

Building CyberLiteracy Through Interactive Lessons: Design, Development, and Deployment of Jupyter Notebooks for Geospatial Computing Education

Forrest Bowlick¹, Eric Shook², Karen Kemp³, and Anand Padmanabhan⁴

¹University of Massachusetts - Amherst

²University of Minnesota

³University of Southern California

⁴University of Illinois at Urbana Champaign

November 24, 2022

Abstract

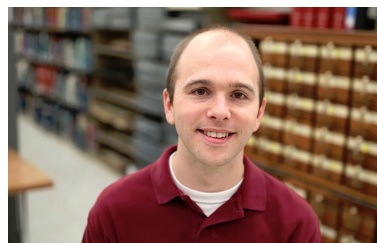
Across geospatial domains and practices, there is a pressing educational need for engagement with and understanding of computational and technical advancements relevant to geospatial work. Computational skills and practices, like working with big data, creation and management of machine learning algorithms, work with automation in data analysis and management, and many others, are growing as fundamentals to conducting geospatial scientific research, and to learning in the geospatial classroom. The Hour of CyberInfrastructure (Hour of CI) project aims to create learning materials for use in diverse learning contexts to provide learners a base to build their practice in eight core areas of cyber literacy pertinent to geographic information science (GIS) and geospatial practice. Leveraging the affordances of Jupyter notebooks and cloud computing, we discuss the design, development, and deployment of introductory lessons in these areas. We report the educational design strategies behind development of these lessons, discuss the technical development and support required to use these in an interactive Jupyter notebook enabled space, and report on the deployment of these lessons in initial classroom testing environments. By sharing components of the entire process in developing Hour of CI lessons, we aim to outline our experiences, share best practices and pitfalls, and consider feedback from initial testing. These results will support other efforts in computer-based STEM education by providing feedback and results from an interwoven, cross-discipline geospatial, GIS, and computer science context.

Building CyberLiteracy Through Interactive Lessons: Design, Development, and Deployment of Jupyter Notebooks for Geospatial Computing Education



Forrest J Bowlick, Eric Shook, Karen Kemp, and Anand Padmanabhan

University of Massachusetts Amherst; University of Minnesota Twin Cities; University of Southern California; University of Illinois at Urbana Champaign



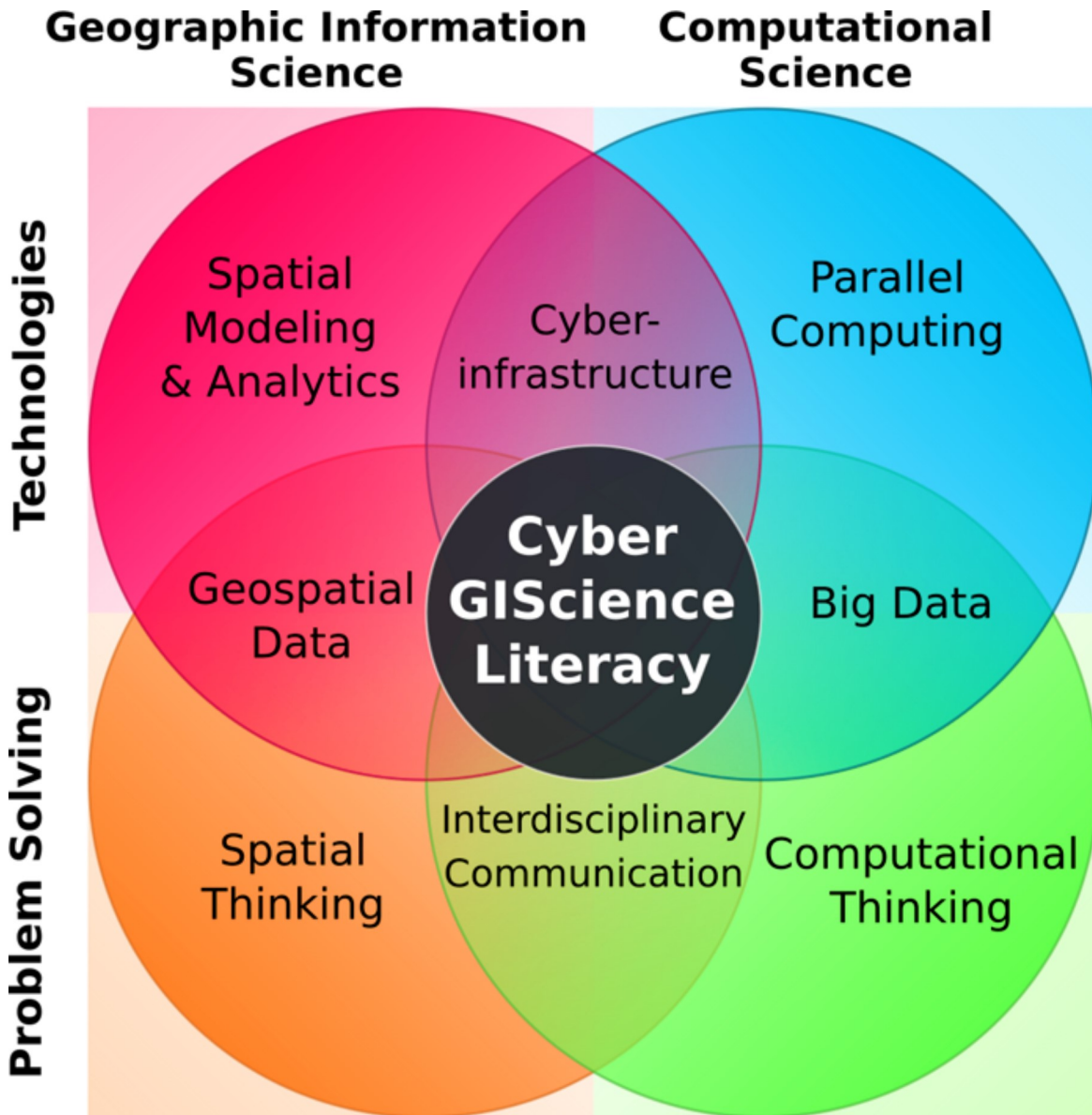
PRESENTED AT:



ABSTRACT

Across geospatial domains and practices, there is a pressing educational need for engagement with and understanding of computational and technical advancements relevant to geospatial work. Computational skills and practices, like working with big data, creation and management of machine learning algorithms, work with automation in data analysis and management, and many others, are growing as fundamentals to conducting geospatial scientific research, and to learning in the geospatial classroom. The Hour of CyberInfrastructure (Hour of CI) project aims to create learning materials for use in diverse learning contexts to provide learners a base to build their practice in eight core areas of cyber literacy pertinent to geographic information science (GIS) and geospatial practice. Leveraging the affordances of Jupyter notebooks and cloud computing, we discuss the design, development, and deployment of introductory lessons in these areas. We report the educational design strategies behind development of these lessons, discuss the technical development and support required to use these in an interactive Jupyter notebook enabled space, and report on the deployment of these lessons in initial classroom testing environments. By sharing components of the entire process in developing Hour of CI lessons, we aim to outline our experiences, share best practices and pitfalls, and consider feedback from initial testing. These results will support other efforts in computer-based STEM education by providing feedback and results from an interwoven, cross-discipline geospatial, GIS, and computer science context.

INTRODUCTION



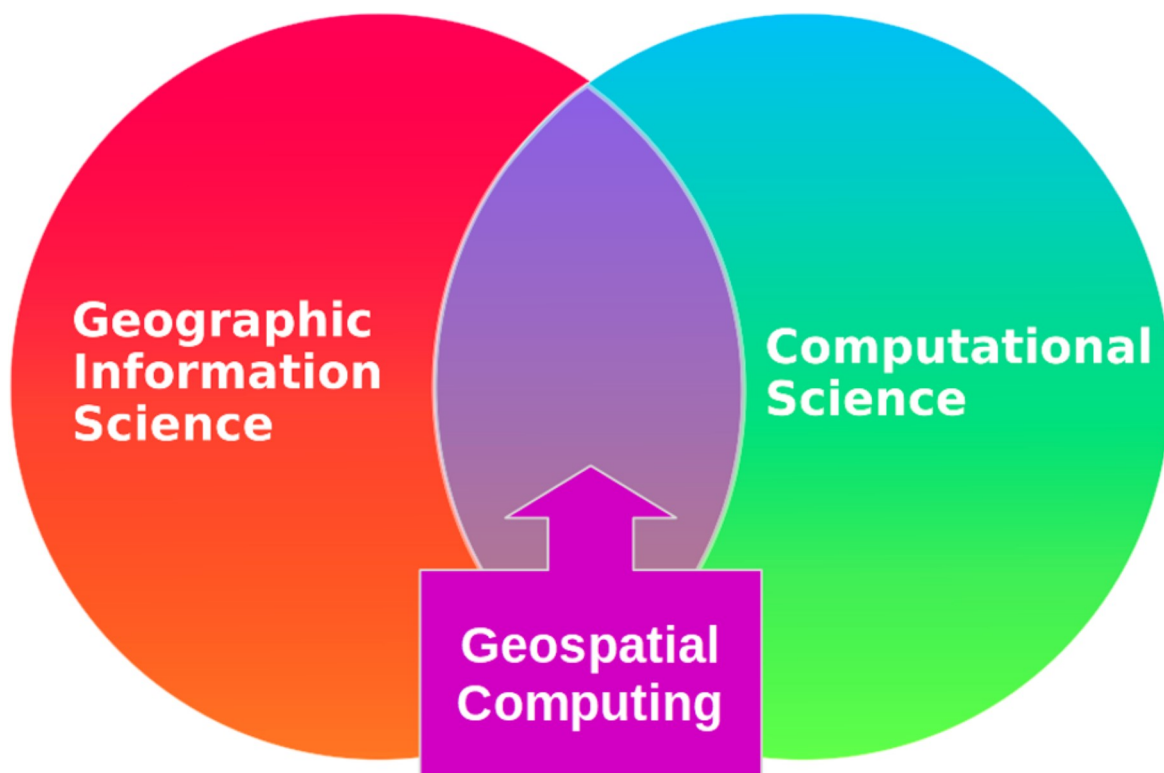
Literacies outline essential abilities and foundational knowledge in a given field, domain, or area of practice. These change as science and society change.

There is a growing necessity within Geographic Information Science (GIS) to leverage the affordances of super computers, big data, and other advanced computing capacities for spatial and geographic analysis.

However, there are many challenges in connecting the capacities of computer science and cyberinfrastructure (CI) to learners without extensive experience. That is to say, the learning curve is very steep.

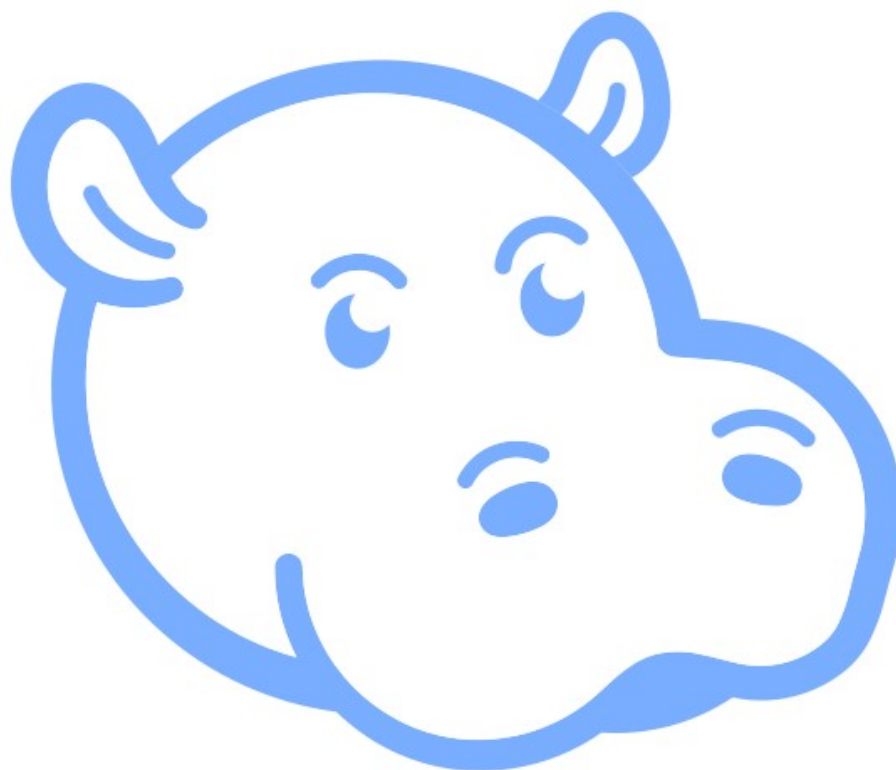


At the same time, experts in CI, computer science, and programming need support learning the spatial and geographic concepts embedded in GIS. This intersection of GIS, computation science, and the related knowledge, skills, and practices, is an area of incredible potential - that needs incredible support in curricular design and development.



There is a clear and immediate need for open educational resources to allow learners from diverse backgrounds, experiences, and domains to build expertise in CI and GIS. This poster explores the design, development, and early deployment of educational materials to serve that need.

DESIGN



Our project is the Hour of Cyberinfrastructure (Hour of CI), a nationwide campaign introducing hundreds of diverse undergraduate and graduate students to cyberinfrastructure and geographic information science (GIScience) while building Cyber Literacy for GIScience. The NSF-supported project is developing 17 interactive, online lessons for students and creating supplementary curriculum materials for instructors. These hour-long lessons will provide base knowledge and skills for across eight core areas and then test this knowledge through interactive content.

We have designed these lessons based on the definition of cyber literacy from our previous work (<https://www.tandfonline.com/doi/abs/10.1080/00330124.2018.1518720?journalCode=rtpg20>):

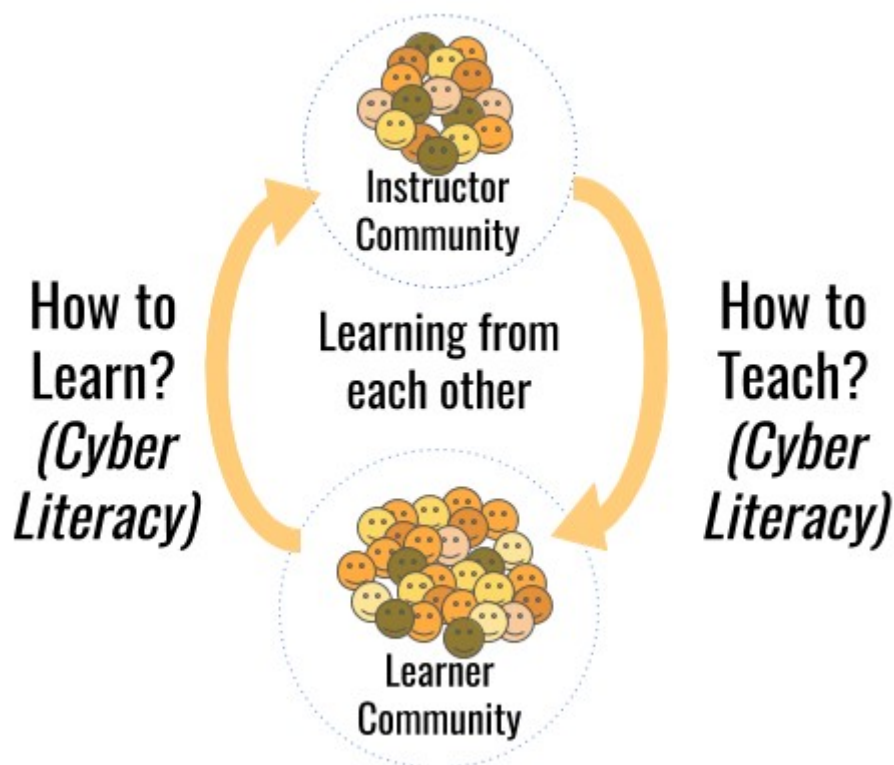
“the ability to understand and use established and emerging technologies to transform all forms and magnitudes of geospatial data into information for interdisciplinary problem solving.”

Our aim is to help 500+ diverse students and 200 instructors develop cyber literacy for GIScience. Supported by the National Science Foundation (NSF) Office of Advanced Cyberinfrastructure (OAC-1829708), learners will have a simple goal: Try cyberinfrastructure for one hour.

We are designing these lessons with a model similar to the "Hour of Code," which exposed 500 million K-12 students to coding one hour at a time. In our case, we are developing 17 interactive, online lessons for students and creating supplementary curriculum materials for instructors. Lessons when complete will be freely and openly available for learners and instructors.

DEVELOPMENT

Developing Hour of CI lessons requires two tracks to consider: the people writing the lesson content, and the technology and infrastructure that the lessons will run on. This section concerns the people developing the lessons.



Whether learners or instructors - we are one big community each asking a slightly different question. If you are a learner, you may be asking "How do I learn Cyber Literacy?" If you are an instructor, you may be asking "How do I teach Cyber Literacy?" However, it is important to recognize that we are all learning from each other. The Hour of CI project is trying to connect these two communities.

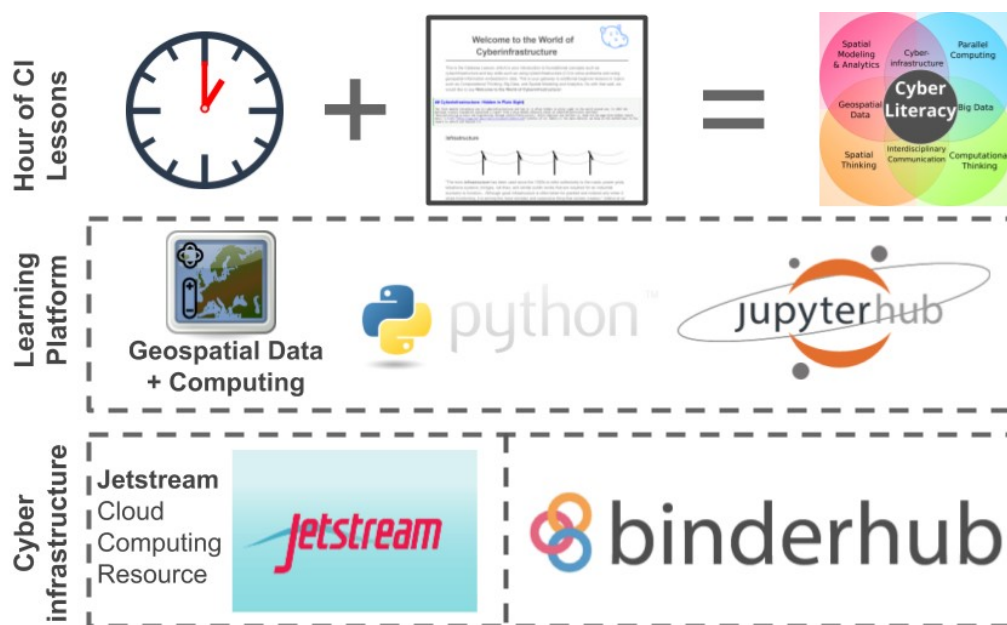
For the initial set of beginner lessons in the Hour of CI, we worked with lesson developers from diverse backgrounds and academic positions to create lessons on the different topical themes. These developers, from different backgrounds and experiences, allowed our lessons to reach learners from different perspectives and expertise.



Accompanying the lessons in the project is a suite of Best Practices that guide the development of Hour of CI Lessons. The Gateway, Beginner, and Intermediate Lessons teach Cyber Literacy knowledge and skills to our learner community. Knowledge and skills are tested by assessments that are incorporated into the lessons themselves. These assessments provide data to improve and refine our Best Practices. This includes Instructor Resources to help instructors add Hour of CI lessons into the classroom.

DEPLOYMENT

Developing Hour of CI lessons requires two tracks to consider: the people writing the lesson content, and the technology and infrastructure that the lessons will run on. This section concerns the technology on which the lessons operate and have been deployed.



The lessons themselves were developed by our wonderful lesson developer team over an extensive period of time on Jupyter Notebooks. Jupyter Notebooks (<https://jupyter.org/>) are open source applications which support extensive deployments of code and code based content. They form the basis of the Hour of CI lessons.

These notebooks contain geospatial data and geospatial computing content from a variety of sources, are written in Python (and encourage learners to learn and run Python themselves), and are hosted for broad distribution on JupyterHub (<https://jupyter.org/hub>).

The Cyberinfrastructure which enables the Hour of CI consists of Jetstream (<https://jetstream-cloud.org/>), an NSF supported cloud-based computation resource, and binderhub (<https://binderhub.readthedocs.io/en/latest/>), which allows for the sharing of code based repositories like those that consist of the Hour of CI lessons.

This distribution ensures that any learner with an internet connection can learn the affordances of cyberinfrastructure.

You can see how this works for yourself in this walkthrough video (<https://echo360.org/media/6ca01456-80f6-4817-af2e-a0ec15b85e27/public>).

TRY IT YOURSELF!

You can sign up for access to the Hour of CI Gateway Lesson right now, and more lessons are under development currently.

Use this link to sign up! (<https://www.hourofci.org/gateway-lesson>)

We have just completed our first pilot of the Hour of CI Gateway Lesson. Our initial pilot with 17 learners indicated through survey results that the lessons are:

Engaging (4.4 average with 5 being Very Engaging)

Effective (4.53 average with 5 being Very Effective) and

Relevant (4.33 average with 5 being Very Relevant)

Take a look at what one of the lessons looks like in these walkthrough videos:

Video 1 (<https://echo360.org/media/5558ed4c-2975-4804-9fcd-e93df3a4c35d/public>)

Video 2 (<https://echo360.org/media/98f38a35-d67a-4540-9c84-291cc25b5fe3/public>)

See you in the Hour of CI!