

# BioWMS: a web based Workflow Management System for Bioinformatics

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## Motivation

An in-silico experiment can be naturally specified as a workflow of activities implementing the data analysis process, in a standardized environment. The workflow owns the advantage to be reproducible, traceable and compositional by reusing other workflows previously defined. A Workflow Management System (WMS), according to Workflow Management Coalition (WfMC) Reference Model [1], is a software component that “defines, manages and executes workflows through the execution of software whose order of execution is driven by a computer representation of the workflow logic”. In bioinformatics although several systems that support the daily work of a bioscientist have been proposed in literature [2,3,4], they are not fully compliant to the WfMC standards. In particular, none of them adopts a process definition language standard like XPDL, but each one owns a specific definition language. In many of these systems, workflow editors -i.e. Taverna- are usually embedded with the workflow engine and/or are heavy stand-alone applications. A web-based flow designer as WebWFlow, provides a light user-friendly interface to edit, store, share and execute a workflow only using a simple Web browser. Moreover, workflow specifications are generally interpreted and in many cases workflow engines centralize the execution and the coordination of the computation. In the framework of LITBIO[5] project we have developed BioWMS, a web-based WMS, able to dynamically generate domain-specific, agent-based workflow engines from a workflow specification. Our approach exploits the proactiveness and mobility of agent-based technology to embed the application domain features inside agents' behaviour. The resulting workflow engine is a multiagent system: a distributed, concurrent system typically open, flexible, and adaptive.

## Methods

BioWMS has been implemented on BioAgent/Hermes architecture. Hermes [6] is an agent-based mobile middleware. This choice has been conditioned by the 3-layers user, system, runtime, component-based architecture that facilitated the management of domain-specific components toward the development of a workflow to multiagent system compiler. User Layer allows bioinformatics to specify their application as a workflow of activities using the graphical notation. In BioWMS we have implemented a web-based process definition tool and workflow client application called WebWFlow. System layer provides a context-aware compiler to generate a pool of user mobile agents from a workflow specification. XPDL has been adopted as BioWMS workflow specification language. Run-time layer supports the activation of a set of specialized service agents and it provides all necessary components to allow agent discovery, mobility, creation, communication and security. Service-Agents (SAs) in the run-time layer are localized to one platform to interface with the local execution environment. BioAgent is a tool of specialized cooperative bio-service agents developed to wrap bioinformatic tools and to perform the primitive activities required by user in in-silico experiments. User-Agents (UAs) in the system layer are Workflow Executors (WEs), created for a specific goal that, in theory, can be reached in a finite time by interacting with other agents both service and user; afterward the agent will die by killing itself. The Hermes Graphical User Interface (GUI) allows the administrator to monitor the status of each platform node, showing the number of WEs running, the SAs activated and memory usage.

## Results

As Figure shows, BioWMS, according to WfMC Reference Model, is a WMS that supports the generation of agent-based workflow engines.

A demo is available at <http://litbio.unicam.it:8080/biowms>. BioWMS is one of the main components of the LITBIO[6] framework. The aim of this project is to develop a Laboratory for

Interdisciplinary Technologies in Bioinformatics and BioWMS helps bioscientist to define in-silico experiments as workflows of complex and primitives activities.

**Availability:** <http://litbio.unicam.it:8080/biowms/>

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