

COP 6726: DATABASE SYSTEM IMPLEMENTATION

Assignment 1: Heap File Implementation

Group Info:

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I. INTRODUCTION

In this assignment, we have implemented the DBFile class. The job of the DBFile class within the database system is simply to store and retrieve records from the disk. We have also written unit test cases using google test unit testing library for every function which we have implemented in DBFile Class. We have also recorded the execution time of each query and also recorded the time taken to scan all the records.

II. ASSUMPTIONS

- A. gcc (or clang) must be installed together with “bison” and “flex” on the machine on which the project will be tested.
- B. Google Test Unit Testing Library should also be installed and compiled on the machine on which the project will be tested.
- C. Google Test Unit Testing Library is not installed on CISE Thunder Server so the gTest command won't run on thunder.

III. FILE STRUCTURE

- A. bin/ : Contains object(.o) files.
- B. src/: Contains .cc and .h files.
- C. table_files/: Contains .tbl files which were generated using tpch data generator.
- D. gtest/: Google Test Unit testing library.
- E. catalog: Catalog file for the schema of .tbl files
- F. MakeFile: Make File.

IV. CODE EXPLANATION

Private Data Structures used in DBFile Class:-

1. **File* myFile:** DBFile Class is built on top of File Class.
2. **Record* currentRecord:** This variable points to the current record of the DBFile.
3. **Page* myPage:** DBFile Class is built on top of Page Class.
4. **bool pageWritten:** This variable indicates whether the current page has been written to the DBFile or not.
5. **Off_t currentPageIndex:** This variable specifies the current page index.

Public Functions used in DBFile Class:-

1. **void Add (Record &addMe);**

This function is used to add records to the file. In the case of the unordered heap file that has been implemented in this assignment, this function simply adds the new record to the end of the file.

2. **int Create (char *name, fType myType, void *startup);**

This function is used to create the file.

3. **int Open (char *name);**

This function is used to open a file that has already been created and also being closed.

4. **int Close();**

This function simply closes the file.

5. **void Load (Schema &mySchema, char *loadMe);**

This function bulk loads the DBFile instance from a text file, appending new data to it using the SuckNextRecord function from Record.h.

6. **int GetNext (Record &fetchMe);**

This function simply gets the next record from the file and returns it to the user.

7. **int GetNext (Record &fetchMe, CNF &applyMe, Record &literal);**

This function accepts a selection predicate and returns the next record in the file which is accepted by the selection predicate.

8. **void MoveFirst ()**

This function forces some pointer to correspond to the first record in the file.

V. **COMMANDS TO RUN THE PROGRAM**

To compile the given test driver, type
make test.out

To run the test driver, type

./test.out

and then follow the on-screen instructions. For scan and filter operation, write any CNF which has been given in the result section below. After writing the CNF, press ENTER and then press Ctrl+D.

The thunder server at cise.ufl.edu doesn't have Google Test installed so you might have to download it.

To compile Google Test, type

make gTest

To run the unit tests, type

cd bin

./gTestProj1

The unit tests should run and you should be able to see the test results.

VI. **RESULTS**

We ran our program on 2 sets of data which was generated by tpch data generator. One set of data is 1G and other is 10M.

A. 1G Data

We verified our results with the results which have been provided by the professor in the assignment folder.

Query 1

(r_name = 'EUROPE')

```
thunder:74% ./test.out

** IMPORTANT: MAKE SURE THE INFORMATION BELOW IS CORRECT **
catalog location:      catalog
tpch files dir:        /cise/tmp/dbi_sp11/DATA/1G/
heap files dir:

select test:
    1. load file
    2. scan
    3. scan & filter
    3

select table:
    1. nation
    2. region
    3. customer
    4. part
    5. partsupp
    6. orders
    7. lineitem
    2
Filter with CNF for : region
Enter CNF predicate (when done press ctrl-D):
    (r_name = 'EUROPE')
r_regionkey: [3], r_name: [EUROPE], r_comment: [ly final courts cajole furiously final excuse]
Selected 1 Records.
Query Time 6.8e-05seconds.
thunder:75% █
```

Query 2

(r_name = 'MIDDLE EAST') AND (r_regionkey > 1)

```
thunder:76% ./test.out

** IMPORTANT: MAKE SURE THE INFORMATION BELOW IS CORRECT **
catalog location:      catalog
tpch files dir:        /cise/tmp/dbi_sp11/DATA/1G/
heap files dir:

select test:
    1. load file
    2. scan
    3. scan & filter
    3

select table:
    1. nation
    2. region
    3. customer
    4. part
    5. partsupp
    6. orders
    7. lineitem
    2
Filter with CNF for : region
Enter CNF predicate (when done press ctrl-D):
    (r_name < 'MIDDLE EAST') AND (r_regionkey > 1)
r_regionkey: [2], r_name: [ASIA], r_comment: [ges. thinly even pinto beans cal
r_regionkey: [3], r_name: [EUROPE], r_comment: [ly final courts cajole furiously final excuse]
Selected 2 Records.
Query Time 0.00011seconds.
thunder:77% █
```

Query 3

(n_regionkey = 3) AND (n_nationkey > 10) AND (n_name > 'JAPAN')

```
select test:
  1. load file
  2. scan
  3. scan & filter
  3

select table:
  1. nation
  2. region
  3. customer
  4. part
  5. partsupp
  6. orders
  7. lineitem
  1

Filter with CNF for : nation
Enter CNF predicate (when done press ctrl-D):
(n_regionkey = 3) AND (n_nationkey > 10) AND (n_name > 'JAPAN')
nationkey: [19], n_name: [ROMANIA], n_regionkey: [3], n_comment: [ular asymptotes are about the furious multipliers. express dependencies nag above the icro
ically ironic account]
nationkey: [22], n_name: [RUSSIA], n_regionkey: [3], n_comment: [ requests against the platelets use never according to the quickly regular pint]
nationkey: [23], n_name: [UNITED KINGDOM], n_regionkey: [3], n_comment: [eans boost carefully special requests. accounts are. carefull]
Selected 3 Records.
Query Time 0.000122seconds.
thunder:100% █
```

Query 4

(c_nationkey = 23) AND (c_mktsegment = 'FURNITURE') AND (c_acctbal > 7023.99) AND (c_acctbal < 7110.83)

```
select test:
  1. load file
  2. scan
  3. scan & filter
  3

select table:
  1. nation
  2. region
  3. customer
  4. part
  5. partsupp
  6. orders
  7. lineitem
  3

Filter with CNF for : customer
Enter CNF predicate (when done press ctrl-D):
(c_nationkey = 23) AND (c_mktsegment = 'FURNITURE') AND (c_acctbal > 7023.99) AND (c_acctbal < 7110.83)
c_custkey: [30970], c_name: [Customer#000030970], c_address: [0,N4bwYdHoSdg64DGAc6OuxWjn5rlP63sWAT], c_nationkey: [23], c_phone: [33-739-174-9054], c_acctbal
: [7054.59], c_mktsegment: [FURNITURE], c_comment: [sly unusual platelets alongside of the express depos]
c_custkey: [35802], c_name: [Customer#000035802], c_address: [r8fEXhwF4MRWZQ,liRTTVjSBqEnb7kENEVDEY], c_nationkey: [23], c_phone: [33-931-338-6655], c_acctba
: [7027.91], c_mktsegment: [FURNITURE], c_comment: [pecial ideas. regular, even pinto beans above the slyly pending pinto beans are blithely across]
c_custkey: [38796], c_name: [Customer#000038796], c_address: [nIGHXxDiaVBoX BCrixlJUKx], c_nationkey: [23], c_phone: [33-893-935-9650], c_acctbal: [7079.41]
c_mktsegment: [FURNITURE], c_comment: [dolites are furiously fluffily final accounts. unusual dugouts cajole furiously careful]
c_custkey: [61179], c_name: [Customer#000061179], c_address: [dpdbiV6kFYz x6OT84qR9j], c_nationkey: [23], c_phone: [33-825-707-8461], c_acctbal: [7075.72], c
mktsegment: [FURNITURE], c_comment: [ully final accounts. slyly special instructions above the quickly expr]
c_custkey: [72898], c_name: [Customer#000072898], c_address: [l2r8Pa4owhhXCH,Lj3Iv], c_nationkey: [23], c_phone: [33-119-734-3569], c_acctbal: [7096.31], c_m
ktsegment: [FURNITURE], c_comment: [ unusual accounts haggle carefully final, fluffy excuses. regu]
c_custkey: [73441], c_name: [Customer#000073441], c_address: [7BHFD659A qNnOliO], c_nationkey: [23], c_phone: [33-868-482-1168], c_acctbal: [7038.25], c_mkts
egment: [FURNITURE], c_comment: [jole carefully silent foxes. asymptotes snooze after the furiously final depende]
c_custkey: [85818], c_name: [Customer#000085818], c_address: [nab9thPpabGH5P7Xsk40qgJUmM], c_nationkey: [23], c_phone: [33-688-221-5550], c_acctbal: [7073.6
7], c_mktsegment: [FURNITURE], c_comment: [s. carefully even pinto beans haggle quickly bold packages. blithely ironic requests ]
c_custkey: [98151], c_name: [Customer#000098151], c_address: [hEkI ENkkn9wwr,lmnPgPBPrz6CWjvjikbG ], c_nationkey: [23], c_phone: [33-870-939-7560], c_acctbal
: [7045.3], c_mktsegment: [FURNITURE], c_comment: [ unusual ideas. unusual, final accounts are carefully packages. furiously ironic excuses sleep never. regu
a]
c_custkey: [125850], c_name: [Customer#000125850], c_address: [q0870ozQ6flfrpcDBi0EdzslbTZuXH2Y], c_nationkey: [23], c_phone: [33-577-932-3052], c_acctbal: [
7076.18], c_mktsegment: [FURNITURE], c_comment: [g requests about the accounts sleep ]
c_custkey: [145598], c_name: [Customer#000145598], c_address: [8n6XgG8vImcXIi7h2AWfsoNVBCIJ4oSaa], c_nationkey: [23], c_phone: [33-685-336-6690], c_acctbal:
[7064.61], c_mktsegment: [FURNITURE], c_comment: [ix fluffily special, even deposits. slyly regular reques]
Selected 10 Records.
Query Time 0.190665seconds.
thunder:82% █
```

Query 5

(p_brand = 'Brand#13') AND (p_retailprice > 500.00) AND (p_retailprice < 930.00) AND (p_size > 28) AND (p_size < 1000000)

```
select test:
  1. load file
  2. scan
  3. scan & filter
  3

select table:
  1. nation
  2. region
  3. customer
  4. part
  5. partsupp
  6. orders
  7. lineitem
  3

Filter with CNF for : customer
Enter CNF predicate (when done press ctrl-D):
(c_nationkey = 23) AND (c_mktsegment = 'FURNITURE') AND (c_acctbal > 7023.99) AND (c_acctbal < 7110.83)
c_custkey: [30970], c_name: [Customer#000030970], c_address: [0.N4BwydH0sDg64DGArc60uxWjn5r1P63sWAT], c_nationkey: [23], c_phone: [33-739-174-9054], c_acctbal: [7054.59], c_mktsegment: [FURNITURE], c_comment: [sly unusual platelets alongside of the express depos]
c_custkey: [35802], c_name: [Customer#000035802], c_address: [r8fEXhwF4MKMZQ,LIrTTVjSBqEnb7kENEVDEY], c_nationkey: [23], c_phone: [33-931-338-6655], c_acctbal: [7027.91], c_mktsegment: [FURNITURE], c_comment: [pecial ideas. regular, even pinto beans above the slyly pending pinto beans are blithely across]
c_custkey: [38796], c_name: [Customer#000038796], c_address: [nIGHXXDiaVBoX BCrIXlJUKx], c_nationkey: [23], c_phone: [33-893-935-9650], c_acctbal: [7079.41]
c_custkey: [61179], c_name: [Customer#000061179], c_address: [dpdbiV6kFYz x6OT84qR9j], c_nationkey: [23], c_phone: [33-825-707-8461], c_acctbal: [7075.72], c_mktsegment: [FURNITURE], c_comment: [ully final accounts. slyly special instructions above the quickly expr]
c_custkey: [72898], c_name: [Customer#000072898], c_address: [1zr8Pa40WhhXCH,Lj9Iv], c_nationkey: [23], c_phone: [33-119-734-3569], c_acctbal: [7096.31], c_mktsegment: [FURNITURE], c_comment: [ unusual accounts haggle carefully final, fluffly excuses. regul]
c_custkey: [73441], c_name: [Customer#000073441], c_address: [7BHFD659A qnN0li0], c_nationkey: [23], c_phone: [33-868-482-1168], c_acctbal: [7038.25], c_mktsegment: [FURNITURE], c_comment: [jole carefully silent foxes. asymptotes snooze after the furiously final depende]
c_custkey: [85818], c_name: [Customer#000085818], c_address: [nahq1hPPabGH5P7Xsk40qdUmJm,], c_nationkey: [23], c_phone: [33-688-221-5550], c_acctbal: [7073.6], c_mktsegment: [FURNITURE], c_comment: [s. carefully even pinto beans haggle quickly bold packages. blithely ironic requests ]
c_custkey: [98151], c_name: [Customer#000098151], c_address: [hEk1 Fntkn9wwr,1nmPgPBPrz6CWjvjkbG ], c_nationkey: [23], c_phone: [33-870-939-7560], c_acctbal: [7045.3], c_mktsegment: [FURNITURE], c_comment: [ unusual ideas. unusual, final accounts are carefully packages. furiously ironic excuses sleep never. regul]
c_custkey: [125850], c_name: [Customer#000125850], c_address: [g0870ozQ6fifrcpCDBi0EdzslbtZuXH2Y], c_nationkey: [23], c_phone: [33-577-932-3052], c_acctbal: [7076.19], c_mktsegment: [FURNITURE], c_comment: [g requests about the accounts sleep ]
c_custkey: [145598], c_name: [Customer#000145598], c_address: [Sn6XqG8w1mdXli7h2AWfsoNVCICIJ4oSaa], c_nationkey: [23], c_phone: [33-685-336-6690], c_acctbal: [7064.61], c_mktsegment: [FURNITURE], c_comment: [ix fluffily special, even deposits. slyly regular reques]
Selected 10 Records.
Query Time 0.190666seconds.
thunder:82%
```

Query 6

(ps_supplycost > 999.98)

```
select table:
  1. nation
  2. region
  3. customer
  4. part
  5. partsupp
  6. orders
  7. lineitem
  5

Filter with CNF for : partsupp
Enter CNF predicate (when done press ctrl-D):
(ps_supplycost > 999.98)
ps_partkey: [1213], ps_suppkey: [3714], ps_availqty: [5070], ps_supplycost: [999.99], ps_comment: [ ironic, special deposits. carefully final deposits haggle fluffily. furiously final foxes use furiously furiously ironic accounts. package]
ps_partkey: [15717], ps_suppkey: [3221], ps_availqty: [9790], ps_supplycost: [999.99], ps_comment: [uriously regular requests haggle. slow foxes at the furiously final accounts hang slyly fluffily express instructions. permanent, final deposits are sometimes after the blithely unusual packages. fi]
ps_partkey: [19079], ps_suppkey: [1581], ps_availqty: [4680], ps_supplycost: [999.99], ps_comment: [y final requests. final platelets cajole carefully. blithely ironic packages wake after the blithely bold requests. s]
ps_partkey: [26924], ps_suppkey: [1929], ps_availqty: [9218], ps_supplycost: [1000], ps_comment: [furiously regular requests. requests alongside of the pending, even courts cajole silent platelets. slyly bold instructions after the furiously unusual a]
ps_partkey: [30836], ps_suppkey: [5843], ps_availqty: [6993], ps_supplycost: [999.99], ps_comment: [ong the slyly regular deposits. even asymptotes haggle against the slyly final Tiresias. blithely regular instructions maintain up the furiously sly requests. furiously special theol]
ps_partkey: [31554], ps_suppkey: [1555], ps_availqty: [2409], ps_supplycost: [1000], ps_comment: [ans kindle along the blithely even excuses. slyly careful foxes are blithely. theodolites dazzle ironically. ideas sleep among the asymptotes. packages above the instructions wal]
ps_partkey: [52644], ps_suppkey: [5150], ps_availqty: [8224], ps_supplycost: [999.99], ps_comment: [ the slyly even deposits. furiously regular foxes along the regular asymptotes sleep slyly unusual deposits. carefully final dolphins abou]
ps_partkey: [99907], ps_suppkey: [7435], ps_availqty: [7911], ps_supplycost: [1000], ps_comment: [ully about the furiously special deposits. slyly express asymptotes affix around the boldly express frays. carl]
ps_partkey: [103943], ps_suppkey: [3944], ps_availqty: [5065], ps_supplycost: [1000], ps_comment: [leep against the theodolites. quickly ironic ideas boost fluffily slyly bold dolphins. fluffily]
ps_partkey: [105389], ps_suppkey: [410], ps_availqty: [8531], ps_supplycost: [999.99], ps_comment: [y unusual requests. quickly bold accounts use quickly quickly regular packages. ironic packages sleep carefully with the final theodolites. even, regul]
ps_partkey: [130470], ps_suppkey: [2984], ps_availqty: [2592], ps_supplycost: [999.99], ps_comment: [ites against the ironic, unusual instructions use fluffily despite the quickly final theodolites. stealthy theodolites naq]
ps_partkey: [142176], ps_suppkey: [7205], ps_availqty: [9737], ps_supplycost: [1000], ps_comment: [cies boost slyly special requests. ironic accounts are quickly. ]
ps_partkey: [182623], ps_suppkey: [7660], ps_availqty: [4963], ps_supplycost: [999.99], ps_comment: [of the slyly even requests haggle fluffily furiously ruthless platelets; furiously final packages sleep until the final packages. blithely final theol]
ps_partkey: [185850], ps_suppkey: [5851], ps_availqty: [9994], ps_supplycost: [1000], ps_comment: [ng the bold ideas. slyly ironic packages mold enticing, special accounts. regul]
Selected 14 Records.
Query Time 0.805436seconds.
thunder:86%
```


Query 7

(ps_availqty < 10) AND (ps_supplycost > 100.00) AND (ps_suppkey < 300)

```
select table:
  1. nation
  2. region
  3. customer
  4. part
  5. partsupp
  6. orders
  7. lineitem
  8
Filter with CNF for : partsupp
Enter CNF predicate (when done press ctrl-D):
  (ps_availqty < 10) AND (ps_supplycost > 100.00) AND (ps_suppkey < 300)
ps_partkey: [7696], ps_suppkey: [197], ps_availqty: [6], ps_supplycost: [268.55], ps_comment: [pecial, regular theodolites haggle fluffily according t]
ps_partkey: [10245], ps_suppkey: [246], ps_availqty: [7], ps_supplycost: [722.6], ps_comment: [ove the even requests. special deposits sleep. epitaphs boost
slowly. final ac]
ps_partkey: [25097], ps_suppkey: [102], ps_availqty: [1], ps_supplycost: [167.93], ps_comment: [s. carefully express frays sleep slyly. pending, regular depo
sits]
ps_partkey: [27573], ps_suppkey: [76], ps_availqty: [2], ps_supplycost: [624.24], ps_comment: [ackages. slyly pending accounts are furiously blithe instructi
ons. express, ]
ps_partkey: [42762], ps_suppkey: [275], ps_availqty: [5], ps_supplycost: [275.99], ps_comment: [ use blithely after the furiously final depths. furiously slo
w pinto beans boost quickly along the furiously even pinto beans. slyly express requests wake. furiously ]
ps_partkey: [50050], ps_suppkey: [51], ps_availqty: [5], ps_supplycost: [487.83], ps_comment: [cies integrate blithely regular deposits. slyly silent deposit
s are blithely silent, special theodolites. special, regular foxes after the carefully unusual instructions wake in place of the]
ps_partkey: [50225], ps_suppkey: [226], ps_availqty: [7], ps_supplycost: [320.96], ps_comment: [ silent packages maintain. regular deposits use carefully acc
ording to the unusual foxes. packages are. blithely bold decoys detect furiously ironic dependencies. even, regular theol]
ps_partkey: [77622], ps_suppkey: [130], ps_availqty: [6], ps_supplycost: [352.93], ps_comment: [st furiously: sometimes bold pinto beans around the busily pe
nding instructions wake slyly furiously regular deposits. bold asym]
ps_partkey: [85011], ps_suppkey: [28], ps_availqty: [4], ps_supplycost: [628.75], ps_comment: [uriously regular Tiresias. slyly ironic pinto beans impress bl
ithely. fluffily regular Tiresias integrate furiously even foxes. ironic excuses around the furiously even waters are quickly]
ps_partkey: [112746], ps_suppkey: [280], ps_availqty: [7], ps_supplycost: [461.99], ps_comment: [y bold foxes cajole of the furiously even ideas. quickly clo
se theodolites along the express, fur]
ps_partkey: [137572], ps_suppkey: [86], ps_availqty: [8], ps_supplycost: [180.55], ps_comment: [n ideas nag slyly after the blithely bold deposits. entic]
ps_partkey: [172720], ps_suppkey: [272], ps_availqty: [5], ps_supplycost: [437.41], ps_comment: [ regular accounts boost. regular, express pinto beans sl]
ps_partkey: [187487], ps_suppkey: [6], ps_availqty: [7], ps_supplycost: [447.8], ps_comment: [y doggedly regular excuses. slyly bold deposits according to th
e instructions sleep carefully even instructions. flu]
ps_partkey: [192666], ps_suppkey: [224], ps_availqty: [1], ps_supplycost: [374.58], ps_comment: [esias integrate carefully. regular accounts alongside of the
requests haggle slyly fluffily ironic deposits. slyly special packages doze carefully. slowly regu]
Selected 14 Records.
Query Time 0.348504seconds.
thunder:88% █
```

Query 8

(o_orderpriority = '1-URGENT') AND (o_orderstatus = 'O') AND (o_shippriority = 0) AND (o_totalprice > 1015.68) AND (o_totalprice < 1051.89)

```
select test:
  1. load file
  2. scan
  3. scan & filter
  4
select table:
  1. nation
  2. region
  3. customer
  4. part
  5. partsupp
  6. orders
  7. lineitem
  8
Filter with CNF for : orders
Enter CNF predicate (when done press ctrl-D):
  (o_orderpriority = '1-URGENT') AND (o_orderstatus = 'O') AND (o_shippriority = 0) AND (o_totalprice > 1015.68) AND (o_totalprice < 1051.89)
o_orderkey: [298468], o_custkey: [72782], o_orderstatus: [O], o_totalprice: [1035.34], o_orderdate: [1996-02-08], o_orderpriority: [1-URGENT], o_clerk: [Clerk#000000305], o_shippriority: [0], o_comment: [ites are slyly above the furiously regu]
o_orderkey: [1636866], o_custkey: [123397], o_orderstatus: [O], o_totalprice: [1030.26], o_orderdate: [1997-01-09], o_orderpriority: [1-URGENT], o_clerk: [Clerk#000000268], o_shippriority: [0], o_comment: [thin deposits. requests print blithely fluffily unusual ]
o_orderkey: [1866274], o_custkey: [43048], o_orderstatus: [O], o_totalprice: [1040.95], o_orderdate: [1998-05-29], o_orderpriority: [1-URGENT], o_clerk: [Clerk#000000353], o_shippriority: [0], o_comment: [ slyly special accounts doze blithely ironic]
o_orderkey: [2270022], o_custkey: [34705], o_orderstatus: [O], o_totalprice: [1020.97], o_orderdate: [1995-07-19], o_orderpriority: [1-URGENT], o_clerk: [Clerk#000000592], o_shippriority: [0], o_comment: [furiously unusual excuses believe ]
o_orderkey: [2364615], o_custkey: [101876], o_orderstatus: [O], o_totalprice: [1051.24], o_orderdate: [1996-06-03], o_orderpriority: [1-URGENT], o_clerk: [Clerk#000000450], o_shippriority: [0], o_comment: [he ironic, ironic requests sleep above the express ]
o_orderkey: [2383909], o_custkey: [105200], o_orderstatus: [O], o_totalprice: [1044.37], o_orderdate: [1998-03-12], o_orderpriority: [1-URGENT], o_clerk: [Clerk#000000824], o_shippriority: [0], o_comment: [pecial, unusual Requests integrate]
o_orderkey: [2459431], o_custkey: [5533], o_orderstatus: [O], o_totalprice: [1019.65], o_orderdate: [1995-11-15], o_orderpriority: [1-URGENT], o_clerk: [Clerk#000000137], o_shippriority: [0], o_comment: [wake quickly regular foxes. carefully regular pinto beans cajole slyly. b]
o_orderkey: [2685028], o_custkey: [109360], o_orderstatus: [O], o_totalprice: [1024.26], o_orderdate: [1997-09-23], o_orderpriority: [1-URGENT], o_clerk: [Clerk#000000273], o_shippriority: [0], o_comment: [ly pending accounts sleep]
o_orderkey: [4442532], o_custkey: [62309], o_orderstatus: [O], o_totalprice: [1038.36], o_orderdate: [1998-02-02], o_orderpriority: [1-URGENT], o_clerk: [Clerk#000000811], o_shippriority: [0], o_comment: [ requests believe against the requests. fu]
o_orderkey: [5859040], o_custkey: [76096], o_orderstatus: [O], o_totalprice: [1039.61], o_orderdate: [1996-01-02], o_orderpriority: [1-URGENT], o_clerk: [Clerk#000000737], o_shippriority: [0], o_comment: [arefully final foxes. express accounts play carefully. fluffily special reques]
Selected 10 Records.
Query Time 1.21391seconds.
thunder:90% █
```

Query 9

(l_shipdate > '1994-01-01') AND (l_shipdate < '1994-01-04') AND (l_discount > 0.04) AND (l_discount < 0.07) AND (l_quantity = 4.00)

```
l_shipmode: [RAIL], l_comment: [sual dinos]
orderkey: [1334916], l_partkey: [152761], l_suppkey: [307], l_linenum: [1], l_quantity: [4], l_extendedprice: [7255.04], l_discount: [0.05], l_tax: [0.0]
l_returnflag: [A], l_linestatus: [F], l_shipdate: [1994-01-03], l_commitdate: [1993-12-27], l_receiptdate: [1994-01-04], l_shipinstruct: [NONE], l_shipmode: [TRUCK], l_comment: [fully fluffily even]
orderkey: [1775014], l_partkey: [1980], l_suppkey: [9981], l_linenum: [2], l_quantity: [4], l_extendedprice: [7559.92], l_discount: [0.05], l_tax: [0.02]
l_returnflag: [A], l_linestatus: [F], l_shipdate: [1994-01-02], l_commitdate: [1994-01-13], l_receiptdate: [1994-01-09], l_shipinstruct: [DELIVER IN PERSON], l_shipmode: [TRUCK], l_comment: [onic packag]
orderkey: [1929446], l_partkey: [79239], l_suppkey: [9240], l_linenum: [2], l_quantity: [4], l_extendedprice: [4872.92], l_discount: [0.05], l_tax: [0.0]
l_returnflag: [A], l_linestatus: [F], l_shipdate: [1994-01-02], l_commitdate: [1994-01-15], l_receiptdate: [1994-01-21], l_shipinstruct: [COLLECT COD], l_shipmode: [TRUCK], l_comment: [accounts about the busily u]
orderkey: [1978016], l_partkey: [7380], l_suppkey: [4881], l_linenum: [7], l_quantity: [4], l_extendedprice: [5149.52], l_discount: [0.05], l_tax: [0.03]
l_returnflag: [A], l_linestatus: [F], l_shipdate: [1994-01-02], l_commitdate: [1994-02-03], l_receiptdate: [1994-01-06], l_shipinstruct: [NONE], l_shipmode: [MAIL], l_comment: [g according to the quickly]
orderkey: [2900837], l_partkey: [179153], l_suppkey: [9154], l_linenum: [1], l_quantity: [4], l_extendedprice: [4928.6], l_discount: [0.06], l_tax: [0], l_returnflag: [R], l_linestatus: [F], l_shipdate: [1994-01-02], l_commitdate: [1993-12-03], l_receiptdate: [1994-01-29], l_shipinstruct: [NONE], l_shipmode: [TRUCK], l_comment: [ular requests according to t]
orderkey: [3029670], l_partkey: [185316], l_suppkey: [353], l_linenum: [1], l_quantity: [4], l_extendedprice: [5605.24], l_discount: [0.05], l_tax: [0], l_returnflag: [A], l_linestatus: [F], l_shipdate: [1994-01-03], l_commitdate: [1994-02-11], l_receiptdate: [1994-01-20], l_shipinstruct: [TAKE BACK RETURN], l_shipmode: [SHIP], l_comment: [ar accounts haggle furiously above the]
orderkey: [3081318], l_partkey: [71366], l_suppkey: [6381], l_linenum: [4], l_quantity: [4], l_extendedprice: [5349.44], l_discount: [0.06], l_tax: [0.0]
l_returnflag: [A], l_linestatus: [F], l_shipdate: [1994-01-02], l_commitdate: [1993-11-09], l_receiptdate: [1994-01-26], l_shipinstruct: [DELIVER IN PERSON], l_shipmode: [FOB], l_comment: [arefully furiously]
orderkey: [3932192], l_partkey: [92903], l_suppkey: [7922], l_linenum: [1], l_quantity: [4], l_extendedprice: [7583.6], l_discount: [0.06], l_tax: [0], l_returnflag: [A], l_linestatus: [F], l_shipdate: [1994-01-02], l_commitdate: [1994-01-17], l_receiptdate: [1994-01-29], l_shipinstruct: [TAKE BACK RETURN], l_shipmode: [TRUCK], l_comment: [l dolphins are fluffily regular, pe]
orderkey: [4651430], l_partkey: [87233], l_suppkey: [2250], l_linenum: [2], l_quantity: [4], l_extendedprice: [4880.92], l_discount: [0.06], l_tax: [0.0]
l_returnflag: [R], l_linestatus: [F], l_shipdate: [1994-01-02], l_commitdate: [1994-03-13], l_receiptdate: [1994-01-28], l_shipinstruct: [DELIVER IN PERSON], l_shipmode: [AIR], l_comment: [latelets a]
orderkey: [4830688], l_partkey: [178621], l_suppkey: [1139], l_linenum: [4], l_quantity: [4], l_extendedprice: [6798.48], l_discount: [0.05], l_tax: [0.03], l_returnflag: [R], l_linestatus: [F], l_shipdate: [1994-01-03], l_commitdate: [1994-01-09], l_receiptdate: [1994-01-29], l_shipinstruct: [TAKE BACK RETURN], l_shipmode: [RAIL], l_comment: [ent deposits ab]
orderkey: [4901252], l_partkey: [118389], l_suppkey: [3412], l_linenum: [3], l_quantity: [4], l_extendedprice: [5629.52], l_discount: [0.06], l_tax: [0.06], l_returnflag: [A], l_linestatus: [F], l_shipdate: [1994-01-02], l_commitdate: [1993-12-22], l_receiptdate: [1994-01-17], l_shipinstruct: [TAKE BACK RETURN], l_shipmode: [MAIL], l_comment: [ays pending]
orderkey: [5818855], l_partkey: [5032], l_suppkey: [2533], l_linenum: [6], l_quantity: [4], l_extendedprice: [3748.12], l_discount: [0.06], l_tax: [0.07], l_returnflag: [R], l_linestatus: [F], l_shipdate: [1994-01-02], l_commitdate: [1993-10-25], l_receiptdate: [1994-01-31], l_shipinstruct: [TAKE BACK RETURN], l_shipmode: [MAIL], l_comment: [along the qui]
Selected 15 Records.
Query Time 3.74231seconds.
Thunder:98%
```

Query 10

(l_orderkey > 100) AND (l_orderkey < 1000) AND (l_partkey > 100) AND (l_partkey < 5000) AND (l_shipmode = 'AIR') AND (l_linestatus = 'F') AND (l_tax < 0.07)

```
* IMPORTANT: MAKE SURE THE INFORMATION BELOW IS CORRECT **
catalog location: catalog
tpch files dir: /cise/tmp/dbi_sp11/DATA/1G/
heap files dir:

select test:
  1. load file
  2. scan
  3. scan & filter
  3

select table:
  1. nation
  2. region
  3. customer
  4. part
  5. partsupp
  6. orders
  7. lineitem
  7

Filter with CNF for : lineitem
Enter CNF predicate (when done press ctrl-D):
(l_orderkey > 100) AND (l_orderkey < 1000) AND (l_partkey > 100) AND (l_partkey < 5000) AND (l_shipmode = 'AIR') AND (l_linestatus = 'F') AND (l_tax < 0.07)
orderkey: [130], l_partkey: [1739], l_suppkey: [4240], l_linenum: [2], l_quantity: [48], l_extendedprice: [78755], l_discount: [0.03], l_tax: [0.02], l_returnflag: [R], l_linestatus: [F], l_shipdate: [1992-07-01], l_commitdate: [1992-07-12], l_receiptdate: [1992-07-24], l_shipinstruct: [NONE], l_shipmode: [AIR], l_comment: [lithely alongside of the regul]
orderkey: [194], l_partkey: [2594], l_suppkey: [5095], l_linenum: [1], l_quantity: [17], l_extendedprice: [25442], l_discount: [0.05], l_tax: [0.04], l_returnflag: [R], l_linestatus: [F], l_shipdate: [1992-05-24], l_commitdate: [1992-05-22], l_receiptdate: [1992-05-30], l_shipinstruct: [COLLECT COD], l_shipmode: [AIR], l_comment: [ regular deposi]
Selected 2 Records.
Query Time 3.76799seconds.
Thunder:98%
```


We also ran our results on 10M data and verified those results by writing SQL queries in MariaDB.

Google Test Results:

```
neel@nrami:~/Desktop/DBI/P1$ cd bin
neel@nrami:~/Desktop/DBI/P1/bin$ ./gTestProj1
[=====] Running 9 tests from 7 test cases.
[-----] Global test environment set-up.
[-----] 2 tests from OpenTest
[ RUN      ] OpenTest.SubTest1
[ OK       ] OpenTest.SubTest1 (0 ms)
[ RUN      ] OpenTest.SubTest2
[ OK       ] OpenTest.SubTest2 (0 ms)
[-----] 2 tests from OpenTest (1 ms total)

[-----] 2 tests from CloseTest
[ RUN      ] CloseTest.SubTest1
[ OK       ] CloseTest.SubTest1 (0 ms)
[ RUN      ] CloseTest.SubTest2
[ OK       ] CloseTest.SubTest2 (0 ms)
[-----] 2 tests from CloseTest (0 ms total)

[-----] 1 test from LoadTest
[ RUN      ] LoadTest.SubTest1
[ OK       ] LoadTest.SubTest1 (0 ms)
[-----] 1 test from LoadTest (0 ms total)

[-----] 1 test from AddTest
[ RUN      ] AddTest.SubTest1
[ OK       ] AddTest.SubTest1 (1 ms)
[-----] 1 test from AddTest (1 ms total)

[-----] 1 test from MoveFirstTest
[ RUN      ] MoveFirstTest.SubTest1
[ OK       ] MoveFirstTest.SubTest1 (0 ms)
[-----] 1 test from MoveFirstTest (0 ms total)

[-----] 1 test from GetNext1Test
[ RUN      ] GetNext1Test.SubTest1
[ OK       ] GetNext1Test.SubTest1 (0 ms)
[-----] 1 test from GetNext1Test (0 ms total)

[-----] 1 test from GetNext2Test
[ RUN      ] GetNext2Test.SubTest1
[ OK       ] GetNext2Test.SubTest1 (0 ms)
[-----] 1 test from GetNext2Test (0 ms total)

[-----] Global test environment tear-down
[=====] 9 tests from 7 test cases ran. (2 ms total)
[ PASSED ] 9 tests.
```