

Appendix C: R-code

The following code is for the statistical computing language R (R Development Core Team, 2009). The first example estimates the person parameter via the generalized linear model and makes use of the `cond`-package of the HOA-bundle (Brazzale, 2005).

```
# data is a person's response vector
persone.glm <- glm(formula=as.numeric(data) ~ discrims-1,
offset=-discrims*difficulties,family=binomial(link = "logit"))
# maximum likelihood estimate
mle <- persone.glm$coefficients
# Modified likelihood root returns the MUE
summary(cond(persone.glm,discrims),alpha=1)
```

The above code only returns confidence limits or MUEs obtained from the modified likelihood root r^* . However, it is easy to compute the confidence limits with the Lugannani-Rice approximation, as shown in the following code example.

```
# the weighted sum score
sufficient <- sum(data*discrims)
intermediate <- seq(mle-2.5,mle+2.5,length.out=30)
# the profile likelihood
L1 <- unlist(lapply(intermediate,function(x){exp((sufficient*x)
-sum(log(1+exp(discrims*(x-difficulties))))))}))
L2 <- exp((sufficient*mle)-sum(log(1+exp(discrims*(mle-difficulties))))))
# -second derivation
P <- plogis(discrims*(mle-difficulties))
Q <- 1-P
info <- (P*discrims^2) %*% Q
# Wald statistic
Wald <- (mle-intermediate)/sqrt(1/info)
# signed likelihood root
```

```
r <- sign(mle-intermediate)*sqrt(2*(log(L2)-log(L1)))
# Lugannani-Rice approximation
LR <- pnorm(r)-dnorm(r)*(1/Wald - 1/r)
lr <- spline(intermediate[is.finite(LR)], LR[is.finite(LR)], 100)
# can have values beyond 0 and 1
lr$y[lr$y < 0] <- 0
lr$y[lr$y > 1] <- 1
alpha <- 0.05 # alternatively: alpha <- 1 to obtain the MUE
CI <- predict(smooth.spline(lr$y, lr$x),c(1-alpha/2,alpha/2), 0)$y
```

References

- Brazzale. (2005). *hoa*: An r package bundle for higher order likelihood inference. *Rnews*, 5(1), 20–27. (ISSN 609–3631)
- R Development Core Team. (2009). *R: A language and environment for statistical computing* [Computer software manual]. Vienna, Austria. Available from <http://www.R-project.org> (ISBN 3-900051-07-0)