MI210 - Modèles Neuro-computationnels

Résumé Théorique

12 septembre 2024

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2022-2024

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1. Introduction

Repository Hello ! My name is Guilherme Nunes Trofino and this is my LaTeX notebook of MI210 - Modèles Neuro-computationnels that can be found in my GitHub repository : https://github.com/tr0fin0/classes_ensta.

Disclaimer This notebook is made so it may help others in this subject and is not intend to be used to cheat on tests so use it by your on risk.

Suggestions If you may find something on this document that does not seam correct please reach me by e-mail : guitrofino@gmail.com.

1.1. Information Matier

Référence Dans cette matière le but sera de comprendre comment le système visuelle humaine donne pour l'Institut de la Vision.
Minimal Square Error : MSE

$$MSE = \frac{1}{2}\sum_{t}(f(t) - n(t))^2 \tag{1.1}$$

n(t) is stocastic values integration time needs to be well fitted composition with the repetitions and from response
S.. T.. A.. : STA

$$STA(\tau) = \frac{1}{T}\sum n(t)\tilde{S}(t-\tau) \tag{1.2}$$

biphasical with there is a curve over and one under the zero the integration is on the negative time it is notdesired that the start of the curve, in zero, is not in zero invert matrix takes $O(N^3)$ multiple matrix takes $O(N^2)$ solve the linear problem takes $O(N^2)$
figure 5 figure 6 analyse the neuron model and the actual data, is the data correcting fitting the phase values and the magnitude. magnitude is not correct, negative values are not correct because a neuron only see positive values
to corrected the negative values you need to rectife the values with the relu = max(values, 0) unit that trucates the values
the model does not fit the the lows after a pick. the model is slow to change with the actual model. to fix this more layers would be need to fix. the model is to smooth to work with the neurons
figure 8 it start closer to zero in the right so it is kind of better it end almost in the same value in the left it has a lot of zip zap because their is a error / noise in the model do not divide the noise data with noise data because the quantity of flutuation will be bigger and will disturb the data. the biology can not zig zag lik that there should be delay because the cells take time to react to the impulse and situmulus the integration is almost zero what is good
it is kind of correlelated because the model predictis almost at the same point as the actual data
how to improve the model : using the machine learning concept and test
Linear-nonLinear Poisson Model : LNP before deep learning

$$P_t(n) = \text{Poisson}(n|f(t)) = \frac{f^n(t)}{!n}e^{-f(t)} \tag{1.3}$$

$$f(t) = NL(w * \tilde{S} + b) \rightarrow \exp(w * \tilde{S} + b) \tag{1.4}$$

from the data the poisson distribuition does not fit the data but there is a normal observation

how to find w and b to fit the model ? can be solved by the log-likelihood maximisation :

$$l(w,b) = \sum_t (n(t) \log f(t) - f(t)) \tag{1.5}$$

when use stocastic values : the problem is convexe, only one max point. find the maximum with calcules, derivative and equal to zero :

$$\frac{\partial l(w,b)}{\partial w(t)} = \sum_t \left[(\frac{n(t)}{f(t)} - 1) \frac{\partial f(t)}{\partial w(t)} \right] = \sum_t [(n(t) - f(t)) \tilde{S}(t-\tau)] \qquad \frac{\partial l(w,b)}{\partial b} = \sum_t [(n(t) - f(t))] \tag{1.6}$$

compute the gradientent and compute the hessian
can be solved by steppest gradient
figure 11 LN Model fitting noise initialized with small noise close to zero, important for non stocastic models because this avoid local maximums how to determin the learning rate in the code ? increase learning rate, reduce number of iterations decrease learning rate, increase number os iterations
– trace log-likelihood - trace log-likelihood test decreasing because of overfitting
figure 12 filter improves, the maximums it is better eventhough there are biiger than the original values, does not start at zero as demanded but it is a bit of the zero at the start
figure 13 there is an outlier on the picks, over 5 times bigger in general the curve is very similar at begin means it is an improved model performance is the coorelenation between the model output values with the original values
LNP model + L2 - Regularisation model to have a somoot w, we shold minimise $(w(\tau) - w(\tau+1))^2$ with a laplacian matrice
figure 20 the curve is much more smoother the performance is better eventhought the data does not match the pick values perfectly
LN2P can be constructed with multiple LNP two layers can count with two variables, so it can predict the behavior of the cells caused by the estimulus, moving bar and the response from the others neurons. to compare the performance we can plot the performance agaist the distance of each variable
if the distribution has differences from the original it means that the conditionnal value influence the beravior of the cells on the model that we are considering
the nuerons has a inertia, it means it has a delay to change state to has a qunatitative value of the distribution we can use the mutual information between pos and spikes on the graph

$$\mathcal{H} - < \mathcal{H}(x|\tau) > p(\tau) \geq 0 \tag{1.7}$$

markus meister TED talk

2. Information Coding

shutter controls the amount of light entering a camera lens absorption occur individually and at random poisson distribution
TD : plot distribution of spikes fired by neurons in each condition with histcounts on MATLAB
TD : plot hit rate beta versus the false alarm rate alpha
TD : use the ROC curve to estimate P[correct] it would be the integral of the following equation as "demonstrated" in the PDF :

$$P[correct] = \int_0^1 \beta \dot{\alpha} \tag{2.1}$$