

Bokeh: A Python Plotting Library for the Web Browser

Presentation at Chair of Structural Mechanics, BGU, TUM

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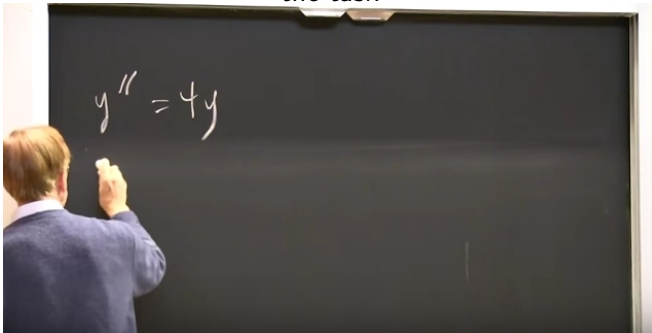
④ Collaborating

Why do we need web visualization?

Phase Plane Pictures: Source, Sink, Saddle

Gilbert Strang, MIT¹

the task



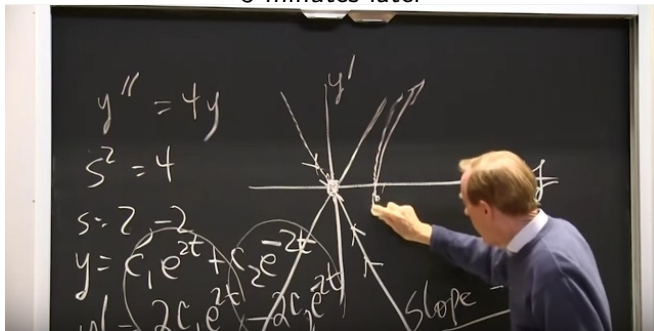
¹<https://www.youtube.com/watch?v=VqXKa11IA6A>

Why do we need web visualization?

Phase Plane Pictures: Source, Sink, Saddle

Gilbert Strang, MIT¹

3 minutes later



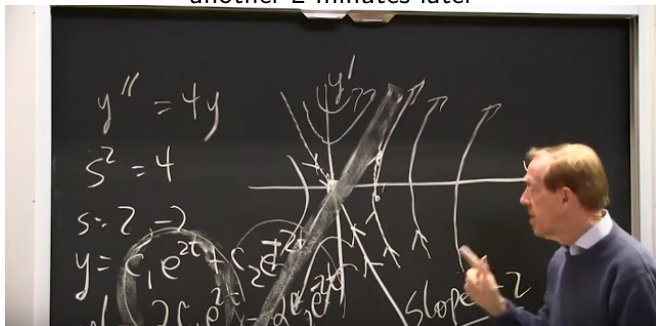
¹<https://www.youtube.com/watch?v=VqXKa11IA6A>

Why do we need web visualization?

Phase Plane Pictures: Source, Sink, Saddle

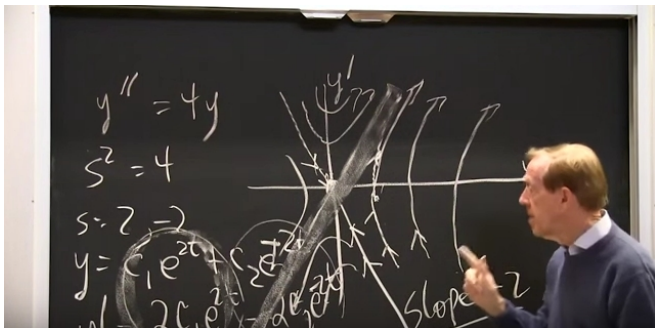
Gilbert Strang, MIT¹

another 2 minutes later



¹<https://www.youtube.com/watch?v=VqXKa11IA6A>

Why do we need web visualization?



Problem with Videos and Lectures

- Advisor needed
- Time intensive
- Not interactive (videos)
- Not individual

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What do we want?

Our goal

- Visualization of math & mechanics content
- Easy-to-use, flexible tool
- For use at home and in lectures

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User Constraints

- No programming experience required
- No special tools required

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Development Constraints

- Easy to implement and understand
- Support for scientific applications

Setup and Tools

Installation

- **Version Control:** Git
`https://git-scm.com/downloads`
- **Python:** Anaconda
`https://www.continuum.io/downloads`
- **IDE:** install PyCharm
`https://www.jetbrains.com/pycharm/`

Setup and Tools

Git: Working on software in a team

- `git clone` for downloading the source
 - `git pull/push` for syncing with the repository
 - `git add/commit` for contributing
 - `git branch` for experiments
-

Setup and Tools

Git: Working on software in a team

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Our repository:

- Sign up on <https://github.com/>
- <https://github.com/BenjaminRueth/Visualization>
- **HTTPS:**

```
git clone https://github.com/BenjaminRueth/Visualization.git
```

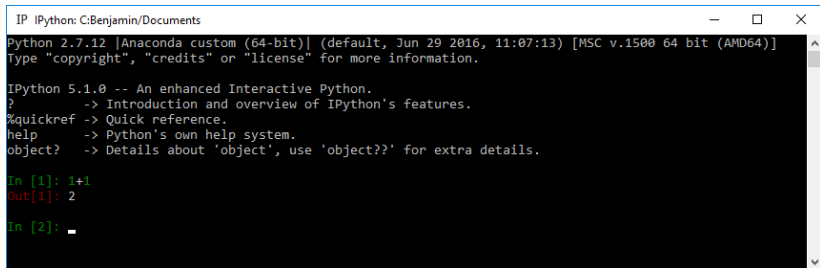
- **SSH:**²

```
git clone git@github.com:BenjaminRueth/Visualization.git
```

Setup and Tools

Anaconda: A Python distribution

- **Anaconda prompt:** `conda install bokeh`
- **Python prompt:** `ipython` or `python`



```
IP IPython: C:\Benjamin\Documents
Python 2.7.12 [Anaconda custom (64-bit)] (default, Jun 29 2016, 11:07:13) [MSC v.1500 64 bit (AMD64)]
Type "copyright", "credits" or "license" for more information.

IPython 5.1.0 -- An enhanced Interactive Python.
?                -> Introduction and overview of IPython's features.
%quickref        -> Quick reference.
help             -> Python's own help system.
object?         -> Details about 'object', use 'object??' for extra details.

In [1]: 1+1
Out[1]: 2

In [2]: _
```

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Introduction to Bokeh



- Python plotting library (similar to matplotlib)
- uses the webbrowser for displaying graphics
- uses D3.js
- open source
- visit <http://bokeh.pydata.org>

Introduction to Bokeh

Necessary preparations

- **Clone the repository:**

use Git.

- **Our working directory:**

```
...\Visualization\Presentation\Examples
```

- **Start a shell:**

- **Windows:** start+r , then type cmd
- **Linux:** ctrl+alt+T
- with `cd <path>` navigate to the working directory

Introduction to Bokeh

Static example: Plotting in the browser

- Fire up a shell in your working directory
- Start with `python staticPlotting.py`
- The browser should show the plot

Introduction to Bokeh

Static example: Plotting in the browser

```
import numpy as np
from bokeh.plotting import figure, show, output_file

# create data
x = np.linspace(0, 4*np.pi, 100)
y = np.sin(x)
# define tools
TOOLS = "pan, wheel_zoom, box_zoom, reset, save, box_select"
# plot data
p1 = figure(title="Legend_Example", tools=TOOLS)
p1.circle(x, y, legend="sin(x)")
p1.circle(x, 2*y, legend="5*sin(x)", color="blue")
p1.circle(x, 3*y, legend="3*sin(x)", color="green")
# save and open plot
output_file("legend.html", title="legend.py_example")
show(p1)
```

Introduction to Bokeh

Server example: An interactive function plotting tool

- Fire up a shell in your working directory
- Start with `bokeh serve functionPlotter.py`
- Visit <http://localhost:5006/functionPlotter>

Introduction to Bokeh

Server example: An interactive function plotting tool

- Fire up a shell in your working directory
- Start with `bokeh serve functionPlotter.py`
- Visit <http://localhost:5006/functionPlotter>
- only 60 LoC!
- uses numpy and scipy

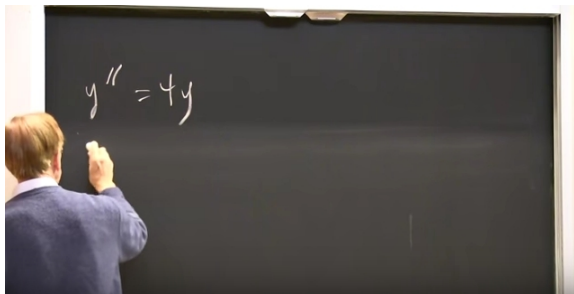
```
from bokeh import ...
import numpy as np
from sympy import sympify, lambdify, diff
...
# Data
line_source = ColumnDataSource(data=dict(x=[], y=[]))

# Controls
f_input = TextInput(value="sin(x)", title="f(x):")
derivative_input = Slider(title="n", value=1.0, start=0.0, end=5.0)
...
# Plotting
plot = Figure(...)
plot.line(x='x', y='y', source=line_source, ...)
plot.line(x='x', y='dy', source=line_source, ...)

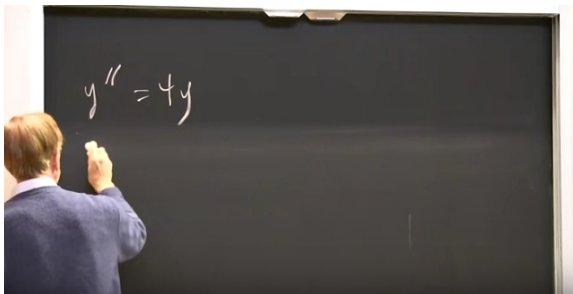
#Callback
f_input.on_change('value', fun_change)
derivative_input.on_change('value', fun_change)

#Layout
curdoc().add_root(row(plot, column(f_input, derivative_input)))
```

Example: Phase Plane Pictures



Example: Phase Plane Pictures



2D ODE system

$$\begin{aligned}y'' &= u(x, y) = 4y \\ y' &= v(x, y) = x\end{aligned}$$

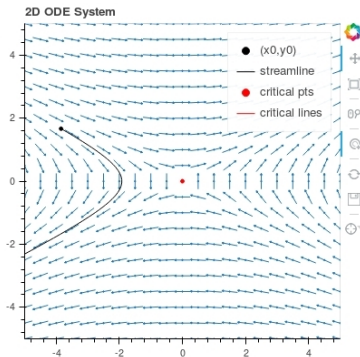
Visualization on http://localhost:5006/odesystem_app

What do we get?

choose a sample function pair or enter one below ▾

$u(x,y):$

$v(x,y):$



Our goal

- ✓ Visualization of math (& mechanics?) content
- ✓ Easy-to-use, flexible tool
- ✓ For use at home and in lectures

What do we get?

User Constraints

- ✓ No programming experience required
- ✓ No special tools required

Development Constraints

- ✓ Easy to implement and understand
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BUT

- we need a server
- the user needs an internet connection
- we have to transfer data
- sometimes slow

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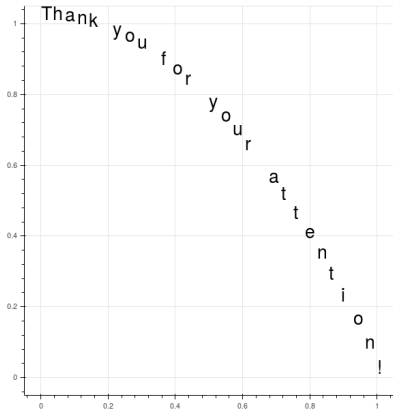
④ Collaborating

Use Git

- **Create a branch:** `git checkout -b <myName>`
- **Develop:** e.g. change something in `Visualization/Example/staticPlotting.py`
- **Finalize:** `git add,`
`git commit -m "my commit message"`
- **Synchronize:** `git push`³
- **Merge:** If feature is done `git checkout master,`
`git merge <myName>`

³probably you get the hint to type:

`git push --set-upstream origin <myName>.` Just do it.



```
import numpy as np
from bokeh.plotting import \
    figure, \
    output_file

thanks = "Thank_you_for_your_attention!"
# create data
t = list(thanks)
x = np.linspace(0, 1, t.__len__())
y = 1-x**2

# plot data
p1 = figure()
p1.text(x,y,t, text_font_size="20pt")
# save and open plot
output_file("thanks.html")
```