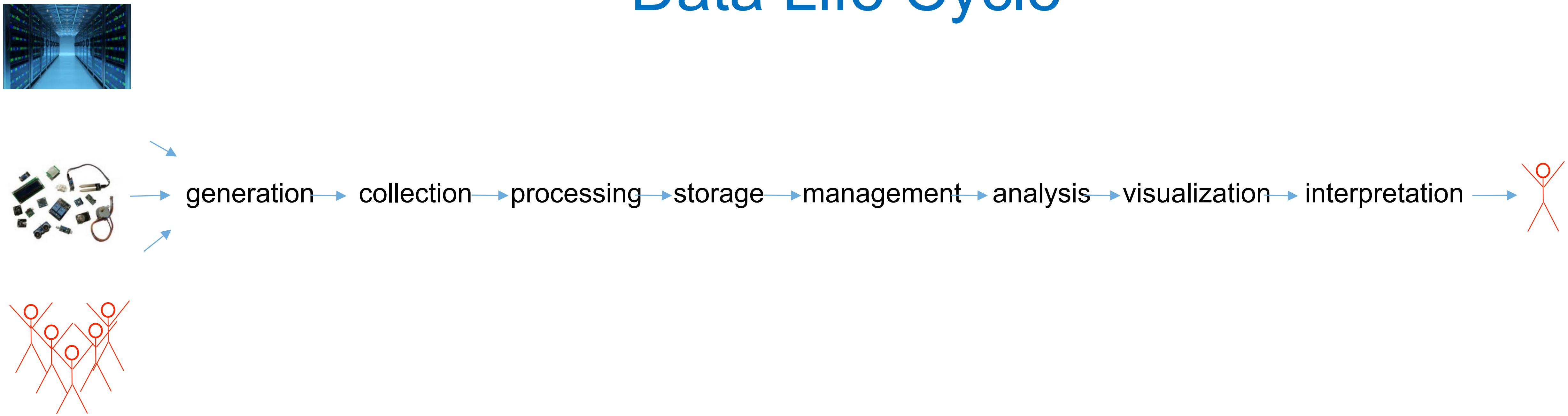
COLUMBIA UNIVERSITY
Data Science Institute

Data Science Meets Open Science

Jeannette M. Wing
Avanessians Director of the Data Science Institute and Professor of Computer Science, Columbia University
Adjunct Professor of Computer Science, Carnegie Mellon University

Open Science Day
EPFL 50th Anniversary
18 October 2019

Data Life Cycle



generation → collection → processing → storage → management → analysis → visualization → interpretation →

privacy and ethical concerns throughout

What is Data Science?

Definition: Data science is the study of extracting value from data.

Outline

- The Good, Bad, and Better News
- Technical and Non-Technical Challenges
- A Big Vision: Academic Cloud

The Good News

Open source software systems are indispensable to practicing data scientists, teaching data science, and researchers

Stan

- Andrew Gelman, Columbia University
- Statistical modeling and analysis platform
- Probabilistic programming language
- Bayesian inference, MCMC built-in, R-based
- Large and diverse user community world-wide
  academia, government, industry

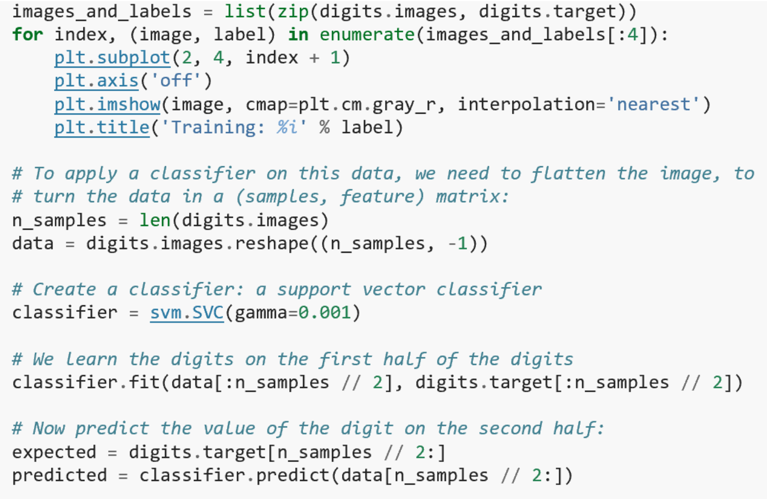
```
parameters {
  real y;
}
model {
  target += -0.5 * y * y;
}
```

→

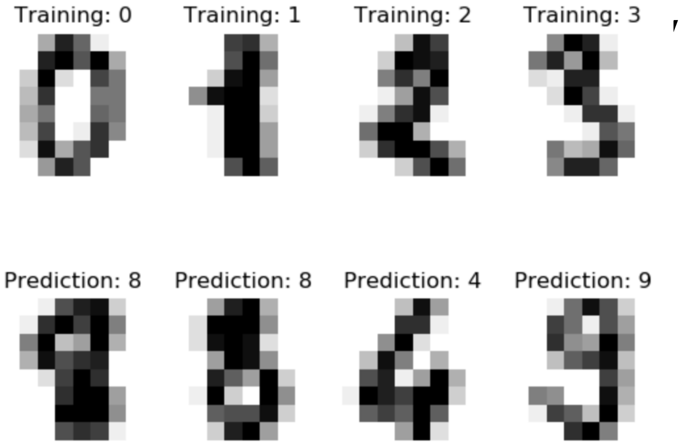
$$\log p(y) = -\frac{y^2}{2} - \log Z$$

scikit learn

- Andreas Mueller, Nicholas Hug, Thomas Fan, (core contributors), Columbia University
- Machine learning
- NumPy, SciPy, matplotlib
- Large and diverse user community world-wide



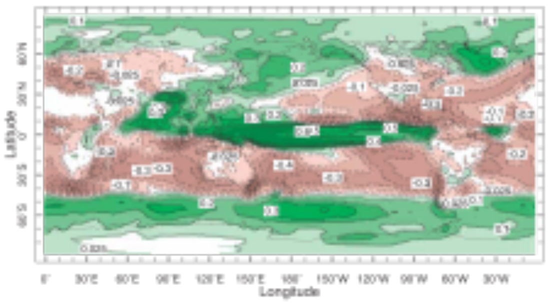
```
images_and_labels = list(zip(digits.images, digits.target))
for index, (image, label) in enumerate(images_and_labels[:4]):
    plt.subplot(2, 4, index + 1)
    plt.axis('off')
    plt.imshow(image, cmap=plt.cm.gray_r, interpolation='nearest')
    plt.title('Training: %i' % label)

# To apply a classifier on this data, we need to flatten the image, to
# turn the data in a (samples, feature) matrix:
n_samples = len(digits.images)
data = digits.images.reshape((n_samples, -1))

# Create a classifier: a support vector classifier
classifier = svm.SVC(gamma=0.001)

# We learn the digits on the first half of the digits
classifier.fit(data[:n_samples // 2], digits.target[:n_samples // 2])

# Now predict the value of the digit on the second half:
expected = digits.target[n_samples // 2:]
predicted = classifier.predict(data[n_samples // 2:])
```

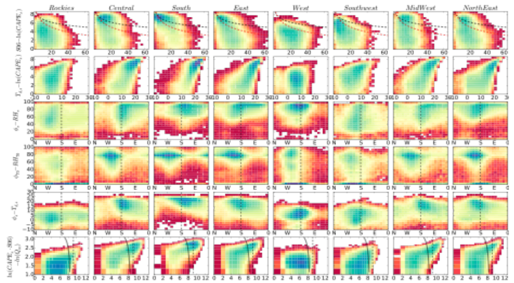


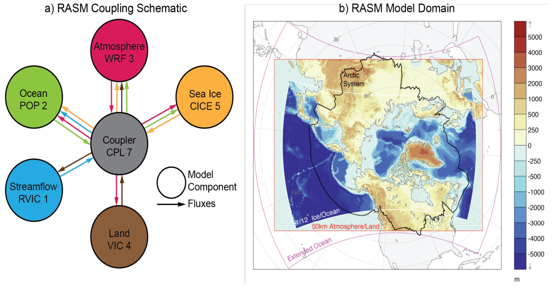
PANGEO

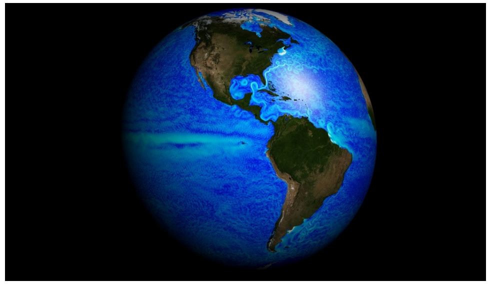
- Ryan Abernathy, Columbia University
- Platform for sharing data, code, and models for geoscience
- Jupyter-in-the-cloud, Python ecosystem
- Applications in meteorology, hydrology, oceanography, climate modeling

$\delta(P-E)$









The Bad News

Much of the big datasets are locked up in companies.

Government funding agencies don’t pay for our unsung heroes and their work.

NETFLIX
Google
Microsoft
amazon
facebook
UBER
Tencent 腾讯
Alibaba.com™
DiDi
Bai du 百度

Data is Locked Up

- Data is locked up for good reason
  - Privacy of customers
  - Data is company asset, and accrues to its bottom-line
- Consequences for science
  - Industry is ahead of academia, in some areas of science

- Academia can/should work on problems industry can’t/won’t
- Academics work inside company, leading to new models of academic-industry relations

Open Source Developers

- Most government funding agencies in the US do not support software engineers
- Academia does not treat them as equal to tenure-track faculty

The Better News

New efforts support data sharing.

New funding sources and culture change for software developers.

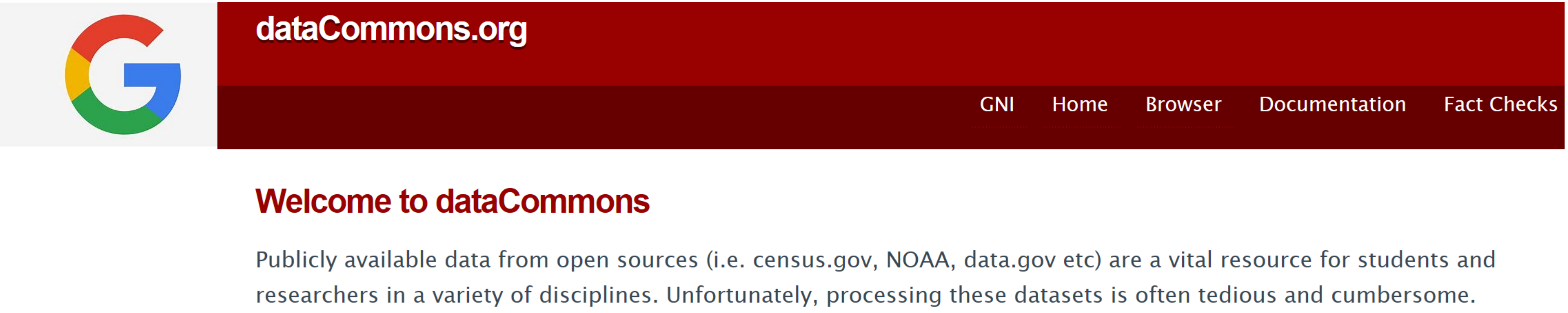
GOVLAB

DATA COLLABORATIVES

CREATING PUBLIC VALUE BY EXCHANGING DATA

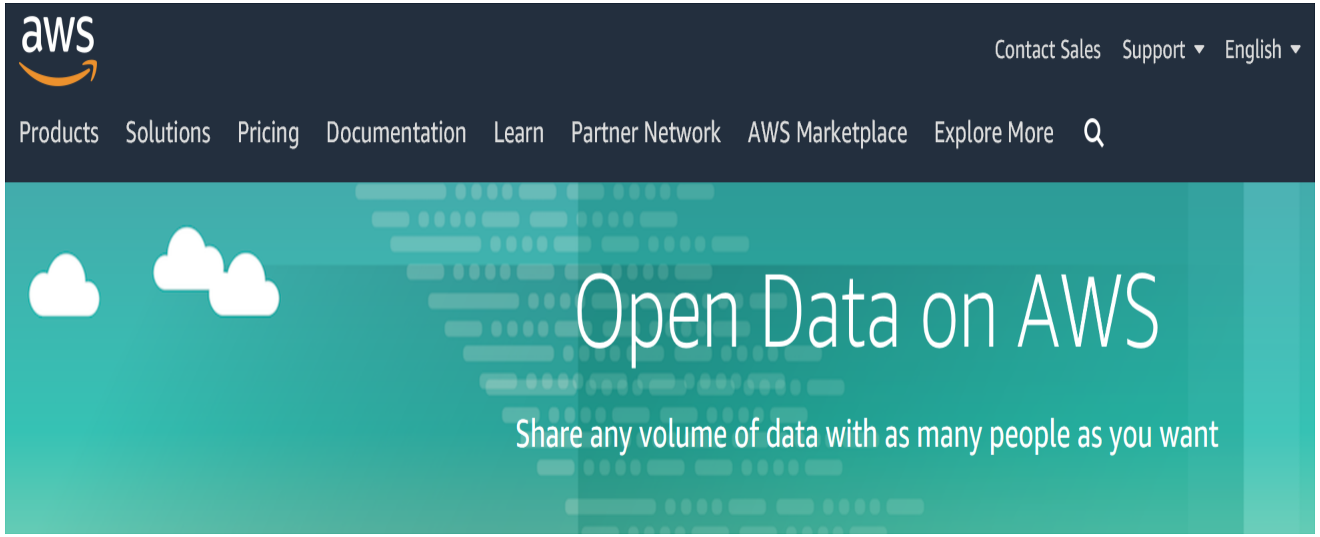
datacollaboratives.org

Private companies (as well as government, non-profits, and academia) exchange **data** to create **public value**.

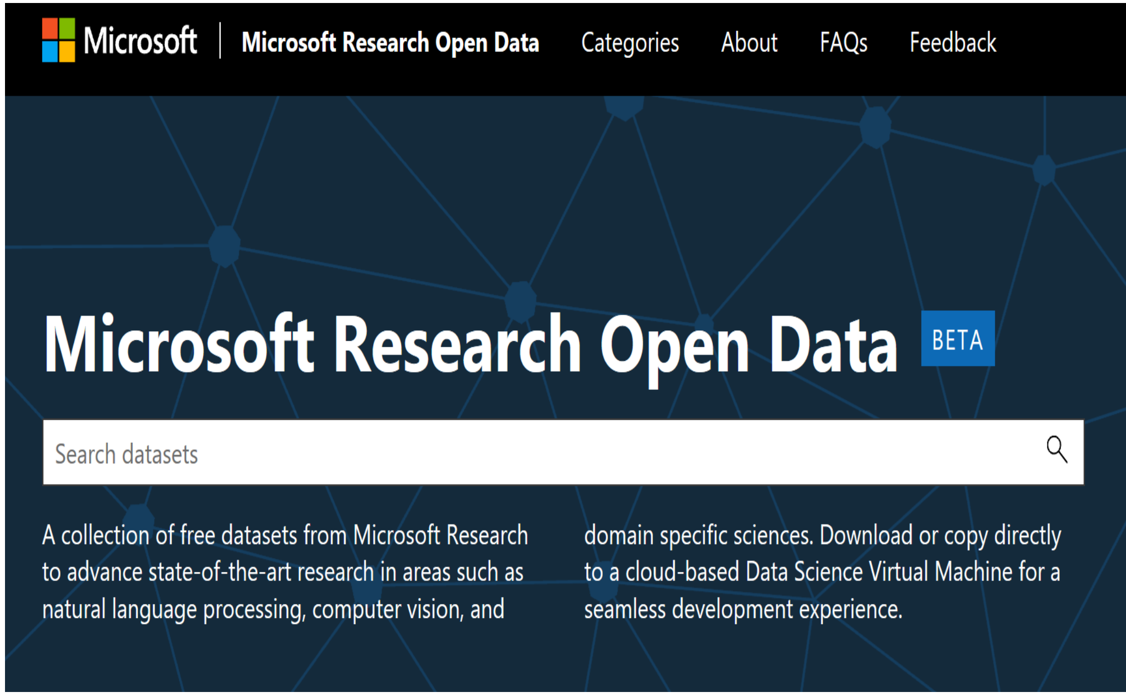


Welcome to dataCommons

Publicly available data from open sources (i.e. census.gov, NOAA, data.gov etc) are a vital resource for students and researchers in a variety of disciplines. Unfortunately, processing these datasets is often tedious and cumbersome.



Share any volume of data with as many people as you want



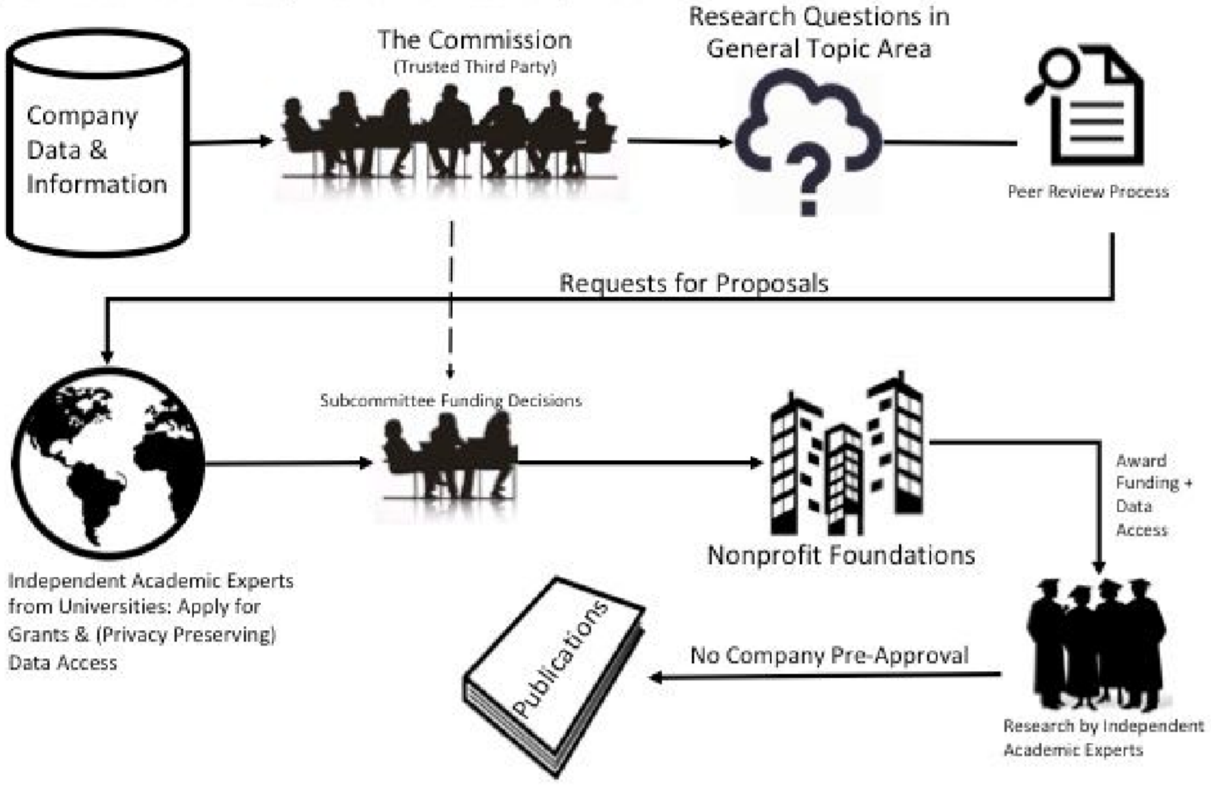
A collection of free datasets from Microsoft Research to advance state-of-the-art research in areas such as natural language processing, computer vision, and domain specific sciences. Download or copy directly to a cloud-based Data Science Virtual Machine for a seamless development experience.

The Social Science Research Council

SSRC + facebook = SOCIAL SCIENCE ONE

Building Industry-Academic Partnerships

Figure 1: Outline of Industry-Academic Partnership Model


Company Data & Information
The Commission
(Trusted Third Party)
Research Questions in General Topic Area
Peer Review Process
Requests for Proposals
Subcommittee Funding Decisions
Nonprofit Foundations
Award Funding + Data Access
Independent Academic Experts from Universities: Apply for Grants & (Privacy Preserving) Data Access
Publications
No Company Pre-Approval
Research by Independent Academic Experts

Gary King and Nathaniel Persily. Working Paper. “[A New Model for Industry-Academic Partnerships](http://j.mp/2q1IQpH)”. Copy at http://j.mp/2q1IQpH

Open Source Developers

- Foundations to the rescue!
  - Chan-Zuckerberg, Moore, Sloan, Schmidt, …
- Forward-looking universities are developing new tracks (or reusing existing ones) to be equivalent to the tenure-track
  - Carnegie Mellon: “systems science”
  - Columbia: “applied data scientist”

Challenges

What should the community focus on next?

What the Community Can Work on Together

- Non-technical
  - Define a “Data IRB”: Institutional Review Board (IRB) process for data
  - Explore new models of academia-industry engagement
  - Create a culture change at universities to acknowledge contributions of open source developers, applied data scientists, etc.
- Technical
  - Make finding and publishing datasets as easy as using the Internet/web/browser
  - Explore “share back” model, to give back control of data to individual. See Inverse Privacy paper, by Gurevich, Hudis, and Wing

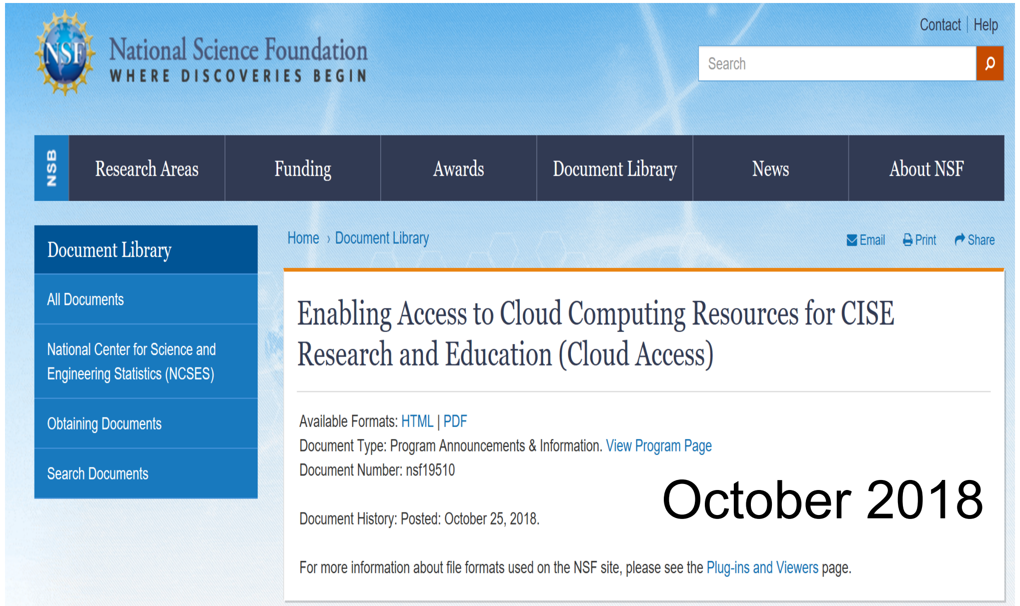
A Big Vision

Academic Cloud

Progress

Academic Cloud for CISE workshop, January 8-9, 2018

“Enabling Computer and Information Science and Engineering Research and Education in the Cloud,” Jennifer Rexford, Magdalena Balazinska, David Culler, and Jeannette M. Wing, ACM Digital Library, June 2018.



Enabling Access to Cloud Computing Resources for CISE Research and Education (Cloud Access)

Available Formats: HTML | PDF

Document Type: Program Announcements & Information. View Program Page

Document Number: nsf19510

Document History: Posted: October 25, 2018.

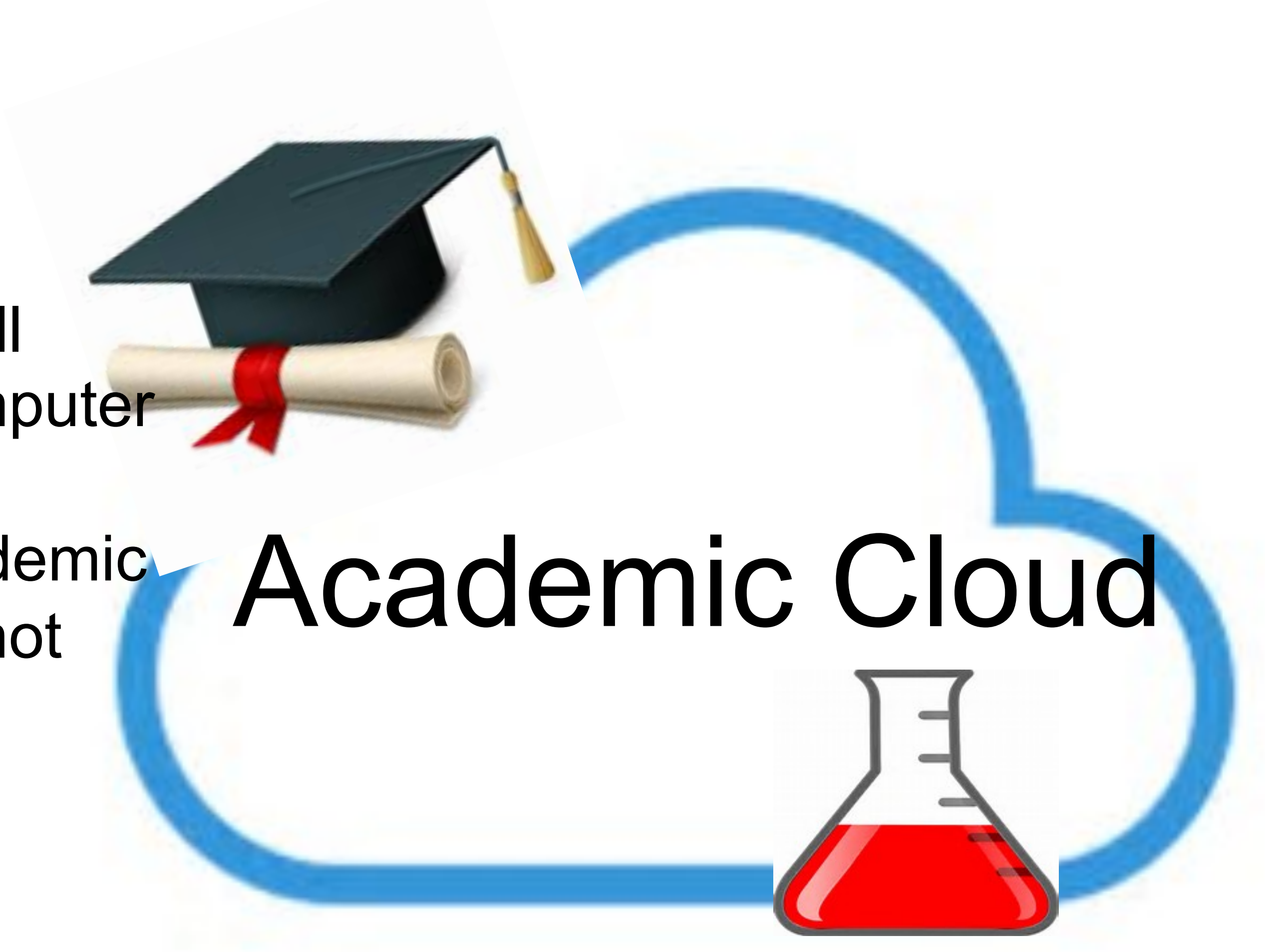
For more information about file formats used on the NSF site, please see the Plug-ins and Viewers page.

October 2018

Coordinating “entity” (UW, UC San Diego, UC Berkeley) awarded August 2019

Academic Cloud = the next “Internet”

But, it needs to be for all disciplines, not just computer science, and ideally (eventually), for all academic institutions worldwide, not just in the US.



Academic Cloud

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Thank You