Development of a Web Processing Service for Environmental Applications

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Web Processing Services

Standardizing the analysis of spatial data within the disciplines of biology and environmental sciences can be an issue at times. Proprietary software often is expensive and requires good knowledge, which limits the community of users.

Web Processing Services (WPS) give an opportunity for standardized data analysis for a variety of users, without the need for specific software and a minimum of hardware requirements.
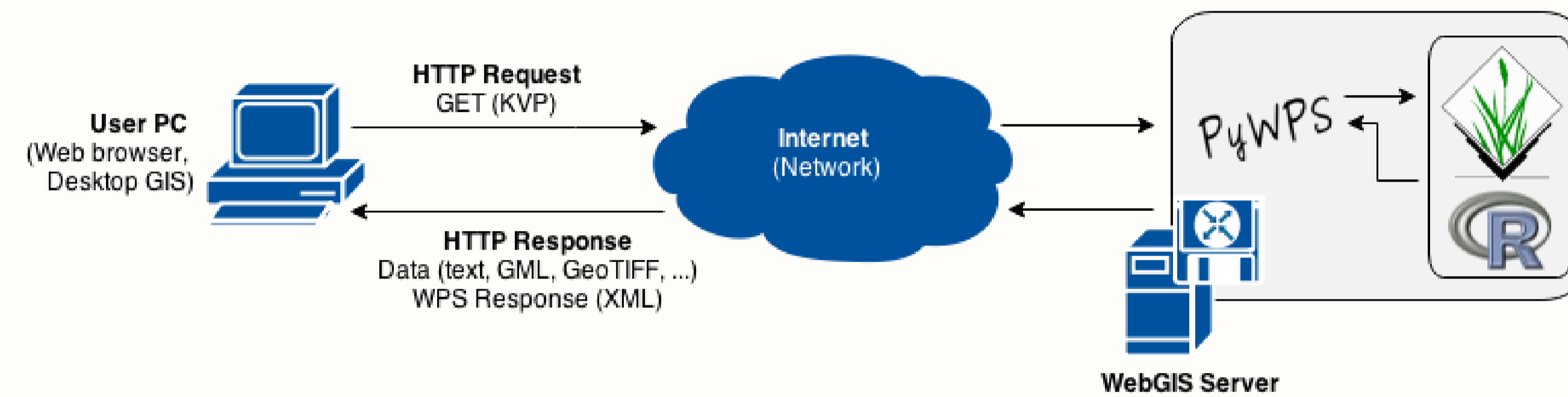

Figure: Basic Scheme of a WPS. The user sends a request to the WebGIS Server via the Internet, which then processes the request and gives the results as a response back to the user.

The OGC (Open Geospatial Consortium) WPS Interface Standard provides a directive for the implementation of web-based data processing and their in- and outputs. Hence, an automation of frequently used analyzing methods is possible, so that a standard for processing spatial data can be achieved.

System Architecture and Capabilities

HotSpot Realtime WPS is based on *PyWPS*, a Python open source implementation of the OGC WPS 1.0.0 standard, which is running on a Linux Server. Server versions of *GRASS GIS* and *R Statistics* are embedded into the system to process spatial data, which is then stored in a *PostgreSQL/PostGIS* database.

So far the service provides a range of frequently used geostatistical interpolation methods, including kriging, kernel density analysis and inverse distance weighting. These can be used to analyse spatial datasets from a variety of disciplines.

Table: Species Distribution Modeling Applications inside HotSpot GeoCMS.

Software	Function
Redhat EL5	Server OS
PostgreSQL/PostGIS	(Geo-)Database
Hotspot - GeoCMS	
PyWPS	OGC WPS Interface Standard Implementation
GRASS GIS, R Statistics	WPS Interfaces
MaxEnt, dismo	Species distribution modelling software

Species Distribution Modeling within the WPS

The *maxent* process is an implementation into the *HotSpot* WPS based on the MaxEnt software for species habitat modeling, provided by Princeton University.

The maximum entropy method can be used for many biological applications and therefore was chosen as the first implementation of a process for biological application.

It uses species presence data combined with environmental parameters to estimate the species' distribution, as well as the most important factors for it. Therefore it has been applied to model potential habitats considering changing environmental parameters.
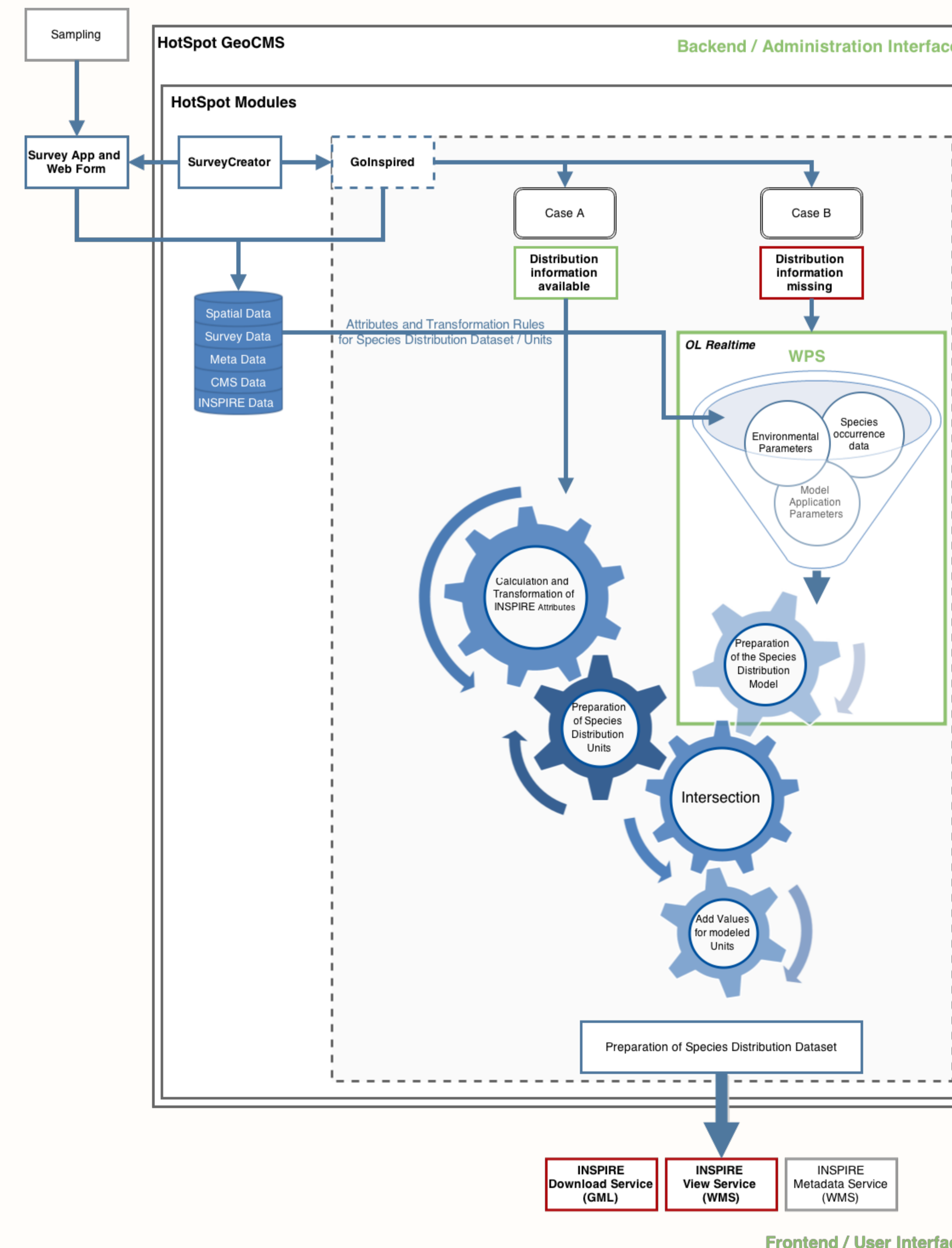

Figure: Integration of Species Distribution Modeling software into a WPS.

maxent was integrated into *HotSpot Realtime* as a new process using the R package *dismo*. *dismo* contains several functions for species distribution modeling, and enables R to access the MaxEnt java application via the *rJava* package.

To run a MaxEnt analysis using the java applet or dismo, it is necessary to set up the system with the required software. Furthermore a keen knowledge of the software is required. The access of the *maxent* process within *HotSpot Realtime* is much more user friendly.

HotSpot User Interface

To run a species distribution model, the user is required to make three types of input using the *HotSpot GUI*:

The user uploads (1) georeferenced species occurrence data (as .csv-file) and (2) environmental layers of the desired region (as raster files). (3) Parameters to fit the model can be chosen within the GUI.

Data then is processed by the WPS and results are handed back to the *HotSpot GUI*. Results then are merged and projected to species distribution units to complete the INSPIRE dataset. The INSPIRE conform output can be downloaded and will be directly be displayed in a Web Map Service on line. Furthermore it is automatically being stored within a geodatabase and provided as GML-dataset.
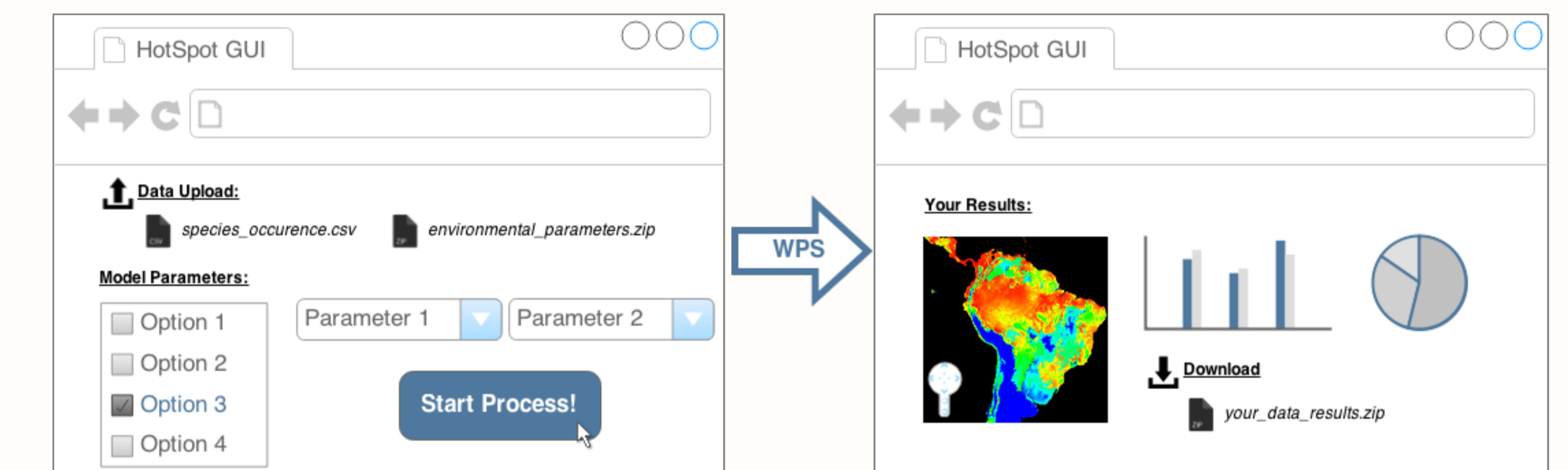

Figure: Schematic GUI for WPS process initialisation and process results.

Summary and Outlook

Our WPS is supposed to facilitate analysis of spatial data within the disciplines of biology and environmental sciences.

Analysis within the service takes place on a server and therefore is independent of (proprietary) software and OS platforms. It can be performed with little knowledge of the underlying system, via a GUI, and has a INSPIRE conform output for the spatial data theme Species Distribution.

So far, the maxent process for SDM has been implemented. Other environmental calculations, like e.g. the Shannon-Weaver index etc., are planned.

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