What is Python?

"Python is a dynamic object-oriented programming language that can be used for many kinds of software development. It offers strong support for integration with other languages and tools, comes with extensive standard libraries, and can be learned in a few days. Many Python programmers report substantial productivity gains and feel the language encourages the development of higher quality, more maintainable code."[1]

Numerical libraries [2] provide Python with an efficient and powerful N-dimensional array object as well as a range of scientific functions, similar to the MATLAB package. The syntax is very similar to MATLAB, making any transition relatively straightforward. We have found using Python offers a number of advantages for our research (see Discussion).

Entropy and Information

Entropy is a measure of uncertainty, denoted by H(·). Mutual Information between a stimulus and a response is given by:

\[ I(S;R) = H(R) - H(R|S) \]

Information is the reduction in uncertainty about the response given knowledge that a particular stimulus was presented.

- Information is symmetric; applies to both encoding and decoding problem.
- Takes into account all correlations with no underlying assumptions about the system.
- Uses meaningful units (bits) that can be compared between experiments.

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Origns of the Bias

Calculation of the entropy requires estimation of the underlying probability distributions. Since only limited quantities of data are available experimentally this leads to limited sampling bias. This causes over-estimation of the information.

Bias Correction

Fortunately, a number of techniques have been developed to compensate for the bias effect.

These techniques can be difficult to implement. We have developed PyEntropy, a Python library to allow efficient calculation of bias-corrected entropy and information values [4,5].

Using Python allowed us to implement this algorithm for a wider range of parameters than was possible with MATLAB, due to better sparse matrix support and lower level handing of memory issues.

The code is available online [5].

References


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