A Bibliography of Publications on Floating-Point Arithmetic

Norbert Juffa
2445 Mission College Blvd.
Santa Clara, CA 95054
USA
Tel: +1-408-727-1885
FAX: +1-408-727-1265
E-mail: juffa@ira.uka.de (Internet)

Nelson H. F. Beebe
University of Utah
Department of Mathematics, 110 LCB
155 S 1400 E RM 233
Salt Lake City, UT 84112-0090
USA
Tel: +1 801 581 5254
FAX: +1 801 581 4148
E-mail: beebe@math.utah.edu, beebe@acm.org, beebe@computer.org (Internet)
WWW URL: https://www.math.utah.edu/~beebe/

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Introduction

This is a bibliography of material on floating-point arithmetic that I came up with while doing research on a floating-point package of my own. I don’t claim it to be anywhere near complete. The material listed is only what I myself possess.

My main interest was in software based, binary floating-point arithmetic on a microprocessor, so you won’t find much material about the hardware used in floating-point arithmetic (e.g. adders, carry propagation schemes, higher radix
representation for multiplication and division, etc.) in this list. There is also not too much on non-binary floating-point arithmetic.

For most fields covered in this bibliography, the important or historically relevant articles should be included. There is also some material on integer arithmetic in this list as some of the methods used with integer arithmetic contain interesting ideas that may be useful in the realization of a floating-point arithmetic package.

Also, depending on the type of microprocessor used, one may need to implement integer multiplication and division for use in the floating-point package, so articles about this topic are included as well.

As I am German, there is a bit of material in German in this bibliography. However, English translations are provided for all non-English titles.

Thanks to the people who have helped me with previous versions of this document by sending me papers or additional references:

- Steven Sommars (sesv@research.bell-labs.com),
- Jim Kiernan (jmk@teak.cray.com),
- Warren Ferguson (ferguson@seas.smu.edu),
- Nhuan Doduc (ndoduc@framentec.fr),
- K. C. Ng (kwok.ng@eng.sun.com),
- Nelson H. F. Beebe (beebe@math.utah.edu).

Bibliography entries in the Books section are ordered alphabetically by author; ordering is by ascending year in the remaining sections.

**Warning:** it has yet not been possible to bring this citation list up-to-date with the entries in the Bibliography entries in the **Books** section are ordered alphabetically by author; ordering is by ascending year in the remaining sections.

### Books, hardware oriented

[1721, 281, 1286, 1216, 3113, 3318, 1916, 841, 1164, 1000, 1457, 843, 1343, 7294, 7295, 1557]

### Books, software oriented or theory

[1273, 466, 469, 470, 119, 1420, 2395, 908, 1049, 352, 2954, 2436, 2971, 2272, 320, 527, 7148]

### Books, machine specific

[2176, 3219, 3115, 2438, 1767, 1903, 2291, 1935, 2473]
1 CHOICE OF BASE, FLOATING POINT FORMATS

Journal Publications, Conference Papers, Technical Reports, Ph.D. Dissertations, Book Contributions, etc.

1 Choice of base, floating point formats

[498, 750, 752, 730, 893, 1141, 1131, 2036, 2269, 2393, 2546, 2773, 2787]

1.1 Precision and Rounding

[433, 558, 745, 847, 881, 896, 964, 1032, 1041, 1045, 1194, 1296, 1435, 1376, 1538, 1729, 2458, 2531, 2844, 3160, 3283]

1.2 Determination of parameters of floating point arithmetic

[686, 823, 1636, 2275, 2202]

1.3 IEEE standards for floating point arithmetic

[993, 1197, 1223, 1206, 1234, 1196, 1203, 1340, 1326, 1280, 1300, 1458, 1385, 1409, 1387, 1725, 1824, 1862, 1863, 1860, 2087, 2173, 2341, 2575, 3055]

1.4 Floating point arithmetic, general and implementation issues

[633, 719, 1014, 1035, 1083, 1095, 1094, 1236, 1238, 1210, 1274, 1266, 1475, 1493, 1992, 2012, 2218, 2219, 2374, 2448, 2351, 2530, 2774, 2775, 2703, 2772, 3013]

1.5 Floating point packages

[1287, 1700, 1679, 1773, 1731, 1884, 1849, 1885, 1967, 2080, 2102, 2205, 2300, 2301, 2302, 2481, 2482, 1352]

1.6 Floating point units

1.7  Test of floating point routines

2  Addition and Subtraction
[375, 1513]

2.1  Floating-point Summation
[325, 345, 362, 361, 570, 639, 677, 831, 1661, 2277, 2354]

2.2  Multiplication
[680, 1246, 1260, 1476, 1543, 1516, 1574, 1601, 1593, 1619, 1676, 1591, 1758]

2.3  Division
[209, 238, 223, 322, 348, 438, 1017, 1064, 1311, 1403, 1567, 1645, 1623, 1606, 1770, 1890, 2015, 1994, 2389, 2779, 2724, 2969, 3018, 7316, 2951]

3  Elementary functions, general
[384, 398, 586, 650, 615, 1122, 1265, 1656, 1756, 1719, 1717, 1794, 1840, 7235, 1945, 2051, 2155, 2098, 2279, 7254, 2562, 2599, 2549, 3337, 2551, 2520, 2699, 2852, 2663, 2814, 2815, 2692, 3370, 3338]

3.1  Elementary functions, CORDIC and related algorithms
[190, 191, 248, 264, 373, 523, 551, 659, 651, 667, 733, 855, 1068, 1084, 1293, 1451, 1699, 1897, 1708, 1811, 1963, 2160, 2383, 2312, 2543, 2569, 2718, 2812, 3012, 3007, 3130, 3070, 3116]

3.2  Elementary functions, function approximation
[240, 241, 481, 623, 768, 767, 983, 1021, 1162, 2000, 2052, 2612, 2687, 2785, 2786]

3.2.1  Polynomial evaluation
[259, 279, 304, 426, 1061, 1228, 2353]
3.3 Square root, general
[1082, 1187, 1481, 1598, 1651, 2567, 2679]

3.3.1 Square root, bit-oriented, iterative, and table methods of computation
[120, 153, 359, 1022, 1008, 1151, 1353, 1444, 1406, 1372, 1426, 1537, 1825, 1922, 
1834, 1887, 1971, 1952, 2035, 1955, 2006, 2046, 2089, 2140, 2180, 2255, 2392, 
2579, 2536, 2711, 3040]

3.3.2 Square root, Newton’s method
[158, 280, 302, 374, 347, 343, 383, 451, 427, 513, 518, 532, 596, 585, 579, 581, 
702, 1328, 1317, 1397, 1583, 2335, 3020, 2949]

3.4 Sine and Cosine
[180, 1068, 1018, 1023, 1176, 1398, 1544, 1666, 1665, 1765, 1853, 1953, 2121, 
2232, 2608, 2963, 2960, 2882, 2982, 3076]

3.5 Logarithm
[154, 271, 331, 690, 998, 1112, 1299, 2107, 2108, 2609, 2737]

3.6 Exponential function
[141, 409, 1183, 1361, 1518, 1748, 1847, 2472, 2610, 3004]

3.7 Arctangent
[143, 160, 207]

3.8 Other transcendental functions
[499, 613, 161, 1024, 365, 275, 360, 2100, 1157, 2862, 3056]

4 Binary-decimal conversion
[189, 173, 222, 475, 576, 684, 1165, 1291, 1292, 1405, 1654, 1709, 2002, 1975, 
2511, 2603, 2527, 2858]
5 BCD arithmetic

[674, 726, 777, 778, 779, 780, 781, 782, 783, 1382, 1492, 1705, 1640, 2037, 2648, 2962]

6 Multiple precision arithmetic

[292, 330, 410, 428, 632, 616, 953, 1002, 1099, 1098, 1265, 1350, 1430, 1542, 2807, 2791, 3035, 3226]

7 Conferences on computer arithmetic

[7174, 7184, 7189, 7198, 7201, 7214, 7232, 7233, 7275, 7305, 7313, 7307, 7339]

8 Additional contributions from Nelson H. F. Beebe


Title word cross-reference

#26 [5495].

\[(2^n)^m\] [3800]. \((10^x - 1)/9\) [1976]. \((2^n)\) [4353, 4374, 4558, 4567, 4472]. \((2^n + 1)\) [1081, 4791, 3913]. \((2^n - 1)\) [5010]. \((2^n - 1, 2^n+p, 2^n+1)\) [6285]. \((2^n2^n)\) [6090]. \((2^n \pm 1)\) [5522, 4140]. \((2m)\) [4437]. \((2n + 3)\) [6541]. \((2n - (2p \pm 1))\) [4853]. \((a \cdot x) \cdot x?\) [6817]. \((d, r)\) [789]. \((M, p, k)\) [5813]. \((R)\) [2910]. \((p)\) [4353, 4437].
\[(x + y) \times (x - y) \] [6688]. \( -2 \) [743, 183, 206, 949, 801]. \( -\infty < n < +\infty \) [141, 160]. 0 [5641]. 0 \( < N < 1 \) [161]. 0 \( \neq 0 \) [699]. $1$ [3742]. 1 [4990, 4346, 5155, 5642, 3697, 2166]. 1, 000, 000 [618]. \( 1/\sqrt{x} \) [5784]. 1/t [2175]. 10 [530, 6021]. 116 [4022]. 128 [4859]. 15 [530]. 16 [2506, 4187, 4075]. 17 \( \times 69 \) [3049]. 20 [1005, 4304, 2049, 5678, 3231, 3994, 618, 6054, 430, 4346, 5011, 3286, 3462, 1760, 3472, 3142, 3479, 5616, 3494, 530, 321, 3684, 3819, 4453, 3697, 5099, 3364, 4943]. 2, 576, 980, 370, 000 [5643]. 22n + 1 [2147]. 256 [4440]. 27 [433]. 2n + 1 + 1 [3971]. 2n+1 - 1 [6036]. 2n+2 - 1 [6036]. 2^n [6026]. 2^n - 1 [2858]. 2^k [4845, 4998, 5502, 5039, 5047]. 2^k + 1 [866]. 2^{k-1} [4485]. 2^n [4559]. 2^n [1568, 6036, 3971]. 2n + 1 [3971, 4990, 5724, 4463]. 2n+1 - 1 [6531]. 2n+1 + k [6531]. 2n - (2^{n+1} - 1) [5342]. 2^N - 1 [2989, 4826, 6531, 4216, 3971]. 2^n - 3 [7033]. 2^n + 1 [6026]. 2^n + 3 [6026]. 2^n [6252]. 2^n [5921]. 3 [377, 4992, 4181, 430, 4037, 4205, 4042, 5031, 4876, 321, 6221, 4121, 6615, 4940, 4941]. 3 - j [296]. 32 [3987, 4440]. 3 \times 3 [2495]. 4 [3971, 4318, 4662, 2523, 2524, 430, 3431, 5729, 5528, 4385, 4718, 2952, 4075, 4077, 2813, 3527, 3532]. 8 [49.95] [3709]. 6 [5026, 4803]. 54 \times 54 [3486]. 6 - j [298]. 64 \times 64 [2280]. 8 [433, 3444, 4075, 3494]. 84 [307]. 88500 [4145, 4146]. 88602 [530]. 88654. 8 \times 8 [5099]. 9 - j [298]. 8 [6229]. 9 > [6229]. 0, 1 [5155]. 0 [4359]. 2 [5742]. 4 \times 8 [4593]. \epsilon [1159]. \epsilon [1159]. TM [4629]. \mu (N + C) [1910]. a + b [3641]. a + b + c [6312]. AB + CAB + C [6967]. ab + cd [6105]. ab + cd + c [7119]. a \cdot (x, x) [6871]. A \cdot T [4068]. arctan Z [143]. a \times b + c \cdot d [6312]. b \cdot \mu [6343, 7078]. C + AB^2 [4283]. [\sqrt{a^2 + b^2}] [6294]. CLP(R) [2930]. \cos^{-1} [3130]. \cos N [180]. \cos x [373]. \cot - x [373]. d [4696, 5505, 3806]. \Delta_0^2 [4944]. \epsilon [459]. \epsilon^n [141]. \epsilon^n [409]. \epsilon [3475]. \eta [5670]. \eta T [5247]. \exp(x) [1361]. \exp x [373]. f(x) = 0 [1222]. G_0 [809]. GF(2)[x] [5867]. GF(2^n) [4407, 4775, 4390, 6055, 4977, 5433, 4908, 5871]. GF(2^n) [4202]. GF(p^m) [4654]. H [5127]. I^2L [3240]. \infty [5018]. K [5441, 4304, 5923, 2107, 6009, 6334, 5965]. k < m [6343]. L [4346]. L^2 [5255]. L^3 [5254, 6997, l_2 [6065]. ln(x) [1529]. ln x [373]. log n [1228]. log Z [143]. LU [6806, 6563]. M [4840, 180, 4135, 2628, 2633, 2642, 2920, 5336, 581, 6343]. M^E \mod N [2777]. F_2[X] [7077]. f_m [4323]. F_{p^n} [5688]. R^n [6919]. Z^2 [4063, 5038]. GF(2) [5310, 1692]. GF(2)^2 [6168]. GF(2^m) [3924]. GF(2^n) [6168]. GF(2^k) [4965, 3771, 4923]. GF(2^m) [5485, 4675, 4983, 3876, 4529, 5144, 3584, 4553, 3887, 5144, 3775, 4863, 5310, 5173, 4717, 4388, 5035, 2430, 5434, 4607, 4748, 4909, 5438, 3200, 4283, 4938, 7474, 2310]. GF(2^n) [4997]. GF(p) [2081]. GF(p^m) [3490]. GF(p^k) [4650]. GF(q^n) [4698]. MECIPTI [282]. \mu [1426, 4869, 4911, 2311]. \mu P [1610, 2008]. N [3966, 808, 2335, 2336, 160, 161, 180, 4578, 5071, 4929, 5965, 5690, 4162, 6054, 4306, 1265, 1613, 6422, 5856]. r = n^{e(k)} [1438]. r^n [4948]. r^n - 1 [4948]. r^{c+1} [4948]. \{r^n - 2, r^{n-1}, r^n\} [5301].
$r \geq 8$ [5856]. $s$ [4880]. $\sin(\text{BIG})$ [5236]. $\sin^{-1}$ [3130]. $\sin N$ [180]. $\sin x$ [373]. $\sqrt{a^2 + b^2}$ [6294]. $\sqrt{x}$ [1481]. $\sqrt{x/d}$ [3848]. $\sqrt{2}$ [7001]. $\sqrt{x}$ [1307, 451]. $\sqrt{x+y^2}$ [5678]. $T$ [6579]. $\tan^{-1} x$ [373]. $\theta(\log N)$ [2356]. $\times$ [4068, 3918, 4134].

$\sin x$ [373]. $p(\frac{a^2}{b^2} + b^2)$ [6294]. $p(x)$ [1481]. $p(x/d)$ [3848]. $x^n$ [5898, 3310]. $x^*(1/x) \neq 1$ [3248]. $y$ [4416]. $Z$ [5333].


.NET [6432, 5074].

/m [4869]. /spl [4869].

0.18-CMOS [5780]. 0.4.1rc [6433]. 0.80pJ [6567]. 0.80pJ/flop [6567]. '00 [7415, 7420, 2542]. '01 [7429]. '03 [7458]. '04 [7467, 7475]. '07 [7510, 7516, 7518, 7523]. '08 [7527, 3034, 5381].

8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE


8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE


8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

8  ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE  13

[1708, 5238, 1709, 1260, 3962, 4956, 6478, 3037, 3220, 3715, 3852, 1806, 3040, 725, 6869, 5247, 1372, 807, 1492, 2048, 5473, 6374, 6646, 6488, 6761, 1098, 1814, 3401, 4973, 3560, 1497, 5687, 3725, 814, 5691, 1820, 2201, 5264, 3985, 2341, 2059, 1017, 1825, 2871, 5138, 2349, 1831, 3070, 4005, 5705, 6400, 1115, 1835, 428, 4016, 4835, 6165, 5511, 3434, 4850, 3604, 3757, 4032, 4550, 4034, 4203, 4204, 6536, 2383, 2718, 1617, 5014, 5727, 5729, 740, 3450, 972, 5524, 2090, 5743, 1630, 1873, 5310, 3291, 2737, 828, 6914, 5931, 6088, 3460, 313, 5315, 5316, 4063, 2423, 5039, 1048, 5608]. Algorithm [2105, 569, 2107, 262, 640, 4728, 2113, 6925, 762, 2949, 1649, 1890, 2115, 2256, 5336, 2568, 6201, 6443, 1654, 1897, 4414, 2776, 2962, 4416, 1532, 1661, 2779, 2780, 3663, 6011, 7127, 4900, 5430, 5771, 1157, 2591, 6117, 4906, 923, 2140, 924, 7080, 775, 4613, 1243, 2015, 5637, 6019, 372, 3818, 4116, 3186, 4121, 4451, 5091, 1693, 6222, 456, 4459, 2824, 3521, 2156, 489, 5560, 5786, 5870, 5961, 595, 3701, 1478, 244, 3208, 3534, 5110, 4282, 2632, 1710, 603, 2174, 2040, 4785, 6479, 3552, 3853, 5243, 6373, 3402, 1582, 1720, 4805, 2663, 2664, 3406, 5131, 3231, 2671, 2509, 3983, 3570].

Algorithm [3415, 5696, 3729, 3418, 3240, 4335, 4336, 3873, 3874, 6269, 3581, 3072, 465, 4885, 4887, 4996, 4011, 3582, 1204, 5289, 4839, 2216, 5828, 5711, 6276, 1971, 3887, 4197, 3260, 3439, 3440, 4202, 2901, 514, 515, 2717, 4035, 3892, 5921, 4711, 5021, 2400, 748, 5745, 2734, 2735, 5169, 2552, 2738, 6698, 5841, 4569, 3462, 4572, 4573, 3630, 3781, 5042, 2939, 2248, 5847, 573, 4882, 761, 577, 1762, 2950, 4885, 5051, 1891, 983, 5421, 6005, 3308, 6336, 2778, 5856, 3147, 5544, 2781, 2969, 1907, 2970, 2450, 4743, 5429, 2132, 2585, 4604, 4749, 4910, 997, 1064, 3339, 3178, 3687, 3516, 1922, 3517, 2604, 293].

algorithm [1927, 2813, 3003, 5092, 4766, 5451, 5452, 4279, 3192, 4663, 659, 2485, 3201, 3364, 4773, 5457, 5107, 6025, 3374, 7132, 4945, 6663, 3035, 3553, 2048, 6761, 1192, 2202, 3054, 3055, 3056, 3057, 384, 6057, 1118, 1205, 5000, 5503, 432, 4020, 512, 6407, 564, 2089, 3668, 5444, 270, 2807, 3942, 4443, 5654, 6808].

algorithm-based [2248, 3516, 3201, 3364, 3374]. Algorithmen [4677, 5325, 4344, 2758]. Algorithmic [5101, 3796, 3318, 1440, 3800, 1443, 4252, 1444, 1770, 6012, 2791, 3805, 7322, 6014, 6830, 5951, 5952, 7310, 6950, 4611, 774, 2458, 3505, 5348, 925, 7083, 7084, 711, 3685, 373, 4115, 1341, 2605, 2814, 2815, 5784].

Algorithms [4560, 3292, 4379, 630, 5839, 5317, 2932, 1528, 4064, 3122, 2925, 3298, 7373, 7493, 1049, 6816, 3639, 1639, 1887, 686, 1640, 690, 1641, 4881, 7251, 7265, 4401, 5048, 4585, 3302, 447, 356, 476, 6706, 360, 3646, 5052, 4407, 2569, 3793, 7060, 4411, 1322, 3796, 3318, 1440, 3800, 1443, 4252, 1444, 1770, 6012, 2791, 3805, 7322, 6014, 6830, 5951, 5952, 7310, 6950, 4611, 774, 2458, 3505, 5348, 925, 7083, 7084, 711, 3685, 373, 4115, 1341, 2605, 2814, 2815, 5784].
8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

5869, 3007, 939, 2826, 3831, 1699, 2302, 5563, 3362, 1473, 3370, 7131, 5109, 5378, 7133, 551, 3211, 1083, 3551, 5464, 5971. algorithms [4499, 4967, 4311, 5127, 6144, 6249, 6763, 6872, 7273, 2666, 2200, 221, 3862, 1960, 419, 3992, 1827, 1199, 2683, 3062, 3419, 4820, 2206, 1836, 3249, 4684, 6903, 3428, 225, 5146, 5149, 6067, 6404, 7300, 4026, 4704, 5721, 6907, 1299, 3272, 5304, 1982, 741, 2920, 4381, 2413, 3118, 4574, 1754, 2424, 3783, 830, 1755, 1882, 1637, 5610, 7407, 7418, 7434, 7447, 7461, 7478, 4069, 2563, 4730, 3133, 2758, 5050, 5185, 2435, 2567, 5187, 5422, 6445, 4080, 5857, 4082, 1422, 1663, 5621, 6208, 2268, 4901, 2454, 4604, 2593, 4092, 3932, 4612, 3168, 3169, 3507, 5350, 2464, 1784, 2023, 5214, 4764, 3002. 


8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

7209, 216, 5229, 7509, 7171, 2847, 2848, 7134, 411, 2632, 2171, 5460, 1947, 2040, 3551, 495, 1488, 1089, 1189, 1368, 1807, 2847, 2848, 7134, 411, 2632, 2171, 5460, 1947, 2040, 3551, 495, 1488, 1089, 1189, 1368, 1807, 2181, 2499, 225, 465, 4687, 4996, 4011, 4691, 505, 3428, 3586, 225, 510, 6060, 5824, 5002, 5149, 2373, 2708, 7225, 3598, 2220, 308, 824, 2079, 1744, 3268, 3269, 5728.

Analysis [5304, 1982, 5730, 7181, 5921, 3282, 472, 3285, 6083, 628, 3286, 747, 1224, 519, 1225, 1226, 4381, 6428, 3776, 1882, 1637, 524, 571, 2248, 4240, 7054, 1647, 1648, 5538, 5051, 5333, 363, 403, 2442, 2118, 2956, 2957, 835, 3145, 984, 2961, 375, 3824, 3825, 4452, 1175, 7280, 2827, 3193, 1251, 715, 794, 3009, 5648, 1703, 3837, 1182, 2626, 3840, 6663, 1816, 7308].

8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE


Applications [1485, 2314, 5970, 3222, 1490, 4154, 7427, 7273, 5689, 2056, 5892, 2337, 1727, 3420, 3732, 6665, 2686, 6269, 1839, 2367, 5146, 4701, 4026, 5009, 6525, 4199, 5725, 7119, 5991, 6419, 3105, 3453, 748, 2417, 7335, 2934, 7249, 2560, 2944, 316, 4890, 4595, 3150, 2587, 5775, 7206, 5956, 3504, 3514, 2018, 790, 455, 17, 3192, 7325, 1351, 5790, 1704, 5375, 1975, 1700, 7171].

ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

6338, 2141, 2832, 5115. **Arbitrary-accuracy** [6434]. **Arbitrary-Precision** [6297, 6545, 6189, 6314, 4116, 4483, 5992, 7053, 6338]. **Arbor** [7201, 735].

**Architect** [4389]. **Architectural** [7271, 4321, 5823, 4702, 1417, 5943, 2306].

**Architecture** [7191, 6856, 3958, 4780, 5572, 2493, 5117, 6366, 7193, 4956, 6138, 1369, 2655, 1816, 1100, 5259, 6148, 1820, 4671, 5133, 5487, 1019, 2879, 6263, 4984, 6900, 4175, 1517, 4353, 6277, 2710, 4028, 3602, 7288, 7369, 7441, 7558, 3262, 3263, 2381, 2222, 4362, 5302, 1856, 1216, 3097, 3274, 5158, 7289, 7304, 7443, 4244, 6822, 6935, 7292, 5948, 6011, 3318, 7288, 7304, 7443, 4208, 4708, 4709, 6293, 6416, 6421, 5743, 2094, 2918, 3621, 4219, 4559, 1422, 4562, 4564, 6086, 5315, 6186, 1312, 1881, 4231, 3299, 6329, 6335, 2951, 7350, 4244, 6822, 6935, 3318, 7292, 5948, 6011, 4259, 4900, 5428, 6945, 6717, 6117, 993, 4608, 2995, 7268, 1679, 6591, 4437, 6954].

**Architectures** [2805, 2987, 3510, 6725, 2151, 5217, 5361, 1467, 5786, 5961, 1469, 3363, 3365, 6228, 7103, 6734, 6848, 4775, 6736, 1083, 4491, 6475, 2638, 4785, 3899, 1810, 5814, 2663, 3231, 3053, 4167, 4675, 2349, 2064, 7221, 2369, 7018, 4845, 7019, 1972, 3596, 5519, 2223, 7169, 4710, 2724, 5408, 2229, 2230, 2397, 2398, 2404, 2548, 4221, 2738, 2414, 2415, 3905, 2243, 3777, 2422, 4876, 3913, 1760, 4877, 2561, 2756, 2757, 2254, 5421, 5617, 5060, 2572, 3660, 480, 2267, 4263, 3669, 6209, 2589, 2590, 1062, 7206, 5073, 2283, 5783, 3517, 935, 1339, 4762, 4766, 1788, 2297, 3200, 1704, 2164, 6025, 3377, 935, 1339, 4762, 4766, 1788, 2297, 3200, 1704, 2164, 6025, 3377, 4855].

**Ariane** [3542, 3779, 3631]. **Arithmetic** [7572, 2631, 1708, 6976, 850, 851, 1005, 1080, 1081, 1186, 1563, 6631, 2037, 4486, 5799, 3023, 7366, 3961, 6469, 5876, 1009, 1712, 2637, 3710, 3846, 4646, 5120, 5241, 5424, 5462, 5659, 6369, 6474, 5803, 3549, 3550, 3711, 3965, 4292, 377, 4293, 3712, 3850, 4297,
8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

7433, 5748, 635, 5930, 2417, 2741, 5314, 3908, 5840, 5177, 7121, 5318, 2421, 2930, 3909, 5996, 4228, 4871, 5607, 5936, 1, 4574, 3120, 4395, 4576, 5323, 5416, 5533, 5844, 351, 4577, 4578, 3782, 3783, 636, 524, 571, 2425, 1757, 5324, 5938, 1638.

arithmetic [3126, 6566, 1050, 1995, 2753, 234, 1313, 7123, 1760, 2943, 640, 687, 3641, 688, 574, 2251, 4879, 5612, 575, 6571, 6100, 2758, 5184, 5050, 447, 7145, 356, 357, 476, 761, 832, 981, 1052, 1053, 5185, 6704, 3789, 6705, 3140, 2432, 6002, 318, 695, 5338, 5331, 5332, 3647, 5540, 6928, 1319, 1999, 5616, 5337, 3307, 6006, 1764, 2570, 4411, 7125, 5854, 5767, 984, 4734, 2260, 3146, 5, 1153, 6936, 1232, 2448, 4737, 3319, 580, 5191, 4082, 4897, 2574, 1442, 1663, 5858, 4251, 5066, 3151, 4253, 5621, 698, 3801, 3802, 3803, 4087, 4255, 4740, 2577, 2578].


Array-Like [851]. Arrays [7466, 7483, 1186, 1823, 870, 5982, 3251, 7014, 2706, 1135, 6185, 4060, 2932, 5998, 3124, 3465, 978, 3473, 643, 1664, 2131, 2796, 5640, 7451, 6379, 2690, 2405, 3125, 3484, 3516, 4283, 3201, 3364].

8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

8  ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

Cases [3422, 2353, 5292, 4391, 4722, 5178, 5415, 5933, 4402, 4621, 5089, 5236, 6495, 4705, 3452, 4721, 4583, 4727, 4761, 5087]. Casting [6043, 7040, 2831].


Causes [6346, 6456, 3353, 1702]. Causing [5975].


Celeste [40]. celestial [40]. Cell [5683, 2891, 4022, 7304, 2389, 2911, 3180, 5569, 2676, 3736, 2892, 2724, 3280, 2415, 2749, 3183, 5055, 5065]. Cells [6630, 3433]. Cellular [5261, 5483, 1595, 2884, 4012, 1217, 4564, 637, 685, 938, 3407, 5411, 2582].

Center [333, 165]. Centered [6776]. central [3148, 3149]. Centre [7572, 7304, 7458, 7374, 4030, 7416, 27, 31, 5475, 1321, 930].


8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

Computation [903, 6434, 5845, 523, 2936, 2937, 143, 1049, 758, 2562, 6098, 3138, 6575, 448, 4887, 1901, 1533, 1326, 4426, 4600, 4900, 7152, 1988, 2925, 974, 7248, 2097, 2732, 5602, 4383, 7335, 6560, 5041, 1638, 6330, 364, 1896, 5058, 2118, 7190, 4415, 986, 1327, 4743, 1535, 4604, 3159, 1241, 1333, 5956, 211, 3336, 2286, 2288, 5082, 5083, 4444, 4445, 4620, 131, 5553, 5095, 2825, 2478, 3196, 6023, 1471, 1472, 542, 2623, 544, 1937, 2637, 2652, 2569, 7525, 7326, 1794, 995].

Computationally [3628, 3190].

Computations [3535, 4488, 3221, 5124, 6040, 5388, 3563, 3729, 872, 1028, 4186, 4540, 5713, 6530, 1132, 1412, 3609, 4555, 3899, 5995, 3772, 894, 1044, 6697, 904, 1430, 6574, 7235, 5541, 5772, 2975, 4903, 6014, 2431, 4615, 5079, 6596, 5358, 848, 1348, 3370, 4289, 5464, 4655, 5891, 6150, 6779, 2066, 3880, 2690, 3740, 3886, 7371, 3904, 5837, 4224, 1140, 634, 5175, 5017, 756, 5334, 5335, 5419, 5540, 7205, 4910, 3940, 5210, 2621].

Compute [5887, 6374, 6526, 2985, 5988, 6939, 1907, 4263, 2802, 2984, 3178].

Compute-Bound [2985, 2802, 2984].

Computer [7191, 7143, 7149, 7156, 7158, 7159, 7163, 1563, 719, 1007, 7192, 7366, 1009, 7193, 2637, 7312, 3710, 3847, 5241, 5242, 5462, 5659, 5803, 3550, 1362, 326, 7244, 7313, 721, 853, 1188, 1364, 4651, 7454, 2643, 7512, 606, 6249, 6760, 5128, 3048, 7533, 3975, 5677, 7534, 5679, 6492, 7231, 246, 3979, 7428, 7569, 1194, 7343, 248, 7168, 1721, 7500, 7576, 7401, 4330, 7245, 2885, 872, 873, 1025, 1114, 2358, 7275, 136, 174, 4531, 466, 281, 509, 429, 1028, 337, 964, 1125, 7211, 5506, 1515, 2530, 2702, 2703, 3590, 4537, 4700, 5827, 62, 675, 555, 1128, 4701].


Computer [7381, 5031, 1636, 4389, 1312, 2422, 1427, 569, 3466, 3634, 7522, 4580, 2940, 5534, 1761, 1641, 4728, 5537, 446, 4242, 317, 162, 5614, 266, 7494, 7568, 6198, 6929, 5420, 2000, 3649, 4244, 2765, 7564, 642, 7230, 2770, 2959, 6008, 478, 5190, 6937, 2122, 3318, 1439, 2574, 4252, 5621, 121, 7292, 7531, 988, 7351, 129, 3491, 6585, 1672,
ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

7105, 6658, 6771, 6423, 6699, 6435, 6709, 6934, 6726, 6497, 6709, 7062, 6464.

3331, 4603, 6451, 6210, 1450, 1675, 6946, 6947, 1452, 5862, 3504, 3505, 4914, 4271, 4441, 7479, 1777, 5782, 3511, 999, 1919, 1457, 4447, 4763, 5784, 4123, 4453, 4454, 5218, 3006, 591, 2822, 7098, 2027, 5363, 5364, 2474, 2157, 2158, 5645, 6616, 2031, 2301, 6731, 3198, 4628, 3362, 5648, 3202, 795, 3205, 3206, 1560, 1003, 4286, 5232, 5377, 4775, 6735, 6970, 5569, 1479, 2169, 6776, 2684, 3211, 4785, 604, 1716, 2188, 58, 4801, 1499, 2333, 2337, 419, 5979, 2349, 4177, 2694, 4345, 621, 879, 1030, 5987, 2894, 3080, 2532]. design [6405, 3758, 2221, 2713, 2539, 2084, 4707, 2719, 1857, 1038, 2394, 4213, 4215, 5598, 3289, 4052, 1632, 2736, 4714, 3777, 3909, 2423, 3782, 3783, 2759, 5050, 695, 2565, 2433, 3306, 2955, 2260, 1153, 3314, 3320, 3321, 2263, 1059, 3661, 771, 4910, 3161, 3500, 3675, 7480, 3817, 7376, 4921, 7177, 4122, 3829, 2485, 3526, 4635, 4942, 6025, 4947, 2347, 7486, 1000, 7146]. Designed [6468, 1964, 1868, 6000].

One diminished-digit 


Form [3391, 3295, 1436]. Directed [5418, 4088, 4257, 7133, 7460, 5952].
Discovery [5666]. Discrete [4784, 5502, 5039, 1896, 790, 2028, 4932, 2630, 815, 1826, 4014, 4343, 2708, 5844, 5422, 1907, 4263, 2030, 4769, 3009, 3205, 3206, 6971, 6521].
Discretely [174]. Discriminant [5473, 5251]. Discussion [5678, 9, 10, 58, 544]. Discussions [18, 105, 52, 36, 26, 86, 30, 94, 5475].
dish [6115]. disk [5730]. displays [2206]. Dissecting [6543]. Dissipation [4104, 4157, 4169, 4917]. Distance [4005, 4063, 5038, 3927, 3673, 4474].
Distance-Calculation [4005]. Distillation [3962, 5110, 4890]. distinctions [2306]. Distributed [1712, 1381, 1586, 7415, 7443, 5845, 589, 5641, 5222, 1359, 2678, 5699, 2912, 1760, 6208, 4275, 1787, 5454, 849, 4468, 2487, 4477].
divides [1516, 1403, 1623]. Dividing [6673]. Divisibility [2858]. Divide [437]. Division [2634, 7108, 6, 1567, 1568, 852, 6984, 3852, 1366, 857, 5809, 726, 4502, 1081, 6999, 3556, 5974, 728, 3228, 3401, 6649, 6873, 7000, 6146, 1581, 32, 729, 5392, 5687, 814, 5259, 670, 3864, 3985, 1017, 4671, 3058, 3235, 4983, 3999, 3422, 5493, 6054, 7009, 3738, 1602, 1835, 3249, 3250, 4008, 4173, 4683, 2071, 6401, 424, 507, 552, 4016, 431, 1606, 822, 305, 6520, 2706, 6064, 3256, 2377, 1851, 5717, 3752, 7115, 4193, 6072, 5722, 3755, 4359, 3757, 4032, 4203, 5014, 4709, 4039, 3447, 3448, 740, 6029, 343, 5524, 5920, 4045, 3451, 4048, 7035, 3766, 3767, 6548].
8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

division

Division-and-accumulation
Division/Square
Divisionless
Divisions
Divisor
Divisors
DivSqrt
DLFloat
DLLs
DMT
DNA
DNA-based
DNN
DNNs
DNA-based
Document
Documentation
Documents
Does
Domain
Domains
Domestic
dominated
don't
done
données
does
Dog
Doing
Dojo
Dokumentation
Dollars
Domain
Domains
Domestic
Donald
done
données
Down
downloadable
Downloadable
drawing [2926, 4604]. Dream [60]. Dreixel [7463]. Drift [921, 922]. Driven
[5117, 1375, 6557, 6192, 3805, 2472, 2609, 3004, 2534, 2610, 3375]. Drivers

8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE 49

4452, 6351, 1175, 4128, 2850, 2851, 3374, 7132, 4142, 6663, 3241.


Evaluation [4950, 2036, 1082, 1361, 7108, 6478, 297, 6482, 728, 953, 5813, 248, 5693, 5893, 1383, 2674, 5983, 2520, 279, 733, 872, 873, 1025, 1113, 304, 426, 466, 1122, 736, 7021, 3436, 2715, 3445, 6413, 6683, 6075, 3578, 5924, 6298, 259, 6554, 399, 439, 1228, 5316, 7044, 5324, 690, 1529, 3132, 3136, 6575, 3915, 4731, 5765, 3309, 763, 836, 916, 6938, 1443, 6337, 1061, 6345, 1542, 1914, 5076, 6127, 1176, 1183, 2852, 4521, 551, 2180, 4499, 4652, 4653, 862, 954, 6996, 7109, 5389, 1818, 2870, 4823, 2882, 3065, 6157, 2208, 1396, 1512, 6789, 4834, 4839, 5509].

8  ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE  51

5211, 2827, 4814]. extended-precision [720, 6150, 4026, 632]. Extended-
Range [1456]. Extending [1486, 5245, 616, 3740, 6312, 6102, 1892, 4312].
Extensible [6228]. Extension [1260, 4293, 3851, 6987, 2651, 3868,
6512, 1732, 5911, 6904, 7114, 5719, 5162, 5163, 5164, 5520, 3770, 2731, 6914,
764, 918, 6823, 3156, 2271, 4098, 1935, 1469, 7104, 4299, 6658, 5585, 734,
4907, 2462, 4925]. Extensions [5121, 4301, 2043, 5477, 6167, 5188, 480,
5948, 3154, 2139, 3520, 7100, 1995, 5100]. Extent [1553, 17]. Extentions
[4586]. External [6757, 3473]. Extra [2177, 4857, 5137]. Extra-Precise
[4857, 5137]. Extracting [13, 36, 7071, 1444, 5084, 6852]. Extraction
[726, 158, 49, 637, 685, 5336, 4074, 5961, 3595, 4030, 1159]. Extractor
[2711]. Extracts [2579, 1397]. Extrapolation [6554, 3308, 6663]. extremal
[4583, 4727]. Extreme [2477, 2078].

F [5475]. F00F [3865]. F77 [3473]. F90 [3473]. Face [6933]. Face-off
[6933]. Facilities [4171, 826]. Facility [2102]. fact [3691]. Factor
[5238, 1822, 2812, 1976, 2745, 1437]. Factor-2 [5238]. Factorial
[2900]. factorising [603]. Factorization [6563, 5948, 6011, 2824, 6130, 4705, 2116, 3333, 4758, 5795]. Factorizations
[7129]. Factors
[6979, 2070, 6099, 2210]. fact
[3691]. Factorial-Base [2900]. FacMath [2514]. Fast
[4485, 6631, 6854, 3535, 4288, 4646, 5801, 377, 219, 3851, 5244, 6139, 2180,
6986, 3042, 3043, 5670, 3225, 3855, 2048, 6763, 1717, 6252, 2050, 953, 6648,
5683, 1583, 2335, 2336, 4321, 5482, 1383, 1587, 6657, 6658, 6659, 1018, 3991,
6505, 1594, 1828, 3060, 3238, 2680, 5491, 3240, 5395, 5897, 4522, 4523, 4821,
5902, 3420, 4003, 1831, 6397, 3070, 7009, 2522, 4997, 3425, 4180, 820, 4016, 6061,
1606, 3742, 1842, 1517, 1847, 1612, 556, 2077, 5516, 3888, 5294, 3604, 3756, 5593,
4853, 3606, 3608, 2715, 1299, 6536, 3445, 3272, 4035, 6414, 6291, 3448, 6177, 309,
5924, 4219]. Fast [4373, 2549, 2732, 1421, 3291, 3771, 1635, 3905, 5839, 6700,
1880, 5323, 5533, 1048, 5180, 1885, 2108, 5045, 3136, 4731, 2568, 6200, 6441,
5765, 7061, 6106, 6107, 7674, 5189, 5338, 1152, 918, 3655, 4415, 4592, 4735, 5857,
2779, 2780, 3800, 4082, 6581, 5342, 5067, 3805, 2794, 4603, 4906, 4430, 4746,
1676, 2140, 5442, 5548, 5627, 5861, 4096, 1542, 1165, 4915, 2461, 4441, 6459,
6592, 3175, 2742, 2464, 2602, 2605, 5026, 1182, 1692, 2154, 1072, 6021, 6461, 3356,
3357, 6362, 6844, 6963, 849, 324, 2839, 3018, 3369, 3370, 3529, 5228, 2166, 5373,
5374, 6024, 2841, 5965, 4478, 5233, 5234, 2852, 4814]. Fast [5269, 4282, 4933,
6363, 802, 3025, 2498, 952, 5811, 1496, 6379, 2055, 6772, 3418, 4823, 2883, 3066,
3874, 4004, 4529, 4015, 4839, 4979, 2216, 1739, 5509, 1971, 6405, 6406, 4198,
3260, 1214, 1295, 4202, 5518, 3268, 1410, 7027, 7028, 7118, 1619, 5304, 3613,


8

ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

55

5735, 6293, 5524, 5738, 5740, 5920, 5922, 6294, 6420, 4042, 4367, 3896, 5525,
1303, 1626, 1221, 2393, 6182, 6298, 6691, 255, 6300, 1627, 5925, 6183, 626,
344, 1223, 1307, 1416, 1986, 2233, 2915, 3763, 3897, 3898, 4214, 4368, 4557,
4857, 4858, 5019, 5409, 4371, 3765, 742, 745, 3286, 7035, 5306, 3287]. Floating
[1870, 5744, 2547, 6549, 1750, 890, 1041, 258, 2548, 3290, 5528, 827, 4222, 3458,
2409, 2922, 2923, 1138, 5311, 5312, 5836, 4380, 3772, 750, 751, 893, 1987, 4563,
895, 1045, 752, 6085, 5838, 5929, 3294, 6556, 6557, 6915, 6916, 6305, 6306,
4568, 4870, 6697, 6089, 6186, 6309, 6311, 5176, 1636, 6092, 5034, 2103, 349,
2419, 2742, 2744, 2931, 6188, 4571, 4872, 5037, 6189, 6314, 6559, 5753, 5754,
6811, 1528, 440, 5320, 5321, 7044, 7046, 6193, 1141, 6435, 2105, 5180, 5998,
6436, 831, 904, 1430, 570, 5755, 6194, 3298, 2936, 2937, 2247, 2426, 6322, 6565,
2748, 1889, 4886, 2557, 94, 6567, 1759]. Floating [639, 686, 2559, 5940, 3642,
979, 6439, 1640, 2755, 7052, 1642, 6196, 3129, 5848, 6815, 4582, 525, 576, 910,
1147, 3787, 5762, 402, 2564, 1148, 4402, 6925, 6328, 1998, 6329, 3474, 3138,
5614, 4403, 7056, 7124, 982, 2255, 5539, 5330, 3790, 449, 6003, 6004, 6332, 6333,
6334, 6576, 6577, 362, 2434, 5541, 1531, 1763, 6199, 641, 1895, 2117, 2258, 2438,
2439, 3143, 5055, 5618, 6201, 6442, 1437, 3918, 1151, 2118, 2767, 7066, 4410,
2445, 2446, 6444, 6580, 6710, 5943, 915, 5062, 5944, 6010, 3794, 5189, 5338,
7065, 3484, 2776, 4081, 3654, 3656, 3658, 3797, 3798, 4080, 5065]. Floating
[2571, 2964, 2572, 5946, 4417, 2779, 2780, 5424, 7068, 2003, 644, 1058, 1324,
2575, 2264, 4256, 6207, 645, 6716, 1156, 1234, 1326, 5948, 6011, 5622, 2128,
7073, 701, 4259, 4425, 6012, 2268, 2787, 2788, 3154, 2007, 6585, 5546, 837, 2791,
2975, 1772, 6116, 2584, 3157, 4903, 5623, 5431, 5432, 2008, 6449, 6450, 2274, 991,
2978, 2275, 1238, 3672, 921, 922, 6210, 2276, 993, 3160, 2277, 4608, 5624, 2278,
6212, 2799, 5072, 5440, 5441, 5626, 5953, 4265, 6719, 6455, 1540, 6346, 1679,
453, 1680, 6347, 3934, 3935, 5074, 1543, 4097, 2596, 1454, 1775, 4914, 5076, 5348,
2284, 4105, 4271, 4441, 4755, 5077]. Floating [5779, 7083, 4615, 5079, 2985,
1685, 7088, 1776, 5636, 5865, 2597, 3683, 4918, 2463, 269, 212, 2148, 2986, 2017,
5782, 1546, 2465, 787, 1686, 2807, 2992, 3180, 3181, 3182, 3345, 3688, 3689, 2289,
5958, 6220, 6955, 7094, 3346, 6121, 6122, 6597, 2020, 2021, 1689, 1690, 2997,
5959, 2603, 4919, 5207, 5208, 5209, 5210, 5445, 5446, 5447, 5448, 5449, 2811,
2998, 843, 1338, 1458, 1459, 1785, 5552, 3944, 3945, 5090, 1340, 2293, 4116, 2025,
5868, 4274, 6221, 3947, 1786, 5554, 2472, 2609, 2610, 3004, 5093, 5094, 1465,
5555, 6727, 1789, 5217, 5361, 3520, 4926, 6124, 6610, 4124, 592, 3350, 4458].
Floating [6353, 7097, 6020, 7098, 6460, 1072, 5362, 2027, 3830, 848, 5363, 5556,
2824, 3192, 3521, 2826, 6729, 3353, 6354, 2828, 2829, 1349, 5097, 1075, 5557,
5870, 3698, 1350, 3833, 3195, 6226, 6461, 6462, 2301, 3951, 215, 6362, 1469,
1701, 2619, 1702, 5103, 5226, 5370, 5371, 5564, 5565, 5647, 5650, 6464, 1556,
1354, 1471, 1472, 1473, 1474, 3955, 2033, 5791, 7101, 2034, 3013, 3014, 5963,
216, 3203, 2304, 6228, 2838, 4284, 6129, 134, 1797, 5229, 5964, 2627, 799, 1357,
3021, 1706, 3532, 5377, 5794, 4139, 948, 1941, 6734, 6848, 6849, 5966, 6625,
5110, 5568, 5654, 5111, 5378, 5235, 6627, 5584, 5701]. Floating [5898, 4627,
6357, 4282, 1937, 2173, 3378, 5379, 662, 2853, 1943, 1944, 6466, 3960, 1564,
5657, 6230, 3025, 3708, 3845, 5459, 5460, 6030, 6133, 6031, 720, 296, 1485, 2494,


8

ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

56

2636, 3031, 3216, 3383, 3384, 3385, 3386, 4491, 6368, 6475, 6476, 6981, 2495,
1085, 1010, 5662, 1800, 2314, 1801, 1802, 1362, 2316, 1569, 1570, 2041, 2317,
4785, 6137, 4148, 1487, 2498, 2863, 3039, 5574, 5884, 2043, 1368, 1807, 2181,
2499, 2182, 5885, 4303, 2045, 2321, 6986, 2645, 3223, 3041, 2322, 4306, 5245,
5246, 1091, 2183, 1370, 2325, 5810, 4790, 2500, 1190, 5126, 3855, 2326]. floating
[6247, 2327, 2187, 2648, 2649, 3047, 1813, 4311, 4506, 4656, 4793, 4794, 4795,
5127, 5249, 5973, 6249, 3720, 1716, 299, 2188, 666, 5252, 5576, 4314, 3856, 1015,
4798, 5387, 5577, 6994, 6995, 7110, 2189, 1016, 1193, 6377, 5814, 6650, 3228,
4975, 3559, 1815, 2191, 2658, 7111, 6379, 1954, 6495, 1377, 6496, 3404, 6256,
1378, 4805, 4976, 2663, 3230, 379, 1585, 6381, 3859, 4979, 1818, 2056, 2667,
3726, 3861, 5892, 1380, 1722, 2201, 2337, 4512, 5484, 3982, 3983, 5976, 4807,
4808, 3986, 1589, 5486, 5694, 6150, 4165, 2676, 1104, 1961, 3992, 4674, 4519,
421, 5489, 3415, 5696, 2344]. floating [2872, 2873, 2874, 3869, 3998, 3239,
6266, 2681, 6267, 5396, 5397, 959, 1276, 2683, 6391, 5979, 5702, 3061, 2880,
3243, 3419, 4525, 4679, 4820, 6154, 6052, 4001, 3063, 249, 4824, 5140, 5270,
4339, 961, 4528, 5585, 6665, 5142, 2518, 5275, 2519, 4989, 2350, 4172, 2884,
5276, 2206, 502, 1733, 1734, 2886, 5985, 4004, 1202, 5278, 5143, 5497, 734, 1116,
4995, 4177, 4178, 6903, 4689, 4690, 5588, 1512, 1968, 2362, 1736, 1969, 819,
508, 3740, 1204, 5285, 1029, 6272, 2892, 2366, 4838, 6670, 4696, 5824, 4697,
282, 3078, 3255, 4699, 4841, 3079, 2528, 621, 879, 1030, 1208, 1283]. floating
[1739, 3431, 2894, 3080, 1031, 2704, 1843, 5507, 1844, 2532, 1845, 5711, 2372,
4844, 4845, 1846, 5403, 5989, 6066, 6521, 1287, 2373, 252, 178, 3885, 2377, 1850,
4354, 4848, 3886, 2534, 4025, 6677, 6678, 3082, 4026, 5007, 3596, 5830, 7023,
4027, 4543, 4703, 6525, 2896, 2897, 3598, 6408, 3085, 3437, 3599, 1291, 1407,
1213, 1974, 3601, 2220, 3438, 1408, 1297, 3263, 3092, 4033, 2221, 4551, 2902,
2537, 3093, 2713, 5298, 5299, 1744, 2905, 6413, 6538, 6683, 5725, 2084, 5726,
516, 826, 1215, 2385, 5728, 681, 2387, 1218, 1863, 1746, 3278, 3611, 5161, 5162,
5164, 5520, 2224, 2225, 4037, 4554, 3610]. floating [1133, 1219, 1866, 2388,
4710, 5918, 2908, 4556, 5736, 5737, 1624, 3281, 5991, 6180, 6295, 6296, 6419,
201, 2088, 3614, 5992, 6423, 2228, 2913, 3104, 3282, 5993, 2230, 2397, 2398,
2231, 3105, 2092, 2093, 3452, 3617, 3618, 4213, 4215, 5596, 5742, 4712, 2917,
3284, 3454, 3620, 3285, 6083, 628, 473, 744, 2401, 2402, 2403, 2404, 746, 747,
1224, 2237, 2097, 1632, 311, 520, 4864, 4865, 2736, 1225, 1226, 2408, 2410, 2411,
1751, 1874, 1527, 1752, 5603, 6806, 3626, 3904, 4381, 3117, 3293, 4868, 5605,
2926, 3459, 5313, 829, 897, 973, 1993, 4225, 5930, 6087, 4869, 2553]. floating
[3295, 899, 975, 2928, 7041, 2243, 2244, 5932, 6428, 6308, 3907, 3908, 5840,
5177, 7121, 6191, 755, 2743, 2930, 3119, 4570, 5843, 6093, 5996, 5936, 4873,
3780, 4395, 4576, 351, 4578, 3911, 4874, 524, 571, 5609, 1757, 5324, 3633, 5610,
5938, 1638, 5326, 5327, 4233, 6000, 4876, 6566, 2249, 1050, 1995, 1313, 2943,
3640, 573, 640, 757, 758, 401, 688, 689, 574, 6001, 2251, 4878, 1996, 1997, 980,
909, 3128, 1434, 2563, 4583, 4727, 6100, 3131, 2253, 2114, 2758, 5049, 2254,
5329, 3137, 6704, 7055, 1646, 1647, 1648, 695, 2565, 5763, 5851, 3476, 5331,
4885, 5051, 5333, 5334, 5335, 5419, 5540]. floating [6928, 2566, 1999, 3917,
5054, 5421, 319, 1894, 2257, 2437, 2440, 2764, 3650, 6006, 2956, 2957, 917,


8

ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

58

1975, 970, 6534, 2540, 2714, 2904, 6173, 6290, 1300, 5302, 5831, 3891, 1131,
6176, 1618, 6539, 1860, 1861, 1862, 2086, 2087, 6540, 7030, 5163, 5732, 6685,
3098, 3099, 4205, 342, 5594, 6080, 5919, 5524, 5738, 5740, 5920, 5922, 6294, 6420,
4367, 3896, 5525, 1221, 6182, 6298, 6691, 1627, 5925, 6183, 344, 1223, 1307, 1416,
1986, 2915, 3763, 3897, 3898, 4214, 4368, 4557, 4857, 4858, 5019, 5409, 4371,
3765, 742, 745, 7035, 5306, 1870, 2547, 6549, 890, 1041, 3290]. Floating-Point
[5528, 827, 2409, 2923, 5311, 5312, 5836, 3772, 750, 751, 893, 1045, 5929, 3294,
6556, 6557, 6915, 6916, 6306, 6186, 6311, 6092, 5034, 2744, 6188, 4872, 5037,
6189, 6314, 6559, 5753, 5754, 1528, 440, 5320, 5321, 7044, 7046, 2105, 5180,
5998, 831, 904, 1430, 570, 5755, 6194, 3298, 2936, 2937, 2247, 2426, 6322, 2748,
4886, 2557, 6567, 639, 686, 2559, 5940, 6439, 1640, 2755, 7052, 5848, 6815, 4582,
525, 576, 1148, 3474, 5614, 4403, 7056, 7124, 982, 5539, 5330, 2434, 5541, 1763,
6199, 641, 1895, 2117, 2258, 2438, 2439, 3143, 5055, 5618, 6201, 6442, 1151, 2767,
2445, 2446]. Floating-Point [6444, 6580, 6710, 915, 5062, 5189, 5338, 2776,
4081, 3656, 3658, 3797, 2964, 5946, 2779, 2780, 5424, 7068, 2003, 644, 1324, 2575,
2264, 6716, 6011, 7073, 701, 4259, 6012, 2787, 2788, 3154, 6585, 5546, 4903, 5623,
5431, 5432, 6450, 2274, 2275, 1238, 3672, 921, 922, 6210, 2276, 993, 3160, 2277,
4608, 2278, 2799, 5072, 5440, 5441, 5626, 5953, 6719, 6455, 1680, 6347, 3935,
1543, 4097, 1454, 1775, 4914, 5076, 5348, 4441, 4755, 5077, 5779, 7083, 5079,
2985, 7088, 5636, 5865, 3683, 2463, 212, 2986, 2807, 2992, 3180, 3181, 3345, 3688,
3689, 2289, 5958, 6220, 6955, 7094, 6121, 6122, 6597, 2020]. Floating-Point
[2997, 2603, 4919, 1458, 1459, 1785, 5552, 5090, 1340, 5868, 1786, 5554, 2472,
2609, 2610, 3004, 1465, 5555, 6727, 1789, 3520, 4926, 6124, 6610, 4124, 592, 3350,
6353, 6020, 7098, 5362, 2027, 848, 5556, 2824, 3521, 2826, 6729, 3353, 6354, 5870,
3833, 3195, 6226, 6462, 2301, 215, 1469, 1701, 2619, 5103, 5226, 5370, 5371, 5564,
5565, 5650, 1354, 2033, 3014, 216, 3203, 2304, 6228, 5229, 2627, 799, 3021, 1706,
5377, 4139, 6848, 6849, 6625, 5110, 5568, 5654, 5111, 5378, 5235, 6627, 5701,
5898, 4627, 6357, 4492, 6976, 4487, 2171, 2172, 416, 3217, 1947, 4300, 6484, 2328,
6991, 6992, 1578, 1579]. Floating-point [1718, 5255, 6491, 4800, 4974, 2505,
6380, 2668, 2669, 2670, 5975, 6043, 1501, 1824, 2203, 2062, 3729, 5271, 4682,
1394, 4691, 2526, 2370, 307, 3748, 5153, 1296, 5519, 1298, 3894, 7031, 4210, 4209,
4042, 3286, 258, 2922, 4563, 895, 6085, 6305, 4568, 4870, 6697, 2419, 6811, 6435,
1759, 3642, 979, 3129, 6925, 6328, 2255, 3918, 2118, 2572, 5622, 2007, 2008, 6212,
3934, 4271, 4918, 2148, 2465, 2293, 2025, 4274, 6221, 7097, 3830, 5363, 3192,
2828, 2829, 1075, 3698, 1350, 6461, 1471, 1472, 1473, 1474, 5964, 6734, 5584,
1937, 2173, 3378, 2853, 3960, 1564, 6230, 5460, 6133, 720, 1485, 2636]. floatingpoint [3031, 3383, 3384, 3385, 4491, 6368, 6475, 2495, 1085, 5662, 1800, 2314,
1801, 1802, 6137, 4148, 2863, 3039, 5574, 5884, 5885, 2321, 6986, 2645, 2322,
4306, 5245, 5246, 2183, 2325, 5810, 4790, 5126, 2327, 2187, 2648, 3047, 1813,
4311, 4793, 4794, 5127, 5973, 6249, 3720, 2188, 5252, 5576, 4314, 1015, 4798,
5387, 5577, 6994, 6995, 2189, 1016, 1193, 6377, 5814, 6650, 3228, 4975, 2191,
7111, 6495, 1377, 3404, 4976, 1585, 6381, 4979, 2056, 2667, 3861, 4512, 3983,
3986, 1589, 5486, 5694, 6150, 1961, 3992, 4674, 5489, 2344, 2872, 2873, 2874,
3998, 6267, 5396, 5397, 2683]. floating-point [6391, 5702, 3061, 4525, 4001,



Floating-Point [1215, 5728, 2387, 1218, 1863, 1746, 3611, 5162, 5164, 5520, 2224, 2225, 4037, 1133, 1219, 1866, 4710, 5918, 2908, 5736, 5737, 1624, 5991, 6180, 6295, 6296, 6419, 5992, 2230, 2397, 3284, 3454, 3285, 628, 473, 744, 2401, 2402, 2403, 2404, 4864, 2736, 2408, 2410, 2411, 1527, 1752, 5603, 6806, 3626, 3904, 4868, 5605, 3459, 829, 897, 973, 4225, 5930, 6087, 4869, 2553, 3295, 7041, 2243, 2244, 5932, 6428, 6308, 3907, 3908, 5840, 6191, 755, 2743, 2956, 2957, 7062, 2443, 2444, 984, 4246, 4734, 2261, 3146, 6204, 3314, 3923, 6939, 4895, 5339, 5857, 6206, 480, 4248, 3148, 5340, 5544, 5858, 985, 5769, 986, 3802, 4087, 7071, 4740, 4898, 5770, 2265, 700, 989, 2266, 2970, 3804].


GAMM-IMACS

Additional Contributions From Nelson H. F. Beebe


Gaps [6290]. Gate [7466, 7483, 3251, 1042, 6185, 3124, 3465, 5640, 7451, 2826, 3125]. gatelfield [1702]. Gates [1778, 5551, 5351]. gating [4156, 6056].

gauge [2385]. Gauss [5662, 5475, 6266, 5284, 1630, 3623, 3135, 1693, 4933].

Gaussian [6135, 1807, 1813, 5135, 6159, 5715, 5829, 2734, 6586, 6950, 7080, 1541, 1461, 1924, 2024, 2030].

gave [6135, 1807, 1813, 5135, 6159, 5715, 5829, 2734, 6586, 6950, 7080, 2826, 3125].

General-Purpose [2671, 5295, 4878, 2431, 1530, 2432, 2257, 4746, 4285, 2311, 2684, 4933, 1210].

General [7365, 1807, 1813, 5135, 6159, 5715, 5829, 2734, 6586, 6950, 7080, 1541, 1461, 1924, 2024, 2030].

gave [6135, 1807, 1813, 5135, 6159, 5715, 5829, 2734, 6586, 6950, 7080, 2826, 3125].

Generalized [548, 1371, 1959, 6523, 2107, 1886, 2576, 581, 2137, 4109, 5094, 4458, 3699, 815, 6505, 5169, 2925, 3151, 1913, 2594, 4923, 4125, 4637, 4777, 6809].

Generators [5296, 7347, 749, 1905, 4430, 6124, 1467, 2479, 1352, 603, 2498, 300, 2671, 5295, 4878, 2431, 1530, 2432, 2257, 4746, 4285, 2311, 2684, 4933, 1210].

General-Purpose [5296, 7347, 749, 1905, 4430, 6124, 1467, 2479, 1352, 603, 2498, 300, 2671, 5295, 4878, 2431, 1530, 2432, 2257, 4746, 4285, 2311, 2684, 4933, 1210].


Generation [7572, 4640, 2312, 6245, 5383, 3724, 4320, 5693, 4819, 4994, 2215, 6519, 6169, 6278, 7574, 7581, 7583, 557, 6998, 2538, 7460, 6292, 7033, 343, 5597, 398, 4724, 5611, 4402, 982, 115, 4591, 5765, 2776, 4088, 4257, 5640, 6610, 1555, 1353, 5455, 717, 5229, 2646, 2200, 1727, 4001, 3432, 6677, 5999, 1759, 2563, 3919, 3659, 3152, 3675, 4934, 849, 3366, 2164, 3375, 4637, 4777].

Generative [6798, 7025]. Generator [6382, 5912, 6416, 6542, 6708, 6835, 3684, 6626, 1084, 952, 2676, 6417, 4873, 3680, 3177, 5583].

Generators [5798, 6042, 914, 2784, 6593, 3841, 4485, 3728, 3594].


Geometric [1717, 3403, 4527, 2379, 3655, 3302, 3164, 3683, 3974, 4314, 4051, 4224, 4383, 2741, 5041, 5329, 4411, 3336, 3682, 3816].

Geometrical [599]. géométrique [3974]. Geometry [7353, 7399, 7424, 4821, 3075, 4042, 5525, 5031, 4913, 7144, 3857, 3586, 2432, 7374, 4285].

Georg [1051]. George [44]. Georgia [7342, 7284, 7577, 7252]. German [2377, 2097, 547, 61, 2695, 390, 159, 3101, 1136, 3456, 751, 1229, 3463, 907, 2937, 835, 578, 3156, 1334, 107, 776, 653, 1166, 7207, 7363, 124, 800, 4481, 4776, 35, 273, 1468].

Germany [7365, 7366, 7313, 7387, 7528, 7503, 7402, 7486, 7433, 7199, 7436, 7351, 5475, 61, 7465, 7405, 7442, 7522, 7557, 7553].


Gets [1949, 6732, 5834]. Getting [2525, 2746, 4580]. gewisser [1811].

GF [4276, 3800, 4567, 6519, 4353, 4221, 4374, 4558, 4559, 4375, 2734, 4437,
ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE 65


Umwandlung
Hexadecimal-BCD
HGCD-D
Heuristics
High-Order
Heterogeneous
Heslington
High-Performance
3169
Heterogeneous
Hessington
Hessenberg
heterodyne
Heterogeneity
Hierarchical [6512, 4222, 7100, 7132, Hierarchy [4944, High [7384, 7497, 2631, 851, 1186, 3555, 5572, 5573, 2038, 3964, 4147, 1571, 4148, 2861, 4498, 4902, 5808, 5882, 6033, 3366, 4788, 1576, 6758, 1812, 4310, 5671, 1094, 2048, 6872, 2867, 6376, 6873, 6494, 3559, 5476, 5684, 3724, 4320, 729, 3980, 1585, 3858, 5975, 669, 4806, 6877, 1825, 4514, 3572, 3994, 3235, 6262, 6156, 2676, 5069, 1596, 4680, 3421, 3068, 3581, 5587, 5705, 3250, 125, 2071, 1395, 1396, 1511, 3253, 4182, 5706, 6789, 5503, 1840, 822, 4699, 93, 1517, 5712, 6063, 1402, 4354, 200, 339, 340, 5916, 4548, 4707, 5015, 1132, 1745, 1980, 2541, 7577, 2224, 4205, 5734, 3449.
high [5759, 2558, 50, 2945, 3137, 7145, 2565, 4406, 2958, 1153, 3314, 3799, 4736, 2778, 5856, 4084, 4250, 4739, 3152, 5344, 5770, 2580, 4744, 2585, 4904, 2008, 95, 3669, 1062, 1678, 5627, 3171, 3172, 1066, 2996, 5084, 1784, 3692, 1172, 3354, 5648, 6622, 2620, 2850, 3375, 2684, 2051, 2569.
High-Bandwidth [6873, High-Dimensional [6325, 6666]. High-end [1517, high-frequency [4861]. High-Level [1094, 6156, 1511, 4182, 7057, 993, 6730, 4148, 6872, 6432, 4588, 1696, 1062, 6355]. High-Order [2048, 3572, 1054, 3168, 3169]. High-Performance [7384, 1571, 5684, 3724, 4320, 3858, 4806, 5503, 5015, 4205, 6181, 5063, 5623, 5450, 6354, 5366, 5561, 5645, 6965, 6966, 6789,
8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE


8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

Additional Contributions from Nelson H. F. Beebe

Information [3846, 3227, 301, 7164, 3081, 7536, 3894, 7477, 4210, 5520, 5732, 6685, 1631, 7198, 7507, 7161, 7162, 5622, 7252, 6239, 6650, 7358, 2753, 5956, 5085, 5209, 5445, 5446, 5447, 5448, 5449, 1746, 3278, 3895, 4364, 5161, 7151, 7161, 7351, 7536, 3227, 301, 7164, 3081, 7536, 3894, 7477, 4210, 5520, 5732, 6685, 1631, 7198, 7507, 7161, 7162, 5622, 7252, 6239, 6650, 7358, 2753, 5956, 5085, 5209, 5445, 5446, 5447, 5448, 5449, 1746, 3278, 3895, 4364, 5161, 7151, 7161, 7351].

Informed [6818, 1942]. Ingénierie [3153]. ingenuity [4404].

Inherent [6742, 903, 355, 1660, 4529]. Inheritable [3649]. Inherited [6343].

Initial [4489, 385, 7165, 179, 3447, 3448, 902, 4078, 2360, 2523, 3743, 137, 138, 3761, 3339].

Initialized [3473]. iniziali [137, 138].

Injecting [5798]. Injection [5370]. Injection-Based [5370]. Inlining [4767].

Inn [7233].

Inner [1383, 3603, 6684, 5922, 5528, 1898, 1452, 1919, 595, 3065, 3107, 3108, 3110, 1920, 1697, 491, 2621].

Innocuous [3427, 6017]. innovation [7523]. innovations [3198]. Innovative [7169].

Input [6999, 1195, 1594, 1608, 6520, 7022, 753, 1904, 1547, 537, 2482, 1176, 1356, 1800, 2343, 1276, 1213, 1974, 3438, 5999, 2759, 3322, 3323].


Inquiry [3542, 3631]. Insecure [4466].

insertion [4895]. Insight [7445, 5375]. Insights [5171].

Insignificant [6004]. Insomniacs [5174].

Inspired [7532, 5788]. Instabilities [700].


Instinct [6856].

Institut [7199]. Institute [7342]. Instruction [6856, 4289, 4488, 6365, 2672, 5585, 5911, 6904, 1849, 2351, 2547, 5310, 5317, 5321, 988, 3928, 5379, 2635, 6475, 1110, 1391, 4339, 6393, 6397, 6158, 2376, 1850, 4026, 1224, 2265, 7077, 5867, 3528, 4941, 6518].

Instruction-Level [5321]. instruction-set [5379].

Instruments [61, 1015, 3189]. Insurance [33]. Integer [2634, 7108, 6984, 5382, 3040, 6481, 5124, 1951, 3046, 5248, 1814, 5387, 6996, 2331, 1817, 1955, 5392, 6502, 6043, 1821, 6385, 222, 4167, 3867, 224, 2346, 6390, 5897, 1021, 6053, 7009, 3071, 5587, 5705, 2889, 5502, 385, 5504, 4350, 5148, 5402, 5914, 4702, 6167, 6794, 6072, 6528, 6679, 2536, 3604, 3441, 740, 5739, 6548, 5527, 5311, 5312, 5351, 5752, 5935, 5040, 2108, 2109, 2250, 6573, 6579, 6818, 145, 3487, 2121, 3489, 4419, 1905, 7073, 4901, 1669, 2133, 6337, 1774, 2592, 4429, 6210, 2140, 6455, 6950, 7080, 3935, 4269, 7084, 4757, 2147, 588, 5091, 5093, 5217, 5361, 6839].

Integer [5363, 5364, 5785, 6223, 6356, 5099, 3361, 1253, 1076, 3530, 5653, 5818, 2180, 4790, 5814, 2657, 2193, 4160, 6505, 5395, 6894, 2206, 820, 3586, 5288, 2700, 2893, 2368, 5289, 6066, 4541, 4705, 6527, 7117, 3091, 5161, 2405, 5603, 4225, 5999, 4233, 2750, 4729, 7053, 5851, 6928, 6005, 6006, 7075, 1668, 6338, 2804, 3687, 5086, 2999, 4448, 4629, 5652, 3278].

Integer-Division [6548]. Integerarithmetik [2121].

Integers [6865, 18, 549, 811, 5263, 5264, 3057, 877, 6673, 5722, 3889, 4373, 3638, 3639, 2112, 1146, 6197, 5764, 1768, 4423, 1667, 4601, 7076, 530, 2015, 3948, 5563, 2305, 3209, 3376, 2320, 1826, 871, 3256, 5609, 5615, 5199, 2030, 4769].

integrable [4411]. Integral [547, 333, 1349, 282]. Integral-Ungleichun [547]. Integrals
[ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE]

integrands [5155]. Integrate [6921].


8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

Kind [6905]. Kingdom [7276]. Kingdom [7379]. Kit [2304, 2821].
Know [4329, 6775, 2821, 3014, 2]. Knowledge [5798].
Known [6998, 5908, 831, 4798]. Knuth [1505, 6119, 3839].
Kobe [7488].
Koblitz [5842, 5380, 5121, 5398, 4355].
Kolloquium [1484]. Komma [107]. komplexe [2051, 2100].
Kong [7458]. Können [1136]. Konrad [1379].
Konverter [3346]. Konvertierung [1975]. Konvertierungsroutinen [2481].
Konvolutionssumme [3156].
Korea [7403, 7509]. Koren [4668].
Krivine [6568, 6341].
Krylov [3551, 6903, 4273]. Kulisch [1671, 1672].
Kummer [6933]. Kutta [7112].
kvadratroden [1328].
KY [7457]. Kyoto [7575, 3192].

L [1483, 6764, 1671, 4785, 4979, 4992, 2389, 5043]. L-U [2389].
Laboratory [7137, 3550, 4093, 5105]. Lafayette [7330, 7393, 7480].
Lagrange [5122]. Lahey [3846]. Lake [7517, 7539]. Lakes [7467, 7526, 7393, 7409].
lambda [7123]. lambda-calculus [7123].
Lancaster [7280].
Lanczos [4018, 5185]. Land [6320].
Language [7282, 7468, 2857, 1101, 1728, 1389, 4327, 4328, 4329, 1511, 4186, 4348, 1400, 3747, 3265, 826, 2907, 3418, 6504, 3692, 5093, 5708, 5528, 6565, 3658, 5430, 5771, 5637, 6019, 3007, 6970, 4800, 3233, 3234, 6266, 5523, 4717, 4568, 4870, 5049, 5767, 3657, 3923, 3936].
Latency [7108, 4956, 4957, 3969, 3049, 4974, 6649, 6873, 5708, 5528, 6565, 3658, 5430, 5771, 5637, 6019, 3007, 6970, 4800, 3233, 3234, 6266, 5523, 4717, 4568, 4870, 5049, 5767, 3657, 3923, 3936].
Large-Number [25]. Large-Scale [7137, 5704, 1412, 1530, 6830, 3645, 7206].
Leaves [6504]. learn [3618]. Learned [3497]. learners [5066]. Learning
LEMA [5067]. L’empire [3593].


Look-Ahead [5218].

Look-Up [1742, 4196, 5059, 2123, 4426, 3827, 3436, 2663, 4019, 3946, 4943].

Lookahead [4159, 3460, 2001, 5232, 2662, 1899].

Looking [6563].

Lookup [5502, 4016, 6075, 5029, 5047, 5761, 2125, 2126, 6345, 3811, 1544, 998, 2814, 2815, 3860, 3433, 4035, 4856, 3322, 3323, 4085, 3152, 2035].

Lookup-Table-Based [6075].

Loop [3381, 3100, 7012, 5421, 2164, 3101].

Loops [3229, 4602].

LORIA [7498].

Losing [7087].

Loss [1513, 5622, 1512, 1968].

Lossless [5822, 7043, 7046, 5097, 2303, 3695].

Lossy [6495].

Lost [812, 5832, 6344].

L¨osung [1598, 4481, 4776].

Lottery [7087].

Louis [21, 7245].

Louisiana [7258, 7393, 7480].

Louisville [7226].

Lubbock [7233].

LUCAS [1658, 1470, 660].

Luigi [5877].

Luminy [7374].

LWE [7089, 6967].

LX [563].

LX-1 [563].

Lyapunov [6023].

Lyon [7453, 7368, 7564].

LZA [2537].

M [24, 3264, 4221, 4869, 4911].

M.I.R.A.C.L. [2285].

M68000 [1578, 1579].

MA [7467, 7573, 7271, 7158, 7194, 7257, 7538, 7240].

mac [4970, 5972, 6501, 6887, 7003, 5825, 6421, 6911, 5939, 6819, 4259, 6951, 4119, 4943, 2319].

MACHAR [2202].

Machin [4604].


Machine-Checked [4029].

Machine-Efficient [6997].

machine-independent [757].

Machinery [105, 86, 94, 7137].

Machines [7470, 5806, 7355, 1375, 81, 3741, 7029, 448, 7375, 7382, 7396, 7449, 7508, 7524, 77, 4622, 4313, 29, 40, 636, 72, 6104, 95,
Macro [4546, 3183]. Macro-Model [4546]. Macrocell [5256, 3918, 3841].
Macrocellular [869]. Macromodule [773]. Macros [1591]. Macsyma
[1076, 134, 3777]. Magnification [2160]. Magnitude [1090, 1871, 288, 583,
5352, 2883, 1878, 683, 2480]. Magnum [2625]. mail [3742]. main [378, 800].
[3512]. Major [6161, 3817]. Majority [4346, 6177, 6812]. Majority-Logic-
Decodable [4346]. majors [2811, 2998]. Make [6392, 5996, 5973, 1330, 3702].
[4171, 6513, 6897, 7015, 410, 3477]. Makuhari [7415]. malicious [6230]. Malo
[7253]. man [1328, 3938, 5639]. management [3038, 1696]. Managing
[127, 245]. Manifest [6768]. Manipulating [6691, 1238, 2378, 1332].
Manipulation [7190, 1070]. Manipulations [5296, 6188]. Manitoba
[2373, 7234]. Manticore [6988, 6848]. Mantissa [6675, 2282, 1794, 2928,
3319, 4898, 776, 1780, 941]. mantissas [2013, 2281, 2595]. Mantisse
[776]. Mantis [1794]. Manual [4492, 1946, 2176, 497, 2655, 301, 1273,
224, 958, 2067, 4659, 69, 3086, 1621, 1864, 1865, 834, 1895, 2117, 2258,
2438, 2439, 2441, 2995, 2987, 3510, 2151, 4456, 1467, 3363, 1477, 1085,
1010, 1091, 1380, 2514, 1133, 1219, 1525, 2114, 2946, 1894, 2437, 2440, 1161].
Many [6680, 437, 6549, 6044, 1624, 777, 5233]. many-core [6044]. Many-Term
[6680, 6549]. Map [5994, 5964, 3862, 3198]. MAPLD [7452]. Maple
[7335, 5416, 2867, 4971, 5394, 3600, 5344, 6949, 7378]. MAPM [4432].
March [1483, 7284, 7330, 7211, 7574, 7581, 7583, 7388, 7196, 7213, 7227, 7233,
7358, 7460, 7486, 7306, 7409, 7506, 7235, 7436, 7410, 7182, 7552, 7337, 7208].
[6230, 5669]. marks [2029]. Marriott [7409, 7377]. Marseille [7190]. Maryland
[7482, 7170, 7417, 3691, 721, 7170]. mashinnoi [1245]. mask
[4637, 4777]. Masking [3395, 2167]. MasPar [3550]. Massachusetts
[7167, 7424, 7279, 7291, 7316, 7317, 7491, 7494, 7422]. Massey [3084, 4607].
Massive [5802, 6282]. Massively [2502, 2887, 4181, 7347, 5599, 3511, 2645,
2646, 3253, 4183, 2981, 4912, 2347, 3242]. massively-parallel [2645, 4183,
2981]. master [7485]. Mastrovito [6317, 4117]. matched [909]. Matching
[2766, 4154]. Materialiensammlung [1484]. Math [5117, 6366, 6473, 3713,
3716, 1095, 1719, 3727, 3413, 3414, 3573, 553, 2526, 3742, 6905, 2529, 2083,
3089, 3090, 2090, 439, 4392, 6439, 2755, 2252, 4584, 1998, 3138, 5420, 3484,
3329, 2135, 4432, 7079, 2599, 2020, 2021, 5205, 5206, 2291, 3348, 2154, 6020,
3203, 3702, 5468, 2505, 2660, 4993, 2693, 2697, 4710, 2008, 1330, 1688, 1921,
3204, 7135, 6953]. Math-who [3089]. math.h [6753, 3631, 6431]. math.h
[7199, 4780, 1481, 4954, 5121]. Mathematica
ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

Mathematicians [7446, 4030]. Mathematics [7342, 7219, 7469, 4498, 5807, 7330, 6774, 3738, 2373, 7562, 1629, 4213, 4215, 6555, 7234, 7162, 2138, 7182, 2800, 7237, 2032, 2622, 7579, 718, 2308, 7171, 1377, 1839, 7346, 7472, 3616, 2753, 7145, 4074, 7199, 7324, 1796, 6851, 7346, 339, 340].


ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

Multiple
8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE


N 8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE 87

Multiply-by-Three [875]. multiply/addr [1704]. Multiplying [1587, 3523, 2309, 3376, 4685, 3368].

Multiply-by-Three [875]. multiply/addr [1704]. Multiplying [1587, 3523, 2309, 3376, 4685, 3368].

Multiply-by-Three [875]. multiply/addr [1704]. Multiplying [1587, 3523, 2309, 3376, 4685, 3368].

Multiply-by-Three [875]. multiply/addr [1704]. Multiplying [1587, 3523, 2309, 3376, 4685, 3368].

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Multiply-by-Three [875]. multiply/addr [1704]. Multiplying [1587, 3523, 2309, 3376, 4685, 3368].

Multiply-by-Three [875]. multiply/addr [1704]. Multiplying [1587, 3523, 2309, 3376, 4685, 3368].
8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

918, 3485, 2777, 1439, 3489, 3320, 3321, 4418, 4594, 2576, 4088, 4257, 987, 1155, 766, 1906, 3327, 3156, 3492, 1673, 6826, 1911, 6828, 1539, 5862, 708, 454, 484, 6217, 3337, 1916, 531, 785, 2147, 2295, 5869, 938, 2028, 1250, 6612, 2829, 2158, 6361, 5647, 3527, 3018, 706, 4636.

Number [597, 3021, 7171, 2630, 3208, 3379, 3380, 4948, 4949, 4485, 1710, 4291, 4644, 3538, 2638, 2315, 3850, 4649, 5880, 4782, 4642, 3579, 2178, 1088, 1261, 1488, 2043, 4154, 3854, 5576, 6254, 3976, 3722, 4661, 937, 1247, 5359, 3947, 2471, 2295, 5869, 938, 2028, 1250, 6612, 2829, 2158, 6361, 5647, 3527, 3018, 706, 4636.

number [2700, 2893, 2368, 3883, 5588, 226, 2369, 2371, 2705, 252, 1034, 1209, 2375, 2376, 1168, 6723, 4619, 4622, 2605, 937, 1247, 5359, 3947, 2471, 2295, 5869, 938, 2028, 1250, 6612, 2829, 2158, 6361, 5647, 3527, 3018, 706, 4636.

Number-Theoretic Numbers [7453, 7498, 664, 1012, 4153, 39, 5124, 1492, 1492, 1094, 6374, 2503, 550, 5889, 6145, 3558, 6499, 6500, 7386, 4510, 1382, 2511, 6657, 331, 1388, 1107, 1828, 1829, 4331, 156, 6783, 4827, 6514, 672, 1206, 4836, 7465, 55, 877, 1515, 3744, 6673, 54, 3747, 6170, 7022, 2710, 558, 559, 41, 1211, 2536, 6796, 1975, 2540, 2714, 2904, 6174, 6176, 4206, 342, 5919, 6184, 6301, 4561, 7039, 1635, 6085, 260, 1528, 5534, 638, 685, 5848, 6570, 446, 2947, 4403, 2255, 3477, 6003, 115, 6007, 7059, 1151, 2779, 2780, 367, 4601, 1448, 3806, 1238, 6831, 185, 3934, 4913, 2147].

Numbers [6595, 2603, 4919, 5358, 3823, 3521, 1698, 3359, 6464, 6732, 1470, 1256, 5965, 948, 1078, 4944, 6778, 5238, 3960, 6133, 3384, 4967, 2326, 3559, 4902, 6379, 5689, 5131, 2668, 2669, 2670, 5894, 4807, 4808, 2343, 5585, 2833, 5275, 3734, 2688, 2689, 2698, 2367, 137, 1403, 2373, 307, 2378, 1614, 6071, 4543, 4703, 5404, 1214, 1295, 138, 6172, 3271, 681, 1623, 256, 2097, 2735, 2920, 4866, 5028, 3459, 5313, 1993, 2928, 6308, 4062, 5609, 6566, 2251, 6196, 3129, 1634, 2946, 1318, 3645, 3478, 3303, 363, 5617, 2764, 3650, 8, 4741, 4258,
ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE


Optimale [750, 751, 893, 107].

Optimalen [1493].

Optimaler [1210, 1061, 1789, 1352].

Optimisation [4838].

Optimised [4423].

Optimistic [5306].

Optimization [3555, 6880, 6156, 6664, 7460, 3624, 6303, 6916, 977, 4586, 3487, 4595, 3152, 6823, 6583, 3671, 5778, 3686, 5562, 2662, 2344, 2683, 3881, 4009, 2704, 5007, 6799, 5598, 2403, 7062, 5339, 3334, 6018, 6218, 7086, 7460].

Optimizations [3967, 3430, 4184, 6185, 4608, 4476, 4658, 5767, 6204].

optimize [5840, 6351].

Optimized [4780, 3706, 6478, 6667, 6900, 5591, 4194, 6549, 6190, 6315, 6097, 2766, 6443, 6579, 7126, 7067, 7068, 5948, 7089, 5636, 6841, 3659, 5768, 4916, 3241].

Optimizing [5397, 6160, 508, 2364, 1848, 6277, 5990, 5300, 2554, 5036, 3300, 4891, 5197, 3348, 6839, 3241].

Optimum [851, 3536, 333, 5173, 2158, 2727].

Options [966, 1032, 2135, 2311].

Optoelectronic [4181, 6943, 3782].

Oracle [6973].

Oracle-free [6973].

Orbit [2586].

Orbits [7038].

Order [2631, 7354, 2048, 7426, 3572, 4822, 93, 3605, 4367, 1643, 1054, 6933, 2964, 3671, 1912, 4097, 4101, 6596, 2992, 74, 3041, 6375, 2349, 249, 3085, 5295, 3619, 1436, 4732, 3801, 4497, 4274, 3830, 3011, 3528, 2626].

Ordered [1259, 5849].

Ordering [2277, 3069, 2927].

Ordinary [7165, 179, 4078, 5151, 6681, 364].

ordinateur [3153].

Ordinateurs [486, 4505, 5812, 6254].

Ordnance [7137].

Orecan [7534, 7576, 7236].

Oregone [7213, 7531, 6601, 4453, 1507, 1129, 1743, 2535, 3957, 4542, 206].

organizations [1852].

organized [7164, 7161].

Organizing [6821, 6889].

Organalist [1321, 1166, 1466].

orientation [6206].

Oriented [7192, 3989, 1025, 5280, 6668, 4207, 3791, 2949, 2776, 1236, 4473, 1995, 4732, 846, 3829].

origin [400].

original [3970, 3296].

Origins [5715, 5829, 7175, 7203, 703, 704, 769, 990, 1235].

Orlando [7526, 7311, 7261, 7264, 7523, 7208].

Orleans [7299, 7258, 7213].

Orthogonal [2143, 372, 4499, 3576, 3875, 4633, 4634].

Orthogonality [1524, 2808].

Orthogonalization [4380, 5002].

Orthonormal [3756].

OS/360 [562, 504, 439].

Oscillations [1054, 1276, 3743, 744, 1436].

oscillator [2853].

Osnovy [1245].

OSR [3981].

osservati [137].

Other [622, 1399, 1135, 6574, 3656, 3797, 7144, 4213, 4215, 235, 2773, 3322, 3323, 4113, 3918].

otsenochnoi [2323].

Our [14, 7287, 4721].

Out-of-Order [4367, 4097].

out-of-order-execution [3528].

Outer [3603, 4109].

outline [3992, 4634].

Output [1195, 1608, 5347, 1547, 537, 2482, 1878, 319, 3322, 3323, 6342, 1356].

Outputs [697].

Over-Redundant [6054, 3306, 3305, 3819].

Over-Relaxation [314].

Over-the-air [4552].

Over/Underflow [344].

overestimation [5345].


Overflow-Free
8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

8

ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

97

Place [7212, 7317, 6116, 3260]. placement [3536]. Places [1630]. plain
[2586]. Planning [246, 63, 64, 65, 66, 67, 68]. PLAs [1180]. Platform
[4646, 5776, 4623]. platforms [5191]. PLAUs [7059]. Plaza [7238]. pLiner
Point [2039, 6982, 3958, 2631, 5797, 2036, 6468, 4640, 4951, 5239, 5798, 6027,
6132, 6632, 4486, 5570, 4641, 3843, 6855, 6978, 4489, 4952, 217, 3962, 5658,
6231, 6470, 6979, 6232, 5876, 1484, 2854, 2855, 2856, 3026, 3027, 3028, 3029,
3030, 3213, 3214, 3215, 3541, 4646, 5118, 5120, 6032, 6367, 6369, 6638, 6980,
5802, 5660, 5661, 5804, 5805, 169, 1803, 5121, 5881, 6753, 2318, 4962, 1367,
1808, 3390, 5972, 1012, 3391, 3392, 3969, 4150, 4151, 4152, 1949, 4500, 2324,
4307, 1950, 4787, 6756, 1576, 2501, 3719, 5672, 860, 1014, 1094, 2047, 2651,
2866, 4507, 4508, 5250]. Point [5470, 5674, 5886, 6038, 6039, 6040, 6374, 6646,
6759, 3398, 3399, 3400, 2050, 6041, 2503, 2051, 727, 2330, 5889, 6145, 1266,
1267, 1376, 4316, 6378, 6649, 7000, 3558, 6494, 5476, 247, 864, 5686, 171, 3229,
3405, 1497, 1498, 5390, 5130, 6653, 2661, 1583, 5578, 2665, 3564, 4321, 5479,
5815, 6876, 1270, 6258, 6385, 3984, 1724, 2511, 730, 1196, 1385, 1502, 1725,
2341, 3055, 3987, 6149, 3989, 1197, 1198, 1274, 1387, 1726, 5895, 3866, 3993,
5133, 5265, 5487, 5488, 2871, 4324, 3413, 3414, 3573, 2061, 3416, 6156, 6152,
3574, 3868, 3870, 4329, 6775, 2346, 2515, 2516, 6662, 3999, 4000, 4331]. Point
[2205, 4818, 616, 2348, 2881, 3244, 4338, 4524, 4526, 4678, 4821, 5901, 5902,
6050, 6780, 6155, 1964, 6895, 5273, 1731, 5141, 6511, 5398, 3735, 4342, 6897,
6783, 1965, 2065, 501, 6158, 3878, 1732, 2885, 2887, 1967, 5400, 504, 1833, 6399,
6901, 6668, 4530, 5281, 5499, 3424, 3739, 4010, 4176, 3251, 5500, 1837, 6161,
2212, 1278, 6786, 6787, 962, 1511, 3425, 1203, 6516, 1513, 6162, 5589, 4182,
7014, 2214, 6517, 4999, 5822, 1279, 2215, 2891, 6273, 4532, 2699, 5707, 4347,
3254, 3742, 227, 228, 1607, 1970, 5505, 823, 877, 4022, 880, 1284, 6792, 1740,
2702, 2703, 4700, 965, 5402]. Point [5914, 6274, 6672, 966, 1032, 3884, 1402,
1609, 6673, 4351, 4540, 5510, 306, 677, 2218, 2219, 2374, 1848, 1849, 4188, 7021,
5716, 5717, 2709, 6169, 6278, 6279, 6280, 6283, 6794, 7114, 4849, 341, 969, 391,
392, 3435, 4029, 4191, 4192, 5293, 3888, 6526, 2536, 1035, 3602, 3087, 6796,
5593, 1615, 1975, 435, 6680, 4360, 970, 6534, 2538, 5723, 2540, 2714, 2904, 6173,
6682, 6290, 1300, 1409, 5302, 5831, 3891, 1131, 6176, 1618, 5158, 6539, 1860,
1861, 1862, 2086, 2087, 6540, 7030, 5163, 5732, 6685, 3098, 3099, 4205, 3276,
342, 1864, 5160, 6292, 5594, 6080, 2909, 5919]. Point [3100, 3101, 5735, 6293,
5524, 5738, 5740, 5920, 5922, 6294, 6420, 4367, 3896, 5525, 1303, 1626, 1221,
2393, 6182, 6298, 6691, 255, 6300, 1627, 5925, 6183, 344, 1223, 1307, 1416, 1986,
2233, 2915, 3763, 3897, 3898, 4214, 4368, 4557, 4857, 4858, 5019, 5409, 4371,
3765, 742, 745, 7035, 5306, 1870, 5744, 2547, 6549, 1750, 890, 1041, 5308, 3290,
5528, 4375, 827, 4222, 3458, 2409, 2923, 5311, 5312, 5836, 4380, 3772, 750, 751,
893, 1045, 752, 5838, 5929, 3294, 3906, 6556, 6557, 6915, 6916, 6306, 6089, 6186,


8

ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

98

6309, 6311, 5176, 6430, 1636, 6092, 5034, 2103, 2742, 2744, 2931, 5842, 6188].
Point [4571, 4872, 5037, 6189, 6314, 6559, 5753, 5754, 4392, 1528, 440, 5320,
5321, 7044, 7046, 6193, 1141, 2105, 5180, 5998, 6436, 831, 904, 1430, 570, 5755,
6194, 3298, 2936, 2937, 2247, 2426, 6322, 6565, 2748, 4886, 2557, 6567, 639, 686,
2559, 5940, 6439, 1640, 2755, 7052, 1642, 5848, 6815, 4582, 525, 576, 3787, 402,
2564, 1148, 4402, 1998, 6329, 3474, 3138, 5614, 4403, 6440, 7056, 7124, 982, 5539,
5330, 3790, 449, 6003, 6004, 6332, 6333, 6334, 6576, 6577, 362, 4405, 4590, 2434,
5541, 1531, 1763, 6199, 641, 1895, 2117, 2258, 2438, 2439, 3143, 5055, 5618, 6201,
6442, 1151, 2767]. Point [7066, 4410, 2445, 2446, 6444, 6580, 6710, 5943, 915,
5062, 5944, 6010, 3794, 5189, 5338, 7065, 3484, 2776, 4081, 3654, 3656, 3658,
3797, 3798, 5065, 2571, 2964, 5946, 4417, 2779, 2780, 5424, 7068, 2003, 644,
1058, 1324, 2575, 2264, 4419, 4596, 4256, 6207, 6716, 1156, 1234, 1326, 5948,
6011, 2128, 7073, 701, 4259, 4425, 6012, 2787, 2788, 3154, 3665, 6585, 5546,
2791, 2975, 1772, 2584, 3157, 4903, 5623, 5431, 5432, 6449, 6450, 2274, 991,
2275, 1238, 3672, 921, 922, 6210, 2276, 993, 3160, 2277, 4608, 5624, 2278, 2799,
5072, 5440, 5441, 5626, 5953, 4265, 6719, 6455, 1540, 6346, 1679, 453, 1680].
Point [6347, 5778, 3935, 5074, 1543, 4097, 2596, 1454, 1775, 4914, 5076, 5348,
2284, 4105, 4441, 4755, 5077, 5779, 7083, 4615, 5079, 2985, 7088, 1776, 5636,
5865, 2597, 3683, 2463, 269, 212, 2986, 2017, 5782, 1686, 2807, 2992, 3180, 3181,
3182, 3345, 3688, 3689, 2289, 5958, 6220, 6955, 7094, 3346, 6121, 6122, 6597,
2020, 2021, 1689, 2997, 5959, 2603, 4919, 843, 1338, 1458, 1459, 1785, 5552,
3944, 3945, 5090, 1340, 4116, 5868, 3947, 1786, 5554, 2472, 2609, 2610, 3004,
5093, 5094, 1465, 5555, 6727, 1789, 5217, 5361, 6609, 3520, 4926, 6124, 6610,
4124, 592, 3350, 4458, 6353, 6020, 7098]. Point [6460, 1072, 5362, 2027, 848,
5556, 2824, 3521, 2826, 6729, 3353, 6354, 1349, 490, 5097, 5870, 6615, 3833, 3195,
6226, 6462, 2301, 3951, 6731, 215, 6362, 1469, 1701, 2619, 5103, 5226, 5370, 5371,
5564, 5565, 5647, 5650, 6464, 1556, 1354, 2033, 5791, 7101, 3013, 3014, 5963,
216, 3203, 2304, 6228, 4284, 6129, 1797, 4471, 5229, 2627, 799, 3021, 1706, 3532,
5377, 5794, 4139, 948, 1941, 6848, 6849, 5966, 6625, 5110, 5568, 5654, 5111, 5378,
5235, 6627, 5701, 5898, 6049, 6778, 4627, 6357, 4282, 2173, 4492, 3378, 5379, 662,
2853, 2632, 1943, 1944, 6466, 6976, 3960, 1564, 4487, 5657, 6230, 3025]. point
[2171, 2172, 3708, 3845, 5459, 416, 5460, 3538, 6030, 6133, 6031, 720, 296, 1485,
2494, 2636, 3031, 3216, 3217, 3383, 3384, 3385, 3386, 4491, 6368, 6475, 6476,
6981, 2495, 1085, 1010, 1947, 2040, 5662, 1800, 2314, 1801, 1802, 1362, 2316,
1569, 1570, 2041, 2317, 4785, 6137, 4148, 4300, 1487, 2498, 2863, 3039, 5574,
5884, 2043, 1262, 1368, 1807, 2181, 2499, 2182, 1809, 5885, 4303, 2045, 2321,
6986, 2645, 3223, 3041, 2322, 4306, 5245, 5246, 1091, 2183, 1370, 2325, 5810,
4790, 2500, 1190, 5126, 3855, 2186, 2326, 6247, 6484, 2327, 2187, 2328, 2648,
2649, 3047]. point [1813, 4311, 4506, 4656, 4793, 4794, 4795, 5127, 5249, 5973,
6249, 6991, 3720, 6992, 1578, 1579, 1716, 299, 2188, 1718, 666, 5252, 5576, 4314,
3856, 1015, 4798, 5255, 5387, 5577, 6994, 6995, 7110, 2189, 1016, 1193, 6491,
4800, 4974, 6377, 5814, 6650, 3228, 4975, 3559, 2505, 1815, 4801, 2191, 2658,
7111, 6379, 6380, 1954, 6495, 1377, 6496, 3404, 6256, 1378, 4805, 4976, 2663,
3230, 379, 1585, 2664, 6381, 3859, 4979, 1818, 2056, 2667, 3726, 3861, 5892,


8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

1380, 1722, 2201, 2668, 2669, 2670, 5975, 6043, 2337, 3052, 4512, 5484, 3892, 3053, 3983, 5976, 4807, 4808, 3986, 1501, 1589, 1824.

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1380, 1722, 2201, 2668, 2669, 2670, 5975, 6043, 2337, 3052, 4512, 5484, 3892, 3053, 3983, 5976, 4807, 4808, 3986, 1501, 1589, 1824.

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8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE


point [2797, 2978, 2589, 2266, 2970, 2267, 3804, 7074, 2268, 2269, 2581, 3328, 2007, 526, 7075, 3495, 2270, 837, 7136, 2585, 2793, 2977, 4904, 2008, 2273, 3331, 4090, 5773, 2453, 2588].

point [3940, 5203, 1546, 2465, 787, 4113, 4443, 6722, 3817, 2468, 1688, 1921, 2996, 4618, 1690, 2290, 1169, 2469, 2470, 4444, 4445, 4620, 5084, 5085, 5086, 5207, 5208, 5209, 5210, 5211, 5212, 5353, 5354, 5355, 5356, 5445, 5446, 5447, 5448, 5449, 2811, 2998, 2459, 3933, 3934, 5633, 3675, 3335, 776, 2013, 2281, 2595, 2142, 7082, 4912, 6018, 780, 709, 710, 3172, 3814, 4106, 4754, 5549, 3936, 4271, 4442, 4916, 4917, 5780, 3938, 3680, 2801, 2802, 2983, 2984, 2803, 1685, 3342, 483, 4910, 926, 3343, 3178, 3508, 2016, 3509, 2148, 1065.

point [4281, 2029, 941, 6355, 2828, 2829, 4930, 4931, 715, 794, 3696, 1075, 5557, 1793, 2617, 2478, 2480, 3698, 4461, 4462, 1350, 2031, 6461, 5224, 1351, 2831, 2161, 492, 2483, 849, 1702, 3953, 2486, 3009, 4771, 4936, 5225, 5372, 5790, 6023, 2163, 2487, 1795, 1471, 1472, 1473, 1474, 1703, 1355, 1796, 540, 541, 542, 3955, 2163, 2303, 5104, 795, 2034, 2488, 2489, 1255, 294, 1704, 2164, 3204, 3368, 1938, 1559, 2306, 2838, 2490, 1356, 2623, 2624, 4132, 5228, 1798, 1560, 4939, 5231, 5567, 5792, 5964, 947, 2626, 4134, 4285, 4940, 4941, 7104, 5793, 598, 797, 1357, 2843, 6968, 194, 2845].

Point-Targeted [6901].

Point/Target [6901].

Point/Integer [2346].

Point/logarithmic [2296].

Pointers [3484].

Points [2051, 5813, 5740, 3665, 3960, 6996, 3647].

Poisoning [6855].

Poland [7430, 7579].

Polar [6623].

Polish [457].

Pollard [2116].

Polyhedra [4005].

Polyhedron [3603, 4031].

Polymath [1321].

Polymorphic [901].

Polynomapproximation [768].

Polynome [1061].


polynomial [3022, 1252, 4594].

Polynomials [5969, 6478, 4796, 420, 4322, 4003, 5983, 5280, 304, 6168, 1228, 3136, 766, 1456, 241, 2162, 4657, 4977, 5397, 4823, 6397, 6157, 1510, 1126, 1738, 4846, 5403, 1037, 6413, 6538, 6683, 259, 284, 4573, 1429, 6336, 6445, 2786, 5775, 6348, 192, 193, 4479, 6048, 768, 1061].

Polyphase
8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE


Portland [7534, 7576, 7277, 7584, 7236]. Porto [7512, 7552]. Portugal [7455]. PosAx [6909]. PosAx-O [6909]. Posit [6977, 6742, 6651, 6652, 6497, 6382, 6655, 6386, 6657, 6659, 6877, 6878, 6887, 7003, 7010, 6900, 6902, 7017, 6792, 6279, 6280, 6281, 6798, 6412, 6909, 6416, 6542, 6802, 7034, 6911, 6807, 7040, 6430, 6699, 6432, 7043, 7047, 6564, 6813, 7050, 6921, 6922, 6923, 6924, 6708, 6819, 6931, 6932, 7057, 7058, 7059, 7060, 6712, 6713, 6822, 6938, 7067, 7069, 6945, 6948, 6591, 6826, 6827, 6831, 6948, 6591, 6833, 6834, 6952, 6720, 6835, 7091, 6954, 6957, 6727, 6611, 6840, 6612, 6845, 6964, 6733, 6626, 6735, 6850, 7105, 6972, 6613, 6771, 6905, 6417, 6709, 7090, 6805, 6717, 6728].


8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

Proceedings [7420, 7182, 7293, 7268, 7463, 7525, 7176, 7338, 7339, 7573, 7178, 7297, 7296, 7209, 7553, 7182, 7293, 7268, 7463, 7525, 7176, 7338, 7339, 7573, 7178, 7297, 7296, 7209, 7553, 7171, 7252, 7467, 1979, 7510, 7527, 7299, 7532, 7365, 7366, 7342, 7210, 7312, 7454, 7512, 7368, 7187, 7428, 7357, 7544, 7440, 7576, 7535, 7456, 7222, 7164, 7502, 7402, 7389, 7226, 7134, 7370, 7404, 7416, 7442, 7458, 7459, 7474, 7475, 7486, 7489, 7504, 7515, 7519, 7549, 7550, 7262, 7151, 7306, 7406, 7381, 7250, 7264, 7215, 7263, 7372, 7198, 7349, 7335, 7446, 7336, 7407, 7418, 7447, 7461, 7478, 7394, 7448, 7145, 7235, 7350, 7230, 7436, 7173, 7321, 7322, 7204].

Proceedings [7420, 7182, 7293, 7268, 7463, 7525, 7176, 7338, 7339, 7573, 7178, 7297, 7296, 7209, 7553, 7171, 7252, 7467, 1979, 7510, 7527, 7299, 7532, 7365, 7366, 7342, 7210, 7312, 7454, 7512, 7368, 7187, 7428, 7357, 7544, 7440, 7576, 7535, 7456, 7222, 7164, 7502, 7402, 7389, 7226, 7134, 7370, 7404, 7416, 7442, 7458, 7459, 7474, 7475, 7486, 7489, 7504, 7515, 7519, 7549, 7550, 7262, 7151, 7306, 7406, 7381, 7250, 7264, 7215, 7263, 7372, 7198, 7349, 7335, 7446, 7336, 7407, 7418, 7447, 7461, 7478, 7394, 7448, 7145, 7235, 7350, 7230, 7436, 7173, 7321, 7322, 7204].
1410, 516, 2408, 2410, 2411, 3262, 2741, 2423, 2427, 2562, 3128, 2563, 1646, 1999, 2257, 2437, 3164, 4615, 6353, 97, 151, 1558, 6224, 5973, 1593, 6264, 4991, 7012, 5824, 3437, 3599, 3452, 2234, 5606, 2554, 6829, 6018, 3367, 3895.

**Programmierzeichen** [1094]. **Programmierende** [888]. **programm** [5184]. **Programmiersprachen** [1094]. **Programmierung** [3115, 3115]. **Programm** [7185, 7254, 7271, 7282, 7468, 2857, 2631, 6246, 7367, 6989, 1094, 172, 4329, 157, 4182, 6058, 3587, 4186, 1400, 3265, 3894, 4210, 5520, 6298, 1524, 2725, 4370, 5599, 3115, 1312, 7188, 6438, 4234, 6323, 445, 3301, 2953, 2954, 2771, 3155, 7204, 6119, 7128, 2921, 3184, 3833, 942, 2619, 325, 4471, 493, 6229, 3963, 4299, 1091, 300, 1507, 6272, 2906, 5162, 5163, 5164, 7248, 2404, 2422, 316, 2760, 2570, 1161, 486, 488, 147, 1248, 5095, 3367, 3016, 3373, 7378, 3895]. **Programmpaketes** [1885]. **Programms** [6753, 2860, 3035, 1714, 1373, 5250, 5470, 5675, 6038, 6043, 2674, 2675, 7005, 6897, 6273, 7037, 2436, 642, 5855, 4434, 3164, 4615, 6353, 97, 151, 1558, 6224, 5973, 1593, 6264, 4991, 7012, 5824, 3437, 3599, 3452, 2234, 5606, 2554, 6829, 6018, 5444, 2292, 6351, 6973]. **Progress**
2087, 5729, 5303, 6418, 6179, 6811, 2393, 3114, 6084, 630, 5929, 5930, 3461, 4385, 4718, 5315, 4064, 6701, 1883, 6318, 7048, 3467, 3472, 1146, 3222, 4304, 1713, 4310, 4318, 2510, 3994, 423, 2524, 3073, 2361, 3582, 3431, 7024, 3444, 2386, 2227, 2913, 3104, 3282, 889, 2735, 2927, 2929, 4058, 3462, 1760, 2435, 2762, 2952, 3142, 3479, 4077, 2778, 5856, 4084, 4249, 4250, 4739, 4599, 4743, 4744, 2977, 5439, 3168, 3169, 3171, 3172, 5078, 3517, 2813, 3003, 1172, 3835, 5566, 5648, 2842, 1746, 1568, 2506, 1725, 1824, 6054, 2523, 1605, 1613, 5011, 4385, 4718, 3494, 4440, 1932, 4453, 6021, 3527, 3532, 4304, 4318, 3994, 2524, 3431, 3444, 3462, 1760, 3479, 4077, 2813, 3003.


2357, 2359, 2360, 2523, 2690, 3249, 4684, 4830, 2361, 1971, 1406, 3595, 4190, 4850, 4704, 5721, 4197, 4198, 4030, 3091, 3444, 625, 739, 4036, 5730, 3761, 2724.

root [3280, 2090, 3106, 3287, 3905, 2929, 4077, 4080, 4895, 1328, 2005, 4899, 3495, 1668, 1159, 4604, 3931, 3932, 4094, 6456, 4612, 781, 3170, 3172, 3507, 2469, 2470, 5448, 291, 188, 4275, 1463, 4277, 5453, 5216, 4279, 78, 84, 4461, 6463, 4771, 3019, 5795, 4480, 4945, 4287, 2046, 1834, 6025].

Root-Finding [1834].

Rooting [1187, 1583, 1115, 1207, 2536, 120, 1887, 359, 702, 3561, 3980, 2510, 3994, 4168, 2890, 3612, 2400, 3901, 3464, 2255, 2567, 4085, 2132, 2035, 3017].

Roots [4639, 3535, 5807, 18, 548, 549, 1094, 809, 5678, 5684, 1952, 812, 3561, 3980, 2510, 3994, 4168, 2890, 3612, 2400, 3901, 3464, 2255, 2567, 4085, 2132, 2035, 3017].

Ropes [5471].

Rostock [7387].

Rotation [4147, 2070, 2706, 3756, 3096, 5743, 2210, 5711, 5408].

Rotation/Vectoring [4147].

Rotations [3735, 6283, 3756, 4282, 6763, 294].

Rotator [3387, 2684].

Rotators [4598].

Rotten [2774, 2775].

Round [602, 6870, 6250, 6759, 608, 864, 1199, 277, 6158, 7112, 881, 4541, 6173, 6174, 5730, 473, 5747, 5836, 5933, 204, 205, 2748, 314, 6098, 6325, 4402, 6013, 6121, 6122, 6597, 4122, 6353, 1936, 3521, 4128, 4281, 1182, 1185, 2171, 1582, 955, 3996, 422, 4811, 4812, 961, 3743, 5290, 967, 6172, 5407, 5411, 1755, 1882, 2251, 3308, 1059, 2266, 3940, 2023, 2120].

Round-Off [6870, 608, 277, 7112, 881, 204, 205, 2748, 314, 6325, 6597, 6533, 3521, 602, 6250, 864, 1199, 6158, 5730, 473, 6121, 6122, 4122, 1936, 3521, 4128, 4281, 1182, 1185, 2171, 1582, 955, 3996, 422, 4811, 4812, 961, 3743, 5290, 967, 6172, 5407, 5411, 1755, 1882, 2251, 3308, 1059, 2266, 3940, 2023, 2120].

Rounded [6870, 608, 277, 7112, 881, 204, 205, 2748, 314, 6325, 6597, 6533, 3521, 602, 6250, 864, 1199, 6158, 5730, 473, 6121, 6122, 4122, 1936, 3521, 4128, 4281, 1182, 1185, 2171, 1582, 955, 3996, 422, 4811, 4812, 961, 3743, 5290, 967, 6172, 5407, 5411, 1755, 1882, 2251, 3308, 1059, 2266, 3940, 2023, 2120].

Round-To-Odd [4541].

Rounding [5784, 1790, 5364, 5785, 79, 3950, 490, 5561, 6462, 5370, 3010, 7148, 4815, 5269].
of the document as if you were reading it naturally.
[4302, 4714, 4267, 4270, 5106, 4133]. Saturation [1054, 4269, 4915, 4669].
Saudi [2865]. Savage [1733, 1734, 1736, 1740, 1750, 1763, 1772, 1689].
Savart [7082]. Save [4522, 4523, 6153, 335, 5281, 753, 3141, 2784, 3569, 2877, 4337, 2886, 4686, 5915, 1167, 5781, 5866, 4460]. Saving [4580]. SC’06 [7479].
Scalar [1945, 5380, 4288, 6469, 5121, 2650, 5891, 5511, 4550, 5744, 6011, 4734, 4416, 4592, 4735, 4436, 4611, 4478, 5243, 5244, 3394, 6395, 2230, 2397, 2398, 2099, 1993, 2416, 6209, 3005, 5228, 6486, 4869]. Scalars [4611, 4879].
Scanning [2479]. SCG’01 [7424]. Schaltkreisen [2611]. Schaltungen [1164]. Schaltungsanordnung [2097]. scheduling [2723]. Scheme [4950, 7108, 1363, 6870, 610, 2070, 5004, 5152, 7115, 5010, 5594, 3283, 3769, 1421, 896, 4719, 440, 261, 2997, 1069, 6359, 1183, 4291, 2210, 4019, 4023, 5005, 7019, 5298, 5299, 3622, 2408, 2410, 3127, 6215, 4633, 4634, 3375, 4827, 3900, 2798, 4132].
Second-Generation 8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE 117

8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

593, 6841, 3954, 90, 2506, 4665, 4161, 5718, 4062, 3151, 5196, 3670, 2467, 5375.
Signed-Digit [219, 1365, 1819, 4321, 4211, 6084, 4068, 2576, 3327, 489, 593, 3954, 2506, 4665, 4161, 3151, 5196].
Signed-LSB [5522].
Signed-Number [671].
Significance [859, 1013, 1513, 283, 1747, 761, 832, 1053, 793, 1512, 1968, 178, 981, 1052, 787, 2614, 2615, 941].
Significand [5561].
significands [4024].
Significant [3034, 5381, 461, 5890, 55, 554, 54, 346, 7045, 162, 5945, 5622, 237, 847, 3703, 3886, 318, 2967, 1554].
significant-digit [318].
Signs [3714, 3874].
SIGNUM [7185, 538].
SIGPLAN [7282, 7468].
SIKE [6667, 6785, 6553].
Silicon [5309, 7004, 2273].
SIMD [4292, 6136, 4785, 5676, 4979, 5698, 4984, 4339, 6789, 3587, 7019, 5726, 5831, 6716, 7076, 5554, 4285, 7104, 6225, 6357].
Similar [1699, 942].
Simple [857, 4796, 1267, 1376, 1602, 2524, 5501, 2890, 1517, 4540, 4550, 6536, 4553, 5167, 2550, 441, 572, 2762, 6206, 121, 1770, 649, 1452, 1794, 4657, 2679, 118, 5403, 1971, 6096, 2952, 452, 3192].
simpler [4693, 4833].
simplification [2840].
simplified [5010, 5040, 1353, 3913].
simplify [4493].
simplifying [3488].
simulated [5290, 7038, 759].
simulating [7013, 6534].
simulation [7438, 6487, 5820, 3579, 334, 2887, 5717, 635, 2938, 3653, 7006, 3161, 6347, 5782, 1943, 1944, 3566, 3061, 746, 1224, 1527, 1752, 4387, 5939, 980, 5345, 1449, 1934, 3006, 795, 353].
simulation-based [5717].
simulations [5926, 6187, 6339, 5550, 6471, 5894, 5486, 5694, 6267, 6799, 4578].
simulator [880, 3276, 1446, 879].
simulink [5776, 3332].
simulink-based [5776].
simultaneous [4288, 6394, 1207, 253, 3416, 4822, 6159, 7113, 2080, 7032, 3896, 2095, 3455, 5029, 5838, 6427, 6186, 6311, 5322, 2934, 5761, 1149, 1655, 5065, 1673, 708, 3948, 6738, 6739, 4961, 1956, 5689, 2872, 2873, 2874, 4339, 2884, 625, 1867, 2924, 2241, 2242, 3780, 3633, 5938, 1760, 4878, 3786, 5617, 2259, 2273, 3680, 3177, 2604, 1928, 3529, 251].
single-[3896].
single-board [2080].
single-channel [2242].
single-chip [2872, 2873, 2874, 1928].
single-multiplier [4297].
single-precision [3714, 5322, 5065, 2934, 4878, 3680, 3177].
single-rail [3786].
single-term [5689].
singular [3735, 4342, 3096, 1886, 4172, 4415].
singularity [5155].
sink [6516].
sinking [6627].
sinks [3596, 1408].
slash [1138, 910, 1147, 1888, 2461].
slave [1950].
sleef [6721].
SLI [3549, 2936, 2937, 3126, 2475, 2827, 3193, 3522].
SLI-Arithmetik [2936, 2937].
slice [1401, 1954, 1255].
sliced [5680, 4431].
8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

1077, 495, 547, 3578, 4199, 1755, 1637, 833, 2593, 946. Stabilized [103].

Stabilizing [4898]. Stable [5030, 1228, 2612, 888, 889]. Stack [1033, 1285].

Stacked [6221]. Stacking [6221]. stage [5979]. Stages [4180, 3494, 3495, 1933, 2836].

Staggered [5469, 3506]. stairs' [2955]. Stairway [3704].


Standardized [4368]. Standards [5118, 2673, 5160, 3939, 6727, 2300, 1501, 2203, 1757, 3473].

Standpoint [389]. Stanford [7390, 7250]. STAP [5762].

Start [5045]. Starting [280, 383, 2761, 579, 3679, 532, 596, 5170, 451, 3170].


Std [2039, 6506, 6540]. Steady [6929]. Steamboat [7501].

Steering [6240, 6749, 6861, 6606]. Stein [1017]. Stencil [6596]. Stengle [6568, 6341].

Step [6250, 6762, 1075, 92, 3107, 3108, 3109, 3110, 1697]. step-by-step [92].


Stocks [4261]. STOIC [1685]. Stokes [3565, 3582, 4130]. stopping [415].

Storage [865, 5506, 7577, 286, 144, 5915, 3343]. Storage-Efficient [865].


Strawman [4673]. Stream [6713, 6834, 6245]. Stream-Based [6834, 6713].
8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE 126

8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE

1521, 971, 7160, 7213, 7277, 7278, 7334, 7404, 7416, 7430, 7444, 7474,
7488, 7489, 7490, 7492, 7504, 7505, 7516, 7519, 7538, 7540, 7550, 5732,
6685, 1864, 4555, 682, 743, 3624, 5168, 7228, 6913, 1137, 1423, 1875, 5604

Systems [752, 5839, 5931, 3906, 5032, 5176, 287, 1142, 5756, 7336, 6563, 5328,
7395, 7408, 7419, 7435, 7448, 7462, 7530, 7542, 7571, 1147, 1888, 5048, 4241,
4883, 4242, 2954, 3480, 6820, 2771, 918, 3485, 2964, 3318, 1439, 2576, 3327,
3156, 3492, 5200, 1673, 7828, 3502, 7450, 3678, 1916, 2145, 3681, 4109, 7323,
3013, 1077, 796, 3208, 5378, 1004, 3379, 3380, 4948, 6975, 2040, 2315, 3850, 4782,
45, 1487, 3552, 2180, 1263, 2642, 1810, 2328, 5576, 3976, 1815].

[278x527]systems

[6380, 2197, 955, 5257, 2668, 2669,
2670, 2671, 4667, 4515, 4516, 4667, 4515, 4516, 1826, 5139, 3736, 1836, 1277, 7221, 386, 2695,
2696, 2698, 2700, 3588, 226, 336, 2528, 5290, 2964, 5327, 3009, 6023, 1559, 946, 1182, 4136, 4776, 1942, 1251, 1758, 1236, 1935, 800].

Systolic [2042, 5467, 1814, 2194, 2195, 3051, 5259, 2513, 4983, 2691, 7014, 2706,
3887, 2081, 2389, 4559, 2405, 3292, 4060, 4388, 3135, 7126, 2127, 2131, 2796,
1914, 3180, 1697, 2158, 3199, 5871, 2166, 1953, 2178, 2204, 4675, 2681, 2877,
3064, 2690, 2898, 1857, 4221, 2415, 2739, 4717, 4226, 4390, 4509, 5035, 4397,
1999, 2966, 2263, 4264, 3514, 2030, 3200, 4283, 4938, 4774, 2310, 2684].

Szabo [509].

Szeged [7401].

T [6680, 929, 6229, 2220, 6443, 6839].

T-count [6443, 6839].

T-depth [6839].

T-Series [220].

T. [929, 2467].

T800 [3079, 2082].

T9000 [2733].

Tabellenzugriff [2035].

Table [6241, 6640, 6750, 6862, 5813, 1581, 52,
4823, 4016, 2534, 1742, 4196, 3436, 6075, 24, 4378, 5029, 4401, 5047, 4073, 2123,
2125, 2126, 4426, 3805, 3674, 3811, 1544, 998, 4114, 3827, 6607, 4272, 2609,
2610, 2814, 2815, 3004, 1705, 2035, 3375, 4332, 4987, 5818, 6509, 2663, 5494,
3433, 4035, 101, 4856, 2952, 4732, 3322, 3323, 4085, 3152, 3946, 6136, 4721].

Table-assisted [1705].

Table-Based [5813, 4196, 4073, 5818, 6509, 4823, 4732].

Table-Driven [3805, 2472, 2609, 3004, 2534, 2610].

Table-Lookup

[2814, 2815, 3152].

Tables [1719, 3237, 54, 7048, 5059, 3922, 5954, 6345,
3162, 3503, 3810, 4099, 4920, 5088, 4521, 3860, 6518, 2555, 409, 4943].

tabular [5826].

tackles [1969].

Tagging [6779].

Taylor [7571, 7539].

Tails [5926].

Taipei [7278, 7476, 7540].

Taiwan [7278, 7540, 7476].

take [3385].

Taken [10].

Takes [3412, 2319].

Taking [18, 6039, 3966, 188].

Tale [3477, 3344, 3478].

Talk [6070, 6091, 6116, 5596].
Theories [7263, 2271, 5625, 7325]. théorique [17]. Theory [7172, 7510, 7527, 5573, 7157, 4959, 7244, 3733, 4002, 1026, 337, 1125, 41, 1211, 4029, 7528, 7388, 7276, 5413, 7188, 525, 7157, 955, 2507, 2201, 2203, 1839, 7300, 5404, 7503, 4365, 2924, 3118, 1425, 5323, 5533, 3641, 290, 986, 7374, 1907, 3001, 1172, 7147].


Tolerant [6147, 6661, 5720, 3103, 6318, 2131, 6451, 6962, 6975, 2178, 3042, 3043, 4185, 3588, 4552, 2965, 3324, 3325, 3514, 2822, 3829, 3201, 3364].

Tools [6978, 6760, 6654, 7223, 7430, 6610, 6730, 4013, 2721, 3347, 2820, 4580].
toolset [4330]. Tool [5248, 5652]. Tool’n’Half [5671]. ToolTalk [4860].
Top [6474]. Topics [53, 7144]. topological [5287]. Topologies [5343, 6361].
Tracking [3254, 6627, 4011, 4013, 6669, 7016, 4874]. Trade [6498, 1609, 4042, 633, 6217, 3241, 6974, 2512, 4170, 5399, 2433, 4733]. Trading [7003].
Trade-Off [633, 6498, 4042, 3241, 1308]. Trade-Offs [6217, 6974, 2512, 4170, 4737, 3835]. Tradeoff [6328, 3809, 4162]. Tradeoffs [5586, 3116, 4412, 3688, 3689, 4628, 4771, 3382, 1716, 5399, 4733].
Training [6468, 6871, 7003, 6390, 6798, 6547, 6564, 6813, 6702, 6331, 7065, 6941, 7072, 6827, 7093, 6464, 6846, 6737, 6726].
Transforms [6901, 1305, 1152, 2630, 1261, 815, 2055, 3576, 3875, 3615, 1988, 1990, 906, 909, 5220, 4934, 4769, 4648]. Transistor [2407, 3486, 1702].
Trig [2451, 3187, 783]. Trigger [6916, 7041]. Trigonometric [5813, 1026, 3076, 6904, 4192, 139, 1665, 1666, 6345, 1544, 3513, 190, 2882, 2534, 201, 5703]. Trimming [1963]. Trinomial [4965].
True [1572, 60, 6799]. Truncated [6765, 2059, 6268, 5982, 5710, 6550, 7122, 5200, 3167, 4104, 5960, 4120, 4628, 4770, 4935, 5102, 4284, 4469, 2844, 4659, 7117]. Truncation [345, 3769, 370, 325, 1004, 3402, 422, 3578, 1878, 683, 6614].


Tübinger [159, 7363]. Tukey [6648]. Tunable [6444, 6580, 6018, 5081].

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Ultra-efficiency [6848]. ultrasonic [2334, 2508]. ultrasonics [1781].

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Uncertainty [3681, 6623, 5257]. Unconstrained [4586, 6272].

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8 ADDITIONAL CONTRIBUTIONS FROM NELSON H. F. BEEBE 135

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Vector [4492, 1945, 6028, 3381, 6366, 3216, 3393, 6987, 1092, 2651, 2866, 6653, 3995, 6887, 970, 7029, 4205, 5744, 5528, 2096, 6914, 1883, 5055, 2446, 6710, 1657, 7073, 2143, 4098, 2149, 2422, 1326, 1327, 1465, 4894, 970, 7029, 4205, 5744, 5528, 2096, 6914, 1883, 5055, 2446, 6710, 1657, 7073, 2143, 4098, 2149, 2422, 1326, 1327, 1465, 4894, 970, 7029, 4205, 5744, 5528, 2096, 6914, 1883, 5055, 2446, 6710, 1657, 7073, 2143, 4098, 2149, 2422, 1326, 1327, 1465].

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Vectoring [3964, 4147, 3774, 4282].

vectorizable [6379].

Vectorization [6231, 2235, 2236, 5043, 5126, 6093].

Vectorized [6987, 6992, 6877, 6721, 6397, 5788].

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Verilog [4921].

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vertex [5725].

Vertices [5505].

verwendeten [2302].

Very [3964, 4147, 6847, 5469, 4158, 3073, 3250, 386, 1516, 5749, 3461, 4058, 2950, 4072, 3848, 3860, 4665, 1624, 5934, 3477, 4406, 5652].

Very-High [3964, 4147, 3250, 3461, 4406].

VFloat [5650, 5620].

VFP9 [4492].

VFP9-S [4492].

VHDL [4819, 4681, 5140, 3758, 2736, 4878, 5770, 5782].

VI [7331, 7373, 7552, 782, 7147, 7325].

Via [5281, 1207, 5071, 1190, 5579, 6502, 4672, 4981, 2680, 3062, 3245, 464, 3576, 5143, 5497, 4686, 5500, 508, 6272, 6677, 5515, 3091, 6541, 5738, 6543, 4372, 7036, 2097, 6916, 7041, 6090, 5996, 6563, 6329, 6578, 1765, 4415, 5340, 5067, 5775, 6594, 6358, 4482, 6740, 6518].

vice [2193, 401].

Victoria [7527, 7333].

Video [494, 6945, 5220, 5745].

View [3385, 3236, 1650, 2517, 3377].

VII [7503, 783].

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Villa [7246].

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1. Table 5 (page 124):
insert $k \leftarrow 0$ after assertion, and also delete $k \leftarrow 0$ from Table 6.

2. Table 9 (page 125):
   for 
   substitute
   and delete the comment.

3. Table 10 (page 125):
   for
   substitute

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The main aim is to produce a usably efficient implementation, which can be easily interfaced with existing C++ code. This contrasts with previous implementations in functional languages (Haskell, Miranda etc.), which, although theoretically important, seem to be rather too slow for real use.

This code is designed as an add-on to Victor Shoup’s arbitrary-precision arithmetic package NTL, and implements a new type XR, to complement NTL’s ZZ and RR integer and real types.

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1095


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- branch and bound algorithms for global optimization,
- constraint propagation,
- solution sets of linear systems,
- hardware and software systems for interval computations, and
- fuzzy logic.

Actual applications described in the book include:

- economic input-output models,
- quality control in manufacturing design,
- a computer-assisted proof in quantum mechanics,
- medical expert systems,
- and others.

A realistic view of interval computations is taken: the articles indicate when and how overestimation and other challenges can be overcome. An introductory chapter explains the content of the papers in terminology accessible to mathematically literate graduate students. The style of the individual, refereed contributions has been made uniform and understandable, and there is an extensive book-wide index. Audience: Valuable to students and researchers interested in automatic result verification. Detailed information, including contents, contributors, and an order form can be found:

- on Kluwer homepage [http://www.wkap.nl](http://www.wkap.nl), or

The information on the Interval Computations homepage is basically a mirror image of the Kluwer one (the only difference is that the fonts are fancier).
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