Plotting

It's quite difficult - practically impossible - to perceive data from rows and columns with numerical data. This holds true for complex (scientific) data; but also for much simpler data, e.g. temperature records over time. Graphical plots allow fast perception. That makes plots very important - also for debugging while development.

Plot Types

There are many plot types, you can select from. See https://datavizcatalogue.com/

Terminal / Command Line

Gnuplot is a portable command-line tool for creating plots.

Usually, comma seperated value (CSV) files are used as input, see comma separated values. But it's also possible to plot from binary data files.

C++

Following plotting libraries might be used for creating (debug) plot files.

First some meta results, which already give a good overview:

- https://gasparri.org/2019/12/06/best-plot-and-charting-c-packages-for-data-visualization/
- https://www.researchgate.net/post/What_are_the_best_plot_and_charting_C_package_which_can_be_used_for_data_visualization
- https://stackoverflow.com/questions/4283731/plotting-package-for-c

Here some (additional) links:

- sciplot
  - https://sciplot.github.io/
  - https://github.com/sciplot/sciplot
- Matplot++
  - https://alandefreitas.github.io/matplotplusplus/
  - https://github.com/alandefreitas/matplotplusplus
- VTK
  - https://vtk.org/
  - https://gitlab.kitware.com/vtk/vtk
  - https://kitware.github.io/vtk-examples/site/Cxx/Plotting/LinePlot/
- PLplot
  - https://plplot.sourceforge.net/
- https://github.com/ABRG-Models/morphologica

- https://github.com/thclark/cpplot
- Matplotlib-Cpp - requires python
    - https://github.com/lava/matplotlib-cpp
- Immediate Mode Plotting (implot)
    - https://github.com/epezent/implot
    - Dear ImGui: https://github.com/ocornut/imgui

Python

A python script/program allowing interactive commands is better suited for experimenting/development.

However, C++ developers might use python when compiling their code as python module with bindings, e.g. with pybind11. Interface functions might utilize numpy or Eigen, see https://pybind11.readthedocs.io/en/stable/advanced/cast/eigen.html

In python, there are several plot libraries available:

- Matplotlib
    - https://matplotlib.org/
    - https://github.com/matplotlib/matplotlib
- PyQtGraph - builds on Qt
    - https://www.pyqtgraph.org/
    - https://github.com/pyqtgraph/pyqtgraph
- seaborn
    - https://seaborn.pydata.org/
    - https://github.com/mwaskom/seaborn

i really like colored heatmaps:

- https://stackoverflow.com/questions/33282368/plotting-a-2d-heatmap
- https://github.com/DingWB/PyComplexHeatmap
- https://matplotlib.org/stable/gallery/images_contours_and_fields/image_annotated_heatmap.html
- https://seaborn.pydata.org/examples/spreadsheet_heatmap.html

Colormaps

Colormaps are used for visualizing or mapping mostly linear or grayscale data. IMHO, `jet` is very appealing for linear or logarithmic data. matplotlibs' documentation shows many colormaps: https://matplotlib.org/stable/tutorials/colors/colormaps.html

From technical point of view, `turbo` is an improved alternative for `jet`, see https://ai.googleblog.com/2019/08/turbo-improved-rainbow-colormap-for.html

Other colormaps like `viridis`, `plasma` or `inferno` provide perceptually uniform sequential lightness.

Here an interesting video on this topic: https://www.youtube.com/watch?v=xAoljeRJ3lU

In SDR and signal processing, such colormaps are used to visualize the power (or energy) in one single pixel to allow spectrogram plots, which already use x and y axes for time and frequency. For sure, there are usages in many other fields.

Cyclic colormaps

Circular data, e.g. phase values, should be treated special - as -180° equals +180°. *Cyclic* colormaps like `twilight` or `hsv` are for that case.

These colormaps are ideally viewed on circle like here: https://stackoverflow.com/questions/62531754/how-to-draw-a-hsv-color-wheel-using-matplotlib - and not on a ruler.

Other links

- https://blog.habrador.com/2023/04/colormaps-overview-code-implementations-rainbow-virids.html
- https://stackoverflow.com/questions/7706339/grayscale-to-red-green-blue-matlab-jet-color-scale