Welcome
SELECT [Airline Name],
       SUM([Arrdelayminutes])
FROM [Extract]
WHERE [Airline Name] IN ('Alaska Airlines',...)
GROUP BY [Airline Name]
Show Me the Queries!

Rick Cole
Senior Research Scientist
Tableau Research
Show Me the Queries!
Wednesday | 1:45 – 2:45 | MCCNO – L3 – 388
Show Me the Queries!
Thursday | 2:15 – 3:15 | MCCNO – L2 – 225
The Truth is in the Stars with Data Architectures for Tableau
Tuesday | 12:30 – 1:30 | MCCNO – L3 – 346

Understanding Tableau Queries, Techniques, and Tools to Use
Tuesday | 2:15 – 3:15 | MCCNO – L3 – 388

Designing Efficient Workbooks | Live on Stage
Thursday | 10:45 – 11:45 | MCCNO – L2 – La Nouvelle Ballroom C
About Me

3 years @ Tableau

Research and development in query processing

Why Tableau?

Query visualization, data lineage, data sketching, machine learning
Agenda

How a visualization becomes a query
What is a query anyway?
Tableau’s query ecosystem
Show me the queries!
How a Visualization Becomes a Query
SELECT
    [Airline Name],
    SUM([Arrdelayminutes])
FROM
    [Extract]
WHERE
    [Airline Name] IN (‘Alaska Airlines’,...)
GROUP BY
    [Airline Name]
Logical Query
Logical Query
Logical Query

Flights

Connection
○ Live
○ Extract
Extract will include all data.
Logical Query

Arrdelayminutes

[Arrival Time] - [Planned Arrival Time]

The calculation is valid.

Apply  OK
Logical Query

![Logical Query Diagram]

- Flights

Filters
Airline Name

Arrdelayminutes

[Arrival Time] - [Planned Arrival Time]

The calculation is valid.

Apply OK

Connection
- Live
- Extract

Extract will include all data.
Logical Query

Select

Project

Flights

Connection

Live

Extract

Extract will include all data.

Filters

Airline Name

Arrdelayminutes

[Arrival Time] - [Planned Arrival Time]

The calculation is valid.

Apply

OK
Logical Query

select
project
project
[Extract]

- Flights

Columns
SUM(ArrDelayMinutes)

Rows
Airline Name

Filters
Airline Name

ArrDelayMinutes

[Arrival Time] - [Planned Arrival Time]

The calculation is valid.

Apply
OK

Connection
Live
Extract

Extract will include all data.
Logical Query

Columns: SUM(ArrDelayMinutes)

Rows: Airline Name

Filters: Airline Name

ArrDelayMinutes

[Arrival Time] - [Planned Arrival Time]

The calculation is valid.

Apply  OK

- Flights

Connection
- Live  - Extract

Extract will include all data.

Flights  Airports
Logical Query

- Filters
  - Airline Name

- Sum of ArrDelayMinutes

- [Arrival Time] - [Planned Arrival Time]

The calculation is valid.

- Flights

- Extract

Connection
- Live
- Extract

Extract will include all data.
Logical Query

{ [Parameter1] := ‘Arrival Delay’ }
Logical Query

\[ \text{[Delay]} := \begin{cases} 
\text{[Arrival Time]} - \text{[Planned Arrival Time]} & \text{IF [Parameter1] = ‘Arrival Delay’} \\
\text{[Departure Time]} - \text{[Planned Departure Time]} & \text{ELSE} 
\end{cases} \]

{ [Parameter1] := ‘Arrival Delay’ }
Logical Query

\[\text{[Delay]} := \begin{cases} 
\text{IF [Parameter1] = ‘Arrival Delay’ THEN} \\
\phantom{IF} \quad [\text{Arrival Time}] - [\text{Planned Arrival Time}] \\
\text{ELSE} \\
\phantom{ELSE} \quad [\text{Departure Time}] - [\text{Planned Departure Time}] \\
\end{cases}\]

[Parameter1] := ‘Arrival Delay’
Logical Query

\[
[\text{Delay}] := \begin{cases} 
\text{IF } \text{‘Arrival Delay’} = \text{‘Arrival Delay’} \text{ THEN} \\
[\text{Arrival Time}] - [\text{Planned Arrival Time}] \\
\text{ELSE} \\
[\text{Departure Time}] - [\text{Planned Departure Time}] \\
\text{END}
\end{cases}
\]

\[
[\text{Parameter1}] := \text{‘Arrival Delay’}
\]
Logical Query

[Delay] :=
  IF 'Arrival Delay' = 'Arrival Delay' THEN
    [Arrival Time] - [Planned Arrival Time]
  ELSE
    [Departure Time] - [Planned Departure Time]
  END

[Parameter1] := 'Arrival Delay'
[Delay] :=
    IF TRUE THEN
        [Arrival Time] – [Planned Arrival Time]
    ELSE
        [Departure Time] – [Planned Departure Time]
    END

[Parameter1] := ‘Arrival Delay’
[Delay] :=
  IF TRUE THEN
    [Arrival Time] – [Planned Arrival Time]
  ELSE
    [Departure Time] – [Planned Departure Time]
  END

[Parameter1] := ‘Arrival Delay’
[Delay] := [Arrival Time] - [Planned Arrival Time]

[Parameter1] := ‘Arrival Delay’
Logical Query

\[
[\text{Delay}] := [\text{Arrival Time}] - [\text{Planned Arrival Time}]
\]

\[
[\text{Parameter1}] := '\text{Arrival Delay}'
\]
Logical Query

\[
\text{Delay} := \text{[Arrival Time]} - \text{[Planned Arrival Time]}
\]
Example Simplifications

Expression inlining
Constant folding and propagation
Remove unused values
Simplify functions
Remove redundant operations
Remove unused joins
Why Simplify?

Performance

Caching

Predictability
VizQL → Resolve → Simplify → Optimize → Format → Query
Optimize

Rearrange logical tree to be executed more efficiently
  May be less simple!

Before 10.0, Tableau primarily relied on the database optimizer
  In 10.0, federation!
Optimizations

When to filter and aggregate data?

Data movement

Execution movement

Caching
Formats

SQL dialects
Tableau Data Engine – Hyper!
Tableau Server
MDX
SELECT
  [Airline Name],
  SUM([Arrdelayminutes])
FROM
  [Extract]
WHERE
  [Airline Name] IN (‘Alaska Airlines’, ...)
GROUP BY
  [Airline Name]
Example Formatting

Tableau calculation

\[ \text{[ShownAd]} \land \text{[Bought]} \]

Postgres

“ShownAd” AND “Bought”

SQL Server

```
CASE
  WHEN (([ShownAd] <> 0) AND ([Bought] <> 0)) THEN 1
  WHEN NOT (([ShownAd] <> 0) AND ([Bought] <> 0)) THEN 0
  ELSE NULL
END
```
Resolve  Simplify  Optimize  Format
VizQL → Resolve → Simplify → Optimize → Format → SQL → TQL
VizQL

Resolve  Simplify  Optimize  Format

SQL
Resolve
Simplify
Optimize
Format
What is a Query?
A horse is a horse, of course, of course...

Mister Ed
Resolve
Simplify
Optimize
Format
Relational processing entails treating whole relationships as operands…

E. F. Codd
What is a Query Anyway?

The calculus and algebra from the relational model

Inputs and outputs of the query pipeline

Multiple abstractions between these inputs and outputs
   Such as abstract query, AQL, logical query, query function

Multiple abstractions within the local and remote servers
   Such as logical query, physical query, generated code

An ecosystem of query processing
Tableau’s Query Ecosystem
The Tableau Platform

From connection through collaboration, Tableau is the most powerful, secure, and flexible end-to-end analytics platform for your data. Tableau your data. Watch your expectations get blown away.

**Interact**

Put your data anywhere you need it. With Tableau, you can securely consume your data via browser, desktop, mobile, or embedded into any application.

**Collaboration**

**Analytics**

**Content Discovery**

**Governance**

**Data Prep**

**Data Access**

**Deployment**

Deploy where and how you want. Tableau can integrate into your existing data infrastructure, whether on-prem or in the cloud.

- On-Premise
- Cloud
- Hosted
- Windows
- Linux
- Mac
- Multi-Tenant
From connection through collaboration, Tableau is the most powerful, secure, and flexible end-to-end analytics platform for your data. Tableau your data. Watch your expectations get blown away.

**Interact**

Put your data anywhere you need it. With Tableau, you can securely consume your data via browser, desktop, mobile, or embedded into any application.

---

**Collaboration**

---

**Analytics**

---

**Content Discovery**

---

**Governance**

---

**Data Prep**

---

**Data Access**

---

**Deployment**

Deploy where and how you want. Tableau can integrate into your existing data infrastructure, whether on-prem or in the cloud.
SELECT [Airline Name], SUM([ArrDelay])
FROM [Extract]
WHERE [Airline Name] = 'Delta Airlines'
GROUP BY [Airline Name]
Show Me the Queries!
Query Pipeline Examples

Rewrites
  Making queries robust

Optimizations
  LOD calculations
  Temporary tables

Federation
  Federated queries
Rewrites and Caching
Rewrites and Caching

Making queries robust

Join culling using referential integrity constraints

Enables use of the query cache
Caching

<table>
<thead>
<tr>
<th>Airlineid</th>
<th>Arrdelayminutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>19393</td>
<td>18M</td>
</tr>
<tr>
<td>19790</td>
<td>18M</td>
</tr>
<tr>
<td>19805</td>
<td>10M</td>
</tr>
<tr>
<td>20304</td>
<td>16M</td>
</tr>
<tr>
<td>20366</td>
<td>18M</td>
</tr>
</tbody>
</table>

Connections

Add

- localhost
- PostgreSQL

flightinformation_since2013
84672 log.txt 11/04/2016 - 15:53:10.889 0.024 end-compute-quick-filt... elapsed: 0.024; sheet: Caching; view: Caching

84673 log.txt 11/04/2016 - 15:53:11.121 msg Finished rendering sheet: Caching

84675 log.txt 11/04/2016 - 15:53:11.276 msg render-pipeline: Render End


phase: before-Aggregate_FuseLookup
query: <aggregateOp class='logical-operator'>
  <measures>
    <binding name='__measure__1'>
      <funcallExp class='logical-expression' function='SUM' shape='aggregate'>
        <funcallExp class='logical-expression' function='/' shape='scalar'>
          <identifierExp class='logical-expression' identifier='[arrdelayminutes]'></identifierExp>
        </funcallExp>
      </funcallExp>
    </binding>
    <lookupExp class='logical-expression' domain='total'>
      <aggregateOp class='logical-operator'>
        <measures>
          <binding name='__measure__0'>
            <funcallExp class='logical-expression' function='SUM' shape='aggregate'>
              <identifierExp class='logical-expression' identifier='[arrdelayminutes]'></identifierExp>
            </funcallExp>
          </binding>
        </aggregateOp>
      </lookupExp>
    </lookupExp>
  </measures>
</aggregateOp>
<table>
<thead>
<tr>
<th>ID</th>
<th>File</th>
<th>Time</th>
<th>Elapsed</th>
<th>Key</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>84672</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:10.889</td>
<td>0.024</td>
<td>end-compute-quick-filter</td>
<td>elapsed: 0.024; sheet: Caching; view: Caching</td>
</tr>
<tr>
<td>84673</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:11.121</td>
<td></td>
<td>msg</td>
<td>Finished rendering sheet: Caching</td>
</tr>
<tr>
<td>84675</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:11.276</td>
<td></td>
<td>msg</td>
<td>render-pipeline: Render End</td>
</tr>
<tr>
<td>84684</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:13.538</td>
<td></td>
<td>logical-query</td>
<td>datasource-caption: flightinformation_since2013 (public.flighti...</td>
</tr>
<tr>
<td>84685</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:13.539</td>
<td></td>
<td>logical-query-rewrite</td>
<td>phase: before-query-rewrite-rewrite; query: &lt;topop class=&quot;logical-oper...</td>
</tr>
<tr>
<td>84687</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:13.540</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td>elapsed: 0; phase: after-Project_EliminateUnneededBindings; que...</td>
</tr>
<tr>
<td>84689</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:13.542</td>
<td></td>
<td>logical-query</td>
<td>datasource-caption: flightinformation_since2013 (public.flighti...</td>
</tr>
<tr>
<td>84690</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:13.542</td>
<td></td>
<td>logical-query</td>
<td>datasource-caption: flightinformation_since2013 (public.flighti...</td>
</tr>
<tr>
<td>84691</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:13.543</td>
<td></td>
<td>federate-query</td>
<td>phase: before federate; query: &lt;logical-query&gt; &lt;select&gt; ...</td>
</tr>
<tr>
<td>84692</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:13.545</td>
<td></td>
<td>federate-query</td>
<td>phase: after federate; query: &lt;fed-op aggregation=&quot;false&quot; cach...</td>
</tr>
<tr>
<td>84693</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:13.546</td>
<td></td>
<td>federate-query</td>
<td>phase: after local cast planning; query: &lt;fed-op aggregation=&quot;f...</td>
</tr>
<tr>
<td>84694</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:13.547</td>
<td></td>
<td>federate-query</td>
<td>phase: after temp table planning; query: &lt;fed-op aggregation=&quot;f...</td>
</tr>
<tr>
<td>84695</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:13.553</td>
<td></td>
<td>remote-query-planning</td>
<td>phase: before; query: &lt;fed-op aggregation=&quot;false&quot; caching=&quot;nor...</td>
</tr>
<tr>
<td>84696</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:13.554</td>
<td></td>
<td>remote-query-planning</td>
<td>phase: after; query: &lt;fed-op aggregation=&quot;false&quot; caching=&quot;nor...</td>
</tr>
<tr>
<td>84698</td>
<td>tabprotos..</td>
<td>11/04/2016 - 15:53:16.731</td>
<td></td>
<td>create-resultset-access</td>
<td>field: pktable_cat; msg: Adding resultset column</td>
</tr>
<tr>
<td>84700</td>
<td>tabprotos..</td>
<td>11/04/2016 - 15:53:16.732</td>
<td></td>
<td>create-resultset-access</td>
<td>field: pktable_name; msg: Adding resultset column</td>
</tr>
<tr>
<td>84701</td>
<td>tabprotos..</td>
<td>11/04/2016 - 15:53:16.732</td>
<td></td>
<td>create-resultset-access</td>
<td>field: pkcolumn_name; msg: Adding resultset column</td>
</tr>
</tbody>
</table>
84875 log.txt 11/04/2016 - 15:53:20.406 0.034 ap-query-end cache-hit: literal; elapsed: 0.034; owner-component: QuickFilte...
84876 log.txt 11/04/2016 - 15:53:20.406 remote-query-planning phase: before; query: <fed-op aggregation='false' caching='noru...
84877 log.txt 11/04/2016 - 15:53:20.407 remote-query-planning phase: after; query: <fed-op aggregation='false' caching='noru...
84878 log.txt 11/04/2016 - 15:53:20.415 logical-query datasource-caption: flightinformation_since2013 (public.flight...
84881 log.txt 11/04/2016 - 15:53:20.419 0.000 logical-query-rewrite elapsed: 0; phase: after-Aggregate_PullUpFilter; query: <topnOp ph...
84882 log.txt 11/04/2016 - 15:53:20.421 0.000 logical-query-rewrite elapsed: 0; phase: after-Aggregate_EliminateUnneededMeasure...
84883 log.txt 11/04/2016 - 15:53:20.421 logical-query-rewrite phase: before-Project_EliminateUnneededMeasurements; query: <proje...
84884 log.txt 11/04/2016 - 15:53:20.423 logical-query-rewrite phase: after-Project_EliminateUnneededMeasurements; que...
84885 log.txt 11/04/2016 - 15:53:20.423 0.000 logical-query-rewrite elapsed: 0; phase: before-joinPreCulls; query: <joinOp class='logical-oper...
84886 log.txt 11/04/2016 - 15:53:20.424 0.000 logical-query-rewrite elapsed: 0; phase: before-Join_PreCulls; query: <joinOp class='l...
84890 log.txt 11/04/2016 - 15:53:20.427 logical-query datasource-caption: flightinformation_since2013 (public.flighti...
84891 log.txt 11/04/2016 - 15:53:20.427 logical-query datasource-caption: flightinformation_since2013 (public.flighti...
84892 log.txt 11/04/2016 - 15:53:20.428 logical-query phase: before federate; query: <logical-query> <selects> ...phase: after federate; query: <fed-op aggregation='true' cachin...
84893 log.txt 11/04/2016 - 15:53:20.429 federate-query phase: before temporary table planning; query: <fed-op aggregation='t...
84894 log.txt 11/04/2016 - 15:53:20.431 federate-query phase: after temporary table planning; query: <fed-op aggregation='t...
84895 log.txt 11/04/2016 - 15:53:20.432 federate-query phase: before; query: <fed-op aggregation='true' caching='norma...
84896 log.txt 11/04/2016 - 15:53:20.433 federate-query phase: after; query: <fed-op aggregation='true' caching='normal...
84897 log.txt 11/04/2016 - 15:53:20.438 remote-query-planning phase: before; query: <fed-op aggregation='true' caching='norma...
84898 log.txt 11/04/2016 - 15:53:20.439 remote-query-planning phase: after; query: <fed-op aggregation='true' caching='normal...
84899 log.txt 11/04/2016 - 15:53:20.443 eqc-store class: postgres; column-count: 2; outcome: ignore-speculative; ...cache-hit: abstract; owner-component: DataInterpreter; owner-da...
84900 log.txt 11/04/2016 - 15:53:20.447 ap-query-end elapsed: 0.077; elapsed-compute-keys: 0.001; elapsed-sum: 0.109...
84901 log.txt 11/04/2016 - 15:53:20.447 0.077 ap-batch-summary sheet: Caching; view: Caching
<table>
<thead>
<tr>
<th>ID</th>
<th>File</th>
<th>Time</th>
<th>Elapsed</th>
<th>Key</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>84887</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.406</td>
<td>0.034</td>
<td>ap-query-end</td>
<td>cache-hit: literal; elapsed: 0.034; owner-component: QuickFilte...</td>
</tr>
<tr>
<td>84876</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.406</td>
<td></td>
<td>remote-query-planning</td>
<td>phase: before; query: &lt;fed-op aggregation='false' caching='norun'&gt;...</td>
</tr>
<tr>
<td>84877</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.407</td>
<td></td>
<td>remote-query-planning</td>
<td>phase: after; query: &lt;fed-op aggregation='false' caching='norun'&gt;...</td>
</tr>
<tr>
<td>84878</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.415</td>
<td></td>
<td>logical-query</td>
<td>datasource-caption: flightinformation_since2013 (public.flighti...</td>
</tr>
<tr>
<td>84881</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.419</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td>elapsed: 0; phase: after-Aggregate_PullUpFilter; query: &lt;topop...</td>
</tr>
<tr>
<td>84884</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.423</td>
<td></td>
<td>logical-query-rewrite</td>
<td>phase: before-Project_EliminateUnneededBindings; query: &lt;project...</td>
</tr>
<tr>
<td>84885</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.423</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td>elapsed: 0; phase: after-Project_EliminateUnneededBindings; que...</td>
</tr>
<tr>
<td>84887</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.424</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td>elapsed: 0; phase: after-Join_PreCulls; query: &lt;joinOp class='logical-op...</td>
</tr>
<tr>
<td>84889</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.425</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td>elapsed: 0; phase: after-Join_PostCulls; query: &lt;relationOp cla...</td>
</tr>
<tr>
<td>84891</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.428</td>
<td></td>
<td>logical-query</td>
<td>datasource-caption: flightinformation_since2013 (public.flighti...</td>
</tr>
<tr>
<td>84892</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.428</td>
<td></td>
<td>logical-query</td>
<td>datasource-caption: flightinformation_since2013 (public.flighti...</td>
</tr>
<tr>
<td>84893</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.429</td>
<td></td>
<td>federate-query</td>
<td>phase: before federate; query: &lt;logical-query&gt; &lt;selects&gt; ...</td>
</tr>
<tr>
<td>84897</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.438</td>
<td></td>
<td>remote-query-planning</td>
<td>phase: before; query: &lt;fed-op aggregation='true' caching='norun'&gt;...</td>
</tr>
<tr>
<td>84899</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.443</td>
<td></td>
<td>eqc-store</td>
<td>class: postgres; column-count: 2; outcome: ignore-speculative; ...</td>
</tr>
<tr>
<td>84900</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.447</td>
<td>0.077</td>
<td>ap-query-end</td>
<td>cache-hit: abstract; owner-component: DataInterpreter; owner-da...</td>
</tr>
<tr>
<td>84901</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.447</td>
<td></td>
<td>ap-batch-summary</td>
<td>sheet: 0.077; elapsed-compute-keys: 0.001; elapsed-sum: 0.109...</td>
</tr>
<tr>
<td>ID</td>
<td>File</td>
<td>Time</td>
<td>Elapsed</td>
<td>Key</td>
<td>Value</td>
</tr>
<tr>
<td>------</td>
<td>---------------</td>
<td>--------------------</td>
<td>---------</td>
<td>----------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>84875</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.406</td>
<td>0.034</td>
<td>ap-query-end</td>
<td>cache-hit: literal; elapsed: 0.034; owner-component: QuickFile...</td>
</tr>
<tr>
<td>84876</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.406</td>
<td>0.034</td>
<td>remote-query-planning</td>
<td>phase: before; query: &lt;fed-op aggregation='false' caching='nor...</td>
</tr>
<tr>
<td>84877</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.407</td>
<td>0.034</td>
<td>remote-query-planning</td>
<td>phase: after; query: &lt;fed-op aggregation='false' caching='norun...</td>
</tr>
<tr>
<td>84878</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.415</td>
<td>0.034</td>
<td>logical-query</td>
<td>datasource-caption: flightinformation_since2013 (public.flighti...</td>
</tr>
<tr>
<td>84879</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.416</td>
<td>0.034</td>
<td>logical-query-rewrite</td>
<td>phase: before-query-rewrite; query: &lt;aggregateOp class='logical...</td>
</tr>
<tr>
<td>84880</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.419</td>
<td>0.034</td>
<td>logical-query-rewrite</td>
<td>phase: before-Aggregate_PullUpFilter; query: &lt;aggregateOp class...</td>
</tr>
<tr>
<td>84881</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.419</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td>elapsed: 0; phase: after-Aggregate_PullUpFilter; query: &lt;topOp...</td>
</tr>
<tr>
<td>84882</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.421</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td>phase: before-Aggregate_EliminateUnneededMeasures; query: &lt;aggr...</td>
</tr>
<tr>
<td>84883</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.421</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td>elapsed: 0; phase: after-Aggregate_EliminateUnneededMeasures; q...</td>
</tr>
<tr>
<td>84884</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.423</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td>phase: before-Project_EliminateUnneededBindings; query: &lt;projec...</td>
</tr>
<tr>
<td>84885</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.423</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td>elapsed: 0; phase: after-Project_EliminateUnneededBindings; que...</td>
</tr>
<tr>
<td>84886</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.424</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td>phase: before-Join_PreCulls; query: &lt;joinOp class='logical-oper...</td>
</tr>
<tr>
<td>84887</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.425</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td>elapsed: 0; phase: after-Join_PreCulls; query: &lt;joinOp class='l...</td>
</tr>
<tr>
<td>84888</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.425</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td>phase: before-Join_PostCulls; query: &lt;joinOp class='logical-op...</td>
</tr>
<tr>
<td>84889</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.425</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td>elapsed: 0; phase: after-Join_PostCulls; query: &lt;relationOp cla...</td>
</tr>
<tr>
<td>84890</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.447</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td>phase: after-query-rewrite; query: &lt;topOp class='logical-opera...</td>
</tr>
<tr>
<td>84891</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.447</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td>phase: before federate; query: &lt;logical-query&gt; &lt;selects&gt; ...</td>
</tr>
<tr>
<td>84892</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.447</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td>phase: after federate; query: &lt;fed-op aggregation='true' cachin...</td>
</tr>
<tr>
<td>84893</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.447</td>
<td>0.000</td>
<td>federate-query</td>
<td>phase: after local cast planning; query: &lt;fed-op aggregation='t...</td>
</tr>
<tr>
<td>84894</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.447</td>
<td>0.000</td>
<td>federate-query</td>
<td>phase: after temp table planning; query: &lt;fed-op aggregation='t...</td>
</tr>
<tr>
<td>84895</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.447</td>
<td>0.000</td>
<td>remote-query-planning</td>
<td>phase: before; query: &lt;fed-op aggregation='true' caching='norma...</td>
</tr>
<tr>
<td>84896</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.447</td>
<td>0.000</td>
<td>remote-query-planning</td>
<td>phase: after; query: &lt;fed-op aggregation='true' caching='normal...</td>
</tr>
<tr>
<td>84897</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.447</td>
<td>0.000</td>
<td>logical-query</td>
<td>eqc-store: postgres; column-count: 2; outcome: ignore-speculativ...</td>
</tr>
<tr>
<td>84898</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.447</td>
<td>0.000</td>
<td>logical-query</td>
<td>cache-hit: abstract; owner-component: DataInterpreter; owner-da...</td>
</tr>
<tr>
<td>84899</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.447</td>
<td>0.000</td>
<td>logical-query</td>
<td>elapsed: 0.077; elapsed-compute-keys: 0.001; elapsed-sum: 0.109...</td>
</tr>
<tr>
<td>84900</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.447</td>
<td>0.077</td>
<td>ap-query-end</td>
<td>sheet: Caching; view: Caching</td>
</tr>
<tr>
<td>84901</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.447</td>
<td>0.077</td>
<td>ap-batch-summary</td>
<td>sheet: Caching; view: Caching</td>
</tr>
<tr>
<td>84902</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.462</td>
<td>0.077</td>
<td>begin-update-sheet</td>
<td>sheet: Caching; view: Caching</td>
</tr>
<tr>
<td>84903</td>
<td>log.txt</td>
<td>11/04/2016 - 15:53:20.463</td>
<td>0.077</td>
<td>begin-data-interpreter</td>
<td>sheet: Caching; view: Caching</td>
</tr>
</tbody>
</table>
cache-hit: abstract
owner-component: DataInterpreter
owner-dashboard: 
owner-worksheet: Caching
query-id: 1
LOD Calculations
LOD Calculations

Optimize the query by fusing together similar LOD calculations

Identify similar calculations

Replace with a common source
<table>
<thead>
<tr>
<th>ID</th>
<th>File</th>
<th>Time</th>
<th>Elapsed</th>
<th>Key</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>77500</td>
<td>log.txt</td>
<td>11/03/2016 - 15:57:36.196 0.000 logical-query-rewrite elapsed: 0; phase: after-Project_EliminateUnneededBindings; query: &lt;joinOp class='logical-oper...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77501</td>
<td>log.txt</td>
<td>11/03/2016 - 15:57:36.198 logical-query-rewrite elapsed: 0; phase: after-Join_PreCulls; query: &lt;joinOp class='logical-oper...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77502</td>
<td>log.txt</td>
<td>11/03/2016 - 15:57:36.199 logical-query-rewrite elapsed: 0; phase: after-Join_PreCulls; query: &lt;joinOp class='logical-oper...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77503</td>
<td>log.txt</td>
<td>11/03/2016 - 15:57:36.200 logical-query-rewrite elapsed: 0; phase: after-Join_PreCulls; query: &lt;joinOp class='logical-oper...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77504</td>
<td>log.txt</td>
<td>11/03/2016 - 15:57:36.201 logical-query-rewrite elapsed: 0; phase: after-Join_PreCulls; query: &lt;joinOp class='logical-oper...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77505</td>
<td>log.txt</td>
<td>11/03/2016 - 15:57:36.202 logical-query-rewrite elapsed: 0; phase: after-Join_PreCulls; query: &lt;joinOp class='logical-oper...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77506</td>
<td>log.txt</td>
<td>11/03/2016 - 15:57:36.203 logical-query-rewrite elapsed: 0; phase: after-Join_PreCulls; query: &lt;joinOp class='logical-oper...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77507</td>
<td>log.txt</td>
<td>11/03/2016 - 15:57:36.204 logical-query-rewrite elapsed: 0; phase: after-Join_PreCulls; query: &lt;joinOp class='logical-oper...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77508</td>
<td>log.txt</td>
<td>11/03/2016 - 15:57:36.205 logical-query-rewrite elapsed: 0; phase: after-Join_PreCulls; query: &lt;joinOp class='logical-oper...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77510</td>
<td>log.txt</td>
<td>11/03/2016 - 15:57:36.211 logical-query-rewrite elapsed: 0; phase: after-Aggregate_FuseLookup; query: &lt;aggregate...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77511</td>
<td>log.txt</td>
<td>11/03/2016 - 15:57:36.212 logical-query-rewrite elapsed: 0; phase: after-Aggregate_FuseLookup; query: &lt;aggregate...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77512</td>
<td>log.txt</td>
<td>11/03/2016 - 15:57:36.213 logical-query-rewrite elapsed: 0; phase: after-Aggregate_FuseLookup; query: &lt;aggregate...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77513</td>
<td>log.txt</td>
<td>11/03/2016 - 15:57:36.214 logical-query-rewrite elapsed: 0; phase: after-Aggregate_FuseLookup; query: &lt;aggregate...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77514</td>
<td>tabprotos...</td>
<td>11/03/2016 - 15:57:36.045 binding-info info: ODBCRowSetSource::BindColumn: Binding column.; name: Airline Name BindColumns: column binding complete</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77515</td>
<td>tabprotos...</td>
<td>11/03/2016 - 15:57:36.045 binding-info info: ODBCRowSetSource::BindColumn: Binding column.; name: sum: 0.000000 BindColumns: column binding complete</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77516</td>
<td>tabprotos...</td>
<td>11/03/2016 - 15:57:36.045 binding-info info: ODBCRowSetSource::BindColumn: Binding column.; name: sum: 0.000000 BindColumns: column binding complete</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77517</td>
<td>tabprotos...</td>
<td>11/03/2016 - 15:57:36.045 binding-info info: ODBCRowSetSource::BindColumn: Binding column.; name: usr: 0.000000 BindColumns: column binding complete</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77518</td>
<td>tabprotos...</td>
<td>11/03/2016 - 15:57:36.045 binding-info info: ODBCRowSetSource::BindColumn: Binding column.; name: usr: 0.000000 BindColumns: column binding complete</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77519</td>
<td>log.txt</td>
<td>11/03/2016 - 15:57:36.215 logical-query datasource-caption: flightinformation_since2013 (public.flightinformation...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77520</td>
<td>log.txt</td>
<td>11/03/2016 - 15:57:36.216 logical-query datasource-caption: flightinformation_since2013 (public.flightinformation...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77521</td>
<td>log.txt</td>
<td>11/03/2016 - 15:57:36.217 logical-query federate-query phase: before federate; query: &lt;logical-query&gt; &lt;selects&gt; ...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77522</td>
<td>log.txt</td>
<td>11/03/2016 - 15:57:36.218 logical-query federate-query phase: after federate; query: &lt;fed-op aggregation='true' cachin...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77523</td>
<td>log.txt</td>
<td>11/03/2016 - 15:57:36.219 logical-query federate-query phase: after local cast planning; query: &lt;fed-op aggregation='t...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77524</td>
<td>log.txt</td>
<td>11/03/2016 - 15:57:36.220 logical-query federate-query phase: after temp table planning; query: &lt;fed-op aggregation='t...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77525</td>
<td>log.txt</td>
<td>11/03/2016 - 15:57:36.221 logical-query federate-query phase: after temp table planning; query: &lt;fed-op aggregation='t...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77526</td>
<td>tabprotos...</td>
<td>11/03/2016 - 15:57:36.107 13.589 end-query cols: 4; elapsed: 13.565; protocol-id: 8; query: SELECT &quot;t&quot;.&quot;Airline Name&quot; AS ...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77527</td>
<td>tabprotos...</td>
<td>11/03/2016 - 15:57:36.262 begin-query protocol-id: 8; query: SELECT &quot;t&quot;.&quot;Airline Name&quot; AS ...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77528</td>
<td>tabprotos...</td>
<td>11/03/2016 - 15:57:43.464 resolve-preferred-import field: Airline Name; msg: Forced to new wire data type and octe...</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Temporary Tables
Temporary Tables

Optimize a query by using temporary tables in the data source

Typically used for large IN-lists

Some data sources may do this optimization on their own

And some may not
Airline Name
Southwest Airlines Co.
ExpressJet Airlines
SkyWest Airlines
Delta Air Lines
American Eagle Airlines
United Air Lines
JetBlue Airways
American Airlines
Endeavor Air
US Airways
Frontier Airlines
AirTran Airways Corporation
Alaska Airlines
Virgin America
Mesa Airlines
Hawaiian Airlines

Airline Name: ExpressJet Airlines
Arrdelayminutes: 5,488,368
<table>
<thead>
<tr>
<th>ID</th>
<th>File</th>
<th>Time</th>
<th>Elapsed</th>
<th>Key</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>49626</td>
<td>log.txt</td>
<td>11:03</td>
<td>compute-x-axis-description elapsed: 0.000</td>
<td>protocol-id: 19 query: SELECT CAST(&quot;airline&quot;.&quot;Airline Name&quot; AS TEXT) AS &quot;Airline Name&quot;, SUM(&quot;flightinformation_since2013&quot;.&quot;arrdelayminutes&quot;) AS &quot;sum:arrdelayminutes:ok&quot; FROM &quot;public&quot;.&quot;flightinformation_since2013&quot; &quot;flightinformation_since2013&quot; INNER JOIN &quot;public&quot;.&quot;airline&quot; &quot;airline&quot; ON (&quot;flightinformation_since2013&quot;.&quot;airlineid&quot; = &quot;airline&quot;.&quot;airlineid&quot;) INNER JOIN &quot;public&quot;.&quot;city&quot; &quot;city&quot; ON (&quot;flightinformation_since2013&quot;.&quot;origincityid&quot; = &quot;city&quot;.&quot;cityid&quot;) INNER JOIN &quot;public&quot;.&quot;state&quot; &quot;state&quot; ON (&quot;flightinformation_since2013&quot;.&quot;originstateid&quot; = &quot;state&quot;.&quot;stateid&quot;) INNER JOIN &quot;#Tableau_19_1_Filter&quot; &quot;t0&quot; ON (&quot;city&quot;.&quot;City and State&quot; = &quot;t0&quot;.&quot;City and State&quot;) GROUP BY 1 query-category: Data query-hash: 1684085914</td>
<td></td>
</tr>
</tbody>
</table>
Insertion query into the database:

```sql
INSERT INTO "#Tableau_19.1_Filter" ("City and State", ",_Tableau_join_flag")
VALUES ('Aberdeen, SD', 1),
       ('Adak Island, AK', 1),
       ('Akron, OH', 1),
       ('Albany, NY', 1),
       ('Alexandria, LA', 1),
       ('Alpena, MI', 1),
       ('Anchorage, AK', 1),
       ('Appleton, WI', 1),
       ('Asheville, NC', 1),
       ('Aspen, CO', 1),
       ('Atlantic City, NJ', 1),
       ('Austin, TX', 1),
       ('Baltimore, MD', 1),
       ('Barrow, AK', 1),
       ('Beaumont/Port Arthur, TX', 1),
       ('Bemidji, MN', 1),
       ('Bethel, AK', 1),
       ('Binghamton, NY', 1),
       ('Bismarck/Mandan, ND', 1),
```

This query inserts data into the specified table.
<table>
<thead>
<tr>
<th>ID</th>
<th>File</th>
<th>Time</th>
<th>Elapsed</th>
<th>Key</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>49565</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:11.874</td>
<td></td>
<td>msg</td>
<td>/Users/Shard/data-dev_hyper_ricole/tableau-1.3/build/Debug/TableauLog_viewer/singleton/logs/2016/03/03/16/11/11/11.874/msg.log 49565 0 msg 0.008 0.008 17 SELECT &quot;city&quot; cols: 1 elapsed: 0.008 protocol-id: 17 query: SELECT &quot;city&quot;...</td>
</tr>
<tr>
<td>49566</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:11.892</td>
<td>0.026</td>
<td>end-query</td>
<td>cache-hit: none elapsed: 0.026 protocol-id: 17 query: SELECT &quot;city&quot;...</td>
</tr>
<tr>
<td>49567</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:11.903</td>
<td>0.071</td>
<td>ap-query-end</td>
<td></td>
</tr>
<tr>
<td>49568</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.685</td>
<td>0.062</td>
<td>construct-protocol</td>
<td></td>
</tr>
<tr>
<td>49569</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.693</td>
<td></td>
<td>protocol-added-to-group</td>
<td></td>
</tr>
<tr>
<td>49570</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.694</td>
<td></td>
<td>remote-query-planning</td>
<td></td>
</tr>
<tr>
<td>49571</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.694</td>
<td></td>
<td>remote-query-planning</td>
<td></td>
</tr>
<tr>
<td>49572</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.705</td>
<td>logical-query</td>
<td>datasource-caption: flightinformation_since2013 (public.flights)</td>
<td></td>
</tr>
<tr>
<td>49573</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.708</td>
<td></td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>49574</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.710</td>
<td></td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>49575</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.710</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>49576</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.712</td>
<td></td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>49577</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.712</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>49578</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.713</td>
<td></td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>49579</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.713</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>49580</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.714</td>
<td></td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>49581</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.714</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>49582</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.717</td>
<td></td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>49583</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.717</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>49584</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.719</td>
<td></td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>49585</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.719</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>49586</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.720</td>
<td></td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>49587</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.720</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>49588</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.721</td>
<td></td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>49589</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.721</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>49590</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.728</td>
<td></td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>49591</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:12.730</td>
<td></td>
<td>logical-query</td>
<td></td>
</tr>
<tr>
<td>49592</td>
<td>log.txt</td>
<td>11/03/2016 - 11:15:11.957</td>
<td></td>
<td>open-log</td>
<td>path: /Users/ricole/Documents/My Tableau Repository (Beta)/Logs...</td>
</tr>
</tbody>
</table>

highlighted: (query)
datasource-caption: flightinformation_since2013 (public-flightinformation_since2013)
+ (ricole)
datasource-name: federated.18ppdqx0Xw5lmb13k5z9h0mid8x
phase: before-rewrite
query: <logical-query>
  <selects>
    <field>[Airline Name]</field>
    <field>[sum:arrdelayminutes:ok]</field>
  </selects>
  <aggregateOp class='logical-operator'>
    <measures>
      <funcallExp class='logical-expression' function='SUM' shape='aggregate'>
        <identifierExp class='logical-expression' identifier='[arrdelayminutes]'>
        </identifierExp>
      </funcallExp>
    </measures>
    <groupbys>
      <binding name='[Airline Name]'>
      </binding>
    </groupbys>
  </aggregateOp>
</logical-query>
protocol-id: 19
query: SELECT CAST("AirlineName" AS TEXT) AS "Airline Name",
SUM("flightinformation_since2013"."arrdelayminutes") AS "sum:arrdelayminutes:ok"
FROM "public"."flightinformation_since2013" "flightinformation_since2013"
INNER JOIN "public"."airline" "airline" ON ("flightinformation_since2013"."airlineid" = "airline"."airlineid")
INNER JOIN "public"."city" "city" ON ("flightinformation_since2013"."origincityid" = "city"."cityid")
INNER JOIN "public"."state" "state" ON ("flightinformation_since2013"."originstateid" = "state"."stateid")
INNER JOIN #Tableau_19_1_Filter "t0" ON ("city"."City and State" = "t0"."City and State")
GROUP BY 1
query-category: Data
query-hash: 1684085914
Federated Queries
Federated Queries

Queries with multiple data sources benefit from optimization
For example, predicate push down

A federated optimization phase assigns sub-trees to data sources

Federation leverages the Tableau Data Engine to consolidate data
<table>
<thead>
<tr>
<th>ID</th>
<th>File</th>
<th>Time</th>
<th>Elapsed</th>
<th>Key</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>35804</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.964</td>
<td>0.003</td>
<td>end-data-interpreter</td>
<td>elapsed: 0.003</td>
</tr>
<tr>
<td>35805</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.964</td>
<td>0.003</td>
<td>begin-partition-interp...</td>
<td></td>
</tr>
<tr>
<td>35806</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.964</td>
<td>0.003</td>
<td>compute-x-set-interp...</td>
<td></td>
</tr>
<tr>
<td>35807</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.976</td>
<td>0.000</td>
<td>logical-query</td>
<td>datasource-caption: flightinformation_since2013 (public.fligh...</td>
</tr>
<tr>
<td>35808</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.977</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>35809</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.979</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>35810</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.979</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>35811</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.981</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>35812</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.981</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>35813</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.982</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>35814</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.982</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>35815</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.986</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>35816</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.986</td>
<td>0.000</td>
<td>logical-query-rewrite</td>
<td></td>
</tr>
<tr>
<td>35817</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.989</td>
<td>0.000</td>
<td>logical-query</td>
<td>datasource-caption: flightinformation_since2013 (public.fligh...</td>
</tr>
<tr>
<td>35818</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.992</td>
<td>0.000</td>
<td>federate-query</td>
<td>phase: before federate; query: logical-query  &lt;selects&gt; ...</td>
</tr>
<tr>
<td>35819</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.997</td>
<td>0.000</td>
<td>federate-query</td>
<td>phase: after federate; query: fed-op aggregation='true' cachin...</td>
</tr>
<tr>
<td>35820</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.999</td>
<td>0.000</td>
<td>federate-query</td>
<td>phase: after local cast planning; query: fed-op aggregation='t...</td>
</tr>
<tr>
<td>35821</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.001</td>
<td>0.000</td>
<td>federate-query</td>
<td>phase: after temp table planning; query: fed-op aggregation='t...</td>
</tr>
<tr>
<td>35822</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.002</td>
<td></td>
<td>ds-connect</td>
<td>class: dataengine; dbname:/var/folders/n4/fqsqq1533j38vxv7y...</td>
</tr>
<tr>
<td>35823</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.002</td>
<td></td>
<td>ds-connect-data-connect...</td>
<td>Metadata timestamp was not set, using Now() for m_metadataTim...</td>
</tr>
<tr>
<td>35824</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.003</td>
<td></td>
<td>msg</td>
<td>Metadata timestamp was not set, using Now() for m_metadataTim...</td>
</tr>
<tr>
<td>35825</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.003</td>
<td>0.000</td>
<td>end-ds-connect-data-con...</td>
<td>exception: fedeval_dataengine_connection_ds; elapsed: 0</td>
</tr>
<tr>
<td>35826</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.003</td>
<td>0.000</td>
<td>ds-load-metadata</td>
<td>exception: fedeval_dataengine_connection_ds; elapsed: 0</td>
</tr>
<tr>
<td>35827</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.003</td>
<td>0.000</td>
<td>end-ds-load-metadata</td>
<td>exception: fedeval_dataengine_connection_ds; elapsed: 0</td>
</tr>
<tr>
<td>35828</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.003</td>
<td>0.000</td>
<td>ds-connect</td>
<td>exception: fedeval_dataengine_connection_ds; elapsed: 0</td>
</tr>
<tr>
<td>35829</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.006</td>
<td></td>
<td>set-collation</td>
<td>charset=80x0 en_US (LEN_RUS) column: [postgres.1e9tl...</td>
</tr>
<tr>
<td>35830</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.006</td>
<td></td>
<td>ds-connect</td>
<td>class: dataengine; dbname:/var/folders/n4/fqsqq1533j38vxv7y...</td>
</tr>
<tr>
<td>35831</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.006</td>
<td></td>
<td>ds-connect-data-connect...</td>
<td>class: dataengine; dbname:/var/folders/n4/fqsqq1533j38vxv7y...</td>
</tr>
<tr>
<td>35832</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.006</td>
<td></td>
<td>msg</td>
<td>Metadata timestamp was not set, using Now() for m_metadataTim...</td>
</tr>
<tr>
<td>ID</td>
<td>File</td>
<td>Time</td>
<td>Elapsed</td>
<td>Key</td>
<td>Value</td>
</tr>
<tr>
<td>-------</td>
<td>-----------</td>
<td>-----------------------</td>
<td>---------</td>
<td>------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>35804</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.964</td>
<td>0.003</td>
<td>end-data-interpreter</td>
<td>elapsed: 0.003</td>
</tr>
<tr>
<td>35805</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.964</td>
<td>0.000</td>
<td>begin-partition-interp</td>
<td></td>
</tr>
<tr>
<td>35806</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.964</td>
<td>0.000</td>
<td>compute-x-set-interp</td>
<td></td>
</tr>
<tr>
<td>35807</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.976</td>
<td>0.000</td>
<td>logical-query</td>
<td>phase: before-query-rewrite; query: &lt;aggregateOp class='logical...'</td>
</tr>
<tr>
<td>35808</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.977</td>
<td>0.000</td>
<td>logical-query</td>
<td>phase: before-Project_EliminateUnneededBindings; query: &lt;project...</td>
</tr>
<tr>
<td>35809</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.979</td>
<td>0.000</td>
<td>logical-query</td>
<td>phase: before-Project_EliminateUnneededBindings; query: &lt;project...</td>
</tr>
<tr>
<td>35810</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.979</td>
<td>0.000</td>
<td>logical-query</td>
<td>elapsed: 0; phase: after-Project_EliminateUnneededBindings; queue:...</td>
</tr>
<tr>
<td>35811</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.981</td>
<td>0.000</td>
<td>logical-query</td>
<td>query: &lt;joinOp class='logical-ope...</td>
</tr>
<tr>
<td>35812</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.981</td>
<td>0.000</td>
<td>logical-query</td>
<td>elapsed: 0; phase: after-Join_Preculls; query: &lt;joinOp class='l...</td>
</tr>
<tr>
<td>35813</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.982</td>
<td>0.000</td>
<td>logical-query</td>
<td>elapsed: 0; phase: after-Join_Preculls; query: &lt;joinOp class='l...</td>
</tr>
<tr>
<td>35814</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.982</td>
<td>0.000</td>
<td>logical-query</td>
<td>elapsed: 0; phase: after-Join_Preculls; query: &lt;joinOp class='l...</td>
</tr>
<tr>
<td>35815</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.986</td>
<td>0.000</td>
<td>logical-query</td>
<td>elapsed: 0; phase: after-Join_Preculls; query: &lt;joinOp class='l...</td>
</tr>
<tr>
<td>35816</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.988</td>
<td>0.000</td>
<td>logical-query</td>
<td>elapsed: 0; phase: after-Join_Preculls; query: &lt;joinOp class='l...</td>
</tr>
<tr>
<td>35817</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.989</td>
<td>0.000</td>
<td>logical-query</td>
<td>elapsed: 0; phase: after-Join_Preculls; query: &lt;joinOp class='l...</td>
</tr>
<tr>
<td>35818</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.992</td>
<td>0.000</td>
<td>logical-query</td>
<td>elapsed: 0; phase: after-Join_Preculls; query: &lt;joinOp class='l...</td>
</tr>
<tr>
<td>35819</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.997</td>
<td>0.000</td>
<td>logical-query</td>
<td>elapsed: 0; phase: after-Join_Preculls; query: &lt;joinOp class='l...</td>
</tr>
<tr>
<td>35820</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:42.999</td>
<td>0.000</td>
<td>logical-query</td>
<td>elapsed: 0; phase: after-Join_Preculls; query: &lt;joinOp class='l...</td>
</tr>
<tr>
<td>35821</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.001</td>
<td>0.001</td>
<td>federate-query</td>
<td>phase: after temp table planning; query: &lt;fed-op aggregation='t...</td>
</tr>
<tr>
<td>35822</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.002</td>
<td>0.002</td>
<td>ds-connect</td>
<td>class: dataengine; dbname: /var/folders/n4/fsqsxv153j38v5x7yd...</td>
</tr>
<tr>
<td>35823</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.002</td>
<td>0.002</td>
<td>ds-connect-data-connect</td>
<td>Metadata timestamp was not set, using Now() for m_metadataTimes...</td>
</tr>
<tr>
<td>35824</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.003</td>
<td>0.003</td>
<td>msg</td>
<td>Metadata timestamp was not set, using Now() for m_metadataTimes...</td>
</tr>
<tr>
<td>35825</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.003</td>
<td>0.003</td>
<td>end-ds-connect-data-connect</td>
<td>Metadata timestamp was not set, using Now() for m_metadataTimes...</td>
</tr>
<tr>
<td>35826</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.003</td>
<td>0.003</td>
<td>ds-load-metadata</td>
<td>Metadata timestamp was not set, using Now() for m_metadataTimes...</td>
</tr>
<tr>
<td>35827</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.003</td>
<td>0.003</td>
<td>end-ds-load-metadata</td>
<td>Metadata timestamp was not set, using Now() for m_metadataTimes...</td>
</tr>
<tr>
<td>35828</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.003</td>
<td>0.003</td>
<td>end-ds-connect</td>
<td>Metadata timestamp was not set, using Now() for m_metadataTimes...</td>
</tr>
<tr>
<td>35829</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.006</td>
<td>0.006</td>
<td>set-collation</td>
<td>Metadata timestamp was not set, using Now() for m_metadataTimes...</td>
</tr>
<tr>
<td>35830</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.006</td>
<td>0.006</td>
<td>ds-connect</td>
<td>Metadata timestamp was not set, using Now() for m_metadataTimes...</td>
</tr>
<tr>
<td>35831</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.006</td>
<td>0.006</td>
<td>ds-connect-data-connect</td>
<td>Metadata timestamp was not set, using Now() for m_metadataTimes...</td>
</tr>
<tr>
<td>35832</td>
<td>log_1.txt</td>
<td>11/03/2016 - 08:30:43.006</td>
<td>0.006</td>
<td>msg</td>
<td>Metadata timestamp was not set, using Now() for m_metadataTimes...</td>
</tr>
</tbody>
</table>
Query Visualization - ID: 35821 - Key: federate-query

result
  runquery
    logical-query
    aggregate
      join
        [FQ_Temp_1]
        [FQ_Temp_2]
        [FQ_Temp_3]
          runquery
            logical-query
              select
                [public].[flightinformation_since2013]
                tag: relationOp
                class: relation
                fullName: [public].[flightinformation_since2013]
                federated: hyper
                class: logical-operator
                connection: hyper.1207xh21cncs1h1ayoh8z080it7q
                name: [public].[flightinformation_since2013]
Tableau Prep
Hyper Optimizer Steps
Hyper Query Plans
result

plan

cardinality: 3000687
from: lineitem
segment: 14

sort
What is a Query Again?
Query Visualization and Future Work

What did we cover

From viz to query, Tableau’s query ecosystem, example queries from the query pipeline, Tableau Prep, and Hyper

Future work

Run time performance metrics
Ecosystem visualization: query lineage
Graph compares: how are these two queries different?

*Performance recording dashboard integration via extensions api*
Query Visualization and Future Work

What did we cover

From viz to query, Tableau’s query ecosystem, example queries

Future work

Run time performance metrics
Ecosystem visualization: query lineage
Graph compares: how are these two queries different?
Performance recording dashboard integration via extensions api

User interface performance feedback: what should I change?
Questions
Resources
Resources

Query visualization
https://github.com/tableau/query-graphs

Tableau log viewer
https://github.com/tableau/tableau-log-viewer

Details on logs and logging
See https://github.com/tableau/tableau-log-viewer/wiki
See session “Understanding Tableau Queries, Techniques and Tools to Use”
The Truth is in the Stars with Data Architectures for Tableau
Tuesday | 12:30 – 1:30 | MCCNO – L3 – 346

Understanding Tableau Queries, Techniques, and Tools to Use
Tuesday | 2:15 – 3:15 | MCCNO – L3 – 388

Designing Efficient Workbooks | Live on Stage
Thursday | 10:45 – 11:45 | MCCNO – L2 – La Nouvelle Ballroom C
Please complete the session survey from the Session Details screen in your TC18 app.
Thank you!

ricole@tableau.com

https://research.tableau.com/user/rick-cole