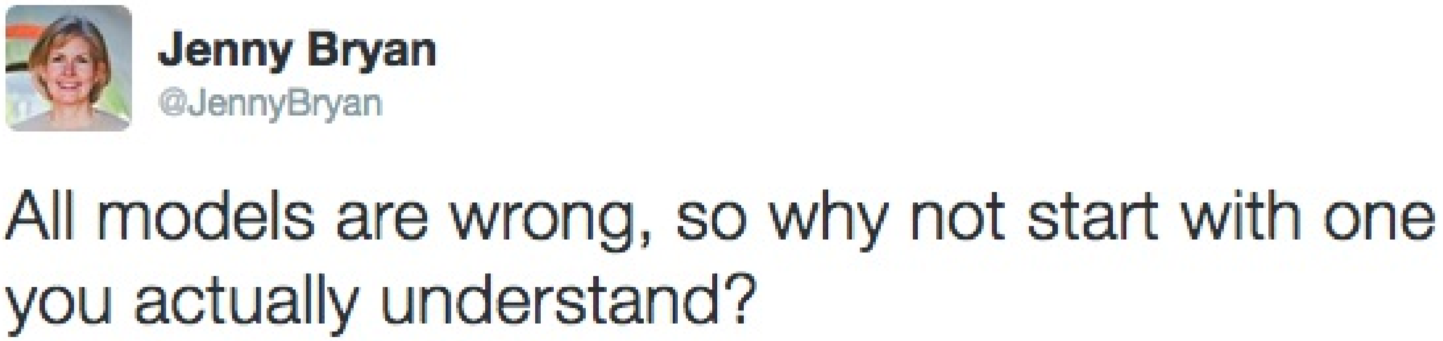
Fancy stuff

David L Miller

A word of warning



Jenny Bryan
@JennyBryan

All models are wrong, so why not start with one you actually understand?

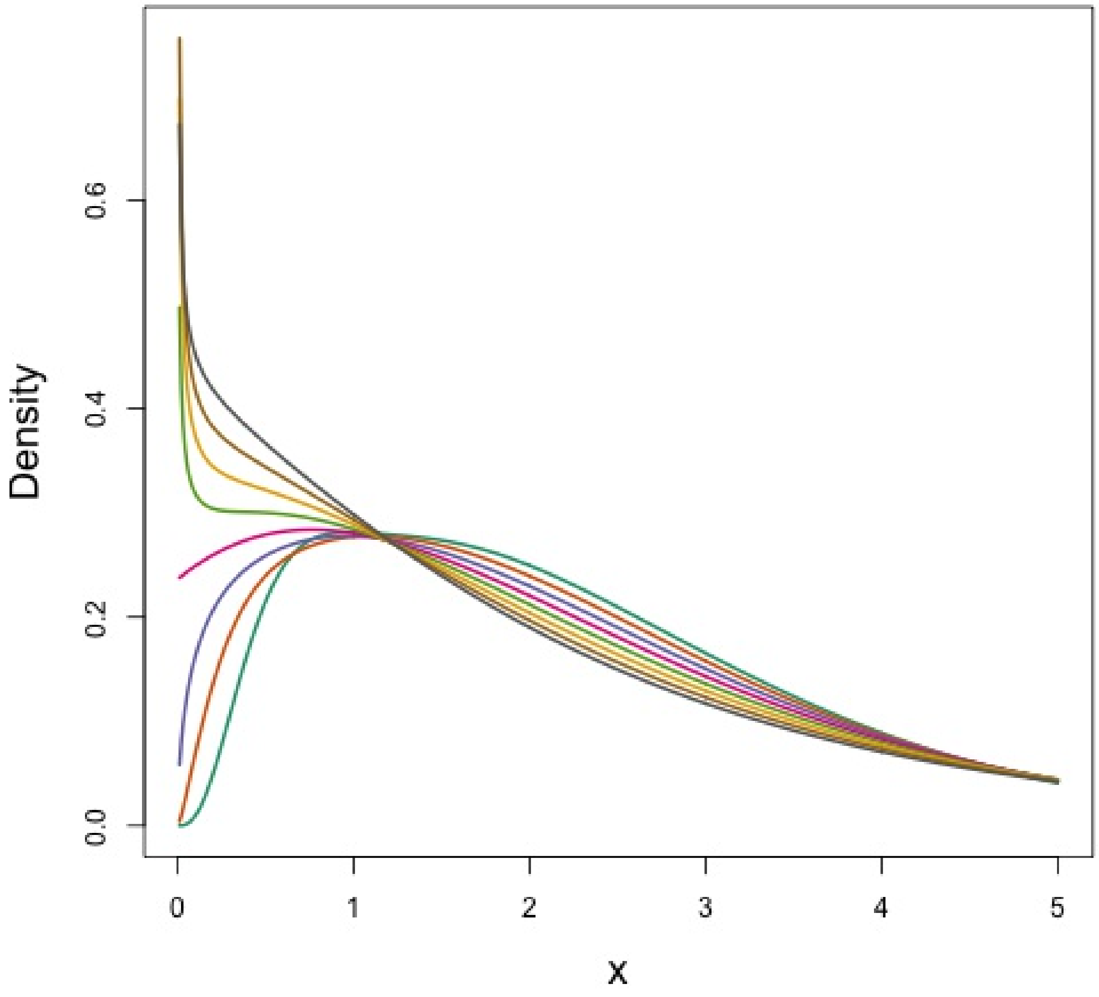
Away from the exponential family

Modelling ”counts”

Counts and count-like things

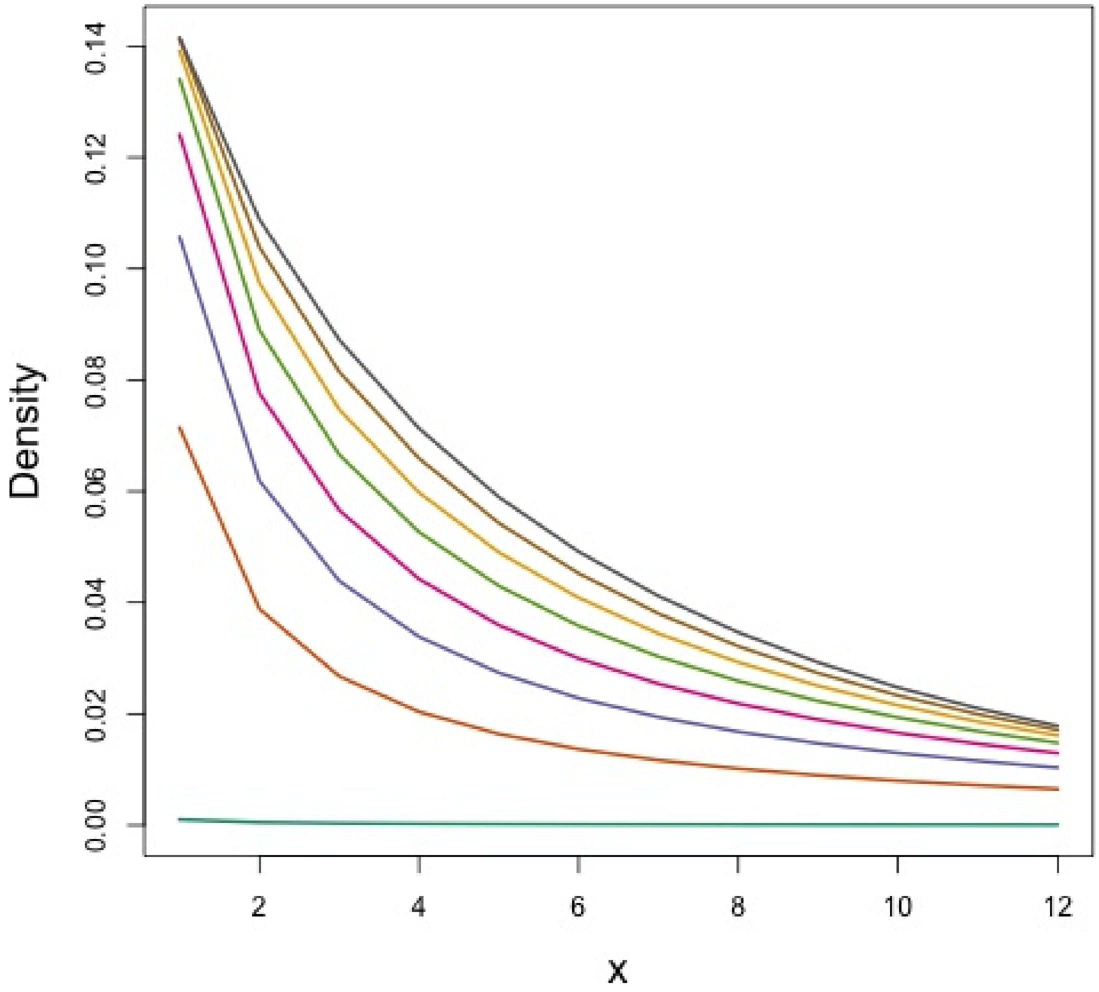
- Response is a count (not always integer)
- Often, it's mostly zero (that's complicated)
- Could also be catch per unit effort, biomass etc
- Flexible mean-variance relationship

Tweedie distribution



- $\mathrm{Var}(\mathrm{count}) = \varphi(\mathrm{count})^q$
- Common distributions are sub-cases:
  - $q = 1 \Rightarrow$ Poisson
  - $q = 2 \Rightarrow$ Gamma
  - $q = 3 \Rightarrow$ Normal
- We are interested in $1 < q < 2$
- (here $q = 1.2, 1.3, \ldots, 1.9$)
- `tw()`

Negative binomial



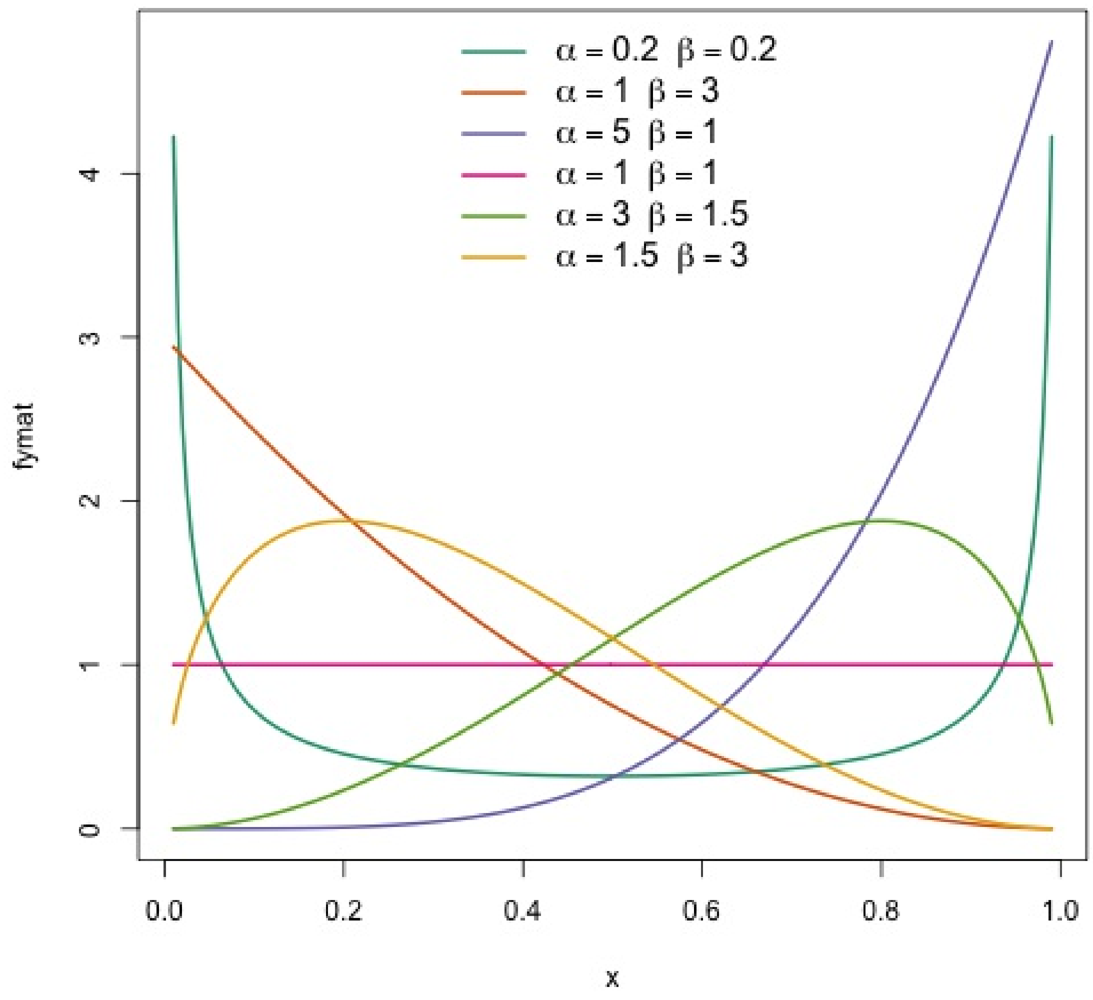
- Var(count) = (count) + $\varkappa$(count)^2
- Estimate $\varkappa$
- Is quadratic relationship a “strong” assumption?
- Similar to Poisson: Var(count) = (count)
- nb()

Zero-inflated distributions

- Models the probability of zeros seperately from mean counts given that you've observed more than zero at a location.
- `ziP` and `ziplss` (for location-scale models)
- zero inflation is assessed *conditional* on the model
  - is what you have zero inflation or just lots of zeros?
  - don't just jump straight to zero inflation

Other distributions

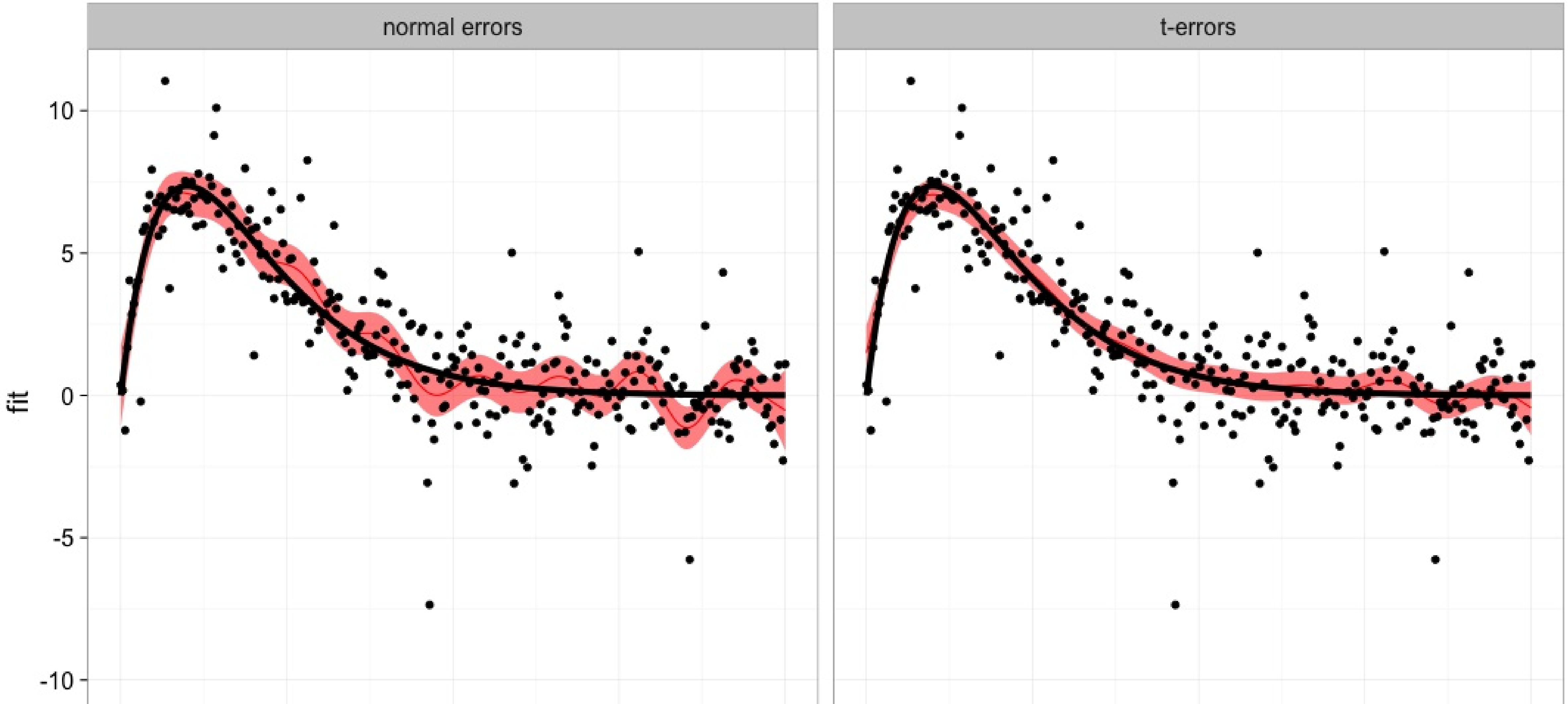
The Beta distribution



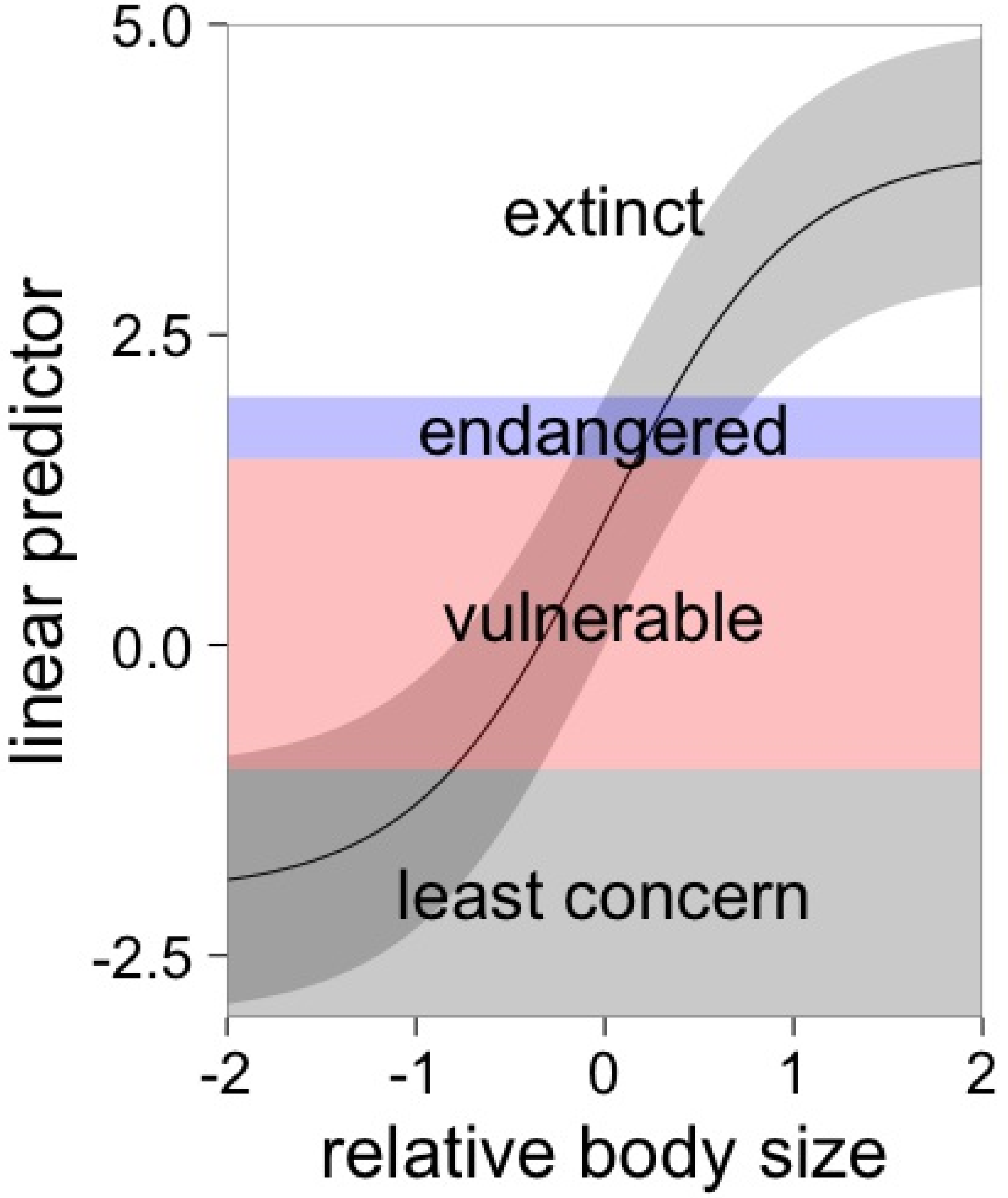
- Proportions; continuous, bounded at 0 & 1
- Beta distribution is convenient choice
- Two strictly positive shape parameters, α & β
- Has support on $x \in (0, 1)$
- Density at $x = 0$ & $x = 1$ is ∞, fudge
- `betar()` family in **mgcv**

t-distribution

- Models continuous data w/ longer tails than normal
- Far less sensitive to outliers
- Has one extra parameter: df.
- bigger df: t dist approaches normal



Ordered categorical data



- Data are categories, have order
- e.g.: conservation status: “least concern”, “vulnerable”, “endangered”, “extinct”
- fits a linear latent model using covariates, w/ threshold for each level
- see `?ocat`
- for unordered categories, see `?multinom`

Other distributions (quickly)

- Multivariate normal (`family = "mvn"`)
  - Multivariate response, each has different smooth, allow correlation
- Cox proportional hazards (`"family = cox.ph"`)
  - Censored data: time until an event occurs, or the study was stopped
- Gaussian location-scale models (`"family = gaulss"`)
  - mean (“location”) and variance (“scale”) as smooths

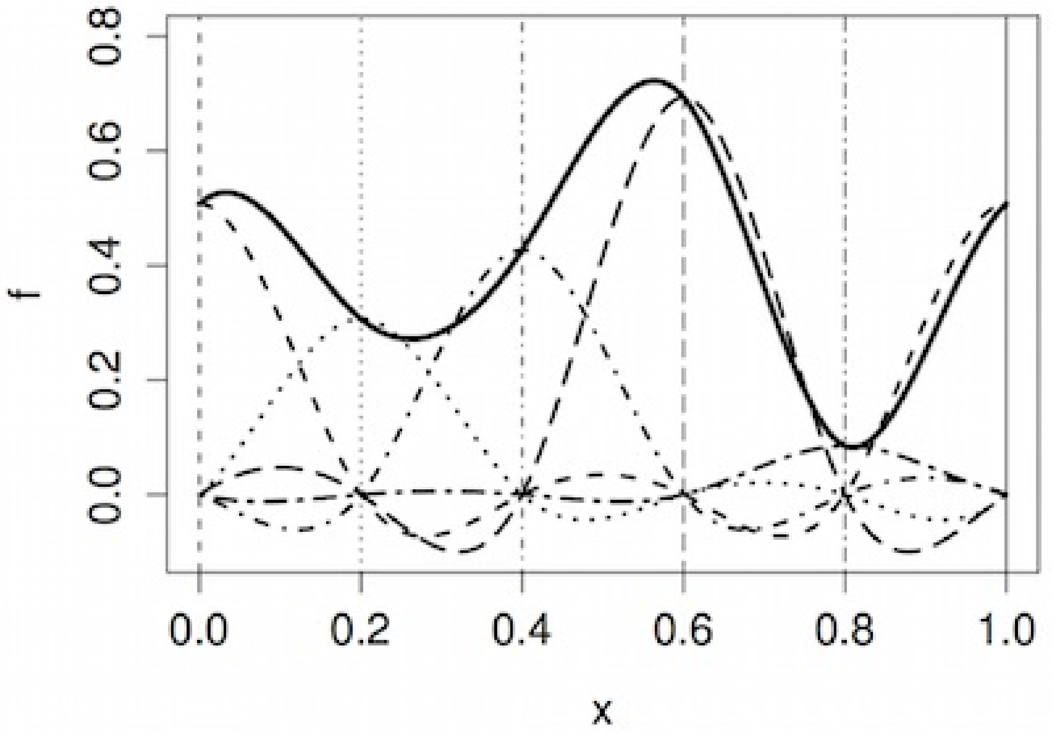
All of these distributions have quirks! Read the manual!

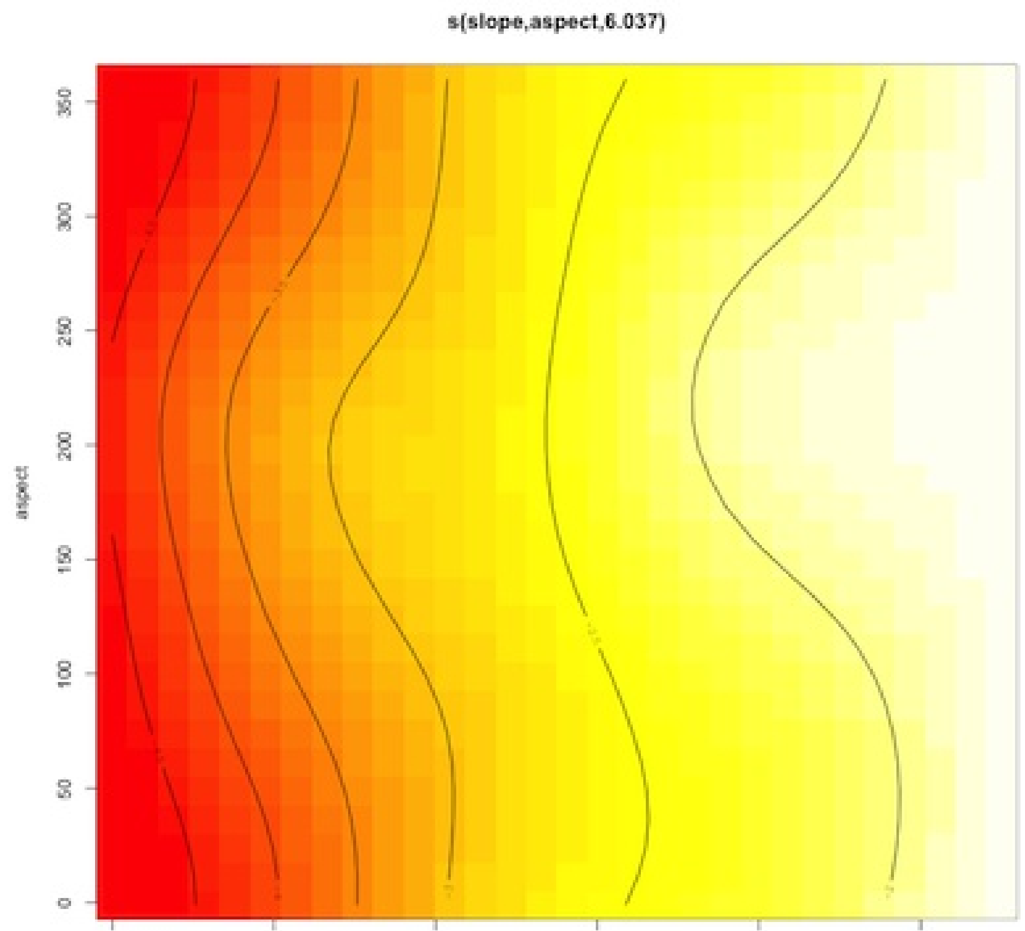
`?family` and `?family.mgcv`

The end of the distribution zoo

Fancy smoothers

Cyclic smooths

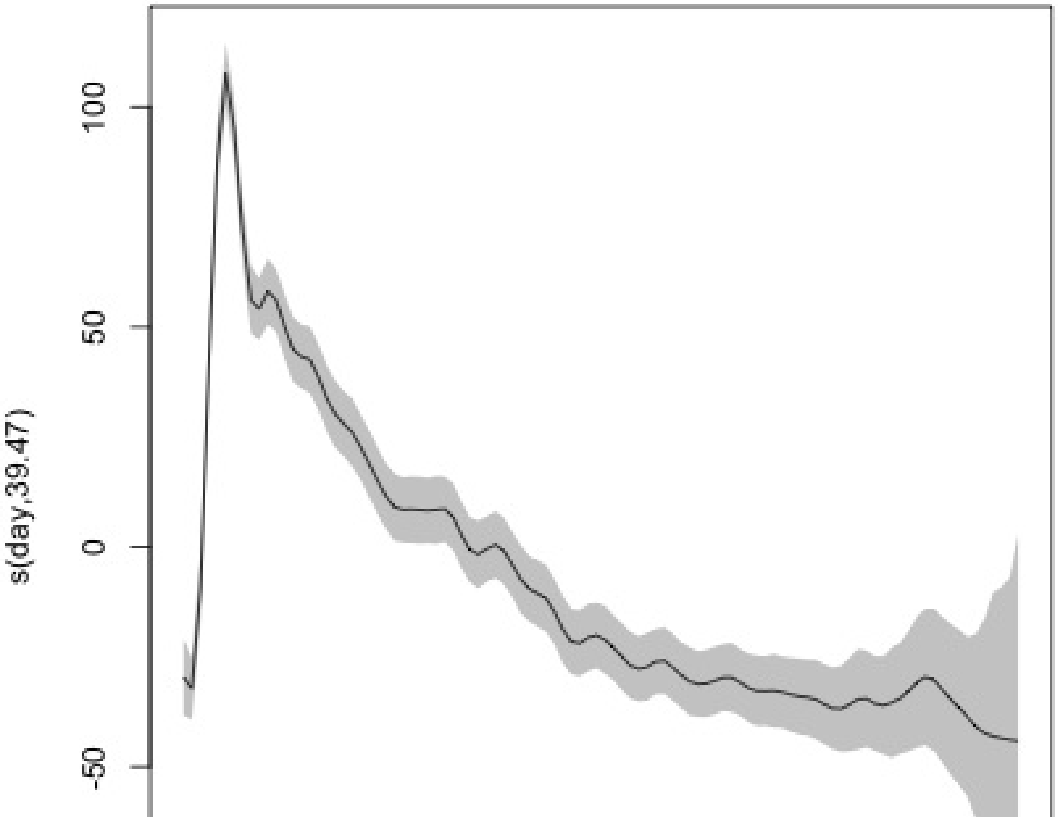


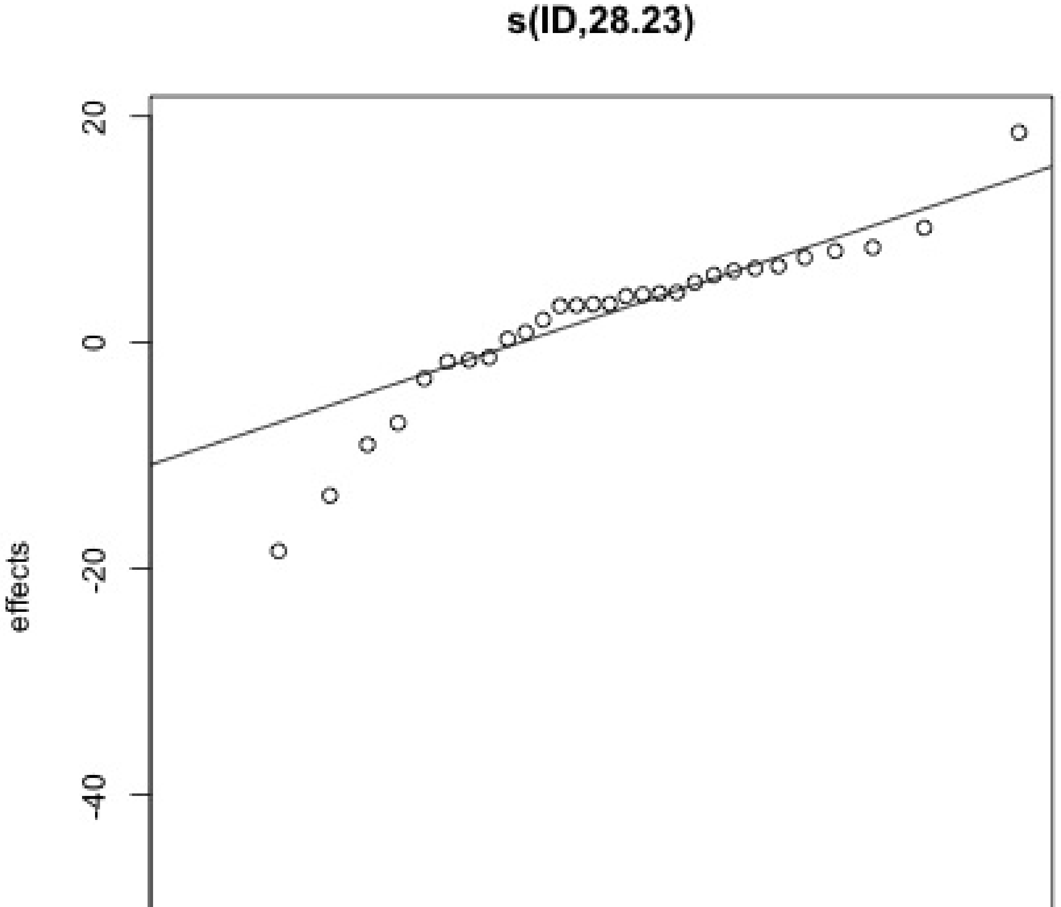


- cyclic smooths (`bs="cc"`)
- what if smooths need to “mat
- ensure up to 2nd derivs matc
- need to be careful with end p
- ? `smooth.construct.cc.s`

”Simple” random effects

- Earlier: “penalties can be thought of as variance components”
- We can think of random effects as splines too!
- in `mgcv` we can set `bs="re"`
- these are **simple**, non-nested random effects





Complicated random effects

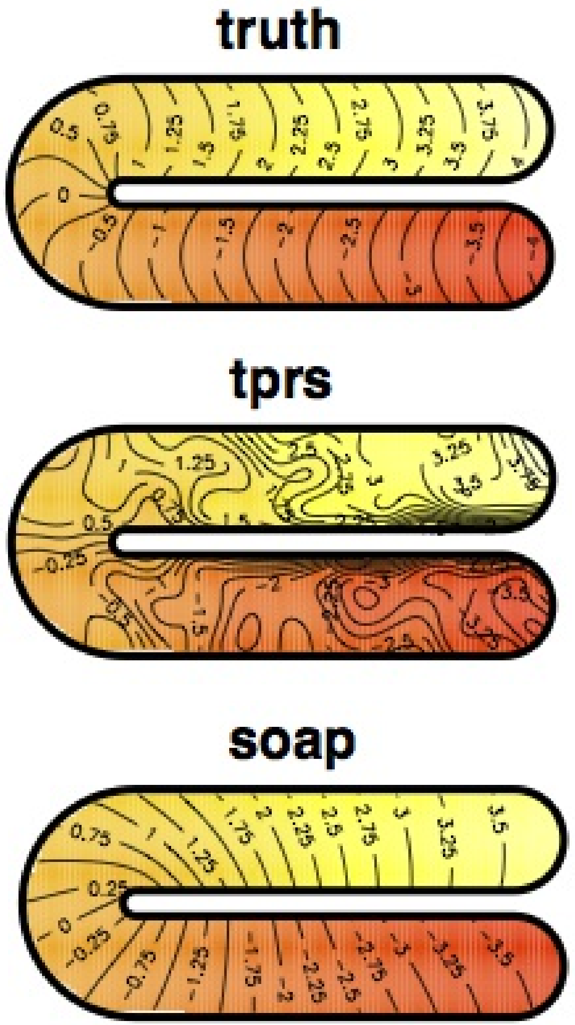
- `gamm` — uses spline-random effects equiv.
- cast splines as random effects, fit using `nlme`
- random effects are sparse, splines are dense
- often modelling problems with complex models
- `random=...` argument for nesting etc
- model has a `$gam` and `$lme` parts

Correlation stuctures

- again, need to use `gamm`
- `correlation=...` gives structure
- `corAR1`, `corARMA`, `corCAR1` etc
- tend to be hard to fit for SDMs

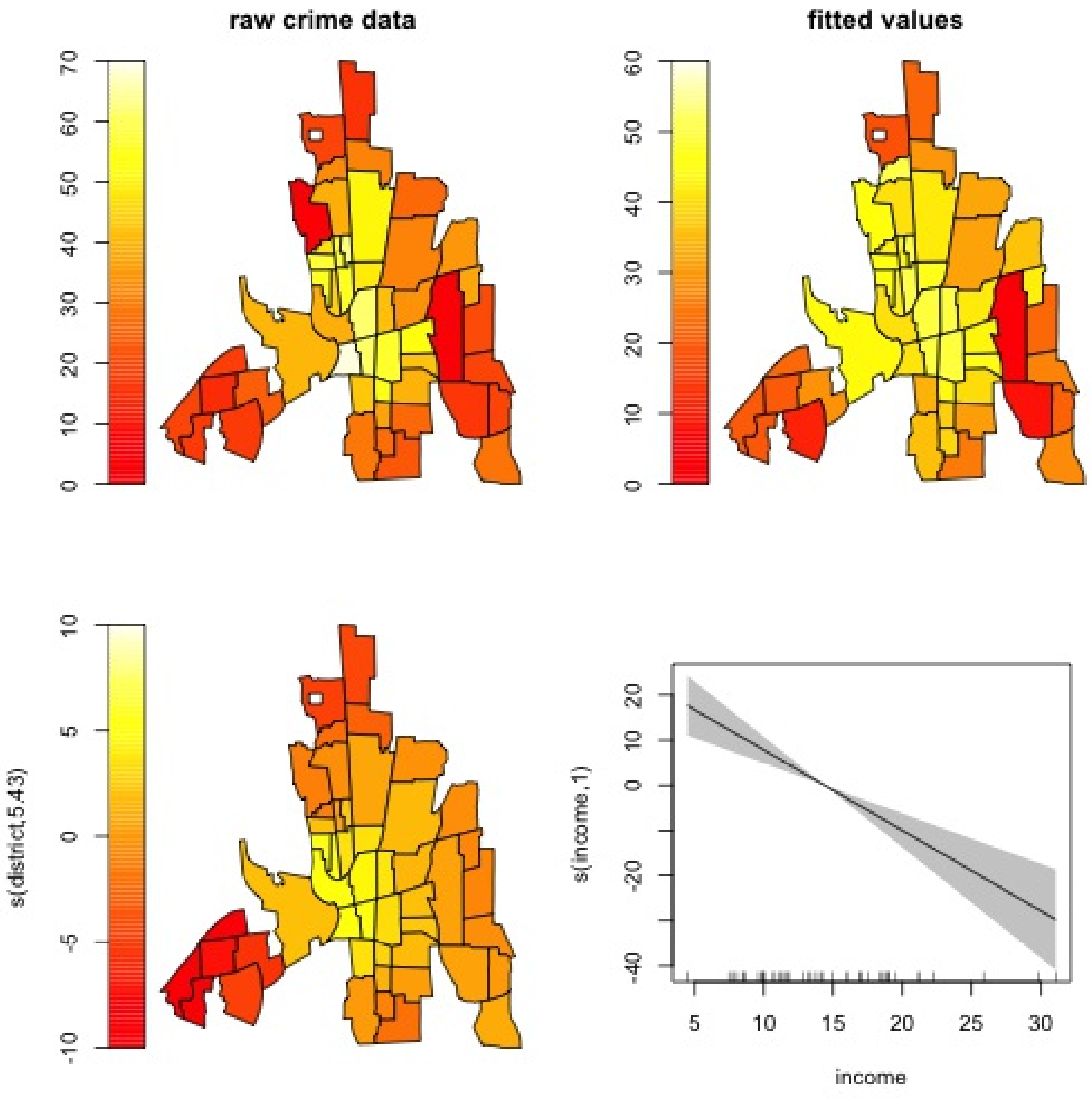
Fancy 2D smoothing

Funny-shaped regions



- Soap film smoother (`bs="so"`)
- Model takes boundary into account by construction
- Need to specify a boundary and internal knots
- see `?soap`

Spatial models using areas



- Markov random fields (`bs="mrf"`)
- Need to specify polygons or adjacency matrix
- Not necessarily that useful for marine work?
- see `?mrf`

Very general modelling

`mgcv` can fit *anything* you can write as (on the link scale):

$$\mathbf{y} = \mathrm{X}\boldsymbol{\beta} \qquad \text{s.t.} \sum_{\mathrm{j}} \boldsymbol{\beta}\mathrm{S}_{\mathrm{j}}\boldsymbol{\beta}$$

if you can write your likelihood in a quadratic form, it can be part of a model in `mgcv`

`?paraPen`

Models for large datasets

- `bam` for big additive models
- can handle simple correlation structures
- parallel (block QR decompositions)
- fast! (still experimental)
- Wood, Goude, Shaw (2015)

Fancy summary

- You can do *a lot* of things in `mgcv`
- Start small, work up to complex models
- Sometimes convergence is against you
- There is *a lot* of information in the manual

Okay, that’s enough

converged.yt/mgcv-workshop