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Conference 2018

Callysto: Bringing Jupyter and Computational Thinking to the K-12 Curriculum

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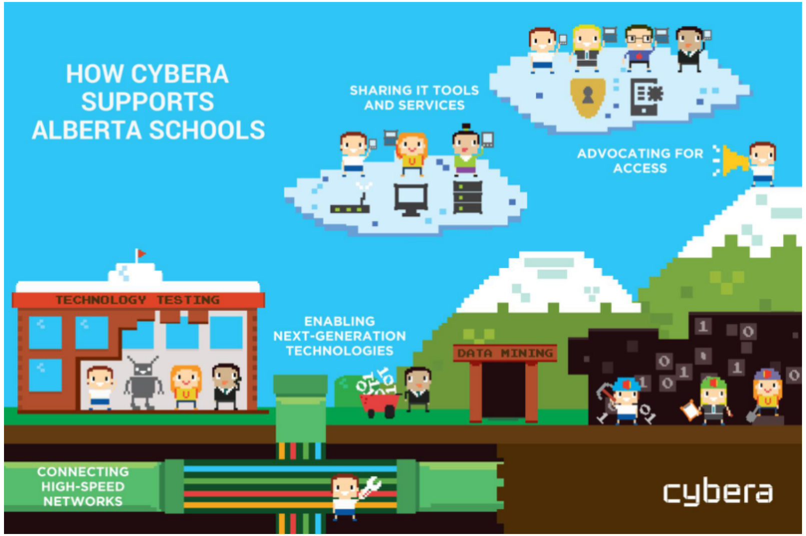
Agenda

1. Introduction to PIMS, Cybera and their new project: Callysto
2. What are Jupyter Notebooks? (the Syzygy story)
3. K-12 experiences with Jupyter
4. Example Callysto notebooks
5. Next Steps: Calling All Teachers!

cybera


HOW CYBERA SUPPORTS ALBERTA SCHOOLS
SHARING IT TOOLS AND SERVICES
ADVOCATING FOR ACCESS
TECHNOLOGY TESTING
ENABLING NEXT-GENERATION TECHNOLOGIES
DATA MINING
CONNECTING HIGH-SPEED NETWORKS
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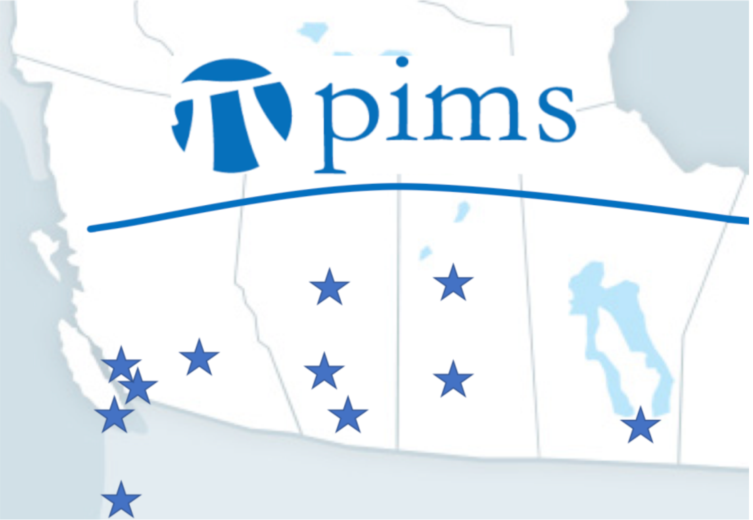
Pacific Institute *for the* Mathematical Sciences



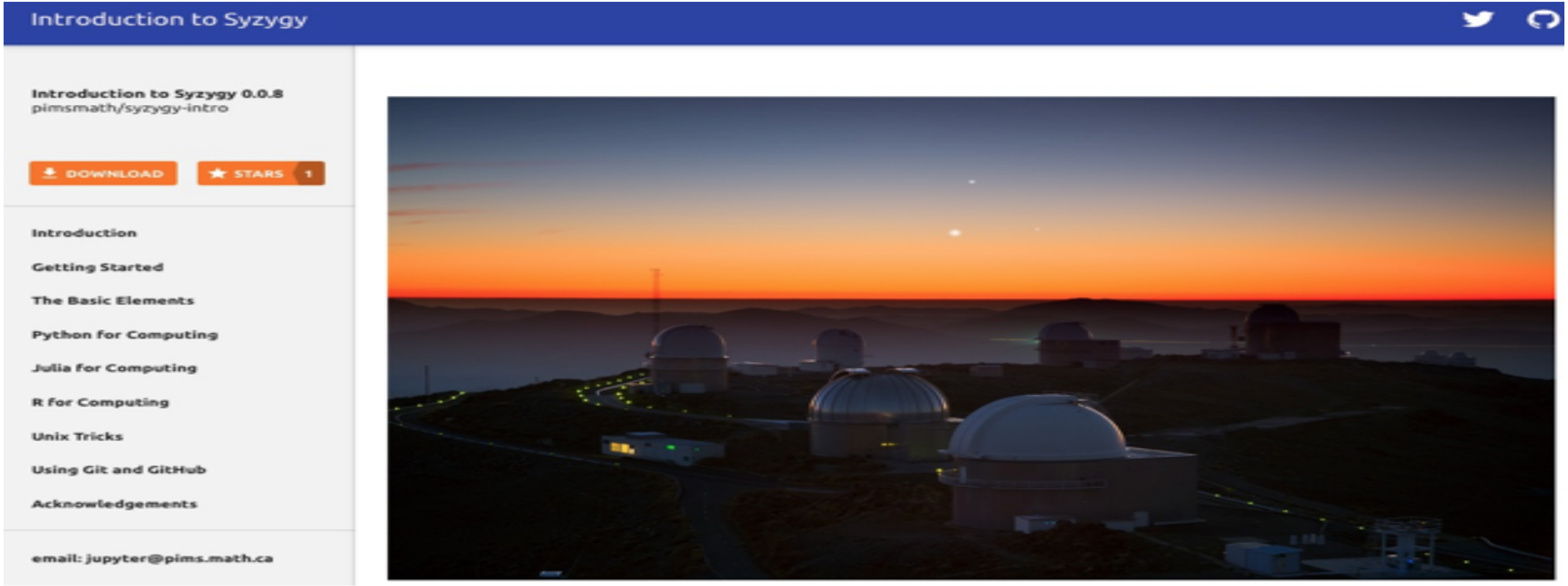
Callysto

Innovation, Science and Economic Development Canada
Innovation, Sciences et Développement économique Canada
<CanCODE>
Canada

The Callysto Story

- Bring computational thinking to K-12 (CanCode)
    - Data and code for teachers and students
- Based on the Jupyter platform
    - Notebooks and a web-based hub service
- Builds on our experience with the Syzygy service for Canadian researchers
    - 6,000 users at 20+ sites in Canada

The Syzygy story : intro.syzygy.ca

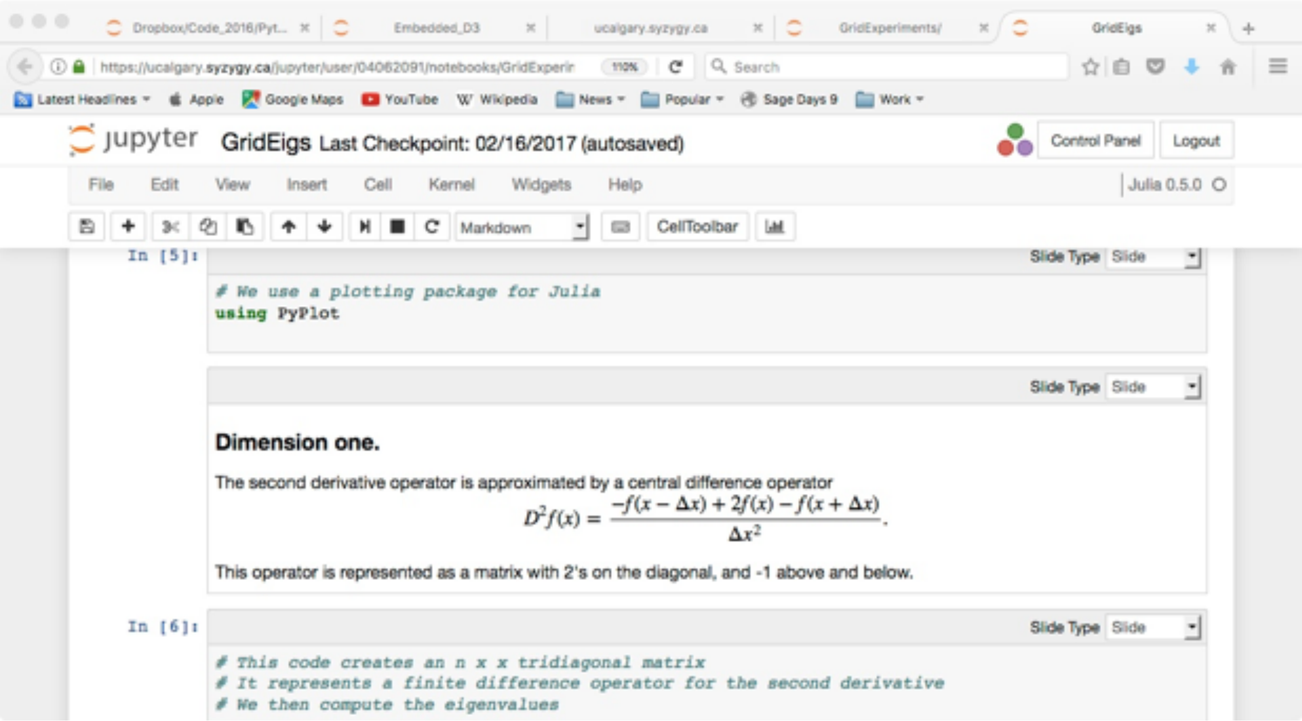


Syzygy: Built on Jupyter

- Jupyter Notebook:
  - Combines formatted text, math, code, and graphics
  - Ideal for data with analysis, animations, interaction

- Jupyter Hub:
  - Server runs the notebook online, in a browser
  - Handles file storage, administration, sharing
  - Terminal commands, Unix in background

Jupyter: A sample notebook.



In [5]:

```
# We use a plotting package for Julia
using PyPlot
```

Dimension one.

The second derivative operator is approximated by a central difference operator

$$D^2f(x) = \frac{-f(x-\Delta x)+2f(x)-f(x+\Delta x)}{\Delta x^2}.$$

This operator is represented as a matrix with 2's on the diagonal, and -1 above and below.

In [6]:

```
# This code creates an n x x tridiagonal matrix
# It represents a finite difference operator for the second derivative
# We then compute the eigenvalues
```

Jupyter: Markdown text

- Easy to make:
    - Headings
    - Bold or italicized text
    - Lists and enumerations
- Simple commands include:
    - ## headers of various levels
    - * for bulleted lists
    - * for italics *, ** for bold **

Jupyter: Math formulas

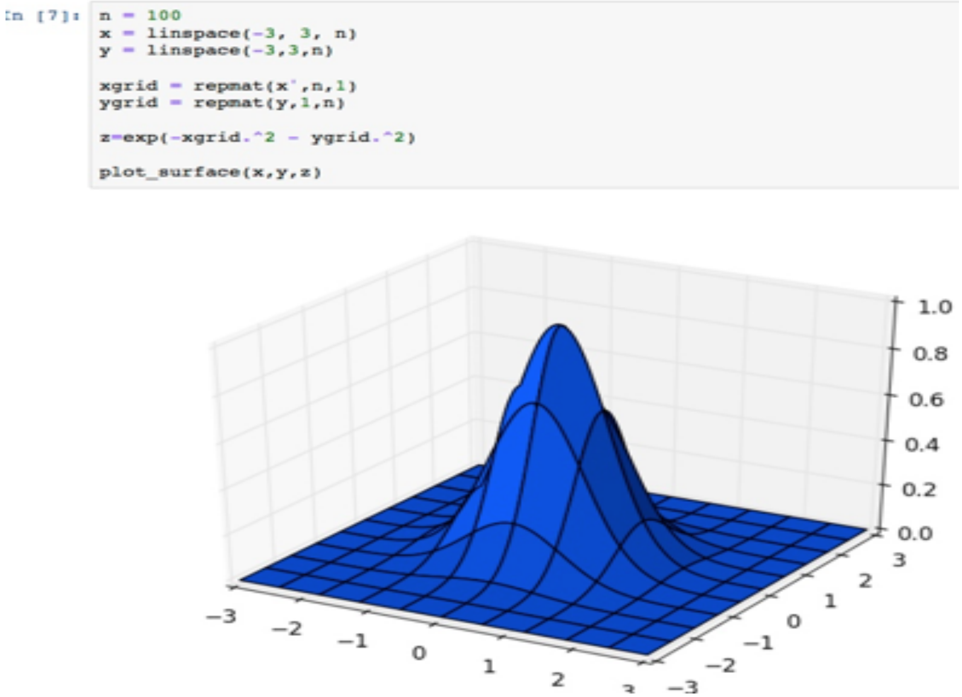
- $$\int_0^1 \sin (2\pi x) dx = 0 $$ becomes

$$\int_0^1 \sin(2\pi x) dx = 0$$

- As Einstein once said, in general relativity $$G_{\mu \mu}) … $$

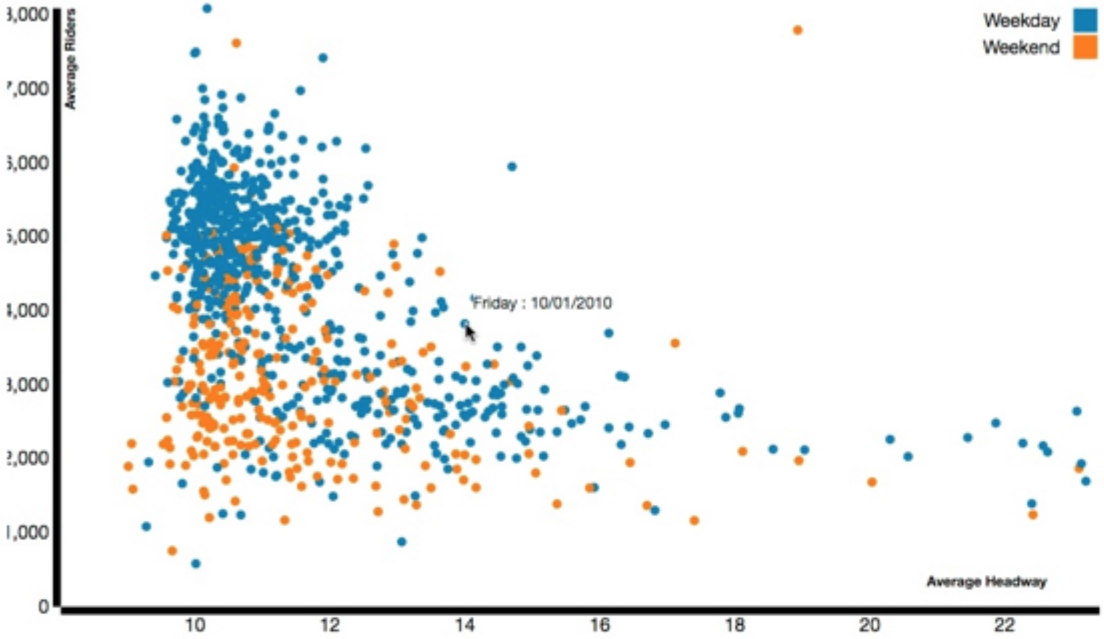
$$G_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$

Jupyter: Code in Julia, Python, R

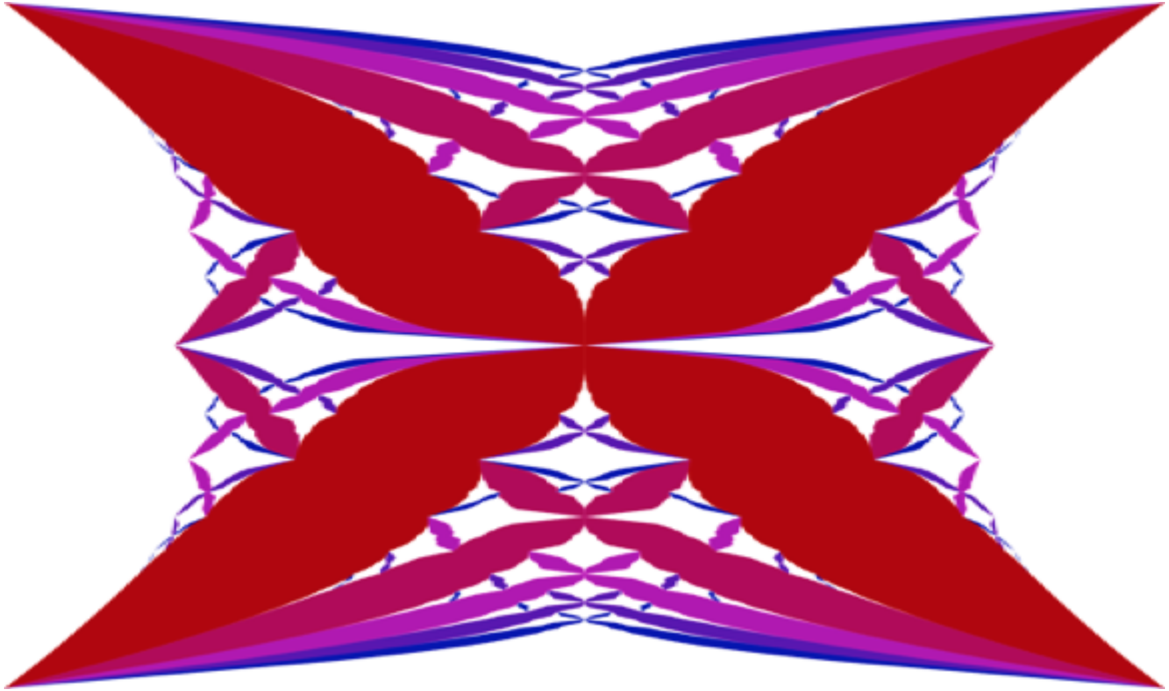


```
In [7]: n = 100
        x = linspace(-3, 3, n)
        y = linspace(-3,3,n)

        xgrid = repmat(x',n,1)
        ygrid = repmat(y,1,n)

        z=exp(-xgrid.^2 - ygrid.^2)

        plot_surface(x,y,z)
```

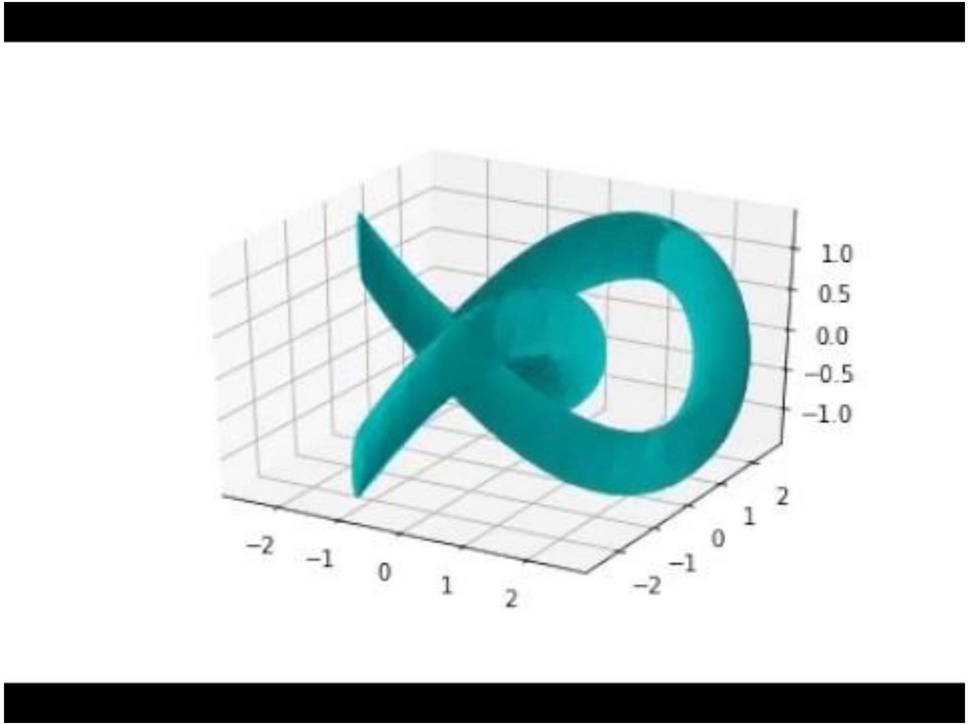
Jupyter: Interactive Data with D3



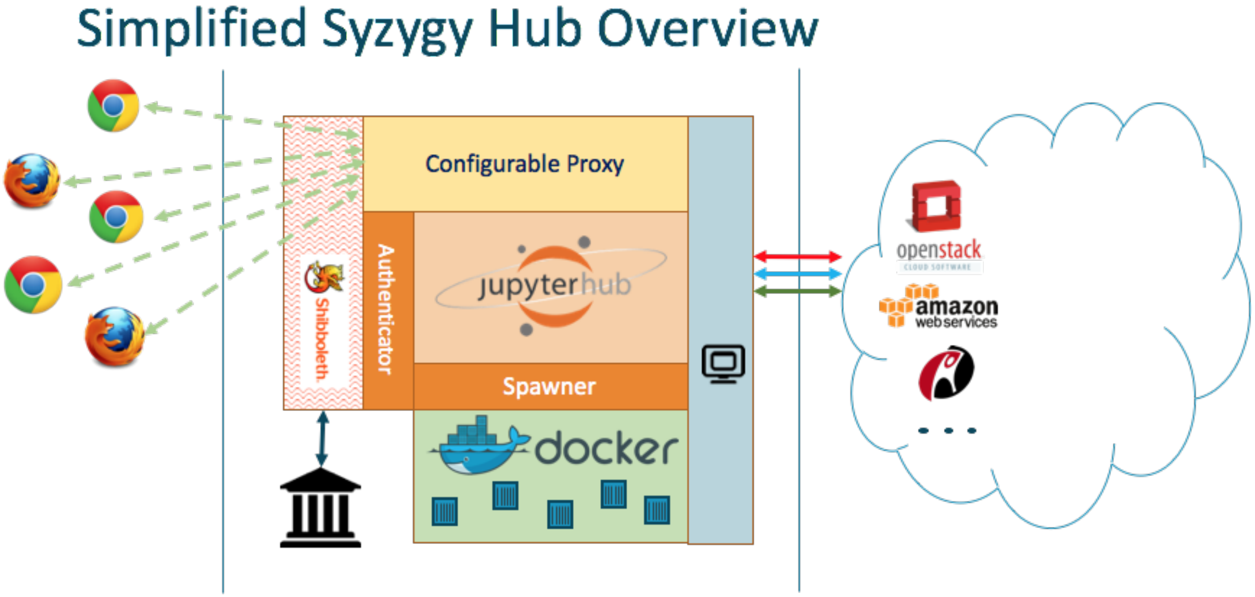
Jupyter: Graphics



Jupyter: Animations



Jupyter Hub: Technical details

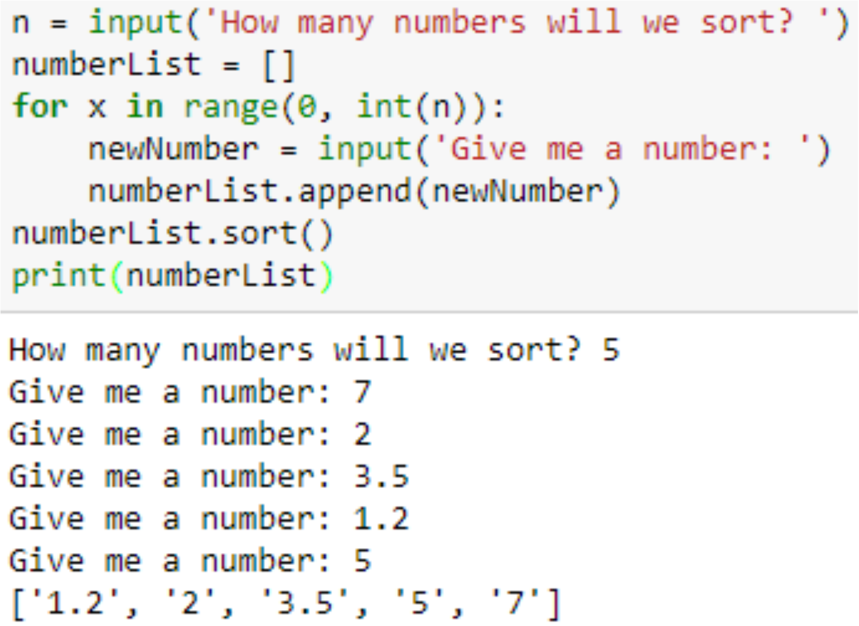


Callysto project

- Build notebook demos:
  - Address curriculum outcomes
  - Math, Science, Social Science, Humanities
  - For teachers and student, to use and emulate
- Build creator teams:
  - One teacher / curriculum expert
  - One professor / supervisor
  - Three to five Uni students programmers / developers

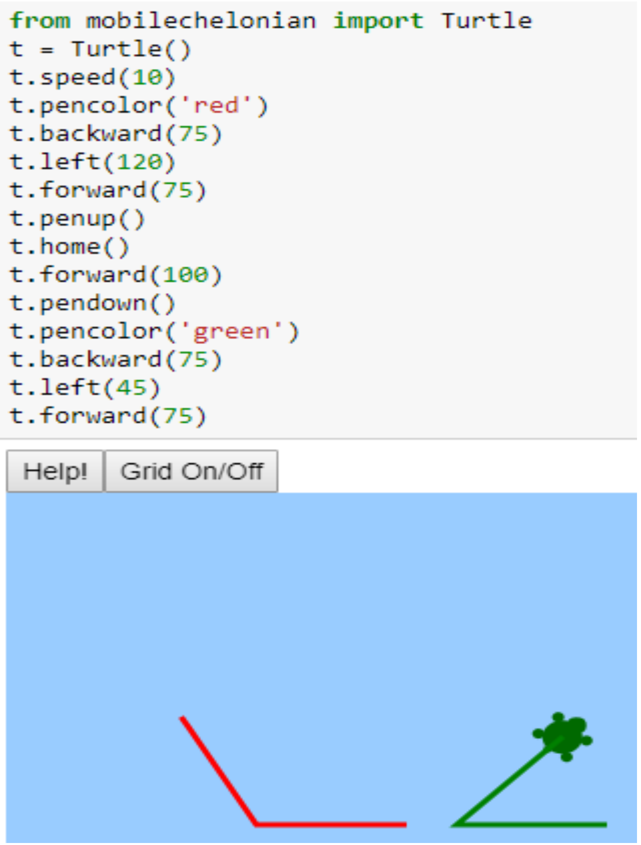
David Hay’s experience

- Introduced this to Grade 5 & 6 classes in Math, Science, and Social Studies
  - graphing, turtles, statistics (e.g. random.randint), open data, basic math (integers vs. decimal, ordering numbers)
- Computational Thinking in regular subjects, not as a separate option (CS&x)
- Other teachers: Math, CS, CTF/CTS, Science, etc.
- Looking forward to: open educational resources (some courses don’t have textbooks), collaboration, increasing computational literacy

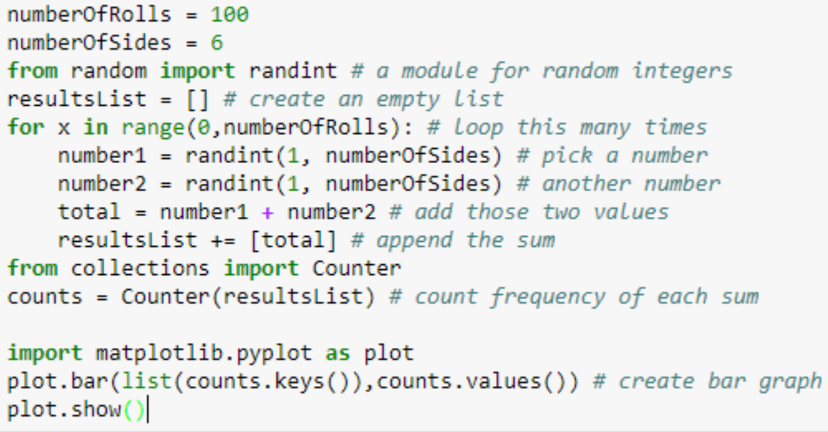


```python
n = input('How many numbers will we sort? ')
numberList = []
for x in range(0, int(n)):
    newNumber = input('Give me a number: ')
    numberList.append(newNumber)
numberList.sort()
print(numberList)
```

```
How many numbers will we sort? 5
Give me a number: 7
Give me a number: 2
Give me a number: 3.5
Give me a number: 1.2
Give me a number: 5
['1.2', '2', '3.5', '5', '7']
```

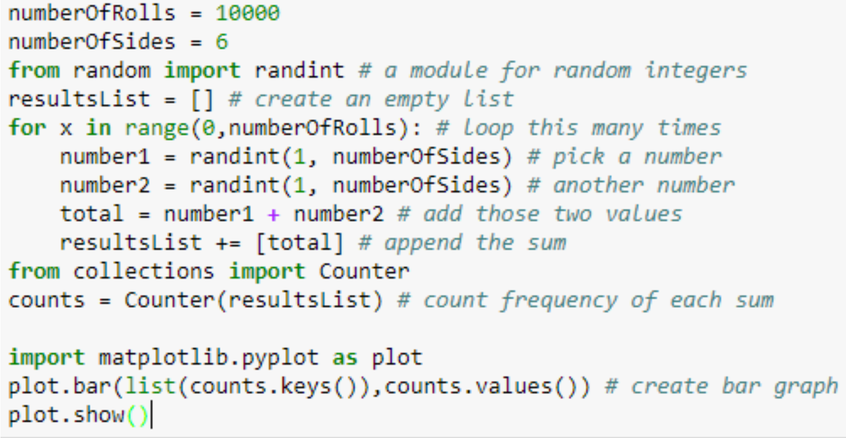


```python
from mobilechelonian import Turtle
t = Turtle()
t.speed(10)
t.pencolor('red')
t.backward(75)
t.left(120)
t.forward(75)
t.penup()
t.home()
t.forward(100)
t.pendown()
t.pencolor('green')
t.backward(75)
t.left(45)
t.forward(75)
```



```
numberOfRolls = 100
numberOfSides = 6
from random import randint # a module for random integers
resultsList = [] # create an empty list
for x in range(0,numberOfRolls): # loop this many times
    number1 = randint(1, numberOfSides) # pick a number
    number2 = randint(1, numberOfSides) # another number
    total = number1 + number2 # add those two values
    resultsList += [total] # append the sum
from collections import Counter
counts = Counter(resultsList) # count frequency of each sum

import matplotlib.pyplot as plot
plot.bar(list(counts.keys()),counts.values()) # create bar graph
plot.show()
```



```
numberOfRolls = 10000
numberOfSides = 6
from random import randint # a module for random integers
resultsList = [] # create an empty list
for x in range(0,numberOfRolls): # loop this many times
    number1 = randint(1, numberOfSides) # pick a number
    number2 = randint(1, numberOfSides) # another number
    total = number1 + number2 # add those two values
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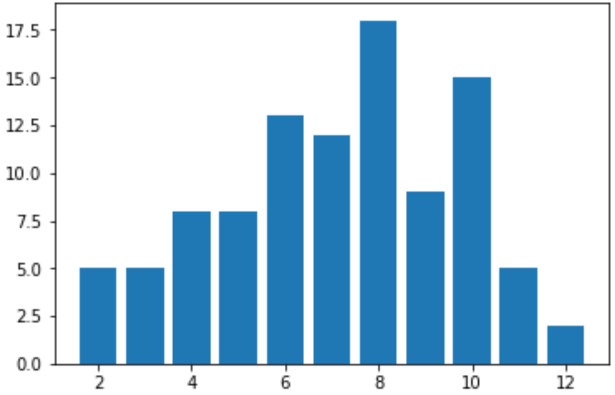
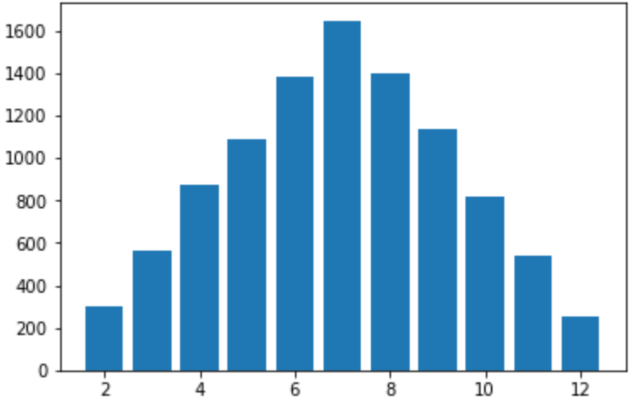


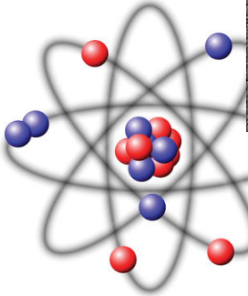


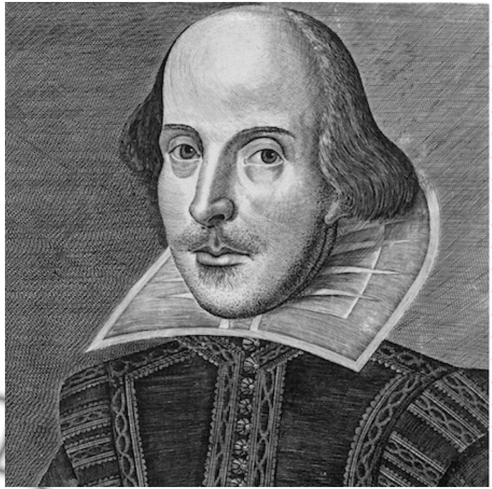
David Hay’s experience

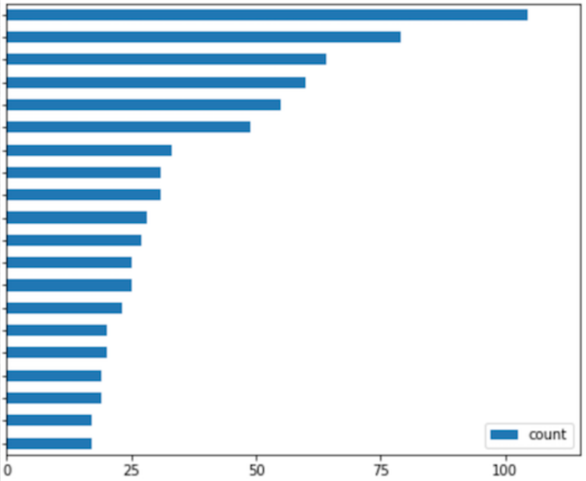
- A pie chart: pies
- A 3D object designed with code: literacy dice

Example Callysto Notebooks

- Shakespeare and Statistics
- Chemistry
- Nuclear Processes
- American Revolution







Next Steps: Calling All Teachers!

Our Goal:

To have 750 grades 5-12 teachers and 25,000 grades 5-12 students using these Jupyter notebooks in the classroom by Spring 2019.

Please invite teachers to sign up at **callysto.ca**

Email us: **callysto@cybera.ca**