CWI

Database Architectures

Verifying TPC-DS Results

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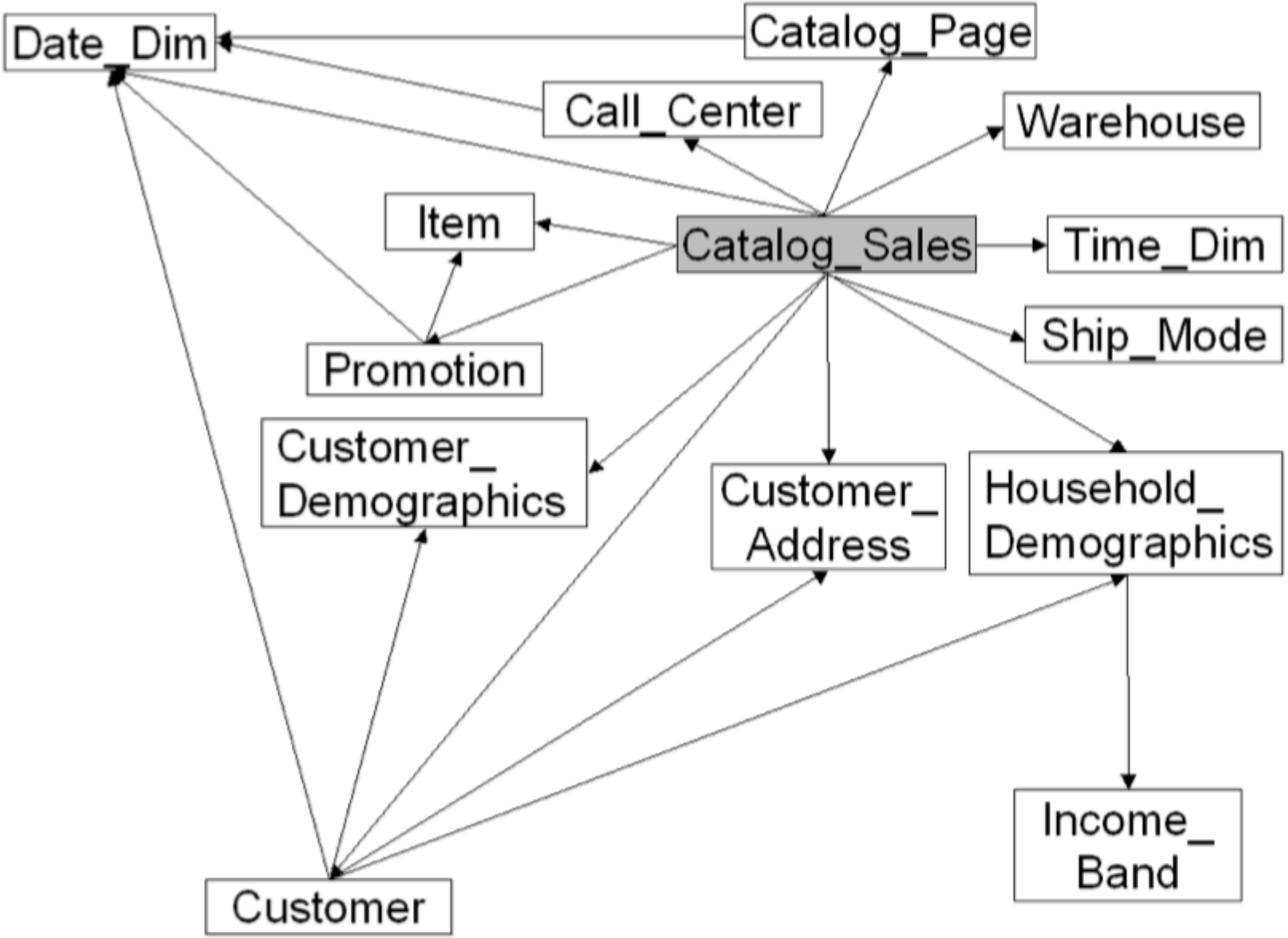
TPC-DS?

- “Decision Support”
- VLDB ’06, Othayoth & Pöss: The Making of TPC-DS
    - “TPC-H is not representative”
- *One* official result, 2018
    - “Transwarp Data Hub v5.1” ?!
    - 12 years later? Why?

TPC-DS Design

- Multiple snowflake schemas with *shared dimensions*
  - 24 tables with an average of 18 columns
  - More representative skewed database content + NULLs
  - Sub-linear scaling of non-fact tables
- Ad-hoc, reporting, iterative and extraction queries
  - ~~99~~ **103** distinct SQL 99 queries with random substitutions (ROLLUP & PARTITION)
  - Substitutes also aggr funcs *and column names*
- ETL-like data maintenance (ignored)


Date_Dim
Catalog_Page
Call_Center
Warehouse
Item
Catalog_Sales
Time_Dim
Promotion
Ship_Mode
Customer_
Demographics
Customer_
Address
Household_
Demographics
Income_
Band
Customer

TPC-DS Q1

```
with customer_total_return as
(select sr_customer_sk as ctr_customer_sk
,sr_store_sk as ctr_store_sk
,sum([AGG_FIELD]) as ctr_total_return
from store_returns
,date_dim
where sr_returned_date_sk = d_date_sk
and d_year = [YEAR]
group by sr_customer_sk
,sr_store_sk)
select c_customer_id
from customer_total_return ctr1
,store
,customer
where ctr1.ctr_total_return > (select avg(ctr_total_return)*1.2
from customer_total_return ctr2
where ctr1.ctr_store_sk = ctr2.ctr_store_sk)
and s_store_sk = ctr1.ctr_store_sk
and s_state = '[STATE]'
and ctr1.ctr_customer_sk = c_customer_sk
order by c_customer_id
LIMIT 100;
```

TPC-DS Q4

```
with year_total as (
 select c_customer_id customer_id
       ,c_first_name customer_first_name
       ,c_last_name customer_last_name
       ,c_preferred_cust_flag customer_preferred_cust_flag
       ,c_birth_country customer_birth_country
       ,c_login customer_login
       ,c_email_address customer_email_address
       ,d_year dyear
       ,sum(((ss_ext_list_price-ss_ext_wholesale_cost-ss_ext_discount_amt)+ss_ext_sales_price)/2) year_total
       ,'s' sale_type
 from customer
     ,store_sales
     ,date_dim
 where c_customer_sk = ss_customer_sk
   and ss_sold_date_sk = d_date_sk
 group by c_customer_id
         ,c_first_name
         ,c_last_name
         ,c_preferred_cust_flag
         ,c_birth_country
         ,c_login
         ,c_email_address
         ,d_year
 union all
 select c_customer_id customer_id
       ,c_first_name customer_first_name
       ,c_last_name customer_last_name
       ,c_preferred_cust_flag customer_preferred_cust_flag
       ,c_birth_country customer_birth_country
       ,c_login customer_login
       ,c_email_address customer_email_address
       ,d_year dyear
       ,sum((((cs_ext_list_price-cs_ext_wholesale_cost-cs_ext_discount_amt)+cs_ext_sales_price)/2) ) year_total
       ,'c' sale_type
 from customer
     ,catalog_sales
     ,date_dim
 where c_customer_sk = cs_bill_customer_sk
   and cs_sold_date_sk = d_date_sk
 group by c_customer_id
         ,c_first_name
         ,c_last_name
         ,c_preferred_cust_flag
         ,c_birth_country
         ,c_login
         ,c_email_address
         ,d_year
union all
 select c_customer_id customer_id
       ,c_first_name customer_first_name
       ,c_last_name customer_last_name
       ,c_preferred_cust_flag customer_preferred_cust_flag
       ,c_birth_country customer_birth_country
       ,c_login customer_login
       ,c_email_address customer_email_address
       ,d_year dyear
       ,sum((((ws_ext_list_price-ws_ext_wholesale_cost-ws_ext_discount_amt)+ws_ext_sales_price)/2) ) year_total
       ,'w' sale_type
 from customer
     ,web_sales
     ,date_dim
 where c_customer_sk = ws_bill_customer_sk
   and ws_sold_date_sk = d_date_sk
 group by c_customer_id
         ,c_first_name
         ,c_last_name
         ,c_preferred_cust_flag
         ,c_birth_country
         ,c_login
         ,c_email_address
         ,d_year
         )
 select
                 t_s_secyear.customer_id
                ,t_s_secyear.customer_first_name
                ,t_s_secyear.customer_last_name
                ,[SELECTONE]
 from year_total t_s_firstyear
     ,year_total t_s_secyear
     ,year_total t_c_firstyear
     ,year_total t_c_secyear
     ,year_total t_w_firstyear
     ,year_total t_w_secyear
 where t_s_secyear.customer_id = t_s_firstyear.customer_id
   and t_s_firstyear.customer_id = t_c_secyear.customer_id
   and t_s_firstyear.customer_id = t_c_firstyear.customer_id
   and t_s_firstyear.customer_id = t_w_firstyear.customer_id
   and t_s_firstyear.customer_id = t_w_secyear.customer_id
   and t_s_firstyear.sale_type = 's'
   and t_c_firstyear.sale_type = 'c'
   and t_w_firstyear.sale_type = 'w'
   and t_s_secyear.sale_type = 's'
   and t_c_secyear.sale_type = 'c'
   and t_w_secyear.sale_type = 'w'
   and t_s_firstyear.dyear =  [YEAR]
   and t_s_secyear.dyear = [YEAR]+1
   and t_c_firstyear.dyear =  [YEAR]
   and t_c_secyear.dyear =  [YEAR]+1
   and t_w_firstyear.dyear = [YEAR]
   and t_w_secyear.dyear = [YEAR]+1
   and t_s_firstyear.year_total > 0
   and t_c_firstyear.year_total > 0
   and t_w_firstyear.year_total > 0
   and case when t_c_firstyear.year_total > 0 then t_c_secyear.year_total / t_c_firstyear.year_total else null end
            > case when t_s_firstyear.year_total > 0 then t_s_secyear.year_total / t_s_firstyear.year_total else null end
   and case when t_c_firstyear.year_total > 0 then t_c_secyear.year_total / t_c_firstyear.year_total else null end
            > case when t_w_firstyear.year_total > 0 then t_w_secyear.year_total / t_w_firstyear.year_total else null end
 order by t_s_secyear.customer_id
         ,t_s_secyear.customer_first_name
         ,t_s_secyear.customer_last_name
         ,[SELECTONE]
limit 100;
```

“Qualification”

- Reference results “provided” for SF 1
  - *Completely borked* format, every single one had different encoding (grrr)
- NULL first/last difference, hence 2 sets of results for many queries
- Query placeholder values only in spec PDF (grrr)

B.1 query1.tpl

Find customers who have returned items more than 20% more often than the average customer returns for a store in a given state for a given year.

Qualification Substitution Parameters:

- YEAR.01=2000
- STATE.01=TN
- AGG_FIELD.01 = SR_RETURN_AMT

[Q 34 NULLs last]

```
SQL*Plus: Release 12.1.0.2.0 Production on Wed Jun 8 16:25:41 2016

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SQL> Connected.
SQL> SQL> SQL> SQL>
C_LAST_NAME          C_FIRST_NAME     C_SALUTATI C SS_TICKET_NUMBER  CNT
-------------------- ---------------- ---------- - --------------- ----------
Abbott               Harriet          Ms.        N          195008   15
Acosta               Victor           Mr.        N          156807   15
Adams                Jerry            Sir        N          216653   15
…
Woody                Philip           Mr.        N          211173   16
Wright               Amanda                      Y          105395   15
Yates                Kimberly         Ms.        Y          220849   15
                     Grace                       147095   16
                     Joshua           Sir        N          108357   15
                     Judy             Dr.                   234350   16
                     Roy                         200033   15
                        Mr.                      Y          214003   15
                        Ms.                       54536   16
                             148695   16
                             151297   15
                             Y         16278   15
                             Y        146557   16
                             N         55640   15
                             N         58614   15
                             N         96514   15
                             N        220211   15

451 rows selected.

Elapsed: 00:00:03.36
SQL> Disconnected from Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 - 64bit Production
With the Partitioning, Real Application Clusters, Automatic Storage Management, OLAP,
Advanced Analytics and Real Application Testing options
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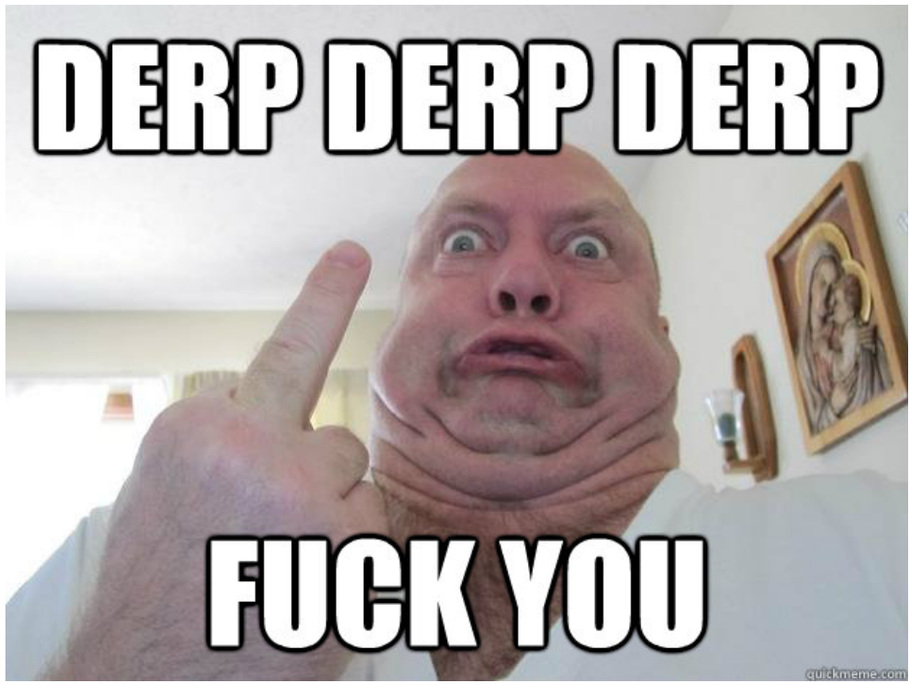


Challenge: Reproduce Results

- What are the correct answers to the qualification queries on SF1?
- Very useful for testing!
  - check correctness before bragging about performance

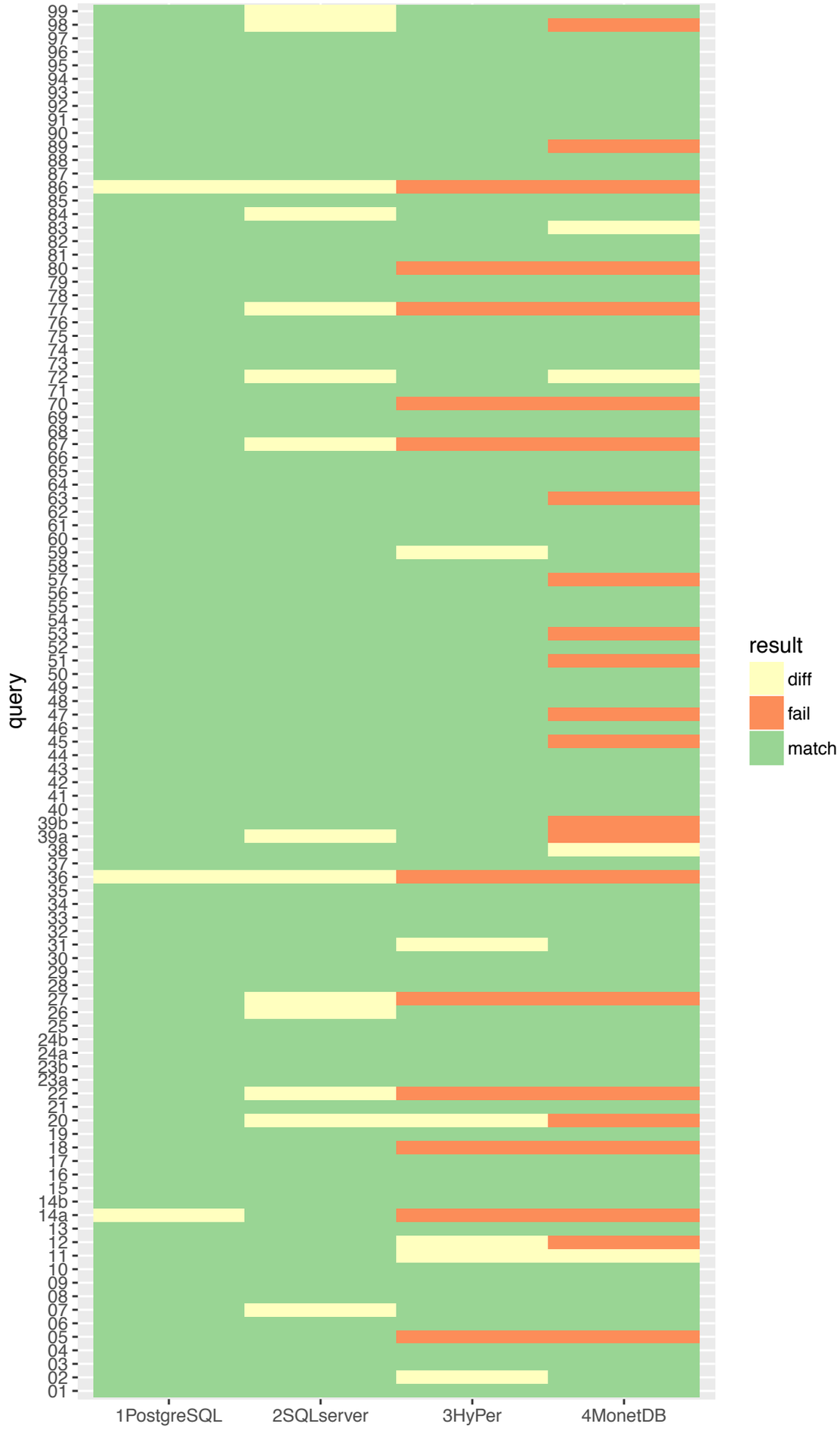
- Steps:
  - Clean up reference results (manually)
  - Create tool to check reference results (numeric diffs)
  - Create qualification queries from PDF (manually)
  - Run queries on bunch of systems to see whether they agree

Systems tested

- Postgres 11.0
- HyPer 20182.18.1009.2120
- SQL Server on Docker
- MonetDB 11.31.11
- SQLite 3.24.0
  - (dropped because could not run enough queries)

Results

- Reference results for Queries 21, 34, 66, 71, 73, 79 and 98 were wrong (missing/additional rows, values, spacing)
  - Determined by consensus of 2 or more systems
- Queries 78 and 83 are probably broken (int div/rounding)
- Postgres/SQL server can run all queries
- HyPer misses ROLLUP, thus failing ~ 10 queries
- MonetDB misses ROLLUP and PARTITION, thus failing ~ 20 queries
  - Analytics branch can’t do PARTITION queries yet (checked 2018-10-29)
- All but three queries have reproduced results
  - Need additional systems to double-check reference results


query
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14b
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02
01
1PostgreSQL
2SQLserver
3HyPer
4MonetDB
result
diff
fail
match

https://github.com/cwida/tpcds-kit

- Cleaned and checked reference (results NULL first+last)
- Qualification queries
- Data generator
  - Copy of SF1 at https://homepages.cwi.nl/~hannes/tpcds-sf1-xz/
- Load scripts for various DBs
- Result diff tool (1% numeric drift and spaces allowed)
- Plotting script (R)
- Some more cleanup and documentation to come

Next steps

- Cleanup repo and document
- Verify last three inconsistent results
  - Which system? Oracle? Vectorwise? Redshift
- Write paper for TPCTC?
- Actually run a performance comparison?
- Create test cases for systems / file bug reports
- Questions?