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CARMEN: an e-science virtual laboratory supporting collaboration in neuroinformatics

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Studies of neural networks and the processes they control frequently employ recording techniques to determine temporal patterns of activity within individual neurons and their interactions. Neuroinformatics is the rapidly growing science that addresses the manipulation and analysis of the vast volumes of data generated from such techniques. However, although these data are often difficult and expensive to produce, they are rarely shared and collaboratively exploited, and dissemination of new analysis methods may be restricted by issues of software and file compatibility. CARMEN (Code Analysis, Repository and Modeling for e-Neuroscience) aims to address these issues by creating an environment for handling time series data and for deploying analysis algorithms using distributed computing technology.

The CARMEN infrastructure builds heavily on software developed in previous e-science projects. The "Cloud" architecture allows the co-location of data and computation (avoiding the need to repeatedly transfer large quantities of data) and enabling users to conduct their science through a web browser. The data handling capabilities of the CARMEN portal have recently been deployed, enabling registration of users and upload of data files. The primary data consists mainly of files of electrophysiological data, for which we use Storage Resource Broker to manage the distributed store. To provide a description of experimental protocols, an extensible metadata schema has been developed [1] and implemented using templates to avoid the necessity of re-entering values for common protocols. A security layer enables the contributor to control access rights to both the data and metadata, so that the originator and collaborators can share and analyze the data in a private environment until publication when the data may be made public. This repository satisfies the requirements of funding agencies to make research output publicly available and provides a resource for computational neuroscientists.

The project consortium is developing new analysis methods including spike detection services that use wavelet and morphology techniques [2], a spike sorting methodology that extends WaveClus [3], information theoretic analysis and Bayesian network analysis to determine causal relations, and algorithms for resolving spike synchrony. An associated thick client tool, Signal Data Explorer, provides data visualization, signal processing and pattern matching capabilities. Because analysis applications need to be executed on a wide range of data formats, we have specified a uniform file and format structure for data sharing and communication between applications [4]. We are implementing an enactment engine to enable linking of applications into more complex and user-defined workflows.

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