APECS Portal

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"A virtual space for neuroscience collaboration"

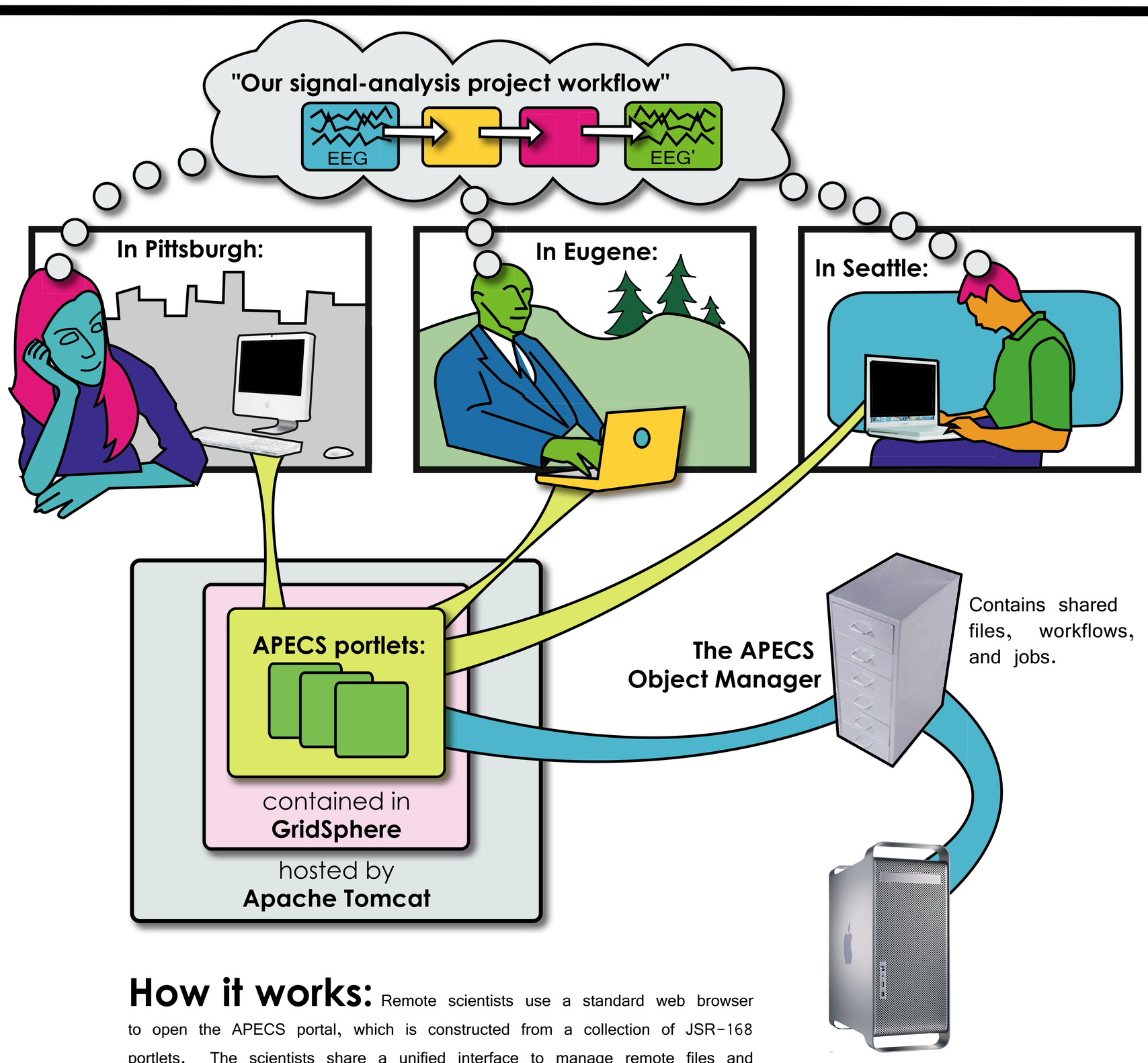
BACKGROUND

Neuroscientists use electroencephalography (EEG) as a non-invasive measure of brain activity. EEG has clinical applications for epilepsy, depression, and other conditions. Unfortunately, raw EEG data is usually contaminated with biological artifacts. For example, eyeblinks generate electromyographic potentials that can mistakenly appear as spike neurological activity. Fortunately, a variety of algorithms can "clean" artifacts from EEG data. Infomax, FastICA, and Sobi are three component separation algorithms, which seperate eyeblink artifacts from useful cortical activity by decomposing the EEG into component signals.

The automated protocol for electromagnetic component separation (APECS) is a Matlab toolbox that implements several cleaning algorithms, including the ones mentioned above [1][2]. APECS can also use high-performance parallel implementations of the Infomax and FastICA algorithms. Additionally, APECS can apply metrics to evaluate the success of signal decomposition.

MOTIVATION

Ideally, neuroscientists could easily share files and collaborate to use APECS tools. Currently, data-sharing is constrained by EEG filesizes (easily gigabytes in size). Scientists, who share EEG data, face time-consuming file transfers and significant local storage demands. Project collaboration is also thwarted by geographic limitations. Specifically, the APECS tools are only available as standalone Matlab "m-files." The ideal collaborative environment would include tools for scientists to jointly compose, execute, and manage signal analysis projects. On the front end, collaboration requires creative user interfaces. On the back end, collaboration leads to tricky concurrency issues. A good solution to these problems must balance a usable interface with a flexible architecture.



How it works: Remote scientists use a standard web browser to open the APECS portal, which is constructed from a collection of JSR-168 portlets. The scientists share a unified interface to manage remote files and compose projects. The APECS Object Manager is a robust engine for maintining users' shared projects and files. The object manager dispatches artifact-cleaning tasks to a remote MATLAB server.

WHAT ARE PORTALS?

Portals are web applications that provide a unified user interface to diverse system resources. Portals are a new software engineering paradigm which extend the model-view-controller (MVC) architecture to heterogeneous web environments.

"Portlets" are interchangeable user-interface components, built from Java servlets. The Java Portlet Specification (JSR 168) enables interoperability between portlets and "portlet containers." The Gridsphere Portal Framework[4][5] is a popular portlet container, which can be hosted in Apache Tomcat.

THE APECS PORTAL

The Apecs Portal provides a user-centric virtual space for neuroscientists to share files and collaboratively compose signal analysis projects. Distinctive features include:

1. a rich interface, using GridSphere portlets and AJAX (asynchronous Java and XML)
2. virtual tools that can be shared and reused
3. a flexible system architecture that can support future job types and additional cleaning algorithms.

SHARING & COLLABORATION

In the APECS portal, users can manipulate, share, and reuse several types of virtual objects:

Workflows

An APECS workflow contains one or more APECS jobs, chained together. In the portal, scientists can compose workflows, specify input and output files, and manage results from intermediate stages.

Jobs

An APECS job is the primary building block of workflows. Common jobs include data conversion and artifact removal.

Files

The APECS portal manages a diversity of filetypes: EEG data, sphering matrices, blink templates, cleaning logs, and rendered EEG graphics. Scientists can upload files to the portal, then use those files in workflow compositions.

SUMMER 2006 AND BEYOND

As of Summer 2006, the APECS portal is a functional prototype with support for eyeblink artifact removal. Scientists can compose, execute, and view results from artifact-removal jobs. Also, the portal provides tools for file-sharing and storage.

Our primary concern is usability. To this end, the portal interface is evolving alongside user evaluation. Future plans include tools for EEG visualization, shared file annotation, and a new grid-enabled APECS Object Manager. Currently, visualization can only occur outside the portal, with tools such as EEGlab[3]. Shared file annotation would allow scientists to append meta-data to EEG files, including information about data sources and experimental conditions. Finally, a grid-enabled Object Manager is possible with the GEMINI project[6]. GEMINI is a suite of libraries and services for grid-enabled signal processing and neuro-imaging. The combination of GEMINI with the APECS portal would provide a more secure and more flexible file management system.

REFERENCES

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