

Visualizing Queries

A User-Friendly CQL2 Filter Builder for Geospatial Data

Noam Rabi, September 2025



Hi, I'm Noam

- Senior Front-End Engineer at **UP42**
- Background in video and post-prod, now working on **maps** 🌍
- Big fan of **ice cream**

Agenda

- Why visualize queries?
- CQL2 filters
- Parsing Text & JSON
- Extending using Visitors

Why visualize queries?

We want to make
exploring geospatial
datasets easier.

***Web interfaces
are good for that!***

The screenshot displays the UP42 console search interface. At the top, there is a search bar with a magnifying glass icon and a '18' indicator. Below the search bar, there are two radio buttons: 'My account' (selected) and 'My workspace'. The interface is divided into several sections with filters:

- Creation date:** Includes 'From' and 'To' date pickers.
- Acquisition date:** Includes 'From' and 'To' date pickers.
- Ground sampling distance:** A horizontal slider ranging from 0 m to 100 m, with intermediate markers at 2.5 m, 10 m, and 30 m.
- Maximum cloud coverage:** A horizontal slider ranging from 0% to 100%.
- Data product, provider, and collection:** A text input field with the placeholder 'Search by data product, provider, and collection'.
- Order IDs:** A text input field with the placeholder 'Search by complete order IDs'.
- Asset IDs:** A text input field with the placeholder 'Search by complete asset IDs'.
- Tags:** Includes 'Include' and 'Exclude' sections, each with a text input field and the placeholder 'Search by complete tags'.
- Source:** Includes three checkboxes: 'Catalog', 'Processing', and 'Tasking'.

At the bottom of the interface, there are two buttons: 'Clear' (in a red box) and 'Search' (in a dark blue box).

Why visualize queries?

How to translate the form to a query?

Unfortunately, there was no JavaScript library to help me...

So I made one.

Microsoft | Planetary Computer Explore Data Catalog

Explore datasets Advanced | Clear

Landsat Collection 2 Level-2

Custom filters Select filters

Acquired	08/22/1982 - 06/11/2025	<input checked="" type="checkbox"/> Acquired
Gsd	Greater than 0	<input type="checkbox"/> Description
WRS Row	(Empty)	<input checked="" type="checkbox"/> Cloud Cover
Cloud Cover	Under 50%	<input checked="" type="checkbox"/> Gsd
Platform	Include all	<input type="checkbox"/> Item ID
Off Nadir	Under 45.00°	<input type="checkbox"/> Instrument
Sun Azimuth	Under 180.00°	<input type="checkbox"/> Cloud Cover Land
		<input type="checkbox"/> Collection Cat.
		<input type="checkbox"/> Collection Number
		<input type="checkbox"/> Correction
		<input type="checkbox"/> Scene ID
		<input type="checkbox"/> WRS Path
		<input checked="" type="checkbox"/> WRS Row
		<input type="checkbox"/> Wrs Type
		<input checked="" type="checkbox"/> Platform
		<input type="checkbox"/> Data DOI
		<input checked="" type="checkbox"/> Off Nadir
		<input checked="" type="checkbox"/> Sun Azimuth
		<input type="checkbox"/> Sun Elevation

Natural color

Landsat Collection 2 Level-2

Sorry, no items matched your filter. Try adjusting the query parameters or expand the map area.

[Planetary Computer](#)

Filters

Temporal Extent

All times in Coordinated Universal Time (UTC).

Spatial Extent

☐ Filter by spatial extent

Additional filters

☒ Match all filters (and) ☐ Match any filters (or)

Add filter

Item ID

= foo

Acquired

< 2025-06-10 09:4

All times in Coordinated Universal Time (UTC).

Sort

Default

Not all of the options may be supported.

Items per page

Default (12)

Number of items requested per page, max. 1000 items.

[STAC Browser](#)

CQL2-filters-parser library

- **Unified** way to parse CQL2 Text and JSON encodings
- Runs in **Browsers** and **JavaScript** hosts
- **Extendable** to your needs

CQL2 text or JSON

Filter Builder

```
event = 'Geomob' AND T_EQUALS(talk_date, DATE('2025-09-25'))
```



CQL2 filters

What is CQL2 and why is it helpful?

STAC vs CQL2

STAC

SpatioTemporal Asset Catalog

a way to organize geospatial data

- STAC Item
- STAC Catalog

[Spec](#)

CQL2

Common Query Language

a language to describe filter expressions for spatial and temporal data

[Spec](#)

Two encodings

CQL2 comes in two encodings,
Text and **JSON**

- Query language
- Only operators and operands
- No flow control, loops, recursion

```
// CQL2 Text encoding  
event = 'Geomob'
```

```
// CQL2 JSON encoding  
{  
  "op": "=",  
  "args": [  
    { "property": "event" },  
    "Geomob"  
  ]  
}
```

Two encodings

Differences:

- Audience
- Usage

```
// CQL2 Text encoding  
event = 'Geomob'
```

```
// CQL2 JSON encoding  
{  
  "op": "=",  
  "args": [  
    { "property": "event" },  
    "Geomob"  
  ]  
}
```

Building blocks

- **Literals:** strings, numbers, booleans, etc.
- **Properties:** the variables of CQL2
- **Operators:** logical, comparison, arithmetic
- **Combining:** binary expression, function, etc.
- **Spatial:** bbox, geometries
- **Temporal:** timestamp, date, interval

All of these nodes expressions in a tree data structure.

```
// CQL2 Text encoding  
event = 'Geomob'
```

```
// CQL2 JSON encoding  
{  
  "op": "=",  
  "args": [  
    { "property": "event" },  
    "Geomob"  
  ]  
}
```



Parsing Text, Parsing JSON

Parsers

Text → tokenizer → parser → Expression tree

JSON → depth first parser → Expression tree

parse() → Expression tree

Parsers

```
import { parse } from "cql2-filters-parser";

const { encoding, expression } = parse("event='Geomob'");

console.log(encoding); // -> Text
console.log(expression.toText()); // -> "event = 'Geomob' "
console.log(expression.toJSON()); // ->
// {
//   op: '=',
//   args: [ { property: 'event' }, 'Geomob' ]
// }
```



Visitors welcome

Especially for this library :)

Visitor design pattern

Separates the operation from the object.
Allows defining new operations on data structure.

Visitor design pattern

Each node type has a corresponding visit function:

- Literal → visit**Literal**Expression()
- Operator → visit**Operator**Expression()
- Property → visit**Property**Expression()
- Binary expression → visit**Binary**Expression()

The **visitor object** is something that **implements visit functions**

HTML Builder Visitor

The **visitor object** is something that **implements visit functions**

```
const HTMLBuilderVisitor = {  
  visitLiteralExpression(expr) { /* ... */ },  
  visitOperatorExpression(expr) { /* ... */ },  
  visitPropertyExpression(expr) { /* ... */ },  
  visitBinaryExpression(expr) { /* ... */ },  
};  
  
const { expression } = parse("event='Geomob'");  
const builderForm = expression.accept(HTMLBuilderVisitor);  
document.getElementById("builder").appendChild(builderForm);
```

HTML Builder Visitor

```
const HTMLBuilderVisitor = {
  visitLiteralExpression(expr) {
    return createElement(expr.value, expr.type);
  },
  visitOperatorExpression(expr) {
    return createOperatorSelectElement(expr.text);
  },
  visitPropertyExpression(expr) {
    return createElement(expr.name, "text");
  },
  visitBinaryExpression(expr) {
    const left = expr.left.accept(BuilderVisitor);
    const op = expr.operator.accept(BuilderVisitor);
    const right = expr.right.accept(BuilderVisitor);
    return createBinaryPairElement(left, op, right);
  },
};

const builderForm = expression.accept(HTMLBuilderVisitor);
```

VISITORS WELCOME

HTML Builder Visitor

```
const HTMLBuilderVisitor = {  
  visitLiteralExpression(expr) {  
    return createLiteralElement(expr.value);  
  },  
  visitOperationExpression(expr) {  
    return createOperationElement(expr.operator, expr.left, expr.right);  
  },  
  visitPropertyAccessExpression(expr) {  
    return createPropertyAccessElement(expr.object, expr.property);  
  },  
  visitBinaryExpression(expr) {  
    const left = expr.left.accept(this);  
    const operator = expr.operator;  
    const right = expr.right.accept(this);  
    return createBinaryElement(left, operator, right);  
  },  
};
```

CQL2 Text

event='Geomob' AND talk_duration > 10

Filter Builder

event

=

▼

Geomob

and

▼

talk_duration

>

▼

10

⬆

```
const builderForm = expression.accept(HTMLBuilderVisitor);
```



Wrapping up

WRAPPING UP

CQL2-filters-parser library

[GitHub repository](#)

- **Unified** way to parse CQL2 Text and JSON encodings
- Runs in **Browsers** and **JavaScript** hosts
- **Extendable** to your needs



CQL2 text or JSON

Filter Builder

```
event = 'Geomob' AND T_EQUALS(talk_date, DATE('2025-09-25'))
```

AND ▼

Convert to rule

Property ▼

event

= ▼

String ▼

Geomob

Convert to AND / OR

T_EQUALS

(Property ▼

talk_date

, Date ▼

25.09.2025

)

CQL2 Playground - <https://noamra.github.io/ogc-cql2-filters>

GitHub repository - <https://github.com/NoamRa/ogc-cql2-filters>

npm i **cql2-filters-parser**