CS101 Computer Programming and Utilization

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1. So far

2. The Cowherd of Gokul

The story so far ...

- We have seen various control flows.
- We have seen multi-dimensional arrays and the `char` data type.
- We saw the use of functions and calling methods.
- We have seen structs, sorting, searching.

This week...

A real life problem..

Srirang

Srirang is a cowherd from Gokul. He has a single cow. By god's grace:

- The cow gives 50 litres of milk everyday.
- The expense of maintaining this cow is Rs. 250 per day.

Srirang wishes to sell this milk. Every evening, Srirang gets bids from various parties. Each bid is of the form:

- Name of the bidder.
- The price at which he/she will purchase milk.
- The volume that he/she requires.

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- The price at which he/she will purchase milk.
- The volume that he/she requires.

Looking at the bids, Srirang decides on a price for the next day, say X. This price is offered to all customers. The customers who can afford the price collect the milk and pay Rs. X/litre.

Here is an example:

name	volume	price
roshni	5	20
prema	15	8
radha	20	10
rukmi	10	5
gauri	10	3
neha	10	6

Srirang

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He fixes a price of Rs.5. Gauri goes away. There is an overall demand of 60. The others distribute the supply of 50 liters somehow. Sriang earns Rs. 250.

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He gets a bit greedy and fixes the price to Rs. 7 and makes the following table:

Declared Price	7
Demand	40
Supply	40
Earnings	280

The Poser

Question: What price Rs. X/liter should Srirang set to maximize his profits?

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Some Observations:

- Clearly as X increases, the demand decreases.
- For the price X if the demand is greater than 50 then the supply can only be 50.
- For the price X if the demand is less than 50 then it can be met.
- We need to maximize X*Supply.

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Why is this?

- The net earning depends on the demand.
- If, for prices $X_1 < X_2$, the demand is unchanged then clearly X_2 is prefered.
- The demand can only change when we hit a customer price.

Solution

A computational solution is now easy:

- Try every customer price.
- Compute Demand at that price.
- Compute Supply and Earnings.
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The bids
The Maximum Supply (50L)
My Costs (Rs. 250)

The basic data structures are:

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struct bid
{
  char name[6];
  int  price, vol;
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bid bidlist[10]
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The basic functions are:

```
int ComputeDemand
  (bid bidlist[],int price);
int Supply;
Supply=Min(MaxSupply,Demand);
```

Compute Demand

```
int ComputeDemand(bid bidlist[],
                    int X,int N)
{
   int i,d=0;
   for (i=0;i<N;i=i+1)
     if (bidlist[i].price>=X)
         d=d+bidlist[i].volume;
   return (d);
};
```

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Whats happening?

- X is the price.
  N is the number of bids.
  d is the total
- We rush through all the bids, and total up all demands greater than or equal to X.

srirang.cpp

```
int main()
{
  int i,N,MaxSupply,E,Earnings,Xbest;
  int X,demand, supply, Sup; bid bids[20];
  cout << " N and MaxSupply? \n";
  cin >> N >> MaxSupply;
  for (i=0;i<N;i=i+1)
  {
     cin >> bids[i].name >> bids[i].volume >> bids[i].price;
  };
  Xbest=0;
  Earnings=0;
  Sup=0;
  IMPORTANT CODE HERE
  cout << "best price " << Xbest << "\n";
  cout << "Earnings   " << Earnings << "\n";
  cout << "Supply     " << Sup << "\n";
};
```

The important part

```
Xbest=0;
Earnings=0;
Sup=0;
for (i=0;i<N;i=i+1)
{
  X=bids[i].price;
  demand=ComputeDemand(bids,
                          X,N);
  supply=min(demand,MaxSupply);
  E=supply*X;
  if (E>Earnings)
  {
    Earnings=E;
    Xbest=X;
    Sup=supply;
  };
}; // of for
```

Whats happening:

- Keep

Xbest	the best price so far
E	earnings at Xbest
Sup	supply at that price

- Initialize this data, and run across each price. This is because we know that the optimum occurs at some offered price.
- Update the variables above for each price. Call ComputeDemand t do this.

Input and Output

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prema 15 8
radha 20 10
rukmi 10 5
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neha 10 6
```

Thus maximum supply is 50 and there are 6 bids.

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[sohoni@nsl-13 lectures]$ ./a.ou
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best price 8
Earnings   320
Supply     40
```

Thus we see that the best price is 8 and that the supply at this price is 40 litres. Earnings are Rs. 320.

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- Gauri is refused, and yet..
- 10 litres of milk is left behind!
- So much for MARKET ECONOMY!

Two questions

What if there were 1000 bids?

- There are 1000 possible prices X. Thus the outer loop will run 1000 times. In oher words, ComputeDemand is called 1000 times.
- Each call of ComputeDemand will take 1000 steps!
- Thus the time taken is 1000^2. In other words, this is an $O(N^2)$ algorithm.

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- Sort the bids in decreasing oredr. This takes $O(N \log N)$ time.
- Eliminate ComputeDemand.
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Assignment

Implement `sortedsrirang.cpp`

The second question

Siddhartha is Srirang's older brother. He gets

- buy bids just as Srirang, but also
- sell bids.

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gopal	10	4
vithal	10	3
narayan	15	6

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Siddhartha must announce

- a buying price Y at which he will buy milk.
- a selling price X at which he will sell milk.

Write a program to compute the best pair (Y,X) which maximizes his earnings.

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