# problem you want to solve and why

**Midterm Project Proposal: SNN for Image Classification**

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Figure 1 Poisson Encoded

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Figure 2 Bernoulli Encoded

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Figure 3 Rank Order Encoded

The three pictures above show the accuracy results of the three encoding methods of Poisson Encoded, Bernoulli Encoded and Rank Order Encoded with different learning rules. It can be observed that the DichlAndCook model has the biggest difference under different encoding methods.

When the DiehlAndCook model uses Poisson Encoded Input, the accuracy can reach above 0.8 or even better. However, when using Bernoulli Encoded Input, the results are not as good as we imagined. The best Accuracy is 0.37 using PostPre.

Our goal is to improve the adaptability of the DiehlAndCook model to make it more suitable for different types of input encodings, thus improving its applicability to a wider range of tasks. In addition to solving the significant differences in the DiehlAndCook model under different encoded inputs, we also hope to improve the accuracy of other neuro models under different encoded inputs.

# Technical part: how do you propose to solve it?

First, understand the differences between these three Learning Rules (PostPre (STDP), WeightDependentPostPre, Hebbian), differences between the models (IF, LIF, SRMO DiehlAndCook), and understand how many Neural Models and what algorithms are used.

In the second step, we search online to see if there are other Neural Models, and then use the same environment (batch size = 64, lr=1e-4, etc.), using MINST data and three Learning Rules (PostPre(STDP), conduct training under Hebbian, WeightDependentPostPre) and observe whether the final Accuracy is better or even higher than DiehlAndCook.

In addition to searching for other neuron models online, we can also adjust the hyperparameters to improve the performance of the model. The main adjustable hyperparameters are as shown in Figure 4:

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自動產生的描述Figure 4 adjustable hyperparameters

Finally, get a better model for accuracy from the second step, then understand the structure of its neuron models and compare it with the DiehlAndCook model. Through the comparison results, analyze why other Neural Models can improve Accuracy, and then try to change it in the DiehlAndCook model. algorithms, or add partial structures from other neuron models to improve accuracy.

# Milestones achieved so far

We are currently implementing the DiehlAndCook model and comparing different encoding schemes and learning rules. The following figure shows several combinations with higher accuracy:

1. Encoding scheme: Poisson

Leaning rule: PostPre

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Figure 5 training accuracy

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Figure 6 testing accuracy

1. Encoding scheme: Bernoulli

Leaning rule: PostPre

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Figure 7 training accuracy

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Figure 8 testing accuracy

1. Encoding scheme: RankOrder

Leaning rule: PostPre

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Figure 9 training accuracy

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Figure 10 testing accuracy

After installing the environment for implementation requirements, we started to copy some experiments in the paper and found that the overall data was roughly the same as the paper, which proved that we were in the same direction as the paper. During the training process, we found that RankOrder Encoded Input takes the most time to train, and Bernoulli is the fastest, and Bernoulli's accuracy is higher than RankOrder. This is different from the intuitive feeling of the model. The more complex the model, the longer it usually takes to train. However, more complex models tend to have better performance at the extreme limit of accuracy. Different combinations of encoded input and learning rules may bring about very ideal results. Both are equally important changes.

# Remaining milestones (dates and sub-goals)

**Different Combination of model and rule:**

Use other encoding methods, learning rules, and SNN model combinations in bindsnet to improve accuracy, such as: Null Encoder, Repeat Encoder, MSTDP, Rmax, AdaptiveLIFNodes, etc.

**Different Dataset:**

Try applying the same SNN model to different datasets, such as CIFAR10, STL10, etc. to determine whether the dataset and model are inconsistent.

**Hyperparameters:**

The figure below is the information provided by the reference material. It is mentioned that the hyperparameters in the SNN model are adjustable.

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Figure 11 adjustable hyperparameters

Adjusting timescale, spatial data, bias, etc. to improve the training accuracy, SNN and CNN have different hyperparameters. Since SNN is a relatively new concept, it is necessary to understand how to adjust the hyperparameters to make the model perform better. This is also one of the research projects dedicated to this topic.