1 Introduction

tikz-helper is a set of common lisp functions and macros to make plots. This is done by generating LaTeX code using pgf and Ti*k*Z.

To generate a plot, one of the macros with-tikz-to-file, with-tikz-to-string or with-tikz-to-stream is called. with-tikz-to-file and with-tikz-to-string are just wrappers for with-tikz-to-stream. The macros set up the latex environment needed by the figures, collects information needed to perform transformations between the data frame and a default frame, and draws axis for the plot. The transformations are linear and works so that (plot-x-min,plot-y-min) is at (0cm,0cm) in the default frame, and (plot-x-max,plot-x-min) is at (width in cm, height in cm)

The axis-style should be one of :rectangle :cross :left-bottom :popped-out or :none. Examples of all the different axis styles are below. Axis ticks are added to the axis. The position of the ticks is so that they are placed with a spacing of 1,2 or 5 times 10 to a power such that you get between 4 and 10 ticks on the axis. If custom ticks are needed, or ticks with names, not numbers, use :none, and call the corresponding draw-axis-* function.

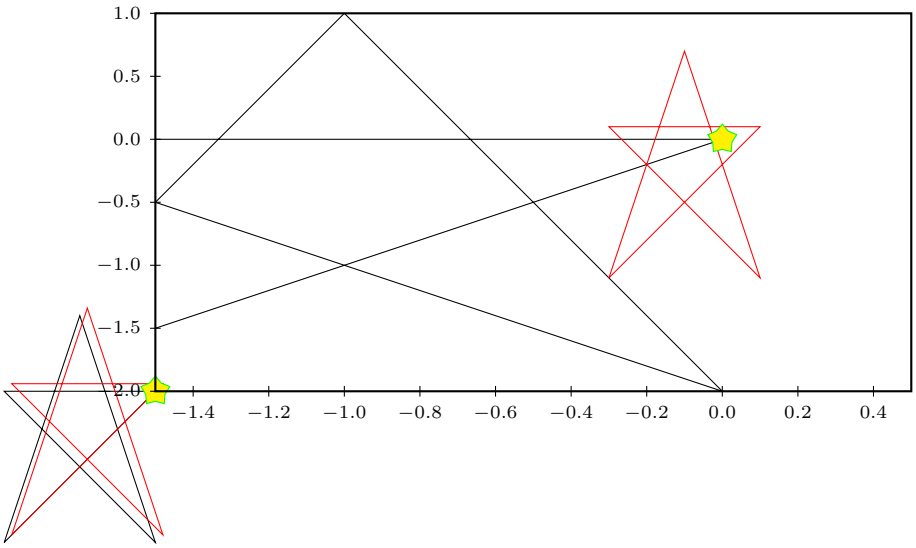


Figure 1: By default paths and nodes are drawn in a frame where origin is the lower left corner of the plot, and the units in x and y is 1cm. The transform macro generates tikz transformations, so that all points within the scope are drawn in the plot frame, defined by plot- x-min x-max and y-min y-max. The clip-and-transform macro also clips the plotting area. Values with units like cm or pt are not scaled, but all points are translated. The black star path is here drawn in the current frame, the red one is shifted by (0.1,0.1) in the current frame, then drawn in units of cm.

2 Simple plots

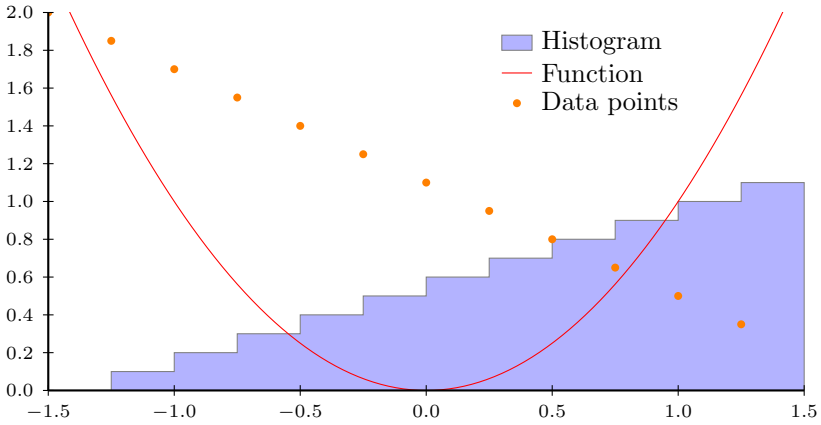


Figure 2: A histogram, a function and some data points. Most functions dealing with sets of data points call the clip-and-transform macro themselves, so calling it from top level is not necessary.

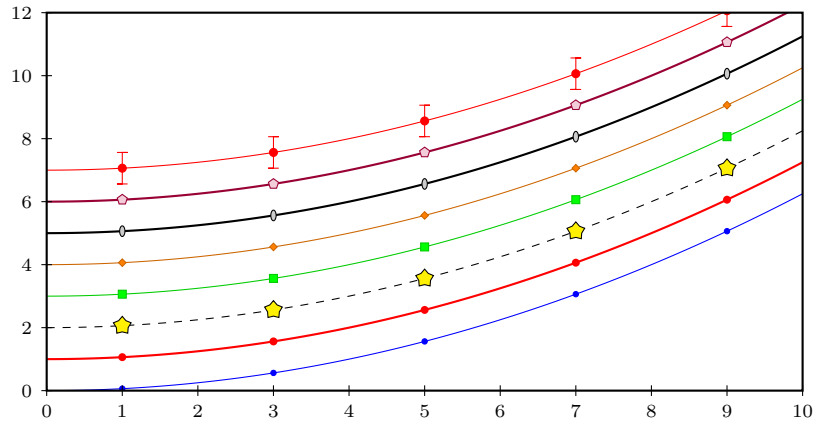


Figure 3: Different styles of lines and nodes. The styles are just regular tikz options.

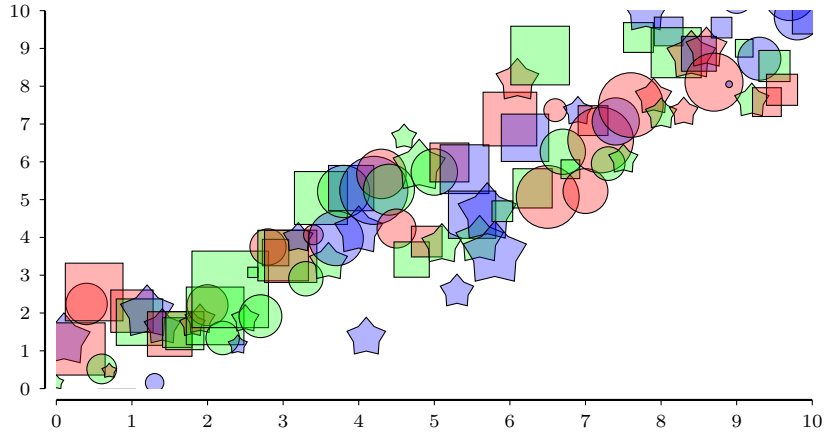


Figure 4: Data points of varying sizes, shapes and colors. Draw node does not automatically transform, since it can be useful in the default frame.

The with-tikz-to-string macro is nice for mixing text and drawings(like so ⬟). It's possible to draw stuff in captions by including the following:.

```
%The preamble needs:
\usepackage[singlelinecheck=off]{caption}
%Inside the figure environment
\captionsetup{singlelinecheck=off}
\caption[foo bar]{\node at (0,0) ...}
```

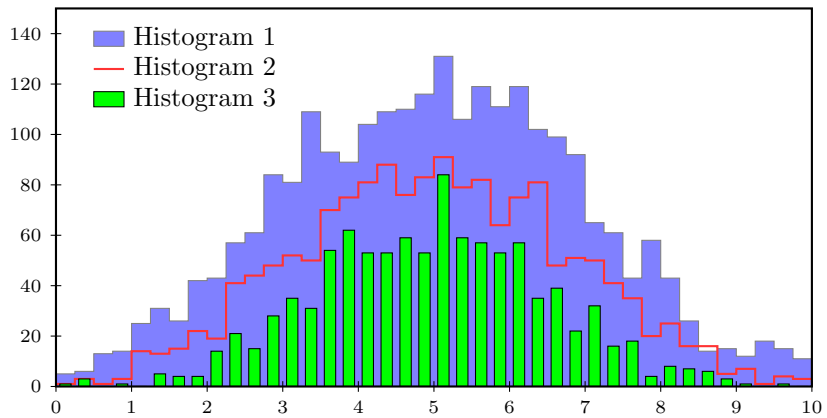


Figure 5: Some Gaussian histograms with different styles and with legend entries. The legend entries are placed in the default cm frame, unless draw-histogram is called within (transform (tikz) ...). With some trickery it is also possible to get legends in captions: Histogram 1, Histogram 2, Histogram 3.

Simple sparkline:
More complex sparkline: 0.8, indicates the 1σ band

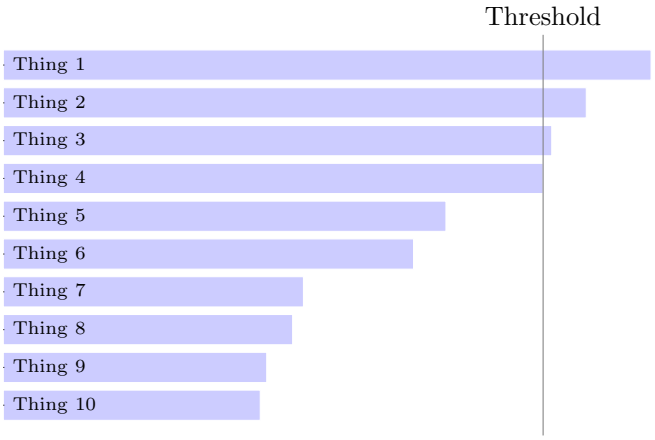


Figure 6: Histogram with bins extending in the horizontal direction. This is just a tikzpicture with the transformation rotate=-90. The text is not rotated, so axis ticks require extra care, and text in legend entries will not be properly aligned. The bins are named with the draw-axis-ticks function.

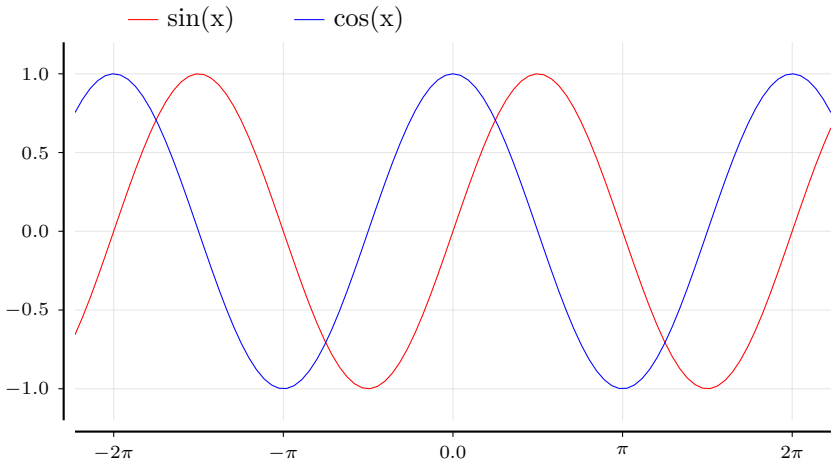


Figure 7: Plotting sin(x) and cos(x), with grid lines and tick names on the x-axis.

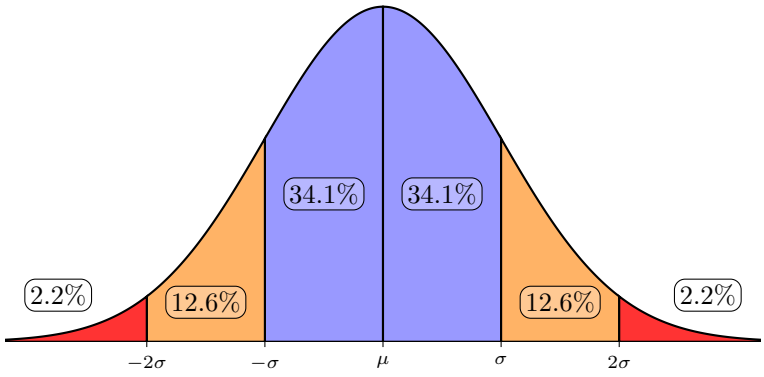


Figure 8: Gaussian function, made by closing, drawing and filling function segments.

3 Fitting with Levenberg-Mmarquart

The Levenberg-Marquart algorithm minimizes the squared distance in the y-direction between a function and a set of data points by changing function parameters. If errors are supplied the χ^2, or the squared normalized differences, is minimized.

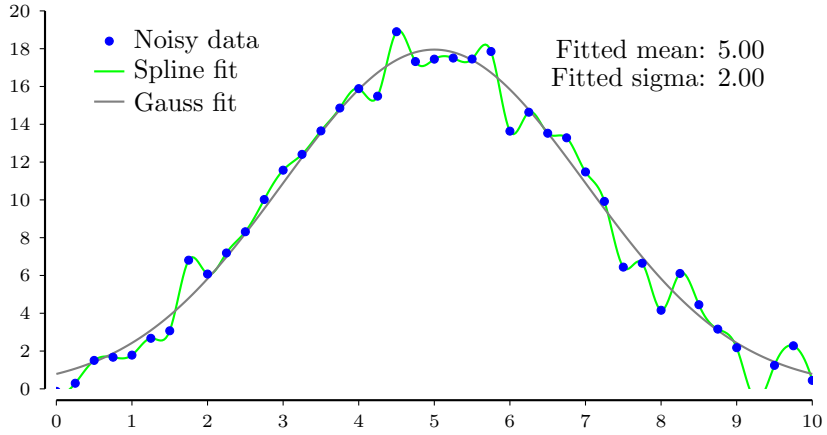


Figure 9: Some Gauss smeared data points, fitted with the Gaussian function. Fit parameters are printed in the plot. A spline fit is also plotted.

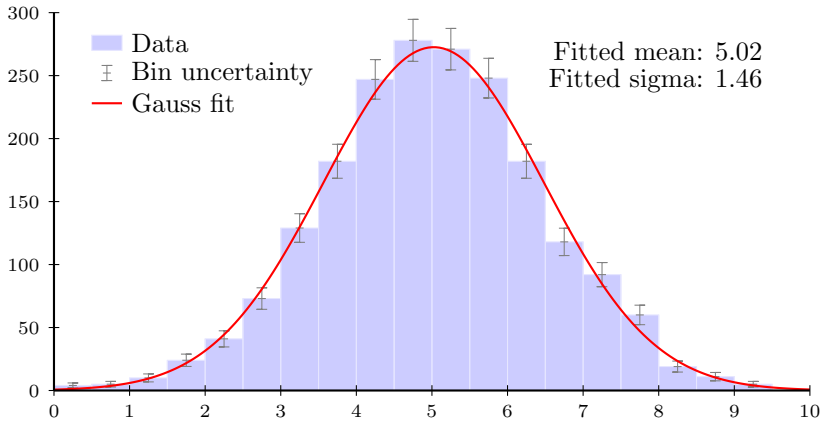


Figure 10: Same as above, except the data points have errors. The error bars are calculated from bin content. Empty bins are discarded in the fit.

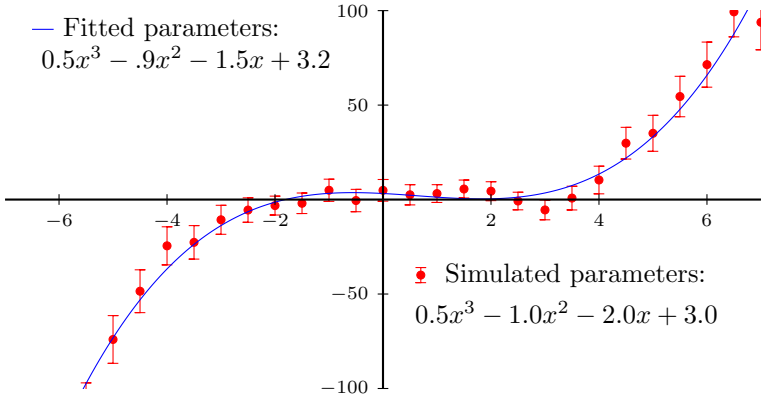


Figure 11: Noisy data points, with known errors, fitted with a polynomial of the third degree. The "Simulated parameter" legend is placed in the default frame, the "Fitted parameters" in the data frame.

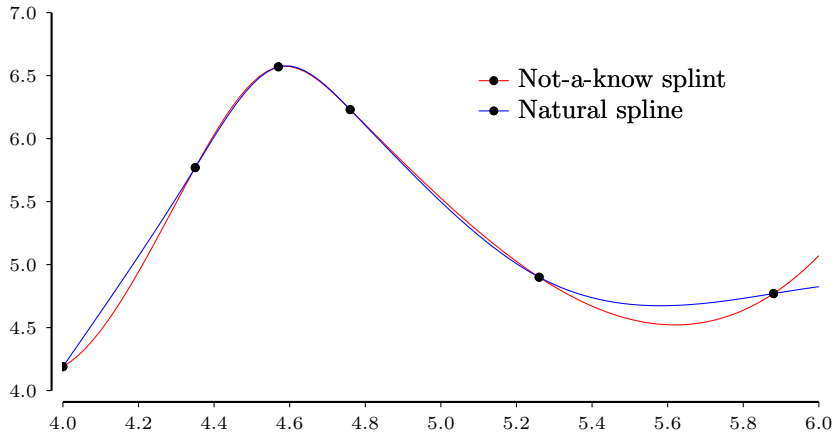


Figure 12: Cubic splines, with different end point conditions.

4 Sub figures

The with-sub-figure macro makes it possible to draw with a new set of transformations within the same tikz figure. In addition to the with-tikz-to-stream arguments, the sub-figure also expects the offset from (0,0) in the default cm frame.

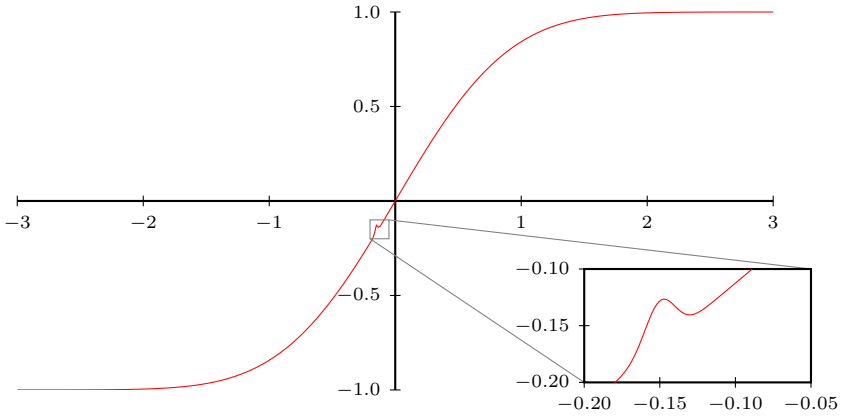


Figure 13: More than one plot can be plotted in the same figure by using sub figures. Sub figures are basically a new set of transformations, and do not affect the default cm frame at all. Here is a function with a zoomed view of a region of interest.

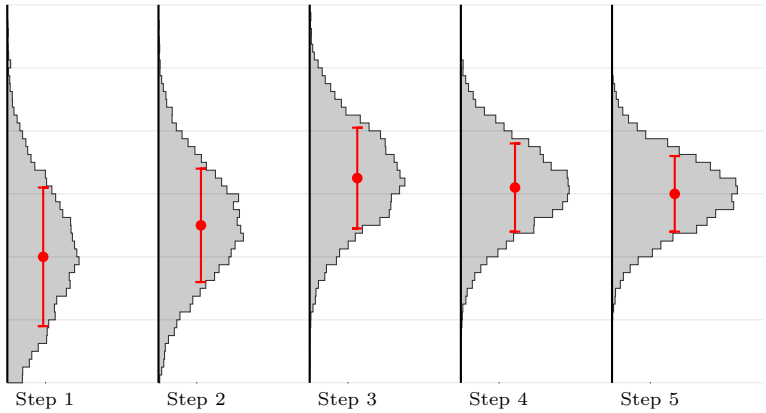


Figure 14: Horizontal histograms, in sub figures side by side. The mean and σ are indicated by red verical bars.

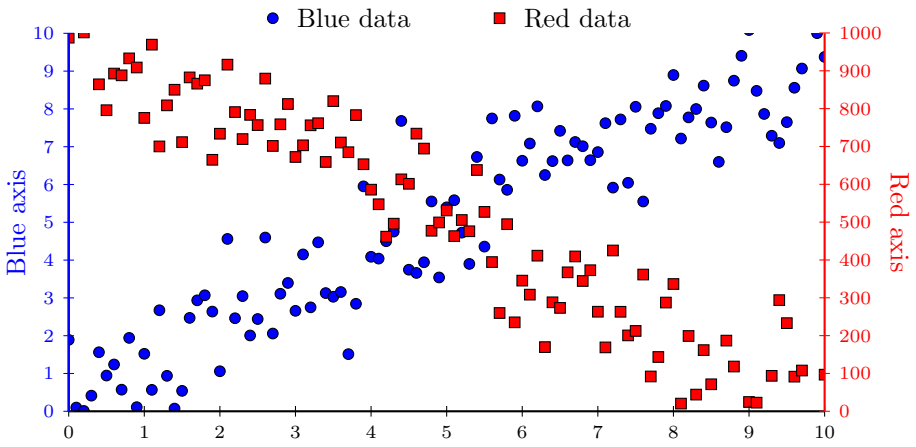


Figure 15: Two data sets with different transformations are plotted on top of ech other.

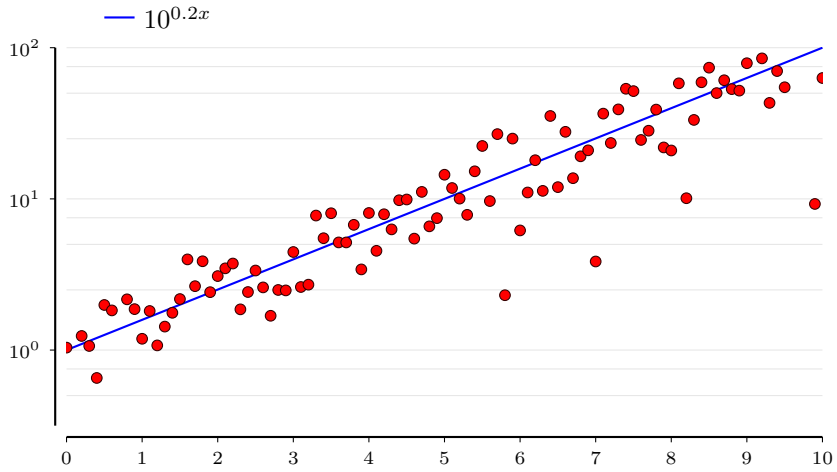


Figure 16: Plot with log scale in the y direction. Explicit transformation.

5 2D histograms

2D representations of 2D histograms.

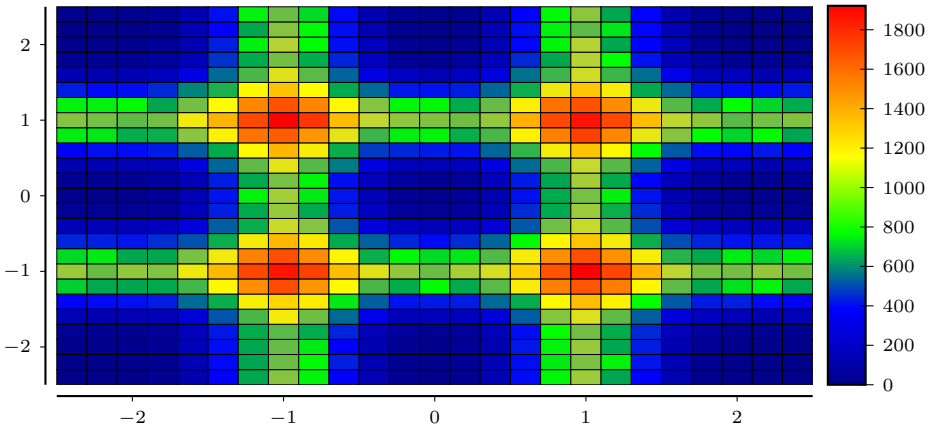


Figure 17: 2D histogram drawn as filled rectangles. Takes a while to compile with pdflatex, especially if the binning is fine.

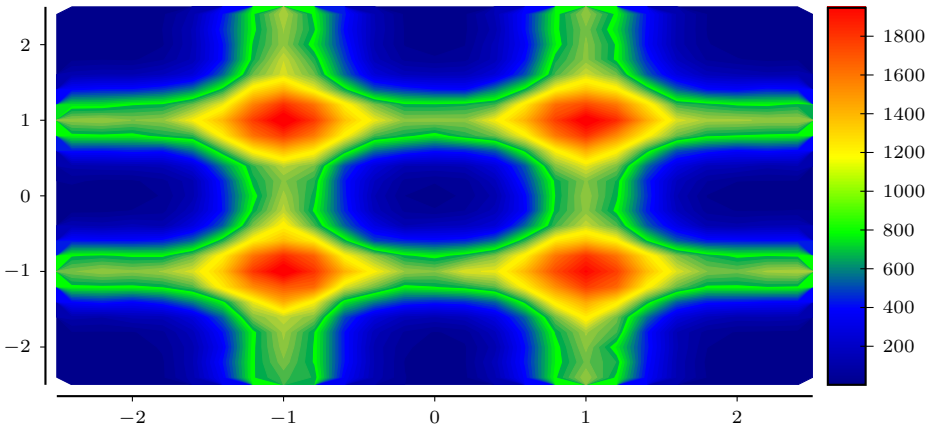


Figure 18: 2D histogram drawn as filled contour regions. The points making up the contour lines are just linear interpolation between neighbors on either side of the contour height.

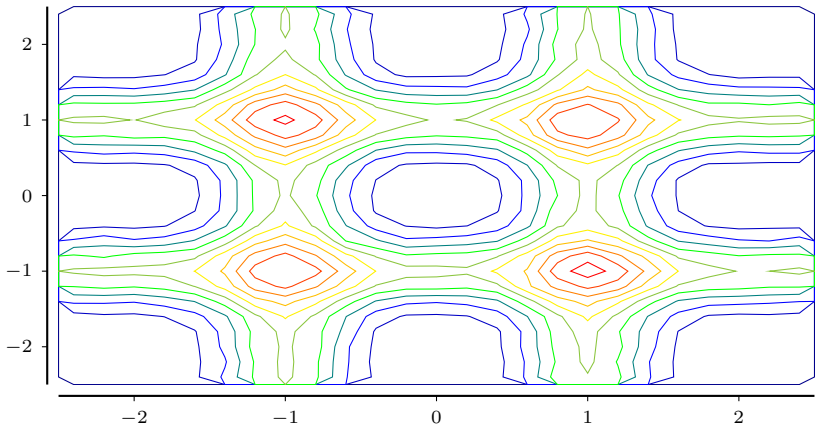


Figure 19: 2D histogram drawn as isolines.

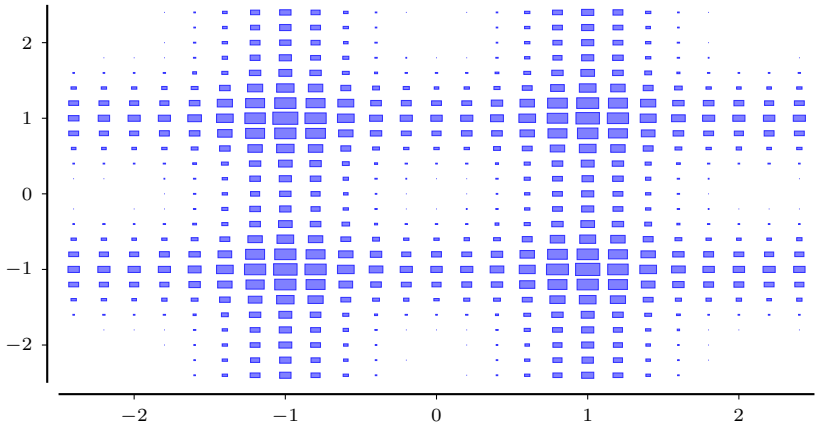


Figure 20: 2D histograms drawn as nodes of varying sizes.

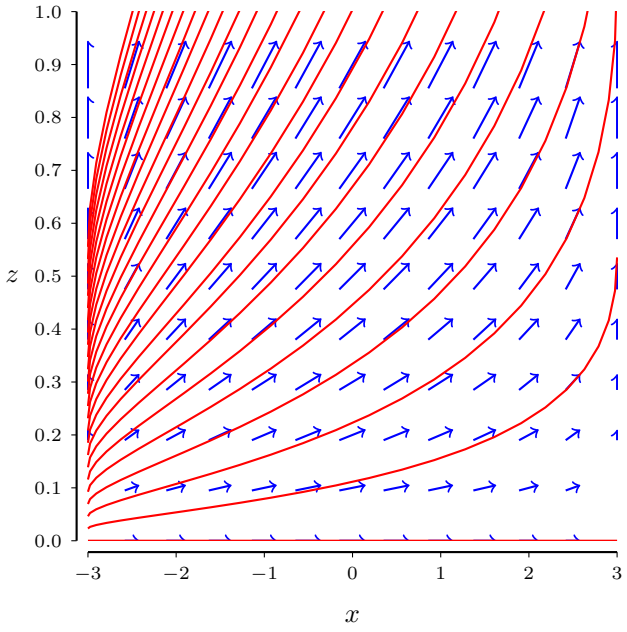


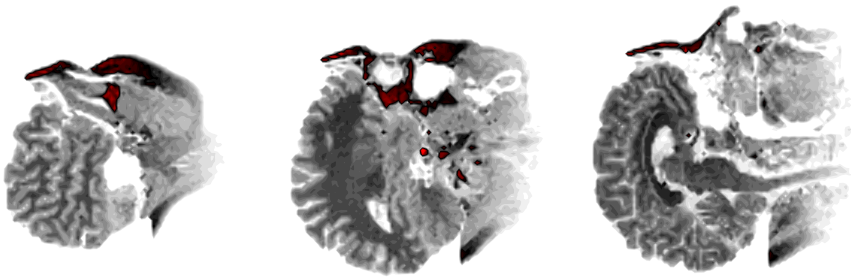
Figure 21: Velocity field with streamlines as parametrized functions.

6 3D scalar fields

3D histograms can be visualized by projecting 3D scalar data into a 2D histogram in a projection plane. The camera is pointed towards a reference point. The projection has a horizontal axis parallel to the cross product of the differ-

ence vector between the camera and the reference point, and the z-axis. The vertical axis is parallel to the cross product between the difference and the horizontal axis. The hight and width of the projection is measured along the axes around the reference point. Rays are emitted from the bins in the projection plane, moving away from the camera. The distance from the camera to the projection plane is specified in units of the distance from the camera to the reference. The reference point is only in the projection plane if this distance in 1. If the projection plane is inside the 3D scalar field, only data further away from the camera will be used in the visualization. The plots are generated in the file volumes-example.lisp.

Three projection methods are implemented. The first method uses a line integral along the ray emitting from the projection bin. The data is from http://www.cg.tuwien.ac.at/research/publications/2005/dataset-stagbeetle/

The second method is the Maximum Intensity Projection (MIP). The maximum value the ray passes through is used. The data is from http://graphics.stanford.edu/data/voldata/CThead.tar.gz.

The third method is the Local Maximum Intensity Projection (LMIP). This is similar to MIP, but the first value above a threshold passed by each ray is returned. If the treshold is set very low, the projection plane can be studied as a cut plane. The data is from http://graphics.stanford.edu/data/voldata/MRbrain.tar.gz.