

Implementation of OGC's WPS standard: PyWPS

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March 15, 2007

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In this file, you can found the description of installation and configuration of PyWPS script. At the and, you can learn, how to add your own process to the list of processes. The file describes most recent version of PyWPS (*SVN*), available in subversion repository.

PyPWS project has been started on April 2006 with support of DBU – Deutsche Bundess-tiftung Umwelt (<http://dbu.de>) and with help of GDF-Hannover (<http://gdf-hannover.de>) and Help Service Remote Sensing (<http://bnhelp.cz>) companies. Initial author is Jachym Cepicky (<http://les-ejk.cz>).

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1 Introduction

PyWPS (Python Web Processing Service) is implementation of Web Processing Service standard from Open Geospatial Consortium.

It has been started on Mai 2006 as project supported by DBU. It offers environment for programming own process (geofunctions or models) which can be accessed from the public. The main advantage of PyWPS is, that it has been written with native support for GRASS. Access GRASS modules via web interace should be as easy as possible.

Processes can be written using GRASS GIS, but usage of other programs is also possible. Usage together with R package or GDAL or PROJ tools.

PyWPS is written in Python programming language, your processes must use this language too.

PyWPS Homepage can be found at <http://pywps.wald.intevation.org>. PyWPS Wiki is hosted on <http://pywps.ominiverdi.org>.

2 Bugs

Known bugs and limitations to

- Sometimes, when there is e.g. `SyntaxError` in the process, temporary file `/tmp/pywps*` is not deleted, which ledts to `ServerBussy` exception and the files have to be removed by hand.
- If inputs are of type `LiteralValue` and it's type is string, it is not controlled properly. Take care on your inputs and do not use it directly in scripts to avoid your server to be hacked.

Please report all problems or unexpected handling.

3 Installation

Required packages:

- Web Server (e.g. Apache)
- python
- python-xml

Recommended packages:

- GIS GRASS – <http://grass.itc.it> - Geographical Resources Analysis Support System (GRASS) is Open Source GIS, which provides more then 350 modules for raster and vector (2D, 3D) data analysis. PyWPS is written with native support for GRASS and it's functions.
- PROJ.4 – <http://proj.maptools.org> - Cartographic Projections library used in various Open Source projects, such as GRASS, UMN MapServer, QGIS and others. It can be used e.g. for data transformation.

- GDAL/OGR – <http://gdal.org> - translator library for raster geospatial data formats, is used in various projects for importing, exporting and transformation between various raster and vector data formats.
- R – <http://www.r-project.org> - is a language and environment for statistical computing and graphics.

3.1 Installation the quick 'n' dirty way

For installing pywps to your server simply unzip the archive to the directory, where cgi programs are allowed to run.

3.2 Installation the 'clean' way

Unzip the package

```
$ tar -xzf pywps-VERSION.tar.gz
```

and run

```
$ python setup.py install
```

Several binary packages for Linux distributios are also avaiable on PyWPS site¹.

3.3 Testing after installation

For test, just run wps.py in your command line:

```
$ ./wps.py
```

```
Content-type: text/xml
```

```
<?xml version="1.0" ?>
<ExceptionReport version="1.0.0" xmlns="http://www.opengis.net/ows"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <Exception exceptionCode="MissingParameterValue" locator="request"/>
</ExceptionReport>
```

If you got some other message, like e.g.:

```
Traceback (most recent call last):
```

```
File "trunk/index.py", line 53, in ?
```

```
from Wps import wpsexceptions
```

```
File "/home/jachym/prog/pywps/trunk/Wps/wpsexceptions.py", line 8, in ?
```

```
from xml.dom.minidom import Document
```

```
ImportError: No module named xml.dom.minidom
```

Than something is wrong with your Python installation or with the program. This message means, that the xml.dom.minidom package is not installed in your system.

¹<http://pywps.wald.intevation.org>

4 Configuration

Before you start to tune your pywps program, you should get your copy of OpenGIS(R) Web Processing Service document (OGC 05-007r4) version 0.4.0 from

<http://www.opengeospatial.org/specs/?page=specs>

NOTE: Note, that the configuration option are CASE SENSITIVE

Pywps configuration takes places in two files. The files are actually python scripts, so it does not harm, if you have some experience in python programming language. But you should be able to setup the program without any python knowledge.

The first file is in `etcsettings.py` and (optional) the second file is `etcgrass.py` which has to be setuped if you do want to use GRASS GIS modules in your scripts. Some special "tuning" can be done in `processes/__init__.py` file

4.1 etc/settings.py

This file has got two sections: WPS and serverSettings

In the WPS section, the main configuration is set, which appears mostly in GetCapabilities request. The *mandatory* parameters, which should be set up are (with default/recommend values):

```
'version': "0.4.0",
'ServiceIdentification': {
    'Title':"Jachym's WPS server",
    'ServiceType':"WPS",
    'ServiceTypeVersion':"0.1.0",
    'Abstract':'Abstract to this WPS',
},
'ServiceProvider': {
    'ProviderName' : "Your Company",
    'IndividualName':"Your Name",
    'PositionName':"Your Position",
    'Role':"your role",
    'DeliveryPoint': "Street",
    'City': "City",
    'PostalCode':"00000",
    'Country': "Your country",
    'ElectronicMailAddress':"your.email@address",
},
'OperationsMetadata': {
    'ServerAddress' : "http://localhost/cgi-bin/wps/wps.py",
},
'Keywords' : ['GRASS','GIS','WPS'],
```

In the ServerSettings section, the variables are set, which have impact on the whole server.

```

# NOTE: You have to create this directory manually and set rights, so
#       the program is able to store data in there
'outputPath': '/var/www/wpsoutputs',

#
# 'outputUrl' - URL of the directory, where the outputs will be stored
'outputUrl': 'http://192.168.1.31/wpsoutputs',

#
# tempPath - path to directory, where temporary data will be stored.
# NOTE: the pywps has to have rights, to create directories and files
#       in this directory
'tempPath': '/tmp',

#
# maxOperations - maximum number of operations, which is allowed to low
# on this server at ones
# default = 1
'maxOperations':1,

#
# maxSize: maximum input file size in bytes
# NOTE: maximum file size is 5MB, no care, if this number is higher
'maxSize':5242880, # 5 MB

#
# maxInputParamLength: maximal length of input values
# NOTE: maximum length of input parameters is 256, no matter, how height
#       is this number
'maxInputParamLength':256,

```

4.2 etc/grass.py

This file servers for configuration of GRASS GIS environment (if your processes need one). Everything is stored in grassenv structure.

```

# PATH in which your modules (processes) should be able the search.
# Default value:
'PATH': "/usr/local/grass-6.1.cvs/bin/:/usr/local/grass-6.1.cvs/scripts/:\"
/usr/bin/:/bin/:",

# Add eventually some other path, in which should GRASS search for modules
'GRASS_ADDON_PATH': "",

# Version of GRASS, you are using
'GRASS_VERSION': "6.1.cvs",

```



```

13
14         self.Title="South Dakota path searching"
15

```

5.2 Running in GRASS session

You have to define GRASS Location² If your process should happen in existing GRASS-Location, and you just need the input parameters for GRASS modules, you can specify it's name by `grassLocation` variable.

```

16         # use existing GRASS Location
17         self.grassLocation="/var/grassdata/spearfish60/"
18         # use temporary GRASS Location
19         #self.grassLocation=None

```

If this variable is set to `None`, new temporary GRASS Location && mapset will be generated (using XY coordinate system) and you can work in there. The projection of the location will be XY. If this variable is not set, GRASS will not be started.

Metadata definition is stored in array `self.Metadata` in `__init__` method. You can add new Metadata using `self.AddMetadata()` method:

```

        self.AddMetadata(Identifier="point",type="point",
                        textContent="Click in the map")

```

This code will produce in DescribeProcess response document following element:

```

...
<ows:Metadata Identifier="point" type="point">
    Click in the map
</ows:Metadata>
...

```

5.2.1 Data Inputs

Data inputs are stored in `self.Inputs` array. To add inputs to your process, you should use methods defined in `WPSProcess` class.

Four types of data inputs are defined:

LiteralInput Basic type of data input is `LiteralInput` type. To define `LiteralInput` the easy way, you should use `AddLiteralInput` method:

```

20
21         self.AddLiteralInput(Identifier="value",
                                Title="Value to be added",
                                type=type(0))

```

Above example will add new input with identifier value of type integer. Examples of other possibilities of `LiteralInputs` and resulting part of XML are following:

²see e.g. http://grass.itc.it/grass63/manuals/html63_user/helptext.html for details

Example of any allowed input value (default)

```
self.AddLiteralInput(Identifier="someinput",
                    Title="Some Input",
                    allowedvalues='*')

...
<Input>
  <ows:Identifier>someinput</ows:Identifier>
  <ows:Title>Some Input</ows:Title>
  <ows:Abstract/>
  <LiteralData>
    <SupportedUOMs defaultUOM="m">
      <ows:UOM>m</ows:UOM>
    </SupportedUOMs>
    <ows:AnyValue/>
  </LiteralData>
  <MinimumOccurs>1</MinimumOccurs>
</Input>
...
```

Example of specified list (with range) of allowed inputs Following example will define input with specified list of values: Only values 20, 30, everything between 40-100 and 110 will be accepted:

```
self.AddLiteralInput(Identifier="someinput",
                    Title="Some Input",
                    allowedvalues=[20,30,[40,100],110])

...
<Input>
  <ows:Identifier>someinput</ows:Identifier>
  <ows:Title>Some Input</ows:Title>
  <ows:Abstract/>
  <LiteralData>
    <SupportedUOMs defaultUOM="m">
      <ows:UOM>m</ows:UOM>
    </SupportedUOMs>
    <AllowedValues>
      <Value>20</Value>
      <Value>30</Value>
      <Range>
        <MinimumValue>40</MinimumValue>
        <MaximumValue>100</MaximumValue>
      </Range>
      <Value>110</Value>
    </AllowedValues>
  </LiteralData>
</Input>
...
```


6 Note to grass programming

WMSProcess class provides special method `self.Gcmd(command.string)`, which tries to catch output from GRASS modules, especially progress information indicated by percent done. Method `Gcmd()` stores the output of GRASS modules to `self.status` variable, so if the process is running asynchronously, client application can track the progress of each module directly.

It is also possible to run GRASS modules using python's `os.system()` or `os.popen()` function. Before you do so, it is important to import the `os` python package (usually one of the first lines in the file). This approach might not be the best, but it is the simplest one. Feel free to use any other low-end functions.

Unfortunately, the GRASS modules are very verbose. Some messages are written to `STDOUT`, some to `STDERR`. The `STDERR` will be stored in the error file of your web server. But you have to "catch" the messages, sent to `STDOUT`. This can be done e.g. by using `"1 > &2"` statement (redirecting `STDOUT` to `STDERR` in shell):

```
os.system("""
    echo "Rekni jim drazi, tatko, za to nic nedas." >&2
""")
```

You can avoid this problem using formentioned `self.Gcmd()` method.

7 Testing your new process

To test your PyWPS installation, you run it either as Webserver cgi-application or in the command line directly. It is always good to start with the command line test, so do not have to check `error.log` of the web server.

- GetCapabilities request (webserver)

```
./wps.py "service=wps&request=getcapabilities"

wget -nv -q -O - "http://localhost/cgi-bin/wps.py?\
service=Wps&request=getcapabilities"
```

- DescribeProcess request:

```
./wps.py "version=0.4.0&service=Wps&request=DescribeProcess&\
Identifier=your_process"

wget -nv -q -O - "http://localhost/cgi-bin/wps.py?\
version=0.4.0&service=Wps&request=DescribeProcess&\
Identifier=your_process"
```

- Execute request:

```

./wps.py "version=0.4.0&service=Wps&\
request=Execute&Identifier=your_process&\
datainputs=input1,value1,input2,value2"

wget -nv -q -O - "http://localhost/cgi-bin/wps.py?\
version=0.4.0&service=Wps&\
request=Execute&Identifier=your_process&\
datainputs=input1,value1,input2,value2" \

```

8 Using PyWPS

8.1 Input

To get response from PyWPS you have to formulate appropriate query string first. You can use HTTP GET style or HTTP POST style.

HTTP GET style is standard URL, with all parameters in one line. You can not set any ComplexValue data in your process via HTTP GET. Example:

```

wget -nv -q -O - --post-data="version=0.4.0&service=Wps&\
request=Execute&Identifier=your_process&\
datainputs=input1,value1,input2,value2"\
"http://localhost/cgi-bin/wps.py"

```

In HTTP POST style, you send one "request" parameter, which contains XML input. The XML file can contain also included ComplexValue data, e.g. GML file. Example:

```

wget --post-file=execute-post.txt \
"http://localhost/pywps/wps.py" -O - -nv -q

```

The execute-post.txt file can look like follows:

```

request=<?xml version="1.0" encoding="utf-8"?>
<Execute service="WPS" version="0.4.0" store="false" status="false"
xmlns="http://www.opengeospatial.net/wps"
xmlns:ows="http://www.opengeospatial.net/ows"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengeospatial.net/wps/wpsDescribeProcess.xsd">
  <ows:Identifier>searchpath</ows:Identifier>
  <DataInputs>
    <Input>
      <ows:Identifier>streetmap</ows:Identifier>
      <ows:Title>The map</ows:Title>
      <ows:ComplexValue>
        <Value>
<ogr:FeatureCollection
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://ogr.maptools.org/ donut.xsd"

```

```

    xmlns:ogr="http://ogr.maptools.org/"
    xmlns:gml="http://www.opengis.net/gml">
<gml:boundedBy>
  <gml:Box>
    <gml:coord><gml:X>4.263256414560601e-14</gml:X>
      <gml:Y>-70.71067811865474</gml:Y></gml:coord>
    <gml:coord><gml:X>141.4213562373095</gml:X>
      <gml:Y>70.71067811865474</gml:Y></gml:coord>
    </gml:Box>
  </gml:boundedBy>
<gml:featureMember>
  <ogr:donut fid="F0">
    <ogr:geometryProperty><gml:LineString><gml:coordinates>
      70.710678118654755,70.710678118654741,0 141.42135623730951,0.0,
      0 70.710678118654741,-70.710678118654741,0 0.0000000000000043,
      0.0000000000000057,0 70.710678118654755,
      70.710678118654741,0</gml:coordinates>
    </gml:LineString></ogr:geometryProperty>
  </ogr:donut>
</gml:featureMember>
<gml:featureMember>
  <ogr:donut fid="F0">
    <ogr:geometryProperty><gml:LineString><gml:coordinates>50.000000000000014,
      0.0000000000000021,0 71.213203435596427,-21.213203435596419,0
      92.426406871192853,0.0,0 71.213203435596427,21.213203435596423,0
      50.000000000000014,0.0000000000000021,0</gml:coordinates>
    </gml:LineString></ogr:geometryProperty>
  </ogr:donut>
</gml:featureMember>
</ogr:FeatureCollection>
  </Value>
</ows:ComplexValue>
</Input>

<Input>
  <ows:Identifier>x1</ows:Identifier>
  <ows:LiteralValue>591679.31</ows:LiteralValue>
</Input>
<Input>
  <ows:Identifier>y1</ows:Identifier>
  <ows:LiteralValue>4927205.07</ows:LiteralValue>
</Input>
<Input>
  <ows:Identifier>x2</ows:Identifier>
  <ows:LiteralValue>608642.625</ows:LiteralValue>
</Input>
<Input>

```

```

        <ows:Identifier>y2</ows:Identifier>
        <ows:LiteralValue>4915876.31</ows:LiteralValue>
    </Input>
</DataInputs>
</Execute>

```

You can see, that there are 4 inputs in this process:

1. ComplexValue GML File
2. x1 coordinate
3. y1 coordinate
4. x2 coordinate
5. y2 coordinate

8.2 Output

The output from PyWPS can be either XML file or results of processes directly. In default configuration, no files are stored on the server, resulting values (maps) are returned to the client. If you want to return XML file with outputs encoding, you have to enable it in you process configuration with option `storeSupported`:

```
self.storeSupported = "true"
```

And you have to call the PyWPS with "store=true" option:

```
version=0.4.0&service=Wps&request=Execute&Identifier=your_process&\
datainputs=input1,value1,input2,value2&store=true
```

Or in XML input:

```
request=<?xml version="1.0" encoding="utf-8"?>
<Execute service="WPS" version="0.4.0" store="true" status="false"
xmlns="http://www.opengeospatial.net/wps"
xmlns:ows="http://www.opengeospatial.net/ows"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengeospatial.net/wps/wpsDescribeProcess.xsd">
...

```

This will cause PyWPS to look after `self.status` array in your process in form form

```
self.status = ["Message", Percent_Done]
```

and generate XML file in statusLocation with this embed message. E.g.

```
self.status = ["Generating raster map", 50]
```

will become

```
...
<Status>
    <ProcessStarted message="Generating raster map" percentCompleted="50"/>
</Status>
...
```

You can set also `self.status` variable using `self.SetStatus()` method.

A Sample process: addvalue

This sample process describes how to made your own WPS processes. Purpose of this process is:

- Download input raster map from some server
- Convert it to integer values
- Add input value to each raster cell
- Convert raster to vector
- Export raster to TIFF and vector to GML. Vector file will be embed ot output XML file.

```
"""
```

pywps process example:

```
addvalue: Adds some value to raster map
```

```
"""
```

```
# Author: Jachym Cepicky
```

```
#          http://les-ejk.cz
```

```
# Lince:      GNU/GPL
```

```
#
```

```
# Copyright (C) 2006 Jachym Cepicky
```

```
import os,time,string,sys,shutil
```

```
from pywps.Wps.process import WPSProcess
```

```
class Process (WPSProcess):
```

```
    #
```

```
    # Initialization
```

```
    #
```



```

def __init__(self):
    WPSProcess.__init__(self,
        Identifier="Addvalue",
        Title="Add some value to input raster map",
        processVersion = "0.2",
        statusSupported="true",
        storeSupported="true")

    # define GRASS location -- use temporary one
    self.grassLocation = None

    #
    # Inputs
    self.AddComplexInput(Identifier="input",
        Title="Input raster map",
        Formats=["image/tiff"])
    self.AddLiteralInput(Identifier="value",
        Title="Value to be added",
        type=type(0))

    #
    # Outputs
    self.AddComplexValueReferenceOutput(Identifier="output",
        Title="Resulting output map",
        Formats=["image/tiff"])

    #
    # Execute part of the process
    #
    def execute(self):
        """
        This function
        1) Imports the raster map
        2) runs r.mapcalc out=in+value
        3) Exports the raster map
        4) returns the new file name or 'None' if something went wrong
        """

        # import of the data
        self.SetStatus("Importing data")
        if not self.Gcmd("r.in.gdal -o in=%s out=input" %\
            (self.GetInputValue("input"))):
            return "Could not import raster file"
        self.SetStatus("Importing data",10)

        # compositing 3 bands to one raster file
        for gdalinfo in os.popen("gdalinfo %s" %\
            (self.GetInputValue("input"))):

```

```

        if gdalinfo.split()[0] == "Band" and gdalinfo.split()[1] == "3":
            self.Gcmd("""g.region rast=input.red """)
            self.Gcmd("r.composite r=input.red b=input.blue g=input.green out=input")

    # region setting
    self.Gcmd("""g.region rast=input""")

    # adding the value
    self.SetStatus("Adding new value to raster map",50)
    self.Gcmd("r.mapcalc output='input+%f'" % float(self.GetInputValue('value')))

    # output
    self.SetStatus("Raster file export", 90)
    self.Gcmd("r.out.gdal type=Int32 in=output out=%s" % "output.tif")

    # setting output values
    self.SetOutputValue("output","output.tif")
    if "output.tif" in os.listdir(os.curdir):
        return # OK
    else:
        return "Output file not created!" # FAILED
"""

```

B KVP request encoding of addvalue

This process can be launched with URL:

<http://localhost/cgi-bin/wps.py?service=wps&version=0.4.0&identifier=addvalue&request=execute&\datainputs=input,http://localhost/data/raster.tif,value,250&status=true&store=true>

C XML request encoding addvalue

```

request=<?xml version='1.0' encoding='UTF-8' standalone='yes'?>
<Execute service='wps' version='0.4.0' store='true' status='false'
    xmlns="http://www.opengeospatial.net/wps"
    xmlns:ows="http://www.opengeospatial.net/ows">
<ows:Identifier>addvalue</ows:Identifier>
<DataInputs>
    <Input>
        <ows:Identifier>input</ows:Identifier>
        <ComplexValueReference reference='http://localhost/wps/data/soils.tif' />
    </Input>
    <Input>
        <ows:Identifier>value</ows:Identifier>
        <LiteralValue>250</LiteralValue>
    </Input>

```

```
<!-- Input>
  <ows:Identifier>bbox</ows:Identifier>
  <BoundingBoxValue>
    <BoundingBox>
      <LowerCorner>-1 -1</LowerCorner>
      <UpperCorner>10 10</UpperCorner>
    </BoundingBox>
  </BoundingBoxValue>
</Input -->
</DataInputs>
</Execute>
```

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