

## **Breakout Session 4: Track A**

# **Google Cloud Pipeline for Mouse Behavior and Frailty Assessment for the Aging Research Community**

Dr. Vivek Kumar (Moderator)  
*Associate Professor, The Jackson Laboratory*

# Google Cloud Pipeline for Mouse Behavior and Frailty Assessment for the Aging Research Community

Vivek Kumar, PhD  
Associate Professor  
@vivekdna

ODSS cloud program PI meeting  
Jan 17-18, 2024



# Kumar lab



Key Individuals: Brian Geuther, Leinani Hession, Gautam Sabnis, Keith Sheppard, Glen Beane



**Develop better pre-clinical animal models**

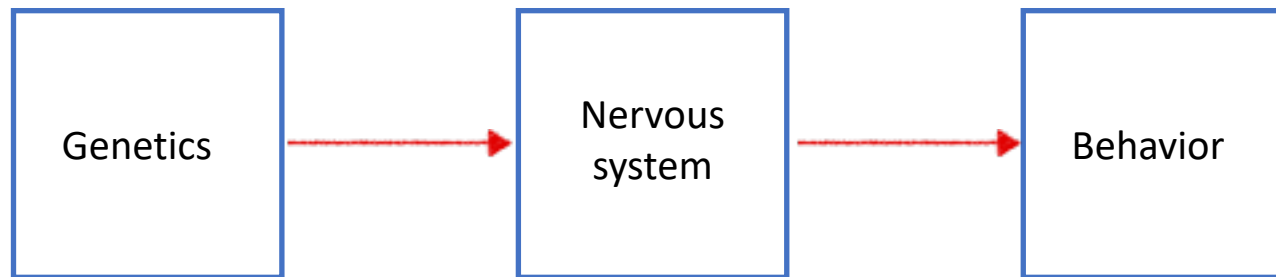
**Aging**

**Neuropsychiatric**

**Neurodevelopmental**

**...**

# Simple Model



# How do we study behaviors in mouse models?



# Current methods

- Subjective
- Standardization
- Fragmented studies
- Lack proper validity

***INCREASED VARIABILITY***

***POOR REPRODUCIBILITY AND REPLICABILITY***

***DECREASED TRANSLATABILITY***



OPINION

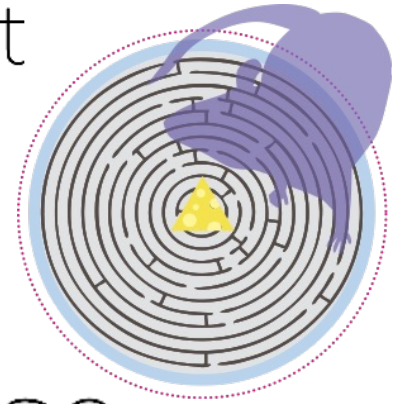
## Misbehaving mice

BY VIRGINIA HUGHES / 19 AUGUST 2010

NEWS

## Mutant mice show inconsistent behaviors in different labs

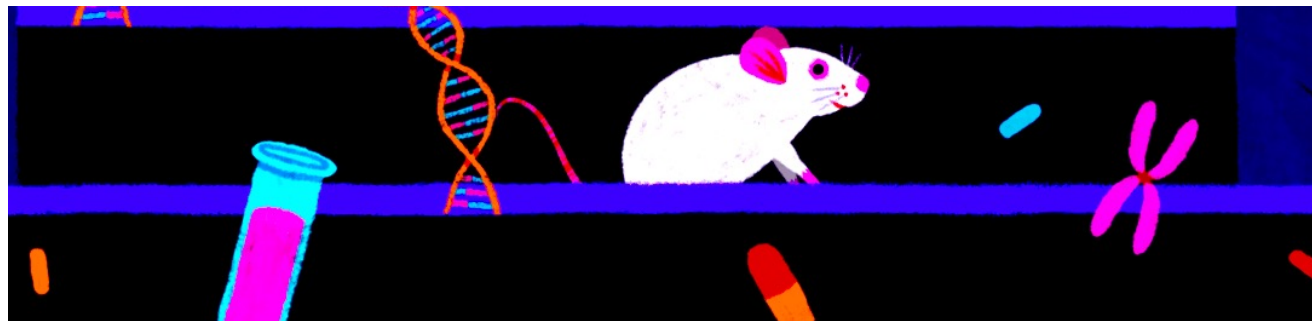
BY EMILY SINGER / 7 JANUARY 2013



OPINION / VIEWPOINT

## Promises and limitations of mouse models of autism

BY JACQUELINE CRAWLEY / 10 MAY 2011



ILLUS

Why studying autism in mice may be doomed to fail

## Why animal research needs to improve

29 SEPTEMBER 2011 | VOL 477 | NATURE | 511

Preclinical Success To Clinical Failure: Do We Have A Model Problem Or An Endpoint Problem?

**nature** International weekly journal of science

Published online 30 March 2010 | Nature | doi:10.1038/news.2010.158

News

**Animal studies paint misleading picture**



# Toward a Science of Computational Ethology

David J. Anderson<sup>1,2,4,\*</sup> and Pietro Perona<sup>3,4,\*</sup>

<sup>1</sup>Division of Biology and Biological Engineering

<sup>2</sup>Howard Hughes Medical Institute

California Institute of Technology, Pasadena, CA 91125, USA

<sup>3</sup>Division of Engineering, California Institute of Technology, Pasadena, CA 91125, USA

# Can we do better?

## Use computer vision + machine learning

- Increased reproducibility and replicability
  - Standardized pipeline
  - Objective measurements
- Allow reuse of data
- Highly scalable
- Increased translatability

# Kumar Lab Publications

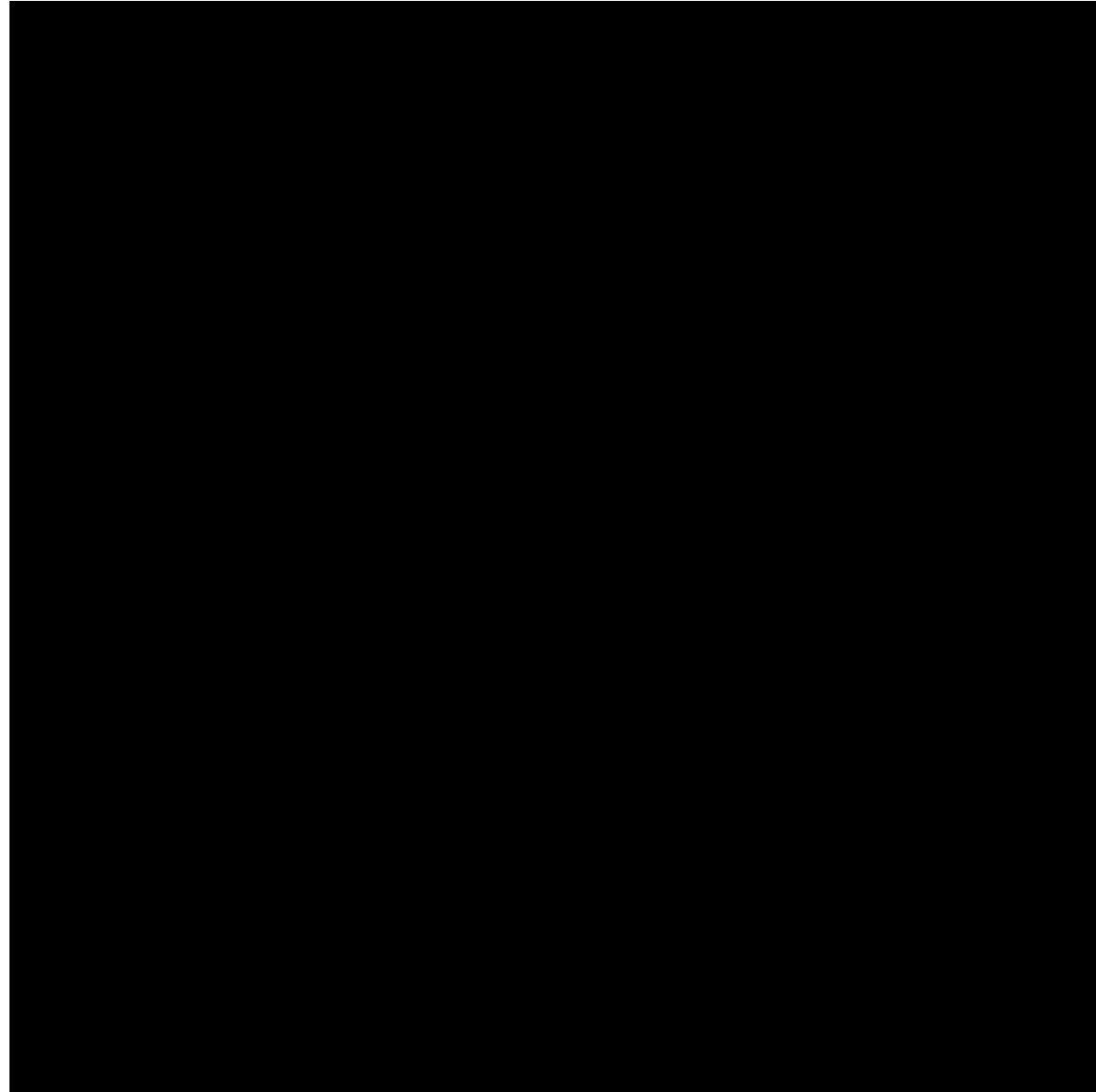
- Action detection (eLife, 2021)
- Mouse tracking (Nature Comm. Biol, 2019)
- Nociception assay (Mol. Pain 2020)
- **Gait and posture (Cell Reports, Jan 2022)**
- Sleep states (Sleep, 2021)
- **Frailty Index (Nature Aging, August 2022)**
- Social Interaction (unpublished)

***Accuracy, scalability, replicability***

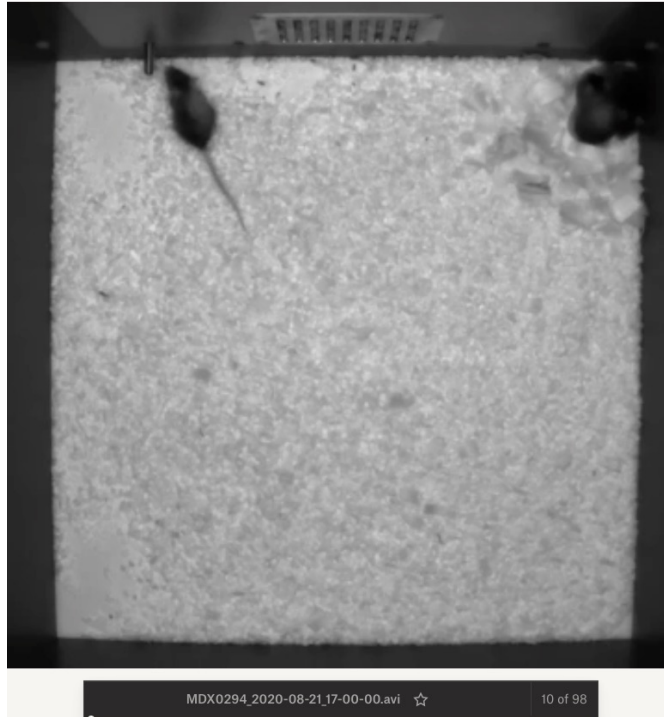


# Video Processing for analysis

Custom NN with pose, identity tracking



# Long Term Monitoring Dataset



800x800 px

30fps

8bit grey

1 hour video chunks

Total video count is 10944

Each video is 10-15Gb

**Total dataset is ~150Tb**

Located in Dropbox



# Visual Frailty Index

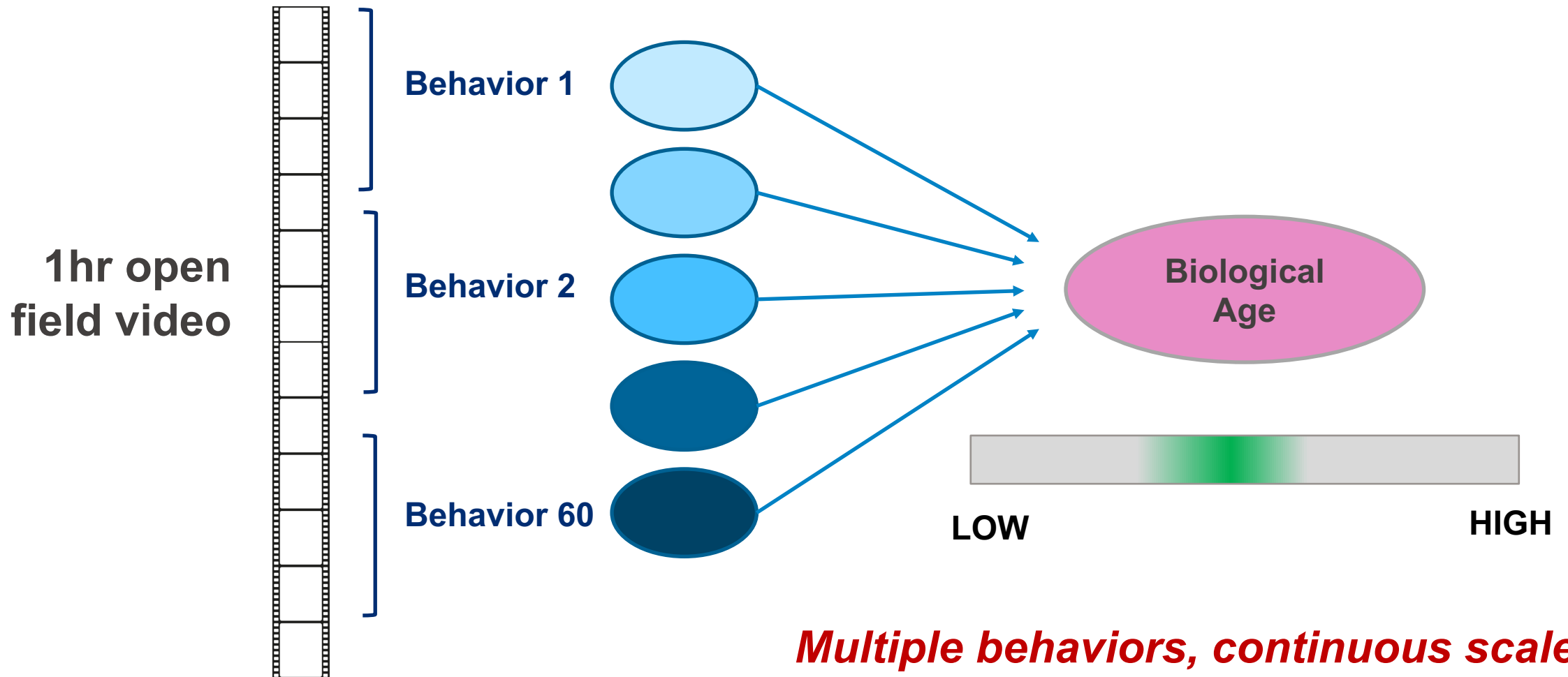


Biological age can be determined by frailty indexing in man and mouse.  
Mouse assay is cumbersome and affected by tester.

Leinani Hession, Gautam Sabnis, Gary Churchill  
Nature Aging (2022)

# Approaches to behavior annotation

## 3b. Indexing – Frailty/Pain



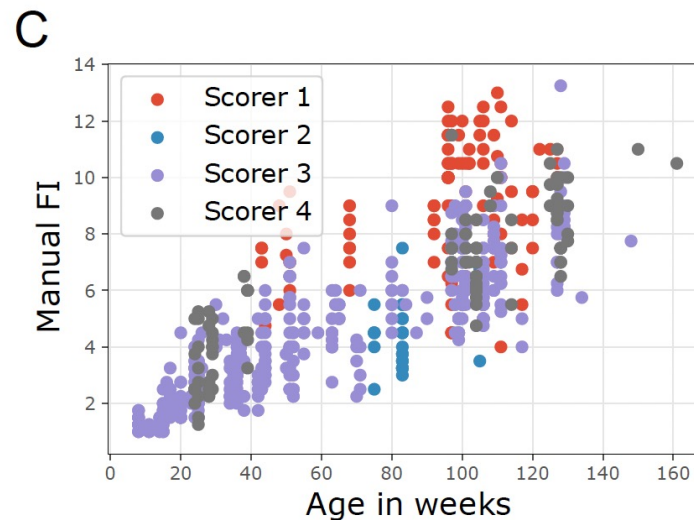
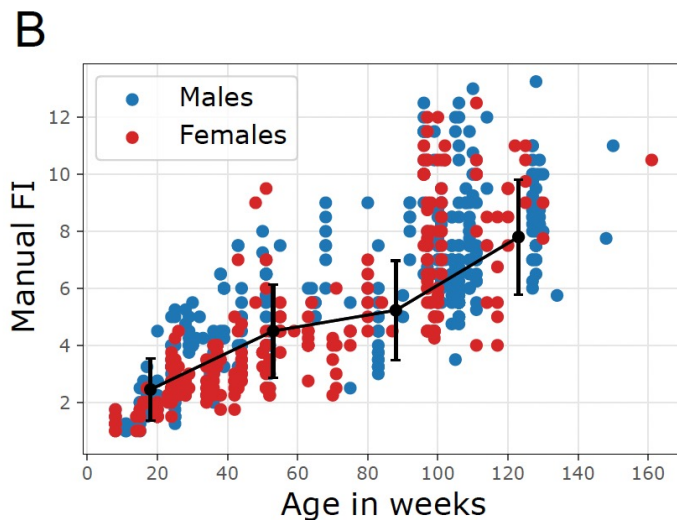
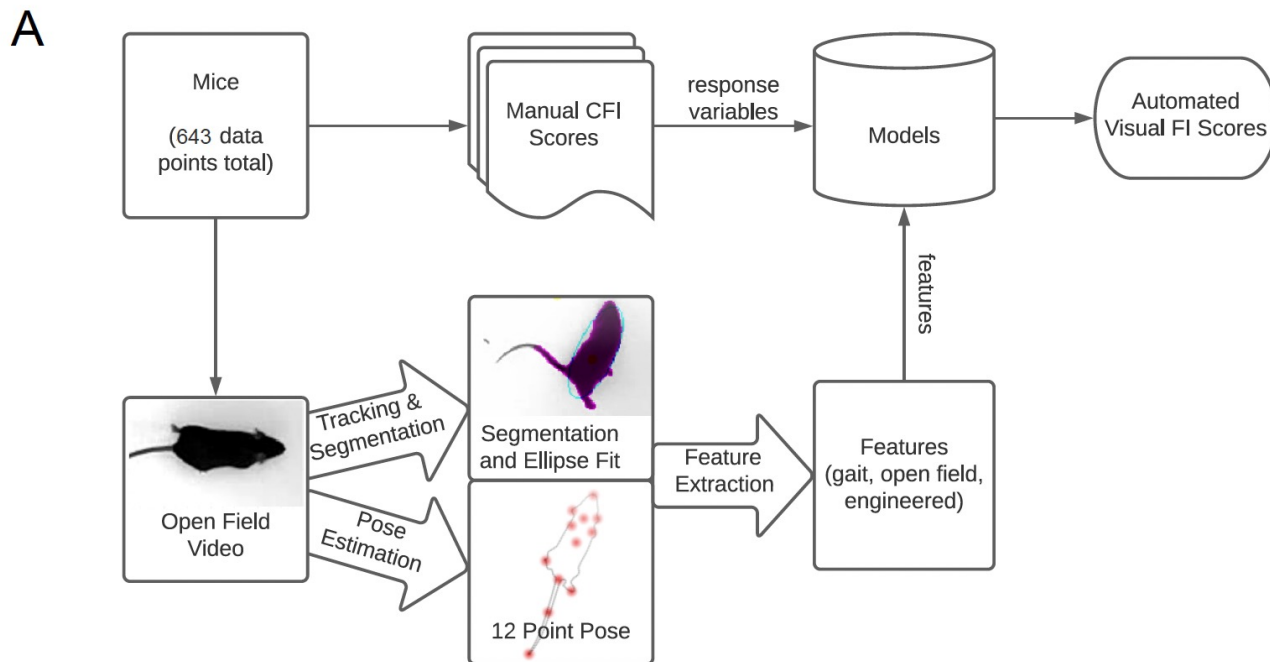
## Solution: Develop an automated visual frailty index



We are very accurately able to predict frailty score from the video

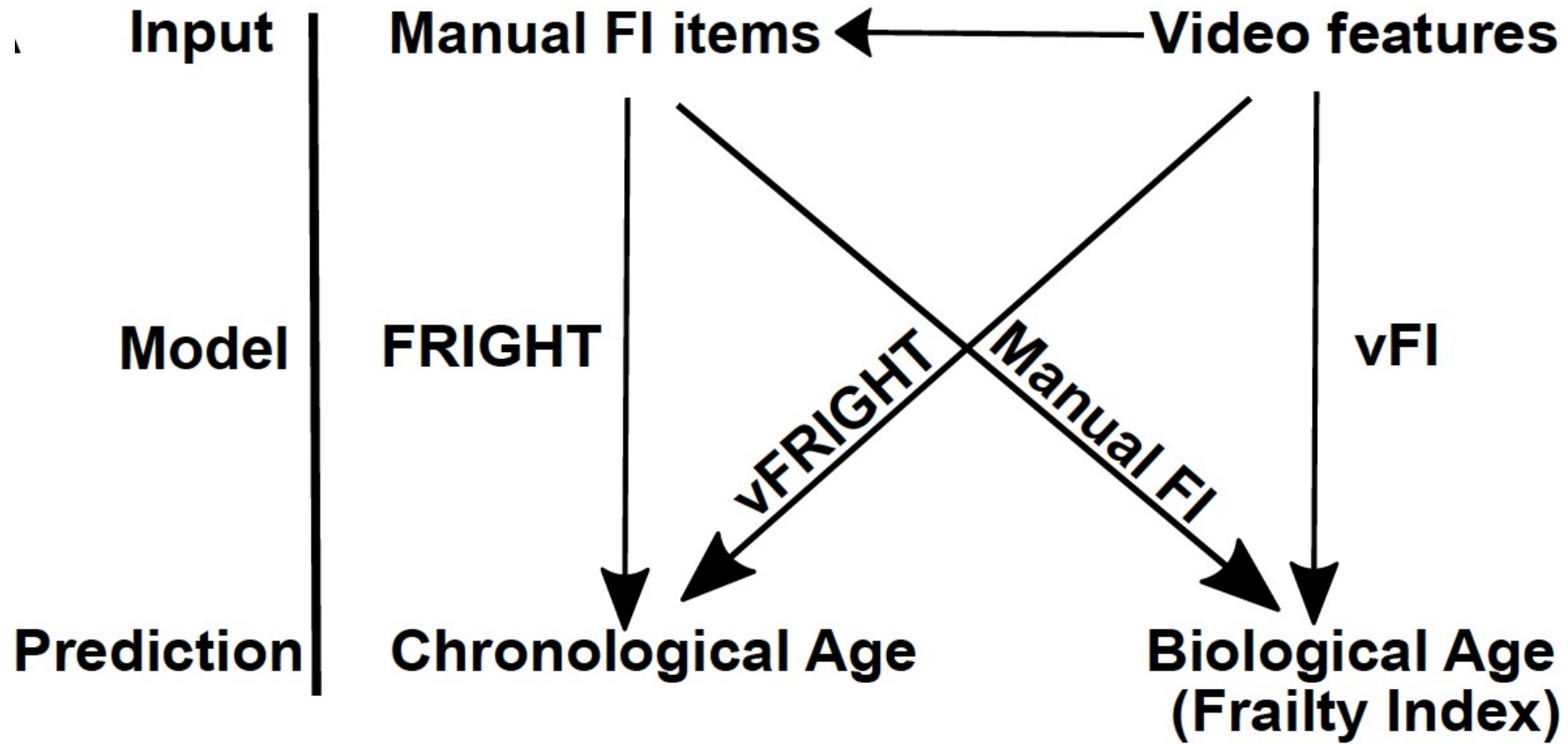


# Visual Frailty Index

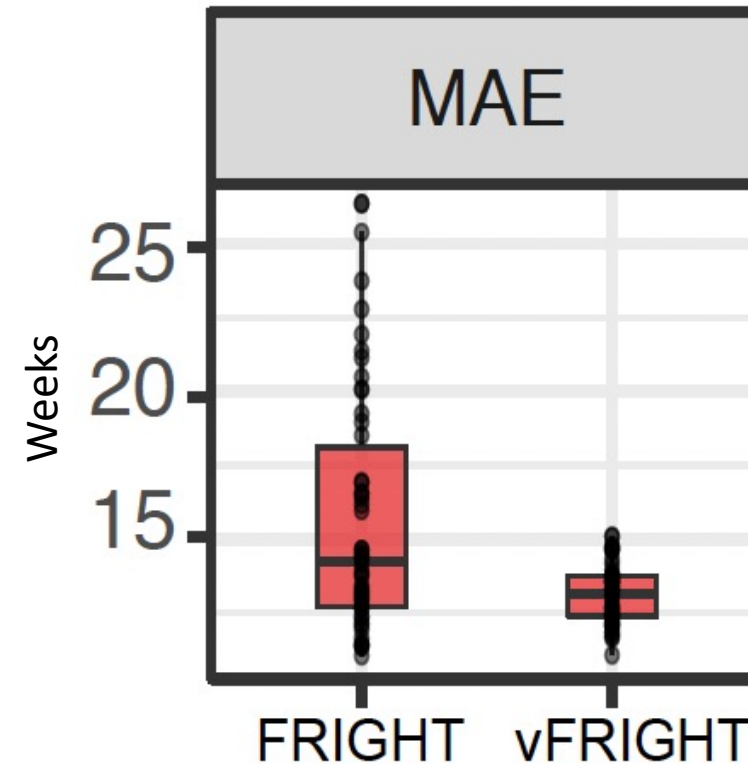
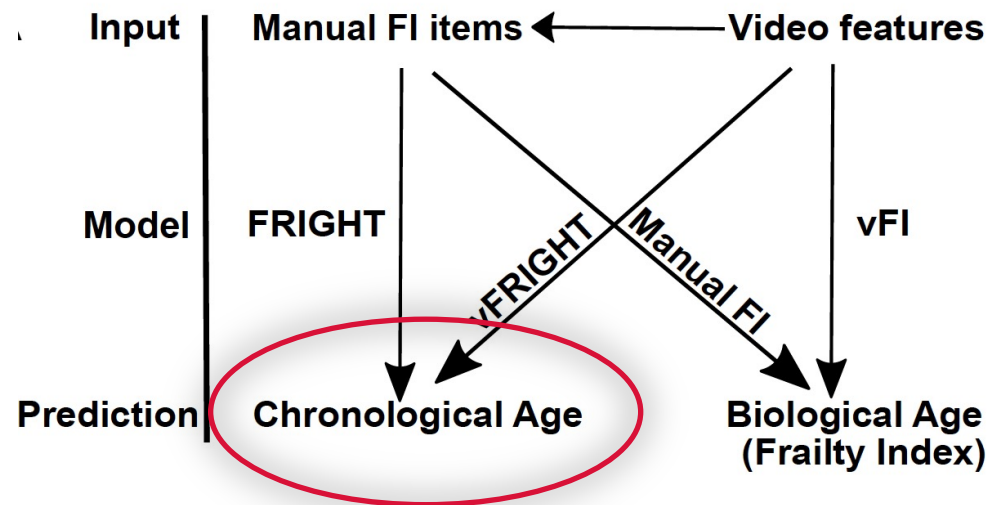


**42% variability is due to Scorer**

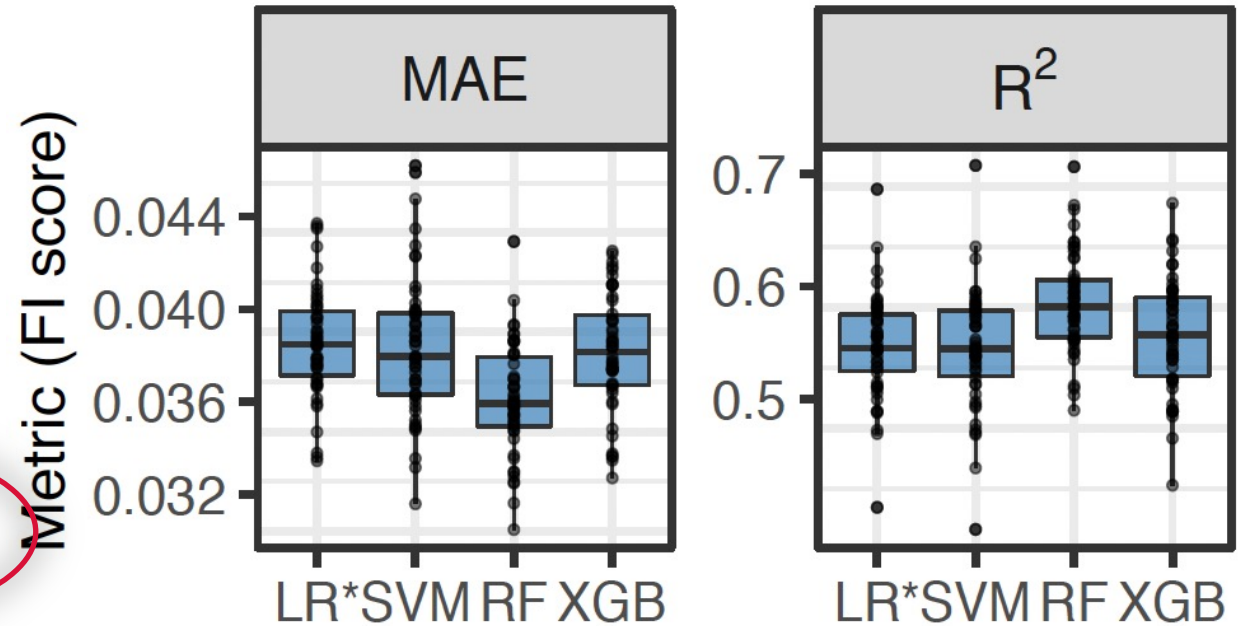
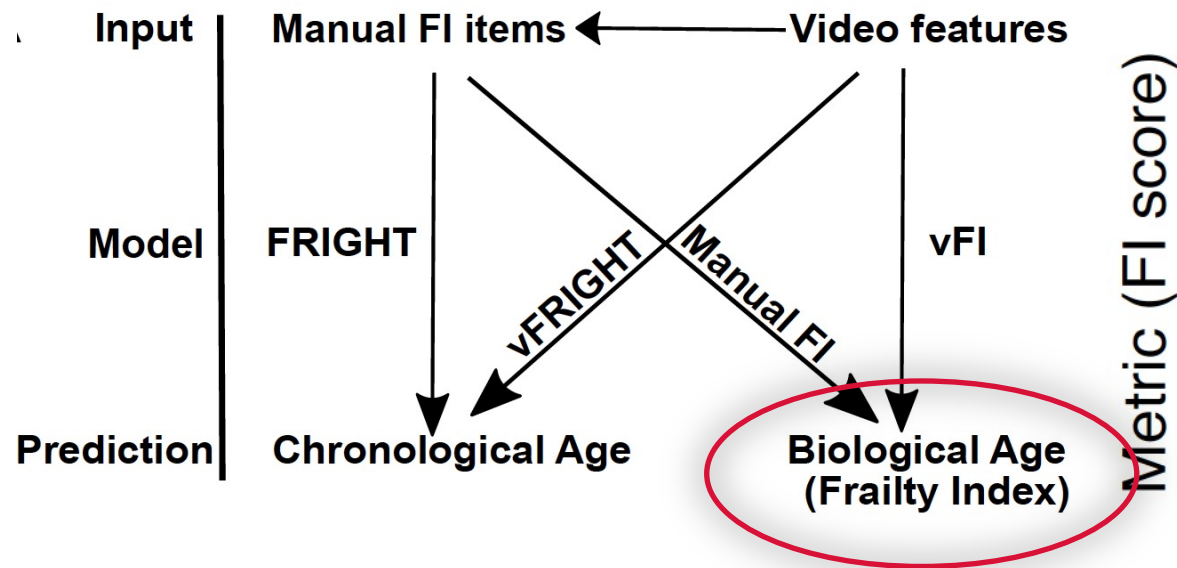
# Models



# Prediction of Chronological Age from clinical items or from video

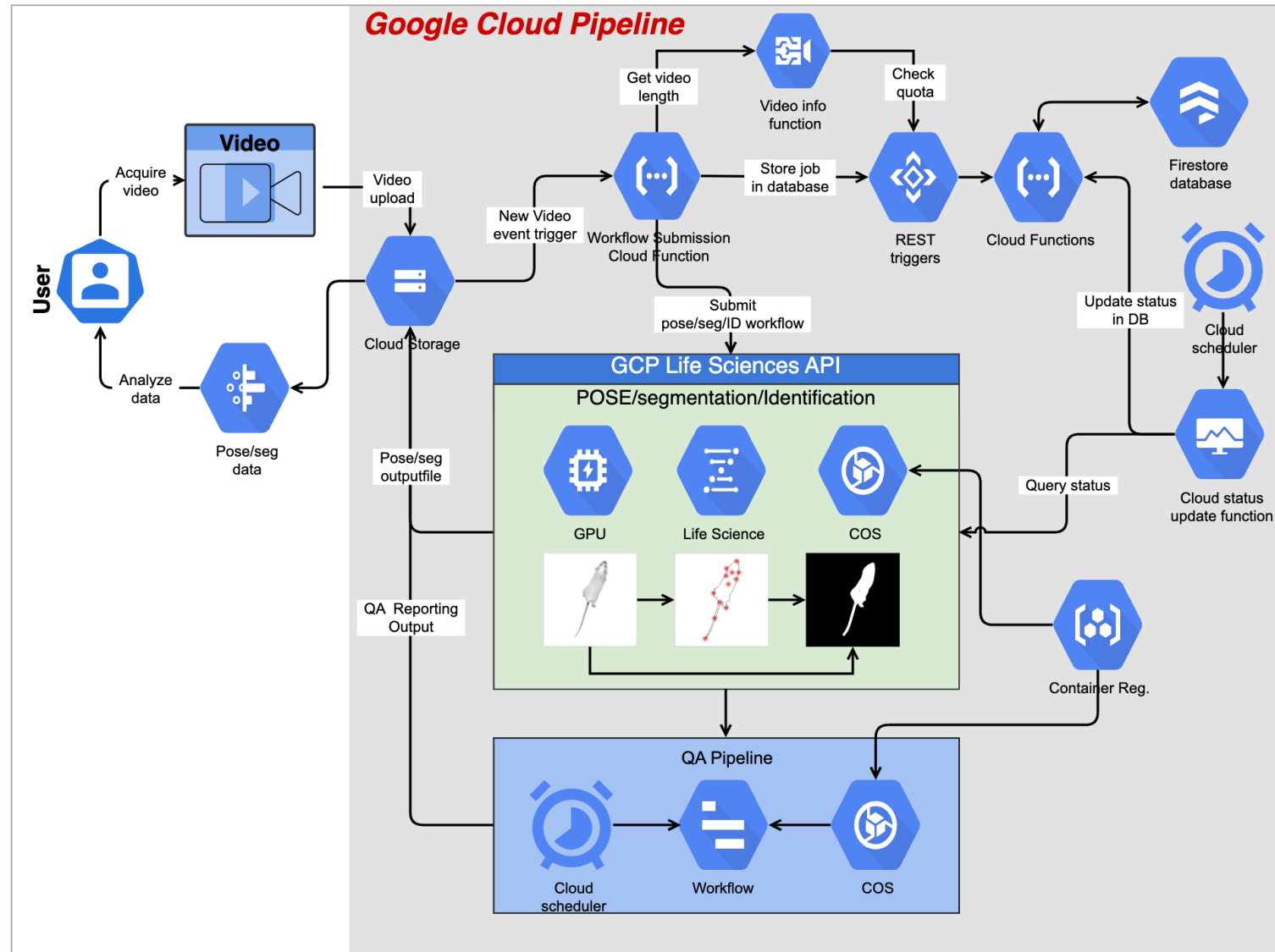


# Prediction of Frailty from video



Error is  
1 item out of 27 or  
2 - 0.5 items out of 27

# Cloud pipeline to process video data



# Thank you.

## Kumar Lab Trainees

Arojit Mitra, Phd  
Kyungin Kim, Phd  
Leinani Hession  
Yehya Barakat  
Justin Gardner, Phd  
Jaycee Choi  
Sandeep Kumar, Phd

## Engineers/Statisticians

Brian Geuther, MS  
Keith Sheppard, MS  
Gautam Sabnis, PhD  
Janine Wotton, PhD

## Research Associates

Tom Sproule  
Sean Deats  
Marina Santos

## IIT-Madras

Balaraman Ravindran, Phd  
Vinit Mehta  
Dhruv Laad  
Vihaan Akshay  
Rohith Dhinakar  
Shreyas Kulkarni



JAX  
Director's  
Innovation Fund



DA041668  
DA050837  
AG072861  
DA051235  
DA045299  
DA048634  
AG078530  
MH129298