Virtual V1sion: a collaborative coding project

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Virtual V1sion is a new idea for fostering modeling collaborations and data sharing. While still in its infancy, the ultimate goal is a website that hosts repositories for (1) interchangeable model elements, (2) datasets that can be fit/predicted by those models, and (3) educational modules that explain the background for both the models and the datasets. The scope of the modeling is limited to predictions of V1 responses, although not all computations represented by model elements in Virtual V1sion are required to be V1-intrinsic: a goal of the project is to provide a framework in which predictions for modulation by cortico-cortical projections (i.e., feedback) can be tested. The basic framework is an array of channels (neurons), mapped either to image space or to cortex space (via log-polar transform), with user-specified tuning (e.g., oriented vs. non-oriented, color-selective or not, simple or complex) and user-specified interactions (e.g., normalization or facilitation by selective or non-selective local pooling or long-range signals). Thus, the model predicts either behavioral responses (sensitivity/selectivity in channel most sensitive to stimulus) or electrophysiology data (diverse responses in local population) or neuroimaging data (pattern of aggregate response, with user-selected weighting and blurring, mapped to cortical hemodynamic responses or scalp potentials).

For the model components, the website (currently v1sion.cla.umn.edu) hosts python code that can either be run in a web-based interactive mode or downloaded from a git repository. The git repository will facilitate contributions from an ever-growing user base. An API (applications programming interface) will be established so contributors can design modules to be interchangeable (e.g., testing different log-polar transforms or testing different normalization methods for a V1 neuron module).

For the data components, datasets hosted in a repository will provide gold standards against which the models can be tested. Each raw dataset will be associated with metadata that can be compared against model predictions. The data repository will not be particularly large; it will be limited in scope to behavioral, neuroimaging and single-unit electrophysiology datasets that can inform model development and provide a suite of standard results against which new model elements can be tested. A core team of researchers will serve as an advisory board that contributes initial datasets and curates the collection to replace limited or outdated data with new sets as they come available.

Finally, key goals of the project are to facilitate training and to help new investigators get research programs off the ground faster. Therefore, each dataset and model will be accompanied by documentation that explains the contents thoroughly – at a level accessible to a novice – and explains the relationship of each element to other elements in the collection, with clear information about what aspects of the models are agreed upon (by a majority of users) and which aspects are debatable or experimental. This collaborative vision is both large in scope and complex, but achievable and valuable for reducing redundancy between laboratories and putting methods and data out there in a common space to enable direct comparisons between competing methods.