In this assignment, you will generate data and compare two systems to see how they work for querying.

1. For the tests on each system you will receive 20 points. If you manage to test both and give a comparison, you will receive $20 + 20 + 10$ (for the comparison). We will run your code on our data as well as look at the results on your data. Our data will have the same schema and the same random distributions.

Design a program in your favorite programming language that can generate tuples where field values can be unique, have a fixed set of distinct values that are allocated to tuples according to a uniform probability distribution, and a fixed set allocated to the tuples according to a fractal probability distribution (70-30 rule). An example function is pseudocode to do this is as follows:

```plaintext
gen(frac, N)
begin
  p:= random permutation of numbers from 1 to N
  outvec:= p // so outvec is of length N
  while(|p| > 1
    p:= first frac*|p| elements of p // round down
    concatenate p to outvec
  end while
  return random permutation of outvec
end
```

Here is an example:

```
|p| is just the size of vector p.
so let’s say that p is 7 4 6 2 3 8 1 5
|p| = 8
Initially outvec is the same as p
if frac is 0.5 then the first loop will
make p = 7 4 6 2
and outvec = 7 4 6 2 3 8 1 5 7 4 6 2
After the second iteration,
p = 7 4
and outvec
7 4 6 2 3 8 1 5 7 4 6 2 7 4
Finally after the last iteration
outvec = 7 4 6 2 3 8 1 5 7 4 6 2 7 4 7
```

Execute this program with `gen(0.3, x)` where `x` is 70,000 or so (might be more). The idea is to generate an array of 100,000 fractally distributed stock symbols.
Populate table trade(stocksymbol, time, quantity, price) such that there are 100,000 stock symbols, quantities uniformly ranging from 100 to 10,000, and prices uniformly ranging in some five point interval between 50 and 500, so successive prices should vary by at least 1 but no more than 5. Time is just a numerical value. The trade table should have 10 million rows with time as the only key.

Next write and time the following queries (send in your typescript file that you get from the script command) in your favorite sql dialect (but it would be easiest in q):

(a) Find the weighted (by quantity) average price of each stock over the entire time series.
(b) Find the vector of 10 trade unweighted moving averages per stock.
(c) Find the vector of 10 trade weighted moving averages per stock.
(d) Find the single best buy first/sell later trade you could have done on a single stock (your query should work on our data as well as yours).

2. (30 points) Choose two rules of thumb from the book (e.g., rules having to do with chopping, indexes, commits, checkpoints, etc.). For each one, find (and demonstrate using e.g. mysql and kdb). data distributions/access patterns where it is satisfied and data distributions/access patterns where it is not. A data distribution refers to the frequency of occurrences of different values of a given variable across the rows - e.g. uniform and fractal are two different (and convenient since you already generated data with them) distributions. Thus, you need to show four different performance numbers for each rule of thumb derived by executing real queries in a real database: results with and without the rule of thumb applied to columns with two different data distributions. Comment on whether the case (i.e. the data distribution) where the rule of thumb is satisfied is more likely than when it isn’t. Also explore how you would modify the statement of the rule of thumb to make it more precise given the performance results.

3. This is a slight adaptation of a challenge posed by Peter Boncz. In a social network context, you are given

- a table relating individuals to performing artists they like. Like(userid, artistid).
- A table relating users to their cities. Location(userid, city)
- A table identifying the friends of each user Friend(userid, frienduserid).

These tables are all very large (we will generate them for you). The challenge is to use mysql to find the most efficient way to solve the following query: for each user u and each artist a that the user does not yet like, find friends of u who like a.