fastplotlib

Augmenting our scientific imagination

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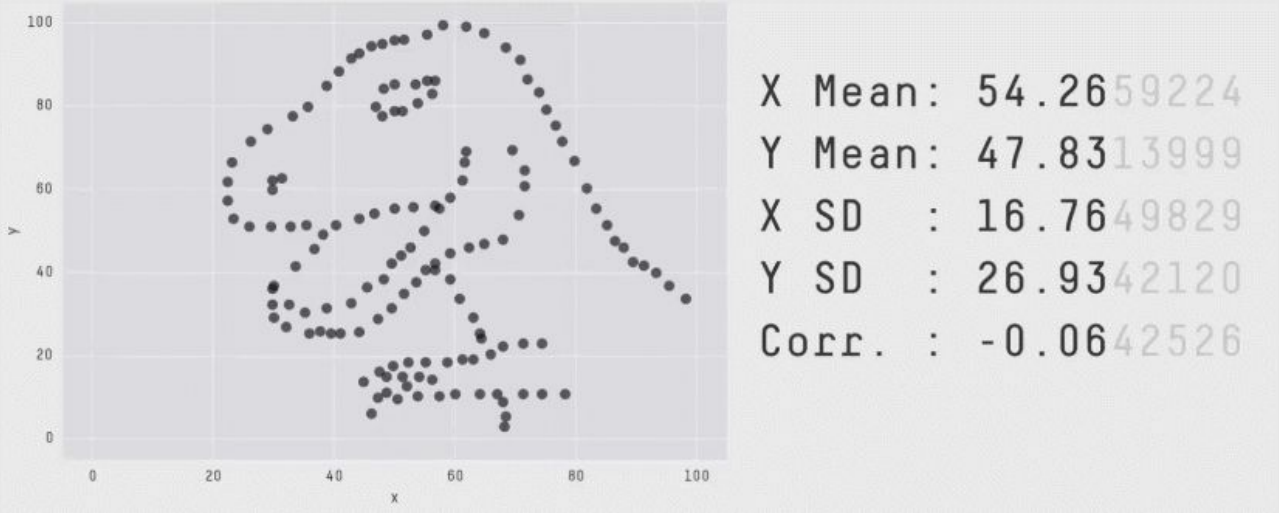
It is important to look at your data!

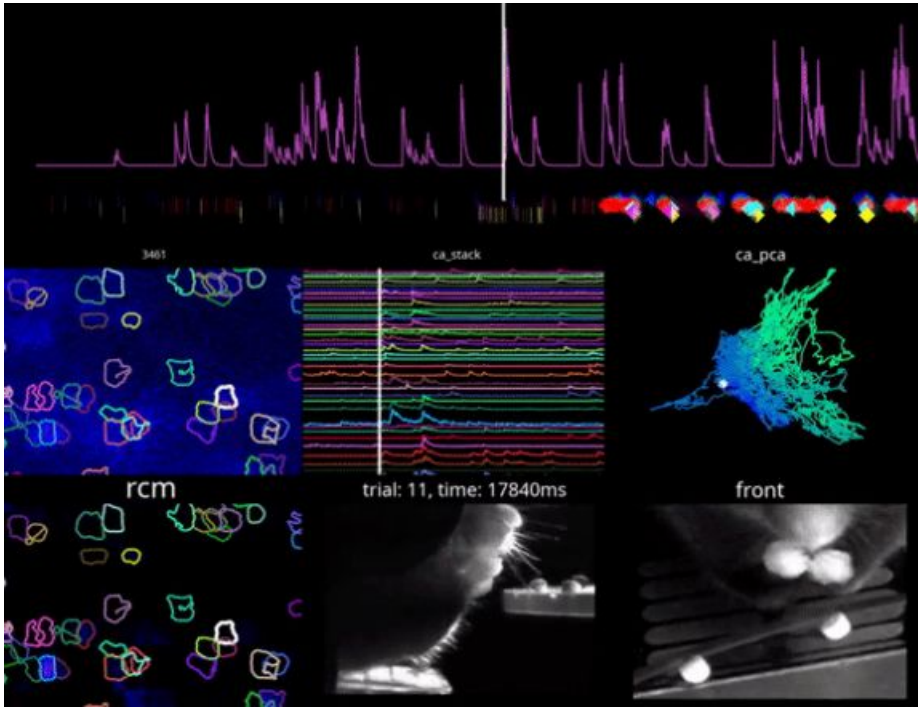
- Statistics are not sufficient
- “All models are wrong, some are useful”
- All algorithms are approximations



Matejka, Justin, and George Fitzmaurice. ***"Same stats, different graphs: generating datasets with varied appearance and identical statistics through simulated annealing."*** *Proceedings of the 2017 CHI conference on human factors in computing systems*. 2017.

Data visualization can be hard

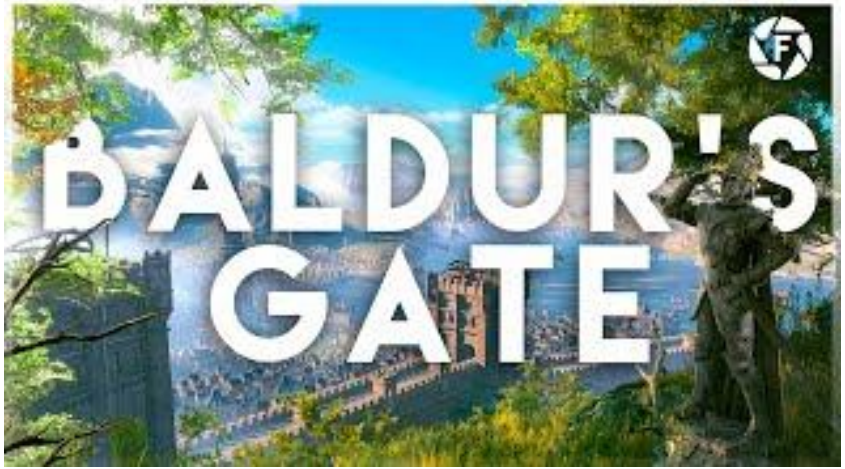
- Rendering needs to be ***fast***
- Non-trivial to represent and visualize high dimensional data
  - Visualization of data from multiple instruments
    - Data from cameras, PMTs, etc. simultaneously: behavior + physiology
- Interactivity
  - APIs in many libraries may be limited or complicated

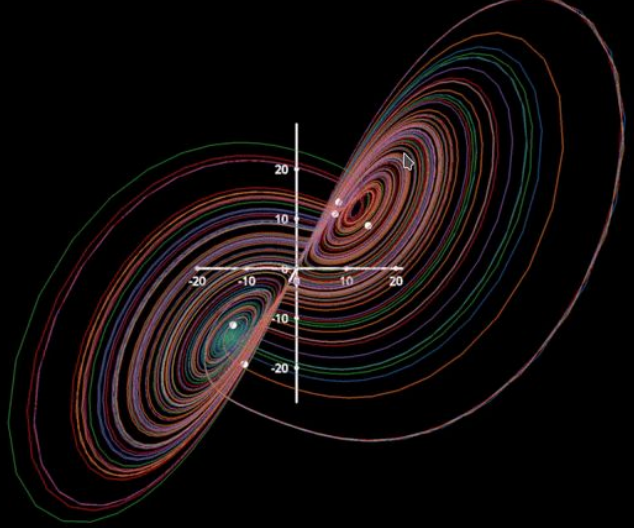


Why don’t scientific plots look as good as modern video games?

Graphics ~20 years ago

Graphics today

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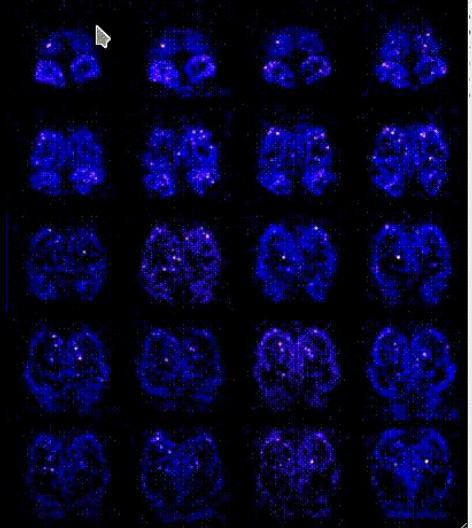

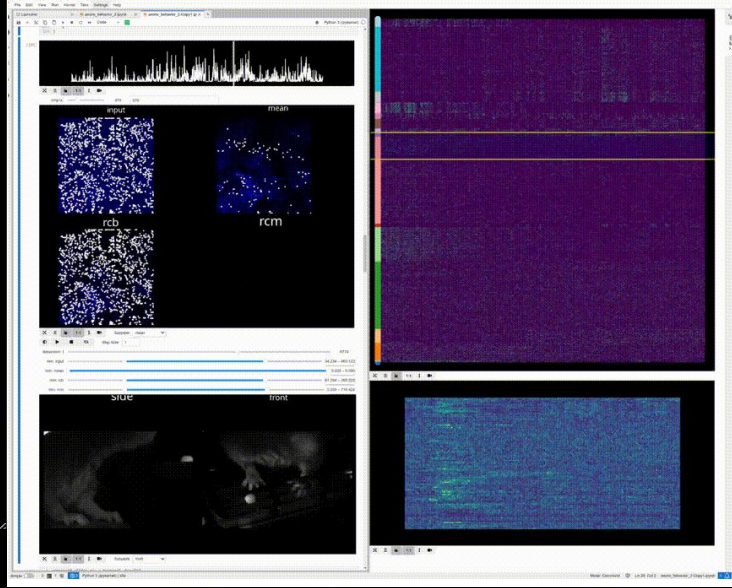
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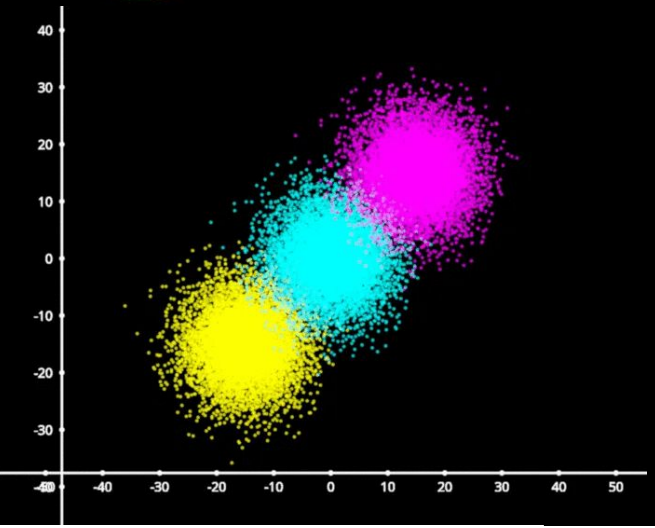
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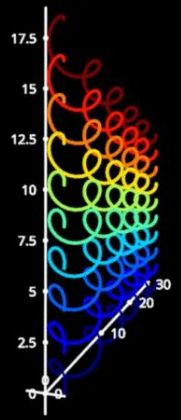
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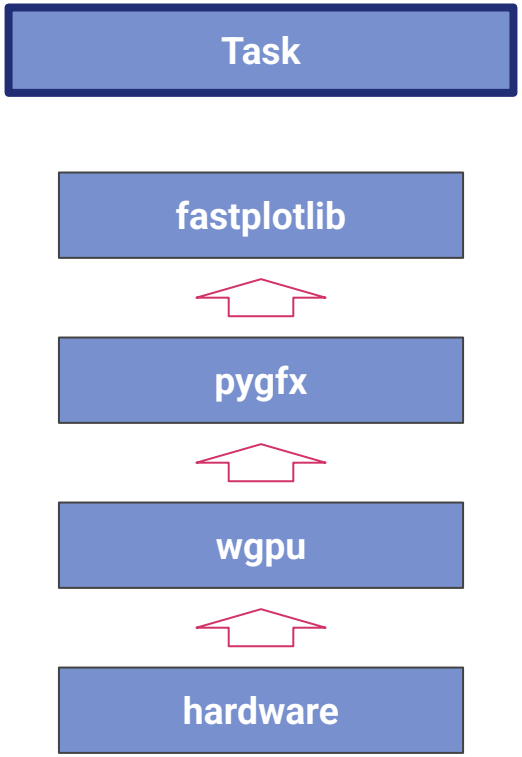
Next-gen graphics technology

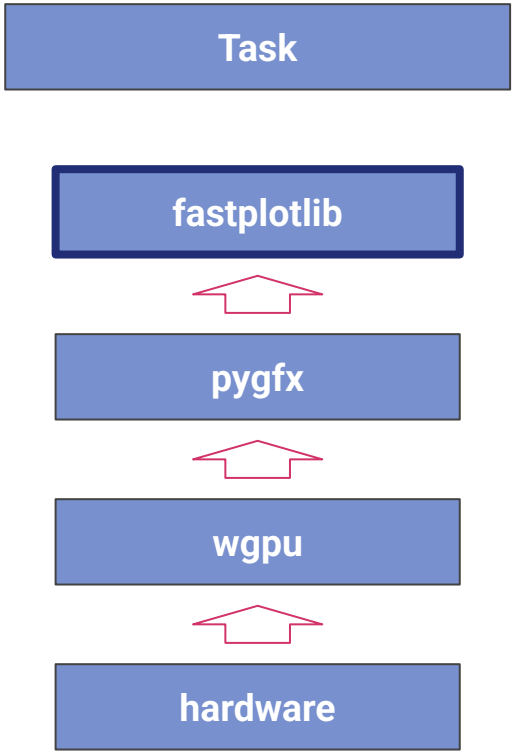
Image



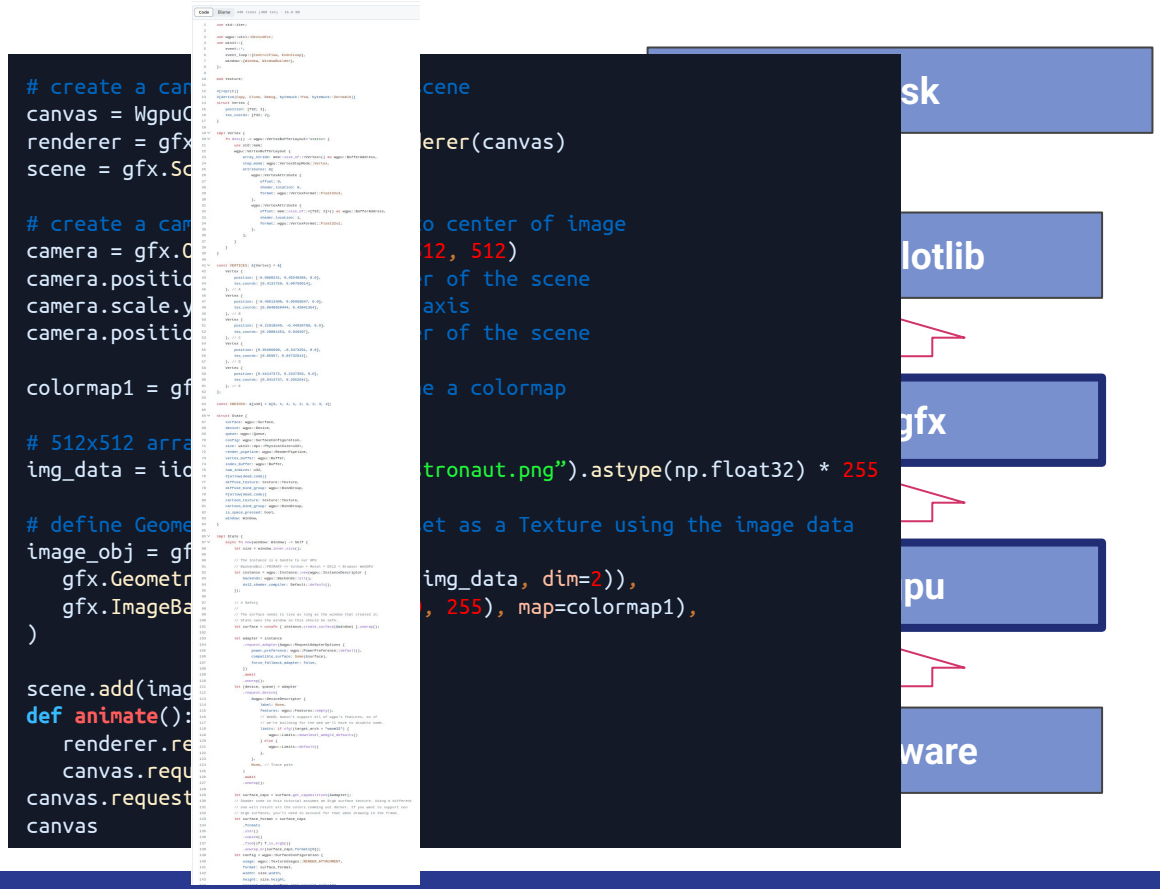
Next-gen graphics technology

Image

```
fig = fpl.Figure() # create a figure

data = iio.imread("imageio:astronaut.png") # data

fig[0, 0].add_image(data=data) # plot an image

fig.show() # show the figure :D
```



fastplotlib-pygfx-wgpu Stack

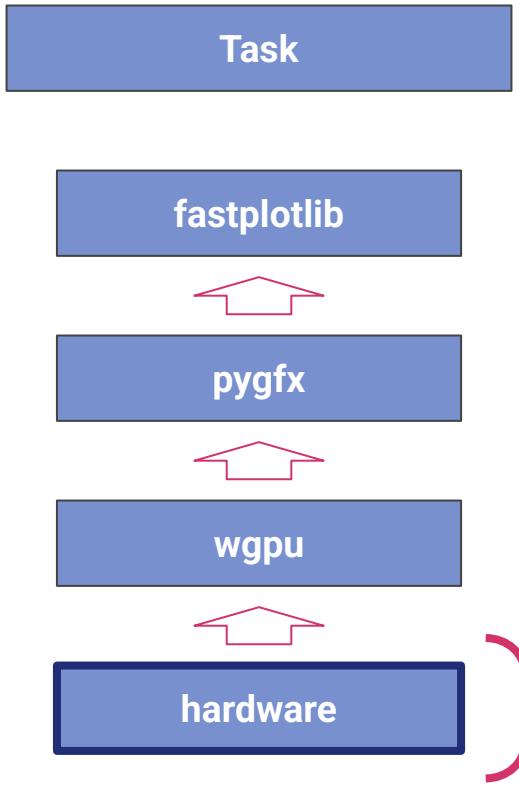


- Mozilla
- Apple
- Microsoft
- Google

gpu

Next-gen graphics technology

Image

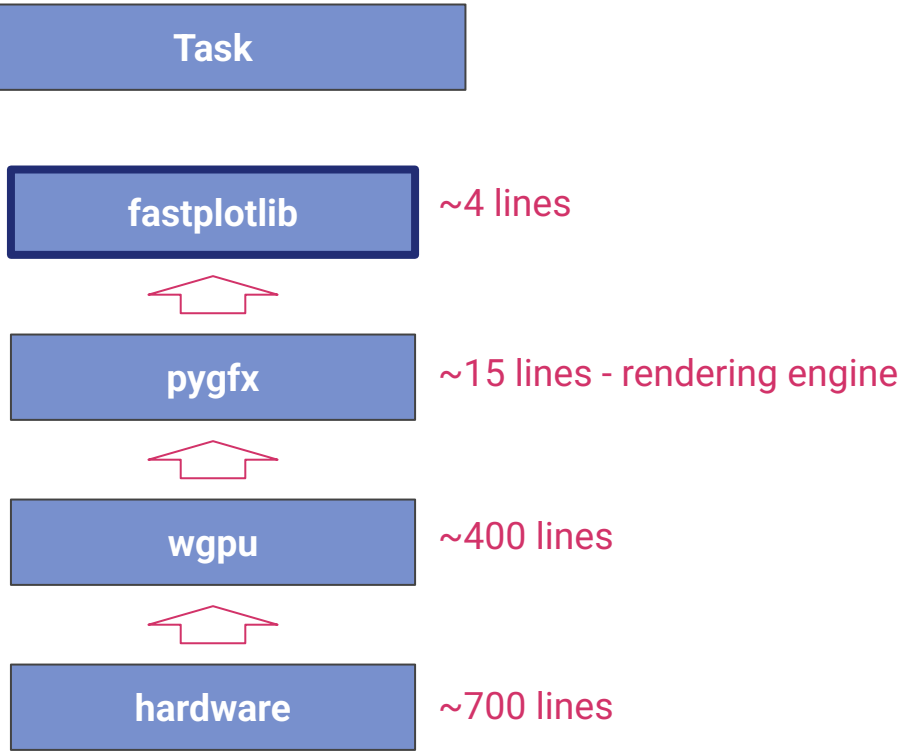


New technologies: very fast, efficient, & leverage modern GPU hardware better than OpenGL

This is also what newer games use!

Next-gen graphics technology

Image

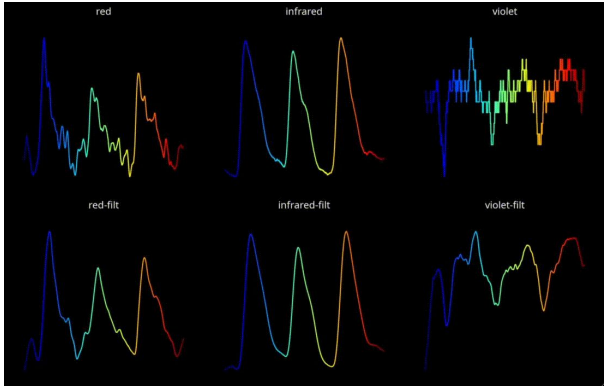


fastplotlib

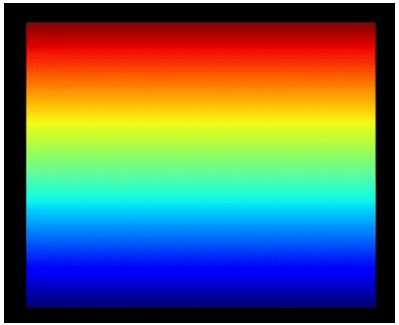
- High-level API for scientific plotting - inspiration from *pyqtgraph* and other libs
  - ❤️ pyqtgraph
- Uses the *pygfx* rendering engine
- Very new ~2 years old
- Goals: fast visualization, fast user implementation
  - **Think like numpy arrays!**
  - Minimize cognitive overhead
  - “expressive & elegant API”
- Core developers & leadership:
  - **Kushal Kolar - Flatiron Institute/NYU**
  - **Caitlin Lewis - Duke University**
- Major developers:
  - **Almar Klein - Independent/funded by Flatiron Institute**
  - **Amol Pasarkar -Columbia University**

What can I do with fastplotlib?

- GPU accelerated visualization
  - Modern integrated graphics is sufficient for many use-cases!
- Rapid prototyping and algorithm design
  - Examples: matrix decompositions, time series exploration
  - Design, develop, evaluate and ship machine learning models
- Exploration and fast rendering of large-scale data
- Create real-time acquisition systems for instruments



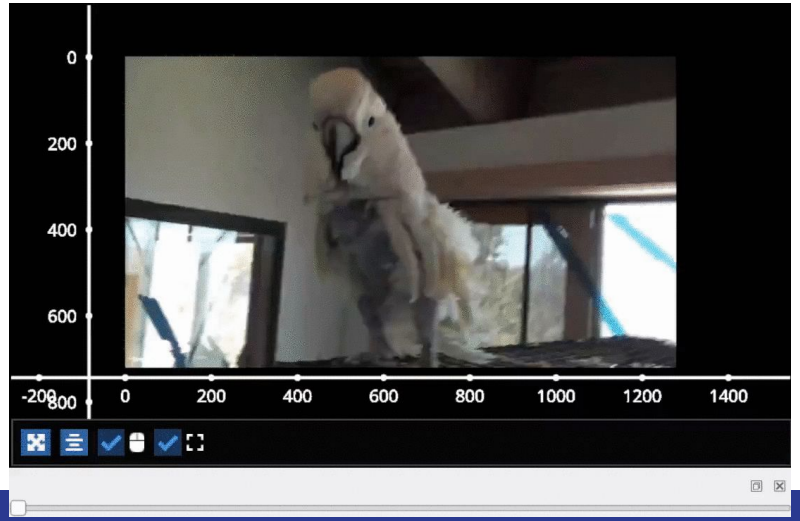
3 million points - fastplotlib midrange 2017 GPU

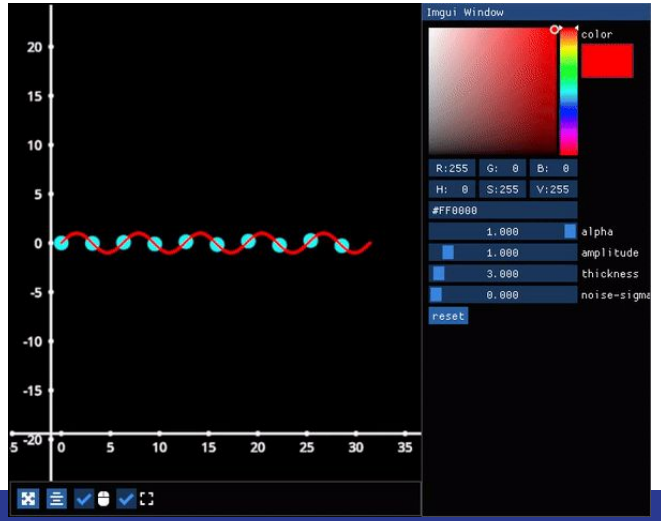


Where can I use fastplotlib?

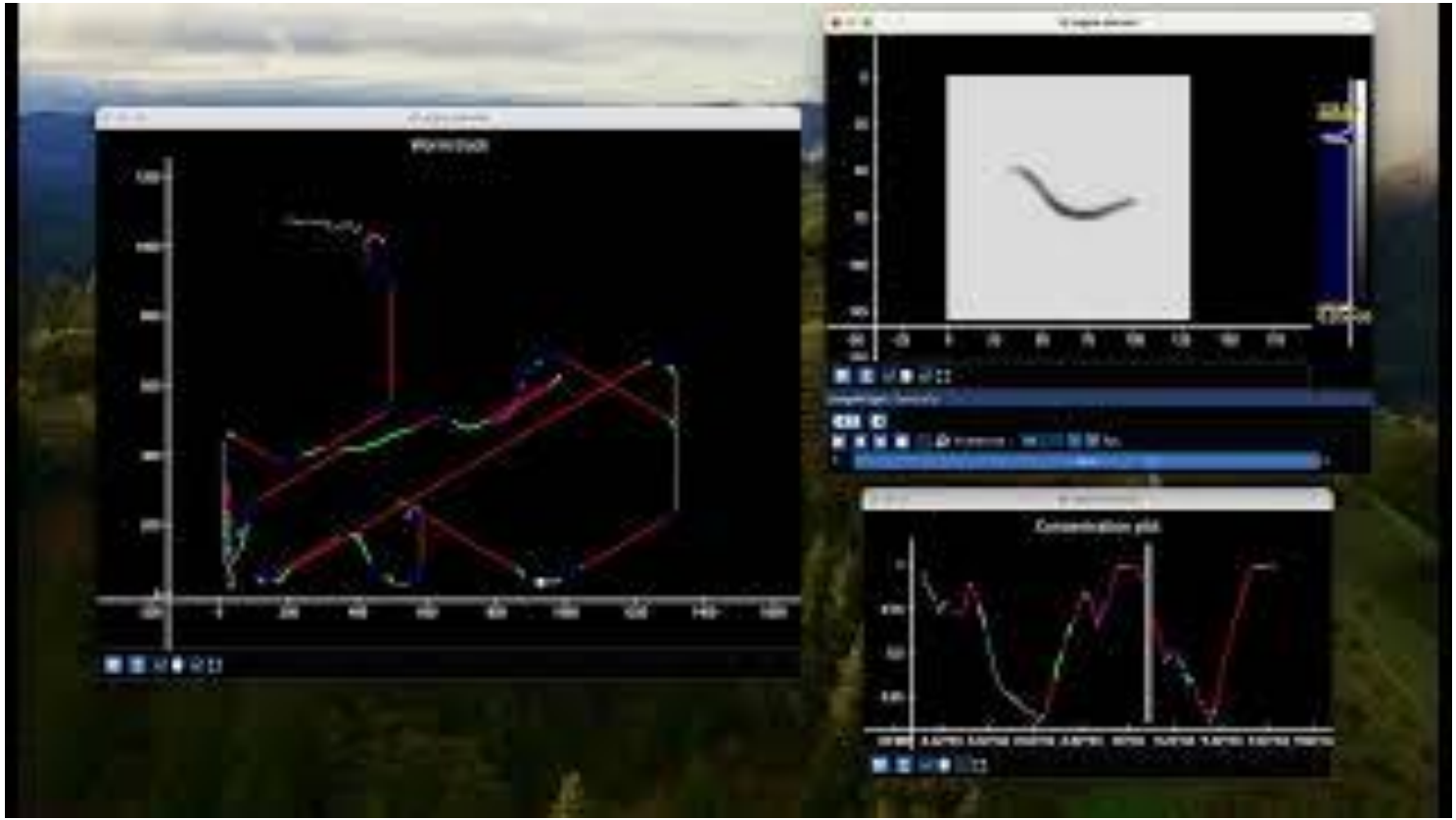
- Identical code across Qt, glfw, and jupyter lab
  - **cloud computing, remote infrastructure**
  - Prototype in jupyter → ship Qt, glfw or web app!
- Imgui-integration

“Write once, run everywhere”, ~~a.k.a. “Write once debug everywhere”~~

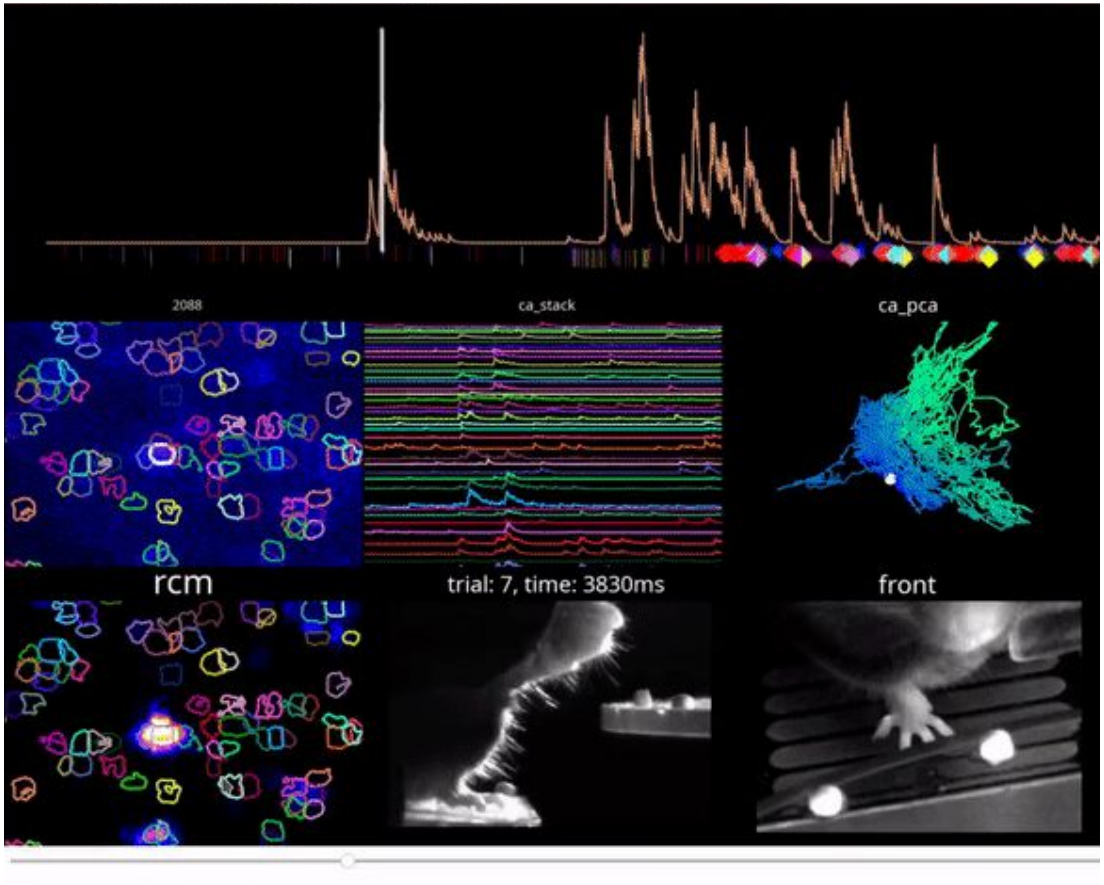




Curating experimental data - Phil Kidd



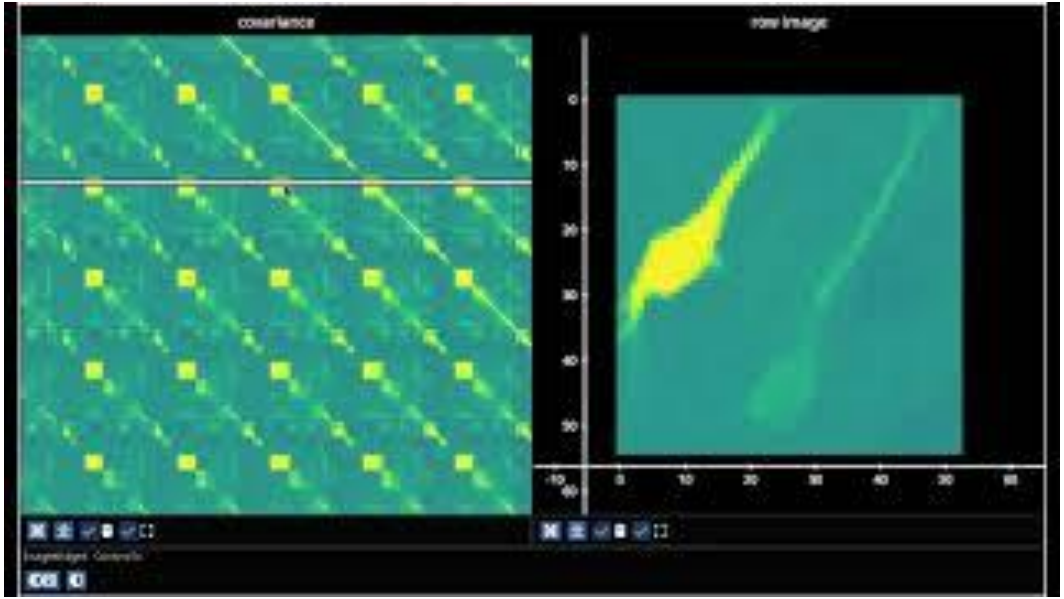
Exploration of large multi-modal experimental datasets



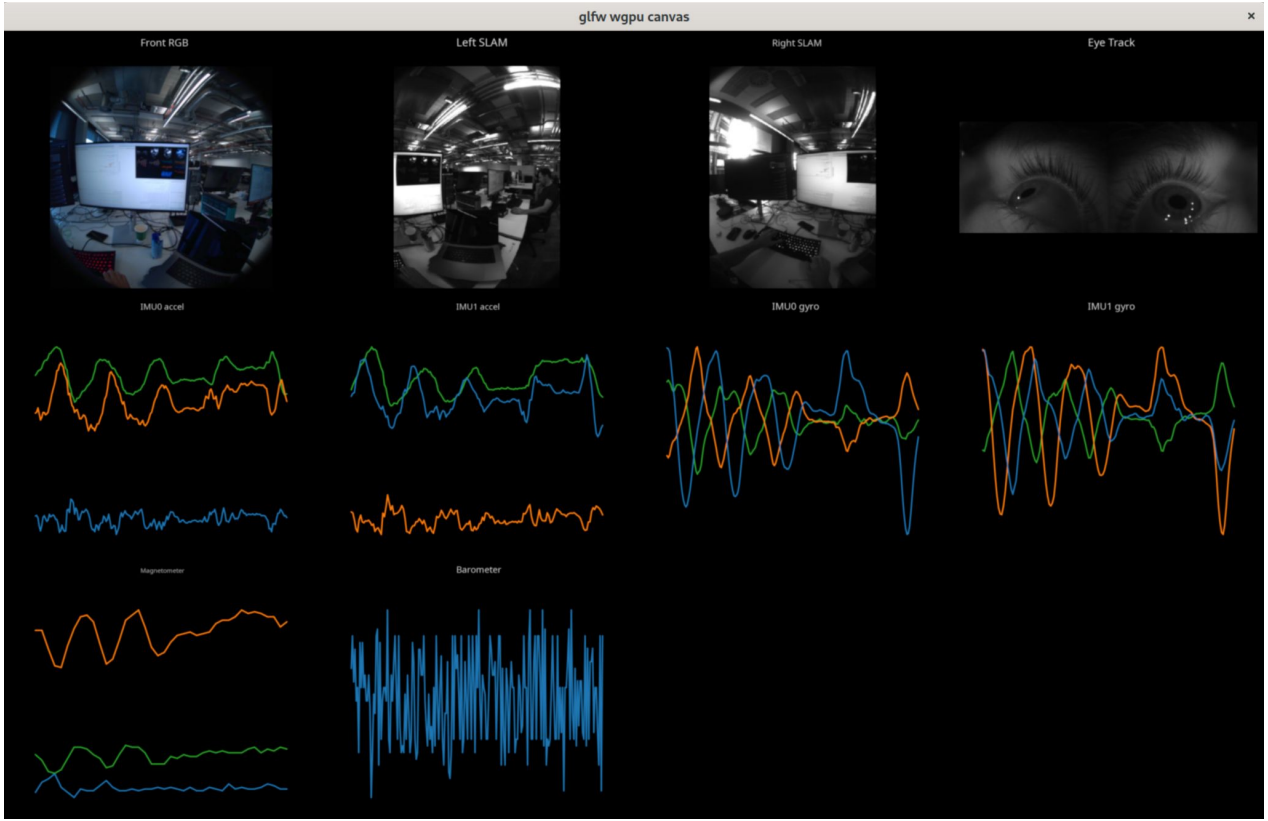
Visualize data structures

1. Create an ImageWidget with the covariance matrix
2. Add a selector
3. Update the image when the selector moves

Everything is regular numpy arrays one very basic function!

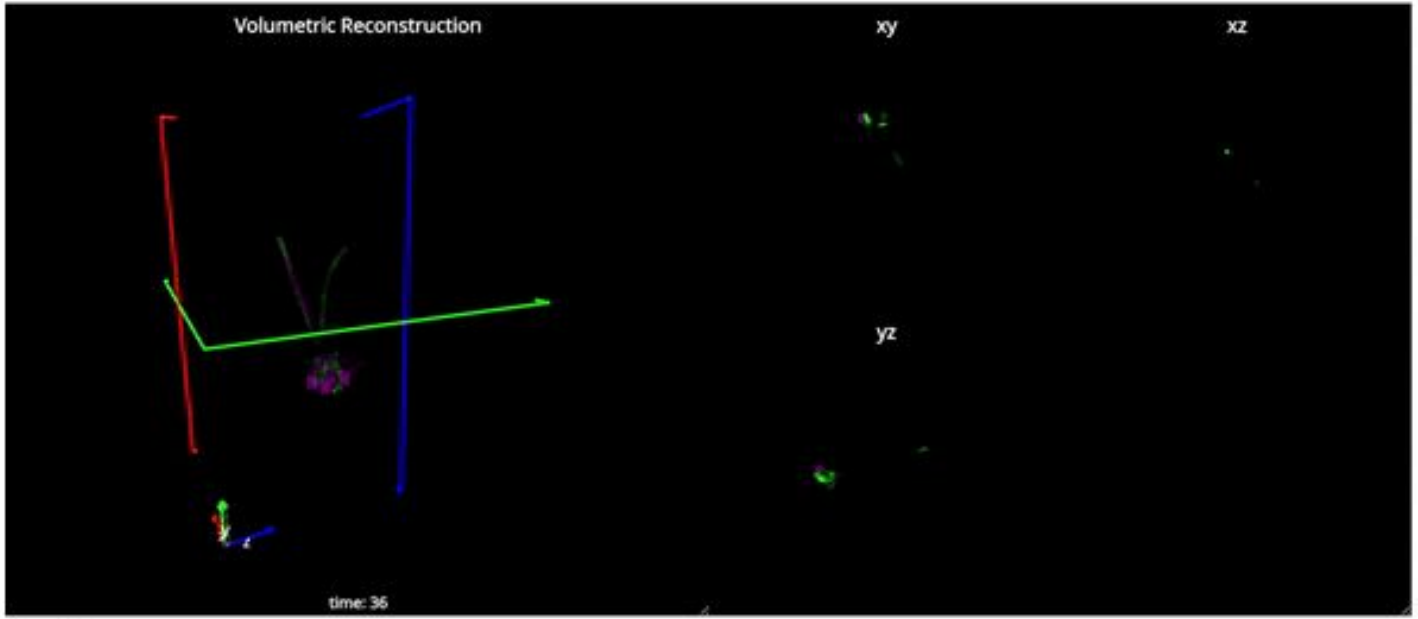


Streaming live data in realtime - Meta/facebook research



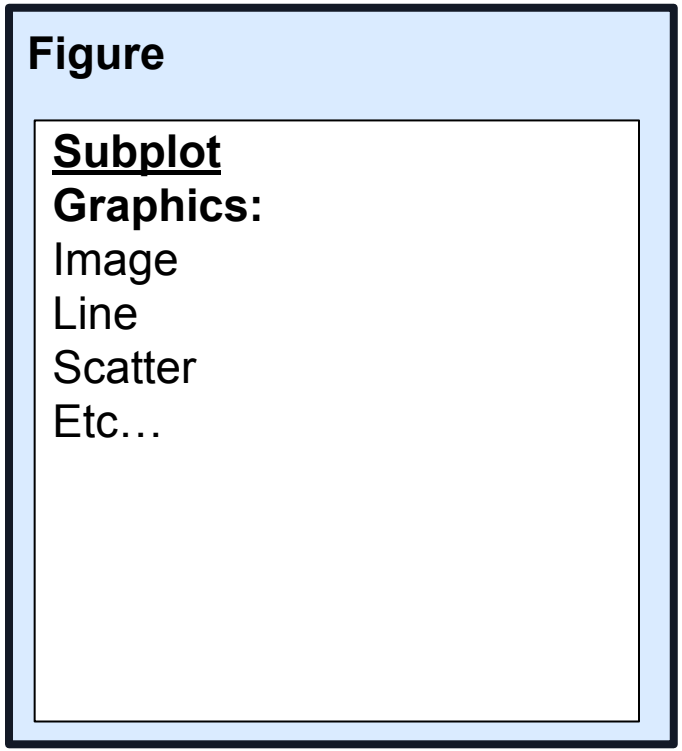
https://facebookresearch.github.io/projectaria_tools/docs/ARK/sdk/samples/device_stream

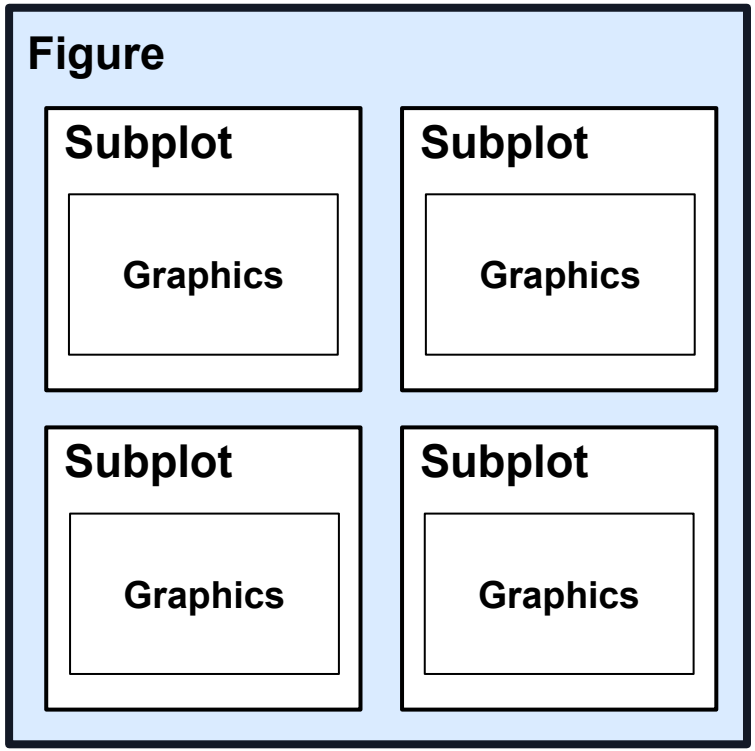
Reflective Fourier Light field Computed Tomography (ReFLeCT)



https://www.biorxiv.org/content/10.1101/2024.09.16.609432v1

API Walkthrough!





Demo!

Documentation & Examples

https://www.fastplotlib.org/ver/dev/

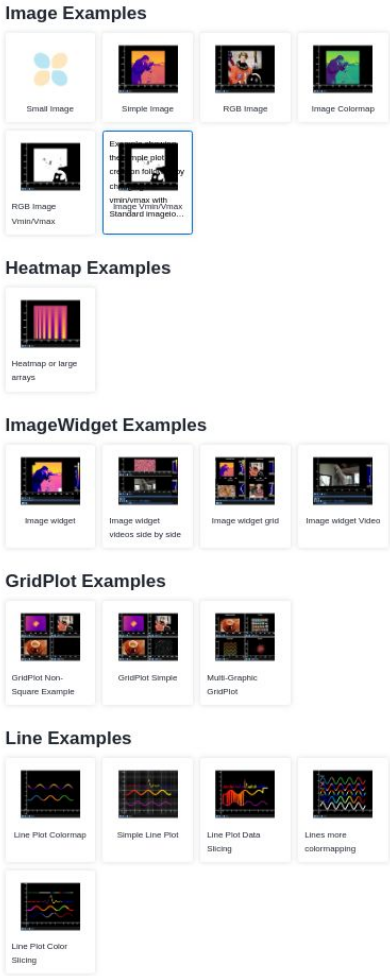
Includes a user guide and how-to on getting started using fastplotlib!

Extensive examples gallery that we are always expanding :D

- 50+ examples so far
- We would love to add more examples for your use-case!

We are also always happy to help you with visualizing your data!!

- Feel free to reach out on our GitHub via an issue or discussion post!
- You can also find Flynn O'Connell, your local fastplotlib expert!
- Please don't ask chatgpt.



Thank you!

What fastplotlib is not

- Fastplotlib is NOT related to matplotlib in any way!
  - Different use cases, different APIs!
  - Fastplotlib is not aimed towards the creation of static publication figures
- Fastplotlib does not handle data loading
  - Numpy-like data arrays which support **memoryview()** should work
- Fastplotlib is a plotting library, not a viewer, GUI, or application
  - You can use it to build viewers and GUI applications

Remote rendering

- Server-side rendering, client only receives a jpeg byte stream
- Inherently faster than client-sided libs - bokeh, dash, plotly, etc.
  - Render big data on server/cloud, client only gets small jpeg stream!
  - **~100x smaller than json serialization!**