Ephemera

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Principles of Complex Systems, Vols. 1 & 2
CSYS/MATH 300 and 303, 2021–2022| @pocsvox

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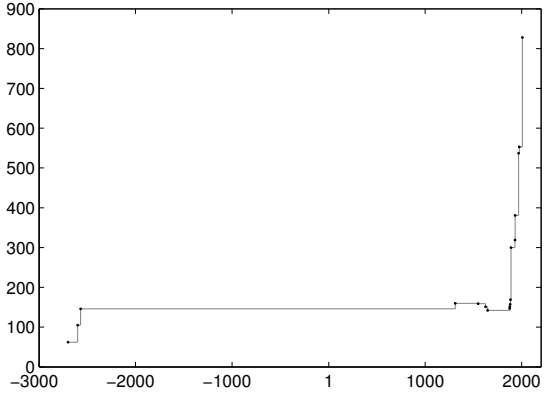
Outline

What's this?



The walkie-talkie dialect:[1]

- Stamps: Lickie Stickie
- Defibrillators: Heartie Startie
- Bumble bees: Fuzzie Buzzie
- Pregnancy test: Maybe Baby
- Fork: Stabbie Grabbie
- Socks: Feetie Heatie
- Hippo: Floatie Bloatie
- Nightmare: Screamie Dreamie

[1] From the inciting tweet of excellence:
https://twitter.com/Flaminhaystack/status/977899605349339137

More:

- Ambulance: Sendie Mendie
- Miniature sausage dog: Teenie Weenie
- Shot glass: Dinkie Drinkie
- Lifejacket: Boatie Coatie
- Low fat desserts: Fakey Cakey
- Cat: Furrie Purrie

A small task—Order the following adjectives to describe a knife (alphabetically ordered):

- little
- lovely
- old
- orange
- rectangular
- steel
- whittling
- Victorian

As in "something-something-...-something knife."

How does these feel?

- "orange lovely knife",
- "rectangular old knife",
- "Victorian little knife",
- "whittling little knife".
- "A whittling, steel, Victorian, orange, rectangular, old, little, lovely, knife."

Adjective order in English:[2]

"Adjectives in English absolutely have to be in this order: opinion - size - age - shape - colour - origin - material - purpose.

So you can have a lovely, little, old, rectangular, green, Victorian, steel, whittling knife.

But if you mess with that word order in the slightest you'll sound like a maniac.

It's an odd thing that every English speaker uses that list, but almost none of us could write it out."

[2] http://www.bbc.com/culture/story/
20160908-the-language-rules-we-know-but-dont-know-we-know

Vowel space fun times (ablaut reduplication):

- Tick-tock not tock-tick.
- Hip-hop not hop-hip.
- Bing-bong not bong-bing.
- Ping-pong not pong-ping.
- Flip-flop not flop-flip.
- Clip-clop not clop-clip (Onomatopoeia)
- Dilly-dally not dally-dilly.
- Pitter-patter not patter-pitter.
- Pitapat not patapit.
- Zig-zag not zag-zig.
- Om not Mo (A-U-M, back to front of the mouth).

The exception to the rule proves the rule:[3]

Vowel sequencing overrules adjective ordering:

- Order: opinion - size - age - shape - color - origin - material - purpose.
- Little Red Riding Hood (okay: size - color - purpose).
- Big Bad Wolf (vowel ordering wins: size - opinion).
- Lon-lat is horizontal-vertical (x-y) but doesn't sound good.
- Lat-lon sounds good but is vertical-horizontal (y-x). Yikes.
- (Separately: x-y is sensibly alphabetic, but we have made an abstraction concrete.)
- Trouble-at-mill: Twitter has in the past had lon-lat and lat-lon in a single tweet's json.

[2] https://en.wikipedia.org/wiki/Coodabeen_Champions

Welcome to DodecaPoCS

Twelve is a hero:

- 12 is a superior highly composite number, highly totient, and super abundant.
- 12 is one of only two known sublime numbers, for which both the number and sum of their positive factors are perfect numbers (6 and 28).
- Compositeness means the Duoedecimal System is for Winners: 12 hours in half a day, 12 inches in a foot.[4]
- 'Twelve', 'twelfth', and 'twelvish' all have excellent speekfeel.
- And 'dozen'. 'Dozen', 'dozen', 'dozen'.
- Related: The Rampaging On-Line Encyclopedia of Integer Sequences, https://oeis.org.

[4] Metric-Schmetric

Europe:

- Many errors called out in comments. Why hasn't this been done well?

John Conway's Doomsday rule for determining a date's day of the week:

Memorable Doomsdays:

Month	Memorable date	Month/Day	Mnemonic[6]
January	January 3 (common years), January 4 (leap years)	1/3 or 1/4	the 3rd **3** years in 4 and the 4th in the **4**th
February	February 28 (common years), February 29 (leap years)	2/28 or 2/29	last day of February
March	"March 0"	3/0	last day of February
April	April 4	4/4	**4/4**, 6/6, 8/8, 10/10, 12/12
May	May 9	5/9	**9-to-5** at 7-11
June	June 6	6/6	4/4, **6/6**, 8/8, 10/10, 12/12
July	July 11	7/11	9-to-5 at **7-11**
August	August 8	8/8	4/4, 6/6, **8/8**, 10/10, 12/12
September	September 5	9/5	**9-to-5** at 7-11
October	October 10	10/10	4/4, 6/6, 8/8, **10/10**, 12/12
November	November 7	11/7	9-to-5 at **7-11**
December	December 12	12/12	4/4, 6/6, 8/8, 10/10, **12/12**

- Pi day (March 14), July 4, Halloween, and Boxing Day are always Doomsdays.

Outline:

- Determine "anchor day" for a given century, then find Doomsday for a given year in that century.
- Remember special Doomsday dates and work from there.
- Naturally: Load this year's Doomsday into brain.

Century's anchor day (Gregorian, Sunday $\equiv 0$):

$$5 \times \left(\left\lfloor \frac{YYYY}{100} \right\rfloor \bmod 4\right) \bmod 7 + \text{Tuesday}$$

Offset:

$$\left(365YY + \left\lfloor \frac{YY}{4} \right\rfloor\right) \bmod 7 = \left(YY + \left\lfloor \frac{YY}{4} \right\rfloor\right) \bmod 7$$

Doomsdays for the Gregorian calendar

Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
1898	1899	1900	1901	1902	1903	→	1904	1905	1906	1907	→	1908	1909
1910	1911	→	1912	1913	1914	1915	→	1916	1917	1918	1919	→	1920
1921	1922	1923	→	1924	1925	1926	1927	→	1928	1929	1930	1931	→
1932	1933	1934	1935	→	1936	1937	1938	1939	→	1940	1941	1942	1943
→	1944	1945	1946	1947	→	1948	1949	1950	1951	→	1952	1953	1954
1955	→	1956	1957	1958	1959	→	1960	1961	1962	1963	→	1964	1965
1966	1967	→	1968	1969	1970	1971	→	1972	1973	1974	1975	→	1976
1977	1978	1979	→	1980	1981	1982	1983	→	1984	1985	1986	1987	→
1988	1989	1990	1991	→	1992	1993	1994	1995	→	1996	1997	1998	1999
→	2000	2001	2002	2003	→	2004	2005	2006	2007	→	2008	2009	2010
2011	→	2012	2013	2014	2015	→	2016	2017	2018	2019	→	2020	2021
2022	2023	→	2024	2025	2026	2027	→	2028	2029	2030	2031	→	2032
2033	2034	2035	→	2036	2037	2038	2039	→	2040	2041	2042	2043	→
2044	2045	2046	2047	→	2048	2049	2050	2051	→	2052	2053	2054	2055
→	2056	2057	2058	2059	→	2060	2061	2062	2063	→	2064	2065	2066
2067	→	2068	2069	2070	2071	→	2072	2073	2074	2075	→	2076	2077
2078	2079	→	2080	2081	2082	2083	→	2084	2085	2086	2087	→	2088
2089	2090	2091	→	2092	2093	2094	2095	→	2096	2097	2098	2099	2100

- Works for Gregorian (1582–, haphazardly) and the increasingly inaccurate Julian calendars (400 and 28 years cycles).
- Apparently inspired by Lewis Carroll's work on a perpetual calendar.

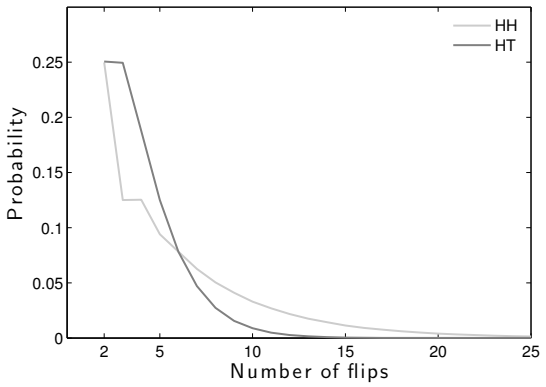
The bissextile year

"The Julian calendar, which was developed in 46 BC by Julius Caesar, and became effective in 45 BC, distributed an extra ten days among the months of the Roman Republican calendar. Caesar also replaced the intercalary month by a single intercalary day, located where the intercalary month used to be. To create the intercalary day, the existing ante diem sextum Kalendas Martias (February 24) was doubled, producing ante diem bis sextum Kalendas Martias. Hence, the year containing the doubled day was a bissextile (bis sextum, "twice sixth") year. For legal purposes, the two days of the bis sextum were considered to be a single day, with the second half being intercalated; but in common practice by 238, when Censorinus wrote, the intercalary day was followed by the last five days of February, a. d. VI, V, IV, III and pridie Kal. Mart. (the days numbered 24, 25, 26, 27, and 28 from the beginning of February in a common year), so that the intercalated day was the first half of the doubled day. Thus the intercalated day was effectively inserted between the 23rd and 24th days of February."

Homo nonprobabilisticus, continued:

- Important detour: The final digits of primes are not entirely random (how did we not know this?).
- Start flipping a coin ...
- Two tosses: What are the probabilities of flipping (1) HH and (2) HT?
- Flip a coin $n \geq 2$ times: What are the probabilities that the last two tosses are (1) HH or (2) HT?
- Estimate: On average, how many flips does it take to first see the sequence HT?
- Estimate: On average, how many flips does it take to first see the sequence HH?
- What's the probability of first flipping a HT sequence on the $n-1$th and nth flips?
- What's the probability of first flipping two heads in a row (HH) on the $(n-1)$th and nth flips?

Homo nonprobabilisticus, continued:



Average number of flips: 4 and 6.

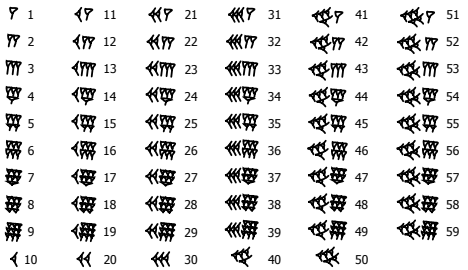
Universal numbers

From here.

- Accidents of evolution[1] give us 5 + 5 = 10 fingers and hence base 10.
- We could be happy with base 6, 8, 12, ...
- We like these:
  - 60 seconds in a minute
  - 60 minutes in an hour.
  - 2 × 12 = 24 hours in a day.
  - 360 degrees in a circle.

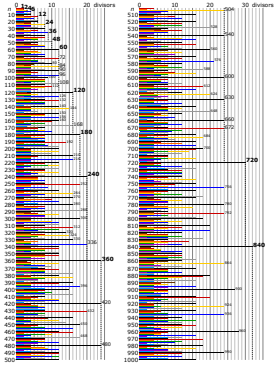
[1] Maybe 5 fingers are not an accident

We've liked these kinds of numbers for a long time:



- 2000 BC: Babylonian base 60/Sexagesimal system.
- Other bases (or radices): 2, 10, 12 (duodecimal/dozenal), 6 (senary), 8, 16, 20 (vigesimal), 60.

Highly composite numbers:



By Cmglee - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=31684018

- HCN = natural number with more divisors than any smaller natural number.
- 2, 4, 6, 12, 24, 36, 48, 60, 120, 180, 240, 360, 720, 840, 1260, 1680, 2520, 5040 (Plato's optimal city population), ...
- OEIS sequence A002182

Superior highly composite numbers:

# prime factors	SHCN n	prime factorization	prime exponents	# divisors d(n)		primorial factorization
1	2	2	1	2	2	2
2	6	$2 \cdot 3$	1,1	2^2	4	6
3	12	$2^2 \cdot 3$	2,1	3×2	6	$2 \cdot 6$
4	60	$2^2 \cdot 3 \cdot 5$	2,1,1	3×2^2	12	$2 \cdot 30$
5	120	$2^3 \cdot 3 \cdot 5$	3,1,1	4×2^2	16	$2^2 \cdot 30$
6	360	$2^3 \cdot 3^2 \cdot 5$	3,2,1	$4 \times 3 \times 2$	24	$2 \cdot 6 \cdot 30$
7	2520	$2^3 \cdot 3^2 \cdot 5 \cdot 7$	3,2,1,1	$4 \times 3 \times 2^2$	48	$2 \cdot 6 \cdot 210$
8	5040	$2^4 \cdot 3^2 \cdot 5 \cdot 7$	4,2,1,1	$5 \times 3 \times 2^2$	60	$2^2 \cdot 6 \cdot 210$
9	55440	$2^4 \cdot 3^2 \cdot 5 \cdot 7 \cdot 11$	4,2,1,1,1	$5 \times 3 \times 2^3$	120	$2^2 \cdot 6 \cdot 2310$
10	720720	$2^4 \cdot 3^2 \cdot 5 \cdot 7 \cdot 11 \cdot 13$	4,2,1,1,1,1	$5 \times 3 \times 2^4$	240	$2^2 \cdot 6 \cdot 30030$

- SHCN = natural number n whose number of divisors exceeds that of any other number when scaled relative to itself in a sneaky way:

$$\frac{d(n)}{n^\epsilon} \geq \frac{d(j)}{j^\epsilon} \text{ and } \frac{d(n)}{n^\epsilon} > \frac{d(k)}{k^\epsilon}$$

for $j < n < k$ and some $\epsilon > 0$.

There's more: Superabundant numbers

- n is superabundant if:

$$\frac{\sigma_1(n)}{n} > \frac{\sigma_1(j)}{j}$$

for $j < n$ and where $\sigma_x(n) = \sum_{d|n} d^x$ is the divisor function.

- 449 numbers are both superabundant and highly composite.

Yet more: Colossally abundant numbers:

- n is colossally abundant if for all j and some $\epsilon > 0$:

$$\frac{\sigma_1(n)}{n^{1+\epsilon}} \geq \frac{\sigma_1(j)}{j^{1+\epsilon}}$$

- Infinitely many but only 22 less than 10^{18}.

Some very, very silly units of measurement courtesy of the Imperial system:

- 22 yards in a chain = 1 cricket pitch, 100 links in a chain, 10 chains in a furlong, 80 chains in a mile.
- 1 acre = 1 furlong × 1 chain = 43,560 square feet.
- 160 fluid ounces in a gallon.
- 14 pounds in a stone.
- Hundredweight = 112 pounds.

Also:

- Fahrenheit, Celcius, and Kelvin.
- The entire metric system.

Burning through stories for fuel in the Experimental Training Laboratory:

References I