IMPLEMENTING MACHINE LEARNING TECHNIQUES TO QUANTIFY MOUSE BEHAVIORAL ASSAYS

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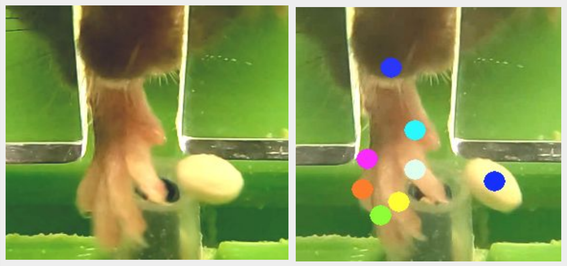
1 Introduction

When using mouse models of human disorders, assessing behavioral outcome measures are important for validating the functional effectiveness of treatments that promote axon regeneration and other anatomical measures of recovery. However, analyzing videos of mouse behavior is tedious because mice movements are subtle and fleeting.

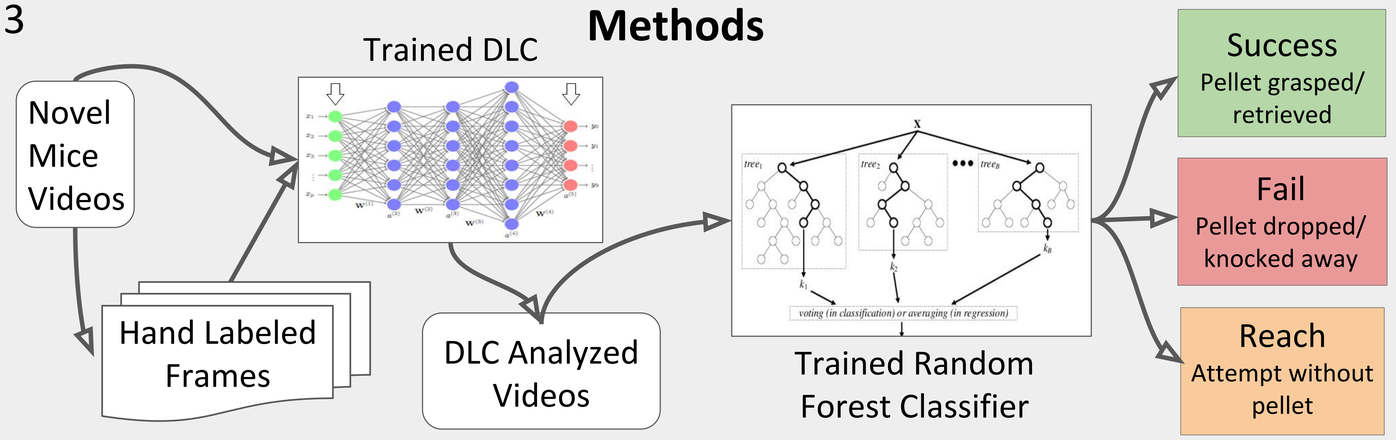
Objective: Use DeepLabCut and a Random Forest Classifier (RFC) to automate the classification of reaches, successes, and fails in mice pellet retrieval tasks.

2 DeepLabCut

DeepLabCut (DLC) utilizes a convolutional neural network to estimate X and Y coordinates of an object throughout a recorded movement. We use DLC to track pellet and mice body parts (labeled by colored dots below), and quantify mice reaches.



3 Methods



4 Random Forest Classifies Retrieval Attempt Outcomes

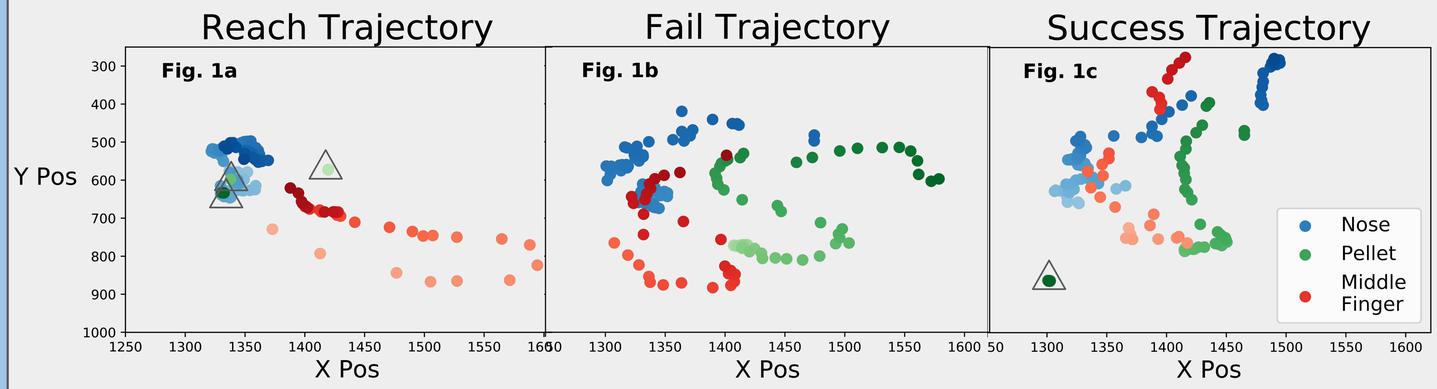


Figure 1) The movement of a food pellet, mouse nose, and middle finger, plotted with DLC estimated X and Y positions. Time goes from light to dark. Positions differ between reaches, fails, and successes, making it well suited for Machine Learning (ML) classifiers such as Random Forest Classifiers (RFC).

△ Denotes incorrect pellet predictions

Figure 2) The RFC identified around 90% of all attempts. Of those, the RFC is better at differentiating between reach/fail and reach/success than between fail/success. With 447 examples of attempts, the RFC correctly predicted 95% of the reaches, 98% of the fails, and 85% of successes.

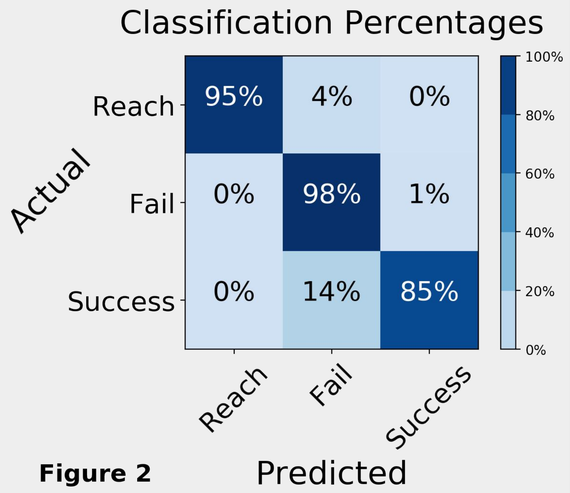


Figure 2

5 Conclusions

- We implemented tools to count reaches, successes, and fails in a mouse pellet retrieval task to track recovery under potential treatments.
- The pipeline from DLC and through the RFC successfully quantifies mouse behavior in pellet retrieval, with room for improvement.
- ML techniques, especially DLC, have the potential to quantify behavior in a wide range of animal experiments.

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References

Ellens et al. An automated rat single pellet reaching system with high-speed videocapture. J. Neurosci Methods 271:119 (2016)

Torres-Espiín et al. A motorized pellet dispenser to deliver high intensity training of the single pellet reaching and grasping task in rats. Behav Br Res. 336:67 (2018)

Mathis et al. DeepLabCut: markerless pose estimation of user-defined body parts with deep learning. Nat Neurosci 21:1281 (2018)