## A simple partitioning problem, or how to copy from a hard disk sub-directory onto one or more floppies, investigated by Mike Mudge.

The area of investigation this month, which is more on the practical side (or at least almost so!) than those usually to be found in 'Numbers Count', is due to Michael Meierruth of Milan who describes the level of difficulty as 'relatively low'. The background concerns the inadequacy of utility programs to efficiently copy the contents of a hard disk sub-directory onto one or more floppy disks. These all do the obvious of sequentially copying as many files as possible and requesting a change of floppy disk when the next file will not fit in the available space.

The investigation is concerned with working out, and implementing, an algorithm for optimising the copying process: that is, using the minimum number of floppy disks while not requiring an excessive amount of calculation time.

Consider floppy disks having 3600-byte capacity and then ask what is the arrangement of files needed on each floppy disk to accommodate the 17 files below on no more than 3 floppy disks: 63, 127, 175, 190, 215, 311, 407, 463, 517, 537, 711, 801, 827, 1019, 1251, 1272, 1914. This is a simple partitioning problem which, due to its nature, is subject to the time consuming difficulties of typical combinatorial problems. A further complication may also arise if not all the floppy disks have the same capacity, and further if the problem has not been set up so as to fill all of the floppies exactly. (Note: the above problem, being artificial, does indeed fill all of the floppies. However, the odds are very much against this occurring in a practical situation.)

The unique answer to the above problem is:
Floppy 1: 63, 311, 463, 711, 801, 1251. Total 3600.
Floppy 2: 127, 215, 517, 827, 1914. Total 3600.
Floppy 3: 175, 190, 407, 537, 1019, 1272. Total 3600.

This solution was obtained by an exhaustive search, readily seen to require an excessive amount of calculation time when the number of files is large and/or when either of the above-mentioned complications are present.

One possibly promising algorithm involves ordering the files by size and then starting to copy from the side with the largest files. When the next smallest file will not fit on the remaining space, start copying from the side with the smallest files, continuing this process until all files have been copied. This algorithm is seen to fail to generate the optimal number of floppies in the artificial case above. However, Michael Meierruth claims a success rate (defined as those cases resulting in the use of the optimal number of floppies) of about 78% using randomly generated samples, compared with a 30% success rate using the same samples with simple sequential copying. Michael also has a slightly altered version of the above algorithm which yields a 98.5% success rate!

Readers are challenged to reproduce, and if possible improve upon, the above success rates. Particular attention should be given to the simulation (random generation process) of the file samples both with regard to their number and spread of magnitudes. A unit of 1 floppy accompanied by decimal file sizes may be relevant here?

Attempts at this challenge may be sent to Mike Mudge, 1 Dolboeth, Cwm Mabws, Llanrhystud, Dyfed SY23 5BB, tel (Nebo) 09746-548 to arrive by 1 December 1990. Any communications received will be judged, using suitable subjective criteria, and a prize will be awarded, by *PCW*, to the 'best' contribution arriving by the closing date. It would be appreciated if such submissions contained a brief description of the hardware used, together with sufficient details of programs to enable the results (and in particular the random samples of files) to be reproduced. Run times, a summary of results obtained and suggestions for further work in this area should also be enclosed, in a form suitable for publication in *PCW*. Please note that submissions can only be returned if a suitable stamped addressed envelope is provided.

### Review April 1990, Pseudoprimes & Carmichael Numbers

This research area attracted considerable attention. Among those submissions deserving of a mention are Norman Meeres, who referred to *Recreations in the Theory of Numbers* by AH Beiler for (A) and then used Basic on the Lynx 48k to find Carmichael numbers up to 49,657. Gordon Mills used an Amstrad PC1640 to investigate (A) up to 29,341 for bases 2/3/5/7 and then to find the lowest Carmichael numbers with up to 15 factors together with complete lists up to $3x10^6$ for 3, 4 & 5 factor Carmichaels. Frank Webster's results included 5 & 6 factor Carmichaels less than $2x10^9$. Gareth Suggett implemented a routine obtained from Fred Hartley, a previous prizewinner, while Henry Ibstedt used Turbo Basic on a Tandon 386 with a 387 co-processor to provide a graphical and numerical display of prime bases less than 100 which produce simultaneous pseudoprimes for the bases 2,3,5 . . 19; further, a list of all Carmichael numbers less than $5x10^7$ was produced in about 140 hours.

However, after much soul searching, this month the worthy prizewinner is David Kirkby of 5 Parkmead, Loughton, Essex IG10 3JW, who used a range of different IBM compatible computers including three 80386 based machines, each with 4Mb of RAM, and an i486 machine with 16Mb, 'more than one computer often used simultaneously.'

Bases up to 289 for which the smallest pseudoprime is even were investigated and all Carmichaels up to 270857521 found; the largest Carmichael found by David has 75 digits! He has also studied the paper of Jack Chernick, *On Fermat's Simple Theorem*, Bull Amer Math Soc 1939, vol 45, pp 269-274.

Mike Mudge welcomes correspondence on any subject within the areas of number theory and computational mathematics. Particularly welcome are suggestions for future Numbers Count articles.

## LEISURE LINES

## Brainteasers courtesy of JJ Clessa.

### This month's quickie

No answers, no prizes, for the quickie. Arrange four pennies into two straight lines of coins with three pennies in each.

### Prize Puzzle

What is the smallest number which:
Divides by 3 with 1 left over.
Divides by 5 with 2 left over.
Divides by 7 with 3 left over.
Divides by 11 with 4 left over.
Divides by 13 with 5 left over.
Divides by 17 with 6 left over.
Divides by 19 with 7 left over.

Answers on postcards or backs of sealed envelopes — no letters please. Send to: October Prize Puzzle, *PCW* Editorial, VNU House, 32-34 Broadwick Street, London W1A 2HG, to arrive not later than 31 October 1990.

### Winner, July 1990

A very good response to the July puzzle about the Celtic and Rangers fans, which we said was difficult but in fact turned out to be remarkably easy providing a micro *wasn't* used! Our mistake? We assumed that people would adopt a computer solution, whereas all that was needed was to put the numbers 1-30 round the circumference of a circle and score out every 13th until 15 had been removed. The solution is to put the Celtic fans in the positions: 1, 2, 3, 4, 5, 10, 11, 14, 16, 17, 19, 21, 24, 27, 28.

Most of the 180 entries were correct and the winning card, which was drawn at random from the pile, came from Mr Andrew Peabody of Doncaster. Well done, Andrew, your prize will be with you shortly. Usual message to the also-rans — keep trying, it could be your turn next.