# Roles of Neuroinformatics in Visual Neurophysiology Research

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## Introduction

Neuroinformatics may be defined in many different ways. Here we define it as a research discipline for designing and constructing a methodology and infrastructure necessary for sharing our knowledge on neuroscience in a systematic manner. Traditionally, this has been the domain of academic publications in the form of journals. Researchers conducted scientific studies, and published their findings in research journals. However, with the advancement of information technologies, we are no longer limited to publications as printed material. Although most of the current attempts still emulates and patterned after academic publications, taking the form of, for example, electronic version of articles also available in print or accompanying extra multi-media materials such as animations, and movies, future possibilities are endless regarding what type of knowledge can be shared.

Almost anything that may be represented electronically can be shared. Examples include software (source code and/or executable) for conducting computational experiments and modelling computations, experimental data, software for controlling and conducting experiments. However, there are two main difficulties for implementing effective information sharing schemes. One is a technical problem which neuroinformatics research is trying to solve: setting up a framework for organizing, classifying, and accessing knowledge we share. Unlike gene sequence data, and some of the medical imaging data, the kind of data generated as results of neuroscience research have a high degree of variations in their format and environments in which they can be used. This is also true for computational models which may be described in many different computer languages and simulation enviromnents. The other is cultural or institutional and may require changes in the way we think about sharing knowledge. There is still a strong resistance for making original data and model source code available for sharing. In this presentation, we will

**Fig. 1: Various data sets deposited in Visiome Platform**

examine the first of these these two aspects from a practical point of view, mainly as a user of systems that have been developed by NRV (Neuroinformatics Research in Vision) Project.

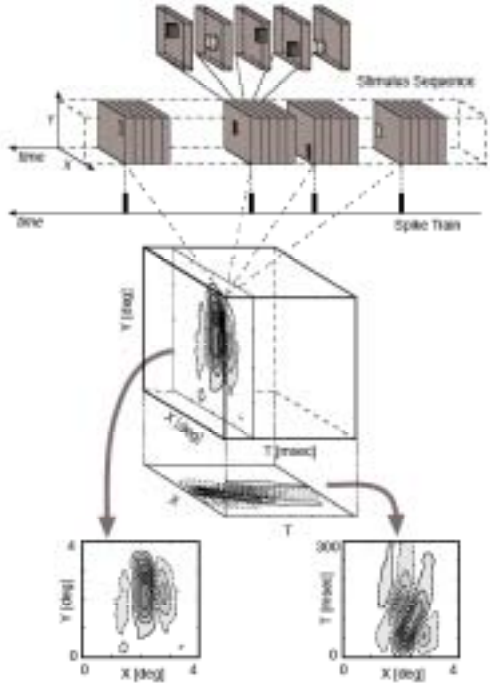


**Fig. 2: Receptive field of a V1 neuron**

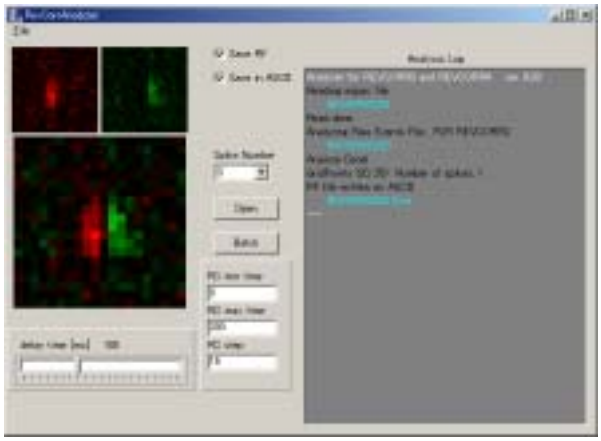

**Fig. 3: Receptive field analysis program accompanying data files.**

## Sharing Data

Original data are major components of the desired contents of Visiome Platform. In addition to standard publications through traditional journals and new on-line publications patterned after them, it is desirable to have the original data that formed the basis of the publications made available for sharing. Indeed, in recognition of making data sharing an important part of research projects, the NIH (U.S. National Institutes of Health) has recently instituted a policy in which investigators submitting an NIH grant application seeking $500,000 or more in direct costs in any single year are expected to include a plan for data sharing (http://grants.nih.gov/grants/policy/data_sharing/). This marks the first time data sharing is made a condition for research funding. While the new policy currently affects only relatively large-scale projects, the trend is clear in that publicly funded research projects are expected to release data obtained during the course of the study in a timely manner. It is likely that such policy will be applied to smaller grants in the future, and funding sources other than NIH and in other countries will follow the initiative. Many of these policy issues are beyond the scope of this presentation, but it is obvious that we should begin designing and planning effective and easy-to-use repositories for data and models in order to make maximum use of the shared data. Visiome Platform is the primary project undertaken in Japan for promoting data sharing.

There are additional difficulties for sharing data from neuroscience. There is no standard

for the way data are encoded and stored electronically. While there are efforts for making such standards, it is not practical to expect, let alone enforce, a standard data format. Where possible, the use of data file formats such as those natively supported by Matlab (Mathworks) and Excel (Microsoft) are being used. However, not all forms of data can be stored in such formats. For example, as shown in Fig. 1, we have deposited action potential and stimulus event data from receptive field mapping experiment on Visiome Platform. The data files contain many different aspects of measurements such as specification of stimuli used and action potential time and waveform data from single cells in the primary visual cortex as shown in Fig. 2, and standard application file formats are not suitable for use.

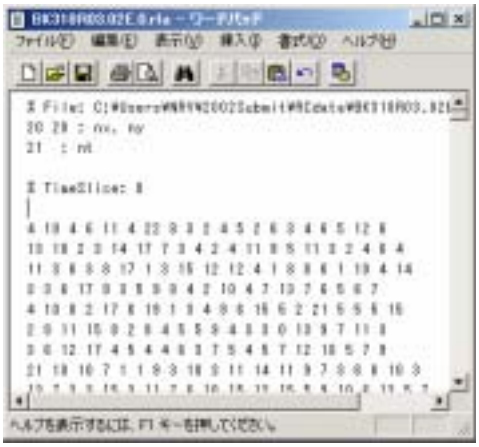

**Fig. 4: Data output from application in Fig. 3.**

Therefore, in many cases, deposited data must be accompanied by a detailed description of the format and explanation of what each recorded item means. Ideally, such data should also be accompanied by a simplified example program which reads in the data file for cursory display of the content of the file as well as for allowing generation of numerical data suitable for plotting and further analysis. We have included a simple data analysis application as shown in Fig. 3, which reads in experiment specification and raw action potential data files, and displays the data as well as writing out data in ASCII format as illustrated in Fig. 4. It is a relatively simple matter to load the content of files like the one shown in Fig. 4 into Matlab, Mathematica or any other data analysis applications.

**Sharing Models**

Models in visual neuroscience and perceptual science span a wide range of levels from those simulating biophysical aspects of neural properties to those that mainly focus on functional aspects of signal transformations along the visual pathway. Platforms, modeling environments and tools are also quite varied among researchers and there is no definite dominant environment. Although Matlab is emerging as a substantial force among the commercially available environments, many of the modeling studies are being carried out by custom-written tools. Visiome Platform is designed with this in mind, and is able to accept a wide variety of models for registration, including those written as custom-written original programs. One example of a registered model script that relies on the popular Matlab is that demonstrating "Computational theory of color transparency: recovery of spectral properties for overlapping surfaces" contributed by S. Nakauchi and colleagues. Of the models that are based on custom-written original programs, K. Fukushima has contributed source code for his well-known Neocognitron both in the C and historical Fortran language versions.

## Sharing Stimuli

In studies of high-order vision, developing and using appropriate visual stimuli is a major part of any investigation. Studies of visual illusions, for example, rely heavily on developing unique stimuli that effectively demonstrate a particular phenomenon. One of the categories of items for registration is stimulus, which may be an image (picture), movie, data describing a stimulus, or a original program or script that generates a stimulus. Examples of stimuli registered on the Platform include those by S. Nishida and colleagues demonstrating various perceptual effects related to visual motion and texture perception.

## Conclusion

The usefulness of a database like Visiome Platform first depends on the ease-of-use and unique features that are available for users. However, it also depends heavily on how much useful information are already available in the database. This is a typical chicken-and-egg problem, and the members of the NRV project has strived to achieve both aspects of the key factors by implementing features and adding initial content worthy of users' time and efforts. We have come to depend heavily on these vision research support tools that we have developed ourselves on a daily basis. It is our sincere hope that many other users find Visiome Platform useful as well.