0.fit_qinlabrls.Rmd

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June 9, July 6-11, 2016

20170424. Major bug found. file names and strains names are inconsistent.

20160711-> Fitting RLS dataset merged by strains.

20160706-0711. Finished batch fitting of all individual RLS data sets. The fitting results showed that 'n' are often in the range of [5,7], though it is very noisy.

```
rm(list=ls())
#setwd("~/github/0.network.aging.prj.bmc/0a.rls.fitting")
setwd("~/github/bmc_netwk_aging_manuscript/R1/0.nat.rls.fitting")
library('flexsurv')
```

```
## Loading required package: survival
```

```
source("../lifespan.r")
```

Parse strains from files

```
files = list.files(path="../qinlab_rls/", pattern="rls.tab")
tmp1 = gsub("\\d{6}.", "", files)
redundant_strains = gsub(".rls.tab", "", tmp1)
strains = sort( unique( redundant_strains ))
strains
```

```
##  [1] "101S"           "BY4716"         "BY4741"         "BY4742"
##  [5] "BY4743"         "JSBY4741"       "M1-2"           "M13"
##  [9] "M14"            "M2-8"           "M22"            "M32"
## [13] "M34"            "M5"             "M8"             "RM112N"
## [17] "S288c"          "SGU57"          "sir2D.4741a"    "sir2D.4742"
## [21] "sir2DSIR2.4742" "SK1"            "W303"           "YPS128"
## [25] "YPS163"
```

Take files from natural isolates

```
my.strains=c("101S", "M1-2","M13","M14","M2-8","M22","M32","M34","M5","M8","RM112N","S288c","SGU57", "Y
files2=c();
for( i in 1:length(my.strains)){
 files2 = c( files2, files[grep(my.strains[i], files)]);
}

report = data.frame(cbind(my.strains))
report$samplesize = NA; report$R=NA; report$t0=NA; report$n=NA; report$G=NA; report$longfilename=NA;

files = files2;
strains = my.strains;
```

Explore the fitting outcomes of 'flexsurv'.

```
i=2
  tb = read.table( paste("../qinlab_rls/",files[i],sep=''), sep="\t")
  GompFlex = flexsurvreg(formula = Surv(tb[,1]) ~ 1, dist = 'gompertz')
  WeibFlex = flexsurvreg(formula = Surv(tb[,1]) ~ 1, dist = 'weibull')
#str(GompFlex)
GompFlex$res
```

```
##                est         L95%        U95%           se
## shape 0.1687294394 0.1133678236 0.224091055 0.0282462414
## rate  0.0006950097 0.0001325189 0.003645052 0.0005876487
```

```
GompFlex$res.t
```

```
##              est       L95%       U95%         se
## shape  0.1687294  0.1133678  0.2240911 0.02824624
## rate  -7.2715847 -8.9287849 -5.6143845 0.84552585
```

```
GompFlex$opt$hessian
```

```
##            shape     rate
## shape 23297.3140 757.0619
## rate    757.0619  26.0000
```

```
#str(WeibFlex)
```

Now, fit all RLS data sets by strains

```
for( i in 1:length(report[,1])){
#for( i in 3:4){
  my.files = files[grep(strains[i], files)]
  report$longfilename[i] = paste(my.files, collapse = "::");
  tb = read.table( paste("../qinlab_rls/",my.files[1],sep=''), sep="\t")
  if( length(my.files)> 1){
    for( fi in 2:length(my.files)) {
      tmp.tb = read.table( paste("../qinlab_rls/",my.files[fi],sep=''), sep="\t")
      tb = rbind( tb, tmp.tb)
    }
  }
  report$samplesize[i] = length(tb[,1])

  GompFlex = flexsurvreg(formula = Surv(tb[,1]) ~ 1, dist = 'gompertz')
  WeibFlex = flexsurvreg(formula = Surv(tb[,1]) ~ 1, dist = 'weibull')

  report$avgLS[i] =  mean(tb[,1])
  report$stdLS[i] =  sd(tb[,1])
  report$CV[i] = report$stdLS[i] / report$avgLS[i]

  report$GompGFlex[i] = GompFlex$res[1,1]
  report$GompRFlex[i] = GompFlex$res[2,1]
  report$GompLogLikFlex[i] = round(GompFlex$loglik, 1)
  report$GompAICFlex[i] = round(GompFlex$AIC)
```

```
  report$WeibShapeFlex[i] = WeibFlex$res[1,1]
  report$WeibRateFlex[i] = WeibFlex$res[2,1]
  report$WeibLogLikFlex[i] = round(WeibFlex$loglik, 1)
  report$WeibAICFlex[i] = round(WeibFlex$AIC)

  #set initial values
  Rhat = report$GompRFlex[i]; # 'i' was missing. a bug costed HQ a whole afternoon.
  Ghat = report$GompGFlex[i];
  nhat = 6;
  t0= (nhat-1)/Ghat;
  fitBinom = optim ( c(Rhat, t0, nhat),  llh.binomialMortality.single.run,
                     lifespan=tb[,1],
                     #method='SANN') #SANN needs control
                     method="L-BFGS-B",
                     lower=c(1E-10, 1, 4), upper=c(1,200,20) );
  report[i, c("R", "t0", "n")] = fitBinom$par[1:3]
  report$G[i] = (report$n[i] - 1)/report$t0[i]
}
```

Show the results

```
#report[ grep("tBY", report$strains), ]
report
```

```
##    my.strains samplesize           R       t0        n          G
## 1        101S         85 0.001963826 36.96827 7.286027 0.17003846
## 2        M1-2         54 0.002597778 40.44275 7.581458 0.16273519
## 3         M13         70 0.002863446 40.56801 7.650792 0.16394178
## 4         M14         60 0.004156533 54.65063 6.031192 0.09206101
## 5        M2-8        105 0.003438767 42.75291 8.026908 0.16436094
## 6         M22         60 0.004669075 46.38267 6.035812 0.10857096
## 7         M32         60 0.001856854 35.31281 7.690560 0.18946549
## 8         M34         58 0.002238125 31.64343 7.085632 0.19231896
## 9          M5        166 0.003348780 74.58364 7.898541 0.09249403
## 10         M8         60 0.001863662 31.46248 6.021022 0.15958760
## 11     RM112N         59 0.002702475 55.93484 6.023393 0.08980795
## 12      S288c         41 0.004995123 57.42117 7.948488 0.12100918
## 13      SGU57         58 0.006334776 55.69961 7.714361 0.12054593
## 14     YPS128         69 0.002045751 41.96634 6.960180 0.14202285
## 15     YPS163        130 0.001820701 36.99506 6.820331 0.15732725
##                                                                                longfilename
## 1                                  060805.101S.rls.tab::091904.101S.rls.tab::122004.101S.rls.tab
## 2                                                      030905.M1-2.rls.tab::091904.M1-2.rls.tab
## 3                                                        030205.M13.rls.tab::051704.M13.rls.tab
## 4                                                        030905.M14.rls.tab::032105.M14.rls.tab
## 5                                                      011705.M2-8.rls.tab::020105.M2-8.rls.tab
## 6                                                        030905.M22.rls.tab::090104.M22.rls.tab
## 7                                                        020905.M32.rls.tab::122004.M32.rls.tab
## 8                                                        010305.M34.rls.tab::030105.M34.rls.tab
## 9  020205.M5.rls.tab::040805.M5.rls.tab::041505.M5.rls.tab::090104.M5.rls.tab::122004.M5.rls.tab
## 10                                                       030205.M8.rls.tab::030905.M8.rls.tab
## 11                                                 032105.RM112N.rls.tab::042805.RM112N.rls.tab
## 12                                                                  051704.S288c.rls.tab
## 13                                                   042805.SGU57.rls.tab::091904.SGU57.rls.tab
```

```
## 14                                                 010305.YPS128.rls.tab::020105.YPS128.rls.tab
## 15    010305.YPS163.rls.tab::020905.YPS163.rls.tab::030105.YPS163.rls.tab::040805.YPS163.rls.tab
##       avgLS     stdLS        CV  GompGFlex    GompRFlex GompLogLikFlex
## 1  31.34118  7.512772 0.2397093 0.13407292 0.0012654562         -295.0
## 2  27.83333  9.201620 0.3305971 0.12310344 0.0024494207         -193.6
## 3  26.54286  9.142488 0.3444425 0.12284897 0.0029261133         -250.1
## 4  36.55000 12.804164 0.3503191 0.09148573 0.0019510502         -233.7
## 5  24.80952  8.133614 0.3278424 0.11608390 0.0043612883         -373.3
## 6  31.83333 10.271182 0.3226549 0.10778993 0.0021454528         -222.9
## 7  27.96667  6.888868 0.2463242 0.14043277 0.0017384578         -205.6
## 8  27.01724  8.206740 0.3037593 0.15692797 0.0012896468         -198.0
## 9  36.62651 12.938747 0.3532618 0.06684902 0.0041472501         -670.1
## 10 34.93333  6.905823 0.1976858 0.15888831 0.0003653141         -201.9
## 11 44.06780 13.006450 0.2951464 0.08938574 0.0010363304         -232.0
## 12 26.26829 10.254327 0.3903690 0.08686882 0.0064512047         -154.2
## 13 23.86207 10.538898 0.4416590 0.08956763 0.0076748634         -216.5
## 14 35.00000  9.719598 0.2777028 0.11866014 0.0011041546         -252.2
## 15 34.43077  8.591449 0.2495282 0.13387276 0.0007889455         -459.6
##    GompAICFlex WeibShapeFlex WeibRateFlex WeibLogLikFlex WeibAICFlex
## 1          594      4.778139     34.15561         -291.0         586
## 2          391      3.538533     30.92356         -195.6         395
## 3          504      3.114056     29.26548         -259.1         522
## 4          471      3.361407     40.80155         -236.8         478
## 5          751      3.371375     27.61417         -368.5         741
## 6          450      3.596392     35.37118         -223.9         452
## 7          415      4.419104     30.62828         -201.4         407
## 8          400      3.985745     29.77062         -203.7         411
## 9         1344      3.098392     40.98709         -658.3        1321
## 10         408      5.872213     37.70008         -200.1         404
## 11         468      4.038465     48.63895         -233.7         471
## 12         312      2.792964     29.42942         -153.3         311
## 13         437      2.455703     26.85910         -218.2         440
## 14         508      4.294122     38.52990         -253.0         510
## 15         923      4.825655     37.62671         -460.2         924
```

```
summary(report[, c("avgLS", "t0", "n")])
```

```
##      avgLS             t0              n
##  Min.   :23.86   Min.   :31.46   Min.   :6.021
##  1st Qu.:26.78   1st Qu.:36.98   1st Qu.:6.428
##  Median :31.34   Median :41.97   Median :7.286
##  Mean   :31.27   Mean   :45.52   Mean   :7.118
##  3rd Qu.:34.97   3rd Qu.:55.18   3rd Qu.:7.702
##  Max.   :44.07   Max.   :74.58   Max.   :8.027
```

Calculate lambda based on t0 = (1-p)/(p Lambda) So, 1/lambda = t0 * p / (1-p)

```
p = 0.7
report$One.over.lambdaP07 = report$t0 * p/ (1-p)
report[, c("t0", "One.over.lambdaP07")]
```

```
##          t0 One.over.lambdaP07
## 1  36.96827           86.25929
## 2  40.44275           94.36642
## 3  40.56801           94.65870
## 4  54.65063          127.51813
```

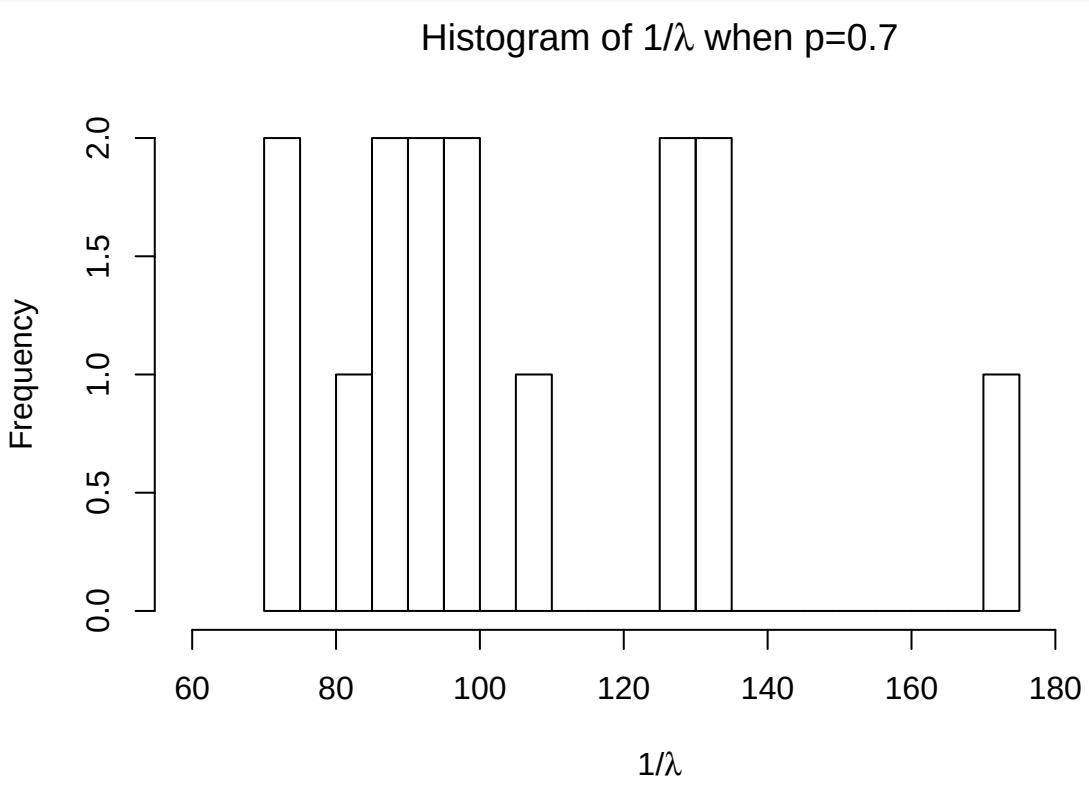
```
## 5  42.75291           99.75678
## 6  46.38267          108.22624
## 7  35.31281           82.39657
## 8  31.64343           73.83468
## 9  74.58364          174.02849
## 10 31.46248           73.41245
## 11 55.93484          130.51462
## 12 57.42117          133.98272
## 13 55.69961          129.96576
## 14 41.96634           97.92146
## 15 36.99506           86.32181
```

```
summary( report[, c("t0", "One.over.lambdaP07")])
```

```
##        t0        One.over.lambdaP07
##  Min.   :31.46   Min.   : 73.41
##  1st Qu.:36.98   1st Qu.: 86.29
##  Median :41.97   Median : 97.92
##  Mean   :45.52   Mean   :106.21
##  3rd Qu.:55.18   3rd Qu.:128.74
##  Max.   :74.58   Max.   :174.03
```

Histogram of 1/lambda for p=0.7

```
hist(report$One.over.lambdaP07, br=20, xlim=c(60,190), xlab=expression(paste("1/",lambda) ), main=expres
```




```
p = 0.9
report$One.over.lambdaP09 = report$t0 * p/ (1-p)
report[, c("t0", "One.over.lambdaP09")]
```

```
##          t0 One.over.lambdaP09
## 1  36.96827           332.7144
```

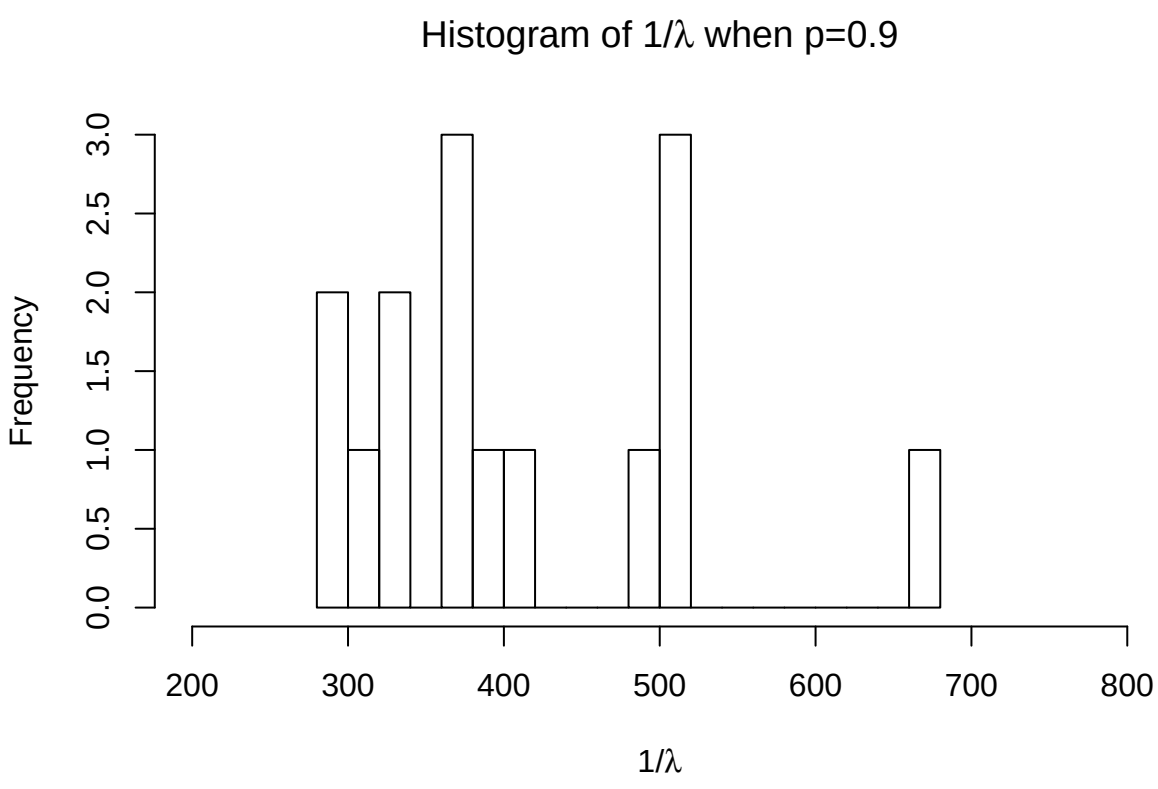
```
## 2  40.44275           363.9847
## 3  40.56801           365.1121
## 4  54.65063           491.8556
## 5  42.75291           384.7762
## 6  46.38267           417.4441
## 7  35.31281           317.8153
## 8  31.64343           284.7909
## 9  74.58364           671.2527
## 10 31.46248           283.1623
## 11 55.93484           503.4135
## 12 57.42117           516.7905
## 13 55.69961           501.2965
## 14 41.96634           377.6971
## 15 36.99506           332.9555
```

```
summary( report[, c("t0", "One.over.lambdaP09")] )
```

```
##        t0        One.over.lambdaP09
##  Min.   :31.46   Min.   :283.2
##  1st Qu.:36.98   1st Qu.:332.8
##  Median :41.97   Median :377.7
##  Mean   :45.52   Mean   :409.7
##  3rd Qu.:55.18   3rd Qu.:496.6
##  Max.   :74.58   Max.   :671.3
```

Histogram 1/lambda, p=0.9

```
hist(report$One.over.lambdaP09, br=20, xlim=c(200,800), xlab=expression(paste("1/",lambda) ), main=expr
```



Explorative analysis

```
# my.strains=c("101S", "BY4743","M1-2","M13","M14","M2-8","M22","M32","M34","M5","M8","RM112N","S288c",

#my.strains=c("101S", "M1-2","M13","M14","M2-8","M22","M32","M34","M5","M8","RM112N","S288c","SGU57", "
report2 = report
summary(lm(log10(report2$GompRFlex) ~ report2$GompGFlex))
```

```
##
## Call:
## lm(formula = log10(report2$GompRFlex) ~ report2$GompGFlex)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.50796 -0.22010 -0.03155  0.20504  0.36320
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)        -1.6976     0.3278  -5.179 0.000177 ***
## report2$GompGFlex  -8.7148     2.7614  -3.156 0.007585 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.2789 on 13 degrees of freedom
## Multiple R-squared:  0.4338, Adjusted R-squared:  0.3902
## F-statistic:  9.96 on 1 and 13 DF,  p-value: 0.007585
```

```
summary(lm(log10(report2$R) ~ report2$GompGFlex))
```

```
##
## Call:
## lm(formula = log10(report2$R) ~ report2$GompGFlex)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.16896 -0.09699  0.01555  0.08156  0.21625
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)        -1.9873     0.1451 -13.699 4.21e-09 ***
## report2$GompGFlex  -4.7701     1.2223  -3.903  0.00182 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1234 on 13 degrees of freedom
## Multiple R-squared:  0.5395, Adjusted R-squared:  0.5041
## F-statistic: 15.23 on 1 and 13 DF,  p-value: 0.001817
```

```
summary(lm(log10(report2$R) ~ report2$G)) #G from t0 and n
```

```
##
## Call:
## lm(formula = log10(report2$R) ~ report2$G)
##
## Residuals:
```

```
##       Min        1Q    Median        3Q       Max
## -0.191584 -0.112059  0.002454  0.085419  0.274808
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -2.0949     0.1574 -13.313 5.96e-09 ***
## report2$G    -3.1369     1.0797  -2.905   0.0123 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1417 on 13 degrees of freedom
## Multiple R-squared:  0.3937, Adjusted R-squared:  0.3471
## F-statistic: 8.441 on 1 and 13 DF,  p-value: 0.01228
```

```
summary(lm(report2$GompGFlex ~ report2$G)) #good agreement bwteen GFlex and G from binomial modeling
```

```
##
## Call:
## lm(formula = report2$GompGFlex ~ report2$G)
##
## Residuals:
##        Min         1Q     Median         3Q        Max
## -0.0158806 -0.0099107 -0.0007003  0.0080448  0.0311292
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.02065    0.01524   1.355    0.199
## report2$G    0.67115    0.10459   6.417 2.28e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.01372 on 13 degrees of freedom
## Multiple R-squared:  0.7601, Adjusted R-squared:  0.7416
## F-statistic: 41.18 on 1 and 13 DF,  p-value: 2.281e-05
```

```
summary(lm(log10(report2$R) ~ report2$t0)) #G from t0 and n
```

```
##
## Call:
## lm(formula = log10(report2$R) ~ report2$t0)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.218092 -0.103701  0.003555  0.086222  0.242351
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -2.982154   0.143440 -20.790 2.33e-11 ***
## report2$t0   0.009722   0.003055   3.183   0.0072 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1364 on 13 degrees of freedom
## Multiple R-squared:  0.4379, Adjusted R-squared:  0.3947
## F-statistic: 10.13 on 1 and 13 DF,  p-value: 0.007204
```

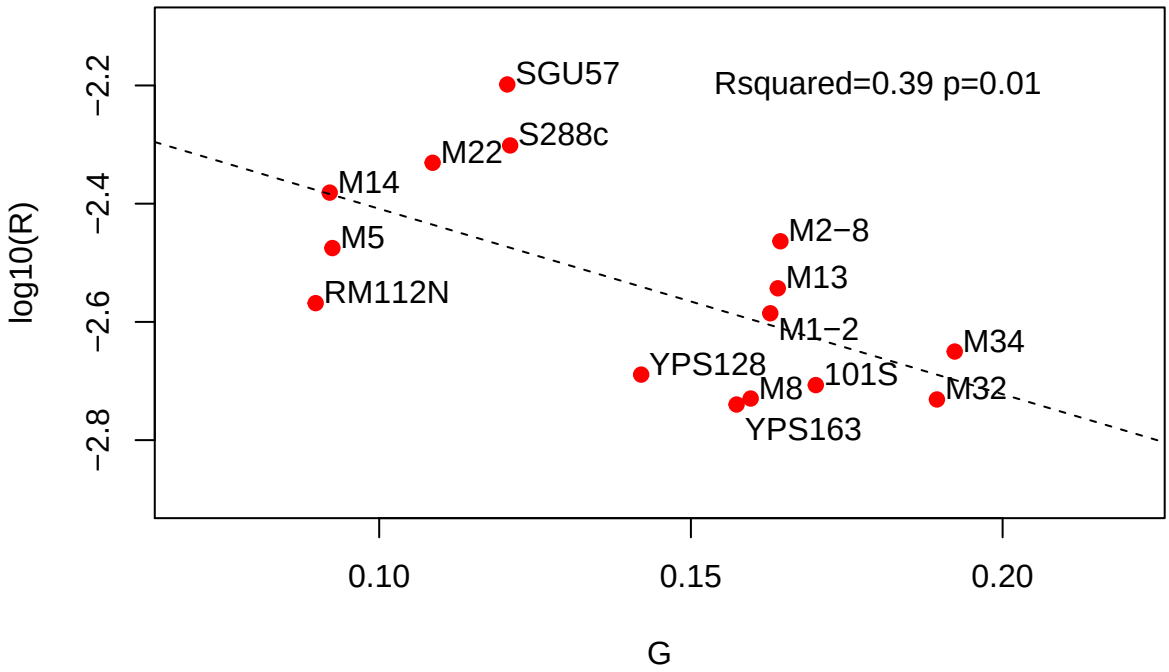
```r
summary(lm(log10(report2$R) ~ report2$n)) #G from t0 and n
```

```
##
## Call:
## lm(formula = log10(report2$R) ~ report2$n)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.21173 -0.14773 -0.02223  0.12030  0.32038
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -2.78978    0.44916  -6.211 3.16e-05 ***
## report2$n    0.03515    0.06276   0.560    0.585
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1798 on 13 degrees of freedom
## Multiple R-squared:  0.02355,    Adjusted R-squared:  -0.05156
## F-statistic: 0.3136 on 1 and 13 DF,  p-value: 0.585
```

Strehler-Mildvan correlation in natural isolates

```r
plot( log10(report2$R) ~ report2$G, pch=19, col='red', xlab='G', ylab='log10(R)',
      xlim=c(0.07, 0.22), ylim=c(-2.9, -2.1),
      main="Strehler-Mildvan correlation in yeast wild isolates")
m = lm(log10(report2$R) ~ report2$G)
abline (m, col='black', lty=2);
text(0.18, -2.2, "Rsquared=0.39 p=0.01")

my.x = report2$G +0.0013 ; my.y = log10(report2$R) ;
names(my.x) = report2$my.strains; names(my.y) = report2$my.strains;
my.y[c("YPS163", "M1-2" )]=c(-2.8, -2.63)
text(my.x,my.y, report2$my.strains, adj=c(0,0) )
```




```
summary(lm(log10(report2$R) ~ report2$G)) #G from t0 and n
```

```
##
## Call:
## lm(formula = log10(report2$R) ~ report2$G)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.191584 -0.112059  0.002454  0.085419  0.274808
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -2.0949     0.1574 -13.313 5.96e-09 ***
## report2$G    -3.1369     1.0797  -2.905   0.0123 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1417 on 13 degrees of freedom
## Multiple R-squared:  0.3937, Adjusted R-squared:  0.3471
## F-statistic: 8.441 on 1 and 13 DF,  p-value: 0.01228
```

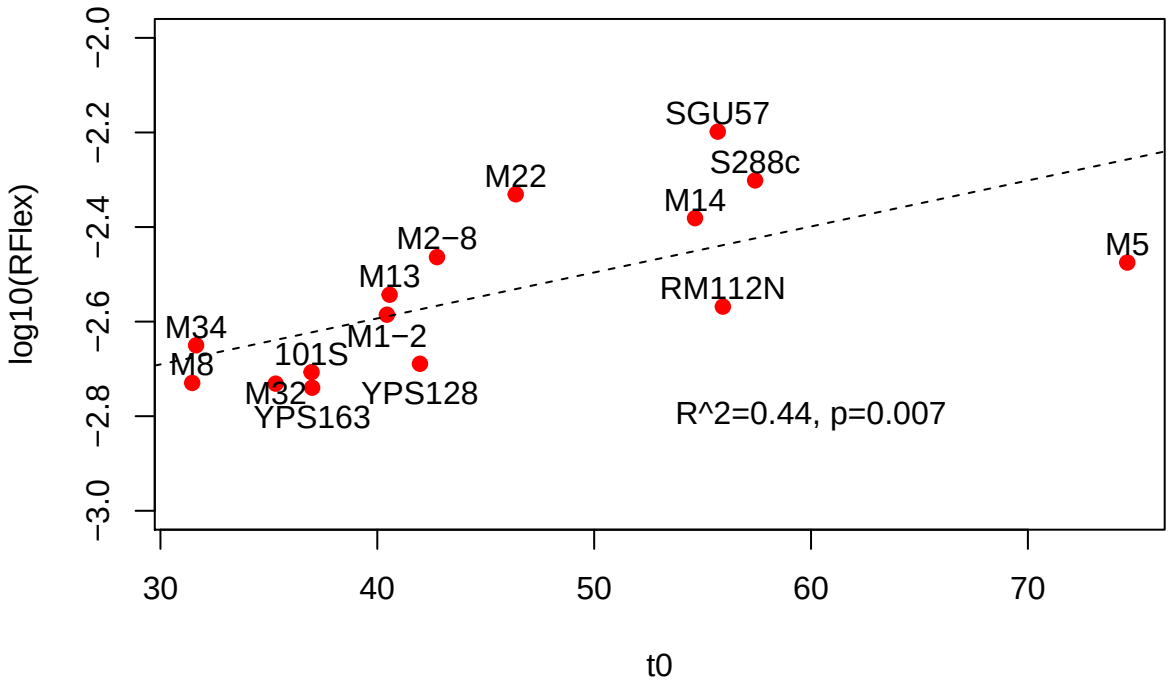
```
summary(lm(log10(report2$GompRFlex) ~ report2$GompGFlex)) #G from t0 and n
```

```
##
## Call:
## lm(formula = log10(report2$GompRFlex) ~ report2$GompGFlex)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.50796 -0.22010 -0.03155  0.20504  0.36320
##
```

```
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)        -1.6976     0.3278  -5.179 0.000177 ***
## report2$GompGFlex  -8.7148     2.7614  -3.156 0.007585 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.2789 on 13 degrees of freedom
## Multiple R-squared:  0.4338, Adjusted R-squared:  0.3902
## F-statistic:  9.96 on 1 and 13 DF,  p-value: 0.007585
```

plot log10(R) ~ t0

```
plot( log10(report2$R) ~ report2$t0, col='red',  pch=19, xlab='t0', ylab='log10(RFlex)', ylim=c(-3,-2))
my.x = report2$t0; my.y = log10(report2$R) + 0.04;
names(my.x) = report2$my.strains; names(my.y) = report2$my.strains;
my.y[c("M32","YPS163", "YPS128", "M1-2" )]=c(-2.75, -2.8, -2.75, -2.63)
text(my.x,my.y, report2$my.strains )
m = lm(  log10(report2$R) ~ report2$t0  )
abline (m, col='black', lty=2);
text( 60, -2.8, "R^2=0.44, p=0.007")
```



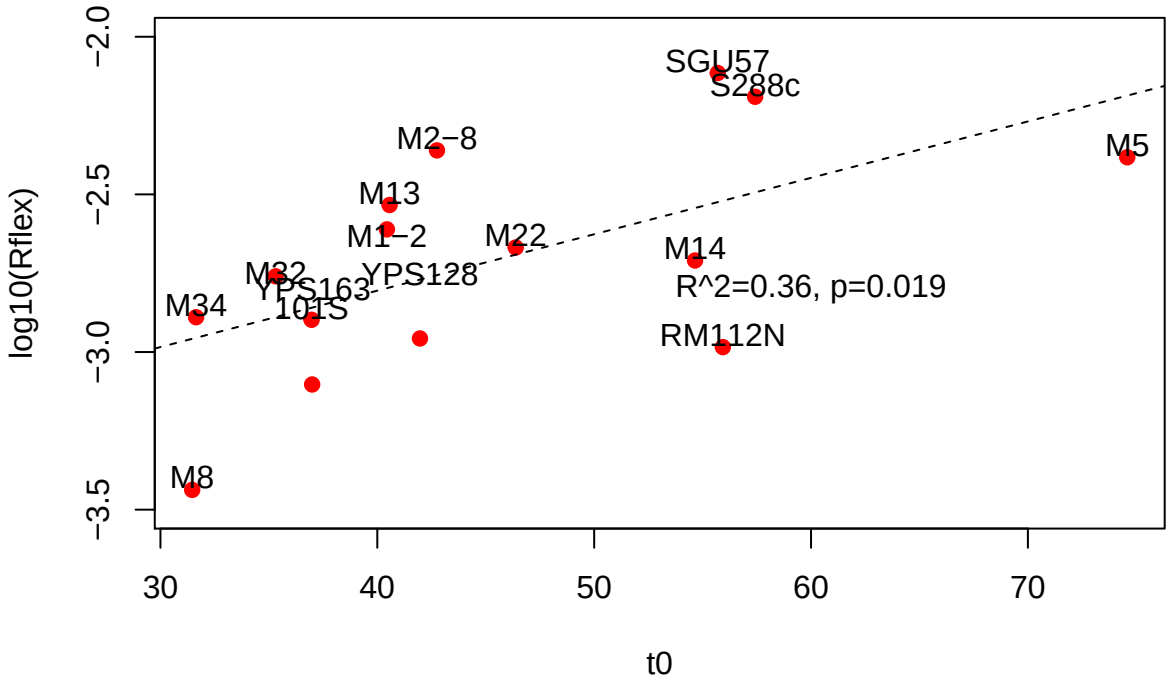

```
summary(m)
```

```
##
## Call:
## lm(formula = log10(report2$R) ~ report2$t0)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.218092 -0.103701  0.003555  0.086222  0.242351
```

```
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -2.982154   0.143440 -20.790 2.33e-11 ***
## report2$t0   0.009722   0.003055   3.183   0.0072 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1364 on 13 degrees of freedom
## Multiple R-squared:  0.4379, Adjusted R-squared:  0.3947
## F-statistic: 10.13 on 1 and 13 DF,  p-value: 0.007204
```

plot log10(GompRFlex) ~ t0

```
plot( log10(report2$GompRFlex) ~ report2$t0, col='red',  pch=19, xlab='t0', ylab='log10(Rflex)', ylim=c
my.x = report2$t0; my.y = log10(report2$GompRFlex) + 0.04;
names(my.x) = report2$my.strains; names(my.y) = report2$my.strains;
my.y[c("M32","YPS163", "YPS128", "M1-2" )]=c(-2.75, -2.8, -2.75, -2.63)
text(my.x,my.y, report2$my.strains )
m = lm(  log10(report2$GompRFlex) ~ report2$t0  )
abline (m, col='black', lty=2);
text( 60, -2.8, "R^2=0.36, p=0.019")
```




```
summary(m)
```

```
##
## Call:
## lm(formula = log10(report2$GompRFlex) ~ report2$t0)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
```

```
## -0.47921 -0.19118  0.02271  0.22402  0.40957
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -3.521012   0.312535 -11.266 4.44e-08 ***
## report2$t0   0.017891   0.006656   2.688   0.0186 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.2972 on 13 degrees of freedom
## Multiple R-squared:  0.3572, Adjusted R-squared:  0.3078
## F-statistic: 7.225 on 1 and 13 DF,  p-value: 0.01862
```

Could t0 be the cause of logR-G correlation?

Partial regression on G ~ log(R) + t0.

```
summary(lm( log10(report2$GompRFlex) ~ report2$t0 + report2$GompGFlex  )) #poor
```

```
##
## Call:
## lm(formula = log10(report2$GompRFlex) ~ report2$t0 + report2$GompGFlex)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.52342 -0.24509  0.04331  0.22083  0.34492
##
## Coefficients:
##                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)        -0.002954   2.387477  -0.001    0.999
## report2$t0         -0.017838   0.024884  -0.717    0.487
## report2$GompGFlex -16.337520  10.999937  -1.485    0.163
##
## Residual standard error: 0.2843 on 12 degrees of freedom
## Multiple R-squared:  0.457,  Adjusted R-squared:  0.3666
## F-statistic: 5.051 on 2 and 12 DF,  p-value: 0.02562
```

```
summary(lm( log10(report2$GompGFlex) ~ report2$t0 + report2$GompRFlex  ))#good
```

```
##
## Call:
## lm(formula = log10(report2$GompGFlex) ~ report2$t0 + report2$GompRFlex)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.014137 -0.009475 -0.003030  0.002393  0.027857
##
## Coefficients:
##                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)       -0.5486398  0.0159799  -34.33 2.37e-13 ***
## report2$t0        -0.0086467  0.0003984  -21.70 5.36e-11 ***
## report2$GompRFlex -2.2235872  2.2233354   -1.00    0.337
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
## Residual standard error: 0.01458 on 12 degrees of freedom
## Multiple R-squared:  0.984,  Adjusted R-squared:  0.9814
## F-statistic:   370 on 2 and 12 DF,  p-value: 1.652e-11
```

```
#summary(lm( report2$G ~ log10(report2$R) + report2$t0  ))
#summary(lm( report2$G ~ report2$t0 + log10(report2$R)   ))
summary(lm( report2$GompGFlex ~ report2$t0 + log10(report2$R)   ))
```

```
##
## Call:
## lm(formula = report2$GompGFlex ~ report2$t0 + log10(report2$R))
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.007884 -0.003343 -0.002527  0.001311  0.011427
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)       0.1379103  0.0399225   3.454  0.00477 **
## report2$t0       -0.0019345  0.0001938  -9.983 3.65e-07 ***
## log10(report2$R) -0.0259630  0.0131902  -1.968  0.07257 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.006486 on 12 degrees of freedom
## Multiple R-squared:  0.9505, Adjusted R-squared:  0.9423
## F-statistic: 115.2 on 2 and 12 DF,  p-value: 1.469e-08
```

```
summary(lm( report2$GompGFlex ~ report2$t0 + log10(report2$GompRFlex)   ))
```

```
##
## Call:
## lm(formula = report2$GompGFlex ~ report2$t0 + log10(report2$GompRFlex))
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.008037 -0.004385 -0.001282  0.001773  0.012763
##
## Coefficients:
##                             Estimate Std. Error t value Pr(>|t|)
## (Intercept)                0.1818701  0.0236582   7.687 5.64e-06 ***
## report2$t0                -0.0020169  0.0001916 -10.529 2.05e-07 ***
## log10(report2$GompRFlex) -0.0095046  0.0063994  -1.485    0.163
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.006857 on 12 degrees of freedom
## Multiple R-squared:  0.9447, Adjusted R-squared:  0.9355
## F-statistic: 102.5 on 2 and 12 DF,  p-value: 2.861e-08
```

Mediation test on Gflex <–t0 <– RFlex

Hong thinks this gives positive result.

```r
library(mediation)
```

```
## Loading required package: MASS
```

```
## Loading required package: Matrix
```

```
## Loading required package: mvtnorm
```

```
## Loading required package: sandwich
```

```
## mediation: Causal Mediation Analysis
## Version: 4.4.5
```

```r
set.seed(20170801)
report2$log10GompRFlex = log10(report2$GompRFlex)
med.fit = lm(t0 ~ log10GompRFlex, data=report2)
summary(med.fit)
```

```
##
## Call:
## lm(formula = t0 ~ log10GompRFlex, data = report2)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -10.2238  -7.6956  -0.6106   1.5195  22.5871
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)      99.564     20.269   4.912 0.000284 ***
## log10GompRFlex   19.967      7.429   2.688 0.018617 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 9.928 on 13 degrees of freedom
## Multiple R-squared:  0.3572, Adjusted R-squared:  0.3078
## F-statistic: 7.225 on 1 and 13 DF,  p-value: 0.01862
```

```r
out.fit = lm(GompGFlex ~ t0 + log10GompRFlex, data=report2)
summary(out.fit)
```

```
##
## Call:
## lm(formula = GompGFlex ~ t0 + log10GompRFlex, data = report2)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.008037 -0.004385 -0.001282  0.001773  0.012763
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)     0.1818701  0.0236582   7.687 5.64e-06 ***
## t0             -0.0020169  0.0001916 -10.529 2.05e-07 ***
## log10GompRFlex -0.0095046  0.0063994  -1.485    0.163
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.006857 on 12 degrees of freedom
```

```
## Multiple R-squared:  0.9447, Adjusted R-squared:  0.9355
## F-statistic: 102.5 on 2 and 12 DF,  p-value: 2.861e-08
```

```
med.out <- mediate(med.fit, out.fit, treat = "log10GompRFlex", mediator = "t0", robustSE = TRUE, sims =
summary(med.out)
```

```
##
## Causal Mediation Analysis
##
## Quasi-Bayesian Confidence Intervals
##
##                Estimate 95% CI Lower 95% CI Upper p-value
## ACME           -0.04383     -0.08096        -0.01  <2e-16 ***
## ADE            -0.00718     -0.02469         0.01    0.46
## Total Effect   -0.05101     -0.08276        -0.02  <2e-16 ***
## Prop. Mediated  0.86767      0.46191         1.23  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Sample Size Used: 15
##
##
## Simulations: 100
```

Mediation test 2 on Rflex <–t0 <– GFlex

Hong thinks this is negative result.

```
med.fit = lm(t0 ~ GompGFlex, data=report2)
summary(med.fit)
```

```
##
## Call:
## lm(formula = t0 ~ GompGFlex, data = report2)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2.6401 -1.9424 -0.8670 -0.0658  8.1513
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   94.999      3.723   25.52 1.72e-12 ***
## GompGFlex   -427.325     31.369  -13.62 4.50e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.168 on 13 degrees of freedom
## Multiple R-squared:  0.9345, Adjusted R-squared:  0.9295
## F-statistic: 185.6 on 1 and 13 DF,  p-value: 4.503e-09
```

```
out.fit = lm(log10GompRFlex ~ t0 + GompGFlex, data=report2)
summary(out.fit)
```

```
##
## Call:
```

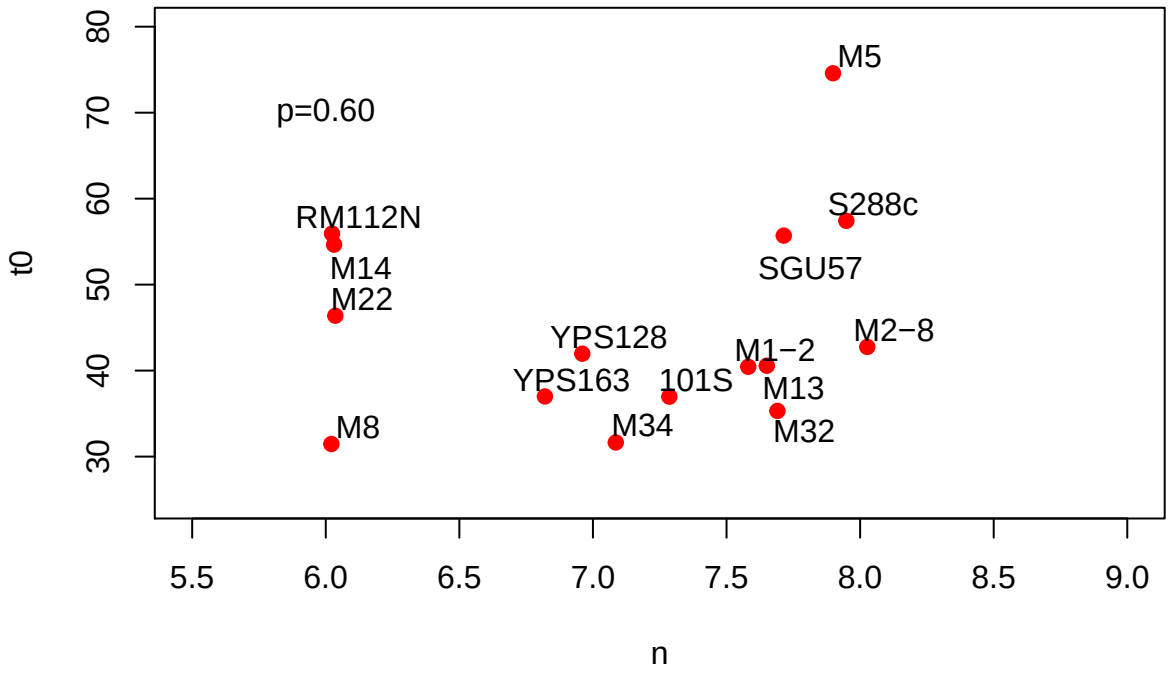
```
## lm(formula = log10GompRFlex ~ t0 + GompGFlex, data = report2)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.52342 -0.24509  0.04331  0.22083  0.34492
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -0.002954   2.387477  -0.001    0.999
## t0           -0.017838   0.024884  -0.717    0.487
## GompGFlex   -16.337520  10.999937  -1.485    0.163
##
## Residual standard error: 0.2843 on 12 degrees of freedom
## Multiple R-squared:  0.457,  Adjusted R-squared:  0.3666
## F-statistic: 5.051 on 2 and 12 DF,  p-value: 0.02562
```

```
med.out <- mediate(med.fit, out.fit, treat = "GompGFlex", mediator = "t0", robustSE = TRUE, sims = 100)
summary(med.out)
```

```
##
## Causal Mediation Analysis
##
## Quasi-Bayesian Confidence Intervals
##
##                Estimate 95% CI Lower 95% CI Upper p-value
## ACME              6.454      -14.468        31.46    0.74
## ADE             -15.052      -45.810         8.83    0.18
## Total Effect     -8.598      -18.553        -1.06    0.04 *
## Prop. Mediated   -0.526       -9.794         3.54    0.74
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Sample Size Used: 15
##
##
## Simulations: 100
```

Plot initial virtula life ~ n (average interactions)

```
plot( report2$t0 ~ report2$n, col='red', xlim=c(5.5, 9), ylim=c(25, 80), pch=19, xlab='n', ylab='t0')
my.x = report2$n + 0.1; my.y = report2$t0 + 2;
names(my.x) = report2$my.strains; names(my.y) = report2$my.strains;
my.y[c("M14","SGU57", "M32","M13" )]=c(52, 52, 33, 38)
text(my.x,my.y, report2$my.strains )
text(6, 70, "p=0.60")
```




```
summary(lm(log10(report2$t0) ~ report2$n)) #G from t0 and n
```

```
##
## Call:
## lm(formula = log10(report2$t0) ~ report2$n)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.14438 -0.07600 -0.03324  0.09232  0.21110
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.49752    0.27584   5.429 0.000115 ***
## report2$n    0.02077    0.03854   0.539 0.599159
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1104 on 13 degrees of freedom
## Multiple R-squared:  0.02184,    Adjusted R-squared:  -0.0534
## F-statistic: 0.2903 on 1 and 13 DF,  p-value: 0.5992
```

Gompert versus Weibull? AIC: smaller is better (for information loss)

```
report$BestModel = ifelse(report$GompAICFlex < report$WeibAICFlex, "Gomp", "Weib")
report$BestModel = ifelse(abs(report$GompAICFlex - report$WeibAICFlex)<2, "<2", report$BestModel)
```

CV ~ Gomp and Weibull? How does noises influence likelihood of Gompertz and Weibull fitting?

```
summary(lm(report$CV ~ report$BestModel ))
```

```
##
## Call:
## lm(formula = report$CV ~ report$BestModel)
##
## Residuals:
```

```
##      Min       1Q   Median       3Q      Max
## -0.07528 -0.03570 -0.01063  0.03596  0.10837
##
## Coefficients:
##                       Estimate Std. Error t value Pr(>|t|)
## (Intercept)            0.31995    0.04309   7.426 7.99e-06 ***
## report$BestModelGomp   0.01334    0.04817   0.277    0.787
## report$BestModelWeib -0.04698    0.05098  -0.922    0.375
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.06093 on 12 degrees of freedom
## Multiple R-squared:  0.2032, Adjusted R-squared:  0.07043
## F-statistic:  1.53 on 2 and 12 DF,  p-value: 0.2559
```

```
summary(lm(report$CV ~ report$WeibLogLikFlex ))
```

```
##
## Call:
## lm(formula = report$CV ~ report$WeibLogLikFlex)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.11400 -0.04749  0.01106  0.03587  0.13004
##
## Coefficients:
##                         Estimate Std. Error t value Pr(>|t|)
## (Intercept)            3.124e-01  4.099e-02   7.623 3.78e-06 ***
## report$WeibLogLikFlex 3.708e-06  1.347e-04   0.028    0.978
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.06558 on 13 degrees of freedom
## Multiple R-squared:  5.83e-05,   Adjusted R-squared:  -0.07686
## F-statistic: 0.000758 on 1 and 13 DF,  p-value: 0.9785
```

```
summary(lm(report$CV ~ report$GompLogLikFlex  ))
```

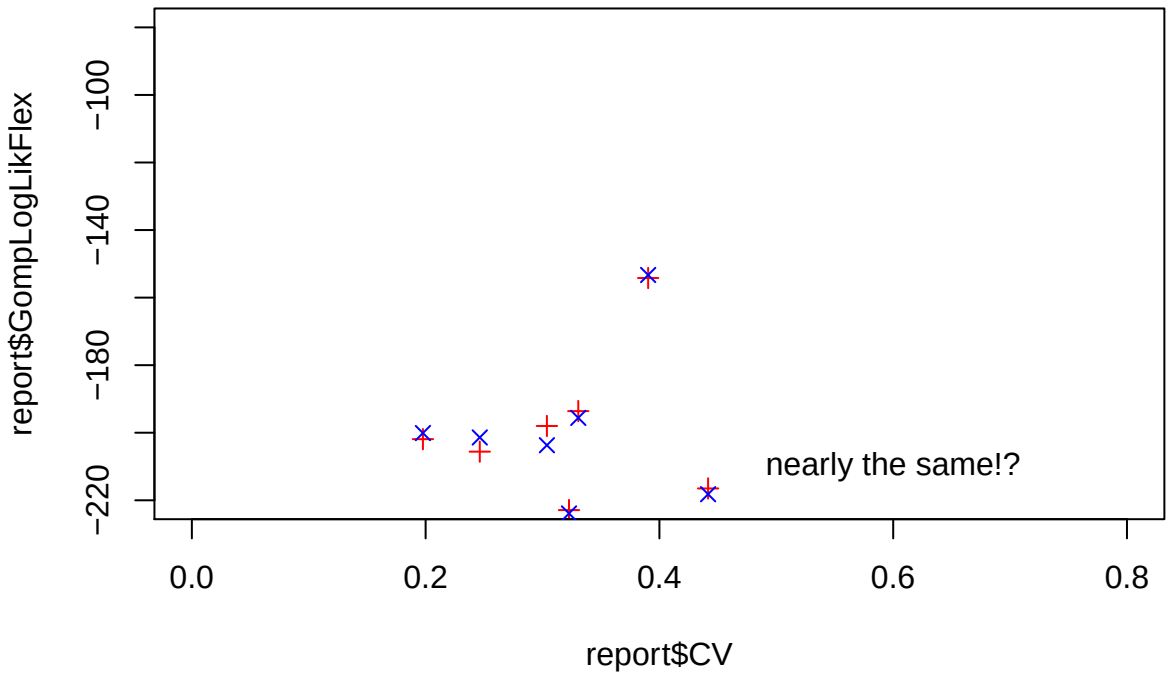
```
##
## Call:
## lm(formula = report$CV ~ report$GompLogLikFlex)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.11419 -0.04729  0.01091  0.03576  0.12988
##
## Coefficients:
##                         Estimate Std. Error t value Pr(>|t|)
## (Intercept)            3.131e-01  4.023e-02   7.785 3.01e-06 ***
## report$GompLogLikFlex 6.258e-06  1.316e-04   0.048    0.963
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.06558 on 13 degrees of freedom
## Multiple R-squared:  0.0001739,  Adjusted R-squared:  -0.07674
```

```
## F-statistic: 0.002261 on 1 and 13 DF,  p-value: 0.9628
```

```
summary(lm(report$CV ~ (report$GompLogLikFlex - report$WeibLogLikFlex)))
```

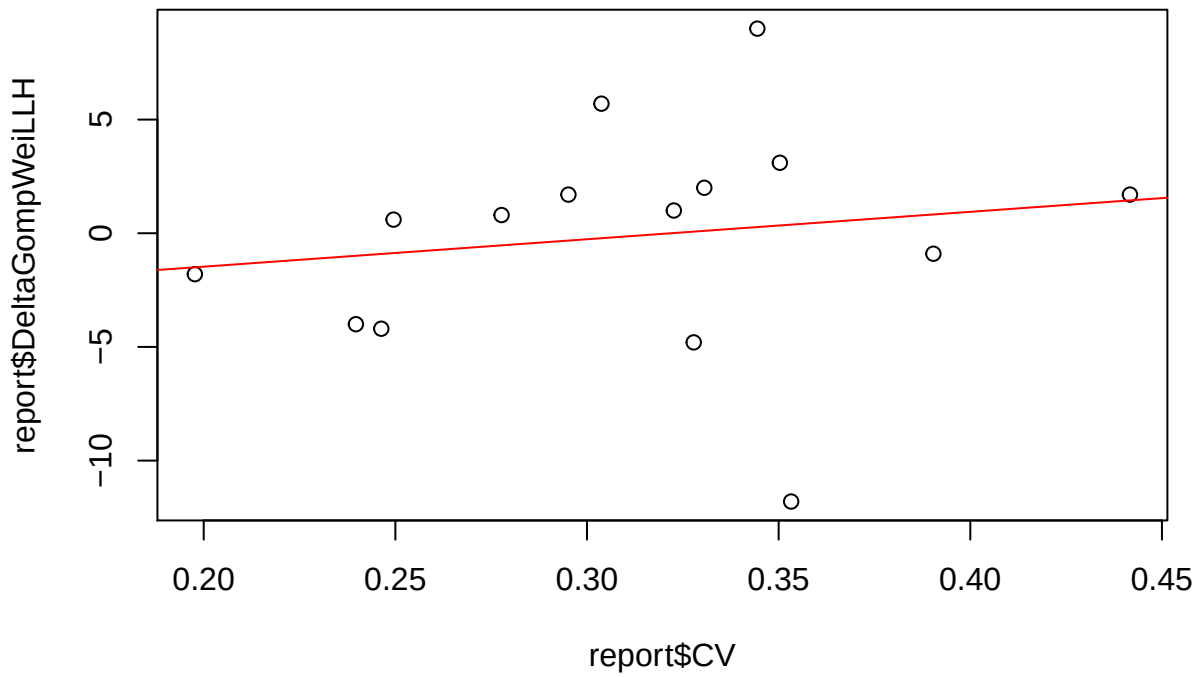
```
##
## Call:
## lm(formula = report$CV ~ (report$GompLogLikFlex - report$WeibLogLikFlex))
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.11419 -0.04729  0.01091  0.03576  0.12988
##
## Coefficients:
##                          Estimate Std. Error t value Pr(>|t|)
## (Intercept)             3.131e-01  4.023e-02   7.785 3.01e-06 ***
## report$GompLogLikFlex 6.258e-06  1.316e-04   0.048    0.963
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.06558 on 13 degrees of freedom
## Multiple R-squared:  0.0001739,  Adjusted R-squared:  -0.07674
## F-statistic: 0.002261 on 1 and 13 DF,  p-value: 0.9628
```

```
plot( report$GompLogLikFlex ~ report$CV, col="red", pch=3, xlim=c(0, 0.8), ylim=c(-220, -80))
points( report$CV, report$WeibLogLikFlex, col="blue", pch=4)
m1 = lm( report$GompLogLikFlex ~ report$CV)
m2 = lm( report$WeibLogLikFlex ~ report$CV)
abline( m1, col="red", lty=2)
abline( m2, col='blue', lty=1)
text(0.6, -210, "nearly the same!?")
```



The QIN-RLS data suggested that noisy system signal perfer Gompertz model, based on GG01 theory. Notice that CV measures distrubition of system signals and are different from white noises (residues)

```
report$DeltaGompWeiLLH = report$GompLogLikFlex - report$WeibLogLikFlex
plot( report$DeltaGompWeiLLH ~ report$CV )
m3 = lm( report$DeltaGompWeiLLH ~ report$CV)
abline(m3, col='red')
```



TODO: Calculate the white noises (fitting errors) using the fitting residues for Gompertz and Weibull models.

```
# report$residues ??
```

Output

```
#write.csv(report2, file = 'sandbox/_report_qinlab_natural_isolates_rls.csv', row.names = FALSE)
```