

Design and Implementation of JVO SkyNode

IVOA Small Projects Meeting, 2004 Oct 1

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Current JVO activities

We are focusing on the following subjects:

- contribution to the IVOA activity in designing the **VO query language** (VOQL WG)
- development of a toolkit for making existing data services VO compliant (**JVO SkyNode toolkit**),
- development of a **VO portal** service (Masahiro Tanaka)
- VO enabled **science** using JVO system (Satoshi Honda)

Data Resources in NAOJ

- **Subaru** 8.2m Optical-Infrared Telescope
- **Kiso** 105cm Schmidt Camera
- **Okayama** 188cm Optical Telescope
- **Nobeyama 45m** Radio Telescope
- **Nobeyama Millimeter Array**
- **Nobeyama Radioheliograph**
- **VSOP**
- **VERA**
- **ALMA**



SMOKA Archive in NAOJ

SMOKA Science Archive Microsoft Internet Explorer

http://smoka.nao.ac.jp/search.jsp

SMOKA Archive Advanced Search

[Click here for Simple Search.](#)

Object Name (for name resolve) Resolver
 SIMBAD NED
 Don't Resolve

RA Dec Radius (arcmin) Equinox
Galactic Longitude Galactic Latitude Ecliptic Longitude Ecliptic Latitude

Observation Date Exp. Time (sec) Observer

Frame ID Exposure ID

Imagers:
Subaru: Suprime-Cam
Subaru: FOCAS
Subaru: OHS/CISCO
Subaru: IRCS
Subaru: CIAO
Subaru: CDS/CIS
Subaru: CAC
Subaru: MIP/CIS
Kiso: 1k CCD
Kiso: 2k CCD
Okayama: CASIS

Spectrographs:
Subaru: FOCAS
Subaru: HEE
Subaru: CHAMA 500
Subaru: IRCS
Subaru: CIAO
Subaru: CDS/CIS
Okayama: ESO
Okayama: IFS

Data Type:
OBJECT
BIAE
DARF
FLAT
CCD WISCON

Observation Band Filter lists / Wavelength

Output Options
Output columns:
Reset

<http://smoka.nao.ac.jp/>

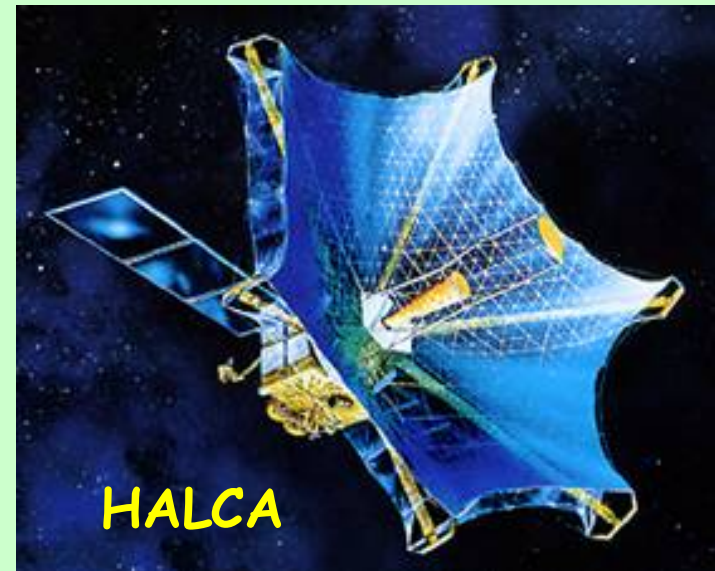
Public science archive of the

- **Subaru Telescope,**
- **188cm telescope** at Okayama Astrophysical Observatory,
- **105cm Schmidt telescope** at Kiso Observatory / University of Tokyo.

Reduced data of Subaru Suprime-Cam is now available.

Data Resources in JAXA/ISAS

- **ASCA** X-ray astronomy satellite
- **YOHKO** solar physics satellite
- **Ginga** X-ray astronomy satellite
- **HALCA** VLBI satellite
- **Geotail** geomagnetosphere satellite
- **Akebono** aurora observation satellite
- **ASTRO-F** Infrared satellite
- **ASTRO-E2** X-ray satellite
- **SOLAR-B**



DARTS

宇宙航空研究開発機構
宇宙科学研究本部
宇宙科学情報解析センター

DARTS

JAXA ISAS
Center for PLanning and
Information systems

[English | [Japanese](#)] [What's New?](#) Last Updated: 17 September, 2004

Database <http://www.darts.isas.jaxa.jp>

- Astrophysics
 - [ASCA, BeppoSAX, and HALCA](#)
 - [Ginga](#)
 - [FRTS Data Base](#)
 - [ROSAT All-Sky Survey](#) [Mirror site of [MPE](#)]
 - [Other services](#)
- Solar Physics
 - [DARTS/Yohkoh, TRACE, RHESSI \(new\)](#)
 - [SXT Daily Images \(Monthly Format\)](#)
 - [SXT Recent Images \(@ TMSAT\)](#)
 - [Yohkoh \(complete\), TRACE, Solar Soft \(+DB\)](#)

JVO Query Language (JVOQL)

JVOQL is designed as a prototype of VO Query Language.

Characteristics of the JVOQL:

- **SQL** based Query Language
- Query Language for the **distributed astronomical DB**.
- Can search and retrieve **observational data** as well as catalog data
- Upward compatible with the **ADQL** and **SIAP** syntax.
- **Scalable** syntax structure. Very simple core syntax and extension syntax packages.

JVOQL Syntax Requirement 1

- **Unified** query language for both the catalog and observation data such as image data, spectrum, 3D-cube, photon list ...
 - Parameter query (SIAP) can be replaced by SQL thinking that **the parameters are columns** of a relational table.
 - Observational data or pointer (URL) to retrieve the data is also a column of the relation table.

<http://jvo.nao.ac.jp/imageData?Pos=24,5&Size=0.2&format=VOTable>

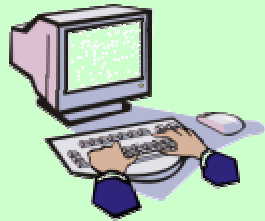


```
Select    imageURL, ...
From      naoj:imageData
Where     pos=Point(24,5) and size=0.2 and format='VOTable'
```

“pos” , “size” , “imageURL” are **virtual columns**.

Image Search

Parameter based Image Query



Search Parameters



Image Search Engine



SQL

FITS file management table

FITS_ID	Coord.	Filename

File name, Metadata

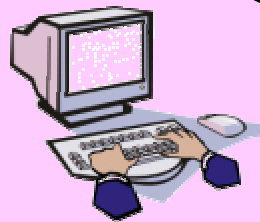
Image cutout



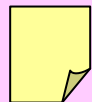
Image FITS file

SQL based Image Query

Data Search on a virtual table.



SQL



XML, FITS, Jpeg

Column metadata request

region	Other search parameters	Image
region1	...	
region2	...	
region3	...	

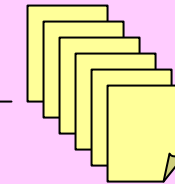
FITS_ID	Coord.	Filename

SQL



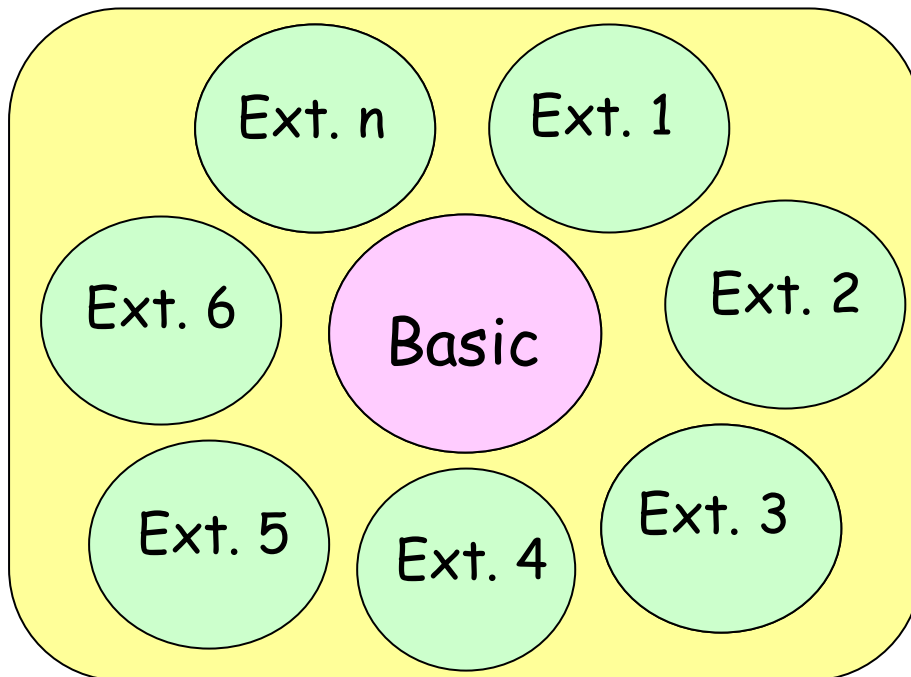
File name, Metadata

image cutout



JVOQL Syntax Requirement 2

- VOQL should have **scalable** syntax:
 - **Small** size DBs → very **simple** syntax for easy implementation.
 - **Large** size DBs → **sophisticated** syntax for efficient data search.
- **hybrid syntax structure** : a basic syntax to be implemented by all the VO data service and extension syntax packages.



Information which extensions are implemented will be registered in the **registry** service or data service itself returns the information through "**voqlSpec**" interface.

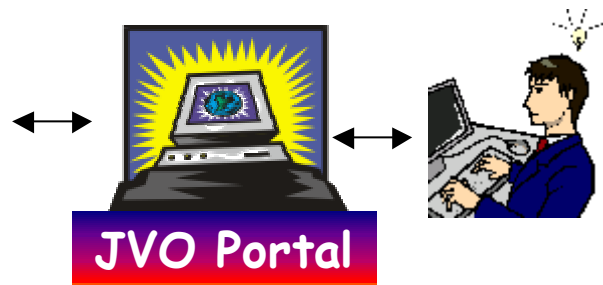
Development of JVO Skynode Toolkit

JVO Skynode :

- can accept **ADQL-x** over HTTP/SOAP, **SIAP** over HTTP/Parameters → **VO compliant**,
- can accept **JVOQL** over HTTP/SOAP and Grid (experimental) . → **functionality test of JVOQL**,
- returns VOTable, CSV file and FITS file,

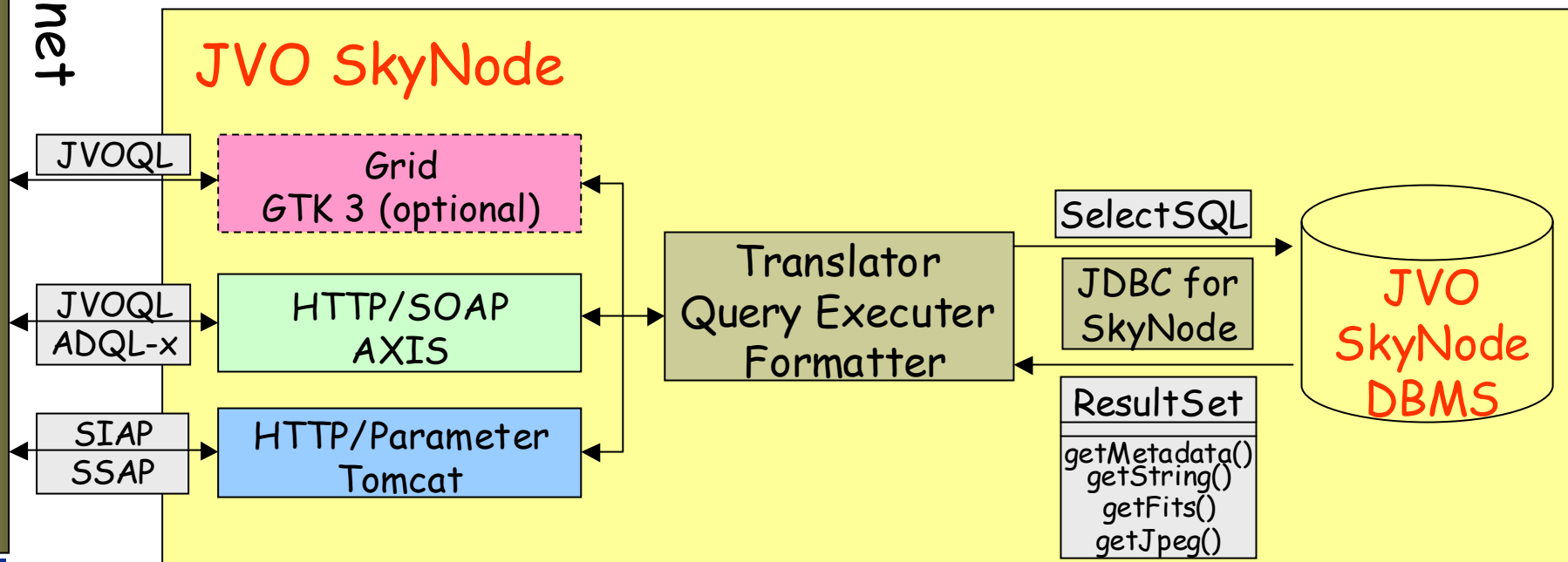
The JVO Skynode toolkit is intended to be used as an **wrapper** for existing data services to become VO compliant → **easy and quick implementation** of the skynode interface on the existing system.

JVO SkyNode Architecture



- Apache **Axis** and **Tomcat** are used for implementing the VO standard interface, and **Globus** Toolkit is used for an optional Grid interface.
- Four kinds of query languages are converted to java class **SelectSQL** and query is executed through **JDBC-like interface**.
- Query results is obtained as **ResultSet**, and table data is formatted to **VOTable** or **CSV** file.

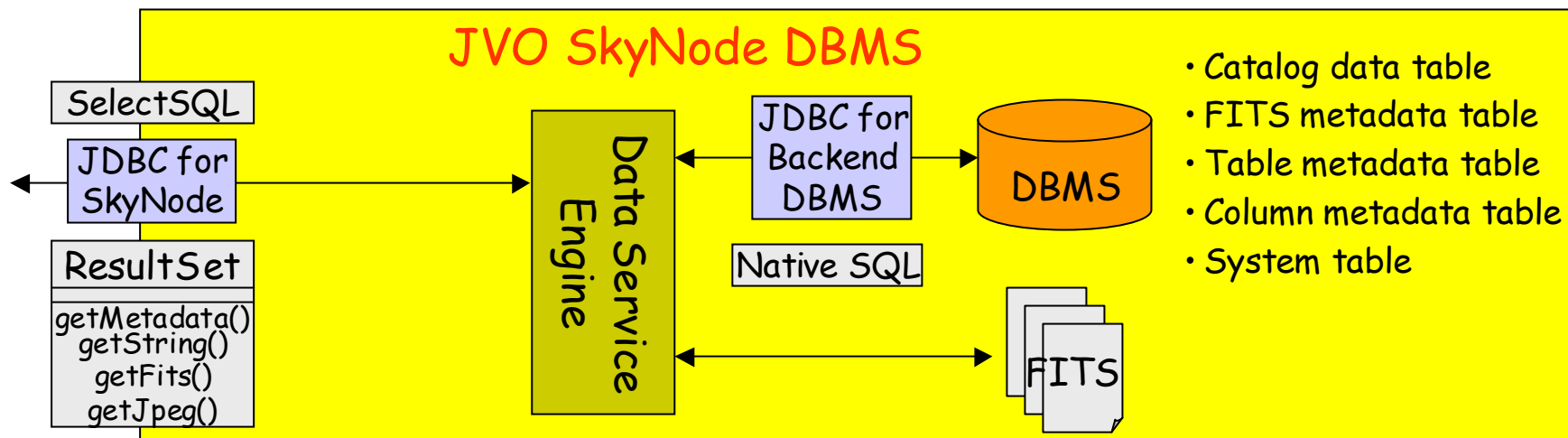
Internet



JVO SkyNode DBMS

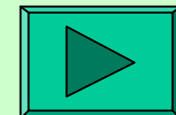
JVO SkyNode DBMS :

- is an **astronomical database system** which accept **JVOQL** syntax and return **observation data as well as tabular data** ,
- includes **DBMS** which is used to store **catalog data**, FITS file metadata, and system information,
- can access to observational data of **FITS files** which are managed by **unix file system**,
- implements a **JDBC-like interface**, search request can be specified by **SelectSQL** java class and result is returned as **ResultSet**.



Free software used in JVO Skynode

- **Java (J2SE)** : Generally used in the development.
- **JAXB 1.0**: used for generating Java class files from VO standard schema, ADQL, VOTable, VOResource etc...
- **JavaCC** : used for [parsing JVOQL](#) and constructing SelectSQL java object.
- **PostgreSQL** : Backend DBMS.
- **HTM library** : developed by JHU, used for [region search](#).
- **Apache AXIS, Tomcat** : Web service and servlet.
- **Globus Toolkit** : Grid service.
- etc...



JVOQL \leftrightarrow ADQL-x

```
Select ra, dec, mag
From spcam
Where (ra, dec) within
      Point((20, 30), 1.0)
```

JVOQL2Parser parses JVOQL and constructs SelectSQL object. SelectSQL object has a method to return a SelectType object which is a data model defined in ADQL schema.

This is an example of translation from JVOQL to ADQL-x.

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<Select xmlns:ns1="urn:vo-coord" xmlns:region="urn:vo-region"
        xmlns="http://www.ivoa.net/xml/ADQL/v0.8">
  <SelectionList>
    <Item Table="spcam" Name="ra" xsi:type="columnReferenceType"/>
    <Item Table="spcam" Name="dec" xsi:type="columnReferenceType"/>
    <Item Table="spcam" Name="mag" xsi:type="columnReferenceType"/>
  </SelectionList>
  <From>
    <Table Name="spcam" Alias="" xsi:type="tableType"/>
  </From>
  <Where>
    <Condition xsi:type="regionSearchType">
      <Region> <region:Circle unit="deg" coord_system_id="IRCS">
        <region:Center>20.0 30.0</region:Center> <region:Radius>1.0</region:Radius>
      </region:Circle>
    </Region>
  </Condition>
</Where>
</Select>
```



JVOQL \leftrightarrow ADQL-X

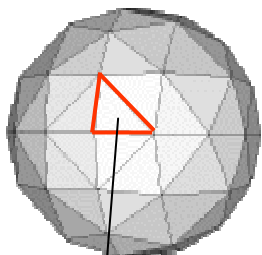
```
Select  opt.ra as ra, opt.dec as dec, (opt.R - opt.B) as color, opt.mag, x.flux
From    spcam opt, xmm x
Where   (opt.ra, opt.dec) within ((20, 30), 1.0)
        and Distance((opt.ra, opt.dec), (x.ra, x.dec)) < 1
```



```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?> <Select xmlns:ns1="urn:vo-coord"
xmlns:region="urn:vo-region" xmlns="http://www.ivoa.net/xml/ADQL/v0.8"> <SelectionList> <Item
As="ra" xsi:type="aliasSelectionItemType"> <Expression Table="opt" Name="ra"
xsi:type="columnReferenceType"/> </Item> <Item As="dec" xsi:type="aliasSelectionItemType">
<Expression Table="opt" Name="dec" xsi:type="columnReferenceType"/> </Item> <Item As="color"
xsi:type="aliasSelectionItemType"> <Expression xsi:type="closedExprType"> <Arg Oper="-"
xsi:type="binaryExprType"> <Arg Table="opt" Name="R" xsi:type="columnReferenceType"/> <Arg
Table="opt" Name="B" xsi:type="columnReferenceType"/> </Arg> </Expression> </Item> <Item
Table="opt" Name="mag" xsi:type="columnReferenceType"/> <Item Table="x" Name="flux"
xsi:type="columnReferenceType"/> </SelectionList> <From> <Table Name="spcam" Alias="opt"
xsi:type="tableType"/> <Table Name="xmm" Alias="x" xsi:type="tableType"/> </From> <Where>
<Condition xsi:type="intersectionSearchType"> <Condition xsi:type="regionSearchType"> <Region>
<region:Circle unit="deg" coord_system_id="IRCS"> <region:Center>20.0 30.0</region:Center>
<region:Radius>1.0</region:Radius> </region:Circle> </Region> </Condition> <Condition Comparison="&lt;"
xsi:type="comparisonPredType"> <Arg xsi:type="userDefinedFunctionType">
<Name>GCdistance</Name> <Params xsi:type="userDefinedFunctionType"> <Name>Point</Name>
<Params Table="opt" Name="ra" xsi:type="columnReferenceType"/> <Params Table="opt" Name="dec"
xsi:type="columnReferenceType"/> </Params> <Params xsi:type="userDefinedFunctionType">
<Name>Point</Name> <Params Table="x" Name="ra" xsi:type="columnReferenceType"/> <Params
Table="x" Name="dec" xsi:type="columnReferenceType"/> </Params> </Arg> <Arg
xsi:type="atomType"> <Literal Value="1.0"/> </Arg> </Condition> </Condition> </Where> </Select>
```


Region Search using HTM index

Region search is a common search criterion for an astronomical database. For efficient search data should be properly indexed on the object coordinate.

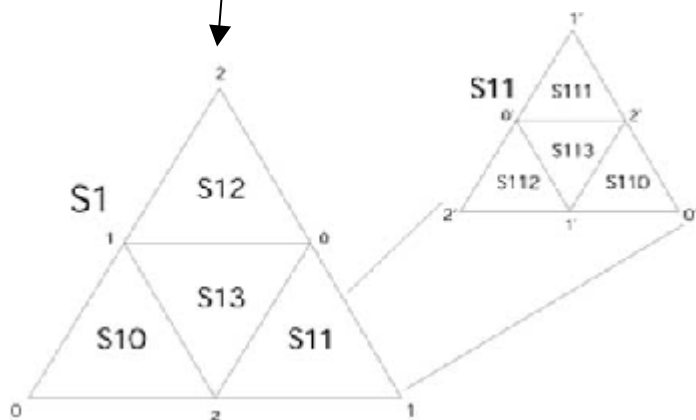


Catalog table

id	ra	dec	mag
1	12.3	-23.4	18.4
2	38.5	+34.2	16.5
...

HTM Index table

id	htm
1	16522516
2	16754765
...	...



<http://www.sdss.jhu.edu/htm/>

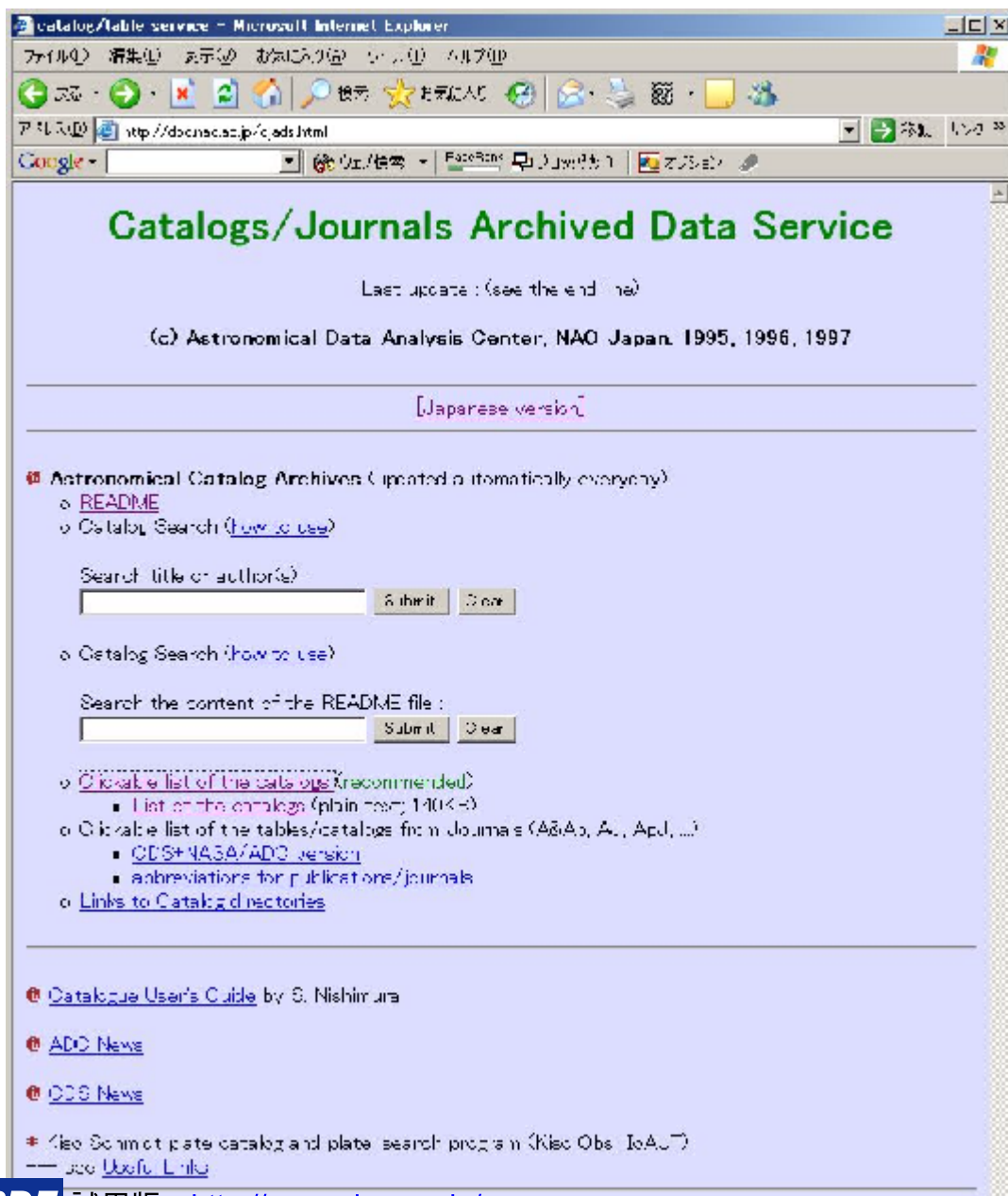
```
Select ra, dec, mag
From Catalog
Where Point(ra,dec) within Box((20,+15), 1.0)
```

```
Select c.ra, c.dec, c.mag
From Catalog as c
Natural Left Join htmIndex as i
Where i.htm between 16522500 and 16522512
OR
i.htm between 16522500 and 16522512
...
```

Progress

- We have started Skynode implementation a few weeks ago.
- First release will complete in December and will be applied to the data of Subaru Deep survey.
- We plan to apply the JVO SkyNode toolkit to the Subaru Sprime-Cam reduced database next year.

Catalog Data Service in NAOJ



The screenshot shows a Microsoft Internet Explorer browser window displaying the 'Catalogs/Journals Archived Data Service' page. The browser's address bar shows the URL 'http://dbcnac.nao.ac.jp/c_ads.html'. The page content includes a title, a last update notice, a copyright notice for the Astronomical Data Analysis Center, NAO Japan (1995, 1996, 1997), a link to the Japanese version, and a list of services including a search interface and various catalog lists.

catalogs/journals service - Microsoft Internet Explorer

アドレス http://dbcnac.nao.ac.jp/c_ads.html

Catalogs/Journals Archived Data Service

Last update : (see the end line)

(c) Astronomical Data Analysis Center, NAO Japan. 1995, 1996, 1997

[Japanese version]

- Astronomical Catalog Archives (updated automatically everyday)
 - o [README](#)
 - o Catalog Search ([how to use](#))

Search title or author(s)

- o Catalog Search (how to use)

Search the content of the README file :

- o [Clickable list of the catalogs \(recommended\)](#)
 - [List of the catalogs \(plain text: 140K+\)](#)
- o [Clickable list of the tables/catalogs from Journals \(A&A, A., ApJ, ...\)](#)
 - [CDS+NASA/ADO version](#)
 - [abbreviations for publications/journals](#)
- o [Links to Catalog directories](#)

- o [Catalogue User's Guide](#) by S. Nishimura
- o [ADO News](#)
- o [CDS News](#)

* [Kiso Schmidt plate catalog and plate search program \(Kiso Obs. IoAO\)](#)

--- [see Useful Links](#)

Basic Specification

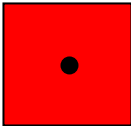
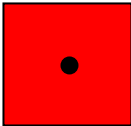
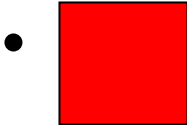
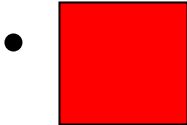
```
Select  ColumnName [[AS] AliasName], ... | *  
From    TableName [[AS] AliasName]  
Where   Condition [AND Condition]
```

- Only column name or "*" is specified in the selection list.
- Don't support an algebraic expression.
- Only one table is specified at "From" part.
- Table name and Column name can have alias name.
- Comparison operators: =, <, >, >=, <=, <>, LIKE, BETWEEN
- Region Comparison operator: =, within, contains, overlaps
- Logical operator: AND and NOT (OR is not supported)
- Functions: Distance(), Point(), Circle(), Box()

Region Comparison

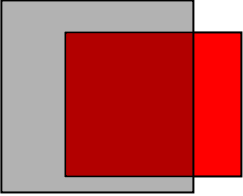
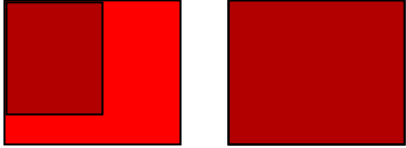
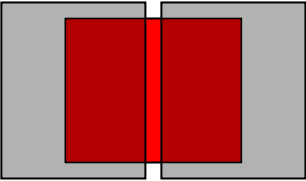
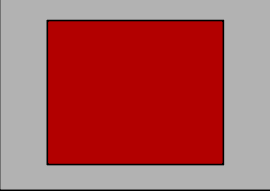

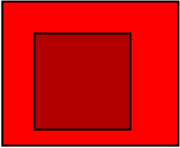
[<SpacePoint> <RegionCompOper>] <SpaceRegion>

<SpaceRegion> [<RegionCompOper> <SpacePoint>]

Region Comparison	Meaning	Image Atlas Data Service
A within B	Point A is within Region B.	
A contains B	Region A contains Point B.	
A outside B	Point A is outside Region B.	
A excludes B	Region A excludes Point B.	

Region Comparison

<SpaceRegion> <RegionCompOper> <SpaceRegion>

Region Comparison	Meaning	Image Atlas Data Service	Image Cutout Service
$A = B$	Region A is the smallest region which overlaps the largest part of B.		
A overlaps B	Region A is the smallest region which overlaps B.		Same as $A = B$
A contains B	Region A is the smallest region which contains B.		
A within B	Region A is the largest region which is contained in B.		Same as $A = B$

Example for basic spec. JVOQL


Catalog Query for the specified region

```
Select  ra, dec, mag_r
From    galaxy
Where   Point(ra, dec) within Circle((24.3, +5.0), 2.0))
        and mag_r < 24
```

Image Query for the specified region.

```
Select  filter, image
From    imageData
Where   region = Box((24.3, +5.0), 0.2))
```

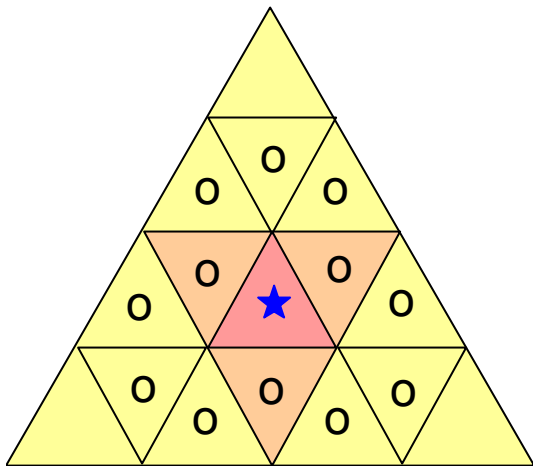
pos = Point(24.2, 5.0) and size = 0.2



c.f. <http://jvo.nao.ac.jp/imageData?POS=24.2,5.0&SIZE=0.2>

Simple quick cross match procedure

- Cross identification of the object in two catalogs are fundamental procedure in the astronomical analysis.
- The simplest way is doing $N \times M$ sequential search, which is a time consuming process if N and M is large.
- Alternatively, dividing the data into n partitions according to the htm index, we can reduce the time by a factor n if data access time is ignored.



1. Determine the size and level of a triangle from the specified cross match precision.
2. From table A, select data of the same htm index.
3. From table B, select data of the neighbor htm index (o and star in the figure).
4. Try $N' \times M'$ sequential search.
5. Repeat 2~4 for all object in table A.