Verification package for “R”

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Research Application Program

verify: Verification Toolkit

Purpose:

- To verify a variety of types of forecasts with different kinds of observations. These use standard as well as new verification techniques.
- Forecast formats differ. There are continuous, probabilistic, binary, ordinal and nominal.
- Observations differ as well.
- Created initially for internal audience, hopefully useful to a larger audience. We've avoided weather specific references.

Features:

- Calculates a range of common skill scores.
- Diagnostic plots - attribute diagrams, receiver operating characteristic plots (ROC), conditional quantile plots.
- `verify` creates a verify class object, which utilizes methods.

Functions

attribute Attribute diagram

brier Brier score

crps Continuous ranked probability score

int.scale.verify Barbara Casati's intensity scale verification model

leps Linear error in probability space.

observation.error, measurement.error Briggs' measurement error score

reliability.plot Reliability plot

roc.plot Relative operating characteristic curve plot - with bi-normal distribution assumption and empirical distribution assumption.

verify Principle package function.

verify Function

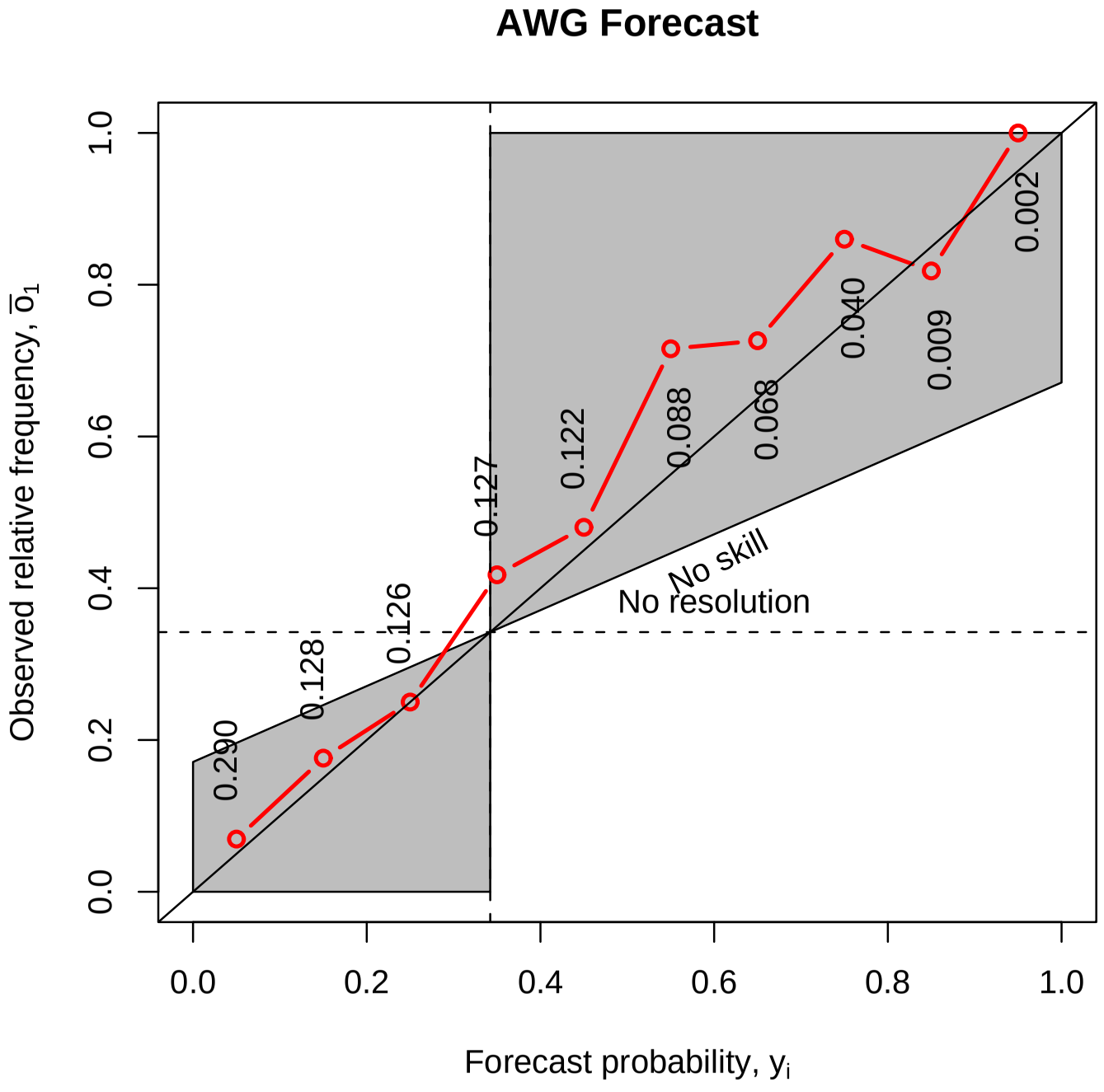
- `verify(obs, pred,  tseries= NULL, baseline = NULL,`
  `frcst.type = "prob", obs.type = "binary",`
  `thresholds = seq(0,1,0.1))`
- Types of forecasts and observations include binary, probabilistic, continuous, spatial?, distribution?.
- Depending on the type of forecast/obs, this function yields the following information (Brier Score, Brier Skill Score, Skill Score, Hit rate, False alarm rate, Threat Score or Critical Success Index, Equitable Threat Score, Bias, Contingency Table, Heidke Skill Score,Kuniper Skill Score, Mean error, Mean-squared error, Mean absolute error, ...

Probabilistic Forecast Example

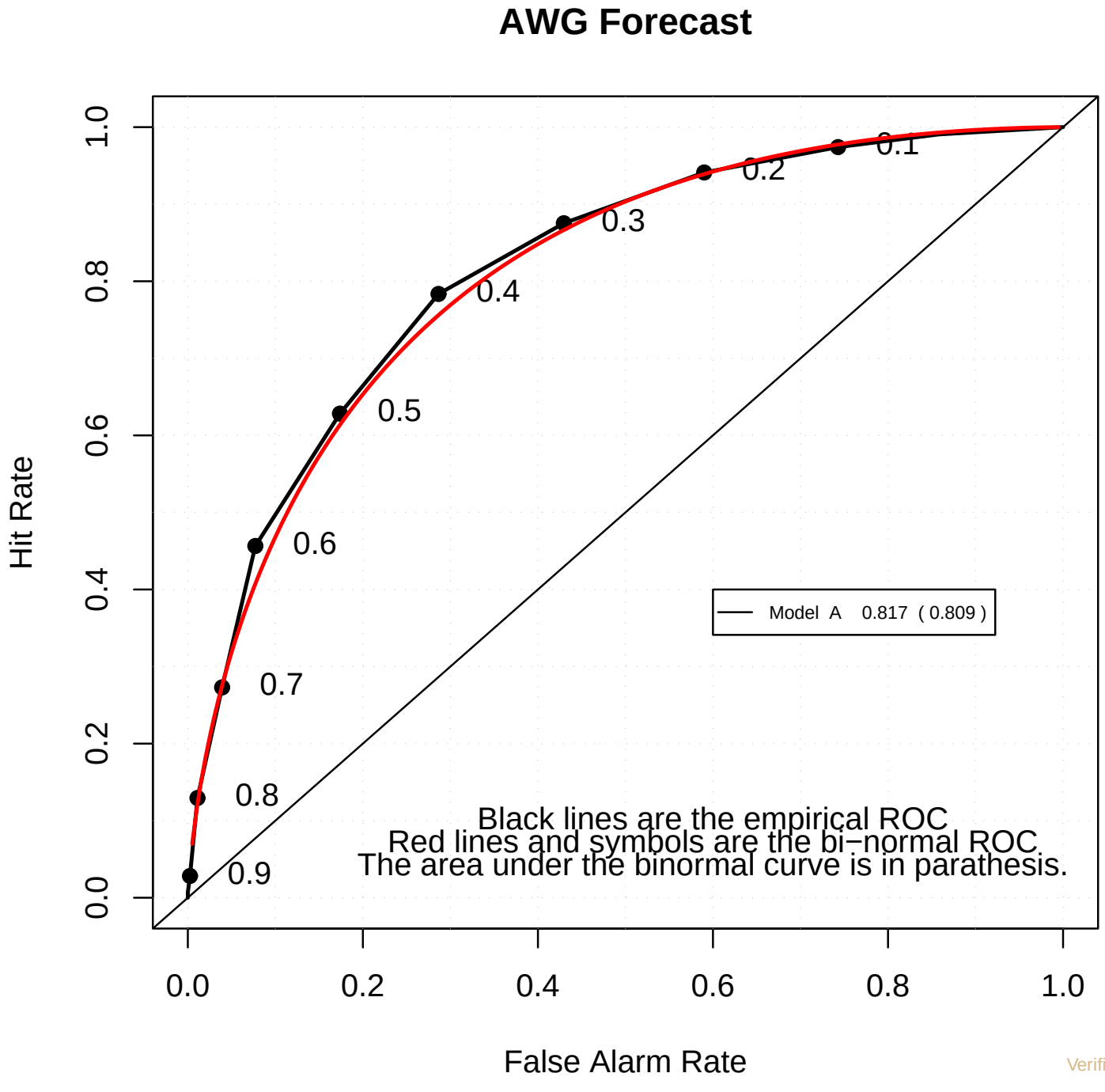
```
 A <- verify(prob.frcs.dat$obs, prob.frcs.dat$frcst/100)
If baseline is not included, baseline values
will be calculated from the  sample obs.
> summary(A)

The forecasts are probablistic, the observations
are binary.
Sample baseline calcluated from observations.
Brier Score (BS)              =  0.1615
Brier Score - Baseline        =  0.2251
Skill Score                   =  0.2824
Reliability                   =  0.004194
Resolution                    =  0.06528
Uncertaintity                 =  0.2251
```

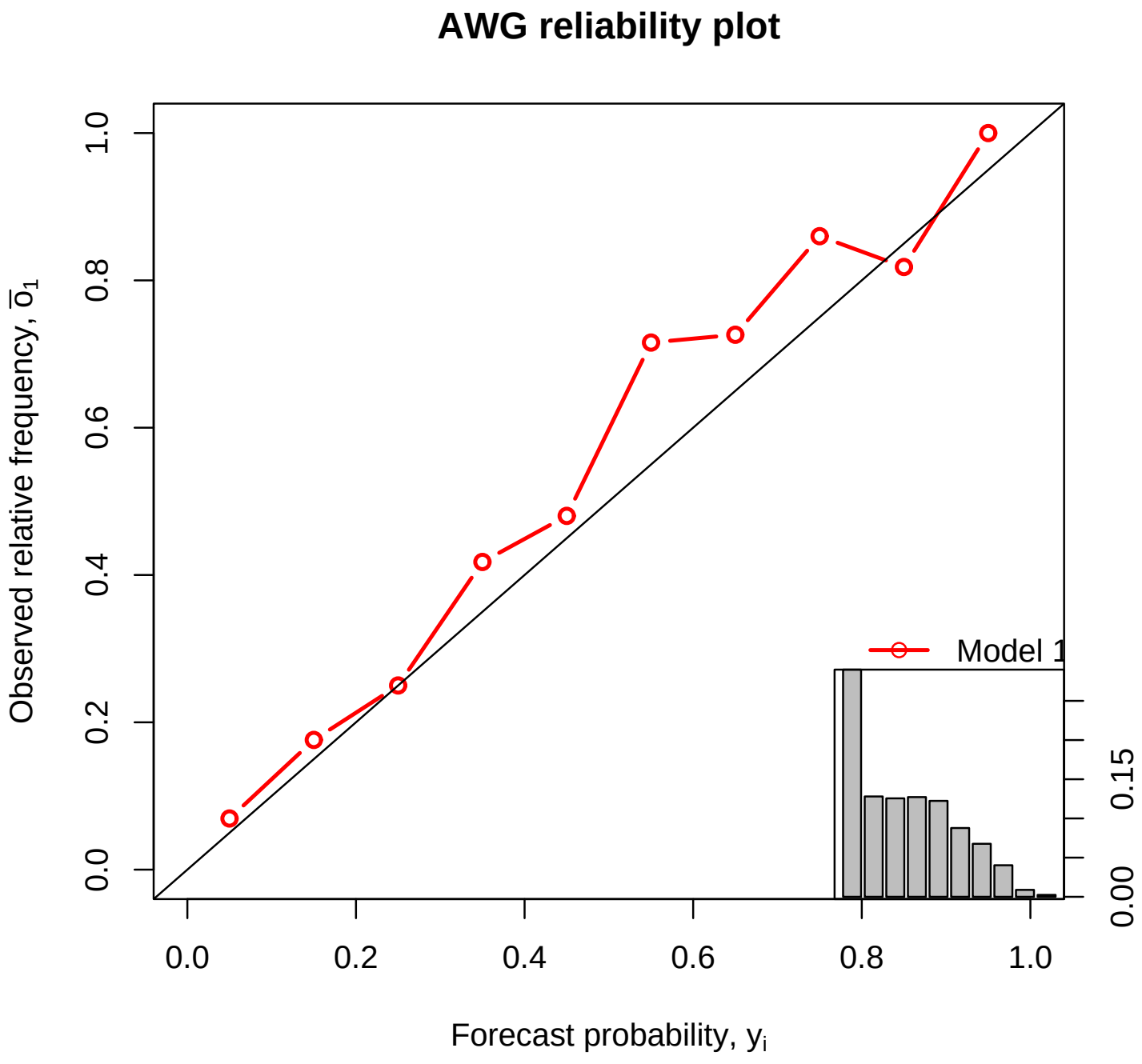
Attribute Plot



ROC Plot


AWG Forecast
Hit Rate
False Alarm Rate
0.0
0.2
0.4
0.6
0.8
1.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Model A 0.817 (0.809)
Black lines are the empirical ROC
Red lines and symbols are the bi−normal ROC
The area under the binormal curve is in parathesis.

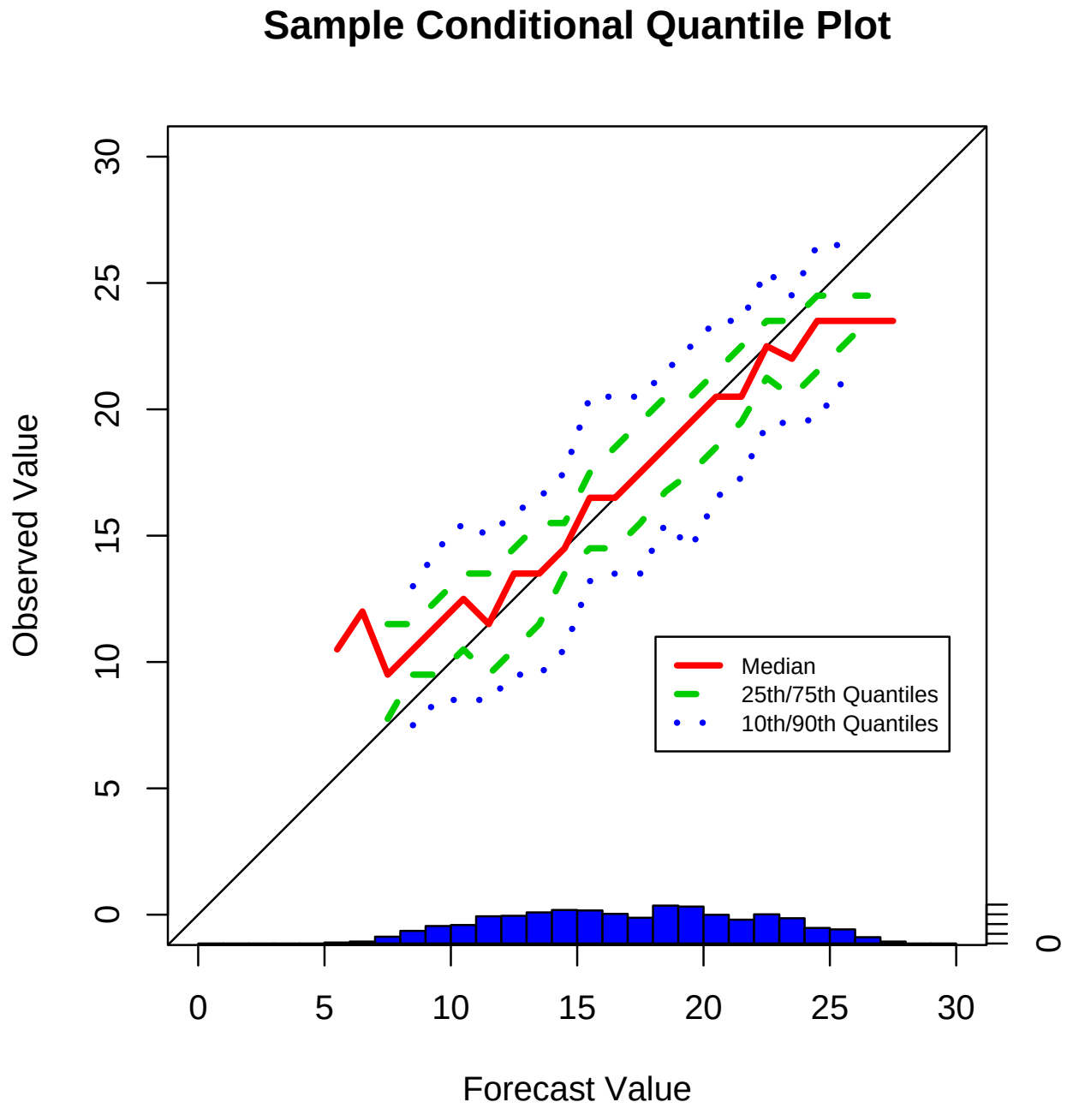
Reliability Plot



Comparing Multiple Models

- ROC plot will accept multiple forecasts.
- Attribute plot will accept multiple forecasts.
  - With two models, sharpness diagrams will be presented.
  - With more than two models, extra diagrams will not be shown.
- Output from `verify`, `roc.plot`, `attribute`, `int.scale.verify` can be directed to another object or output.

Conditional Quantile Plot for Continuous forecast/ obs



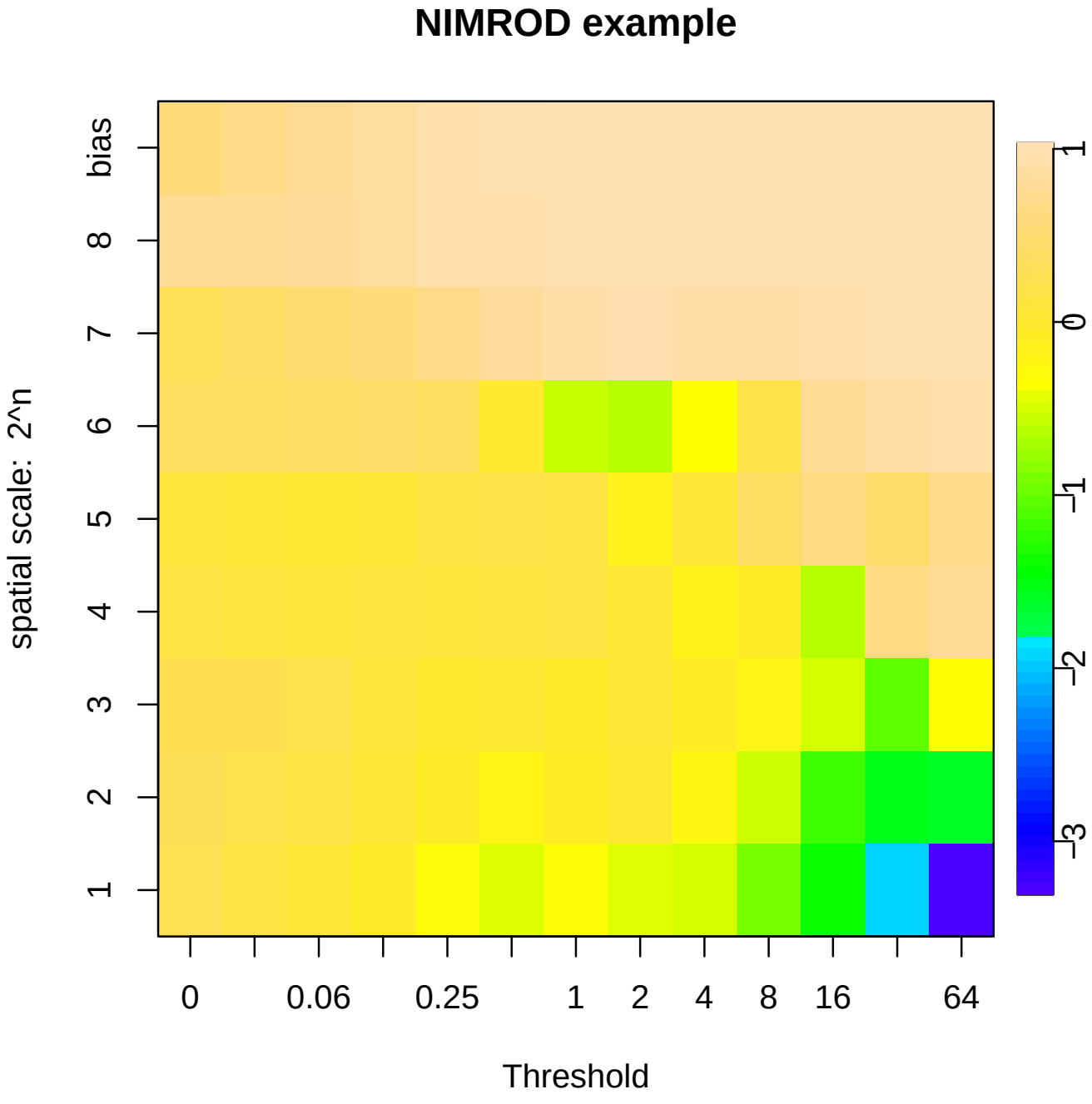
Other contributed functions

- Measurement Errors
  - Developed by Matt Briggs - Cornell Medical School.
  - Used to calculate results presented earlier today.
- Continuous ranked probability scores
  - Algorithm contributed by Tilman Gneitting

Spatial Intensity Scale

- Developed by Barbara Casati
- Produces both scale intensity plots and mean square error plots. (Without Contours).

Scale-Intensity Plot



The use of R in the software development process

- Using packages increase the robustness of analysis. Major code reuse. Object oriented style.
- Simple to use the cvs version control system.
- Package updates go into the nightly build.
- Platform independent

Next Steps

- Incorporate a spatial class of verification routines.
- Improve methods for verifying forecasts expresses as distributions – particularly those expressed in forms other then the normal.
- Continue to solicit contributions from others.
- Write article in R Notes. Explore working in other topics in verification.

Other R packages developed at NCAR

- `fields` - spatial statistics tools - by Geophysical Statistics Project (Doug Nychka)
- `RadioSonde` - displays data from weather instruments - Tim Hoar and Eric Gilleland
- `extRemes` - graphical user interface for extreme value statistics - by Eric Gilleland (`ismev` by Stuart Coles)
- `rapRtools` - Internal set of functions containing functions such as wind roses and run computation tools.

For more information

www.r-project.org (See CRAN for package)
www.ucar.edu
www.cgd.ucar.edu/stats/
www.rap.ucar.edu/

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Statistics at the NCAR

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" to support, enhance, and extend the capabilities of the university community, nationally and internationally; to understand the behavior of the atmospheric and related systems and the global environment; and **to foster the transfer of knowledge and technology for the betterment of life on Earth.** "