Assessing Stem Cell Therapeutics in Murine Models

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1 Introduction and Problem Statement

Spinal cord injury (SCI) is a debilitating condition that impacts up to 300,000 individuals in the U.S. each year. As such, a significant focus of stem cell research is dedicated to developing therapeutics that could help bring affected individuals' livelihood back. Likewise, the tests and methods used to assess different therapeutics are incredibly important. The efficiency and rigor of these tests allow for discovery of novel therapies and help advance the research field dedicated to solving spinal cord injury. The ladder beam test is a behavioral method for assessing recovery following SCI in murine models. During the test, mice must walk across a ladder with fifty rungs. Injured mice are expected to have more missteps while recovering mice should have more plantar or sufficient steps. However, to properly utilize this test our sponsors must spend several hours analyzing hundreds of videos of mice completing the task in order to individually score each mouse's performance. Consequently, this tedious process tends to slow down the lab's workflow and some automation would provide a significant increase in efficiency.

Streamlining the ladder beam task and its data analysis would allow for significant efficiency in retrieving data necessary for the advancement of SCI research and therapeutics. Our primary goal is to use appropriate machine learning algorithms and build off existing research to aid in the lab's data collection process for the ladder beam task. Secondly, we will assess the effectiveness of different treatments through appropriate statistical models and hypothesis tests.

2 Related Work

Access to ladder beam datasets and manual ground data for multiple published works as well as our current SCI project focused on stem cell and drugs. Currently there is no machine learning model for mice animal models that undergo contusion SCI, which will be the focus of this project. For this Capstone project, we propose to develop a machine-learning software that only requires inexpensive recording equipment and allows for limb placement tracking and comprehensive post-analysis that can reveal biologically relevant differences in locomotor function over the course of 16 weeks following SCI and therapeutic intervention.

DeepLabCut[1]

[2]

[3]

[1] Mathis, A., Mamidanna, P., Cury, K.M. et al. DeepLabCut: markerless pose estimation of user-defined body parts with deep learning. Nat Neurosci 21, 1281–1289 (2018). https://doi.org/10.1038/s41593-018-0209-y

[2] Weber, R.Z., Mulders, G., Kaiser, J. et al. Deep learning-based behavioral profiling of rodent stroke recovery. BMC Biol 20, 232 (2022). https://doi.org/10.1186/s12915-022-01434-9

[3] Aljovic, A., Zhao, S., Chahin, M. et al. A deep learning-based toolbox for Automated Limb Motion Analysis (ALMA) in murine models of neurological disorders. Commun Biol 5, 131 (2022). https://doi.org/10.1038/s42003-022-03077-6

3 Data Sets

We obtained our data from our sponsors at the UCI Stem Cell Research Center. Specifically, we received about a hundred videos of mice completing the ladder beam task and the

Table 1: Example of First 10 Rows of Manually Input Data Set Obtained from Ladder Beam Task

animal	**total_good**	**total_bad**	**ave_good**	**ave_bad**	**lb_score**	**type**
1	276	24	46.00000	4.000000	92.00000	w
2	280	20	46.66667	3.333333	93.33333	k
3	255	45	42.50000	7.500000	85.00000	w
4	228	71	38.00000	11.833333	76.25418	k
5	267	33	44.50000	5.500000	89.00000	v
6	279	21	46.50000	3.500000	93.00000	v
7	276	24	46.00000	4.000000	92.00000	k
8	226	74	37.66667	12.333333	75.33333	w
9	227	73	37.83333	12.166667	75.66667	k
10(11)	222	78	37.00000	13.000000	74.00000	v

4 Overall Technical Approach

4.1 Data Wrangling

4.2 Exploratory Data Analysis

5 Software

6 Experiments and Evaluation

7 Notebook Description

8 Members Participation

Table 2: Percentage of workload across group members

Task	**Giles**	**Nathan**	**Alex**	**Vinh**	**Owen**
task 1	100%	100%	100%	100%	100%

9 Discussion and Conclusion

What did you learn about the methods and algorithms you worked with? What did you learn about their strengths? And their limitations?

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What ended up being harder than you expected in your project? What was surprising about your project?

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What other lessons did you learn, expected or unexpected (e.g., perhaps about the tools you used, if you used anything out of the ordinary?

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If you were in charge of a research lab, what ideas and directions might you invest in over the next year or two to try to make major progress on this problem? Feel free to be speculative in discussing possible future directions.

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