

# Stanford Neurosciences Institute

Studying the human brain:  
Quantitative magnetic resonance imaging and artificial intelligence

A wide-angle photograph of the Stanford University Main Quad during sunset. The central building, known as the Main Quad, is a large, multi-story structure with a prominent central tower and a large mural on its facade. The building is surrounded by a well-maintained green lawn and several trees. The sky is filled with large, golden clouds, and the overall atmosphere is warm and serene. The text "A campus-wide interdisciplinary research initiative" is overlaid on the bottom half of the image.

A campus-wide interdisciplinary  
research initiative

## THE SNI WAS INITIATED BY PRESIDENT HENNESSY (2013)

*“How our brains enable us to feel, think and act is among the most exciting and consequential problems in all of science.*

*The potential of this inquiry may transform the ways we educate our children, treat illness, seek justice, or pursue innovation.”*



# Stanford Neurosciences Institute – the new building



25 research labs (10 new hires)

Theory center (6 PIs)

Campus hub for 200 neuroscience labs

# Stanford Neurosciences Institute – the new building

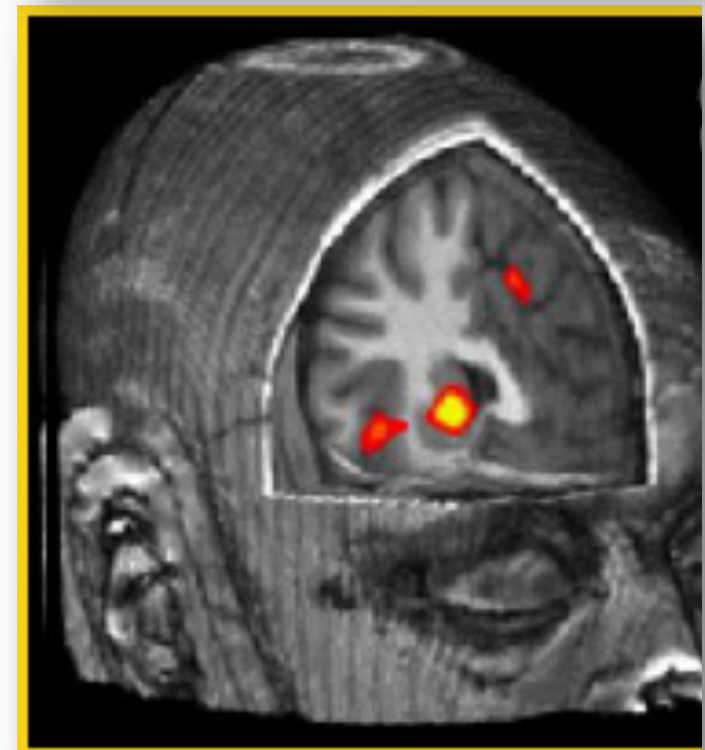
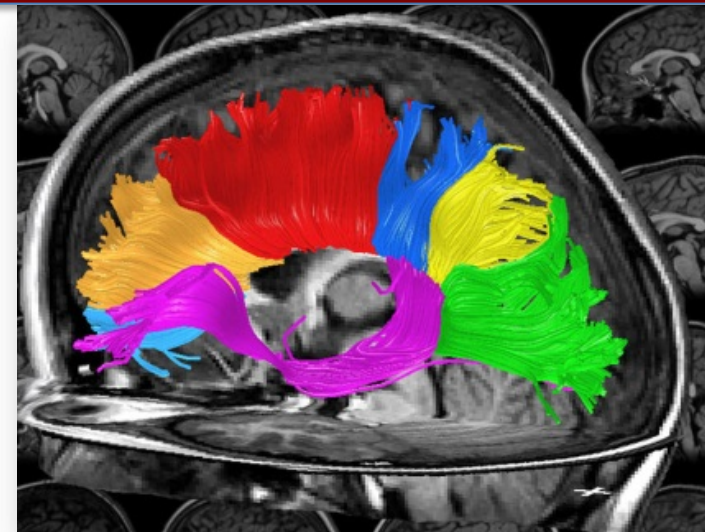
## SNI Executive Committee

Bill Newsome,  
Brian Wandell,  
Rob Malenka, Scott Delp,  
Marion Buckwalter



## The CNI's Mission

- Support neuroscience discovery for enhancing society
- Develop and disseminate imaging methods
- Create a structured, safe, and innovative teaching environment for human neuroscience research



# MRI Installation November 13, 2010



# MRI Installation November 13, 2010



# The CNI is now the most active MRI research scanner on Stanford campus

## CNI Investigators

More than 40 research groups  
and 200 grants

More than 1050 students and  
postdocs trained

Users from Med School, Basic  
Sciences, Engineering, Ed School  
and Business School

## CNI Data

27,000 anatomicals

73,000 functional acquisitions

7400 diffusion scans

100T of MRI data just at this one  
center

Scanner uptime estimated at 99%

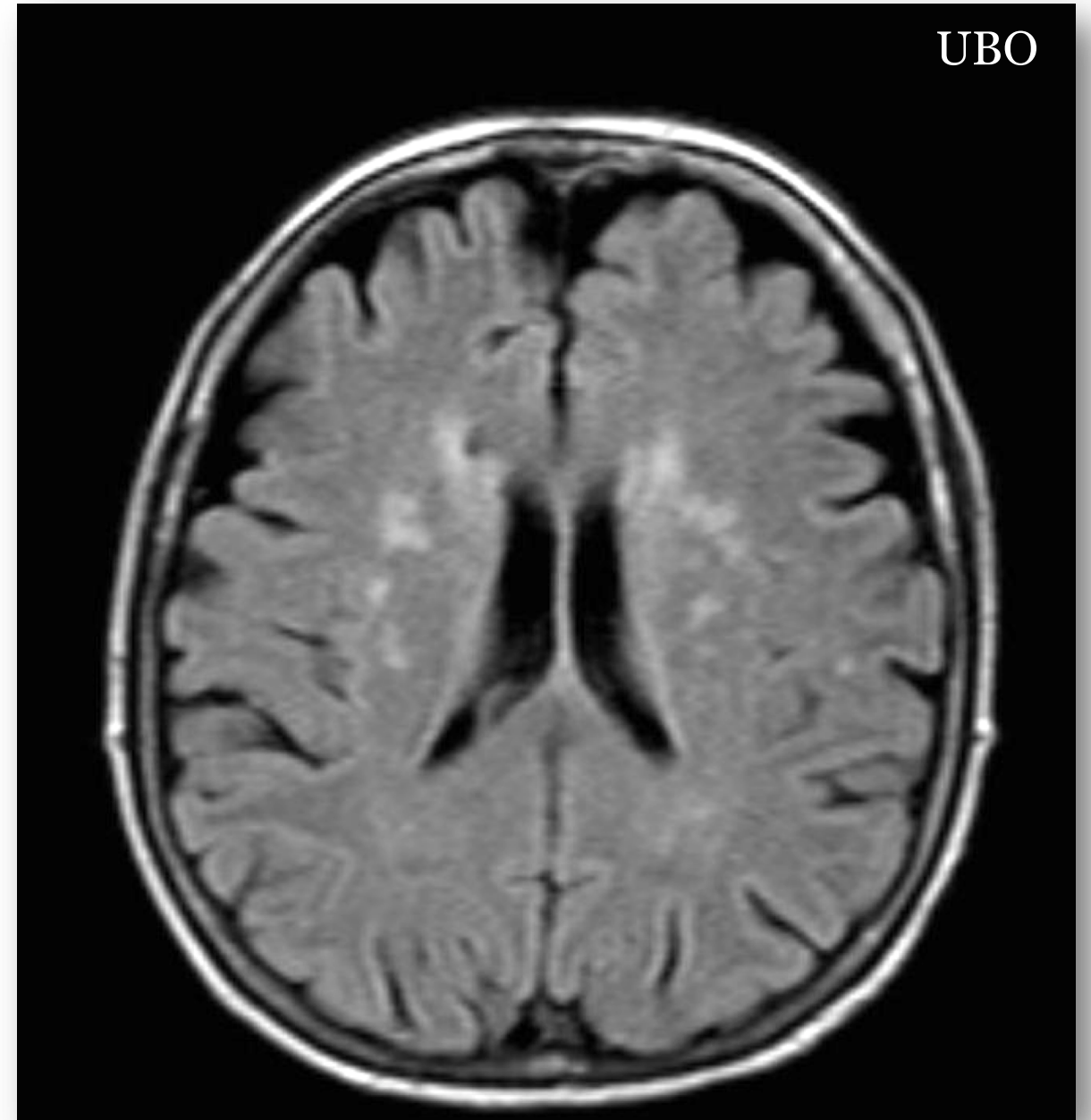
# CNI: Principles and technologies

- Quantitative MRI
- Data and artificial intelligence tools
- Commercial collaborations



# Quantitative MRI: Multiple sclerosis diagnosis

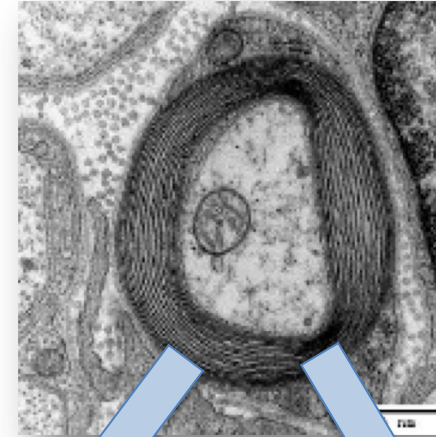
- Historically, MRI in Radiology has been a qualitative field
- This image illustrates a well-known type of diagnosis
- The doctor sees the image and notices that there are surprising white regions, called **UBOs**
- S/he measures the number and area of these white regions and calls it the 'burden'



# Quantitative MRI – measure the substrate based on biophysical principles

- Every region of the brain includes water and other, larger, molecules
- Typical magnetic resonance (T1) measures energy transfer between both water and other macromolecules
- With modern methods we can now quantify in each  $1 \text{ mm}^3$  voxel **what fraction is water** and make **quantitative measures** about the macromolecules

Brain tissue



$$T_1(\text{measured}) \leftarrow \{ T_1(\text{molecules}), T_1(\text{water}) \}$$

# Quantitative MRI: new opportunities in mental health care

- New applications for MRI
  - Psychiatric disorders
  - Reading and learning disorders
  - The effect of drug therapies on neurodegenerative diseases ...
- Quantitative and labeled data
  - Machine learning applications
  - Comparisons across instruments, people and over time

Different data acquisition sites around the world



New software tools are needed to enable this advance

I founded a commercial venture, Flywheel.io, to implement the vision

# See How Flywheel Empowers Neuroimaging Research

A Stanford University VistaLab Success Story

DOWNLOAD IT HERE



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# Research Data Management Solution



# Visualization and Artificial Intelligence

The screenshot displays the FLYWHEEL web application interface. On the left, a navigation sidebar includes sections for DATA (Projects, Sessions, Collections, Upload), GEARS (Installed Gears, Gear Rules), and ADMIN (Users & Groups, Project Report, Usage Report, Access Log). The main content area is titled 'Projects' and features a table with columns for PROJECT, GROUP, SESSIONS, SUBJECTS, USERS, and ACCESS. Below this, there are detailed views for 'Anxiety Study' and 'Depression Study', including session lists, acquisition logs, and analysis results. A 'SESSIONS (14)' table shows details for various sessions, and an 'ACQUISITIONS (166)' table lists specific acquisition parameters like '3Plane Loc: BPFSE' and 'T1: high-res: mprimg: FSPGR BRWAO'. A 'SUBJECTS (10)' table is also visible at the bottom left.

This screenshot shows a medical imaging software interface with three MRI brain scans. The scans are displayed in axial, sagittal, and coronal views. A green crosshair is overlaid on each scan, indicating a specific region of interest. A yellow circle highlights a small area on the axial scan. The word 'Labeling' is written in white text across the top right of the scans. Below the scans, there is a '1000 Viewer' window displaying a series of blue waveforms, likely representing functional data or time-series analysis.

# Stanford CNI

The Researcher's Data & Analysis Platform

FLYWHEEL

Sign in with Google

## Overview

15,000 scan sessions

7,500 subjects

40 research groups

## Data acquisitions

75,000 fMRI

25,000 Anatomical (T1)

7500 Diffusion

640 Spectroscopy

FLYWHEEL

Search

DATA

Projects

Sessions

Collections

Upload

GEARS

Gear Rules

Installed Gears

REPORTING

Project Report

Usage Report

ADMIN

Projects

Filter by Name

All Groups

Create New Project

PROJECT GROUP SESSIONS SUBJECTS USERS ACCESS VIEW

ADNI: DWI (AD) ADNI (adni) 154 49 Admin

ADNI: DWI (MCI) ADNI 162 42

ADNI: DWI (Norm) ADNI 162 42

ADNI: T1

Albinism: Control

ALDIT

FLYWHEEL

Search

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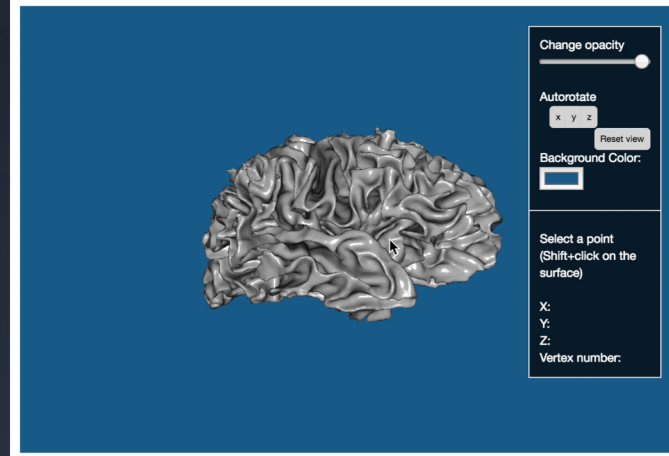
ADMIN

Users

Groups

Projects

rh.white.obj



# Commercialization adoption

“Flywheel, together with the Google Cloud Platform, are the nervous center of our Center, providing the innervation for the many coordinated functions of a modern, distributed laboratory potentially spanning the world,”

“Leveraging the power of the cloud is obvious and central to the future of scientific investigation.”

Professor Thomas Vaughan, Director  
Columbia MR Research Center  
Zuckerman Institute

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**Google, Flywheel partner for 1st cloud-based MRI research center at Columbia**

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# Flywheel Customers, Partners, Collaborators



# Google Cloud Partner



## Next Partner Summit 2018: Elevating Higher Education with GCP Offerings

Jul 24



### Stanford University: Improving scientific data management

*Brain Scapes by Laura Jacobson*

**Stanford**  
University

#### About Stanford CNI and VISTA Lab

The Stanford Center for Cognitive and Neurobiological Imaging (CNI) provides resources for cognitive and neurobiological research, while Stanford's VISTA Lab conducts research on vision science.

**FLYWHEEL**

# Cloud-scale collaborative science

- Quantitative MRI for generalization across instruments, time, and people
- Data management from multiple universities and research hospitals
- Computational support, including machine-learning, for science and precision health

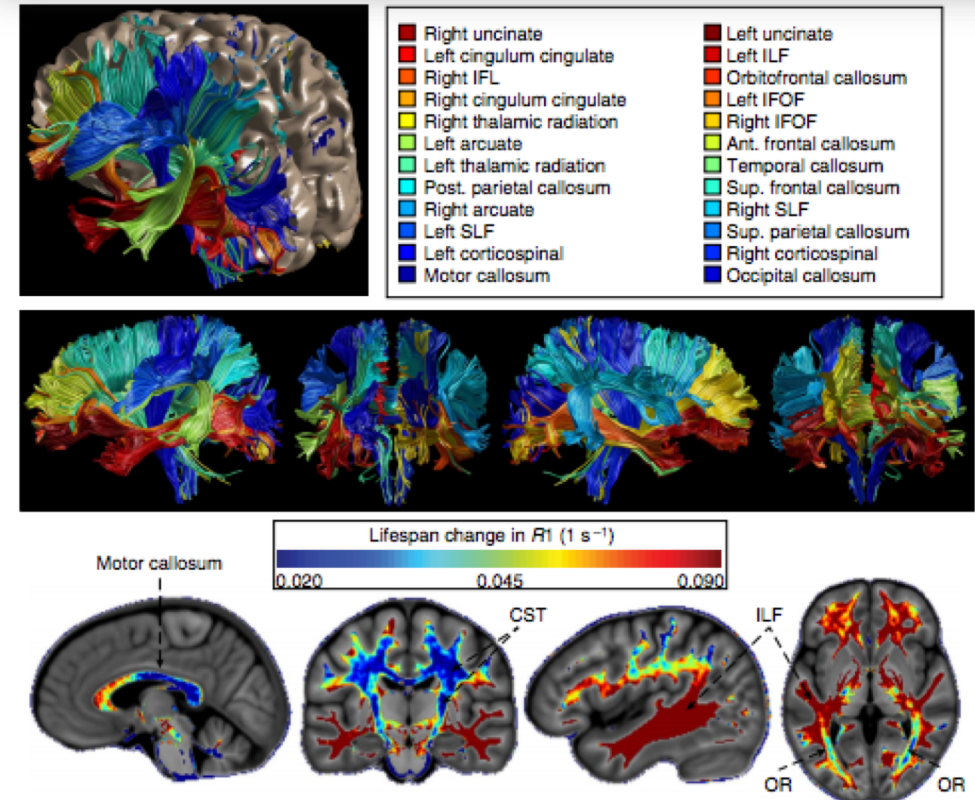
ARTICLE

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## Lifespan maturation and degeneration of human brain white matter

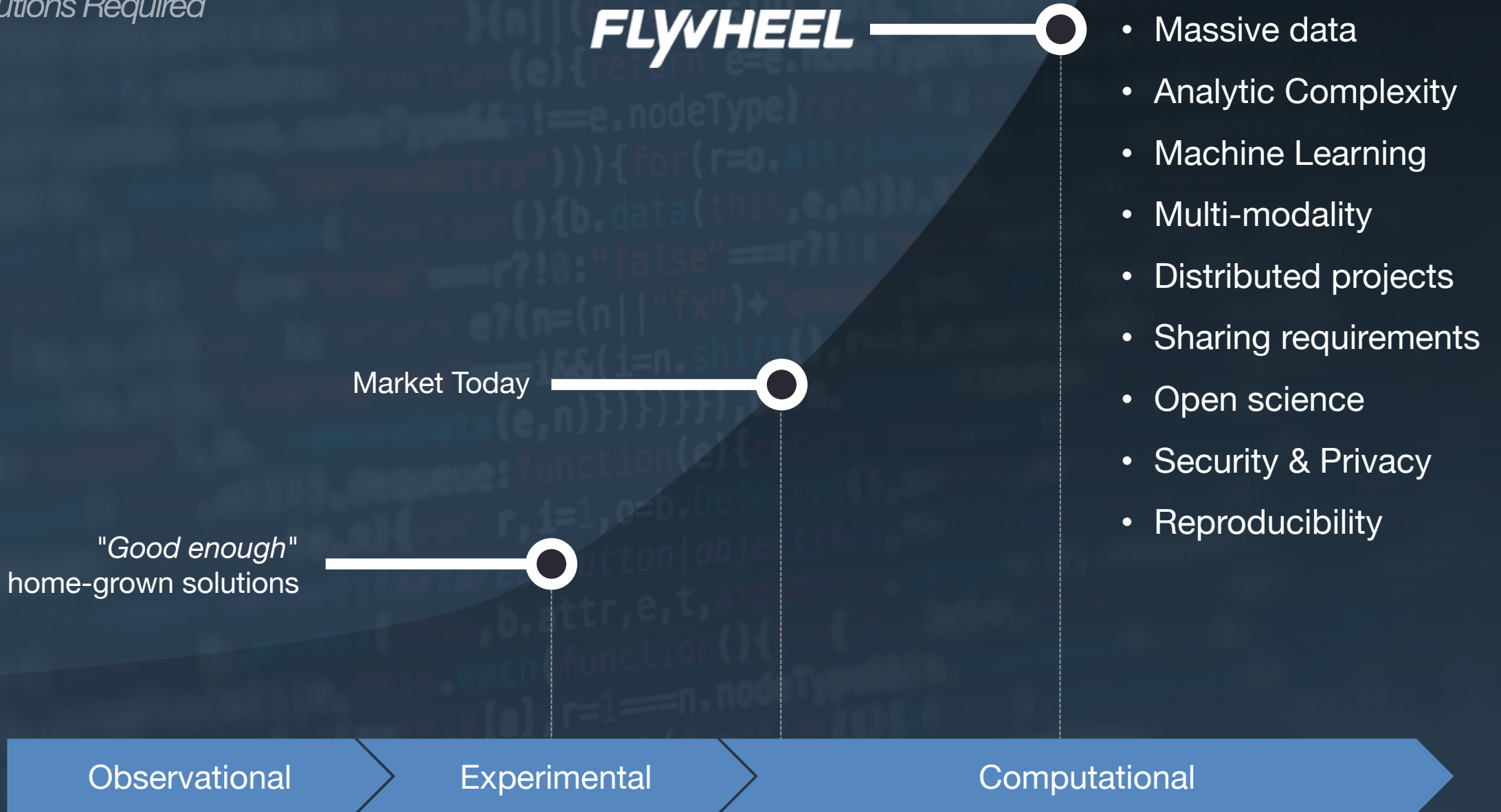
Jason D. Yeatman<sup>1,2</sup>, Brian A. Wandell<sup>1,2</sup> & Aviv A. Mezer<sup>1,2,3</sup>



# Research Complexity is Increasing

*New Solutions Required*

**FLYWHEEL**



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Stanford Neurosciences Institute (SNI)  
Stanford's Center for Cognitive and Neurobiological Imaging (CNI)

Thank you for your attention

A campus-wide interdisciplinary  
research initiative