

# Dealing with `quasi-` models in R

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Computing “quasi-AIC” (QAIC), in R is a minor pain, because the R Core team (or at least the ones who wrote `glm`, `glmmPQL`, etc.) are purists and don’t believe that quasi- models should report a likelihood. As far as I know, there are three R packages that compute/handle QAIC: `bbmle`, `AICcmodavg` (both on CRAN) and `MuMin` (formerly known as `dRedging`, on r-forge).

The basic problem is that quasi- model fits with `glm` return an NA for the log-likelihood, while the dispersion parameter ( $\hat{c}$ ,  $\phi$ , whatever you want to call it) is only reported for quasi- models. Various ways to get around this are:

- fit the model twice, once with a regular likelihood model (`family=binomial`, `poisson`, etc.) and once with the `quasi-` variant — extract the log-likelihood from the former and the dispersion parameter from the latter
- only fit the regular model; extract the overdispersion parameter manually with

```
> dfun <- function(object) {  
+   with(object, sum((weights * residuals^2)[weights > 0])/df.residual)  
+ }
```

- use the fact that quasi- fits still contain a deviance, even if they set the log-likelihood to NA. The deviance is twice the negative log-likelihood (it’s offset by some constant which I haven’t figured out yet, but it should still work fine for model comparisons)

Example: use the values from one of the examples in `?glm`:

```
> ## Dobson (1990) Page 93: Randomized Controlled Trial :  
> counts <- c(18,17,15,20,10,20,25,13,12)  
> outcome <- gl(3,1,9)  
> treatment <- gl(3,3)
```

Fit Poisson and quasi-Poisson models with all combinations of predictors:

```

> glmOT.D93 <- glm(counts ~ outcome + treatment, family = poisson)
> glmO.D93 <- update(glmOT.D93, . ~ . - treatment)
> glmT.D93 <- update(glmOT.D93, . ~ . - outcome)
> glmX.D93 <- update(glmT.D93, . ~ . - treatment)
> glmQOT.D93 <- update(glmOT.D93, family = quasipoisson)
> glmQO.D93 <- update(glmO.D93, family = quasipoisson)
> glmQT.D93 <- update(glmT.D93, family = quasipoisson)
> glmQX.D93 <- update(glmX.D93, family = quasipoisson)

```

Extract log-likelihoods:

```

> (sum(dpois(counts,
+          lambda=exp(predict(glmOT.D93)),log=TRUE))) ## by hand
[1] -23.38066

```

```

> (logLik(glmOT.D93)) ## from Poisson fit
'log Lik.' -23.38066 (df=5)

```

The deviance (`deviance(glmOT.D93)=5.129` is not the same as  $-2L$  ( $-2*\logLik(glmOT.D93)=46.761$ ), but the calculated differences in deviance are consistent, and are also extractable from the quasi- fit even though the log-likelihood is NA:

```

> (-2 * (logLik(glmT.D93) - logLik(glmOT.D93)))
'log Lik.' 5.452305 (df=3)

```

```

> (deviance(glmT.D93) - deviance(glmOT.D93))
[1] 5.452305

```

```

> (deviance(glmQT.D93) - deviance(glmQOT.D93))
[1] 5.452305

```

Compare hand-computed dispersion (in two ways) with the dispersion computed by `summary.glm()` on a quasi- fit:

```

> (dfun(glmOT.D93))
[1] 1.293300
> (sum(residuals(glmOT.D93, "pearson")^2)/glmOT.D93$df.residual)
[1] 1.293300
> (summary(glmOT.D93)$dispersion)
[1] 1
> (summary(glmQOT.D93)$dispersion)
[1] 1.293300

```

## Examples

**bbmle package (Ben Bolker), CRAN/R-forge**

```
> library(bbmle)
> (qAIC(glmOT.D93, dispersion = dfun(glmOT.D93)))

[1] 46.15658

> (qAICc(glmOT.D93, dispersion = dfun(glmOT.D93), nobs = length(counts)))

[1] 90.15658

> ICTab(glmOT.D93, glmT.D93, glmO.D93, glmX.D93, dispersion = dfun(glmOT.D93),
+       type = "qAIC")

      dqAIC df
glmO.D93  0.0  3
glmX.D93  0.2  1
glmOT.D93 4.0  5
glmT.D93  4.2  3

> ICTab(glmOT.D93, glmT.D93, glmO.D93, glmX.D93, dispersion = dfun(glmOT.D93),
+       nobs = length(counts), type = "qAICc")

      dqAICc df
glmX.D93   0.0  1
glmO.D93   7.8  3
glmT.D93  12.0  3
glmOT.D93 43.8  5

> detach("package:bbmle")
```

**AICcmodavg package (Marc Mazerolle), CRAN**

```
> library(AICcmodavg)
> aictab(list(glmOT.D93, glmT.D93, glmO.D93, glmX.D93), modnames = c("OT",
+   "T", "O", "X"), c.hat = dfun(glmOT.D93))
```

Model selection based on QAICc :  
(c-hat estimate = 1.293300 )

	K	QAICc	Delta QAICc	QAICcWt	Cum.Wt
X	2	46.3724	0.0000	0.9776	0.9776
O	4	54.1566	7.7842	0.0199	0.9976
T	4	58.3724	12.0000	0.0024	1.0000
OT	6	90.1566	43.7842	0.0000	1.0000

```
> detach("package:AICcmodavg")
```

## MuMin package (Kamil Bartoń), r-forge

```
> library(MuMin)
> ## MuMin has only QAIC, not QAICc -- add it
> QAICc <- function(object,...,chat,nobs) {
+   df <- attr(logLik(object),"df")+1
+   QAIC(object,...,chat=chat)+2*df*(df+1)/(nobs-df-1)
+ }
> (gg <- dredge(glmOT.D93,rank="QAIC",chat=dfun(glmOT.D93)))
```

Model selection table

	(Intr)	outcom	trtmnt	k	Dev.	QAIC	delta	weight
2	3.045		1	3	5.129	11.97	0.0000	0.464
1	2.813			1	10.580	12.18	0.2158	0.417
4	3.045		1	5	5.129	15.97	4.0000	0.063
3	2.813			3	10.580	16.18	4.2160	0.056

```
> (ggc <- dredge(glmOT.D93,rank="QAICc",nobs=length(counts),chat=dfun(glmOT.D93)))
```

Model selection table

	(Intr)	outcom	trtmnt	k	Dev.	QAICc	delta	weight
1	2.813			1	10.580	14.18	0.000	0.978
2	3.045		1	3	5.129	21.97	7.784	0.020
3	2.813			3	10.580	26.18	12.000	0.002
4	3.045		1	5	5.129	57.97	43.780	0.000

```
> detach("package:MuMin")
```

Since dredge is clever, can work with quasi- models as well by using deviance():

```
> (ggqc <- dredge(glmQOT.D93, rank = "QAICc", nobs = length(counts),
+   chat = summary(glmQOT.D93)$dispersion))
```

gives identical results to the previous table.

Notes: ICtab only gives delta-IC, limited decimal places (on purpose, but how do you change these defaults if you want to?). Need to add 1 to parameters to account for scale parameter. When doing corrected-IC you need to get the absolute number of parameters right, not just the relative number ... Not sure which classes of models each of these will handle (lm, glm, (n)lme, lme4, mle2 ...). Remember need to use overdispersion parameter from most complex model. glmmPQL: needs to be hacked somewhat more severely (does not contain deviance element, logLik has been NA'd out).

package	lm	glm	(n)lme	multinom	polr	lme4	mle2
AICcmodavg	y	y	y	y	y	?	?
MuMin	?	?	?	?	?	?	?
mle2	?	?	?	?	?	?	?