

# Word Hy-phen-a-tion By Com-pu-ter

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In 1982, Frank Liang published in his doctoral dissertation *Word Hy-phen-a-tion By Com-pu-ter* a description of the hyphenation algorithm that he invented for Donald Knuth's TeX typesetting program; his algorithm is the basis of most of the hyphenation programs used today. Liang's algorithm is described in Appendix H of *The TeXbook* by Knuth. Liang's algorithm never inserts a hyphen where one does not belong, but does miss some opportunities to insert hyphens where they do belong; Liang claims to find 95% of the hyphens in most texts. Liang's algorithm is quick, and reasonably stingy with space.

Liang's method works by pre-computing a list of hyphenating and inhibiting patterns based on a hyphenation dictionary. First, a list of hyphenating patterns is established; for instance, `-tion` and `c-c` are good hyphenating patterns. But all hyphenating patterns have exceptions; for instance, the `-tion` pattern improperly hyphenates the word `cat-tion`. Thus, a set of inhibiting patterns prevents hyphenations; in this case, the inhibition pattern `.ca=t` (the dot indicates the beginning or end of a word, the equal-sign inhibits a hyphen) overrides the hyphenation pattern and prevents the hyphen at `ca-tion`. Of course, there are exceptions to the inhibition patterns; Liang's algorithm goes five levels deep — hyphenation, inhibition, hyphenation, inhibition, hyphenation — to get a good set of patterns, and even then requires an exception listing to fix a few words that would otherwise be hyphenated incorrectly. It is also required that a word must have a least five letters to be hyphenated, no hyphens can be inserted after the first letter or before the last letter of a word, and any word that includes non-alphabetic characters is never hyphenated.

Consider this example of hyphenating the word `hyphenation`: there are two hyphenating patterns `1na` and `1tio`, then three inhibiting patterns `n2at`, `2io`, and `he2n`, then another hyphenating pattern `hy3ph`, another inhibiting pattern `hena4`, and finally another hyphenating pattern `hen5at`:

```
. h y p h e n a t i o n .  
    1n a  
        1t i o  
            n2a t  
                2i o  
                    h e2n  
h y3p h  
    h e n a4  
    h e n5a t  
.0h0y3p0h0e2n5a4t2i0o0n0.  
h y-p h e n-a t i o n
```

After all the patterns present in the word are identified, the highest number at any inter-letter position wins (we'll call that number a *rule*), and hyphens are inserted at all the odd-numbered rules. In this case, the `1na` pattern originally placed a hyphen at `hyphe-nation`, but the `he2n`

pattern inhibited the hyphen, because rule 2 trumps rule 1; likewise, hena4 inhibited 1tio. Note that three patterns start at the fourth letter of hyphenation: he2n, hena4, and hen5at.

Liang's hyphenation algorithm iterates through the letters of the input word, identifying all the patterns that are present in the word, and takes the maximum rule at each position. The task of identifying the patterns calls for some sort of search algorithm; Liang used a trie that he cleverly packed into an array.

Our implementation follows Liang's closely. Our tries are based on association lists, but instead of the standard Scheme association lists kept in random order, we use our own association lists, in which comparisons are case-insensitive and characters are stored in ascending order; `a-look` looks up the value associated with character `c` in a-list `a`, and `a-bind` establishes a binding of value `x` for character `c` in a-list `a` whether or not `c` is already present in `a`:

```
(define a-null '())

(define (a-look c a)
  (cond ((null? a) #f)
        ((char-ci<? c (caar a)) #f)
        ((char-ci<? (caar a) c) (a-look c (cdr a)))
        (else (car a))))

(define (a-bind c x a)
  (cond ((null? a) (list (cons c x)))
        ((char-ci<? c (caar a)) (cons (cons c x) a))
        ((char-ci<? (caar a) c) (cons (car a) (a-bind c x (cdr a))))
        (else (cons (cons c x) (cdr a)))))
```

Following Chris Okasaki's implementation of tries in his textbook *Purely Functional Data Structures*, a trie is a pair consisting of a value and an a-list of successors. The value is boxed in a list, so `'()` indicates no-value and `'(x)` indicates the value `x`. The null trie conses the null list to the null a-list:

```
(define t-null (cons '() a-null))
```

Trie lookup goes one character at a time. There are two ways for lookup to fail: if the end of the key finds a `'()` value, or if an intermediate node does not exist:

```
(define (t-look ks t)
  (if (null? ks)
      (if (pair? (car t)) (caar t) #f)
      (let ((x (a-look (car ks) (cdr t))))
        (if x (t-look (cdr ks) (cdr x)) #f))))
```

Adding or replacing a value in a trie is similar to lookup, except that it never fails; if necessary, the trie is extended with a null node:

```
(define (t-bind ks x t)
  (if (null? ks) (cons (list x) (cdr t))
      (let* ((a1 (a-look (car ks) (cdr t)))
              (t2 (t-bind (cdr ks) x (if (pair? a1) (cdr a1) t-null))))
        (cons (car t) (a-bind (car ks) t2 (cdr t))))))
```

We store the patterns and exceptions in lists (they are symbols, not strings, because that's how Liang's listing is given); the full lists are given below:

```
(define patterns '(.ach4 .ad4der .afl1 ... zte4 4z1z2 z4zy))

(define exceptions '(as-so-ciate ... ta-ble))
```

Our first task is to split a pattern like `hen5at` into the key `henat` and rules `000500`; note the use of `symbol->string`:

```
(define (split-pat pat)
  (let loop ((ps (string->list (symbol->string pat))) (cs '()) (ns '()))
    (cond ((null? ps)
           (if (= (length cs) (length ns))
               (values (reverse cs) (reverse (cons 0 ns)))
               (values (reverse cs) (reverse ns))))
          ((and (null? (cdr ps)) (char-numeric? (car ps)))
           (values (reverse cs)
                   (reverse (cons (- (char->integer (car ps)) 48) ns))))
          ((not (char-numeric? (car ps)))
           (loop (cdr ps) (cons (car ps) cs) (cons 0 ns)))
          (else (loop (cddr ps)
                      (cons (cadr ps) cs)
                      (cons (- (char->integer (car ps)) 48) ns))))))
```

Exceptions are handled by making them un-exceptional: an exception like `ta-ble` is turned into a pattern like `6.6t6a7b6l6e6.6` and entered into the trie along with the regular patterns. Because 7 and 6 are greater than the other hyphenation and inhibition rules, and because the pattern is anchored with a dot at beginning and end, the exception rules will always trump any other rules that may exist in the word. Turning the exceptions into patterns means they don't have to be handled specially, so the program can be simpler. Here is the code to split an exception into pattern and key:

```
(define (split-exn exn)
  (let loop ((ps (append (list #\.) (string->list (symbol->string exn)) (list #\.)))
            (cs '()) (ns '()))
    (cond ((null? ps) (values (reverse cs) (reverse (cons 6 ns))))
          ((char=? (car ps) #\.)
           (loop (cddr ps) (cons (cadr ps) cs) (cons 7 ns)))
          (else (loop (cdr ps) (cons (car ps) cs) (cons 6 ns))))))
```

T-hyph is the trie that stores all the key/rule pairs, built by looping through the lists of patterns and exceptions:

```
(define t-hyph
  (let loop ((pats patterns) (exns exceptions) (t t-null))
    (cond ((null? exns) t)
          ((null? pats)
           (call-with-values (lambda () (split-exn (car exns)))
                             (lambda (cs ns) (loop pats (cdr exns) (t-bind cs ns t)))))
          (else (call-with-values (lambda () (split-pat (car pats)))
                                   (lambda (cs ns) (loop (cdr pats) exns (t-bind cs ns t)))))))
```

The standard trie function `t-look` returns the single value associated with a key. We need instead to get a list of all the rules along the path from a substring; for instance, when examining

the substring `henation.`, we find the three patterns `he2n`, `hena4`, and `hen5at`. `T-looks` is similar to `t-look`, but returns a list, possibly null, instead of a single value:

```
(define (t-looks ks t)
  (if (null? ks)
      (if (pair? (car t)) (list (caar t)) '())
      (let ((x (a-look (car ks) (cdr t))))
        (if x
            (if (pair? (car t))
                (cons (caar t) (t-looks (cdr ks) (cdr x)))
                (t-looks (cdr ks) (cdr x)))
            (if (pair? (car t)) (list (caar t)) '())))))
```

We are ready now to show the function that performs hyphenation. `Hyphenate` takes a single word, as a string, and returns a list of substrings between hyphenation points; for instance, `(hyphenate "hyphenation")` returns `("hy" "phen" "ation")`. After testing the length and looking for non-alphabetic characters, the outer loop iterates over the letters of the input word, surrounded by dots. The rules are stored in a two-part list, the part before the current letter and the part after the current letter. When the input word is exhausted, the substrings are collected in the first inner `let`. Otherwise, the `fold-left` in the second inner `let` saves the maximum rule at each position for each pattern returned by `t-looks`.

```
(define (hyphenate word)
  (let ((ws (string->list word)))
    (cond ((< (length ws) 5) (list word))
          ((any? (lambda (c) (not (char-alphabetic? c))) ws) (list word))
          (else (let loop ((ws (append (list #\.) ws (list #\.)))
                            (front (make-list (+ (length ws) 3) 0)) (back '()))
                    (if (null? ws)
                        (let loop ((cs (string->list word)) (hs (fixup back)) (p '()) (ps '()))
                          (cond ((null? (cdr hs)) (reverse (cons (list->string (reverse p)) ps)))
                                ((odd? (car hs))
                                 (loop (cdr cs) (cdr hs) (list (car cs))
                                       (cons (list->string (reverse p)) ps)))
                                (else (loop (cdr cs) (cdr hs) (cons (car cs) p) ps))))
                        (let ((new-front (fold-left max-rule front (t-looks ws t-hyph))))
                          (loop (cdr ws) (cdr new-front) (cons (car new-front) back))))))))))
```

`Hyphenate` calls two helper functions: `max-rule` is called by `fold-left` to loop through the rules for a particular pattern, saving only the maximum at each step, and `fixup` implements the requirement that a word cannot begin or end with a single-letter substring:

```
(define (max-rule xs ys)
  (let loop ((xs xs) (ys ys) (zs '()))
    (if (or (null? xs) (null? ys))
        (append (reverse zs) xs)
        (loop (cdr xs) (cdr ys) (cons (max (car xs) (car ys)) zs))))

(define (fixup xs)
  (cons 0 (cons 0 (cdddr (reverse (cons 0 (cons 0 (cddr xs))))))))
```

`Fold-left`, `make-list` and `any?` come from a standard library:

```
(define (fold-left op base xs)
  (if (null? xs)
      base
      (fold-left op (op base (car xs)) (cdr xs))))
```

```
(define (make-list n x)
  (let loop ((n n) (xs '()))
    (if (zero? n) xs
        (loop (- n 1) (cons x xs)))))

(define (any? pred? xs)
  (cond ((null? xs) #f)
        ((pred? (car xs)) #t)
        (else (any? pred? (cdr xs)))))
```

Liang's dissertation described a program `patgen` for pre-computing the hyphenating and inhibiting rules, for English or any other language, given a hyphenating dictionary. This is harder than it looks, because the rules of hyphenation are arcane; consider, for instance, the difference between `dem-on-stra-tion` and `de-mon-stra-tive` (Liang resolves that particular problem by inhibiting the first hyphen in both words). Using `patgen` and a dictionary of fifty-thousand words (including inflected forms such as plurals and past participles formed by adding `-s` or `-ed`) with hyphenation points marked, Liang created the following list of 4447 patterns for TeX 82:

```
.ach4 .ad4der .aflt .al3t .am5at .an5c .ang4 .ani5m .ant4 .an3te .anti5s .ar5s
.ar4tie .ar4ty .as3c .aslp .asls .aster5 .atom5 .auld .av4i .awn4 .ba4g .ba5na
.bas4e .ber4 .be5ra .be3sm .be5sto .bri2 .but4ti .cam4pe .can5c .capa5b .car5ol
.ca4t .ce4la .ch4 .chill5i .ci2 .cit5r .co3e .co4r .cor5ner .de4moi .de3o .de3ra
.de3ri .des4c .dictio5 .do4t .du4c .dumb5 .earth5 .eas3i .eb4 .eer4 .eg2 .el5d
.el3em .enam3 .en3g .en3s .eq5ui5t .er4ri .es3 .eu3 .eye5 .fes3 .for5mer .ga2
.ge2 .gen3t4 .ge5og .gi5a .gi4b .go4r .hand5i .han5k .he2 .hero5i .hes3 .het3
.hi3b .hi3er .hon5ey .hon3o .hov5 .id4l .idol3 .im3m .im5pin .inl .in3ci .ine2
.in2k .in3s .ir5r .is4i .ju3r .la4cy .la4m .lat5er .lath5 .le2 .leg5e .len4
.lep5 .levl .li4g .lig5a .li2n .li3o .li4t .mag5a5 .mal5o .man5a .mar5ti .me2
.mer3c .me5ter .misl .mist5i .mon3e .mo3ro .mu5ta .muta5b .ni4c .od2 .odd5
.of5te .or5ato .or3c .orld .or3t .os3 .os4tl .oth3 .out3 .ped5al .pe5te .pe5tit
.pi4e .pio5n .pi2t .pre3m .ra4c .ran4t .ratio5na .ree2 .re5mit .res2 .re5stat
.ri4g .rit5u .ro4q .ros5t .row5d .ru4d .sci3e .self5 .sell5 .se2n .se5rie .sh2
.si2 .sing4 .st4 .sta5bl .sy2 .ta4 .te4 .ten5an .th2 .ti2 .til4 .tim5o5 .ting4
.tin5k .ton4a .to4p .top5i .tou5s .trib5ut .unla .un3ce .under5 .unle .un5k
.un5o .un3u .up3 .ure3 .us5a .ven4de .ve5ra .wil5i .ye4 4ab. a5bal a5ban abe2
ab5erd abi5a ab5it5ab ab5lat ab5o5liz 4abr ab5rog ab3ul a4car ac5ard ac5aro
a5ceou acler a5chet 4a2ci a3cie aclin a3cio ac5rob act5if ac3ul ac4um a2d ad4din
ad5er. 2adi a3dia ad3ica adi4er a3dio a3dit a5diu ad4le ad3ow ad5ran ad4su 4adu
a3duc ad5um ae4r aeri4e a2f aff4 a4gab aga4n ag5ell age4o 4ageu agli 4ag4l agln
a2go 3agog ag3oni a5guer ag5ul a4gy a3ha a3he ah4l a3ho ai2 a5ia a3ic. ai5ly
a4i4n ain5in ain5o ait5en alj aklen al5ab al3ad a4lar 4aldi 2ale al3end a4lenti
a5le5o alli al1a al4e. al4e al5lev 4allic 4alm a5log. a4ly. 4alys 5a5lyst 5alyp
3alyz 4ama am5ab am3ag ama5ra am5asc a4matis a4m5ato am5era am3ic am5if am5ily
amlin ami4no a2mo a5mon amor5i amp5en a2n an3age 3analy a3nar an3arc anar4i
a3nati 4and ande4s an3dis anl4l an4dow a5nee a3nen an5est. a3neu 2ang ang5ie
anlgl a4nlic a3nies an3i3f an4ime a5nimi a5nine an3io a3nip an3ish an3it a3niu
an4kli 5anniz ano4 an5ot anoth5 an2sa an4sco an4sn an2sp ans3po an4st an4sur
antal4 an4tie 4anto an2tr an4tw an3ua an3ul a5nur 4ao apar4 ap5at ap5ero a3pher
4aphi a4pilla ap5illar ap3in ap3ita a3pitu a2pl apoc5 ap5ola apor5i apos3t
aps5es a3pu aque5 2a2r ar3act a5rade ar5adis ar3al a5ramete aran4g ara3p ar4at
a5ratio ar5ativ a5rau ar5av4 araw4 arbal4 ar4chan ar5dine ar4dr ar5eas a3ree
ar3ent a5ress ar4fi ar4fl arli ar5ial ar3ian a3riet ar4im ar5inat ar3io ar2iz
ar2mi ar5o5d a5roni a3roo ar2p ar3q arre4 ar4sa ar2sh 4as. as4ab as3ant ashi4
a5sia. a3sib a3sic 5a5si4t ask3i as4l a4sosc as5ph as4sh as3ten asltr asur5a a2ta
at3abl at5ac at3alo at5ap ate5c at5ech at3ego at3en. at3era ater5n a5terna
at3est at5ev 4ath ath5em a5then at4ho ath5om 4ati. a5tia at5i5b atlic at3if
ation5ar at3itu a4tog a2tom at5omiz a4top a4tos altr at5rop at4sk at4tag at5te
at4th a2tu at5ua at5ue at3ul at3ura a2ty au4b augh3 au3gu au4l2 aun5d au3r
au5sib aut5en aulth a2va av3ag a5van ave4no av3era av5ern av5ery avli avi4er
av3ig av5oc alvor 3away aw3i aw4ly aws4 ax4ic ax4id ay5al aye4 ays4 azi4er azz5i
5ba. bad5ger ba4ge balla ban5dag ban4e ban3i barbi5 bari4a bas4si lbat ba4z 2blb
b2be b3ber bbi4na 4bl4 4be. beak4 beat3 4be2d be3da be3de be3di be3gi be5gu lbel
belli be3lo 4be5m be5nig be5nu 4bes4 be3sp be5str 3bet bet5iz be5tr be3tw be3w
be5yo 2bf 4b3h bi2b bi4d 3bie bi5en bi4er 2b3if lbil bi3liz bina5r4 bin4d bi5net
```

bi3ogr bi5ou bi2t 3bi3tio bi3tr 3bit5ua b5itz blj bk4 b2l2 blath5 b4le. blen4  
 5blesp b3lis b4lo blun4t 4blm 4b3n bne5g 3bod bod3i bo4e bol3ic bom4bi bon4a  
 bon5at 3boo 5bor. 4blora bor5d 5bore 5bori 5bos4 b5ota both5 bo4to bound3 4bp  
 4brit broth3 2b5s2 bsor4 2bt bt4l b4to b3tr buf4fer bu4ga bu3li bumi4 bu4n  
 bunt4i bu3re bus5ie buss4e 5bust 4buta 3butio b5uto blv 4b5w 5by. bys4 lca  
 cab3in calbl cach4 ca5den 4cag4 2c5ah ca3lat cal4la call5in 4calo can5d can4e  
 can4ic can5ic can3iz can4ty cany4 ca5per car5om cast5er cas5tig 4casy ca4th  
 4cativ cav5al c3c ccha5 cci4a ccompa5 ccon4 ccou3t 2ce. 4ced. 4ceden 3cei 5cel.  
 3cell lcen 3cenc 2cen4e 4ceni 3cent 3cep ce5ram 4cesa 3cessi ces5si5b ces5t cet4  
 c5e4ta cew4 2ch 4ch. 4ch3ab 5chanic ch5a5nis che2 cheap3 4ched che5lo 3chemi  
 ch5ene ch3er. ch3ers 4chlin 5chine. ch5iness 5chini 5chio 3chit chi2z 3cho2  
 ch4ti lci 3cia ci2a5b cia5r ci5c 4cier 5cific. 4cii ci4la 3cili 2cim 2cin c4ina  
 3cinat cin3em cling c5ing. 5cino cion4 4cipe ci3ph 4cipic 4cista 4cisti 2clit  
 cit3iz 5ciz ck1 ck3i lc4l4 4clar c5laratio 5clare cle4m 4clic clim4 cly4 c5n lco  
 co5ag coe2 2cog co4gr coi4 co3inc col5i 5colo col3or com5er con4a c4one con3g  
 con5t co3pa cop3ic ccha5 cci4a ccompa5 ccon4 ccou3t 2ce. 4ced. 4ceden 3cei 5cel.  
 cras5t 5crat. 5cratic cre3at 5cred 4c3reta cre4v cri2 cri5f c4rin cris4 5criti  
 cro4pl crop5o cros4e cru4d 4c3s2 2clt cta4b ct5ang c5tant c2te c3ter c4ticu  
 ctim3i ctu4r c4tw cud5 c4uf c4ui cu5ity 5culi cul4tis 3cultu cu2ma c3ume cu4mi  
 3cun cu3pi cu5py cur5a4b cu5ria lous cuss4i 3c4ut cu4tie 4c5utiv 4cutr lcy cze4  
 ld2a 5da. 2d3a4b dach4 4daf 2dag da2m2 dan3g dard5 dark5 4dary 3dat 4dativ 4dato  
 5dav4 dav5e 5day dlb d5c dld4 2de. dea5f deb5it de4bon decan4 de4cil de5com  
 2dled 4dee. de5if deli4e del5i5q de5lo d4em 5dem. 3demic dem5ic. de5mil de4mons  
 demor5 lden de4nar de3nu denti5f de3nu delp de3pa depi4 de2pu d3eq d4erh 5derm  
 dern5iz der5s des2 d2es. delsc de2s5o des3ti de3str de4su delt de2to delv dev3il  
 4dey 4dlf d4ga d3ge4t dgli d2gy dlh2 5di. ld4i3a dia5b di4cam d4ice 3dict 3did  
 5di3en dlif di3ge di4lato dlin ldina 3dine. 5dini di5niz ldio dio5g di4pl dir2  
 dlire dirt5i disl 5disi d4is3t d2iti ldilv dlj d5k2 4d5la 3dle. 3dled 3dles.  
 4dless 2d3lo 4d5lu 2dly dlm 4dln4 ldo 3do. do5de 5doe 2d5of d4og do4la doli4  
 do5lor dom5iz do3nat doni4 doo3d dop4p d4or 3dos 4d5out do4v 3dox dlp ldr  
 drag5on 4drai dre4 drea5r 5dren dri4b dril4 dro4p 4drow 5drupli 4dry 2dls2 ds4p  
 d4sw d4sy d2th ldu dlula du2c dluca duc5er 4duct. 4ducts du5el du4g d3ule dum4be  
 du4n 4dup du4pe dlv dlw d2y 5dyn dy4se dys5p ela4b e3act ead1 ead5ie ea4ge  
 ea5ger ea4l eal5er eal3ou eam3er e5and ear3a ear4c ear5es ear4ic ear4il ear5k  
 ear2t eart3e ea5sp e3ass east3 ea2t eat5en eath3i e5atif e4a3tu ea2v eav3en  
 eav5i eav5o 2elb e4bel. e4bels e4ben e4bit e3br e4cad ecan5c ecca5 elce e5essa  
 ec2i e4cib ec5ificat ec5ifie ec5ify ec3im eci4t e5cite e4clam e4clus e2col  
 e4comm e4compe e4conc e2cor ec3ora eco5ro elcr e4crem ec4tan ec4te elcu e4cul  
 ec3ula 2e2da 4ed3d e4dler ede4s 4edi e3dia ed3ib ed3ica ed3im edlit edi5z 4edo  
 e4dol edon2 e4dri e4dul ed5ulo ee2c eed3i ee2f eel3i ee4ly ee2m ee4na ee4pl  
 ee2s4 eest4 ee4ty e5ex elf e4f3ere leff e4fic 5efici efil4 e3fine ef5i5nite  
 3efit efor5es e4fuse. 4egal eger4 eg5ib eg4ic eg5ing e5git5 eg5n e4go. e4gos  
 eglul e5gur 5egy elh4 eher4 ei2 e5ic ei5d eig2 ei5gl e3imb e3inf eling e5inst  
 eir4d eit3e ei3th e5ity elj e4jud ej5udi eki4n ek4la ella e4la. e4lac elan4d  
 el5ativ e4law elaxa4 e3lea el5ebra 5elec e4led el3ega e5len e4l1er elles el2f  
 el2i e3libe e4l5ic. el3ica e3lier el5igib e5lim e4l3ing e3lio e2lis el5ish  
 e3liv3 e4lla el4lab ello4 e5loc el5og el3op. el2sh el4ta e5lud el5ug e4mac e4mag  
 e5man em5ana em5b elme e4met em3ica emi4e em5igra emlin2 em5ine em3i3ni  
 e4mis em5ish e5miss em3iz 5emniz emo4g emoni5o em3pi e4mul em5ula emu3n e3my  
 en5amo e4nant ench4er en3dic e5nea e5nee en3em en5ero en5esi en5est en3etr e3new  
 en5ics e5nie e5nil e3nio en3ish en3it e5niu 5eniz 4enn 4eno eno4g e4nos en3ov  
 en4sw ent5age 4enthes en3ua en5uf e3ny. 4en3z e5of eo2g e4oi4 e3ol eop3ar elor  
 eo3re eo5rol eos4 e4ot eo4to e5out e5ow e2pa e3pai ep5anc e5pel e3pent ep5etitio  
 ephe4 e4pli elpo e4prec ep5reca e4pred ep3reh e3pro e4prob ep4sh ep5ti5b e4put  
 ep5uta elq equi3l e4q3ui3s erla era4b 4erand er3ar 4erati. 2erb er4bl er3ch  
 er4che 2ere. e3real ere5co ere3in er5el. er3emo er5ena er5ence 4erene er3ent  
 ere4q er5ess er3est eret4 erlh erli elria4 5erick e3rien eri4er er3ine elrio  
 4erit er4iu eri4v e4riva er3m4 er4nis 4ernit 5erniz er3no 2ero er5ob e5roc ero4r  
 erlou erls er3set ert3er 4ertl er3tw 4eru eru4t 5erwau els4a e4sage. e4sages  
 es2c e2sca es5can e3scr es5cu els2e e2sec es5ecr es5enc e4sert. e4serts e4serva  
 4esh e3sha esh5en elsi e2sic e2sid es5iden es5igna e2s5im es4i4n esis4te esi4u  
 e5skin es4mi e2sol es3olu e2son es5ona elsp es3per es5pira es4pre 2ess es4si4b  
 estan4 es3tig es5tim 4es2to e3ston 2estr e5stro estruc5 e2sur es5urr es4w eta4b  
 eten4d e3teo ethod3 etlic e5tide etin4 eti4no e5tir e5titio et5itiv 4etn et5ona  
 e3tra e3tre et3rif et3rog et5ros et3ua et5ym et5z 4eu e5un e3up eu3ro  
 eus4 eute4 euti5l eu5tr eva2p5 e2vas ev5ast e5vea ev3ell evel3o e5veng even4i  
 evler e5verb elvi ev3id evi4l e4vin evi4v e5voc e5vu elwa e4wag e5wee e3wh ewil5  
 ew3ing e3wit lexp 5eyc 5eye. eys4 lfa fa3bl fab3r fa4ce 4fag fain4 fall5e 4fa4ma  
 fam5is 5far far5th fa3ta fa3the 4fato fault5 4f5b 4fd 4fe. feas4 feath3 fe4b  
 4feca 5fect 2fed fe3li fe4mo fen2d fend5e ferl 5ferr fev4 4flf f4fes f4fie  
 f5fin. f2f5is f4fly f2fy 4fh lfi fi3a 2f3ic. 4f3ical f3ican 4ficate f3icen

fi3cer fic4i 5ficia 5ficie 4fics fi3cu fi5del fight5 fil5i fill5in 4fily 2fin  
 5fina fin2d5 fi2ne flin3g fin4n fis4ti f4l2 f5less flin4 flo3re f2ly5 4fm 4fn  
 lfo 5fon fon4de fon4t fo2r fo5rat for5ay fore5t for4i fort5a fos5 4f5p fra4t  
 f5rea fres5c fri2 fril4 fro15 2f3s 2ft f4to f2ty 3fu fu5el 4fug fu4min fu5ne  
 fu3ri fusi4 fus4s 4futa lfy lga gaf4 5gal. 3gali ga3lo 2gam ga5met g5amo gan5is  
 ga3niz gani5za 4gano gar5n4 gass4 gath3 4gativ 4gaz g3b gd4 2ge. 2ged geez4  
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 geth5 4geto ge4ty ge4v 4glg2 g2ge g3ger gglu5 ggo4 gh3in gh5out gh4to 5gi. lgi4a  
 gia5r glic 5gicia g4ico gien5 5gies. gil4 g3imen 3g4in. gin5ge 5g4ins 5gio 3gir  
 gir4l g3isl gi4u 5giv 3giz gl2 gla4 glad5i 5glas lgle gli4b g3lig 3glo glo3r glm  
 g4my gn4a g4na. gnet4t glni g2nin g4nio glno g4non lgo 3go. gob5 5goe 3g4o4g  
 go3is gon2 4g3o3na gondo5 go3ni 5goo go5riz gor5ou 5gos. govl g3p lgr 4grada  
 g4rai gran2 5graph. g5rapher 5graphic 4graphy 4gray gre4n 4gress. 4grit g4ro  
 gruf4 gs2 g5ste gth3 gu4a 3guard 2gue 5gui5t 3gun 3gus 4gu4t g3w lgy 2g5y3n  
 gy5ra h3ab4l hach4 hae4m hae4t h5agu ha3la hala3m ha4m han4ci han4cy 5hand.  
 han4g hang5er hang5o h5a5niz han4k han4te hap3l hap5t ha3ran ha5ras har2d hard3e  
 har4le harp5en har5ter has5s haun4 5haz haz3a h1b lhead 3hear he4can h5ecat h4ed  
 he5do5 he3l4i hel4lis hel4ly h5elo hem4p he2n hena4 hen5at heo5r hep5 h4era  
 hera3p her4ba here5a h3ern h5erou h3ery hles he2s5p he4t het4ed heu4 h1f h1h  
 hi5an hi4co high5 h4il2 himer4 h4ina hion4e hi4p hir4l hi3ro hir4p hir4r his3el  
 his4s hith5er hi2v 4hk 4h1l4 hlan4 h2lo hlo3ri 4hlm hmet4 2h1n h5odiz h5ods ho4g  
 hoge4 hol5ar 3hol4e ho4ma home3 hon4a ho5ny 3hood hoon4 hor5at ho5ris hort3e  
 ho5ru hos4e ho5sen hoslp l hous house3 hov5el 4h5p 4hr4 hree5 hro5niz hro3po  
 4h1s2 h4sh h4tar htlen htles h4ty hu4g hu4min hun5ke hun4t hus3t4 hu4t h1w  
 h4wart hy3pe hy3ph hy2s 2ila i2al iam4 iam5ete i2an 4ianc ian3i 4ian4t ia5pe  
 iass4 i4ativ ia4tric i4atu ibe4 ib3era ib5ert ib5ia ib3in ib5it. ib5ite ilbl  
 ib3li i5bo ilbr i2b5ri i5bun 4icam 5icap 4icar i4car. i4cara icas5 i4cay iccu4  
 4iceo 4ich 2ici i5cid ic5ina i2cip ic3ipa i4cly i2c5oc 4ilcr 5icra i4cry ic4te  
 ictu2 ic4t3ua ic3ula ic4um ic5uo i3cur 2id i4dai id5anc id5d ide3al ide4s i2di  
 id5ian idi4ar i5die id3io idi5ou idlit id5iu i3dle i4dom id3ow i4dr i2du id5uo  
 2ie4 ied4e 5ie5ga ield3 ien5a4 ien4e i5enn i3enti iler. i3esc ilest i3et 4if.  
 if5ero iff5en if4fr 4ifc. i3fie i3fl 4ift 2ig iga5b ig3era ight3i 4igi i3gib  
 ig3il ig3in ig3it i4g4l i2go ig3or ig5ot i5gre igu5i iglur i3h 4i5i4 i3j 4ik  
 illa il3a4b i4lade i2l5am ila5ra i3leg iller ilev4 il5f illi il3ia il2ib il3io  
 il4ist 2ilit il2iz ill5ab 4iln il3oq il4ty il5ur il3v i4mag im3age ima5ry  
 imenta5r 4imet imli im5ida imi5le i5mini 4imit im4ni i3mon i2mu im3ula 2in.  
 i4n3au 4inav incel4 in3cer 4ind in5dling 2ine i3nee iner4ar i5ness 4inga 4inge  
 in5gen 4ingi in5gling 4ingo 4ingu 2ini i5ni. i4nia in3io inlis i5nite. 5initio  
 in3ity 4ink 4inl 2inn 2ilno i4no4c ino4s i4not 2ins in3se insur5a 2int. 2in4th  
 inlu i5nus 4iny 2io 4io. ioge4 io2gr iolol io4m ion3at ion4ery ion3i io5ph ior3i  
 i4os io5th i5oti io4to i4our 2ip ipe4 iphras4 ip3i ip4ic ip4re4 ip3ul i3qua  
 iq5uef iq3uid iq3ui3t 4ir ilra ira4b i4rac ird5e ire4de i4ref i4rel4 i4res ir5gi  
 irli iri5de ir4is iri3tu 5i5r2iz ir4min iro4g 5iron. ir5ul 2is. is5ag is3ar  
 isas5 2islc is3ch 4ise is3er 3isf is5han is3hon ish5op is3ib isi4d i5sis is5itiv  
 4is4k islan4 4isms i2so iso5mer islp is2pi is4py 4isls is4sal issen4 is4ses  
 is4ta. islte islti ist4ly 4istral i2su is5us 4ita. ita4bi i4tag 4ita5m i3tan  
 i3tat 2ite it3era i5teri it4es 2ith ilti 4itia 4i2tic it3ica 5i5tick it3ig  
 it5ill i2tim 2itio 4tism i4tism i2t5o5m 4iton i4tram it5ry 4itt it3uat i5tud  
 it3ul 4itz. ilu 2iv iv3ell iv3en. i4v3er. i4vers. iv5il. iv5io ivlit i5vore  
 iv3o3ro i4v3ot 4i5w ix4o 4iy 4izar izi4 5izont 5ja jac4q ja4p lje jer5s 4jestie  
 4jesty jew3 jo4p 5judg 3ka. k3ab k5ag kais4 kal4 k1b k2ed lkee ke4g ke5li k3en4d  
 kler kes4 k3est. ke4ty k3f kh4 k1i 5ki. 5k2ic k4ill kilo5 k4im k4in. kin4de  
 k5iness kin4g ki4p kis4 k5ish kk4 k1l 4kley 4kly k1m k5nes 1k2no ko5r kosh4 k3ou  
 kro5n 4k1s2 k4sc ks4l k4sy k5t k1w lab3ic l4abo laci4 l4ade la3dy lag4n lam3o  
 3land lan4dl lan5et lan4te lar4g lar3i las4e la5tan 4lateli 4lativ 4lav la4v4a  
 2llb lbin4 4llc2 lce4 l3ci 2ld l2de ld4ere ld4eri ldi4 ld5is l3dr l4dri le2a  
 le4bi left5 5leg. 5legg le4mat lem5atic 4len. 3lenc 5lene. 1lent le3ph le4pr  
 lera5b ler4e 3lerg 3l4eri l4ero les2 le5sco 5lesq 3less 5less. l3eva lev4er.  
 lev4era lev4ers 3ley 4leye 2lf l5fr 4llg4 l5ga lgar3 l4ges lgo3 2l3h li4ag li2am  
 liar5iz li4as li4ato li5bi 5licio li4cor 4lics 4lict. l4icu l3icy l3ida lid5er  
 3lidi li3fer l4iff li4fl 5ligate 3ligh li4gra 3lik 4l4i4l lim4bl lim3i li4mo  
 l4im4p l4ina l14ine lin3ea lin3i link5er li5og 4l4iq lis4p l1it l2it. 5litica  
 l5i5tics liv3er l1iz 4lj lka3 l3kal lka4t l1l l4law l2le l5lea l3lec l3leg l3lel  
 l3le4n l3le4t l12i l2lin4 l5lina l14o lloqui5 l15out l5low 2lm l5met lm3ing  
 l4mod lmon4 2lln2 3lo. lob5al lo4ci 4lof 3logic l5ogo 3logu lom3er 5long lon4i  
 l3o3niz lood5 5lope. lop3i l3opm lora4 lo4rato lo5rie lor5ou 5los. los5et  
 5losophiz 5losophy los4t lo4ta loun5d 2lout 4lov 2lp lpa5b l3pha l5phi lp5ing  
 l3pit l4pl l5pr 4llr 2lls2 l4sc l2se l4sie 4lt lt5ag ltane5 l1te lten4 ltera4  
 lth3i l5ties. ltis4 l1tr ltu2 ltur3a lu5a lu3br luch4 lu3ci lu3en luf4 lu5di  
 lu4ma 5lumi l5umn. 5lumnia lu3o luo3r 4lup luss4 lus3te llut l5ven l5vet4 2llw  
 lly 4lya 4lyb ly5me ly3no 2lys4 l5yse lma 2mab ma2ca ma5chine ma4cl mag5in 5magn

2mah maid5 4mald ma3lig ma5lin mal4li mal4ty 5mania man5is man3iz 4map ma5rine.  
 ma5riz mar4ly mar3v ma5sce mas4e maslt 5mate math3 ma3tis 4matiza 4mlb mba4t5  
 m5bil m4b3ing mbi4v 4m5c 4me. 2med 4med. 5media me3die m5e5dy me2g mel5on mel4t  
 me2m memlo3 lmen men4a men5ac men4de 4mene men4i mens4 mensu5 3ment men4te me5on  
 m5ersa 2mes 3mesti me4ta met3al melte me5thi m4etr 5metric me5trie me3try me4v  
 4mlf 2mh 5mi. mi3a mid4a mid4g mig4 3milial m5i5lie m4ill min4a 3mind m5inee  
 m4ingl min5gli m5ingly min4t m4inu miot4 m2is mis4er. mis5l mis4ti m5istry 4mith  
 m2iz 4mk 4ml1 mlm mma5ry 4mln mn4a m4nin mn4o lmo 4mocr 5mocratiz mo2dl mo4go  
 mois2 moi5se 4mok mo5lest mo3me mon5et mon5ge moni3a mon4ism mon4ist mo3niz  
 monol4 mo3ny. mo2r 4mora. mos2 mo5sey mo3sp moth3 m5ouf 3mous mo2v 4mlp mpara5  
 mpa5rab mpar5i m3pet mphas4 m2pi mpi4a mp5ies m4plin m5pir mp5is mpo3ri mpos5ite  
 m4pous mpov5 mp4tr m2py 4m3r 4mls2 m4sh m5si 4mt lmu mula5r4 5mult multi3 3mum  
 mun2 4mup mu4u 4mw lna 2nla2b n4abu 4nac. na4ca n5act nag5er. nak4 na4li na5lia  
 4nalt na5mit n2an nanci4 nan4it nank4 nar3c 4nare nar3i nar4l n5arm n4as nas4c  
 nas5ti n2at na3tal nato5miz n2au nau3se 3naut nav4e 4nlb4 ncar5 n4ces. n3cha  
 n5cheo n5chil n3chis ncln nc4it ncour5a nlcr nlcu n4dai n5dan nlde nd5est.  
 ndi4b n5d2if nldit n3diz n5duc ndu4r nd2we 2ne. n3ear ne2b neb3u ne2c 5neck 2ned  
 ne4gat neg5ativ 5nege ne4la nel5iz ne5mi ne4mo lnen 4nene 3neo ne4po ne2q nler  
 nera5b n4erar n2ere n4er5i ner4r lnes 2nes. 4nesp 2nest 4nesw 3netic ne4v n5eve  
 ne4w n3f n4gab n3gel nge4n4e n5gere n3geri ng5ha n3gib nglin n5git n4gla ngov4  
 ng5sh nlgu n4gum n2gy 4nlh4 nha4 nhab3 nhe4 3n4ia ni3an ni4ap ni3ba ni4bl ni4d  
 ni5di ni4er ni2fi ni5ficat n5igr nik4 nlim ni3miz nlin 5nine. nin4g ni4o 5nis.  
 nis4ta n2it n4ith 3nitio n3itor ni3tr nlj 4nk2 n5kero n3ket nk3in nlkl 4nll n5m  
 nme4 nmet4 4nll2 nne4 nni3al nni4v nob4l no3ble n5ocl 4n3o2d 3noe 4nog noge4  
 nois5i no5l4i 5nologis 3nomic n5o5miz no4mo no3my no4n non4ag non5i n5oniz 4nop  
 5nop5o5li nor5ab no4rary 4nosc nos4e nos5t no5ta lnou 3noun nov3el3 nowl3 nlp4  
 npi4 npre4c nlq nlr nru4 2nls2 ns5ab nsati4 ns4c n2se n4s3es nsidl nsig4 n2sl  
 ns3m n4soc ns4pe n5spi nsta5bl nlt nta4b nter3s nt2i n5tib nti4er nti2f n3tine  
 n4t3ing nti4p ntrol5li nt4s ntu3me nula nu4d nu5en nuf4fe n3uin 3nu3it n4um  
 nulme n5umi 3nu4n n3uo nu3tr nlv2 nlw4 nym4 nyp4 4nz n3za 4oa oad3 o5a5les oard3  
 oas4e oast5e oat5i ob3a3b o5bar obe4l olbi o2bin ob5ing o3br ob3ul olce och4  
 o3chet ocif3 o4cil o4clam o4cod oc3rac oc5ratiz ocre3 5ocrit octor5a oc3ula  
 o5cure od5ded od3ic odi3o o2do4 odor3 od5uct. od5ucts o4el o5eng o3er oe4ta o3ev  
 o2fi of5ite ofit4t o2g5a5r og5ativ o4gato olge o5gene o5geo o4ger o3gie lolgis  
 og3it o4gl o5g2ly 3ogniz o4gro ogu5i logy 2ogyn olh2 ohab5 oi2 oic3es oi3der  
 oif4 oig4 oi5let o3ing oint5er o5ism oi5son oist5en oi3ter oj2 2ok o3ken ok5ie  
 olla o4lan olass4 ol2d oldle ol3er o3lesc o3let ol4fi ol2i o3lia o3lice ol5id.  
 o3li4f o5lil ol3ing o5lio o5lis. ol3ish o5lite o5litio o5liv ol1i4e ol5ogiz  
 olo4r ol5pl ol2t ol3ub ol3ume ol3un o5lus ol2v o2ly om5ah oma5l om5atiz om2be  
 om4bl o2me om3ena om5erse o4met om5etry o3mia om3ic. om3ica o5mid omlin o5mini  
 5ommend omo4ge o4mon om3pi ompro5 o2n onla on4ac o3nan onlc 3oncil 2ond on5do  
 o3nen on5est on4gu onlic o3nio onlis o5niu on3key on4odi on3omy on3s onspi4  
 onspir5a onsu4 onten4 on3t4i ontif5 on5um onva5 oo2 ood5e ood5i oo4k oop3i o3ord  
 oost5 o2pa ope5d oplr 3opera 4operag 2oph o5phan o5pher op3ing o3pit o5pon  
 o4posi olpr oplu opy5 olq olra o5ra. o4r3ag or5aliz or5ange ore5a o5real or3ei  
 ore5sh or5est. orew4 or4gu 4o5ria or3ica o5ril orlin olrio or3ity o3riu or2mi  
 orn2e o5rof or3oug or5pe 3orrh or4se ors5en orst4 or3thi or3thy or4ty o5rum olry  
 o3al os2c os4ce o3scop 4oscopi o5scr o5i4e os5itiv os3ito os3ity osi4u os4l  
 o2so os4pa os4po os2ta o5stati os5til os5tit o4tan otele4g ot3er. ot5ers o4tes  
 4oth oth5esi oth3i4 ot3ic. ot5ica o3tice o3tif o3tis oto5s ou2 ou3bl ouch5i  
 ou5et ou4l ounce5er oun2d ou5v ov4en over4ne over3s ov4ert o3vis oviti4 o5v4ol  
 ow3der ow3el ow5est owli own5i o4wo oyla pa4ca pa4ce pac4t p4ad 5pagan  
 p3agat p4ai pain4 p4al pan4a pan3el pan4ty pa3ny palp pa4pu para5bl par5age  
 par5di 3pare par5el p4a4ri par4is pa2te pa5ter 5pathic pa5thy pa4tric pav4 3pay  
 4plb pd4 4pe. 3pe4a pear4l pe2c 2p2ed 3pede 3pedi pedia4 ped4ic p4ee pee4d pek4  
 pe4la peli4e pe4nan p4enc pen4th pe5on p4era. pera5bl p4erag p4eri peri5st  
 per4mal perme5 p4ern per3o per3ti pe5ru perlrv pe2t pe5ten pe5tiz 4pf 4pg 4ph.  
 phar5i phe3no ph4er ph4es. phlic 5phie ph5ing 5phisti 3phiz ph2l 3phob 3phone  
 5phoni pho4r 4phs ph3t 5phu lphy pi3a pian4 pi4cie pi4cy p4id p5ida pi3de 5pidi  
 3piec pi3en pi4grap pi3lo pi2n p4in. pind4 p4ino 3pilo pion4 p3ith pi5tha pi2tu  
 2p3k2 lp2l2 3plan plas5t pli3a pli5er 4plig pli4n ploia plu4m plum4b 4plm 2p3n  
 po4c 5pod. po5em po3et5 5po4g poin2 5point poly5t po4ni po4p lp4or po4ry lpos  
 posls p4ot po4ta 5poun 4plp ppa5ra p2pe p4ped p5pel p3pen p3per p3pet ppo5site  
 pr2 pray4e 5preci pre5co pre3em pref5ac pre4la pre3r p3rese 3press pre5ten pre3v  
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 pur4r 5pus pu2t 5pute put3er pu3tr put4ted put4tin p3w qu2 qua5v 2que. 3quer  
 3quet 2rab ra3bi rach4e r5acl raf5fi raf4t r2ai ra4lo ram3et r2ami rane5o ran4ge  
 r4ani ra5no rap3er 3raphy rar5c rare4 rar5ef 4raril r2as ration4 rau4t ra5vai  
 rav3el ra5zie rlb r4bab r4bag rbi2 rbi4f r2bin r5bine rb5ing. rb4o rlc r2ce  
 rcen4 r3cha rch4er r4ci4b rc4it rcum3 r4dal rd2i rdi4a rdi4er rdin4 rd3ing 2re.



relal re3an re5arr 5reav re4aw r5ebrat rec5oll rec5ompe re4cre 2r2ed relde  
 re3dis red5it re4fac re2fe re5fer. re3fi re4fy reg3is re5it relli re5lu r4en4ta  
 ren4te relo re5pin re4posi relpu rler4 r4eri rero4 re5ru r4es. re4spi ress5ib  
 res2t re5stal re3str re4ter re4ti4z re3tri reu2 re5uti rev2 re4val rev3el  
 r5ev5er. re5vers re5vert re5vil rev5olu re4wh rlf rfu4 r4fy rg2 rg3er r3get  
 r3gic rgi4n rg3ing r5gis r5git r1gl rgo4n r3gu rh4 4rh. 4rhal ri3a ria4b ri4ag  
 r4ib rib3a ric5as r4ice 4rici 5ricid ri4cie r4ico rid5er ri3enc ri3ent riler  
 ri5et rig5an 5rigi ril3iz 5riman rim5i 3rimo rim4pe r2ina 5rina. rin4d rin4e  
 rin4g rilo 5riph riph5e ri2pl rip5lic r4iq r2is r4is. ris4c r3ish ris4p ri3ta3b  
 r5ited. rit5er. rit5ers rit3ic ri2tu rit5ur riv5el riv3et riv3i r3j r3ket rk4le  
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 rm3ing r4ming. r4mio r3mit r4my r4nar r3nel r4ner r5net r3ney r5nic rlnis4 r3nit  
 r3niv rno4 r4nou r3nu rob3l r2oc ro3cr ro4e rolfe ro5fil rok2 ro5ker 5role.  
 rom5ete rom4i rom4p ron4al ron4e ro5n4is ron4ta lroom 5root ro3pel rop3ic ror3i  
 ro5ro ros5per ros4s ro4the ro4ty ro4va rov5el rox5 rlp r4pea r5pent rp5er. r3pet  
 rp4h4 rig3ing r3po rlr4 rre4c rre4f r4reo rre4st rri4o rri4v rron4 rros4 rrys4  
 4rs2 rlsa rsa5ti rs4c r2se r3sec rse4cr rs5er. rs3es rse5v2 rlsh r5sha rlsi  
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 ru4gl r3in rum3pl ru2n runk5 run4ty r5usc ruti5n rv4e rvel4i r3ven rv5er.  
 r5vest r3vey r3vic rvi4v r3vo rlv ry4c 5rynge ry3t sa2 2slab 5sack sac3ri s3act  
 5sai salar4 sal4m sa5lo sal4t 3sanc san4de slap sa5ta 5sa3tio sat3u sau4 sa5vor  
 5saw 4s5b scan4t5 sca4p scav5 s4ced 4scai s4ces sch2 s4cho 3s4cie 5scin4d scle5  
 s4cli scof4 4scopy scour5a slcu 4s5d 4se. se4a seas4 sea5w se2c3o 3sect 4s4ed  
 se4d4e s5edl se2g seg3r 5sei selle 5self 5selv 4seme se4mol sen5at 4senc sen4d  
 s5ened sen5g s5enin 4sented 4sentl sep3a3 4sler. s4erl ser4o 4servo sle4s se5sh  
 ses5t 5se5um 5sev sev3en sew4i 5sex 4s3f 2s3g s2h 2sh. shler 5shev shlin sh3io  
 3shw shiv5 sho4 sh5old shon3 shor4 short5 4shw silb s5icc 3side. 5sides 5sidi  
 si5diz 4signa sil4e 4sily 2slin s2ina 5sine. s3ing lsio 5sion sion5a si2r sir5a  
 lsis 3sitio 5siu lsiv 5siz sk2 4ske s3ket sk5ine sk5ing sll2 s3lat s2le slith5  
 2slm s3ma small3 sman3 smel4 s5men 5smith smol5d4 sln4 lso so4ce soft3 so4lab  
 sol3d2 so3lic 5solv 3som 3s4on. sona4 son4g s4op 5sophic s5ophiz s5ophy sor5c  
 sor5d 4sov so5vi 2spa 5spai spa4n spen4d 2s5peo 2sper s2phe 3spher spho5 spil4  
 sp5ing 4spio s4ply s4pon spor4 4spot squal4l slr 2ss slsa ssas3 s2s5c s3sel  
 s5seng s4ses. s5set slsi s4sie ssi4er ss5ily s4sl ss4li s4sn sspend4 ss2t ssur5a  
 ss5w 2st. s2tag s2tal stam4i 5stand s4ta4p 5stat. s4ted stern5i s5tero ste2w  
 stew5a s3the st2i s4ti. s5tia sltic 5stick s4tie s3tif st3ing 5stir sltle 5stock  
 stom3a 5stone s4top 3store st4r s4trad 5stratu s4tray s4trid 4stry 4st3w s2ty  
 lsu sulal su4b3 su2g3 su5is suit3 s4ul su2m sum3i su2n su2r 4sv sw2 4swo s4y  
 4syc 3syl syn5o sy5rin lta 3ta. 2tab ta5bles 5taboliz 4taci ta5do 4taf4 tai5lo  
 ta2l ta5la tal5en tal3i 4talk tal4lis ta5log ta5mo tan4de tanta3 ta5per ta5pl  
 tar4a 4tarc 4tare ta3riz tas4e ta5sy 4tatic ta4tur taun4 tav4 2taw tax4is 2tlb  
 4tc t4ch tch5et 4tld 4te. tead4i 4teat tece4 5tect 2tled te5di ltee teg4 te5ger  
 te5gi 3tel. telia 5tels te2ma2 tem3at 3tenan 3tenc 3tend 4tenes ltent ten4tag  
 lteo te4p te5pe ter3c 5ter3d lteri ter5ies ter3is teri5za 5ternit ter5v 4tes.  
 4tess t3ess. teth5e 3teu 3tex 4tey 2tlf 4tlg 2th. than4 th2e 4thea th3eas the5at  
 the3is 3thet th5ic. th5ica 4thil 5think 4thl th5ode 5thodic 4thoo thor5it  
 tho5riz 2ths ltia ti4ab ti4ato 2ti2b 4tick t4ico t4iclu 5tidi 3tien tif2 ti5fy  
 2tig 5tigu till5in ltim 4timp tim5ul 2tlin t2ina 3tine. 3tini ltio ti5oc tion5ee  
 5tiq ti3sa 3tise tis4m ti5so tis4p 5tistica ti3tl ti4u ltiv tiv4a ltiz ti3za  
 ti3zen 2tl t5la tlan4 3tle. 3tled 3tles. t5let. t5lo 4tlm tme4 2tln2 lto to3b  
 to5crat 4todo 2tof to2gr to5ic to2ma tom4b to3my ton4ali to3nat 4tono 4tony  
 to2ra to3rie tor5iz tosr2 5tour 4tout to3war 4tlp ltra tra3b tra5ch traci4  
 trac4it trac4te tras4 tra5ven trav5es5 tre5f tre4m trem5i 5tria tri5ces 5tricia  
 4trics 2trim tri4v tro5mi tron5i 4trony tro5phe tro3sp tro3v tru5i trus4 4tls2  
 t4sc tsh4 t4sw 4t3t2 t4tes t5to ttu4 ltu tula tu3ar tu4bi tud2 4tue 4tuf4 5tu3i  
 3tum tu4nis 2t3up. 3ture 5turi tur3is tur5o tu5ry 3tus 4tv tw4 4tlwa twis4 4two  
 lty 4tya 2tyl type3 ty5ph 4tz tz4e 4uab uac4 ua5na uan4i uar5ant uar2d uar3i  
 uar3t ulat uav4 ub4e u4bel u3ber u4bero ulb4i u4b5ing u3ble. u3ca uci4b uc4it  
 ucle3 u3cr u3cu u4cy ud3er ud5est udev4 uldic ud3ied ud3ies ud5is u5dit  
 u4don ud4si u4du u4ene uens4 uen4te uer4il 3ufa u3fl ugh3en ug5in 2ui2 uil5iz  
 ui4n uling uir4m uita4 uiv3 uiv4er. u5j 4uk ulla ula5b u5lati ulch4 5ulche  
 ul3der ul4e ullen ul4gi ul2i u5lia ul3ing ul5ish ul4lar ul4li4b ul4lis 4ul3m  
 ull4o 4uls uls5es ullti ultra3 4ultu u3lu ul5ul ul5v um5ab um4bi um4bly ulmi  
 u4m3ing umor5o um2p unat4 u2ne un4er ulni un4im u2nin un5ish uni3v un3s4 un4sw  
 unt3ab un4ter. un4tes unu4 un5y un5z u4ors u5os ulou ulpe uper5s u5pia up3ing  
 u3pl up3p upport5 upt5ib uptu4 ulra 4ura. u4rag u4ras ur4be urc4 urld ure5at  
 ur4fer ur4fr u3rif uri4fic urlin u3rio ulrit ur3iz ur2l url5ing. ur4no uros4  
 ur4pe ur4pi urs5er ur3the urti4 ur4tie u3ru 2us u5sad u5san us4ap usc2  
 us3ci use5a u5sia u3sic us4lin uslp us5sl us5tere usltr u2su usur4 uta4b u3tat  
 4ute. 4utel 4uten uten4i 4ult2i uti5liz u3tine ut3ing ution5a u4tis 5u5tiz u4tll

ut5of uto5g uto5matic u5ton u4tou uts4 u3u uu4m ulv2 uxu3 uz4e lva 5va. 2vla4b  
 vac5il vac3u vag4 va4ge va5lie val5o vallu va5mo va5niz va5pi var5ied 3vat 4ve.  
 4ved veg3 v3el. vel3li ve4lo v4ely ven3om v5enue v4erd 5vere. v4erel v3eren  
 ver5enc v4eres ver3ie vermi4n 3verse ver3th v4e2s 4ves. ves4te ve4te vet3er  
 ve4ty vi5ali 5vian 5vide. 5vided 4v3iden 5vides 5vidi v3if vi5gn vik4 2vil  
 5vilit v3i3liz vlin 4vi4na v2inc vin5d 4ving vio3l v3io4r vilou vi4p vi5ro  
 vis3it vi3so vi3su 4viti vit3r 4vity 3viv 5vo. voi4 3vok vo4la v5ole 5volt 3volv  
 vom5i vor5ab vori4 vo4ry vo4ta 4votee 4vv4 v4y w5abl 2wac wa5ger wag5o wait5  
 w5al. wam4 war4t was4t walte wa5ver wlb wea5rie weath3 wed4n weet3 wee5v wel4l  
 wler west3 w3ev whi4 wi2 wil2 will5in win4de win4g wir4 3wise with3 wiz5 w4k  
 wl4es wl3in w4no lwo2 woml wo5ven w5p wra4 wri4 writa4 w3sh ws4l ws4pe w5s4t 4wt  
 wy4 xla xac5e x4ago xam3 x4ap xas5 x3c2 xle xe4cuto x2ed xer4i xe5ro xlh xhi2  
 xhil5 xhu4 x3i xi5a xi5c xi5di x4ime xi5miz x3o x4ob x3p xpan4d xpecto5 xpe3d  
 xlt2 x3ti xlu xu3a xx4 y5ac 3yar4 y5at ylb ylc y2ce yc5er y3ch ych4e ycom4 ycot4  
 yld y5ee yler y4erf yes4 ye4t y5gi 4y3h yli y3la ylla5bl y3lo y5lu ymbol5 yme4  
 ympa3 yn3chr yn5d yn5g yn5ic 5ynx ylo4 yo5d y4o5g yom4 yo5net y4ons y4os y4ped  
 yper5 yp3i y3po y4poc yp2ta y5pu yra5m yr5ia y3ro yr4r ys4c y3s2e ys3ica ys3io  
 3ysis y4so yss4 yslt ys3ta ysur4 y3thin yt3ic ylw zal z5a2b zar2 4zb 2ze ze4n  
 ze4p zler ze3ro zet4 2zli z4il z4is 5zl 4zm lzo zo4m zo5ol zte4 4z1z2 z4zy

Liang also had fourteen exceptions:

as-so-ciate as-so-ciates dec-li-na-tion oblig-a-tory phil-an-thropic present  
 presents project projects reci-procity re-cog-ni-zance ref-or-ma-tion  
 ret-ri-bu-tion ta-ble

Updated pattern and exception lists are available from the CTAN Archives at the TeX User Group website at <http://www.tug.org>, as well as pattern and exception lists for languages other than English. Liang's dissertation is available at <http://www.tug.org/docs/liang/>.