Engaging high school interns
Mark SubbaRao, The Adler Planetarium & Astronomy Museum

Data to Dome
Data to Dome in an initiative of the International Planetarium Society designed to streamline the process of going from data to dome, increasing the potential for scientific communication and storytelling in the planetarium.

The task force will undertake initiatives (inclusive of Data to Dome) aimed at:
- Preparing planetaria for the big data streams that will come from next generation telescopes, satellites, experiments and computational simulations.
- Creating professional development opportunities aimed at developing more "data savvy" planetarians.
- Developing and promoting best practices for data visualization in the dome.
- Encouraging the visualization of a wide range of scientific data in the dome (moving beyond astronomy).

Find out more here: http://data2dome.org

OpenSpace Data to Dome Resources
We have developed a python-based GitHub repository contains libraries and example code for creating OpenSpace visualization modules. Generator routines will create a visualization module either from a data table, or directly from a CDSn (Strasbourg astronomical Data Center) http://cds.u-strasbg.fr/ catalog number. This enables the visualizations of tens of thousands of published astronomical catalogs with just one or two lines of python code. https://github.com/IPSScienceVisualization/OpenSpace

Galaxy Zoo in OpenSpace
Galaxy Zoo (https://www.zooniverse.org/projects/zookeeper/galaxy-zoo) is a decade-long citizen science project that has engaged millions of people in classifying galaxies from various astronomical surveys. Here we provide a python based Jupyter notebook that illustrates how to:
- download the data sets containing the Galaxy Zoo classifications
- explore that data
- build an OpenSpace visualization module.
https://github.com/archiekinnane/AdlerSummer/blob/master/JupyterNotebooks/adler1.ipynb

Informal interactive opportunities
and videos for museums and teaching
Rachel Smith, North Carolina Museum of Natural Science

Astronomy & Astrophysics Research Lab
- "Digital narrative" for visual storytelling in display format, ongoing thematic displays visible in museum
- Special events, OpenSpace helps inspiring conversations on astronomy, research, and data visualization; OpenSpace can be worked into many types of special astronomy-related events
  - Astronomy Days and members’ tours at NCMNS
  - Apollo 50th anniversary
- Internship opportunities for students
- Informal interactive opportunities for visitors in lab during special events

Videos for exhibits/displays
- Research screen, NCMNS
- Example: Museum of Life and Science, Lunar Lander exhibit
An expanding OpenSpace mp4 library
- Videos that enhance public outreach and teaching
- Example: undergraduate course, Astrobiology: Searching for Life in the Universe, Appalachian State University
- Example of using OpenSpace for research communication — Sci Tech Expo talk on meteorites and star formation research

Live, interactive presentation tool
_Carter Emmart, American Museum of Natural History_

Astronomical programs: The Tour of the Universe
- Local Stellar Neighborhood and Radio Sphere
- Milky Way Galaxy
- Extragalactic Structure
- Contextualizing the Cosmic Background Radiation
- Dynamic Scene Graph to seamlessly accommodate the true scale range of the universe

Dedicated to contextualizing the various datasets that comprise the Digital Universe, they not only show the extent of our knowledge, they also show our limitations imposed by distance, brightness, survey extent, uncertainty and understanding.

Space Mission programs: NASA SPICE and Image Projection
- New Horizons
- Rosetta
- OSIRIS-Rex
- Apollo 8 / Earthrise
- Apollo 11 50th Anniversary

Showing not just the results of planetary missions, such as carefully produced global maps, but how missions are actually conducted is made possible by visualizing the actual geometry of the missions. This is made possible by NASA’s Navigation and Ancillary Information Facility (NAIF) and their space mission navigation codification structure called SPICE (for Spacecraft, Planets, Instruments, Cameras and Events). SPICE has become an international standard of use especially with nations that are tracked by the multi-national Deep Space Network. OpenSpace uses SPICE in order to depict missions as they are conceived or were actually flown.

Planetary Science programs: Globe Browsing with Multi-Scale Height Maps
- Earth Day
- Mars 2020 Site Candidates
- Apollo Landing Sites as imaged by the Lunar Reconnaissance Orbiter
- Mercury results of the MESSENGER mission

Like Google Earth, OpenSpace has developed use of remote serving of high-resolution maps for worlds that space missions have surveyed thus far. Built on the Geospatial Data Abstraction Language (GDAL), OpenSpace has developed multiple scale height map browsing allowing finest resolution of both imagery and terrain modeling. Adding regional and local close-up patches is also supported and has been used for specific programs of interest.
Putting OpenSpace into use | ASTC 2019

Apollo 16 astronaut, Charlie Duke, Lunar Module Pilot, was interviewed in a closed session in the Hayden Planetarium and a YouTube 360 recording was made as a record: https://www.youtube.com/watch?v=MarfXBo8Et8&t=1217s

**Planetary Surface programs: Surface scale overlay models**
- Apollo EVA Photogrammetry
- Mars Curiosity Rover and Navcam terrain models

Models are geospatially located to show proper context to surrounding terrain. In the case of Apollo, historic EVA photography was used for photogrammetry reconstruction of boulders at several stations where samples were collected. The lunar module was constructed from photogrammetry of LM-2 at the Smithsonian National Air & Space Museum. In the case of Curiosity Rover, all action is visualized as SPICE playback of actual operations.

A YouTube record of the OpenSpace Apollo 11 50th Anniversary Recreation broadcast to NASA@MyLibrary was done as a live YouTube stream: https://www.youtube.com/watch?v=Xhh7mNUJ9Oo

**Space Weather programs: Collaboration with NASA’s Community Coordinated Modeling Center (CCMC)**
- Sun-Earth Connection
- Sun-Earth Interaction

Starting in 2012, prior to NASA funding, early development work on OpenSpace was conducted by master thesis students from LiU stationed at NASA Goddard CCMC with the goal of creating interactive volumetric rendering and field and flow line tracing of simulation time series of solar events and interaction with earth’s magnetosphere. Two major public programs were developed from this on-going work.

In 2017 and 2018, the Sun-Earth Connection was presented in the Hayden Planetarium and LeFrak Large Screen Theater venue at AMNH in collaboration Predictive Science Inc. A YouTube 360 recording was made: 
https://www.youtube.com/watch?v=rDDjcxBP6aq
https://www.youtube.com/watch?v=VM_6XpLR3gw
OpenSpace w/ Teen Interns at the Adler Planetarium

Data Science . Astronomy . Science Communication
At the Apollo 50th Celebrations Adler Teens presented OpenSpace to over 1,000 visitors. Here with mentors (recent Astronomy graduates and Dr. Reatha Clark King who worked on rocket fuel for Apollo at the National Bureau of Standards.)
1. Introduction to Python and Jupyter Notebook

Cells in Jupyter Notebook

There are two types of cells:

- **Text cell**: Texts are written (like this cell)
- **Code cell**: You can enter Python codes here and can run them. To run codes in a code cell, first select the cell and then press Shift-Enter key, click the 'play' button in the tool bar above, or select Cell | Run Cells in the menu bar. For code cells, input numbers are displayed at the left of the cell, for example 'In [ 1 ]'. When running cell, the output is displayed below the cell.

In the following workshop, you basically first read explanations of a topic in a text cell, and then try it in a code cell next to the text cell.

**Print function**

The print function is useful to display the status of the running code. It can be used like

```python
print('text')
```

It can also display values of variables like

```python
a = 1
print(a)
```

Enter the following code in the cell below and run it (Shift+Enter) to check this.

```python
print('text')
a = 1
print(a)
```
OpenSpace Python Resources

This repository contains libraries and example code for using python to create OpenSpace visualization modules. Generator routines will create a visualization module either from an Astropy Table, or directly from a CDS http://cds.u-strasbg.fr/ catalog number providing access to tens of thousands of published astronomical catalogs.
Open Space Intern
Presentation Skills Activities

1. **Watch A Ted Talk (Deconstruct Mark & Jedidah)**
   - How do you think they did?
   - What could they improve on?
   - What did they do well?
   - What’s one thing that stood out to you about their presentation?
   - What’s one thing you can borrow from them while giving your presentation?

2. **Keep It Simple Stupid (K.I.S.S) & 10-20-30 Rule**
   - The Idea of K.I.S.S
   - 10-20-30 Rule Idea

3. **Speak Loud & Clear (Led by Reyhanneh)**
4. **Grab Attention & Tell Stories (Led by Reyhanneh)**
5. **Make Eye Contact & Use Body Language (Led by Reyhanneh)**
6. **Show Passion & Focus (Led by Reyhanneh)**
7. **Give Their Presentations Week 5 & 6 (8/14/19 Bash Event)**
8. **Present On Space Topics Throughout SVL Open Hours**
Apollo 11 Story Board

1. "Apollo 11 spacecraft (orbit)
   speed: 10,000 sec (sec)

2. "Apollo 11 spacecraft (view)
   speed: 10,000 sec

3. "Apollo 11 lander
   (orbit: July 20, 19:10, Earth's surface 200 sec)
   speed: 5,000 sec/sec

4. "Apollo 11 ladder (close)

5. "Apollo 11 ladder (arrived)

(file: apollo11mission.scn) - "Apollo II Lander (arrived)"

Apollo 11 Story Board

Scene 1
Rocket launch

Scene 2
Apollo 11 spacecraft in orbit
Apollo 11 spacecraft in Earth's orbit (Apollo 11 lander)
Earth rise (inside module)

Scene 2:
- Astronauts (Buzz Aldrin, Jim Lovell, Michael Collins)
- First human to walk on the Moon's surface
- Launched from Cape Canaveral, FL to Kennedy Space Center

Scene 3
- Landed on the Moon's surface
- Mission's success"
The Community Bash
North Carolina Museum of Natural Sciences

Association of Science-Technology Centers annual conference
Toronto, Canada
September 20, 2019
Astronomy & Astrophysics Research Lab
Creating thematic visuals with OpenSpace
Digital Narrative

Mars
Digital Narrative

Earth
Special Events
Examples: Astronomy Days, members’ tours

Weekend event during the last weekend in January 2019: 14,959 visitors experienced OpenSpace through program and/or lab
Example: Apollo 11 50th anniversary
Students and Interns
Students and Interns

Appalachian State University, Dark Sky Observatory, Boone, NC
Interactive visitor opportunities
Museum Exhibits
Museum of Life and Science
Durham, NC
Lunar lander exhibit
Digital Library

Ever-expanding OpenSpace mp4 video library
Undergraduate general education course: Astrobiology: Searching for Life in the Universe

**MARS**
Chapter 8

March 14, 2019

Example lectures

Beyond the solar system

January 24, 2019
Using *OpenSpace* for research communication

Example: Sci Tech Expo research presentation
OpenSpace

Live, interactive presentation tool

Carter Emmart, AMNH
GAIA DR2 star catalog
30 SECONDS OF FUEL
THEY GET THE WARNING
Modeling from Observations
CME Modeling, July 2012
Open Magnetosphere Temperature on Field Lines