Lab notebook

KBC

4/5/2021

2021-04-05 report

Utility functions

Opposites already manually paired

Bill can explain where these came from better than I can.

Comparison to Chris et al.'s stuff

OK, we know the intersection/complements, so let's see what Chris's opposites look like, exactly.

RO exploration

I extracted the terms from the current version of the RO, then got the absolute frequencies of their words:

/Users/kevincohen/Dropbox/Scripts-new/lexicalFrequency.pl experimental-outputs/ro.terms.txt

. . . which reveals imbalances in the use of words that are clear opposites, e.g.:

- during 11 before 4 after 2
- to 49 from 16 towards 1 *how about away?*
- directly 18 indirectly 8
- indirect 2 direct 2

. . . which suggests that I could be adding a bunch of opposite terms to the ontology.

So, I ran the current version of my antonym-finding script:

code/findAntonyms.pl resources/ontologies/ro.2021-03-08.obo.txt |wc -l

. . . which finds 43 pairs of opposites.

Next step: find overlap with Mike's resources/ontologies/predicates.txt.

For next weeks. . .

0. With Bill, reorganize repository and merge with TRANSLATOR's
1. Test cases in human-readable form
2. Handle substitutions (e.g. hypercalcemia vs. hypocalcemia)
3. Suffixes (e.g. hydrophilic vs. hydrophobic)
4. Word-internal, possibly (might produce a lot of false positives later when we do generation)

2021-04-15 report

Analysis of PATO opposites WRT the excluded middle

Motivation: this picks out a specific type of opposition: what Pustejovsky calls *polar*, meaning that there's a scale and the things at the two poles of the scale are opposites of each other.

How I assigned the excluded.middle value

0. If the middle is reasonably clearly excluded, I assigned the value *yes*. Examples: *acute/chronic, aerobic/anaerobic*. If that is not the case, then I put the "middle" value in the excluded.middle field. Example: for *phosphorylated/dephosphorylated*, I put the value *unphosphorylated* in the excluded.middle column.
1. Almost every pair that fits the pattern *increased/decreased x* has a mid-point or neutral point *normal x*.
2. Most pairs of the form *x/unx* (e.g. *responsive/unresponive*) exclude the middle. Exception: *damaged/undamaged/repaired*.
3. Most pairs of the form *x/dex* (e.g. *phosphorylated/dephosphorylated*) have a neutral point *unx* (e.g. *unphosphorylated*).
4. Most pairs of the form *hypox/hyperx* where both members of the pair are single words have a single-word neutral point *normox*. For example, for the pair *hypotrophic/hypertrophic*, there is a neutral point *normotrophic*. If I had any question about the legitimacy of these, I checked Google Scholar to ensure that the *normox* word is used.
5. If I did not find such a word via Google Scholar, then I searched for the phrase *neither term01 nor term02*. If I found it, then I put the phrase in the field. (TODO: now that I think about it, if I didn't find the phrase, I didn't try again with the order *term02 term01*. Need to do that.)

```
# "current" is the ones that Bill found currently in use
in.both <- read.table("/Users/kevincohen/Dropbox/N-Z/translator-concept-oppositeness/experimental-outpu
in.mine.only  <- read.table("/Users/kevincohen/Dropbox/N-Z/translator-concept-oppositeness/experimental
in.current.only <- read.table("/Users/kevincohen/Dropbox/N-Z/translator-concept-oppositeness/experimenta

in.both$excluded.middle <- as.character(in.both$excluded.middle)
in.mine.only$excluded.middle <- as.character(in.mine.only$excluded.middle)
in.current.only$excluded.middle <- as.character(in.current.only$excluded.middle)
# in.both <- as_tibble(in.both)
# in.both <- mutate(in.both, found.by = "BOTH")
# in.mine.only <- as_tibble(in.mine.only)
# in.mine.only <- mutate(in.mine.only, found.by = "ME")
# in.current.only <- as_tibble(in.current.only)
# in.current.only <- mutate(in.current.only, found.by = "CURRENT")

# in.combined <- as_tibble(in.both, in.mine.only, in.current.only)

#ggplot(data = in.combined, mapping = aes(x = found.by, )) +
#  geom_bar(stat ="identity")

in.counts <- c(nrow(in.both), nrow(in.mine.only), nrow(in.current.only))
#in.counts <- as_tibble(in.counts, counts = in.counts)
barplot(in.counts, names.arg = c("BOTH", "ME ONLY", "CURRENT ONLY"))
```

```
# I CAN'T GET THIS TO WORK...
#excluded.middle.counts <- c()
##count.both <- nrow(select(in.both, in.both$excluded.middle == "yes"))
##select(in.both, in.both$excluded.middle == "yes")
##count.both <- nrow(in.both$term01[in.both$term01 == "yes"])
##count.both <- in.both[which(in.both$excluded.middle == 'yes')]

#count.mine <- nrow(in.mine.only$term01[in.mine.only$term01 == "yes"])
#count.current <- nrow(in.current.only$term01[in.current.only$term01 == "yes"])
#excluded.middle.counts <- c(count.both, count.mine, count.current)

#barplot(excluded.middle.counts, names.arg = c("BOTH", "ME ONLY", "CURRENT ONLY"))
```

For next weeks...

1. Test cases in human-readable form
2. Handle substitutions (e.g. hypercalcemia vs. hypocalcemia)
3. Failing test case: *protein folding* versus *protein unfolding*
4. Failing test case: *name: oil gland decreased thickness* versus *oil gland increased thickness*
5. Suffixes (e.g. hydrophilic vs. hydrophobic)
6. Consistent naming scheme for experimental-results directory
7. Word-internal, possibly (might produce a lot of false positives later when we do generation)
8. *See email exchange with Bill*

2021-04-21 report

Now handling:

1. Now handling morphological substitutions, as opposed to additions. That means that where we used to get only pairs like abnormal, where the contrast is between presence of ab and absence of ab, we now also get hypercalcemia/hypocalcemia, where the contrast is not presence/absence, but rather between two things that are... Shit, I'm tired of trying to squeeze this into non-technical language. We used to only get prefix + free morpheme; now we are getting prefix + bound morpheme. Honi soit qui mal y pense.
2. Now handling suffixes. So, we now get pairs like hydrophilic/hydrophobic (thanks to Leslie Rapp for that one). Embarrassingly, I am not getting leukemia/leukopenia–bug being hunted.
3. Test cases in human-readable form
4. Failing test case: *protein folding* versus *p274rotein unfolding*
5. Failing test case: *name: oil gland decreased thickness* versus *oil gland increased thickness*
6. Consistent naming scheme for experimental-results directory
7. *See email exchange with Bill*
8. Word-internal, possibly (might produce a lot of false positives later when we do generation)

2021-05-05 report

1. Took a week of vacation
2. Took a sick day
3. Generated the outputs for all of the CRAFT ontologies, plus HPO, MPO, and PATO

2021-05-26

```
# only need to do once
#install.packages("entropy")
#library(entropy)

mi.calcs <- read.table("/Users/kevincohen/Dropbox/N-Z/translator-concept-oppositeness/experimental-outpu

get.rid.of.commas <- function(input.vector) {
  output.vector <- gsub(",", "", input.vector)
  return(output.vector)
}

# preprocessing--some things need to be integers, others factors
mi.calcs$opposite <- factor(mi.calcs$opposite)
mi.calcs$x.count <- as.integer(get.rid.of.commas(mi.calcs$x.count))
mi.calcs$y.count <- as.integer(get.rid.of.commas(mi.calcs$y.count))
mi.calcs$y.minus.x.count <- as.integer(get.rid.of.commas(mi.calcs$y.minus.x.count))
mi.calcs$x.minus.y.count <- as.integer(get.rid.of.commas(mi.calcs$x.minus.y.count))
mi.calcs$xy.count <- as.integer(get.rid.of.commas(mi.calcs$xy.count))
as_tibble(mi.calcs)


#mi.calcs <- mi.calcs %>% mutate(p.x = (x.count / (x.count + y.minus.x.count))) %>% mutate(p.y = (y.cou
#mutate(mi.or.something = p.xy / (p.x * p.y))

#mi.calcs <- mi.calcs %>% mutate(p.x = x.count / (x.not.y.count + y.not.x.count + x.and.y.count))
#mi.calcs <- mi.calcs %>% mutate(p.x = x.count)
# calculate p(x)
mi.calcs <- mi.calcs %>% mutate(p.x = x.count / (x.minus.y.count + y.minus.x.count + xy.count))
# calculate p(y)
mi.calcs <- mi.calcs %>% mutate(p.y = y.count / (x.minus.y.count + y.minus.x.count + xy.count))
# calculate p(x,y)
mi.calcs <- mi.calcs %>% mutate(p.xy = xy.count / (x.minus.y.count + y.minus.x.count + xy.count))
mi.calcs <- mi.calcs %>% mutate(mi.or.something = p.xy / (p.x * p.y))

#mi.calcs$mi.or.something <- log(mi.calcs$mi.or.something)

# Here I plot the values on a scale from 0.0 to 1.0
ggplot(data = mi.calcs, mapping = aes(x = opposite, y = mi.or.something)) +
  geom_boxplot() +
  ylim(0, 1.0) +
  #ylab("MI or something") +
  labs(x = "Non-opposites versus opposites", y = "MI or something", title = "Like MI but not log")
  #names(c("Not opposites", "Opposites"))

shapiro.test(mi.calcs$mi.or.something)

# Here I plot their logs
mi.calcs$mi.or.something <- log(mi.calcs$mi.or.something)
ggplot(data = mi.calcs, mapping = aes(x = opposite, y = mi.or.something)) +
  geom_boxplot() +
  #ylim(0, 1.0) +
```

```
  #ylab("MI or something") +
  labs(x = "Non-opposites versus opposites", y = "MI or something", title = "MI (maybe)")
  #names(c("Not opposites", "Opposites"))

head(mi.calcs)
#mi.calcs$mi.or.something %>% gather(opposite)

#mi.calcs <- mi.calcs %>%  select(opposite, mi.or.something)
#head(mi.calcs)

#wilcox.test(select(mi.calcs$opposite == "0"), select(mi.calcs$opposite == "1"))
```

Next step

Multi-word phrases, moving towards opposite sides of normal

HPO/MPO/MONDO terms with increase and decrease; then adjectival ones (especially hyper- and hypo-) (and generate more of those? Easy enough to do)

- Variability across those? Like, increased versus "increase in", "elevation of", etc.? Again, it's generation...
- Additional affixes: over- and under-

2021-06-02

1. Observation: synonymy is impoverished in these ontologies. For example, *increased hemoglobin* is probably equivalent to *elevated hemoglobin*, but only the first is in the ontology.
2. So, the data would benefit from Dr. Funking.
3. Logical opposites don't necessarily occur in these ontologies, and there might be good reasons for that. For example, *hypoxemia* is a clearly clinically relevant concept, but *hyperoxemia* might *not* be. This contrasts with *decreased hemoglobin affinity for oxygen* and *increased hemoglobin affinity for oxygen*, both of which *are* entirely clinically relevant.

Here are some numbers that support (1) and (3):

HPO contains:

- 459 non-obsolete terms with 'increased'
- 370 non-obsolete terms with 'decreased'
- 168 paired non-obsolete increased/decreased terms

This suggests that although perhaps there should *not* be more pairs of opposites, there certainly *could* be.

- 453 non-obsolete terms with 'hyper'
- 671 non-obsolete terms with 'hypo'
- 108 paired non-obsolete hypo/hyper terms

Again, this suggests that although perhaps there should *not* be more pairs of opposites, there certainly *could* be.

- 165 with 'reduced'

- 153 with 'elevated'
- 4 with 'depressed'
- 33 with 'high'
- 61 with 'low'

The 153:33 ratio of *elevated* to *high* and 165:4:61 of *reduced/depressed/low* suggests that for recognition in text, Funkification would increase recall.

So, for any given ontology, here's what I did:

1. Grep out the terms with *increase, decrease, hyper,* or *hypo.*
2. Find the subset of those (increase/decrease and hyper/hypo) that do occur in addition to their logical opposite. (scripts: *increasedDecreasedOpposites.pl* and *hyperHypoOpposites.pl*)
3. For that subset, generate synonyms for both members of the pair. (script: *generatePairs.pl*)

Now let's go to a terminal...

2021-06-09

I've updated the format of the files that contain opposites and synonyms. Now it encodes whether or not they're opposites, whether or not they're synonyms (you can be one, or the other, or neither, but not both); whether they're in the original form (i.e. exact match to the term in the ontology), or derived; and their source.

So, this code takes those and automates the searches that last week I was doing manually.

```
library("easyPubMed")
```

```
## Warning: package 'easyPubMed' was built under R version 4.0.2
```

```
files <- c("/Users/kevincohen/Downloads/TRANSLATOR opposites MI - PATO.tsv",
           "/Users/kevincohen/Downloads/TRANSLATOR opposites MI - HPO.tsv")

#sheet <- read.table("/Users/kevincohen/Downloads/TRANSLATOR opposites MI - PATO.tsv",
#                    header = TRUE, sep = "\t")

counts <- as.integer(c())
sheet <- data.frame()

for (file_number in 1:length(files)) {
  if (DEBUG) { print(paste("File:", files[file_number])) }
  sheet <- NULL
  counts <- NULL
  # stupid name for the variable, derived from the fact that
  # I made the files from different sheets of the same spreadsheet
  sheet <- data.frame()
  sheet <- read.table(files[file_number], header = TRUE, sep = "\t")
  sheet$opposites <- as.factor(sheet$opposites)
```

```
  # FOR DEV ONLY
  #sheet <- sheet[1:5, ]

  for (i in 1:nrow(sheet)) {
  #for (i in 1:5) {

    if (DEBUG) { print(paste("Row number:", i))}

    my_query <- paste('"', sheet[i, "term.01"], '"', " ",  '"', sheet[i, "term.02"], '"', sep = "")
    #my_query <- paste('"', sheet[i, "term.01"], '"', " ",  '"', sheet[i, "term.02"], sep = "")
    print(my_query)
    my_entrez_id <- get_pubmed_ids(my_query)
    #print(my_entrez_id$Count)
    counts <- c(counts, as.integer(my_entrez_id$Count))
  } # loop through pairs of terms

  column.names <- colnames(sheet)
  if (DEBUG) { print("Add counts to data.frame")
            print(paste("Rows in data.frame:", nrow(sheet), "Elements in counts:", length(counts)))}
  sheet <- cbind(sheet,counts)
  column.names <- c(column.names, "counts")
  if (DEBUG) { print("Reset column names") }
  colnames(sheet) <- column.names

  if (DEBUG) { print("Finally, generate the graph") }
  boxplot(sheet$counts ~ sheet$opposites,
          main = files[file_number])

  wilcox.test(sheet$counts ~ sheet$opposites)

} # close for-loop through list of files
```

```
## [1] "\"abaxial to\" \"axial to\""
## [1] "\"abaxial to\" \"abaxial\""
## [1] "\"abnormal\" \"normal\""
## [1] "\"absent\" \"present\""
## [1] "\"active\" \"inactive\""
## [1] "\"acute\" \"chronic\""
## [1] "\"acyclic cyclicity\" \"cyclic cyclicity\""
## [1] "\"adhesive\" \"non-adhesive\""
## [1] "\"aerobic (for occurrence)\" \"anaerobic (for occurrence)\""
## [1] "\"aerobic\" \"anaerobic\""
## [1] "\"aligned with\" \"misaligned with\""
## [1] "\"alobate\" \"lobate\""
## [1] "\"anaplastic\" \"aplastic\""
## [1] "\"aneuploid\" \"euploid\""
## [1] "\"aromatic\" \"non-aromatic\""
## [1] "\"arrhythmic\" \"rhythmic\""
## [1] "\"asymmetrical\" \"symmetrical\""
## [1] "\"asynchronous\" \"synchronous\""
## [1] "\"atonicity\" \"tonicity\""
## [1] "\"back\" \"front\""
## [1] "\"balanced\" \"unbalanced\""
```

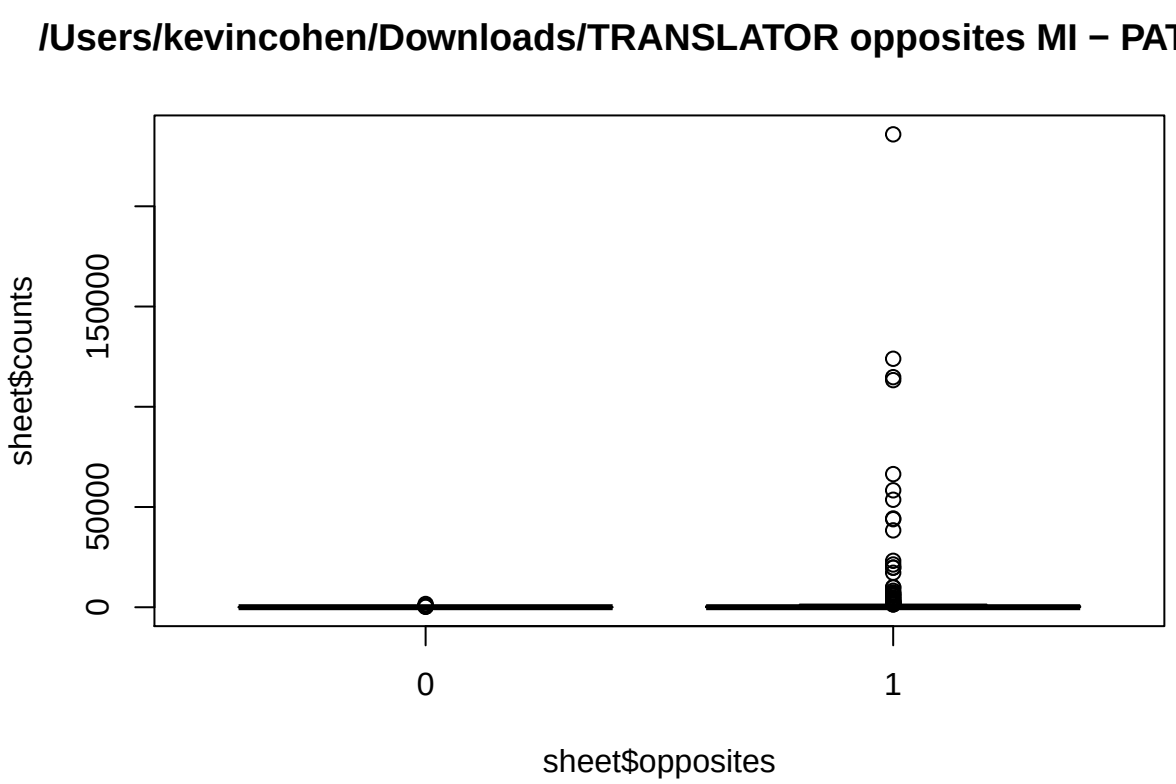
```
## [1] "\"branched\" \"unbranched\""
## [1] "\"closed\" \"open\""
## [1] "\"coiled\" \"uncoiled\""
## [1] "\"colored\" \"discolored\""
## [1] "\"compatible\" \"incompatible\""
## [1] "\"complete structure\" \"incomplete structure\""
## [1] "\"complex\" \"simple\""
## [1] "\"condensed\" \"decondensed\""
## [1] "\"conspicuous\" \"inconspicuous\""
## [1] "\"continuous\" \"discontinuous\""
## [1] "\"contractile\" \"non-contractile\""
## [1] "\"coordinated\" \"uncoordinated\""
## [1] "\"crowded\" \"uncrowded\""
## [1] "\"curved dorsal\" \"curved ventral\""
## [1] "\"damaged\" \"undamaged\""
## [1] "\"dark blue\" \"light blue\""
## [1] "\"dark brown\" \"light brown\""
## [1] "\"dark cyan\" \"light cyan\""
## [1] "\"dark green\" \"light green\""
## [1] "\"dark grey\" \"light grey\""
## [1] "\"dark magenta\" \"light magenta\""
## [1] "\"dark orange\" \"light orange\""
## [1] "\"dark phase\" \"light phase\""
## [1] "\"dark purple\" \"light purple\""
## [1] "\"dark red brown\" \"light red brown\""
## [1] "\"dark red\" \"light red\""
## [1] "\"dark violet\" \"light violet\""
## [1] "\"dark yellow brown\" \"light yellow brown\""
## [1] "\"dark yellow\" \"light yellow\""
## [1] "\"decreased accumulation\" \"increased accumulation\""
## [1] "\"decreased accumulation\" \"reduced accumulation\""
## [1] "\"decreased accumulation\" \"decrease in accumulation\""
## [1] "\"decreased acidity\" \"increased acidity\""
## [1] "\"decreased acidity\" \"reduced acidity\""
## [1] "\"decreased acidity\" \"decrease in acidity\""
## [1] "\"decreased adhesivity\" \"increased adhesivity\""
## [1] "\"decreased adhesivity\" \"reduced adhesivity\""
## [1] "\"decreased adhesivity\" \"decrease in adhesivity\""
## [1] "\"decreased affinity\" \"increased affinity\""
## [1] "\"decreased affinity\" \"decrease in affinity\""
## [1] "\"decreased age\" \"increased age\""
## [1] "\"decreased amount\" \"increased amount\""
## [1] "\"decreased angle to\" \"increased angle to\""
## [1] "\"decreased anterior-posterior diameter\" \"increased anterior-posterior diameter\""
## [1] "\"decreased area\" \"increased area\""
## [1] "\"decreased avidity\" \"increased avidity\""
## [1] "\"decreased behavioural activity\" \"increased behavioural activity\""
## [1] "\"decreased branchiness\" \"increased branchiness\""
## [1] "\"decreased cellular motility\" \"increased cellular motility\""
## [1] "\"decreased circumference\" \"increased circumference\""
## [1] "\"decreased coiling\" \"increased coiling\""
## [1] "\"decreased combustibility\" \"increased combustibility\""
## [1] "\"decreased concentration\" \"increased concentration\""
## [1] "\"decreased contractility\" \"increased contractility\""
```

```
## [1] "\"decreased coordination\" \"increased coordination\""
## [1] "\"decreased curvature\" \"increased curvature\""
## [1] "\"decreased degree of illumination\" \"increased degree of illumination\""
## [1] "\"decreased depth\" \"increased depth\""
## [1] "\"decreased depth\" \"reduced depth\""
## [1] "\"increased depth\" \"increase of depth\""
## [1] "\"decreased diameter\" \"increased diameter\""
## [1] "\"decreased diameter\" \"reduced diameter\""
## [1] "\"increased diameter\" \"increase in diameter\""
## [1] "\"decreased distance\" \"increased distance\""
## [1] "\"decreased distance\" \"reduced distance\""
## [1] "\"increased distance\" \"increase in distance\""
## [1] "\"decreased distribution\" \"increased distribution\""
## [1] "\"decreased distribution\" \"reduced distribution\""
## [1] "\"increased distribution\" \"increase of distribution\""
## [1] "\"decreased duration of temperature\" \"increased duration of temperature\""
## [1] "\"decreased duration\" \"increased duration\""
## [1] "\"decreased duration\" \"reduced duration\""
## [1] "\"decreased efficacy\" \"increased efficacy\""
## [1] "\"decreased efficiency\" \"increased efficiency\""
## [1] "\"decreased elasticity\" \"increased elasticity\""
## [1] "\"decreased elevation\" \"increased elevation\""
## [1] "\"decreased fatigability\" \"increased fatigability\""
## [1] "\"decreased fecundity\" \"increased fecundity\""
## [1] "\"decreased female fertility\" \"increased female fertility\""
## [1] "\"decreased female receptivity\" \"increased female receptivity\""
## [1] "\"decreased fertility\" \"increased fertility\""
## [1] "\"decreased flexibility\" \"increased flexibility\""
## [1] "\"decreased fluid flow\" \"increased fluid flow\""
## [1] "\"decreased fluorescence\" \"increased fluorescence\""
## [1] "\"decreased force\" \"increased force\""
## [1] "\"decreased fragility\" \"increased fragility\""
## [1] "\"decreased frequency\" \"increased frequency\""
## [1] "\"decreased functionality\" \"increased functionality\""
## [1] "\"decreased height\" \"increased height\""
## [1] "\"decreased humidity\" \"increased humidity\""
## [1] "\"decreased intensity\" \"increased intensity\""
## [1] "\"decreased length\" \"increased length\""
## [1] "\"decreased life span\" \"increased life span\""
## [1] "\"decreased linear velocity\" \"increased linear velocity\""
## [1] "\"decreased magnetism\" \"increased magnetism\""
## [1] "\"decreased magnitude\" \"increased magnitude\""
## [1] "\"decreased male fertility\" \"increased male fertility\""
## [1] "\"decreased male receptivity\" \"increased male receptivity\""
## [1] "\"decreased mass density\" \"increased mass density\""
## [1] "\"decreased mass\" \"increased mass\""
## [1] "\"decreased mobility\" \"increased mobility\""
## [1] "\"decreased object quality\" \"increased object quality\""
## [1] "\"decreased occurrence\" \"increased occurrence\""
## [1] "\"decreased odor\" \"increased odor\""
## [1] "\"decreased osmolality\" \"increased osmolality\""
## [1] "\"decreased osmolarity\" \"increased osmolarity\""
## [1] "\"decreased perimeter\" \"increased perimeter\""
## [1] "\"decreased permeability\" \"increased permeability\""
```

```
## [1] "\"decreased phosphorylation\" \"increased phosphorylation\""
## [1] "\"decreased photosensitivity\" \"increased photosensitivity\""
## [1] "\"decreased pigmentation\" \"increased pigmentation\""
## [1] "\"decreased porosity\" \"increased porosity\""
## [1] "\"decreased position\" \"increased position\""
## [1] "\"decreased pressure\" \"increased pressure\""
## [1] "\"decreased process quality\" \"increased process quality\""
## [1] "\"decreased propagation velocity\" \"increased propagation velocity\""
## [1] "\"decreased proportionality to\" \"increased proportionality to\""
## [1] "\"decreased quality\" \"increased quality\""
## [1] "\"decreased radioactivity\" \"increased radioactivity\""
## [1] "\"decreased radiopacity\" \"increased radiopacity\""
## [1] "\"decreased rate\" \"increased rate\""
## [1] "\"decreased resistance to\" \"increased resistance to\""
## [1] "\"decreased sensitivity of a process to oxygen\" \"increased sensitivity of a process to oxygen\
## [1] "\"decreased sensitivity of a process\" \"increased sensitivity of a process\""
## [1] "\"decreased sensitivity to irradiation\" \"increased sensitivity to irradiation\""
## [1] "\"decreased sensitivity toward\" \"increased sensitivity toward\""
## [1] "\"decreased size\" \"increased size\""
## [1] "\"decreased solubility\" \"increased solubility\""
## [1] "\"decreased spatial extent of a process\" \"increased spatial extent of a process\""
## [1] "\"decreased speed\" \"increased speed\""
## [1] "\"decreased stability\" \"increased stability\""
## [1] "\"decreased strength\" \"increased strength\""
## [1] "\"decreased susceptibility toward\" \"increased susceptibility toward\""
## [1] "\"decreased temperature\" \"increased temperature\""
## [1] "\"decreased tendency\" \"increased tendency\""
## [1] "\"decreased thickness\" \"increased thickness\""
## [1] "\"decreased threshold\" \"increased threshold\""
## [1] "\"decreased tolerance to\" \"increased tolerance to\""
## [1] "\"decreased tonicity\" \"increased tonicity\""
## [1] "\"decreased turgor\" \"increased turgor\""
## [1] "\"decreased variability of color\" \"increased variability of color\""
## [1] "\"decreased variability of rate\" \"increased variability of rate\""
## [1] "\"decreased variability of size\" \"increased variability of size\""
## [1] "\"decreased variability of temperature\" \"increased variability of temperature\""
## [1] "\"decreased variability\" \"increased variability\""
## [1] "\"decreased velocity\" \"increased velocity\""
## [1] "\"decreased viscosity\" \"increased viscosity\""
## [1] "\"decreased volume\" \"increased volume\""
## [1] "\"decreased waxiness\" \"increased waxiness\""
## [1] "\"decreased weight\" \"increased weight\""
## [1] "\"decreased wetness\" \"increased wetness\""
## [1] "\"decreased width and length\" \"increased width and length\""
## [1] "\"decreased width\" \"increased width\""
## [1] "\"defasciculated\" \"fasciculated\""
## [1] "\"degenerate\" \"non-degenerate\""
## [1] "\"dephosphorylated\" \"phosphorylated\""
## [1] "\"desaturated blue\" \"saturated blue\""
## [1] "\"desaturated brown\" \"saturated brown\""
## [1] "\"desaturated cyan\" \"saturated cyan\""
## [1] "\"desaturated green\" \"saturated green\""
## [1] "\"desaturated magenta\" \"saturated magenta\""
## [1] "\"desaturated orange\" \"saturated orange\""
```

```
## [1] "\"desaturated purple\" \"saturated purple\""
## [1] "\"desaturated red\" \"saturated red\""
## [1] "\"desaturated violet\" \"saturated violet\""
## [1] "\"desaturated yellow\" \"saturated yellow\""
## [1] "\"differentiated\" \"undifferentiated\""
## [1] "\"discriminate\" \"indiscriminate\""
## [1] "\"disorganized\" \"organized\""
## [1] "\"disoriented\" \"oriented\""
## [1] "\"disposition\" \"position\""
## [1] "\"distributed\" \"undistributed\""
## [1] "\"dorsal orientation\" \"ventral orientation\""
## [1] "\"dorsal to\" \"ventral to\""
## [1] "\"down\" \"up\""
## [1] "\"dry\" \"wet\""
## [1] "\"dystonicity\" \"tonicity\""
## [1] "\"edible\" \"inedible\""
## [1] "\"efficient\" \"inefficient\""
## [1] "\"elastic\" \"inelastic\""
## [1] "\"elongated\" \"shortened\""
## [1] "\"female fertile\" \"female sterile\""
## [1] "\"female semi-fertile\" \"female semi-sterile\""
## [1] "\"fertile\" \"sterile\""
## [1] "\"flexible\" \"inflexible\""
## [1] "\"fragile\" \"non-fragile\""
## [1] "\"functional\" \"non-functional\""
## [1] "\"glutinous\" \"non-glutinous\""
## [1] "\"hard\" \"soft\""
## [1] "\"high brightness\" \"low brightness\""
## [1] "\"high saturation\" \"low saturation\""
## [1] "\"hydrophilic\" \"hydrophobic\""
## [1] "\"hyperelliptic\" \"hypoelliptic\""
## [1] "\"hyperplastic\" \"hypoplastic\""
## [1] "\"hyperresponsive to\" \"hyporesponsive to\""
## [1] "\"hypertrophic growth\" \"hypotrophic growth\""
## [1] "\"hypertrophic\" \"hypotrophic\""
## [1] "\"ictal\" \"non-ictal\""
## [1] "\"immature\" \"mature\""
## [1] "\"immobile relative to\" \"mobile relative to\""
## [1] "\"immobile\" \"mobile\""
## [1] "\"imperforate\" \"perforate\""
## [1] "\"impermeable\" \"permeable\""
## [1] "\"inflated\" \"uninflated\""
## [1] "\"insensitive toward\" \"sensitive toward\""
## [1] "\"insoluble in\" \"soluble in\""
## [1] "\"insufficient\" \"sufficient\""
## [1] "\"insusceptible toward\" \"susceptible toward\""
## [1] "\"invariant color\" \"variant color\""
## [1] "\"invariant shape\" \"variant shape\""
## [1] "\"invariant temperature\" \"variant temperature\""
## [1] "\"invariant\" \"variant\""
## [1] "\"irregular duration\" \"regular duration\""
## [1] "\"irregular sleep pattern\" \"regular sleep pattern\""
## [1] "\"irregular spatial pattern\" \"regular spatial pattern\""
## [1] "\"lumenized\" \"unlumenized\""
```

```
## [1] "\"magnetic\" \"non-magnetic\""
## [1] "\"male fertile\" \"male sterile\""
## [1] "\"male semi-fertile\" \"male semi-sterile\""
## [1] "\"necessary (continuant)\" \"unnecessary (continuant)\""
## [1] "\"necessary (occurrent)\" \"unnecessary (occurrent)\""
## [1] "\"negative charge\" \"positive charge\""
## [1] "\"non-porous\" \"porous\""
## [1] "\"non-potable\" \"potable\""
## [1] "\"non-progressive\" \"progressive\""
## [1] "\"nonpolar polarity\" \"polar polarity\""
## [1] "\"obsolete backcross fertile\" \"obsolete backcross sterile\""
## [1] "\"obsolete decreased action potential\" \"obsolete increased action potential\""
## [1] "\"obsolete decreased consumption\" \"obsolete increased consumption\""
## [1] "\"obsolete decreased percentage\" \"obsolete increased percentage\""
## [1] "\"obsolete decreased relaxation\" \"obsolete increased relaxation\""
## [1] "\"obsolete f1 fertile\" \"obsolete f1 sterile\""
## [1] "\"obsolete f2 fertile\" \"obsolete f2 sterile\""
## [1] "\"obsolete high enzyme function value\" \"obsolete low enzyme function value\""
## [1] "\"obsolete high percentage\" \"obsolete low percentage\""
## [1] "\"obsolete high yield\" \"obsolete low yield\""
## [1] "\"obsolete high\" \"obsolete low\""
## [1] "\"obsolete intercross fertile\" \"obsolete intercross sterile\""
## [1] "\"obsolete negative regulation\" \"obsolete positive regulation\""
## [1] "\"old\" \"young\""
## [1] "\"opaque\" \"transparent\""
## [1] "\"ornamented\" \"unornamented\""
## [1] "\"pigmented\" \"unpigmented\""
## [1] "\"postdisplaced growth\" \"predisplaced growth\""
## [1] "\"responsive to\" \"unresponsive to\""
## [1] "\"rough\" \"smooth\""
## [1] "\"serrated\" \"unserrated\""
## [1] "\"splayed dorsal\" \"splayed ventral\""
## [1] "\"stratified\" \"unstratified\""
## [1] "\"structured\" \"unstructured\""
```




```
## [1] "\"abnormal dark-adapted electroretinogram\" \"abnormal light-adapted electroretinogram\""
## [1] "\"abnormal hard palate morphology\" \"abnormal soft palate morphology\""
## [1] "\"abnormal large intestinal mucosa morphology\" \"abnormal small intestinal mucosa morphology\""
## [1] "\"acellular urinary casts\" \"cellular urinary casts\""
## [1] "\"activating thyroid-stimulating hormone receptor defect\" \"inactivating thyroid-stimulating ho
## [1] "\"acute bronchitis\" \"chronic bronchitis\""
## [1] "\"acute colitis\" \"chronic colitis\""
## [1] "\"acute constipation\" \"chronic constipation\""
## [1] "\"acute cutaneous wound\" \"chronic cutaneous wound\""
## [1] "\"acute disseminated intravascular coagulation\" \"chronic disseminated intravascular coagulatio
## [1] "\"acute hepatic failure\" \"chronic hepatic failure\""
## [1] "\"acute hepatitis\" \"chronic hepatitis\""
## [1] "\"acute leukemia\" \"chronic leukemia\""
## [1] "\"acute myelomonocytic leukemia\" \"chronic myelomonocytic leukemia\""
## [1] "\"acute otitis media\" \"chronic otitis media\""
## [1] "\"acute pancreatitis\" \"chronic pancreatitis\""
## [1] "\"acute respiratory acidosis\" \"chronic respiratory acidosis\""
## [1] "\"acute sinusitis\" \"chronic sinusitis\""
## [1] "\"acute tubulointerstitial nephritis\" \"chronic tubulointerstitial nephritis\""
## [1] "\"acute\" \"chronic\""
## [1] "\"adenocarcinoma of the large intestine\" \"adenocarcinoma of the small intestine\""
## [1] "\"affected\" \"unaffected\""
## [1] "\"agranulocytosis\" \"granulocytosis\""
## [1] "\"alobar holoprosencephaly\" \"lobar holoprosencephaly\""
## [1] "\"anhidrotic ectodermal dysplasia\" \"hidrotic ectodermal dysplasia\""
## [1] "\"asymmetric peripheral demyelination\" \"symmetric peripheral demyelination\""
```

```
## [1] "\"atonic seizure\" \"tonic seizure\""
## [1] "\"atypical absence seizure\" \"typical absence seizure\""
## [1] "\"atypical absence status epilepticus\" \"typical absence status epilepticus\""
## [1] "\"cleft hard palate\" \"cleft soft palate\""
## [1] "\"closed comedo\" \"open comedo\""
## [1] "\"communicating hydrocephalus\" \"noncommunicating hydrocephalus\""
## [1] "\"complete atrioventricular canal defect\" \"partial atrioventricular canal defect\""
## [1] "\"complete breech presentation\" \"incomplete breech presentation\""
## [1] "\"complete congenital stationary night blindness\" \"incomplete congenital stationary night bli
## [1] "\"complete diaphragmatic absence of pericardium\" \"partial diaphragmatic absence of pericardiu
## [1] "\"complete duplication of the 1st metatarsal\" \"partial duplication of the 1st metatarsal\""
## [1] "\"complete duplication of the distal phalanges of the hand\" \"partial duplication of the distal
## [1] "\"complete duplication of the distal phalanx of the 2nd finger\" \"partial duplication of the di
## [1] "\"complete duplication of the distal phalanx of the 2nd toe\" \"partial duplication of the dista
## [1] "\"complete duplication of the distal phalanx of the 3rd finger\" \"partial duplication of the di
## [1] "\"complete duplication of the distal phalanx of the 3rd toe\" \"partial duplication of the dista
## [1] "\"complete duplication of the distal phalanx of the 4th finger\" \"partial duplication of the di
## [1] "\"complete duplication of the distal phalanx of the 4th toe\" \"partial duplication of the dista
## [1] "\"complete duplication of the distal phalanx of the 5th finger\" \"partial duplication of the di
## [1] "\"complete duplication of the distal phalanx of the 5th toe\" \"partial duplication of the dista
## [1] "\"complete duplication of the distal phalanx of the hallux\" \"partial duplication of the distal
## [1] "\"complete duplication of the middle phalanges of the hand\" \"partial duplication of the middle
## [1] "\"complete duplication of the middle phalanx of the 2nd finger\" \"partial duplication of the mi
## [1] "\"complete duplication of the middle phalanx of the 2nd toe\" \"partial duplication of the middl
## [1] "\"complete duplication of the middle phalanx of the 3rd finger\" \"partial duplication of the mi
## [1] "\"complete duplication of the middle phalanx of the 3rd toe\" \"partial duplication of the middl
## [1] "\"complete duplication of the middle phalanx of the 4th finger\" \"partial duplication of the mi
## [1] "\"complete duplication of the middle phalanx of the 4th toe\" \"partial duplication of the middl
## [1] "\"complete duplication of the middle phalanx of the 5th finger\" \"partial duplication of the mi
## [1] "\"complete duplication of the middle phalanx of the 5th toe\" \"partial duplication of the middl
## [1] "\"complete duplication of the phalanges of the 2nd finger\" \"partial duplication of the phalang
## [1] "\"complete duplication of the phalanges of the 3rd finger\" \"partial duplication of the phalang
## [1] "\"complete duplication of the phalanges of the 4th finger\" \"partial duplication of the phalang
## [1] "\"complete duplication of the phalanges of the 5th finger\" \"partial duplication of the phalang
## [1] "\"complete duplication of the proximal phalanges of the hand\" \"partial duplication of the prox
## [1] "\"complete duplication of the proximal phalanx of the 2nd finger\" \"partial duplication of the
## [1] "\"complete duplication of the proximal phalanx of the 2nd toe\" \"partial duplication of the pro
## [1] "\"complete duplication of the proximal phalanx of the 3rd finger\" \"partial duplication of the
## [1] "\"complete duplication of the proximal phalanx of the 3rd toe\" \"partial duplication of the pro
## [1] "\"complete duplication of the proximal phalanx of the 4th finger\" \"partial duplication of the
## [1] "\"complete duplication of the proximal phalanx of the 4th toe\" \"partial duplication of the pro
## [1] "\"complete duplication of the proximal phalanx of the 5th finger\" \"partial duplication of the
## [1] "\"complete duplication of the proximal phalanx of the 5th toe\" \"partial duplication of the pro
## [1] "\"complete duplication of the proximal phalanx of the hallux\" \"partial duplication of the prox
## [1] "\"complete duplication of thumb phalanx\" \"partial duplication of thumb phalanx\""
## [1] "\"complete left sided absence of pericardium\" \"partial left sided absence of pericardium\""
## [1] "\"complete right sided absence of pericardium\" \"partial right sided absence of pericardium\""
## [1] "\"complex febrile seizure\" \"simple febrile seizure\""
## [1] "\"complex renal cyst\" \"simple renal cyst\""
## [1] "\"conjugated hyperbilirubinemia\" \"unconjugated hyperbilirubinemia\""
## [1] "\"cyclophoria\" \"incyclophoria\""
## [1] "\"cyclotropia\" \"incyclotropia\""
## [1] "\"decreased activity of mitochondrial respiratory chain\" \"increased activity of mitochondrial
## [1] "\"decreased adiponectin level\" \"increased adiponectin level\""
```

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## [1] "\"decreased adiponectin level\" \"reduced adiponectin level\""
## [1] "\"decreased adipose tissue\" \"increased adipose tissue\""
## [1] "\"decreased adipose tissue\" \"reduced adipose tissue\""
## [1] "\"decreased antimullerian hormone level\" \"increased antimullerian hormone level\""
## [1] "\"decreased arden ratio of electrooculogram\" \"increased arden ratio of electrooculogram\""
## [1] "\"decreased basophil count\" \"increased basophil count\""
## [1] "\"decreased basophil count\" \"reduced basophil count\""
## [1] "\"decreased biotinidase level\" \"increased biotinidase level\""
## [1] "\"decreased blood drug concentration\" \"increased blood drug concentration\""
## [1] "\"decreased body fat percentage\" \"increased body fat percentage\""
## [1] "\"decreased body mass index\" \"increased body mass index\""
## [1] "\"decreased body weight\" \"increased body weight\""
## [1] "\"decreased circulating 18-hydroxycortisone level\" \"increased circulating 18-hydroxycortisone
## [1] "\"decreased circulating a-type natriuretic peptide level\" \"increased circulating a-type natriu
## [1] "\"decreased circulating acth level\" \"increased circulating acth level\""
## [1] "\"decreased circulating androgen level\" \"increased circulating androgen level\""
## [1] "\"decreased circulating antibody level\" \"increased circulating antibody level\""
## [1] "\"decreased circulating beta-2-microglobulin level\" \"increased circulating beta-2-microglobuli
## [1] "\"decreased circulating beta-c-terminal telopeptide level\" \"increased circulating beta-c-termi
## [1] "\"decreased circulating ceruloplasmin concentration\" \"increased circulating ceruloplasmin conc
## [1] "\"decreased circulating chylomicron concentration\" \"increased circulating chylomicron concenti
## [1] "\"decreased circulating copper concentration\" \"increased circulating copper concentration\""
## [1] "\"decreased circulating corticosterone level\" \"increased circulating corticosterone level\""
## [1] "\"decreased circulating cortisol level\" \"increased circulating cortisol level\""
## [1] "\"decreased circulating free fatty acid level\" \"increased circulating free fatty acid level\"
## [1] "\"decreased circulating free t3\" \"increased circulating free t3\""
## [1] "\"decreased circulating free t4 level\" \"increased circulating free t4 level\""
## [1] "\"decreased circulating globulin level\" \"increased circulating globulin level\""
## [1] "\"decreased circulating gonadotropin level\" \"increased circulating gonadotropin level\""
## [1] "\"decreased circulating heparan sulfate level\" \"increased circulating heparan sulfate level\"
## [1] "\"decreased circulating iga level\" \"increased circulating iga level\""
## [1] "\"decreased circulating igg level\" \"increased circulating igg level\""
## [1] "\"decreased circulating igg1 level\" \"increased circulating igg1 level\""
## [1] "\"decreased circulating igg2 level\" \"increased circulating igg2 level\""
## [1] "\"decreased circulating igg3 level\" \"increased circulating igg3 level\""
## [1] "\"decreased circulating igg4 level\" \"increased circulating igg4 level\""
## [1] "\"decreased circulating osteocalcin level\" \"increased circulating osteocalcin level\""
## [1] "\"decreased circulating progesterone\" \"increased circulating progesterone\""
## [1] "\"decreased circulating purine concentration\" \"increased circulating purine concentration\""
## [1] "\"decreased circulating renin level\" \"increased circulating renin level\""
## [1] "\"decreased circulating selenium concentration\" \"increased circulating selenium concentration\
## [1] "\"decreased circulating t4 level\" \"increased circulating t4 level\""
## [1] "\"decreased complex n-glycan level\" \"increased complex n-glycan level\""
## [1] "\"decreased core 1 o-glycan level\" \"increased core 1 o-glycan level\""
## [1] "\"decreased corneal thickness\" \"increased corneal thickness\""
## [1] "\"decreased csf alanine concentration\" \"increased csf alanine concentration\""
## [1] "\"decreased csf albumin concentration\" \"increased csf albumin concentration\""
## [1] "\"decreased csf arginine concentration\" \"increased csf arginine concentration\""
## [1] "\"decreased csf glutamate concentration\" \"increased csf glutamate concentration\""
## [1] "\"decreased csf glutamine concentration\" \"increased csf glutamine concentration\""
## [1] "\"decreased csf histidine concentration\" \"increased csf histidine concentration\""
## [1] "\"decreased csf isoleucine concentration\" \"increased csf isoleucine concentration\""
## [1] "\"decreased csf leucine concentration\" \"increased csf leucine concentration\""
## [1] "\"decreased csf lysine concentration\" \"increased csf lysine concentration\""
```

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## [1] "\"decreased csf phenylalanine concentration\" \"increased csf phenylalanine concentration\""
## [1] "\"decreased csf protein\" \"increased csf protein\""
## [1] "\"decreased csf serine concentration\" \"increased csf serine concentration\""
## [1] "\"decreased csf threonine concentration\" \"increased csf threonine concentration\""
## [1] "\"decreased csf tyrosine concentration\" \"increased csf tyrosine concentration\""
## [1] "\"decreased csf valine concentration\" \"increased csf valine concentration\""
## [1] "\"decreased csf/serum albumin ratio\" \"increased csf/serum albumin ratio\""
## [1] "\"decreased cystatin c level\" \"increased cystatin c level\""
## [1] "\"decreased dlco\" \"increased dlco\""
## [1] "\"decreased female libido\" \"increased female libido\""
## [1] "\"decreased femoral torsion\" \"increased femoral torsion\""
## [1] "\"decreased fetal movement\" \"increased fetal movement\""
## [1] "\"decreased fibular diameter\" \"increased fibular diameter\""
## [1] "\"decreased fucosylation of n-linked protein glycosylation\" \"increased fucosylation of n-link
## [1] "\"decreased fucosylation of o-linked protein glycosylation\" \"increased fucosylation of o-link
## [1] "\"decreased glomerular filtration rate\" \"increased glomerular filtration rate\""
## [1] "\"decreased glucagon level\" \"increased glucagon level\""
## [1] "\"decreased glucose-6-phosphate dehydrogenase level in blood\" \"increased glucose-6-phosphate
## [1] "\"decreased glucose-6-phosphate dehydrogenase level in dried blood spot\" \"increased glucose-6
## [1] "\"decreased glucose-6-phosphate dehydrogenase level in leukocytes\" \"increased glucose-6-phospl
## [1] "\"decreased glucose-6-phosphate dehydrogenase level in red blood cells\" \"increased glucose-6-p
## [1] "\"decreased glucose-6-phosphate dehydrogenase level in tissue\" \"increased glucose-6-phosphate
## [1] "\"decreased hdl cholesterol concentration\" \"increased hdl cholesterol concentration\""
## [1] "\"decreased hdl2a concentration\" \"increased hdl2a concentration\""
## [1] "\"decreased hdl2b concentration\" \"increased hdl2b concentration\""
## [1] "\"decreased hdl3a concentration\" \"increased hdl3a concentration\""
## [1] "\"decreased hdl3b concentration\" \"increased hdl3b concentration\""
## [1] "\"decreased hdl3c concentration\" \"increased hdl3c concentration\""
## [1] "\"decreased head circumference\" \"increased head circumference\""
## [1] "\"decreased heart rate variability\" \"increased heart rate variability\""
## [1] "\"decreased helper t cell proportion\" \"increased helper t cell proportion\""
## [1] "\"decreased hemoglobin concentration\" \"increased hemoglobin concentration\""
## [1] "\"decreased hepatic echogenicity\" \"increased hepatic echogenicity\""
## [1] "\"decreased high-mannose n-glycan level\" \"increased high-mannose n-glycan level\""
## [1] "\"decreased immunoglobulin level in body fluid\" \"increased immunoglobulin level in body fluid
## [1] "\"decreased incisura length\" \"increased incisura length\""
## [1] "\"decreased inflammatory response\" \"increased inflammatory response\""
## [1] "\"decreased intestinal transit time\" \"increased intestinal transit time\""
## [1] "\"decreased intracranial pressure\" \"increased intracranial pressure\""
## [1] "\"decreased ldl cholesterol concentration\" \"increased ldl cholesterol concentration\""
## [1] "\"decreased level of carnosine in blood\" \"increased level of carnosine in blood\""
## [1] "\"decreased level of gaba in serum\" \"increased level of gaba in serum\""
## [1] "\"decreased level of platelet-activating factor\" \"increased level of platelet-activating facto
## [1] "\"decreased libido\" \"increased libido\""
## [1] "\"decreased lymphocyte apoptosis\" \"increased lymphocyte apoptosis\""
## [1] "\"decreased male libido\" \"increased male libido\""
## [1] "\"decreased mannose-binding protein level\" \"increased mannose-binding protein level\""
## [1] "\"decreased mannosylation of n-linked protein glycosylation\" \"increased mannosylation of n-lin
## [1] "\"decreased mean corpuscular hemoglobin concentration\" \"increased mean corpuscular hemoglobin
## [1] "\"decreased mean corpuscular volume\" \"increased mean corpuscular volume\""
## [1] "\"decreased mean platelet volume\" \"increased mean platelet volume\""
## [1] "\"decreased mitochondrial number\" \"increased mitochondrial number\""
## [1] "\"decreased monosialylated core 1 o-glycan level\" \"increased monosialylated core 1 o-glycan le
## [1] "\"decreased muscle glycogen content\" \"increased muscle glycogen content\""
```

```
## [1] "\"decreased phosphoribosylpyrophosphate synthetase level\" \"increased phosphoribosylpyrophospha
## [1] "\"decreased pineal volume\" \"increased pineal volume\""
## [1] "\"decreased pituitary glycoprotein hormone alpha subunit level\" \"increased pituitary glycopro
## [1] "\"decreased proportion of cd4+cd25+ regulatory t cells\" \"increased proportion of cd4+cd25+ reg
## [1] "\"decreased proportion of class-switched memory b cells\" \"increased proportion of class-switc
## [1] "\"decreased proportion of gamma-delta t cells\" \"increased proportion of gamma-delta t cells\"
## [1] "\"decreased proportion of immature b cells\" \"increased proportion of immature b cells\""
## [1] "\"decreased proportion of immature gamma-delta t cells\" \"increased proportion of immature gamm
## [1] "\"decreased proportion of marginal zone b cells\" \"increased proportion of marginal zone b cell
## [1] "\"decreased proportion of memory b cells\" \"increased proportion of memory b cells\""
## [1] "\"decreased proportion of memory t cells\" \"increased proportion of memory t cells\""
## [1] "\"decreased proportion of naive b cells\" \"increased proportion of naive b cells\""
## [1] "\"decreased proportion of naive cd4 t cells\" \"increased proportion of naive cd4 t cells\""
## [1] "\"decreased proportion of naive cd8 t cells\" \"increased proportion of naive cd8 t cells\""
## [1] "\"decreased proportion of naive t cells\" \"increased proportion of naive t cells\""
## [1] "\"decreased proportion of plasmablasts\" \"increased proportion of plasmablasts\""
## [1] "\"decreased proportion of transitional b cells\" \"increased proportion of transitional b cells
## [1] "\"decreased proportion of unswitched memory b cells\" \"increased proportion of unswitched memo
## [1] "\"decreased qrs voltage\" \"increased qrs voltage\""
## [1] "\"decreased red blood cell count\" \"increased red blood cell count\""
## [1] "\"decreased resting energy expenditure\" \"increased resting energy expenditure\""
## [1] "\"decreased salivary cortisol level\" \"increased salivary cortisol level\""
## [1] "\"decreased scrotal rugation\" \"increased scrotal rugation\""
## [1] "\"decreased serum estradiol\" \"increased serum estradiol\""
## [1] "\"decreased serum estriol\" \"increased serum estriol\""
## [1] "\"decreased serum estrone\" \"increased serum estrone\""
## [1] "\"decreased serum ferritin\" \"increased serum ferritin\""
## [1] "\"decreased serum insulin-like growth factor 1\" \"increased serum insulin-like growth factor 1
## [1] "\"decreased serum iron\" \"increased serum iron\""
## [1] "\"decreased serum leptin\" \"increased serum leptin\""
## [1] "\"decreased serum testosterone level\" \"increased serum testosterone level\""
## [1] "\"decreased serum zinc\" \"increased serum zinc\""
## [1] "\"decreased sialylated n-glycan level\" \"increased sialylated n-glycan level\""
## [1] "\"decreased sialylation of n-linked protein glycosylation\" \"increased sialylation of n-linked
## [1] "\"decreased size of nasopharyngeal adenoids\" \"increased size of nasopharyngeal adenoids\""
## [1] "\"decreased size of the clitoris\" \"increased size of the clitoris\""
## [1] "\"decreased skull ossification\" \"increased skull ossification\""
## [1] "\"decreased superoxide dismutase level\" \"increased superoxide dismutase level\""
## [1] "\"decreased t3/t4 ratio\" \"increased t3/t4 ratio\""
## [1] "\"decreased thyroid-stimulating hormone level\" \"increased thyroid-stimulating hormone level\"
## [1] "\"decreased total hemolytic complement activity\" \"increased total hemolytic complement activi
## [1] "\"decreased total iron binding capacity\" \"increased total iron binding capacity\""
## [1] "\"decreased uridine diphosphate glucose-4-epimerase level in plasma\" \"increased uridine diphos
## [1] "\"decreased uridine diphosphate glucose-4-epimerase level in red blood cells\" \"increased uridi
## [1] "\"decreased urinary 1-methylhistidine\" \"increased urinary 1-methylhistidine\""
## [1] "\"decreased urinary 3-methylhistidine\" \"increased urinary 3-methylhistidine\""
## [1] "\"decreased urinary copper concentration\" \"increased urinary copper concentration\""
## [1] "\"decreased urinary potassium\" \"increased urinary potassium\""
## [1] "\"decreased urinary sulfate\" \"increased urinary sulfate\""
## [1] "\"decreased urinary urate\" \"increased urinary urate\""
## [1] "\"decreased urine alpha-ketoglutarate concentration\" \"increased urine alpha-ketoglutarate conc
## [1] "\"decreased urine urobilinogen\" \"increased urine urobilinogen\""
## [1] "\"decreased vldl cholesterol concentration\" \"increased vldl cholesterol concentration\""
## [1] "\"decreased waist to hip ratio\" \"increased waist to hip ratio\""
```

```
## [1] "\"disproportionate short stature\" \"proportionate short stature\""
## [1] "\"disproportionate tall stature\" \"proportionate tall stature\""
## [1] "\"dysgerminoma\" \"germinoma\""
## [1] "\"early chronotype\" \"late chronotype\""
## [1] "\"early inspiratory crackles\" \"late inspiratory crackles\""
## [1] "\"early spermatogenesis maturation arrest\" \"late spermatogenesis maturation arrest\""
## [1] "\"fast-growing nails\" \"slow-growing nails\""
## [1] "\"happy demeanor\" \"unhappy demeanor\""
## [1] "\"heavy-chain paraproteinemia\" \"light-chain paraproteinemia\""
## [1] "\"high anterior hairline\" \"low anterior hairline\""
## [1] "\"high insertion of columella\" \"low insertion of columella\""
## [1] "\"high maternal serum alpha-fetoprotein\" \"low maternal serum alpha-fetoprotein\""
## [1] "\"high maternal serum chorionic gonadotropin\" \"low maternal serum chorionic gonadotropin\""
## [1] "\"high posterior hairline\" \"low posterior hairline\""
## [1] "\"high pulse pressure\" \"low pulse pressure\""
## [1] "\"high serum calcifediol\" \"low serum calcifediol\""
## [1] "\"high serum calcitriol\" \"low serum calcitriol\""
## [1] "\"high-frequency sensorineural hearing impairment\" \"low-frequency sensorineural hearing impai
## [1] "\"high-output congestive heart failure\" \"low-output congestive heart failure\""
## [1] "\"hodgkin lymphoma\" \"non-hodgkin lymphoma\""
## [1] "\"hyperactive bowel sounds\" \"hypoactive bowel sounds\""
## [1] "\"hyperalaninemia\" \"hypoalaninemia\""
## [1] "\"hyperalbuminemia\" \"hypoalbuminemia\""
## [1] "\"hyperammonemia\" \"hypoammonemia\""
## [1] "\"hyperamylasemia\" \"hypoamylasemia\""
## [1] "\"hyperargininemia\" \"hypoargininemia\""
## [1] "\"hyperasparaginemia\" \"hypoasparaginemia\""
## [1] "\"hyperautofluorescent macular lesion\" \"hypoautofluorescent macular lesion\""
## [1] "\"hyperautofluorescent retinal lesion\" \"hypoautofluorescent retinal lesion\""
## [1] "\"hypercalcemia\" \"hypocalcemia\""
## [1] "\"hypercalciuria\" \"hypocalciuria\""
## [1] "\"hypercapnia in cord blood\" \"hypocapnia in cord blood\""
## [1] "\"hypercapnia\" \"hypocapnia\""
## [1] "\"hyperchloremia\" \"hypochloremia\""
## [1] "\"hyperchloriduria\" \"hypochloriduria\""
## [1] "\"hypercholesterolemia\" \"hypocholesterolemia\""
## [1] "\"hypercitraturia\" \"hypocitraturia\""
## [1] "\"hyperdeviation\" \"hypodeviation\""
## [1] "\"hyperfibrinogenemia\" \"hypofibrinogenemia\""
## [1] "\"hyperglutamatemia\" \"hypoglutamatemia\""
## [1] "\"hyperglycemia\" \"hypoglycemia\""
## [1] "\"hyperglycinemia\" \"hypoglycinemia\""
## [1] "\"hyperglycorrhachia\" \"hypoglycorrhachia\""
## [1] "\"hypergonadotropic hypogonadism\" \"hypogonadotropic hypogonadism\""
## [1] "\"hyperhidrosis\" \"hypohidrosis\""
## [1] "\"hyperintensity of cerebral white matter on mri\" \"hypointensity of cerebral white matter on m
## [1] "\"hyperisoleucinemia\" \"hypoisoleucinemia\""
## [1] "\"hyperkalemia\" \"hypokalemia\""
## [1] "\"hyperleucinemia\" \"hypoleucinemia\""
## [1] "\"hyperlipidemia\" \"hypolipidemia\""
## [1] "\"hyperlipoproteinemia\" \"hypolipoproteinemia\""
## [1] "\"hypermagnesiuria\" \"hypomagnesiuria\""
## [1] "\"hypermanganesemia\" \"hypomanganesemia\""
## [1] "\"hypermelanotic macule\" \"hypomelanotic macule\""
```

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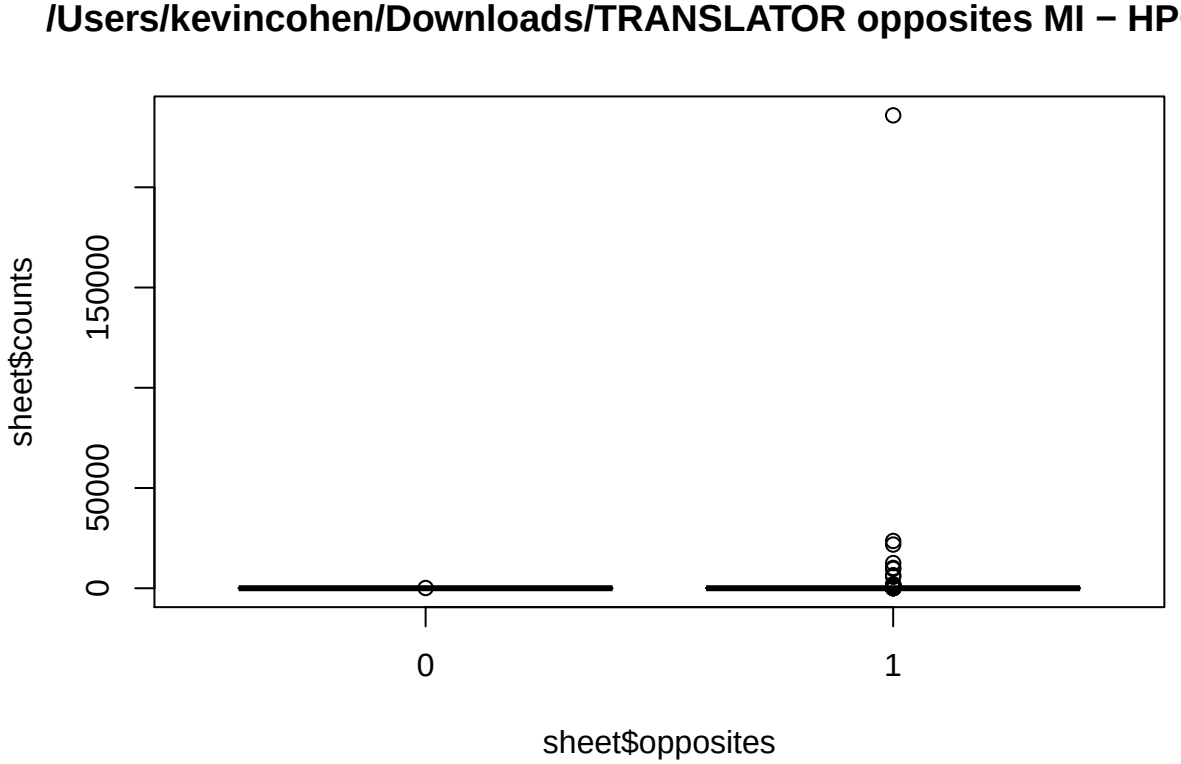
## [1] "\"hypermethioninemia\" \"hypomethioninemia\""
## [1] "\"hypermetric horizontal saccades\" \"hypometric horizontal saccades\""
## [1] "\"hypermetric saccades\" \"hypometric saccades\""
## [1] "\"hypernatriuria\" \"hyponatriuria\""
## [1] "\"hyperparathyroidism\" \"hypoparathyroidism\""
## [1] "\"hyperperistalsis\" \"hypoperistalsis\""
## [1] "\"hyperphenylalaninemia\" \"hypophenylalaninemia\""
## [1] "\"hyperphoria\" \"hypophoria\""
## [1] "\"hyperphosphatemia\" \"hypophosphatemia\""
## [1] "\"hyperphosphaturia\" \"hypophosphaturia\""
## [1] "\"hyperpigmentation of the fundus\" \"hypopigmentation of the fundus\""
## [1] "\"hyperpigmentation of the skin\" \"hypopigmentation of the skin\""
## [1] "\"hyperpigmented genitalia\" \"hypopigmented genitalia\""
## [1] "\"hyperpigmented streaks\" \"hypopigmented streaks\""
## [1] "\"hyperpituitarism\" \"hypopituitarism\""
## [1] "\"hyperplasia of the maxilla\" \"hypoplasia of the maxilla\""
## [1] "\"hyperplasia of the premaxilla\" \"hypoplasia of the premaxilla\""
## [1] "\"hyperplastic labia majora\" \"hypoplastic labia majora\""
## [1] "\"hyperprolinemia\" \"hypoprolinemia\""
## [1] "\"hyperproteinemia\" \"hypoproteinemia\""
## [1] "\"hyperreflexia\" \"hyporeflexia\""
## [1] "\"hypersegmentation of neutrophil nuclei in csf\" \"hyposegmentation of neutrophil nuclei in cs
## [1] "\"hypersegmentation of neutrophil nuclei\" \"hyposegmentation of neutrophil nuclei\""
## [1] "\"hypertaurinemia\" \"hypotaurinemia\""
## [1] "\"hypertelorism\" \"hypotelorism\""
## [1] "\"hypertension\" \"hypotension\""
## [1] "\"hyperthreoninemia\" \"hypothreoninemia\""
## [1] "\"hyperthyroidism\" \"hypothyroidism\""
## [1] "\"hypertriglyceridemia\" \"hypotriglyceridemia\""
## [1] "\"hypertropia\" \"hypotropia\""
## [1] "\"hypertryptophanemia\" \"hypotryptophanemia\""
## [1] "\"hypertyrosinemia\" \"hypotyrosinemia\""
## [1] "\"hyperuricemia\" \"hypouricemia\""
## [1] "\"hyperventilation\" \"hypoventilation\""
## [1] "\"ketotic hypoglycemia\" \"nonketotic hypoglycemia\""
## [1] "\"large basal ganglia\" \"small basal ganglia\""
## [1] "\"large cell lung carcinoma\" \"small cell lung carcinoma\""
## [1] "\"large earlobe\" \"small earlobe\""
## [1] "\"large face\" \"small face\""
## [1] "\"large for gestational age\" \"small for gestational age\""
## [1] "\"large foramen magnum\" \"small foramen magnum\""
## [1] "\"large forehead\" \"small forehead\""
## [1] "\"large humeral epiphyses\" \"small humeral epiphyses\""
## [1] "\"large intestinal polyposis\" \"small intestinal polyposis\""
## [1] "\"large placenta\" \"small placenta\""
## [1] "\"large radial epiphyses\" \"small radial epiphyses\""
## [1] "\"large sella turcica\" \"small sella turcica\""
## [1] "\"large vessel vasculitis\" \"small vessel vasculitis\""
## [1] "\"leukemia\" \"leukopenia\""
## [1] "\"medial calcification of large arteries\" \"medial calcification of small arteries\""
## [1] "\"medullary thyroid carcinoma\" \"non-medullary thyroid carcinoma\""
## [1] "\"monoclonal elevation of igg heavy chain\" \"monoclonal elevation of igg light chain\""
## [1] "\"neoplasm of the large intestine\" \"neoplasm of the small intestine\""
## [1] "\"non-obstructive azoospermia\" \"obstructive azoospermia\""
```

```
## [1] "\"non-restrictive ventricular septal defect\" \"restrictive ventricular septal defect\""
## [1] "\"non-secretory adrenocortical adenoma\" \"secretory adrenocortical adenoma\""
## [1] "\"non-small cell lung carcinoma\" \"small cell lung carcinoma\""
## [1] "\"nonopposable triphalangeal thumb\" \"opposable triphalangeal thumb\""
## [1] "\"nonproductive cough\" \"productive cough\""
## [1] "\"nonproductive cough\" \"non-productive cough\""
## [1] "\"nonprogressive cerebellar ataxia\" \"progressive cerebellar ataxia\""
## [1] "\"nonprogressive encephalopathy\" \"progressive encephalopathy\""
## [1] "\"nonprogressive visual loss\" \"progressive visual loss\""
## [1] "\"nonprogressive\" \"progressive\""
## [1] "\"obsolete decreased proportion of cd4+ central memory cells\" \"obsolete increased proportion
## [1] "\"postauricular pit\" \"preauricular pit\""
## [1] "\"postauricular skin tag\" \"preauricular skin tag\""
## [1] "\"postaxial foot polydactyly\" \"preaxial foot polydactyly\""
## [1] "\"postaxial hand polydactyly\" \"preaxial hand polydactyly\""
## [1] "\"postaxial polydactyly\" \"preaxial polydactyly\""
## [1] "\"postductal coarctation of the aorta\" \"preductal coarctation of the aorta\""
## [1] "\"postlingual sensorineural hearing impairment\" \"prelingual sensorineural hearing impairment\
## [1] "\"primary amenorrhea\" \"secondary amenorrhea\""
## [1] "\"primary caesarian section\" \"secondary caesarian section\""
## [1] "\"primary hyperaldosteronism\" \"secondary hyperaldosteronism\""
## [1] "\"primary hypercortisolism\" \"secondary hypercortisolism\""
## [1] "\"primary hyperparathyroidism\" \"secondary hyperparathyroidism\""
## [1] "\"secondary hyperparathyroidism\" \"tertiary hyperparathyroidism\""
## [1] "\"submucous cleft hard palate\" \"submucous cleft soft palate\""
## [1] "\"undetectable dark-adapted electroretinogram\" \"undetectable light-adapted electroretinogram\
```



```
#print(counts)

#boxplot(counts)
```

For reproducibility

```
## R version 4.0.1 (2020-06-06)
## Platform: x86_64-apple-darwin17.0 (64-bit)
## Running under: macOS  10.16
##
## Matrix products: default
## BLAS:   /Library/Frameworks/R.framework/Versions/4.0/Resources/lib/libRblas.dylib
## LAPACK: /Library/Frameworks/R.framework/Versions/4.0/Resources/lib/libRlapack.dylib
##
## locale:
## [1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
##  [1] easyPubMed_2.13     ggVennDiagram_0.5.0 forcats_0.5.1
##  [4] stringr_1.4.0       dplyr_1.0.4         purrr_0.3.4
##  [7] readr_1.4.0         tidyr_1.1.1         tibble_3.0.1
## [10] ggplot2_3.3.2       tidyverse_1.3.0
##
## loaded via a namespace (and not attached):
##  [1] Rcpp_1.0.4.6         lubridate_1.7.9      class_7.3-17
##  [4] assertthat_0.2.1     digest_0.6.25        R6_2.4.1
##  [7] cellranger_1.1.0     futile.options_1.0.1 backports_1.1.8
## [10] reprex_1.0.0         evaluate_0.14        e1071_1.7-3
## [13] highr_0.8            httr_1.4.1           pillar_1.4.4
## [16] rlang_0.4.10         readxl_1.3.1         VennDiagram_1.6.20
## [19] rstudioapi_0.11      rmarkdown_2.8        munsell_0.5.0
## [22] broom_0.7.4          compiler_4.0.1       modelr_0.1.8
## [25] xfun_0.23            pkgconfig_2.0.3      htmltools_0.5.1.1
## [28] tidyselect_1.1.0     fansi_0.4.1          crayon_1.3.4
## [31] dbplyr_2.1.0         withr_2.4.1          sf_0.9-8
## [34] grid_4.0.1           jsonlite_1.7.0       gtable_0.3.0
## [37] lifecycle_0.2.0      DBI_1.1.0            magrittr_1.5
## [40] formatR_1.8          units_0.7-1          scales_1.1.1
## [43] KernSmooth_2.23-17   cli_2.0.2            stringi_1.4.6
## [46] fs_1.4.1             xml2_1.3.2           futile.logger_1.4.3
## [49] ellipsis_0.3.1       generics_0.0.2       vctrs_0.3.6
## [52] lambda.r_1.2.4       tools_4.0.1          glue_1.4.1
## [55] hms_1.0.0            yaml_2.2.1           colorspace_1.4-1
## [58] classInt_0.4-3       rvest_0.3.6          knitr_1.33
## [61] haven_2.3.1
```