Subject: Re: counting bits
Posted by thompson on Wed, 26 Feb 2003 20:15:28 GMT
View Forum Message <> Reply to Message

JD Smith <jdsmith@as.arizona.edu> writes:

> IDL> r=ulong(randomu(sd,100)*2.^31) & for i=0,31 do print,FORMAT='(I2,": ",I2,A)',i,total((r AND ulong(2.D^i)) ne 0UL),'% set'
> 0: 0% set
> 1: 0% set
> 2: 1% set
> 3: 1% set
> 4: 9% set
> 5: 17% set
> 6: 27% set
> 7: 59% set
> 8: 44% set
> 9: 50% set
> 10: 46% set
> 11: 57% set
> 12: 50% set
> 13: 55% set
> 14: 51% set
> 15: 48% set
> 16: 56% set
> 17: 51% set
> 18: 52% set
> 19: 43% set
> 20: 46% set
> 21: 44% set
> 22: 35% set
> 23: 52% set
> 24: 47% set
> 25: 51% set
> 26: 44% set
> 27: 51% set
> 28: 46% set
> 29: 53% set
> 30: 45% set
> 31: 0% set

That's pretty simple to explain. Floating point numbers are stored with a mantissa and an exponent, both stored within the same 4 byte word. A few of the bits are devoted to the exponent, and the rest are devoted to the mantissa. When you call

 randomu(sd,100)

you generate a bunch of numbers which mostly have the same exponent bits,
because all the numbers are of the same order of magnitude, while the mantissa
bits are generally 50% on or 50% off. When you then multiply this by 2.^31 and
convert it into a long integer, you're primarily sampling the mantissa bits.
In fact, the only reason why the last few bits are sometimes set at all is that
some of the random numbers are close to zero, and thus end up with different
exponents.

You can see this by looking directly at the bits of the original floating point
numbers.

```
IDL> r=ulong(randomn(sd,100),0,100) & for i=0,31 do print,FORMAT='(I2,": ",I2,A)',i,total((r AND
ulong(2.D^i)) ne 0UL),'% set'
 0: 58% set
 1: 49% set
 2: 48% set
 3: 48% set
 4: 49% set
 5: 49% set
 6: 47% set
 7: 42% set
 8: 53% set
 9: 51% set
10: 55% set
11: 46% set
12: 44% set
13: 48% set
14: 50% set
15: 59% set
16: 40% set
17: 52% set
18: 53% set
19: 57% set
20: 48% set
21: 41% set
22: 43% set
23: 43% set
24: 75% set
25: 86% set
26: 96% set
27: 96% set
28: 96% set
29: 96% set
30:  4% set
31: 53% set
```

See how the mantissa is stored in the lower bits, and there's very little
variation in the uppermost bits where the mantissa is stored?