

Lab notebook

KBC

4/5/2021

2021-04-05

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
- 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.

PATO: opposites already annotated

```
library("ggVennDiagram")
```

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

```
library(tidyverse)
```

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

```
## -- Attaching packages ----- tidyverse
```

```
## v ggplot2 3.3.2      v purrr   0.3.4
## v tibble  3.0.1      v dplyr   1.0.4
## v tidyr   1.1.1      v stringr 1.4.0
## v readr   1.4.0      v forcats 0.5.1
```

```

## Warning: package 'ggplot2' was built under R version 4.0.2

## Warning: package 'tidyr' was built under R version 4.0.2

## Warning: package 'readr' was built under R version 4.0.2

## Warning: package 'dplyr' was built under R version 4.0.2

## Warning: package 'forcats' was built under R version 4.0.2

## -- Conflicts ----- tidyverse_conflict
## x dplyr::filter() masks stats::filter()
## x dplyr::lag() masks stats::lag()

# NB: need to add reduce/increase. Do HP, then RO.

# only found by me
# comm -23 experimental-outputs/pato.mine.terms.only.tsv resources/current-opposites.sorted.terms.only.
#      59

# only in current annotations
#comm -13 experimental-outputs/pato.mine.terms.only.tsv resources/current-opposites.sorted.terms.only.
#      27

# in both
#comm -12 experimental-outputs/pato.mine.terms.only.tsv resources/current-opposites.sorted.terms.only.
#      188

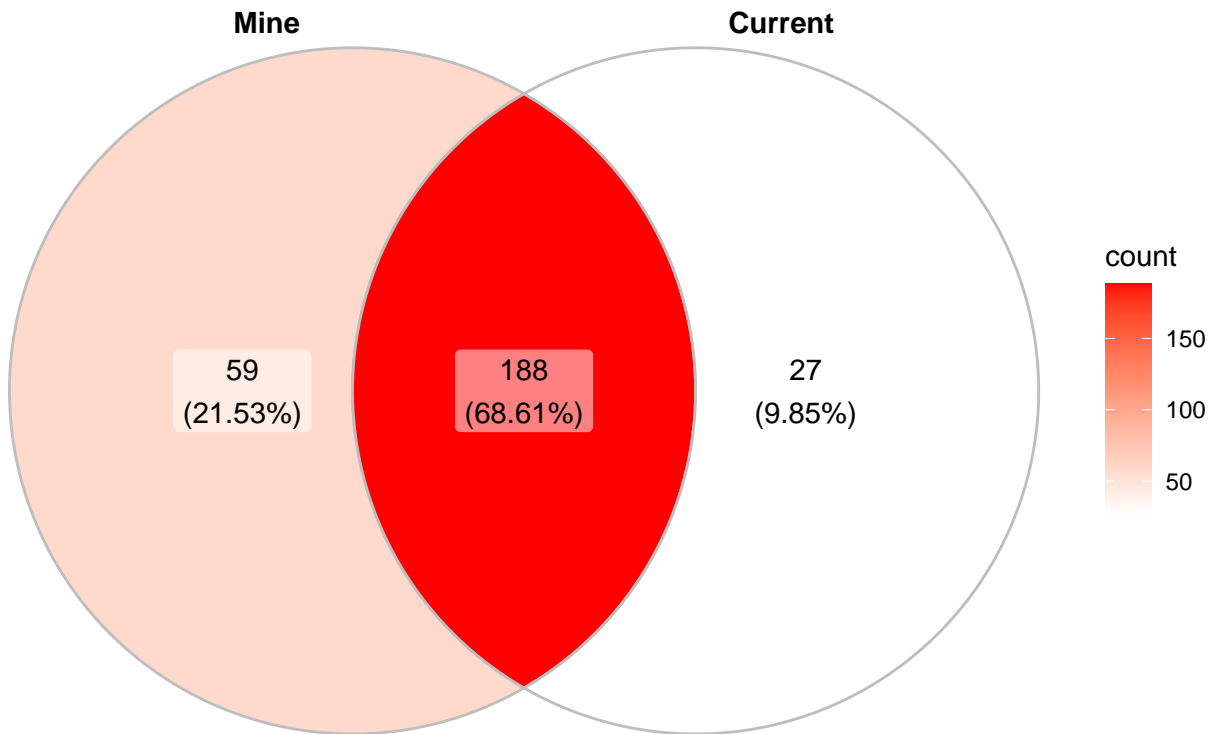
# https://www.datanovia.com/en/fr/blog/magnifique-diagramme-de-venn-ggplot-avec-r/

# this separates out the three entirely--not what the ggVennDiagram() function is looking for
# Here I'm just getting the terms themselves in printable fashion, separating them by who "finds" them
pato.mine.only <- as.vector(read_lines("/Users/kevincohen/Dropbox/N-Z/translator-concept-oppositeness/experim
pato.mine.only <- stringr::str_split(pato.mine.only, pattern = "\\t")
#pato.mine.only
current.only <- as.vector((read_lines("/Users/kevincohen/Dropbox/N-Z/translator-concept-oppositeness/experim
current.only <- stringr::str_split(current.only, pattern = "\\t")
both.mine.and.current <- as.vector((read_lines("/Users/kevincohen/Dropbox/N-Z/translator-concept-oppositeness/experim
both.mine.and.current <- stringr::str_split(both.mine.and.current, pattern = "\\t")

# here I have *everything* that I found and *everything* in current, so that we can quantify overlap &
pato.mine <- as.vector(read_lines("/Users/kevincohen/Dropbox/N-Z/translator-concept-oppositeness/experim
current <- as.vector(read_lines("/Users/kevincohen/Dropbox/N-Z/translator-concept-oppositeness/resources

x <- list(Mine = pato.mine, Current = current)
ggVennDiagram(x)

```



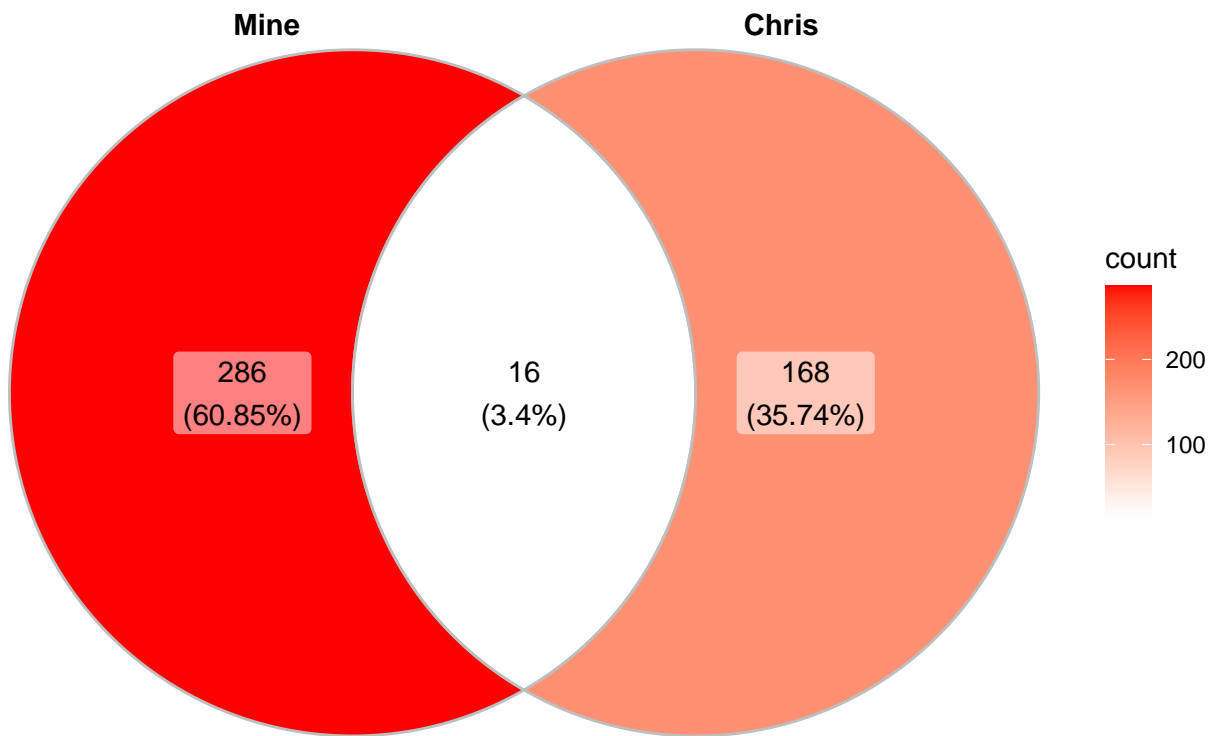
```
# print("In both mine and 'current':")
# print(both.mine.and.current, row.names = FALSE)
# print("In mine only:")
# print(pato.mine.only)
# print("In 'current' only:")
# print(current.only)

#as.tibble(pato.mine.only)
```

Comparison to Chris et al.'s stuff

```
chris <- read.table("/Users/kevincohen/Dropbox/N-Z/translator-concept-oppositeness/experimental-outputs",
colnames(chris) <- c("term01", "term02")
chris <- as_tibble(chris)
hp.mine <- read.table("/Users/kevincohen/Dropbox/N-Z/translator-concept-oppositeness/experimental-outputs",
colnames(hp.mine) <- c("term01", "term02")
hp.mine <- as_tibble(hp.mine)

# Reran my stuff on HPO 2021-04
chris.as.vector <- as.vector(paste(chris$term01, chris$term02))
hp.mine.as.vector <- as.vector(paste(hp.mine$term01, hp.mine$term02))
x <- list(Mine = hp.mine.as.vector, Chris = chris.as.vector)
ggVennDiagram(x)
```



```
print("Mine:")
```

```
## [1] "Mine:"
```

```
print(hp.mine)
```

```
## # A tibble: 302 x 2
##   term01      term02
##   <chr>      <chr>
## 1 HP:0030469 HP:0008275
## 2 HP:0100737 HP:0100736
## 3 HP:0025090 HP:0025129
## 4 HP:0031199 HP:0031197
## 5 HP:0011790 HP:0011791
## 6 HP:0012388 HP:0004469
## 7 HP:0100282 HP:0100281
## 8 HP:0012451 HP:0012450
## 9 HP:0032675 HP:0032676
## 10 HP:0011880 HP:0005520
## # ... with 292 more rows
```

```
print("Chris's:")
```

```
## [1] "Chris's:"
```

```
print(chris)
```

```
## # A tibble: 184 x 2
##   term01      term02
##   <chr>      <chr>
## 1 HP:0000098 HP:0004322
## 2 HP:0000103 HP:0011037
## 3 HP:0000154 HP:0000160
## 4 HP:0000158 HP:0000171
## 5 HP:0000188 HP:0011341
## 6 HP:0000239 HP:0005486
## 7 HP:0000253 HP:0004481
## 8 HP:0000274 HP:0100729
## 9 HP:0000275 HP:0000283
## 10 HP:0000276 HP:0011219
## # ... with 174 more rows
```

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

```
library(ontologyIndex)
```

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

```
# His data is IDs only, and we need the terms, so we need to have a searchable version of HPO.
hpo.ontology <- get_ontology("/Users/kevincohen/Dropbox/a-m/Corpora/obo/hp-2020-20-12.obo")
for (i in 1:nrow(chris)) {
  #print(chris[i,])
  opposites <- chris[i,]
  id01 <- as.character(opposites[1])
  id02 <- as.character(opposites[2])
  term01 <- get_term_property(hpo.ontology, property = "name", term = id01)
  term02 <- get_term_property(hpo.ontology, property = "name", term = id02)
  print(paste(term01, term02, sep = "      "))
  # term01 <- chris[i,]
  # term02 <- chris[i,]
}
```

```
## [1] "Tall stature      Short stature"
## [1] "Polyuria         Decreased urine output"
## [1] "Wide mouth       Narrow mouth"
## [1] "Macroglossia     Microglossia"
## [1] "Short upper lip   Long upper lip"
## [1] "Large fontanelles Small fontanelle"
## [1] "Progressive microcephaly Progressive macrocephaly"
## [1] "Small face       Large face"
## [1] "Narrow face      Broad face"
## [1] "Long face        Short face"
## [1] "Hypertelorism    Hypotelorism"
## [1] "Short philtrum   Long philtrum"
## [1] "Hypoplasia of the maxilla Hyperplasia of the maxilla"
## [1] "Short chin       Tall chin"
## [1] "Broad forehead   Narrow forehead"
```

[1] "Small forehead Large forehead"
 ## [1] "Wide nose Narrow nose"
 ## [1] "Short neck Long neck"
 ## [1] "Microcornea Megalocornea"
 ## [1] "Long eyelashes Short eyelashes"
 ## [1] "Thick eyebrow Thin eyebrow"
 ## [1] "Long palpebral fissure Short palpebral fissure"
 ## [1] "Hypodontia Increased number of teeth"
 ## [1] "Microdontia Macrodontia"
 ## [1] "Hypoplasia of the thymus Thymus hyperplasia"
 ## [1] "Hypothyroidism Hyperthyroidism"
 ## [1] "Hypertension Hypotension"
 ## [1] "Hypoparathyroidism Hyperparathyroidism"
 ## [1] "Increased circulating gonadotropin level Decreased circulating gonadotropin level"
 ## [1] "Hyperinsulinemia Hypoinsulinemia"
 ## [1] "Increased circulating renin level Decreased circulating renin level"
 ## [1] "Hyperaldosteronism Decreased circulating aldosterone level"
 ## [1] "Parathyroid hypoplasia Parathyroid hyperplasia"
 ## [1] "Long clavicles Short clavicles"
 ## [1] "Hypertrichosis obsolete Hypotrichosis"
 ## [1] "Broad palm Narrow palm"
 ## [1] "Large hands Small hand"
 ## [1] "Short umbilical cord Long umbilical cord"
 ## [1] "Hyporeflexia Hyperreflexia"
 ## [1] "Limitation of joint mobility Joint hypermobility"
 ## [1] "Onychogryposis Thin nail"
 ## [1] "Broad nail Narrow nail"
 ## [1] "Short toe Long toe"
 ## [1] "Long hallux Short hallux"
 ## [1] "Leukopenia Leukocytosis"
 ## [1] "Hypoglycemia Hyperglycemia"
 ## [1] "Hyperammonemia Hypoammonemia"
 ## [1] "Hypophosphatemia Hyperphosphatemia"
 ## [1] "Hyperuricemia Hypouricemia"
 ## [1] "Hypercalciuria Hypocalciuria"
 ## [1] "Hyperkalemia Hypokalemia"
 ## [1] "Hyperglycinemia Hypoglycinemia"
 ## [1] "Hypertriglyceridemia Hypotriglyceridemia"
 ## [1] "Increased CSF lactate Reduced CSF lactate"
 ## [1] "Pancreatic hypoplasia Pancreatic hyperplasia"
 ## [1] "Small foramen magnum Large foramen magnum"
 ## [1] "Thickened calvaria Thin calvarium"
 ## [1] "Large sella turcica Small sella turcica"
 ## [1] "Lymphadenopathy Lymph node hypoplasia"
 ## [1] "Decreased lymphocyte apoptosis Increased lymphocyte apoptosis"
 ## [1] "Hypoventilation Hyperventilation"
 ## [1] "Decreased circulating total IgM Increased circulating IgM level"
 ## [1] "Hypocalcemia Hypercalcemia"
 ## [1] "Hyponatremia Hypernatremia"
 ## [1] "Hyperchloriduria Hypochloriduria"
 ## [1] "Hypomagnesemia Hypermagnesemia"
 ## [1] "Decreased circulating ACTH level Increased circulating ACTH level"
 ## [1] "Hypoalbuminemia Hyperalbuminemia"
 ## [1] "Hyperlipidemia Hypolipidemia"

[1] "Increased urinary potassium Decreased urinary potassium"
 ## [1] "Hyperphosphaturia Hypophosphaturia"
 ## [1] "Hypochloremia Hyperchloremia"
 ## [1] "Increased circulating cortisol level Decreased circulating cortisol level"
 ## [1] "Hypercholesterolemia Hypocholesterolemia"
 ## [1] "Elevated alkaline phosphatase Low alkaline phosphatase"
 ## [1] "Decreased HDL cholesterol concentration Increased HDL cholesterol concentration"
 ## [1] "Hypermethioninemia Hypomethioninemia"
 ## [1] "Increased circulating IgG level Decreased circulating IgG level"
 ## [1] "Elevated serum creatinine Decreased serum creatinine"
 ## [1] "Increased serum ferritin Decreased serum ferritin"
 ## [1] "Decreased urinary sulfate Increased urinary sulfate"
 ## [1] "CNS hypomyelination CNS hypermyelination"
 ## [1] "Large humeral epiphyses Small humeral epiphyses"
 ## [1] "Large radial epiphyses Small radial epiphyses"
 ## [1] "Short palm Long palm"
 ## [1] "Decreased circulating antibody level Increased circulating antibody level"
 ## [1] "Increased body weight Decreased body weight"
 ## [1] "Increased skull ossification Decreased skull ossification"
 ## [1] "Reduced bone mineral density Increased bone mineral density"
 ## [1] "Increased circulating purine concentration Decreased circulating purine concentration"
 ## [1] "Biconcave vertebral bodies Biconvex vertebral bodies"
 ## [1] "Decreased mean platelet volume Increased mean platelet volume"
 ## [1] "Short middle phalanx of finger Long middle phalanx of finger"
 ## [1] "Thyroid hypoplasia Thyroid hyperplasia"
 ## [1] "Long proximal phalanx of finger Short proximal phalanx of finger"
 ## [1] "Small placenta Large placenta"
 ## [1] "Broad femoral neck Narrow femoral neck"
 ## [1] "Large basal ganglia Small basal ganglia"
 ## [1] "Peripheral hypomyelination Peripheral hypermyelination"
 ## [1] "Generalized hyperpigmentation Generalized hypopigmentation"
 ## [1] "Long upper eyelashes Short upper eyelashes"
 ## [1] "Macular hypopigmentation Macular hyperpigmentation"
 ## [1] "Foveal hyperpigmentation Foveal hypopigmentation"
 ## [1] "Decreased activity of mitochondrial respiratory chain Increased activity of mitochondrial r
 ## [1] "Increased muscle glycogen content Decreased muscle glycogen content"
 ## [1] "Increased adipose tissue Decreased adipose tissue"
 ## [1] "Enlarged epiphysis of the distal phalanx of the 5th finger Small epiphysis of the distal pha
 ## [1] "Enlarged epiphysis of the proximal phalanx of the 5th finger Small epiphysis of the proxima
 ## [1] "Enlarged epiphysis of the middle phalanx of the 5th finger Small epiphysis of the middle pha
 ## [1] "Enlarged epiphysis of the middle phalanx of the 4th finger Small epiphysis of the middle pha
 ## [1] "Enlarged epiphysis of the distal phalanx of the 4th finger Small epiphysis of the distal pha
 ## [1] "Enlarged epiphysis of the proximal phalanx of the 4th finger Small epiphysis of the proxima
 ## [1] "Enlarged epiphysis of the middle phalanx of the 3rd finger Small epiphysis of the middle pha
 ## [1] "Enlarged epiphysis of the distal phalanx of the 3rd finger Small epiphysis of the distal pha
 ## [1] "Enlarged epiphysis of the proximal phalanx of the 3rd finger Small epiphysis of the proxima
 ## [1] "Enlarged epiphyses of the 5th finger Small epiphyses of the 5th finger"
 ## [1] "Enlarged epiphyses of the 4th finger Small epiphyses of the 4th finger"
 ## [1] "Enlarged epiphyses of the 3rd finger Small epiphyses of the 3rd finger"
 ## [1] "Enlarged epiphyses of the 2nd finger Small epiphyses of the 2nd finger"
 ## [1] "Enlarged epiphysis of the distal phalanx of the 2nd finger Small epiphysis of the distal pha
 ## [1] "Enlarged epiphysis of the middle phalanx of the 2nd finger Small epiphysis of the middle pha
 ## [1] "Enlarged epiphysis of the proximal phalanx of the 2nd finger Small epiphysis of the proxima
 ## [1] "Enlarged epiphysis of the proximal phalanx of the thumb Small epiphysis of the proximal pha

[1] "Enlarged epiphysis of the distal phalanx of the thumb Small epiphysis of the distal phalanx
 ## [1] "Enlarged thumb epiphysis Small thumb epiphysis"
 ## [1] "Reduced number of teeth Increased number of teeth"
 ## [1] "Short distal phalanx of finger Long distal phalanx of finger"
 ## [1] "Enlarged epiphysis of the 1st metacarpal Small epiphysis of the 1st metacarpal"
 ## [1] "Short metacarpal Long metacarpals"
 ## [1] "Enlarged epiphyses of the hallux Small epiphyses of the hallux"
 ## [1] "Enlarged epiphysis of the proximal phalanx of the hallux Small epiphysis of the proximal phalanx
 ## [1] "Enlarged epiphysis of the distal phalanx of the hallux Small epiphysis of the distal phalanx
 ## [1] "Enlarged epiphysis of the 1st metatarsal Small epiphysis of the 1st metatarsal"
 ## [1] "Enlarged epiphyses of the toes Small epiphyses of the toes"
 ## [1] "Enlarged epiphyses of the phalanges of the hand Small epiphyses of the phalanges of the hand
 ## [1] "Enlarged epiphyses of the distal phalanges of the hand Small epiphyses of the distal phalanx
 ## [1] "Enlarged epiphyses of the middle phalanges of the hand Small epiphyses of the middle phalanx
 ## [1] "Enlarged epiphyses of the proximal phalanges of the hand Small epiphyses of the proximal phalanx
 ## [1] "Hyperpituitarism Hypopituitarism"
 ## [1] "Enlarged epiphyses Small epiphyses"
 ## [1] "Hypoplasia of the premaxilla Hyperplasia of the premaxilla"
 ## [1] "Broad uvula Narrow uvula"
 ## [1] "Long uvula Short uvula"
 ## [1] "Increased urinary copper concentration Decreased urinary copper concentration"
 ## [1] "Hyperlipoproteinemia Hypolipoproteinemia"
 ## [1] "Increased corneal thickness Decreased corneal thickness"
 ## [1] "Decreased urinary urate Increased urinary urate"
 ## [1] "Elevated circulating luteinizing hormone level Decreased circulating luteinizing hormone level
 ## [1] "Erythroid hyperplasia Erythroid hypoplasia"
 ## [1] "Granulocytic hyperplasia Granulocytic hypoplasia"
 ## [1] "Monocytosis Monocytopenia"
 ## [1] "Increased urine alpha-ketoglutarate concentration Decreased urine alpha-ketoglutarate concentration
 ## [1] "Hypocitraturia Hypercitraturia"
 ## [1] "Enlarged pituitary gland Small pituitary gland"
 ## [1] "Hyponatriuria Hypernatruria"
 ## [1] "Hypermagnesiuria Hypomagnesiuria"
 ## [1] "Decreased inflammatory response Increased inflammatory response"
 ## [1] "Decreased pineal volume Increased pineal volume"
 ## [1] "Narrow jaw Broad jaw"
 ## [1] "Increased serum testosterone level Decreased serum testosterone level"
 ## [1] "Increased circulating androgen level Decreased circulating androgen level"
 ## [1] "Decreased mitochondrial number Increased mitochondrial number"
 ## [1] "Chorioretinal hypopigmentation Chorioretinal hyperpigmentation"
 ## [1] "Long lower eyelashes Short lower eyelashes"
 ## [1] "Increased head circumference Decreased head circumference"
 ## [1] "Increased size of the clitoris Decreased size of the clitoris"
 ## [1] "Decreased size of nasopharyngeal adenoids Increased size of nasopharyngeal adenoids"
 ## [1] "Enlarged epiphyses of the 2nd toe Small epiphyses of the 2nd toe"
 ## [1] "Enlarged epiphyses of the 3rd toe Small epiphyses of the 3rd toe"
 ## [1] "Enlarged epiphyses of the 4th toe Small epiphyses of the 4th toe"
 ## [1] "Enlarged epiphyses of the 5th toe Small epiphyses of the 5th toe"
 ## [1] "Enlarged epiphysis of the distal phalanx of the 2nd toe Small epiphysis of the distal phalanx
 ## [1] "Enlarged epiphysis of the middle phalanx of the 2nd toe Small epiphysis of the middle phalanx
 ## [1] "Enlarged epiphysis of the proximal phalanx of the 2nd toe Small epiphysis of the proximal phalanx
 ## [1] "Enlarged epiphysis of the distal phalanx of the 3rd toe Small epiphysis of the distal phalanx
 ## [1] "Enlarged epiphysis of the middle phalanx of the 3rd toe Small epiphysis of the middle phalanx
 ## [1] "Enlarged epiphysis of the proximal phalanx of the 3rd toe Small epiphysis of the proximal phalanx


```
## [1] "Enlarged epiphysis of the distal phalanx of the 4th toe      Small epiphysis of the distal phalanx of the 4th toe"
## [1] "Enlarged epiphysis of the middle phalanx of the 4th toe     Small epiphysis of the middle phalanx of the 4th toe"
## [1] "Enlarged epiphysis of the proximal phalanx of the 4th toe    Small epiphysis of the proximal phalanx of the 4th toe"
## [1] "Enlarged epiphysis of the distal phalanx of the 5th toe     Small epiphysis of the distal phalanx of the 5th toe"
## [1] "Enlarged epiphysis of the middle phalanx of the 5th toe     Small epiphysis of the middle phalanx of the 5th toe"
## [1] "Enlarged epiphysis of the proximal phalanx of the 5th toe    Small epiphysis of the proximal phalanx of the 5th toe"
## [1] "Long ear      Short ear"
```

```
intersection.ids <- intersect(hp.mine, chris)
if (DEBUG) { print(intersection.ids) }

for (i in 1:nrow(intersection.ids)) {
  opposites <- intersection.ids[i,]
  id01 <- as.character(opposites[1])
  id02 <- as.character(opposites[2])
  term01 <- get_term_property(hpo.ontology, property = "name", term = id01)
  term02 <- get_term_property(hpo.ontology, property = "name", term = id02)
  print(paste(term01, term02, sep = " "))
}
```

```
## [1] "Decreased activity of mitochondrial respiratory chain      Increased activity of mitochondrial respiratory chain"
## [1] "Decreased circulating ACTH level      Increased circulating ACTH level"
## [1] "Decreased circulating antibody level   Increased circulating antibody level"
## [1] "Decreased HDL cholesterol concentration      Increased HDL cholesterol concentration"
## [1] "Decreased inflammatory response      Increased inflammatory response"
## [1] "Decreased lymphocyte apoptosis      Increased lymphocyte apoptosis"
## [1] "Decreased mean platelet volume      Increased mean platelet volume"
## [1] "Decreased mitochondrial number      Increased mitochondrial number"
## [1] "Decreased pineal volume      Increased pineal volume"
## [1] "Decreased size of nasopharyngeal adenoids      Increased size of nasopharyngeal adenoids"
## [1] "Decreased urinary sulfate      Increased urinary sulfate"
## [1] "Decreased urinary urate      Increased urinary urate"
## [1] "Large basal ganglia      Small basal ganglia"
## [1] "Large humeral epiphyses      Small humeral epiphyses"
## [1] "Large radial epiphyses      Small radial epiphyses"
## [1] "Large sella turcica      Small sella turcica"
```

```
mine.only.ids <- setdiff(hp.mine, chris)
chris.only.ids <- setdiff(chris, hp.mine)

# TODO: could make term-only tibbles here
for (i in 1:nrow(mine.only.ids)) {
  opposites <- mine.only.ids[i,]
  id01 <- as.character(opposites[1])
  id02 <- as.character(opposites[2])
  term01 <- get_term_property(hpo.ontology, property = "name", term = id01)
  term02 <- get_term_property(hpo.ontology, property = "name", term = id02)
  print(paste(term01, term02, sep = " "))
}
```

```
## [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 hormone receptor defect"
 ## [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 coagulation"
 ## [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 blindness"
 ## [1] "Complete diaphragmatic absence of pericardium Partial diaphragmatic absence of pericardium"
 ## [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 phalanges of the hand"
 ## [1] "Complete duplication of the distal phalanx of the 2nd finger Partial duplication of the distal phalanx of the 2nd finger"
 ## [1] "Complete duplication of the distal phalanx of the 2nd toe Partial duplication of the distal phalanx of the 2nd toe"
 ## [1] "Complete duplication of the distal phalanx of the 3rd finger Partial duplication of the distal phalanx of the 3rd finger"
 ## [1] "Complete duplication of the distal phalanx of the 3rd toe Partial duplication of the distal phalanx of the 3rd toe"
 ## [1] "Complete duplication of the distal phalanx of the 4th finger Partial duplication of the distal phalanx of the 4th finger"
 ## [1] "Complete duplication of the distal phalanx of the 4th toe Partial duplication of the distal phalanx of the 4th toe"
 ## [1] "Complete duplication of the distal phalanx of the 5th finger Partial duplication of the distal phalanx of the 5th finger"
 ## [1] "Complete duplication of the distal phalanx of the 5th toe Partial duplication of the distal phalanx of the 5th toe"
 ## [1] "Complete duplication of the distal phalanx of the hallux Partial duplication of the distal phalanx of the hallux"
 ## [1] "Complete duplication of the middle phalanges of the hand Partial duplication of the middle phalanges of the hand"
 ## [1] "Complete duplication of the middle phalanx of the 2nd finger Partial duplication of the middle phalanx of the 2nd finger"
 ## [1] "Complete duplication of the middle phalanx of the 2nd toe Partial duplication of the middle phalanx of the 2nd toe"
 ## [1] "Complete duplication of the middle phalanx of the 3rd finger Partial duplication of the middle phalanx of the 3rd finger"
 ## [1] "Complete duplication of the middle phalanx of the 3rd toe Partial duplication of the middle phalanx of the 3rd toe"
 ## [1] "Complete duplication of the middle phalanx of the 4th finger Partial duplication of the middle phalanx of the 4th finger"
 ## [1] "Complete duplication of the middle phalanx of the 4th toe Partial duplication of the middle phalanx of the 4th toe"
 ## [1] "Complete duplication of the middle phalanx of the 5th finger Partial duplication of the middle phalanx of the 5th finger"
 ## [1] "Complete duplication of the middle phalanx of the 5th toe Partial duplication of the middle phalanx of the 5th toe"
 ## [1] "Complete duplication of the phalanges of the 2nd finger Partial duplication of the phalanges of the 2nd finger"

[1] "Complete duplication of the phalanges of the 3rd finger Partial duplication of the phalanges
 ## [1] "Complete duplication of the phalanges of the 4th finger Partial duplication of the phalanges
 ## [1] "Complete duplication of the phalanges of the 5th finger Partial duplication of the phalanges
 ## [1] "Complete duplication of the proximal phalanges of the hand Partial duplication of the proximal
 ## [1] "Complete duplication of the proximal phalanx of the 2nd finger Partial duplication of the proximal
 ## [1] "Complete duplication of the proximal phalanx of the 2nd toe Partial duplication of the proximal
 ## [1] "Complete duplication of the proximal phalanx of the 3rd finger Partial duplication of the proximal
 ## [1] "Complete duplication of the proximal phalanx of the 3rd toe Partial duplication of the proximal
 ## [1] "Complete duplication of the proximal phalanx of the 4th finger Partial duplication of the proximal
 ## [1] "Complete duplication of the proximal phalanx of the 4th toe Partial duplication of the proximal
 ## [1] "Complete duplication of the proximal phalanx of the 5th finger Partial duplication of the proximal
 ## [1] "Complete duplication of the proximal phalanx of the 5th toe Partial duplication of the proximal
 ## [1] "Complete duplication of the proximal phalanx of the hallux Partial duplication of the proximal
 ## [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 adiponectin level Increased adiponectin level"
 ## [1] "Decreased adipose tissue Increased 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 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 level"
 ## [1] "Decreased circulating A-type natriuretic peptide level Increased circulating A-type natriuretic peptide level"
 ## [1] "Decreased circulating androgen level Increased circulating androgen level"
 ## [1] "Decreased circulating beta-2-microglobulin level Increased circulating beta-2-microglobulin level"
 ## [1] "Decreased circulating beta-C-terminal telopeptide level Increased circulating beta-C-terminal telopeptide level"
 ## [1] "Decreased circulating ceruloplasmin concentration Increased circulating ceruloplasmin concentration"
 ## [1] "Decreased circulating chylomicron concentration Increased circulating chylomicron concentration"
 ## [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"
 ## [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-linked
 ## [1] "Decreased fucosylation of O-linked protein glycosylation Increased fucosylation of O-linked
 ## [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 del
 ## [1] "Decreased glucose-6-phosphate dehydrogenase level in dried blood spot Increased glucose-6-ph
 ## [1] "Decreased glucose-6-phosphate dehydrogenase level in leukocytes Increased glucose-6-phospha
 ## [1] "Decreased glucose-6-phosphate dehydrogenase level in red blood cells Increased glucose-6-ph
 ## [1] "Decreased glucose-6-phosphate dehydrogenase level in tissue Increased glucose-6-phosphate d
 ## [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 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 factor"
 ## [1] "Decreased libido Increased libido"
 ## [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-linked protein glycosylation"
 ## [1] "Decreased mean corpuscular hemoglobin concentration Increased mean corpuscular hemoglobin concentration"
 ## [1] "Decreased mean corpuscular volume Increased mean corpuscular volume"
 ## [1] "Decreased monosialylated core 1 O-glycan level Increased monosialylated core 1 O-glycan level"
 ## [1] "Decreased muscle glycogen content Increased muscle glycogen content"
 ## [1] "Decreased phosphoribosylpyrophosphate synthetase level Increased phosphoribosylpyrophosphate synthetase level"
 ## [1] "Decreased pituitary glycoprotein hormone alpha subunit level Increased pituitary glycoprotein hormone alpha subunit level"
 ## [1] "Decreased proportion of CD4+CD25+ regulatory T cells Increased proportion of CD4+CD25+ regulatory T cells"
 ## [1] "Decreased proportion of CD4-positive T cells Increased proportion of CD4-positive T cells"
 ## [1] "Decreased proportion of CD4-positive, alpha-beta memory T cells Increased proportion of CD4-positive, alpha-beta memory T cells"
 ## [1] "Decreased proportion of CD8-positive, alpha-beta memory T cells Increased proportion of CD8-positive, alpha-beta memory T cells"
 ## [1] "Decreased proportion of CD8-positive, alpha-beta TEMRA T cells Increased proportion of CD8-positive, alpha-beta TEMRA T cells"
 ## [1] "Decreased proportion of central memory CD4-positive, alpha-beta T cells Increased proportion of central memory CD4-positive, alpha-beta T cells"
 ## [1] "Decreased proportion of central memory CD8-positive, alpha-beta T cells Increased proportion of central memory CD8-positive, alpha-beta T cells"
 ## [1] "Decreased proportion of class-switched memory B cells Increased proportion of class-switched memory B cells"
 ## [1] "Decreased proportion of effector memory CD8-positive, alpha-beta T cells Increased proportion of effector memory CD8-positive, alpha-beta T cells"
 ## [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 gamma-delta T cells"
 ## [1] "Decreased proportion of marginal zone B cells Increased proportion of marginal zone B cells"
 ## [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 memory B cells"
 ## [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 protein glycosylation"
 ## [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 total hemolytic complement activity Increased total hemolytic complement activity"
 ## [1] "Decreased total iron binding capacity Increased total iron binding capacity"
 ## [1] "Decreased uridine diphosphate glucose-4-epimerase level in plasma Increased uridine diphosph
 ## [1] "Decreased uridine diphosphate glucose-4-epimerase level in red blood cells Increased uridin
 ## [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 urine alpha-ketoglutarate concentration Increased urine alpha-ketoglutarate conce
 ## [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 impairm
 ## [1] "High-output congestive heart failure Low-output congestive heart failure"
 ## [1] "Hodgkin lymphoma Non-Hodgkin lymphoma"
 ## [1] "Ketotic hypoglycemia Nonketotic hypoglycemia"
 ## [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 intestinal polyposis Small intestinal polyposis"
 ## [1] "Large placenta Small placenta"
 ## [1] "Large vessel vasculitis Small vessel vasculitis"
 ## [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] "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 of
## [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"
```

```
for (i in 1:nrow(chris.only.ids)) {
  opposites <- chris.only.ids[i,]
  id01 <- as.character(opposites[1])
  id02 <- as.character(opposites[2])
  term01 <- get_term_property(hpo.ontology, property = "name", term = id01)
  term02 <- get_term_property(hpo.ontology, property = "name", term = id02)
  print(paste(term01, term02, sep = "      "))
}
```

```
## [1] "Tall stature      Short stature"
## [1] "Polyuria      Decreased urine output"
## [1] "Wide mouth      Narrow mouth"
## [1] "Macroglossia      Microglossia"
## [1] "Short upper lip      Long upper lip"
## [1] "Large fontanelles      Small fontanelle"
## [1] "Progressive microcephaly      Progressive macrocephaly"
## [1] "Small face      Large face"
## [1] "Narrow face      Broad face"
## [1] "Long face      Short face"
## [1] "Hypertelorism      Hypotelorism"
## [1] "Short philtrum      Long philtrum"
## [1] "Hypoplasia of the maxilla      Hyperplasia of the maxilla"
## [1] "Short chin      Tall chin"
## [1] "Broad forehead      Narrow forehead"
## [1] "Small forehead      Large forehead"
## [1] "Wide nose      Narrow nose"
## [1] "Short neck      Long neck"
## [1] "Microcornea      Megalocornea"
## [1] "Long eyelashes      Short eyelashes"
## [1] "Thick eyebrow      Thin eyebrow"
## [1] "Long palpebral fissure      Short palpebral fissure"
## [1] "Hypodontia      Increased number of teeth"
## [1] "Microdontia      Macrodontia"
## [1] "Hypoplasia of the thymus      Thymus hyperplasia"
## [1] "Hypothyroidism      Hyperthyroidism"
## [1] "Hypertension      Hypotension"
## [1] "Hypoparathyroidism      Hyperparathyroidism"
## [1] "Increased circulating gonadotropin level      Decreased circulating gonadotropin level"
## [1] "Hyperinsulinemia      Hypoinsulinemia"
## [1] "Increased circulating renin level      Decreased circulating renin level"
```

[1] "Hyperaldosteronism Decreased circulating aldosterone level"
 ## [1] "Parathyroid hypoplasia Parathyroid hyperplasia"
 ## [1] "Long clavicles Short clavicles"
 ## [1] "Hypertrichosis obsolete Hypotrichosis"
 ## [1] "Broad palm Narrow palm"
 ## [1] "Large hands Small hand"
 ## [1] "Short umbilical cord Long umbilical cord"
 ## [1] "Hyporeflexia Hyperreflexia"
 ## [1] "Limitation of joint mobility Joint hypermobility"
 ## [1] "Onychogryposis Thin nail"
 ## [1] "Broad nail Narrow nail"
 ## [1] "Short toe Long toe"
 ## [1] "Long hallux Short hallux"
 ## [1] "Leukopenia Leukocytosis"
 ## [1] "Hypoglycemia Hyperglycemia"
 ## [1] "Hyperammonemia Hypoammonemia"
 ## [1] "Hypophosphatemia Hyperphosphatemia"
 ## [1] "Hyperuricemia Hypouricemia"
 ## [1] "Hypercalciuria Hypocalciuria"
 ## [1] "Hyperkalemia Hypokalemia"
 ## [1] "Hyperglycinemia Hypoglycinemia"
 ## [1] "Hypertriglyceridemia Hypotriglyceridemia"
 ## [1] "Increased CSF lactate Reduced CSF lactate"
 ## [1] "Pancreatic hypoplasia Pancreatic hyperplasia"
 ## [1] "Small foramen magnum Large foramen magnum"
 ## [1] "Thickened calvaria Thin calvarium"
 ## [1] "Lymphadenopathy Lymph node hypoplasia"
 ## [1] "Hypoventilation Hyperventilation"
 ## [1] "Decreased circulating total IgM Increased circulating IgM level"
 ## [1] "Hypocalcemia Hypercalcemia"
 ## [1] "Hyponatremia Hypernatremia"
 ## [1] "Hyperchloriduria Hypochloriduria"
 ## [1] "Hypomagnesemia Hypermagnesemia"
 ## [1] "Hypoalbuminemia Hyperalbuminemia"
 ## [1] "Hyperlipidemia Hypolipidemia"
 ## [1] "Increased urinary potassium Decreased urinary potassium"
 ## [1] "Hyperphosphaturia Hypophosphaturia"
 ## [1] "Hypochloremia Hyperchloremia"
 ## [1] "Increased circulating cortisol level Decreased circulating cortisol level"
 ## [1] "Hypercholesterolemia Hypocholesterolemia"
 ## [1] "Elevated alkaline phosphatase Low alkaline phosphatase"
 ## [1] "Hypermethioninemia Hypomethioninemia"
 ## [1] "Increased circulating IgG level Decreased circulating IgG level"
 ## [1] "Elevated serum creatinine Decreased serum creatinine"
 ## [1] "Increased serum ferritin Decreased serum ferritin"
 ## [1] "CNS hypomyelination CNS hypermyelination"
 ## [1] "Short palm Long palm"
 ## [1] "Increased body weight Decreased body weight"
 ## [1] "Increased skull ossification Decreased skull ossification"
 ## [1] "Reduced bone mineral density Increased bone mineral density"
 ## [1] "Increased circulating purine concentration Decreased circulating purine concentration"
 ## [1] "Biconcave vertebral bodies Biconvex vertebral bodies"
 ## [1] "Short middle phalanx of finger Long middle phalanx of finger"
 ## [1] "Thyroid hypoplasia Thyroid hyperplasia"

[1] "Long proximal phalanx of finger Short proximal phalanx of finger"
 ## [1] "Small placenta Large placenta"
 ## [1] "Broad femoral neck Narrow femoral neck"
 ## [1] "Peripheral hypomyelination Peripheral hypermyelination"
 ## [1] "Generalized hyperpigmentation Generalized hypopigmentation"
 ## [1] "Long upper eyelashes Short upper eyelashes"
 ## [1] "Macular hypopigmentation Macular hyperpigmentation"
 ## [1] "Foveal hyperpigmentation Foveal hypopigmentation"
 ## [1] "Increased muscle glycogen content Decreased muscle glycogen content"
 ## [1] "Increased adipose tissue Decreased adipose tissue"
 ## [1] "Enlarged epiphysis of the distal phalanx of the 5th finger Small epiphysis of the distal phalanx of the 5th finger"
 ## [1] "Enlarged epiphysis of the proximal phalanx of the 5th finger Small epiphysis of the proximal phalanx of the 5th finger"
 ## [1] "Enlarged epiphysis of the middle phalanx of the 5th finger Small epiphysis of the middle phalanx of the 5th finger"
 ## [1] "Enlarged epiphysis of the middle phalanx of the 4th finger Small epiphysis of the middle phalanx of the 4th finger"
 ## [1] "Enlarged epiphysis of the distal phalanx of the 4th finger Small epiphysis of the distal phalanx of the 4th finger"
 ## [1] "Enlarged epiphysis of the proximal phalanx of the 4th finger Small epiphysis of the proximal phalanx of the 4th finger"
 ## [1] "Enlarged epiphysis of the middle phalanx of the 3rd finger Small epiphysis of the middle phalanx of the 3rd finger"
 ## [1] "Enlarged epiphysis of the distal phalanx of the 3rd finger Small epiphysis of the distal phalanx of the 3rd finger"
 ## [1] "Enlarged epiphysis of the proximal phalanx of the 3rd finger Small epiphysis of the proximal phalanx of the 3rd finger"
 ## [1] "Enlarged epiphyses of the 5th finger Small epiphyses of the 5th finger"
 ## [1] "Enlarged epiphyses of the 4th finger Small epiphyses of the 4th finger"
 ## [1] "Enlarged epiphyses of the 3rd finger Small epiphyses of the 3rd finger"
 ## [1] "Enlarged epiphyses of the 2nd finger Small epiphyses of the 2nd finger"
 ## [1] "Enlarged epiphysis of the distal phalanx of the 2nd finger Small epiphysis of the distal phalanx of the 2nd finger"
 ## [1] "Enlarged epiphysis of the middle phalanx of the 2nd finger Small epiphysis of the middle phalanx of the 2nd finger"
 ## [1] "Enlarged epiphysis of the proximal phalanx of the 2nd finger Small epiphysis of the proximal phalanx of the 2nd finger"
 ## [1] "Enlarged epiphysis of the proximal phalanx of the thumb Small epiphysis of the proximal phalanx of the thumb"
 ## [1] "Enlarged epiphysis of the distal phalanx of the thumb Small epiphysis of the distal phalanx of the thumb"
 ## [1] "Enlarged thumb epiphysis Small thumb epiphysis"
 ## [1] "Reduced number of teeth Increased number of teeth"
 ## [1] "Short distal phalanx of finger Long distal phalanx of finger"
 ## [1] "Enlarged epiphysis of the 1st metacarpal Small epiphysis of the 1st metacarpal"
 ## [1] "Short metacarpal Long metacarpals"
 ## [1] "Enlarged epiphyses of the hallux Small epiphyses of the hallux"
 ## [1] "Enlarged epiphysis of the proximal phalanx of the hallux Small epiphysis of the proximal phalanx of the hallux"
 ## [1] "Enlarged epiphysis of the distal phalanx of the hallux Small epiphysis of the distal phalanx of the hallux"
 ## [1] "Enlarged epiphysis of the 1st metatarsal Small epiphysis of the 1st metatarsal"
 ## [1] "Enlarged epiphyses of the toes Small epiphyses of the toes"
 ## [1] "Enlarged epiphyses of the phalanges of the hand Small epiphyses of the phalanges of the hand"
 ## [1] "Enlarged epiphyses of the distal phalanges of the hand Small epiphyses of the distal phalanges of the hand"
 ## [1] "Enlarged epiphyses of the middle phalanges of the hand Small epiphyses of the middle phalanges of the hand"
 ## [1] "Enlarged epiphyses of the proximal phalanges of the hand Small epiphyses of the proximal phalanges of the hand"
 ## [1] "Hyperpituitarism Hypopituitarism"
 ## [1] "Enlarged epiphyses Small epiphyses"
 ## [1] "Hypoplasia of the premaxilla Hyperplasia of the premaxilla"
 ## [1] "Broad uvula Narrow uvula"
 ## [1] "Long uvula Short uvula"
 ## [1] "Increased urinary copper concentration Decreased urinary copper concentration"
 ## [1] "Hyperlipoproteinemia Hypolipoproteinemia"
 ## [1] "Increased corneal thickness Decreased corneal thickness"
 ## [1] "Elevated circulating luteinizing hormone level Decreased circulating luteinizing hormone level"
 ## [1] "Erythroid hyperplasia Erythroid hypoplasia"
 ## [1] "Granulocytic hyperplasia Granulocytic hypoplasia"
 ## [1] "Monocytosis Monocytopenia"

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## [1] "Increased urine alpha-ketoglutarate concentration      Decreased urine alpha-ketoglutarate conce
## [1] "Hypocitraturia      Hypercitraturia"
## [1] "Enlarged pituitary gland      Small pituitary gland"
## [1] "Hyponatriuria      Hypernatriuria"
## [1] "Hypermagnesiuria      Hypomagnesiuria"
## [1] "Narrow jaw      Broad jaw"
## [1] "Increased serum testosterone level      Decreased serum testosterone level"
## [1] "Increased circulating androgen level      Decreased circulating androgen level"
## [1] "Chorioretinal hypopigmentation      Chorioretinal hyperpigmentation"
## [1] "Long lower eyelashes      Short lower eyelashes"
## [1] "Increased head circumference      Decreased head circumference"
## [1] "Increased size of the clitoris      Decreased size of the clitoris"
## [1] "Enlarged epiphyses of the 2nd toe      Small epiphyses of the 2nd toe"
## [1] "Enlarged epiphyses of the 3rd toe      Small epiphyses of the 3rd toe"
## [1] "Enlarged epiphyses of the 4th toe      Small epiphyses of the 4th toe"
## [1] "Enlarged epiphyses of the 5th toe      Small epiphyses of the 5th toe"
## [1] "Enlarged epiphysis of the distal phalanx of the 2nd toe      Small epiphysis of the distal phalan
## [1] "Enlarged epiphysis of the middle phalanx of the 2nd toe      Small epiphysis of the middle phalan
## [1] "Enlarged epiphysis of the proximal phalanx of the 2nd toe      Small epiphysis of the proximal p
## [1] "Enlarged epiphysis of the distal phalanx of the 3rd toe      Small epiphysis of the distal phalan
## [1] "Enlarged epiphysis of the middle phalanx of the 3rd toe      Small epiphysis of the middle phalan
## [1] "Enlarged epiphysis of the proximal phalanx of the 3rd toe      Small epiphysis of the proximal p
## [1] "Enlarged epiphysis of the distal phalanx of the 4th toe      Small epiphysis of the distal phalan
## [1] "Enlarged epiphysis of the middle phalanx of the 4th toe      Small epiphysis of the middle phalan
## [1] "Enlarged epiphysis of the proximal phalanx of the 4th toe      Small epiphysis of the proximal p
## [1] "Enlarged epiphysis of the distal phalanx of the 5th toe      Small epiphysis of the distal phalan
## [1] "Enlarged epiphysis of the middle phalanx of the 5th toe      Small epiphysis of the middle phalan
## [1] "Enlarged epiphysis of the proximal phalanx of the 5th toe      Small epiphysis of the proximal p
## [1] "Long ear      Short ear"

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