

# GSReg: A Package for Gene Set Variability Analysis

Bahman Afsari<sup>1</sup> and Elana J. Fertig<sup>1</sup>

<sup>1</sup>The Sidney Kimmel Comprehensive Cancer Center,  
Johns Hopkins University School of Medicine

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## 1 Introduction

The **GSReg** package allows to analyze pathways based on the variability of the expression of sets of genes that are targets of those pathways. Basing this set statistic on variability enables inference of dysregulated pathways in diseases, including notably cancers. The first set statistic for gene variability was in the work of Eddy and his colleagues (see [1]) which used a ranked based methodology called *DIRAC*. *DIRAC* calculates a measure of variability of the ordering of the expression of genes in a pathway for specific phenotype. The basic idea

behind *DIRAC* is to generate a template for the pair-wise comparisons of gene expressions of a pathway within a phenotype. *DIRAC* calculates a measure of the variability of the ordering within the phenotype, i.e. the expected distance of a sample from the phenotype and the template of the phenotype. In mathematical terms, if we denote two i.i.d. samples from the same phenotypes by  $X$  and  $X'$  and  $D$  Kendall- $\tau$ -distance on the specific pathways, then the EVA [?] statistic is  $E(D(X, X'))$ . It identifies significantly dysregulated pathways by estimating p-values from a permutation test. Eddy et al. found that more pathological phenotypes usually have more pathways with higher variability compared to less pathological phenotypes.

However, the permutation test in *DIRAC* is computationally intensive and reaching low p-values may be impractical since they require a huge number of permutations. Low p-values are required for multiple hypothesis correction. A similar measure of variability of the orderings of gene sets was proposed in [2]. This method approximates the p-value theoretically, without a permutation test. This method is based on Kendall- $\tau$  distance [3] and the theory of U-Statistics, thus we call this method Gene Set Expression Variation Analysis (or in short EVA). Specifically, Kendall- $\tau$  distance between two expression profiles counts the number of disagreeing pairwise comparisons between two profiles. The EVA measures the variability of the gene expression of pathway genes from a phenotype by calculating the expectation of Kendall- $\tau$  distance between two random samples from the phenotype. EVA then identifies if the variability is significantly different across two phenotypes. To approximate this p-value EVA applies a U-Statistic Theory approach.

The **GReg** package contains two following utilities:

1. Identifying the dysregulated pathways with *DIRAC* measure of variability. The significance is calculated using permutation test. This is the first time that *DIRAC* analysis has been implemented in *R*. It also is more adaptable to new datasets than the original Matlab code in [1].
2. Identifying the dysregulated pathways with *EVA* measure of variability. The significance is approximated through applying U-statistics theory. This is very time efficient and consistent with both *DIRAC* and applying permutation test on EVA.

## 2 Input Data

### 2.1 Data structure

In short, the **GReg** package requires the following data in the following format:

## 1. Gene Expression Data

- (a) The expression be in the form of a matrix where rows represent genes (or probes) and columns represent samples.
- (b) The expression matrix cannot have NAs.
- (c) The expression matrix rows must have names of genes or the probes.

## 2. Pathways

- (a) The list of pathways must contain character vectors. Only the elements of the vectors which appear in rownames of the expression matrix are considered for analysis.
- (b) The list of the pathways must have names for each vectors.

## 3. Phenotypes

- (a) A factor with binary levels.

We used the data provided in the **GSBenchMark** package to reproduce the results in Eddy et al. [1]. The **GSBenchMark** contains data for the pathways as well as the gene expression and phenotype data from twelve studies. We load the information about the pathways from

**GSBenchMark**:

```
> library(GSBenchMark)
> data(diracpathways)
> class(diracpathways)

[1] "list"

> names(diracpathways)[1:5]

[1] "DEATHPATHWAY"          "TCAPOPTOSISPATHWAY" "CCR3PATHWAY"
[4] "NEUTROPHILPATHWAY"    "ALTERNATIVEPATHWAY"

> class(diracpathways[[1]])

[1] "character"
```

AS mentioned **GSReg** package requires the information of the pathways to be as a list of character vectors. Also, **GSReg** requires the pathways to have names. The variable **diracpathways** contains gene pathways. It is a list. Each element represents a pathway with its name. Each elements contains a list of characters which represent the genes in the pathway. e.g. `diracpathways[["DEATHPATHWAY"]]`.

Now, we load the datasets' names:

```

> data(GSBenchMarkDatasets)
> print(GSBenchMark.Dataset.names)

[1] "leukemia_GSEA"          "marfan_GDS2960"          "melanoma_GDS2735"
[4] "parkinsons_GDS2519"    "prostate_GDS2545_m_nf"  "prostate_GDS2545_m_p"
[7] "prostate_GDS2545_p_nf" "sarcoma_data"           "squamous_GDS2520"
[10] "breast_GDS807"         "bipolar_GDS2190"

```

The remaining examples in this vignette rely on one of the datasets, i.e. “squamous GDS2520.” Similar analyses may be reproduced for other datasets by selecting a different element of “GS-BenchMark.Dataset.names.”

```

> DataSetStudy = GSBenchMark.Dataset.names[[9]]
> print(DataSetStudy)

[1] "squamous_GDS2520"

> data(list=DataSetStudy)

```

The data consists of two variables: **exprsdata** and **phenotypes**. **exprsdata** consists of a gene expression matrix where the rows and columns represent genes and the samples respectively. **GSReg** requires the rownames of gene expression variable represent the gene names, *i.e.* they are represented in the pathway information variable.

The **GSReg** does not allow any missing data. To comply with the requirements we remove genes with NAs. The user may use any imputation to resolve this issue:

```

> if(sum(apply(is.nan(exprsdata),1,sum)>0))
  exprsdata = exprsdata[-which(apply(is.nan(exprsdata),1,sum)>0),];

```

One can extract the gene names by:

```

> genenames = rownames(exprsdata);
> genenames[1:10]

[1] "MAPK3"    "TIE1"    "CYP2C19" "CXCR5"   "CXCR5"   "DUSP1"   "MMP10"   "DDR1"
[9] "EIF2AK2" "HINT1"

```

### 3 Analysis of the pathways

Here, we demonstrate how to use the **GSReg** package to compute DIRAC and EVA statistics.

### 3.1 DIRAC Analysis

First, we load the library:

```
> library(GSReg)
```

The package also implements the alternative EVA statistic in the function `GSReg.GeneSets.DIRAC`. This function receives gene expression as `geneexpres`, the pathway information as `pathways` and phenotypes of samples as a factor with two levels and length equal to column number of `geneexpres`. *DIRAC* uses can use either a permutation test or normal approximation for p-value calculation; so, `GSReg.GeneSets.DIRAC` receives the number of permutations through (`Nperm`) with default value equal to 0 which indicates the normal approximation.

```
> Nperm = 10
> system.time({DIRACperm =GSReg.GeneSets.DIRAC(exprsdata,diracpathways,phenotypes,Nperm=Nperm)})
   user  system elapsed 
7.008   0.287   9.325 

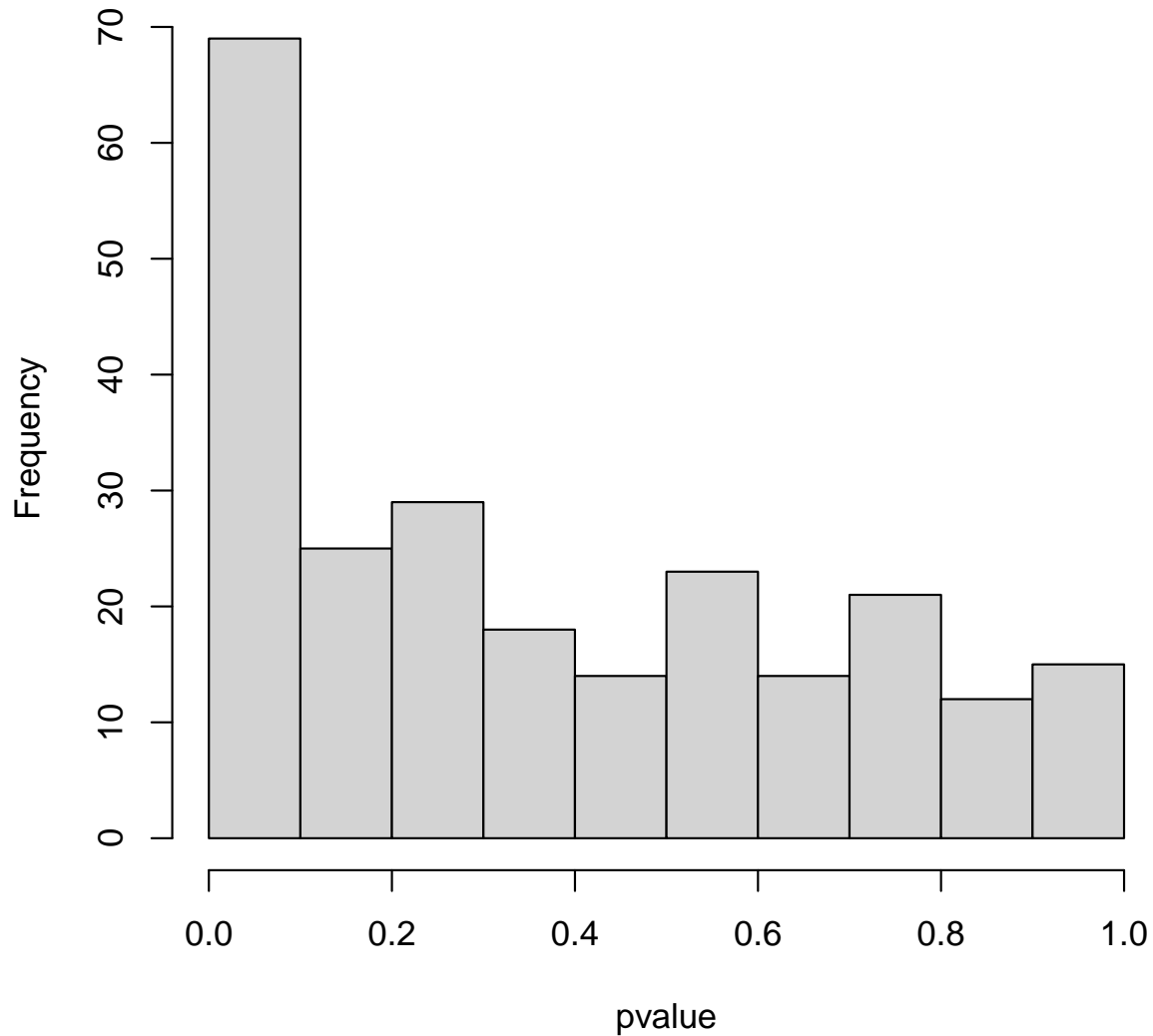
> system.time({DIRACan =GSReg.GeneSets.DIRAC(exprsdata,diracpathways,phenotypes)})
   user  system elapsed 
0.882   0.028   1.492 

>
```

Here is the histogram of the DIRAC p-values:

```
> hist(DIRACan$pvalues,xlab="pvalue",main="Hist of pvalues applying DIRAC Analysis.")
```

### Hist of pvalues applying DIRAC Analysis.



To check if the approximations are reliable, we plot the z-scores calculated to approximate p-values versus the p-values from the permutation tests.

Figure 2 shows the result of comparing p-value DIRAC computing from 1000 permutation test and approximation using normal approximation (offline generated).

## 3.2 EVA

The package also implements the alternative EVA statistic in the function `GSReg.GeneSets.EVA`. The function requires the similar inputs as `GSReg.GeneSets.DIRAC` (i.e. `geneexpres`, `path-`

```

> plot(x=abs(DIRACAn$zscores),y=DIRACperm$pvalues,xlab="|Z-score|",
      ylab="p-value",col="red1",main="DIRAC p-value comparisons")
> zscorelin <- seq(min(abs(DIRACAn$zscores)),max(abs(DIRACAn$zscores)),by = 0.1)
> pvaltheoretic = (1-pnorm(zscorelin))*2
> lines(x=zscorelin,y=pvaltheoretic,type="l",pch=50,lty=5,col="darkblue")
> legend("topright",legend=c("permutation test","Normal Approx."),
      col=c("red1","blue"),text.col=c("red1","blue"),
      lty=c(NA,1),lwd=c(NA,2.5),pch=c(21,NA))

```

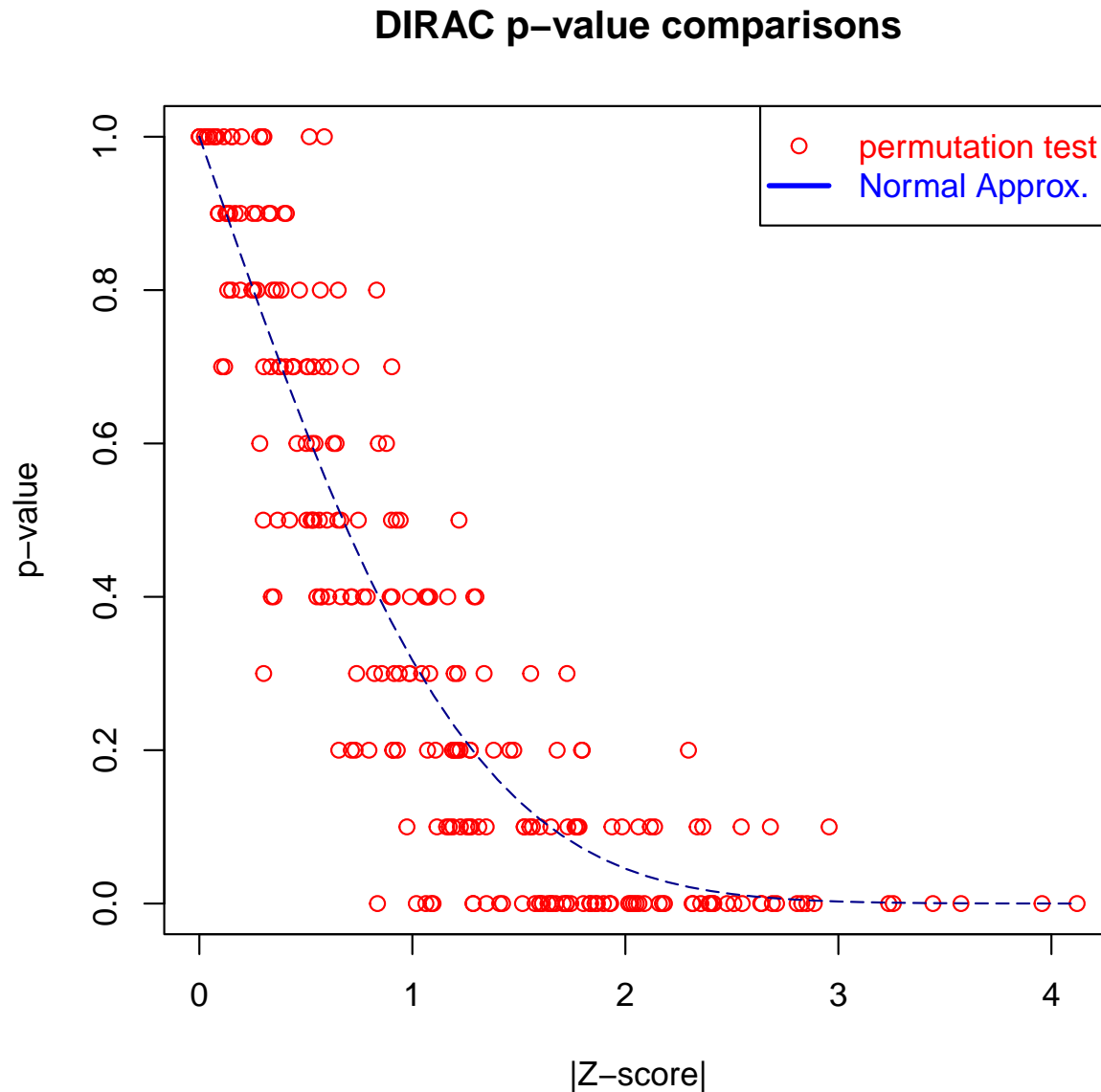


Figure 1: Comparing p-value from permutation test and normal approximation with only 10 permutations.

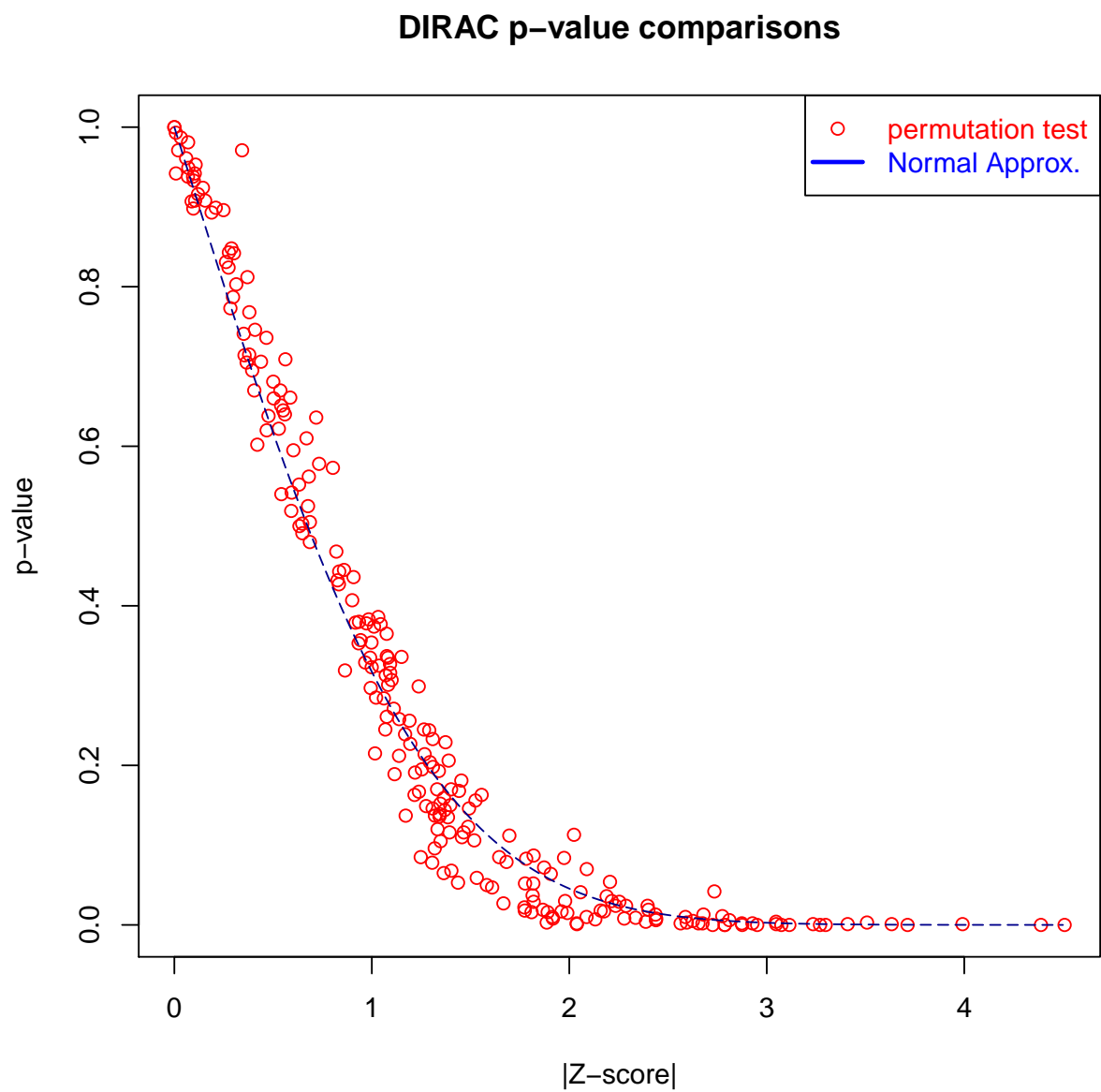


Figure 2: Theoretical p-value versus empirical p-value using 1000 permutations.



ways, phenotypes) except it does not need Nperm since the p-value is not calculated through permutation test but through the mentioned U-statistic theory approach.

```
> #Calculating the variance for the pathways
> #Calculate how much it takes to calculate the statistics and their p-value for all pathways
>
> system.time({VarAnKendallV = GSReg.GeneSets.EVA(geneexpres=exprsdata,
  pathways=diracpathways, phenotypes=as.factor(phenotypes)) })
  user  system elapsed
1.091   0.040   1.299

> names(VarAnKendallV)[[1]]

[1] "DEATHPATHWAY"

> VarAnKendallV[[1]]

$E1
[1] 0.09441352

$E2
[1] 0.1310383

$E12
[1] 0.1187962

$zscore
[1] -3.711215

$zscoreD12D1
[1] 3.693266

$zscoreD12D2
[1] -4.005794

$VarEta1
[1] 3.480369e-05

$VarEta2
[1] 6.248694e-05

$sdtotal
[1] 0.009863601

$CovD12D12p
[1] 3.345665e-05

$CovD12D1p2
[1] 0.0006611348

$CovD1D12
```

```

[1] 0.0001258984

$CovD1D12
[1] 0.0001258984

$vartotD12D1
[1] 4.34854e-05

$vartotD12D2
[1] 9.239714e-06

$pvalue
[1] 0.0002062669

$pvalueD12D1
[1] 0.0002213919

$pvalueD12D2
[1] 6.180938e-05

$pvalueTotal
[1] 0.0001854281

$mysdttotal
[1] 0.01159303

```

The output consists of a list. Each element of the list corresponds to a pathway. The element itself is a list. **E1** and **E2** are two fields which contain the measure of variability for phenotype levels(phenotypes) [1] and levels(phenotypes) [2] respectively. Other list elements are **pvalue** and **zscore** which are calculated through the theory of U-statistics and indicate the statistical significance of the difference between *E1* and *E2*.

### 3.3 Comparison of DIRAC and EVA

We ran the following code to compare statistics from DIRAC and from EVA.

```

> Nperm = 10;
> VarAnPerm = vector(mode="list",length=Nperm)
> for( i in seq_len(Nperm))
{
  VarAnPerm[[i]] = GSReg.GeneSets.EVA(geneexpres=exprsdata, pathways=diracpathways,
                                     phenotypes=sample(phenotypes))
}
> pvaluesperm = vector(mode="numeric",length=length(VarAnPerm[[1]]))
> for( i in seq_along(VarAnPerm[[1]]))
{
  z = sapply(VarAnPerm,function(x) x[[i]]$E1 - x[[i]]$E2)

```

```

    pvaluesperm[i] = mean(abs(VarAnKendallV[[i]]$E1-VarAnKendallV[[i]]$E2)<abs(z))
  }
> zscore = sapply(VarAnKendallV,function(x) x$zscore);
> pvalustat = sapply(VarAnKendallV,function(x) x$pvalue);

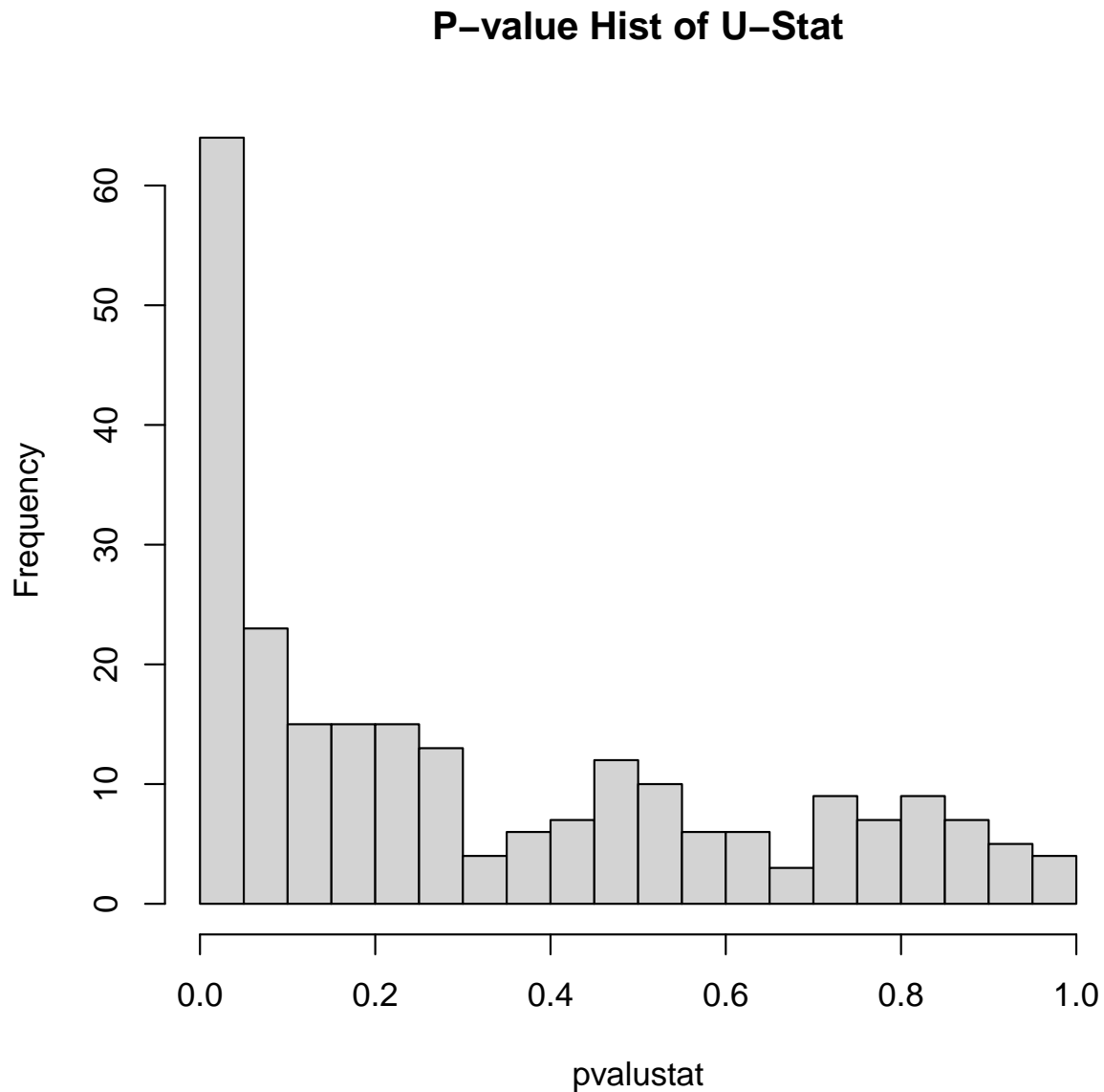
```

The figure represents that the theoretical p-value and p-value calculated from permutation test in EVA are very similar and we can use the theoretical p-value as a surrogate for p-value. Here is the histogram.

```

> hist(x=pvalustat,breaks=20,main="P-value Hist of U-Stat",xlim=c(0,1))

```



```

> plot(x=abs(zscore),y=pvaluesperm,xlab="|Z-score|",
      ylab="p-value",col="red1",main="p-value comparisons")
> zscorelin = seq(0,6,0.1);
> pvaltheoretic = (1-pnorm(zscorelin))*2
> lines(x=zscorelin,y=pvaltheoretic,type="l",pch=50,lty=5,col="darkblue")
> legend("topright",legend=c("permutation test","U-Stat Estimation"),
      col=c("red","blue"),text.col=c("red","blue"),
      lty=c(NA,1),lwd=c(NA,2.5),pch=c(21,NA))

```

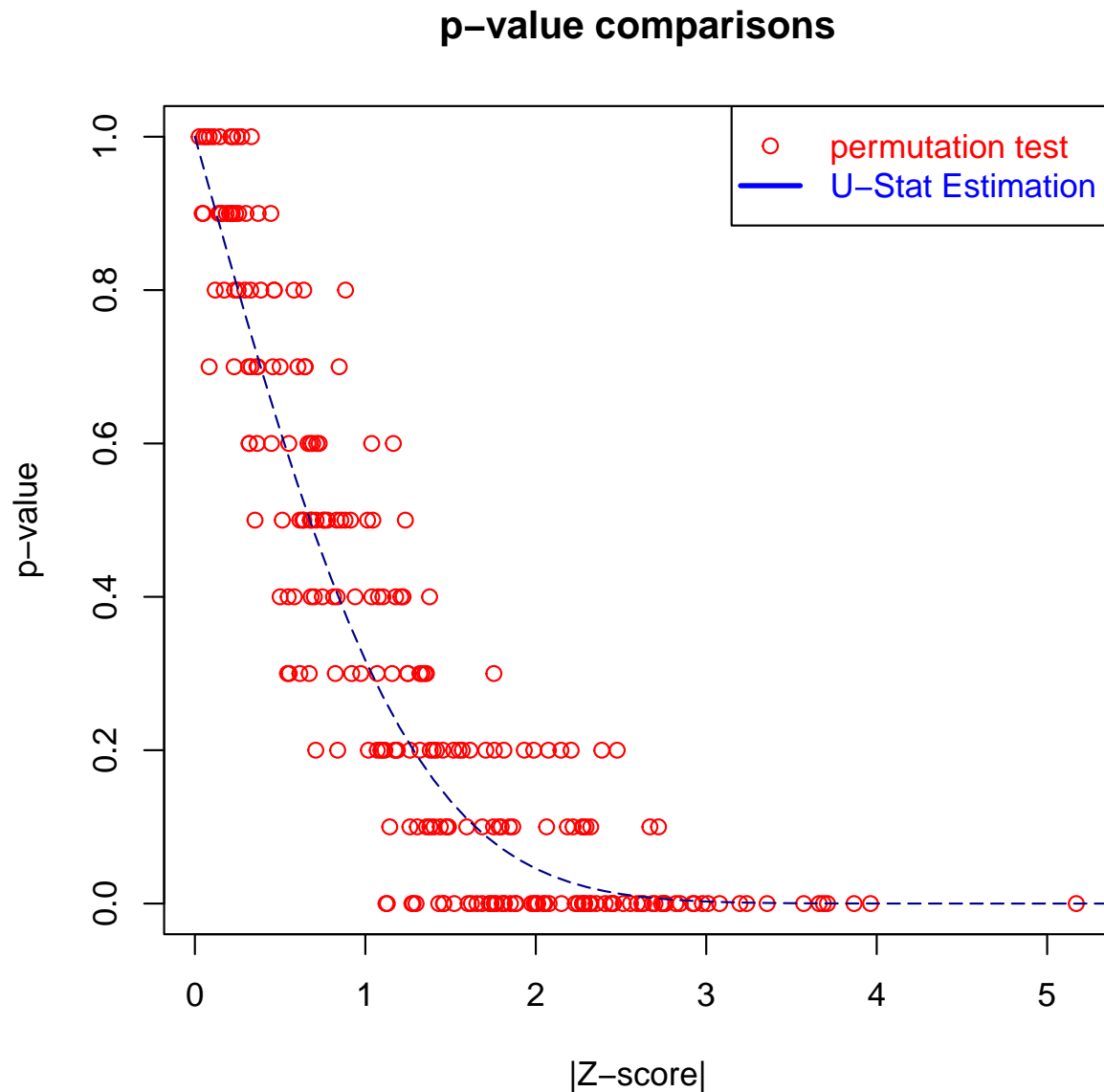


Figure 3: Comparing p-value from permutation test and U-statistic theory with only 10 permutations.

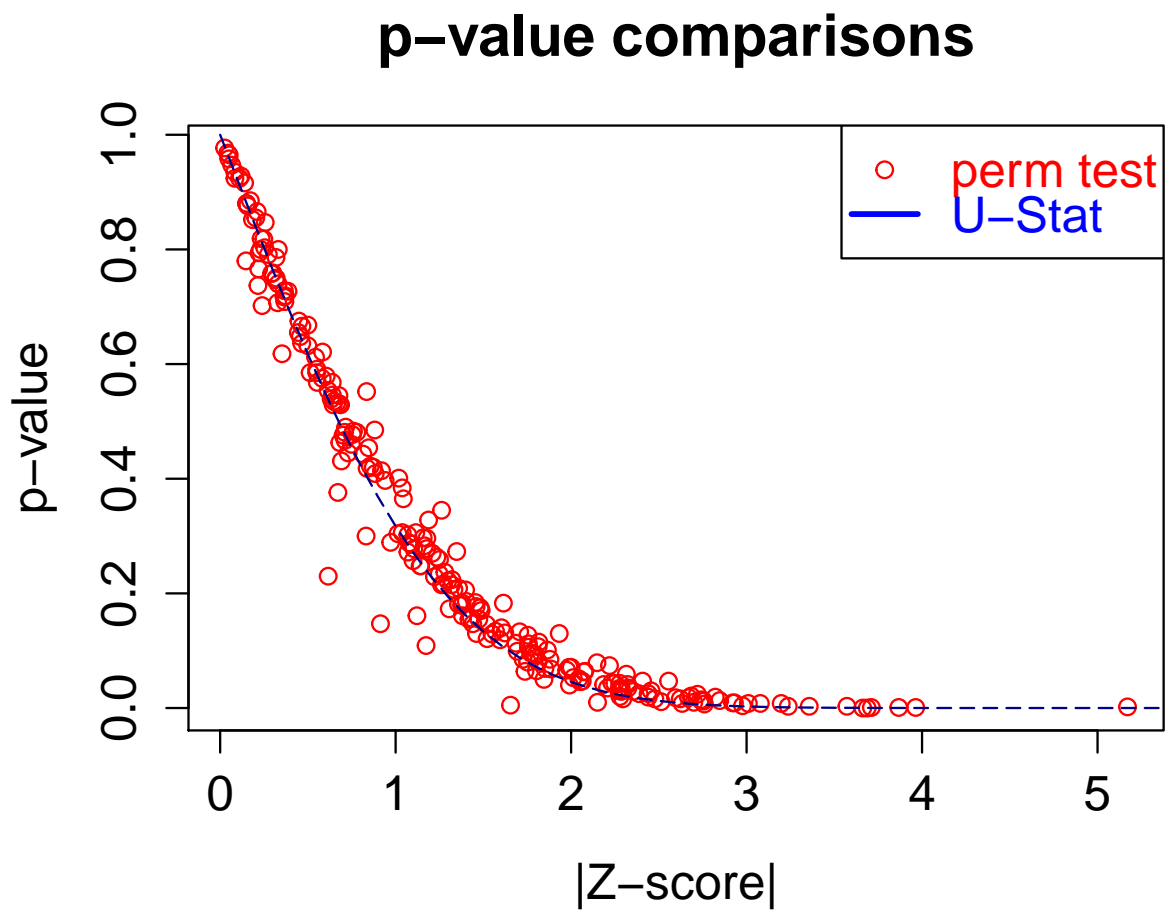


Figure 4: Theoretical p-value versus empirical p-value using 1000 permutations.

Figure 4 shows the result of comparing p-value EVA computing from 1000 permutation test and approximation using U-statistics theory (offline generated).

To compare with the p-value of the DIRAC analysis, we show the p-values of DIRAC versus U-Statistic methodology:

```
> plot(x=DIRACAn$pvalues,y=pvalustat,xlab ="DIRAC",
       ylab="EVA",main=sprintf("P-value Comparison corr=%2.2g",cor(x=DIRACAn$pvalues,y=pvalustat)))
> lmfit = lm(pvalustat~DIRACAn$pvalues-1)
> abline(lmfit)
> cor.test(x=DIRACAn$pvalues,y=pvalustat)

Pearson's product-moment correlation

data:  DIRACAn$pvalues and pvalustat
t = 15.834, df = 238, p-value < 2.2e-16
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 0.6484375 0.7727928
sample estimates:
      cor
0.7162546
```

### P-value Comparison corr=0.72



Also, the correlation of the p-values of DIRAC and U-Statistics is very high:

```
> cor(x=DIRACan$pvalues,y=pvalustat)
[1] 0.7162546
```

If we use 1000 permutations instead of 10 permutations, we can see that the correlation is higher (0.88) as seen in Figure (5). The dysregulated pathways identified by *DIRAC* are the following pathways:

|                             |                        |                       |
|-----------------------------|------------------------|-----------------------|
| [1] "DEATHPATHWAY"          | "NEUTROPHILPATHWAY"    | "PGC1APATHWAY"        |
| [4] "RARRXRPATHWAY"         | "SKP2E2FPATHWAY"       | "KERATINOCYTEPATHWAY" |
| [7] "CHEMICALPATHWAY"       | "TGFBPATHWAY"          | "PROTEASOMEPATHWAY"   |
| [10] "MAPKPATHWAY"          | "PDGFPATHWAY"          | "BIOPEPTIDESPATHWAY"  |
| [13] "SPPAPATHWAY"          | "PYK2PATHWAY"          | "MYOSINPATHWAY"       |
| [16] "BETAOXIDATIONPATHWAY" | "IL7PATHWAY"           | "FMLPPATHWAY"         |
| [19] "VITCBPATHWAY"         | "CD40PATHWAY"          | "CDC25PATHWAY"        |
| [22] "MTORPATHWAY"          | "RNAPATHWAY"           | "FBW7PATHWAY"         |
| [25] "LYMPHOCYTEPATHWAY"    | "LAIRPATHWAY"          | "HIVNEFPATHWAY"       |
| [28] "ALKPATHWAY"           | "P35ALZHEIMERSPATHWAY" | "MSPPATHWAY"          |
| [31] "GSK3PATHWAY"          | "RELAPATHWAY"          | "METPATHWAY"          |
| [34] "TNFR2PATHWAY"         | "AT1RPATHWAY"          | "FREEPATHWAY"         |
| [37] "ARAPPATHWAY"          | "MRPPATHWAY"           | "P53HYPOXIAPATHWAY"   |
| [40] "IL18PATHWAY"          | "STRESSPATHWAY"        | "MEF2DPATHWAY"        |
| [43] "STAT3PATHWAY"         | "HSP27PATHWAY"         | "EPONFKBPATHWAY"      |
| [46] "NKCELLSPATHWAY"       | "MONOCYTEPATHWAY"      | "CARM_ERPATHWAY"      |

DIRAC and EVA have been shown mathematically similar. The main advantages of the EVA is efficiency in calculation as well as easier interpretation. Figure 5 a graphical example of such comparison. One can see that the p-values generated by DIRAC and EVA have high correlation, i.e. 0.88. Note that EVA is much faster than DIRAC. For example, in this case, we ran the computations on a Lenovo Thinkpad with Core(TM) i7-3720QM Intel CPU @2.6 GHz. For a thousand permutation, the DIRAC analysis took 207.47 seconds while the latter only took 0.3 seconds. Note that for multiple hypothesis adjustment, a thousand permutations may not be satisfactory and we require hundreds of thousand or a million permutation which may not be feasible.

Note that it is possible that some of the genes in a pathway are not represented in the expression data or are too short (e.g. less than 5 genes). Both `GSReg.GeneSets.EVA` and `GSReg.GeneSets.DIRAC` may ignore such pathways through parameter `minGeneNum`. Please see the manual for more details. If we the user wants to compare the results of DIRAC and

EVA, they can run the following code for plot DIRAC diagram of significantly perturbed pathways:

```
> DIRACAn =GSReg.GeneSets.DIRAC(exprsdata,diracpathways,phenotypes,Nperm=1000)

> significantPathwaysDIRAC = names(DIRACAn$mu1)[which(DIRACAn$pvalues<0.05)];
> mu1 = DIRACAn$mu1[significantPathwaysDIRAC];
> mu2 = DIRACAn$mu2[significantPathwaysDIRAC];
> #The dysregulated pathways
> names(mu1)

[1] "DEATHPATHWAY"      "NEUTROPHILPATHWAY"  "PGC1APATHWAY"
[4] "RARRXRPATHWAY"    "SKP2E2FPATHWAY"    "KERATINOCYTEPATHWAY"
[7] "CHEMICALPATHWAY"  "TGFBPATHWAY"       "PROTEASOMEPATHWAY"
```



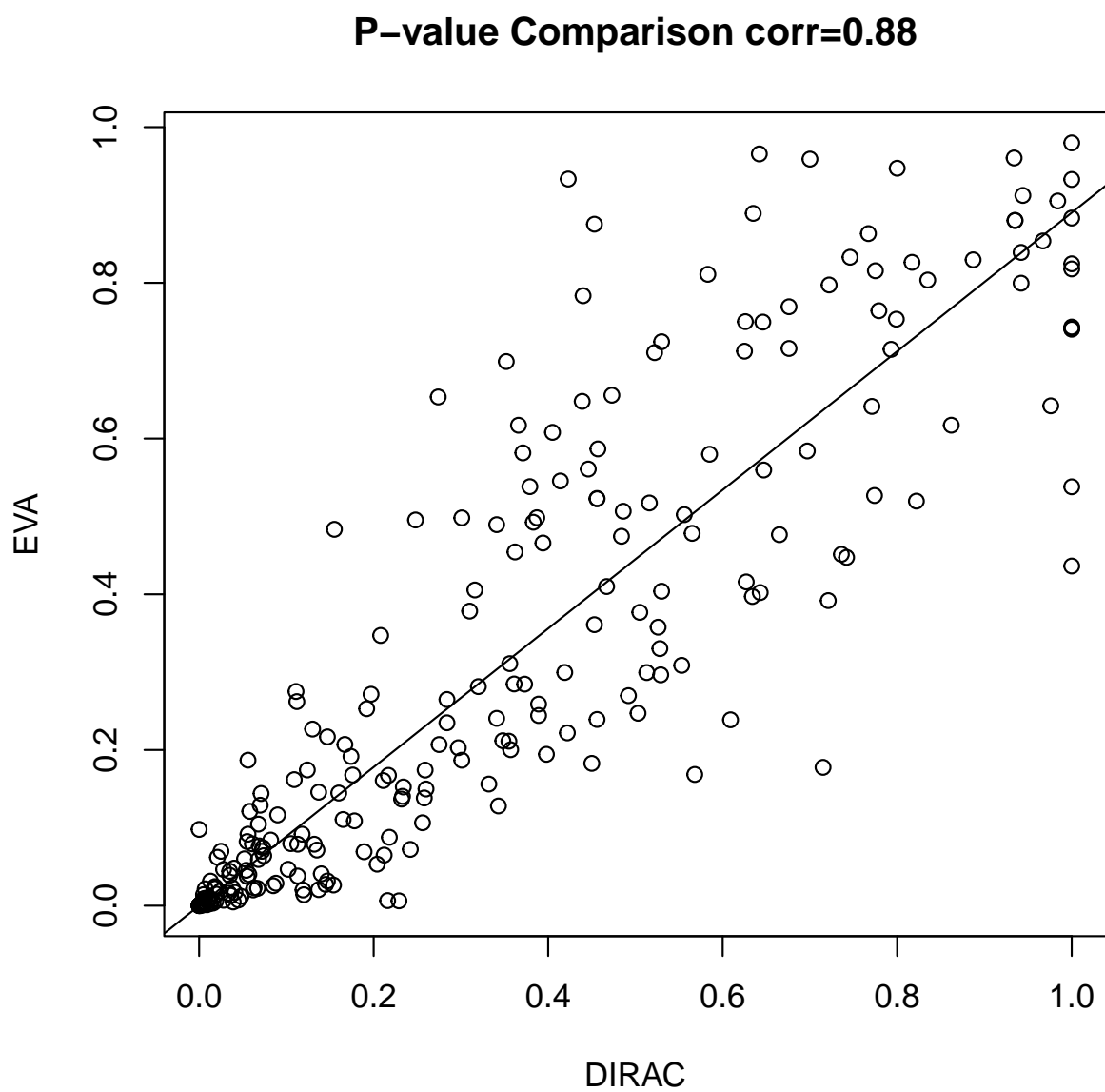


Figure 5: Comparing p-values EVA versus DIRAC. The correlation is 0.88.

|      |                        |                        |                     |
|------|------------------------|------------------------|---------------------|
| [10] | "MAPKPATHWAY"          | "PDGFPATHWAY"          | "BIOPEPTIDESPATWAY" |
| [13] | "SPPAPATHWAY"          | "PYK2PATHWAY"          | "MYOSINPATHWAY"     |
| [16] | "BETAOXIDATIONPATHWAY" | "IL7PATHWAY"           | "FMLPPATHWAY"       |
| [19] | "VITCBPATHWAY"         | "CD40PATHWAY"          | "CDC25PATHWAY"      |
| [22] | "MTORPATHWAY"          | "RNAPATHWAY"           | "FBW7PATHWAY"       |
| [25] | "LYMPHOCYTEPATHWAY"    | "LAIRPATHWAY"          | "HIVNEFPATHWAY"     |
| [28] | "ALKPATHWAY"           | "P35ALZHEIMERSPATHWAY" | "MSPPATHWAY"        |
| [31] | "GSK3PATHWAY"          | "RELAPATHWAY"          | "METPATHWAY"        |
| [34] | "TNFR2PATHWAY"         | "AT1RPATHWAY"          | "FREEPATHWAY"       |
| [37] | "ARAPPATHWAY"          | "MRPPATHWAY"           | "P53HYPOXIAPATHWAY" |
| [40] | "IL18PATHWAY"          | "STRESSPATHWAY"        | "MEF2DPATHWAY"      |
| [43] | "STAT3PATHWAY"         | "HSP27PATHWAY"         | "EPONFKBPATHWAY"    |
| [46] | "NKCELLSPATHWAY"       | "MONOCYTEPATHWAY"      | "CARM_ERPATHWAY"    |

```

> plot(x=mu1,y=mu2,
      xlim=c(0,max(mu1,mu2)),ylim=c(0,max(mu1,mu2)),xlab="normal",ylab="disease",
      main="(a) DIRAC significantly dysregulated pathways")
> lines(x=c(0,max(mu1,mu2)),y=c(0,max(mu1,mu2)))

```

### (a) DIRAC significantly dysregulated pathways



Now, if we do the analysis using EVA, we have:

```
> significantPathwaysGSV = names(which(pvalustat<0.05));
```

|                          |                       |                     |
|--------------------------|-----------------------|---------------------|
| [1] "DEATHPATHWAY"       | "TCAPOPTOSISPATHWAY"  | "NEUTROPHILPATHWAY" |
| [4] "PGC1APATHWAY"       | "TERCPATHWAY"         | "RARRXPATHWAY"      |
| [7] "SKP2E2FPATHWAY"     | "KERATINOCYTEPATHWAY" | "CHEMICALPATHWAY"   |
| [10] "METHIONINEPATHWAY" | "TGFBPATHWAY"         | "PS1PATHWAY"        |
| [13] "PROTEASOMEPATHWAY" | "CDK5PATHWAY"         | "MAPKPATHWAY"       |
| [16] "NTHIPATHWAY"       | "PDGFPATHWAY"         | "BIOPEPTIDEPATHWAY" |
| [19] "SPPAPATHWAY"       | "PYK2PATHWAY"         | "CDC42RACPATHWAY"   |

```

[22] "MYOSINPATHWAY"      "BETAOXIDATIONPATHWAY" "IL7PATHWAY"
[25] "FMLPPATHWAY"        "FASPATHWAY"           "VITCBPATHWAY"
[28] "CD40PATHWAY"        "IGF1PATHWAY"          "CDC25PATHWAY"
[31] "MTORPATHWAY"        "RNAPATHWAY"           "FBW7PATHWAY"
[34] "LYMPHOCYTEPATHWAY"  "LAIRPATHWAY"          "HIVNEFPATHWAY"
[37] "ALKPATHWAY"         "PEPIPATHWAY"          "MSPPATHWAY"
[40] "EDG1PATHWAY"        "GSK3PATHWAY"          "RELAPATHWAY"
[43] "METPATHWAY"         "TNFR2PATHWAY"         "AT1RPATHWAY"
[46] "ATRBRCPATHWAY"      "GLYCOLYSISPATHWAY"    "TIDPATHWAY"
[49] "EPOPATHWAY"         "WNTPATHWAY"           "ARAPPATHWAY"
[52] "MRPPATHWAY"         "P53HYPOXIAPATHWAY"    "PITX2PATHWAY"
[55] "IL18PATHWAY"        "STRESSPATHWAY"        "MEF2DPATHWAY"
[58] "MITOCHONDRIAPATHWAY" "STAT3PATHWAY"         "EPONFKBPATHWAY"
[61] "NKCELLSPATHWAY"     "MONOCYTEPATHWAY"      "CARM_ERPATHWAY"
[64] "HCMVPATHWAY"

```

```
> eta1 = sapply(VarAnKendallV,function(x) x$E1)[significantPathwaysGSV];
```

|                   |                     |                      |                     |
|-------------------|---------------------|----------------------|---------------------|
| DEATHPATHWAY      | TCAPOPTOSISPATHWAY  | NEUTROPHILPATHWAY    | PGC1APATHWAY        |
| 0.09441352        | 0.08600289          | 0.35559678           | 0.04477053          |
| TERCPATHWAY       | RARRXRPATHWAY       | SKP2E2FPATHWAY       | KERATINOCYTEPATHWAY |
| 0.07316017        | 0.06914038          | 0.03367003           | 0.07404055          |
| CHEMICALPATHWAY   | METHIONINEPATHWAY   | TGFBPATHWAY          | PS1PATHWAY          |
| 0.08521303        | 0.09913420          | 0.05028305           | 0.08080808          |
| PROTEASOMEPATHWAY | CDK5PATHWAY         | MAPKPATHWAY          | NTHIPATHWAY         |
| 0.09617180        | 0.07975863          | 0.08504987           | 0.08091115          |
| PDGFPATHWAY       | BIOPEPTIDESPATHWAY  | SPPAPATHWAY          | PYK2PATHWAY         |
| 0.08698709        | 0.06767807          | 0.09690598           | 0.04711514          |
| CDC42RACPATHWAY   | MYOSINPATHWAY       | BETAOXIDATIONPATHWAY | IL7PATHWAY          |
| 0.08948195        | 0.09005280          | 0.02683983           | 0.10609668          |
| FMLPPATHWAY       | FASPATHWAY          | VITCBPATHWAY         | CD40PATHWAY         |
| 0.05736961        | 0.08676830          | 0.07888408           | 0.05294705          |
| IGF1PATHWAY       | CDC25PATHWAY        | MTORPATHWAY          | RNAPATHWAY          |
| 0.09115972        | 0.06265031          | 0.04188827           | 0.03009689          |
| FBW7PATHWAY       | LYMPHOCYTEPATHWAY   | LAIRPATHWAY          | HIVNEFPATHWAY       |
| 0.03174603        | 0.22390572          | 0.15222872           | 0.09020600          |
| ALKPATHWAY        | PEPIPATHWAY         | MSPPATHWAY           | EDG1PATHWAY         |
| 0.09130361        | 0.05194805          | 0.12150072           | 0.08801738          |
| GSK3PATHWAY       | RELAPATHWAY         | METPATHWAY           | TNFR2PATHWAY        |
| 0.11946928        | 0.06302309          | 0.10561315           | 0.05051566          |
| AT1RPATHWAY       | ATRBRCPATHWAY       | GLYCOLYSISPATHWAY    | TIDPATHWAY          |
| 0.05943314        | 0.07166907          | 0.02308802           | 0.07331013          |
| EPOPATHWAY        | WNTPATHWAY          | ARAPPATHWAY          | MRPPATHWAY          |
| 0.07319696        | 0.10526414          | 0.05988456           | 0.04877345          |
| P53HYPOXIAPATHWAY | PITX2PATHWAY        | IL18PATHWAY          | STRESSPATHWAY       |
| 0.07708666        | 0.09375387          | 0.13015873           | 0.05505364          |
| MEF2DPATHWAY      | MITOCHONDRIAPATHWAY | STAT3PATHWAY         | EPONFKBPATHWAY      |
| 0.04399740        | 0.12572150          | 0.05179344           | 0.07910272          |
| NKCELLSPATHWAY    | MONOCYTEPATHWAY     | CARM_ERPATHWAY       | HCMVPATHWAY         |
| 0.07718643        | 0.25171192          | 0.06462137           | 0.07781385          |

```
> eta2 = sapply(VarAnKendallV,function(x) x$E2)[significantPathwaysGSV];
```

|                   |                     |                      |                     |
|-------------------|---------------------|----------------------|---------------------|
| DEATHPATHWAY      | TCAPOPTOSISPATHWAY  | NEUTROPHILPATHWAY    | PGC1APATHWAY        |
| 0.13103827        | 0.04531025          | 0.23546691           | 0.05588351          |
| TERCPATHWAY       | RARRXRPATHWAY       | SKP2E2FPATHWAY       | KERATINOCYTEPATHWAY |
| 0.12770563        | 0.09090909          | 0.05856181           | 0.09013983          |
| CHEMICALPATHWAY   | METHIONINEPATHWAY   | TGFBPATHWAY          | PS1PATHWAY          |
| 0.11832612        | 0.15454545          | 0.07165057           | 0.12332852          |
| PROTEASOMEPATHWAY | CDK5PATHWAY         | MAPKPATHWAY          | NTHIPATHWAY         |
| 0.13083213        | 0.10251869          | 0.10114801           | 0.09532055          |
| PDGFPATHWAY       | BIOPEPTIDESPATHWAY  | SPPAPATHWAY          | PYK2PATHWAY         |
| 0.11066711        | 0.08559859          | 0.12604711           | 0.06023958          |
| CDC42RACPATHWAY   | MYOSINPATHWAY       | BETAOXIDATIONPATHWAY | IL7PATHWAY          |
| 0.11283954        | 0.11997526          | 0.06147186           | 0.13455988          |
| FMLPPATHWAY       | FASPATHWAY          | VITCBPATHWAY         | CD40PATHWAY         |
| 0.06840858        | 0.10725265          | 0.04252044           | 0.08041958          |
| IGF1PATHWAY       | CDC25PATHWAY        | MTORPATHWAY          | RNAPATHWAY          |
| 0.12087036        | 0.04413179          | 0.05994640           | 0.08719852          |
| FBW7PATHWAY       | LYMPHOCYTEPATHWAY   | LAIRPATHWAY          | HIVNEFPATHWAY       |
| 0.06307978        | 0.16065416          | 0.11574140           | 0.11884884          |
| ALKPATHWAY        | PEPIPATHWAY         | MSPPATHWAY           | EDG1PATHWAY         |
| 0.11181840        | 0.13593074          | 0.17344877           | 0.11010728          |
| GSK3PATHWAY       | RELAPATHWAY         | METPATHWAY           | TNFR2PATHWAY        |
| 0.16320909        | 0.08203463          | 0.12858234           | 0.07308378          |
| AT1RPATHWAY       | ATRBRCPATHWAY       | GLYCOLYSISPATHWAY    | TIDPATHWAY          |
| 0.08115533        | 0.08771185          | 0.05112348           | 0.09458733          |
| EPOPATHWAY        | WNTPATHWAY          | ARAPPATHWAY          | MRPPATHWAY          |
| 0.09569080        | 0.12762130          | 0.07615440           | 0.08571429          |
| P53HYPOXIAPATHWAY | PITX2PATHWAY        | IL18PATHWAY          | STRESSPATHWAY       |
| 0.09759247        | 0.11618223          | 0.18989899           | 0.07523998          |
| MEF2DPATHWAY      | MITOCHONDRIAPATHWAY | STAT3PATHWAY         | EPONFKBPATHWAY      |
| 0.05508870        | 0.16778499          | 0.09647495           | 0.13372688          |
| NKCELLSPATHWAY    | MONOCYTEPATHWAY     | CARM_ERPATHWAY       | HCMVPATHWAY         |
| 0.09574739        | 0.17662338          | 0.08397641           | 0.08899711          |

> #The dysregulated pathways  
> names(etal)

```

[1] "DEATHPATHWAY"      "TCAPOPTOSISPATHWAY" "NEUTROPHILPATHWAY"
[4] "PGC1APATHWAY"      "TERCPATHWAY"        "RARRXRPATHWAY"
[7] "SKP2E2FPATHWAY"    "KERATINOCYTEPATHWAY" "CHEMICALPATHWAY"
[10] "METHIONINEPATHWAY" "TGFBPATHWAY"        "PS1PATHWAY"
[13] "PROTEASOMEPATHWAY" "CDK5PATHWAY"        "MAPKPATHWAY"
[16] "NTHIPATHWAY"       "PDGFPATHWAY"        "BIOPEPTIDESPATHWAY"
[19] "SPPAPATHWAY"       "PYK2PATHWAY"        "CDC42RACPATHWAY"
[22] "MYOSINPATHWAY"     "BETAOXIDATIONPATHWAY" "IL7PATHWAY"
[25] "FMLPPATHWAY"       "FASPATHWAY"         "VITCBPATHWAY"
[28] "CD40PATHWAY"       "IGF1PATHWAY"        "CDC25PATHWAY"
[31] "MTORPATHWAY"       "RNAPATHWAY"         "FBW7PATHWAY"
[34] "LYMPHOCYTEPATHWAY" "LAIRPATHWAY"        "HIVNEFPATHWAY"
[37] "ALKPATHWAY"        "PEPIPATHWAY"        "MSPPATHWAY"
[40] "EDG1PATHWAY"       "GSK3PATHWAY"        "RELAPATHWAY"
[43] "METPATHWAY"        "TNFR2PATHWAY"       "AT1RPATHWAY"
[46] "ATRBRCPATHWAY"     "GLYCOLYSISPATHWAY"  "TIDPATHWAY"

```

```

[49] "EPOPATHWAY"          "WNTPATHWAY"          "ARAPPATHWAY"
[52] "MRPPATHWAY"          "P53HYPOXIAPATHWAY"  "PITX2PATHWAY"
[55] "IL18PATHWAY"         "STRESSPATHWAY"       "MEF2DPATHWAY"
[58] "MITOCHONDRIAPATHWAY" "STAT3PATHWAY"        "EPONFKBPATHWAY"
[61] "NKCELLSPATHWAY"      "MONOCYTEPATHWAY"     "CARM_ERPATHWAY"
[64] "HCMVPATHWAY"

> plot(x=eta1,y=eta2,xlim=c(0,max(eta1,eta2)),ylim=c(0,max(eta1,eta2)),xlab="normal",ylab="disease",
      main="(b) EVA: Dysregulated pathways")

NULL

> lines(x=c(0,max(eta1,eta2)),y=c(0,max(eta1,eta2)))

NULL

```

### (b) EVA: Dysregulated pathways



Although there is discrepancy in identified dysregulated pathways ( $p\text{-value} < 0.05$ ), the general trend found in [1] holds still true. The trend is that usually the dysregulated pathways have higher variability measure in more dangerous phenotypes. The figures reveal that both DIRAC and EVA have this property. DIRAC found 48 dysregulated pathways and EVA discovered 64 pathways, 45 pathways showed up in both analysis, and 67 pathways were discovered totally.

```
> print(significantPathwaysGSV)
```

```

[1] "DEATHPATHWAY"          "TCAPOPTOSISPATHWAY"  "NEUTROPHILPATHWAY"
[4] "PGC1APATHWAY"          "TERCPATHWAY"         "RARRXRPATHWAY"
[7] "SKP2E2FPATHWAY"       "KERATINOCYTEPATHWAY" "CHEMICALPATHWAY"
[10] "METHIONINEPATHWAY"    "TGFBPATHWAY"         "PS1PATHWAY"
[13] "PROTEASOMEPATHWAY"    "CDK5PATHWAY"         "MAPKPATHWAY"
[16] "NTHIPATHWAY"          "PDGFPATHWAY"         "BIOPEPTIDESPATHWAY"
[19] "SPPAPATHWAY"          "PYK2PATHWAY"         "CDC42RACPATHWAY"
[22] "MYOSINPATHWAY"        "BETAOXIDATIONPATHWAY" "IL7PATHWAY"
[25] "FMLPPATHWAY"          "FASPATHWAY"          "VITCBPATHWAY"
[28] "CD40PATHWAY"          "IGF1PATHWAY"         "CDC25PATHWAY"
[31] "MTORPATHWAY"          "RNAPATHWAY"          "FBW7PATHWAY"
[34] "LYMPHOCYTEPATHWAY"    "LAIRPATHWAY"         "HIVNEFPATHWAY"
[37] "ALKPATHWAY"           "PEPIPATHWAY"         "MSPPATHWAY"
[40] "EDG1PATHWAY"          "GSK3PATHWAY"         "RELAPATHWAY"
[43] "METPATHWAY"           "TNFR2PATHWAY"        "AT1RPATHWAY"
[46] "ATRBRCAPATHWAY"       "GLYCOLYSISPATHWAY"   "TIDPATHWAY"
[49] "EOPATHWAY"            "WNTPATHWAY"          "ARAPPATHWAY"
[52] "MRPPATHWAY"           "P53HYPOXIAPATHWAY"   "PITX2PATHWAY"
[55] "IL18PATHWAY"          "STRESSPATHWAY"       "MEF2DPATHWAY"
[58] "MITOCHONDRIAPATHWAY"  "STAT3PATHWAY"        "EPONFKBPATHWAY"
[61] "NKCELLSPATHWAY"       "MONOCYTEPATHWAY"     "CARM_ERPATHWAY"
[64] "HCMVPATHWAY"

[1] "DEATHPATHWAY"          "TCAPOPTOSISPATHWAY"  "NEUTROPHILPATHWAY"
[4] "PGC1APATHWAY"          "TERCPATHWAY"         "RARRXRPATHWAY"
[7] "SKP2E2FPATHWAY"       "KERATINOCYTEPATHWAY" "CHEMICALPATHWAY"
[10] "METHIONINEPATHWAY"    "TGFBPATHWAY"         "PS1PATHWAY"
[13] "PROTEASOMEPATHWAY"    "CDK5PATHWAY"         "MAPKPATHWAY"
[16] "NTHIPATHWAY"          "PDGFPATHWAY"         "BIOPEPTIDESPATHWAY"
[19] "SPPAPATHWAY"          "PYK2PATHWAY"         "CDC42RACPATHWAY"
[22] "MYOSINPATHWAY"        "BETAOXIDATIONPATHWAY" "IL7PATHWAY"
[25] "FMLPPATHWAY"          "FASPATHWAY"          "VITCBPATHWAY"
[28] "CD40PATHWAY"          "IGF1PATHWAY"         "CDC25PATHWAY"
[31] "MTORPATHWAY"          "RNAPATHWAY"          "FBW7PATHWAY"
[34] "LYMPHOCYTEPATHWAY"    "LAIRPATHWAY"         "HIVNEFPATHWAY"
[37] "ALKPATHWAY"           "PEPIPATHWAY"         "MSPPATHWAY"
[40] "EDG1PATHWAY"          "GSK3PATHWAY"         "RELAPATHWAY"
[43] "METPATHWAY"           "TNFR2PATHWAY"        "AT1RPATHWAY"
[46] "ATRBRCAPATHWAY"       "GLYCOLYSISPATHWAY"   "TIDPATHWAY"
[49] "EOPATHWAY"            "WNTPATHWAY"          "ARAPPATHWAY"
[52] "MRPPATHWAY"           "P53HYPOXIAPATHWAY"   "PITX2PATHWAY"
[55] "IL18PATHWAY"          "STRESSPATHWAY"       "MEF2DPATHWAY"
[58] "MITOCHONDRIAPATHWAY"  "STAT3PATHWAY"        "EPONFKBPATHWAY"
[61] "NKCELLSPATHWAY"       "MONOCYTEPATHWAY"     "CARM_ERPATHWAY"
[64] "HCMVPATHWAY"

> print(significantPathwaysDIRAC)

[1] "DEATHPATHWAY"          "NEUTROPHILPATHWAY"   "PGC1APATHWAY"
[4] "RARRXRPATHWAY"        "SKP2E2FPATHWAY"      "KERATINOCYTEPATHWAY"
[7] "CHEMICALPATHWAY"      "TGFBPATHWAY"         "PROTEASOMEPATHWAY"
[10] "MAPKPATHWAY"          "PDGFPATHWAY"         "BIOPEPTIDESPATHWAY"
[13] "SPPAPATHWAY"          "PYK2PATHWAY"         "MYOSINPATHWAY"

```



|      |                        |                        |                       |
|------|------------------------|------------------------|-----------------------|
| [16] | "BETAOXIDATIONPATHWAY" | "IL7PATHWAY"           | "FMLPPATHWAY"         |
| [19] | "VITCBPATHWAY"         | "CD40PATHWAY"          | "CDC25PATHWAY"        |
| [22] | "MTORPATHWAY"          | "RNAPATHWAY"           | "FBW7PATHWAY"         |
| [25] | "LYMPHOCYTEPATHWAY"    | "LAIRPATHWAY"          | "HIVNEFPATHWAY"       |
| [28] | "ALKPATHWAY"           | "P35ALZHEIMERSPATHWAY" | "MSPPATHWAY"          |
| [31] | "GSK3PATHWAY"          | "RELAPATHWAY"          | "METPATHWAY"          |
| [34] | "TNFR2PATHWAY"         | "AT1RPATHWAY"          | "FREEPATHWAY"         |
| [37] | "ARAPPATHWAY"          | "MRPPATHWAY"           | "P53HYPOXIAPATHWAY"   |
| [40] | "IL18PATHWAY"          | "STRESSPATHWAY"        | "MEF2DPATHWAY"        |
| [43] | "STAT3PATHWAY"         | "HSP27PATHWAY"         | "EPONFKBPATHWAY"      |
| [46] | "NKCELLSPATHWAY"       | "MONOCYTEPATHWAY"      | "CARM_ERPATHWAY"      |
| [1]  | "DEATHPATHWAY"         | "NEUTROPHILPATHWAY"    | "PGC1APATHWAY"        |
| [4]  | "RARRXRPATHWAY"        | "SKP2E2FPATHWAY"       | "KERATINOCYTEPATHWAY" |
| [7]  | "CHEMICALPATHWAY"      | "TGFBPATHWAY"          | "PROTEASOMEPATHWAY"   |
| [10] | "MAPKPATHWAY"          | "PDGFPATHWAY"          | "BIOPEPTIDESPATHWAY"  |
| [13] | "SPPAPATHWAY"          | "PYK2PATHWAY"          | "MYOSINPATHWAY"       |
| [16] | "BETAOXIDATIONPATHWAY" | "IL7PATHWAY"           | "FMLPPATHWAY"         |
| [19] | "VITCBPATHWAY"         | "CD40PATHWAY"          | "CDC25PATHWAY"        |
| [22] | "MTORPATHWAY"          | "RNAPATHWAY"           | "FBW7PATHWAY"         |
| [25] | "LYMPHOCYTEPATHWAY"    | "LAIRPATHWAY"          | "HIVNEFPATHWAY"       |
| [28] | "ALKPATHWAY"           | "P35ALZHEIMERSPATHWAY" | "MSPPATHWAY"          |
| [31] | "GSK3PATHWAY"          | "RELAPATHWAY"          | "METPATHWAY"          |
| [34] | "TNFR2PATHWAY"         | "AT1RPATHWAY"          | "FREEPATHWAY"         |
| [37] | "ARAPPATHWAY"          | "MRPPATHWAY"           | "P53HYPOXIAPATHWAY"   |
| [40] | "IL18PATHWAY"          | "STRESSPATHWAY"        | "MEF2DPATHWAY"        |
| [43] | "STAT3PATHWAY"         | "HSP27PATHWAY"         | "EPONFKBPATHWAY"      |
| [46] | "NKCELLSPATHWAY"       | "MONOCYTEPATHWAY"      | "CARM_ERPATHWAY"      |

### 3.4 Splice-EVA Analysis

SEVA needs junction overlap matrices. This can be done by function `GSReg.overlapJunction`. Here is a piece of code which shows how to use this function.

```
> require('Homo.sapiens')
[1] TRUE

> require('org.Hs.eg.db')
[1] TRUE

> require('GenomicRanges')
[1] TRUE

> data(juncExprsSimulated)
[1] "juncExprsSimulated"

> overlapMat <- GSReg.overlapJunction(juncExprs = junc.RPM.Simulated,
                                     geneexpr = geneExprsGSReg)
```

\$Rest

\$Rest\$CMPK1

|                        | chr1:47799788-47834141 | chr1:47834287-47838627 |
|------------------------|------------------------|------------------------|
| chr1:47799788-47834141 | 1                      | 0                      |
| chr1:47834287-47838627 | 0                      | 1                      |
| chr1:47838779-47840581 | 0                      | 0                      |
| chr1:47838779-47840869 | 0                      | 0                      |
| chr1:47840657-47840869 | 0                      | 0                      |
| chr1:47840965-47842376 | 0                      | 0                      |
|                        | chr1:47838779-47840581 | chr1:47838779-47840869 |
| chr1:47799788-47834141 | 0                      | 0                      |
| chr1:47834287-47838627 | 0                      | 0                      |
| chr1:47838779-47840581 | 1                      | 1                      |
| chr1:47838779-47840869 | 1                      | 1                      |
| chr1:47840657-47840869 | 0                      | 1                      |
| chr1:47840965-47842376 | 0                      | 0                      |
|                        | chr1:47840657-47840869 | chr1:47840965-47842376 |
| chr1:47799788-47834141 | 0                      | 0                      |
| chr1:47834287-47838627 | 0                      | 0                      |
| chr1:47838779-47840581 | 0                      | 0                      |
| chr1:47838779-47840869 | 1                      | 0                      |
| chr1:47840657-47840869 | 1                      | 0                      |
| chr1:47840965-47842376 | 0                      | 1                      |

\$Rest\$CSF1

|                          | chr1:110453684-110456881 | chr1:110457003-110458256 |
|--------------------------|--------------------------|--------------------------|
| chr1:110453684-110456881 | 1                        | 0                        |
| chr1:110457003-110458256 | 0                        | 1                        |
| chr1:110458318-110459915 | 0                        | 0                        |
| chr1:110460085-110464469 | 0                        | 0                        |
| chr1:110464616-110465788 | 0                        | 0                        |
| chr1:110464616-110466682 | 0                        | 0                        |
| chr1:110466812-110467398 | 0                        | 0                        |
| chr1:110467450-110467769 | 0                        | 0                        |
| chr1:110467824-110468685 | 0                        | 0                        |
| chr1:110467824-110471474 | 0                        | 0                        |
|                          | chr1:110458318-110459915 | chr1:110460085-110464469 |
| chr1:110453684-110456881 | 0                        | 0                        |
| chr1:110457003-110458256 | 0                        | 0                        |
| chr1:110458318-110459915 | 1                        | 0                        |
| chr1:110460085-110464469 | 0                        | 1                        |
| chr1:110464616-110465788 | 0                        | 0                        |
| chr1:110464616-110466682 | 0                        | 0                        |
| chr1:110466812-110467398 | 0                        | 0                        |
| chr1:110467450-110467769 | 0                        | 0                        |
| chr1:110467824-110468685 | 0                        | 0                        |
| chr1:110467824-110471474 | 0                        | 0                        |
|                          | chr1:110464616-110465788 | chr1:110464616-110466682 |
| chr1:110453684-110456881 | 0                        | 0                        |
| chr1:110457003-110458256 | 0                        | 0                        |
| chr1:110458318-110459915 | 0                        | 0                        |

|   |   |   |
|---|---|---|
| chr1:110460085-110464469                          | 0 | 0 |
| chr1:110464616-110465788                          | 1 | 1 |
| chr1:110464616-110466682                          | 1 | 1 |
| chr1:110466812-110467398                          | 0 | 0 |
| chr1:110467450-110467769                          | 0 | 0 |
| chr1:110467824-110468685                          | 0 | 0 |
| chr1:110467824-110471474                          | 0 | 0 |
| chr1:110466812-110467398 chr1:110467450-110467769 |   |   |
| chr1:110453684-110456881                          | 0 | 0 |
| chr1:110457003-110458256                          | 0 | 0 |
| chr1:110458318-110459915                          | 0 | 0 |
| chr1:110460085-110464469                          | 0 | 0 |
| chr1:110464616-110465788                          | 0 | 0 |
| chr1:110464616-110466682                          | 0 | 0 |
| chr1:110466812-110467398                          | 1 | 0 |
| chr1:110467450-110467769                          | 0 | 1 |
| chr1:110467824-110468685                          | 0 | 0 |
| chr1:110467824-110471474                          | 0 | 0 |
| chr1:110467824-110468685 chr1:110467824-110471474 |   |   |
| chr1:110453684-110456881                          | 0 | 0 |
| chr1:110457003-110458256                          | 0 | 0 |
| chr1:110458318-110459915                          | 0 | 0 |
| chr1:110460085-110464469                          | 0 | 0 |
| chr1:110464616-110465788                          | 0 | 0 |
| chr1:110464616-110466682                          | 0 | 0 |
| chr1:110466812-110467398                          | 0 | 0 |
| chr1:110467450-110467769                          | 0 | 0 |
| chr1:110467824-110468685                          | 1 | 1 |
| chr1:110467824-110471474                          | 1 | 1 |
| \$Rest\$FAM72B                                    |   |   |
| chr1:120839865-120841975 chr1:120839985-120841975 |   |   |
| chr1:120839865-120841975                          | 1 | 1 |
| chr1:120839985-120841975                          | 1 | 1 |
| chr1:120842052-120845995                          | 0 | 0 |
| chr1:120846119-120854492                          | 0 | 0 |
| chr1:120842052-120845995 chr1:120846119-120854492 |   |   |
| chr1:120839865-120841975                          | 0 | 0 |
| chr1:120839985-120841975                          | 0 | 0 |
| chr1:120842052-120845995                          | 1 | 0 |
| chr1:120846119-120854492                          | 0 | 1 |
| \$Rest\$KLHL12                                    |   |   |
| chr1:202861787-202862367 chr1:202861787-202863312 |   |   |
| chr1:202861787-202862367                          | 1 | 1 |
| chr1:202861787-202863312                          | 1 | 1 |
| chr1:202862553-202863312                          | 0 | 1 |
| chr1:202863410-202863719                          | 0 | 0 |
| chr1:202863877-202864650                          | 0 | 0 |
| chr1:202863877-202878138                          | 0 | 0 |
| chr1:202864845-202865982                          | 0 | 0 |

|                          |                          |   |
|--------------------------|--------------------------|---|
| chr1:202866088-202878138 | 0                        | 0 |
| chr1:202878252-202880182 | 0                        | 0 |
| chr1:202880331-202887299 | 0                        | 0 |
| chr1:202887516-202888883 | 0                        | 0 |
| chr1:202889036-202894096 | 0                        | 0 |
| chr1:202894335-202896217 | 0                        | 0 |
| chr1:202862553-202863312 | chr1:202863410-202863719 |   |
| chr1:202861787-202862367 | 0                        | 0 |
| chr1:202861787-202863312 | 1                        | 0 |
| chr1:202862553-202863312 | 1                        | 0 |
| chr1:202863410-202863719 | 0                        | 1 |
| chr1:202863877-202864650 | 0                        | 0 |
| chr1:202863877-202878138 | 0                        | 0 |
| chr1:202864845-202865982 | 0                        | 0 |
| chr1:202866088-202878138 | 0                        | 0 |
| chr1:202878252-202880182 | 0                        | 0 |
| chr1:202880331-202887299 | 0                        | 0 |
| chr1:202887516-202888883 | 0                        | 0 |
| chr1:202889036-202894096 | 0                        | 0 |
| chr1:202894335-202896217 | 0                        | 0 |
| chr1:202863877-202864650 | chr1:202863877-202878138 |   |
| chr1:202861787-202862367 | 0                        | 0 |
| chr1:202861787-202863312 | 0                        | 0 |
| chr1:202862553-202863312 | 0                        | 0 |
| chr1:202863410-202863719 | 0                        | 0 |
| chr1:202863877-202864650 | 1                        | 1 |
| chr1:202863877-202878138 | 1                        | 1 |
| chr1:202864845-202865982 | 0                        | 1 |
| chr1:202866088-202878138 | 0                        | 1 |
| chr1:202878252-202880182 | 0                        | 0 |
| chr1:202880331-202887299 | 0                        | 0 |
| chr1:202887516-202888883 | 0                        | 0 |
| chr1:202889036-202894096 | 0                        | 0 |
| chr1:202894335-202896217 | 0                        | 0 |
| chr1:202864845-202865982 | chr1:202866088-202878138 |   |
| chr1:202861787-202862367 | 0                        | 0 |
| chr1:202861787-202863312 | 0                        | 0 |
| chr1:202862553-202863312 | 0                        | 0 |
| chr1:202863410-202863719 | 0                        | 0 |
| chr1:202863877-202864650 | 0                        | 0 |
| chr1:202863877-202878138 | 1                        | 1 |
| chr1:202864845-202865982 | 1                        | 0 |
| chr1:202866088-202878138 | 0                        | 1 |
| chr1:202878252-202880182 | 0                        | 0 |
| chr1:202880331-202887299 | 0                        | 0 |
| chr1:202887516-202888883 | 0                        | 0 |
| chr1:202889036-202894096 | 0                        | 0 |
| chr1:202894335-202896217 | 0                        | 0 |
| chr1:202878252-202880182 | chr1:202880331-202887299 |   |
| chr1:202861787-202862367 | 0                        | 0 |
| chr1:202861787-202863312 | 0                        | 0 |

|  |   |   |
|--|---|---|
| chr1:202862553-202863312                                       | 0 | 0 |
| chr1:202863410-202863719                                       | 0 | 0 |
| chr1:202863877-202864650                                       | 0 | 0 |
| chr1:202863877-202878138                                       | 0 | 0 |
| chr1:202864845-202865982                                       | 0 | 0 |
| chr1:202866088-202878138                                       | 0 | 0 |
| chr1:202878252-202880182                                       | 1 | 0 |
| chr1:202880331-202887299                                       | 0 | 1 |
| chr1:202887516-202888883                                       | 0 | 0 |
| chr1:202889036-202894096                                       | 0 | 0 |
| chr1:202894335-202896217                                       | 0 | 0 |
| chr1:202887516-202888883 chr1:202889036-202894096              |   |   |
| chr1:202861787-202862367                                       | 0 | 0 |
| chr1:202861787-202863312                                       | 0 | 0 |
| chr1:202862553-202863312                                       | 0 | 0 |
| chr1:202863410-202863719                                       | 0 | 0 |
| chr1:202863877-202864650                                       | 0 | 0 |
| chr1:202863877-202878138                                       | 0 | 0 |
| chr1:202864845-202865982                                       | 0 | 0 |
| chr1:202866088-202878138                                       | 0 | 0 |
| chr1:202878252-202880182                                       | 0 | 0 |
| chr1:202880331-202887299                                       | 0 | 0 |
| chr1:202887516-202888883                                       | 1 | 0 |
| chr1:202889036-202894096                                       | 0 | 1 |
| chr1:202894335-202896217                                       | 0 | 0 |
| chr1:202894335-202896217                                       |   |   |
| chr1:202861787-202862367                                       | 0 |   |
| chr1:202861787-202863312                                       | 0 |   |
| chr1:202862553-202863312                                       | 0 |   |
| chr1:202863410-202863719                                       | 0 |   |
| chr1:202863877-202864650                                       | 0 |   |
| chr1:202863877-202878138                                       | 0 |   |
| chr1:202864845-202865982                                       | 0 |   |
| chr1:202866088-202878138                                       | 0 |   |
| chr1:202878252-202880182                                       | 0 |   |
| chr1:202880331-202887299                                       | 0 |   |
| chr1:202887516-202888883                                       | 0 |   |
| chr1:202889036-202894096                                       | 0 |   |
| chr1:202894335-202896217                                       | 1 |   |
| \$Rest\$KLHL21   |   |   |
| chr1:6653718-6655545 chr1:6655617-6659107 chr1:6659512-6659810 |   |   |
| chr1:6653718-6655545   | 1 | 0 |
| chr1:6655617-6659107   | 0 | 1 |
| chr1:6659512-6659810   | 0 | 0 |
| chr1:6659512-6661857   | 0 | 0 |
| chr1:6659512-6661857   |   |   |
| chr1:6653718-6655545   | 0 |   |
| chr1:6655617-6659107   | 0 |   |
| chr1:6659512-6659810   | 1 |   |
| chr1:6659512-6661857   | 1 |   |

\$Rest\$MIR4632

chr1:12251142-12251831

chr1:12251142-12251831 1

\$Rest\$MYSM1

chr1:59125827-59126842 chr1:59126899-59127078

|                        |   |   |
|------------------------|---|---|
| chr1:59125827-59126842 | 1 | 0 |
| chr1:59126899-59127078 | 0 | 1 |
| chr1:59127183-59131171 | 0 | 0 |
| chr1:59131303-59132710 | 0 | 0 |
| chr1:59132898-59133519 | 0 | 0 |
| chr1:59133593-59134102 | 0 | 0 |
| chr1:59133593-59134304 | 0 | 0 |
| chr1:59134238-59134656 | 0 | 0 |
| chr1:59134354-59134656 | 0 | 0 |
| chr1:59134710-59137542 | 0 | 0 |
| chr1:59137630-59139245 | 0 | 0 |
| chr1:59139322-59141149 | 0 | 0 |
| chr1:59141252-59142598 | 0 | 0 |
| chr1:59142728-59147457 | 0 | 0 |
| chr1:59148217-59150825 | 0 | 0 |
| chr1:59150923-59154710 | 0 | 0 |
| chr1:59154788-59155898 | 0 | 0 |
| chr1:59155921-59156012 | 0 | 0 |
| chr1:59156089-59158533 | 0 | 0 |
| chr1:59158603-59160801 | 0 | 0 |
| chr1:59160879-59165657 | 0 | 0 |

chr1:59127183-59131171 chr1:59131303-59132710

|                        |   |   |
|------------------------|---|---|
| chr1:59125827-59126842 | 0 | 0 |
| chr1:59126899-59127078 | 0 | 0 |
| chr1:59127183-59131171 | 1 | 0 |
| chr1:59131303-59132710 | 0 | 1 |
| chr1:59132898-59133519 | 0 | 0 |
| chr1:59133593-59134102 | 0 | 0 |
| chr1:59133593-59134304 | 0 | 0 |
| chr1:59134238-59134656 | 0 | 0 |
| chr1:59134354-59134656 | 0 | 0 |
| chr1:59134710-59137542 | 0 | 0 |
| chr1:59137630-59139245 | 0 | 0 |
| chr1:59139322-59141149 | 0 | 0 |
| chr1:59141252-59142598 | 0 | 0 |
| chr1:59142728-59147457 | 0 | 0 |
| chr1:59148217-59150825 | 0 | 0 |
| chr1:59150923-59154710 | 0 | 0 |
| chr1:59154788-59155898 | 0 | 0 |
| chr1:59155921-59156012 | 0 | 0 |
| chr1:59156089-59158533 | 0 | 0 |
| chr1:59158603-59160801 | 0 | 0 |
| chr1:59160879-59165657 | 0 | 0 |

chr1:59132898-59133519 chr1:59133593-59134102

|   |   |   |
|---|---|---|
| chr1:59125827-59126842                        | 0 | 0 |
| chr1:59126899-59127078                        | 0 | 0 |
| chr1:59127183-59131171                        | 0 | 0 |
| chr1:59131303-59132710                        | 0 | 0 |
| chr1:59132898-59133519                        | 1 | 0 |
| chr1:59133593-59134102                        | 0 | 1 |
| chr1:59133593-59134304                        | 0 | 1 |
| chr1:59134238-59134656                        | 0 | 0 |
| chr1:59134354-59134656                        | 0 | 0 |
| chr1:59134710-59137542                        | 0 | 0 |
| chr1:59137630-59139245                        | 0 | 0 |
| chr1:59139322-59141149                        | 0 | 0 |
| chr1:59141252-59142598                        | 0 | 0 |
| chr1:59142728-59147457                        | 0 | 0 |
| chr1:59148217-59150825                        | 0 | 0 |
| chr1:59150923-59154710                        | 0 | 0 |
| chr1:59154788-59155898                        | 0 | 0 |
| chr1:59155921-59156012                        | 0 | 0 |
| chr1:59156089-59158533                        | 0 | 0 |
| chr1:59158603-59160801                        | 0 | 0 |
| chr1:59160879-59165657                        | 0 | 0 |
| chr1:59133593-59134304 chr1:59134238-59134656 |   |   |
| chr1:59125827-59126842                        | 0 | 0 |
| chr1:59126899-59127078                        | 0 | 0 |
| chr1:59127183-59131171                        | 0 | 0 |
| chr1:59131303-59132710                        | 0 | 0 |
| chr1:59132898-59133519                        | 0 | 0 |
| chr1:59133593-59134102                        | 1 | 0 |
| chr1:59133593-59134304                        | 1 | 1 |
| chr1:59134238-59134656                        | 1 | 1 |
| chr1:59134354-59134656                        | 0 | 1 |
| chr1:59134710-59137542                        | 0 | 0 |
| chr1:59137630-59139245                        | 0 | 0 |
| chr1:59139322-59141149                        | 0 | 0 |
| chr1:59141252-59142598                        | 0 | 0 |
| chr1:59142728-59147457                        | 0 | 0 |
| chr1:59148217-59150825                        | 0 | 0 |
| chr1:59150923-59154710                        | 0 | 0 |
| chr1:59154788-59155898                        | 0 | 0 |
| chr1:59155921-59156012                        | 0 | 0 |
| chr1:59156089-59158533                        | 0 | 0 |
| chr1:59158603-59160801                        | 0 | 0 |
| chr1:59160879-59165657                        | 0 | 0 |
| chr1:59134354-59134656 chr1:59134710-59137542 |   |   |
| chr1:59125827-59126842                        | 0 | 0 |
| chr1:59126899-59127078                        | 0 | 0 |
| chr1:59127183-59131171                        | 0 | 0 |
| chr1:59131303-59132710                        | 0 | 0 |
| chr1:59132898-59133519                        | 0 | 0 |
| chr1:59133593-59134102                        | 0 | 0 |
| chr1:59133593-59134304                        | 0 | 0 |

|   |   |   |
|---|---|---|
| chr1:59134238-59134656                        | 1 | 0 |
| chr1:59134354-59134656                        | 1 | 0 |
| chr1:59134710-59137542                        | 0 | 1 |
| chr1:59137630-59139245                        | 0 | 0 |
| chr1:59139322-59141149                        | 0 | 0 |
| chr1:59141252-59142598                        | 0 | 0 |
| chr1:59142728-59147457                        | 0 | 0 |
| chr1:59148217-59150825                        | 0 | 0 |
| chr1:59150923-59154710                        | 0 | 0 |
| chr1:59154788-59155898                        | 0 | 0 |
| chr1:59155921-59156012                        | 0 | 0 |
| chr1:59156089-59158533                        | 0 | 0 |
| chr1:59158603-59160801                        | 0 | 0 |
| chr1:59160879-59165657                        | 0 | 0 |
| chr1:59137630-59139245 chr1:59139322-59141149 |   |   |
| chr1:59125827-59126842                        | 0 | 0 |
| chr1:59126899-59127078                        | 0 | 0 |
| chr1:59127183-59131171                        | 0 | 0 |
| chr1:59131303-59132710                        | 0 | 0 |
| chr1:59132898-59133519                        | 0 | 0 |
| chr1:59133593-59134102                        | 0 | 0 |
| chr1:59133593-59134304                        | 0 | 0 |
| chr1:59134238-59134656                        | 0 | 0 |
| chr1:59134354-59134656                        | 0 | 0 |
| chr1:59134710-59137542                        | 0 | 0 |
| chr1:59137630-59139245                        | 1 | 0 |
| chr1:59139322-59141149                        | 0 | 1 |
| chr1:59141252-59142598                        | 0 | 0 |
| chr1:59142728-59147457                        | 0 | 0 |
| chr1:59148217-59150825                        | 0 | 0 |
| chr1:59150923-59154710                        | 0 | 0 |
| chr1:59154788-59155898                        | 0 | 0 |
| chr1:59155921-59156012                        | 0 | 0 |
| chr1:59156089-59158533                        | 0 | 0 |
| chr1:59158603-59160801                        | 0 | 0 |
| chr1:59160879-59165657                        | 0 | 0 |
| chr1:59141252-59142598 chr1:59142728-59147457 |   |   |
| chr1:59125827-59126842                        | 0 | 0 |
| chr1:59126899-59127078                        | 0 | 0 |
| chr1:59127183-59131171                        | 0 | 0 |
| chr1:59131303-59132710                        | 0 | 0 |
| chr1:59132898-59133519                        | 0 | 0 |
| chr1:59133593-59134102                        | 0 | 0 |
| chr1:59133593-59134304                        | 0 | 0 |
| chr1:59134238-59134656                        | 0 | 0 |
| chr1:59134354-59134656                        | 0 | 0 |
| chr1:59134710-59137542                        | 0 | 0 |
| chr1:59137630-59139245                        | 0 | 0 |
| chr1:59139322-59141149                        | 0 | 0 |
| chr1:59141252-59142598                        | 1 | 0 |
| chr1:59142728-59147457                        | 0 | 1 |



|   |   |   |
|---|---|---|
| chr1:59148217-59150825                        | 0 | 0 |
| chr1:59150923-59154710                        | 0 | 0 |
| chr1:59154788-59155898                        | 0 | 0 |
| chr1:59155921-59156012                        | 0 | 0 |
| chr1:59156089-59158533                        | 0 | 0 |
| chr1:59158603-59160801                        | 0 | 0 |
| chr1:59160879-59165657                        | 0 | 0 |
| chr1:59148217-59150825 chr1:59150923-59154710 |   |   |
| chr1:59125827-59126842                        | 0 | 0 |
| chr1:59126899-59127078                        | 0 | 0 |
| chr1:59127183-59131171                        | 0 | 0 |
| chr1:59131303-59132710                        | 0 | 0 |
| chr1:59132898-59133519                        | 0 | 0 |
| chr1:59133593-59134102                        | 0 | 0 |
| chr1:59133593-59134304                        | 0 | 0 |
| chr1:59134238-59134656                        | 0 | 0 |
| chr1:59134354-59134656                        | 0 | 0 |
| chr1:59134710-59137542                        | 0 | 0 |
| chr1:59137630-59139245                        | 0 | 0 |
| chr1:59139322-59141149                        | 0 | 0 |
| chr1:59141252-59142598                        | 0 | 0 |
| chr1:59142728-59147457                        | 0 | 0 |
| chr1:59148217-59150825                        | 1 | 0 |
| chr1:59150923-59154710                        | 0 | 1 |
| chr1:59154788-59155898                        | 0 | 0 |
| chr1:59155921-59156012                        | 0 | 0 |
| chr1:59156089-59158533                        | 0 | 0 |
| chr1:59158603-59160801                        | 0 | 0 |
| chr1:59160879-59165657                        | 0 | 0 |
| chr1:59154788-59155898 chr1:59155921-59156012 |   |   |
| chr1:59125827-59126842                        | 0 | 0 |
| chr1:59126899-59127078                        | 0 | 0 |
| chr1:59127183-59131171                        | 0 | 0 |
| chr1:59131303-59132710                        | 0 | 0 |
| chr1:59132898-59133519                        | 0 | 0 |
| chr1:59133593-59134102                        | 0 | 0 |
| chr1:59133593-59134304                        | 0 | 0 |
| chr1:59134238-59134656                        | 0 | 0 |
| chr1:59134354-59134656                        | 0 | 0 |
| chr1:59134710-59137542                        | 0 | 0 |
| chr1:59137630-59139245                        | 0 | 0 |
| chr1:59139322-59141149                        | 0 | 0 |
| chr1:59141252-59142598                        | 0 | 0 |
| chr1:59142728-59147457                        | 0 | 0 |
| chr1:59148217-59150825                        | 0 | 0 |
| chr1:59150923-59154710                        | 0 | 0 |
| chr1:59154788-59155898                        | 1 | 0 |
| chr1:59155921-59156012                        | 0 | 1 |
| chr1:59156089-59158533                        | 0 | 0 |
| chr1:59158603-59160801                        | 0 | 0 |
| chr1:59160879-59165657                        | 0 | 0 |

|                        |                        |                        |                      |
|------------------------|------------------------|------------------------|----------------------|
|                        | chr1:59156089-59158533 | chr1:59158603-59160801 |                      |
| chr1:59125827-59126842 | 0                      | 0                      |                      |
| chr1:59126899-59127078 | 0                      | 0                      |                      |
| chr1:59127183-59131171 | 0                      | 0                      |                      |
| chr1:59131303-59132710 | 0                      | 0                      |                      |
| chr1:59132898-59133519 | 0                      | 0                      |                      |
| chr1:59133593-59134102 | 0                      | 0                      |                      |
| chr1:59133593-59134304 | 0                      | 0                      |                      |
| chr1:59134238-59134656 | 0                      | 0                      |                      |
| chr1:59134354-59134656 | 0                      | 0                      |                      |
| chr1:59134710-59137542 | 0                      | 0                      |                      |
| chr1:59137630-59139245 | 0                      | 0                      |                      |
| chr1:59139322-59141149 | 0                      | 0                      |                      |
| chr1:59141252-59142598 | 0                      | 0                      |                      |
| chr1:59142728-59147457 | 0                      | 0                      |                      |
| chr1:59148217-59150825 | 0                      | 0                      |                      |
| chr1:59150923-59154710 | 0                      | 0                      |                      |
| chr1:59154788-59155898 | 0                      | 0                      |                      |
| chr1:59155921-59156012 | 0                      | 0                      |                      |
| chr1:59156089-59158533 | 1                      | 0                      |                      |
| chr1:59158603-59160801 | 0                      | 1                      |                      |
| chr1:59160879-59165657 | 0                      | 0                      |                      |
|                        | chr1:59160879-59165657 |                        |                      |
| chr1:59125827-59126842 | 0                      |                        |                      |
| chr1:59126899-59127078 | 0                      |                        |                      |
| chr1:59127183-59131171 | 0                      |                        |                      |
| chr1:59131303-59132710 | 0                      |                        |                      |
| chr1:59132898-59133519 | 0                      |                        |                      |
| chr1:59133593-59134102 | 0                      |                        |                      |
| chr1:59133593-59134304 | 0                      |                        |                      |
| chr1:59134238-59134656 | 0                      |                        |                      |
| chr1:59134354-59134656 | 0                      |                        |                      |
| chr1:59134710-59137542 | 0                      |                        |                      |
| chr1:59137630-59139245 | 0                      |                        |                      |
| chr1:59139322-59141149 | 0                      |                        |                      |
| chr1:59141252-59142598 | 0                      |                        |                      |
| chr1:59142728-59147457 | 0                      |                        |                      |
| chr1:59148217-59150825 | 0                      |                        |                      |
| chr1:59150923-59154710 | 0                      |                        |                      |
| chr1:59154788-59155898 | 0                      |                        |                      |
| chr1:59155921-59156012 | 0                      |                        |                      |
| chr1:59156089-59158533 | 0                      |                        |                      |
| chr1:59158603-59160801 | 0                      |                        |                      |
| chr1:59160879-59165657 | 1                      |                        |                      |
| \$Rest\$NPHP4          |                        |                        |                      |
|                        | chr1:5923465-5923950   | chr1:5924093-5924398   | chr1:5924577-5925162 |
| chr1:5923465-5923950   | 1                      | 0                      | 0                    |
| chr1:5924093-5924398   | 0                      | 1                      | 0                    |
| chr1:5924577-5925162   | 0                      | 0                      | 1                    |
| chr1:5925333-5926433   | 0                      | 0                      | 0                    |

|                      |                      |                      |   |
|----------------------|----------------------|----------------------|---|
| chr1:5926518-5927090 | 0                    | 0                    | 0 |
| chr1:5927175-5927800 | 0                    | 0                    | 0 |
| chr1:5927956-5933312 | 0                    | 0                    | 0 |
| chr1:5933395-5934531 | 0                    | 0                    | 0 |
| chr1:5937358-5940174 | 0                    | 0                    | 0 |
| chr1:5940299-5947346 | 0                    | 0                    | 0 |
| chr1:5947526-5950928 | 0                    | 0                    | 0 |
| chr1:5951088-5964677 | 0                    | 0                    | 0 |
| chr1:5964864-5965352 | 0                    | 0                    | 0 |
| chr1:5965543-5965692 | 0                    | 0                    | 0 |
| chr1:5965843-5967175 | 0                    | 0                    | 0 |
| chr1:5967282-5969212 | 0                    | 0                    | 0 |
| chr1:5969273-5987709 | 0                    | 0                    | 0 |
| chr1:5987847-5993207 | 0                    | 0                    | 0 |
| chr1:5993389-6007164 | 0                    | 0                    | 0 |
| chr1:6007290-6008130 | 0                    | 0                    | 0 |
| chr1:6008311-6012760 | 0                    | 0                    | 0 |
| chr1:6012896-6021854 | 0                    | 0                    | 0 |
| chr1:6022009-6027359 | 0                    | 0                    | 0 |
| chr1:6027423-6029147 | 0                    | 0                    | 0 |
| chr1:6029319-6038330 | 0                    | 0                    | 0 |
| chr1:6038473-6046215 | 0                    | 0                    | 0 |
| chr1:6046387-6052304 | 0                    | 0                    | 0 |
| chr1:5934717-5934934 | 0                    | 0                    | 0 |
| chr1:5965840-5967175 | 0                    | 0                    | 0 |
| chr1:5936583-5937153 | 0                    | 0                    | 0 |
| chr1:5937358-5939406 | 0                    | 0                    | 0 |
| chr1:5939692-5940174 | 0                    | 0                    | 0 |
| chr1:5925333-5926433 | chr1:5926518-5927090 | chr1:5927175-5927800 |   |
| chr1:5923465-5923950 | 0                    | 0                    | 0 |
| chr1:5924093-5924398 | 0                    | 0                    | 0 |
| chr1:5924577-5925162 | 0                    | 0                    | 0 |
| chr1:5925333-5926433 | 1                    | 0                    | 0 |
| chr1:5926518-5927090 | 0                    | 1                    | 0 |
| chr1:5927175-5927800 | 0                    | 0                    | 1 |
| chr1:5927956-5933312 | 0                    | 0                    | 0 |
| chr1:5933395-5934531 | 0                    | 0                    | 0 |
| chr1:5937358-5940174 | 0                    | 0                    | 0 |
| chr1:5940299-5947346 | 0                    | 0                    | 0 |
| chr1:5947526-5950928 | 0                    | 0                    | 0 |
| chr1:5951088-5964677 | 0                    | 0                    | 0 |
| chr1:5964864-5965352 | 0                    | 0                    | 0 |
| chr1:5965543-5965692 | 0                    | 0                    | 0 |
| chr1:5965843-5967175 | 0                    | 0                    | 0 |
| chr1:5967282-5969212 | 0                    | 0                    | 0 |
| chr1:5969273-5987709 | 0                    | 0                    | 0 |
| chr1:5987847-5993207 | 0                    | 0                    | 0 |
| chr1:5993389-6007164 | 0                    | 0                    | 0 |
| chr1:6007290-6008130 | 0                    | 0                    | 0 |
| chr1:6008311-6012760 | 0                    | 0                    | 0 |
| chr1:6012896-6021854 | 0                    | 0                    | 0 |

|  |   |   |   |
|--|---|---|---|
| chr1:6022009-6027359   | 0 | 0 | 0 |
| chr1:6027423-6029147   | 0 | 0 | 0 |
| chr1:6029319-6038330   | 0 | 0 | 0 |
| chr1:6038473-6046215   | 0 | 0 | 0 |
| chr1:6046387-6052304   | 0 | 0 | 0 |
| chr1:5934717-5934934   | 0 | 0 | 0 |
| chr1:5965840-5967175   | 0 | 0 | 0 |
| chr1:5936583-5937153   | 0 | 0 | 0 |
| chr1:5937358-5939406   | 0 | 0 | 0 |
| chr1:5939692-5940174   | 0 | 0 | 0 |
| chr1:5927956-5933312 chr1:5933395-5934531 chr1:5937358-5940174 |   |   |   |
| chr1:5923465-5923950   | 0 | 0 | 0 |
| chr1:5924093-5924398   | 0 | 0 | 0 |
| chr1:5924577-5925162   | 0 | 0 | 0 |
| chr1:5925333-5926433   | 0 | 0 | 0 |
| chr1:5926518-5927090   | 0 | 0 | 0 |
| chr1:5927175-5927800   | 0 | 0 | 0 |
| chr1:5927956-5933312   | 1 | 0 | 0 |
| chr1:5933395-5934531   | 0 | 1 | 0 |
| chr1:5937358-5940174   | 0 | 0 | 1 |
| chr1:5940299-5947346   | 0 | 0 | 0 |
| chr1:5947526-5950928   | 0 | 0 | 0 |
| chr1:5951088-5964677   | 0 | 0 | 0 |
| chr1:5964864-5965352   | 0 | 0 | 0 |
| chr1:5965543-5965692   | 0 | 0 | 0 |
| chr1:5965843-5967175   | 0 | 0 | 0 |
| chr1:5967282-5969212   | 0 | 0 | 0 |
| chr1:5969273-5987709   | 0 | 0 | 0 |
| chr1:5987847-5993207   | 0 | 0 | 0 |
| chr1:5993389-6007164   | 0 | 0 | 0 |
| chr1:6007290-6008130   | 0 | 0 | 0 |
| chr1:6008311-6012760   | 0 | 0 | 0 |
| chr1:6012896-6021854   | 0 | 0 | 0 |
| chr1:6022009-6027359   | 0 | 0 | 0 |
| chr1:6027423-6029147   | 0 | 0 | 0 |
| chr1:6029319-6038330   | 0 | 0 | 0 |
| chr1:6038473-6046215   | 0 | 0 | 0 |
| chr1:6046387-6052304   | 0 | 0 | 0 |
| chr1:5934717-5934934   | 0 | 0 | 0 |
| chr1:5965840-5967175   | 0 | 0 | 0 |
| chr1:5936583-5937153   | 0 | 0 | 0 |
| chr1:5937358-5939406   | 0 | 0 | 1 |
| chr1:5939692-5940174   | 0 | 0 | 1 |
| chr1:5940299-5947346 chr1:5947526-5950928 chr1:5951088-5964677 |   |   |   |
| chr1:5923465-5923950   | 0 | 0 | 0 |
| chr1:5924093-5924398   | 0 | 0 | 0 |
| chr1:5924577-5925162   | 0 | 0 | 0 |
| chr1:5925333-5926433   | 0 | 0 | 0 |
| chr1:5926518-5927090   | 0 | 0 | 0 |
| chr1:5927175-5927800   | 0 | 0 | 0 |
| chr1:5927956-5933312   | 0 | 0 | 0 |

|  |   |   |   |
|--|---|---|---|
| chr1:5933395-5934531   | 0 | 0 | 0 |
| chr1:5937358-5940174   | 0 | 0 | 0 |
| chr1:5940299-5947346   | 1 | 0 | 0 |
| chr1:5947526-5950928   | 0 | 1 | 0 |
| chr1:5951088-5964677   | 0 | 0 | 1 |
| chr1:5964864-5965352   | 0 | 0 | 0 |
| chr1:5965543-5965692   | 0 | 0 | 0 |
| chr1:5965843-5967175   | 0 | 0 | 0 |
| chr1:5967282-5969212   | 0 | 0 | 0 |
| chr1:5969273-5987709   | 0 | 0 | 0 |
| chr1:5987847-5993207   | 0 | 0 | 0 |
| chr1:5993389-6007164   | 0 | 0 | 0 |
| chr1:6007290-6008130   | 0 | 0 | 0 |
| chr1:6008311-6012760   | 0 | 0 | 0 |
| chr1:6012896-6021854   | 0 | 0 | 0 |
| chr1:6022009-6027359   | 0 | 0 | 0 |
| chr1:6027423-6029147   | 0 | 0 | 0 |
| chr1:6029319-6038330   | 0 | 0 | 0 |
| chr1:6038473-6046215   | 0 | 0 | 0 |
| chr1:6046387-6052304   | 0 | 0 | 0 |
| chr1:5934717-5934934   | 0 | 0 | 0 |
| chr1:5965840-5967175   | 0 | 0 | 0 |
| chr1:5936583-5937153   | 0 | 0 | 0 |
| chr1:5937358-5939406   | 0 | 0 | 0 |
| chr1:5939692-5940174   | 0 | 0 | 0 |
| chr1:5964864-5965352 chr1:5965543-5965692 chr1:5965843-5967175 |   |   |   |
| chr1:5923465-5923950   | 0 | 0 | 0 |
| chr1:5924093-5924398   | 0 | 0 | 0 |
| chr1:5924577-5925162   | 0 | 0 | 0 |
| chr1:5925333-5926433   | 0 | 0 | 0 |
| chr1:5926518-5927090   | 0 | 0 | 0 |
| chr1:5927175-5927800   | 0 | 0 | 0 |
| chr1:5927956-5933312   | 0 | 0 | 0 |
| chr1:5933395-5934531   | 0 | 0 | 0 |
| chr1:5937358-5940174   | 0 | 0 | 0 |
| chr1:5940299-5947346   | 0 | 0 | 0 |
| chr1:5947526-5950928   | 0 | 0 | 0 |
| chr1:5951088-5964677   | 0 | 0 | 0 |
| chr1:5964864-5965352   | 1 | 0 | 0 |
| chr1:5965543-5965692   | 0 | 1 | 0 |
| chr1:5965843-5967175   | 0 | 0 | 1 |
| chr1:5967282-5969212   | 0 | 0 | 0 |
| chr1:5969273-5987709   | 0 | 0 | 0 |
| chr1:5987847-5993207   | 0 | 0 | 0 |
| chr1:5993389-6007164   | 0 | 0 | 0 |
| chr1:6007290-6008130   | 0 | 0 | 0 |
| chr1:6008311-6012760   | 0 | 0 | 0 |
| chr1:6012896-6021854   | 0 | 0 | 0 |
| chr1:6022009-6027359   | 0 | 0 | 0 |
| chr1:6027423-6029147   | 0 | 0 | 0 |
| chr1:6029319-6038330   | 0 | 0 | 0 |

|                      |                      |                      |   |
|----------------------|----------------------|----------------------|---|
| chr1:6038473-6046215 | 0                    | 0                    | 0 |
| chr1:6046387-6052304 | 0                    | 0                    | 0 |
| chr1:5934717-5934934 | 0                    | 0                    | 0 |
| chr1:5965840-5967175 | 0                    | 0                    | 1 |
| chr1:5936583-5937153 | 0                    | 0                    | 0 |
| chr1:5937358-5939406 | 0                    | 0                    | 0 |
| chr1:5939692-5940174 | 0                    | 0                    | 0 |
| chr1:5967282-5969212 | chr1:5969273-5987709 | chr1:5987847-5993207 |   |
| chr1:5923465-5923950 | 0                    | 0                    | 0 |
| chr1:5924093-5924398 | 0                    | 0                    | 0 |
| chr1:5924577-5925162 | 0                    | 0                    | 0 |
| chr1:5925333-5926433 | 0                    | 0                    | 0 |
| chr1:5926518-5927090 | 0                    | 0                    | 0 |
| chr1:5927175-5927800 | 0                    | 0                    | 0 |
| chr1:5927956-5933312 | 0                    | 0                    | 0 |
| chr1:5933395-5934531 | 0                    | 0                    | 0 |
| chr1:5937358-5940174 | 0                    | 0                    | 0 |
| chr1:5940299-5947346 | 0                    | 0                    | 0 |
| chr1:5947526-5950928 | 0                    | 0                    | 0 |
| chr1:5951088-5964677 | 0                    | 0                    | 0 |
| chr1:5964864-5965352 | 0                    | 0                    | 0 |
| chr1:5965543-5965692 | 0                    | 0                    | 0 |
| chr1:5965843-5967175 | 0                    | 0                    | 0 |
| chr1:5967282-5969212 | 1                    | 0                    | 0 |
| chr1:5969273-5987709 | 0                    | 1                    | 0 |
| chr1:5987847-5993207 | 0                    | 0                    | 1 |
| chr1:5993389-6007164 | 0                    | 0                    | 0 |
| chr1:6007290-6008130 | 0                    | 0                    | 0 |
| chr1:6008311-6012760 | 0                    | 0                    | 0 |
| chr1:6012896-6021854 | 0                    | 0                    | 0 |
| chr1:6022009-6027359 | 0                    | 0                    | 0 |
| chr1:6027423-6029147 | 0                    | 0                    | 0 |
| chr1:6029319-6038330 | 0                    | 0                    | 0 |
| chr1:6038473-6046215 | 0                    | 0                    | 0 |
| chr1:6046387-6052304 | 0                    | 0                    | 0 |
| chr1:5934717-5934934 | 0                    | 0                    | 0 |
| chr1:5965840-5967175 | 0                    | 0                    | 0 |
| chr1:5936583-5937153 | 0                    | 0                    | 0 |
| chr1:5937358-5939406 | 0                    | 0                    | 0 |
| chr1:5939692-5940174 | 0                    | 0                    | 0 |
| chr1:5993389-6007164 | chr1:6007290-6008130 | chr1:6008311-6012760 |   |
| chr1:5923465-5923950 | 0                    | 0                    | 0 |
| chr1:5924093-5924398 | 0                    | 0                    | 0 |
| chr1:5924577-5925162 | 0                    | 0                    | 0 |
| chr1:5925333-5926433 | 0                    | 0                    | 0 |
| chr1:5926518-5927090 | 0                    | 0                    | 0 |
| chr1:5927175-5927800 | 0                    | 0                    | 0 |
| chr1:5927956-5933312 | 0                    | 0                    | 0 |
| chr1:5933395-5934531 | 0                    | 0                    | 0 |
| chr1:5937358-5940174 | 0                    | 0                    | 0 |
| chr1:5940299-5947346 | 0                    | 0                    | 0 |

|                      |                      |                      |   |
|----------------------|----------------------|----------------------|---|
| chr1:5947526-5950928 | 0                    | 0                    | 0 |
| chr1:5951088-5964677 | 0                    | 0                    | 0 |
| chr1:5964864-5965352 | 0                    | 0                    | 0 |
| chr1:5965543-5965692 | 0                    | 0                    | 0 |
| chr1:5965843-5967175 | 0                    | 0                    | 0 |
| chr1:5967282-5969212 | 0                    | 0                    | 0 |
| chr1:5969273-5987709 | 0                    | 0                    | 0 |
| chr1:5987847-5993207 | 0                    | 0                    | 0 |
| chr1:5993389-6007164 | 1                    | 0                    | 0 |
| chr1:6007290-6008130 | 0                    | 1                    | 0 |
| chr1:6008311-6012760 | 0                    | 0                    | 1 |
| chr1:6012896-6021854 | 0                    | 0                    | 0 |
| chr1:6022009-6027359 | 0                    | 0                    | 0 |
| chr1:6027423-6029147 | 0                    | 0                    | 0 |
| chr1:6029319-6038330 | 0                    | 0                    | 0 |
| chr1:6038473-6046215 | 0                    | 0                    | 0 |
| chr1:6046387-6052304 | 0                    | 0                    | 0 |
| chr1:5934717-5934934 | 0                    | 0                    | 0 |
| chr1:5965840-5967175 | 0                    | 0                    | 0 |
| chr1:5936583-5937153 | 0                    | 0                    | 0 |
| chr1:5937358-5939406 | 0                    | 0                    | 0 |
| chr1:5939692-5940174 | 0                    | 0                    | 0 |
| chr1:6012896-6021854 | chr1:6022009-6027359 | chr1:6027423-6029147 |   |
| chr1:5923465-5923950 | 0                    | 0                    | 0 |
| chr1:5924093-5924398 | 0                    | 0                    | 0 |
| chr1:5924577-5925162 | 0                    | 0                    | 0 |
| chr1:5925333-5926433 | 0                    | 0                    | 0 |
| chr1:5926518-5927090 | 0                    | 0                    | 0 |
| chr1:5927175-5927800 | 0                    | 0                    | 0 |
| chr1:5927956-5933312 | 0                    | 0                    | 0 |
| chr1:5933395-5934531 | 0                    | 0                    | 0 |
| chr1:5937358-5940174 | 0                    | 0                    | 0 |
| chr1:5940299-5947346 | 0                    | 0                    | 0 |
| chr1:5947526-5950928 | 0                    | 0                    | 0 |
| chr1:5951088-5964677 | 0                    | 0                    | 0 |
| chr1:5964864-5965352 | 0                    | 0                    | 0 |
| chr1:5965543-5965692 | 0                    | 0                    | 0 |
| chr1:5965843-5967175 | 0                    | 0                    | 0 |
| chr1:5967282-5969212 | 0                    | 0                    | 0 |
| chr1:5969273-5987709 | 0                    | 0                    | 0 |
| chr1:5987847-5993207 | 0                    | 0                    | 0 |
| chr1:5993389-6007164 | 0                    | 0                    | 0 |
| chr1:6007290-6008130 | 0                    | 0                    | 0 |
| chr1:6008311-6012760 | 0                    | 0                    | 0 |
| chr1:6012896-6021854 | 1                    | 0                    | 0 |
| chr1:6022009-6027359 | 0                    | 1                    | 0 |
| chr1:6027423-6029147 | 0                    | 0                    | 1 |
| chr1:6029319-6038330 | 0                    | 0                    | 0 |
| chr1:6038473-6046215 | 0                    | 0                    | 0 |
| chr1:6046387-6052304 | 0                    | 0                    | 0 |
| chr1:5934717-5934934 | 0                    | 0                    | 0 |

|                      |   |   |   |
|----------------------|---|---|---|
| chr1:5965840-5967175 | 0 | 0 | 0 |
| chr1:5936583-5937153 | 0 | 0 | 0 |
| chr1:5937358-5939406 | 0 | 0 | 0 |
| chr1:5939692-5940174 | 0 | 0 | 0 |
| chr1:5923465-5923950 | 0 | 0 | 0 |
| chr1:5924093-5924398 | 0 | 0 | 0 |
| chr1:5924577-5925162 | 0 | 0 | 0 |
| chr1:5925333-5926433 | 0 | 0 | 0 |
| chr1:5926518-5927090 | 0 | 0 | 0 |
| chr1:5927175-5927800 | 0 | 0 | 0 |
| chr1:5927956-5933312 | 0 | 0 | 0 |
| chr1:5933395-5934531 | 0 | 0 | 0 |
| chr1:5937358-5940174 | 0 | 0 | 0 |
| chr1:5940299-5947346 | 0 | 0 | 0 |
| chr1:5947526-5950928 | 0 | 0 | 0 |
| chr1:5951088-5964677 | 0 | 0 | 0 |
| chr1:5964864-5965352 | 0 | 0 | 0 |
| chr1:5965543-5965692 | 0 | 0 | 0 |
| chr1:5965843-5967175 | 0 | 0 | 0 |
| chr1:5967282-5969212 | 0 | 0 | 0 |
| chr1:5969273-5987709 | 0 | 0 | 0 |
| chr1:5987847-5993207 | 0 | 0 | 0 |
| chr1:5993389-6007164 | 0 | 0 | 0 |
| chr1:6007290-6008130 | 0 | 0 | 0 |
| chr1:6008311-6012760 | 0 | 0 | 0 |
| chr1:6012896-6021854 | 0 | 0 | 0 |
| chr1:6022009-6027359 | 0 | 0 | 0 |
| chr1:6027423-6029147 | 0 | 0 | 0 |
| chr1:6029319-6038330 | 1 | 0 | 0 |
| chr1:6038473-6046215 | 0 | 1 | 0 |
| chr1:6046387-6052304 | 0 | 0 | 1 |
| chr1:5934717-5934934 | 0 | 0 | 0 |
| chr1:5965840-5967175 | 0 | 0 | 0 |
| chr1:5936583-5937153 | 0 | 0 | 0 |
| chr1:5937358-5939406 | 0 | 0 | 0 |
| chr1:5939692-5940174 | 0 | 0 | 0 |
| chr1:5923465-5923950 | 0 | 0 | 0 |
| chr1:5924093-5924398 | 0 | 0 | 0 |
| chr1:5924577-5925162 | 0 | 0 | 0 |
| chr1:5925333-5926433 | 0 | 0 | 0 |
| chr1:5926518-5927090 | 0 | 0 | 0 |
| chr1:5927175-5927800 | 0 | 0 | 0 |
| chr1:5927956-5933312 | 0 | 0 | 0 |
| chr1:5933395-5934531 | 0 | 0 | 0 |
| chr1:5937358-5940174 | 0 | 0 | 0 |
| chr1:5940299-5947346 | 0 | 0 | 0 |
| chr1:5947526-5950928 | 0 | 0 | 0 |
| chr1:5951088-5964677 | 0 | 0 | 0 |
| chr1:5964864-5965352 | 0 | 0 | 0 |



|   |   |   |   |
|---|---|---|---|
| chr1:5965543-5965692                      | 0 | 0 | 0 |
| chr1:5965843-5967175                      | 0 | 1 | 0 |
| chr1:5967282-5969212                      | 0 | 0 | 0 |
| chr1:5969273-5987709                      | 0 | 0 | 0 |
| chr1:5987847-5993207                      | 0 | 0 | 0 |
| chr1:5993389-6007164                      | 0 | 0 | 0 |
| chr1:6007290-6008130                      | 0 | 0 | 0 |
| chr1:6008311-6012760                      | 0 | 0 | 0 |
| chr1:6012896-6021854                      | 0 | 0 | 0 |
| chr1:6022009-6027359                      | 0 | 0 | 0 |
| chr1:6027423-6029147                      | 0 | 0 | 0 |
| chr1:6029319-6038330                      | 0 | 0 | 0 |
| chr1:6038473-6046215                      | 0 | 0 | 0 |
| chr1:6046387-6052304                      | 0 | 0 | 0 |
| chr1:5934717-5934934                      | 1 | 0 | 0 |
| chr1:5965840-5967175                      | 0 | 1 | 0 |
| chr1:5936583-5937153                      | 0 | 0 | 1 |
| chr1:5937358-5939406                      | 0 | 0 | 0 |
| chr1:5939692-5940174                      | 0 | 0 | 0 |
| chr1:5937358-5939406 chr1:5939692-5940174 |   |   |   |
| chr1:5923465-5923950                      | 0 | 0 |   |
| chr1:5924093-5924398                      | 0 | 0 |   |
| chr1:5924577-5925162                      | 0 | 0 |   |
| chr1:5925333-5926433                      | 0 | 0 |   |
| chr1:5926518-5927090                      | 0 | 0 |   |
| chr1:5927175-5927800                      | 0 | 0 |   |
| chr1:5927956-5933312                      | 0 | 0 |   |
| chr1:5933395-5934531                      | 0 | 0 |   |
| chr1:5937358-5940174                      | 1 | 1 |   |
| chr1:5940299-5947346                      | 0 | 0 |   |
| chr1:5947526-5950928                      | 0 | 0 |   |
| chr1:5951088-5964677                      | 0 | 0 |   |
| chr1:5964864-5965352                      | 0 | 0 |   |
| chr1:5965543-5965692                      | 0 | 0 |   |
| chr1:5965843-5967175                      | 0 | 0 |   |
| chr1:5967282-5969212                      | 0 | 0 |   |
| chr1:5969273-5987709                      | 0 | 0 |   |
| chr1:5987847-5993207                      | 0 | 0 |   |
| chr1:5993389-6007164                      | 0 | 0 |   |
| chr1:6007290-6008130                      | 0 | 0 |   |
| chr1:6008311-6012760                      | 0 | 0 |   |
| chr1:6012896-6021854                      | 0 | 0 |   |
| chr1:6022009-6027359                      | 0 | 0 |   |
| chr1:6027423-6029147                      | 0 | 0 |   |
| chr1:6029319-6038330                      | 0 | 0 |   |
| chr1:6038473-6046215                      | 0 | 0 |   |
| chr1:6046387-6052304                      | 0 | 0 |   |
| chr1:5934717-5934934                      | 0 | 0 |   |
| chr1:5965840-5967175                      | 0 | 0 |   |
| chr1:5936583-5937153                      | 0 | 0 |   |
| chr1:5937358-5939406                      | 1 | 0 |   |

|                      |   |   |
|----------------------|---|---|
| chr1:5939692-5940174 | 0 | 1 |
|----------------------|---|---|

\$Rest\$PEX14

|                        |                        |                        |
|------------------------|------------------------|------------------------|
|                        | chr1:10637247-10637871 | chr1:10659423-10678389 |
| chr1:10637247-10637871 | 1                      | 0                      |
| chr1:10659423-10678389 | 0                      | 1                      |
| chr1:10678474-10683076 | 0                      | 0                      |
| chr1:10683178-10684397 | 0                      | 0                      |
| chr1:10684494-10687329 | 0                      | 0                      |
| chr1:10687420-10689588 | 0                      | 0                      |
| chr1:10596354-10659295 | 1                      | 0                      |
| chr1:10596354-10678389 | 1                      | 1                      |
|                        | chr1:10678474-10683076 | chr1:10683178-10684397 |
| chr1:10637247-10637871 | 0                      | 0                      |
| chr1:10659423-10678389 | 0                      | 0                      |
| chr1:10678474-10683076 | 1                      | 0                      |
| chr1:10683178-10684397 | 0                      | 1                      |
| chr1:10684494-10687329 | 0                      | 0                      |
| chr1:10687420-10689588 | 0                      | 0                      |
| chr1:10596354-10659295 | 0                      | 0                      |
| chr1:10596354-10678389 | 0                      | 0                      |
|                        | chr1:10684494-10687329 | chr1:10687420-10689588 |
| chr1:10637247-10637871 | 0                      | 0                      |
| chr1:10659423-10678389 | 0                      | 0                      |
| chr1:10678474-10683076 | 0                      | 0                      |
| chr1:10683178-10684397 | 0                      | 0                      |
| chr1:10684494-10687329 | 1                      | 0                      |
| chr1:10687420-10689588 | 0                      | 1                      |
| chr1:10596354-10659295 | 0                      | 0                      |
| chr1:10596354-10678389 | 0                      | 0                      |
|                        | chr1:10596354-10659295 | chr1:10596354-10678389 |
| chr1:10637247-10637871 | 1                      | 1                      |
| chr1:10659423-10678389 | 0                      | 1                      |
| chr1:10678474-10683076 | 0                      | 0                      |
| chr1:10683178-10684397 | 0                      | 0                      |
| chr1:10684494-10687329 | 0                      | 0                      |
| chr1:10687420-10689588 | 0                      | 0                      |
| chr1:10596354-10659295 | 1                      | 1                      |
| chr1:10596354-10678389 | 1                      | 1                      |

\$Rest\$PIP5K1A

|                          |                          |                          |
|--------------------------|--------------------------|--------------------------|
|                          | chr1:151171557-151196721 | chr1:151171557-151196724 |
| chr1:151171557-151196721 | 1                        | 1                        |
| chr1:151171557-151196724 | 1                        | 1                        |
| chr1:151196755-151199796 | 0                        | 0                        |
| chr1:151199876-151204147 | 0                        | 0                        |
| chr1:151204277-151204724 | 0                        | 0                        |
| chr1:151204841-151205027 | 0                        | 0                        |
| chr1:151205179-151206673 | 0                        | 0                        |
| chr1:151206972-151209034 | 0                        | 0                        |
| chr1:151209239-151210658 | 0                        | 0                        |

|                          |                          |   |
|--------------------------|--------------------------|---|
| chr1:151209239-151211606 | 0                        | 0 |
| chr1:151210741-151211606 | 0                        | 0 |
| chr1:151211654-151212431 | 0                        | 0 |
| chr1:151212515-151214599 | 0                        | 0 |
| chr1:151212515-151219396 | 0                        | 0 |
| chr1:151214745-151214914 | 0                        | 0 |
| chr1:151215043-151219396 | 0                        | 0 |
| chr1:151219441-151220339 | 0                        | 0 |
| chr1:151196755-151196847 | 0                        | 0 |
| chr1:151196882-151199796 | 0                        | 0 |
| chr1:151212515-151214914 | 0                        | 0 |
| chr1:151196755-151199796 | chr1:151199876-151204147 |   |
| chr1:151171557-151196721 | 0                        | 0 |
| chr1:151171557-151196724 | 0                        | 0 |
| chr1:151196755-151199796 | 1                        | 0 |
| chr1:151199876-151204147 | 0                        | 1 |
| chr1:151204277-151204724 | 0                        | 0 |
| chr1:151204841-151205027 | 0                        | 0 |
| chr1:151205179-151206673 | 0                        | 0 |
| chr1:151206972-151209034 | 0                        | 0 |
| chr1:151209239-151210658 | 0                        | 0 |
| chr1:151209239-151211606 | 0                        | 0 |
| chr1:151210741-151211606 | 0                        | 0 |
| chr1:151211654-151212431 | 0                        | 0 |
| chr1:151212515-151214599 | 0                        | 0 |
| chr1:151212515-151219396 | 0                        | 0 |
| chr1:151214745-151214914 | 0                        | 0 |
| chr1:151215043-151219396 | 0                        | 0 |
| chr1:151219441-151220339 | 0                        | 0 |
| chr1:151196755-151196847 | 1                        | 0 |
| chr1:151196882-151199796 | 1                        | 0 |
| chr1:151212515-151214914 | 0                        | 0 |
| chr1:151204277-151204724 | chr1:151204841-151205027 |   |
| chr1:151171557-151196721 | 0                        | 0 |
| chr1:151171557-151196724 | 0                        | 0 |
| chr1:151196755-151199796 | 0                        | 0 |
| chr1:151199876-151204147 | 0                        | 0 |
| chr1:151204277-151204724 | 1                        | 0 |
| chr1:151204841-151205027 | 0                        | 1 |
| chr1:151205179-151206673 | 0                        | 0 |
| chr1:151206972-151209034 | 0                        | 0 |
| chr1:151209239-151210658 | 0                        | 0 |
| chr1:151209239-151211606 | 0                        | 0 |
| chr1:151210741-151211606 | 0                        | 0 |
| chr1:151211654-151212431 | 0                        | 0 |
| chr1:151212515-151214599 | 0                        | 0 |
| chr1:151212515-151219396 | 0                        | 0 |
| chr1:151214745-151214914 | 0                        | 0 |
| chr1:151215043-151219396 | 0                        | 0 |
| chr1:151219441-151220339 | 0                        | 0 |
| chr1:151196755-151196847 | 0                        | 0 |

|                          |                          |   |
|--------------------------|--------------------------|---|
| chr1:151196882-151199796 | 0                        | 0 |
| chr1:151212515-151214914 | 0                        | 0 |
| chr1:151205179-151206673 | chr1:151206972-151209034 |   |
| chr1:151171557-151196721 | 0                        | 0 |
| chr1:151171557-151196724 | 0                        | 0 |
| chr1:151196755-151199796 | 0                        | 0 |
| chr1:151199876-151204147 | 0                        | 0 |
| chr1:151204277-151204724 | 0                        | 0 |
| chr1:151204841-151205027 | 0                        | 0 |
| chr1:151205179-151206673 | 1                        | 0 |
| chr1:151206972-151209034 | 0                        | 1 |
| chr1:151209239-151210658 | 0                        | 0 |
| chr1:151209239-151211606 | 0                        | 0 |
| chr1:151210741-151211606 | 0                        | 0 |
| chr1:151211654-151212431 | 0                        | 0 |
| chr1:151212515-151214599 | 0                        | 0 |
| chr1:151212515-151219396 | 0                        | 0 |
| chr1:151214745-151214914 | 0                        | 0 |
| chr1:151215043-151219396 | 0                        | 0 |
| chr1:151219441-151220339 | 0                        | 0 |
| chr1:151196755-151196847 | 0                        | 0 |
| chr1:151196882-151199796 | 0                        | 0 |
| chr1:151212515-151214914 | 0                        | 0 |
| chr1:151209239-151210658 | chr1:151209239-151211606 |   |
| chr1:151171557-151196721 | 0                        | 0 |
| chr1:151171557-151196724 | 0                        | 0 |
| chr1:151196755-151199796 | 0                        | 0 |
| chr1:151199876-151204147 | 0                        | 0 |
| chr1:151204277-151204724 | 0                        | 0 |
| chr1:151204841-151205027 | 0                        | 0 |
| chr1:151205179-151206673 | 0                        | 0 |
| chr1:151206972-151209034 | 0                        | 0 |
| chr1:151209239-151210658 | 1                        | 1 |
| chr1:151209239-151211606 | 1                        | 1 |
| chr1:151210741-151211606 | 0                        | 1 |
| chr1:151211654-151212431 | 0                        | 0 |
| chr1:151212515-151214599 | 0                        | 0 |
| chr1:151212515-151219396 | 0                        | 0 |
| chr1:151214745-151214914 | 0                        | 0 |
| chr1:151215043-151219396 | 0                        | 0 |
| chr1:151219441-151220339 | 0                        | 0 |
| chr1:151196755-151196847 | 0                        | 0 |
| chr1:151196882-151199796 | 0                        | 0 |
| chr1:151212515-151214914 | 0                        | 0 |
| chr1:151210741-151211606 | chr1:151211654-151212431 |   |
| chr1:151171557-151196721 | 0                        | 0 |
| chr1:151171557-151196724 | 0                        | 0 |
| chr1:151196755-151199796 | 0                        | 0 |
| chr1:151199876-151204147 | 0                        | 0 |
| chr1:151204277-151204724 | 0                        | 0 |
| chr1:151204841-151205027 | 0                        | 0 |

|   |   |   |
|---|---|---|
| chr1:151205179-151206673                          | 0 | 0 |
| chr1:151206972-151209034                          | 0 | 0 |
| chr1:151209239-151210658                          | 0 | 0 |
| chr1:151209239-151211606                          | 1 | 0 |
| chr1:151210741-151211606                          | 1 | 0 |
| chr1:151211654-151212431                          | 0 | 1 |
| chr1:151212515-151214599                          | 0 | 0 |
| chr1:151212515-151219396                          | 0 | 0 |
| chr1:151214745-151214914                          | 0 | 0 |
| chr1:151215043-151219396                          | 0 | 0 |
| chr1:151219441-151220339                          | 0 | 0 |
| chr1:151196755-151196847                          | 0 | 0 |
| chr1:151196882-151199796                          | 0 | 0 |
| chr1:151212515-151214914                          | 0 | 0 |
| chr1:151212515-151214599 chr1:151212515-151219396 |   |   |
| chr1:151171557-151196721                          | 0 | 0 |
| chr1:151171557-151196724                          | 0 | 0 |
| chr1:151196755-151199796                          | 0 | 0 |
| chr1:151199876-151204147                          | 0 | 0 |
| chr1:151204277-151204724                          | 0 | 0 |
| chr1:151204841-151205027                          | 0 | 0 |
| chr1:151205179-151206673                          | 0 | 0 |
| chr1:151206972-151209034                          | 0 | 0 |
| chr1:151209239-151210658                          | 0 | 0 |
| chr1:151209239-151211606                          | 0 | 0 |
| chr1:151210741-151211606                          | 0 | 0 |
| chr1:151211654-151212431                          | 0 | 0 |
| chr1:151212515-151214599                          | 1 | 1 |
| chr1:151212515-151219396                          | 1 | 1 |
| chr1:151214745-151214914                          | 0 | 1 |
| chr1:151215043-151219396                          | 0 | 1 |
| chr1:151219441-151220339                          | 0 | 0 |
| chr1:151196755-151196847                          | 0 | 0 |
| chr1:151196882-151199796                          | 0 | 0 |
| chr1:151212515-151214914                          | 1 | 1 |
| chr1:151214745-151214914 chr1:151215043-151219396 |   |   |
| chr1:151171557-151196721                          | 0 | 0 |
| chr1:151171557-151196724                          | 0 | 0 |
| chr1:151196755-151199796                          | 0 | 0 |
| chr1:151199876-151204147                          | 0 | 0 |
| chr1:151204277-151204724                          | 0 | 0 |
| chr1:151204841-151205027                          | 0 | 0 |
| chr1:151205179-151206673                          | 0 | 0 |
| chr1:151206972-151209034                          | 0 | 0 |
| chr1:151209239-151210658                          | 0 | 0 |
| chr1:151209239-151211606                          | 0 | 0 |
| chr1:151210741-151211606                          | 0 | 0 |
| chr1:151211654-151212431                          | 0 | 0 |
| chr1:151212515-151214599                          | 0 | 0 |
| chr1:151212515-151219396                          | 1 | 1 |
| chr1:151214745-151214914                          | 1 | 0 |

|                          |                          |   |
|--------------------------|--------------------------|---|
| chr1:151215043-151219396 | 0                        | 1 |
| chr1:151219441-151220339 | 0                        | 0 |
| chr1:151196755-151196847 | 0                        | 0 |
| chr1:151196882-151199796 | 0                        | 0 |
| chr1:151212515-151214914 | 1                        | 0 |
| chr1:151219441-151220339 | chr1:151196755-151196847 |   |
| chr1:151171557-151196721 | 0                        | 0 |
| chr1:151171557-151196724 | 0                        | 0 |
| chr1:151196755-151199796 | 0                        | 1 |
| chr1:151199876-151204147 | 0                        | 0 |
| chr1:151204277-151204724 | 0                        | 0 |
| chr1:151204841-151205027 | 0                        | 0 |
| chr1:151205179-151206673 | 0                        | 0 |
| chr1:151206972-151209034 | 0                        | 0 |
| chr1:151209239-151210658 | 0                        | 0 |
| chr1:151209239-151211606 | 0                        | 0 |
| chr1:151210741-151211606 | 0                        | 0 |
| chr1:151211654-151212431 | 0                        | 0 |
| chr1:151212515-151214599 | 0                        | 0 |
| chr1:151212515-151219396 | 0                        | 0 |
| chr1:151214745-151214914 | 0                        | 0 |
| chr1:151215043-151219396 | 0                        | 0 |
| chr1:151219441-151220339 | 1                        | 0 |
| chr1:151196755-151196847 | 0                        | 1 |
| chr1:151196882-151199796 | 0                        | 0 |
| chr1:151212515-151214914 | 0                        | 0 |
| chr1:151196882-151199796 | chr1:151212515-151214914 |   |
| chr1:151171557-151196721 | 0                        | 0 |
| chr1:151171557-151196724 | 0                        | 0 |
| chr1:151196755-151199796 | 1                        | 0 |
| chr1:151199876-151204147 | 0                        | 0 |
| chr1:151204277-151204724 | 0                        | 0 |
| chr1:151204841-151205027 | 0                        | 0 |
| chr1:151205179-151206673 | 0                        | 0 |
| chr1:151206972-151209034 | 0                        | 0 |
| chr1:151209239-151210658 | 0                        | 0 |
| chr1:151209239-151211606 | 0                        | 0 |
| chr1:151210741-151211606 | 0                        | 0 |
| chr1:151211654-151212431 | 0                        | 0 |
| chr1:151212515-151214599 | 0                        | 1 |
| chr1:151212515-151219396 | 0                        | 1 |
| chr1:151214745-151214914 | 0                        | 1 |
| chr1:151215043-151219396 | 0                        | 0 |
| chr1:151219441-151220339 | 0                        | 0 |
| chr1:151196755-151196847 | 0                        | 0 |
| chr1:151196882-151199796 | 1                        | 0 |
| chr1:151212515-151214914 | 0                        | 1 |
| \$Rest\$PSMB2            |                          |   |
| chr1:36040299-36042923   | chr1:36068975-36070834   |   |
| chr1:36040299-36042923   | 1                        | 0 |

|   |   |   |
|---|---|---|
| chr1:36068975-36070834                        | 0 | 1 |
| chr1:36070883-36074847                        | 0 | 0 |
| chr1:36075009-36096875                        | 0 | 0 |
| chr1:36096945-36101911                        | 0 | 0 |
| chr1:36102033-36106943                        | 0 | 0 |
| chr1:36043093-36070834                        | 0 | 1 |
| chr1:36070883-36074847 chr1:36075009-36096875 |   |   |
| chr1:36040299-36042923                        | 0 | 0 |
| chr1:36068975-36070834                        | 0 | 0 |
| chr1:36070883-36074847                        | 1 | 0 |
| chr1:36075009-36096875                        | 0 | 1 |
| chr1:36096945-36101911                        | 0 | 0 |
| chr1:36102033-36106943                        | 0 | 0 |
| chr1:36043093-36070834                        | 0 | 0 |
| chr1:36096945-36101911 chr1:36102033-36106943 |   |   |
| chr1:36040299-36042923                        | 0 | 0 |
| chr1:36068975-36070834                        | 0 | 0 |
| chr1:36070883-36074847                        | 0 | 0 |
| chr1:36075009-36096875                        | 0 | 0 |
| chr1:36096945-36101911                        | 1 | 0 |
| chr1:36102033-36106943                        | 0 | 1 |
| chr1:36043093-36070834                        | 0 | 0 |
| chr1:36043093-36070834                        |   |   |
| chr1:36040299-36042923                        | 0 |   |
| chr1:36068975-36070834                        | 1 |   |
| chr1:36070883-36074847                        | 0 |   |
| chr1:36075009-36096875                        | 0 |   |
| chr1:36096945-36101911                        | 0 |   |
| chr1:36102033-36106943                        | 0 |   |
| chr1:36043093-36070834                        | 1 |   |
| \$Rest\$RBBP4                                 |   |   |
| chr1:33116923-33117515 chr1:33117662-33123028 |   |   |
| chr1:33116923-33117515                        | 1 | 0 |
| chr1:33117662-33123028                        | 0 | 1 |
| chr1:33123173-33133826                        | 0 | 0 |
| chr1:33133999-33134340                        | 0 | 0 |
| chr1:33134455-33134573                        | 0 | 0 |
| chr1:33134733-33134832                        | 0 | 0 |
| chr1:33134958-33135087                        | 0 | 0 |
| chr1:33135164-33138051                        | 0 | 0 |
| chr1:33138127-33138243                        | 0 | 0 |
| chr1:33138300-33138392                        | 0 | 0 |
| chr1:33138502-33145241                        | 0 | 0 |
| chr1:33116923-33117518                        | 1 | 0 |
| chr1:33123173-33133826 chr1:33133999-33134340 |   |   |
| chr1:33116923-33117515                        | 0 | 0 |
| chr1:33117662-33123028                        | 0 | 0 |
| chr1:33123173-33133826                        | 1 | 0 |
| chr1:33133999-33134340                        | 0 | 1 |
| chr1:33134455-33134573                        | 0 | 0 |

|                        |   |   |
|------------------------|---|---|
| chr1:33134733-33134832 | 0 | 0 |
| chr1:33134958-33135087 | 0 | 0 |
| chr1:33135164-33138051 | 0 | 0 |
| chr1:33138127-33138243 | 0 | 0 |
| chr1:33138300-33138392 | 0 | 0 |
| chr1:33138502-33145241 | 0 | 0 |
| chr1:33116923-33117518 | 0 | 0 |
| chr1:33116923-33117515 | 0 | 0 |
| chr1:33117662-33123028 | 0 | 0 |
| chr1:33123173-33133826 | 0 | 0 |
| chr1:33133999-33134340 | 0 | 0 |
| chr1:33134455-33134573 | 1 | 0 |
| chr1:33134733-33134832 | 0 | 1 |
| chr1:33134958-33135087 | 0 | 0 |
| chr1:33135164-33138051 | 0 | 0 |
| chr1:33138127-33138243 | 0 | 0 |
| chr1:33138300-33138392 | 0 | 0 |
| chr1:33138502-33145241 | 0 | 0 |
| chr1:33116923-33117518 | 0 | 0 |
| chr1:33116923-33117515 | 0 | 0 |
| chr1:33117662-33123028 | 0 | 0 |
| chr1:33123173-33133826 | 0 | 0 |
| chr1:33133999-33134340 | 0 | 0 |
| chr1:33134455-33134573 | 0 | 0 |
| chr1:33134733-33134832 | 0 | 0 |
| chr1:33134958-33135087 | 1 | 0 |
| chr1:33135164-33138051 | 0 | 1 |
| chr1:33138127-33138243 | 0 | 0 |
| chr1:33138300-33138392 | 0 | 0 |
| chr1:33138502-33145241 | 0 | 0 |
| chr1:33116923-33117518 | 0 | 0 |
| chr1:33116923-33117515 | 0 | 0 |
| chr1:33117662-33123028 | 0 | 0 |
| chr1:33123173-33133826 | 0 | 0 |
| chr1:33133999-33134340 | 0 | 0 |
| chr1:33134455-33134573 | 0 | 0 |
| chr1:33134733-33134832 | 0 | 0 |
| chr1:33134958-33135087 | 0 | 0 |
| chr1:33135164-33138051 | 0 | 0 |
| chr1:33138127-33138243 | 1 | 0 |
| chr1:33138300-33138392 | 0 | 1 |
| chr1:33138502-33145241 | 0 | 0 |
| chr1:33116923-33117518 | 0 | 0 |
| chr1:33116923-33117515 | 0 | 0 |
| chr1:33117662-33123028 | 0 | 0 |
| chr1:33123173-33133826 | 0 | 0 |
| chr1:33133999-33134340 | 0 | 0 |
| chr1:33134455-33134573 | 0 | 0 |
| chr1:33134733-33134832 | 0 | 0 |
| chr1:33134958-33135087 | 0 | 0 |
| chr1:33135164-33138051 | 0 | 0 |
| chr1:33138127-33138243 | 1 | 0 |
| chr1:33138300-33138392 | 0 | 1 |
| chr1:33138502-33145241 | 0 | 0 |
| chr1:33116923-33117518 | 0 | 0 |
| chr1:33116923-33117515 | 0 | 1 |
| chr1:33117662-33123028 | 0 | 0 |
| chr1:33123173-33133826 | 0 | 0 |
| chr1:33133999-33134340 | 0 | 0 |



|                        |   |   |
|------------------------|---|---|
| chr1:33134455-33134573 | 0 | 0 |
| chr1:33134733-33134832 | 0 | 0 |
| chr1:33134958-33135087 | 0 | 0 |
| chr1:33135164-33138051 | 0 | 0 |
| chr1:33138127-33138243 | 0 | 0 |
| chr1:33138300-33138392 | 0 | 0 |
| chr1:33138502-33145241 | 1 | 0 |
| chr1:33116923-33117518 | 0 | 1 |

\$Rest\$RBBP5

|                          |                          |                          |
|--------------------------|--------------------------|--------------------------|
|                          | chr1:205057943-205064001 | chr1:205057943-205064115 |
| chr1:205057943-205064001 | 1                        | 1                        |
| chr1:205057943-205064115 | 1                        | 1                        |
| chr1:205064192-205065810 | 0                        | 0                        |
| chr1:205066039-205066454 | 0                        | 0                        |
| chr1:205066523-205068117 | 0                        | 0                        |
| chr1:205068234-205068869 | 0                        | 0                        |
| chr1:205068940-205069039 | 0                        | 0                        |
| chr1:205069192-205069280 | 0                        | 0                        |
| chr1:205069399-205070728 | 0                        | 0                        |
| chr1:205070837-205072985 | 0                        | 0                        |
| chr1:205073147-205074156 | 0                        | 0                        |
| chr1:205074296-205083917 | 0                        | 0                        |
| chr1:205084033-205084986 | 0                        | 0                        |
| chr1:205084089-205084986 | 0                        | 0                        |
| chr1:205085011-205090983 | 0                        | 0                        |
| chr1:205057940-205064001 | 1                        | 1                        |
|                          | chr1:205064192-205065810 | chr1:205066039-205066454 |
| chr1:205057943-205064001 | 0                        | 0                        |
| chr1:205057943-205064115 | 0                        | 0                        |
| chr1:205064192-205065810 | 1                        | 0                        |
| chr1:205066039-205066454 | 0                        | 1                        |
| chr1:205066523-205068117 | 0                        | 0                        |
| chr1:205068234-205068869 | 0                        | 0                        |
| chr1:205068940-205069039 | 0                        | 0                        |
| chr1:205069192-205069280 | 0                        | 0                        |
| chr1:205069399-205070728 | 0                        | 0                        |
| chr1:205070837-205072985 | 0                        | 0                        |
| chr1:205073147-205074156 | 0                        | 0                        |
| chr1:205074296-205083917 | 0                        | 0                        |
| chr1:205084033-205084986 | 0                        | 0                        |
| chr1:205084089-205084986 | 0                        | 0                        |
| chr1:205085011-205090983 | 0                        | 0                        |
| chr1:205057940-205064001 | 0                        | 0                        |
|                          | chr1:205066523-205068117 | chr1:205068234-205068869 |
| chr1:205057943-205064001 | 0                        | 0                        |
| chr1:205057943-205064115 | 0                        | 0                        |
| chr1:205064192-205065810 | 0                        | 0                        |
| chr1:205066039-205066454 | 0                        | 0                        |
| chr1:205066523-205068117 | 1                        | 0                        |
| chr1:205068234-205068869 | 0                        | 1                        |

|                          |                          |   |
|--------------------------|--------------------------|---|
| chr1:205068940-205069039 | 0                        | 0 |
| chr1:205069192-205069280 | 0                        | 0 |
| chr1:205069399-205070728 | 0                        | 0 |
| chr1:205070837-205072985 | 0                        | 0 |
| chr1:205073147-205074156 | 0                        | 0 |
| chr1:205074296-205083917 | 0                        | 0 |
| chr1:205084033-205084986 | 0                        | 0 |
| chr1:205084089-205084986 | 0                        | 0 |
| chr1:205085011-205090983 | 0                        | 0 |
| chr1:205057940-205064001 | 0                        | 0 |
| chr1:205068940-205069039 | chr1:205069192-205069280 |   |
| chr1:205057943-205064001 | 0                        | 0 |
| chr1:205057943-205064115 | 0                        | 0 |
| chr1:205064192-205065810 | 0                        | 0 |
| chr1:205066039-205066454 | 0                        | 0 |
| chr1:205066523-205068117 | 0                        | 0 |
| chr1:205068234-205068869 | 0                        | 0 |
| chr1:205068940-205069039 | 1                        | 0 |
| chr1:205069192-205069280 | 0                        | 1 |
| chr1:205069399-205070728 | 0                        | 0 |
| chr1:205070837-205072985 | 0                        | 0 |
| chr1:205073147-205074156 | 0                        | 0 |
| chr1:205074296-205083917 | 0                        | 0 |
| chr1:205084033-205084986 | 0                        | 0 |
| chr1:205084089-205084986 | 0                        | 0 |
| chr1:205085011-205090983 | 0                        | 0 |
| chr1:205057940-205064001 | 0                        | 0 |
| chr1:205069399-205070728 | chr1:205070837-205072985 |   |
| chr1:205057943-205064001 | 0                        | 0 |
| chr1:205057943-205064115 | 0                        | 0 |
| chr1:205064192-205065810 | 0                        | 0 |
| chr1:205066039-205066454 | 0                        | 0 |
| chr1:205066523-205068117 | 0                        | 0 |
| chr1:205068234-205068869 | 0                        | 0 |
| chr1:205068940-205069039 | 0                        | 0 |
| chr1:205069192-205069280 | 0                        | 0 |
| chr1:205069399-205070728 | 1                        | 0 |
| chr1:205070837-205072985 | 0                        | 1 |
| chr1:205073147-205074156 | 0                        | 0 |
| chr1:205074296-205083917 | 0                        | 0 |
| chr1:205084033-205084986 | 0                        | 0 |
| chr1:205084089-205084986 | 0                        | 0 |
| chr1:205085011-205090983 | 0                        | 0 |
| chr1:205057940-205064001 | 0                        | 0 |
| chr1:205073147-205074156 | chr1:205074296-205083917 |   |
| chr1:205057943-205064001 | 0                        | 0 |
| chr1:205057943-205064115 | 0                        | 0 |
| chr1:205064192-205065810 | 0                        | 0 |
| chr1:205066039-205066454 | 0                        | 0 |
| chr1:205066523-205068117 | 0                        | 0 |
| chr1:205068234-205068869 | 0                        | 0 |

|  |   |   |
|--|---|---|
| chr1:205068940-205069039                                       | 0 | 0 |
| chr1:205069192-205069280                                       | 0 | 0 |
| chr1:205069399-205070728                                       | 0 | 0 |
| chr1:205070837-205072985                                       | 0 | 0 |
| chr1:205073147-205074156                                       | 1 | 0 |
| chr1:205074296-205083917                                       | 0 | 1 |
| chr1:205084033-205084986                                       | 0 | 0 |
| chr1:205084089-205084986                                       | 0 | 0 |
| chr1:205085011-205090983                                       | 0 | 0 |
| chr1:205057940-205064001                                       | 0 | 0 |
| chr1:205084033-205084986 chr1:205084089-205084986              |   |   |
| chr1:205057943-205064001                                       | 0 | 0 |
| chr1:205057943-205064115                                       | 0 | 0 |
| chr1:205064192-205065810                                       | 0 | 0 |
| chr1:205066039-205066454                                       | 0 | 0 |
| chr1:205066523-205068117                                       | 0 | 0 |
| chr1:205068234-205068869                                       | 0 | 0 |
| chr1:205068940-205069039                                       | 0 | 0 |
| chr1:205069192-205069280                                       | 0 | 0 |
| chr1:205069399-205070728                                       | 0 | 0 |
| chr1:205070837-205072985                                       | 0 | 0 |
| chr1:205073147-205074156                                       | 0 | 0 |
| chr1:205074296-205083917                                       | 0 | 0 |
| chr1:205084033-205084986                                       | 1 | 1 |
| chr1:205084089-205084986                                       | 1 | 1 |
| chr1:205085011-205090983                                       | 0 | 0 |
| chr1:205057940-205064001                                       | 0 | 0 |
| chr1:205085011-205090983 chr1:205057940-205064001              |   |   |
| chr1:205057943-205064001                                       | 0 | 1 |
| chr1:205057943-205064115                                       | 0 | 1 |
| chr1:205064192-205065810                                       | 0 | 0 |
| chr1:205066039-205066454                                       | 0 | 0 |
| chr1:205066523-205068117                                       | 0 | 0 |
| chr1:205068234-205068869                                       | 0 | 0 |
| chr1:205068940-205069039                                       | 0 | 0 |
| chr1:205069192-205069280                                       | 0 | 0 |
| chr1:205069399-205070728                                       | 0 | 0 |
| chr1:205070837-205072985                                       | 0 | 0 |
| chr1:205073147-205074156                                       | 0 | 0 |
| chr1:205074296-205083917                                       | 0 | 0 |
| chr1:205084033-205084986                                       | 0 | 0 |
| chr1:205084089-205084986                                       | 0 | 0 |
| chr1:205085011-205090983                                       | 1 | 0 |
| chr1:205057940-205064001                                       | 0 | 1 |
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| chr1:8415180-8415479 chr1:8415659-8416160 chr1:8416306-8418256 |   |   |
| chr1:8415180-8415479   | 1 | 0 |
| chr1:8415659-8416160   | 0 | 1 |
| chr1:8416306-8418256   | 0 | 1 |
| chr1:8418976-8419824   | 0 | 0 |

|  |   |   |   |
|--|---|---|---|
| chr1:8420046-8420172   | 0 | 0 | 0 |
| chr1:8421550-8421823   | 0 | 0 | 0 |
| chr1:8421936-8422743   | 0 | 0 | 0 |
| chr1:8422904-8424116   | 0 | 0 | 0 |
| chr1:8424315-8424806   | 0 | 0 | 0 |
| chr1:8424898-8425872   | 0 | 0 | 0 |
| chr1:8426034-8482787   | 0 | 0 | 0 |
| chr1:8482867-8525985   | 0 | 0 | 0 |
| chr1:8526083-8555123   | 0 | 0 | 0 |
| chr1:8555222-8557465   | 0 | 0 | 0 |
| chr1:8557589-8568686   | 0 | 0 | 0 |
| chr1:8568734-8601273   | 0 | 0 | 0 |
| chr1:8601377-8616534   | 0 | 0 | 0 |
| chr1:8616630-8617477   | 0 | 0 | 0 |
| chr1:8617582-8674620   | 0 | 0 | 0 |
| chr1:8674745-8684369   | 0 | 0 | 0 |
| chr1:8684439-8716032   | 0 | 0 | 0 |
| chr1:8716500-8813490   | 0 | 0 | 0 |
| chr1:8716500-8877219   | 0 | 0 | 0 |
| chr1:8482867-8483621   | 0 | 0 | 0 |
| chr1:8852647-8877219   | 0 | 0 | 0 |
| chr1:8716500-8852463   | 0 | 0 | 0 |
| chr1:8418976-8419824 chr1:8420046-8420172 chr1:8421550-8421823 |   |   |   |
| chr1:8415180-8415479   | 0 | 0 | 0 |
| chr1:8415659-8416160   | 0 | 0 | 0 |
| chr1:8416306-8418256   | 0 | 0 | 0 |
| chr1:8418976-8419824   | 1 | 0 | 0 |
| chr1:8420046-8420172   | 0 | 1 | 0 |
| chr1:8421550-8421823   | 0 | 0 | 1 |
| chr1:8421936-8422743   | 0 | 0 | 0 |
| chr1:8422904-8424116   | 0 | 0 | 0 |
| chr1:8424315-8424806   | 0 | 0 | 0 |
| chr1:8424898-8425872   | 0 | 0 | 0 |
| chr1:8426034-8482787   | 0 | 0 | 0 |
| chr1:8482867-8525985   | 0 | 0 | 0 |
| chr1:8526083-8555123   | 0 | 0 | 0 |
| chr1:8555222-8557465   | 0 | 0 | 0 |
| chr1:8557589-8568686   | 0 | 0 | 0 |
| chr1:8568734-8601273   | 0 | 0 | 0 |
| chr1:8601377-8616534   | 0 | 0 | 0 |
| chr1:8616630-8617477   | 0 | 0 | 0 |
| chr1:8617582-8674620   | 0 | 0 | 0 |
| chr1:8674745-8684369   | 0 | 0 | 0 |
| chr1:8684439-8716032   | 0 | 0 | 0 |
| chr1:8716500-8813490   | 0 | 0 | 0 |
| chr1:8716500-8877219   | 0 | 0 | 0 |
| chr1:8482867-8483621   | 0 | 0 | 0 |
| chr1:8852647-8877219   | 0 | 0 | 0 |
| chr1:8716500-8852463   | 0 | 0 | 0 |
| chr1:8421936-8422743 chr1:8422904-8424116 chr1:8424315-8424806 |   |   |   |
| chr1:8415180-8415479   | 0 | 0 | 0 |

|  |   |   |   |
|--|---|---|---|
| chr1:8415659-8416160   | 0 | 0 | 0 |
| chr1:8416306-8418256   | 0 | 0 | 0 |
| chr1:8418976-8419824   | 0 | 0 | 0 |
| chr1:8420046-8420172   | 0 | 0 | 0 |
| chr1:8421550-8421823   | 0 | 0 | 0 |
| chr1:8421936-8422743   | 1 | 0 | 0 |
| chr1:8422904-8424116   | 0 | 1 | 0 |
| chr1:8424315-8424806   | 0 | 0 | 1 |
| chr1:8424898-8425872   | 0 | 0 | 0 |
| chr1:8426034-8482787   | 0 | 0 | 0 |
| chr1:8482867-8525985   | 0 | 0 | 0 |
| chr1:8526083-8555123   | 0 | 0 | 0 |
| chr1:8555222-8557465   | 0 | 0 | 0 |
| chr1:8557589-8568686   | 0 | 0 | 0 |
| chr1:8568734-8601273   | 0 | 0 | 0 |
| chr1:8601377-8616534   | 0 | 0 | 0 |
| chr1:8616630-8617477   | 0 | 0 | 0 |
| chr1:8617582-8674620   | 0 | 0 | 0 |
| chr1:8674745-8684369   | 0 | 0 | 0 |
| chr1:8684439-8716032   | 0 | 0 | 0 |
| chr1:8716500-8813490   | 0 | 0 | 0 |
| chr1:8716500-8877219   | 0 | 0 | 0 |
| chr1:8482867-8483621   | 0 | 0 | 0 |
| chr1:8852647-8877219   | 0 | 0 | 0 |
| chr1:8716500-8852463   | 0 | 0 | 0 |
| chr1:8424898-8425872 chr1:8426034-8482787 chr1:8482867-8525985 |   |   |   |
| chr1:8415180-8415479   | 0 | 0 | 0 |
| chr1:8415659-8416160   | 0 | 0 | 0 |
| chr1:8416306-8418256   | 0 | 0 | 0 |
| chr1:8418976-8419824   | 0 | 0 | 0 |
| chr1:8420046-8420172   | 0 | 0 | 0 |
| chr1:8421550-8421823   | 0 | 0 | 0 |
| chr1:8421936-8422743   | 0 | 0 | 0 |
| chr1:8422904-8424116   | 0 | 0 | 0 |
| chr1:8424315-8424806   | 0 | 0 | 0 |
| chr1:8424898-8425872   | 1 | 0 | 0 |
| chr1:8426034-8482787   | 0 | 1 | 0 |
| chr1:8482867-8525985   | 0 | 0 | 1 |
| chr1:8526083-8555123   | 0 | 0 | 0 |
| chr1:8555222-8557465   | 0 | 0 | 0 |
| chr1:8557589-8568686   | 0 | 0 | 0 |
| chr1:8568734-8601273   | 0 | 0 | 0 |
| chr1:8601377-8616534   | 0 | 0 | 0 |
| chr1:8616630-8617477   | 0 | 0 | 0 |
| chr1:8617582-8674620   | 0 | 0 | 0 |
| chr1:8674745-8684369   | 0 | 0 | 0 |
| chr1:8684439-8716032   | 0 | 0 | 0 |
| chr1:8716500-8813490   | 0 | 0 | 0 |
| chr1:8716500-8877219   | 0 | 0 | 0 |
| chr1:8482867-8483621   | 0 | 0 | 1 |
| chr1:8852647-8877219   | 0 | 0 | 0 |

|                      |                      |                      |                      |
|----------------------|----------------------|----------------------|----------------------|
| chr1:8716500-8852463 | 0                    | 0                    | 0                    |
|                      | chr1:8526083-8555123 | chr1:8555222-8557465 | chr1:8557589-8568686 |
| chr1:8415180-8415479 | 0                    | 0                    | 0                    |
| chr1:8415659-8416160 | 0                    | 0                    | 0                    |
| chr1:8416306-8418256 | 0                    | 0                    | 0                    |
| chr1:8418976-8419824 | 0                    | 0                    | 0                    |
| chr1:8420046-8420172 | 0                    | 0                    | 0                    |
| chr1:8421550-8421823 | 0                    | 0                    | 0                    |
| chr1:8421936-8422743 | 0                    | 0                    | 0                    |
| chr1:8422904-8424116 | 0                    | 0                    | 0                    |
| chr1:8424315-8424806 | 0                    | 0                    | 0                    |
| chr1:8424898-8425872 | 0                    | 0                    | 0                    |
| chr1:8426034-8482787 | 0                    | 0                    | 0                    |
| chr1:8482867-8525985 | 0                    | 0                    | 0                    |
| chr1:8526083-8555123 | 1                    | 0                    | 0                    |
| chr1:8555222-8557465 | 0                    | 1                    | 0                    |
| chr1:8557589-8568686 | 0                    | 0                    | 1                    |
| chr1:8568734-8601273 | 0                    | 0                    | 0                    |
| chr1:8601377-8616534 | 0                    | 0                    | 0                    |
| chr1:8616630-8617477 | 0                    | 0                    | 0                    |
| chr1:8617582-8674620 | 0                    | 0                    | 0                    |
| chr1:8674745-8684369 | 0                    | 0                    | 0                    |
| chr1:8684439-8716032 | 0                    | 0                    | 0                    |
| chr1:8716500-8813490 | 0                    | 0                    | 0                    |
| chr1:8716500-8877219 | 0                    | 0                    | 0                    |
| chr1:8482867-8483621 | 0                    | 0                    | 0                    |
| chr1:8852647-8877219 | 0                    | 0                    | 0                    |
| chr1:8716500-8852463 | 0                    | 0                    | 0                    |
|                      | chr1:8568734-8601273 | chr1:8601377-8616534 | chr1:8616630-8617477 |
| chr1:8415180-8415479 | 0                    | 0                    | 0                    |
| chr1:8415659-8416160 | 0                    | 0                    | 0                    |
| chr1:8416306-8418256 | 0                    | 0                    | 0                    |
| chr1:8418976-8419824 | 0                    | 0                    | 0                    |
| chr1:8420046-8420172 | 0                    | 0                    | 0                    |
| chr1:8421550-8421823 | 0                    | 0                    | 0                    |
| chr1:8421936-8422743 | 0                    | 0                    | 0                    |
| chr1:8422904-8424116 | 0                    | 0                    | 0                    |
| chr1:8424315-8424806 | 0                    | 0                    | 0                    |
| chr1:8424898-8425872 | 0                    | 0                    | 0                    |
| chr1:8426034-8482787 | 0                    | 0                    | 0                    |
| chr1:8482867-8525985 | 0                    | 0                    | 0                    |
| chr1:8526083-8555123 | 0                    | 0                    | 0                    |
| chr1:8555222-8557465 | 0                    | 0                    | 0                    |
| chr1:8557589-8568686 | 0                    | 0                    | 0                    |
| chr1:8568734-8601273 | 1                    | 0                    | 0                    |
| chr1:8601377-8616534 | 0                    | 1                    | 0                    |
| chr1:8616630-8617477 | 0                    | 0                    | 1                    |
| chr1:8617582-8674620 | 0                    | 0                    | 0                    |
| chr1:8674745-8684369 | 0                    | 0                    | 0                    |
| chr1:8684439-8716032 | 0                    | 0                    | 0                    |
| chr1:8716500-8813490 | 0                    | 0                    | 0                    |

|                      |   |   |   |
|----------------------|---|---|---|
| chr1:8716500-8877219 | 0 | 0 | 0 |
| chr1:8482867-8483621 | 0 | 0 | 0 |
| chr1:8852647-8877219 | 0 | 0 | 0 |
| chr1:8716500-8852463 | 0 | 0 | 0 |
| chr1:8415180-8415479 | 0 | 0 | 0 |
| chr1:8415659-8416160 | 0 | 0 | 0 |
| chr1:8416306-8418256 | 0 | 0 | 0 |
| chr1:8418976-8419824 | 0 | 0 | 0 |
| chr1:8420046-8420172 | 0 | 0 | 0 |
| chr1:8421550-8421823 | 0 | 0 | 0 |
| chr1:8421936-8422743 | 0 | 0 | 0 |
| chr1:8422904-8424116 | 0 | 0 | 0 |
| chr1:8424315-8424806 | 0 | 0 | 0 |
| chr1:8424898-8425872 | 0 | 0 | 0 |
| chr1:8426034-8482787 | 0 | 0 | 0 |
| chr1:8482867-8525985 | 0 | 0 | 0 |
| chr1:8526083-8555123 | 0 | 0 | 0 |
| chr1:8555222-8557465 | 0 | 0 | 0 |
| chr1:8557589-8568686 | 0 | 0 | 0 |
| chr1:8568734-8601273 | 0 | 0 | 0 |
| chr1:8601377-8616534 | 0 | 0 | 0 |
| chr1:8616630-8617477 | 0 | 0 | 0 |
| chr1:8617582-8674620 | 1 | 0 | 0 |
| chr1:8674745-8684369 | 0 | 1 | 0 |
| chr1:8684439-8716032 | 0 | 0 | 1 |
| chr1:8716500-8813490 | 0 | 0 | 0 |
| chr1:8716500-8877219 | 0 | 0 | 0 |
| chr1:8482867-8483621 | 0 | 0 | 0 |
| chr1:8852647-8877219 | 0 | 0 | 0 |
| chr1:8716500-8852463 | 0 | 0 | 0 |
| chr1:8415180-8415479 | 0 | 0 | 0 |
| chr1:8415659-8416160 | 0 | 0 | 0 |
| chr1:8416306-8418256 | 0 | 0 | 0 |
| chr1:8418976-8419824 | 0 | 0 | 0 |
| chr1:8420046-8420172 | 0 | 0 | 0 |
| chr1:8421550-8421823 | 0 | 0 | 0 |
| chr1:8421936-8422743 | 0 | 0 | 0 |
| chr1:8422904-8424116 | 0 | 0 | 0 |
| chr1:8424315-8424806 | 0 | 0 | 0 |
| chr1:8424898-8425872 | 0 | 0 | 0 |
| chr1:8426034-8482787 | 0 | 0 | 0 |
| chr1:8482867-8525985 | 0 | 0 | 1 |
| chr1:8526083-8555123 | 0 | 0 | 0 |
| chr1:8555222-8557465 | 0 | 0 | 0 |
| chr1:8557589-8568686 | 0 | 0 | 0 |
| chr1:8568734-8601273 | 0 | 0 | 0 |
| chr1:8601377-8616534 | 0 | 0 | 0 |
| chr1:8616630-8617477 | 0 | 0 | 0 |
| chr1:8617582-8674620 | 0 | 0 | 0 |

|   |   |   |   |
|---|---|---|---|
| chr1:8674745-8684369                              | 0 | 0 | 0 |
| chr1:8684439-8716032                              | 0 | 0 | 0 |
| chr1:8716500-8813490                              | 1 | 1 | 0 |
| chr1:8716500-8877219                              | 1 | 1 | 0 |
| chr1:8482867-8483621                              | 0 | 0 | 1 |
| chr1:8852647-8877219                              | 0 | 1 | 0 |
| chr1:8716500-8852463                              | 1 | 1 | 0 |
| chr1:8852647-8877219 chr1:8716500-8852463         |   |   |   |
| chr1:8415180-8415479                              | 0 | 0 |   |
| chr1:8415659-8416160                              | 0 | 0 |   |
| chr1:8416306-8418256                              | 0 | 0 |   |
| chr1:8418976-8419824                              | 0 | 0 |   |
| chr1:8420046-8420172                              | 0 | 0 |   |
| chr1:8421550-8421823                              | 0 | 0 |   |
| chr1:8421936-8422743                              | 0 | 0 |   |
| chr1:8422904-8424116                              | 0 | 0 |   |
| chr1:8424315-8424806                              | 0 | 0 |   |
| chr1:8424898-8425872                              | 0 | 0 |   |
| chr1:8426034-8482787                              | 0 | 0 |   |
| chr1:8482867-8525985                              | 0 | 0 |   |
| chr1:8526083-8555123                              | 0 | 0 |   |
| chr1:8555222-8557465                              | 0 | 0 |   |
| chr1:8557589-8568686                              | 0 | 0 |   |
| chr1:8568734-8601273                              | 0 | 0 |   |
| chr1:8601377-8616534                              | 0 | 0 |   |
| chr1:8616630-8617477                              | 0 | 0 |   |
| chr1:8617582-8674620                              | 0 | 0 |   |
| chr1:8674745-8684369                              | 0 | 0 |   |
| chr1:8684439-8716032                              | 0 | 0 |   |
| chr1:8716500-8813490                              | 0 | 1 |   |
| chr1:8716500-8877219                              | 1 | 1 |   |
| chr1:8482867-8483621                              | 0 | 0 |   |
| chr1:8852647-8877219                              | 1 | 0 |   |
| chr1:8716500-8852463                              | 0 | 1 |   |
| \$Rest\$SLAMF7                                    |   |   |   |
| chr1:160709146-160717984 chr1:160709146-160719611 |   |   |   |
| chr1:160709146-160717984                          | 1 | 1 |   |
| chr1:160709146-160719611                          | 1 | 1 |   |
| chr1:160718304-160719611                          | 0 | 1 |   |
| chr1:160719883-160720094                          | 0 | 0 |   |
| chr1:160719922-160720094                          | 0 | 0 |   |
| chr1:160720213-160721135                          | 0 | 0 |   |
| chr1:160720213-160721976                          | 0 | 0 |   |
| chr1:160721238-160721976                          | 0 | 0 |   |
| chr1:160722038-160722896                          | 0 | 0 |   |
| chr1:160718304-160719611 chr1:160719883-160720094 |   |   |   |
| chr1:160709146-160717984                          | 0 | 0 |   |
| chr1:160709146-160719611                          | 1 | 0 |   |
| chr1:160718304-160719611                          | 1 | 0 |   |
| chr1:160719883-160720094                          | 0 | 1 |   |



|   |   |   |
|---|---|---|
| chr1:160719922-160720094                          | 0 | 1 |
| chr1:160720213-160721135                          | 0 | 0 |
| chr1:160720213-160721976                          | 0 | 0 |
| chr1:160721238-160721976                          | 0 | 0 |
| chr1:160722038-160722896                          | 0 | 0 |
| chr1:160719922-160720094 chr1:160720213-160721135 |   |   |
| chr1:160709146-160717984                          | 0 | 0 |
| chr1:160709146-160719611                          | 0 | 0 |
| chr1:160718304-160719611                          | 0 | 0 |
| chr1:160719883-160720094                          | 1 | 0 |
| chr1:160719922-160720094                          | 1 | 0 |
| chr1:160720213-160721135                          | 0 | 1 |
| chr1:160720213-160721976                          | 0 | 1 |
| chr1:160721238-160721976                          | 0 | 0 |
| chr1:160722038-160722896                          | 0 | 0 |
| chr1:160720213-160721976 chr1:160721238-160721976 |   |   |
| chr1:160709146-160717984                          | 0 | 0 |
| chr1:160709146-160719611                          | 0 | 0 |
| chr1:160718304-160719611                          | 0 | 0 |
| chr1:160719883-160720094                          | 0 | 0 |
| chr1:160719922-160720094                          | 0 | 0 |
| chr1:160720213-160721135                          | 1 | 0 |
| chr1:160720213-160721976                          | 1 | 1 |
| chr1:160721238-160721976                          | 1 | 1 |
| chr1:160722038-160722896                          | 0 | 0 |
| chr1:160722038-160722896                          |   |   |
| chr1:160709146-160717984                          | 0 |   |
| chr1:160709146-160719611                          | 0 |   |
| chr1:160718304-160719611                          | 0 |   |
| chr1:160719883-160720094                          | 0 |   |
| chr1:160719922-160720094                          | 0 |   |
| chr1:160720213-160721135                          | 0 |   |
| chr1:160720213-160721976                          | 0 |   |
| chr1:160721238-160721976                          | 0 |   |
| chr1:160722038-160722896                          | 1 |   |
| \$Rest\$SLC41A1                                   |   |   |
| chr1:205760846-205763998 chr1:205764146-205764472 |   |   |
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| chr1:205764146-205764472                          | 0 | 1 |
| chr1:205764606-205766052                          | 0 | 0 |
| chr1:205766131-205767032                          | 0 | 0 |
| chr1:205767179-205767797                          | 0 | 0 |
| chr1:205767943-205768085                          | 0 | 0 |
| chr1:205768229-205768887                          | 0 | 0 |
| chr1:205768958-205770081                          | 0 | 0 |
| chr1:205770188-205779198                          | 0 | 0 |
| chr1:205780215-205781936                          | 0 | 0 |
| chr1:205764606-205766052 chr1:205766131-205767032 |   |   |
| chr1:205760846-205763998                          | 0 | 0 |
| chr1:205764146-205764472                          | 0 | 0 |

|   |   |   |
|---|---|---|
| chr1:205764606-205766052                          | 1 | 0 |
| chr1:205766131-205767032                          | 0 | 1 |
| chr1:205767179-205767797                          | 0 | 0 |
| chr1:205767943-205768085                          | 0 | 0 |
| chr1:205768229-205768887                          | 0 | 0 |
| chr1:205768958-205770081                          | 0 | 0 |
| chr1:205770188-205779198                          | 0 | 0 |
| chr1:205780215-205781936                          | 0 | 0 |
| chr1:205767179-205767797 chr1:205767943-205768085 |   |   |
| chr1:205760846-205763998                          | 0 | 0 |
| chr1:205764146-205764472                          | 0 | 0 |
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| chr1:205766131-205767032                          | 0 | 0 |
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| chr1:205767943-205768085                          | 0 | 1 |
| chr1:205768229-205768887                          | 0 | 0 |
| chr1:205768958-205770081                          | 0 | 0 |
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| chr1:205780215-205781936                          | 0 | 0 |
| chr1:205768229-205768887 chr1:205768958-205770081 |   |   |
| chr1:205760846-205763998                          | 0 | 0 |
| chr1:205764146-205764472                          | 0 | 0 |
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| chr1:205766131-205767032                          | 0 | 0 |
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| chr1:205767943-205768085                          | 0 | 0 |
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| chr1:205768958-205770081                          | 0 | 1 |
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| chr1:205780215-205781936                          | 0 | 0 |
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| chr1:205760846-205763998                          | 0 | 0 |
| chr1:205764146-205764472                          | 0 | 0 |
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| chr1:205766131-205767032                          | 0 | 0 |
| chr1:205767179-205767797                          | 0 | 0 |
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| chr1:205768229-205768887                          | 0 | 0 |
| chr1:205768958-205770081                          | 0 | 0 |
| chr1:205770188-205779198                          | 1 | 0 |
| chr1:205780215-205781936                          | 0 | 1 |

\$Rest\$TFAP2E

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| chr1:36040299-36042923                        | 1 | 0 |
| chr1:36043093-36070834                        | 0 | 1 |

\$Rest\$TMEM51

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| chr1:15479280-15541391                        | 1 | 1 |
| chr1:15480450-15541391                        | 1 | 1 |

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|--------------------------|---|---|
| chr1:15541927-15545822   | 0 | 0 |
| chr1:15480450-15536986   | 1 | 1 |
| chr1:15537058-15541391   | 1 | 1 |
| chr1:15479280-15541391   | 0 | 1 |
| chr1:15480450-15541391   | 0 | 1 |
| chr1:15541927-15545822   | 1 | 0 |
| chr1:15480450-15536986   | 0 | 1 |
| chr1:15537058-15541391   | 0 | 0 |
| chr1:15479280-15541391   | 1 |   |
| chr1:15480450-15541391   | 1 |   |
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| chr1:15480450-15536986   | 0 |   |
| chr1:15537058-15541391   | 1 |   |
| \$Rest\$TMEM63A          |   |   |
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| chr1:226034914-226036193 | 0 | 1 |
| chr1:226036255-226036598 | 0 | 0 |
| chr1:226036713-226037613 | 0 | 0 |
| chr1:226037780-226040365 | 0 | 0 |
| chr1:226040470-226041330 | 0 | 0 |
| chr1:226041492-226043579 | 0 | 0 |
| chr1:226043641-226044353 | 0 | 0 |
| chr1:226044439-226044611 | 0 | 0 |
| chr1:226044717-226046896 | 0 | 0 |
| chr1:226047049-226048560 | 0 | 0 |
| chr1:226048697-226049918 | 0 | 0 |
| chr1:226050051-226050155 | 0 | 0 |
| chr1:226050278-226050471 | 0 | 0 |
| chr1:226050551-226053597 | 0 | 0 |
| chr1:226053667-226054274 | 0 | 0 |
| chr1:226054382-226054812 | 0 | 0 |
| chr1:226054863-226055588 | 0 | 0 |
| chr1:226055730-226058776 | 0 | 0 |
| chr1:226058813-226059687 | 0 | 0 |
| chr1:226059753-226061988 | 0 | 0 |
| chr1:226062067-226065095 | 0 | 0 |
| chr1:226065294-226066920 | 0 | 0 |
| chr1:226067110-226070004 | 0 | 0 |
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| chr1:226034914-226036193 | 0 | 0 |
| chr1:226036255-226036598 | 1 | 0 |
| chr1:226036713-226037613 | 0 | 1 |
| chr1:226037780-226040365 | 0 | 0 |
| chr1:226040470-226041330 | 0 | 0 |
| chr1:226041492-226043579 | 0 | 0 |
| chr1:226043641-226044353 | 0 | 0 |

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| chr1:226050551-226053597                          | 0 | 0 |
| chr1:226053667-226054274                          | 0 | 0 |
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| chr1:226058813-226059687                          | 0 | 0 |
| chr1:226059753-226061988                          | 0 | 0 |
| chr1:226062067-226065095                          | 0 | 0 |
| chr1:226065294-226066920                          | 0 | 0 |
| chr1:226067110-226070004                          | 0 | 0 |
| chr1:226037780-226040365 chr1:226040470-226041330 |   |   |
| chr1:226034633-226034735                          | 0 | 0 |
| chr1:226034914-226036193                          | 0 | 0 |
| chr1:226036255-226036598                          | 0 | 0 |
| chr1:226036713-226037613                          | 0 | 0 |
| chr1:226037780-226040365                          | 1 | 0 |
| chr1:226040470-226041330                          | 0 | 1 |
| chr1:226041492-226043579                          | 0 | 0 |
| chr1:226043641-226044353                          | 0 | 0 |
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| chr1:226044717-226046896                          | 0 | 0 |
| chr1:226047049-226048560                          | 0 | 0 |
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| chr1:226050051-226050155                          | 0 | 0 |
| chr1:226050278-226050471                          | 0 | 0 |
| chr1:226050551-226053597                          | 0 | 0 |
| chr1:226053667-226054274                          | 0 | 0 |
| chr1:226054382-226054812                          | 0 | 0 |
| chr1:226054863-226055588                          | 0 | 0 |
| chr1:226055730-226058776                          | 0 | 0 |
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| chr1:226065294-226066920                          | 0 | 0 |
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| chr1:226036255-226036598                          | 0 | 0 |
| chr1:226036713-226037613                          | 0 | 0 |
| chr1:226037780-226040365                          | 0 | 0 |
| chr1:226040470-226041330                          | 0 | 0 |
| chr1:226041492-226043579                          | 1 | 0 |
| chr1:226043641-226044353                          | 0 | 1 |
| chr1:226044439-226044611                          | 0 | 0 |

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|--------------------------|--------------------------|---|
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| chr1:226047049-226048560 | 0                        | 0 |
| chr1:226048697-226049918 | 0                        | 0 |
| chr1:226050051-226050155 | 0                        | 0 |
| chr1:226050278-226050471 | 0                        | 0 |
| chr1:226050551-226053597 | 0                        | 0 |
| chr1:226053667-226054274 | 0                        | 0 |
| chr1:226054382-226054812 | 0                        | 0 |
| chr1:226054863-226055588 | 0                        | 0 |
| chr1:226055730-226058776 | 0                        | 0 |
| chr1:226058813-226059687 | 0                        | 0 |
| chr1:226059753-226061988 | 0                        | 0 |
| chr1:226062067-226065095 | 0                        | 0 |
| chr1:226065294-226066920 | 0                        | 0 |
| chr1:226067110-226070004 | 0                        | 0 |
| chr1:226044439-226044611 | chr1:226044717-226046896 |   |
| chr1:226034633-226034735 | 0                        | 0 |
| chr1:226034914-226036193 | 0                        | 0 |
| chr1:226036255-226036598 | 0                        | 0 |
| chr1:226036713-226037613 | 0                        | 0 |
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| chr1:226041492-226043579 | 0                        | 0 |
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| chr1:226044439-226044611 | 1                        | 0 |
| chr1:226044717-226046896 | 0                        | 1 |
| chr1:226047049-226048560 | 0                        | 0 |
| chr1:226048697-226049918 | 0                        | 0 |
| chr1:226050051-226050155 | 0                        | 0 |
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| chr1:226053667-226054274 | 0                        | 0 |
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| chr1:226047049-226048560 | chr1:226048697-226049918 |   |
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| chr1:226036255-226036598 | 0                        | 0 |
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| chr1:226037780-226040365 | 0                        | 0 |
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|   |   |   |
|---|---|---|
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| chr1:226044717-226046896                          | 0 | 0 |
| chr1:226047049-226048560                          | 0 | 0 |

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|---|---|---|
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| chr1:226054382-226054812 chr1:226054863-226055588 |   |   |
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| chr1:226044439-226044611                          | 0 | 0 |
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| chr1:226048697-226049918                          | 0 | 0 |

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| chr1:226034914-226036193                          | 0 | 0 |
| chr1:226036255-226036598                          | 0 | 0 |
| chr1:226036713-226037613                          | 0 | 0 |
| chr1:226037780-226040365                          | 0 | 0 |
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| chr1:226065294-226066920 chr1:226067110-226070004 |   |   |
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| chr1:226047049-226048560                          | 0 | 0 |
| chr1:226048697-226049918                          | 0 | 0 |
| chr1:226050051-226050155                          | 0 | 0 |



|                          |   |   |
|--------------------------|---|---|
| chr1:226050278-226050471 | 0 | 0 |
| chr1:226050551-226053597 | 0 | 0 |
| chr1:226053667-226054274 | 0 | 0 |
| chr1:226054382-226054812 | 0 | 0 |
| chr1:226054863-226055588 | 0 | 0 |
| chr1:226055730-226058776 | 0 | 0 |
| chr1:226058813-226059687 | 0 | 0 |
| chr1:226059753-226061988 | 0 | 0 |
| chr1:226062067-226065095 | 0 | 0 |
| chr1:226065294-226066920 | 1 | 0 |
| chr1:226067110-226070004 | 0 | 1 |

\$Rest\$TNFRSF1B

|   |   |   |
|---|---|---|
| chr1:12227226-12248853 chr1:12248952-12251014 |   |   |
| chr1:12227226-12248853                        | 1 | 0 |
| chr1:12248952-12251014                        | 0 | 1 |
| chr1:12251142-12251831                        | 0 | 0 |
| chr1:12251980-12252488                        | 0 | 0 |
| chr1:12252581-12252920                        | 0 | 0 |
| chr1:12253155-12254012                        | 0 | 0 |
| chr1:12254089-12254641                        | 0 | 0 |
| chr1:12254675-12262024                        | 0 | 0 |
| chr1:12262228-12266797                        | 0 | 0 |
| chr1:12227226-12251014                        | 1 | 1 |
| chr1:12251142-12251831 chr1:12251980-12252488 |   |   |
| chr1:12227226-12248853                        | 0 | 0 |
| chr1:12248952-12251014                        | 0 | 0 |
| chr1:12251142-12251831                        | 1 | 0 |
| chr1:12251980-12252488                        | 0 | 1 |
| chr1:12252581-12252920                        | 0 | 0 |
| chr1:12253155-12254012                        | 0 | 0 |
| chr1:12254089-12254641                        | 0 | 0 |
| chr1:12254675-12262024                        | 0 | 0 |
| chr1:12262228-12266797                        | 0 | 0 |
| chr1:12227226-12251014                        | 0 | 0 |
| chr1:12252581-12252920 chr1:12253155-12254012 |   |   |
| chr1:12227226-12248853                        | 0 | 0 |
| chr1:12248952-12251014                        | 0 | 0 |
| chr1:12251142-12251831                        | 0 | 0 |
| chr1:12251980-12252488                        | 0 | 0 |
| chr1:12252581-12252920                        | 1 | 0 |
| chr1:12253155-12254012                        | 0 | 1 |
| chr1:12254089-12254641                        | 0 | 0 |
| chr1:12254675-12262024                        | 0 | 0 |
| chr1:12262228-12266797                        | 0 | 0 |
| chr1:12227226-12251014                        | 0 | 0 |
| chr1:12254089-12254641 chr1:12254675-12262024 |   |   |
| chr1:12227226-12248853                        | 0 | 0 |
| chr1:12248952-12251014                        | 0 | 0 |
| chr1:12251142-12251831                        | 0 | 0 |
| chr1:12251980-12252488                        | 0 | 0 |

|   |   |   |
|---|---|---|
| chr1:12252581-12252920                        | 0 | 0 |
| chr1:12253155-12254012                        | 0 | 0 |
| chr1:12254089-12254641                        | 1 | 0 |
| chr1:12254675-12262024                        | 0 | 1 |
| chr1:12262228-12266797                        | 0 | 0 |
| chr1:12227226-12251014                        | 0 | 0 |
| chr1:12262228-12266797 chr1:12227226-12251014 |   |   |
| chr1:12227226-12248853                        | 0 | 1 |
| chr1:12248952-12251014                        | 0 | 1 |
| chr1:12251142-12251831                        | 0 | 0 |
| chr1:12251980-12252488                        | 0 | 0 |
| chr1:12252581-12252920                        | 0 | 0 |
| chr1:12253155-12254012                        | 0 | 0 |
| chr1:12254089-12254641                        | 0 | 0 |
| chr1:12254675-12262024                        | 0 | 0 |
| chr1:12262228-12266797                        | 1 | 0 |
| chr1:12227226-12251014                        | 0 | 1 |

\$Rest\$UQCRH

|   |   |   |
|---|---|---|
| chr1:46769492-46774773 chr1:46774799-46775827 |   |   |
| chr1:46769492-46774773                        | 1 | 0 |
| chr1:46774799-46775827                        | 0 | 1 |
| chr1:46775716-46775827                        | 0 | 1 |
| chr1:46775988-46782224                        | 0 | 0 |
| chr1:46774799-46775569                        | 0 | 1 |
| chr1:46775716-46775827 chr1:46775988-46782224 |   |   |
| chr1:46769492-46774773                        | 0 | 0 |
| chr1:46774799-46775827                        | 1 | 0 |
| chr1:46775716-46775827                        | 1 | 0 |
| chr1:46775988-46782224                        | 0 | 1 |
| chr1:46774799-46775569                        | 0 | 0 |
| chr1:46774799-46775569                        |   |   |
| chr1:46769492-46774773                        | 0 |   |
| chr1:46774799-46775827                        | 1 |   |
| chr1:46775716-46775827                        | 0 |   |
| chr1:46775988-46782224                        | 0 |   |
| chr1:46774799-46775569                        | 1 |   |

\$genesJunction

\$genesJunction\$CMPK1

[1] "chr1:47799788-47834141" "chr1:47834287-47838627" "chr1:47838779-47840581"  
 [4] "chr1:47838779-47840869" "chr1:47840657-47840869" "chr1:47840965-47842376"

\$genesJunction\$CSF1

[1] "chr1:110453684-110456881" "chr1:110457003-110458256" "chr1:110458318-110459915"  
 [4] "chr1:110460085-110464469" "chr1:110464616-110465788" "chr1:110464616-110466682"  
 [7] "chr1:110466812-110467398" "chr1:110467450-110467769" "chr1:110467824-110468685"  
 [10] "chr1:110467824-110471474"

\$genesJunction\$FAM72B

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[1] "chr1:120839865-120841975" "chr1:120839985-120841975" "chr1:120842052-120845995"
[4] "chr1:120846119-120854492"

$genesJunction$KLHL12
[1] "chr1:202861787-202862367" "chr1:202861787-202863312" "chr1:202862553-202863312"
[4] "chr1:202863410-202863719" "chr1:202863877-202864650" "chr1:202863877-202878138"
[7] "chr1:202864845-202865982" "chr1:202866088-202878138" "chr1:202878252-202880182"
[10] "chr1:202880331-202887299" "chr1:202887516-202888883" "chr1:202889036-202894096"
[13] "chr1:202894335-202896217"

$genesJunction$KLHL21
[1] "chr1:6653718-6655545" "chr1:6655617-6659107" "chr1:6659512-6659810"
[4] "chr1:6659512-6661857"

$genesJunction$MIR4632
[1] "chr1:12251142-12251831"

$genesJunction$MYSM1
[1] "chr1:59125827-59126842" "chr1:59126899-59127078" "chr1:59127183-59131171"
[4] "chr1:59131303-59132710" "chr1:59132898-59133519" "chr1:59133593-59134102"
[7] "chr1:59133593-59134304" "chr1:59134238-59134656" "chr1:59134354-59134656"
[10] "chr1:59134710-59137542" "chr1:59137630-59139245" "chr1:59139322-59141149"
[13] "chr1:59141252-59142598" "chr1:59142728-59147457" "chr1:59148217-59150825"
[16] "chr1:59150923-59154710" "chr1:59154788-59155898" "chr1:59155921-59156012"
[19] "chr1:59156089-59158533" "chr1:59158603-59160801" "chr1:59160879-59165657"

$genesJunction$NPHP4
[1] "chr1:5923465-5923950" "chr1:5924093-5924398" "chr1:5924577-5925162"
[4] "chr1:5925333-5926433" "chr1:5926518-5927090" "chr1:5927175-5927800"
[7] "chr1:5927956-5933312" "chr1:5933395-5934531" "chr1:5937358-5940174"
[10] "chr1:5940299-5947346" "chr1:5947526-5950928" "chr1:5951088-5964677"
[13] "chr1:5964864-5965352" "chr1:5965543-5965692" "chr1:5965843-5967175"
[16] "chr1:5967282-5969212" "chr1:5969273-5987709" "chr1:5987847-5993207"
[19] "chr1:5993389-6007164" "chr1:6007290-6008130" "chr1:6008311-6012760"
[22] "chr1:6012896-6021854" "chr1:6022009-6027359" "chr1:6027423-6029147"
[25] "chr1:6029319-6038330" "chr1:6038473-6046215" "chr1:6046387-6052304"
[28] "chr1:5934717-5934934" "chr1:5965840-5967175" "chr1:5936583-5937153"
[31] "chr1:5937358-5939406" "chr1:5939692-5940174"

$genesJunction$PEX14
[1] "chr1:10637247-10637871" "chr1:10659423-10678389" "chr1:10678474-10683076"
[4] "chr1:10683178-10684397" "chr1:10684494-10687329" "chr1:10687420-10689588"
[7] "chr1:10596354-10659295" "chr1:10596354-10678389"

$genesJunction$PIP5K1A
[1] "chr1:151171557-151196721" "chr1:151171557-151196724" "chr1:151196755-151199796"
[4] "chr1:151199876-151204147" "chr1:151204277-151204724" "chr1:151204841-151205027"
[7] "chr1:151205179-151206673" "chr1:151206972-151209034" "chr1:151209239-151210658"
[10] "chr1:151209239-151211606" "chr1:151210741-151211606" "chr1:151211654-151212431"
[13] "chr1:151212515-151214599" "chr1:151212515-151219396" "chr1:151214745-151214914"
[16] "chr1:151215043-151219396" "chr1:151219441-151220339" "chr1:151196755-151196847"

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[19] "chr1:151196882-151199796" "chr1:151212515-151214914"

\$genesJunction\$PSMB2

[1] "chr1:36040299-36042923" "chr1:36068975-36070834" "chr1:36070883-36074847"  
[4] "chr1:36075009-36096875" "chr1:36096945-36101911" "chr1:36102033-36106943"  
[7] "chr1:36043093-36070834"

\$genesJunction\$RBBP4

[1] "chr1:33116923-33117515" "chr1:33117662-33123028" "chr1:33123173-33133826"  
[4] "chr1:33133999-33134340" "chr1:33134455-33134573" "chr1:33134733-33134832"  
[7] "chr1:33134958-33135087" "chr1:33135164-33138051" "chr1:33138127-33138243"  
[10] "chr1:33138300-33138392" "chr1:33138502-33145241" "chr1:33116923-33117518"

\$genesJunction\$RBBP5

[1] "chr1:205057943-205064001" "chr1:205057943-205064115" "chr1:205064192-205065810"  
[4] "chr1:205066039-205066454" "chr1:205066523-205068117" "chr1:205068234-205068869"  
[7] "chr1:205068940-205069039" "chr1:205069192-205069280" "chr1:205069399-205070728"  
[10] "chr1:205070837-205072985" "chr1:205073147-205074156" "chr1:205074296-205083917"  
[13] "chr1:205084033-205084986" "chr1:205084089-205084986" "chr1:205085011-205090983"  
[16] "chr1:205057940-205064001"

\$genesJunction\$RERE

[1] "chr1:8415180-8415479" "chr1:8415659-8416160" "chr1:8416306-8418256"  
[4] "chr1:8418976-8419824" "chr1:8420046-8420172" "chr1:8421550-8421823"  
[7] "chr1:8421936-8422743" "chr1:8422904-8424116" "chr1:8424315-8424806"  
[10] "chr1:8424898-8425872" "chr1:8426034-8482787" "chr1:8482867-8525985"  
[13] "chr1:8526083-8555123" "chr1:8555222-8557465" "chr1:8557589-8568686"  
[16] "chr1:8568734-8601273" "chr1:8601377-8616534" "chr1:8616630-8617477"  
[19] "chr1:8617582-8674620" "chr1:8674745-8684369" "chr1:8684439-8716032"  
[22] "chr1:8716500-8813490" "chr1:8716500-8877219" "chr1:8482867-8483621"  
[25] "chr1:8852647-8877219" "chr1:8716500-8852463"

\$genesJunction\$SLAMF7

[1] "chr1:160709146-160717984" "chr1:160709146-160719611" "chr1:160718304-160719611"  
[4] "chr1:160719883-160720094" "chr1:160719922-160720094" "chr1:160720213-160721135"  
[7] "chr1:160720213-160721976" "chr1:160721238-160721976" "chr1:160722038-160722896"

\$genesJunction\$SLC41A1

[1] "chr1:205760846-205763998" "chr1:205764146-205764472" "chr1:205764606-205766052"  
[4] "chr1:205766131-205767032" "chr1:205767179-205767797" "chr1:205767943-205768085"  
[7] "chr1:205768229-205768887" "chr1:205768958-205770081" "chr1:205770188-205779198"  
[10] "chr1:205780215-205781936"

\$genesJunction\$TFAP2E

[1] "chr1:36040299-36042923" "chr1:36043093-36070834"

\$genesJunction\$TMEM51

[1] "chr1:15479280-15541391" "chr1:15480450-15541391" "chr1:15541927-15545822"  
[4] "chr1:15480450-15536986" "chr1:15537058-15541391"

\$genesJunction\$TMEM63A

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[1] "chr1:226034633-226034735" "chr1:226034914-226036193" "chr1:226036255-226036598"
[4] "chr1:226036713-226037613" "chr1:226037780-226040365" "chr1:226040470-226041330"
[7] "chr1:226041492-226043579" "chr1:226043641-226044353" "chr1:226044439-226044611"
[10] "chr1:226044717-226046896" "chr1:226047049-226048560" "chr1:226048697-226049918"
[13] "chr1:226050051-226050155" "chr1:226050278-226050471" "chr1:226050551-226053597"
[16] "chr1:226053667-226054274" "chr1:226054382-226054812" "chr1:226054863-226055588"
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#### \$genesJunction\$TNFRSF1B

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[7] "chr1:12254089-12254641" "chr1:12254675-12262024" "chr1:12262228-12266797"
[10] "chr1:12227226-12251014"

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#### \$genesJunction\$UQCRH

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[1] "chr1:46769492-46774773" "chr1:46774799-46775827" "chr1:46775716-46775827"
[4] "chr1:46775988-46782224" "chr1:46774799-46775569"

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#### \$juncexpressed

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[1] "chr1:47799788-47834141" "chr1:47834287-47838627"
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[5] "chr1:47840657-47840869" "chr1:47840965-47842376"
[7] "chr1:110453684-110456881" "chr1:110457003-110458256"
[9] "chr1:110458318-110459915" "chr1:110460085-110464469"
[11] "chr1:110464616-110465788" "chr1:110464616-110466682"
[13] "chr1:110466812-110467398" "chr1:110467450-110467769"
[15] "chr1:110467824-110468685" "chr1:110467824-110471474"
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[59] "chr1:5923465-5923950" "chr1:5924093-5924398"

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| [63]  | "chr1:5926518-5927090"     | "chr1:5927175-5927800"     |
| [65]  | "chr1:5927956-5933312"     | "chr1:5933395-5934531"     |
| [67]  | "chr1:5937358-5940174"     | "chr1:5940299-5947346"     |
| [69]  | "chr1:5947526-5950928"     | "chr1:5951088-5964677"     |
| [71]  | "chr1:5964864-5965352"     | "chr1:5965543-5965692"     |
| [73]  | "chr1:5965843-5967175"     | "chr1:5967282-5969212"     |
| [75]  | "chr1:5969273-5987709"     | "chr1:5987847-5993207"     |
| [77]  | "chr1:5993389-6007164"     | "chr1:6007290-6008130"     |
| [79]  | "chr1:6008311-6012760"     | "chr1:6012896-6021854"     |
| [81]  | "chr1:6022009-6027359"     | "chr1:6027423-6029147"     |
| [83]  | "chr1:6029319-6038330"     | "chr1:6038473-6046215"     |
| [85]  | "chr1:6046387-6052304"     | "chr1:5934717-5934934"     |
| [87]  | "chr1:5965840-5967175"     | "chr1:5936583-5937153"     |
| [89]  | "chr1:5937358-5939406"     | "chr1:5939692-5940174"     |
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| [93]  | "chr1:10678474-10683076"   | "chr1:10683178-10684397"   |
| [95]  | "chr1:10684494-10687329"   | "chr1:10687420-10689588"   |
| [97]  | "chr1:10596354-10659295"   | "chr1:10596354-10678389"   |
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| [101] | "chr1:151196755-151199796" | "chr1:151199876-151204147" |
| [103] | "chr1:151204277-151204724" | "chr1:151204841-151205027" |
| [105] | "chr1:151205179-151206673" | "chr1:151206972-151209034" |
| [107] | "chr1:151209239-151210658" | "chr1:151209239-151211606" |
| [109] | "chr1:151210741-151211606" | "chr1:151211654-151212431" |
| [111] | "chr1:151212515-151214599" | "chr1:151212515-151219396" |
| [113] | "chr1:151214745-151214914" | "chr1:151215043-151219396" |
| [115] | "chr1:151219441-151220339" | "chr1:151196755-151196847" |
| [117] | "chr1:151196882-151199796" | "chr1:151212515-151214914" |
| [119] | "chr1:36040299-36042923"   | "chr1:36068975-36070834"   |
| [121] | "chr1:36070883-36074847"   | "chr1:36075009-36096875"   |
| [123] | "chr1:36096945-36101911"   | "chr1:36102033-36106943"   |
| [125] | "chr1:36043093-36070834"   | "chr1:33116923-33117515"   |
| [127] | "chr1:33117662-33123028"   | "chr1:33123173-33133826"   |
| [129] | "chr1:33133999-33134340"   | "chr1:33134455-33134573"   |
| [131] | "chr1:33134733-33134832"   | "chr1:33134958-33135087"   |
| [133] | "chr1:33135164-33138051"   | "chr1:33138127-33138243"   |
| [135] | "chr1:33138300-33138392"   | "chr1:33138502-33145241"   |
| [137] | "chr1:33116923-33117518"   | "chr1:205057943-205064001" |
| [139] | "chr1:205057943-205064115" | "chr1:205064192-205065810" |
| [141] | "chr1:205066039-205066454" | "chr1:205066523-205068117" |
| [143] | "chr1:205068234-205068869" | "chr1:205068940-205069039" |
| [145] | "chr1:205069192-205069280" | "chr1:205069399-205070728" |
| [147] | "chr1:205070837-205072985" | "chr1:205073147-205074156" |
| [149] | "chr1:205074296-205083917" | "chr1:205084033-205084986" |
| [151] | "chr1:205084089-205084986" | "chr1:205085011-205090983" |
| [153] | "chr1:205057940-205064001" | "chr1:8415180-8415479"     |
| [155] | "chr1:8415659-8416160"     | "chr1:8416306-8418256"     |
| [157] | "chr1:8418976-8419824"     | "chr1:8420046-8420172"     |
| [159] | "chr1:8421550-8421823"     | "chr1:8421936-8422743"     |
| [161] | "chr1:8422904-8424116"     | "chr1:8424315-8424806"     |

```

[163] "chr1:8424898-8425872"      "chr1:8426034-8482787"
[165] "chr1:8482867-8525985"      "chr1:8526083-8555123"
[167] "chr1:8555222-8557465"      "chr1:8557589-8568686"
[169] "chr1:8568734-8601273"      "chr1:8601377-8616534"
[171] "chr1:8616630-8617477"      "chr1:8617582-8674620"
[173] "chr1:8674745-8684369"      "chr1:8684439-8716032"
[175] "chr1:8716500-8813490"      "chr1:8716500-8877219"
[177] "chr1:8482867-8483621"      "chr1:8852647-8877219"
[179] "chr1:8716500-8852463"      "chr1:160709146-160717984"
[181] "chr1:160709146-160719611"  "chr1:160718304-160719611"
[183] "chr1:160719883-160720094"  "chr1:160719922-160720094"
[185] "chr1:160720213-160721135"  "chr1:160720213-160721976"
[187] "chr1:160721238-160721976"  "chr1:160722038-160722896"
[189] "chr1:205760846-205763998"  "chr1:205764146-205764472"
[191] "chr1:205764606-205766052"  "chr1:205766131-205767032"
[193] "chr1:205767179-205767797"  "chr1:205767943-205768085"
[195] "chr1:205768229-205768887"  "chr1:205768958-205770081"
[197] "chr1:205770188-205779198"  "chr1:205780215-205781936"
[199] "chr1:15479280-15541391"    "chr1:15480450-15541391"
[201] "chr1:15541927-15545822"    "chr1:15480450-15536986"
[203] "chr1:15537058-15541391"    "chr1:226034633-226034735"
[205] "chr1:226034914-226036193"  "chr1:226036255-226036598"
[207] "chr1:226036713-226037613"  "chr1:226037780-226040365"
[209] "chr1:226040470-226041330"  "chr1:226041492-226043579"
[211] "chr1:226043641-226044353"  "chr1:226044439-226044611"
[213] "chr1:226044717-226046896"  "chr1:226047049-226048560"
[215] "chr1:226048697-226049918"  "chr1:226050051-226050155"
[217] "chr1:226050278-226050471"  "chr1:226050551-226053597"
[219] "chr1:226053667-226054274"  "chr1:226054382-226054812"
[221] "chr1:226054863-226055588"  "chr1:226055730-226058776"
[223] "chr1:226058813-226059687"  "chr1:226059753-226061988"
[225] "chr1:226062067-226065095"  "chr1:226065294-226066920"
[227] "chr1:226067110-226070004"  "chr1:12227226-12248853"
[229] "chr1:12248952-12251014"    "chr1:12251142-12251831"
[231] "chr1:12251980-12252488"    "chr1:12252581-12252920"
[233] "chr1:12253155-12254012"    "chr1:12254089-12254641"
[235] "chr1:12254675-12262024"    "chr1:12262228-12266797"
[237] "chr1:12227226-12251014"    "chr1:46769492-46774773"
[239] "chr1:46774799-46775827"    "chr1:46775716-46775827"
[241] "chr1:46775988-46782224"    "chr1:46774799-46775569"

```

```
> print(overlapMat[["Rest"]][["CMPK1"]])
```

```

chr1:47799788-47834141 chr1:47834287-47838627
chr1:47799788-47834141      1      0
chr1:47834287-47838627      0      1
chr1:47838779-47840581      0      0
chr1:47838779-47840869      0      0
chr1:47840657-47840869      0      0
chr1:47840965-47842376      0      0
chr1:47838779-47840581 chr1:47838779-47840869
chr1:47799788-47834141      0      0

```

```

chr1:47834287-47838627      0      0
chr1:47838779-47840581      1      1
chr1:47838779-47840869      1      1
chr1:47840657-47840869      0      1
chr1:47840965-47842376      0      0
chr1:47840657-47840869 chr1:47840965-47842376
chr1:47799788-47834141      0      0
chr1:47834287-47838627      0      0
chr1:47838779-47840581      0      0
chr1:47838779-47840869      1      0
chr1:47840657-47840869      1      0
chr1:47840965-47842376      0      1
chr1:47799788-47834141 chr1:47834287-47838627
chr1:47799788-47834141      1      0
chr1:47834287-47838627      0      1
chr1:47838779-47840581      0      0
chr1:47838779-47840869      0      0
chr1:47840657-47840869      0      0
chr1:47840965-47842376      0      0
chr1:47838779-47840581 chr1:47838779-47840869
chr1:47799788-47834141      0      0
chr1:47834287-47838627      0      0
chr1:47838779-47840581      1      1
chr1:47838779-47840869      1      1
chr1:47840657-47840869      0      1
chr1:47840965-47842376      0      0
chr1:47840657-47840869 chr1:47840965-47842376
chr1:47799788-47834141      0      0
chr1:47834287-47838627      0      0
chr1:47838779-47840581      0      0
chr1:47838779-47840869      1      0
chr1:47840657-47840869      1      0
chr1:47840965-47842376      0      1

```

>

Another important function is kendall- $\tau$  restricted.

```

> V <- cbind(c(1,5,3),c(3,2,1))
      [,1] [,2]
[1,]    1    3
[2,]    5    2
[3,]    3    1

> rownames(V) <- c("F1","F2","F3")
[1] "F1" "F2" "F3"

> colnames(V) <- c("S1","S2")
[1] "S1" "S2"

```



```

> GSReg.kendall1.tau.distance(V)

      S1      S2
S1 0.0000000 0.6666667
S2 0.6666667 0.0000000

> myRest1 <- cbind(c(0,1,1),c(1,0,1),c(1,1,0))

      [,1] [,2] [,3]
[1,]    0    1    1
[2,]    1    0    1
[3,]    1    1    0

> rownames(myRest1) <- rownames(V)

[1] "F1" "F2" "F3"

> colnames(myRest1) <- rownames(V)

[1] "F1" "F2" "F3"

> GSReg.kendall1.tau.distance.restricted(V,myRest1)

      S1      S2
S1 0.0000000 0.6666666
S2 0.6666666 0.0000000

> GSReg.kendall1.tau.distance(V)

      S1      S2
S1 0.0000000 0.6666667
S2 0.6666667 0.0000000

> myRest2 <- cbind(c(0,0,1),c(0,0,1),c(1,1,0))

      [,1] [,2] [,3]
[1,]    0    0    1
[2,]    0    0    1
[3,]    1    1    0

> rownames(myRest2) <- rownames(V)

[1] "F1" "F2" "F3"

> colnames(myRest2) <- rownames(V)

[1] "F1" "F2" "F3"

> GSReg.kendall1.tau.distance.restricted(V,myRest2)

      S1      S2
S1 0.0000000 0.4999999
S2 0.4999999 0.0000000

> Temp1 <- cbind(c(0,1,1),c(0,0,0),c(0,1,0))

```

```

      [,1] [,2] [,3]
[1,]    0    0    0
[2,]    1    0    1
[3,]    1    0    0

> rownames(Temp1) <- rownames(V)

[1] "F1" "F2" "F3"

> colnames(Temp1) <- rownames(V)

[1] "F1" "F2" "F3"

> GSReg.kendall.tau.distance.template(V,Temp = Temp1)

      S1      S2
1.0000000 0.3333333

```

Now, we can use SEVA function and use the data from the paper [?].

```

> data(juncExprsSimulated)
> SEVAjunc <- GSReg.SEVA(juncExprs = junc.RPM.Simulated,
                        phenoVect = phenotypes,
                        geneexpr = geneExprsGSReg)
> print(sapply(SEVAjunc,function(x) x$pvalue))

      CMPK1      CSF1      FAM72B      KLHL12      KLHL21      MYSM1      NPHP4
1.00000000 1.00000000 0.00000000 0.00000000 0.19089848 0.00000000 0.53048443
      PEX14      PIP5K1A      PSMB2      RBBP4      RBBP5      RERE      SLAMF7
0.81734872 0.00000000 1.00000000 0.00000000 0.07123363 0.29801755 0.00000000
      SLC41A1      TMEM51      TMEM63A      TNFRSF1B      UQCRH
1.00000000 0.09424228 1.00000000 1.00000000 0.00000000

> #if you want to check Translational as well you can use 2 other p-values
> print(sapply(SEVAjunc,function(x) x$pvalueTotal))

      CMPK1      CSF1      FAM72B      KLHL12      KLHL21      MYSM1      NPHP4
1.00000000 1.00000000 0.00000000 0.00000000 0.26032517 0.00000000 1.00000000
      PEX14      PIP5K1A      PSMB2      RBBP4      RBBP5      RERE      SLAMF7
1.00000000 0.00000000 1.00000000 0.00000000 0.02343778 0.89405265 0.00000000
      SLC41A1      TMEM51      TMEM63A      TNFRSF1B      UQCRH
1.00000000 0.17473402 1.00000000 1.00000000 0.00000000

>

```

## 4 System Information

Session information:

```
> toLatex(sessionInfo())
```

- R version 4.1.1 Patched (2021-08-22 r80813), x86\_64-apple-darwin17.0
- Locale: C/en\_US.UTF-8/en\_US.UTF-8/C/en\_US.UTF-8/en\_US.UTF-8
- Running under: macOS Mojave 10.14.6
- Matrix products: default
- BLAS:  
/Library/Frameworks/R.framework/Versions/4.1/Resources/lib/libRblas.0.dylib
- LAPACK:  
/Library/Frameworks/R.framework/Versions/4.1/Resources/lib/libRlapack.dylib
- Base packages: base, datasets, grDevices, graphics, methods, stats, stats4, utils
- Other packages: AnnotationDbi 1.56.0, Biobase 2.54.0, BiocGenerics 0.40.0, GO.db 3.14.0, GSBenchMark 1.13.0, GSReg 1.28.0, GenomeInfoDb 1.30.0, GenomicFeatures 1.46.0, GenomicRanges 1.46.0, Homo.sapiens 1.3.1, IRanges 2.28.0, OrganismDbi 1.36.0, S4Vectors 0.32.0, TxDb.Hsapiens.UCSC.hg19.knownGene 3.2.2, org.Hs.eg.db 3.14.0
- Loaded via a namespace (and not attached): BiocFileCache 2.2.0, BiocIO 1.4.0, BiocManager 1.30.16, BiocParallel 1.28.0, Biostrings 2.62.0, DBI 1.1.1, DelayedArray 0.20.0, GenomeInfoDbData 1.2.7, GenomicAlignments 1.30.0, KEGGREST 1.34.0, Matrix 1.3-4, MatrixGenerics 1.6.0, R6 2.5.1, RBGL 1.70.0, RCurl 1.98-1.5, RSQLite 2.2.8, Rcpp 1.0.7, Rsamtools 2.10.0, SummarizedExperiment 1.24.0, XML 3.99-0.8, XVector 0.34.0, assertthat 0.2.1, biomaRt 2.50.0, bit 4.0.4, bit64 4.0.5, bitops 1.0-7, blob 1.2.2, cachem 1.0.6, compiler 4.1.1, crayon 1.4.1, curl 4.3.2, dbplyr 2.1.1, digest 0.6.28, dplyr 1.0.7, ellipsis 0.3.2, fansi 0.5.0, fastmap 1.1.0, filelock 1.0.2, generics 0.1.1, glue 1.4.2, graph 1.72.0, grid 4.1.1, hms 1.1.1, httr 1.4.2, lattice 0.20-45, lifecycle 1.0.1, magrittr 2.0.1, matrixStats 0.61.0, memoise 2.0.0, parallel 4.1.1, pillar 1.6.4, pkgconfig 2.0.3, png 0.1-7, prettyunits 1.1.1, progress 1.2.2, purrr 0.3.4, rappdirs 0.3.3, restfulr 0.0.13, rjson 0.2.20, rlang 0.4.12, rstudioapi 0.13, rtracklayer 1.54.0, stringi 1.7.5, stringr 1.4.0, tibble 3.1.5, tidyselect 1.1.1, tools 4.1.1, utf8 1.2.2, vctrs 0.3.8, xml2 1.3.2, yaml 2.2.1, zlibbioc 1.40.0

## 5 Literature Cited

### References

- [1] James A Eddy, Leroy Hood, Nathan D Price, and Donald Geman. Identifying tightly regulated and variably expressed networks by differential rank conservation (dirac). *PLoS computational biology*, 6(5):e1000792, 2010.
- [2] Bahman Afsari. *Modeling cancer phenotypes with order statistics of transcript data*. PhD thesis, Johns Hopkins University, 2013.
- [3] Maurice G Kendall. A new measure of rank correlation. *Biometrika*, 1938.