ipyvolume Documentation

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Maarten A. Breddels

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Contents

IPyvolume is a Python library to visualize 3d volumes and glyphs (e.g. 3d scatter plots), in the Jupyter notebook, with minimal configuration and effort. It is currently pre-1.0, so use at own risk. IPyvolume's *volshow* is to 3d arrays what matplotlib's imshow is to 2d arrays.

Other (more mature but possibly more difficult to use) related packages are yt, VTK and/or Mayavi.

Feedback and contributions are welcome: Github, Email or Twitter.

CHAPTER 1

Quick intro

1.1 Volume

For quick resuls, use `ipyvolume.widgets.quickvolshow`. From a numpy array, we create two boxes, using slicing, and visualize it.

```
import numpy as np
import ipyvolume as ipv
V = np.zeros((128,128,128)) # our 3d array
# outer box
V[30:-30,30:-30,30:-30] = 0.75
V[35:-35,35:-35,35:-35] = 0.0
# inner box
V[50:-50,50:-50,50:-50] = 0.25
V[55:-55,55:-55,55:-55] = 0.0
ipv.quickvolshow(V, level=[0.25, 0.75], opacity=0.03, level_width=0.1, data_min=0,␣
↪data_max=1)
```

[widget]

1.2 Scatter plot

Simple scatter plots are also supported.

```
import ipyvolume as ipv
import numpy as np
x, y, z = np.random.random((3, 10000))
ipv.quickscatter(x, y, z, size=1, marker="sphere")
```

[widget]

1.3 Quiver plot

Quiver plots are also supported, showing a vector at each point.

```
import ipyvolume as ipv
import numpy as np
x, y, z, u, v, w = np.random.random((6, 1000))*2-1
quiver = ipv.quickquiver(x, y, z, u, v, w, size=5)
```

[widget]

1.4 Mesh plot

And surface/mesh plots, showing surfaces or wireframes.

```
import ipyvolume as ipv
x, y, z, u, v = ipv.examples.klein_bottle(draw=False)
ipv.figure()
m = ipv.plot_mesh(x, y, z, wireframe=False)
ipv.squarelim()
ipv.show()
```

[widget]

1.5 Built on Ipywidgets

For anything more sophisticed, use `ipyvolume.pylab`, ipyvolume's copy of matplotlib's 3d plotting (+ volume rendering).

Since ipyvolume is built on ipywidgets, we can link widget's properties.

```
import ipyvolume as ipv
import numpy as np
x, y, z, u, v, w = np.random.random((6, 1000))*2-1
selected = np.random.randint(0, 1000, 100)
ipv.figure()
quiver = ipv.quiver(x, y, z, u, v, w, size=5, size_selected=8, selected=selected)

from ipywidgets import FloatSlider, ColorPicker, VBox, jslink
size = FloatSlider(min=0, max=30, step=0.1)
size_selected = FloatSlider(min=0, max=30, step=0.1)
color = ColorPicker()
color_selected = ColorPicker()
jslink((quiver, 'size'), (size, 'value'))
jslink((quiver, 'size_selected'), (size_selected, 'value'))
jslink((quiver, 'color'), (color, 'value'))
jslink((quiver, 'color_selected'), (color_selected, 'value'))
VBox([ipv.gcc(), size, size_selected, color, color_selected])
```

[widget] Try changing the slider to the change the size of the vectors, or the colors.

CHAPTER 2

Quick installation

This will most likely work, otherwise read install

```
pip install ipyvolume
jupyter nbextension enable --py --sys-prefix ipyvolume
jupyter nbextension enable --py --sys-prefix widgetsnbextension
```

For conda/anaconda, use:

```
conda install -c conda-forge ipyvolume
pip install ipywidgets~=6.0.0b5 --user
```

CHAPTER 3

About

Ipyvolume is an offspring project from vaex. Ipyvolume makes use of threejs, an excellent Javascript library for OpenGL/WebGL rendering.

CHAPTER 4

Contents

4.1 Installation

4.1.1 Using pip

Advice: Make sure you use conda or virtualenv. If you are not a root user and want to use the `--user` argument for pip, you expose the installation to all python environments, which is a bad practice, make sure you know what you are doing.

```
$ pip install ipyvolume
```

4.1.2 Conda/Anaconda

```
$ conda install -c conda-forge ipyvolume
```

4.1.3 For Jupyter lab users

The Jupyter lab extension is not enabled by default (yet).

```
$ conda install -c conda-forge nodejs  # or some other way to have a recent node
$ jupyter labextension install jupyter labextension install @jupyter-widgets/
↪jupyterlab-manager
$ jupyter labextension install ipyvolume
$ jupyter labextension install jupyter-threejs
```

4.1.4 Pre-notebook 5.3

If you are still using an old notebook version, ipyvolume and its dependend extension (widgetsnbextension) need to be enabled manually. If unsure, check which extensions are enabled:

```
$ jupyter nbextention list
```

If not enabled, enable them:

```
$ jupyter nbextension enable --py --sys-prefix ipyvolume
$ jupyter nbextension enable --py --sys-prefix widgetsnbextension
```

4.1.5 Pip as user: (but really, do not do this)

You have been warned, do this only if you know what you are doing, this might hunt you in the future, and now is a good time to consider learning virtualenv or conda.

```
$ pip install ipyvolume --user
$ jupyter nbextension enable --py --user ipyvolume
$ jupyter nbextension enable --py --user widgetsnbextension
```

4.1.6 Developer installation

```
$ git clone https://github.com/maartenbreddels/ipyvolume.git
$ cd ipyvolume
$ pip install -e .
$ jupyter nbextension install --py --symlink --sys-prefix ipyvolume
$ jupyter nbextension enable --py --sys-prefix ipyvolume
```

For all cases make sure ipywidgets is enabled if you use Jupyter notebook version < 5.3 (using `--user` instead of `--sys-prefix` if doing a local install):

```
$ jupyter nbextension enable --py --sys-prefix widgetsnbextension
$ jupyter nbextension enable --py --sys-prefix pythreejs
$ jupyter nbextension enable --py --sys-prefix ipywebrtc
$ jupyter nbextension enable --py --sys-prefix ipyvolume
```

4.1.7 Developer workflow

Jupyter notebook (classical)

Note: There is never a need to restart the notebook server, nbextensions are picked up after a page reload.

Start this command:

```
$ (cd js; npm run watch)
```

It will

- Watch for changes in the sourcecode and run the typescript compiler for transpilation of the `src` dir to the `lib` dir.
- Watch the lib dir, and webpack will build (among other things), `ROOT/ipyvolume/static/index.js`.

Refresh the page.

4.2 Examples

4.2.1 Mixing ipyvolume with Bokeh

This example shows how the selection from a ipyvolume quiver plot can be controlled with a bokeh scatter plot and it's selection tools.

Ipyvolume quiver plot

The 3d quiver plot is done using ipyvolume

[1]:
```
import ipyvolume
import ipyvolume as ipv
import vaex
```

We load some data from vaex, but only use the first 10 000 samples for performance reasons of Bokeh.

[2]:
```
ds = vaex.example()
N = 10000
```

We make a quiver plot using ipyvolume's matplotlib's style api.

[3]:
```
ipv.figure()
quiver = ipv.quiver(ds.data.x[:N],  ds.data.y[:N],  ds.data.z[:N],
                    ds.data.vx[:N], ds.data.vy[:N], ds.data.vz[:N],
                    size=1, size_selected=5, color_selected="grey")
ipv.xyzlim(-30, 30)
ipv.show()
```

```
A Jupyter Widget
```

Bokeh scatter part

The 2d scatter plot is done using Bokeh.

[4]:
```
from bokeh.io import output_notebook, show
from bokeh.plotting import figure
import ipyvolume.bokeh
output_notebook()
```

[5]:
```
tools = "wheel_zoom,box_zoom,box_select,lasso_select,help,reset,"
p = figure(title="E Lz space", tools=tools, webgl=True, width=500, height=500)
r = p.circle(ds.data.Lz[:N], ds.data.E[:N],color="navy", alpha=0.2)
# A 'trick' from ipyvolume to link the selection (one way traffic atm)
ipyvolume.bokeh.link_data_source_selection_to_widget(r.data_source, quiver, 'selected
↪')
show(p)
```

Now try doing a selection and see how the above 3d quiver plot reflects this selection.

[ ]:
```
# this code is currently broken
# import ipywidgets
#out = ipywidgets.Output()
#with out:
#    show(p)
#ipywidgets.HBox([out, ipv.gcc()])
```

Embedding in html

A bit of a hack, but it is possible to embed the widget and the bokeh part into a single html file (use at own risk).

[8]:
```
from bokeh.resources import CDN
from bokeh.embed import components

script, div = components((p))
template_options = dict(extra_script_head=script + CDN.render_js() + CDN.render_css(),
                        body_pre="<h2>Do selections in 2d (bokeh)<h2>" + div + "<h2>
↪And see the selection in ipyvolume<h2>")
ipyvolume.embed.embed_html("tmp/bokeh.html",
                           [ipv.gcc(), ipyvolume.bokeh.wmh], all_states=True,
                           template_options=template_options)
```

[7]:
```
!open tmp/bokeh.html
```

[ ]:
```

```

4.2.2 Mixing ipyvolume with bqplot

This example shows how the selection from a ipyvolume quiver plot can be controlled with a bqplot scatter plot and it's selection tools. We first get a small dataset from vaex

[1]:
```
import numpy as np
import vaex
```

[2]:
```
ds = vaex.example()
N = 2000 # for performance reasons we only do a subset
x, y, z, vx, vy, vz, Lz, E = [ds.columns[k][:N] for k in "x y z vx vy vz Lz E".
↪split()]
```

bqplot scatter plot

And create a scatter plot with bqplot

[3]:
```
import bqplot.pyplot as plt
```

[4]:
```
plt.figure(1, title="E Lz space")
scatter = plt.scatter(Lz, E,
                      selected_style={'opacity': 0.2, 'size':1, 'stroke': 'red'},
                      unselected_style={'opacity': 0.2, 'size':1, 'stroke': 'blue'},
                      default_size=1,
                     )
```

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```
plt.brush_selector()
plt.show()
```

```
A Jupyter Widget
```

Ipyvolume quiver plot

And use ipyvolume to create a quiver plot

[5]:
```
import ipyvolume.pylab as p3
```

[6]:
```
p3.clear()
quiver = p3.quiver(x, y, z, vx, vy, vz, size=2, size_selected=5, color_selected="blue
↪")
p3.show()
```

```
A Jupyter Widget
```

Linking ipyvolume and bqplot

Using jslink, we link the `selected` properties of both widgets, and we display them next to eachother using a VBox.

[7]:
```
from ipywidgets import jslink, VBox
```

[8]:
```
jslink((scatter, 'selected'), (quiver, 'selected'))
```

[9]:
```
hbox = VBox([p3.current.container, plt.figure(1)])
hbox
```

```
A Jupyter Widget
```

Embedding

We embed the two widgets in an html file, creating a standlone plot.

[10]:
```
import ipyvolume.embed
# if we don't do this, the bqplot will be really tiny in the standalone html
bqplot_layout = hbox.children[1].layout
bqplot_layout.min_width = "400px"
```

[14]:
```
ipyvolume.embed.embed_html("bqplot.html", hbox, offline=True, devmode=True)
```

[ ]:
```
!open bqplot.html
```

[ ]:
```

```

4.2.3 MCMC & why 3d matters

This example (although quite artificial) shows that viewing a posterior (ok, I have flat priors) in 3d can be quite useful. While the 2d projection may look quite 'bad', the 3d volume rendering shows that much of the volume is empty, and the posterior is much better defined than it seems in 2d.

[3]:
```
import pylab
import scipy.optimize as op
import emcee
import numpy as np
%matplotlib inline
```

[4]:
```
# our 'blackbox' 3 parameter model which is highly degenerate
def f_model(x, a, b, c):
    return x * np.sqrt(a**2 +b**2 + c**2) + a*x**2 + b*x**3
```

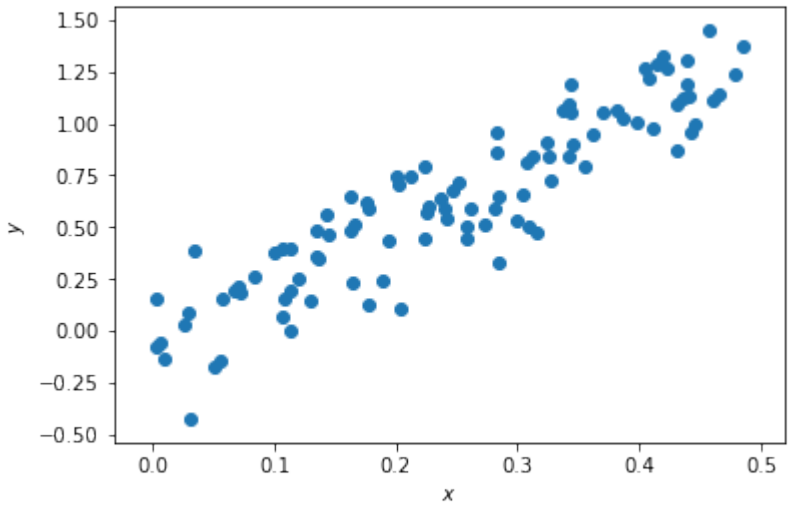
[5]:
```
N = 100
a_true, b_true, c_true = -1., 2., 1.5

# our input and output
x = np.random.rand(N)*0.5#+0.5
y = f_model(x, a_true, b_true, c_true)

# + some (known) gaussian noise
error = 0.2
y += np.random.normal(0, error, N)

# and plot our data
pylab.scatter(x, y);
pylab.xlabel("$x$")
pylab.ylabel("$y$")
```

[5]:
```
<matplotlib.text.Text at 0x10d7b35c0>
```



[6]:
```
# our likelihood
def lnlike(theta, x, y, error):
    a, b, c = theta
    model =  f_model(x, a, b, c)
    chisq = 0.5*(np.sum((y-model)**2/error**2))
    return -chisq
result = op.minimize(lambda *args: -lnlike(*args), [a_true, b_true, c_true], args=(x,␣
↪y, error))
# find the max likelihood
a_ml, b_ml, c_ml = result["x"]
```

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```
print("estimates", a_ml, b_ml, c_ml)
print("true values", a_true, b_true, c_true)
result["message"]
```

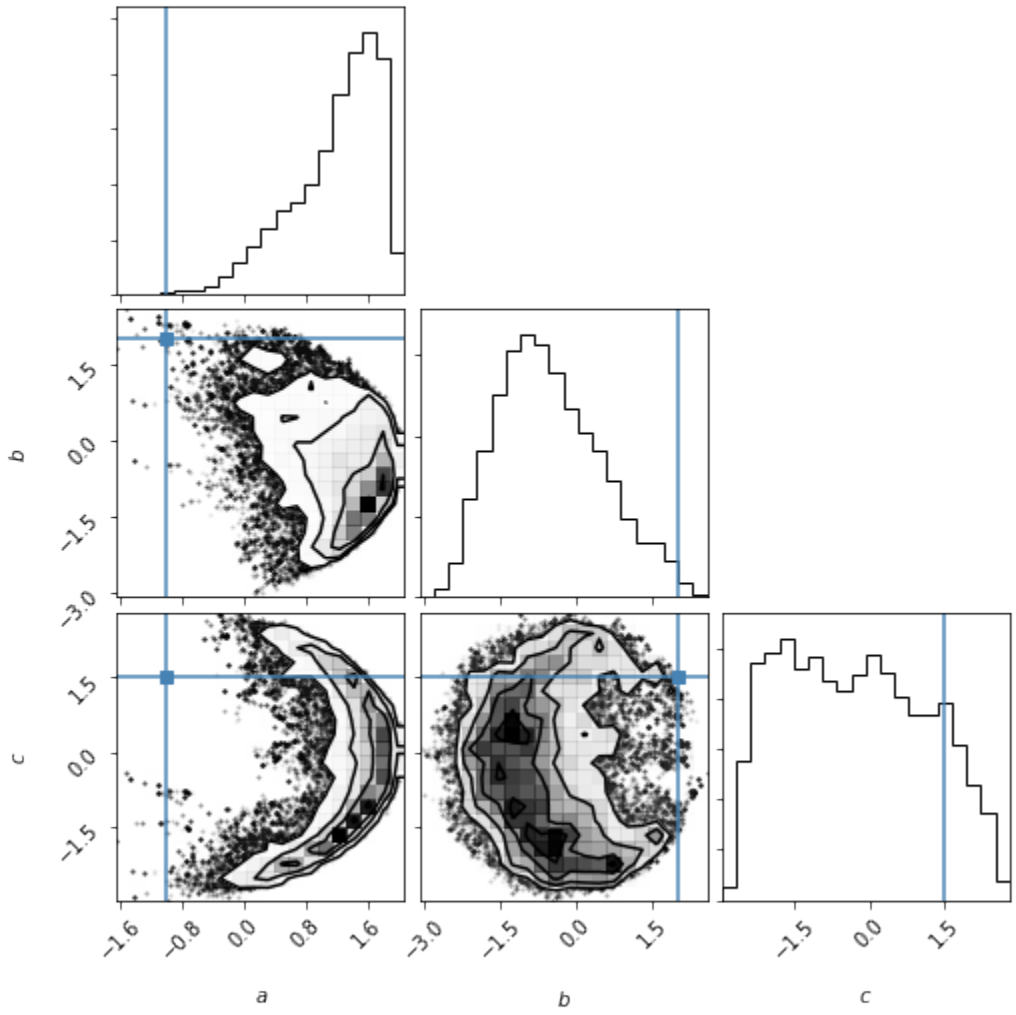
```
estimates 1.74022905195 -1.23351935318 -1.68793098984e-05
true values -1.0 2.0 1.5
```

[6]: 'Optimization terminated successfully.'

[7]:
```
# do the mcmc walk
ndim, nwalkers = 3, 100
pos = [result["x"] + np.random.randn(ndim)*0.1 for i in range(nwalkers)]
sampler = emcee.EnsembleSampler(nwalkers, ndim, lnlike, args=(x, y, error))
sampler.run_mcmc(pos, 1500);
samples = sampler.chain[:, 50:, :].reshape((-1, ndim))
```

Posterior in 2d

[8]:
```
# plot the 2d pdfs
import corner
fig = corner.corner(samples, labels=["$a$", "$b$", "$c$"],
                    truths=[a_true, b_true, c_true])
```



Posterior in 3d

[9]:
```
import vaex
import scipy.ndimage
import ipyvolume
```

[10]:
```
ds = vaex.from_arrays(a=samples[...,0].copy(), b=samples[...,1].copy(), c=samples[...,
↪2].copy())
# get 2d histogram
v = ds.count(binby=["a", "b", "c"], shape=64)
# smooth it for visual pleasure
v = scipy.ndimage.gaussian_filter(v, 2)
```

[11]:
```
ipyvolume.quickvolshow(v, lighting=True)
```

```
A Jupyter Widget
```

Note that actually a large part of the volume is empty.

[ ]:

4.3 Meshes / Surfaces

Meshes (or surfaces) in ipyvolume consist of triangles, and are defined by their coordinate (vertices) and faces/triangles, which refer to three vertices.

[1]:
```
import ipyvolume as ipv
import numpy as np
```

4.3.1 Triangle meshes

Lets first construct a 'solid', a tetrahedron, consisting out of 4 vertices, and 4 faces (triangles) using plot_trisurf

[2]:
```
s = 1/2**0.5
# 4 vertices for the tetrahedron
x = np.array([1.,  -1, 0,  0])
y = np.array([0,   0, 1., -1])
z = np.array([-s, -s, s,  s])
# and 4 surfaces (triangles), where the number refer to the vertex index
triangles = [(0, 1, 2), (0, 1, 3), (0, 2, 3), (1,3,2)]
```

[3]:
```
ipv.figure()
# we draw the tetrahedron
mesh = ipv.plot_trisurf(x, y, z, triangles=triangles, color='orange')
# and also mark the vertices
ipv.scatter(x, y, z, marker='sphere', color='blue')
ipv.xyzlim(-2, 2)
ipv.show()
```

```
VBox(children=(Figure(camera=PerspectiveCamera(fov=46.0, position=(0.0, 0.0, 2.0),␣
↪quaternion=(0.0, 0.0, 0.0, ...
```

4.3.2 Surfaces

To draw parametric surfaces, which go from $\mathbb{R}^2 \to \mathbb{R}^3$, it's convenient to use plot_surface, which takes 2d numpy arrays as arguments, assuming they form a regular grid (meaning you do not need to provide the triangles, since they can be inferred from the shape of the arrays). Note that plot_wireframe has a similar api, as does plot_mesh which can do both the surface and wireframe at the same time.

[4]:
```
# f(u, v) -> (u, v, u*v**2)
a = np.arange(-5, 5)
U, V = np.meshgrid(a, a)
X = U
Y = V
Z = X*Y**2

ipv.figure()
ipv.plot_surface(X, Z, Y, color="orange")
ipv.plot_wireframe(X, Z, Y, color="red")
ipv.show()
```

```
VBox(children=(Figure(camera=PerspectiveCamera(fov=46.0, position=(0.0, 0.0, 2.0),␣
↪quaternion=(0.0, 0.0, 0.0, ...
```

4.3.3 Colors

Vertices can take colors as well, as the example below (adapted from matplotlib) shows.

[5]:
```
X = np.arange(-5, 5, 0.25*1)
Y = np.arange(-5, 5, 0.25*1)
X, Y = np.meshgrid(X, Y)
R = np.sqrt(X**2 + Y**2)
Z = np.sin(R)
```

[6]:
```
from matplotlib import cm
colormap = cm.coolwarm
znorm = Z - Z.min()
znorm /= znorm.ptp()
znorm.min(), znorm.max()
color = colormap(znorm)
```

[7]:
```
ipv.figure()
mesh = ipv.plot_surface(X, Z, Y, color=color[...,:3])
ipv.show()
```

```
VBox(children=(Figure(camera=PerspectiveCamera(fov=46.0, position=(0.0, 0.0, 2.0),␣
↪quaternion=(0.0, 0.0, 0.0, ...
```

4.3.4 Texture mapping

Texture mapping can be done by providing a PIL image, and UV coordiante (texture coordinates, between 0 and 1). Note that like almost anything in ipyvolume, these u & v coordinates can be animated, as well as the textures.

[8]:
```
# import PIL.Image
# image = PIL.Image.open('data/jupyter.png')
```

[9]:
```
# fig = p3.figure()
# p3.style.use('dark')
# # we create a sequence of 8 u v coordinates so that the texture moves across the␣
↪surface.
# u = np.array([X/5 +np.sin(k/8*np.pi)*4. for k in range(8)])
# v = np.array([-Y/5*(1-k/7.) + Z*(k/7.) for k in range(8)])
# mesh = p3.plot_mesh(X, Z, Y, u=u, v=v, texture=image, wireframe=False)
# p3.animation_control(mesh, interval=800, sequence_length=8)
# p3.show()
```

We now make a small movie / animated gif of 30 frames.

[10]:
```
# frames = 30
# p3.movie('movie.gif', frames=frames)
```

And play that movie on a square

[11]:
```
# p3.figure()
# x = np.array([-1.,  1,  1,  -1])
# y = np.array([-1,  -1, 1., 1])
# z = np.array([0., 0, 0., 0])
# u = x / 2 + 0.5
# v = y / 2 + 0.5
# # square
# triangles = [(0, 1, 2), (0, 2, 3)]
# m = p3.plot_trisurf(x, y, z, triangles=triangles, u=u, v=v, texture=PIL.Image.open(
↪'movie.gif'))
# p3.animation_control(m, sequence_length=frames)
# p3.show()
```

[ ]:
```
```

4.4 Animation

All (or most of) the changes in scatter and quiver plots are (linearly) interpolated. On top top that, scatter plots and quiver plots can take a sequence of arrays (the first dimension), where only one array is visualized. Together this can make smooth animations with coarse timesteps. Lets see an example.

[1]:
```
import ipyvolume as ipv
import numpy as np
```

4.4.1 Basic animation

[4]:
```
# only x is a sequence of arrays
x = np.array([[-1, -0.8], [1, -0.1], [0., 0.5]])
y = np.array([0.0, 0.0])
z = np.array([0.0, 0.0])
ipv.figure()
s = ipv.scatter(x, y, z, marker='sphere', size=10)
ipv.xyzlim(-1, 1)
ipv.animation_control(s) # shows controls for animation controls
ipv.show()
```

```
VBox(children=(Figure(animation=200.0, camera=PerspectiveCamera(fov=46.0, position=(0.
↪0, 0.0, 2.0), quaternion...
```

You can control which array to visualize, using the `scatter.sequence_index` property. Actually, the `pylab.animate_glyphs` is connecting the `Slider` and `Play` button to that property, but you can also set it from Python.

[5]:
```
s.sequence_index = 1
```

4.4.2 Animating color and size

We now demonstrate that you can also animate color and size

[6]:
```
# create 2d grids: x, y, and r
u = np.linspace(-10, 10, 25)
x, y = np.meshgrid(u, u)
```

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```
r = np.sqrt(x**2+y**2)
print("x,y and z are of shape", x.shape)
# and turn them into 1d
x = x.flatten()
y = y.flatten()
r = r.flatten()
print("and flattened of shape", x.shape)
```

```
x,y and z are of shape (25, 25)
and flattened of shape (625,)
```

Now we only animate the z component

[7]:
```
# create a sequence of 15 time elements
time = np.linspace(0, np.pi*2, 15)
z = np.array([(np.cos(r + t) * np.exp(-r/5)) for t in time])
print("z is of shape", z.shape)
```

```
z is of shape (15, 625)
```

[8]:
```
# draw the scatter plot, and add controls with animate_glyphs
ipv.figure()
s = ipv.scatter(x, z, y, marker="sphere")
ipv.animation_control(s, interval=200)
ipv.ylim(-3,3)
ipv.show()
```

```
VBox(children=(Figure(animation=200.0, camera=PerspectiveCamera(fov=46.0, position=(0.
↪0, 0.0, 2.0), quaternion...
```

[9]:
```
# Now also include, color, which containts rgb values
color = np.array([[np.cos(r + t), 1-np.abs(z[i]), 0.1+z[i]*0] for i, t in␣
↪enumerate(time)])
size = (z+1)
print("color is of shape", color.shape)
```

```
color is of shape (15, 3, 625)
```

color is of the wrong shape, the last dimension should contain the rgb value, i.e. the shape of should be (15, 2500, 3)

[10]:
```
color = np.transpose(color, (0, 2, 1)) # flip the last axes
```

[11]:
```
ipv.figure()
s = ipv.scatter(x, z, y, color=color, size=size, marker="sphere")
ipv.animation_control(s, interval=200)
ipv.ylim(-3,3)
ipv.show()
```

```
VBox(children=(Figure(animation=200.0, camera=PerspectiveCamera(fov=46.0, position=(0.
↪0, 0.0, 2.0), quaternion...
```

4.4.3 Creating movie files

We now make a movie, with a 2 second duration, where we rotate the camera, and change the size of the scatter points.

[14]:
```
def set_view(figure, framenr, fraction):
    ipv.view(fraction*360, (fraction - 0.5) * 180, distance=2 + fraction*2)
    s.size = size * (2+0.5*np.sin(fraction * 6 * np.pi))
ipv.movie('wave.gif', set_view, fps=20, frames=40)
```

```
Output()
```

[15]:
```
# include the gif with base64 encoding
import IPython.display
import base64
with open('wave.gif', 'rb') as gif:
    url = b"" +base64.b64encode(gif.read())
IPython.display.Image(url=url.decode('ascii'))
```

[15]:
```
<IPython.core.display.Image object>
```

4.4.4 Animated quiver

Not only scatter plots can be animated, quiver as well, so the direction vector (vx, vy, vz) can also be animated, as shown in the example below, which is a (subsample of) a simulation of a small galaxy orbiting a host galaxy (not visible).

[16]:
```
import ipyvolume.datasets
stream = ipyvolume.datasets.animated_stream.fetch()
print("shape of steam data", stream.data.shape) # first dimension contains x, y, z,␣
↪vx, vy, vz, then time, then particle
```

```
shape of steam data (6, 200, 1250)
```

[18]:
```
fig = ipv.figure()
# instead of doing x=stream.data[0], y=stream.data[1], ... vz=stream.data[5], use␣
↪*stream.data
# limit to 50 timesteps to avoid having a huge notebook
q = ipv.quiver(*stream.data[:,0:50,:200], color="red", size=7)
ipv.style.use("dark") # looks better
ipv.animation_control(q, interval=200)
ipv.show()
```

```
VBox(children=(Figure(animation=200.0, camera=PerspectiveCamera(fov=46.0, position=(0.
↪0, 0.0, 2.0), quaternion...
```

[19]:
```
# fig.animation = 0 # set to 0 for no interpolation
```

[ ]:
```

```

4.5 API docs

Note that ipyvolume.pylab and ipyvolume.widgets are imported in the ipyvolume namespace, to you can access ipyvolume.scatter instead of ipyvolume.pylab.scatter.

4.5.1 Quick list for plotting.

ipyvolume.pylab.volshow
ipyvolume.pylab.scatter
ipyvolume.pylab.quiver
ipyvolume.pylab.plot
ipyvolume.pylab.plot_surface
ipyvolume.pylab.plot_trisurf
ipyvolume.pylab.plot_wireframe
ipyvolume.pylab.plot_mesh
ipyvolume.pylab.plot_isosurface

4.5.2 Quick list for controlling the figure.

ipyvolume.pylab.figure
ipyvolume.pylab.gcf
ipyvolume.pylab.gcc
ipyvolume.pylab.clear
ipyvolume.pylab.show
ipyvolume.pylab.view
ipyvolume.pylab.xlim
ipyvolume.pylab.ylim
ipyvolume.pylab.zlim
ipyvolume.pylab.xyzlim

4.5.3 Quick list for style and labels.

ipyvolume.pylab.xlabel
ipyvolume.pylab.ylabel
ipyvolume.pylab.zlabel
ipyvolume.pylab.xyzlabel
ipyvolume.pylab.style.use
ipyvolume.pylab.style.set_style_dark
ipyvolume.pylab.style.set_style_light
ipyvolume.pylab.style.box_off
ipyvolume.pylab.style.box_on
ipyvolume.pylab.style.axes_off
ipyvolume.pylab.style.axes_on
ipyvolume.pylab.style. background_color

4.5.4 Quick list for saving figures.

ipyvolume.pylab.save
ipyvolume.pylab.savefig
ipyvolume.pylab.screenshot

4.5.5 ipyvolume.pylab

4.5.6 ipyvolume.widgets

Test `pythreejs.Camera`

4.5.7 ipyvolume.examples

4.5.8 ipyvolume.headless

4.6 Virtual reality

Ipyvolume can render in stereo, and go fullscreen (not supported for iOS). Together with Google Cardboard or other VR glasses (I am using VR Box 2) this enables virtual reality visualisation. Since mobile devices are usually less powerful, the example below is rendered at low resolution to enable a reasonable framerate on all devices.

Open this page on your mobile device, enter fullscreen mode and put on your glasses, looking around will rotate the object to improve depth perception.

```
import ipyvolume as ipv
aqa2 = ipv.datasets.aquariusA2.fetch()
ipv.quickvolshow(aqa2.data.T, lighting=True, level=[0.16, 0.25, 0.46], width=256,␣
↪height=256, stereo=True, opacity=0.06)
```

[widget]

CHAPTER 5

Changelog

- 0.5
  - New
    - Volume is now its own widget, allowing multivolume rendering
    - Depth aware zooming (Hold Alt key, or toggle in menu) and zoom into any object or volume rendering
    - double click centers that point
    - Configurable ray steps for volume rendering (Volume.ray_steps)
    - Better transparency support, premultiplied colors used consistently, colors can now be of shape *(..., 3 or 4)* to allow alpha channel (note: no proper rendering yet, this is a difficult problem).
    - Panoramic modes: 180 and 360 degrees for dome projection or VR video creations.
    - Maximum intensity volume rendering.
    - Progressive loading of large volumetric cubes.
    - ipyvolume.moviemaker: simple UI for making movies, and keyframes settings for the camera.
    - ipyvolume.astro: (experiment) as domain specific module for astronomy.
    - New example male head volume rendering `ipyvolume.examples.head`
  - Changes
    - 100x faster mesh generation
    - Fixes/improvements for headless rendering
    - Selection method in the kernel, see `ipyvolume.pylab.selector_default`.
    - Fixed memory leak issues in the browser
    - Scatter supports 2d sprites,see `ipyvolume.pylab.scatter`.
    - Pythreejs integration, Camera, Scene and ShaderMaterial are now exposed.
    - 'sphere' marker was double the size as the others, now halved in size/

        * `ipyvolume.pylab.view` can control distance, and returns currents values.
    - New contributors
        * Casper van Leeuwen
        * Oleh Kozynets
        * Oliver Evans
        * Jean-Rémi KING
        * Mathieu Carette
        * Saul (saulthu)
        * Timo Friedri
        * WANG Aiyong
        * mpu-creare
        * xavArtley
        * Eric Larson
        * Hans Moritz Günther
        * Jackie Leng
- 0.4
    - plotting
        * lines
        * wireframes
        * meshes/surfaces
        * isosurfaces
        * texture (animated) support, gif image and MediaStream (movie, camera, canvas)
    - camera control (angles from the python side), FoV
    - movie creation
    - eye separation for VR
    - better screenshot support (can be to a PIL Image), and higher resolution possible
    - mouse lasso (a bit rough), selections can be made from the Python side.
    - icon bar for common operations (fullscreen, stereo, screenshot, reset etc)
    - offline support for embedding/saving to html
    - Jupyter lab support
    - New contributors
        * Chris Sewell
        * Satrajit Ghosh
        * Sylvain Corlay
        * stonebig
        * Matt McCormick

        * Jean Michel Arbona
- 0.3
  - new
    * axis with labels and ticklabels
    * styling
    * animation (credits also to https://github.com/jeammimi)
    * binary transfers
    * default camera control is trackball
  - changed
    * s and ss are now spelled out, size and size_selected

CHAPTER 6

Indices and tables

- genindex
- modindex
- search