Magic Numbers & Un/Pack
a use.perl.org magical mystery tour

Boston.PM
2008-11-18
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aka n1vux

HAKMEM 169

- How many bits are set in a word?

```
sub bc { ### SLOW O(N) ###
   my $v=shift; my $c;
   for ($c = 0; $v; $v >>= 1){  $c += $v & 1; }
   return $c;}
```

- How fast can it be done?
  - For some applications, including keyword search, this is critical. Constant time, space with small constant needed.

ITEM 169 (in order of one-ups-manship: Gosper, Mann, Lenard, [Root and Mann]):

```
To count the ones in a PDP-6/10 word:
        LDB B,[014300,,A]       ;or MOVE B,A then LSH B,-1
        AND B,[333333,,333333]
        SUB A,B
        LSH B,-1
        AND B,[333333,,333333]
        SUBB A,B         ;each octal digit is replaced by number of 1's in it
        LSH B,-3
        ADD A,B
        AND A,[070707,,070707]
        IDIVI A,77              ;casting out 63.'s
```

Original designed for PDP 10 36 bits (9 bit bytes) – works to 62 bits
MIT AI Lab http://www.inwap.com/pdp10/hbaker/hakmem/hacks.html#item169

HAKMEM 169 (32)
011111111111

- Changes look in C and 32bit
  - http://blogs.msdn.com/jeuge/archive/2005/06/08/HAKMEM-Bit-Count.aspx

```
int BitCount(unsigned int n)
{
        unsigned int uCount;

        uCount = n - ((n >> 1) & 033333333333) - ((n >> 2) & 011111111111);
        return ((uCount + (uCount >> 3)) & 030707070707) % 63;
}
```

$n = a_{31} * 2^{31} + a_{30} * 2^{30} + ...+ a_k * 2^k + ...+ a_1 * 2 + a_0;$

$u = a_2*2^2 + a_1*2 + a_0;$

$u>>1 = a_2*2 + a_1;$

$u>>2 = a_2;$

$n - (n>>1) - (n>>2) = (4-2-1)a_2 + (2-1)\ a_1 + 1\ a_0 = a_2+a_1+a_0$

- With sums threes, the >>3 gives <u>two</u> sets of sums of six.
- 030...0707 discards the duplicates.
- sum digits: mod 63=x3f=077
  - casting out nines but in base64 ... but not for 64bit !\

HAKMEM 169

- This number octal 11111111111 is sacred to HAKMEM 169, bitcount.

- http://blogs.msdn.com/jeuge/archive/2005/06/08/HAKMEM-Bit-Count.aspx
  http://infolab.stanford.edu/~manku/bitcount/bitcount.html
  http://www.setbb.com/phpbb/viewtopic.php?mforum=sudoku&p=7629
  http://www.inwap.com/pdp10/hbaker/hakmem/hakmem.html

Magic Numbers & Un/Pack

So far ...

- HAKMEM 169 011111111111

Popcount SWAR reinvented x55/xAA

- often

bm32.pl.html#ilya-

  - rediscovered
  - improved
  - renamed
    - Pop(ulation)count
    - bitcount, bitcnt
    - SWAR: SIMD within a register
    - Sideways addition, sidesum
    - Hamming Weight
    - Ones Count

Popcount notes

- http://aggregate.ee.engr.uky.edu/MAGIC/
- http://en.wikipedia.org/wiki/Hamming_weight
- http://www.math.uni-bielefeld.de/~sillke/PROBLEMS/bitcount
  => http://www.math.uni-bielefeld.de/~sillke/ALGORITHMS/bitmani/
- http://www.ciphersbyritter.com/NEWS4/BITCT.HTM
- http://www.dalkescientific.com/writings/diary/archive/2008/07/03/hakmem_and_other_popcounts.html
  => http://wiki.cs.pdx.edu/forge/popcount.html
- hackers delight
  http://safari.awprofessional.com/0201914654 http://www.hackersdelight.org/
  http://www.pearsonhighered.com/academic/product/0,,0201914654,00%2Ben-USS_01DBC.html
- http://popcnt.org/2007/09/magic-popcount-popcnt-command.html
- http://www.dalkescientific.com/writings/diary/archive/2008/07/05/bitslice_and_popcount.html
- http://graphics.stanford.edu/~seander/bithacks.html#CountBitsSetNaive
  corrects kernighan=>wegner+lehmer
- http://groups.google.com/group/comp.graphics.algorithms/msg/43dfb1f4a0f08441
- "Beautiful Code" http://isbn.nu/9780596510046
- “Programming Pearls” http://isbn.nu/authorx/bentley_jon_louis http://www.cs.bell-labs.com/cm/cs/pearls/

Magic Numbers & Un/Pack

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Usenet Benchmark contest

bm32.pl.html bm64.pl.html bitcount.rtf

-
-

```
wdr@bill-laptop:~/perl/advent/bit-count$ bench=1 perl510 ./bm32.pl
               Rate rec_n direct ls1b decr ilya sprtr katz table ones32 unroll unrmsk parmod hakmem_169 tabunr packtut
rec_n       39172/s    --   -67% -77% -82% -85%  -88% -90%  -91%   -92%   -92%   -92%   -93%        -93%   -94%    -94%
direct     118266/s  202%     -- -29% -44% -54%  -63% -71%  -72%   -76%   -76%   -77%   -80%        -80%   -81%    -83%
ls1b       167166/s  327%    41%   -- -21% -35%  -47% -58%  -61%   -66%   -66%   -67%   -71%        -72%   -72%    -76%
decr       212850/s  443%    80%  27%   -- -18%  -33% -47%  -50%   -56%   -56%   -58%   -63%        -65%   -65%    -70%
ilya       258673/s  560%   119%  55%  22%   --  -18% -36%  -39%   -47%   -47%   -49%   -55%        -57%   -57%    -63%
sprtr      316291/s  707%   167%  89%  49%  22%    -- -21%  -25%   -35%   -35%   -38%   -45%        -47%   -48%    -55%
katz       402668/s  928%   240% 141%  89%  56%   27%   --   -5%   -17%   -17%   -21%   -30%        -33%   -34%    -42%
table      424511/s  984%   259% 154%  99%  64%   34%   5%    --   -13%   -13%   -17%   -27%        -29%   -30%    -39%
ones32     487116/s 1144%   312% 191% 129%  88%   54%  21%   15%     --    -0%    -4%   -16%        -19%   -20%    -30%
unroll     487480/s 1144%   312% 192% 129%  88%   54%  21%   15%     0%     --    -4%   -16%        -19%   -20%    -30%
unrmsk     509460/s 1201%   331% 205% 139%  97%   61%  27%   20%     5%     5%     --   -12%        -15%   -16%    -27%
parmod     579359/s 1379%   390% 247% 172% 124%   83%  44%   36%    19%    19%    14%     --         -4%    -5%    -17%
hakmem_169 601230/s 1435%   408% 260% 182% 132%   90%  49%   42%    23%    23%    18%     4%         --    -1%    -14%
tabunr     606683/s 1449%   413% 263% 185% 135%   92%  51%   43%    25%    24%    19%     5%         1%     --    -13%
packtut    699252/s 1685%   491% 318% 229% 170%  121%  74%   65%    44%    43%    37%    21%        16%    15%      --
# No tests run!
```

Magic Numbers & Un/Pack

So far ...

- HAKMEM 169 011111111111
- Popcount SWAR reinvented x55/xAA
- Usenet Benchmark contest

Bit banging in interpretive languages

- C rarely beats hardware
  - but `bitcnt` in best C can beat *naïve* microcode
- Perl userspace code *should* never beat libc and Perl's C guts
  - loops in C always cheaper than loops in Perl
- only reason to try
  - fun
  - can't find the right builtin yet
    - or doesn't exist and XS + Inline::C out of bounds

Optimization

- Rule 1 – Don't
- Rule 2 – Don't do it yet.
  - *(for experts only)*
- Rule 3 – Benchmark

Magic Numbers & Un/Pack

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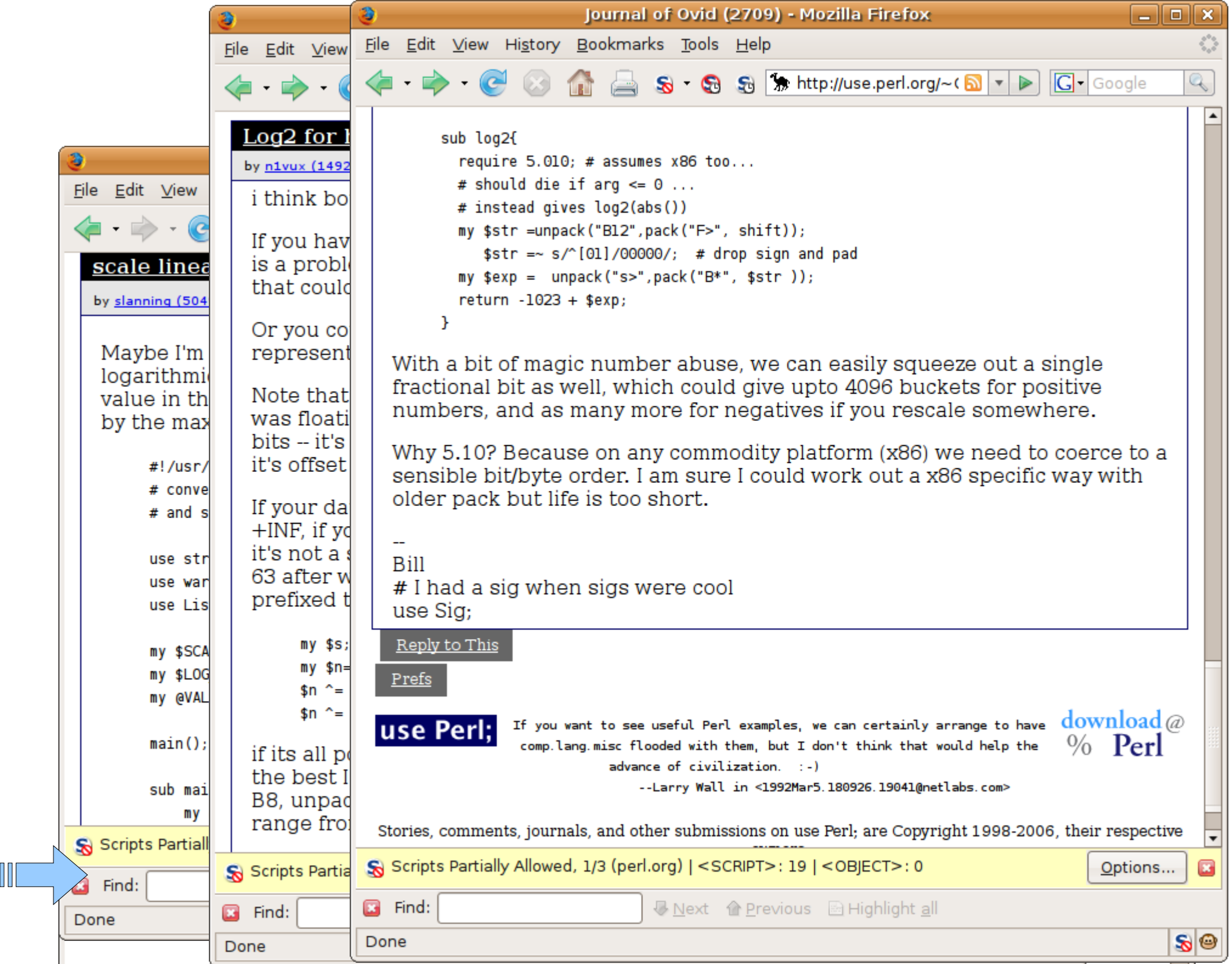
- Rule 1 Don't


Journal of Ovid (2709) - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://use.perl.org/~(
Google
sub log2{
require 5.010; # assumes x86 too...
# should die if arg <= 0 ...
# instead gives log2(abs())
my $str =unpack("B12",pack("F>", shift));
$str =~ s/^[01]/00000/; # drop sign and pad
my $exp = unpack("s>",pack("B*", $str));
return -1023 + $exp;
}
With a bit of magic number abuse, we can easily squeeze out a single fractional bit as well, which could give upto 4096 buckets for positive numbers, and as many more for negatives if you rescale somewhere.
Why 5.10? Because on any commodity platform (x86) we need to coerce to a sensible bit/byte order. I am sure I could work out a x86 specific way with older pack but life is too short.
--
Bill
I had a sig when sigs were cool
use Sig;
Reply to This
Prefs
use Perl;
If you want to see useful Perl examples, we can certainly arrange to have comp.lang.misc flooded with them, but I don't think that would help the advance of civilization. :-)
--Larry Wall in <1992Mar5.180926.19041@netlabs.com>
download @ % Perl
Stories, comments, journals, and other submissions on use Perl; are Copyright 1998-2006, their respective
Scripts Partially Allowed, 1/3 (perl.org) | <SCRIPT>: 19 | <OBJECT>: 0
Options...
Find:
Next
Previous
Highlight all
Done
File Edit View
Log2 for
by n1vux (1492
i think bo
If you hav
is a probl
that coul
Or you co
represent
Note that
was floati
bits -- it's
it's offset
If your da
+INF, if yo
it's not a
63 after w
prefixed t
my $s;
my $n=
$n ^=
$n ^=
if its all p
the best I
B8, unpac
range fro
Scripts Partia
Find:
Done
File Edit View
scale linea
by slanning (504
Maybe I'm
logarithmi
value in th
by the max
#!/usr/
conve
and s
use str
use war
use Lis
my $SCA
my $LOG
my @VAL
main();
sub mai
my
Scripts Partiall
Find:
Done

Log2 perf

log2.pl.html

- SWAR version uses bitcnt and thus 011111111111
- `perl510 log2.pl bench`

```
               Rate log2_xx log2_2 log2_3 log2_1 log2_0 floor_log2 floor_log2_pt log2_LL
log2_xx        406/s      --    -4%    -4%    -5%   -16%       -35%          -45%    -62%
log2_2         422/s      4%     --    -0%    -2%   -12%       -33%          -43%    -61%
log2_3         423/s      4%     0%     --    -1%   -12%       -33%          -42%    -60%
log2_1         429/s      6%     2%     1%     --   -11%       -32%          -42%    -60%
log2_0         481/s     18%    14%    14%    12%     --       -23%          -35%    -55%
floor_log2     628/s     55%    49%    48%    46%    31%         --          -15%    -41%
floor_log2_pt  736/s     81%    74%    74%    71%    53%        17%            --    -31%
log2_LL       1070/s    163%   153%   153%   149%   122%        70%           45%     --
```

```
          Rate log2_Lcs  log2_Lc  log2_LL
log2_Lcs 1060/s       --      -2%      -3%
log2_Lc  1078/s       2%       --      -1%
log2_LL  1088/s       3%       1%       --
```

`my $n=shift;` cost 4%

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- Rule 1 Don't
- Log2 – can use bitcnt but builtin still fastest

Perl 5.10 pack F>

- Byte-order modifiers for pack() and unpack()
  - There are two new byte-order modifiers, **>** (big-endian) and **<** (little-endian), that can be appended to most pack() and unpack() template characters and groups to force a certain byte-order for that type or group. See pack and perlpacktut for details.
  - http://perldoc.perl.org/perldelta.html#Byte-order-modifiers-for-pack%28%29-and-unpack%28%29
  - http://perldoc.perl.org/perlpacktut.html#Dealing-with-Endian-ness
- http://perldoc.perl.org/functions/pack.html
- Must be enabled
  - 5.10 - http://perldoc.perl.org/perldelta.html#The-%27feature%27-pragma

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- Eg, Log2
- Perl 5.10 pack F>

More fun with unpack

- ACK_PAGER_COLOR='less -R' ack --perl '(?<![$])\b(un)?pack\b' ~/perl ~/localperl
-

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Journal of n1vux (1492)

Tuesday March 29, 2005

08:03 AM **Happy "BILL" o'Clock** [Edit | Delete | #23904]

[Elaborating on the original report at http://use.perl.org/comments.pl?sid=25547&cid=39001]

This morning, at 123836GMT/ 7:38:36 EST, the Unix time_t value was (in Network standard byte order) "BILL", that being the ASCII representation of the 32bit number of seconds since New Years 1970.

```
BILL  Tue Mar 29 12:38:36 2005 GMT . Tue Mar 29 07:38:36 2005 ET
```

So happy BILL-o-clock to all the Bill's in my address book.

Also upcoming is Bill-o-clock and a bunch of other 4-letter words.

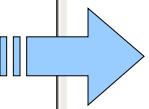
```
BYTE  Sun Apr 10 16:28:53 2005 GMT . Sun Apr 10 12:28:53 2005 ET
Beer  Tue Apr 19 20:09:22 2005 GMT . Tue Apr 19 16:09:22 2005 ET
Bill  Fri Apr 22 21:28:12 2005 GMT . Fri Apr 22 17:28:12 2005 ET
Byte  Thu May  5 01:18:29 2005 GMT . Wed May  4 21:18:29 2005 ET
```

And CAAA-CZZZ, Caaa-Czzz are due in the fall, starting with

```
CABS  Mon Oct  3 14:38:11 2005 GMT . Mon Oct  3 10:38:11 2005 ET
CAFE  Mon Oct  3 14:55:01 2005 GMT . Mon Oct  3 10:55:01 2005 ET
```

This runs about 2 letters a year thru

```
Zoos  Mon Jan 29 19:01:07 2018 GMT . Mon Jan 29 14:01:07 2018 ET
```



n1vux (1492)

n1 vux
Bill Ricker
n1 vux@yahoo.com
(email not shown publicly)
http://boston.pm ... x.cgi?BillRicker
Karma: 25
AOL IM: n1 vux (**Add Buddy, Send Message**)
Yahoo! ID: n1 vux (**Add User, Send Message**)

Only started with Perl4 and Perl5 in 1995. I was doing AWK etc for 12 years before that, and resisted switching. I've been doing OO since before C++ hit bigtime, with Objective-C and SmallTalk, so I really like the (no longer new) Perl5 OO style; and the Lispish Map style is also an old friend. What do I hack with Perl? All data that passes my way; systems monitoring scripts at $DayJob, weather data at night, and I cheat on NPR word puzzles.
Member: Boston.pm.org [pm.org] BLU.org [blu.org] /. LinkedIn [linkedin.com]

N1 VUX is my FCC-issued ham radio callsign.

BILL'o'Clock

- http://use.perl.org/comments.pl?sid=25547&cid=
- http://use.perl.org/~n1vux/journal/23904

time_t2.pl.html

time_t

time_t2.pl.html

- $ perl time_t2.pl -s iaaa izzz

```
IAAA  Thu Dec 11 16:35:13 2008 GMT . Thu Dec 11 11:35:13 2008 ET
IZZZ  Tue Dec 30 17:28:58 2008 GMT . Tue Dec 30 12:28:58 2008 ET
Iaaa  Mon Jan  5 01:24:49 2009 GMT . Sun Jan  4 20:24:49 2009 ET
Izzz  Sat Jan 24 02:18:34 2009 GMT . Fri Jan 23 21:18:34 2009 ET
```

```
$ perl time_t2.pl --sort I > I_time_t.txt
```

```
ICED  Sat Dec 13 05:16:52 2008 GMT . Sat Dec 13 00:16:52 2008 ET
..
IRES  Wed Dec 24 14:21:07 2008 GMT . Wed Dec 24 09:21:07 2008 ET
IRIS  Wed Dec 24 14:38:11 2008 GMT . Wed Dec 24 09:38:11 2008 ET
IRKS  Wed Dec 24 14:46:43 2008 GMT . Wed Dec 24 09:46:43 2008 ET
IRON  Wed Dec 24 15:03:42 2008 GMT . Wed Dec 24 10:03:42 2008 ET
ISLE  Thu Dec 25 09:03:01 2008 GMT . Thu Dec 25 04:03:01 2008 ET
ITCH  Fri Dec 26 02:36:56 2008 GMT . Thu Dec 25 21:36:56 2008 ET
ITEM  Fri Dec 26 02:45:33 2008 GMT . Thu Dec 25 21:45:33 2008 ET ..
Iced  Tue Jan  6 14:06:28 2009 GMT . Tue Jan  6 09:06:28 2009 ET ..
Ires  Sat Jan 17 23:10:43 2009 GMT . Sat Jan 17 18:10:43 2009 ET
Iris  Sat Jan 17 23:27:47 2009 GMT . Sat Jan 17 18:27:47 2009 ET
Irks  Sat Jan 17 23:36:19 2009 GMT . Sat Jan 17 18:36:19 2009 ET
Iron  Sat Jan 17 23:53:18 2009 GMT . Sat Jan 17 18:53:18 2009 ET
Isle  Sun Jan 18 17:52:37 2009 GMT . Sun Jan 18 12:52:37 2009 ET
Itch  Mon Jan 19 11:26:32 2009 GMT . Mon Jan 19 06:26:32 2009 ET
Item  Mon Jan 19 11:35:09 2009 GMT . Mon Jan 19 06:35:09 2009 ET
```

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- Eg, Log2
- Perl 5.10 pack F>
- More fun with unpack
- Bill'o'clock

Obfu

- What does this do?

```
unlink${0}if$^T>1x10;
```

Logout | Preferences | Password | ~n1vux (1492) ~cog (4665)

Journal of cog (4665)

Info | Relation | **Journal** | Firehose | Friends | Fans | Foes | Freaks | Tags | Bookmarks

n1vux's Journal | Write in Journal | Delete/Edit Entries | Top 10 | Edit Preferences | Friend's Journals

Friday March 18, 2005

04:39 AM **Have a nice 1111111111 day** [#23711]

That'll be today.

I first noticed that about 6 months ago, when I was thinking (just for fun) on logic bombs and came up with this one:

```
unlink${0}if$^T>1x10;
```

Nothing really fancy there :-)

Move along now :-)

http://use.perl.org/~cog/journal/23711

/. celebrated `` `date +%s` eq 1111111111 `` too.
http://slashdot.org/article.pl?sid=05/03/17/169200&tid=130

Magic Numbers & Un/Pack

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Today (UTC)

- Obfu was for 1x10 base ten.
- When is 1x11 *base 8* aka 011111111111 ?
- octal 11111111111
  = decimal 1227133513
  = hex 0x49249249
  = (as time_t) Wed Nov 19 22:25:13 UTC 2008
  = Wednesday, November 19, 2008 5:25 PM ET
- it was after UTC Midnight when the meeting started, in POSIX standard systime it's later today!

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- Bill'o'clock
- Obfu 1111111111
- Today (UTC) 011111111111

ta da

Bonus slides

Y2K038

- http://www.google.com/search?q=2038+date

```
5.8.0/386 RH3
   $ perl y2k038.pl
   -7 Tue Jan 19 03:14:01 2038
   -6 Tue Jan 19 03:14:02 2038
   -5 Tue Jan 19 03:14:03 2038
   -4 Tue Jan 19 03:14:04 2038
   -3 Tue Jan 19 03:14:05 2038
   -2 Tue Jan 19 03:14:06 2038
   -1 Tue Jan 19 03:14:07 2038
    0 Fri Dec 13 20:45:52 1901
   +1 Fri Dec 13 20:45:52 1901
   +2 Fri Dec 13 20:45:52 1901

5.8.85/x86_64 RH4
   $ perl ./y2k038.pl
   -7 Tue Jan 19 03:14:01 2038
   -6 Tue Jan 19 03:14:02 2038
   -5 Tue Jan 19 03:14:03 2038
   -4 Tue Jan 19 03:14:04 2038
   -3 Tue Jan 19 03:14:05 2038
   -2 Tue Jan 19 03:14:06 2038
   -1 Tue Jan 19 03:14:07 2038
    0 Tue Jan 19 03:14:08 2038
   +1 Tue Jan 19 03:14:09 2038
   +2 Tue Jan 19 03:14:10 2038
```

```
 1 #! /usr/bin/perl
 2
 3 # http://www.google.com/search?q=2038+date
 4
 5
 6 use POSIX;
 7 $ENV{'TZ'} = "GMT";
 8
 9 my $eow= 2147483641;
10 for ($clock = $eow;  $clock < 2147483651;
                                    $clock++) {
11    my $dt=$clock-$eow-7;
12    print "@{[$dt > 0 ? '+':'']}$dt
                    @{[ctime($clock)]}";
13 }
14
```

y2k038.pl.html

Y2K038 fix

- y2038 http://use.perl.org/~schwern/journal/37688
  - http://y2038.googlecode.com/svn/trunk/patches/Time-Local-Extended.patch
  - http://use.perl.org/~schwern/journal/37688?from=rss
- and the Y3001 bug. http://use.perl.org/~schwern/journal/37586?from=rss

Who needs Bignums?

- http://use.perl.org/~davorg/journal/34739
  - http://use.perl.org/comments.pl?cid=58619&sid=373
- We all do eventually ..
- http://www.forthgo.com/blog/2008/10/19/fast-factoring-for-64-bit-integers/#comment-6319
- http://projecteuler.net/index.php?section=problems
-

check_fact.pl.html

More fun with dates

exif-date.pl.html

- Exif dates
  - reset file system date of cropped foto to exposure date
  - date arithmetic is very plain
  - but has a magic number ... find and understad

dst.pl.html

- dst.pl
  - check Libc TZ defnitions