IOWA STATE UNIVERSITY

Office of the Vice President for Research

Perspectives on Data Driven Discovery

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Big Data Summer School, Iowa State University

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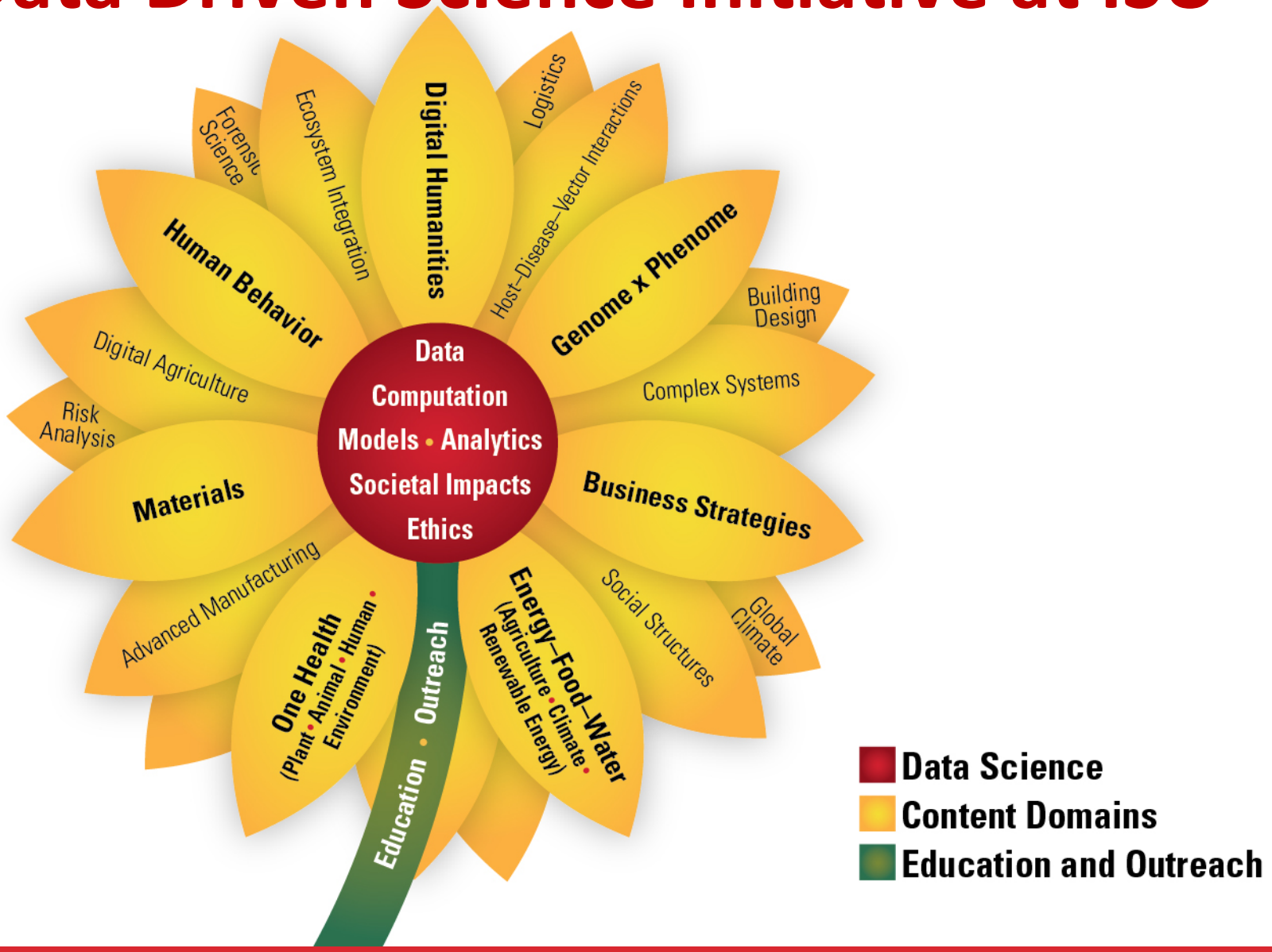
Big Data

- Dozens of Vs?
- Fundamental shift in how we engage with discovery
- Encompasses *not only data*, but *approaches* to research and decision-making that *extract knowledge from complex data sources*
- Our ability to understand data and its underlying structures will soon become as common as regression and microscopy are today

Data Driven Discovery

- *Content domain* or application area – the motivating context
- *Data science* – methodological and broader impacts contexts framed by the application and approach
  1. Methodologies for processing and analyzing data (computing, statistics, curation, …)
  2. Societal impacts (privacy, ethics, …)
- *Education and outreach* – knowledge, tools

Data Driven Science Initiative at ISU



Data Driven Discovery

- Intensely interdisciplinary (applications, methods, societal impacts)
- Funding agencies seek research teams that meaningfully integrate these dimensions
- Pervasive impact also generates huge demand for practical knowledge in the workplace

Challenges

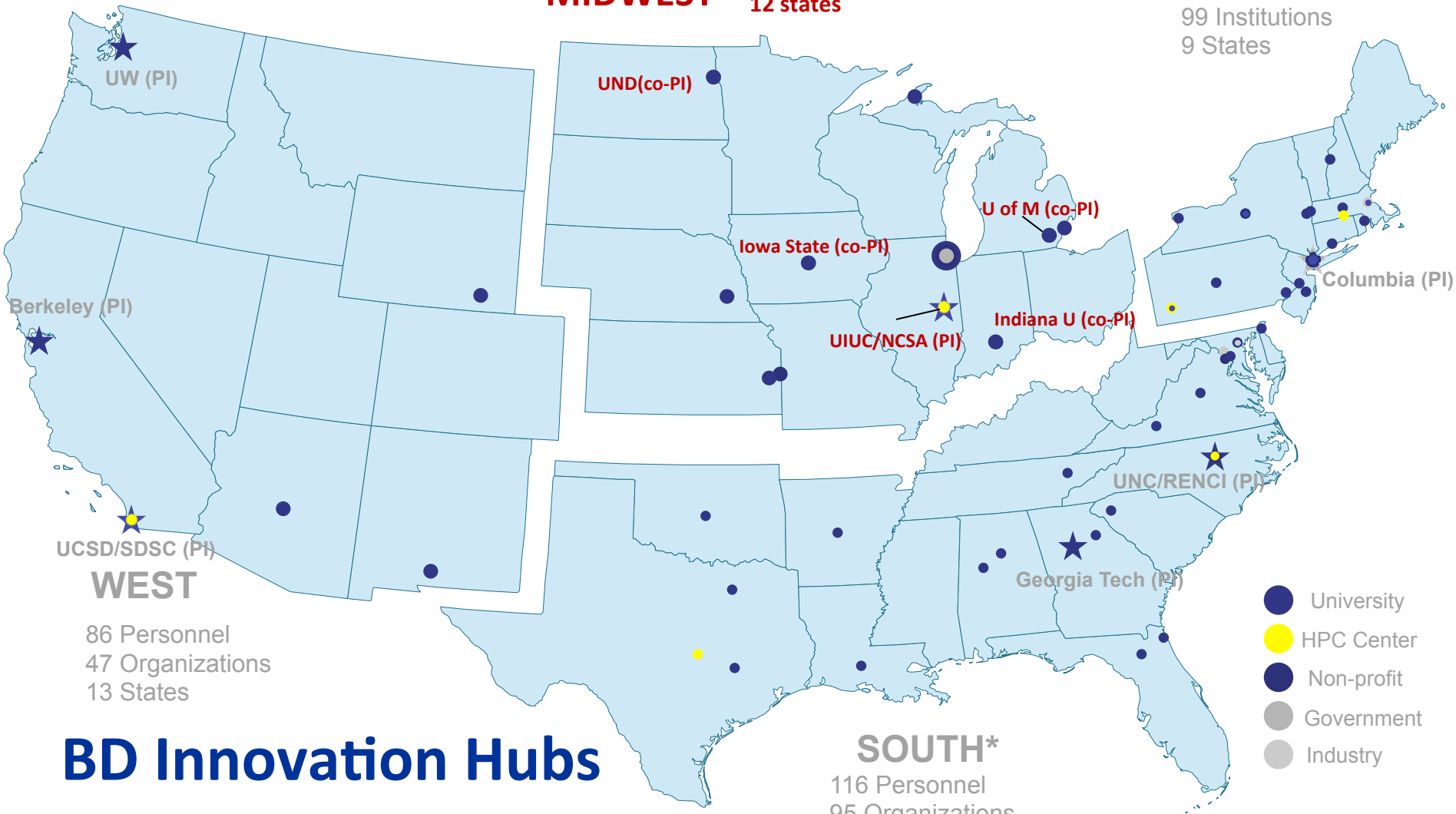
- Inherently interdisciplinary, not really a “field”
- Pervasive, evolving by simultaneously infusing a vast array of fields
- A coherent understanding of big data and data science still emerging
- Insufficient access to knowledge needed to effectively leverage data driven discovery approaches, in all sectors

NSF Support for Addressing Challenges in Big Data

- Research (BIGDATA)
- Computational infrastructure (DIBBS)
- Graduate training (NRT)
- Regional partnership hubs (BD Hubs, Spokes)

An experiment in response to White House mandate to accelerate big data knowledge transfer and innovation across sectors

Alaska & Hawaii are part of the West region
US Territories can participate in any region



BD Innovation Hubs

Points indicate affiliations of individuals named as steering council members and/or task leads.

Midwest Big Data Hub

Accelerating the Big Data Innovation Ecosystem

Ed Seidel
PI (Illinois)

Beth Plale
Co-PI (Indiana)

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Sarah Nusser
Co-PI (Iowa State)

Brian Athey
Co-PI (Michigan)

Josh Riedy
Co-PI (UND)

Melissa Cragin
Executive Director

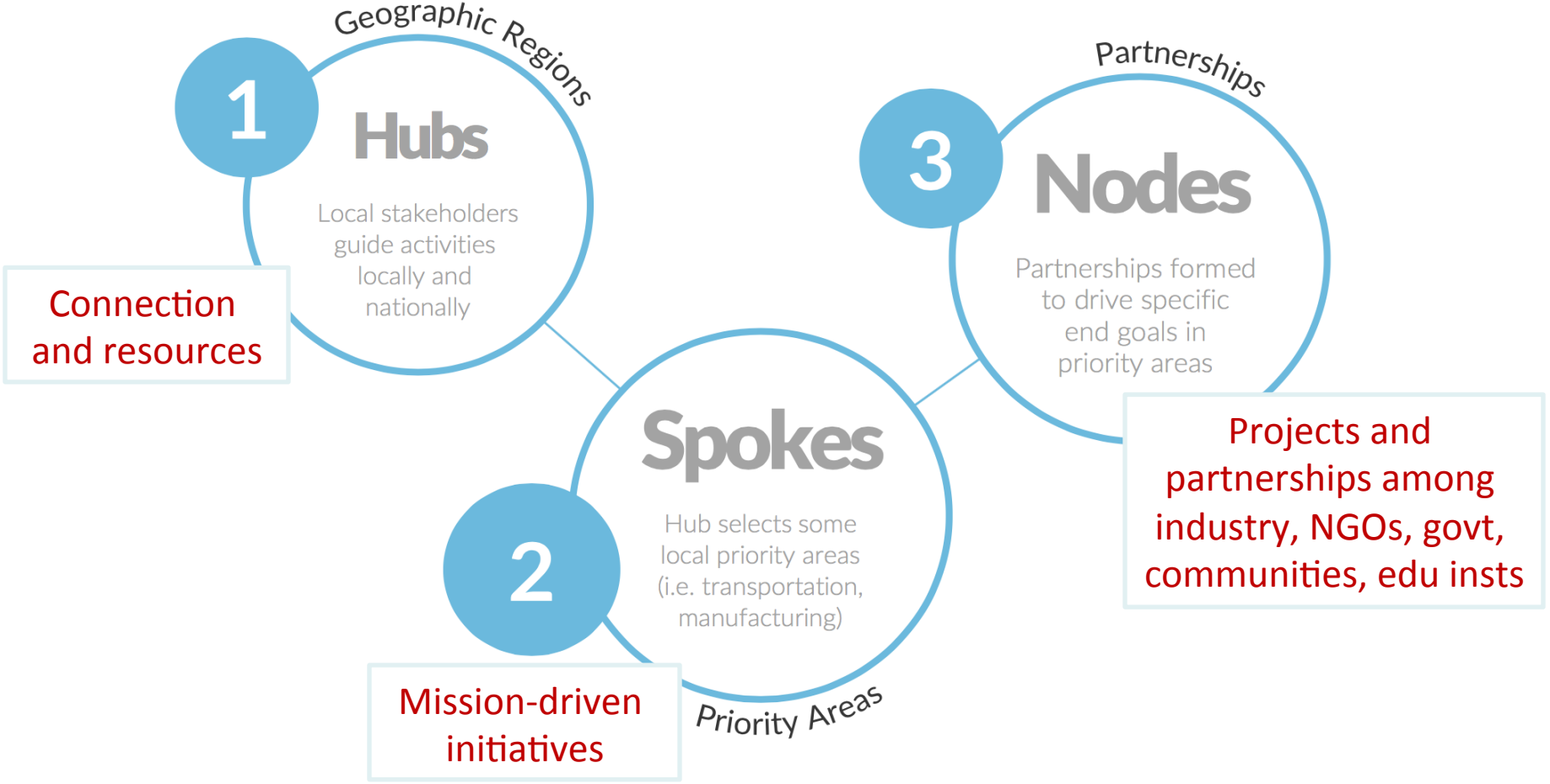
midwestbigdatahub.org

MBDH Mission

Creating effective
cross-sector communities that can
harness the power of data to
address societal problems of relevance
in the Midwest and be a
driver for regional economic development

WHAT IS THE BDHUBS NETWORK?

"Hub and Spoke"– A Nation-Wide Network for Data Innovation



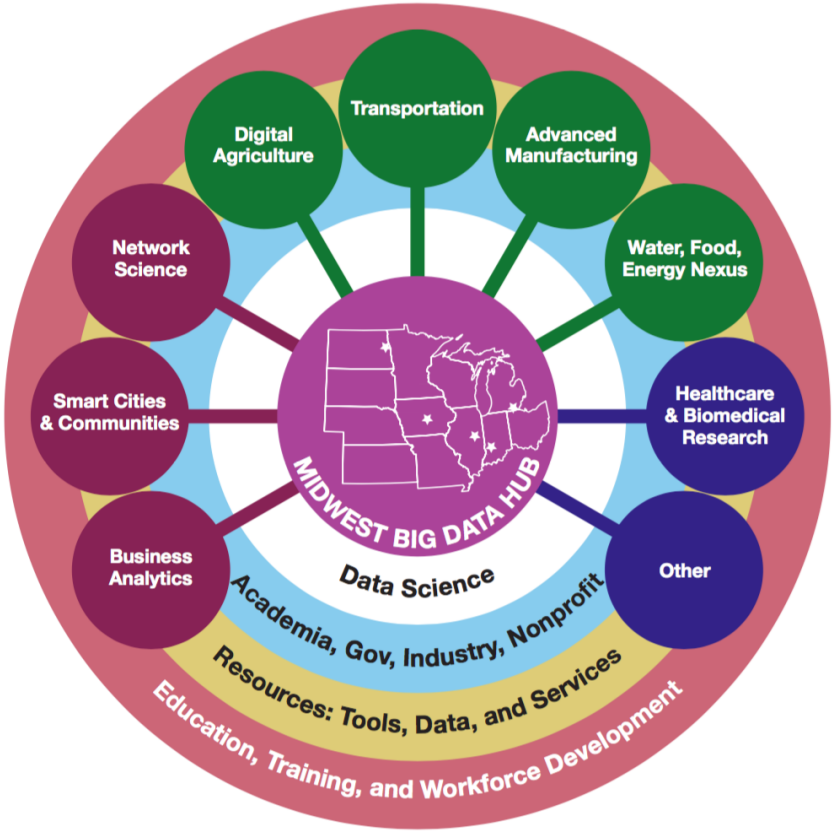
Spokes: Thematic Foci

Cross-sector working groups that facilitate big data innovation in the context of a specific theme

- Contribute to solving grand challenges
- Share assets and resources to address societal issues
- Develop automation opportunities for the data life cycle

MBDH Spokes

- Digital Agriculture
- Food, Energy, Water
- Metropolitan Science
- Transportation
- Healthcare & Biomedical
- Advanced Manufacturing
- Business Analytics
- Network Science
- Others as proposed …



MBDH Cross-cutting Rings

- Data Science
  - Ethical, legal and societal impacts (ELSI)
  - Replicability and reproducibility
- Education
  - New approaches to STEM learning
- Data Tools and Services
  - Data sets, services to share data, and tools to act on them

MBDH Events

midwestbigdatahub.org

- MBDH all-hands meeting (March, Rosemont, IL)
- Digital Agriculture all-hands meeting (May, ISU)
- Midwest Big Data Summer School (June, ISU)
- Data Science for Food, Energy, Water workshop (August, ACM Knowledge Discovery + Data Mining)
- Student Hackathon at U of Iowa
- MBDH all-hands meeting (Oct 10-12, Rosemont, IL)

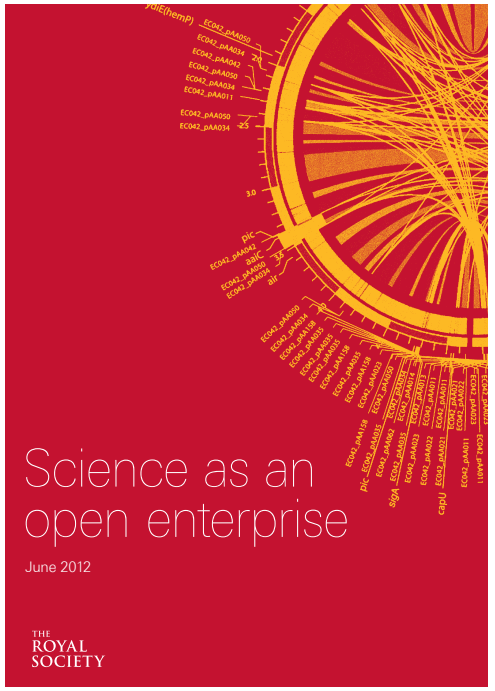
Digital Agriculture All-Hands Mtg

- Participation by academics, foundations, govt, NGOs, industry
- Sally Rockey, Executive Director, Foundation for Food and Agriculture Research
  - Data index – cataloging agricultural data sets and availability
- Industry, start-ups, research communities
  - Sharing new approaches
  - Commercializing tools
  - Creating new business models

Open Science and Inquiry

- Another transformative force
- *Science as an Open Enterprise: Summary Report*

  2012, The Royal Society



royalsociety.org/~/media/policy/projects/sape/2012-06-20-saoe-summary.pdf

Premise of inquiry unchanged

"Open inquiry is at the
heart of the scientific enterprise"

***Science as an Open Enterprise Summary Report*, The Royal Society, 2012**

- Historically, this has involved:
  - Publication of theories, experimental and observational data, interpretations
  - Advancement of ideas through exchanges, colloquia and other venues
  - Self-correction through debate and scrutiny

Practice of inquiry is changing

- Centrality of printed page receding with digital technologies
- Increased emphasis on sharing data publicly
- Large-scale data collection and analysis creates challenges for traditional autonomy of individual researchers
- Internet provides a conduit for networks of scientists and public to collaborate and communicate

Public Health Emergency

- Severe gastrointestinal infection outbreak
  - **May 2011** – 50 deaths/4000 cases in EU/US
  - Rare and little known strain of E. coli
- **Collaborations** on 4 continents, open sharing
  - Draft genome (+3d), genome (+1d), virulence and resistance genes, appropriate antibiotics (+2w)
- Open access to **data** and **publications** led to rapid testing and containment of emergency
  - **July 2011** – Papers published

Open Science and Inquiry

Open data

(available, intelligible, assessable & useable)

combined with

Open access to scholarly publications

and

Effective communication of their contents

[among scholars and public]

Open Data requires more than Access

- Accessible publications and data
- **Effective communication** through more **intelligent openness** when **sharing data**
  - **Understandable** to those who wish to scrutinize data
  - **Assessable** for evaluating reliability of data and competence of data producers
  - **Usable** by others (scholars, public) for understanding and new discoveries

Enabling change – Royal Society List

1. **Culture**: Shift away from a research culture where data are viewed as a private preserve
2. **Credit**: Expand criteria for evaluating research to give credit for useful data communication and novel ways of collaborating (tenure, grant proposals)
3. **Standards**: Develop common standards for communicating data

Enabling change – Royal Society List

4. **Pubs**: Mandate intelligent openness for data relevant to published papers
5. **Workforce**: Increase supply of data scientists to manage and support use of digital data
6. **Tools**: Develop and use new software tools to automate and simplify creation and further use of data sets

Open Science and Inquiry in US

- In the US, other dimensions include
  - Accountability for federal agencies
  - Enabling reproducibility studies
  - Public engagement and trust
  - New opportunities with future reuse

Open Access in the US

- 2013 OSTP memo directed agencies to:
  - Ensure pubs, data from research funding are shared (major funders)
  - Enable costs to be covered in grants
  - Protect privacy and confidentiality, proprietary information, security
- Agencies have responded via DMPs, but still in early stages of mature approach

Open Access to Publications

- Many systems already support open access
  - Journals
  - Agency and disciplinary repositories
- Universities developing policies, programs and recommendations to support open access

Open Data

- Data are not the defined final product that publications represent
- Except for data supporting publications and practice in selected fields, most sharing currently occurs on a small scale
- Disciplinary cultures vary widely in their practices for preparing, sharing, curating data
- Repository system is not complete, nor are guidelines all that helpful currently

Open Data

- What is purpose of sharing? Audience?
  - Validate publication vs reuse, reproducibility
  - Scholars vs public
- What data should be shared for that purpose?
- When should data be protected?
  - Evaluating risk of disclosure
- Alternative approaches for secure release of protected data?
  - Disclosure limitation methods (statistical, systems)

Open Data

- How to communicate data?
  - Context of goals, methods, data manipulations
  - Standards for documenting data
  - Curation practices
- Options for storing data?
  - Data commons, federation of repositories
- Tools for proactive planning in research process?
  - Open Science Center, Research Data Alliance, …

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