Program to compute verification scores for weather forecasts. See https://github.com/WFRT/verif/wiki for how to format input files.

INSTALLATION:

Download source code from the Github repository above and install from source (When in doubt, consult the README.rst file)

Steps

Installing on Ubuntu

Prerequisites

Verif requires a pip installation and Python 3. The python package "cartopy" is optional, but provides a background map when verification scores are plotted on a map. To install Cartopy, with its GEOS and PROJ4 dependencies, do the following:

```
sudo apt-get update
sudo apt-get install libgeos-dev libproj-dev
sudo pip3 install cartopy
```

Installing using pip

After this, the easiest is to install the lastest version of Verif using pip:

```
sudo pip install verif
```

Verif should then be accessible by typing ``verif`` on the command-line. If you do not have sudo-rights, then install verif as follows:

```
pip install verif --user
```

This will create the executable ``~/.local/bin/verif``. Add this to your PATH environment variable if necessary (i.e add ``export PATH=$PATH:~/.local/bin`` to ``~/.bashrc``).

****Installing from source****

Alternatively, to install from source, download the source code of the latest version: https://github.com/WFRT/verif/releases/. Unzip the file and navigate into the extracted folder.

Then install Verif by executing the following inside the extracted folder:

```
sudo pip install -r requirements.txt
sudo python setup.py install
```

This will create the executable ``/usr/local/bin/verif``. Add ``/usr/local/bin`` to your PATH environment variable if necessary. If you do not have sudo privileges do:

```
pip install -r requirements.txt --user
python setup.py install --user
```

This will create the executable ``~/.local/bin/verif``. Add ``~/.local/bin`` to your PATH environment variable.

Utilization of Verif

Arguments:

files	One or more verification files in NetCDF or text format (see 'File Formats' below). The file format is autodetected.
-m metric	Which verification metric to use? See 'Metrics' below.
--config file	Read further arguments from this file. This flag can appear multiple times.
--list-times	Prints what times are available in the files
--list-dates	Like --list-times but in YYYYMMDD HH:MM:SS format
--list-locations	Prints what locations are available in the files
--list-quantiles	Prints what quantiles are available in the files
--list-thresholds	Prints what thresholds are available in the files
--version	Prints what version of verif this is

Dimensions and subset:

(Note: vectors can be entered using commas, or MATLAB syntax i.e 3:5 is 3,4,5 and 3:2:7 is 3,5,7)

-d dates	A vector of dates in YYYYMMDD format, e.g. 20130101:20130201.
-elevrange range	Limit the verification to locations within minelev,maxelev.
-l locations	Limit the verification to these location IDs.
-lx locations	Remove these locations from the verification. This happens after -l, -latrange, -lonrange, and -elevrange has been applied.
-latrange range	Limit the verification to locations within minlat,maxlat.
-lonrange range	Limit the verification to locations within minlon,maxlon.
-o leadtimes	Limit the verification to these leadtimes (in hours).
-obsrange range	Limit the verification to this range of observation values.
-r thresholds	Compute scores using these thresholds (only used by some metrics).
-q quantiles	Compute scores using these quantiles (only used by some metrics).
-t times	A vector of unix timestamps. Only allow these times.
-tod timeofdays	A vector of hours of day, e.g. 0:12. Only allow times with these hour of the day.
-x dim	Plot this dimension on the x-axis: time, leadtime, year, month, week, day, timeofday, dayofyear, monthofyear, location, elev, lat, lon, threshold, leadtimeday, or no. Not supported by all metrics. If not specified, then a default is used based on the metric. 'location' refers to the location id. 'leadtimeday' aggregates leadtimes into whole forecast days. 'no' collapses all dimensions and computes one value.

Data manipulation:

-acc	Accumulated values along the x-axis. Does not work for 'Special diagams.'
-agg type	Aggregation type: 'absmean', 'count', 'iqr', 'max', 'mean', 'meanabs', 'median', 'min', 'range', 'std', 'sum', 'variance', or a number between 0 and 1. Some metrics computes a value for each value on the x-axis. Which function should be used to do the aggregation? Default is 'mean'. Only supported by some metrics. A number between 0 and 1 returns a specific quantile (e.g. 0.5 is the median).
-b type	One of 'below' (< x), 'below=' (<= x), '=within' (<= x <), 'within' (< x <), 'within=' (< x <=), '=within=' (<= x<=), 'above' (> x), or 'above=' (>= x). For threshold plots (ets, hit, within, etc) 'below/above' computes frequency below/above the threshold, and 'within' computes the frequency between consecutive thresholds.
-c file	File containing climatology data. Subtract all forecasts and obs with climatology values.
-C file	File containing climatology data. Divide all forecasts and obs by climatology values.
-fcst field	What variable should be used as the forecast? 'obs', 'fcst' (default), threshold:<threshold>, quantile:<quantile>, 'pit', or the name of any other field in the input files.
-hist	Plot values as histogram. Only works for any field that can be specified with -fcst.
-obs field	What variable should be used as the observation? See -fcst.
-sort	Plot values sorted. Only works for any field than can be specified with -fcst.
-T value	Aggregate observations and forecasts across this many leadtimes.

Plotting options:

-a	Annotate graph by labeling each data point. Not supported by all metrics.
-aspect ratio	Force the aspect ratio of the plot. A value greater than 1will stretch out the y-axis.
-bottom value	Bottom boundary location for saved figure [range 0-1]
-clabel text	Custom colorbar label
-clim limits	Force colorbar limits to the two values lower,upper. Only used in combination with -type map.
-cmap colormap	Use this colormap when possible (e.g. jet, inferno, RdBu). Only used in combination with -type map.
-dpi value	Resolution of image in dots per inch (default 100)
-gc color	Color for grid lines. e.g red,[0.3,0,0],0.3.
-gs style	Line styles for gri, such as -, --, or :.
-gw width	Line width for grid
-f file	Save image to this filename
-fs size	Set figure size width,height (in inches). Default 8x6.
-labfs size	Font size for axis labels
-lc colors	Comma-separated list of line colors, such as red,[0.3,0,0],0.3. Colors are repeated if there are more lines than colors.

-left value	Left boundary location for saved figure [range 0-1]
-leg titles	Comma-separated list of legend titles. Use '_' to represent space.
-legfs size	Font size for legend. Set to 0 to hide legend.
-legloc loc	Where should the legend be placed? Locations such as 'best', 'upper_left', 'lower_right', 'center'. Use underscore when using two words.
-ls styles	Comma-separated list of line styles, such as -,--. Styles are repeated if there are more lines than styles.
-lw width	Comma-separated list of line widths
-maptype type	One of 'simple', 'sat', or 'topo'. 'simple' shows a basic ocean/lakes/land map, 'sat' shows a satellite image, and 'topo' a topographical map. Only relevant when '-type map' has been selected.
-ma markers	Comma-separated list of markers (e.g. o,*,x)
-ms size	Comma-separated list of marker sizes
-nogrid	Turn the grid on the plot off
-nomargin	Remove margins (whitespace) in the plot
-obsleg	Name to put in legend for observations (if applicable)
-right value	Right boundary location for saved figure [range 0-1]. Must be greater than -left.
-simple	Make a simpler plot, without extra lines, subplots, etc.
-sp	Show a line indicating the perfect score
-tickfs size	Font size for axis ticks
-title text	Custom title to chart top
-titlefs size	Font size for title.
-top value	Top boundary location for saved figure [range 0-1]. Must be greater than -bottom.
-type type	One of 'plot' (default), 'text', 'csv', 'map', 'rank', 'maprank', 'impact', or 'mapimpact'.
-xlabel text	Custom x-axis label
-xlim limits	Force x-axis limits to the two values lower,upper
-xlog	Use a logarithmic x-axis
-xrot value	Rotation angle for x-axis labels
-xticks ticks	A vector of values to put ticks on the x-axis
-xticklabels labs	A comma-separated list of labels for the x-axis ticks
-ylabel text	Custom y-axis label
-ylim limits	Force y-axis limits to the two values lower,upper
-ylog	Use a logarithmic y-axis
-yrot value	Rotation angle for y-axis labels
-yticks ticks	A vector of values to put ticks on the y-axis

-yticklabels labs	A comma-separated list of labels for the y-axis ticks

Metrics (-m):

(For a full description of a metric, run verif -m <metric>)

Deterministic:

alphaindex	Alpha index
bias	Bias (forecast - observation)
cmae	Cube-root mean absolute cubic error
corr	Correlation between observations and forecasts
derror	Distribution error
diff	Difference in aggregated statistics (agg(forecast) - agg(observation))
dmb	Degree of mass balance (obs/fcst)
ef	Exceedance fraction: fraction of times that forecasts > observations
fcst	Forecasted value
kendallcorr	Kendall correlation between observations and forecasts
leps	Linear error in probability space
mae	Mean absolute error
mbias	Multiplicative bias (fcst/obs)
nsec	Nash-Sutcliffe efficiency coefficient
obs	Observed value
rankcorr	Rank correlation between observations and forecasts
ratio	Ratio of aggregated statistics (agg(forecast) / agg(observation))
rmse	Root mean squared error
rmsf	Root mean squared factor
stderror	Standard error (i.e. RMSE if forecast had no bias)
within	The percentage of forecasts within some error bound. Use -r to specify error bounds

Threshold:

a	Hit
b	False alarm
baserate	Base rate: Fraction of observations (a + c)
biasfreq	Bias frequency (number of fcsts / number of obs)
c	Miss
d	Correct rejection

dscore	Generalized discrimination score
edi	Extremal dependency index
eds	Extreme dependency score
ets	Equitable threat score
fa	False alarm rate
far	False alarm ratio
fcstrate	Fractions of forecasts (a + b)
hit	Hit rate (a.k.a. probability of detection)
hss	Heidke skill score
kss	Hanssen-Kuiper skill score
lor	Log odds ratio
miss	Miss rate
n	Total cases
or	Odds ratio
pc	Proportion correct
sedi	Symmetric extremal dependency index
seds	Symmetric extreme dependency score
threat	Threat score
yulesq	Yule's Q (Odds ratio skill score)

Probabilistic:

bs	Brier score
bsrel	Brier score, reliability term
bsres	Brier score, resolution term
bss	Brier skill score
bssrel	Brier skill score, reliability term
bssres	Brier skill score, resolution term
bsunc	Brier score, uncertainty term
ign0	Ignorance of the binary probability based on threshold
marginalratio	Ratio of marginal probability of obs to marginal probability of fcst. Use -r to specify thresholds.
pit	Verifying PIT-value (CDF at observation)
pithistdev	PIT histogram deviation factor (actual deviation / expected deviation)
pithistshape	Second derivative of the PIT histogram. Negative means U-shaped.

pithistslope	Average slope of the PIT histogram. Positive mean too many obs in the higher ranks.
quantile	Mean value of a quantile forecast. Use -q to set quantile.
quantilecoverage	Fraction of observations contained within quantile interval. Use -q to set quantiles, and -b to set interval definition.
quantilescore	Quantile score. Use -q to set which quantiles to use, and -b to set interval definition.
spherical	Spherical probabilistic scoring rule for binary events
spread	Spread between two quantiles. Use -q to set which quantiles to use.
threshold	Mean value of threshold forecast. Use -r to set threshold.

Special diagrams:

against	Plots the forecasts for each pair of input files against each other. Colours indicate which input file had the best forecast (but only if the difference is more than 10% of the standard deviation of the observation).
autocorr	Plots error auto-correlation as a function of distance. Use -x to specify axis to find auto-correlations for: -x location gives correlation between all pairs of locations; -x time gives between all pairs of forecast initializations; Similarly for -x leadtime, -x lat, -x lon, -x elev.
autocov	Plots error auto-covariance as a function of distance. Use -x to specify axis to find auto-correlations for: -x location gives correlation between all pairs of locations; -x time gives between all pairs of forecast initializations; Similarly for -x leadtime, -x lat, -x lon, -x elev.
change	Forecast skill (MAE) as a function of change in obs from previous forecast run
cond	Plots forecasts as a function of obs (use -r to specify bin-edges)
discrimination	Discrimination diagram for a certain threshold (-r)
droc	Plots the receiver operating characteristics curve for the deterministic forecast for a single threshold. Uses different forecast thresholds to create points.
droc0	Same as DRoc, except don't use different forecast thresholds: Use the same threshold for forecast and obs.
economicvalue	Economic value diagram for a single threshold (-r). Shows what fraction of costs/loses can be reduced by the forecast relative to using climatology.
error	Decomposition of RMSE into systematic and unsystematic components
freq	Frequency of obs and forecasts
fss	Plots the fractions skill score for different spatial scales. Use -r to specify a threshold, -b to define the event, and '-x leadtime' to specify temporal FSS.
igncontrib	Binary Ignorance contribution diagram for a single threshold (-r). Shows how much each probability issued contributes to the total ignorance.
invreliability	Reliability diagram for a certain quantile (-q)
marginal	Show marginal distribution for different thresholds
meteo	Plot a meteogram, with deterministic forecast, all quantile lines available (use -q to select a subset of quantiles), and observations. This makes most sense to use for a single location

	and forecast initialization time. If multiple dates and locations are used, then the average is used.
obsfcst	Plot observations and forecasts performance
	Categorical performance diagram showing POD, FAR, bias, and Threat score. Also shows the scores the forecasts would attain by using different forecast thresholds (turn off using -simple)
pithist	Histogram of PIT values. Use -r to specify bins.
qq	Quantile-quantile plot of obs vs forecasts
reliability	Reliability diagram for a certain threshold (-r)
roc	Plots the receiver operating characteristics curve for a single threshold (-r)
scatter	Scatter plot of forecasts vs obs and lines showing quantiles of obs given forecast (use -r to specify)
spreadskill	Spread/skill plot showing RMSE of ensemble mean as a function of ensemble spread (use -r to specify spread thresholds and -q to specify a lower and upper quantile to represent spread)
taylor	Taylor diagram showing correlation and forecast standard deviation. Use '-x none' to collapse all data showing only one point. Otherwise, the whole graph is normalized by the standard deviation of the observations.
timeseries	Plot observations and forecasts as a time series (i.e. by concatenating all leadtimes). '-x <dimension>' has no effect, as it is always shown by date.