

# cue/nocue

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```
#Les inn gagnatöfluna
cue_nocue <- read.csv("data/answers_cue_nocue.csv")
```

Samantekt fyrir breytur í gagnatöflunni.

```
summary(cue_nocue)
```

```
##      answerId      lectureId      studentId      questionId
## 11      :      1    2547      : 1790    14      :   236    1436      : 1241
## 28      :      1    361      : 1739   285      :   167    1359      : 1073
## 105     :      1    360      : 1644  14371     :   141   10022     : 1066
## 135     :      1     7      : 1467  13521     :   129   1708      :   869
## 265     :      1     6      : 1335  12948     :   124    504      :   827
## 273     :      1    21      : 1269   328      :   111   1772      :   741
## (Other):28630  (Other):19392  (Other):27728  (Other):22819
##
##                                plonePath      grade
## /tutor-web/math/math104-2calc/lecture52/Ag80q103 : 1241  Min.    :0.000
## /tutor-web/math/math104-2calc/lecture51/Ag20q23  : 1073  1st Qu.:3.000
## /tutor-web/math/math099.0/lec050500/qInt4004     : 1066  Median :5.250
## /tutor-web/math/math104-3calc/lecture10/Hg90qD02  :  869  Mean   :5.129
## /tutor-web/math/math104-1calc/lecture10/Qgen-q7006:  827  3rd Qu.:7.500
## /tutor-web/math/math104-3calc/lecture20/Ag90q04   :  741  Max.   :9.999
## (Other)                                           :22819  NA's    :45
##
##      correct      timeStart      timeEnd
## Min.    :0.0000  2014-10-26 00:38:17:    9  2014-10-26 00:38:20:    9
## 1st Qu.:0.0000  2014-11-06 09:53:09:    5  2014-11-06 09:53:25:    5
## Median :1.0000  2014-11-06 09:59:06:    5  2014-11-06 09:59:56:    5
## Mean    :0.7372  2016-08-25 11:28:20:    4  2016-08-25 11:25:38:    4
## 3rd Qu.:1.0000  2016-08-25 15:22:10:    4  2016-08-31 06:54:33:    4
## Max.    :1.0000  2016-08-31 06:54:25:    4  2016-08-31 06:59:42:    4
##
##      (Other)      :28605  (Other)      :28605
##
## cue      qName
## 0:22553   Q65      : 2010
## 1: 6083   Ag80q103 : 1881
##          qInt4004 : 1782
##          Qgen-q0111: 1761
##          Hg90qD02  : 1499
##          Ag20q23   : 1149
##          (Other)   :18554
```

## Lýsandi tölfræði

Stöplarit og tíðnitafla sem sýnir fjölda réttra og rangra svara eftir cue eða ekki cue spurningu.

```
ggplot(data = cue_nocue,  
       aes(x=cue,  
           fill=correct=="1")) +  
geom_bar() +  
labs(y="Fjöldi",  
     x="cue",  
     fill="Rétt/Rangt",  
     title = "Fjöldi svara fyrir cue eða ekki cue")
```



Tíðnitafla

```
cue_nocue$correct <- with(cue_nocue, ifelse(correct==1, "Rétt", "Rangt"))  
Heild <- sum  
addmargins(table(correct=cue_nocue$correct, cue=cue_nocue$cue), FUN = Heild) %>%  
  kable(col.names = c("Án cue", "Með cue", "Heild"),  
        align = c('cccc'),  
        caption = "Tíðnitafla") %>%  
  kable_styling(bootstrap_options = c("striped", "hover"))
```

```
## Margins computed over dimensions  
## in the following order:  
## 1: correct  
## 2: cue
```

Table 1: Tíðnitafla

	Án cue	Með cue	Heild
Rangt	6154	1372	7526
Rétt	16399	4711	21110
Heild	22553	6083	28636

Table 2: Meðaleinkunn

Cue	Meðaleinkunn
0	7.271317
1	7.744534

```
cue_nocue$correct <- with(cue_nocue, ifelse(correct=="Rétt", 1, 0))
cue_nocue$correct <- as.integer(cue_nocue$correct)
```

Tafla sem sýnir meðaleinkunn fyrir hvorn flokk þar sem einkunnin byggir á fjölda réttra svara deilt með fjölda svara.

```
cue_nocue %>%
  group_by(cue) %>%
    summarise(Medal_einkunn=mean(correct, na.rm = T)*10) %>%
      kable(col.names = c("Cue",
                          "Meðaleinkunn"),
            align = c('cc'),
            caption = "Meðaleinkunn") %>%
      kable_styling(bootstrap_options = c("striped", "hover"))
```

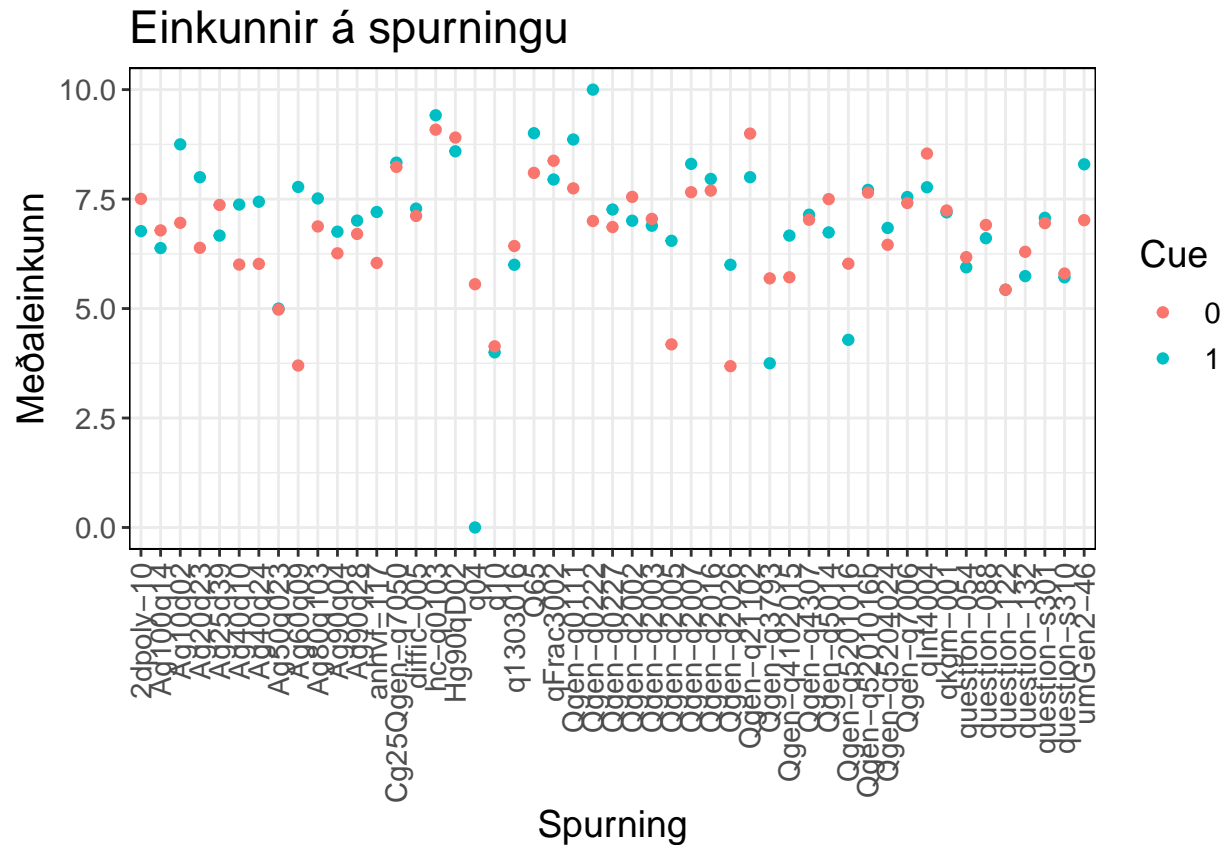
```
## `summarise()` ungrouping output (override with `.groups` argument)
#cue = 0 er spurning án vísbendingar og cue = 1 er vísbendingaspurning.
```

Meðaleinkunn fyrir vísbendingaspurningar er um 0.5 hærri en fyrir aðrir spurningar.

Auka rammi búin til sem eru bara spurningarnar og meðaleiknunnin á þeim eftir cue eða ekki. Gert til að vera með betri grade breytu. Fjöldi réttra svara deilt með fjölda spurninga og nýja grade breytan er því meðaltal. Ramminn skýrður medal

Mynd sem sýnir meðaltöl fyrir cue og ekki cue fyrir hverja spurningu.

```
ggplot(data=medal,
       aes(x=qName,
           y=medal,
           color=cue,
           group=cue)) +
  geom_point() +
  theme(axis.text.x=element_text(angle=90,hjust=1,vjust=0.5)) +
  labs(x="Spurning", y="Meðaleinkunn", color="Cue", title = "Einkunnir á spurningu" )
```



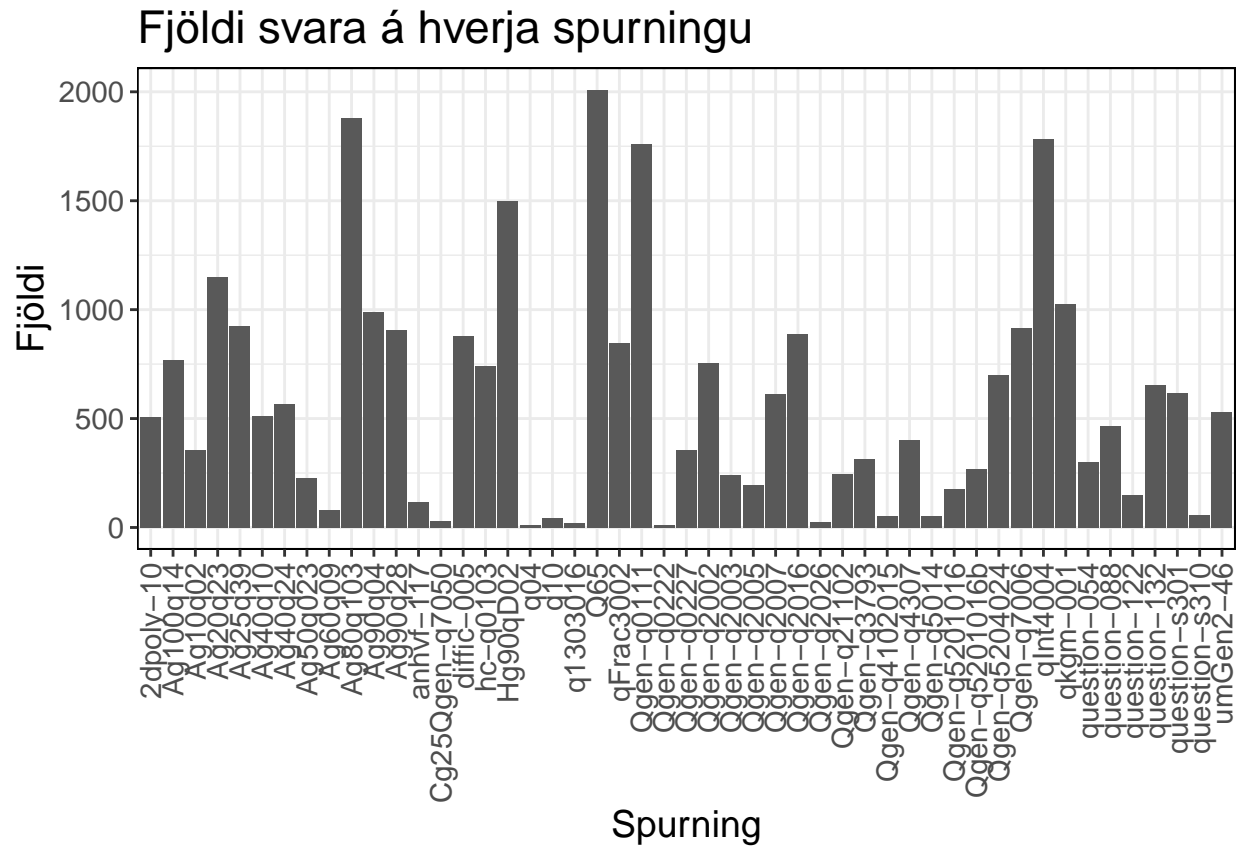
Skoða q04 spurninguna betur þar sem meðaleinkunnin 0 er undarleg.

```
cue_nocue %>%
  filter(qName == "q04") %>% nrow()
```

```
## [1] 13
```

13 svör til við þessari spurningu þar sem cue er aldrei rétt í 4 tilvikum. Skoða hvort það sé í lagi að eyða henni og öðrum spurningum með minna en 20 svör skráð út.

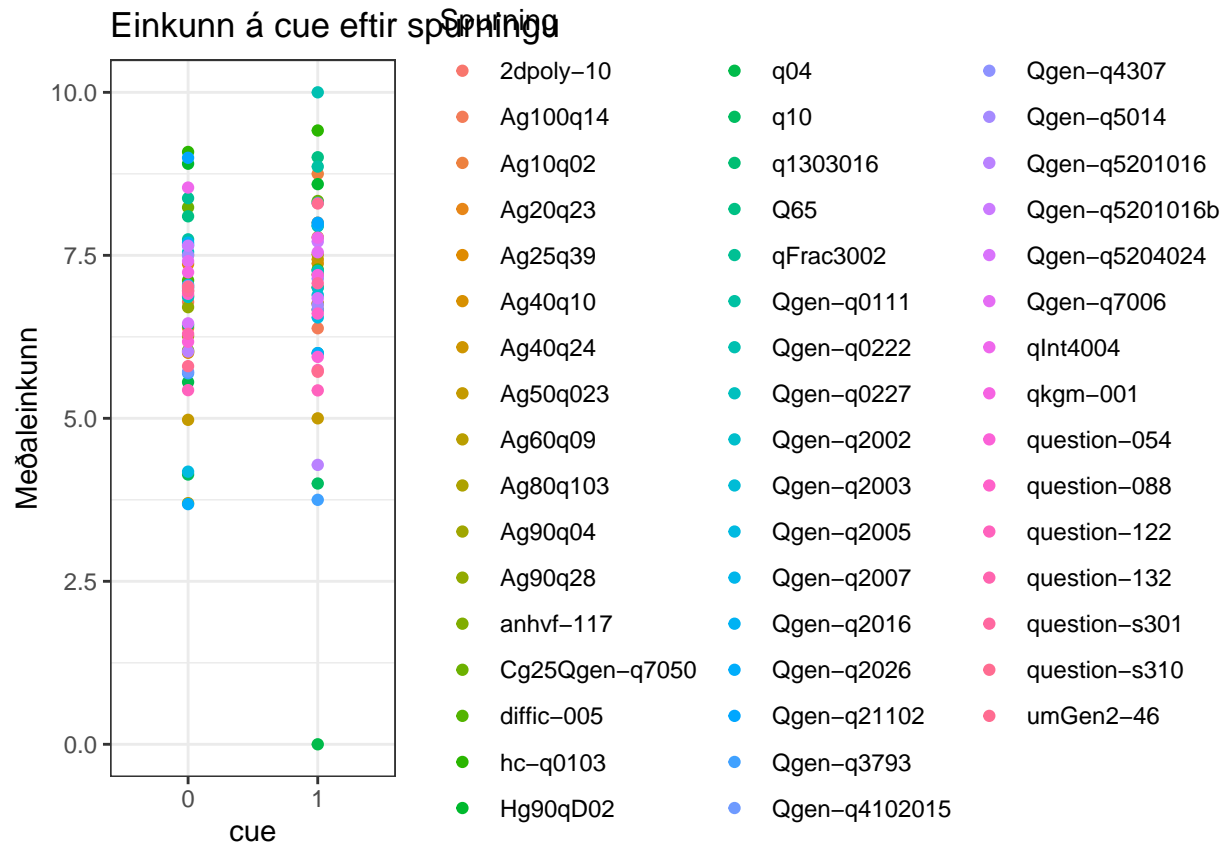
```
cue_nocue %>%
  ggplot(aes(x= qName)) +
  geom_bar() +
  theme(axis.text.x=element_text(angle=90,hjust=1,vjust=0.5)) +
  labs(x="Spurning", y="Fjöldi", title = "Fjöldi svara á hverja spurningu")
```



Sjáum að q04 hefur mjög fá svör samanborið við aðrar spurningar.

Svipuð mynd miðuð við að sýna gengi á hverri spurningu.

```
ggplot(data=medal,
       mapping = aes(x=cue,
                     y=medal,
                     color=qName)) +
  geom_point() +
  theme_bw() +
  labs(x="cue",
       y="Meðaleinkunn",
       color="Spurning",
       title = "Einkunn á cue eftir spurningu")
```



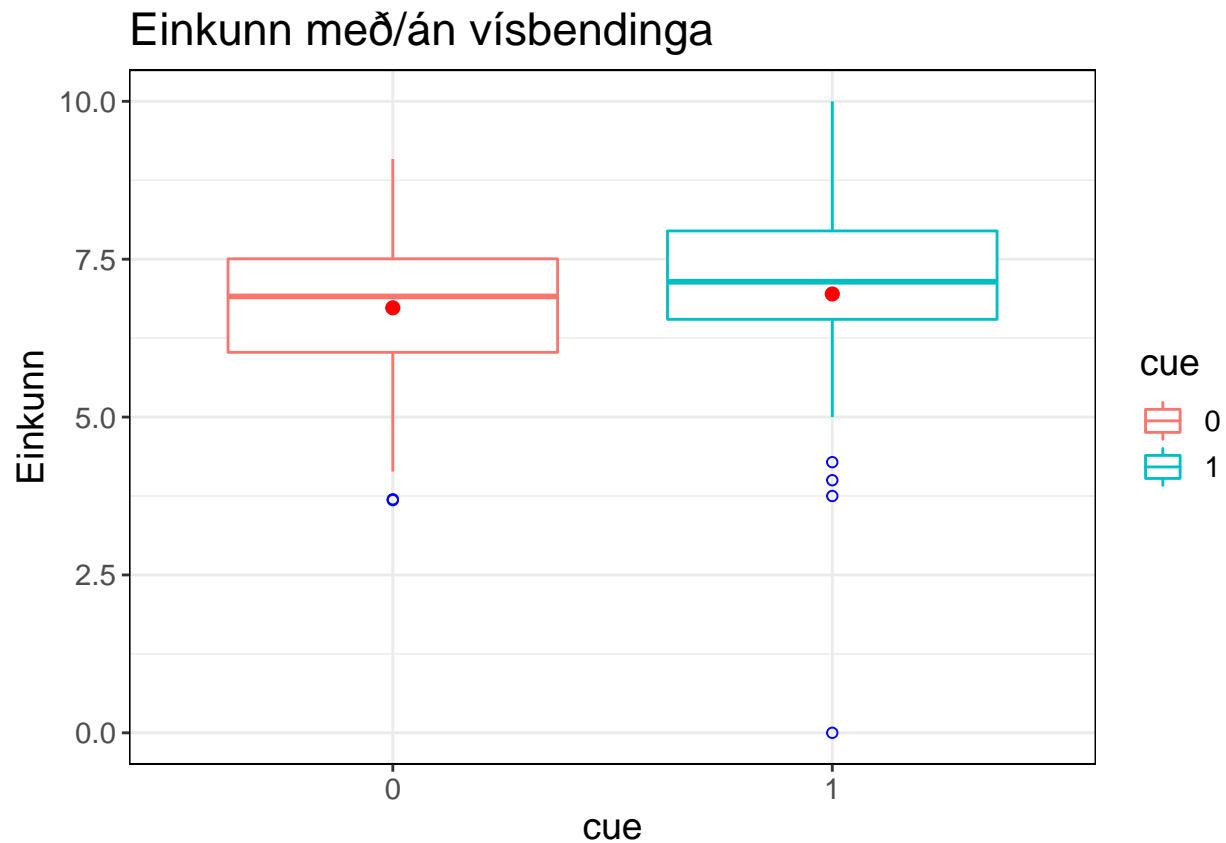
Cue virðist ganga betur.

Kassarit til að sýna meðaltölin og miðgildi á milli hópa.

```
f <- medal %>%
  group_by(cue) %>%
  summarise(
    medal = mean(medal)
  )
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
medal$cue <- as.factor(medal$cue)
ggplot(data=medal,
  aes(x=cue,
    y=medal,
    color=cue)) +
  geom_boxplot(outlier.colour = "blue",
    outlier.shape = 1) +
  xlab("cue") +
  ylab("Einkunn") +
  ggtitle("Einkunn með/án vísbendinga") +
  geom_point(data=f,
    aes(x=cue,
      y=medal),
    col="red",
    size=2)
```



Örlítið hærra miðgildi fyrir cue - munar ekki miklu. Fjórðungamörkin eru þó hærri

Vil skoða hvort það skipti meira máli fyrir fólk með lægri eða hærri einkunnir að fá cue sp.

```
cue_undir_fimm <- filter(cue_nocue, grade<=5)
cue_yfir_fimm <- filter(cue_nocue, grade>=5)

cue_undir_fimm %>%
  filter(cue==0) %>%
  dplyr::select(qName,
                correct,
                cue) %>%
  group_by(qName) %>%
  summarise(medal =
            10*sum(correct==1)/length(qName)) ->
  tmp_nocue_medal_undir
```

## `summarise()` ungrouping output (override with `.groups` argument)

```
cue_undir_fimm %>%
  filter(cue==1) %>%
  dplyr::select(qName,
                correct,
                cue) %>%
  group_by(qName) %>%
  summarise(medal =
            10*sum(correct==1)/length(qName)) ->
  tmp_cue_medal_undir
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
#Tapaði út cue en þarf að fá það aftur inn svona
```

```
tmp_cue_medal_undir$cue <- "1"
```

```
tmp_nocue_medal_undir$cue <- "0"
```

```
rbind.data.frame(tmp_cue_medal_undir,  
                  tmp_nocue_medal_undir) ->  
  medal_undir
```

```
a <- medal_undir %>%  
  group_by(cue) %>%  
  summarise(  
    medal = mean(medal)  
  )
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
medal_undir$cue <-  
  as.factor(medal_undir$cue)
```

```
ufimm <-  
  ggplot(data=medal_undir,  
    aes(x=cue,  
      y=medal,  
      color=cue)) +  
  geom_boxplot(outlier.colour = "blue",  
    outlier.shape = 1) +  
  xlab("cue") +  
  ylab("Einkunn") +  
  ggtitle("Einkunn með/án vísbendinga nemendur undir 5") +  
  geom_point(data=a,  
    aes(x=cue,  
      y=medal),  
    col="red",  
    size=2)
```

```
cue_yfir_fimm %>%  
  filter(cue==0) %>%  
  dplyr::select(qName,  
    correct,  
    cue) %>%  
  group_by(qName) %>%  
  summarise(medal =  
    10*sum(correct==1)/length(qName)) ->  
  tmp_nocue_medal_yfir
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
cue_yfir_fimm %>%  
  filter(cue==1) %>%  
  dplyr::select(qName,  
    correct,  
    cue) %>%  
  group_by(qName) %>%
```



```

    summarise(medal =
      10*sum(correct==1)/length(qName)) ->
tmp_cue_medal_yfir

## `summarise()` ungrouping output (override with `.groups` argument)
tmp_cue_medal_yfir$cue <- "1"
tmp_nocue_medal_yfir$cue <- "0"

rbind.data.frame(tmp_cue_medal_yfir,
                  tmp_nocue_medal_yfir) ->
  medal_yfir

b <- medal_yfir %>%
  group_by(cue) %>%
  summarise(
    medal = mean(medal)
  )

## `summarise()` ungrouping output (override with `.groups` argument)
medal_yfir$cue <-
  as.factor(medal_yfir$cue)

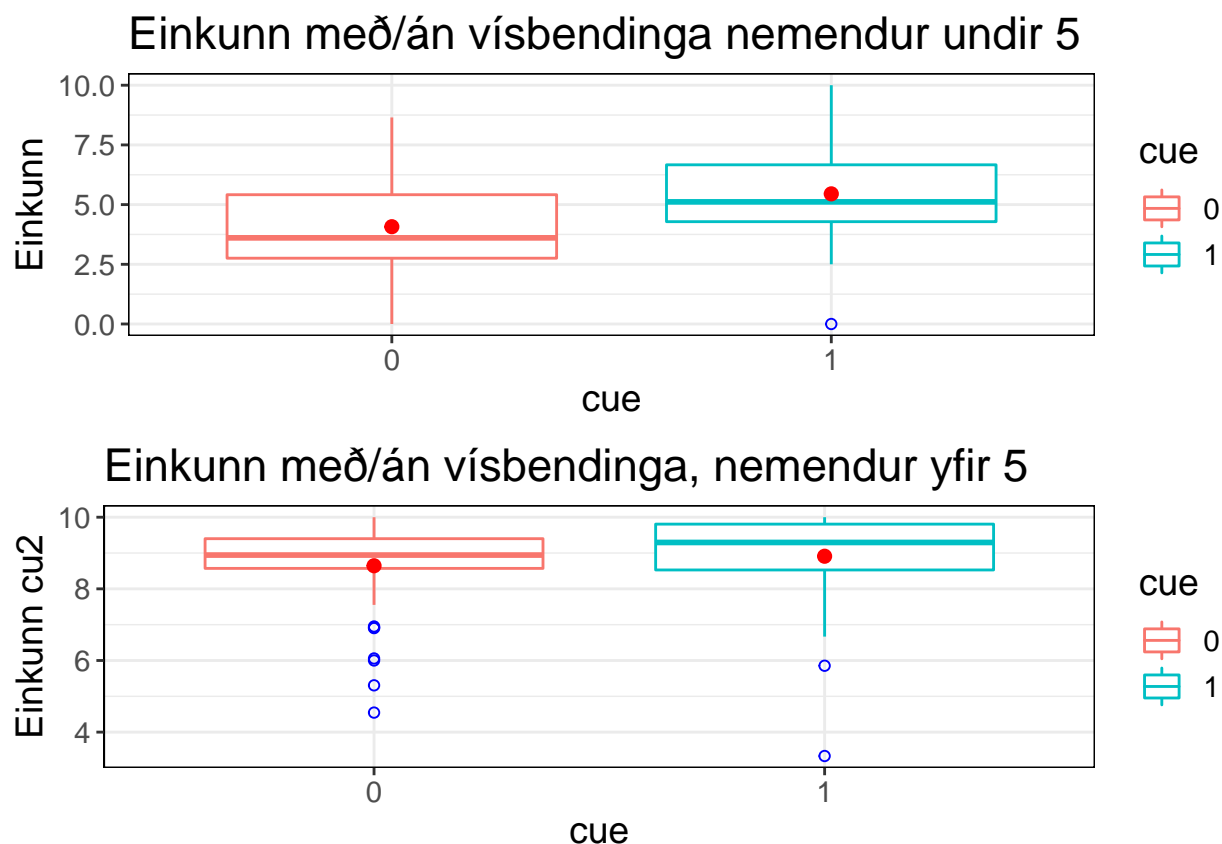
yfimm <-
  ggplot(data=medal_yfir,
    aes(x=cue,
      y=medal,
      color=cue)) +
  geom_boxplot(outlier.colour = "blue",
    outlier.shape = 1) +
  xlab("cue") +
  ylab("Einkunn cu2") +
  ggtitle("Einkunn með/án vísbendinga, nemendur yfir 5") +
  geom_point(data=b,
    aes(x=cue,
      y=medal),
    col="red",
    size=2)

grid.arrange(ufimm, yfimm)

```

Table 3: Fjórðungamörk fyrir cue spurningar

	Meðaleinkunn
0%	0.000000
25%	6.547619
50%	7.142857
75%	7.947368
100%	10.000000



Miklu meiri munur á cue og ekki cue fyrir nemendur með einkunn, eftir spurningu, lægri en 5.

**Tölur sem sýna fjórðungamörk einkunna fyrir svör með og án cue.**

Cue svör:

```
med_cue <-
  filter(medal, cue==1)

med_cue$medal %>%
  quantile() %>%
  kable(col.names = c( "Meðaleinkunn"),
        align = c('cc'),
        caption = "Fjórðungamörk fyrir cue spurningar") %>%
  kable_styling(bootstrap_options = c("striped",
                                       "hover"))
```

Table 4: Fjórðungamörk fyrir án cue spurningar

	Meðaleinkunn
0%	3.684210
25%	6.024845
50%	6.909976
75%	7.505669
100%	9.085714

Table 5: Hlutföll

	Án cue	Með cue
Rangt	0.273	0.226
Rétt	0.727	0.774

Svör án cue:

```
an_cue <-
  filter(medal,
         cue==0)

an_cue$medal %>%
  quantile() %>%
  kable(col.names = c( "Meðaleinkunn"),
        align = c('cc'),
        caption = "Fjórðungamörk fyrir án cue spurningar") %>%
  kable_styling(bootstrap_options = c("striped",
                                       "hover"))
```

Cue kemur betur út en munar mjög litlu.

Hutfalla tafla

```
cue_nocue$correct <-
  with(cue_nocue,
        ifelse(correct==1,
                "Rétt",
                "Rangt"))

kable(prop.table(table(cue_nocue$correct,
                       cue_nocue$cue),
              2),
      col.names = c( "Án cue",
                     "Með cue"),
      align = c('rr'),
      caption = "Hlutföll",
      digits = 3)
```

```
cue_nocue$correct <-
  with(cue_nocue,
        ifelse(correct=="Rétt",
                1,
                0))
cue_nocue$correct <-
```

```
as.integer(cue_nocue$correct)
```

Hlutfallslega fleiri rétt svör í cue flokknum.

Kannað hvort það sé rétt að það séu hlutfallslega fleiri rétt svör í cue hópnum með `prop.test`.

```
prop.test(table(cue_nocue$correct,
               cue_nocue$cue))
```

```
##
## 2-sample test for equality of proportions with continuity correction
##
## data:  table(cue_nocue$correct, cue_nocue$cue)
## X-squared = 55.13, df = 1, p-value = 1.128e-13
## alternative hypothesis: two.sided
## 95 percent confidence interval:
##  0.03039817 0.05132788
## sample estimates:
##      prop 1      prop 2
## 0.8176986 0.7768356
```

Samkvæmt þessu er marktækur munur á hlutföllunum. Semsagt hlutfallslega betra gengi á cue spurningum.

## Líkanagerð

Línulegt aðhvarfsgreiningar líkan fyrir medal töfluna. Breytur eru meðaleinkunn á spurningu og cue.

```
fit.lm <-
  lm(medal ~ cue,
     data = medal)

Anova(fit.lm,
      type = "III") %>%
  broom::tidy() %>%
  kable() %>%
  kable_styling(bootstrap_options = c("striped",
                                       "hover"))
```

term	sumsq	df	statistic	p.value
(Intercept)	2219.4895	1	1033.2083689	0.0000000
cue	1.1740	1	0.5465159	0.4615486
Residuals	206.2227	96	NA	NA

Ekki marktækur munur á meðaltölunum eftir cue eða ekki cue.

## Líkan 1

Tvíkosta aðhvarfsgreiningar líkan fyrir `cue_nocue` gagnaramman. Glm þar sem `correct` er tvíkosta breyta.

```
glm1 <- glm(correct ~ cue,
            family = "binomial",
            data=cue_nocue)
```

Anova tafla fyrir marktækni.

```
# Vantar töflugerð
Anova(glm1,
      type = "III") %>%
  broom::tidy() %>%
  kable() %>%
  kable_styling(bootstrap_options = c("striped",
                                       "hover"))
```

term	statistic	df	p.value
cue	56.72852	1	0

Marktækur munur á meðaltölum fyrir cue. Kemur á óvart.

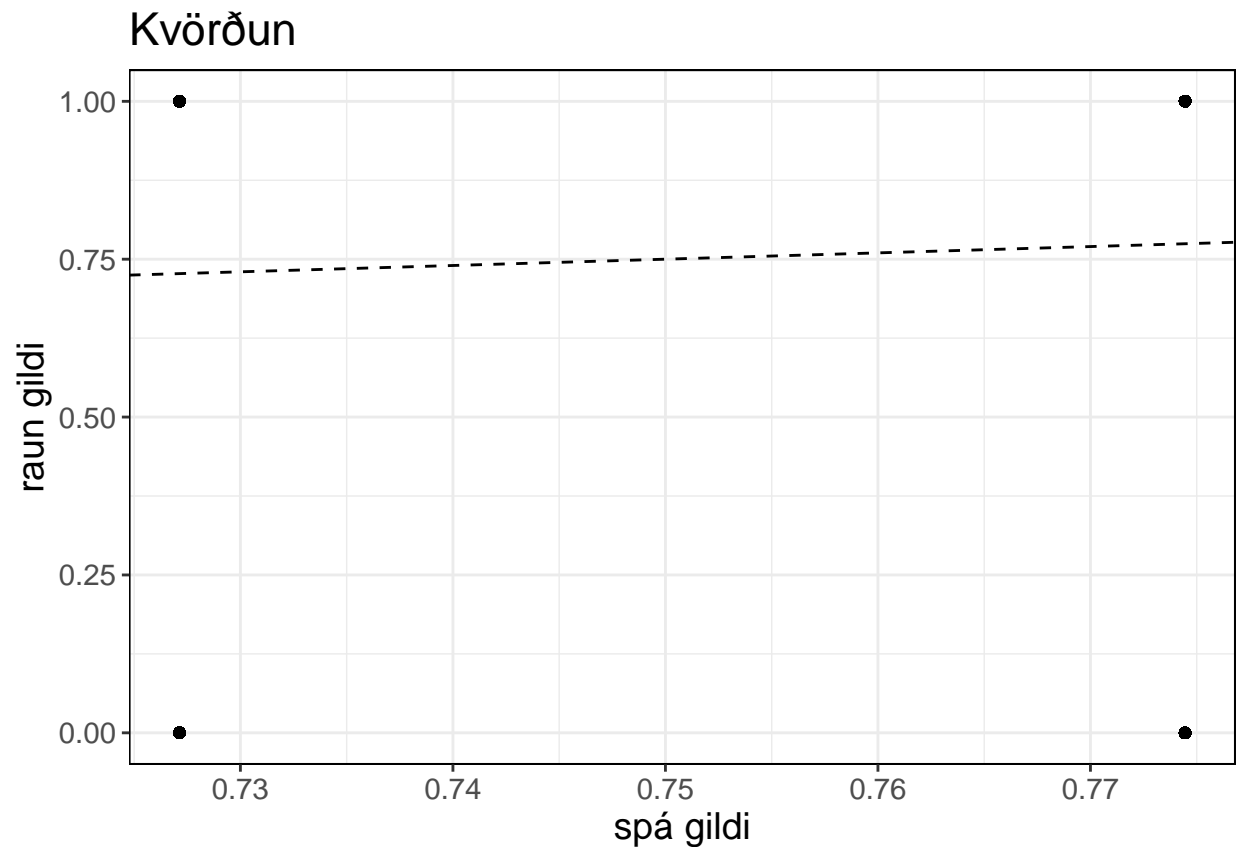
## Gæði líkans 1

Calibration (kvörðun)

*#hvernig gekkk okkur að spá til um þetta? y ásinn eru gildin á tutor-web og x ásinn eru gildin sem glm.  
#sett inn geom\_smooth til að ná að mynda línu.*

```
tibble(y = cue_nocue$correct,
       pred = predict(glm1,
                      type = 'response')) %>%
  ggplot(aes(x = pred,
             y = y)) +
  geom_point() +
  geom_abline(intercept = 0,
             slope = 1,
             lty = 2) +
  geom_smooth() +
  xlab("spá gildi") +
  ylab("raun gildi") +
  ggtitle("Kvörðun")

## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
## Warning: Computation failed in `stat_smooth()`:
## x has insufficient unique values to support 10 knots: reduce k.
```



Ekkert að marka þetta.

ROC kúrfra með AUC og Brier gildum

```
phats <-
  fitted(glm1)
auc(cue_nocue$correct,
    phats) ->
  auc
```

```
## Setting levels: control = 0, case = 1
```

```
## Setting direction: controls < cases
```

```
b <-
  mean((cue_nocue$correct - predict(glm1,
                                     type = 'response'))^2)

bm <-
  mean(predict(glm1,
               type = 'response'))*(1-mean(predict(glm1,
               type = 'response'))

bs <-
  1- b/bm

pred <-
  prediction(phats,
             cue_nocue$correct)

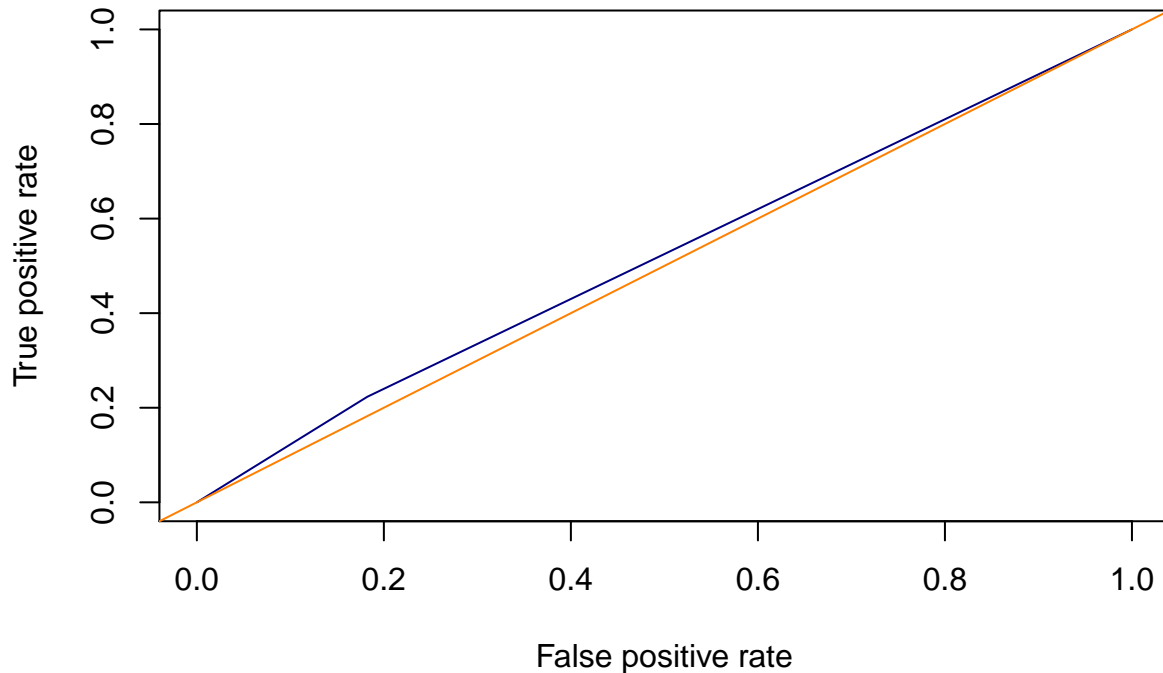
perf <-
```

```

performance(pred,
             "tpr",
             "fpr")
plot(perf,
     col="navyblue",
     cex.main=1,
     main= paste("ROC kúrfa:  AUC =",
                 round(auc,4),
                 " Brier =",
                 round(bs,5)))
abline(a=0,
       b = 1,
       col = 'darkorange1')

```

**ROC kúrfa: AUC = 0.5204 Brier = 0.00193**



ROC kúrfa sem lítur ekki vel út og og AUC sem er mjög nálægt 0.5 og þá því að vera alveg ómarktækt. Fullkomin AUC og Brier gildi eru nálægt 1.

```

#ROC kúrfa í höndunum
y <- cue_nocue$correct
#Spá
phats <- predict(glm1,
                  type = 'response')
#Þröskuldur
pcuts <- seq(0,
             1,
             by = 0.01)

```

```

# nullstillum gagnasett
df <- data.frame(fpr = rep(0,
                          length(pcuts)),
                 tpr = rep(0,
                          length(pcuts)))

p <- sum(y)
n <- length(y) - p

for (i in 1:length(pcuts)) {
  pcut <- pcuts[i]
  fp <- 0
  tp <- 0
  for (j in 1:length(phats)) {
    if (phats[j] >= pcut) {
      if (y[j] == 1) {
        tp <- tp + 1
      }
      else {
        fp <- fp + 1
      }
    }
  }
  df[i, 1] <- fp/n
  df[i, 2] <- tp/p
}

# Bætum inn model predictions til að nota pakka til að teikna roc kúrfu
cue_nocue %>%
  modelr::add_predictions(glm1,
                        type = 'response') -> plot_roc

# Teiknuð ROC kúrfu

ggplot(plot_roc,
       aes(m = pred,
           d = correct)) +
  geom_roc(labels = F) +
  geom_abline(intercept = 0,
              slope = 1,
              lty = 2) -> p1

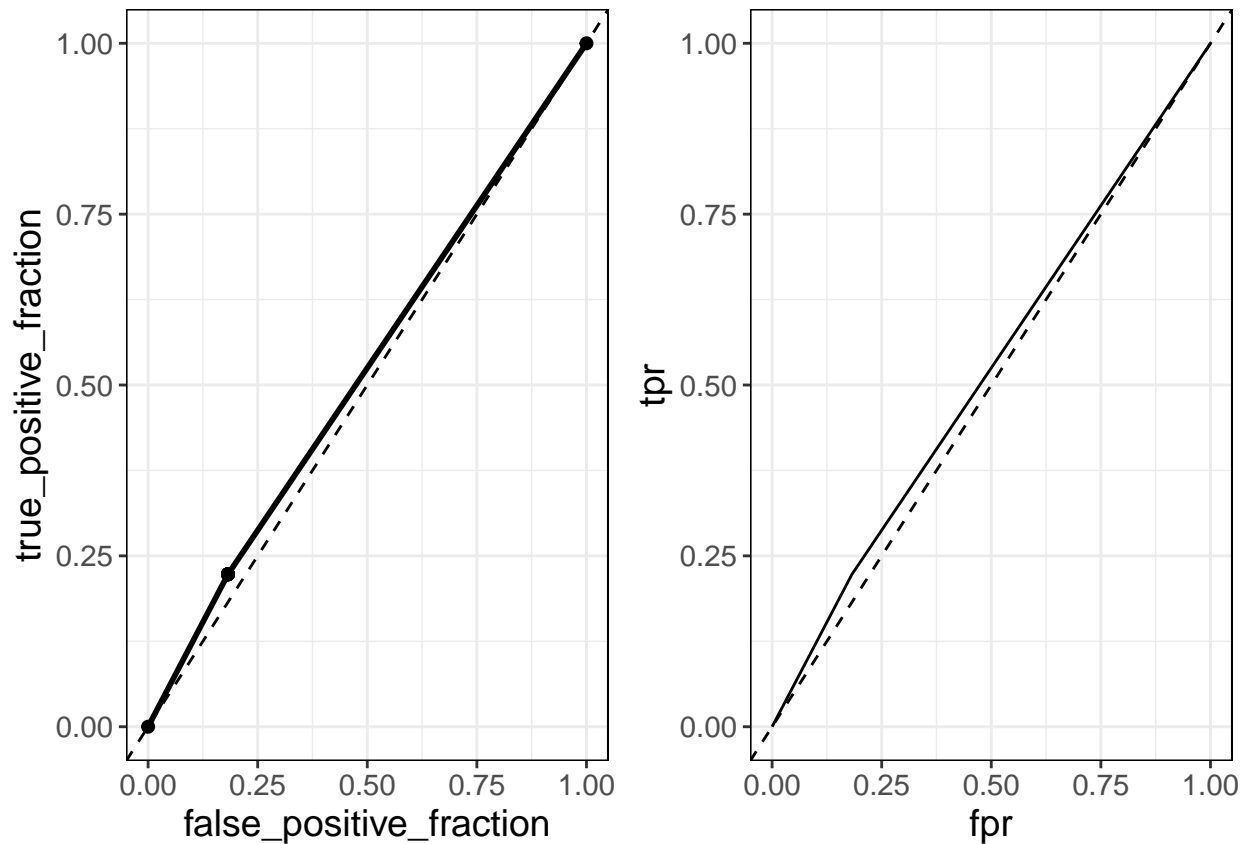
# roc í höndum

df %>%
  as_tibble() %>%
  ggplot(aes(x = fpr,
             y = tpr)) +
  geom_line() +
  geom_abline(intercept = 0,
              slope = 1,
              lty = 2) -> p2

```



```
plot_grid(p1, p2)
```



## Líkan 2

Hafa cue og qName áhrif á correct breytuna ?

```
glm2 <- glm(correct ~ cue + qName,
             family = "binomial",
             data=cue_nocue)

# Vantar fallega töflu
Anova(glm2,
      type = "III") %>%
  broom::tidy() %>%
  kable() %>%
  kable_styling(bootstrap_options = c("striped",
                                       "hover"))
```

term	statistic	df	p.value
cue	28.59043	1	1e-07
qName	1310.39266	48	0e+00

Marktækt fyrir bæði cue og qName miðað við p-gildin.

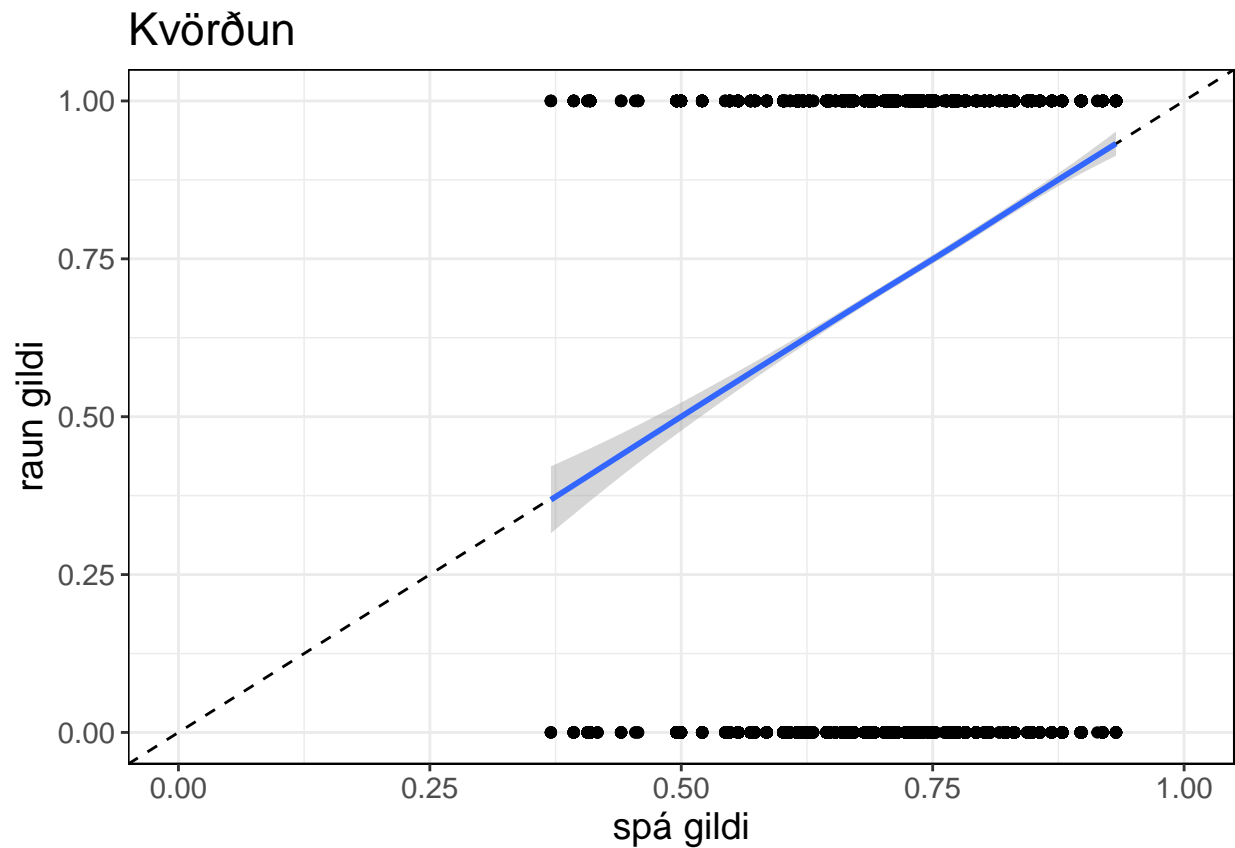
## Gæði líkans 2

Calibration (kvörðun)

```
#hvernig gekkk okkur að spá til um þetta?  
#y ásin eru gildin á tutor-web og x ásin eru gildin sem glm spáir  
#sett inn geom smooth til að ná að mynda línu.
```

```
tibble(y = cue_nocue$correct,  
       pred = predict(glm2,  
                      type = 'response')) %>%  
  ggplot(aes(x = pred,  
            y = y)) +  
  geom_point() +  
  geom_abline(intercept = 0,  
             slope = 1,  
             lty = 2) +  
  geom_smooth() +  
  xlab("spá gildi") +  
  ylab("raun gildi") +  
  ggtitle("Kvörðun") +  
  coord_cartesian(xlim = c(0,1),  
                 ylim = c(0,1))
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```



Nokkuð gott.

ROC kúrfa með AUC og brier skori.

```
phats <- fitted(glm2)

auc(cue_nocue$correct,
    phats) -> auc

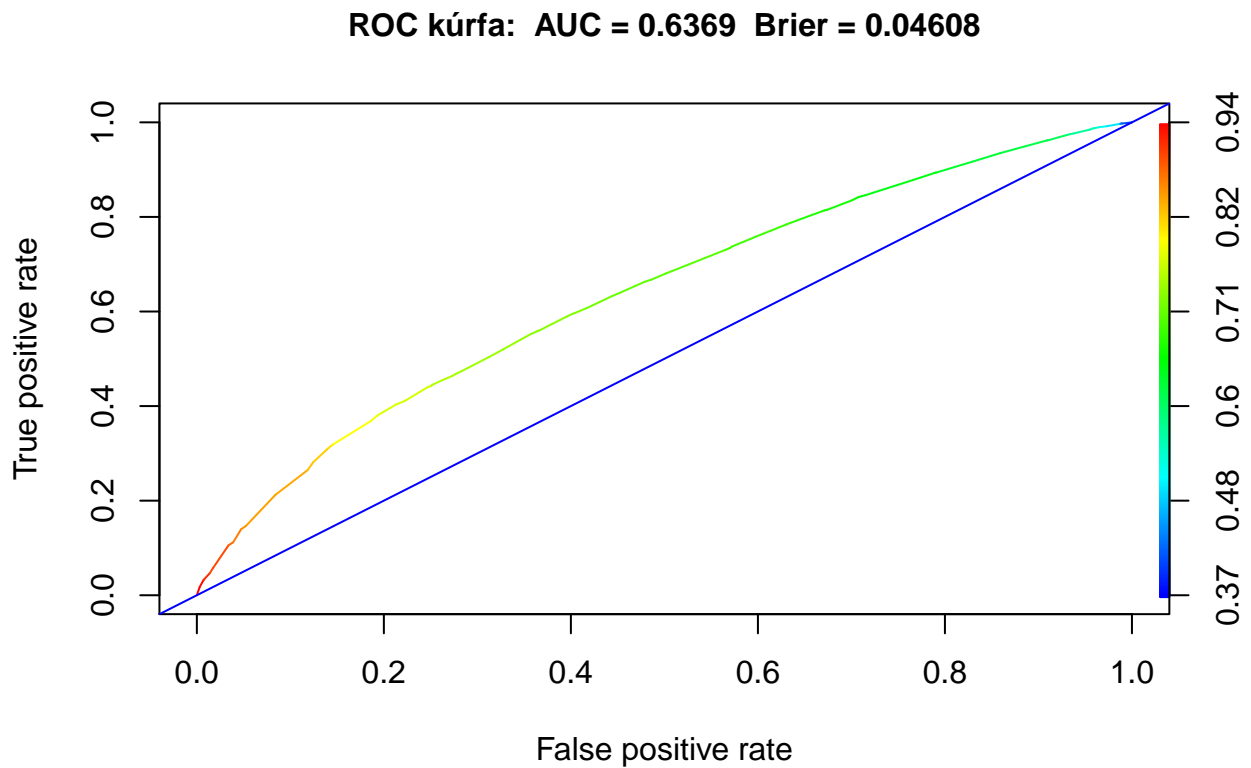
## Setting levels: control = 0, case = 1
## Setting direction: controls < cases
b <- mean((cue_nocue$correct -
           predict(glm2,
                   type = 'response'))^2)
bm <- mean(predict(glm2,
                  type = 'response'))*(1-mean(predict(glm2,
                                                         type = 'response'))))
bs <- 1 - b/bm

pred <- prediction(phats,
                   cue_nocue$correct)

perf <- performance(pred,
                    "tpr",
                    "fpr")

plot(perf,
     colorize=T,
     cex.main=1,
     main= paste("ROC kúrfa:  AUC =",
                 round(auc,4),
                 " Brier =",
                 round(bs,5)))

abline(a=0,
       b = 1,
       col='blue')
```



ROC kúrfra sem lítur ekki vel út en miklu betri en í glm1. AUC gildið er komið uppí 0.6369 sem er ekki galið en brier gildið er mjög lágt.

### Líkön 3

Breytur eru cue, qName og interaction þar á milli.

```
glm3 <- glm(correct ~ cue + qName + cue:qName,
             family = "binomial",
             data=cue_nocue)
```

```
Anova(glm3,
      type = "III") %>%
  broom::tidy() %>%
  kable() %>%
  kable_styling(bootstrap_options = c("striped",
                                       "hover"))
```

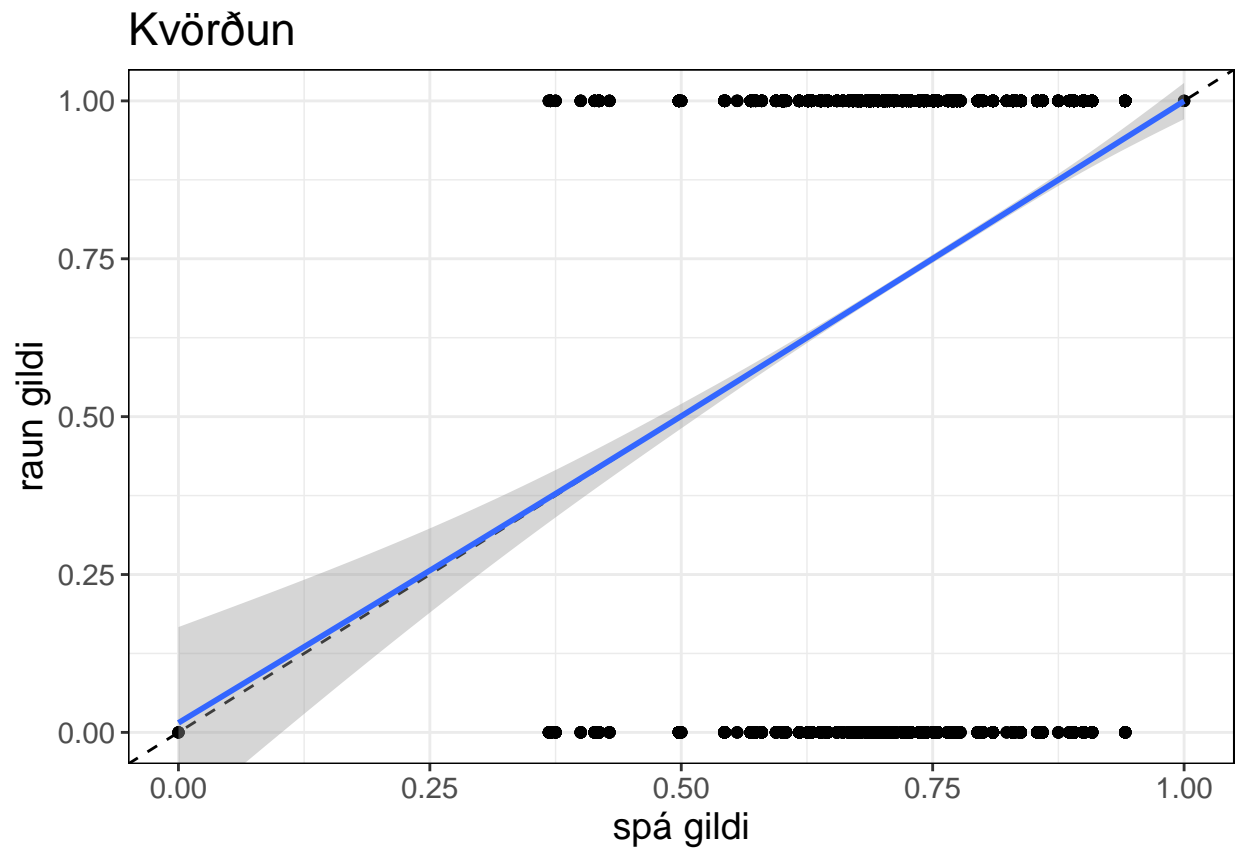
term	statistic	df	p.value
cue	1.537641	1	0.2149693
qName	1050.375908	48	0.0000000
cue:qName	132.232204	48	0.0000000

cue hefur ekki marktæk áhrif en qName og interaction breytan hafa marktæk áhrif.

Calibration (kvörðun)

```
tibble(y = cue_nocue$correct,
       pred = predict(glm3,
                      type = 'response')) %>%
  ggplot(aes(x = pred,
             y = y)) +
  geom_point() +
  geom_abline(intercept = 0,
             slope = 1,
             lty = 2) +
  geom_smooth() +
  xlab("spá gildi") +
  ylab("raun gildi") +
  ggtitle("Kvörðun") +
  coord_cartesian(xlim = c(0, 1),
                 ylim = c(0, 1))
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```



Best hingað til. Lítur mjög vel út

```
phats <- fitted(glm3)

auc(cue_nocue$correct,
    phats) -> auc
```

```
## Setting levels: control = 0, case = 1
```

```
## Setting direction: controls < cases
```

```

b <- mean((cue_nocue$correct - predict(glm3,
                                         type = 'response'))^2)
bm <- mean(predict(glm3,
                   type = 'response')) * (1 - mean(predict(glm3,
                                                           type = 'response'))))
bs <- 1 - b/bm

pred <- prediction(phats,
                  cue_nocue$correct)

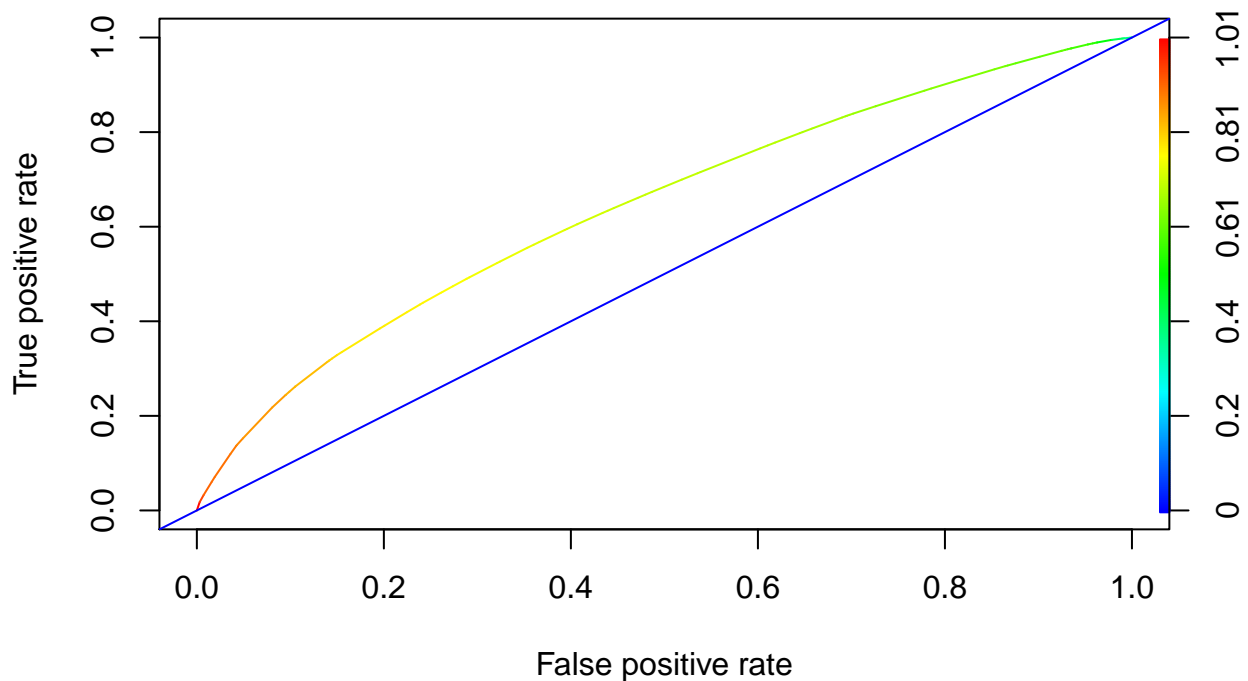
perf <- performance(pred,
                    "tpr",
                    "fpr")

plot(perf,
     colorize=T,
     cex.main=1,
     main= paste("ROC kúrfa:  AUC =",
                 round(auc,4),
                 " Brier =",
                 round(bs,5)))

abline(a=0,
       b = 1,
       col='blue')

```

**ROC kúrfa: AUC = 0.6421 Brier = 0.05017**



Örlítill bæting á bæði AUC og brier frá líkani 2. Brier gildið er ennþá allt of lágt.

## Mixed effect líkön

Hvert svar í gagnarammanum er tilgreint nemanda. Nemendur hafa svarað mis oft eins og sést hér:

```
cue_nocue %>%
  group_by(studentId) %>%
  summarise(fjoldi = length(studentId)) -> ab

## `summarise()` ungrouping output (override with `.groups` argument)
max(ab$fjoldi)

## [1] 236

ab %>%
  filter(fjoldi == "1") %>%
  nrow()

## [1] 748

ab$fjoldi <- as.integer(ab$fjoldi)

ab %>%
  filter(fjoldi >= 100) %>%
  nrow()

## [1] 6
```

Mest eru 236 svör tengd við einn nemanda, 748 nemendur hafa aðeins eitt svar skráð og 6 nemendur hafa svarað jafn oft eða meira en 100 sinnum. Miðað við það eru til dæmis amk 600 svör af 28636 svörum í heildina frá sömu 6 nemendum. Mælingar eiga að vera óháðar fyrir línulega afhvarfsgreiningu sem þær eru ef hver nemandi hefur eitt svar en 100 svör frá sama nemandanum eru innbyrðis háð og því þarf að setja upp mixed effect líkan til að leiðrétta fyrir þetta.

## Mixed effect líkan 1

```
glmer1 <- glmer(correct ~ cue + (1|studentId),
  family = "binomial",
  data=cue_nocue,
  nAGQ = 0)

# failure to converge in 10000 evaluations fyrir nAGQ = 1.
# Kom eftir klukkutíma. Stoppaði keyrslu.

# vantar anova
Anova(glmer1,
  type = "III") %>%
  broom::tidy() %>%
  kable() %>%
  kable_styling(bootstrap_options = c("striped",
    "hover"))
```

term	statistic	df	p.value
(Intercept)	2903.76020	1	0e+00
cue	25.80597	1	4e-07

Marktækt fyrir cue með mixed effect.

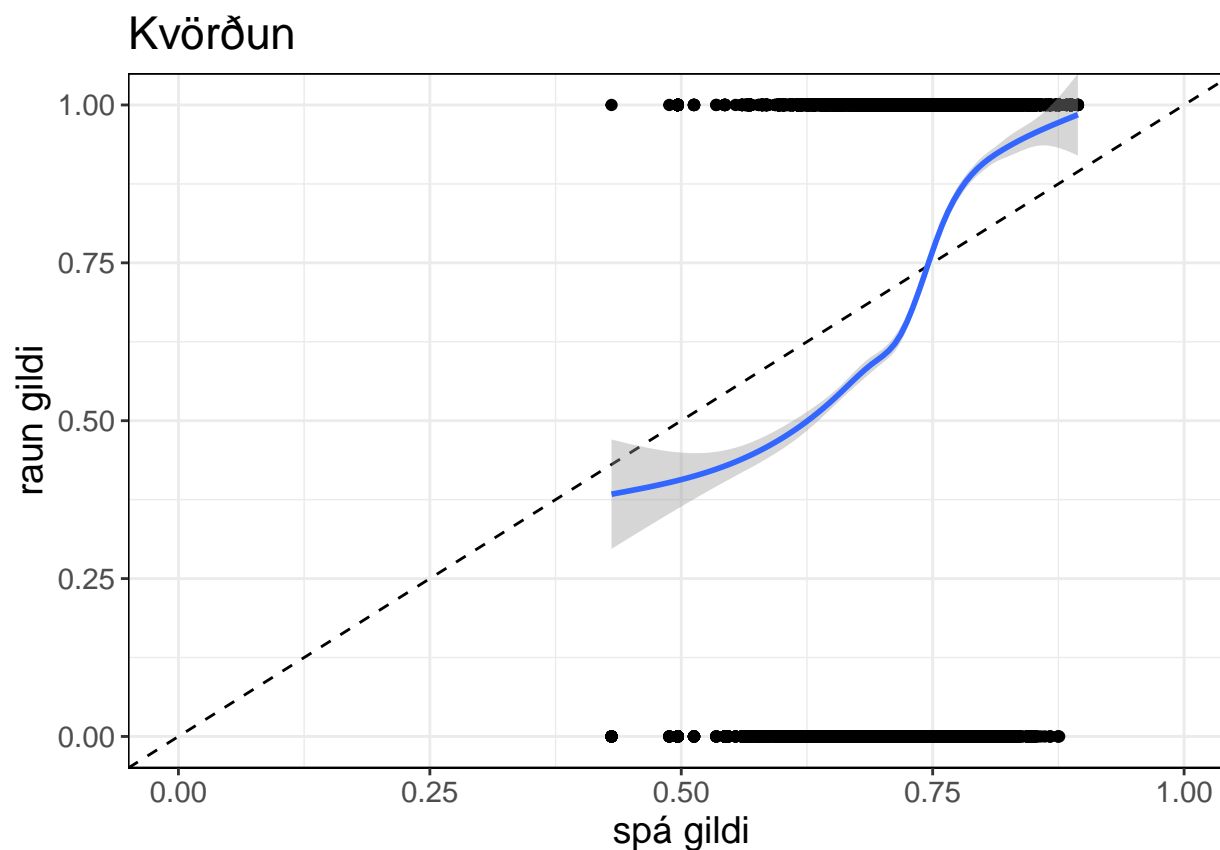
## Gæði mixed effect líkans 1

Kvörðun

```
tibble(y = cue_nocue$correct,
       pred = predict(glmer1,
                      type = 'response')) %>%

  ggplot(aes(x = pred,
             y = y)) +
  geom_point() +
  geom_abline(intercept = 0,
             slope = 1,
             lty = 2) +
  geom_smooth() +
  xlab("spá gildi") +
  ylab("raun gildi") +
  ggtitle("Kvörðun") +
  coord_cartesian(xlim = c(0, 1),
                 ylim = c(0, 1))
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```



Spáin er of lág þar til í 0.75 þar sem spáin verður of há.

ROC kúrfa, AUC og brier gildi.

```
phats <- fitted(glmer1)
```

```
auc(cue_nocue$correct,
```



```

phats) -> auc

## Setting levels: control = 0, case = 1
## Setting direction: controls < cases
b <- mean((cue_nocue$correct - predict(glmer1,
                                     type = 'response'))^2)
bm <- mean(predict(glmer1,
                  type = 'response')) * (1 - mean(predict(glmer1,
                                                          type = 'response'))))
bs <- 1 - b/bm

pred <- prediction(phats,
                  cue_nocue$correct)

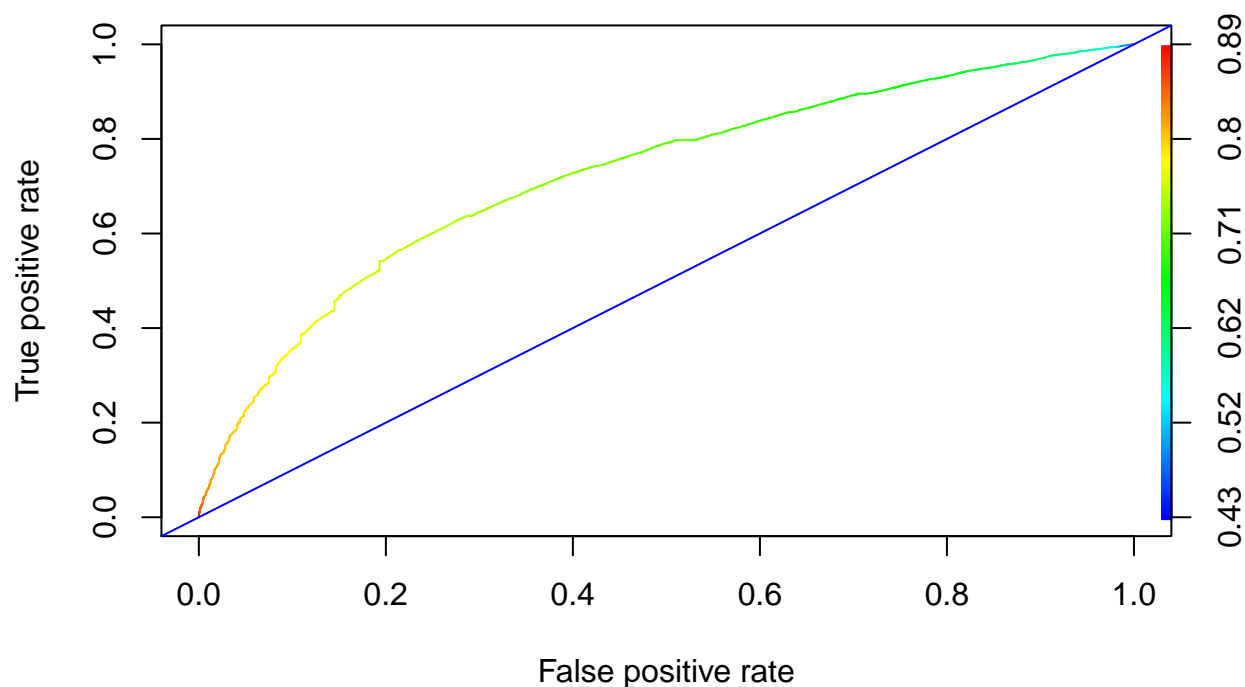
perf <- performance(pred,
                    "tpr",
                    "fpr")

plot(perf,
     colorize=T,
     cex.main=1,
     main= paste("ROC kúrfa: AUC =",
                 round(auc,4),
                 " Brier =",
                 round(bs,5)))

abline(a=0,
       b = 1,
       col='blue')

```

ROC kúrfa: AUC = 0.7239 Brier = 0.07649



Mjög gott miðað við hingað til! Brier gildið reyndar arfa slakt ennþá.

## Líkan 2

```
glmer2 <- glmer(correct ~ cue + qName + (1|studentId),
  family = "binomial",
  data=cue_nocue,
  nAGQ = 0)
```

```
Anova(glmer2,
  type = "III") %>%
  broom::tidy() %>%
  kable() %>%
  kable_styling(bootstrap_options = c("striped",
    "hover"))
```

term	statistic	df	p.value
(Intercept)	102.68741	1	0.0000000
cue	14.36673	1	0.0001504
qName	1170.45194	48	0.0000000

Marktækt fyrir cue og qName.

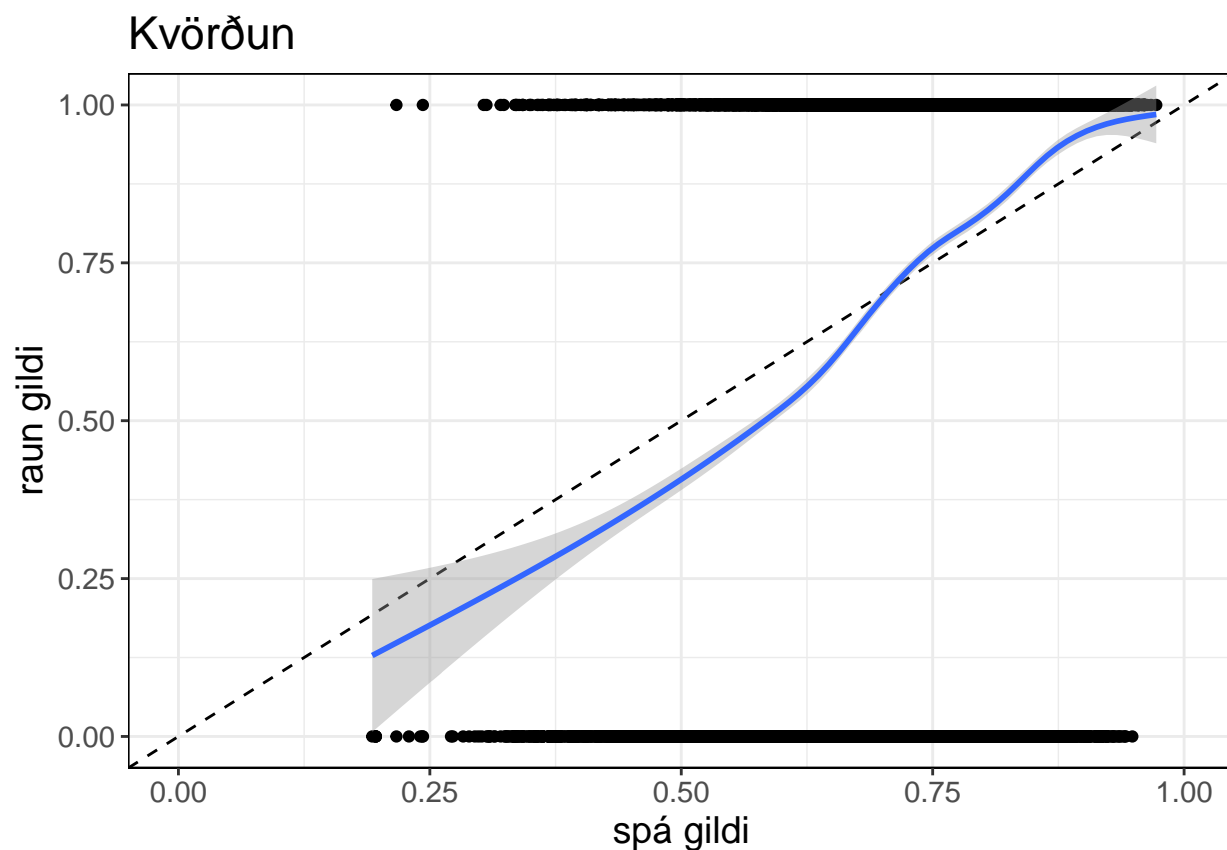
## Gæði mixed effect líkans 2

Kvörðun

```
tibble(y = cue_nocue$correct,
       pred = predict(glmer2,
                      type = 'response')) %>%

  ggplot(aes(x = pred,
             y = y)) +
  geom_point() +
  geom_abline(intercept = 0,
             slope = 1,
             lty = 2) +
  geom_smooth() +
  xlab("spá gildi") +
  ylab("raun gildi") +
  ggtitle("Kvörðun") +
  coord_cartesian(xlim = c(0, 1),
                 ylim = c(0, 1))
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```



Betra en í líkani 1 spá of há fram að 0.7 þegar hún verður of há. Munar ekki miklu.

ROC kúrfa, AUC og brier.

```
phats <- fitted(glmer2)
```

```
auc(cue_nocue$correct,
```

```

phats) -> auc

## Setting levels: control = 0, case = 1
## Setting direction: controls < cases
b <- mean((cue_nocue$correct - predict(glmer2,
                                     type = 'response'))^2)
bm <- mean(predict(glmer2,
                  type = 'response'))*(1-mean(predict(glmer2,
                                                         type = 'response'))))
bs <- 1 - b/bm

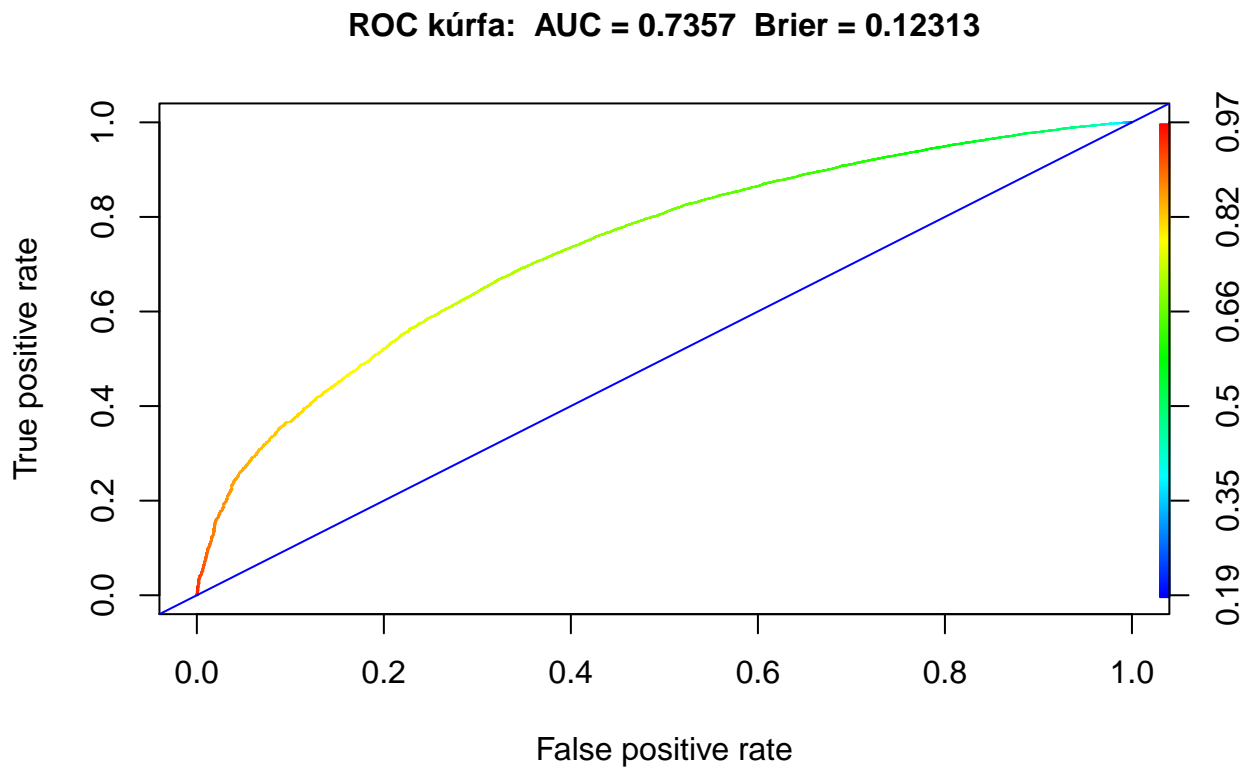
pred <- prediction(phats,
                  cue_nocue$correct)

perf <- performance(pred,
                    "tpr",
                    "fpr")

plot(perf,
     colorize=T,
     cex.main=1,
     main= paste("ROC kúrfa:  AUC =",
                 round(auc,4),
                 " Brier =",
                 round(bs,5)))

abline(a=0,
       b = 1,
       col='blue')

```



AUC komið uppi 0.7357 og brier í 0.12313 sem er það lang besta hingað til.

## Mixed effect líkan 3

```
glmer3 <- glmer(correct ~ cue + qName + cue:qName + (1|studentId),
  family = "binomial",
  data=cue_nocue,
  nAGQ = 0)
```

Anova tafla.

```
# setja inn scientific
Anova(glmer3,
  type = "III") %>%
  broom::tidy() %>%
  kable() %>%
  kable_styling(bootstrap_options = c("striped",
    "hover"))
```

term	statistic	df	p.value
(Intercept)	102.53477	1	0.0000000
cue	3.04862	1	0.0808058
qName	947.73285	48	0.0000000
cue:qName	119.74546	48	0.0000000

Marktækt fyrir qName og interaction á milli cue og qName.

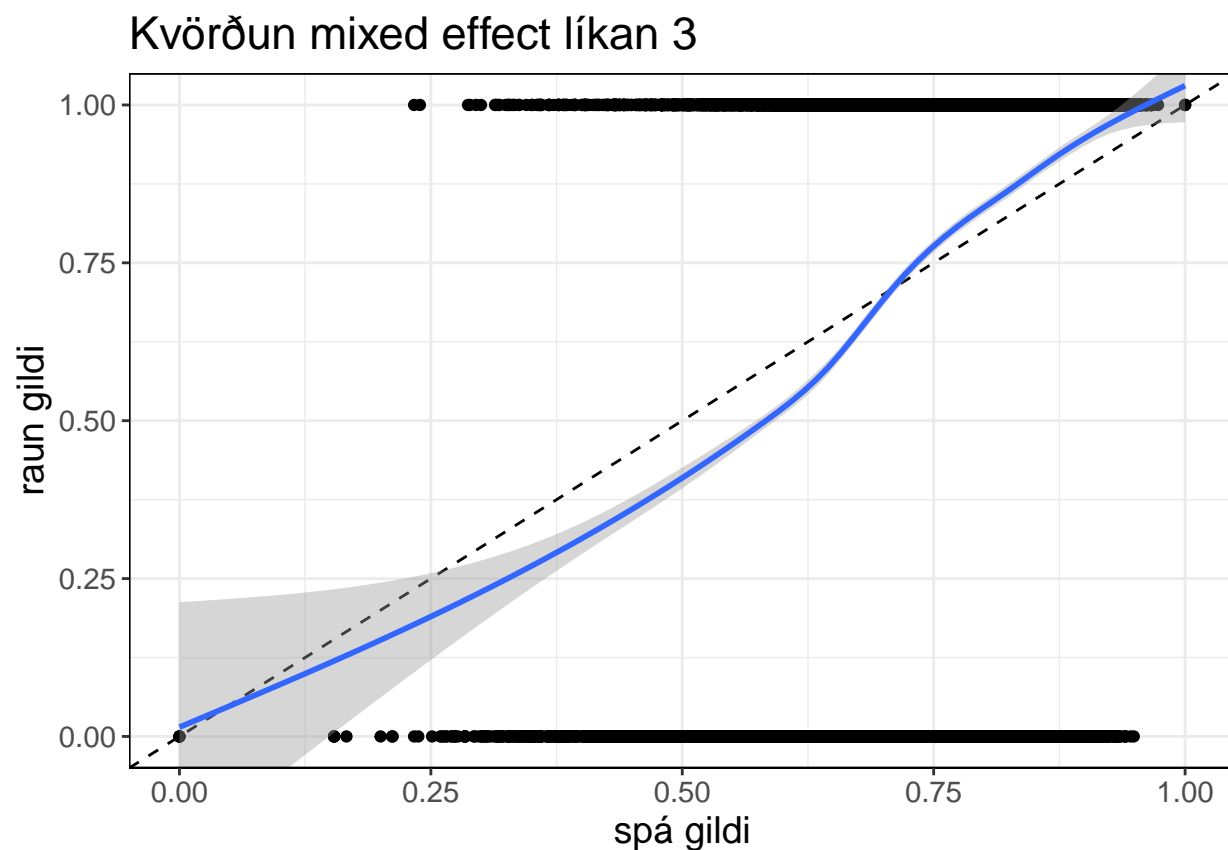
## Gæði mixed effect líkans 3

Kvörðun

```
tibble(y = cue_nocue$correct,
       pred = predict(glmer3,
                      type = 'response')) %>%

  ggplot(aes(x = pred,
             y = y)) +
  geom_point() +
  geom_abline(intercept = 0,
              slope = 1,
              lty = 2) +
  geom_smooth() +
  xlab("spá gildi") +
  ylab("raun gildi") +
  ggtitle("Kvörðun mixed effect líkan 3") +
  coord_cartesian(xlim = c(0, 1),
                  ylim = c(0, 1))
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```



Spáir of lágt fyrir mest allt en engu að síður nokkuð gott og best hingað til.

ROC kúrfa, AUC og brier gildi.

```
phats <- fitted(glmer3)
```

```
auc(cue_nocue$correct,
```

```

phats) -> auc

## Setting levels: control = 0, case = 1
## Setting direction: controls < cases
b <- mean((cue_nocue$correct - predict(glmer3,
                                     type = 'response'))^2)
bm <- mean(predict(glmer3,
                  type = 'response'))*(1-mean(predict(glmer3,
                                                         type = 'response'))))
bs <- 1 - b/bm

pred <- prediction(phats,
                  cue_nocue$correct)

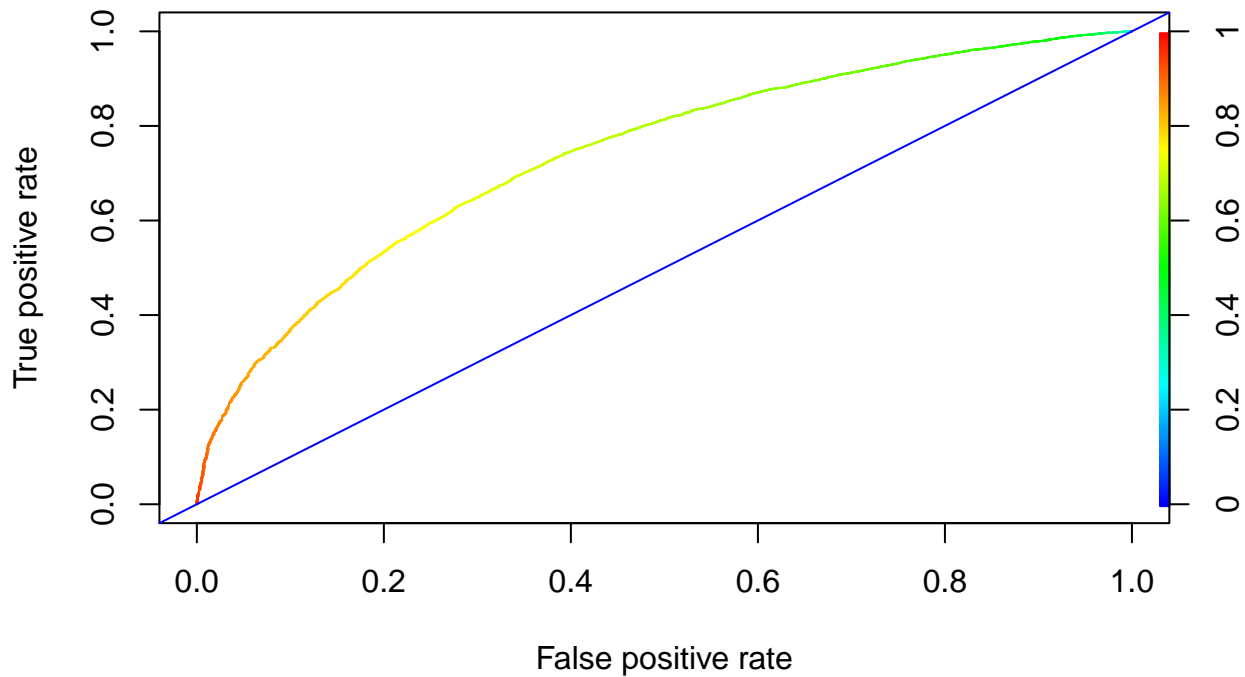
perf <- performance(pred,
                    "tpr",
                    "fpr")

plot(perf,
     colorize=T,
     cex.main=1,
     main= paste("ROC mixed effect líkan 3:  AUC =",
                 round(auc,4),
                 " Brier =",
                 round(bs,5)))

abline(a=0,
       b = 1,
       col='blue')

```

### ROC mixed effect líkan 3: AUC = 0.7395 Brier = 0.12758



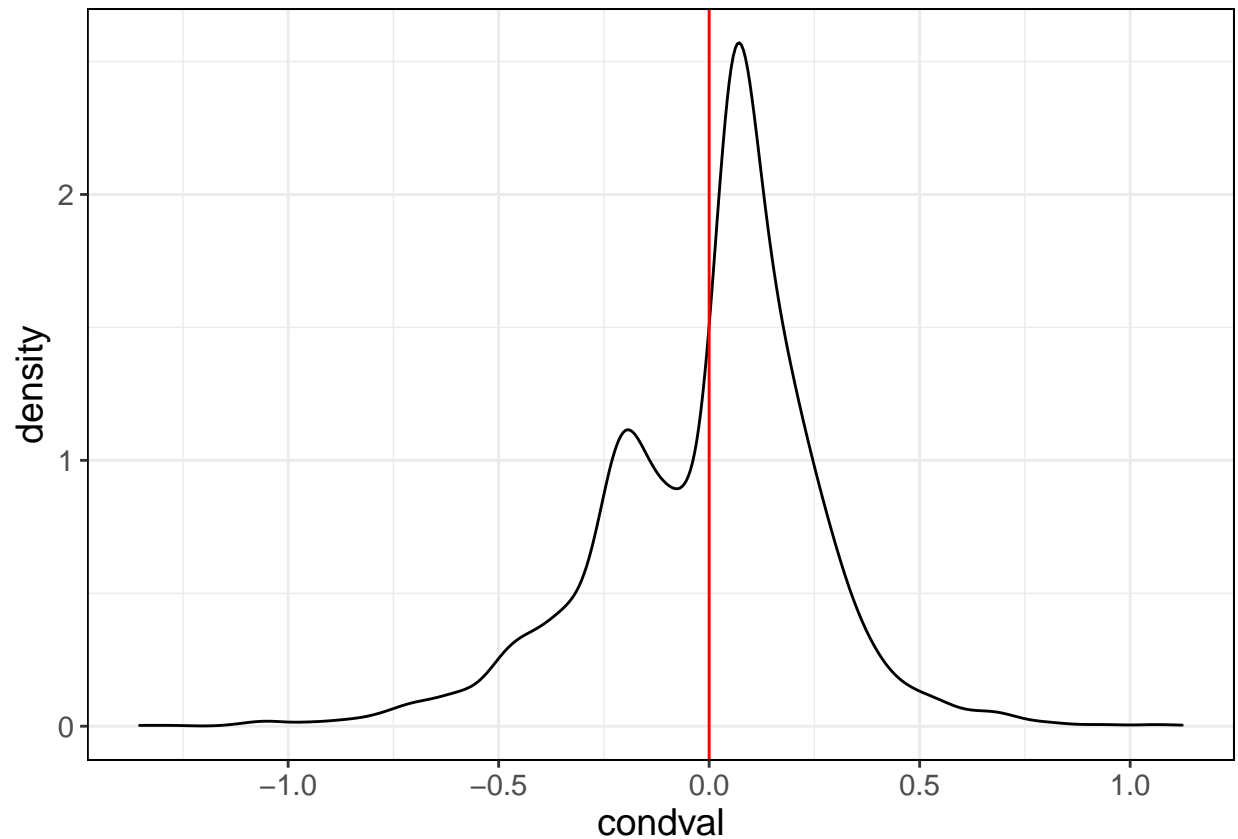
Mjög gott AUC gildi og langbesta brier gildi sem komið hefur upp hingað til.

Dreifni skurðpunkta við y-ás fyrir hvern nemanda í mixed effect líkaninu. Sýnir random effect.

A generic function to extract the conditional modes of the random effects from a fitted model object. For linear mixed models the conditional modes of the random effects are also the conditional means.

```
ranef(glmer3) %>%  
  as_tibble() -> ranef_fitful  
ranef_fitful %>%  
  ggplot(aes(x = condval)) +  
  geom_density() +  
  geom_vline(xintercept = mean(ranef_fitful$condval),  
    col = 'red')
```





gunnar vill fá eitthvað í líkingu við þetta inn

```
#p1 <- lm(correct ~ factor(studentId) + factor(cue), data = cue_nocue)
```

## Bootstrap

Bootstrap með cue, qName og interaction. 100 ítranir.

```
# Taflan gefur okkur auc bjartsýni fyrir hverja ítrun þar sem bjartsýnin er mismunurinn á bootstrap gag
boot <- read.csv("drasl_cue_allt.csv")
```

Myndræn framsetning bootstrap töflunnar:

```
# density = þéttleiki ?

boot %>%
  dplyr::select(1,2,3) %>%
  gather(type,
          Score) %>%
  mutate(type = factor(type,
                        levels = c('auc_b',
                                   'auc_afgangs',
                                   'auc_opt'),
                        labels = c('Bootstrap',
                                   'Afgangs')))
```

```

                                'Bjartsýni')))) %>%
ggplot(aes(x = Score)) +
  geom_density() +
  facet_wrap(~type,
             scales = 'free') +
  labs(x="Gildi", title = "AUC")-> p1

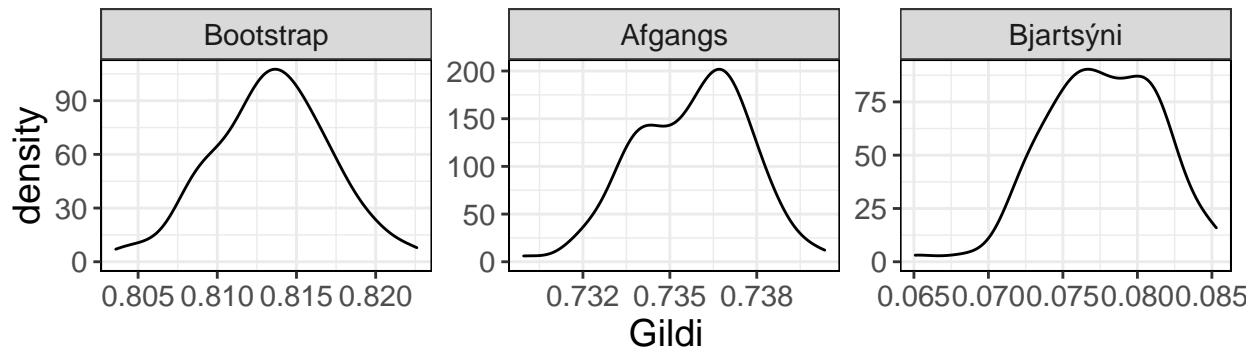
boot %>%
  dplyr::select(4,5,6) %>%
  gather(type,
         Score) %>%
  mutate(type = factor(type,
                       levels = c('brier_afgangs',
                                  'brier_b',
                                  'brier_opt'),
                       labels = c('Bootstrap',
                                   'Afgangs',
                                   'Bjartsýni')))) %>%

ggplot(aes(x = Score)) +
  geom_density() +
  facet_wrap(~type,
             scales = 'free') +
  labs(x="Gildi", title = "Brier") -> p2

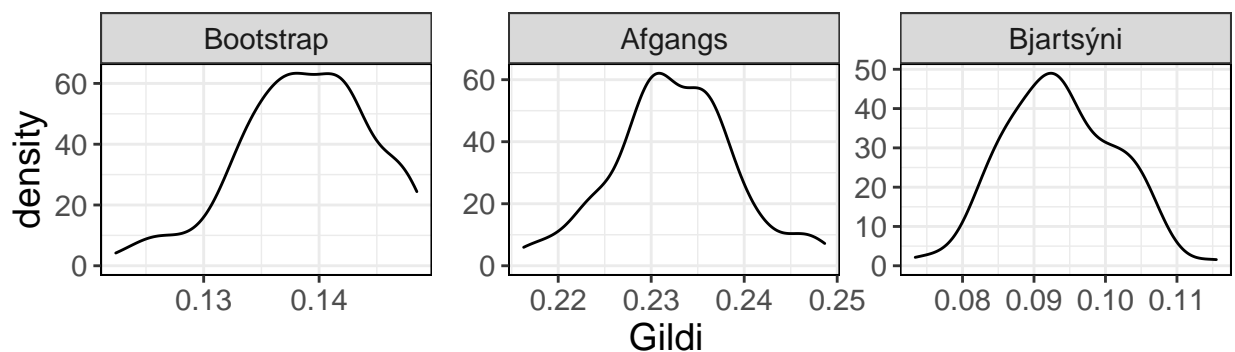
plot_grid(p1, p2,
          align = 'v',
          ncol = 1)

```

## AUC



## Brier



Finna leiðrétt auc og brier.

Brier gildi án bootstrap.

```
b <- mean((cue_nocue$correct - predict(glmer3,
                                     type = 'response'))^2)
bm <- mean(predict(glmer3,
                  type = 'response')) * (1 - mean(predict(glmer3,
                                                          type = 'response'))))
bs <- 1 - b/bm
bs
```

```
## [1] 0.1275836
```

Meðaltal bootstrap bjartsýninnar.

```
brier_medal_opt <- mean(boot$brier_opt)
brier_medal_opt
```

```
## [1] 0.0936886
```

Sem gefur leiðrétt brier gildi.

```
brier_leidrett <- bs - brier_medal_opt
brier_leidrett
```

```
## [1] 0.03389502
```

AUC gildi líkans.

```

auc_likan <- auc(roc(cue_nocue$correct,
                    predict(glmer3,
                            type = 'response'),
                    quiet = T))[[1]]
auc_likan

## [1] 0.7395053
Meðaltal bootstrap bjartsýnnar:
auc_medal_opt <- mean(boot$auc_opt)
auc_medal_opt

## [1] 0.07763758
Leiðrétt AUC er þá:
auc_leidrett <- auc_likan-auc_medal_opt
auc_leidrett

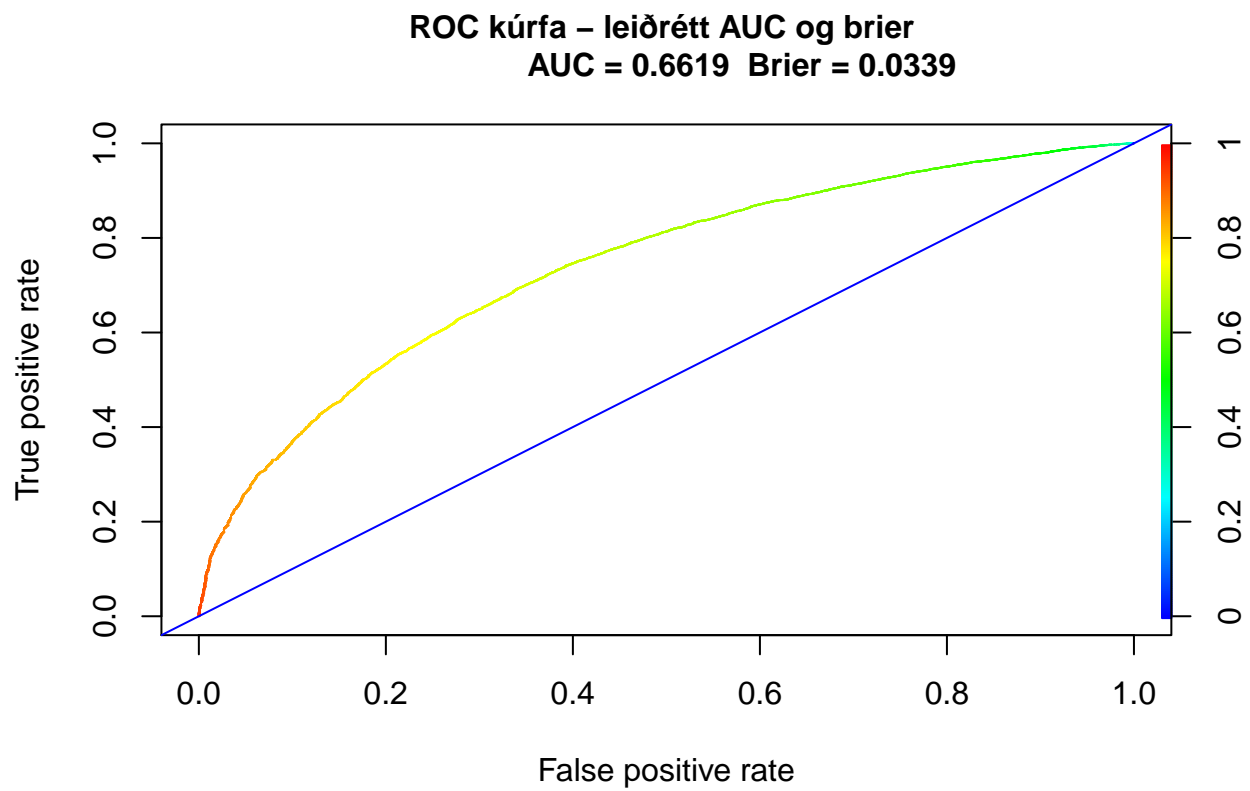
## [1] 0.6618678
ROC mynd fyrir leiðrétt gildi á auc og brier.
phats <- fitted(glmer3)

pred <- prediction(phats,
                   cue_nocue$correct)

perf <- performance(pred,
                    "tpr",
                    "fpr")

plot(perf,
     colorize=T,
     cex.main=1,
     main= paste("ROC kúrfa - leiðrétt AUC og brier
                 AUC =",
                 round(auc_leidrett,4),
                 " Brier =",
                 round(brier_leidrett,5)),
     cex.sub=1,)
abline(a=0, b = 1, col='blue')

```



Brier gildi sem bendir til þess að líkanið sé mjög viðkvæmt fyrir gögnunum.