Bokeh: A Python Plotting Library for the Web Browser

Presentation at Chair of Structural Mechanics, BGU, TUM

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January 25, 2017

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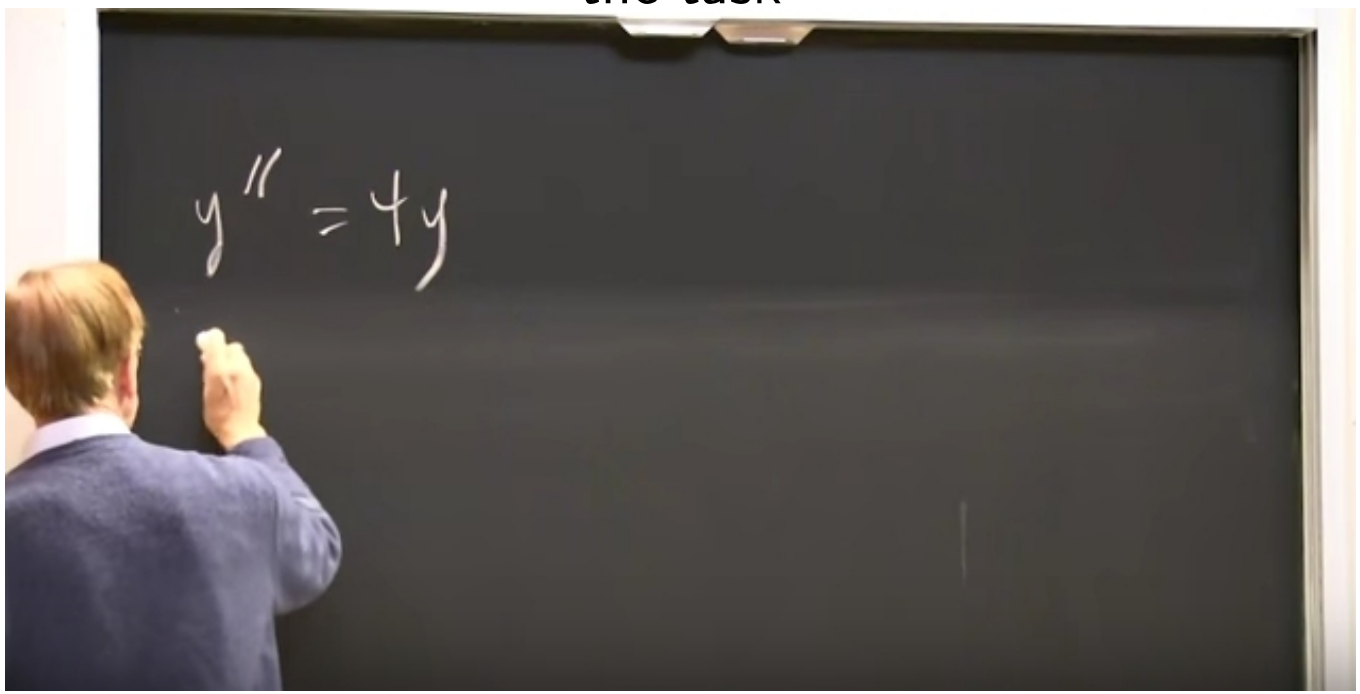
2. Interactive Web Visualization
   - What do we want?
   - Setup and Tools
3. Bokeh
   - Introduction to Bokeh
   - Example: Phase Plane Pictures
   - What do we get?
4. Collaborating

Why do we need web visualization?

Phase Plane Pictures: Source, Sink, Saddle
Gilbert Strang, MIT[1]

the task



[1] https://www.youtube.com/watch?v=VqXKa11IA6A

Why do we need web visualization?

Phase Plane Pictures: Source, Sink, Saddle
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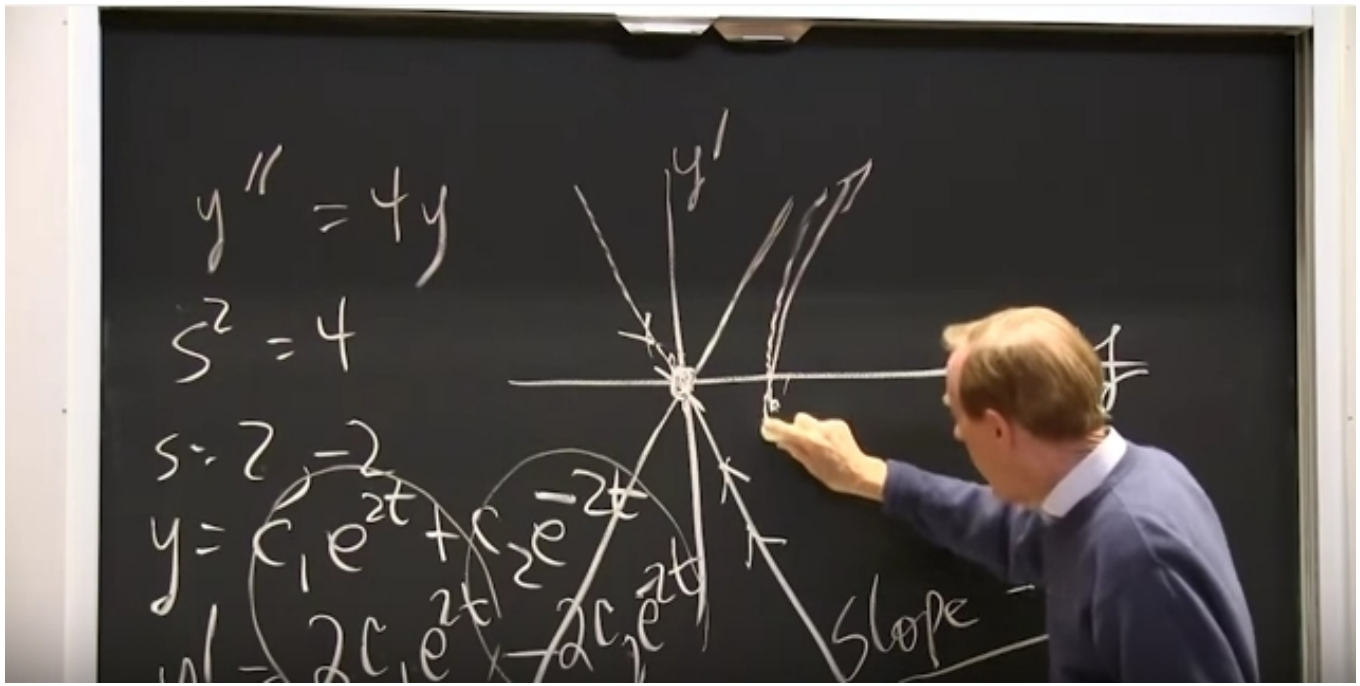
3 minutes later



[1] https://www.youtube.com/watch?v=VqXKa11IA6A

Why do we need web visualization?

Phase Plane Pictures: Source, Sink, Saddle
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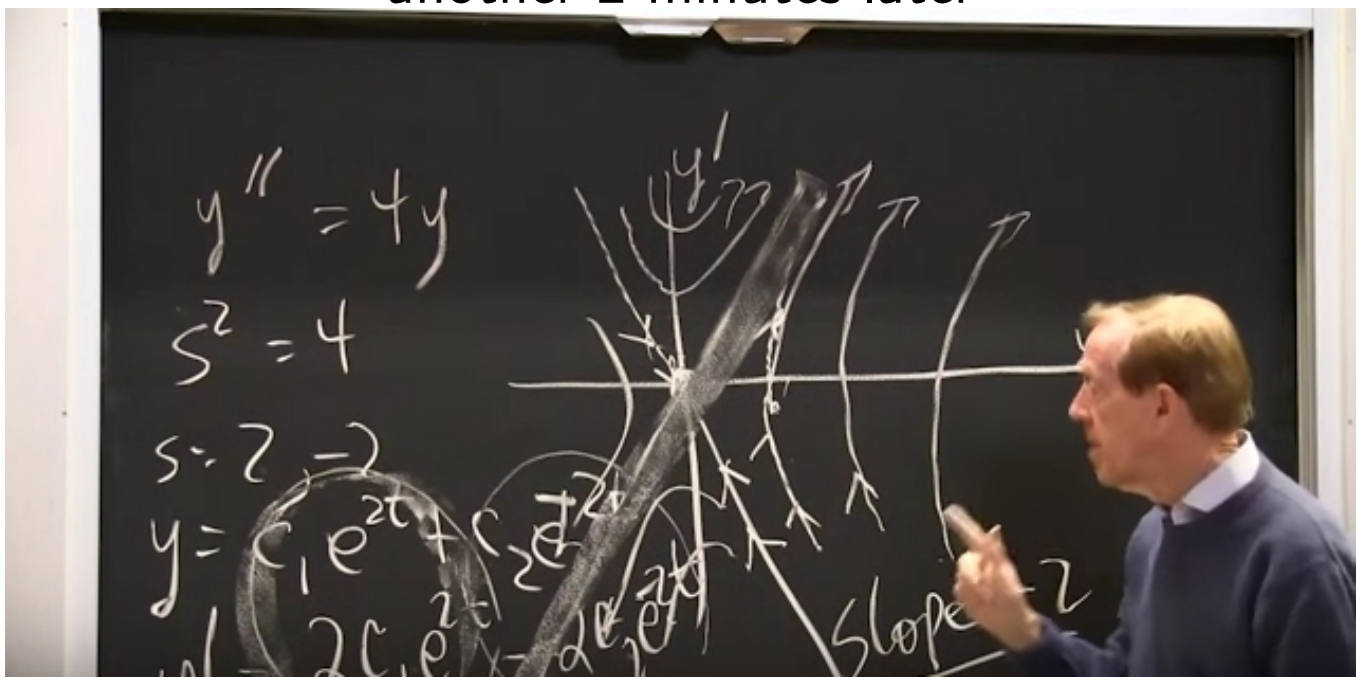
another 2 minutes later



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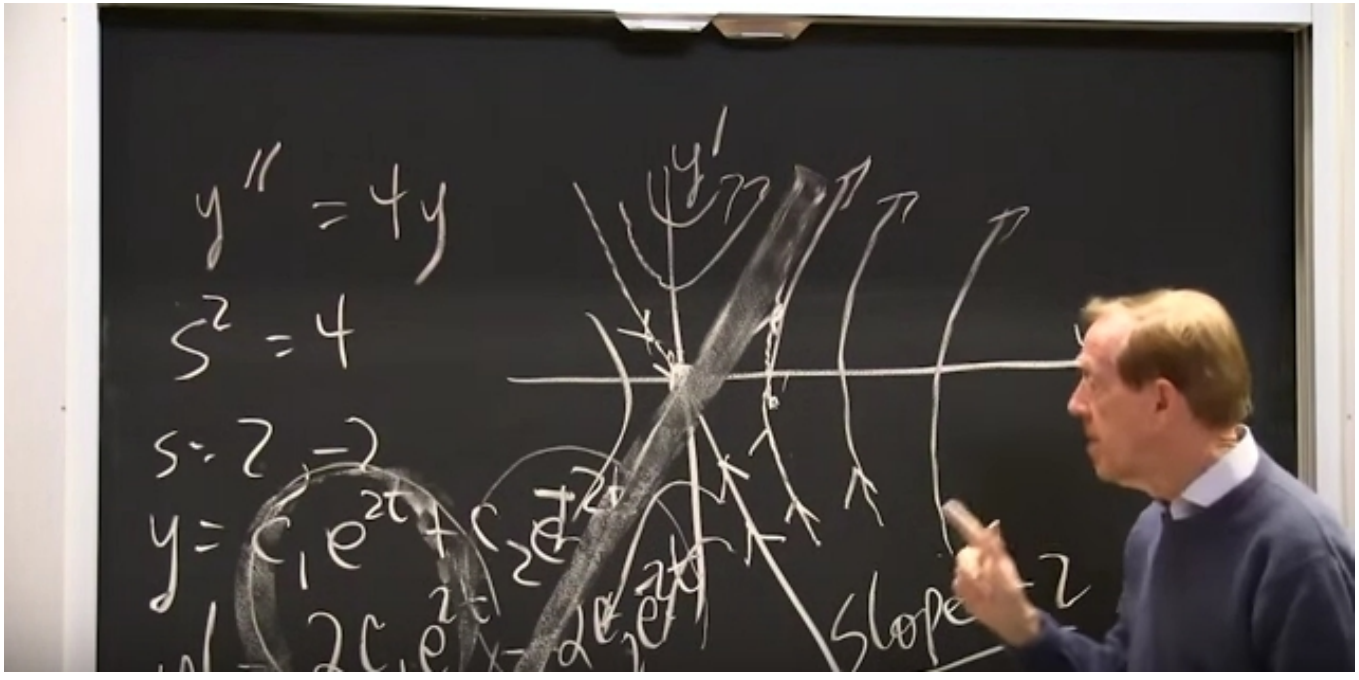
Why do we need web visualization?



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
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Development Constraints

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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/`

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

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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
```

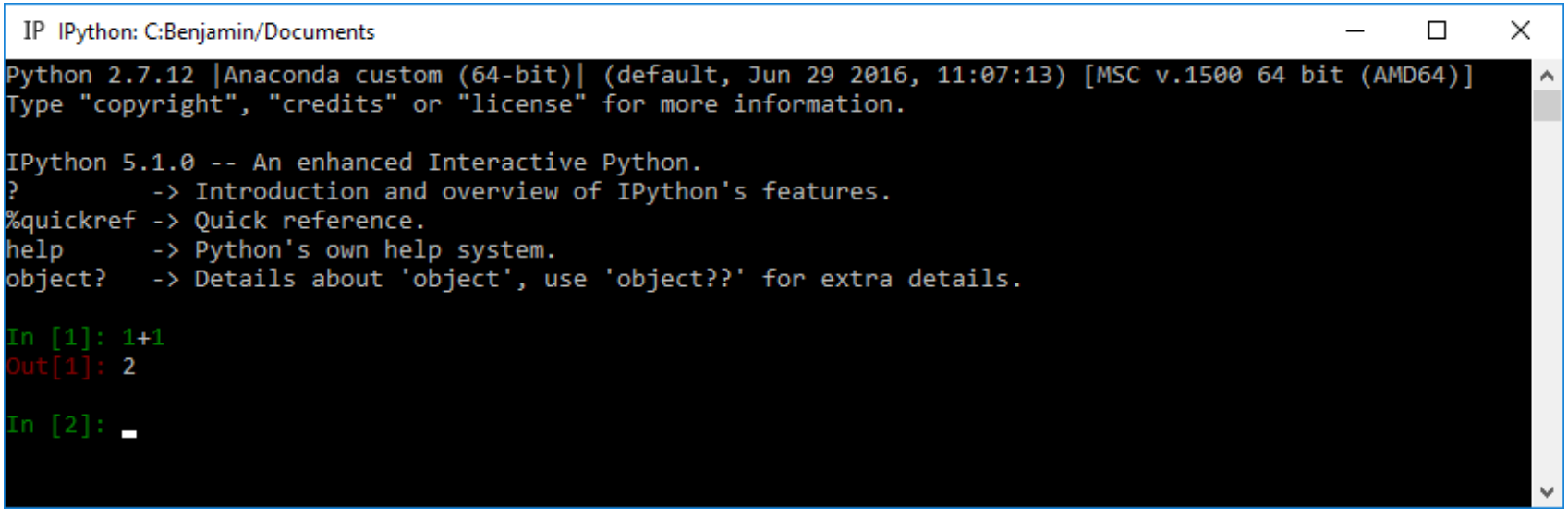
- **SSH:**[2]

```
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`



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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`

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

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="2*sin(x)", color="orange")
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)
```

Server example: An interactive function plotting tool

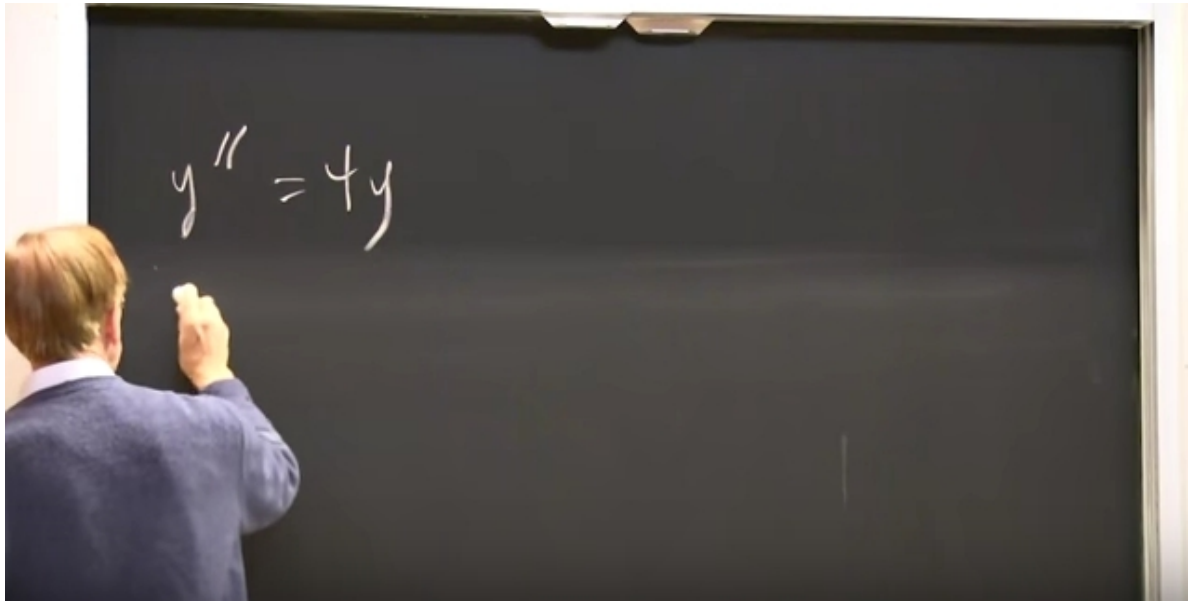
- Fire up a shell in your working directory
- Start with `bokeh serve functionPlotter.py`
- Visit `http://localhost:5006/functionPlotter`

Server example: An interactive function plotting tool

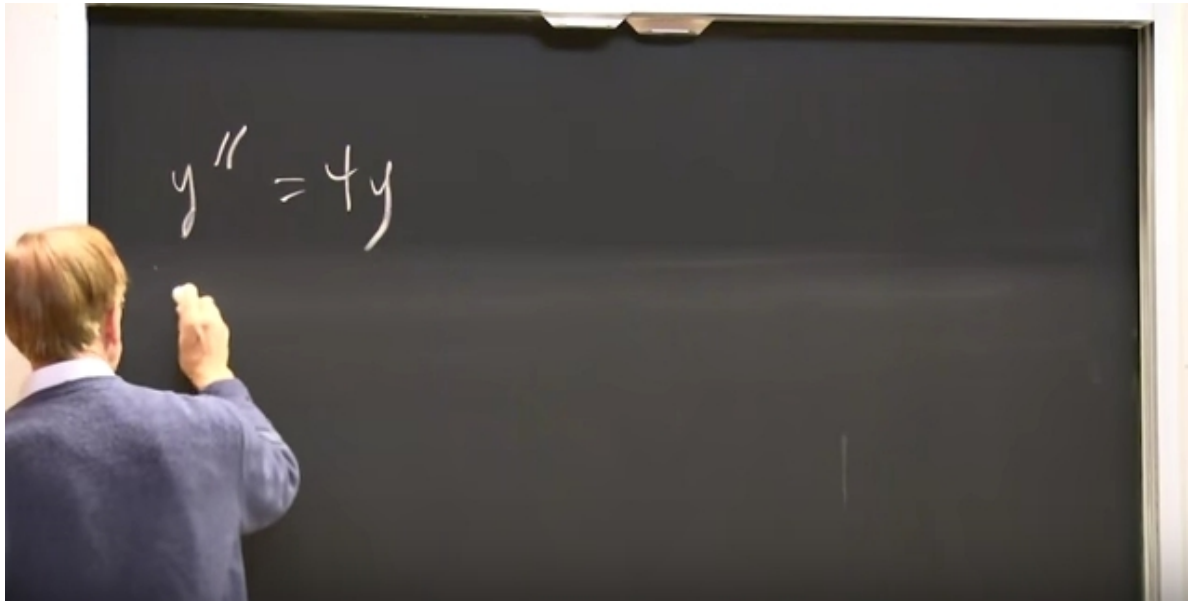
- Fire up a shell in your working directory
- Start with `bokeh serve functionPlotter.py`
- Visit `http://localhost:5006/functionPlotter`
- only 60 LoC!
- uses `numpy` and `scipy`

```
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, en
...
# 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

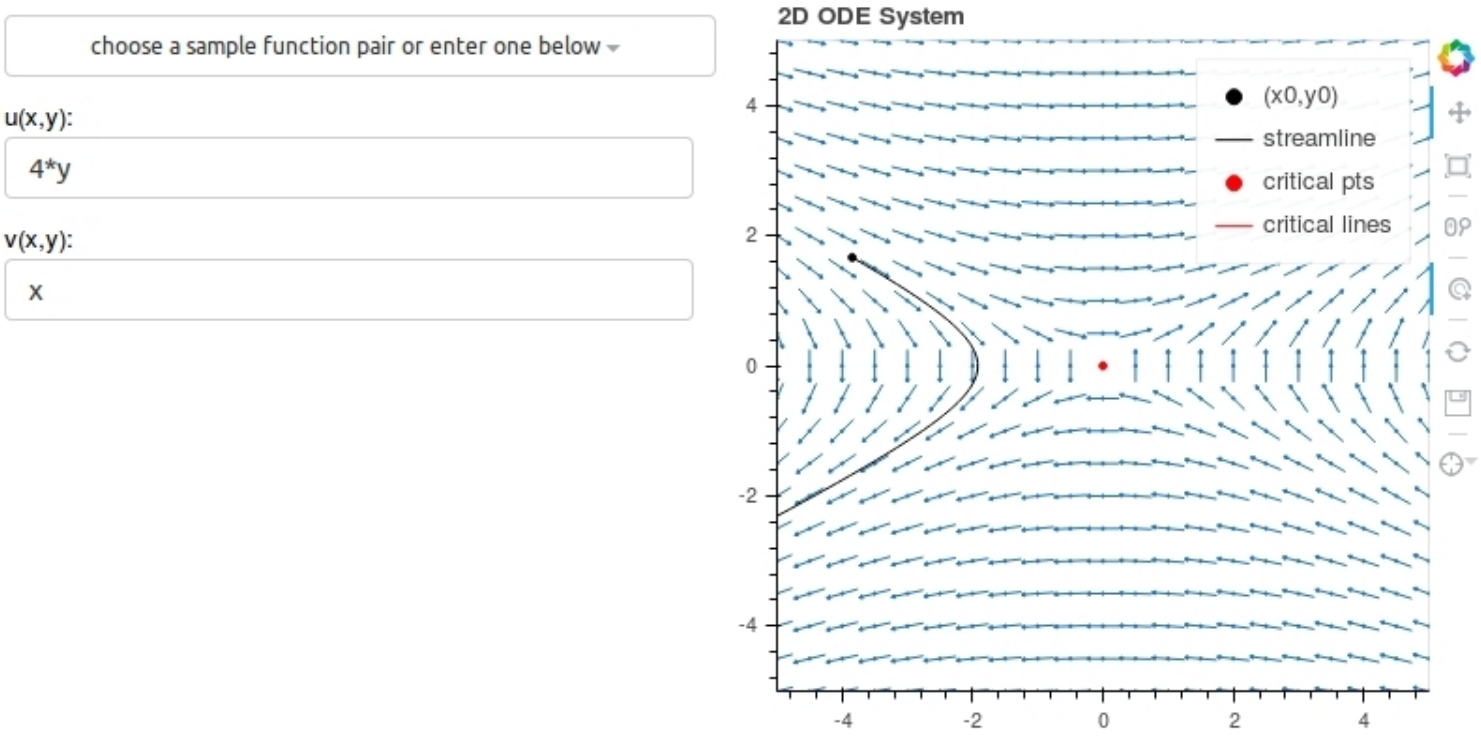


2D ODE system

$$y'' = u(x, y) = 4y$$
$$y' = v(x, y) = x$$

Visualization on `http://localhost:5006/odesystem_app`

What do we get?



Our goal

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

What do we get?

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Development Constraints

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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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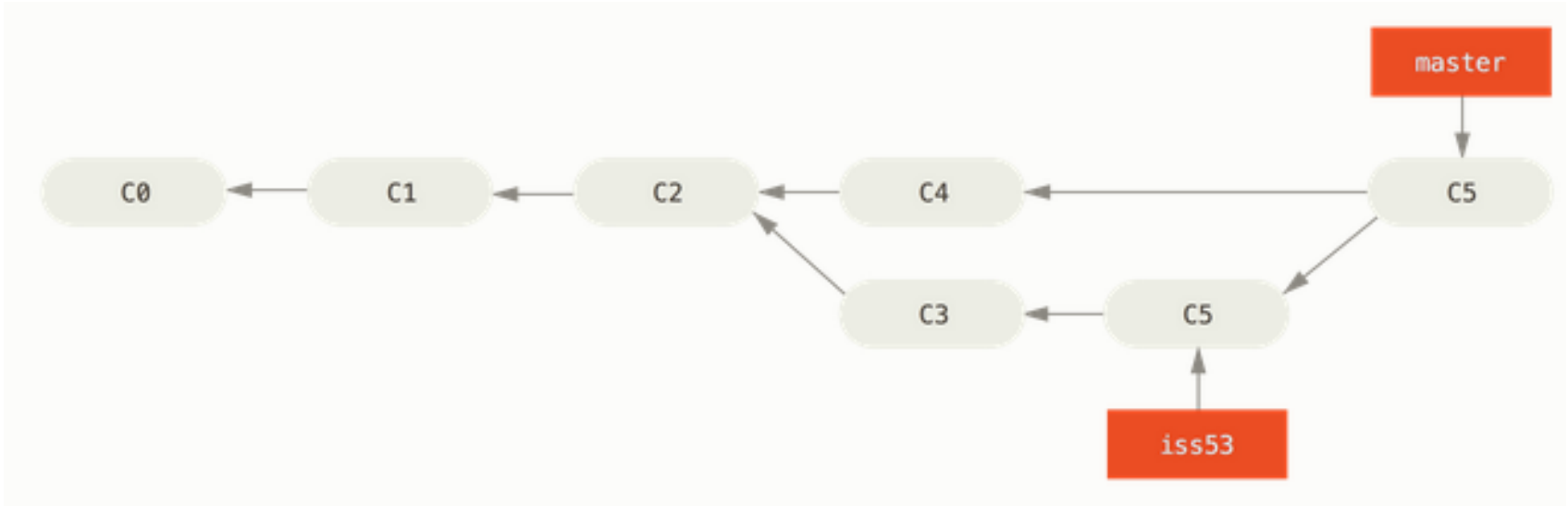
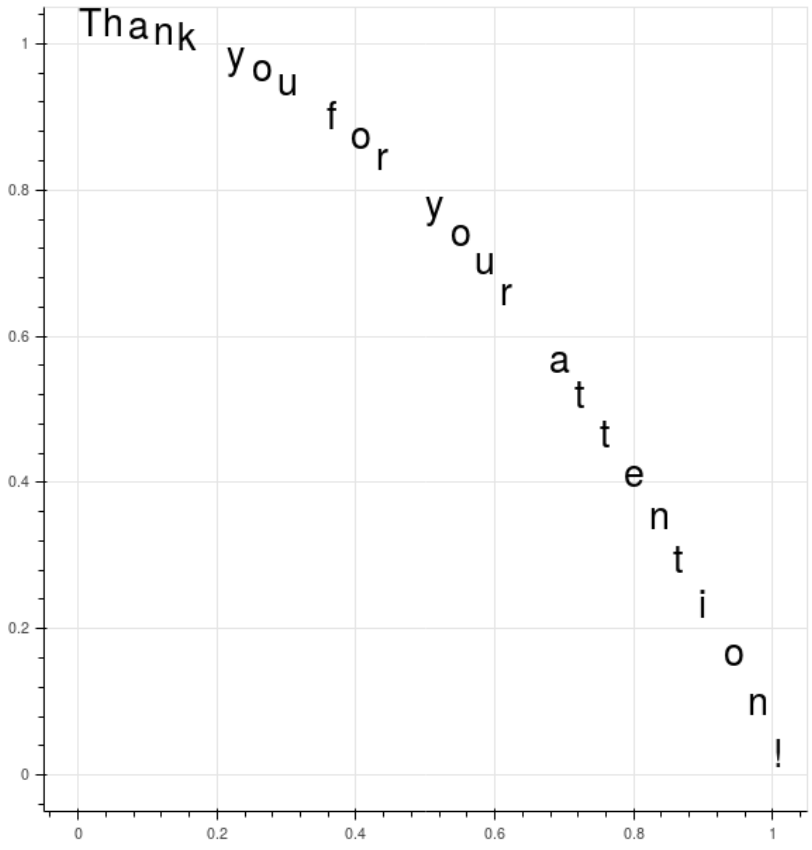
Use Git

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



[3] probably 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")
```