

Understanding WFS Operations

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Learning outcome

On successful completion of this hand-on exercise, you will have an understanding

- About OGC's Web Feature Service¹, also an ISO standard (ISO 19142)²
- How the standard request-response model of the HTTP protocol is used for OGC's WFS web services
- How the different requests are structured, i.e. you will see which and how parameter values are provided in the URL query string.
- How service metadata, data models and other operations are related.
- How easily geodata can be retrieved in different output formats and spatial reference systems.

¹ [OGC-WFS] Web Feature Service 2.0: <http://www.opengeospatial.org/standards/wfs>

² <https://www.iso.org/standard/42136.html>

1 Overview

According to ISO 19142:2010 this standard “specifies the behaviour of a web [...] service that provides transactions on and access to geographic features in a manner independent of the underlying data store. It specifies discovery operations, query operations, locking operations, transaction operations and operations to manage stored parameterized query expressions.”³

2 GetCapabilities

The GetCapabilities operation delivers a service metadata document describing a WFS service provided by a server.

Die GetCapabilities Abfrage liefert die Dienste-Beschreibung in Form eines XML-Dokumentes („Capabilities“). Die Dienste-Beschreibung enthält u. a. Angaben über die vom Dienst unterstützten Operationen.

Task: Analyze the content and structure of the following URL [2019-07-14]:

```
https://www.wfs.nrw.de/geobasis/wfs_nw_alkis_vereinfacht?  
Service=WFS&  
REQUEST=GetCapabilities  
&VERSION=2.0.0
```

or

```
http://geoserv.weichand.de:8080/geoserver/wfs?service=WFS&version=1.1.0&request=GetCapabi  
lities
```

Protocol:

Host:

Query String (in detail):

Task: Which significant entries can you identify in the metadata (contact name, formats)?

Welche wesentlichen Inhalte identifizieren Sie in den Metadaten? (Ansprechpartner, Formate, ...)

Task: Which FeatureTypes do you find?⁴

Task: URNs are used for which purpose? *Wozu werden URNs verwendet?*

³ <https://www.iso.org/standard/42136.html>

⁴ Feature types are names of classes of geographical objects. In the geospatial domain the term “feature” is used, and not “object” like in IT. The difference: Spatial features may be discrete (objects, i. e. separate entities like roads, buildings, trees) or continuous (fields, i. e. temperature variations).

Task: Which output formats do you find (look for `<ows:Parameter name="outputFormat">`)?

Which formats are useful for your work?

Alternative option

```
https://www.wfs.nrw.de/geobasis/wfs_nw_dvg?ACCEPTVERSIONS=2.0.0&SERVICE=WFS&REQUEST=GetCapabilities
```

or

```
http://geo.vliz.be/geoserver/wfs?service=WFS&request=GetCapabilities
```

or

```
https://ows.terrestris.de/geoserver/osm/wfs?service=wfs&version=1.1.0&request=GetCapabilities
```

or

```
http://ovc.catastro.meh.es/INSPIRE/wfsCP.aspx?service=WFS&Version=2.0.0&request=GetCapabilities
```

or

```
https://geodienste.sachsen.de/iwfs_geosn_verwaltungseinheiten/guest?SERVICE=WFS&VERSION=2.0.0&REQUEST=GetCapabilities
```

or⁵

```
http://geoserv.weichand.de:8080/geoserver/wfs?service=WFS&version=1.1.0&request=GetCapabilities
```

3 DescribeFeatureType

The DescribeFeatureType operation returns a description of the structure, i. e. a schema description of a feature type offered by a WFS instance. You have seen before the feature types in the service metadata.

Die GetFeatureType-Abfrage liefert Ihnen die Datenstruktur der angegebenen Feature-Klasse in Form eines XML-Schemadokuments (XSD).

Task: Retrieve the definition of a certain feature type [2018-09-12]:

```
https://www.wfs.nrw.de/geobasis/wfs_nw_alkis_vereinfacht?
Service=WFS&
REQUEST=DescribeFeatureType&
typeName=ave:Flurstueck&
VERSION=2.0.0&
NAMESPACES=xmlns%28ave,http://repository.gdi-de.org/schemas/adv/produkt/alkis-
vereinfacht/1.0%29
```

⁵ Accessed 2019-07-14

Which language is used to describe the structure of the data?⁶
In welcher Sprache wird der Datenaufbau beschrieben?

Which information do you find? *Welche Angaben finden Sie?*

Alternative option

Alternatively you can use this server:

```
https://www.wfs.nrw.de/geobasis/wfs_nw_dvg?REQUEST=DescribeFeatureType&SERVICE=wfs&VERSION=2.0.0&TYPENAMES=nw_dvg1_gem
```

or [2019-07-15]

```
http://geoserv.weichand.de:8080/geoserver/wfs?service=WFS&version=1.1.0&request=DescribeFeatureType&typeName=bvv:gmd_ex
```

Task: You can request as well structural metadata about other feature types (see the GetCapabilities response).
Sie können sich auch andere Objektarten (Feature Types) anschauen (vgl. Ergebnis des GetCapabilities-Aufrufs):

4 GetFeature

The GetFeature operation allows you to retrieve features from a WFS Server, so-called feature collections. We will limit the output later on by specifying further restrictions in the GetFeature request by including an additional parameter or providing the ID of a specific feature.

Mit der GetFeature-Anfrage werden Features (Objekte) von einem WFS-Download-Dienst angefordert. Die Anfrage kann durch die Verwendung bestimmter Parameter bzw. Filteroperatoren (Ausdrücke) gezielt eingeschränkt werden. Bei der Nutzung ist zu beachten, dass bei der Anforderung u. U. sehr große Datenmengen übermittelt werden. Ab WFS-Version 2.0.0 ist die maximale Anzahl der Treffer pro Paging, die pro übermittelt werden sollen, limitierbar.

Task:

Please note that this request might be no more supported. If you get an 404 error use one of the alternative.

```
https://www.wfs.nrw.de/geobasis/wfs_nw_alkis_vereinfacht?
Service=WFS&
REQUEST=GetFeature&
VERSION=2.0.0&
&OutputFormat=text/xml;subtype=gml/3.2.1
TYPENAMES=ave:Flurstueck&
NAMESPACES=xmlns%28ave,http://repository.gdi-de.org/schemas/adv/produkt/alkis-
vereinfacht/1.0%29&COUNT=10
```

Which parameter do you find? In which data format do you receive the data?
Welche Angaben finden Sie? In welchem Datenformat erhalten Sie die Daten?

⁶ bez_gem stands for municipalities in the region, bez_rbz for districts...

Alternative option

```
https://www.wfs.nrw.de/geobasis/wfs_nw_dvg?SERVICE=WFS&VERSION=2.0.0&REQUEST=GetFeature&TYPENAMES=nw_dvg1_krs
```

or [2019-05-06]

```
http://ovc.catastro.meh.es/INSPIRE/wfsCP.aspx?service=wfs&request=getfeature&Typenames=cp.cadastralparcel&SRSname=EPSG::25830&bbox=233673,4015968,233761,4016008
```

or [2019-05-06]

```
http://geo.vliz.be/geoserver/wfs?service=WFS&request=GetFeature&typeName=World:worldcities%20%20
```

4.1 Output format / Ausgabeformate

Task: Now modify your GetFeature request and specify different OutputFormat values in the query string. You can find the formats listed in the metadata!

Modifizieren Sie den Aufruf, in dem Sie verschiedene OutputFormat-Angaben entsprechend den in den Metadaten genannten Formaten spezifizieren.

Example/Beispiel (with another server is not always operational):

```
http://geoserv.weichand.de:8080/geoserver/wfs?service=WFS&version=2.0.0&request=GetFeature&typeNames=bvv:gmd_ex&srsName=EPSG:31468&bbox=4450407.80325,5324432.56981,4481624.47895,5346224.56688,EPG:31468&OutputFormat=JSON
```

If we request CSV format: How are the geometries encoded – what do you expect, how is it solved?

```
http://geoserv.weichand.de:8080/geoserver/wfs?service=WFS&version=2.0.0&request=GetFeature&typeNames=bvv:gmd_ex&srsName=EPSG:31468&bbox=4450407.80325,5324432.56981,4481624.47895,5346224.56688,EPG:31468&OutputFormat=CSV
```

4.2 Spatial Reference Systems / Raumbezugssysteme

Task: Now modify your GetFeature request and specify different srsName values from the metadata as key-value-pair (KVP).

Modifizieren Sie den Aufruf, in dem Sie verschiedene srsName -Angaben entsprechend den in den Metadaten genannten Raumbezugssystemen spezifizieren.

So easy, isn't it? This demonstrates the power of such services.

4.3 Applying Filter Encoding

The GetFeature request used before is one that downloads the feature collection (comprising maybe a very high amount of features) without any constraints to filter the content by.

This may be very costly. To reduce the computing and transfer time, filters can be used.

Filter encoding, a jointly developed OGC and ISO TC/211 International Standard, describes an XML and KVP encoding of a system neutral syntax for expressing projections, selection and sorting clauses collectively called a query expression.

After <http://www.opengeospatial.org/standards/filter>

„Um Daten von einem Web Feature Service über Queries auf der Basis von Filter Encoding zu erhalten, ist ein Client erforderlich, der das Web-Feature-Service-Protokoll versteht, da vor der Query Abfragen der Capabilities und ggf. des Anwendungsschemas erforderlich sind, um die Query formulieren zu können. Darüber hinaus muss der Filter-Encoding-Standard beherrscht werden.“⁷

Reinhard Zäch, Astrid Feichtner, Michaela Jud, Julia Müller, Hans Rumpfinger (Geschäftsstelle Geodateninfrastruktur Bayern, 2015): *Nutzung von Geodatendiensten Leitfaden*. http://www.gdi.bayern.de/file/pdf/978/2014-10-21_Leitfaden_Nutzung_Geodatendienste.pdf

4.3.1 Example: Selection of the Municipality „Rosenheim“

```
http://geoserv.weichand.de:8080/geoserver/wfs?service=WFS&version=1.0.0&request=GetFeature&typeName=bvv:gmd_ex&FILTER=<Filter><PropertyIsEqualTo><PropertyName>bez_krs</PropertyName><Literal>Rosenheim</Literal></PropertyIsEqualTo></Filter>
```

Task: Try to understand the filter (selection) in the the GetCapabilities-request. Perhaps it is useful to “translate” this to SQL?

Analyze the response as well.

4.3.2 Example: Select parcels in a certain polygon

Using a Filter Encoding expression you can limit the number of parcel features. In this case the expression is based on GML encoded definition of a polygon.

Durch den Filterausdruck lässt sich die Ausgabe der Flurstücke auf einen bestimmten Bereich einschränken (durch ein Polygon definiert):⁸

Task: Analyze the following request [2018-09-10]:

```
https://www.wfs.nrw.de/geobasis/wfs_nw_alkis_vereinfacht?Service=WFS&REQUEST=GetFeature&VERSION=2.0.0&TYPENAMES=ave:Flurstueck&NAMESPACES=xmlns(ave,http://repository.gdi-de.org/schemas/adv/produkt/alkis-vereinfacht/1.0) &Filter=%3cfes:Filter%20xmlns=http://www.opengis.net/ogc%20xmlns:fes=http://www.opengis.net/fes/2.0%20xmlns:gml=http://www.opengis.net/gml/3.2%20xmlns:fes:Within%3efes:ValueReference%3eave:geometrie%3c/fes:ValueReference%3cgml:Polygon%20gml:id=%20P1%20srsName=%20urn:ogc:def:crs:EPSG::25832%20gml:exterior%3cgml:LinearRing%3cgml:posList%3e405535%205699461%20405711%205699561%20405916%205699582%20406102%205699454%20406166%205699293%20406234%205699030%20405945%205698913%20405665%
```

⁷ Projektgruppe GDI-Standards (2013): *Adv-Festlegungen zum Web Feature Service (WFS) (Adv-WFS-Profil Version 1.0.0)*. <http://mobile.adv-online.de/Adv-Produkte/Standards-und-Produktblaetter/Adv-Profil/binarywriterservlet?imgUid=c8060312-b3c1-8541-cc29-56f2072e13d6&uBasVariant=11111111-1111-1111-1111-111111111111> [2017-11-19]

⁸ http://www.bezreg-koeln.nrw.de/brk_internet/geobasis/webdienste/anleitung_wfs.pdf

```
205698985%20405506%205699048%20405462%205699253%20405461%205699257%20405535%205699461%3c/gml:posList%3e%3c/gml:LinearRing%3e%3c/gml:exterior%3e%3c/gml:Polygon%3e%3c/fes:Within%3e%3c/fes:Filter%3e
```

Analyse the Key-Value-Pairs which are provided in the query string of the URL.

Which language is used?

Task: Submit the request.

If the server's response is not well formatted, use <https://www.freeformatter.com/xml-formatter.html> to get a well-formatted result.

Which language is used in the response?

4.4 GetFeature mit Minimum Spatial Filter

In the following example a bounding box is used to filter the data.

<http://www.weichand.de/2012/10/17/inspire-wfs-2-0-demoserver-mit-beispielanfragen-geoserver-2-2/>

```
http://geoserv.weichand.de:8080/geoserver/wfs?service=WFS&version=2.0.0&request=GetFeature&typeName=bvv:gmd_ex&srsName=EPSG:31468&bbox=4450407.80325,5324432.56981,4481624.47895,5346224.56688, EPSG:31468
```

4.5 GetFeature with limit count of features⁹

Task: To limit the number of features in the response just add a corresponding key-value-pair to the request:

```
https://www.wfs.nrw.de/geobasis/wfs_nw_alkis_vereinfacht?Service=WFS&REQUEST=GetFeature&VERSION=2.0.0&TYPENAMES=ave:Flurstueck&NAMESPACES=xm1ns%28ave,http://repository.gdi-de.org/schemas/adv/produkt/alkis-vereinfacht/1.0%29&COUNT=10
```

5 Further Operations

5.1 GetPropertyValue

This operation retrieves the value of a specific feature property, or part of the value of a complex feature property, from a data source for a given set of features identified by a query.

“This operation is most useful when the server is being accessed over networks with limited bandwidth because it returns only the property value rather than the complete feature instance data.”¹⁰

In the following example we retrieve only the values of the property `bez_gem` of the `gmd_ex` features:

```
http://geoserv.weichand.de:8080/geoserver/wfs?service=WFS&version=2.0.0&request=GetPropertyValue&typeName=bvv:gmd_ex&valueReference=bez_gem
```

⁹ http://www.bezreg-koeln.nrw.de/brk_internet/geobasis/webdienste/anleitung_wfs.pdf

¹⁰ <http://cite.opengeospatial.org/pub/cite/files/edu/wfs/text/operations.html> [2018-03-20]

5.2 ListStoredQueries

Queries (filters) can become quite complex and difficult to handle. In addition they might be useful for many people. Hence it is possible to store queries on the server itself using the CreateStoredQuery operation.¹¹

All servers shall at least implement the ability to list, describe and execute a stored query that fetches features based on their identifier¹². But additional stored queries may also be offered.

Users can retrieve information about the stored queries and can execute them. Parameters can be passed to the stored query to be acted upon by the requested operation.

Mit Stored Queries wird die Abfrage von Queries für den Client deutlich vereinfacht. Dabei handelt es sich um serverseitig gespeicherte Filterdefinitionen, die in einer Anfrage referenziert werden können. Ein Stored Query kann Template-Parameter („Platzhalter“) enthalten, die bei jeder Anfrage individuell belegt werden können.¹³

Eine neue StoredQuery wird über die Operation CreateStoredQuery angelegt. Ein Beispiel findet sich unter <http://www.weichand.de/2012/04/22/wfs-2-0-stored-queries-beispiele/>

Die ListStoredQueries-Anfrage liefert zunächst eine Liste der auf dem Server gespeicherten vordefinierten Anfragen (Stored Queries) zurück. Als Antwort erhalten Sie im XML-Format eine Liste aller auf dem WFS-Server bereitgestellten Anfragen.

```
http://geoserv.weichand.de:8080/geoserver/wfs?service=WFS&version=2.0.0&request=ListStoredQueries
```

Task: Submit the request and analyze the response. Which language is used here?

Note that there are queries according the European INSPIRE directive¹⁴.

5.3 DescribeStoredQueries (bboxQuery)

Using the DescribeStoredQueries operations we can retrieve a more detailed description of each of the stored queries, i. e. about the parameters need.

Auf dieser Grundlage können wir uns Details über die gespeicherten Anfragen besorgen, wie Informationen über den Aufbau der vordefinierten Anfragen, beispielsweise die Filterdefinition oder Platzhalter und ihre Datentypen.

```
http://geoserv.weichand.de:8080/geoserver/wfs?service=WFS&version=2.0.0&request=DescribeStoredQueries&STOREDQUERY_ID=bboxQuery
```

Task: Submit the request and analyze the response. Which language is used here?

Task: Retrieve the description of one or more other stored query of the list retrieved in section 5.2 (like geometryIntersectionQuery).

5.4 DescribeStoredQueries (INSPIRE example: CRS, DataSetId, Language variabel)

```
http://geoserv.weichand.de:8080/geoserver/wfs?service=WFS&version=2.0.0&request=DescribeStoredQueries&STOREDQUERY_ID=urn:wei:def:query:OGC-WFS::InspireStoredQueryExample
```

¹¹ Some examples can be found at <http://www.weichand.de/2012/04/22/wfs-2-0-stored-queries-beispiele/>.

¹² Having the id `urn:ogc:def:query:OGC-WFS::GetFeatureById`

¹³ <http://www.weichand.de/2012/04/22/wfs-2-0-stored-queries-beispiele/>

¹⁴ <http://inspire.ec.europa.eu/>

5.5 Features über Stored Query abfragen

Parameters can be passed to the stored query identified by its identifier.

Eine auf dem Server vorhandene Stored Query kann über ihren Identifikator (StoredQuery_ID) in der GetFeature-Anfrage referenziert werden. Dabei werden die definierten Template-Parameter („Platzhalter“) mit Werten befüllt.

```
http://geoserv.weichand.de:8080/geoserver/wfs?service=WFS&request=GetFeature&version=2.0.0&StoredQuery_ID=bbboxQuery&x1=4466856&y1=5346319&x2=4466980&y2=5346396
```

6 Alternatives

6.1 PegelOnline (level of water bodies in germany)

GetCapabilities-Operation in WFS 1.1.0:

```
https://www.pegelonline.wsv.de/webservices/gis/aktuell/wfs?service=wfs&version=1.1.0&request=GetCapabilities
```

DescribeFeatureType-Operation in WFS 1.1.0:

```
https://www.pegelonline.wsv.de/webservices/gis/aktuell/wfs?service=wfs&version=1.1.0&request=DescribeFeatureType&typeName=gk:waterlevels
```

GetFeature-Operation in WFS 1.1.0:

```
https://www.pegelonline.wsv.de/webservices/gis/aktuell/wfs?service=wfs&version=1.1.0&request=GetFeature&typeName=gk:waterlevels
```

GetFeature-Operation in WFS 1.0.0:

```
https://www.pegelonline.wsv.de/webservices/gis/aktuell/wfs?service=wfs&version=1.0.0&request=GetFeature&typeName=gk:waterlevels
```

GetFeature-Operation with Filter in WFS 1.1.0, only level resp. feature of river Elbe:

```
https://www.pegelonline.wsv.de/webservices/gis/aktuell/wfs?service=wfs&version=1.1.0&request=GetFeature&typeName=gk:waterlevels&Filter=<Filter><And><PropertyIsEqualTo><PropertyName>water</PropertyName><Literal>ELBE</Literal></PropertyIsEqualTo></And></Filter>
```

6.2 Geodatenzentrum

```
http://sg.geodatenzentrum.de/wfs_geonames?REQUEST=GetCapabilities&VERSION=2.0.0&SERVICE=wfs
```

```
http://sg.geodatenzentrum.de/wfs_dlm250_inspire?REQUEST=GetCapabilities&VERSION=1.3.0&SERVICE=wfs
```

```
http://sg.geodatenzentrum.de/wfs_clc10_2012?SERVICE=WFS&VERSION=1.1.0&REQUEST=GetFeature&
TYPENAME=clc10:clc10&BBOX=51.27,12.26,51.41,12.43,EPG:4326&SRSNAME=EPG:25832
```

Go ahead: Search for further WFS Servers

Appendix A: Structure of a sample DescribeFeatureType Response



