Python Data Visualization -- Huge leaps forward!

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About me

Day job: Managing our Services projects with clients

Night job: Managing our open-source visualization tools available at HoloViz.org, including Panel, hvPlot, HoloViews, GeoViews, Datashader, and Colorcet.

Side job: Running PyViz.org, covering all viz and dashboarding tools.

It's been an exciting year since ACON 2019!

Major improvements in Python data visualization and dashboarding:

1. Several major new libraries for Python dashboarding
2. Widget library unification (Bokeh/Panel/ipywidgets)
3. Ultra-fast server-side rendering/aggregation
4. Use the APIs you already know
5. Annotators (Plotly/Bokeh/HoloViews)
6. Other new developments
7. What limitations does Python have for viz?
8. Exploring further

We'll cover each of these in turn.

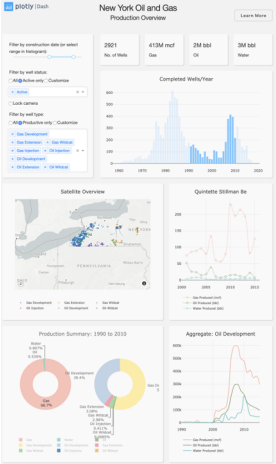
1. Dashboarding

People used to say Python lagged R/Shiny for easy dashboard building tools, but now we have:

- Dash
- Panel
- Voilà
- Streamlit

(see pyviz.org/dashboarding)

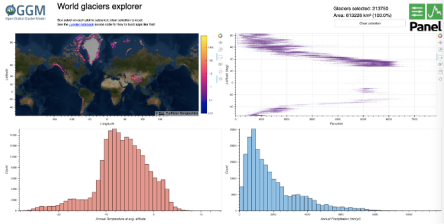
1. Dashboarding: Plotly Dash (2016)



Dash is now the old timer:

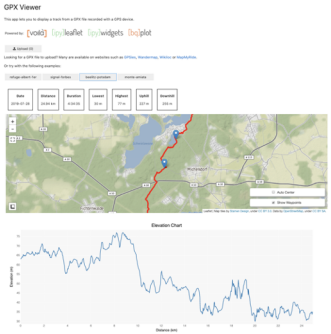
- Scalable server for Plotly plots
- Requires relatively heavy HTML/CSS knowledge
- Typically complex apps with callback structure
- Historically focused only on deployed apps
- jupyter-dash now allows incremental dashboard building
- Dash Oil and Gas Demo (repo)

1. Dashboarding: Panel (Jun 2019)



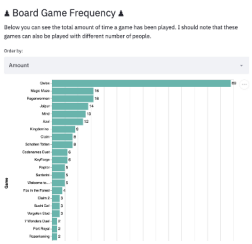
- Easy dashboarding for any plotting library
- Deep (but optional!) Jupyter integration for easy iteration/development
- Zero cost to switch from interactive prototype to deployed app and back
- Easy static HTML/CSS output with live widgets
- glaciers.pyviz.demo.anaconda.com

1. Dashboarding: Voilà (Jun 2019)



- Turns a Jupyter notebook into a shareable dashboard
- Deploys with a full Jupyter kernel (not scalable)
- To build complex layouts, uses ipywidgets or templates (or now Panel!)
- voila-gpx-viewer.pyviz.demo.anaconda.com

1. Dashboarding: Streamlit (Oct 2019)



- Turn your Python scripts into dashboards
- Use your favorite editor (no Jupyter support)
- Re-runs entire script on any interaction (simple to reason about at first, but relies on heavy caching)
- bgexploration.herokuapp.com (blog)

2. Widget library unification

- Previously: Jupyter supported ipywidgets, separate from Bokeh and Dash widgets
- Painful to switch between libraries
- Complex widgets (ipyvolume, VTK) usable with only one ecosystem
- Caused unnecessary split between user groups

2. Widget library unification

- New: ipywidgets_bokeh and jupyter_bokeh
- Wrap Bokeh models as ipywidgets, and vice versa
- Deploy Bokeh or Panel apps in Voila
- Deploy ipyvolume or bqplot in Bokeh Server
- Now everyone can get along:
  - Different notebook/deployment technologies have different strengths
  - Use whichever ones meet your needs!

3. Ultrafast server-side rendering/ aggregation

- Datashader and Vaex (2016):
  - Initially standalone projects
  - Render billions of points to a pixelated representation
  - Only a fixed-size array is sent to the local browser for display
- Datashader now supports GPU/Dask arrays/dataframes
- Vaex renders points to 1D/2D/3D
- Datashader renders to 2D, now including points/lines/areas/trimesh/quadmesh/rasters/polygons

3. Ultrafast server-side rendering/ aggregation

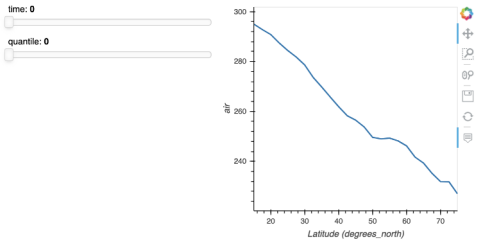
Server-side rendering now integrated into many plotting packages:

- vaex supports bqplot, matplotlib
- datashader supported by HoloViews+Bokeh, hvPlot, and now Plotly
- datashader also integrated into Nvidia cuxfilter, umap
- mpl_scatter_density also available (points only) for mpl

4. Use the APIs you already know

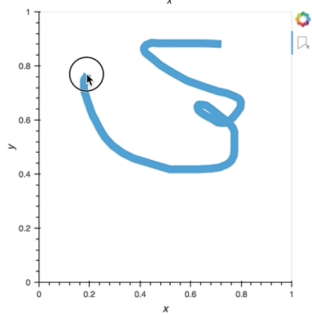
- Pandas Matplotlib .plot() API becoming even more widely supported as a standard:
  - Pandas plotting backend is now officially configurable
  - Now (partially) supported by Plotly Express
  - See pyviz.org/tools.html#high-level-shared-api
- hvPlot now supports .plot() API for Pandas, Xarray, Dask, Streamz, Intake, GeoPandas, and NetworkX objects -- learn API once, use it everywhere!

4. Use the APIs you already know



- HoloViews now offers .df and .xr accessors
  - Calls native Pandas or Xarray methods directly on data
  - Avoids need to learn HoloViews data API
- Upcoming: interactive support for building entire interactive apps directly from Pandas or Xarray APIs:
  - `time,q = IntSlider(...), FloatSlider(...)`
  - `ds.air.interactive(loc='left_top').isel(time=time).quantile(q=q, dim='lon').plot()`

5. Annotators/Drawing tools



- Both Bokeh and Plotly now offer shape-drawing tools:
  - user-generated shapes on top of plots
  - useful for capturing user annotations, labeling ML data, setting up analyses or simulations, ...
- Example for ML annotations: examples.pyviz.org/ml_annotators

6. Other new developments

- New spatial-processing libraries: xarray_spatial, spatialpandas, pygeos, scikit-geometry, cuSpatial
- New editor support for interactive plots in VSCode
- Colorcet: 256-color categorical colormaps
- HoloViews: automatic linked brushing

7. What limitations does Python have for viz?

- Not much, now!
- Of course, some users will always want GUI BI tools (Tableau, Excel, etc.)
- Direct development of JavaScript apps will always be useful for the most scalable and responsive websites
- R users will prefer R solutions, of course!

8. Exploring further

- See full list of all Python viz tools at pyviz.org/tools
- See reproducible larger examples at examples.pyviz.org, awesome-panel.org, and awesome-streamlit.org
- See each package's website for more details
  - holoviz.org, panel.holoviz.org, hvplot.holoviz.org, datashader.org
  - plotly.com/python, plotly.com/dash
  - matplotlib.org, bokeh.org, altair-viz.github.io

Thank you.