



# Research Reproducibility in Control and Systems Engineering

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John Baillieul, Former VP of Publications, IEEE, and Distinguished Professor of Engineering, Boston University

# Systems Engineering and Reproducible Research

Three questions about reproducible research:

- Within systems engineering, what is the level of awareness, interest, concern, and involvement in reproducibility and replicability (R&R) of research results?
- Are there specific areas within systems engineering that are more likely to have issues with reproducing scientific results?
- What reproducibility challenges does systems engineering face with cross disciplinary research?

# Systems Engineering and Reproducible Research

A text for today's briefing:

<http://www.ieee.org/researchreproducibility>

Joint work with:

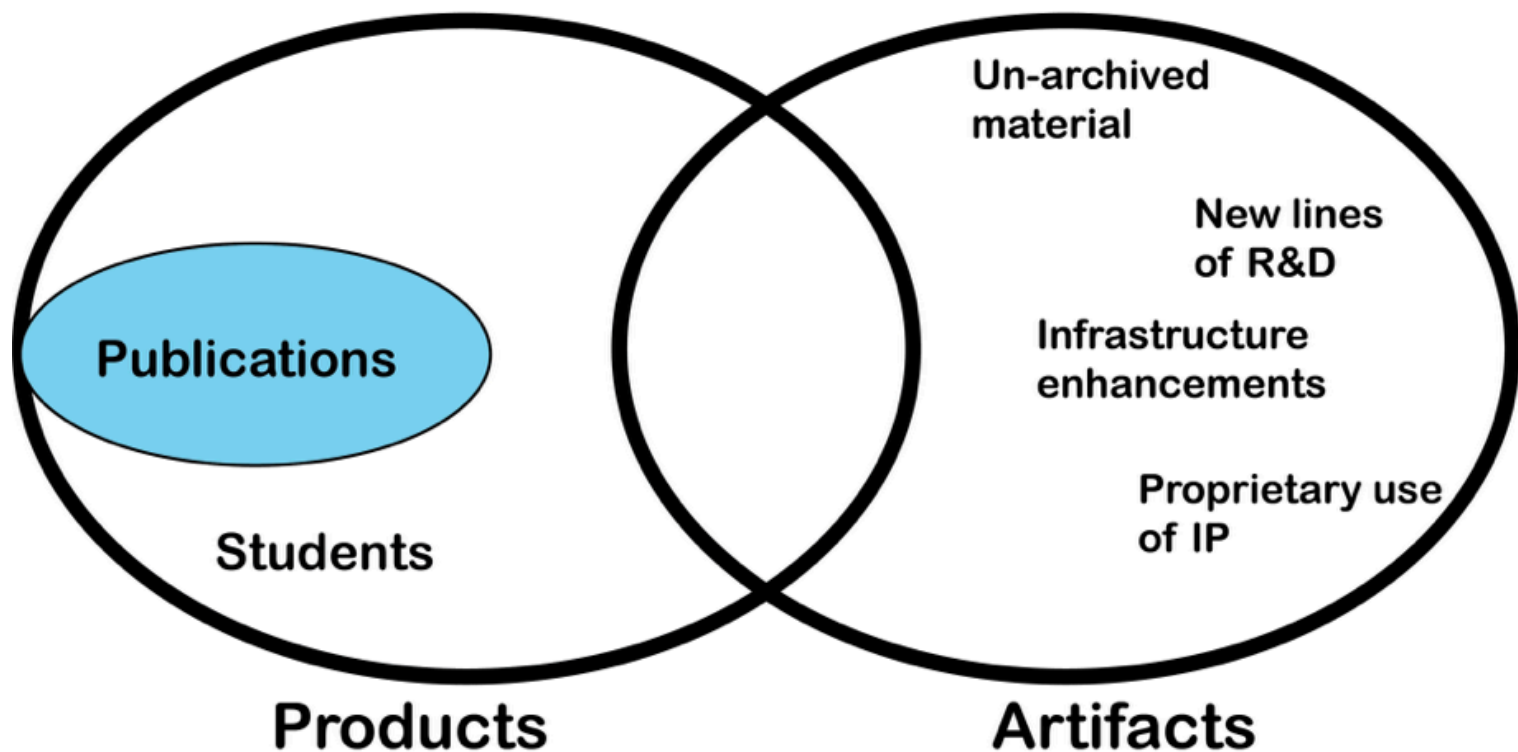
Samir El-Ghazaly, IEEE VP Publications Services  
and Products (PSPB)

Gianluca Setti, former VP PSPB

Gerry Grenier, IEEE Senior Director, Publishing  
Technologies

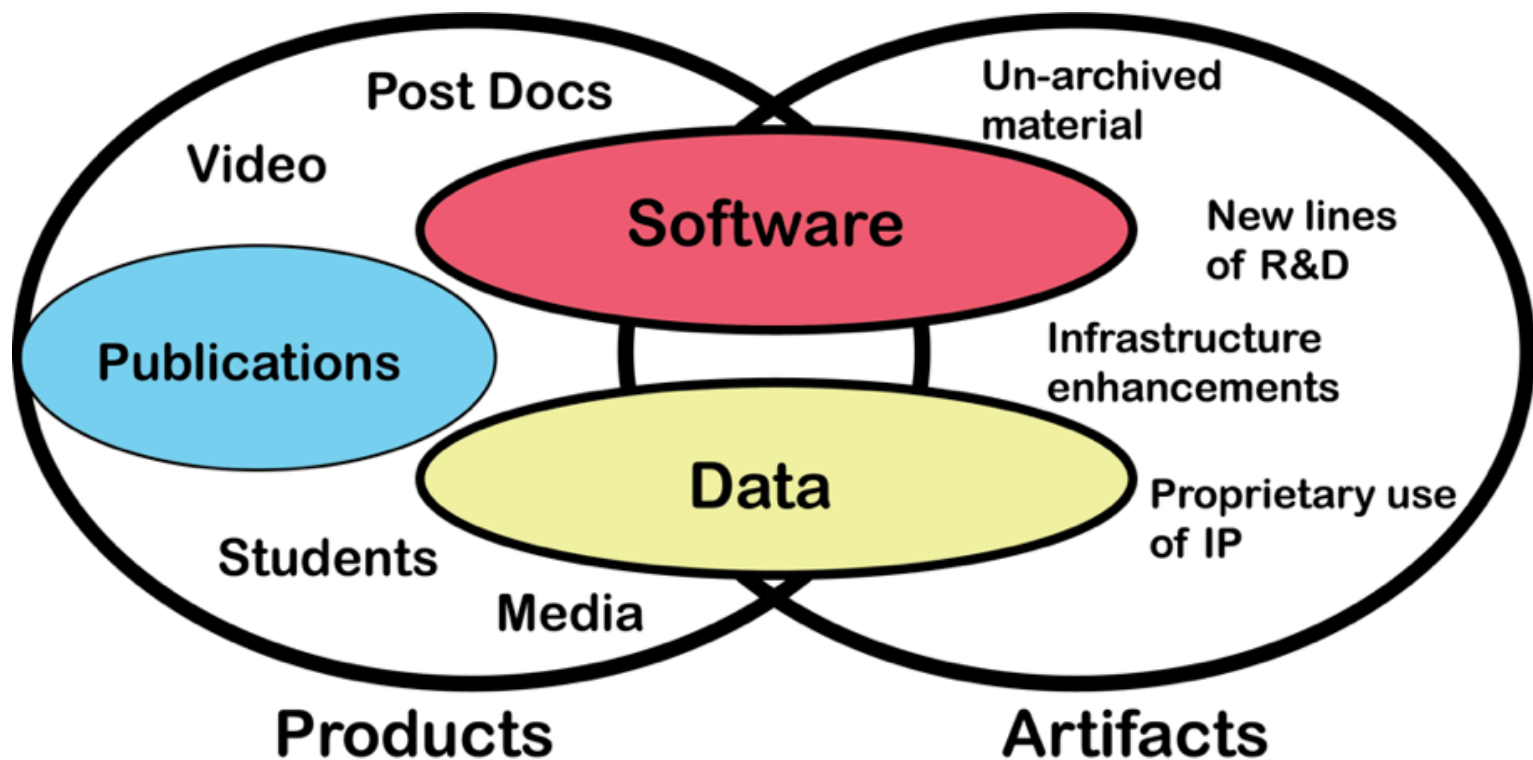
# Systems Engineering and Reproducible Research

## Research Products — Past and Present



# Systems Engineering and Reproducible Research

## Research Products — Past and Present



# Systems Engineering and Reproducible Research

- Research reproducibility is infrequently discussed in systems and control.
- “It’s more relevant in the social sciences than in Engineering.” – A former NSF Assistant Director, 2015.
- Historically, most areas of systems and control have not been involved with data, and although research has had significant software components, it has not been a tradition to publish code.
- There may be change in the air.

# Systems Engineering and Reproducible Research

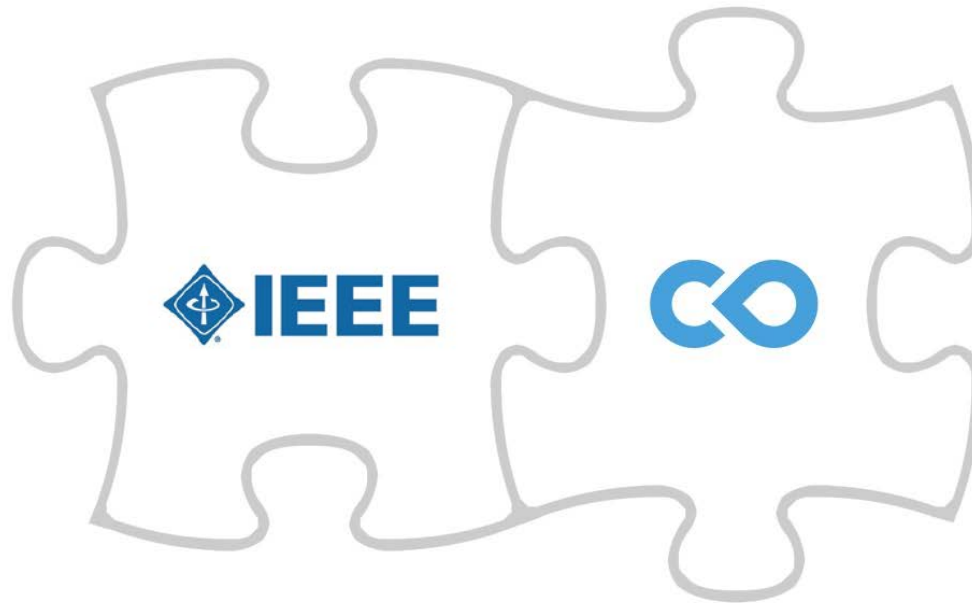
- A growing body of research in robotics deals with exploration and data acquisition.
- Network science has come into its own and is increasingly focused on data
- New journals have been launched:
  - IEEE Transactions on Network Science and Engineering (2014)
  - IEEE Transactions on Control of Network Systems (2014)
  - IEEE Transactions on Signal and Information Processing Over Networks (2015).

# Systems Engineering and Reproducible Research

- Smart grid and advanced building automation technologies are increasingly data intensive
- The increasing use of standard software libraries (e.g. ROS and OpenCV) provide encouragement for researchers to share code.
- The increasing sharing of code using GitHub and other collaboration sites reinforces the tendency to view software as a research product of equal standing to peer reviewed publications.



# Systems Engineering and Reproducible Research



**IEEE - Code Ocean**

**February, 2017**

# What is Code Ocean

An online code execution platform that integrates with any scholarly platform.

<https://codeocean.com/>

Feb. 2017, IEEE and Code Ocean launch joint effort to link journal publications with code



Publisher or repository platform

Plus Code Ocean's technology

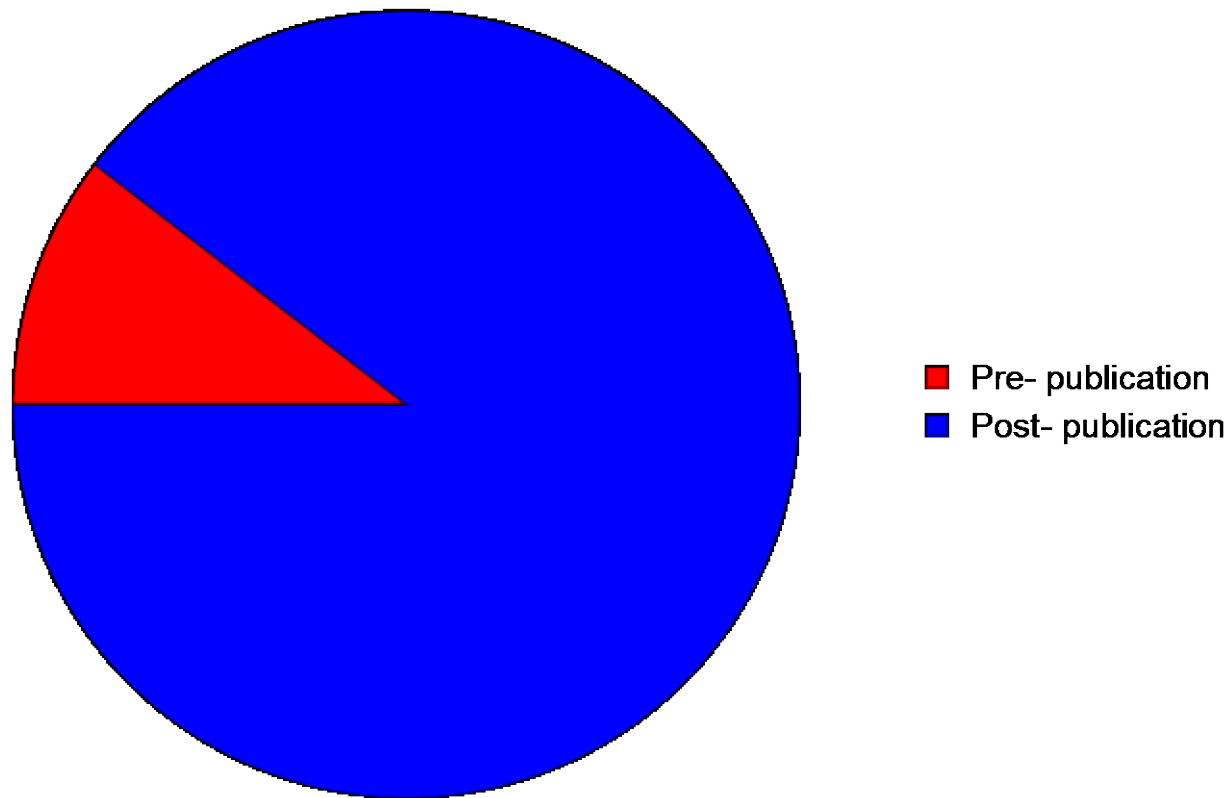


The screenshot displays a web page from 'Scientific Publisher'. At the top, there's a navigation bar with 'Sign in' and 'Register' links. Below the header, the article title 'Tumor Detection Using Diffusion Maps' by John Smith is shown. A small thumbnail image of a brain scan is visible on the right. The article is from 'Progressive Medical Imaging', vol 12, 2015, pp 177-192, dated 08 Feb 2015. Below the title, there are buttons for 'SPREAD THE WORD:' (with social media icons), 'DOWNLOAD PDF', and 'VIEW FULL TEXT'. The 'Abstract' section follows, describing the use of 3-D ultrasound in neuronavigation. Below the abstract, there's a table with tabs for 'AUTHORS', 'CODE OCEAN', 'REFERENCES', 'CITED BY', 'KEYWORDS', and 'METRICS'. The 'CODE OCEAN' tab is active, showing a 'Source Files' section with a list of files including 'Mapping\_For\_Tumor\_Detection.m'. A 'Results' section displays two brain scan images side-by-side, labeled 'Tumor\_Detection\_Evaluation\_1'. The Scientific Publisher logo is at the bottom right.

22 IEEE journals in the beta test

# Systems Engineering and Reproducible Research

## Published Compute Capsule distribution



# Systems Engineering and Reproducible Research

<http://ieeexplore.ieee.org/document/8063416/algorithms>

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## 3D Convolutional Neural Networks for Cross Audio-Visual Matching Recognition

[View Document](#) 356 Full Text Views [Open Access](#)

Comment(s)

4 Author(s) Amirsina Torfi ; Seyed Mehdi Iranmanesh ; Nasser Nasrabadi ; Jeremy Dawson View All Authors

Abstract Authors **Figures** References Citations Keywords Metrics Media **Code & Datasets**

This article contains code made available via IEEE's partnership with Code Ocean, a cloud service that allows users to view, run, modify, and download code from IEEE Xplore articles. Click the code name below to access it on the Code Ocean website.

Name: **3D convolutional Neural Networks for Audio-Visual Recognition**

Programming Language: Python

# Systems Engineering and Reproducible Research

Challenges associated with viewing code, data, and even hardware as primary research products:

- Need to change an established culture to accept *versioning*.
- Need to develop scalable approaches to peer review of non-article research artifacts.
- Probably need new systems of *badging* along the lines being developed by the ACM.
- Code, data, and the associated research record itself need badges.
- Need to understand the boundary between legitimate reuse and plagiarism.

# Systems Engineering and Reproducible Research

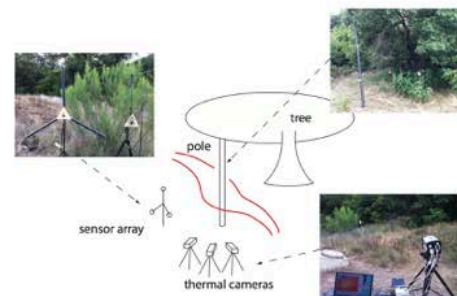
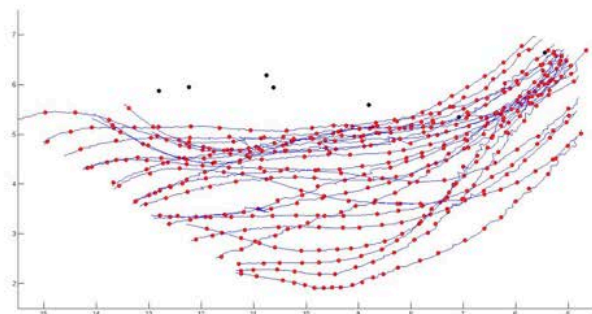
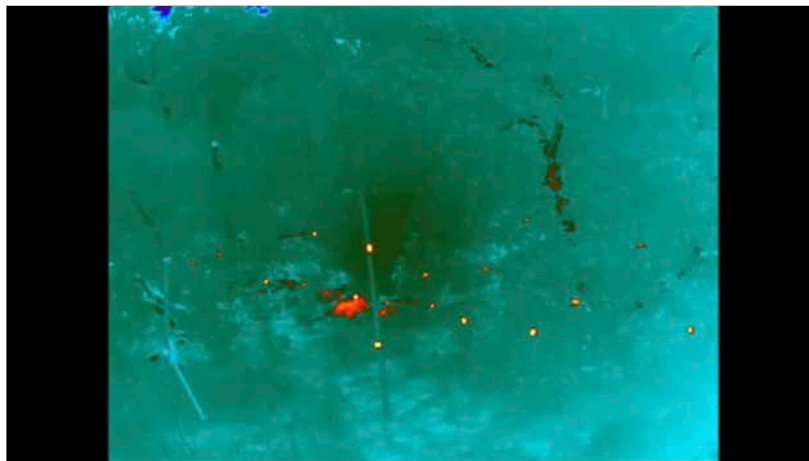
Challenges associated with cross disciplinary research:

**Data**

*Myotis velifer*

15 TB

250 MB



# Systems Engineering and Reproducible Research

Thank you