[Gems on AEM] Search forms made easy with the AEM QueryBuilder

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MAKE IT AN EXPERIENCE

QueryBuilder - What it looks like

- Search for jar files, and order them newest first:

```
type=nt:file
nodename=*.jar
orderby=@jcr:content/jcr:lastModified
orderby.sort=desc
```

- As URL:

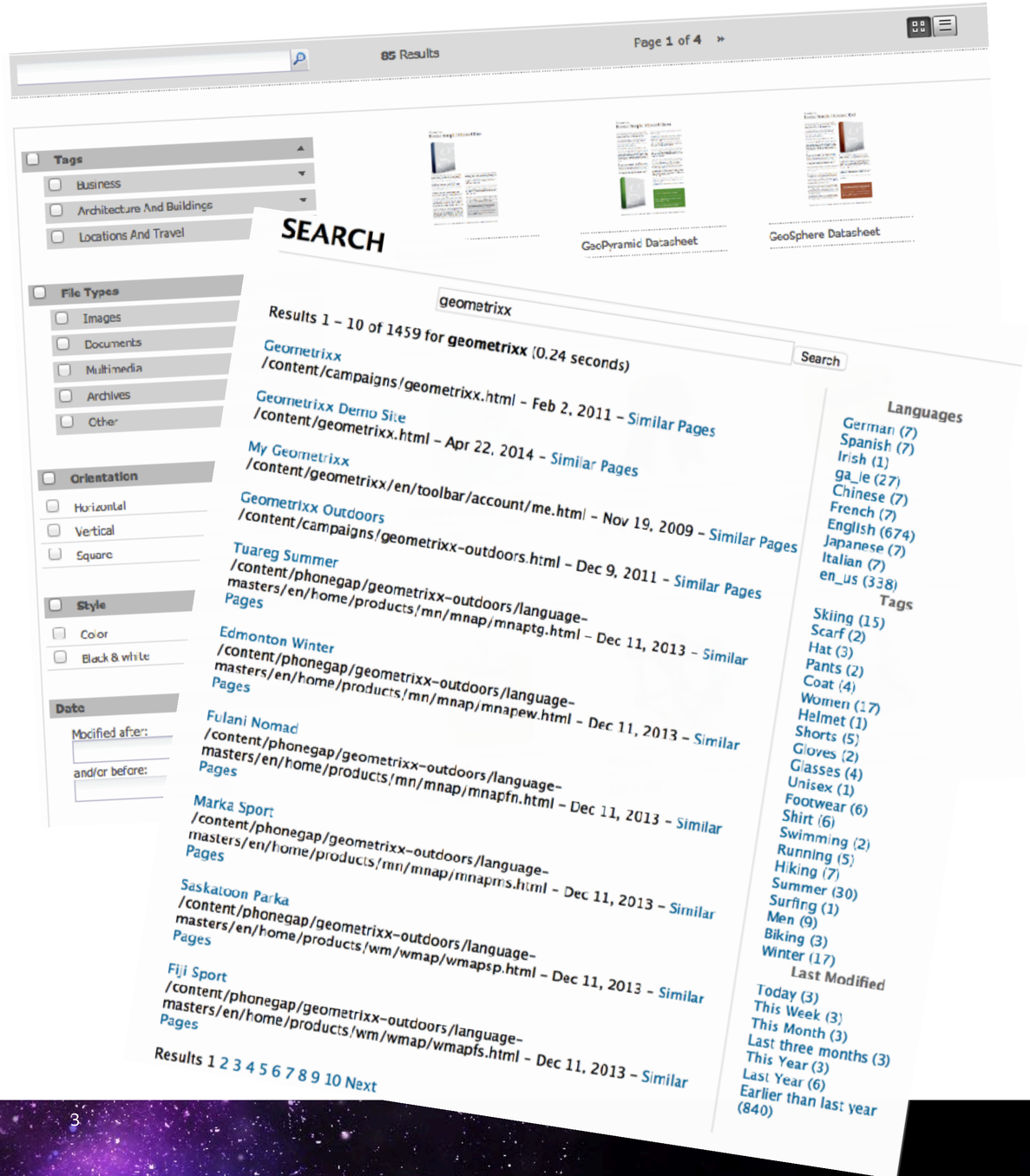
```
http://localhost:4502/bin/querybuilder.json?
type=nt:file&nodename=*.jar&
orderby=@jcr:content/jcr:lastModified&orderby.sort=desc
```

- Result as JSON:

```
{
  success: true,
  results: 10,
  total: 155,
  offset: 0,
  hits: [{
    path: "/apps/cloudmgr/install/cq-change-admin-pwd-1.0.1-SNAPSHOT.jar"
    excerpt: "application/java-archive"
    name: "cq-change-admin-pwd-1.0.1-SNAPSHOT.jar"
    ....
  },{...}
  ]
}
```

Use Cases

- End user searches in UI
- Advanced user search forms
  - example: DAM Asset share
  - easy to edit by authors
- Simple, performance-optimized paging
- Endless scrolling
- Site search component
- Simple AJAX JSON query from client side
- Ad hoc developer/admin queries



Do Not Use it For

- Programmatic queries
  - when result is potentially large & needs to be entirely iterated
  - QueryBuilder result API not optimized for that
  - use direct JCR XPath or SQL query instead
  - such a query will be fixed anyway

Philosophy

- QueryBuilder…
  - is a framework to **build queries** for a query engine (JCR XPath underneath)
  - simple to compose query from conditions = **predicates**
  - natively supports URLs & HTML forms
  - complete query can be copy & pasted in text form
  - no worry about escaping
  - post processing: custom ordering, filtering
  - extensible

- QueryBuilder is **not**…
  - a query engine itself (relies on JCR queries)
  - does not have its own search index (relies on Oak indexes)
  - or even cache (except a simple facet cache)

Consequences: URL parameters

- Set of key = value pairs
  - Java: hash maps, property files

```
http://localhost:4502/bin/querybuilder.json?
type=nt:file&nodename=*.jar&
orderby=@jcr:content/jcr:lastModified&orderby.sort=des
```

- Keep it short for GET requests
  - as fallback, use POST to transport „long“ queries
  - but short queries are more readable

  => Avoid duplication in parameter names

  => Allow to write custom „shortcut“ predicates (extensible)

- Order must be encoded in parameter names
  - HTML form GETs/POSTs are required to be in order
  - but the Java servlet spec gives you a hash map....

  => Conflicts with short names above

  => Solution is not necessarily intuitive at first, but it gets the job done

More Design Consequences

- HTML checkbox behavior
  - checked: `field=on`
  - not checked: *not sent with the request*
- Copy/paste
  - obvious one, but XPath for JCR does not respect it (limit & offset)
  - nothing that can only be done through an API call
  - global settings, given with `p.` prefix, like `p.offset=10`
- Extensible
  - predicates evaluators as OSGi components
  - SCR registration to associate with predicate name

Composing

```
fulltext=my search
```

```
property=cq:tags
property.value=business
```

```
property=jcr:mimeType
property.value=image/png
```

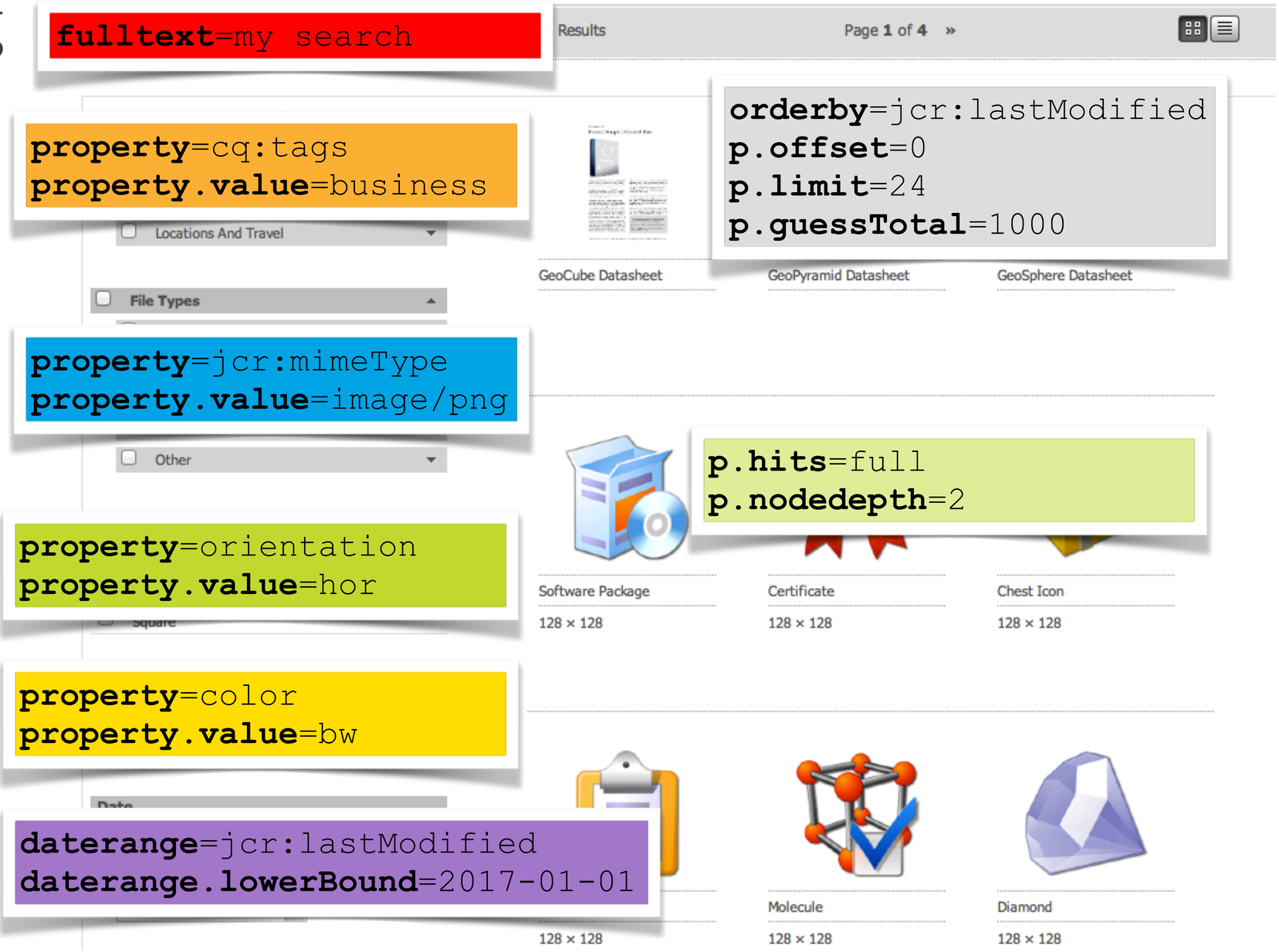
```
property=orientation
property.value=hor
```

```
property=color
property.value=bw
```

```
daterange=jcr:lastModified
daterange.lowerBound=2017-01-01
```

```
orderby=jcr:lastModified
p.offset=0
p.limit=24
p.guessTotal=1000
```

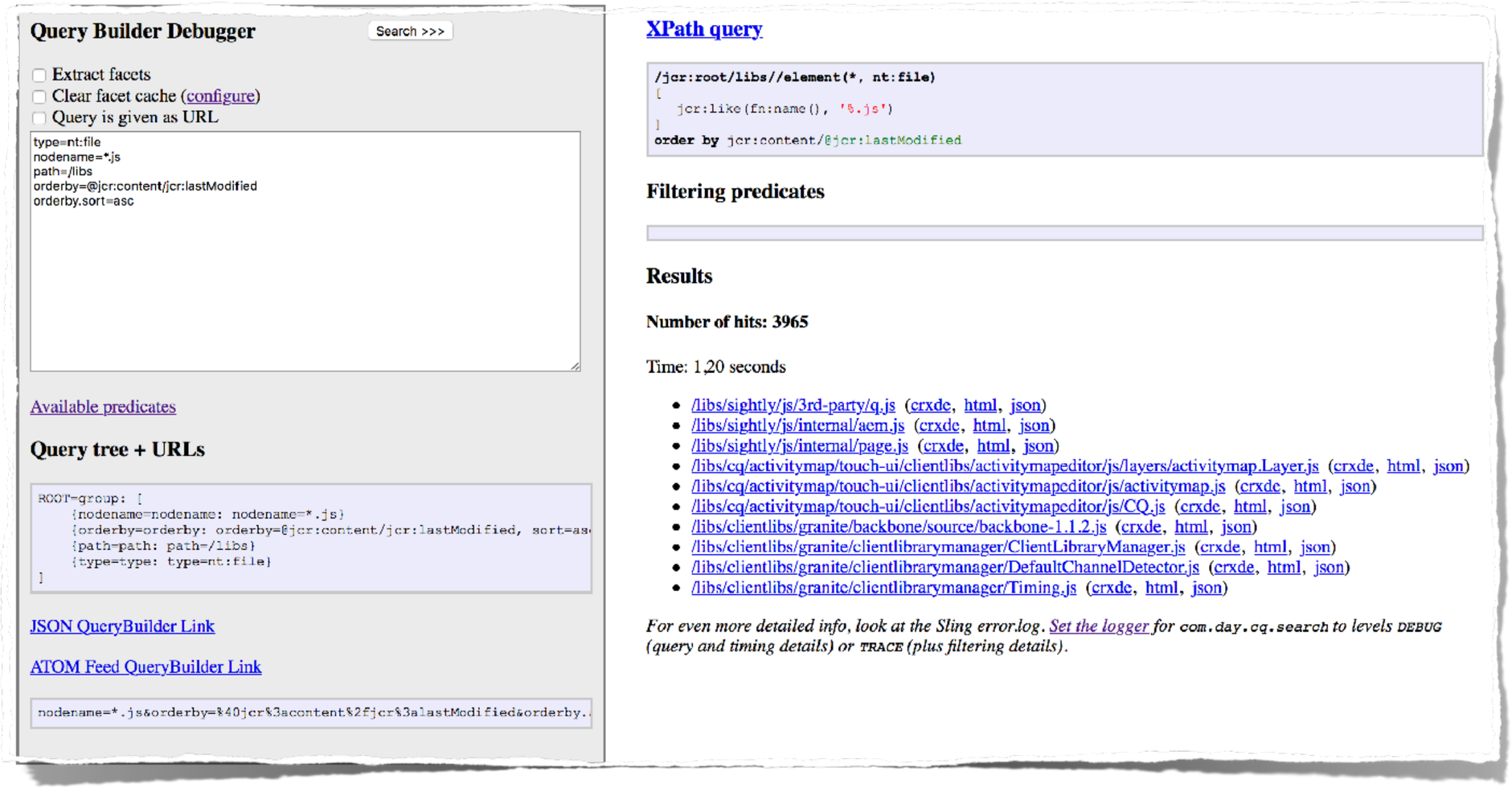
```
p.hits=full
p.nodedepth=2
```



JCR query underneath

- QueryBuilder will run a JCR XPath query
- Executed normally by Oak
- Same query limits, traversal warnings apply
- Needs indexes to be efficient
  - starting with 6.3 unindexed queries will give a warning/be denied
  - create indexes according to your needs
  - try to cover similar queries by shared index
  - see Gem sessions on Oak queries

QueryBuilder Debugger



- http://localhost:4502/libs/cq/search/content/querydebug.html

Debug logs

- Set `com.day.cq.search` to DEBUG or TRACE level
- DEBUG level (shortened):

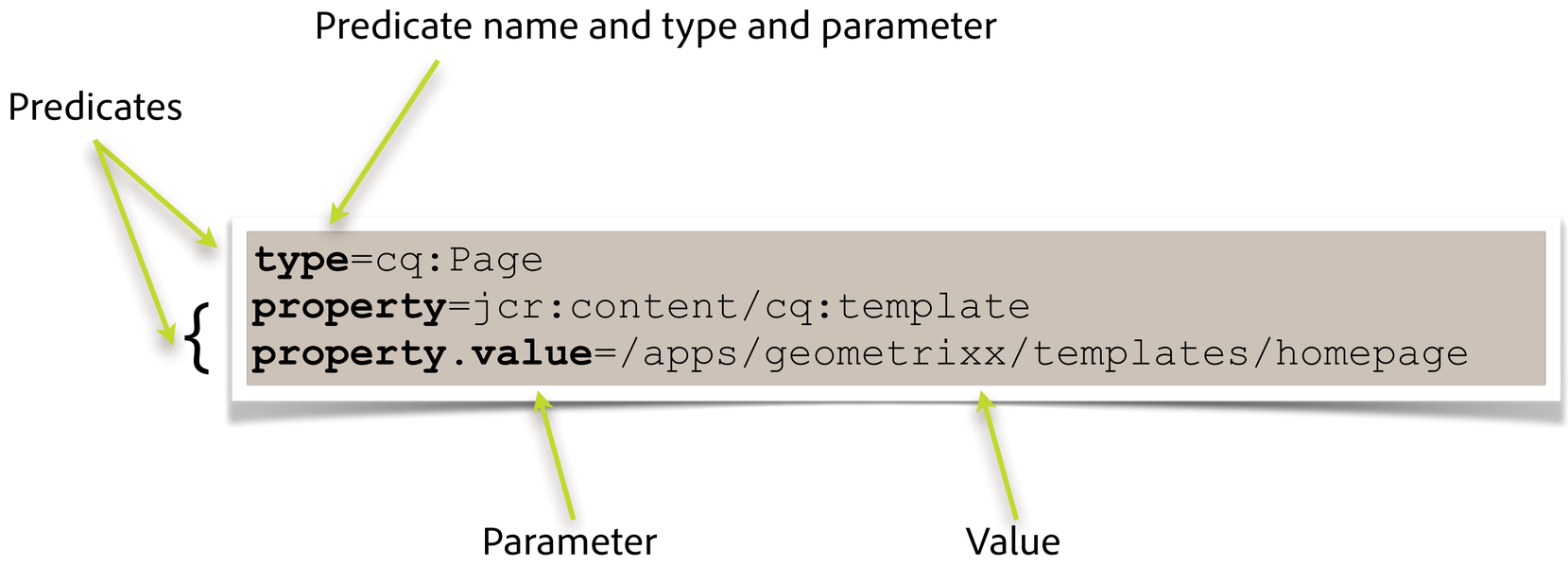
```
21.02.2017 23:26:27.823 *DEBUG* ...QueryImpl executing query (URL):
nodename=*.%5bp%5dng&type=dam%3aAsset
21.02.2017 23:26:27.823 *DEBUG* ...QueryImpl executing query (predicate tree):
ROOT=group: [
    {nodename=nodename: nodename=*.[p]ng}
    {type=type: type=dam:Asset}
]
21.02.2017 23:26:27.823 *DEBUG* ...QueryImpl xpath query: //element(*, dam:Asset)
21.02.2017 23:26:27.824 *DEBUG* ...QueryImpl xpath query creation took 1 ms
21.02.2017 23:26:27.824 *DEBUG* ...QueryImpl filtering predicates: {nodename=nodename: nodename=*.[p]ng}
21.02.2017 23:26:27.852 *DEBUG* ...QueryImpl >> xpath query returned 1407 results (iterated)
21.02.2017 23:26:27.852 *DEBUG* ...QueryImpl >> after filtering there are 76 results
21.02.2017 23:26:27.852 *DEBUG* ...QueryImpl filtering overhead was 6 ms
21.02.2017 23:26:27.852 *DEBUG* ...QueryImpl consider using 'p.guessTotal' if you don't need the full total with every query
21.02.2017 23:26:27.857 *DEBUG* ...QueryImpl filtering overhead was 1 ms
21.02.2017 23:26:27.857 *DEBUG* ...QueryImpl entire query execution took 34 ms
```

- TRACE will also show filtering per node (useful when writing custom filtering)
- Avoid DEBUG or lower in production

Oak Query Debug logs

- To see underlying Oak query details, set DEBUG level
  - `org.apache.jackrabbit.oak.plugins.index`
  - `org.apache.jackrabbit.oak.query`
  - might be useful to push into separate `query.log` file
- Will mention index used
- Lists available indexes and costs

Anatomy of a query



Predicate‘s type is mirrored as parameter internally:

```
type.type=cq:Page
property.property=jcr:content/cq:template
property.value=/apps/geometrixx/templates/homepage
```

Predicate resolution & execution

- Internally, a **predicate evaluator** is resolved
- Based on the **type**
- OSGi component (using factories)

- Handles:
  - mapping to xpath (required)
  - filtering of results
  - custom ordering mechanism
  - facet extraction

Multiple predicates of the same type

- Fixed numbering scheme
- Name = **<nr>_<type>**
- Allows to define an order
  - work around hash maps

```
type=cq:Page
1_property=jcr:content/cq:template
1_property.value=/apps/geometrixx/templates/homepage
2_property=jcr:content/jcr:title
2_property.value=English
```

- No custom names possible!

Standard predicates

- path
  - supports multiple paths
- type
  - node type
- property
  - JCR property
  - different operations
  - depth allows to search inside nested structures
- boolproperty
- fulltext
  - full text search
- range
  - supports decimals
- daterange
- relativedaterange
- nodename
- similar
  - rep:similar
- tagid & tag
- tagsearch
  - searches for matching tag first
- language
  - page languages
- mainasset
  - DAM: asset vs. sub assets
- memberOf
  - sling collection membership
- hasPermission
  - jcr priviliges, aka „can write“
- savedquery
  - include predicates from saved query

Ordering

- Use **orderby** predicate
  - sort ascending by default, use `orderby.desc=true` for descending
  - support case insensitive `orderby.case=ignore` (since 6.2)
- (1) Order by JCR properties
  - `orderby=@cq:tags`
  - `orderby=@jcr:content/cq:tags`
- (2) Reference predicate by name
  - `orderby=mypredicate`
  - predicate evaluator must provide ordering
  - simply a list of properties (=> used in xpath query)
  - or a custom Comparator (=> run after filtering)
- Multiple orderings
  - `1_orderby=@cq:tags`
  - `2_orderby=@cq:lastModified`
  - `3_orderby=nodename`

Grouping of predicates

- Special **group** predicate

```
fulltext=Management
group.p.or=true
group.1_path=/content/geometrixx/en
group.2_path=/content/dam/geometrixx
```

- Like brackets:
  - `(fulltext AND (path=... OR path=...))`
- Nested:

```
fulltext=Management
group.p.or=true
group.1_group.path=/content/geometrixx/en
group.1_group.type=cq:Page
group.2_group.path=/content/dam/geometrixx
group.2_group.type=dam:Asset
```

  - `(ft AND ( (path= AND type=) OR (path= AND type=) ))`

Union

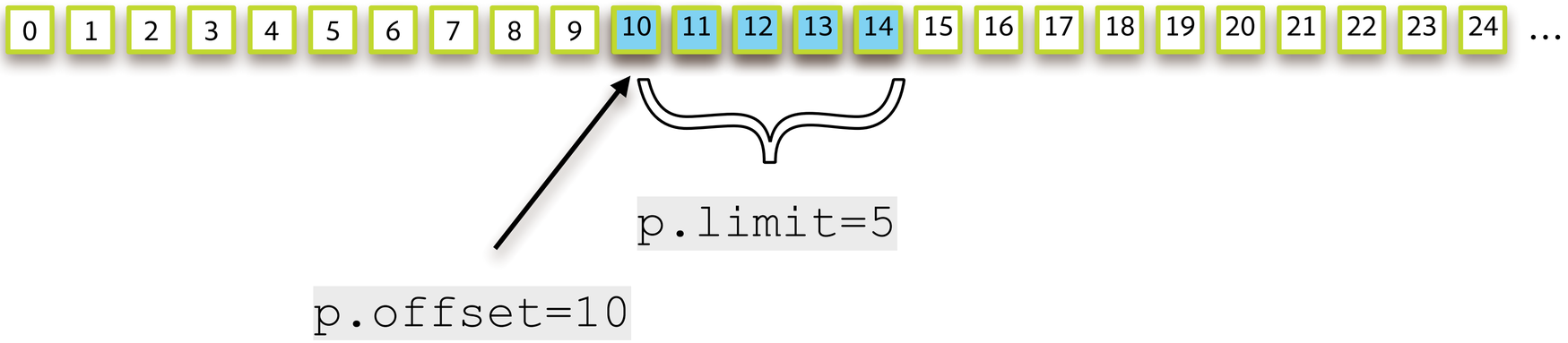
- Since 6.3, union queries are now supported by Xpath
  - aka groups with `p.or=true`
- No longer potentially slow filtering necessary, but passed through
- Oak can leverage indexes

- Common example: multiple paths
  - `group.p.or=true`
  - `group.1_path=/content/dam/we-retail`
  - `group.2_path=/content/dam/geometrixx`

- Maps to this xpath
  - `(/jcr:root/content/dam/we-retail//* | /jcr:root/content/dam/geometrixx//*)`

Limiting

- `p.offset` defines start
- `p.limit` defines page size
- will display results `p.offset` to `p.offset + p.limit`
- part of predicates, works everywhere, API, json servlet, debugger



Paging and result size

- Control offset and page size
  - `p.offset` = start or how many results to skip
  - `p.limit` = page size or how many results to show

- JSON servlet response
  - `total`: total number of results
  - `offset`: same as p.offset
  - `results`: same as p.limit

Efficient queries

- Enemy: large results (100k, millions) and iterating/counting them entirely
- Typical solution: display „1000 results and more“
- Possible with `p.guessTotal`
  - `true`: will only go to minimum `p.offset + p.limit`
  - `<number>`: will count total up to that (since 6.0 SP2)
    - use number below which users want exact numbers
    - …but is small enough to have great performance
  - defaults to false… could change
- Result will tell if there are „more“ results
  - `more: true` in JSON
  - `SearchResult.hasMore()`

Efficient queries: examples

- actual result `2500`
  - `p.guessTotal=1000`
  - will return `total: 1000` and `more: true`

- actual result `73`
  - will return `total: 73` and `more: false`

- actual result `2500`
  - `p.guessTotal=1000`
  - `p.offset=1000` & `p.limit=20`
  - will return `total: 1020` and `more: true`

Paging client side

- show total using `r.total` plus „and more“ if `r.more == true`
- show next page button if `r.more || (r.offset + r.results < r.total)`
- show previous page button if `currentPage > 1`
- `currentPage = Math.floor(r.offset / qb.limit) + 1`

- Using QueryBuilder JS components can help
  - /libs/cq/search/widgets
  - could need an update though
  - see also /libs/dam/components/assetshare/querybuilder

Running queries

- JSON servlet: http://localhost:4502/bin/querybuilder.json
- Atom feed: http://localhost:4502/bin/querybuilder.feed
- Java API

```
PredicateGroup root = PredicateGroup.create(request.getParameterMap());
Query query = queryBuilder.createQuery(root, session);

SearchResult result = query.getResult();
for (Hit hit : result.getHits()) {
    String path = hit.getPath();
    // ....
}
```

JSON servlet

- JSON: http://localhost:4502/bin/querybuilder.json

- `p.hits=` selects how the hits are written
  - **simple**
    - path, lastmodified, etc. only
  - **full**
    - full sling json rendering of node
    - by default entire subtree
    - `p.nodedepth=1` as in sling's json (0 = infinity)
  - **selective**
    - `p.properties` is an array of properties to write
    - just the node itself

Open JSON servlet

- Warning: it is a generic query endpoint, DoS attacks
- Sometimes desire to disable it
- Safe guard with query limits in Oak
  - `-Doak.queryLimitInMemory=500000`
  - `-Doak.queryLimitReads=100000`

Java API

- From HTTP request:

```
Session session = request.getResourceResolver().adaptTo(Session.class);
PredicateGroup root = PredicateGroup.create(request.getParameterMap());
Query query = queryBuilder.createQuery(root, session);
```

- From hash map:

```
Map map = new HashMap();
map.put("path", "/content");
map.put("type", "nt:file");
Query query = builder.createQuery(PredicateGroup.create(map), session);
```

- From predicates:

```
PredicateGroup group = new PredicateGroup();
group.add(new Predicate("mypath", "path").set("path", "/content"));
group.add(new Predicate("mytype", "type").set("type", "nt:file"));
Query query = builder.createQuery(group, session);
```

Persisted Queries

- Store query
  - in Java properties file format
  - in the repository
  - as file node
  - or as string property

```
Query query = .... // create query normally

// store query as file
queryBuilder.storeQuery(query, „/content/myquery“, true, session);


// load it again
Query query = queryBuilder.loadQuery(„/content/myquery“, session);
```

- List component allows this

Facets

- Extract set of possible values found in current result
- Options for a more specific query
- Facet = set of buckets
  - Facet = tag
  - Buckets = product, business, marketing
- Buckets can also be custom ranges
  - Facet = daterange
  - Buckets = yesterday, last week, last year…

```
Map<String, Facet> facets = result.getFacets();
for (String key : facets.keySet()) {
    Facet facet = facets.get(key);
    if (facet.getContainsHit()) {
        writer.key(key).array();
        for (Bucket bucket : facet.getBuckets()) {
        }
    }
}
```

Run new query based on facet/bucket

- Simple as that:

```
String bucketURL =

query.refine(bucket).getPredicates().toURL();
```

- Facets are extracted for all predicates in the current query
  - keep them „empty“ if they should not search

```
type=cq:Page
1_property=jcr:content/cq:template
1_property.value=/apps/geometrixx/templates/homepage
2_property=jcr:content/jcr:title
```

No value for 2_property

Facet Performance & Cache

- Always iterates entire result set (p.guessTotal benefit lost)
  - Linear performance with size of result set, affected by query limits

- Simple facet cache available since 6.0
- Disabled per default, enable & configure via osgi config
  `com.day.cq.search.impl.builder.QueryBuilderImpl`
- Caches facet result by query
  - only reusable for exact same query

- Oak Lucene Index has facet support, would be desirable to tap into it in the future

Extension Points

- Custom predicate: `PredicateEvaluator`
  - generate xpath: `getXPathExpression()`
  - filter via code: `includes()`
- Custom sorting
  - `PredicateEvalutor.getOrderByComparator()`
  - `PredicateEvalutor.getOrderByProperties()`
- Custom facet extraction
  - `PredicateEvalutor.getFacetExtractor()`
  - `FacetExtractor, Facet, Bucket`
- Custom hit format for JSON servlet: `ResultHitWriter`

Extending: Writing custom predicate evaluators

```
/** @scr.component metatype="no"
 *                 factory="com.day.cq.search.eval.PredicateEvaluator/event" */
public class EventPredicateEvaluator extends AbstractPredicateEvaluator {
    public String getXPathExpression(Predicate p, EvaluationContext context) {
        final String from = p.get(„from“);
        final String to = p.get(„to“);

        // build xpath snippet
        return „@start = ,...‘ and @end = ,...‘“;
    }

    public String[] getOrderByProperties(Predicate predicate, EvaluationContext ctx) {
        return new String[] { „start“ };
    }

    public boolean canFilter(Predicate predicate, EvaluationContext context) {
        return false;
    }

    public boolean canXpath(Predicate predicate, EvaluationContext context) {
        return true;
    }
}
```

Extending: Filtering & Facet extraction

- In addition or alternatively to xpath, a predicate can filter
- goes over nodes in result and says include or drop

```
public boolean includes(Predicate p, Row row, EvaluationContext context)
```

- Facet extraction is „lazy"
- Evaluator returns a **FacetExtractor**
- Base implementations available
  - `PropertyFacetExtractor`
  - `DistinctValuesFacetExtractor`
  - `PredefinedBucketsFacetExtractor`

Documentation & Links

- Main documentation plus some examples
  - https://docs.adobe.com/docs/en/aem/6-2/develop/search/querybuilder-api.html
- Javadocs
  - https://docs.adobe.com/docs/en/aem/6-2/develop/ref/javadoc/com/day/cq/search/package-summary.html (click next package to see others)
- Predicate evaluators in Javadocs
  - https://docs.adobe.com/docs/en/aem/6-2/develop/ref/javadoc/com/day/cq/search/eval/package-summary.html
- QueryBuilder Debugger
  - http://localhost:4502/libs/cq/search/content/querydebug.html
- Configuration
  - http://localhost:4502/system/console/configMgr/com.day.cq.search.impl.builder.QueryBuilderImpl
- Oak indexes
  - https://docs.adobe.com/docs/ja/aem/6-2/deploy/platform/queries-and-indexing.html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