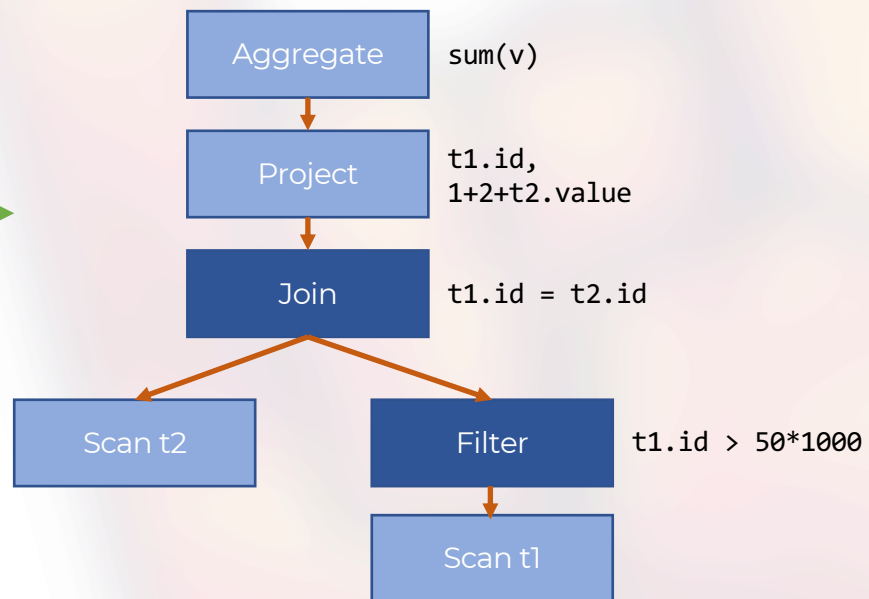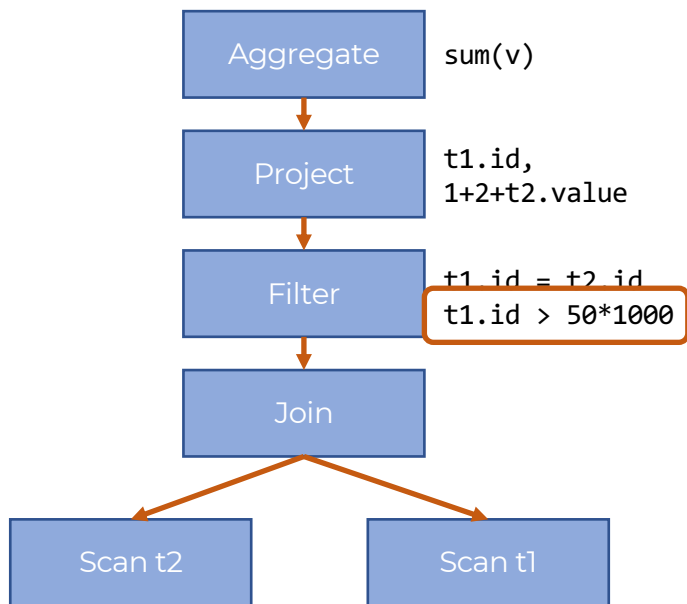Logical plan: describes computations without how to execute them

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Optimization: pre-compute as much as possible
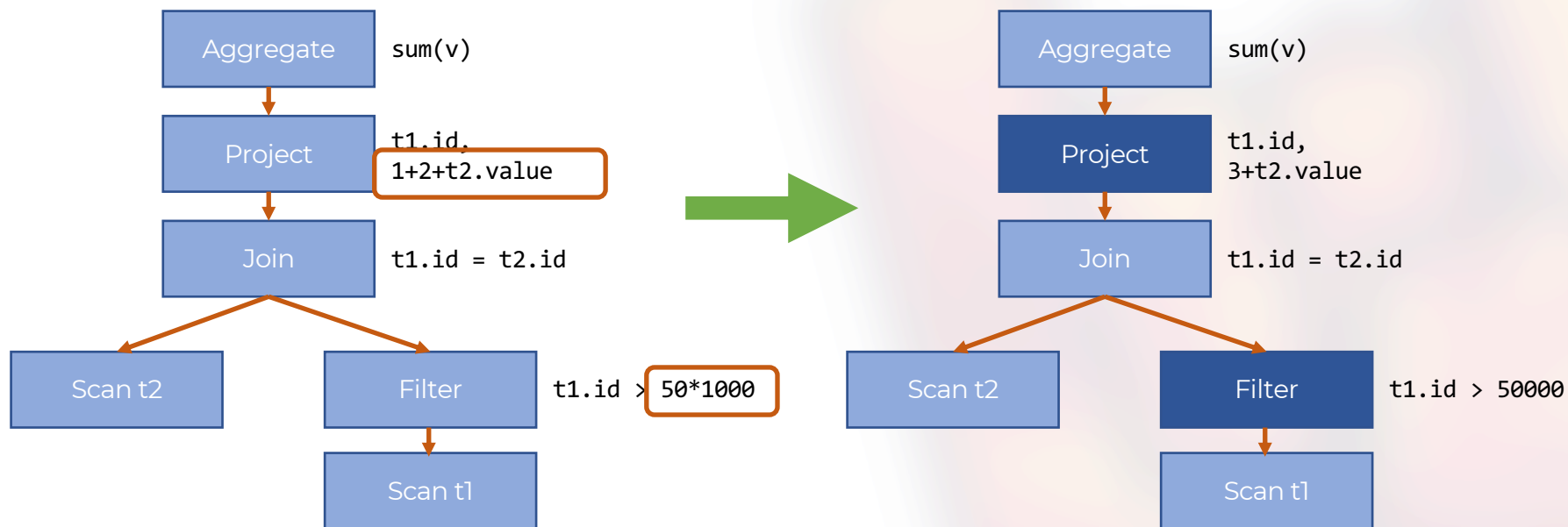
```
1 + 2 + t2.value
```
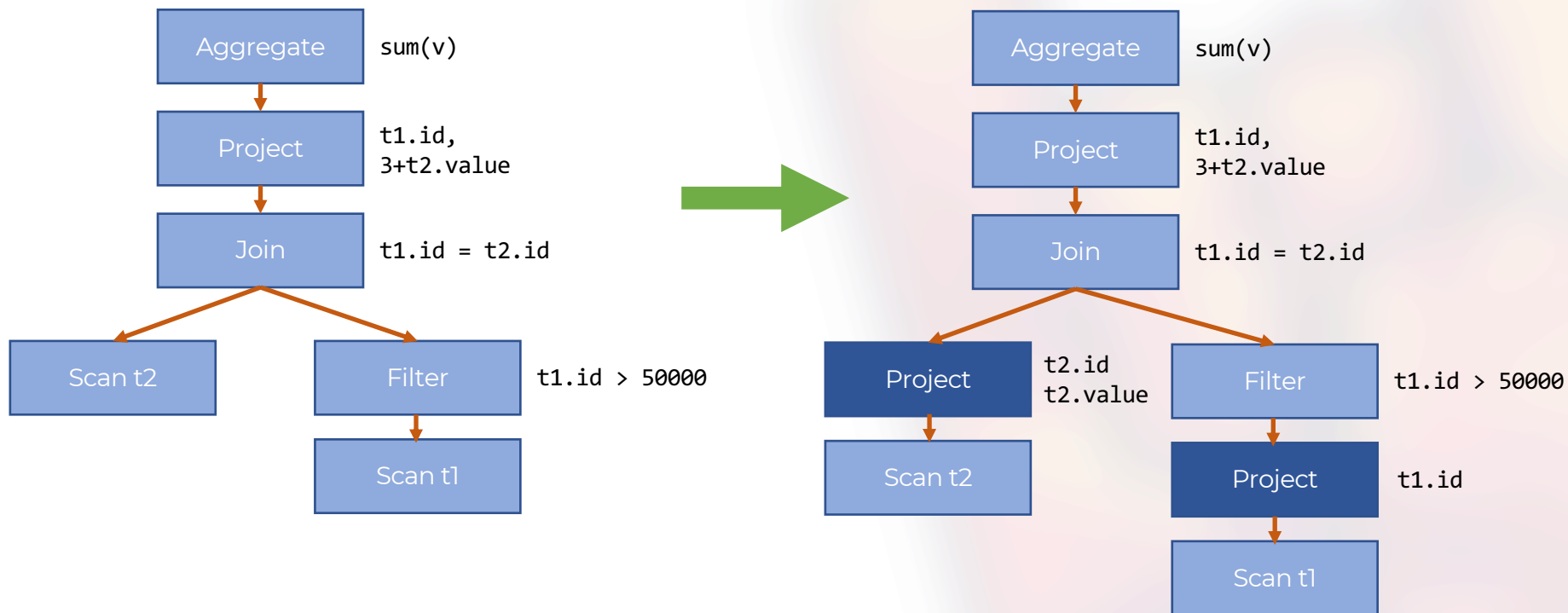
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Optimization: filter pushdown

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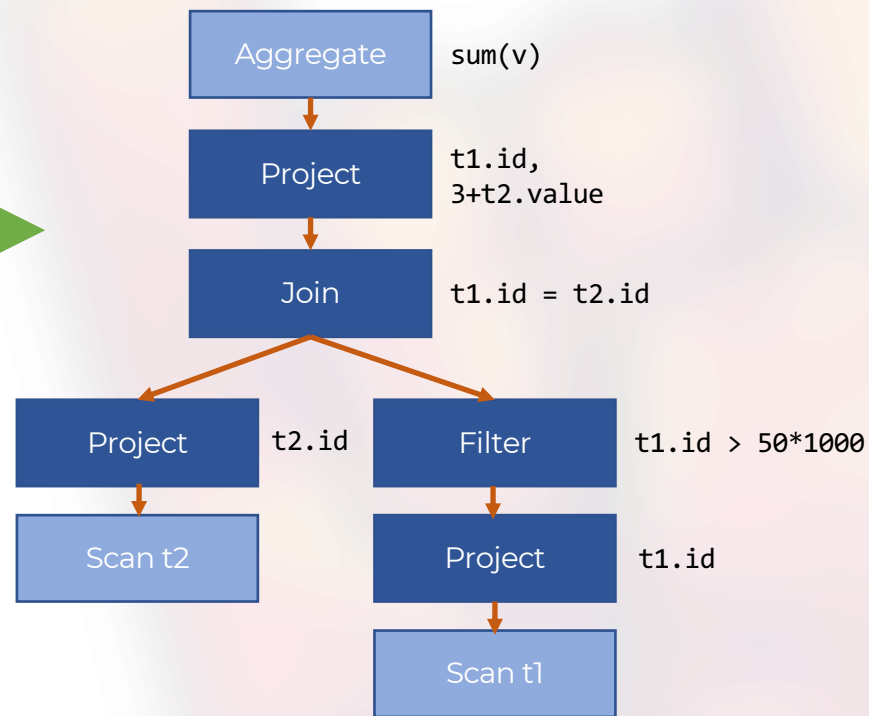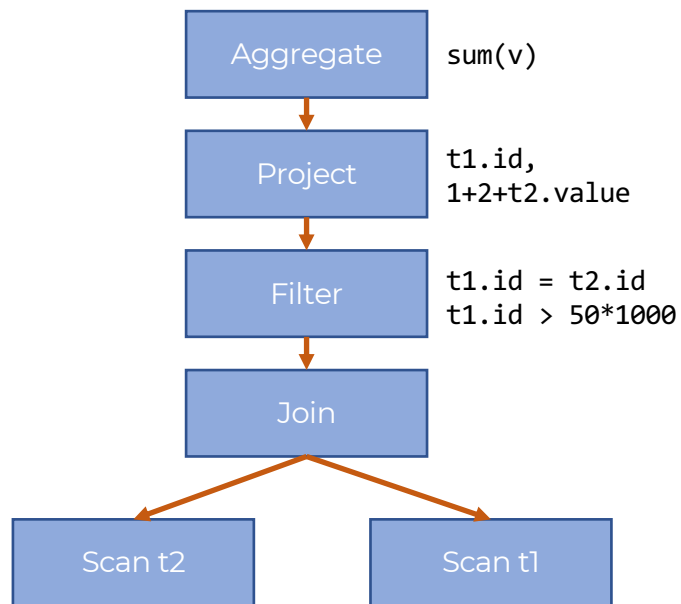Optimization: combining rules

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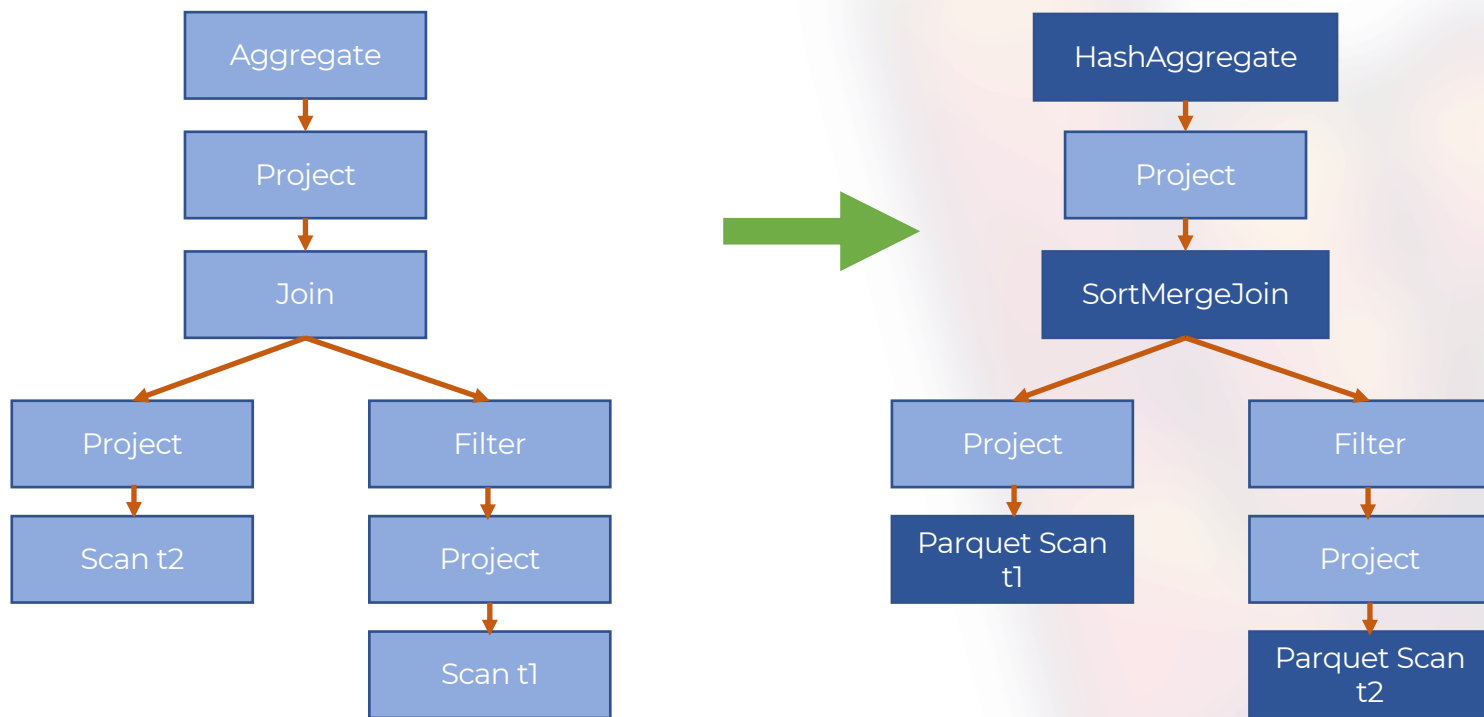
Optimization: column pruning
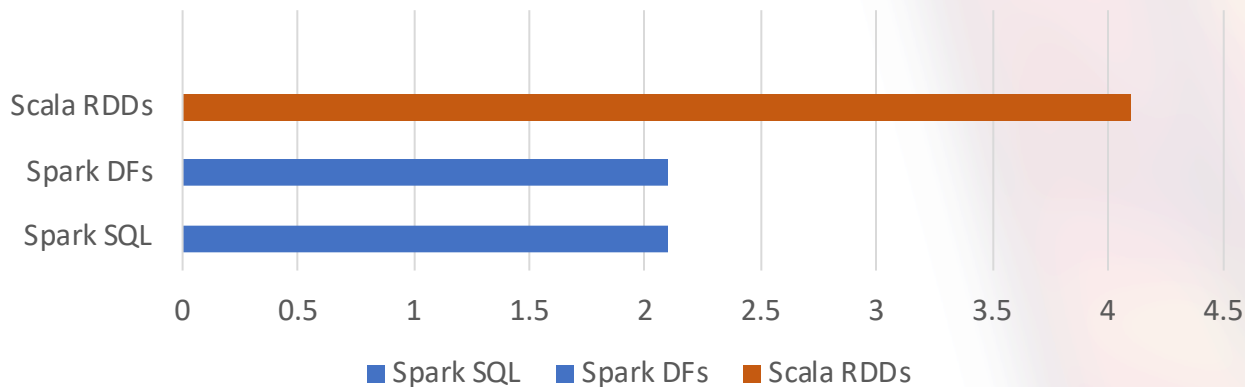
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Combine all:

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Physical plan: known implementation of all operations

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Results

- extra structure (SQL) limits what can be expressed (vs RDDs)
- however, we can express most computations
- expressions are more concise
- structure allows for optimizations

What Catalyst can't do

- can't optimize lambdas

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The best part – it's free.

Spark rocks