Flexible Regression and Smoothing

Centile Estimation

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The Dutch boys data

`head` : the head head circumference of 7040 boys

`age` : the age in years

Source: Buuren and Fredriks (2001)

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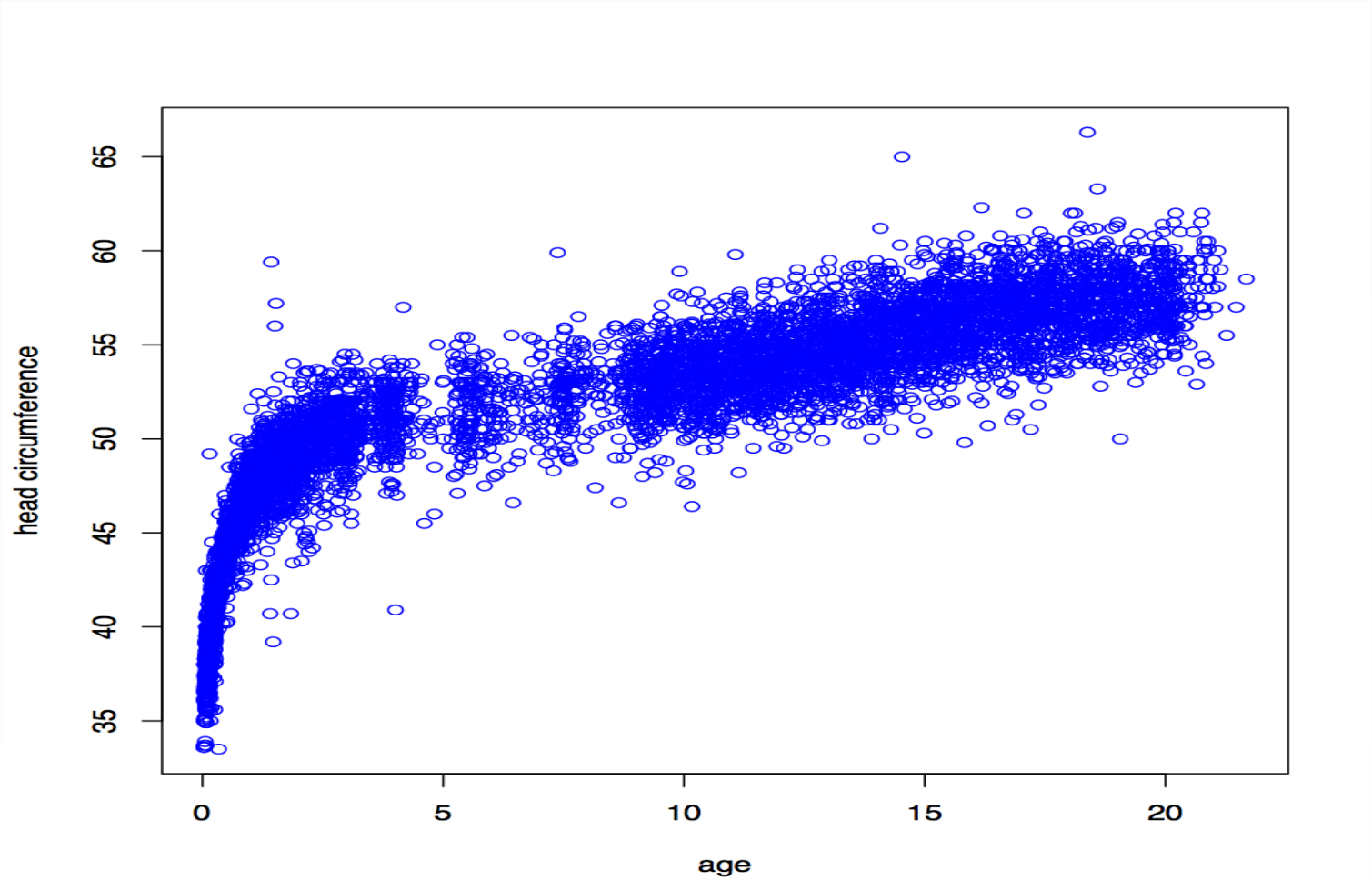
The Dutch boys data



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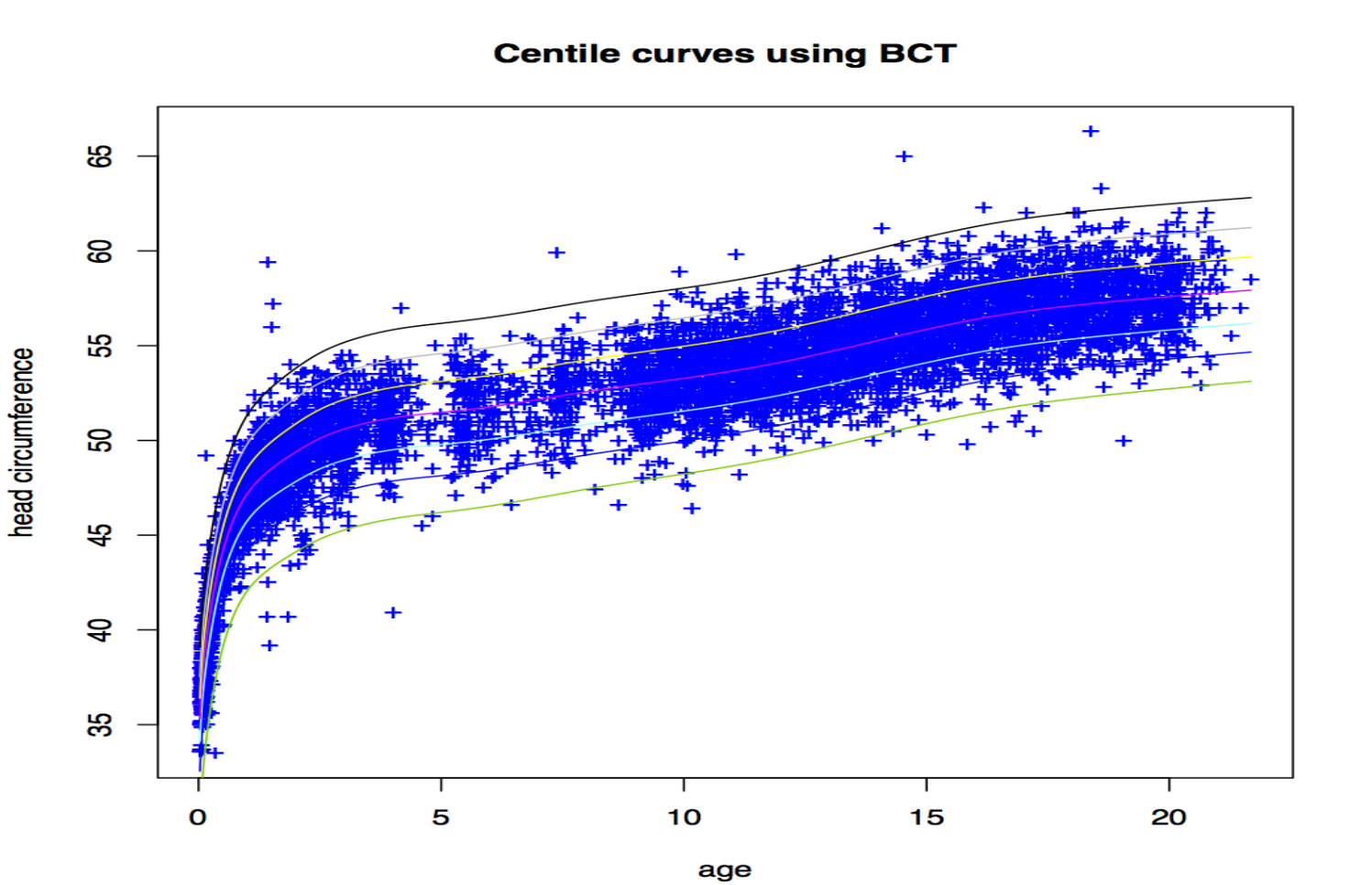
The Dutch boys data with centiles



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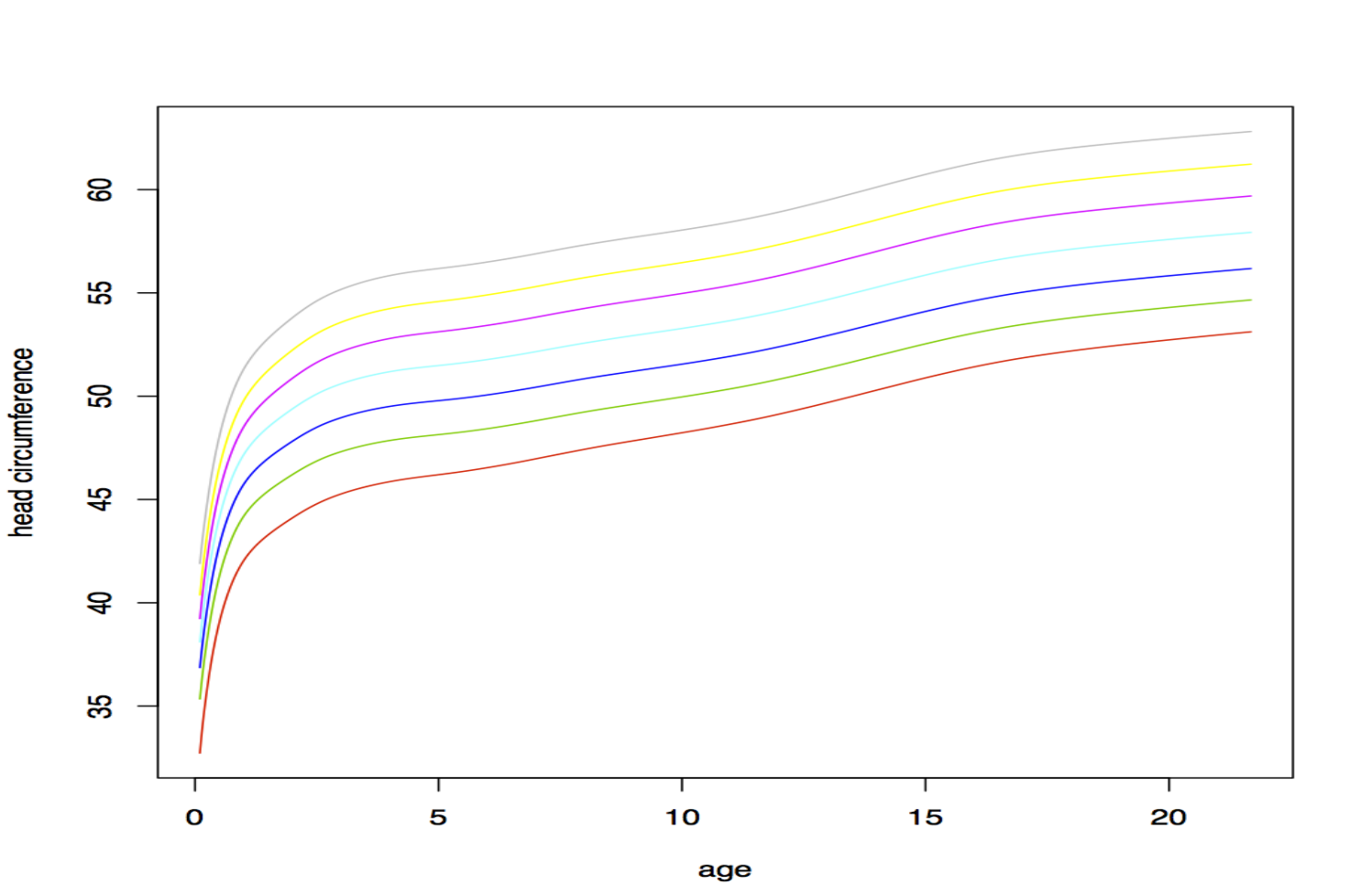
The Dutch boys data: centiles



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The methods

i) the non parametric approach of quantile regression (Koenker, 2005; Koenker and Bassett, 1978)

ii) the parametric LMS approach of Cole (1988), Cole and Green (1992) and its extensions Rigby and Stasinopoulos (2004, 2006, 2007).

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Centiles: the LMS method

$Y \sim f_Y(y|\mu, \sigma, \nu, \tau)$ where $f_Y()$ is any distribution

$Y =$head circumference and $X = AGE^{\xi}$

$$\mu = s(x, df_\mu)$$
$$\log(\sigma) = s(x, df_\sigma)$$
$$\nu = s(x, df_\nu)$$
$$\log(\tau) = s(x, df_\tau)$$

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The LMS method and extensions

Let Y be a random variable with range $Y > 0$ defined through the transformed variable Z given by:

$$Z = \frac{1}{\sigma\nu}\left[\left(\frac{Y}{\mu}\right)^{\nu} - 1\right], \quad \text{if} \quad \nu \neq 0$$
$$= \frac{1}{\sigma}\log\left(\frac{Y}{\mu}\right), \quad \text{if} \quad \nu = 0.$$

1. if $Z \sim N(0,1)$ then $Y \sim BCCG(\mu,\sigma,\nu) =$ LMS method
2. if $Z \sim t_\tau$ then $Y \sim BCT(\mu,\sigma,\nu,\tau) =$ LMST method
3. if $Z \sim PE(0,1,\tau)$ then $Y \sim BCPE(\mu,\sigma,\nu,\tau) =$ LMSP method adopted by WHO

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Centiles: estimation of the smoothing parameters

We need to select the five values $df_\mu, df_\sigma, df_\nu, df_\tau, \xi$

- by trial and error
- minimize the generalized Akaike information criterion, GAIC($\sharp$)
- minimize the the validation global deviance VGD
- using local selection criteria, i.e. CV, ML

Diagnostics should be used in all above cases

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GAMLSS functions for centile estimation

`lms()` automatic selection of an appropriate LMS method

`centiles()` to plot centile curves against an x-variable.

`calibration()` adjust for sample quantiles to create centiles

`centiles.com()` to compare centiles curves for more than one `object`.

`centiles.split()` as for `centiles()`, but splits the plot at specified values of x.

`centiles.fan()` fan plot as in `centiles()`.

`centiles.pred()` to predict and plot centile curves for new x-values.

`fitted.plot()` to plot fitted values for all the parameters against an x-variable

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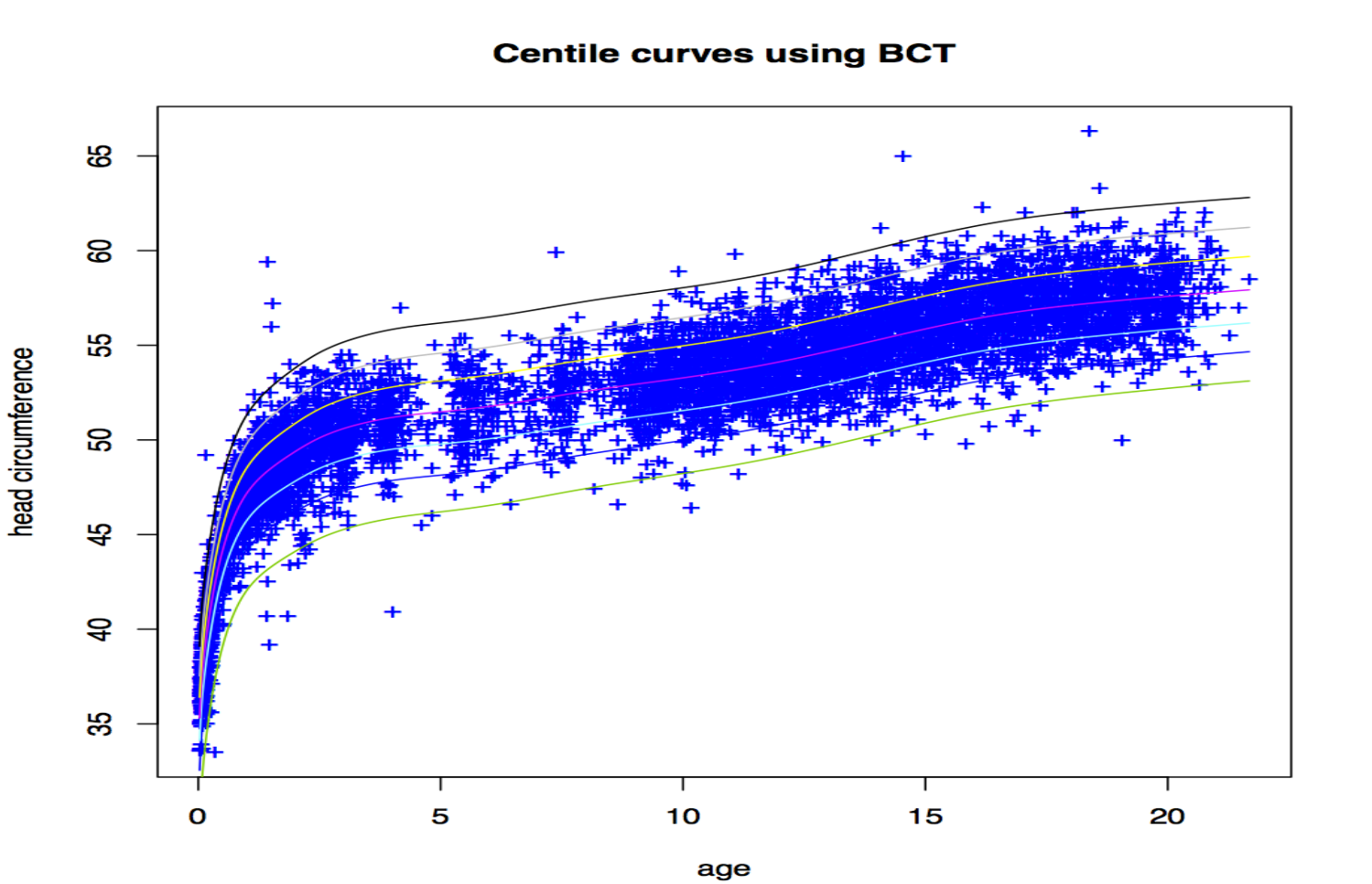
The head circumference data: `centiles()`



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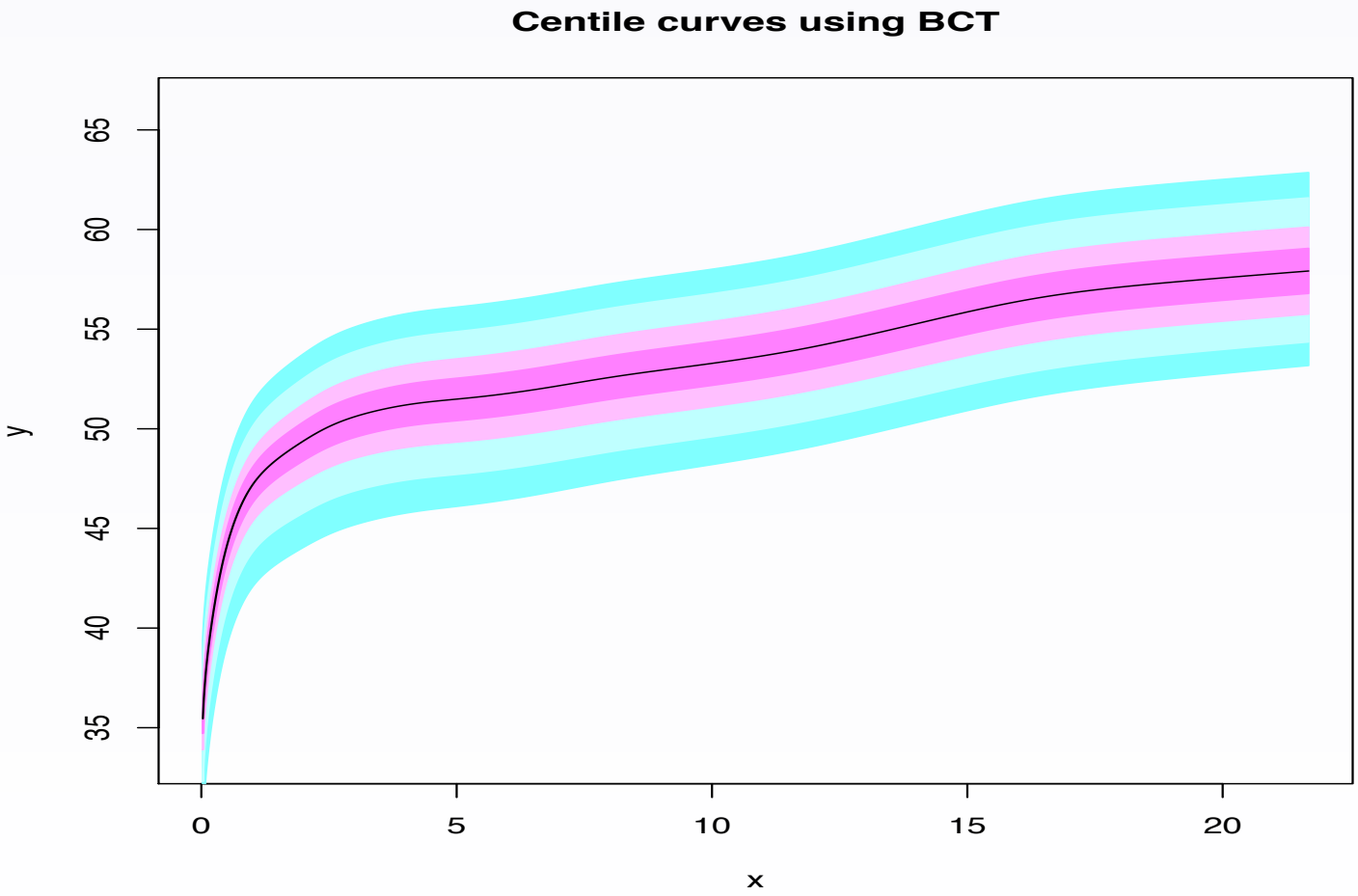
The head circumference data: `centiles.fan()`



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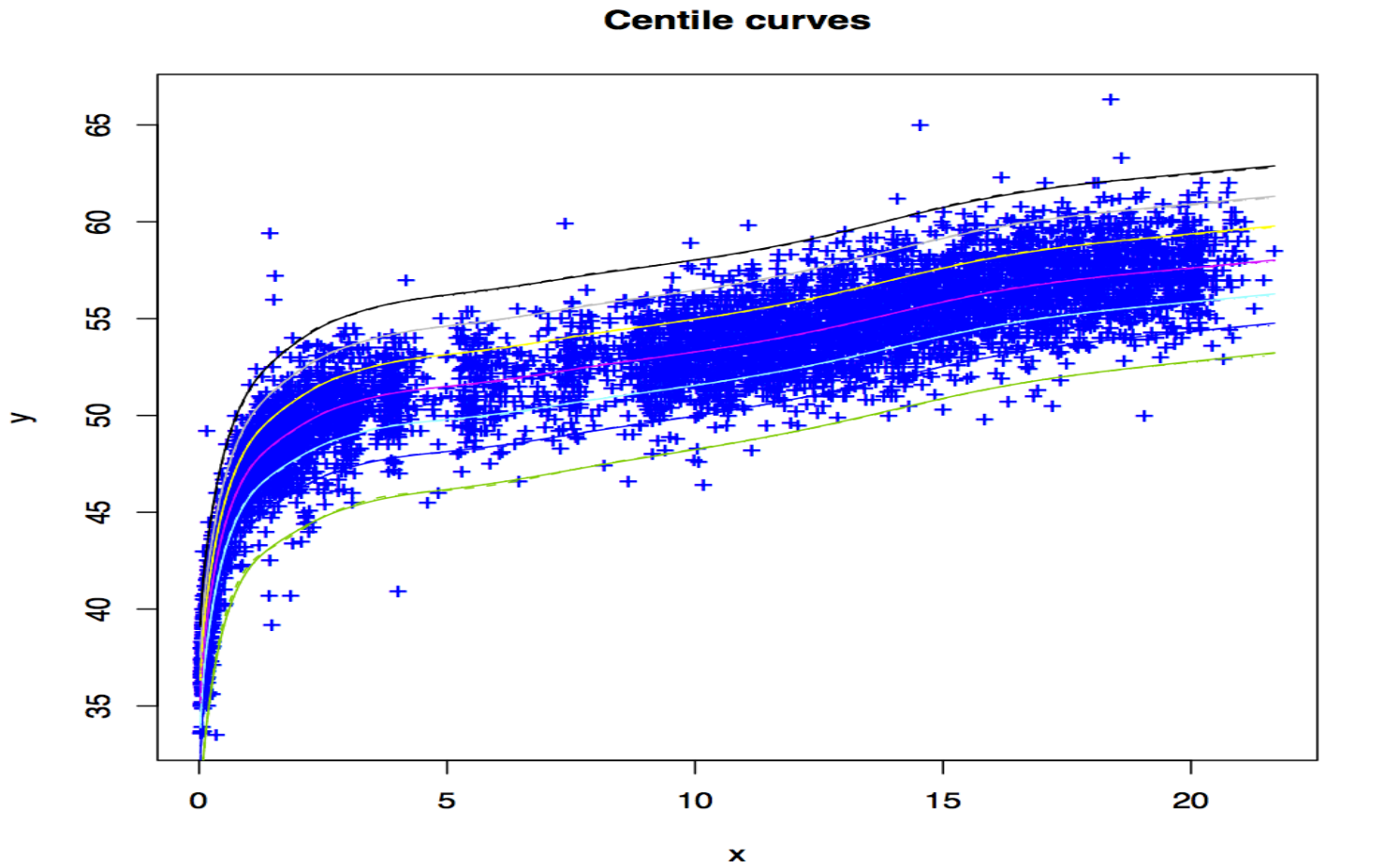
The head circumference data: comparison of the centiles, `centiles.com()`



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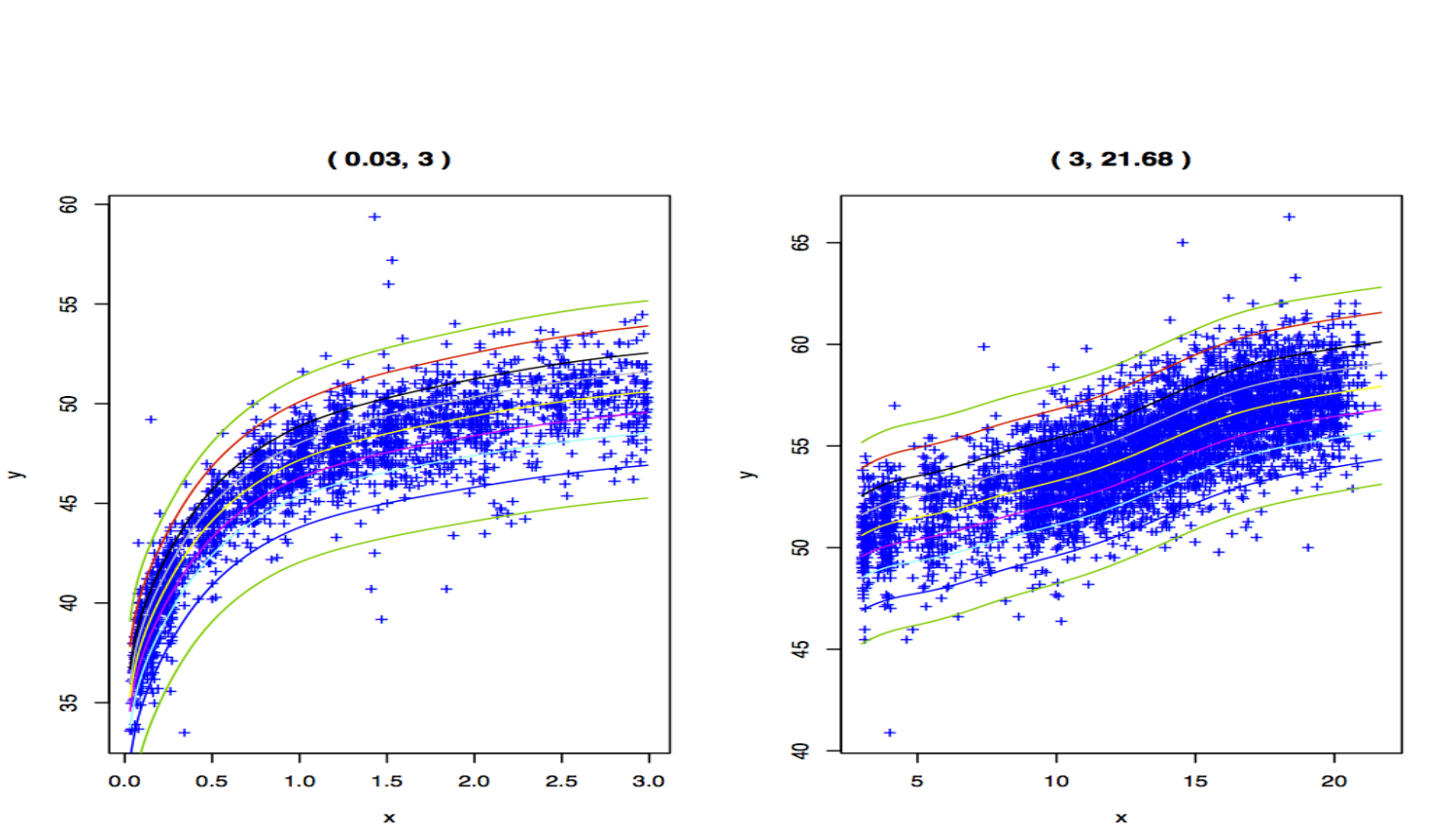
The head circumference data: `centiles.split()`



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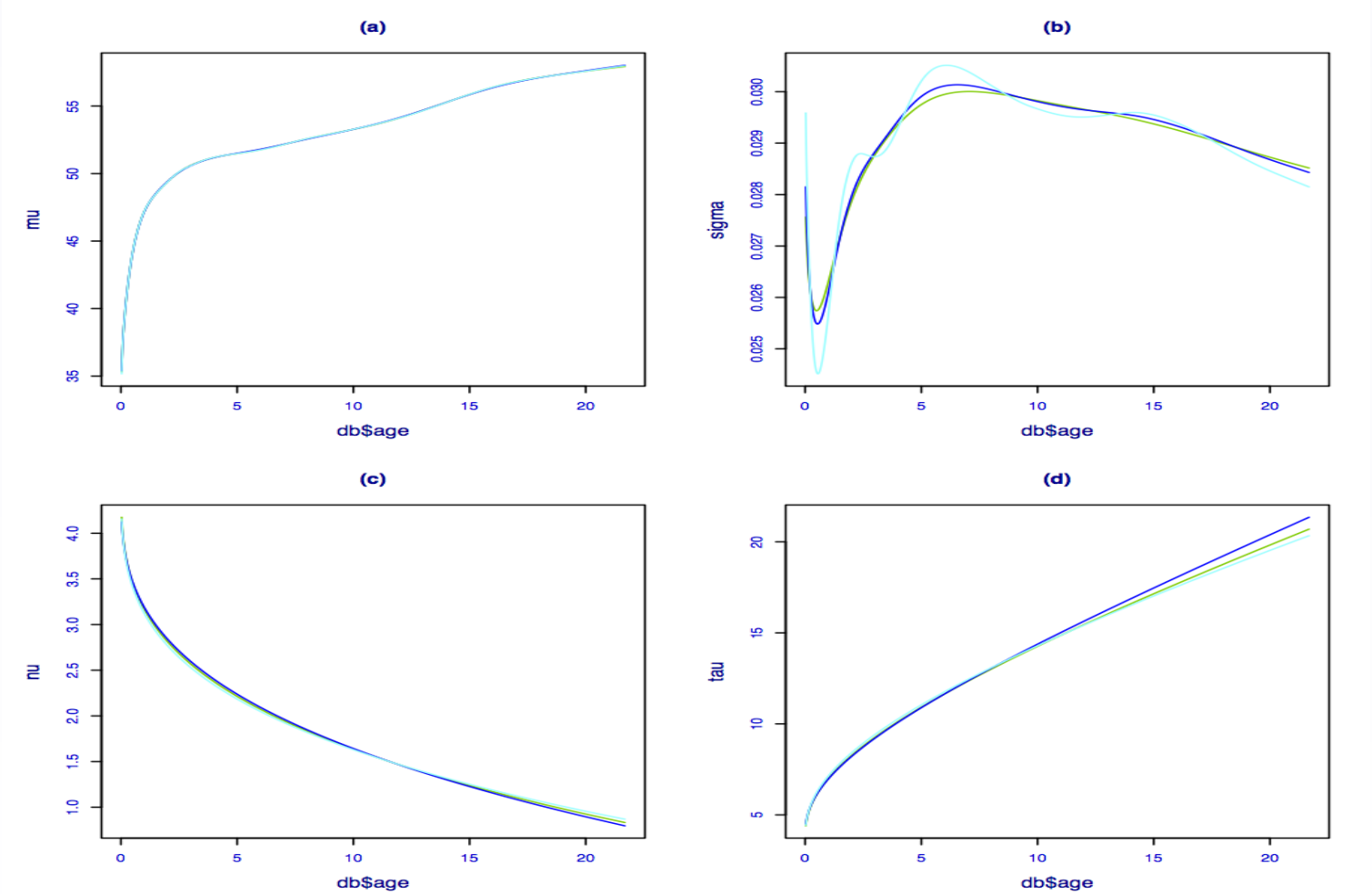
The head circumference data: `fitted.plot()`



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The head circumference data: The Q statistics

	Z1	Z2	Z3	Z4	Agostino	N
0.02500 to 0.24499	0.09	0.85	1.21	0.02	1.47	477
0.24499 to 0.75499	-0.48	-1.18	-0.58	-0.25	0.40	473
0.75499 to 1.255	0.88	-2.27	-0.24	-1.37	1.94	467
1.255 to 1.895	0.01	2.62	1.96	2.76	11.47	460
1.895 to 2.945	-0.29	0.72	-1.70	-0.01	2.90	473
2.945 to 5.535	-0.35	-0.40	-0.72	0.88	1.30	466
....						
15.835 to 17.185	0.45	0.00	-0.59	-0.08	0.35	466
17.185 to 18.675	0.09	0.32	1.01	1.48	3.23	472
18.675 to 21.685	-0.54	-0.65	-0.88	-0.42	0.96	467
TOTAL Q stats	2.85	16.90	15.43	18.04	33.46	7040
df for Q stats	1.95	12.01	12.35	13.00	25.35	0
p-val for Q stats	0.23	0.15	0.24	0.16	0.13	0

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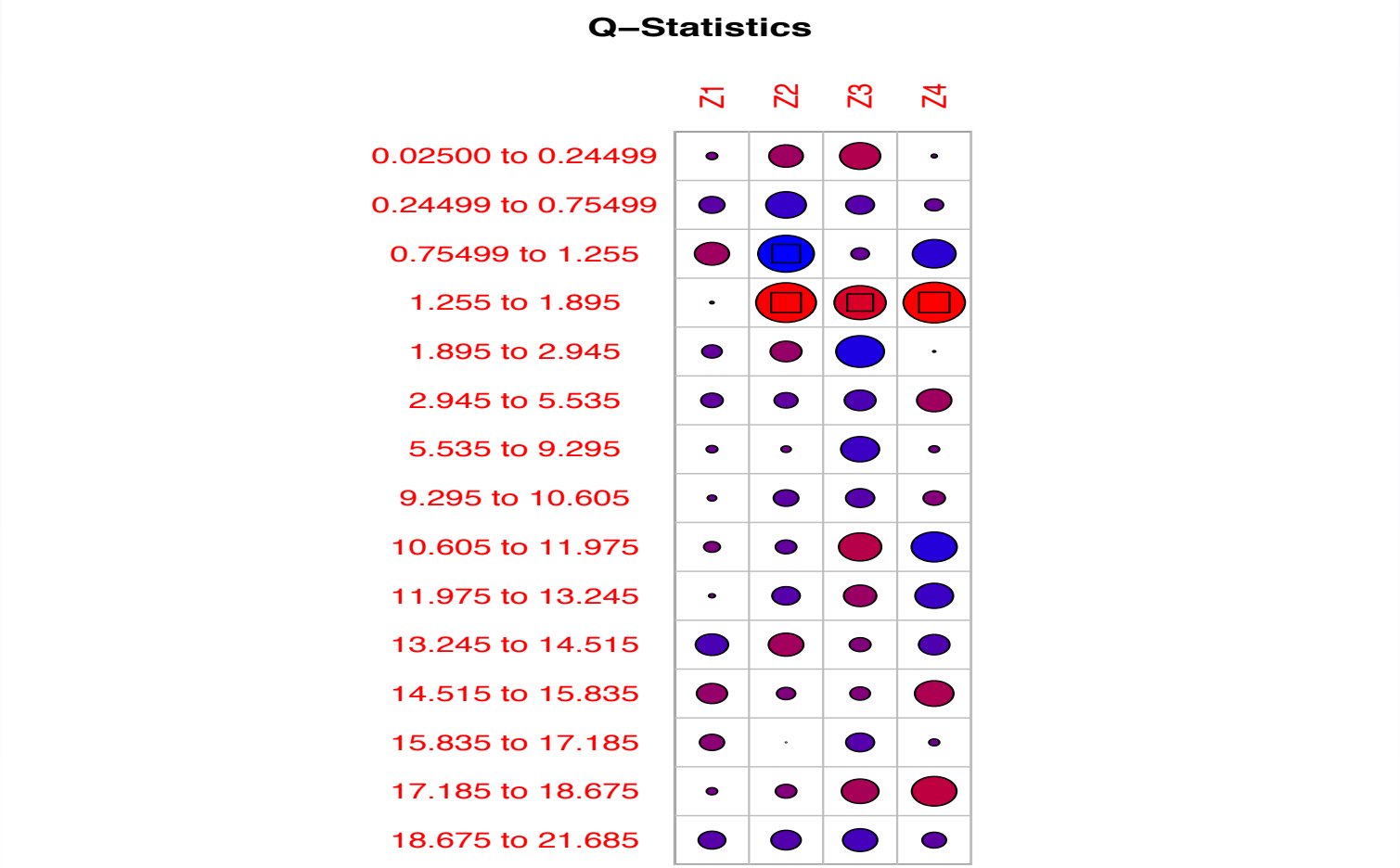
The head circumference data: `Q.stats()`



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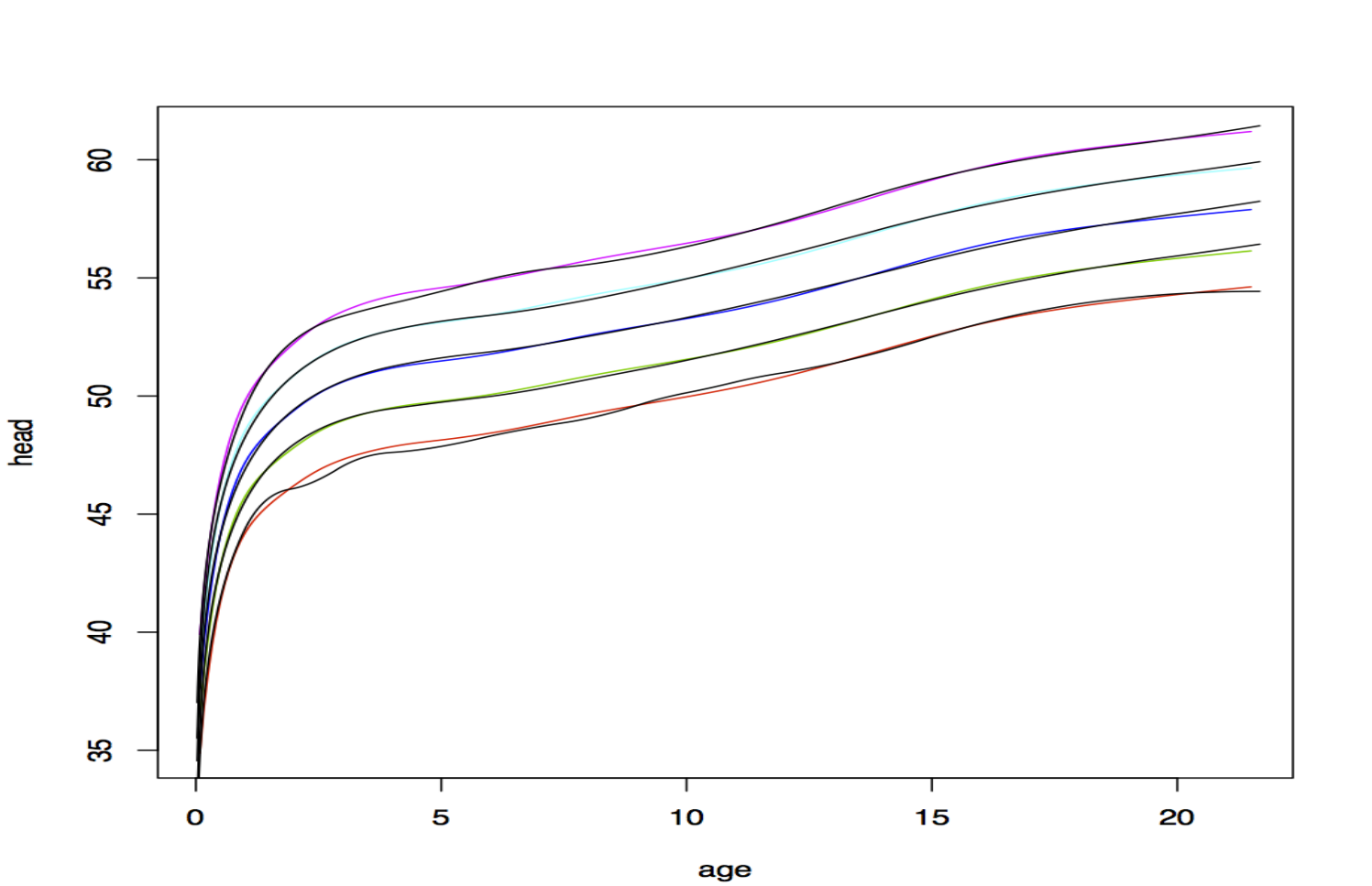
Comparing GAMLSS and QR: fitted centiles



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Conclusions: GAMLSS

- Unified framework for univariate regression type of models
- Allows any distribution for the response variable Y
- Models all the parameters of the distribution of Y
- Allows a variety of additive terms in the models for the distribution parameters
- The fitted algorithm is modular, where different components can be added easily
- Models can be fitted easily and fast
- Explanatory tool to find appropriate set of models
- It deals with overdispersion, skewness and kurtosis

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This is a collaborative work: A list of people who help with the R implementation

present	past
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Nadja Klein	
Abu Hossain	

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End

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for more information see

www.gamlss.org

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