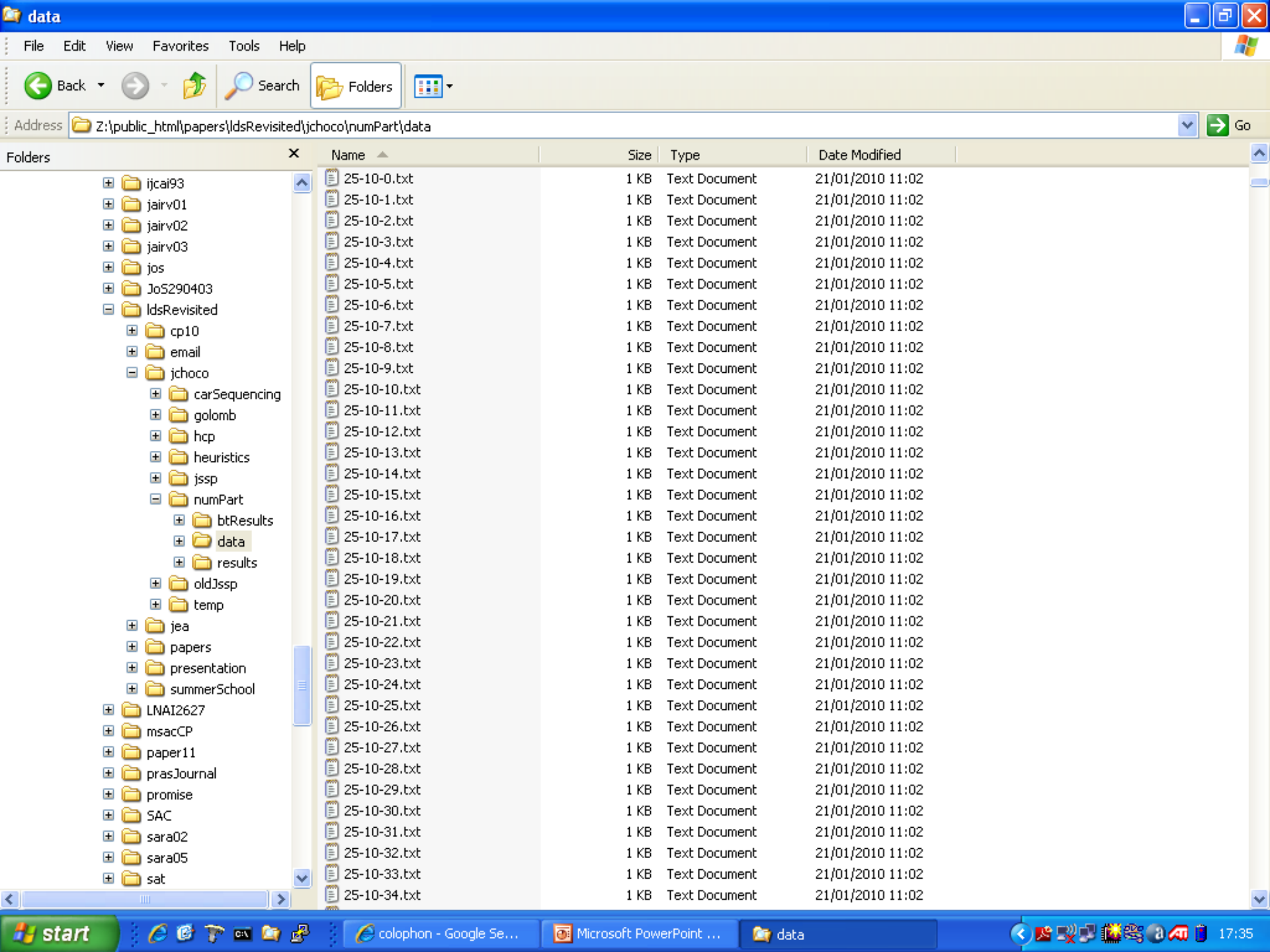
colophon

Or

"What I did early"

Experiments with $25 \leq n \leq 100$, $d=10$


data
File Edit View Favorites Tools Help
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Address Z:\public_html\papers\ldsRevisited\jchoco\numPart\data
Go
Folders
ijcai93
jairv01
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JoS290403
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golomb
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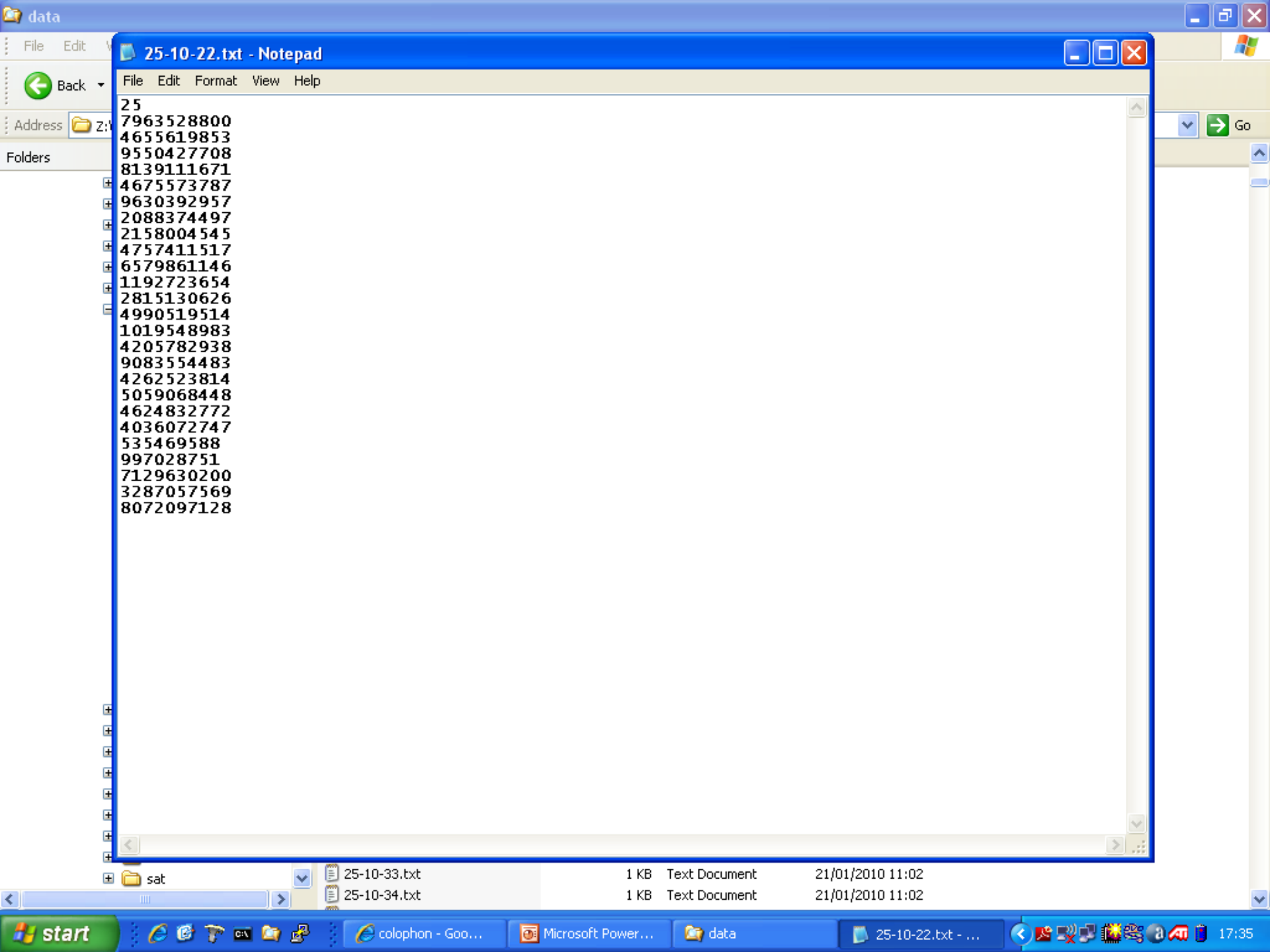
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2088374497
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6579861146
1192723654
2815130626
4990519514
1019548983
4205782938
9083554483
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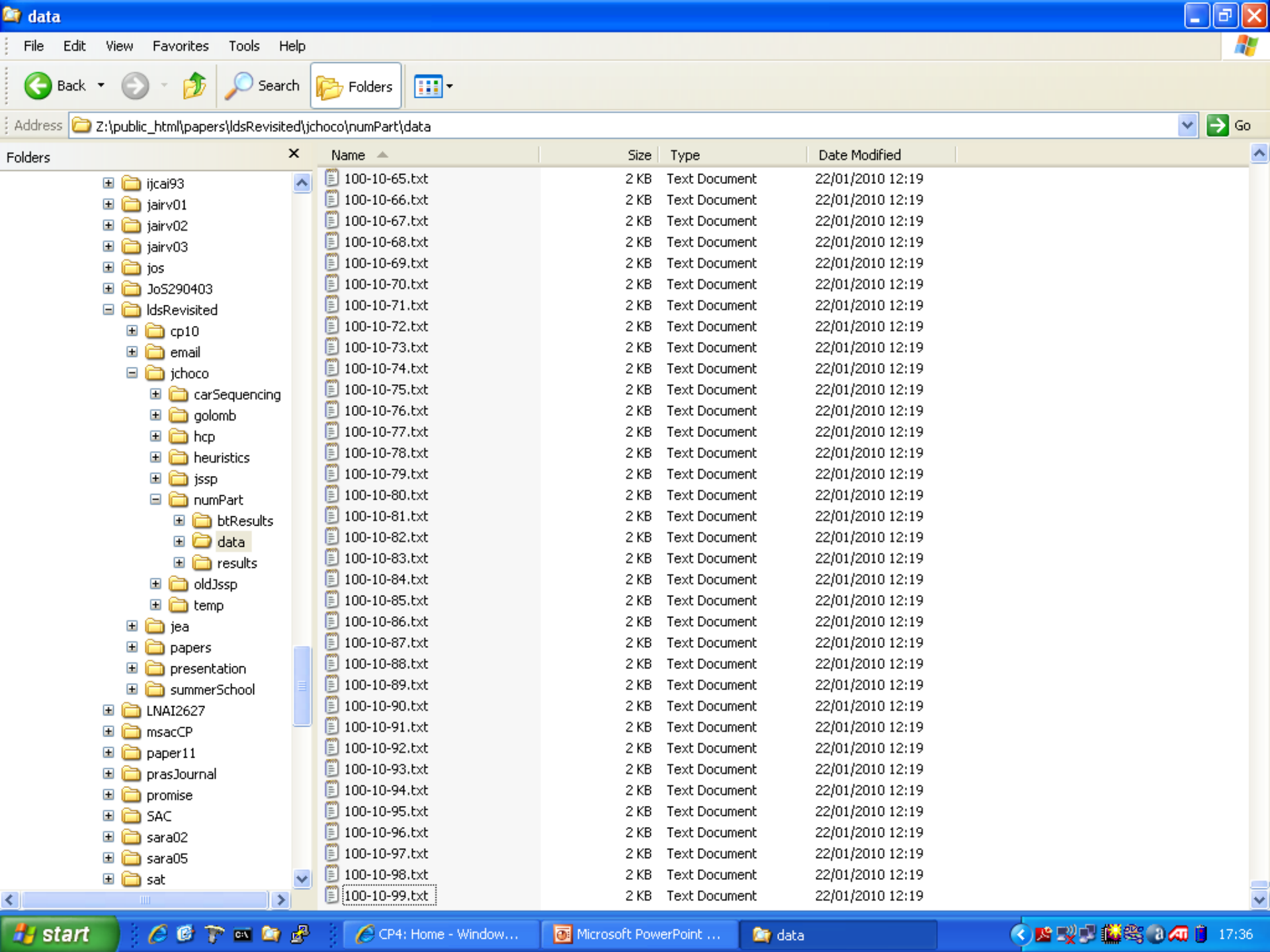
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start
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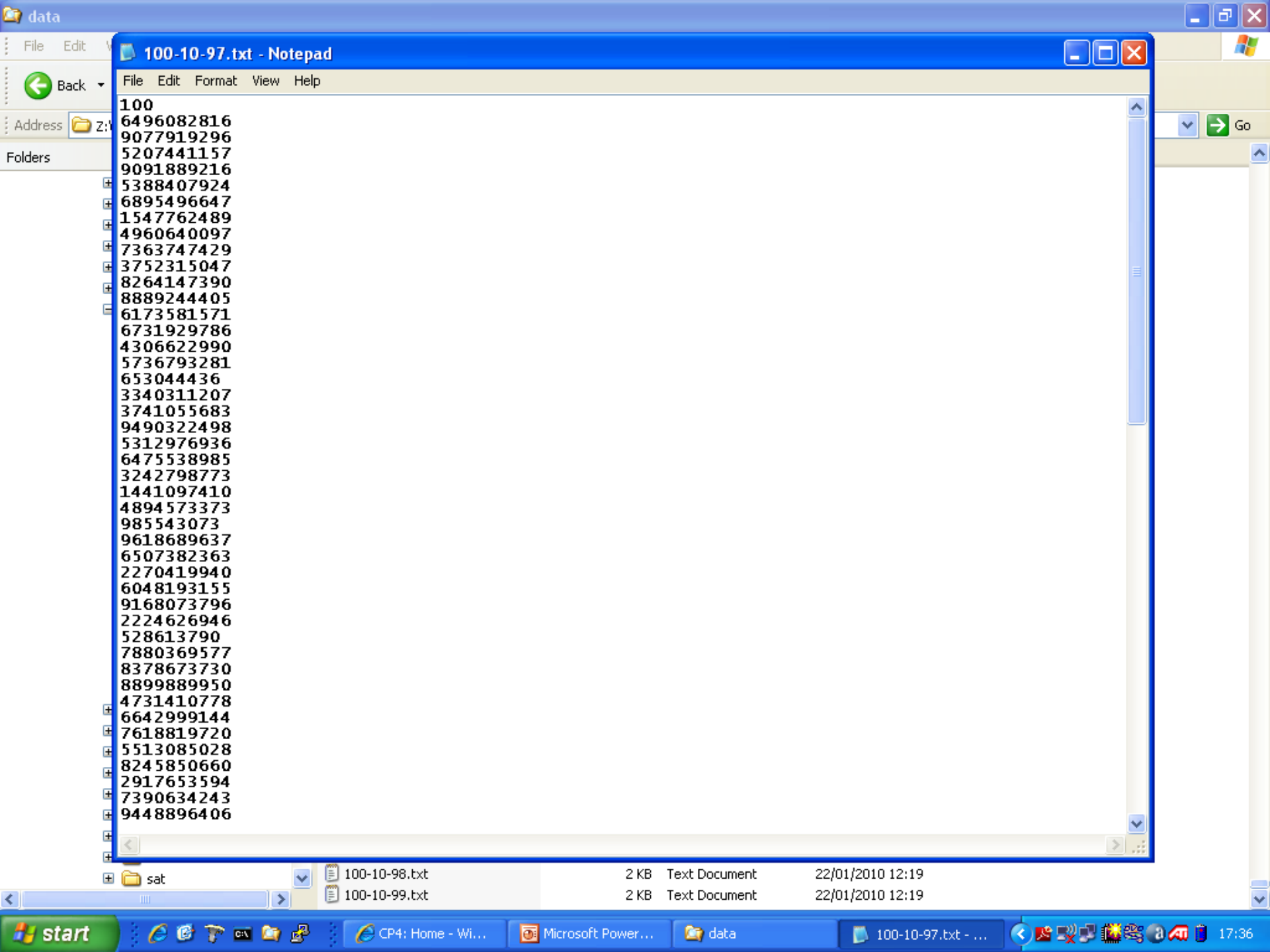
17:36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6496082816
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6895496647
1547762489
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7363747429
3752315047
8264147390
8889244405
6173581571
6731929786
4306622990
5736793281
653044436
3340311207
3741055683
9490322498
5312976936
6475538985
3242798773
1441097410
4894573373
985543073
9618689637
6507382363
2270419940
6048193155
9168073796
2224626946
528613790
7880369577
8378673730
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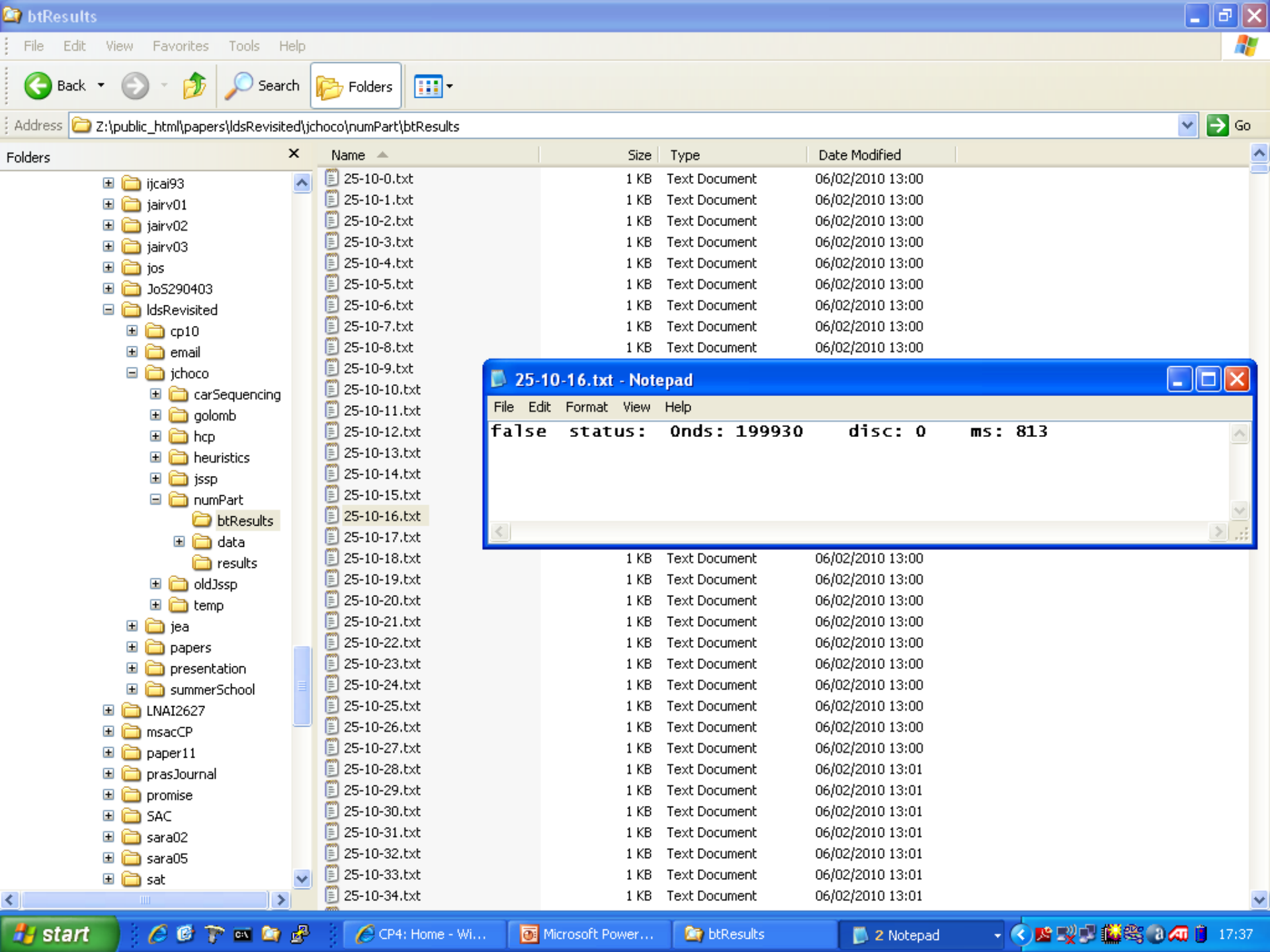
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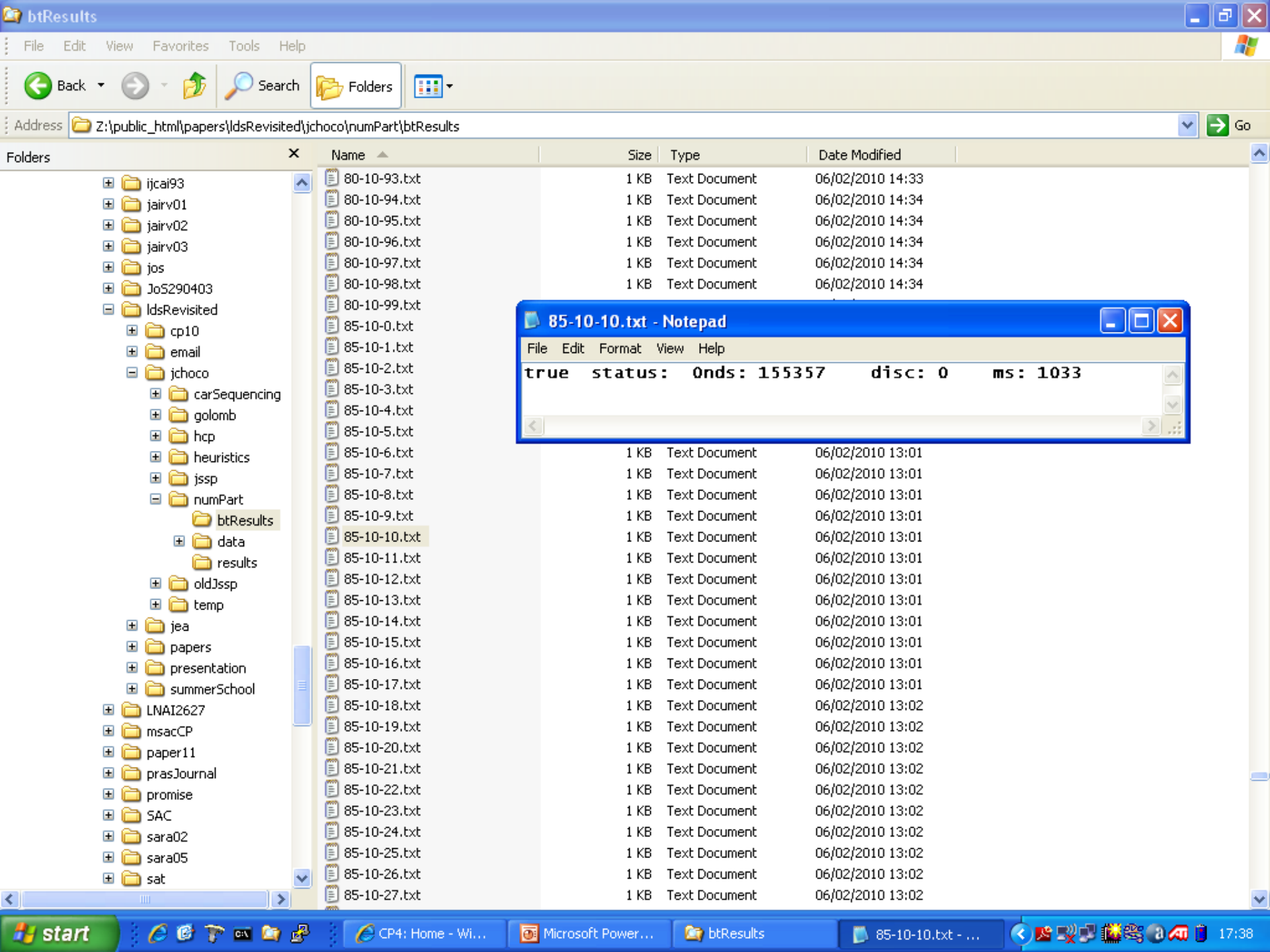
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carSequencing
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17:38

removed from the front of the list. There are then two possible choices: (a) insert in order into L the difference $X - Y$, corresponding to placing the numbers in different bags, or (b) push the sum $X + Y$ onto the front of L, corresponding to placing both numbers in the same bag. Of the two choices option (a) is preferred, i.e. it is the heuristic choice. There are then 3 possible outcomes resulting from a choice: (1) $length(L) = 1$ and $head(L) \in \{0, 1\}$, or (2) $head(L) - sum(tail(L)) \leq 1$, or (3) $head(L) - sum(tail(L)) > 1$. In case (1) a perfect partition exists, in case (2) we can continue making choices, and in case (3) no perfect partition exists. In our model we use the Choco constraint programming toolkit [JCh], and have n 0/1 constrained integer decision variables, v_0 to v_{n-1}, and the list L as a reversible structure. The KK heuristic is encoded as a specialised constraint. If a variable v_i is assigned the value 0 we go with the heuristic, making choice (a), and if assigned the value 1 we go against the heuristic making choice (b). If this results in outcome (1) search terminates successfully, outcome (2) search proceeds, outcome (3) search fails and backtracking takes place.

Problem data sets were generated using the Java program segment given in Figure 5. Problem size n was varied from 25 to 100 in steps of 5, and for each value of n 100 problem instances were produced containing n numbers drawn uniformly at random from the range 1 to $10^d - 1$. In replicating Korf's experiments d was set to 10 and of the numbers generated about 90% were 10 digits long and about 10% were 9 digits long or less, as expected.

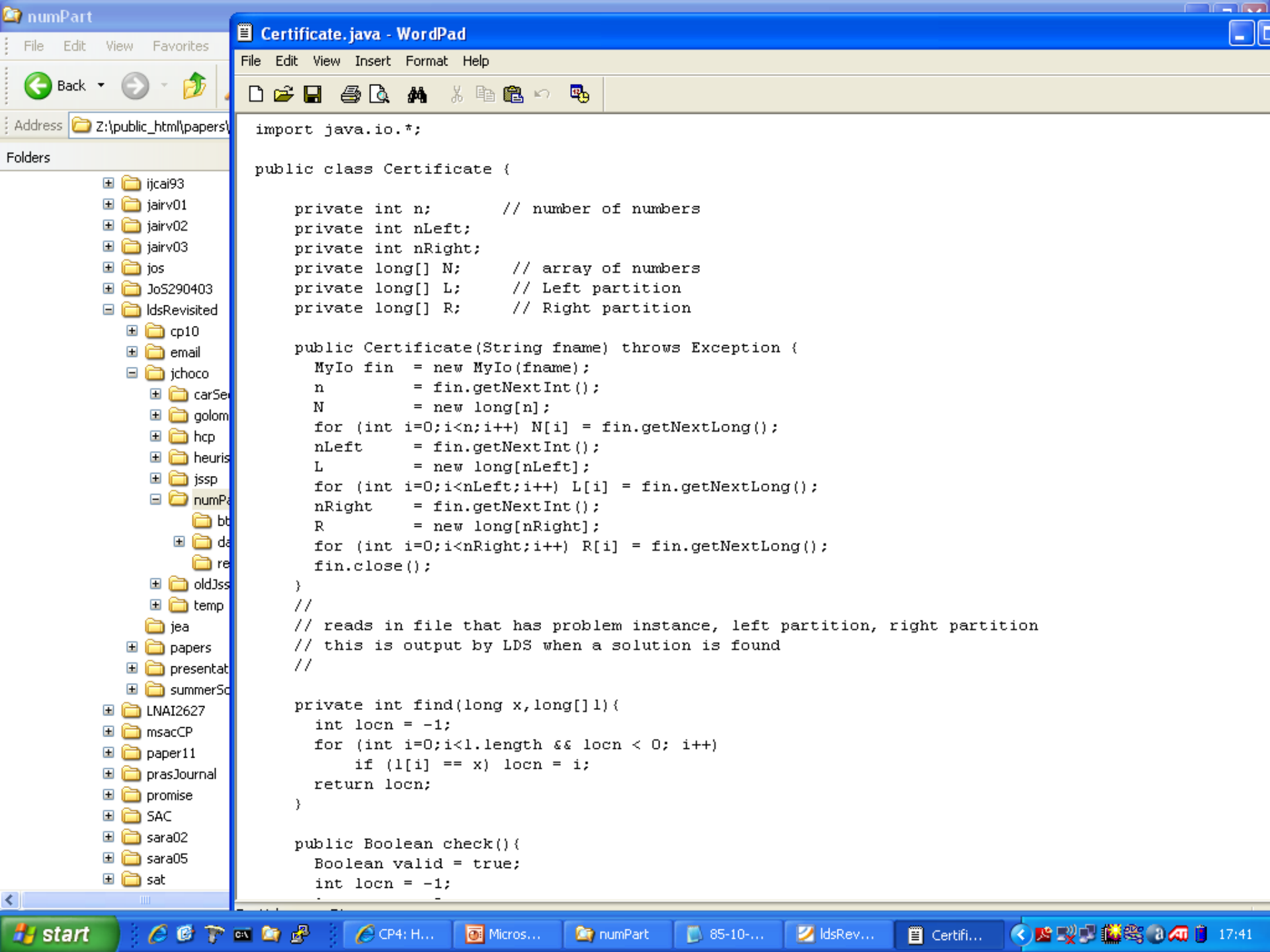
[1] And, it is unclear if YIELDS incorporates Korf's improvement explicitly, although it might be incorporated implicitly into their value ordering heuristic, but they do not mention this.

Fig. 6. On the left, log of average search effort (nodes visited) against problem size, solid contour for ILDS-early and broken contour for ILDS-late. On the right, the number of times ILDS-early beat ILDS-late (solid contour) and number of times ILDS-late beat ILDS-early (broken contour) against problem size.

Experiments were run as background jobs, farmed over 10 processors, taking 7 days elapsed time with most processor time spent on problems in the range $30 \leq n \leq 45$. Since a variety of processors were used we do not report run times. Figure 6, on the left, shows on a log scale the average number of search nodes[2] explored against problem size n, for ILDS taking discrepancies early (solid contour) and late (broken contour).

The contours generally agree with Korf's [Korf 1996]. Although not shown, search effort was plotted against Gent and Walsh's measure of constrainedness [Gent and Walsh 1998] $\kappa = log_2(l)/n$ where numbers are drawn uniformly and at random from (0,l]. The complexity peak occurred at $\kappa = 0.95$ and problem satisfiability about 50%, as expected, i.e. where half of our problem instances had perfect partitions. Figure 6, on the right, shows how often ILDS-early beat ILDS-late, and vice versa. If on a problem instance ILDS-early took less nodes than ILDS-late then ILDS-early scores one point, if ILDS-late takes less nodes than ILDS-early then ILDS-late scores one point, and if they both take the same number of nodes there are no points.

[2] A node corresponds to a decision made by the search process, in this case assigning a value to a decision variable.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hcp
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papers
LNAI2627
msacCP
paper11
prasJournal
promise
SAC
sara02
sara05
sat
Certificate.java - WordPad
File Edit View Insert Format Help
import java.io.*;
public class Certificate {
private int n; // number of numbers
private int nLeft;
private int nRight;
private long[] N; // array of numbers
private long[] L; // Left partition
private long[] R; // Right partition
public Certificate(String fname) throws Exception {
MyIo fin = new MyIo(fname);
n = fin.getNextInt();
N = new long[n];
for (int i=0;i<n;i++) N[i] = fin.getNextLong();
nLeft = fin.getNextInt();
L = new long[nLeft];
for (int i=0;i<nLeft;i++) L[i] = fin.getNextLong();
nRight = fin.getNextInt();
R = new long[nRight];
for (int i=0;i<nRight;i++) R[i] = fin.getNextLong();
fin.close();
}
//
// reads in file that has problem instance, left partition, right partition
// this is output by LDS when a solution is found
//
private int find(long x,long[]l){
int locn = -1;
for (int i=0;i<l.length && locn < 0; i++)
if (l[i] == x) locn = i;
return locn;
}
public Boolean check(){
Boolean valid = true;
int locn = -1;
start
CP4: H...
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85-10-...
ldsRev...
Certifi...
17:41

nds.ps - GSview

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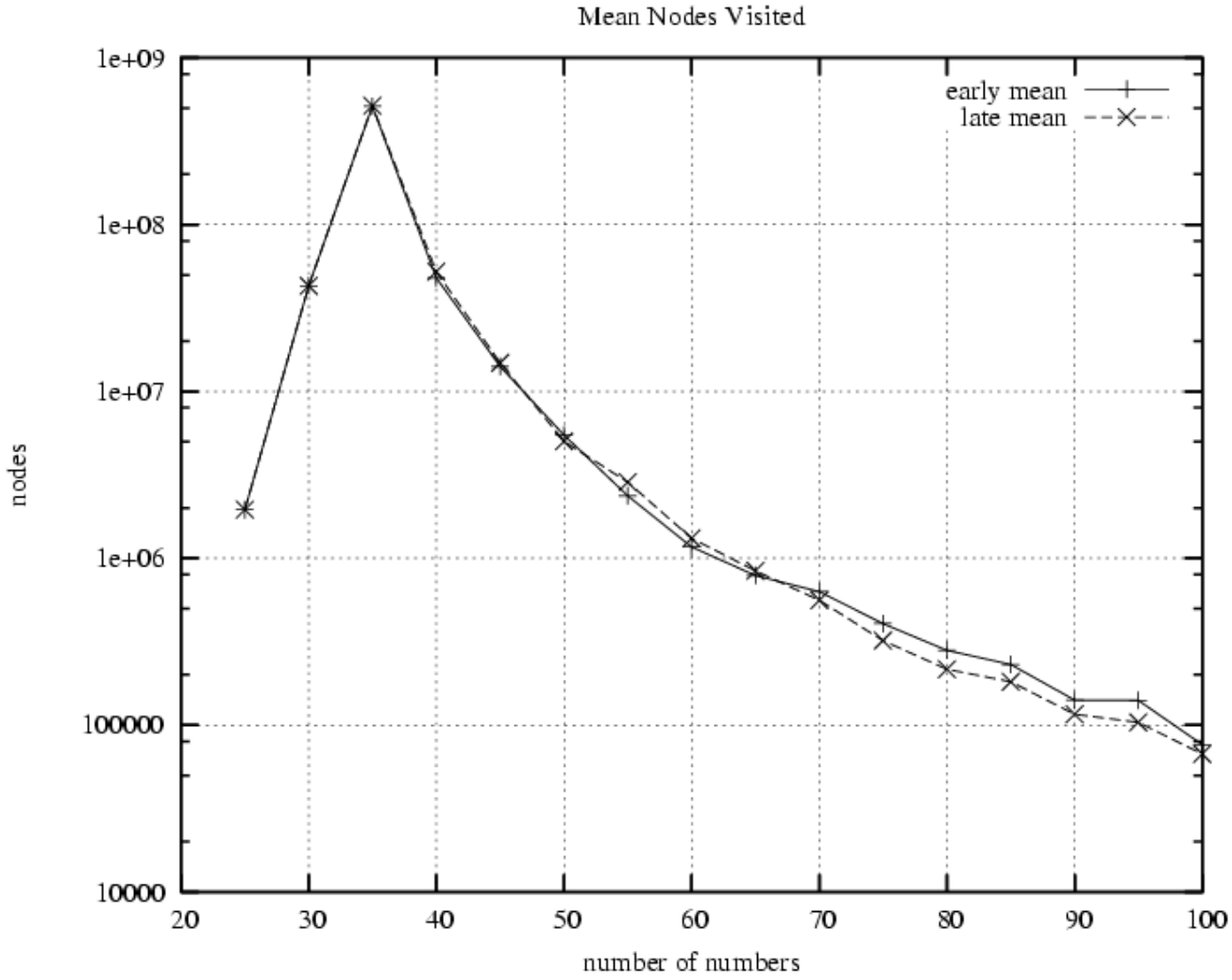

File: nds.ps Page: "1" 1 of 1

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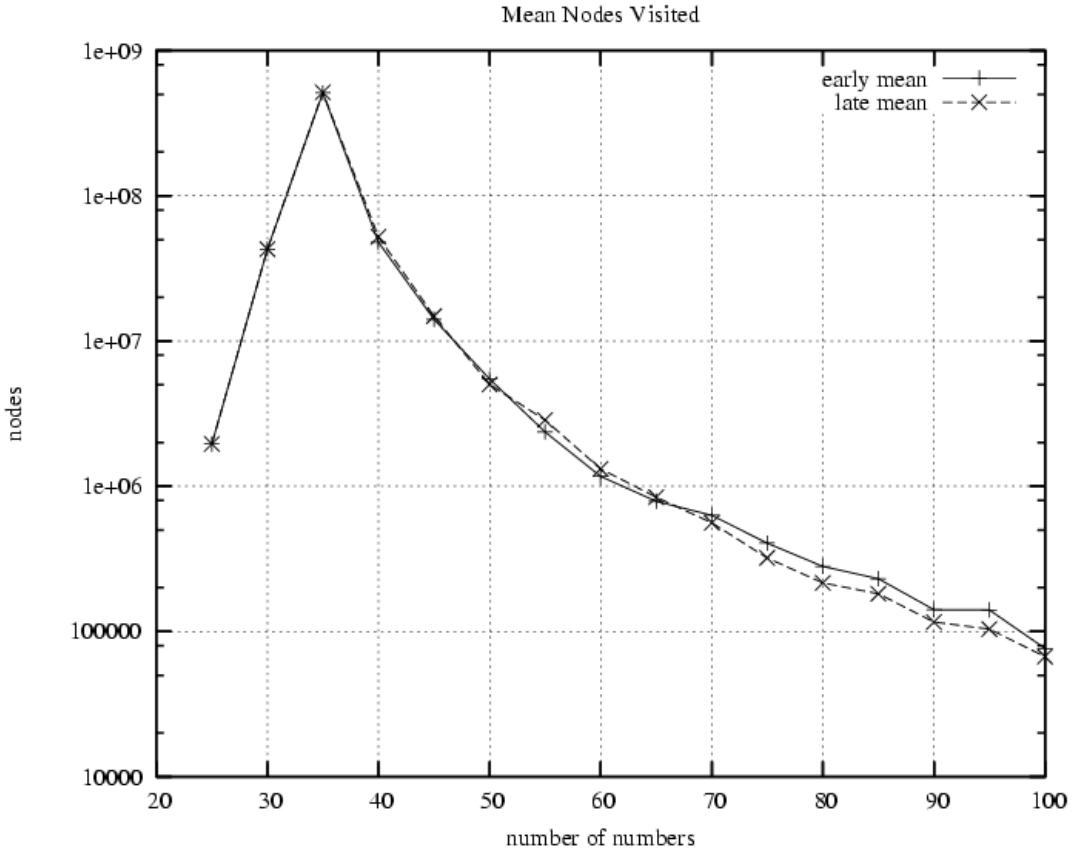


Reflect on this …

You know that sorting is at best O(n.Log(n))
You know that when you increase the size of the data set (n) run time increases
This is kind of what we assume: increase n, increase run time
Is it not strange that in numPart as we increase n runtime eventually falls?

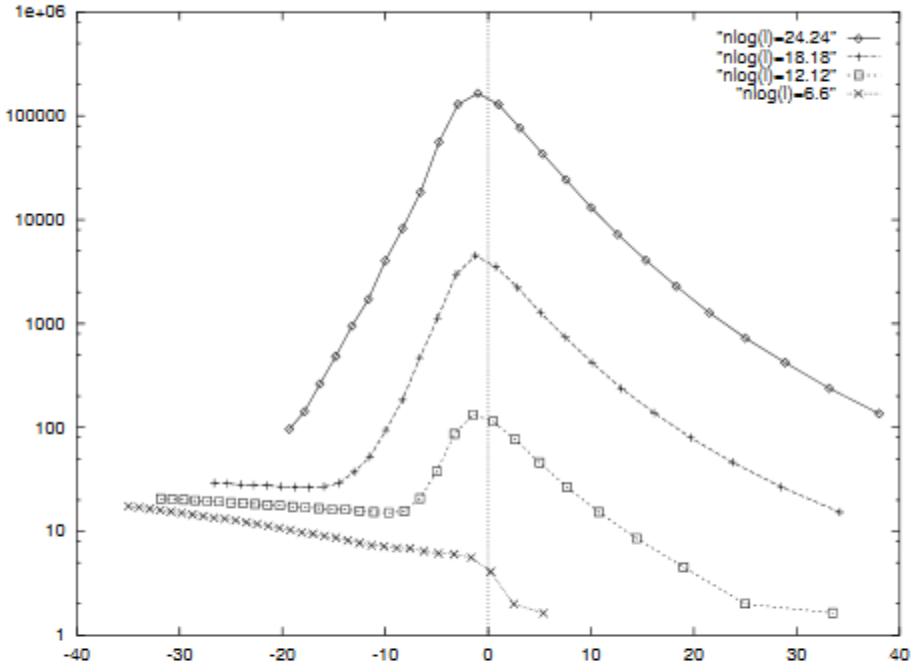


FIGURE 6. Average nodes searched by CKK to find the optimal partition (y-axis) against γ (x-axis) with $\kappa_c = 0.96$ and $\nu = 1$, and the problem input size, $n \log_2(l)$ fixed at 6^2, 12^2, 18^2, and 24^2. Each problem has n numbers drawn uniformly and at random from $(0, l]$ with n varied from 1 to 36.

$$\kappa = \frac{\log_2(l)}{n}.$$

Recent results
2019

```java
public class Partition {

    int n;
    Model model;
    Solver solver;
    IntVar[] D;

    Partition(int[] w){
        n = w.length;
        model = new Model("Partition");
        solver = model.getSolver();

        int total = 0;
        for (int x : w) total = total + x;

        D = model.intVarArray("D",n,0,1); // decision ... left or right?
        model.scalar(D,w,"=",total/2).post();
    }

    boolean solve(){
        solver.setSearch(Search.minDomUBSearch(D)); // take 1 then 0
        return solver.solve();
    }

    long stats(){
        return solver.getMeasures().getNodeCount();
    }
}
```

```
3  public class Experiment {
4
5      private static int random(int d,Random gen){
6          int x = 0;
7          for (int j=0;j<d;j++) x = x * 10 + gen.nextInt(10);
8          return x;
9      }
10     //
11     // make a random number with up to d digits
12     //
13
14     public static void main(String[] args) {
15         int nLow  = Integer.parseInt(args[0]); // number of numbers
16         int nHigh = Integer.parseInt(args[1]); // number of numbers
17         int d     = Integer.parseInt(args[2]); // number of digits
18         int m     = Integer.parseInt(args[3]); // sample size
19
20         Random gen = new Random();
21
22     for (int n=nLow;n<=nHigh;n++)
23         for (int i=0;i<m;i++){
24            int[] w = new int[n];
25            for (int j=0;j<n;j++) w[j] = random(d,gen);
26            Partition part = new Partition(w);
27            boolean solved = part.solve();
28            System.out.println(n +" "+ solved +" "+ part.stats());
29         }
30     }
31 }
```

nLwb-nUpb-digits.txt

Sample size of 50 (very small)

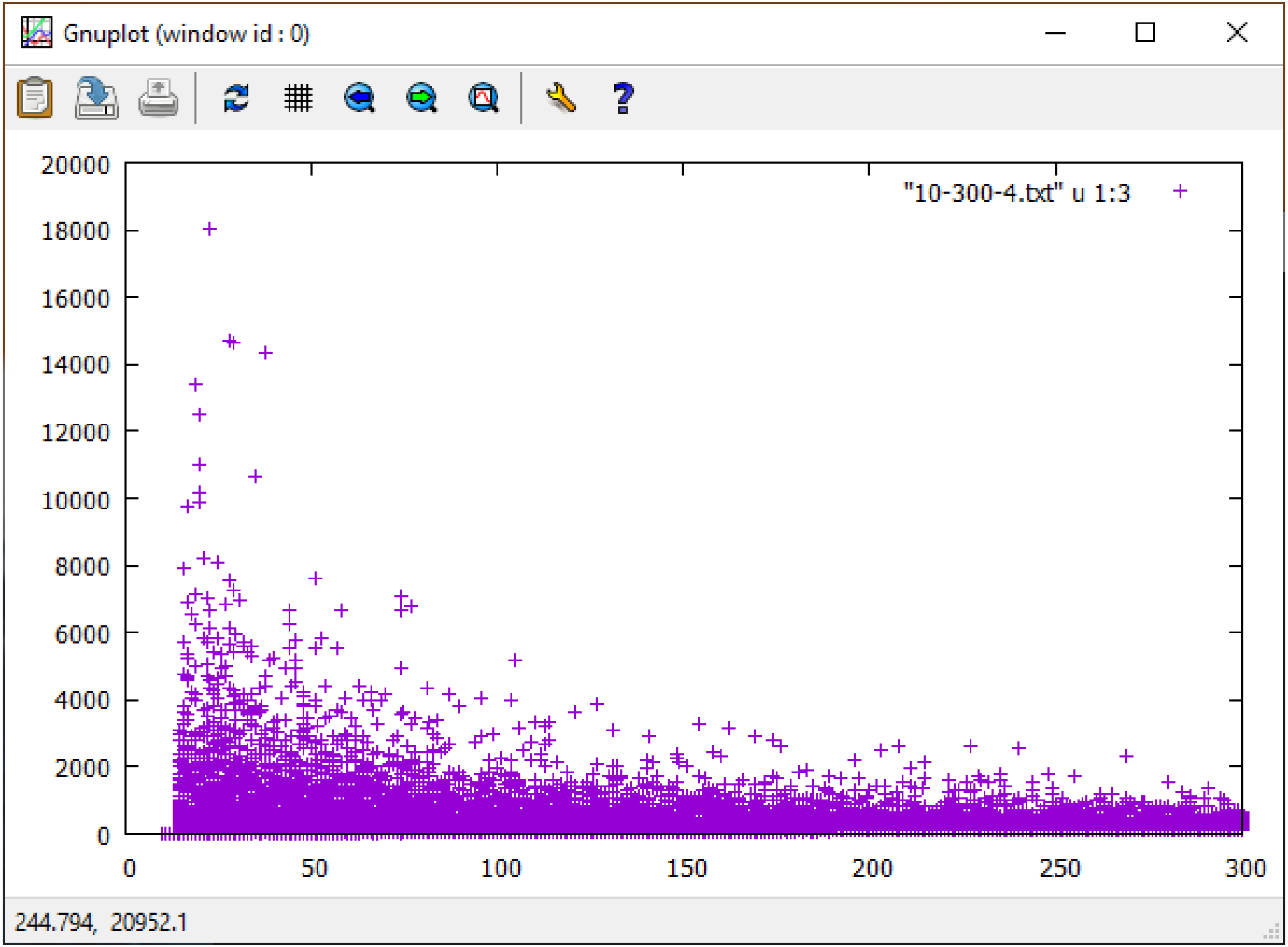
Z:\public_html\cpM\weekByWeek\week9\numPart\10-100-8.txt - Notepad++

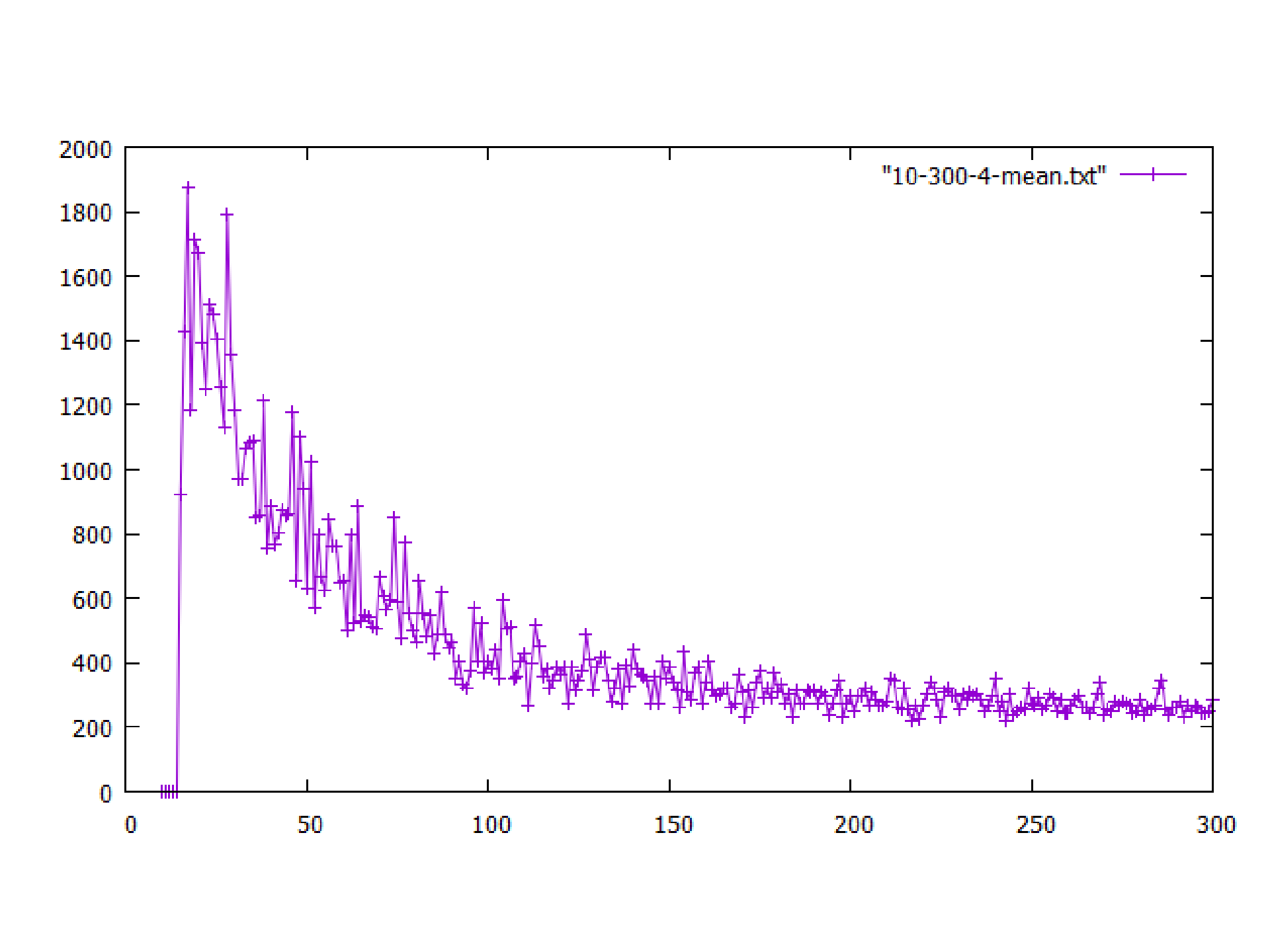
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ? X

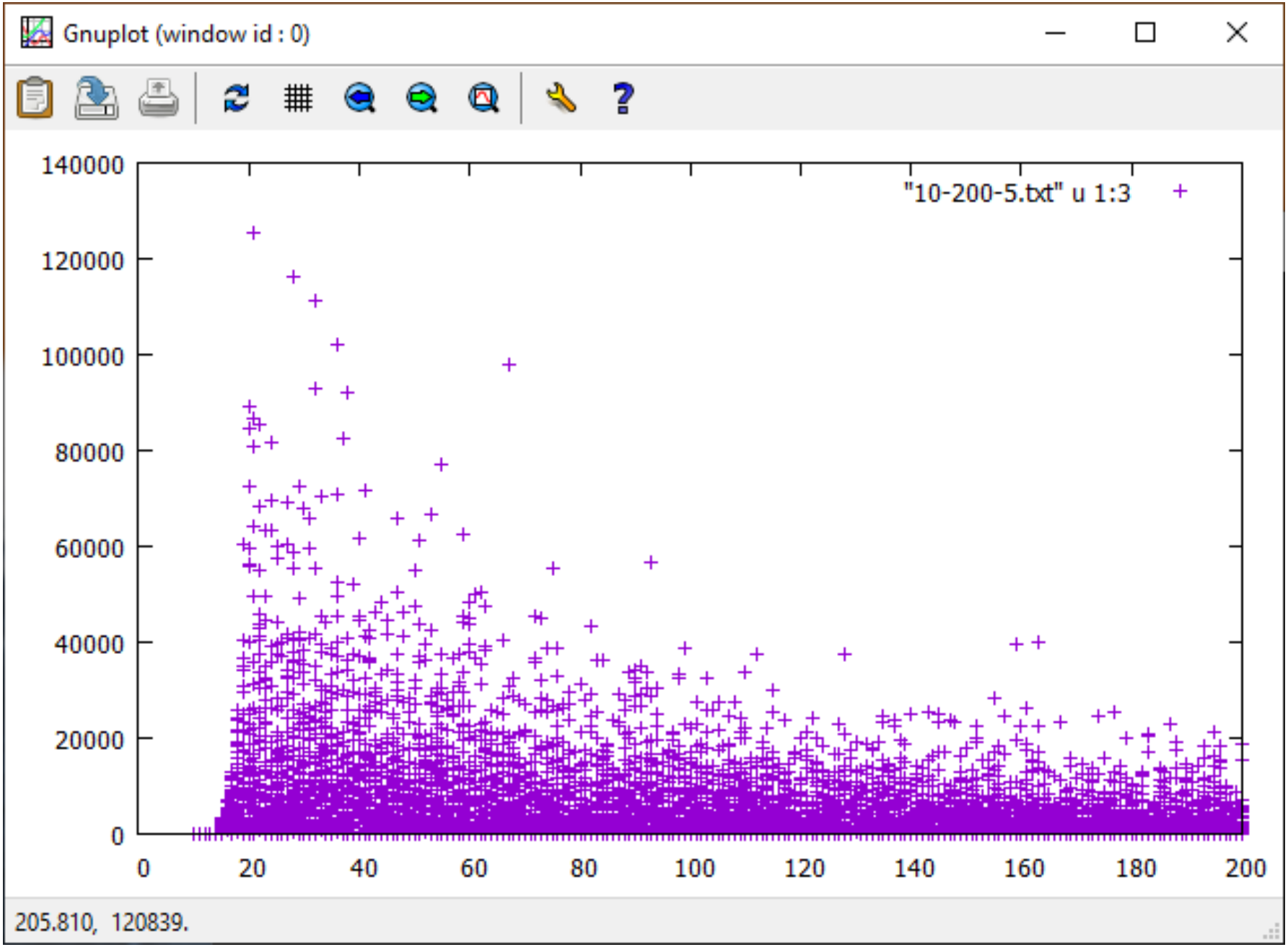
Decision.java | readme.txt | 10-100-8.txt | Partition.java | Experiment.java

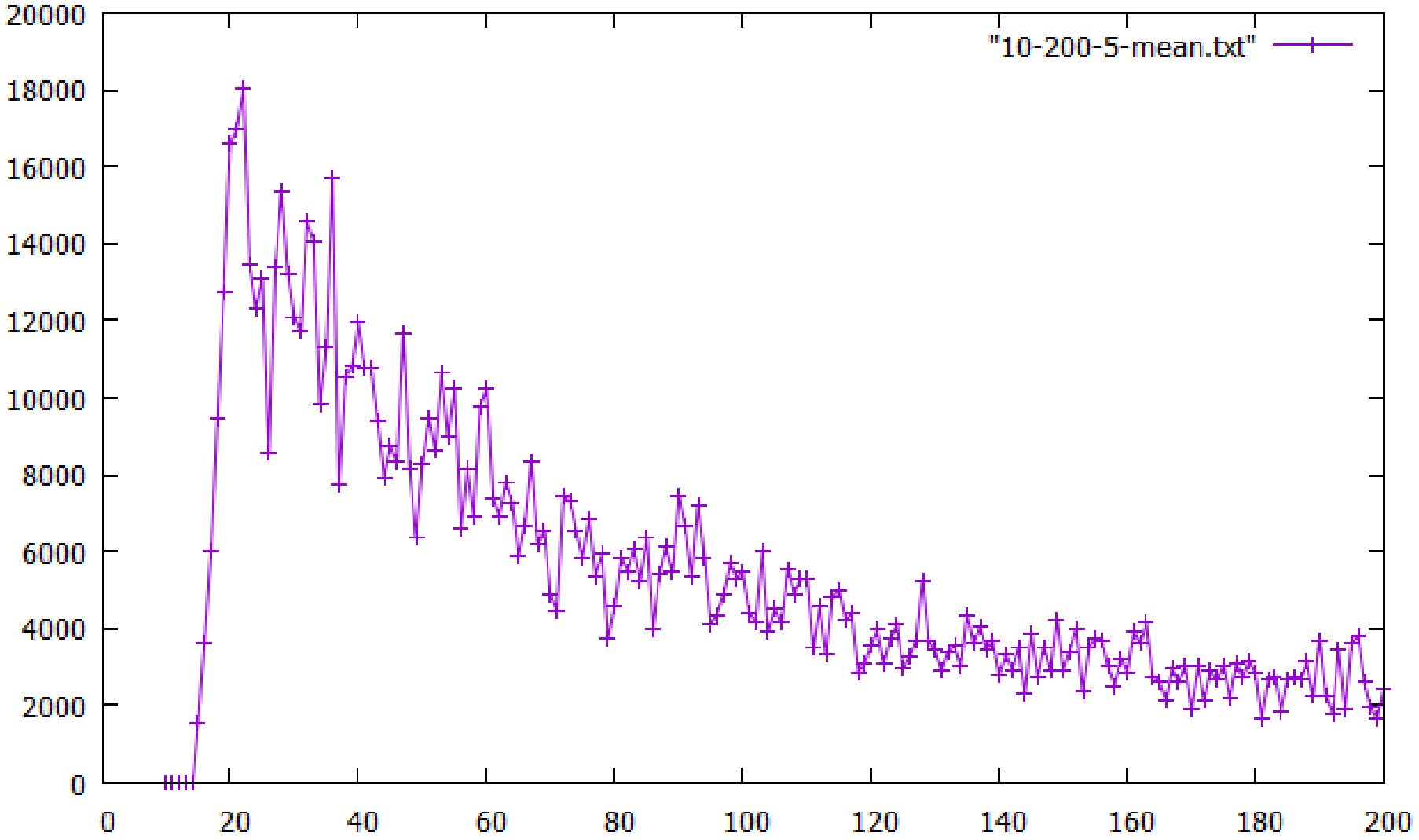
```
29 false 13310515
29 false 37590115
29 true 5461867
29 true 2377399
29 true 16008564
29 false 18111301
29 true 7858315
29 false 25098033
29 true 4440437
29 false 41311401
29 true 1835449
29 false 29818599
29 false 23689739
30 true 5159899
30 true 7954270
30 false 28544183
30 true 4797590
30 true 8607101
30 true 5883780
30 true 13177314
30 true 3934553
30 true 1681832
30 false 31417721
30 false 32281335
30 true 18469792
30 true 13989619
30 false 28131625
30 false 46543703
30 true 15120016
30 true 10279917
```

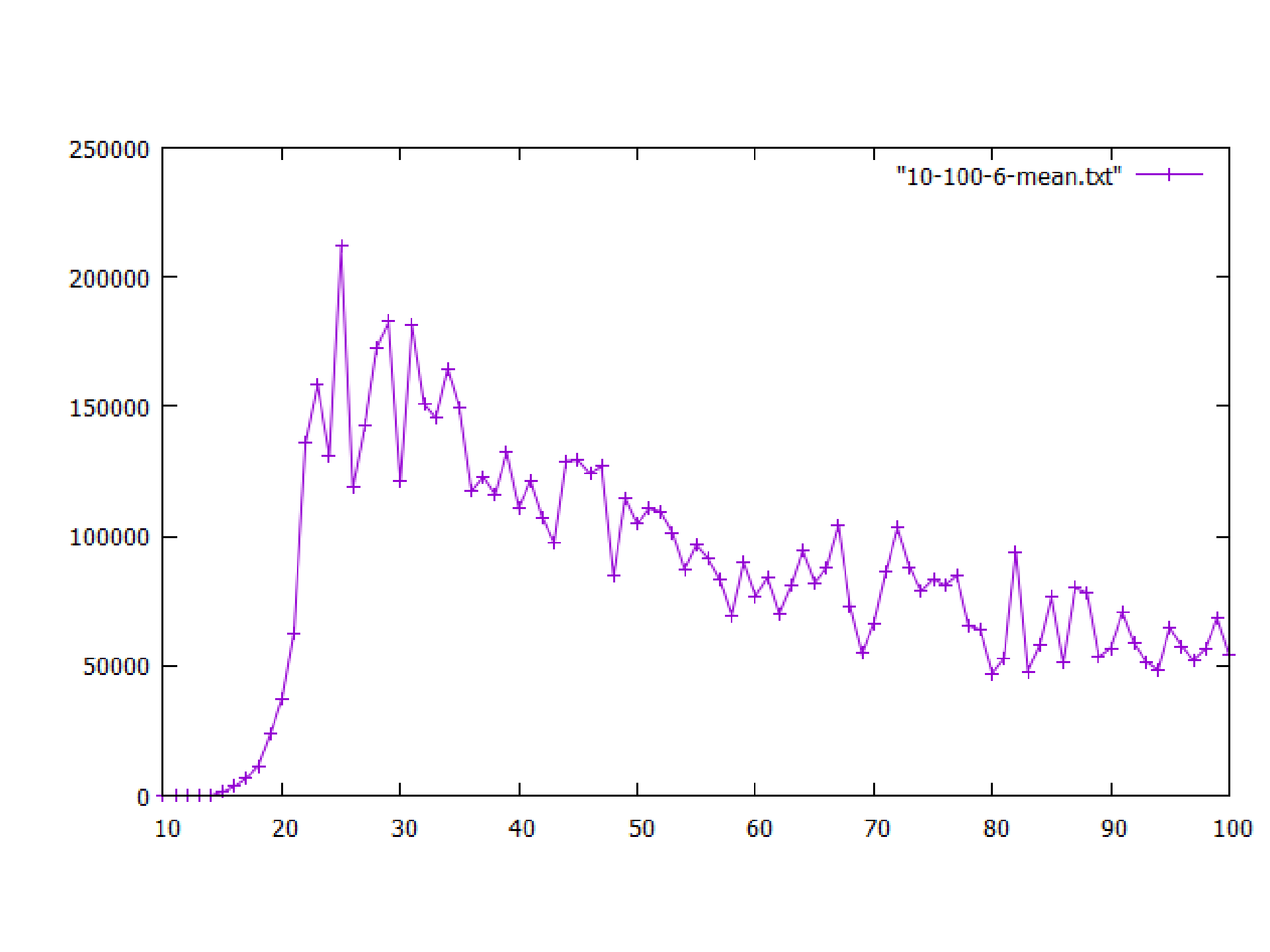
Normal text file | length : 14,701 lines : 1,018 | Ln : 1,017 Col : 17 Sel : 0 | 0 | Unix (LF) | UTF-8 | INS

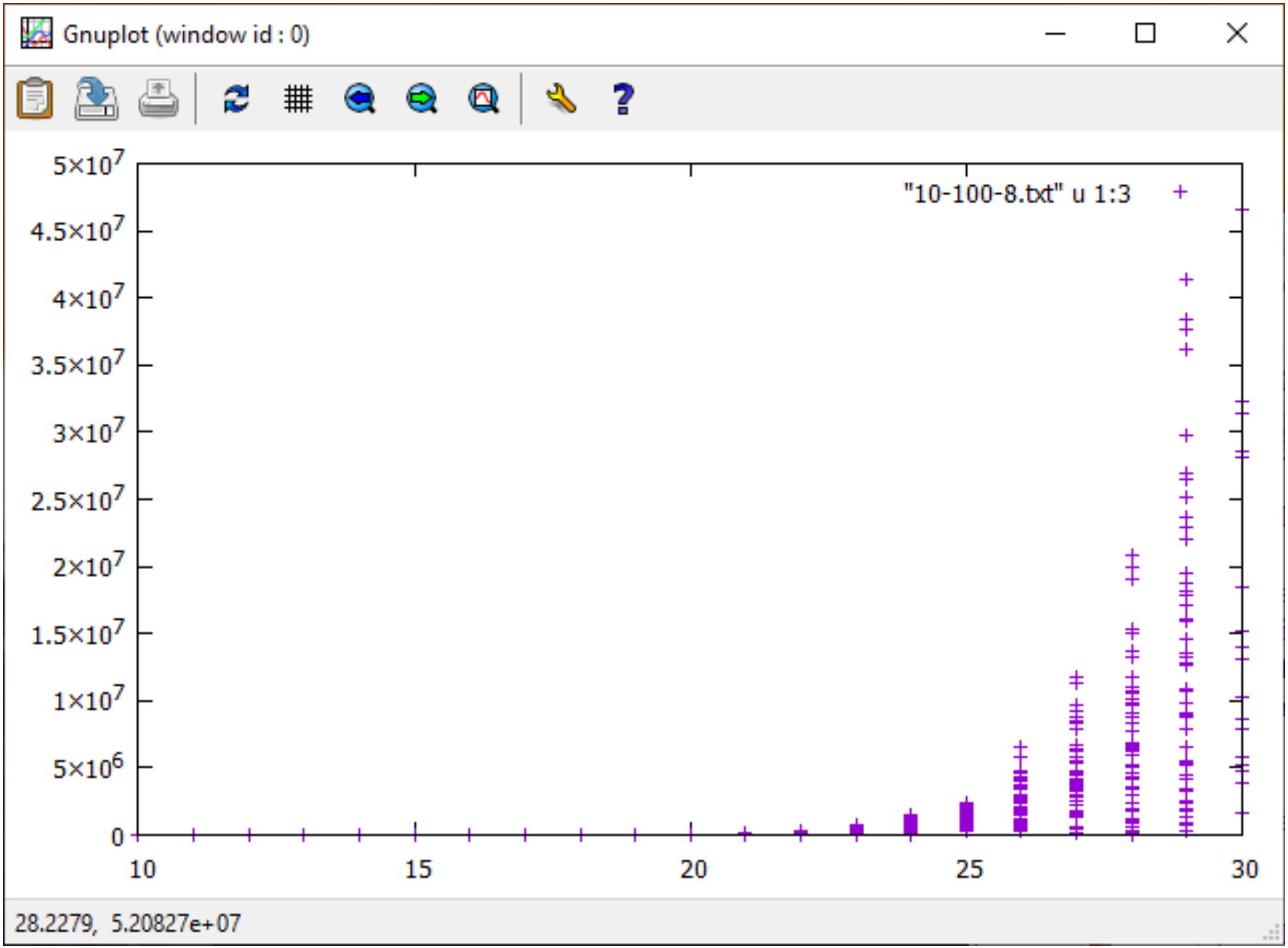

Gnuplot (window id : 0)
"10-300-4.txt" u 1:3
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0
50
100
150
200
250
300
244.794, 20952.1


"10-300-4-mean.txt"
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
50
100
150
200
250
300


Gnuplot (window id : 0)
"10-200-5.txt" u 1:3
140000
120000
100000
80000
60000
40000
20000
0
0
20
40
60
80
100
120
140
160
180
200
205.810, 120839.


"10-200-5-mean.txt"
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0
20
40
60
80
100
120
140
160
180
200


"10-100-6-mean.txt"
250000
200000
150000
100000
50000
0
10
20
30
40
50
60
70
80
90
100


Gnuplot (window id : 0)
"10-100-8.txt" u 1:3
5×10^7
4.5×10^7
4×10^7
3.5×10^7
3×10^7
2.5×10^7
2×10^7
1.5×10^7
1×10^7
5×10^6
0
10
15
20
25
30
28.2279, 5.20827e+07