THE ERRATA OF COMPUTER PROGRAMMING

by

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THE ERRATA OF COMPUTER PROGRAMMING

This report lists all corrections and changes of Volumes 1 and 3 of The Art of Computer Programming, as of January 5, 1979. This updates the previous list in report CS551, May 1976. The second edition of Volume 2 has been delayed two years due to the fact that it was completely revised and put into the TEX typesetting language; since publication of this new edition is not far off, no changes to Volume 2 are listed here.

The present report was prepared with a typesetting system that is now obsolete; please do not wince at the typography. All changes and corrections henceforth will be noted in TEX form on file ERRATA.TEX at SU-AI.

In spite of inflation, the rewards to error-detectors are still $2 for "new" mistakes in the second edition, $1 in the first edition.

Please do not endanger the author's morale by asking him about Volume 4. Thank you for your understanding.

1. throughout the book(s)  2/28/78  2

when the text of these books is on a computer I will try to be consistent in hyphenating compound adjectives like doubly-linked lists and storage-allocation algorithms, etc. . . . but until then, such lapses are not to be considered errors

1. line 1  1  5/27/78  3

Leibnitz ~ Leibniz

1.18 line -7  11/29/77  4

the theorem ~ that the theorem

1.18 line 16  11/29/77  5

3,... ~ 3,...

1.25 line 3, under the big pi  11/12/76  6

n, ~ n

The preparation of this report was supported in part by National Science Foundation grant MCS-77-23738, by Office of Naval Research contract N00014-76-C-0550, and by IBM Corporation. Reproduction in whole or in part is permitted for any purpose of the United States government.
1.41 displayed formula in exercise 32
2/28/78  7

n/ c ← n/c

1.49 add a footnote (see p. v for style)
4/19/77  8

footnote for bottom of page: In fact, permutations are so important, Vaughan Pratt has suggested calling them “perms.” As soon as Pratt’s convention is established, textbooks of computer science will be somewhat shorter (and perhaps less expensive).

1.49 lines -4, -5(twice), -7, -15, -16
11/12/76  9
...

1.45 lines 3, 10, 11, 12, 21
11/12/76  10
...

1.50 exercise 21 line 1
7/31/76  1  1
F α a ← F α i

1.51 line 13
2/28/78  1  2
manner ← matter

1.52 line 6 after Table 1
8/25/76  1  3
S x u-yuen ← S r u-yi i a n

1.56 change in Eq. (17)
11/12/76  1  4
- r ← r and r ← - r
Eq. (18)

\[ n \geq 0. \]

line after (19)

\[-r \]

caption to Table 2, replace third line by;


line -4

\[ A_{n(k-1)} \]

lines 8,9,10


line -7

use same style script F in this line as in line -6 (six places)

new generalized Eq. (29)

\[(x/(n^{*1}))^{n} \cdot (1/(n-1))^{n_{n-1}_{n}} \cdot (1/(n-1)(n-2))^{n_{n-2}_{n}} \cdot \cdots = \sum_{k \geq 0} B_{k}^{(n)} z^{k} / k! . \]  

(29)

(update to previous correction number 25)

to appear, 75-77,
The coefficients $B_k^{(n)}$ which appear in the last formula are called "generalized Bernoulli numbers". Section 1.2.11.2 examines them further in the important special case $n = 1$. For small $k$, we have $B_k^{(n)} / k! = (-1)^k {n \choose n-k} (n-k-1)! / (n-1)!$, but when $k \geq n$ this formula breaks down since it reduces to 0 times 0. An analogous situation holds for the power series $(z / \ln(1+z))^n$, where the coefficient of $a^k$ for $k < n$ is ${n \choose n-k} (n-k-1)! / (n-1)!$. 

1.91 replace lines 1-3 by the following new copy
three \( \sim \) two

exercise 5

\( n^{n-1/2} \sim n^n \)

is loaded. \( \sim \) are loaded.

The contents \( \sim \) A portion of the contents

is \( \sim \) are

Overflow may occur as in ADD. \( \sim \) Same as ADD but with -V in place of V.

move this paragraph in front of the SUB definition on the preceding two lines

MUL requires \( \sim \) MUL, NUM, CHAR each require

box 05

1 \( \sim \) 10
CON ++ CON (4 times)

1,150 lines -10,-9,-8

facilitate facilitate

1,156 stylistic correct ions

line 2: i.e. e.g.
line 3: (X) (Here X
line 5: sun; sun;
line 10: (E) (This number E
line 22: the year that the year

1,198 lines 19-21

An illustration...See also the book See, for example, the book

1,224 line -11

F = 7 F = 9

1,225 line -9

about 1946 during 1946 and 1947

1,237 line -10

down an item an item down
up the stack the stack up

1,248 insert new paragraph after line 4

Further study of Algorithm C has been made by D. S. Wise and D. C. Watson, BIT 16 (1976), 442-450.
we exercise 30 describes a somewhat more natural alternative, and we

Suppose that queues are represented as in (12), but with an empty queue represented by $F = A$ and $R$ undefined. What insertion and deletion procedures should replace (14) and (17)?

exercise 9 line 4

girl6 women

otherwise, otherwise, making the latter node the right son of NODE $(Q)$. 

Binary or dichotomous systems, although regulated by a principle, are among the most artificial arrangements that have ever been invented.

---WILLIAM SWAINSON, A Treatise on the Geography and Classification of Animals, Sec. 250 (1835)

In all Furthermore TYPE $(U)$ is set appropriately, depending on $x$. In all

there is a man now living having somebody now living has

with than
as informally as

-types -tuples

Polya \(\sim\) Pólya

step A2 lines 2-4

unmarked, mark it, and if \(\sim\) unmarked: mark it and, if (twice)

[See the... 372.) \(\sim\) An elaborate system which does this, and which also includes a mechanism for postponing operations on reference counts in order to achieve further efficiency, has been described by L.P. Deutsch and D. G. Bobrow in CACM 19 (1976), 522-526.

see \(\sim\) see N. E. Wiseman and J. O. Hiles, Comp. J., 10 (1968), 338-343,

For these reasons the \(\sim\) A contrary example appears in exercise 7; the point is that neither method clearly dominates the other, hence the simple

each with a random lifetime, \(\sim\) each equally likely to be the next one deleted,
Our assumption that each deletion applies to a random reserved block will be valid if the lifetime of a block is an exponentially-distributed random variable. On the other hand, if all blocks have roughly the same lifetime, this assumption is false; John E. Shore has pointed out that type A blocks tend to be "older" than type C blocks when allocations and deletions tend to have a somewhat first-in-first-out character, since a sequence of adjacent reserved blocks tends to be in order from youngest to oldest and since the most recently allocated block is almost never type A. This tends to produce a smaller number of available blocks, giving even better performance than the fifty-percent rule would predict. [Cf. CACM 20 (1977), 812-820.]

yet another addition after line 7

yet another addition after line 7

yet another addition after line 7

yet another addition after line 7

yet another addition after line 7

yet another addition after line 7

yet another addition after line 7

yet another addition after line 7

yet another addition after line 7
The A-l . . . code; \( \text{\text\footnotesize{\textcopyright 2014 American Math. Soc.}} \) The machine language for several early computers used a three-address code to represent the computation of arithmetic expressions; lines -11 and -10: the A-l compiler language an extended three-address code

\textbf{1.460} line 2

The latter Weizenbaum's

\textbf{1.463} several changes

\textbf{1.473} exercise 44 line 2

\( x^k + y_i \leftrightarrow x^j + y_k \)

\textbf{1.478} line 8

(to appear) \( \text{\text\footnotesize{\textcopyright 1975, 217\textendash 245.}} \) Such graph machines can easily simulate the linking automata defined above, taking one graph step per linking step; conversely, linking automata can simulate graph machines, taking at most a bounded number of steps per graph step when \( n \) and the alphabet size are fixed. The linking model is, of course, quite close to the operations available to programmers on real machines, while the graph model is not.
For example, Eq. (6) holds for all complex \( k \) and \( n \), except in certain cases when \( n \) is a negative integer: Eqs. (7), (9), (20) are never false, although they may occasionally take indeterminate forms such as \( 0 \cdot \infty \) or \( \infty + \infty \). We can even extend the binomial theorem (13) and Vandermonde's convolution (21), obtaining

\[
\sum_k \binom{r+k}{a+k} z^{a+k} = (1+z)^r
\]

and

\[
\sum_k \binom{r+k}{b+k} z^{b+k} = (1+z)^r
\]

formulas which hold for all complex \( r, s, a, b \) whenever the series converge, provided that complex powers are properly defined. [See L. Ramshaw, *Inf. Proc. Letters* 6 (1977), 223-226.]

42, 1/(r+1)B(k+1,r-k+1), if this is defined according to exercise 41(b). In general it appears best to define \( Q = 0 \) when \( k \) is a negative integer, otherwise \( Q = \lim_{s \to r} \Gamma(s+1)/\Gamma(k+1)\Gamma(s-k+1) \), since this preserves most of the important identities.

This formula . . . \( n+4 \) (The constant \( A \) is "Glaisher's constant" 1.2824271..., which R. W. Cosper has proved equal to \( (2\pi e)^{-1/2} \sqrt{12} \)).
exercise 19

24 \( \sim \) 42
1+1)u \( \sim \) 10+10)u

exercise 25

lines 11-12: operations "\( \sim \) operations," jump6 on register even or odd, and binary shift6
last line: M. \( \sim \) M, and others could set register+rA, register+rX.

changes to answer 14

line 1: uses as much \( \sim \) due in part to J. Petolino uses a lot of
line 2: as possible, in \( \sim \) in
line 9: I NCX 1 \( \sim \)
line 10: G \( \sim \) GMINUS1
lines -17 to end of page, replace by:

INCA 61
STA CPLUS60
MUL =3//4+1=
STA XPLUS57(1:2)
CPLUS60
ENTA *
HUL =8//25+1= rA = i? + 24
GMINUS1
ENT2 *
ENT1 1,2
INC2 1,1
INC2 0,2
INC2 0,1
INC2 0,2
INC2 773,1
XPLUS57
INCA -*,2
rA = 11G+773
rA = 11G+Z-X+20+24+30(2 0)
1.512 more changes to answer 14

delete the bottom line and replace lines 1-31 by:

SRAX 5
DIV =30=
DECX 24
JXN 4F
DECX 1
JXP 2F
JXN 3F
DEC1 11
J1NP 2F
3H
INCX 1
2H
DECX 23
4H
STX 2OMINUSN(0:2)
LDA Y
MUL =1//4+1=
ADD Y
SUB XPLUS57(1:2)
2OMINU
ENN1*
INCA 67,1
SRAX 5
DIV =7=
SLAX 5
DECA -4.1
JAN 1F
DECA 31
CHAR
LDA MARCH
JMP 2F
1H
CHAR
LDA APRIL

1.513 new answer

15. The first such year is A.D. 10317, although the error almost leads to failure in A.D. 10108+19k for 0 ≤ k ≤ 10.
still more changes to answer 14

replace lines 1-6 by:

```
BEGIN
  ENTEX 1950
  ENT6 1950-2000
  JMP EASTER
  INC6 1
  ENTEX 2000,6
  J6NP EASTER+1
```

"driver" routine, uses the above subroutine.

line 18

time. \(\sim\) time. (It would be faster to calculate \(r_n(1/m)\) directly when \(m\) is small, and then to apply the suggested procedure.)

bottom line

Berkeley

lines -4,-3

3\(\times\)7 \(\sim\) 7\(\times\)16

exercise 12 lines 7-10

delete "Thus, ...(b)."

line 5


new answer

30, To insert, set \(P \leftarrow \text{AVAIL}, \text{INFO}(P) \leftarrow Y, \text{LINK}(P) \leftarrow A, \text{if} F = A \text{ then } F \leftarrow P \text{ else } \text{LINK}(R) \leftarrow P, \text{and} R \leftarrow P. \) To delete, do (9) with \(F\) replacing \(T.\)
denotes, ... are included. \(\wedge\) denotes "exclusive or." Other invertible operations, such as addition or subtraction modulo the pointer field size, could also be used. It is convenient to include

exercise 2

line 2: next . . . list point \(\wedge\) next, so the links in the list must point
line 3: So . . . the \(\wedge\) Deletion at both ends therefore implies that the
line 4: ways. \(\wedge\) ways. On the other hand, exercise 2.2.4-18 shows that two links can be represented in a single link field; in this way general deque operations are possible.

exercise 9 step G4

desired girls, \(\wedge\) young ladies desired.

line -6

"pedigrees". \(\wedge\) "pedigrees,"

exercise 12 line 5

\(\infty\), \(\wedge\) \(\infty\). Hore \(c(i,j)\) mean6 \(c(j,i)\) if \(j < i\).

answer 5

There is . . . exist. \(\wedge\) When \(n>1\), the number of series-parallel network6 with \(n\) edge6 is \(2c_m\) [see P. A. MacMahon, Proc. London Math. Soc. 22 (1891), 330-339].

fourth line before exercise 33

minimal. \(\wedge\) minimal. [This argument in the case of binary tree6 was apparently first discovered by C. S. Peirce in an unpublished manuscript; see his New Elements of Mathematics 4 (The Hague: Mouton, 1976), 303-304.]
1.594 updates to previous change number 150 9/21/76 103

to appear. 491-500.
(see also the important new contribution by H. G. Baker, Jr., CACM 21 (1978), 280-294, for
which I will probably want to revise Section 2.3.5 entirely!)

1.694 update to previous change number 151 11/29/77 104

Clark's list-copying algorithm appeared in CACM 21 (1978), 351-357, and Robson's in
CACM 20 (1977), 431-433

1.597 last line of answer 6 1/16/77 105

list. list. For an alternative improvement to Algorithm A, see exercise 6.2.3-30.

1.597 exercise 8 6/25/76 106

line 1: also set M = \infty, R
line 3: If R = A or tl If M

1.601 exercise 26 line 3 2/28/78 107

two. two, with blocks in decreasing order of size.
P \geq M \Rightarrow P \geq M - 2^k.

1.601 program line number 12 4/19/77 108

j j.

1.602 new answer 2/28/78 109


1.603 addition to previous change 153 4/19/77 110

Lars-Erik Thoreii, BIT 16 (1976), 426-441.
1.606 exercise 41, numerator in value of $a[5]$  6/14/77 111

19559 18535

1.617L

delete A-I compiler, 458.

1.617L Aardenne-...

Taniana  Tatyana

1.617R

AMM  AMM

1.618L

Baker, Henry Givens, Jr., 594.

1.618R

add p487 to entry for Binomial theorem, generalizations of

1.619L Bobrow entry

add p420

1.619R

Cate, Esko George, 518.

1.619R

Cheney, Christopher John, 420.
Data organization: A way to represent information *in a data structure*, together with algorithms that access and/or modify this structure.

Derangements, 177.

add p420

End of file entry

Garwick entry

244 ~ 245

Hopper entry

255,458. ~ 225.

Hiles, John Owen, 420.

Invert a linked list, 266, 276.

INT entry

225. ~ 224-225.
Leibnitz (≠ Leibniz) ~ Leibniz (≠ Leibnitz)

Kolmogorov, Andrei Nikolaevich, 463.

MacMahon entry
add p. 583

Merrington, Maxine, 66.


Peirce, Charles Santiago Sanders, 588.

add p44 to Pratt entry

Petolino, Joseph Anthony, Jr., 511.

Prüfer, Heinz ~ Prüfer, Ernst Paul Heinz
1.629R
Prinz, Dietrich G.

1.630L
Ramshaw, Lyle Harold, 487.

1.630R
Reversing a list, 266, 276.

1.631L new entry
Series-parallel networks, 583.

1.631L
Shore, John E., 446, 451.

1.631L
Russell, David Lowis, 602.

1.632L
Swainson, William, 332.

1.632L Stirling numbers entry
90, ~90-91,

1.632R
add p630 to Thorelli entry

6/25/76 138
4/19/77 139
31/2/77 140
1/5/79 141
1/16/77 142
2/28/78 143
11/16/77 144
8/25/76 145
4/19/77 146
Watson, Dan Caldwell, 248.

add p487 to Vandermonde entry

Twigg, David William, 518.

van Aardenne-... Taniana Tatyana

Uspenski, Vladimir Andreevich, 463.

add p248 to Wise entry

Windley, Peter F.

delete p420

Wiceman, Neil Ernest, 420.
Young Tanner, Rosalind Cecilia Hildcground, 75.

(name only the endpapers of the book)

also make any changes specified for pages 136-137

quotation for bottom of page

Two hours' daily exercise... will be enough to keep a hack fit for his work.

-M. H. MAHON, The Handy Horse Book (Edinburgh, 1865)

mädchen → Mädchen

Weiner → Wiener

(1965 → 1965)

bottom line of determinant on line 12

\[ a_{mn} \rightarrow a_{mm} \]

Eq. (26)

the j in \[ a_{ij} \] should be in smaller (superscript size) font

line 2 of step S3

right → right of
lines 2-4: we find Euler’s Euler’s line 5: in this case, since lines 7-8 (the two lines following (51)): \( n \); this we have proved that \( n \). The derivative \( g^{(m)}(y) \) is a polynomial in \( y \) time6 \( e^{-2y^2} \), hence \( R_m \cdot O(n(t+1-m)/4) \)
\[
\int_{-\infty}^{+\infty} g^{(m)}(y) dy = O(n(t+1-m)/4).
\]
Furthermore if we replace \( a \) and \( b \) by \(-\infty\) and \(+\infty\) in the right-hand side of (SO), we make an error of at most \( O(\exp(-2n^4)) \) in each term. Thus

exercise 8

accent over \( o \) in Erdős should be "not"

new copy for exercise 28

28. [Mb33 Prove that the average length of the longest increasing subsequence of a random permutation on \( (1, 2, \ldots, n) \) is asymptotically \( 2\sqrt{n} \). (This is the average length of row 1 in the correspondence of Theorem A.)

last line before exercises

Feurzig Feurzeig

lines 7 and 12

\[ \log_2 \sim \lg \]
3.98 line 4
\[ \log_2 \rightarrow \lg \]

3.104 line -2
\[ 6/14/77 \ 174 \]
inversions. \[ \rightarrow \] inversions. Discuss corresponding improvements to Program S.

3.117 simplifications of step Q2
\[ 12/19/76 \ 175 \]
line 3: \[ K \leftarrow K_I, R \leftarrow R_I, \rightarrow K \leftarrow K_I \]
line 4: \[ K \text{ and } R \rightarrow K \]

3.118 comment to program line 05
\[ 12/19/76 \ 176 \]
\[ K \leftarrow K_I, R \leftarrow R_I, \rightarrow K \leftarrow K_I \]

3.120 line -3
\[ 6/14/77 \ 177 \]
\[ S \rightarrow S \]

3.122 line -6
\[ 12/19/76 \ 178 \]
instructions \[ "K \leftarrow K_I, R \leftarrow R_I" \rightarrow \text{ instruction } "K \leftarrow K_I" \]

3.128 line -3
\[ 4/19/77 \ 179 \]
\[ \nu, \rightarrow \nu \]
Yihsiao Wang has suggested that the mean of three key values such as (28) be used as the threshold for partitioning; he has proved that the number of comparisons required to sort uniformly distributed random data will then be asymptotic to \[ 1.082 n \lg n \]

3.132 10 lines after (42)
\[ 5/27/78 \ 180 \]
\[ (N/x)^4 \rightarrow (N/xa)^4 \]

3.132 7 lines after (42)
\[ 5/27/78 \ 181 \]
\[ O(N^{1-1/2}e^{-N/2}) \rightarrow O((xixN)^{1-1/2}e^{-1-xN/2}) \]
in the discussion following (45)

line 3: \( N^i \preceq |M+iN|^i \)

line 4: negligible. \( \preceq \) negligible, when \( N \) and \( N' \) are much larger than \( M \).

Eq. (46) and the line following

\( \preceq + O(n^{-M}) \)

where \( \preceq \) for arbitrarily large \( M \), where

displayed formula on line 12

\( f(n) \preceq |f(n)| \)

1725 \( \preceq \) 173

exercise 16

\( \text{HM46} \preceq \text{HM42} \)

exercise 46 lower limit of integral

\( a+i\infty \preceq a-i\infty \)

exercise 52 binomial coefficient in the sum

remove spurious fraction line between 211 and \( \pi+i \)

line 10

Language, \( \preceq \) Language

about here I will someday insert material about the new “binomial queue” algorithms to be discussed in papers by Vuillemin and Brown. since they appear to outperform leftist trees
that the multiplicity ... Algorithm R, even \( \sim \)
that it ultimately spends too much time fussing with very small piles. Algorithm R is
relatively efficient, even

Well's \( \sim \) Wells's

less \( \sim \) fewer

Eq. (4)

14. [41] (F. K. Hwang.) Let \( h_{3k} = L(43/28) \cdot 2^{k} - 1 \), \( h_{3k+1} = h_{3k} + 3 \cdot 2^{k-3} \), \( h_{3k+2} = L(17/7) \cdot 2^{k} - 6/7 \) for \( k \geq 3 \), and let the initial values be defined so that \((h_{0}, h_{1}, h_{2}, ...) = (1, 1, 2, 2, 3, 4, 5, 7, 9, 11, 14, 18, 23, 29, 38, 48, 60, 76, 97, 121, 154, ...). Prove that \( M(3,h_{t}) > t \) and \( M(3,h_{t-1}) \leq t \) for all \( t \), thereby establishing the exact values of \( M(3,n) \) for all \( n \).
\textbf{3.215} bottom line of Table 1  
31/2177 198  

1 7 \xrightarrow{16xk} \text{ (twice)}

add footnote:

\textbf{3.215} line 4 after second illustration  
31/2177 199  

the values listed in the table for \(n \geq 8\) \xrightarrow{16x} the values shown for \(V_4(9), V_5(10)\) and their duals \(V_6(9), V_6(10)\)

\textbf{3.217} amendment to previous correction number 242  
12/19/76 200  

line 17: A. Schiinhage \[to appear\] \xrightarrow{16x} A. Schiinhage, M. Paterson, and N. Pippenger [J. Camp. Sys. Sci, 13 (1976), 184-199]

line 18: asymptotic \xrightarrow{16x}

lines 19-20: \(3n\), and \ldots \(1.75n\) \xrightarrow{16x} \(3n + O(\log n)3/4\). On the other hand, Vaughan Pratt has obtained an asymptotic lower bound of \(1.75n\) for this problem [cf. Proc, IEEE Conf. Switching and Automata Theory 14 (1973), 70-81]; a generalization of his result appears in exercise 25.

\textbf{3.219} exercise 14  
12/19/76 201  

Show that \ldots comparisons. \xrightarrow{16x} Let \(U_i(n)\) be the minimum number of comparisons needed to find the \(i\) largest of \(n\) elements, without necessarily knowing their relative order. Show that \(U_5(5) \leq 5\).

\textbf{3.220} new exercise  
12/19/76 202  

26. [M32] (A. Schönhage, 1974.) (a) In the notation of exercise 14, prove that \(U_i(n) \geq \min (2+U_i(n-1), 2+U_{i-1}(n-1))\) for \(n \geq 3\). \textit{Hint:} Construct an adversary by reducing from \(n\) to \(n-1\) as soon as the current partial ordering is not composed of components \(\bullet\) or \(\circ\). (b) Similarly, prove that \(V_i(n) \geq \min (2+U_i(n-1), 3+U_{i-1}(n-1), 3+U_{i-2}(n-2))\) for \(n \geq 5\), by constructing an adversary which deals with components \(\bullet, \circ\). (c) Therefore we have \(U_i(n) \geq n+1+ \min (L(n-i)/2, i) - 3\) for \(1 \leq i \leq n/2\). (d) The inequalities in (a) and (b) apply also when \(V\) or \(W\) replaces \(U\), thereby establishing the optimality of several entries in Table 1.
Line 1: Lm/2J \rightarrow 2Lm/2J

Line 2: Ln/2J \rightarrow 2Ln/2J

Remarks about current best known sorting networks


Lines 20-21: a n \lg n \in O(n) comparators, \ldots 3651.

(371/960)n \lg n \in O(n) comparators; in particular, his construction yields \$256 \leq 3657,


Update to previous change number 250

[JACM, to appear] [JACM 23 (1976), 566-571]

Line 9

Line 48

Rating of exercise 48

Lines 4, 5, 6, 7

Has not yet \ldots m = 8. This increase is difficult to analyze precisely, but T. O. Espelid has shown how to extend the snowplow analogy to obtain an approximate formula for the behavior [BIT 16 (1976), 133-142].

According to his formula, which agrees well with empirical tests, the run length will be about $2P \cdot b(m-1.5)/(2P+b(m-2))/(2P+b(m-3))$, when $b$ is the block size and $m \geq 2$. Such an increase

Insert new paragraph before Table 2

The ideas of delayed run-reconstitution and natural selection can be combined, as discussed by T. C. Ting and Y. W. Wang in Camp. J. 20 (1977), 298-301.
3.267 line 7
should be the square root of \((4e-10)^{-1}\)

3.269 line -1
beings \(\Rightarrow\) begins

3.279 line 10 after Table 4
\textit{JACM} (to appear) \(\Rightarrow\) \textit{SIAM J. Computing} 6 (1977), 1-39

3.282 line before the big tableau
"R," \(\Rightarrow\) "R",

3.284 line 22
143 \(\Rightarrow\) 145

3.284 lines 4, 13, 20
25 \(\Rightarrow\) 27

3.303 line -4
always get \(\Rightarrow\) always gets

3.324 line -7
\(L[p]\) \(\Rightarrow\) \(L[m]\)

3.558 lines 1 and 7
1 \(\Rightarrow\) .
in the bottom example look at line 4 of the six lines, where there is a longish black bar as the seventh activity (the sixth activity is a shorter black bar). And lines 1, 2, 3, and 5 have a blank bar just above and below this longish black bar; actually lines 1, 2, 3, and 5 should have parallel upward-slanting diagonal lines (the symbol for “reading in forward direction”) inside these blank bars.

tape \( C \leftrightarrow \) tape \( A \)
tape \( D \leftrightarrow \) tape \( B \)

is \( \sim \) in

merge \( \sim \) radix sort

\( T_3 \leftrightarrow \) Track 3

artificially \( \sim \) artificially

Equation (8)

\( B_2^2 \leftrightarrow B_1^2 \)

about here I should mention C. McCulloch's new approach to external disk sorting (embodied in the KA Sort on Honeywell 200)
3.574 stylistic improvements 11/16/77 2 2 7

line 17: large, and . . . unthinkable! large; it is, however, so large that \( N \) seeks are unthinkable.
line 24: But On the other hand,
line 24: !

3.381 table entries for Straight insertion 6/14/77 2 2 8

| Length: 12 | 10 |
| Space: \( N \) | \( N + 1 \) |
| Average: \( 2N^2 + 9N \) | \( 1.5N^2 + 9.5N \) |
| Maximum: 4 | 3 |
| \( N=16 \): 494 | 412 |
| \( N=1000 \): 19855’74 | 1491928 |

3.384 insert new paragraph before line -1 6/25/76 2 2 9

In Germany, K. Zuse independently constructed a program for straight insertion sorting in 1945, as one of the simplest examples of linear list operations in his "Plankalkül" language. (This pioneering work remained unpublished for nearly 30 years; see Berichte der Gesellschaft für Math. und Datenw. 63 (1972), part 4, 84-85.)

3.387 line 2 8/25/76 2 3 0

near-optimal near-optimal

3.394 caption to Fig. 1 3/27/77 2 3 1

search. "or "house-to-house" search.

3.394 Fig. 1 4/19/77 2 3 2

label the downward branch coming out of box S2 with an \( \bullet \) sign

3.400 lines 12 and -5 2/28/78 2 3 3

running time average running time
correction to previous change 263  
4/19/77 2 3 4

delete this change, the book was right the first time

lines -4, -3  
4/19/77 2 3 5

and $N > 2^k$, we we

$L \log(N-2^k) \cdot 1 \log(N+1-2^k)^

lines 13-14  
3/2/77 2 3 6

H. Bottenbruch . . . He D. H. Lehmer [Proc. Symp. Appl. Math. 10 (1960), 180–181 J was apparently the first to publish a binary search algorithm which works for all $N$. The next step was taken by H. Bottenbruch [JACM 9 (1962), 214], who

line 30  
11/12/76 2 3 7

but his flowchart and analysis were incorrect.

line 7 (append to step D1)  
5/27/78 2 3 8

(For example, if $Q = \text{RLINK}(P)$ for some $P$, this means we would set $\text{RLINK}(P) \leftarrow \text{LLINK}(T)$, etc.)

Fig. 16  
6/14/77 2 3 9

insert "a)" and "b)") to the left of the roots of the trees, and change circles to squares in the right descendants of nodes $\text{AN}$ and $\text{AS}$ in the upper tree

update to previous change 276  
11/15/78 2 4 0

the Garsia-Wachs algorithm appeared in SIAM J. Computing, Dec. 1977, pp. 622ff; but now it seems an even better way has been found by Hu, Kleitman, and Tamaki (UCSD report 78-CS-016)
modifications to exercise 33

line 6: optimum. Cf. optimum; cf.
line 7: ; On machines which cannot make three-way comparisons at once, a program for Algorithm T will have to make two comparisons in step T2, one for equality and one for less-than! B. Sheil and V. R. Pratt have observed that these comparisons need not involve the same key, and it may well be best to have a binary tree whose internal nodes specify an equality test or a less-than test but not always both. This situation would be interesting to explore as an alternative to the stated problem.)

line -3
put a small inverted U over the ia in Akadamiia

Fig. 22
the arrows between boxes A2 and A3 should be reversed (downward arrow on left, upward arrow on right); also delete “P = A” below boxes A3 and A4 and insert the words “Leaf found” between the two arrows leading to A5

line 15
necessary. Essentially the same method can be used if the tree is threaded (cf. exercise 6.2.2-2), since the balancing act never needs to make difficult changes to thread links.

line after (4)
K

Table 1
I will recompute this table, since 144 should be 143; also will modify the discussion on page 462 accordingly and will refer to exercise 11

line 2 after caption
change + and - to typewriter-style type (+ and -)
I will rewrite this, as these trees have been studied almost too thoroughly by now.

Does ... c? What is the asymptotic average number of comparisons made by Algorithm A when inserting the Nth item, assuming that items are inserted in random order?

the root node F were node E and the root node F were both

Prove that when \( n \geq 6 \) the average number of external nodes of each of the types \(+A, -A, +B, -B, +B, -B\) is exactly \( \frac{(n+1)}{14} \), in a random balanced tree of \( n \) internal nodes constructed by Algorithm A.

It is possible for many independent users to be accessing and updating different parts of a large B-tree file simultaneously without "deadlock," if the algorithms are implemented properly; see B. Samadi, Inf. Proc. Letters 6 (1976), 107-112.
less \( \sim \) fewer

text, e.g. \( \sim \) text; e.g.,

to uniquely identify them \( \sim \) to identify them uniquely


superimpose a / over the * sign

using circular . . . complicated. \( \sim \) hashing FIRE and searching down its list, as suggested by D, E. Ferguson, since the lists are short.

E. G. Mallach [*Camp. J. 20 (1977), 137-140*] has experimented with refinements of Brent’s variation, and further recent work on this topic has been done by G. Gonnet and I. Munro [*Proc. ACM Symp. Theory Comp. 9 (1977), 113-121*]
Algorithm R may move some of the table entries, and this is undesirable if they are being pointed to from elsewhere. Another approach to deletions is possible by adapting some of the ideas used in garbage collection (cf. Section 2.3.5): We might keep a “reference count” with each key telling how many other keys collide with it; then it is possible to convert unoccupied cells to empty status when their reference count is zero. Alternatively we might go through the entire table whenever too many deleted entries have accumulated, changing all the unoccupied positions to empty and then looking up all remaining keys, in order to see which unoccupied positions really require ‘deleted’ status. This procedure, which avoids relocation and works with any hash technique, was originally suggested by T. Gunji and E. Goto [to appear].


likely, we, likely, we

buckote, pages or buckotr

access, accesses

change one of change

exercise 60

M48 → HM41

36
She made a hash of the proper names, to be sure.

--GRANT ALLEN, The Tents of Shem, Ch. 26 (1889)

If carefully selected nonrandom codes are used, it is possible to use superimposed coding without having any false drops, as shown by W. H. Kautz and R. C. Singleton, IEEE Transactions IT-10 (1964), 363-377; see exercise 16 for one of their constructions.

this is all wrong, it should be the 31 sextuples shown in the first printing of vol. 3 on page 565

16. [25] (W. H. Kautz and R. C. Singleton.) Show that a Steiner triple system of order \( u \) can be used to construct \( u(u-1)/6 \) codewords of \( u \) bits each such that no codeword is contained in the superposition of any two others.
A similar algorithm can be used to find \( \max\{x_i + y_j | x_i + y_j > t\} \) or to find, e.g.,

\( \min\{x_i + y_j | x_i + y_j > t\} \) given \( t \) and two sorted files \( x_1 \leq x_m, y_1 \leq y_n \).

junctions; STELA, an alternative spelling of 'stele';

\( B_k \) and append \((B_k+1) \Rightarrow k-B_k \) and append \( k-B_k \)

A simple \( O(n^2) \) algorithm to count the number of permutations of \( (1, \ldots, n) \) having respective run lengths \( l_1, \ldots, l_k \) has been given by N. G. de Bruijn, Nieuw Archief voor Wiskunde (3) 18 (1970), 61-65.


13); and still another by the identity in the answer to exercise 5.2.2-16 with \( f(k) = k \);

exercise 33, comments to program

line 07: r12 \( \Rightarrow \) r13
r13 \( \Rightarrow \) r 1 2
lines 09 and 15: To L4 \( \Rightarrow \) To L4 with \( q \Rightarrow p \)
replace lines 3 and 4 by the following new copy

The oo trick also speeds up Program S; the following code suggested by J. H. Halperin uses this idea and the MOVE instruction to reduce the running time to \((6B + 11N - 10)u\), assuming that location INPUT+N+1 already contains the largest possible one-word value:

1. \texttt{START ENT2 N-1}
2. \texttt{2H LDA INPUT,2 N-1}
3. \texttt{ENT1 INPUT, 2 N-1}
4. \texttt{JMP 3F N-1}
5. \texttt{4H MOVE 1,1(1) B}
6. \texttt{3H CMPA 1,1 B+N-1}
7. \texttt{JG 4B B+N-1}
8. \texttt{5H STA 0,1 N-1}
9. \texttt{DEC 2 N-1}
10. \texttt{J2P 2B N-1}

Doubling up the inner loop would save an additional \(B/2\) or so unit of time.

exercise 4

lower the \(\Sigma\) sign and the relation below it

line 10 of the program

\(rA \rightarrow rA\)

answer 11

In general,... elements. The situation becomes more complicated when \(N = 64\); R. Sedgewick has shown how to compute the worst-case permutations, and he has proved that the maximum number of exchanges is \(1 + \lg \lg N + \lg N \times O(1/\lg N)\) times the number of comparisons [SIAM \textit{J. Computing}, to appear].
16. Consider the $\binom{2n}{n}$ lattice paths from $(0,0)$ to $(n,n)$ as in Figs. 11 and 18, and attach weights $f(i-j)$ if $i>j$, $f(j-i-1)+1$ if $i<j$, to the line from $(i,j)$ to $(i+1,j)$; here $f(k)$ is the number of bits 6, 1 in the binary expansion $k \cdot \ldots b_2 b_1 b_0 \ldots 2$. The total number of exchanges on the final merge when $N=2n$ is

$$\sum_{0 \leq j \leq n} (2f(j)+1) \left( \binom{2n}{i-j} - \binom{2n}{i-j-1} \right).$$

R. Sedgewick has simplified this sum to

$$\frac{1}{2} n \binom{2n}{n} + 2 \sum_{k \geq 1} \binom{2n}{k} \sum_{0 \leq j < k} f(j)$$

and used the gamma function method to obtain the asymptotic formula

$$\log n + \frac{1}{2} \log(n) \cdot \left( \sum_{1 \leq n} n \cdot k \right) + \frac{1}{2} \log(n) \cdot \log(n) + O(\sqrt{n} \log n),$$

where $\delta(n)$ is a periodic function of $\log n$ with magnitude bounded by .0005; hence about $1/4$ of the comparisons lead to exchanges, on the average, as $n \to \infty$. [SIAM J. Computing, to appear.]

M. Paterson observes that if the multiplicities of keys are \( \{n_1, \ldots, n_m\} \), the number of comparisons can be reduced to \( n \log n - \sum n_i \log n_i \cdot O(n) \); see *SIAM J. Computing* 6 (1976), 2.

**3.627** bottom of page, new paragraph for answer 6

**3.630** answer 20

**3.634** exercise 6

**3.635** answer 10

[Inf. Proc. Letters]

**3.637** supplement to new answer 22

[See C. K. Yap, *CACM* 19 (1976), 501-508, for a further improvement.]
25. (a) Let the vertices of the two types of components be designated \(a; 6 < c\). The adversary acts as follows on nonredundant comparisons: Case 1. \(a:a'\), make an arbitrary decision. Case 2. \(x:b\), say that \(x \geq 6\); all future comparisons \(y:b\) with this particular 6 will result in \(y > 6\), otherwise the comparisons are decided by an adversary for \(U_i(n-1)\), yielding \(\geq 2+U_i(n-1)\) comparisons in all. This reduction will be abbreviated \(\text{"let } 6 = \min; 2+U_i(n-1).\"

Case 3. \(x:c\), let \(c = \max; 2+U_i(n-1)\).

(b) Let the new types of vertices be designated \(d_1, d_2 < e; f < g < h < i\). Case 1. \(a:a'\) or \(c:c'\), arbitrary decision. Case 2. \(x:b\), let \(b = \min; 2+U_i(n-1)\). Case 3. \(x:d\), let \(d = \min; 2+U_i(n-1)\). Case 5. \(x:a\), let \(a = \max; 3+U_{i-1}(n-1)\). Case 6. \(x: f\), let \(f = \min; 2+U_i(n-1)\). Case 7. \(x:g\), let \(f\) and \(g = \min; 3+U_i(n-2)\). Case 8. \(x:h\), let \(h = \max; 3+U_{i-1}(n-1)\). Case 9. \(x:i\), let \(i = \min; 2+U_i(n-1)\).

(c) For \(t = 1\) we have \(U_i(n) = n-1\), so the inequality holds. For \(1 < t \leq n/2-1\), use induction and \(b\). For \(t = (n-1)/2\), use induction and \(a\). For \(t = n/2\), \(U_i(n-1) = U_{i-1}(n-1)\); use induction and \(a\). Exercise 14 now yields the following lower bound for the median:

\[V_i(2t-1) \geq 3t+4.\]
One might complain that the algorithm compares KEY values that haven’t been initialized. If such behavior is too shocking, it can be avoided by setting all KEYs to 0, say, in step R1.

Exercise 3 line 7
increase I by 1, set . . . . and return set . . . . increase I by 1, and return

Exercise 2
line 1: RTAG
line 2: RLINK (P) . RLINK (P) and RTAG (P) ++ . In step T4, change the test RLINK (P) A to RTAG (P) + .
lst line: . . . . Similar remarks apply with simultaneous left and right threading.)

Tree illustration in answer 23

Clearly there are as many +A’s as −B’s and +−B’s, when \( n \geq 2 \), and there is symmetry between + and −. If there are \( M \) nodes of types +A and −A, consideration of all possible cases when \( n \geq 1 \) shows that the next random insertion produces \( M-1 \) such nodes with probability \( 3M/(n+1) \), otherwise it produces exactly \( M+1 \) such nodes. The result follows. [To be published.]

New answer to exercise 16
Delete E; Case 3 rebalancing at D. Delete G; replace F by G; Case 2 rebalancing at H1 balance factor adjusted at K.
(a new illustration, in the same style as before, must be supplied now)
the line following the tree should become the following (instead of what was stated in the former correction number 355):

It is perhaps most difficult to insert a new node at the extreme left of a tree like this. An insertion algorithm taking at most $O(\log n)^2$ steps has been presented by D. S. Hirschberg, *CACM* 19 (1976), 4''71-473.

---

**3.679** update to previous change 678

, to appear ^9 (1978), 171-181

---

**3.679** changes to answer 5

450. The worst . . . chars. ^-

Interpretation 1, trying to maximize the stated minimum: 450. (The worst . . . chars.)

Interpretation 2, trying to equalize the number of keys after splitting, in order to keep branching factors high: 155 (15 short keys followed by 16 long ones).

---

**3.680** bottom, new paragraph for answer 4

A more versatile way to economize on trie storage has been proposed by Kurt Maly, *CACM* 19 (1976), 409-415.

---

**3.684** line -8

$n \rightarrow N$

---

**3.687** exercise 1

-38 ^-37

---

**3.687** answer 4

change line 1 to: Consider cases with $k$ pairs. The smallest $n$ such that in line 2 (the displayed formula), interchange $m$ and $n$ everywhere, then add "for $m=365,"
3.688 new answer  
12/19/76 322


3.689 exercise 14  
6/14/77 3 2 3

line 2: keys all keys
line 12: until until TAG (P) = 1 and
line 12: points points (perhaps indirectly through words with TAG = 2)

3.693 replace all but first line of answer 37 by:  
12/19/76 3 2 4

\[
MNNS_N = \frac{1}{3} \sum (N \choose k_1, \ldots, k_M)(k_1(k_1 - \frac{1}{2})(k_1 - 1) + \cdots + k_M(k_M - \frac{1}{2})(k_M - 1)) \\
= \frac{1}{3} M \sum (N \choose k)(M-1)^{N-k}(k - \frac{1}{2})(k - 1) \\
= \frac{1}{3} MN(N-1)(N-2) \sum (N-3 \choose k) (M-1)^{N-k} + \frac{1}{3} MN(N-1) \sum (N-2 \choose k-2) (M-1)^{N-k} \\
= \frac{1}{3} MN(N-1)(N-2)M^{N-3} + \frac{1}{2} MN(N-1)M^{N-2}.
\]

The variance is \( SN - \frac{(N-1)/2M}{2} = (N-1)(N+6M-5)/12M^2 \approx \frac{1}{2} \alpha + \frac{1}{4} \sigma^2. \)

3.698 new answer  
1/5/79 3 2 5


3.700 new answer  
3/2/77 3 2 6

16. Let each triple correspond to a codeword, where each codeword has exactly three 1 bits, identifying the elements of the corresponding triple. If \( u, v, w \) are distinct codewords, \( u \) has at most two 1 bits in common with the superposition of \( v \) and \( w \), since it had at most one in common with \( v \) or \( w \) alone. [Similarly, from quadruple systems of order \( u \) we can construct \( u(u-1)/12 \) codewords, none of which is contained in the superposition of any three others, etc.)

3.708 update to previous correction number 373  
11/12/76 3 2 7

appear in the appear in Eq. 5.2.3-19 and in the
Ajtai, Miklos, 698.

Allen, Charles Grant Blairfindie, 549.

add p576 to AND entry

delete index entries for R. M. Baer and P. Brock

Brown, Mark Robbin, 470.

delete Circular lists entry

Chung, Fan Rang King, 688.

de Bruijn entry

add p. 585

Deadlock, 479.
3.713 accent over o in Erdős should be "not ."

3.713L Drysdale, Robert Lewis (Scot), III, 229.

3.713R add p576 to Exclusive or entry

3.713R Espelid, Terje Oskar, 259.

3.714L add p518 to Ferguson entry

3.714L Feurzig ↵ Feurreig

3.714R Gonnet Haas, Gaston Henry, 526.

3.714R Goldstein, Larry Joel, 641.

3.714R Halperin, John Harris, 604.
3.714R

h-ordered, 86-92. \textit{103-104, see} %-ordered.
h-sorting, 86-92.

3.714R

add p607 to Gamma function entry

3.714R

Goto, Eiichi, 527.

3.714R

Cunji, Takao, 527.

3.715L

Index mod \( p \), 9.

3.715L

Hirschberg, Daniel Syna Moses, 677.

3.715R \ new entry

Interchanging blocks of data, \textbf{598} (exercise \textit{6}), 664 (exercise \textit{3}).

3.716L

Kómáros, János, 698.

3.716L \ Kleit man entry

640 \( \rightarrow \) 639
Lehmer, Derrick Henry, 419.

add p. 561, 570 to Kau entry

Kerov, S. V., 594.

add p. 641 to Eukasiewicz entry

Leibholz, Stephen W., 641.

Lozinski, Eliezer Leonid Solomonovich, 621.

add p. 627

Maly, Kurt, 680.

Mallach, Efrem Cershon, 526.
3.717L
add p. 637 to the entry for Median

3.717R
Munro, James Ian, 526.

3.717R
Mahon, Maurice Hartland (Magenta), ix.

3.717R
ROVE, 604.

3.718L
add p. 215 to Noshita entry

3.718L
delete Newell entry

3.718L
Nitty gritty \( \sim \) Nitty-gritty

3.718R
Packed data, 401.

3.718R new entry
Pardo, see Trabb Pardo.
3.718R Paterson entry
add p. 627

3.719L
add p. 576 to Pollard entry

3.719R
Rose, Alan, 641.
Rosser, John Barkley, 641.

3.719R
Rearrangeable network. see Permutation network.

3.719R new entry
Rotation of data, 598.

3.720L
add pp. 606, 607 to Sedgewick entry

3.720L
Samadi, Behrok h, 479.

3.720L
add p. 220 to Schönbage entry

3.720R
add pp. 561, 570 to Singleton entry
**3.720R** entry for SLB
add p. 509

**3.720R**
Sheil, Beaumont Alfred, 450.

**3.721L**
Sprugnoli, R , 507.

**3.721R** replacement for previous change 416
Szemerédi, Endre, 528,698.

**3.721R**
Shanks, Daniel Charles, 575.

**3.722L**
Ting, T. C., 260.

**3.722L** Threaded tree entry
add p.457

**3.722L**
Trabb-Pardo Trabb Pardo

**3.722R**
delete p229 from Van Voorhis entry
3.722R
Wang, Y. W., 260.

3.722R
Wiener, Norbert, 8.

3.722R
delete p641 from Waksman entry

3.722R
Wang, Yihsiao, 128.

3.722R  new name6
Venn, John L.
Windley, Peter F.

3.722R
Yap, Chee-Keng, 637.

3.722R
Vershik, Anatolii Moiseevich, 594.

3.723R 2-ordered, 87, 103, 112, 135.

3.726  (namely the endpapers of the book)
also make any changes specified for pages 136-137 of volume 1
add p. 450 to Vaughan Pratt entry

addendum to previous change 324

John M. Pollard has discovered an elegant method for index computation in about $O(\sqrt{p})$ operations mod $p$, requiring very little memory, based on the theory of random mappings. See Math. Comp. 32 (1978), 918-924, where he also suggests another method based on numbers $n_j \equiv r_j \mod p$ that have only small prime factors.

changes for the book Mariages Stables

p12 line 18: Ac $\sim\sim\sim\sim\sim_Aa$
p14 line 4: Ab $\sim\sim\sim\sim\sim_Bb$
p18 line -5: $B_i \sim\sim\sim B_j$ and $A_i \sim\sim\sim A_j$ (four changes)
p18 line -4: $b_i \sim\sim\sim b_j$ and $a_i \sim\sim\sim a_j$ (four changes)
p18 line -3: $a_n \sim\sim\sim a_k$
p22 line -5, -4, -3: d: $\sim\sim\sim b_i b_j$ c: $\sim\sim\sim d$
p32 line 6: exercises $\sim\sim\sim$ exercices
p32 line -5 exercise $\sim\sim\sim$ exercice
p35 illustration: delete arc from 4 of clubs to 8 of hearts
p38 line -11: C $\sim\sim\sim B$
p47 line 2: Chsbyshav $\sim\sim\sim$ Tschbickev
p50 lines -12, -10, -3 and p51 line 5: Chebshev $\sim\sim\sim$ Tchëbichev
p52 line -6: c $\sim\sim\sim C$
p65 line -4: m $\sim\sim\sim m$
p66 line -10, denominator of third term in sum: $n+1 \sim\sim n-l$
p71 line 8: que $R_A: \sim\sim\sim$ que
p74 line -1: $X \sim\sim\sim x$
p78 line -7: $X \sim\sim\sim z$
p78 line -4: $O[i] \sim\sim\sim$ Q[s]
p86 line 10: femmes. $\sim\sim\sim$ femmes?
p87 line -10: ZZ $\sim\sim\sim$ Zs'
p92 line -8: exercise $\sim\sim\sim$ exercice
p93 line 4: et (C, Bc, Cc $\sim\sim\sim$ et (C, Bc, Cb
p93 lines -6, -3, -2: crossed-out c should be crossed-out c
p95 line 3: $n! P_n \sim\sim\sim n! p_n$
p95 line 9: $\sim\sim\sim$ $\Sigma_i$
p95 line -2: formula should be preceded by (3)
p95 line -2: $dx_2 \ldots dx_n dy_1 dy_2 \ldots dy_n \sim\sim\sim dx_2 \ldots dx_n dy_1 dy_2 \ldots dy_n$
Changes for Surreal Numbers

p86 lines 13-14 should say: II(y,X_L,x), II(y,X_R,x).
p86 line -2, change final comma to a period
p86 line -1, delete this line
p113 Mathematik Analysis
THE TEX/METAFONT PROJECT.

WHAT HAS BEEN DONE:
Don Knuth has finished (and frozen) the implementation of TEX (the typesetting system) and is currently involved in the implementation of METAFONT (the font generator).

WHAT WE WANT TO DO:
We want to complement TEX / METAFONT with a suitable hardware environment, namely:

* An XGP type device that will provide hardcopy capabilities both for proofreading and for (medium quality) originals.

* A high resolution typesetting device for high quality originals.

* A high resolution CRT terminal, capable of displaying TEX output.

We also want to make the system widely available, thus it is needed to implement it in a more widespread language (PASCAL).

And finally we would like to try our hand in making TEX more interactive than what it is now (This one is a tougher cookie.)

IF YOU ARE INTERESTED:
There are many things to be done. There are learning opportunities. There are academic goodies (units, CS293 projects, etc). And there is also monies.

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