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Letter frequency

The **frequency of letters** in text has been studied for use in cryptanalysis, and frequency analysis in particular, dating back to the Iraqi mathematician Al-Kindi (c. 801–873 AD), who formally developed the method (the ciphers breakable by this technique go back at least to the Caesar cipher invented by Julius Caesar, so this method could have been explored in classical times). Letter frequency analysis gained additional importance in Europe with the development of movable type in 1450 AD, where one must estimate the amount of type required for each letterform, as evidenced by the variations in letter compartment size in typographer's type cases.

California Job Case

Linguists use letter frequency analysis as a rudimentary technique for language identification, where it's particularly effective as an indication of whether an unknown writing system is alphabetic, syllablic, or ideographic. For example, the Japanese Hiragana syllabary contains 46 distinct characters, which is more than most phonetic alphabets; by contrast, the English and Hawaiian alphabets have only 26 and 13 letters, respectively.

No exact letter frequency distribution underlies a given language, since all writers write slightly differently. However, most languages have a characteristic distribution which is strongly apparent in longer texts. Even language changes as extreme as from old English to modern English (regarded as mutually unintelligible) show strong trends in related letter frequencies: over a small sample of Biblical passages, from most frequent to least frequent, **enaid sorhm tgþlwu (æ)cfy ðbpxz** of old English compares to **eotha sinrd luymw fgcbp kvjqxz** of modern English, with the most extreme differences concerning letterforms not shared.[1]

Linotype machines for the English language assumed the letter order, from most to least common, to be **etaoin shrdlu cmfwyp vbgkjq xz** based on the experience and custom of manual compositors. The equivalent for the French language was **elaoin sdrétu cmfhyp vbgwqj xz**.

Arranging the alphabet in Morse into groups of letters that require equal amounts of time to transmit, and then sorting these groups in increasing order, yields **e it san hurdm wgvlfbk opxcz jyq**.[a] Letter frequency was used by other telegraph systems, such as the Murray Code.

Similar ideas are used in modern data-compression techniques such as Huffman coding.

Letter	Relative frequency in the English language	
a	8.167%	
b	1.492%	
c	2.202%	
d	4.253%	
e	12.702%	
f	2.228%	
g	2.015%	
h	6.094%	
i	6.966%	
j	0.153%	
k	1.292%	
l	4.025%	
m	2.406%	
n	6.749%	
o	7.507%	
p	1.929%	
q	0.095%	
r	5.987%	
s	6.327%	
t	9.356%	
u	2.758%	
v	0.978%	
w	2.560%	
x	0.150%	
y	1.994%	
z	0.077%	

Contents

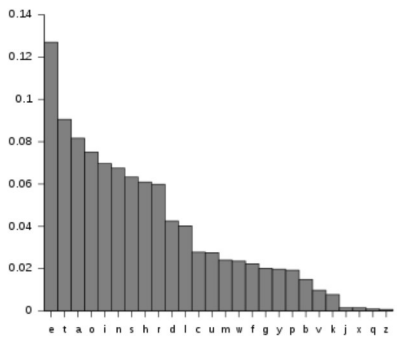
Letter frequencies, like word frequencies, tend to vary, both by writer and by subject. One cannot write an essay about x-rays without using frequent Xs, and the essay will have an idiosyncratic letter frequency if the essay is about the use of x-rays to treat zebras in Qatar. Different authors have habits which can be reflected in their use of letters. Hemingway's writing style, for example, is visibly different from Faulkner's. Letter, bigram, trigram, word frequencies, word length, and sentence length can be calculated for specific authors, and used to prove or disprove authorship of texts, even for authors whose styles are not so divergent.

Accurate average letter frequencies can only be gleaned by analyzing a large amount of representative text. With the availability of modern computing and collections of large text corpora, such calculations are easily made. Examples can be drawn from a variety of sources (press reporting, religious texts, scientific texts and general fiction) and there are differences especially for general fiction with the position of 'h' and 'i', with 'h' becoming more common.

Herbert S. Zim, in his classic introductory cryptography text "Codes and Secret Writing", gives the English letter frequency sequence as "ETAON RISHD LFCMU GYPWB VKJXZQ", the most common letter pairs as "TH HE AN RE ER IN ON AT ND ST ES EN OF TE ED OR TI HI AS TO", and the most common doubled letters as "LL EE SS OO TT FF RR NN PP CC".[2]

Also, to note that different dialects of a language will also affect a letter's frequency. For example, an author in the United States would produce something in which the letter 'z' is more common than an author in the United Kingdom writing on the same topic: words like "analyze", "apologize", and "recognize" contain the letter in American English, whereas the same words are spelled "analyse", "apologise", and "recognise" in British English. This would highly affect the frequency of the letter 'z' as it is a rarely used letter by British speakers in the English language.[3]

The "top twelve" letters constitute about 80% of the total usage. The "top eight" letters constitute about 65% of the total usage. Letter frequency as a function of rank can be fitted well by several rank functions, with the two-parameter Cocho/Beta rank function being the best.[4] Another rank function with no adjustable free parameter also fits the letter frequency distribution reasonably well[5] (the same function has been used to fit the amino acid frequency in protein sequences.[6]) A spy using the VIC cipher or some other cipher based on a straddling checkerboard typically uses a mnemonic such as "a sin to err" (dropping the second "r")[7][8] or "at one sir"[9] to remember the top eight characters.



Relative frequencies ordered by frequency

The use of letter frequencies and frequency analysis plays a fundamental role in cryptograms and several word puzzle games, including Hangman, Scrabble and the television game show *Wheel of Fortune*. One of the earliest descriptions in classical literature of applying the knowledge of English letter frequency to solving a cryptogram is found in Edgar Allan Poe's famous story *The Gold-Bug*, where the method is successfully applied to decipher a message instructing on the whereabouts of a treasure hidden by Captain Kidd.[10]

Letter frequencies had a strong effect on the design of some keyboard layouts. The most frequent letters are on the bottom row of the Blickensderfer typewriter, and the home row of the Dvorak keyboard layout.

Relative frequencies of letters in the English language

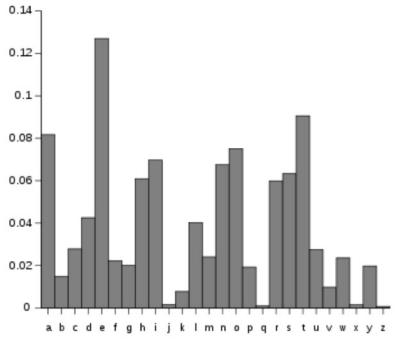
There are three ways to count letter frequency that result in very different charts for common letters. The first method, used in the chart below, is to count letter frequency in root words of a dictionary. The second is to include all word variants when counting, such as "abstracts", "abstracted" and "abstracting" and not just the root word of "abstract". This system results in letters like 's' appearing much more frequently, such as when counting letters from lists of the most used English words on the Internet. A final variant is to count letters based on their frequency of use in actual texts, resulting in certain letter combinations like 'th' becoming more common due to the frequent use of common words like "the", "then", "both", etc. Absolute usage frequency measures like this are used when creating keyboard layouts or letter frequencies in old fashioned printing presses.

An analysis of entries in the Concise Oxford dictionary, ignoring frequency of word use, gives an order of "EARIOTNSLCUDPMHGBFYWKVXZJQ".[11]

The letter-frequency table below is taken from Pavel Mička's website, which cites Robert Lewand's *Cryptological Mathematics*.[12]

According to Lewand, arranged from most to least common in appearance, the letters are: **etaoinshrdlcumwfgypbvkjxqz**. Lewand's ordering differs slightly from others, such as Cornell University Math Explorer's Project, which produced a table after measuring 40,000 words.[13]

In English, the space is slightly more frequent than the top letter (e)[14] and the non-alphabetic characters (digits, punctuation, etc.) collectively occupy the fourth position (having already included the space) between *t* and *a*.[15]



Relative frequencies of letters in text

Relative frequencies of the first letters of a word in the English language

The frequency of the first letters of words or names is helpful in pre-assigning space in physical files and indexes.[16] Given 26 filing cabinet drawers, rather than a 1:1 assignment of one drawer to one letter of the alphabet, it is often useful to use a more equal-frequency-letter code by assigning several low-frequency letters to the same drawer (often one drawer is labeled VWXYZ), and to split up the most-frequent initial letters ('S', 'A', and 'C') into several drawers (often 6 drawers Aa-An, Ao-Az, Ca-Cj, Ck-Cz, Sa-Si, Sj-Sz). The same system is used in some multi-volume works such as some encyclopedias. Cutter numbers, another mapping of names to a more equal-frequency code, are used in some libraries.

Both the overall letter distribution and the word-initial letter distribution approximately match the Zipf distribution and even more closely match the Yule distribution.[17]

Often the frequency distribution of the first digit in each datum is significantly different from the overall frequency of all the digits in a set of numeric data, see Benford's law for details.

An analysis by Peter Norvig on Google Books data determined, among other things, the frequency of first letters of English words.[18]

Letter	Relative frequency as the first letter of an English word	
a	11.682%	
b	4.434%	
c	5.238%	
d	3.174%	
e	2.799%	
f	4.027%	
g	1.642%	
h	4.200%	
i	7.294%	
j	0.511%	
k	0.856%	
l	2.415%	
m	3.826%	
n	2.284%	
o	7.631%	
p	4.319%	
q	0.222%	
r	2.826%	
s	6.686%	
t	15.978%	
u	1.183%	
v	0.824%	
w	5.497%	
x	0.045%	
y	0.763%	
z	0.045%	

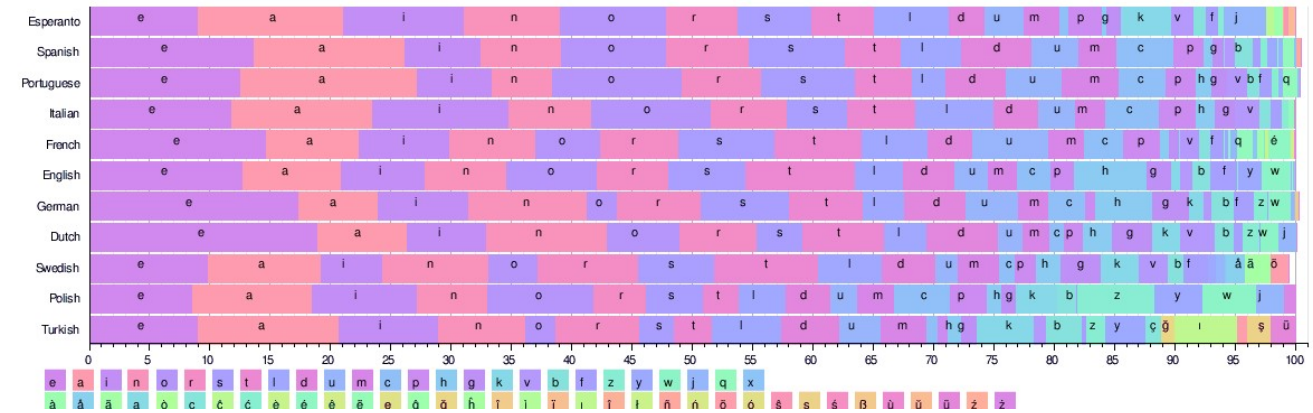
Relative frequencies of letters in other languages

Letter	English	French [19]	German [20]	Spanish [21]	Portuguese [22]	Esperanto [23]	Italian [24]	Turkish [25]	Swedish [26]	Polish [27]	Dutch [28]	Danish [29]	Icelandic [30]	Finnish [31]	Czech
a	8.167%	7.636%	6.516%	11.525%	14.634%	12.117%	11.745%	11.920%	9.383%	10.503%	7.486%	6.025%	10.110%	12.217%	8.421%
b	1.492%	0.901%	1.886%	2.215%	1.043%	0.980%	0.927%	2.844%	1.535%	1.740%	1.584%	2.000%	1.043%	0.281%	0.822%
c	2.782%	3.260%	2.732%	4.019%	3.882%	0.776%	4.501%	0.963%	1.486%	3.895%	1.242%	0.565%	0	0.281%	0.740%
d	4.253%	3.669%	5.076%	5.010%	4.992%	3.044%	3.736%	4.706%	4.702%	3.725%	5.933%	5.858%	1.575%	1.043%	3.475%
e	12.702%	14.715%	16.396%	12.181%	12.570%	8.995%	11.792%	8.912%	10.149%	7.352%	18.91%	15.453%	6.418%	7.968%	7.562%
f	2.228%	1.066%	1.656%	0.692%	1.023%	1.037%	1.153%	0.461%	2.027%	0.143%	0.805%	2.406%	3.013%	0.194%	0.084%
g	2.015%	0.866%	3.009%	1.768%	1.303%	1.171%	1.644%	1.253%	2.862%	1.731%	3.403%	4.077%	4.241%	0.392%	0.092%
h	6.094%	0.737%	4.577%	0.703%	0.781%	0.384%	0.636%	1.212%	2.090%	1.015%	2.380%	1.621%	1.871%	1.851%	1.356%
i	6.966%	7.529%	6.550%	6.247%	6.186%	10.012%	10.143%	8.600%*	5.817%	8.328%	6.499%	6.000%	7.578%	10.817%	6.073%
j	0.153%	0.613%	0.268%	0.493%	0.397%	3.501%	0.011%	0.034%	0.614%	1.836%	1.46%	0.730%	1.144%	2.042%	1.433%
k	0.772%	0.074%	1.417%	0.011%	0.015%	4.163%	0.009%	4.683%	3.140%	2.753%	2.248%	3.395%	3.314%	4.973%	2.894%
l	4.025%	5.456%	3.437%	4.967%	2.779%	6.104%	6.510%	5.922%	5.275%	2.564%	3.568%	5.229%	4.532%	5.761%	3.802%
m	2.406%	2.968%	2.534%	3.157%	4.738%	2.994%	2.512%	3.752%	3.471%	2.515%	2.213%	3.237%	4.041%	3.202%	2.446%
n	6.749%	7.095%	9.776%	6.712%	4.446%	7.955%	6.883%	7.487%	8.542%	6.237%	10.032%	7.240%	7.711%	8.826%	6.468%
o	7.507%	5.796%	2.594%	8.683%	9.735%	8.779%	9.832%	2.476%	4.482%	6.667%	6.063%	4.636%	2.166%	5.614%	6.695%
p	1.929%	2.521%	0.670%	2.510%	2.523%	2.755%	3.056%	0.886%	1.839%	2.445%	1.57%	1.756%	0.789%	1.842%	1.906%
q	0.095%	1.362%	0.018%	0.877%	1.204%	0	0.505%	0	0.020%	0	0.009%	0.007%	0	0.013%	0.001%
r	5.987%	6.693%	7.003%	6.871%	6.530%	5.914%	6.367%	6.722%	8.431%	5.243%	6.411%	8.956%	8.581%	2.872%	4.799%
s	6.327%	7.948%	7.270%	7.977%	6.805%	6.092%	4.981%	3.014%	6.590%	5.224%	3.73%	5.805%	5.630%	7.862%	5.212%
t	9.056%	7.244%	6.154%	4.632%	4.336%	5.276%	5.623%	3.314%	7.691%	2.475%	6.79%	6.862%	4.953%	8.750%	5.727%
u	2.758%	6.311%	4.166%	2.927%	3.639%	3.183%	3.011%	3.235%	1.919%	2.062%	1.99%	1.979%	4.562%	5.008%	2.160%
v	0.978%	1.838%	0.846%	1.138%	1.575%	1.904%	2.097%	0.959%	2.415%	0.012%	2.85%	2.332%	2.437%	2.250%	5.344%
w	2.360%	0.049%	1.921%	0.017%	0.037%	0	0.033%	0	0.142%	5.813%	1.52%	0.069%	0	0.094%	0.016%
x	0.150%	0.427%	0.034%	0.215%	0.253%	0	0.003%	0	0.159%	0.004%	0.036%	0.028%	0.046%	0.031%	0.027%
y	1.974%	0.128%	0.039%	1.008%	0.006%	0	0.020%	3.336%	0.708%	3.206%	0.035%	0.698%	0.900%	1.745%	1.043%
z	0.074%	0.326%	1.134%	0.467%	0.470%	0.494%	1.181%	1.500%	0.070%	4.852%	1.39%	0.034%	0	0.051%	1.503%
à	0	0.486%	0	0	0.072%	0	0.635%	0	0	0	0	0	0	0	0
â	0	0.051%	0	0	0.562%	0	~0%	0	0	0	0	0	0	0	0
á	0	0	0	0.502%	0.118%	0	0	0	0	0	0	0	1.799%	0	0.867%
å	0	0	0	0	0	0	0	0	1.338%	0	0	1.190%	0	0.003%	0
ä	0	0	0.578%	0	0	0	0	0	1.797%	0	0	0	0	3.577%	0
ă	0	0	0	0	0.733%	0	0	0	0	0	0	0	0	0	0
ą	0	0	0	0	0	0	0	0	0	0.699%	0	0	0	0	0
æ	0	0	0	0	0	0	0	0	0	0	0	0.872%	0.867%	0	0
œ	0	0.018%	0	0	0	0	0	0	0	0	0	0	0	0	0
ç	0	0.085%	0	0	0.530%	0	0	1.156%	0	0	0	0	0	0	0
ĉ	0	0	0	0	0	0.657%	0	0	0	0	0	0	0	0	0
ć	0	0	0	0	0	0	0	0	0	0.743%	0	0	0	0	0
č	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.462%
ď	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.015%
ð	0	0	0	0	0	0	0	0	0	0	0	0	4.393%	0	0
è	0	0.271%	0	0	0	0	0.263%	0	0	0	0	0	0	0	0
é	0	1.504%	0	0.433%	0.337%	0	0	0	0	0	0	0	0.647%	0	0.633%
ê	0	0.218%	0	0	0.450%	0	~0%	0	0	0	0	0	0	0	0
ë	0	0.008%	0	0	0	0	0	0	0	0	0	0	0	0	0
ę	0	0	0	0	0	0	0	0	0	1.035%	0	0	0	0	0
ě	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.222%
ĝ	0	0	0	0	0	0.691%	0	0	0	0	0	0	0	0	0
ğ	0	0	0	0	0	0	0	1.125%	0	0	0	0	0	0	0
ĥ	0	0	0	0	0	0.022%	0	0	0	0	0	0	0	0	0
î	0	0.045%	0	0	0	0	~0%	0	0	0	0	0	0	0	0
ì	0	0	0	0	0	0	(0.030%)	0	0	0	0	0	0	0	0
í	0	0	0	0.725%	0.132%	0	0.030%	0	0	0	0	0	1.570%	0	1.643%
ï	0	0.005%	0	0	0	0	0	0	0	0	0	0	0	0	0
ı	0	0	0	0	0	0	0	5.114%*	0	0	0	0	0	0	0
ĵ	0	0	0	0	0	0.055%	0	0	0	0	0	0	0	0	0
ł	0	0	0	0	0	0	0	0	0	2.109%	0	0	0	0	0
ñ	0	0	0	0.311%	0	0	0	0	0	0	0	0	0	0	0
ń	0	0	0	0	0	0	0	0	0	0.362%	0	0	0	0	0
ň	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.007%
ò	0	0	0	0	0	0	0.002%	0	0	0	0	0	0	0	0

Letter	English	French [19]	German [20]	Spanish [21]	Portuguese [22]	Esperanto [23]	Italian [24]	Turkish [25]	Swedish [26]	Polish [27]	Dutch [28]	Danish [29]	Icelandic [30]	Finnish [31]	Czech
ö	0	0	0.443%	0	0	0	0	0.777%	1.305%	0	0	0	0.777%	0.444%	0
ô	0	0.023%	0	0	0.635%	0	~0%	0	0	0	0	0	0	0	0
ó	0	0	0	0.827%	0.296%	0	~0%	0	0	1.141%	0	0	0.994%	0	0.024%
õ	0	0	0	0	0.040%	0	0	0	0	0	0	0	0	0	0
ø	0	0	0	0	0	0	0	0	0	0	0	0.939%	0	0	0
ř	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.380%
ŝ	0	0	0	0	0	0.385%	0	0	0	0	0	0	0	0	0
ş	0	0	0	0	0	0	0	1.780%	0	0	0	0	0	0	0
ś	0	0	0	0	0	0	0	0	0	0.814%	0	0	0	0	0
š	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.688%
ß	0	0	0.307%	0	0	0	0	0	0	0	0	0	0	0	0
ť	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.006%
þ	0	0	0	0	0	0	0	0	0	0	0	0	1.455%	0	0
ù	0	0.058%	0	0	0	0	(0.166%)	0	0	0	0	0	0	0	0
ú	0	0	0	0.168%	0.207%	0	0.166%	0	0	0	0	0	0.613%	0	0.045%
û	0	0.060%	0	0	0	0	~0%	0	0	0	0	0	0	0	0
ŭ	0	0	0	0	0	0.520%	0	0	0	0	0	0	0	0	0
ü	0	0	0.995%	0.012%	0.026%	0	0	1.854%	0	0	0	0	0	0	0
ů	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.204%
ý	0	0	0	0	0	0	0	0	0	0	0	0	0.228%	0	0.995%
ź	0	0	0	0	0	0	0	0	0	0.078%	0	0	0	0	0
ż	0	0	0	0	0	0	0	0	0	0.706%	0	0	0	0	0
ž	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.721%

*See Dotted and dotless I.

The figure below illustrates the frequency distributions of the 26 most common Latin letters across some languages. All of these languages use a similar 25+ character alphabet.



Based on these tables, the 'etaoin shrdlu'-equivalent results for each language is as follows:

- French: 'esait nruol'; (Indo-European: Romance; traditionally, 'esartinulop' is used, in part for its ease of pronunciation[32])
- Spanish: 'eaosr nidlt'; (Indo-European: Romance)
- Portuguese: 'aeosr idmnt' (Indo-European: Romance)
- Italian: 'eaion lrtsc'; (Indo-European: Romance)
- Esperanto: 'aieon lsrtk' (artificial language – lexic influenced by Indo-European languages, Romance, Germanic mostly)
- German: 'enisr atdhu'; (Indo-European: Germanic)
- Swedish: 'eanrt sildo'; (Indo-European: Germanic)
- Turkish: 'aeinr lkdım'; (Turkic)
- Dutch: 'enati rodsl'; (Indo-European: Germanic)[28]
- Polish: 'aieon wrszc'; (Indo-European: Slavic)
- Danish: 'ernta idslo'; (Indo-European: Germanic)
- Icelandic: 'arnie stuló'; (Indo-European: Germanic)
- Finnish: 'ainte slouk'; (Uralic: Finnic)
- Czech: 'aeoni tvsrl'; (Indo-European: Slavic)

See also

- Corpus linguistics
- RSTLNE (Wheel of Fortune)
- English word frequency
- Arabic letter frequency

Notes

a. American Morse code was developed in the 1830s by Alfred Vail, based on English-language letter frequencies, to encode the most frequent letters with the shortest symbols. Some efficiency was lost in the reformed version now used: the International Morse Code.

Citations

1. Moreno, Marsha Lynn (Spring 2005). "Frequency Analysis in Light of Language Innovation" (http://www.math.ucsd.edu/~crypto/Projects/MarshaMoreno/TimeComparisonFrequency.pdf) (PDF). Math. University of California – San Diego. Retrieved 19 February 2015.
2. Zim, Herbert Spencer (1961). *Codes & Secret Writing: Authorized Abridgement*. Scholastic Book Services. OCLC 317853773 (https://www.worldcat.org/oclc/317853773).
3. "British and American spelling - Oxford Dictionaries" (http://www.oxforddictionaries.com/words/british-and-american-spelling). *Oxford Dictionaries - English*. Retrieved 18 April 2018.
4. Li, Wentian; Miramontes, Pedro (2011). "Fitting ranked English and Spanish letter frequency distribution in US and Mexican presidential speeches". *Journal of Quantitative Linguistics*. **18** (4): 359. arXiv:1103.2950 (https://arxiv.org/abs/1103.2950). doi:10.1080/09296174.2011.608606 (https://doi.org/10.1080%2F09296174.2011.608606).
5. Gusein-Zade, S.M. (1988). "Frequency distribution of letters in the Russian language". *Probl. Peredachi Inf.* **24** (4): 102–107.
6. Gamow, George; Ycas, Martynas (1955). "Statistical correlation of protein and ribonucleic acid composition" (http://www.pnas.org/content/41/12/1011.full.pdf) (PDF). *Proc. Natl. Acad. Sci.* **41** (12): 1011–1019. Bibcode:1955PNAS...41.1011G (https://ui.adsabs.harvard.edu/abs/1955PNAS...41.1011G). doi:10.1073/pnas.41.12.1011 (https://doi.org/10.1073%2Fpnas.41.12.1011). PMC 528190 (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC528190). PMID 16589789 (https://www.ncbi.nlm.nih.gov/pubmed/16589789).
7. Bauer, Friedrich L. (2006). *Decrypted Secrets: Methods and maxims of cryptology* (https://books.google.com/books?id=hfWTDr_bvMwC). p. 57 – via Google Books.
8. Goebel, Greg (2009). *The Rise Of Field Ciphers: straddling checkerboard ciphers* (http://www.vectorsite.net/ttcode_03.html).
9. Rijmenants, Dirk. "One-time Pad" (http://users.telenet.be/d.rijmenants/en/onetimepad.htm).
10. Poe, Edgar Allan. "The works of Edgar Allan Poe in five volumes" (http://www.gutenberg.org/catalog/world/readfile?fk_files=1977099). Project Gutenberg.
11. "What is the frequency of the letters of the alphabet in English?" (http://oxforddictionaries.com/words/what-is-the-frequency-of-the-letters-of-the-alphabet-in-english). *Oxford Dictionary*. Oxford University Press. Retrieved 29 December 2012.
12. Mička, Pavel. "Letter frequency (English)" (http://en.algoritmy.net/article/40379/Letter-frequency-English). Algoritmy.net.
13. "Frequency Table" (http://www.math.cornell.edu/~mec/2003-2004/cryptography/subs/frequencies.html). *cornell.edu*.
14. "Statistical Distributions of English Text" (https://web.archive.org/web/20170918020907/http://www.data-compression.com/english.html). *data-compression.com*. Archived from the original (http://www.data-compression.com/english.html) on 2017-09-18.
15. Lee, E. Stewart. "Essays about Computer Security" (http://www.cl.cam.ac.uk/~mgk25/lee-essays.pdf) (PDF). University of Cambridge Computer Laboratory. p. 181.
16. Ohlman, Herbert Marvin (1959). *Subject-Word Letter Frequencies with Applications to Superimposed Coding* (http://books.nap.edu/openbook.php?record_id=10866&page=903). Proceedings of the International Conference on Scientific Information.
17. Pande, Hemlata; Dhami, H.S. "Mathematical Modelling of Occurrence of Letters and Word's Initials in Texts of Hindi Language" (http://www.skase.sk/Volumes/JTL16/pdf_doc/02.pdf) (PDF). *JTL*. **16**.
18. "English Letter Frequency Counts: Mayzner revisited or ETAOIN SRHLDCU" (http://norvig.com/mayzner.html). *norvig.com*. Retrieved 18 April 2018.
19. "Corpus de Thomas Tempé" (https://web.archive.org/web/20070930194046/http://gpl.insa-lyon.fr/Dvorak-Fr/CorpusDeThomasTemp%C3%A9). Archived from the original (http://gpl.insa-lyon.fr/Dvorak-Fr/CorpusDeThomasTemp%C3%A9) on 30 September 2007. Retrieved 15 June 2007.
20. Beutelspacher, Albrecht (2005). *Kryptologie* (7 ed.). Wiesbaden: Vieweg. p. 10. ISBN 3-8348-0014-7.
21. Pratt, Fletcher (1942). *Secret and Urgent: The sstory of codes and ciphers*. Garden City, NY: Blue Ribbon Books. pp. 254–5. OCLC 795065 (https://www.worldcat.org/oclc/795065).
22. "Frequência da ocorrência de letras no Português" (http://www.numaboa.com/criptografia/criptoanalise/310-Frequencia-no-Portugues). Retrieved 16 June 2009.
23. "La Oftecoj de la Esperantaj Literoj" (http://lingvakritiko.com/2007/09/13/literoftecoj-kaj-tabelvortofteco j/). Retrieved 14 September 2007.
24. Singh, Simon; Galli, Stefano (1999). *Codici e Segreti* (in Italian). Milano: Rizzoli. ISBN 978-8-817-86213-4. OCLC 535461359 (https://www.worldcat.org/oclc/535461359).
25. Serengil, Sefik Ilkin; Akin, Murat (20–22 February 2011). *Attacking Turkish Texts Encrypted by Homophonic Cipher* (http://www.wseas.us/e-library/conferences/2011/Cambridge/NEHIPISIC/NEHIPISIC-20.pdf) (PDF). Proceedings of the 10th WSEAS International Conference on Electronics, Hardware, Wireless and Optical Communications. Cambridge, UK. pp. 123–126.
26. "Practical Cryptography" (http://practicalcryptography.com/cryptanalysis/letter-frequencies-various-languages/swedish-letter-frequencies/). Retrieved 30 October 2013.
27. "Wstęp do kryptologii" (http://www.korzen.org/wsisiz/wstep%20do%20kryptologii/wyklady/Wykad%202.doc). *www.korzen.org*. "counting [space] 17.2%, [dot point] 0.9%, [comma] 0.9% and [semicolon] 0.5%"
28. "Letterfrequenties" (http://www.onzetaal.nl/advies/letterfreq.php). *Genootschap OnzeTaal*. Retrieved 17 May 2009.
29. "Danish letter frequencies" (http://practicalcryptography.com/cryptanalysis/letter-frequencies-various-languages/danish-letter-frequencies/). *Practical Cryptography*. Retrieved 24 October 2013.
30. "Icelandic letter frequencies" (http://practicalcryptography.com/cryptanalysis/letter-frequencies-various-languages/icelandic-letter-frequencies/). *Practical Cryptography*. Retrieved 24 October 2013.
31. "Finnish letter frequencies" (http://practicalcryptography.com/cryptanalysis/letter-frequencies-various-languages/finnish-letter-frequencies/). *Practical Cryptography*. Retrieved 24 October 2013.
32. Perec, Georges; *Alphabets*; Éditions Galilée, 1976

Some useful tables for single letter, digram, trigram, tetragram, and pentagram frequencies based on 20,000 words that take into account word-length and letter-position combinations for words 3 to 7 letters in length. The references are as follows:

- Mayzner, M.S.; Tresselt, M.E.; Wolin, B.R. (1965). "Tables of single-letter and digram frequency counts for various word-length and letter-position combinations". *Psychonomic Monograph Supplements*. **1** (2): 13–32. OCLC 639975358 (https://www.worldcat.org/oclc/639975358).
- Mayzner, M.S.; Tresselt, M.E.; Wolin, B.R. (1965). "Tables of trigram frequency counts for various word-length and letter-position combinations". *Psychonomic Monograph Supplements*. **1** (3): 33–78.
- Mayzner, M.S.; Tresselt, M.E.; Wolin, B.R. (1965). "Tables of tetragram frequency counts for various word-length and letter-position combinations". *Psychonomic Monograph Supplements*. **1** (4): 79–143.
- Mayzner, M.S.; Tresselt, M.E.; Wolin, B.R. (1965). "Tables of pentagram frequency counts for various word-length and letter-position combinations". *Psychonomic Monograph Supplements*. **1** (5): 144–190.

External links

- Lewand, Robert Edward. "Cryptographical Mathematics" (https://web.archive.org/web/20070402181401/http://pages.central.edu/emp/LintonT/). *pages.central.edu*.
- "Some examples of letter frequency rankings in some common languages" (http://www.bckelk.ukfsn.org/words/etaoin.html). *www.bckelk.ukfsn.org*.
- "JavaScript Heatmap Visualization showing letter frequencies of texts on different keyboard layouts" (http://www.patrick-wied.at/projects/heatmap-keyboard/). *www.patrick-wied.at*.
- Norvig, Peter. "An updated version of Mayzner's work using Google books Ngrams data set" (http://norvig.com/mayzner.html). *norvig.com*.