Gfdnavi, web-based data and knowledge server software for geophysical fluid sciences

Part I: Rationales, stand-alone features, and supporting knowledge documentation linked to data

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Y.-Y. Hayashi, and GFD Dennou Club

black: Geophysical scientists | blue: Database scientist

What is Gfdnavi

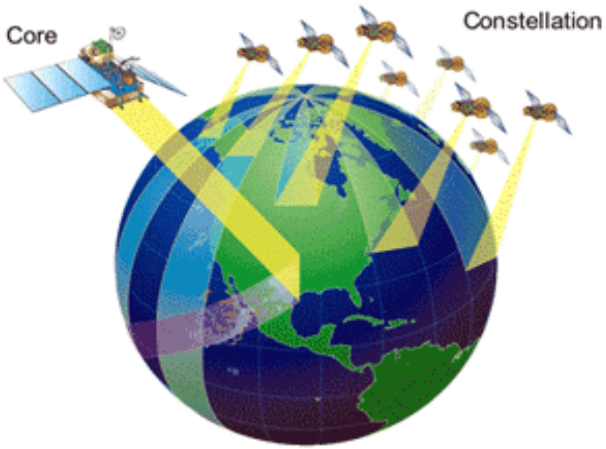
- = **G**eophysical **f**luid **d**ata **navi**gator
- A suite of software to construct Web-based database of geophysical fluid data
- Functionality:
  - Search data
  - Numerical analysis and visualization
  - Documentation of analysis results
- Available:

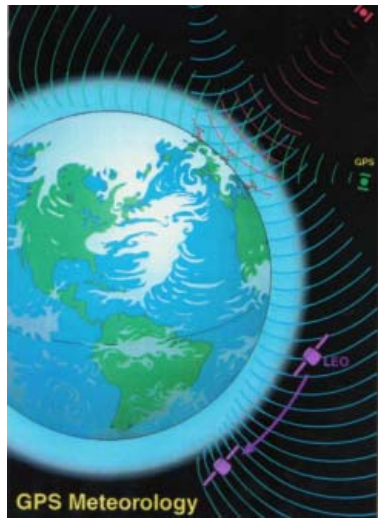
  http://www.gfd-dennou.org/library/davis/gfdnavi/

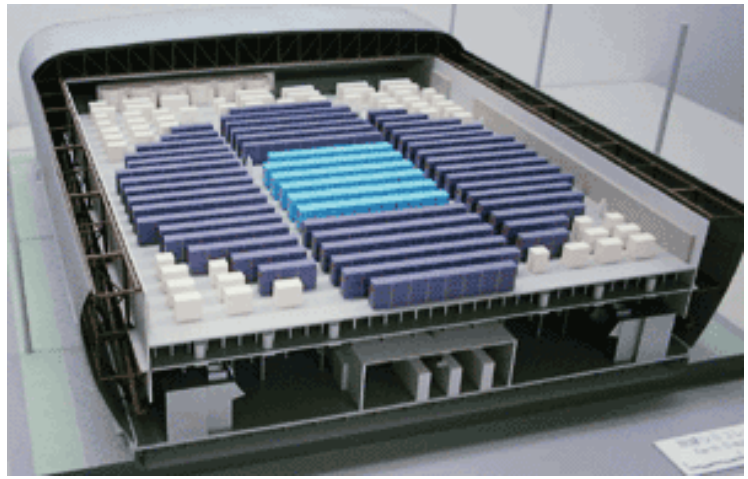
Introduction

Data we use

- Observational data (satellite, station etc etc) / Simulation data (climate prediction etc etc) / other numerical data (assimilation data, idealized data etc)
- Mostly in a few self-descriptive binary formats such as NetCDF, GRIB, HDF-EOS (but not always)







Many organizations/research groups provide data though web

- They provide data files
- Optionally visualization etc: in many cases custom-made (for each project / organization)

Related work

Live Access Sever (LAS)

- Software to build web server for georeferencing geophysical data
- Data browsing, search and visualization
- Web-page structure: Highly configurable

Problem of current web-based data servers

- Limited visualization / analysis capability

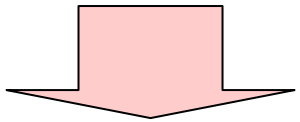
  → Only quick-looks. Need to DL data

  → Service are not available to local data

- Support of non-georeferencing data is weak

Visualization is not the goal

- To others (scientists / society): reports (papers etc)
- While working: memos
- To collaborators: reports / internal documents / discussion



Outputs are documents
(not just pieces of images)

Introducing Gfdnavi

Basic requirement

- Support both browser GUI & programability for users

  → Beyond initial quick-look

  - GUI: good to start up / good for novices – interdisciplinary collaboration
  - Programing : infinite degrees of freedom / good to repeat
- Support a wide range of use cases from public data services, group use, to desktop data management
  - Should be easy to install, start up, and manage
- Support documenting & archiving knowledge obtained through data analysis

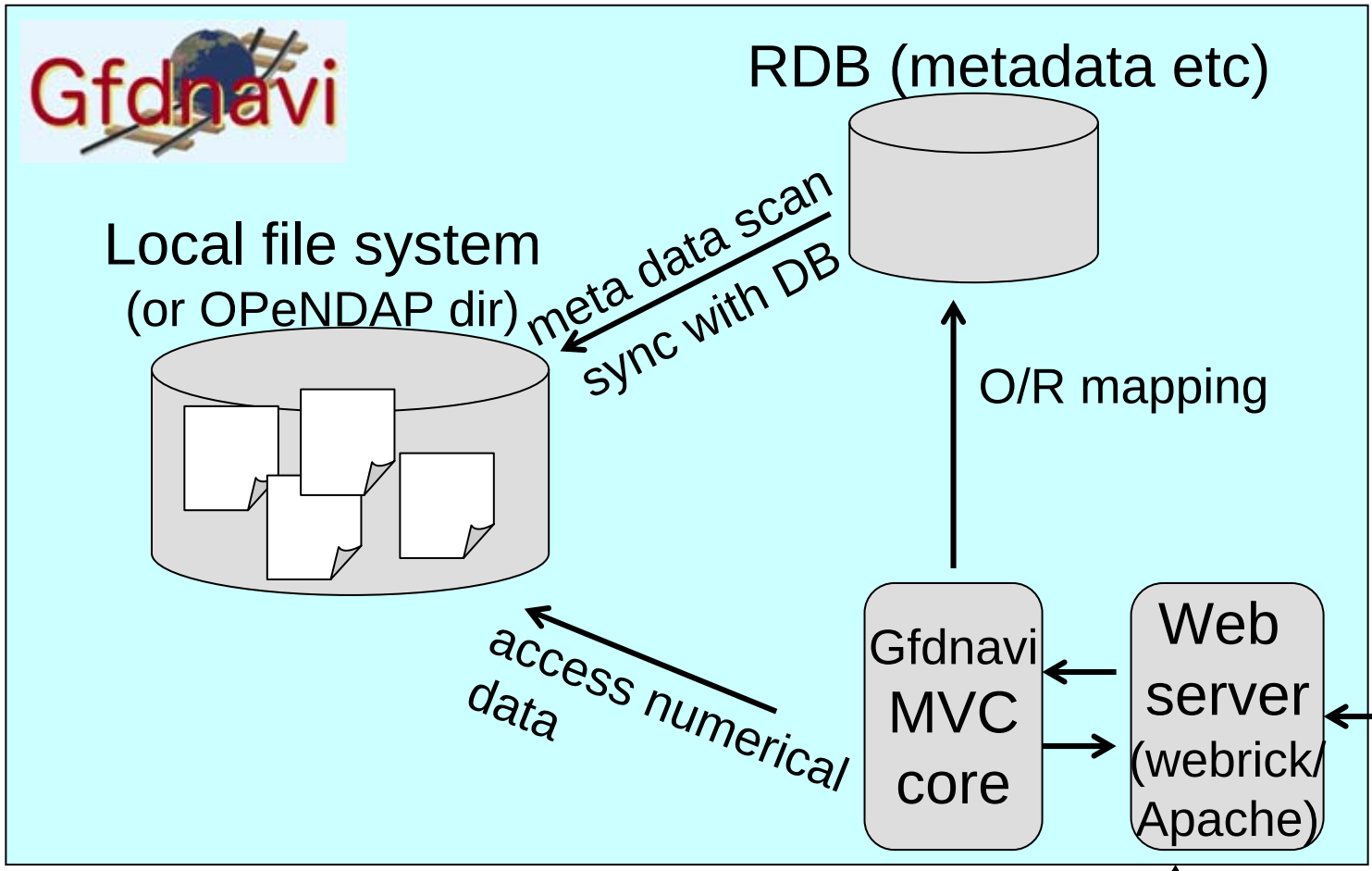
Two fundamental libraries used to build Gfdnavi *(open-source)*

- **GPhys** – a Ruby library to analyze and visualize geophysical fluid data *(by Horinouchi etc since 2003)*
  - For consolidated access to data in files (NetCDF, GRIB, GrADS, NuSDAS, HDF5-EOS etc) or on runtime memory
  - **A community infrastructure for data analysis – Key to unite all forms of data access**
  - **Used by increasing number of scientists**
- **Ruby on Rails** – Web application development framework
  - Written in/for Ruby → We can use GPhys directly
  - Equips its products with web server → Easy to deploy

Support programability in multiple ways

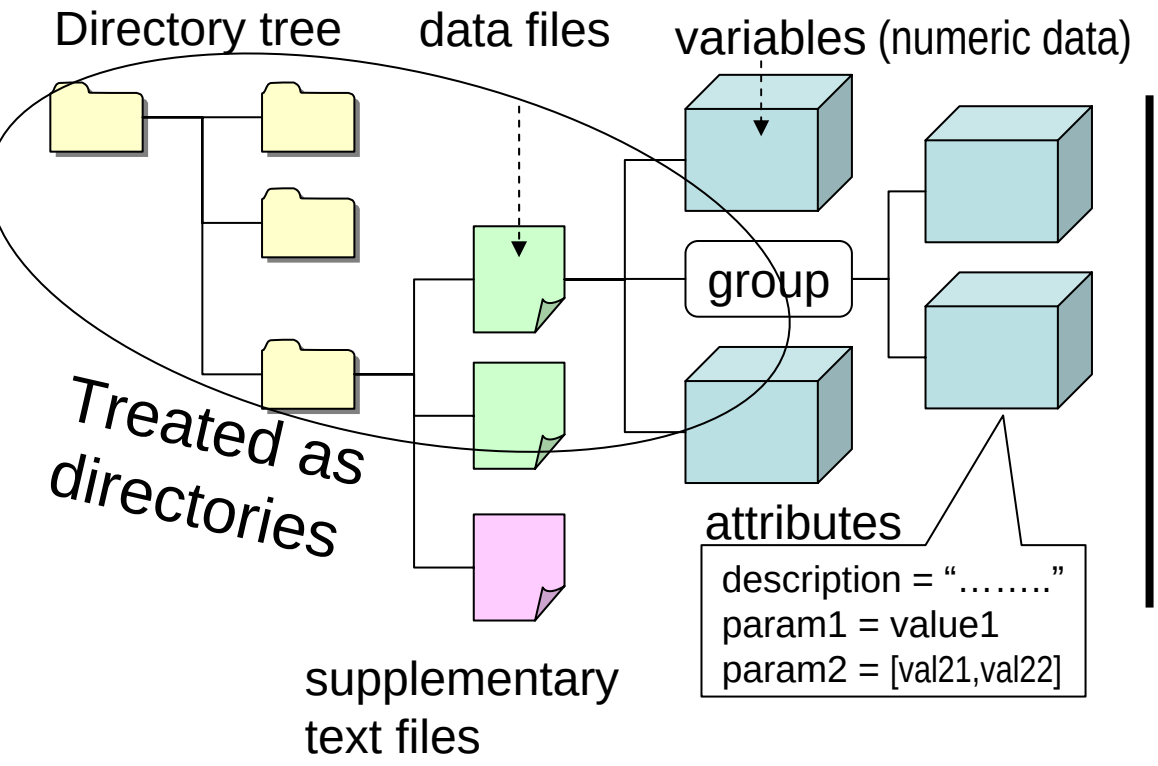
- Web services – Part II (next talk)
- Browser access
  - Download Ruby code and data subset to reproduce visualization
  - Upload Ruby script (for qualified users)

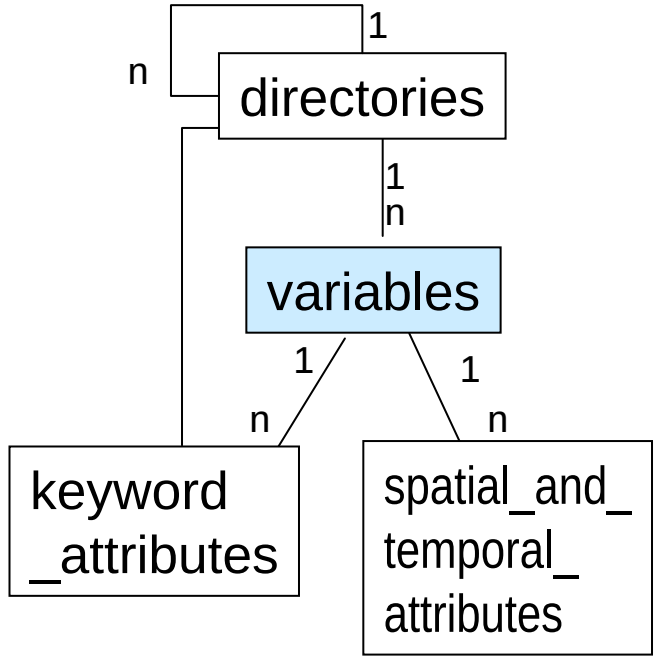
Structure of Gfdnavi



Metadata DB

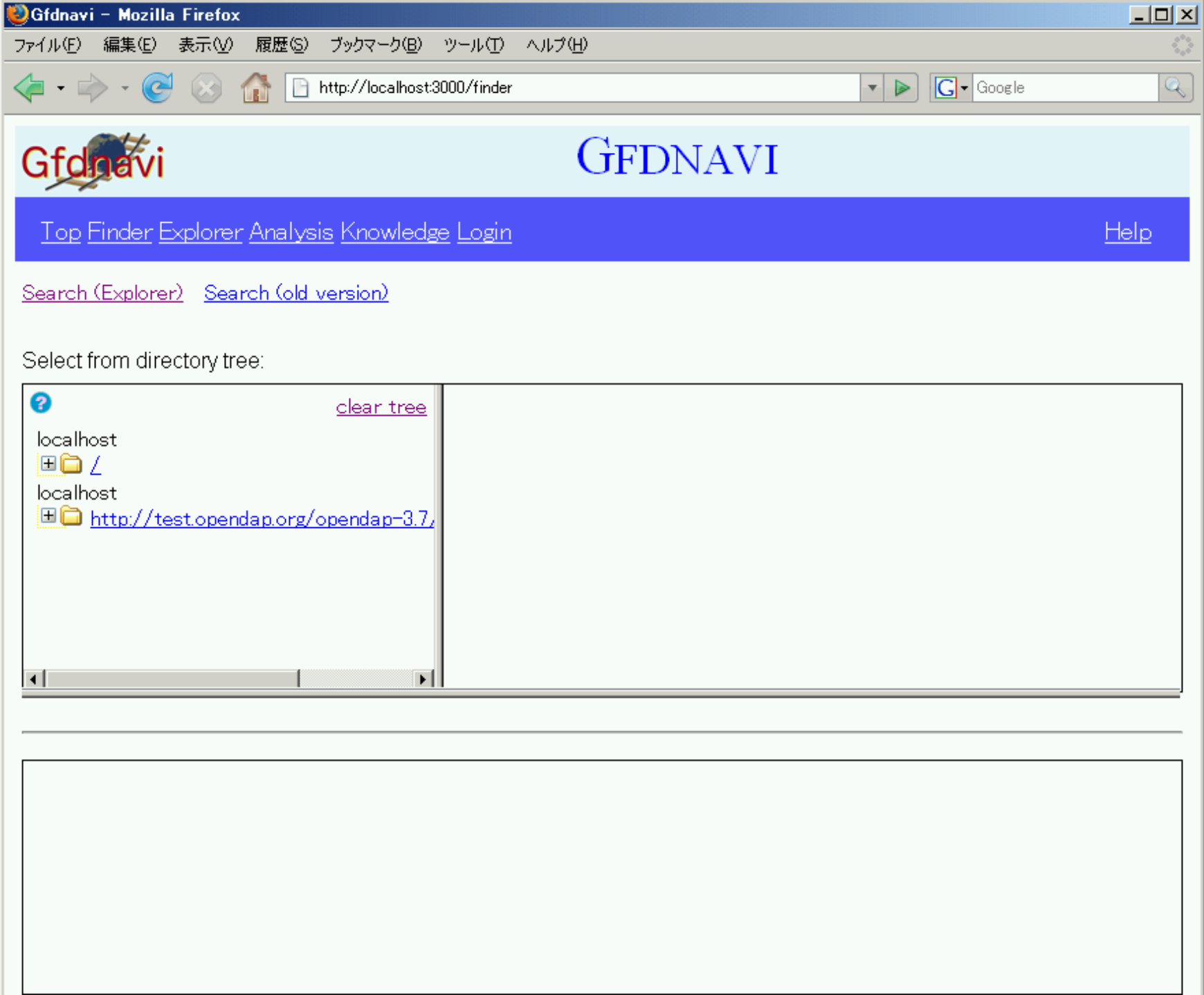
- Attributes (extracted from data files or supplied by additional text files)
- Directory structure





User Interface

Home : Independent simple html → replaceable


Gfdnavi - Mozilla Firefox
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Search (Explorer)
Search (old version)
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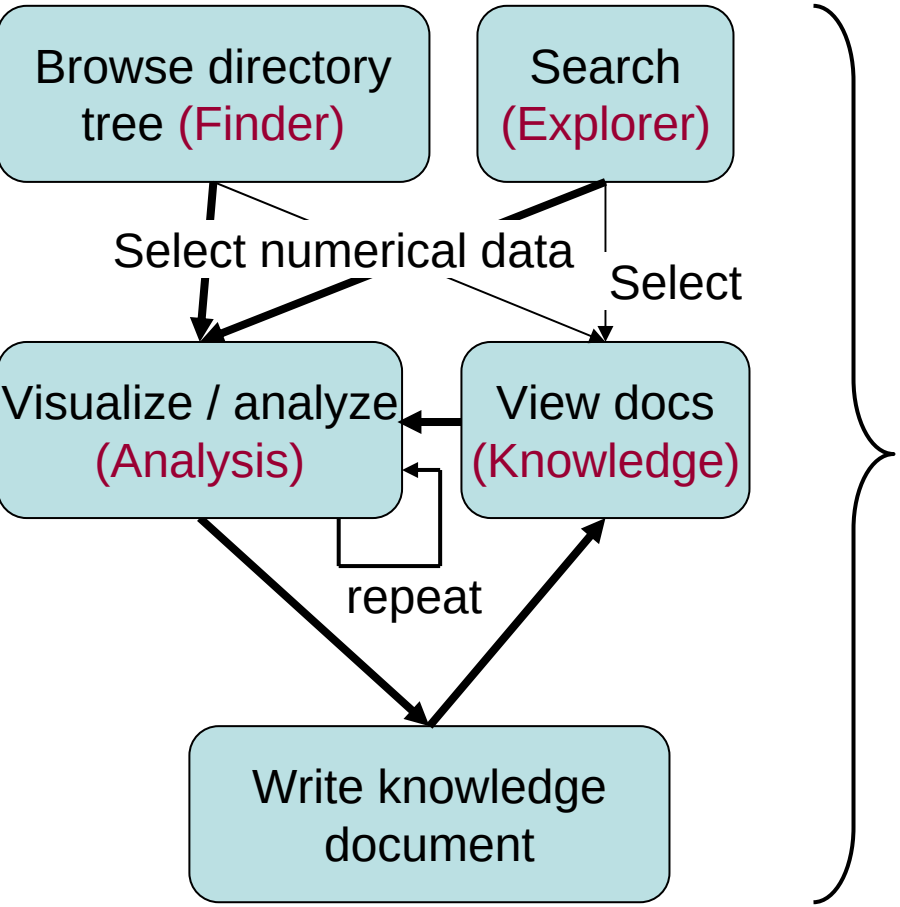
http://test.opendap.org/opendap-3.7/

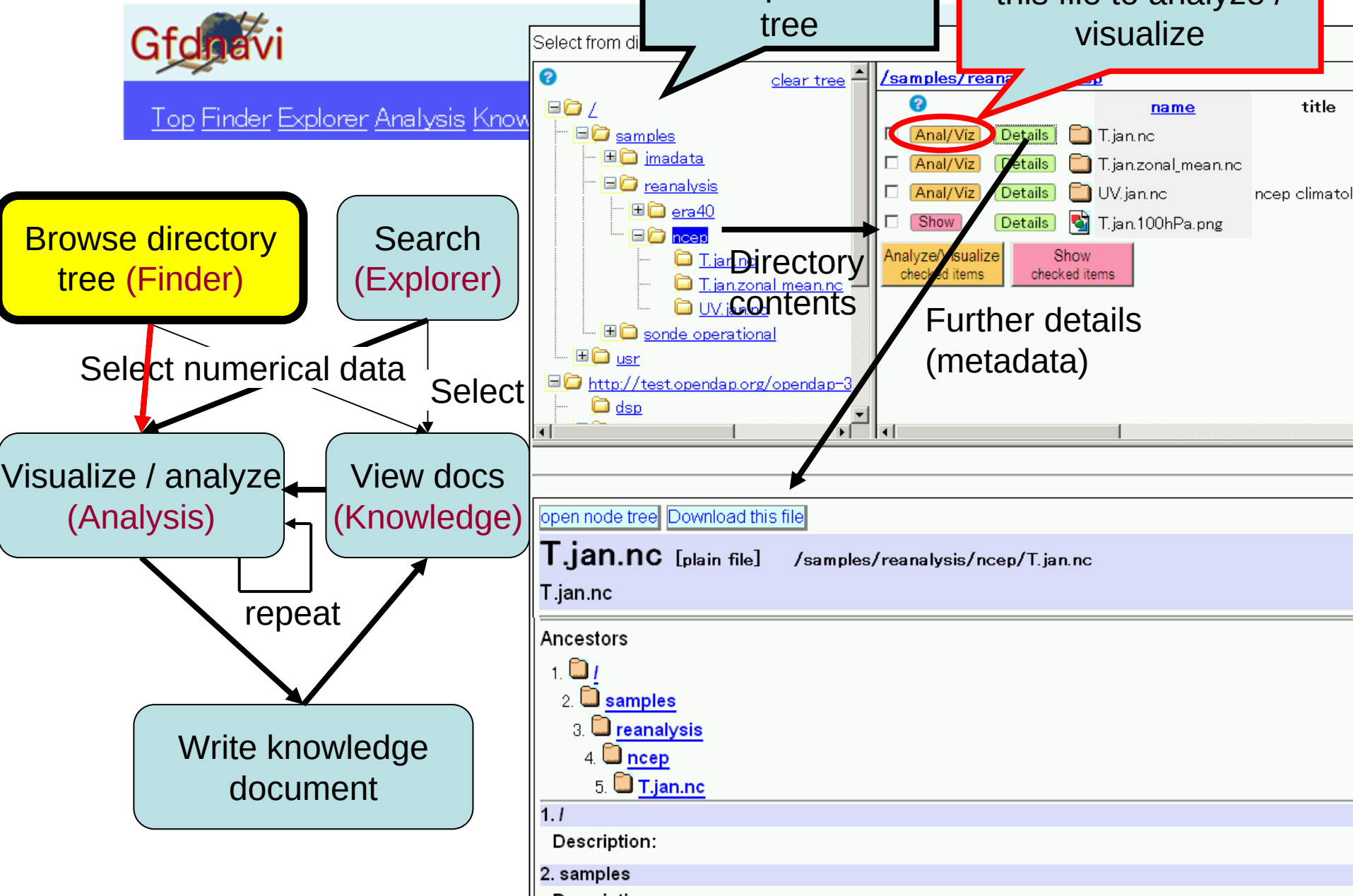
Functionality

Browser UI Header



Typical work flow to use Gfdnavi's browser UI

Functionality



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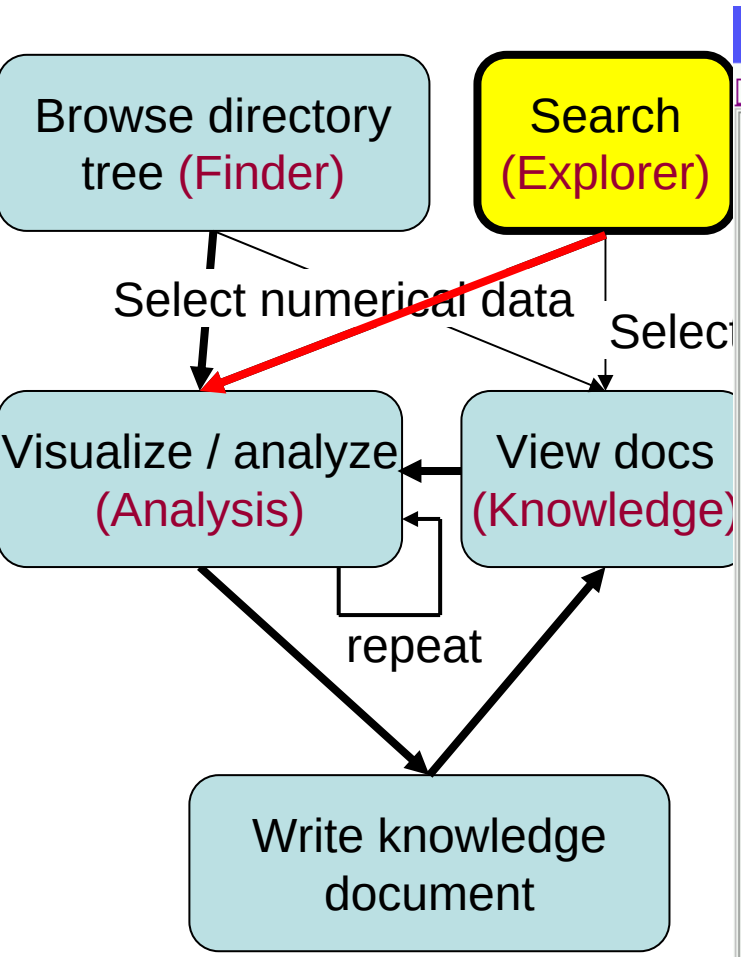

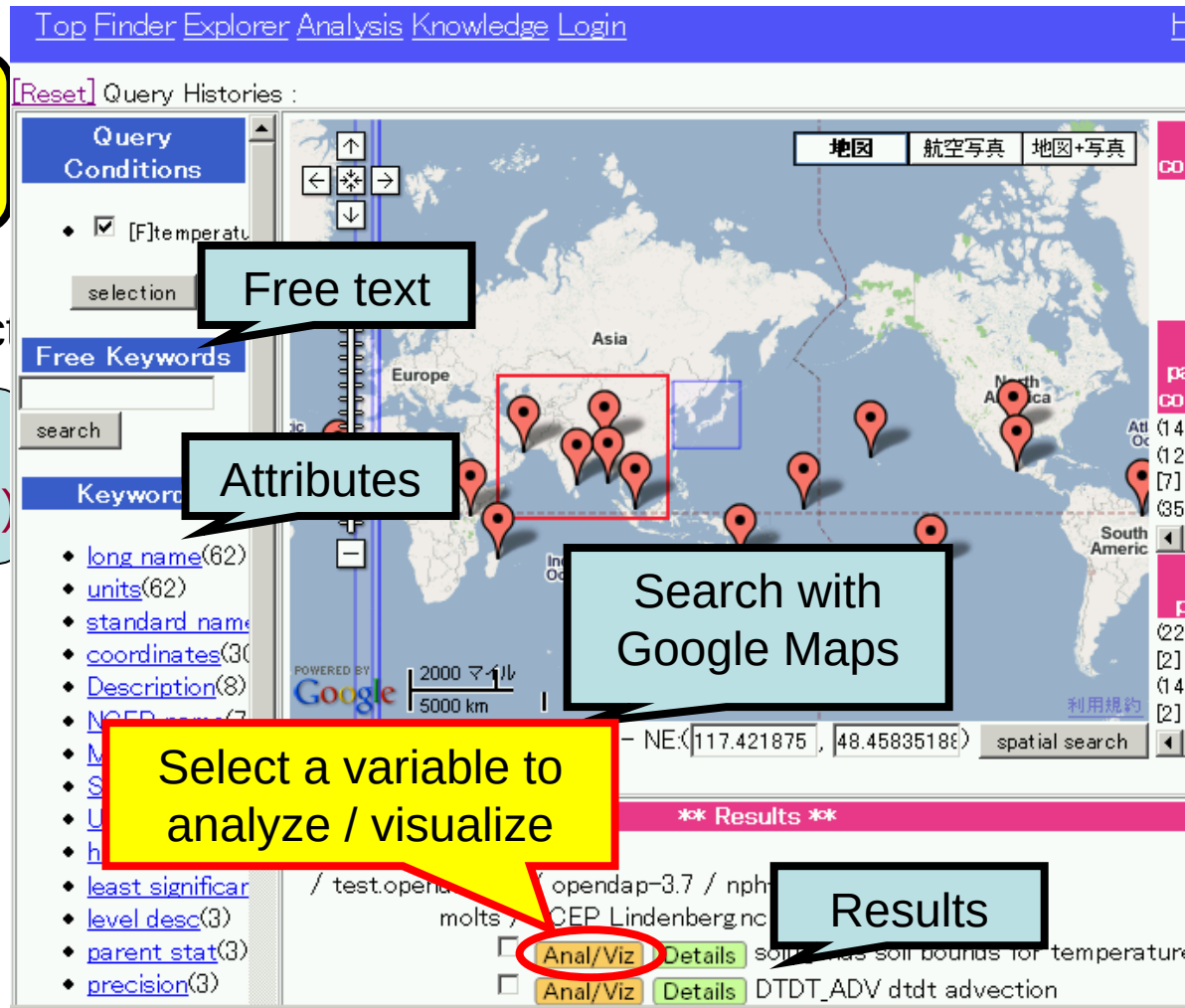

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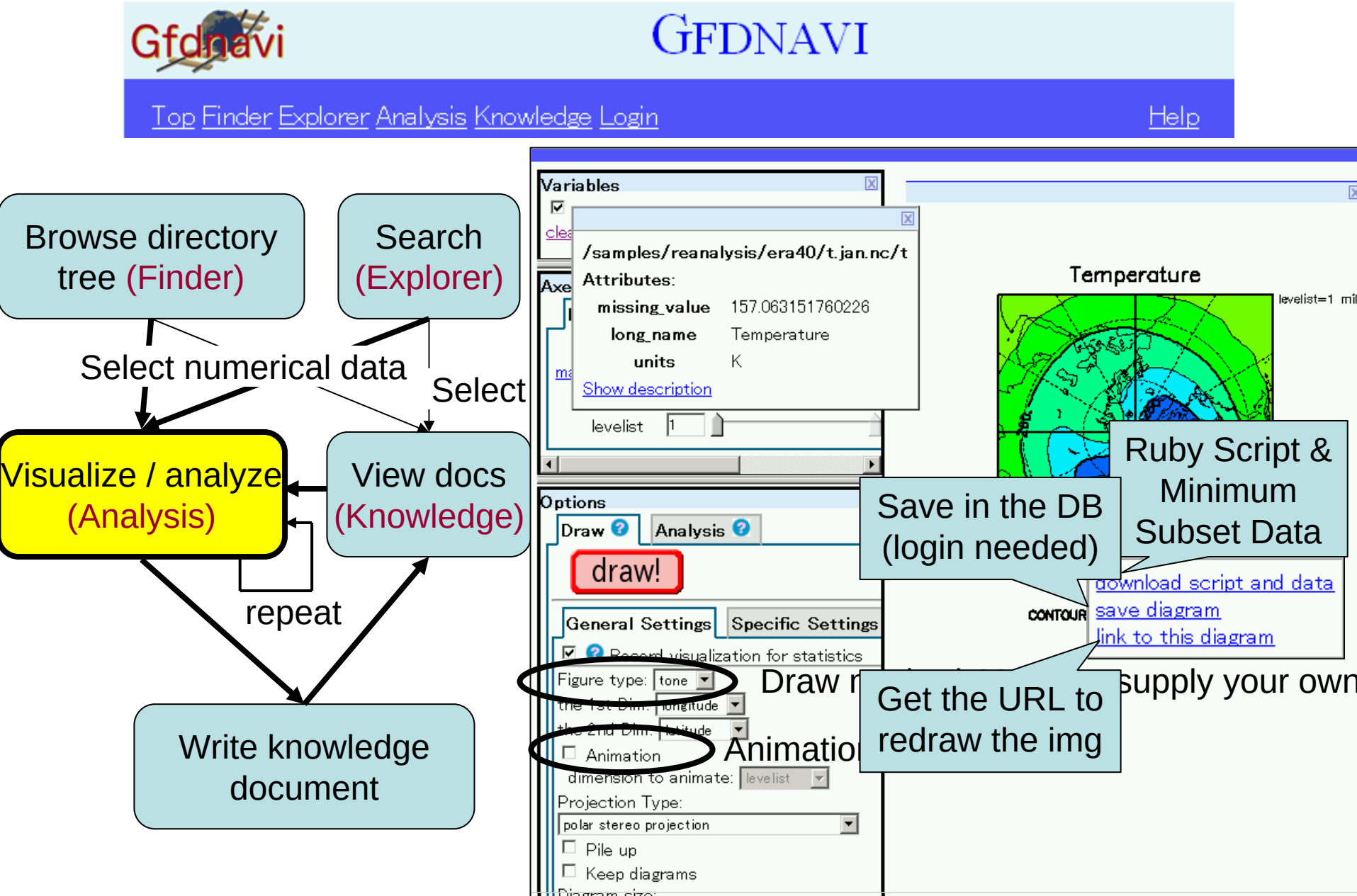

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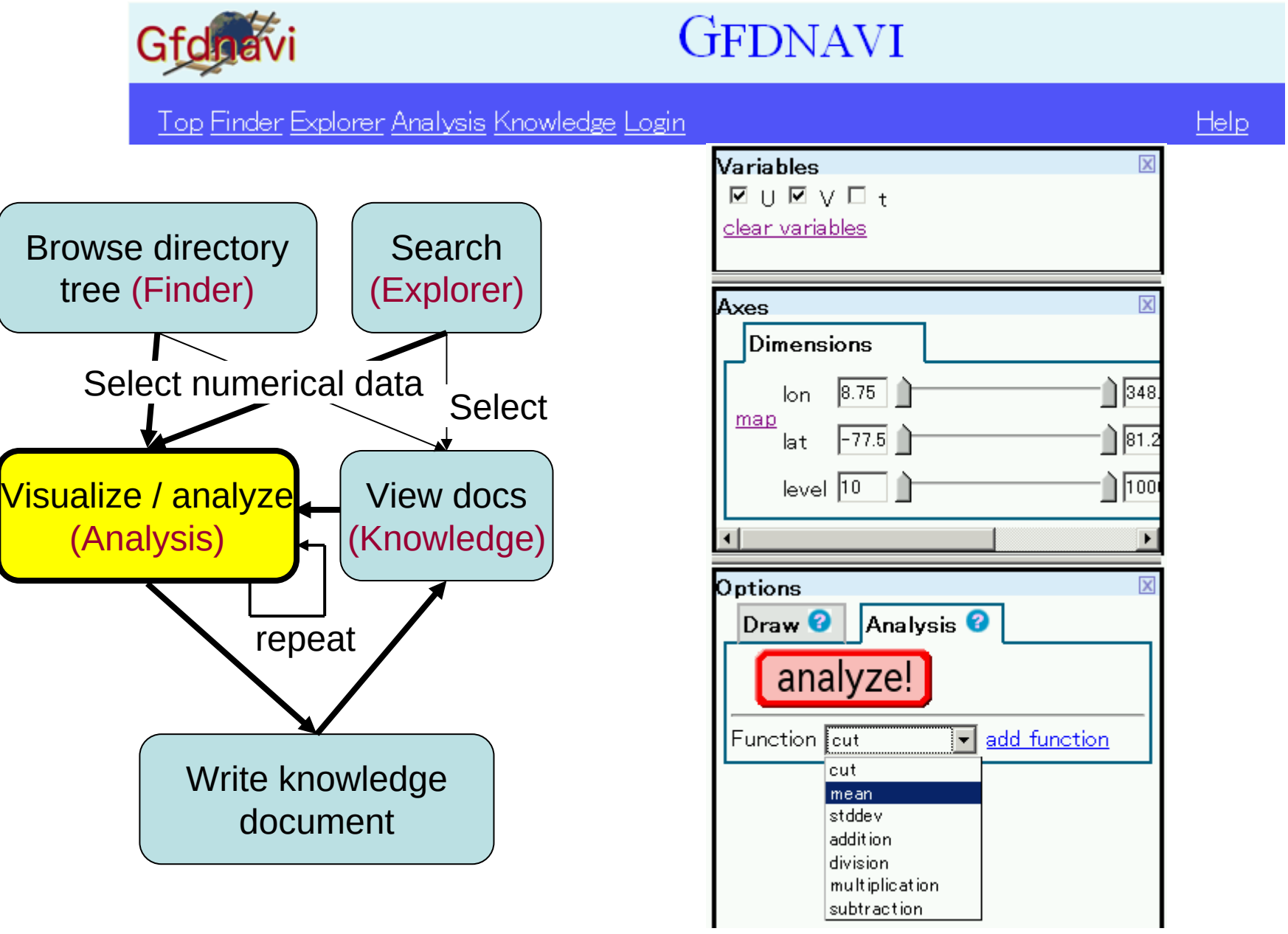

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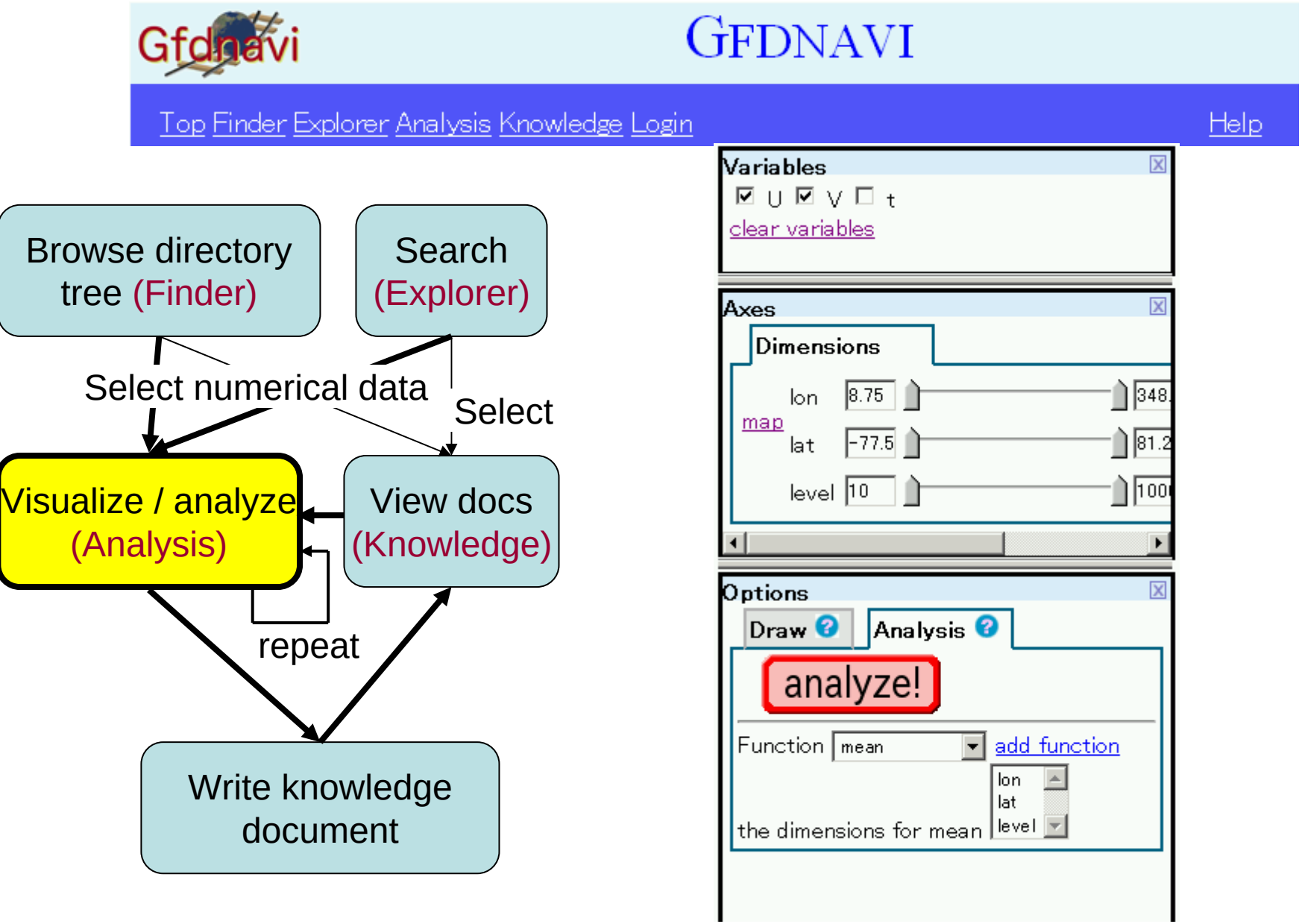

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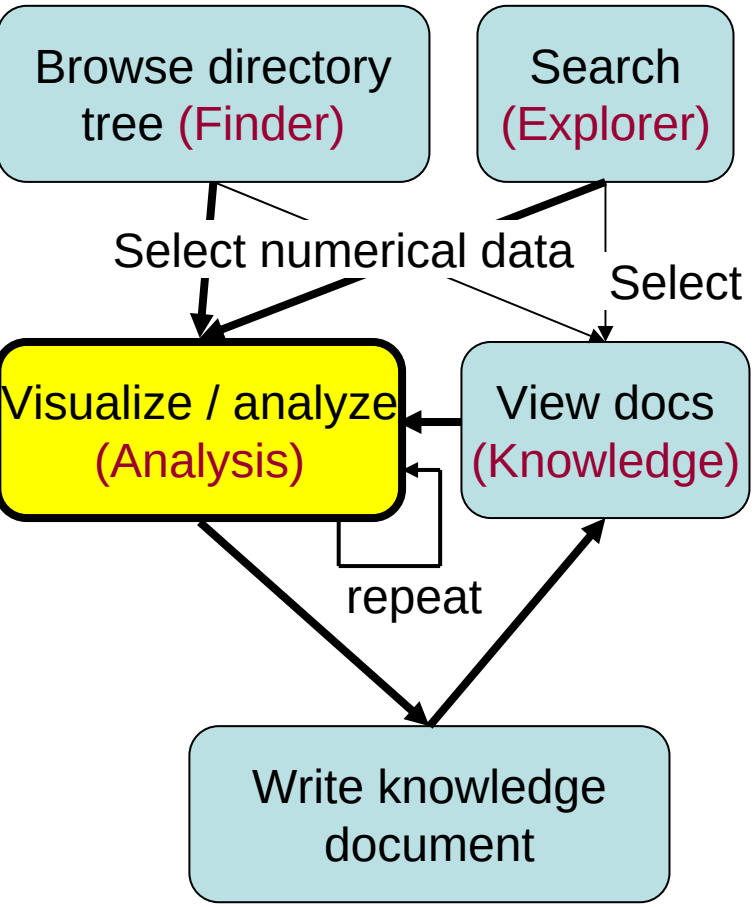

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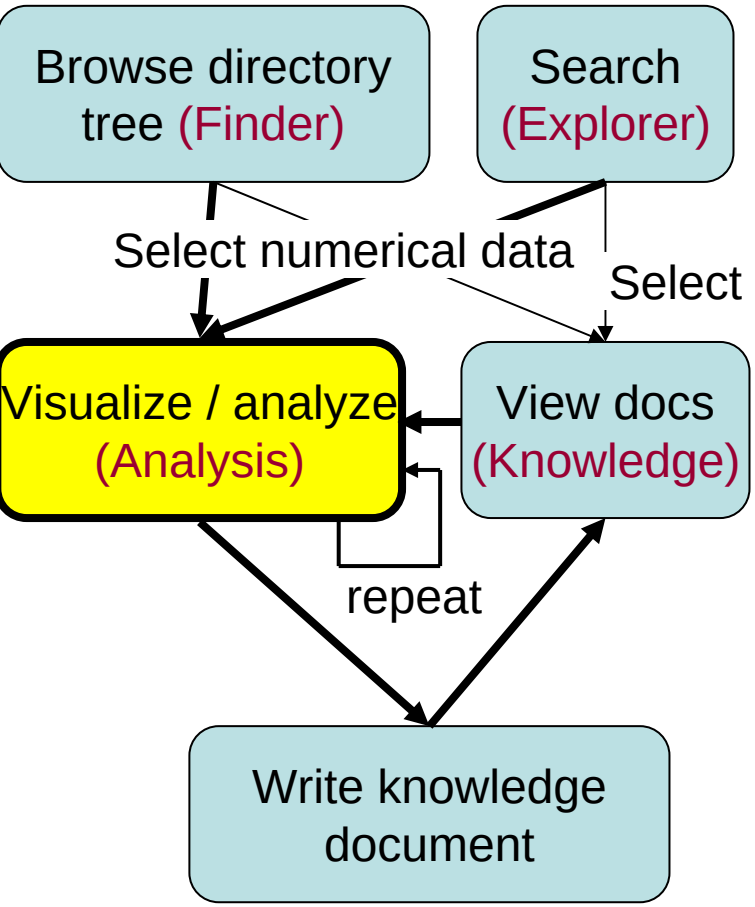


Create Function

Function

name: spectrum

save directory: /usr/root/functions

description: |FFT|^2 along a specified dimension

group: only me / --groups-- create group

number of input variables: 1

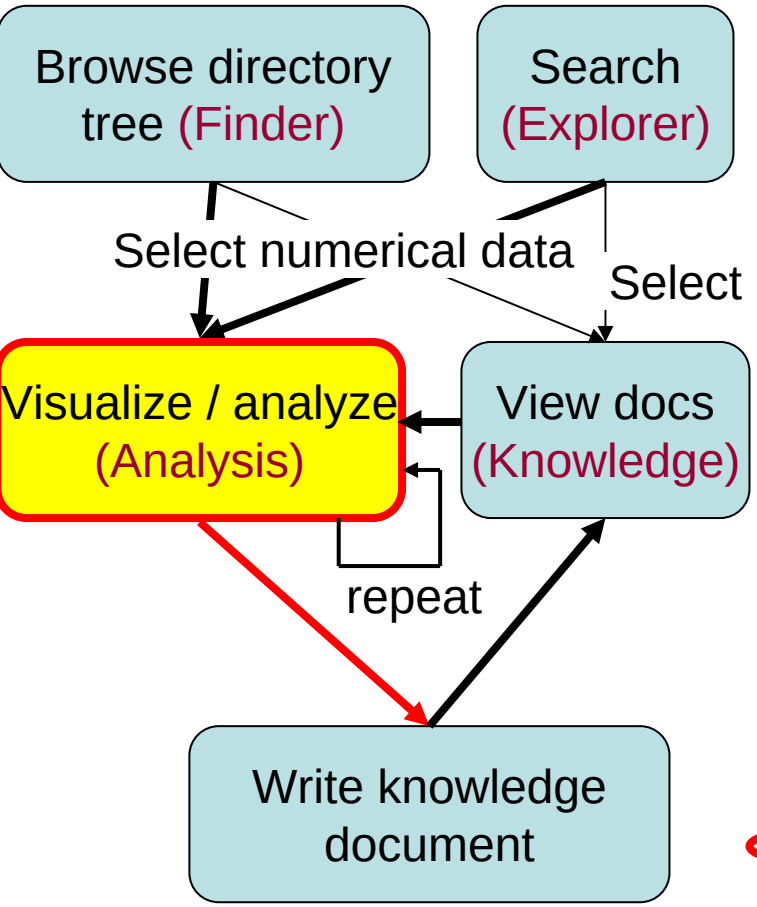
number of arguments: 1

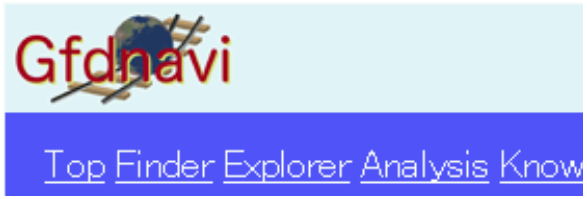
{|arg0, gphys0|
[gphys0.fft(arg0).abs ** 2]
}

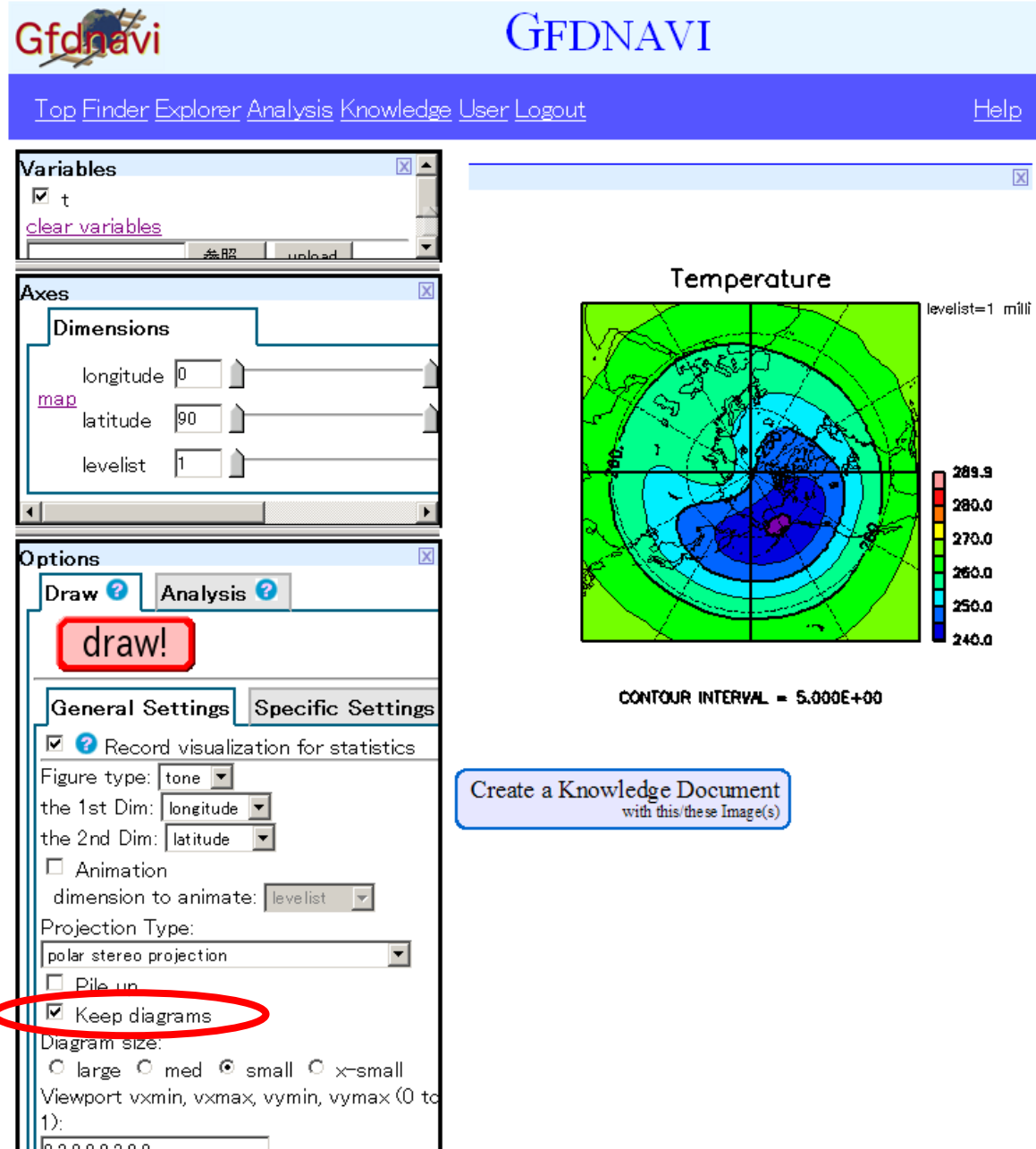
number of output variables: 1

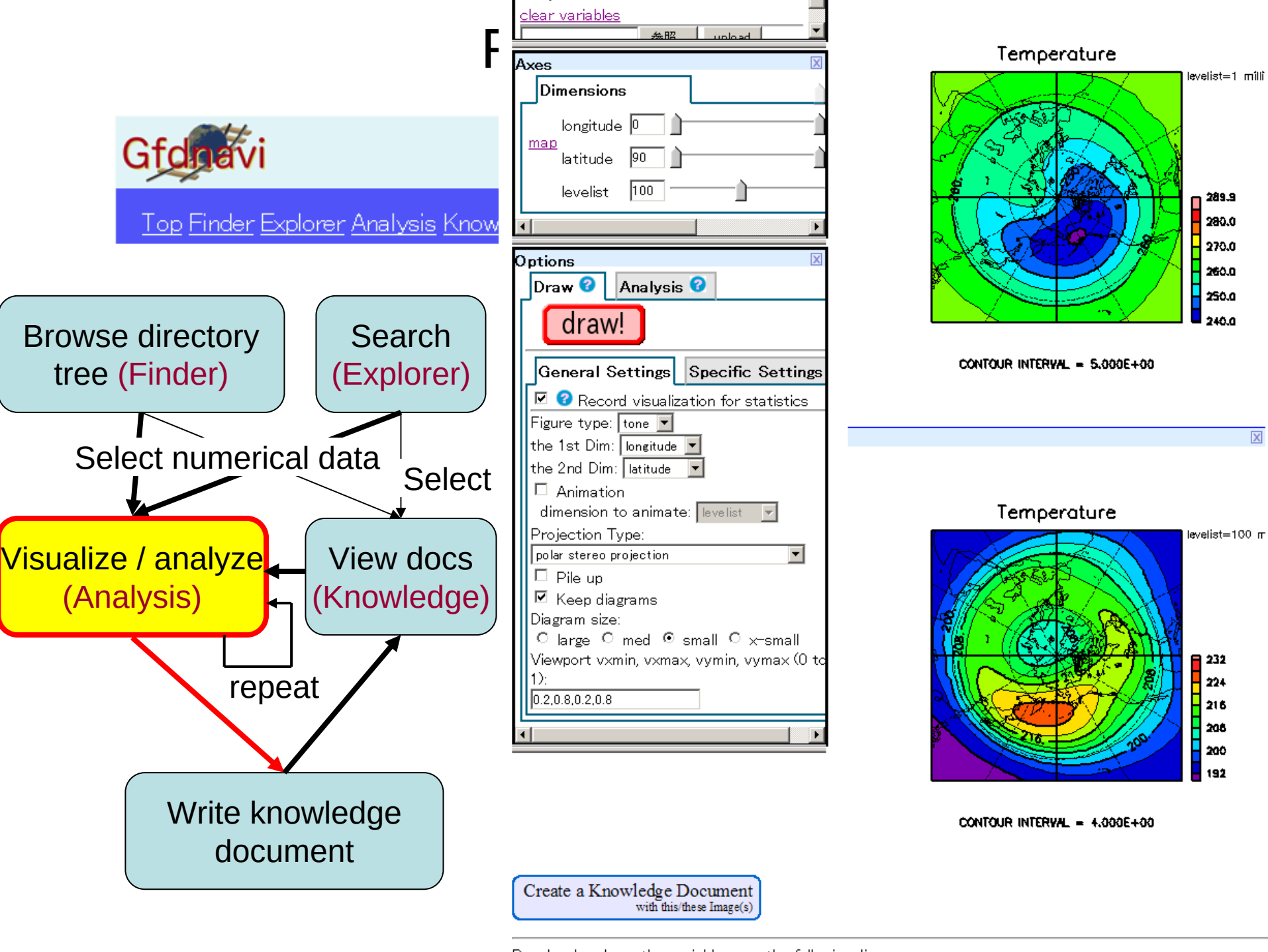
Function Arguments

Functionality





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Search (Explorer)
Select numerical data
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Write knowledge document

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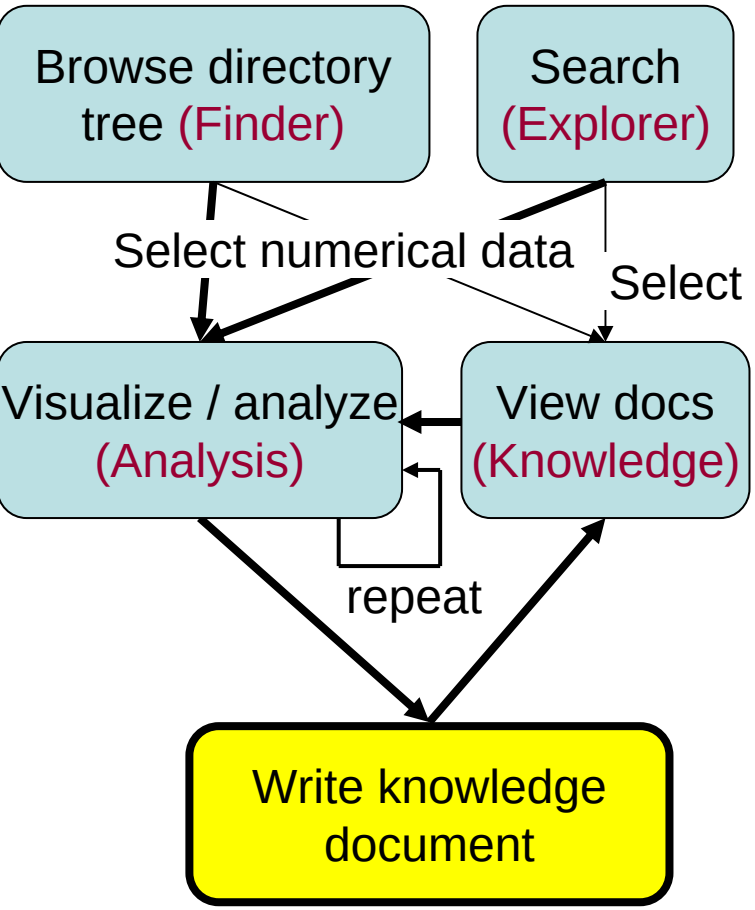


Save Images and Create a New Knowledge

Title: ECMWF Reanalysis January Climatology Author: T Horinouchi

Textbody:

((<Figure 1>)) shows the climatological temperature at 1 hPa using the ECMWF Reanalysis (ERA40) in the northern hemisphere. It shows that the climatological polar vortex is shifted to the Pacific side.

((<Figure 2>)) shows is the same as Fig.1 but for 100 hPa. It shows that the westerly jet is strong in the Pacific strom track.

Path: /usr/root/knowledge/tmp/eraT.knlge

ex) /usr/root/knowledge/folder1/folder2/writing.knlge

visible to: everyone

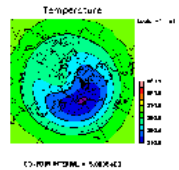
Choose a default layout : figures under text. size of figure: height 100 %

input the number of figures in a row 1

Figure 1

Caption: ERA Jan T at 1 hPa delete

File Name: image001

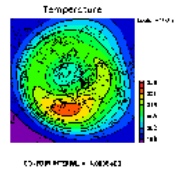


view this image in the original size

Figure 2

Caption: ERA Jan T at 100 hPa delete

File Name: image002



view this image in the original size

More Figure

Create

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Top Finder Explorer Analysis Knowl

Browse directory tree (Finder)

Search (Explorer)

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Write knowledge document

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Top Finder Explorer Analysis Knowledge User Logout Help

Layout : figures under text. size of figure: height 100 % change layout

input the number of figures in a row 2

ECMWF Reanalysis January Climatology

Author: T Horinouchi

Figure 1 shows the climatological temperature at 1 hPa using the ECMWF Reanalysis (ERA40) in the northern hemisphere. It shows that the climatological polar vortex is shifted to the Pacific side.

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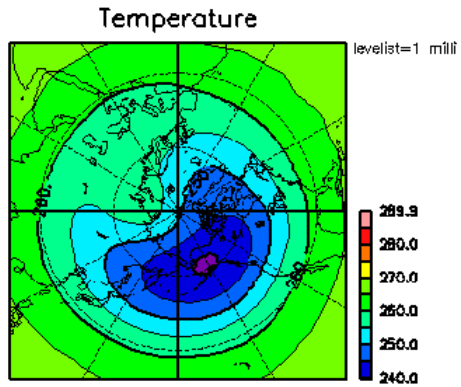

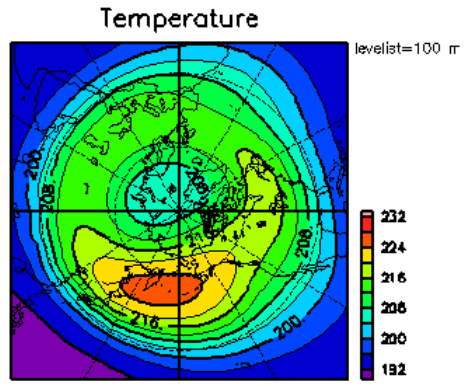

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Fig. 1. ERA Jan T at 1 hPa

<redraw this image> <Get the URL>
Fig. 2. ERA Jan T at 100 hPa

Path: /usr/root/knowledge/tmp/eraT.knlge

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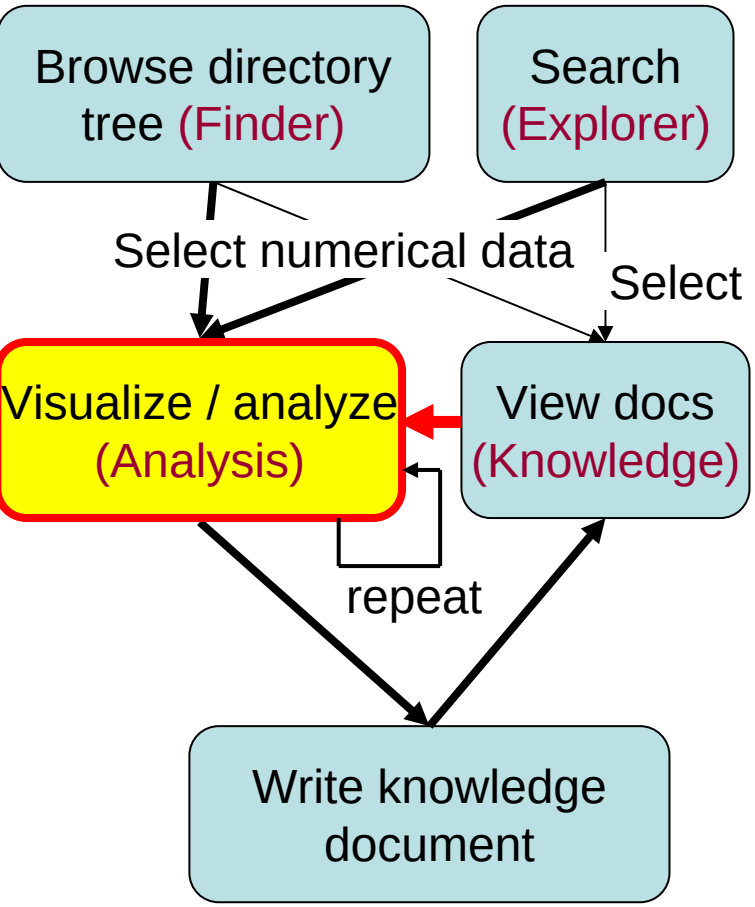
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Write knowledge document


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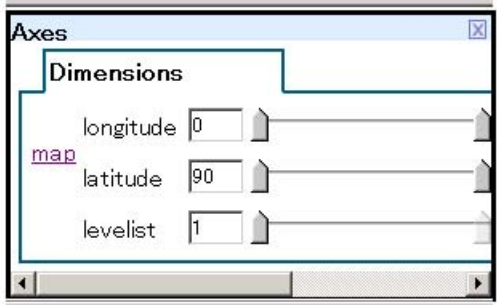
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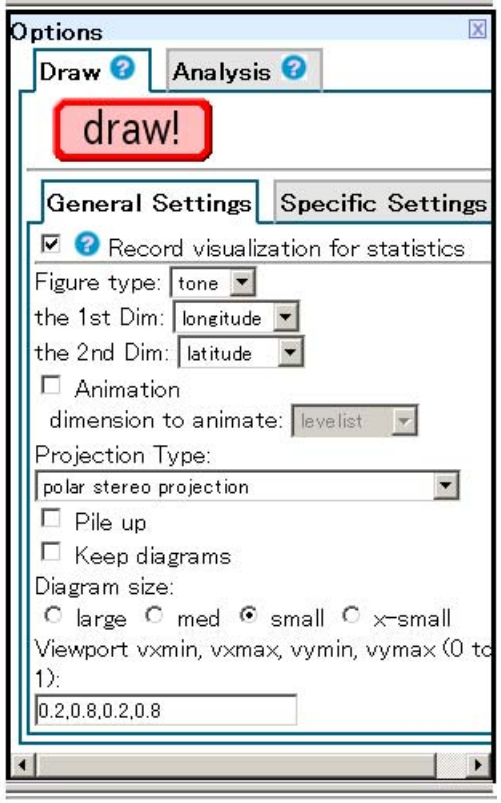
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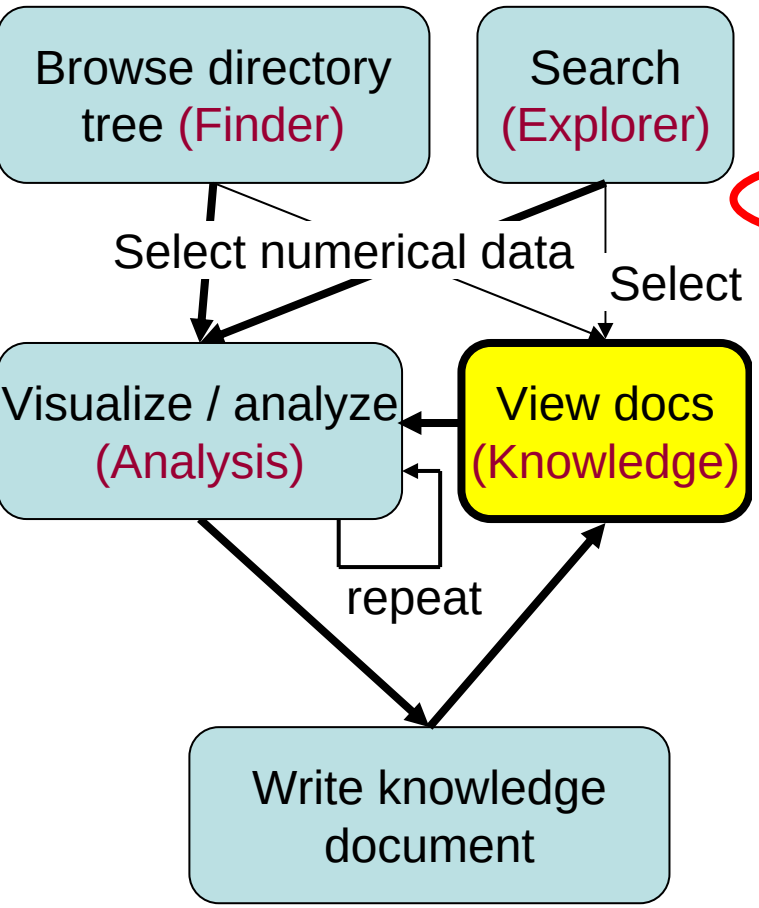

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Top Finder Explorer Analysis Knowledge User Logout

Listing Knowledge Documents

New Knowledge

Previous 1 2 Next

Temperature data from era40 by root last update: Sun Sep 14 13:02:18 show full

about figure. temperature data. levelist 1, so height is about 48km.

path: /usr/root/knowledge/temperature_data_from_era40.knlge Edit Delete

Typhoon Information by root last update: Sun Sep 14 12:54:21

A typhoon occurred at east of philippine A typhoon 5 occurred on July 2005. The figure means amount of

path: /usr/root/knowledge/typhoon4.knlge Edit Delete

Typhoon Information by root last update: Sun Sep 14 12:23:16 show full

A typhoon occurred at east of philippine A typhoon 5 occurred on July 2005. The figure means amount of

path: /usr/root/knowledge/typhoon3.knlge Edit Delete

台風情報 by root last update: Mon Sep 08 01:55:36 show full text here display comme

台風発生 2005年7月、台風5号が発生しました。図は2005年7月16日の、1時間当たりの降雨量を表してい

path: /usr/root/knowledge/typhoon.knlge Edit Delete

複数の絵を描画する方法 by root last update: Sat Aug 23 21:46:15

はじめに この文書では、多くの図が入った知見文書を作成するために、複数の絵を描く方法について解説
に関してはKnowledge 機能の使い方/samples/how_to_knowledge.knlgeをご覧ください。...

path: /samples/how_to_draw_multiple_images.knlge Edit Delete

Previous 1 2 Next

New Knowledge

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Top Finder Explorer Analysis Know

Browse directory tree (Finder)

Search (Explorer)

Select numerical data

Select

Visualize / analyze (Analysis)

View docs (Knowledge)

repeat

Write knowledge document

Typhoon Information

Author: Akinori

A typhoon occurred at east of philippine

A typhoon 5 occurred on July 2005.

The figure means amount of rainfall per hour at July 16, 2005.We can see a typhoon east of philippine.

Forecast of Course of typhoon

According to the forecast of Japan Meteorological Agency, typhoon 5 will change direction of moveme
near Taiwan.The sea around Okinawa is warmed by the intense heat of days, so it seems that the typl
further.There is possibbility of comming off from the expectation and landing on West Japan. Please no
the future.

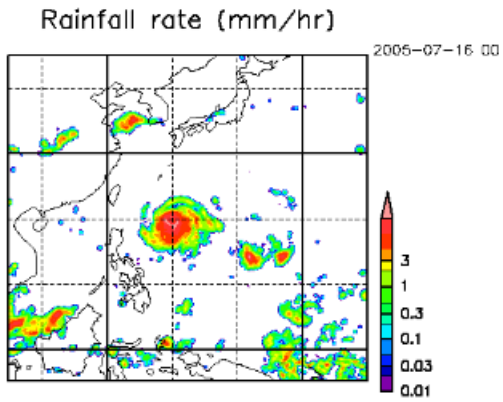

Fig. 1. Rainfall

Path: /usr/root/knowledge/typhoon3.knlge

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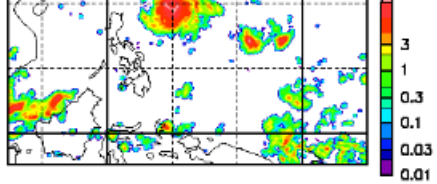

Fig. 1. Rainfall

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Path: /usr/root/knowledge/typhoon4.knlge

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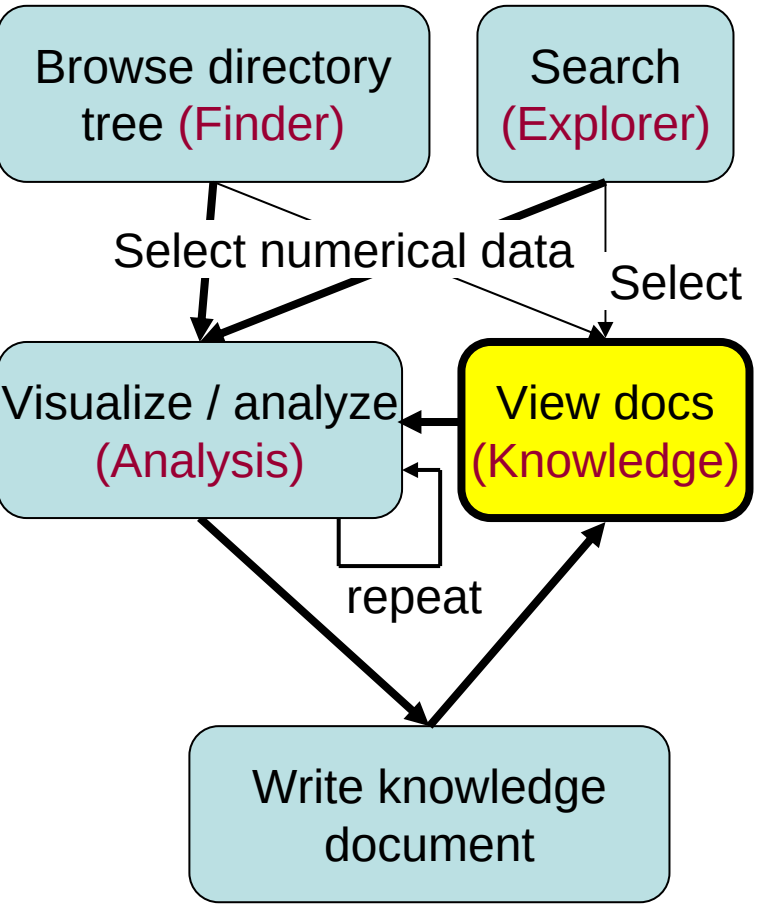

There are no comment on this document.

Add a Comment on this document.

Title: Re[1]:Typhoon Information Author:

Textbody:

Choose a default layout : figures under text. size of figure: height 100 %

input the number of figures in a row 1

Figure 1

Caption:

delete

Figure Path:

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Author: Akinor

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Top Finder Explorer Analysis Know

Browse directory tree (Finder)

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Select numerical data

Select

Visualize / analyze (Analysis)

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repeat

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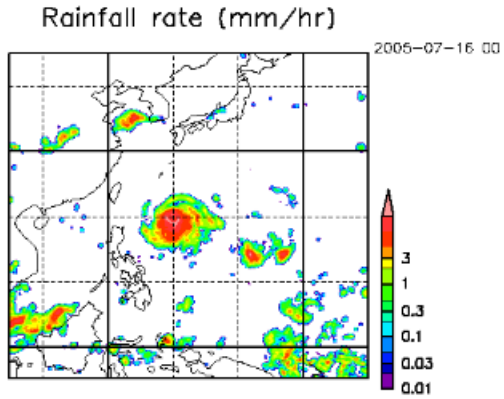

Fig. 1. Rainfall

Path: /usr/root/knowledge/typhoon3.knlge

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1 comment exists.

Show Summary of Comments | Hide Comments | Show full text of Comments

Re[1]:Typhoon Information author: **Akinori Tomobayashi** by **root** last update: **Sun Sep**

After all, typhoon 5 went for Taiwan and landed China.

Write a Coment on this document.

Back to List

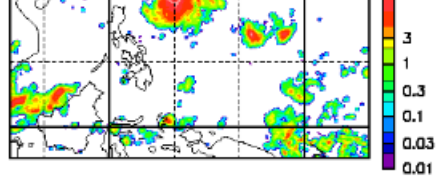


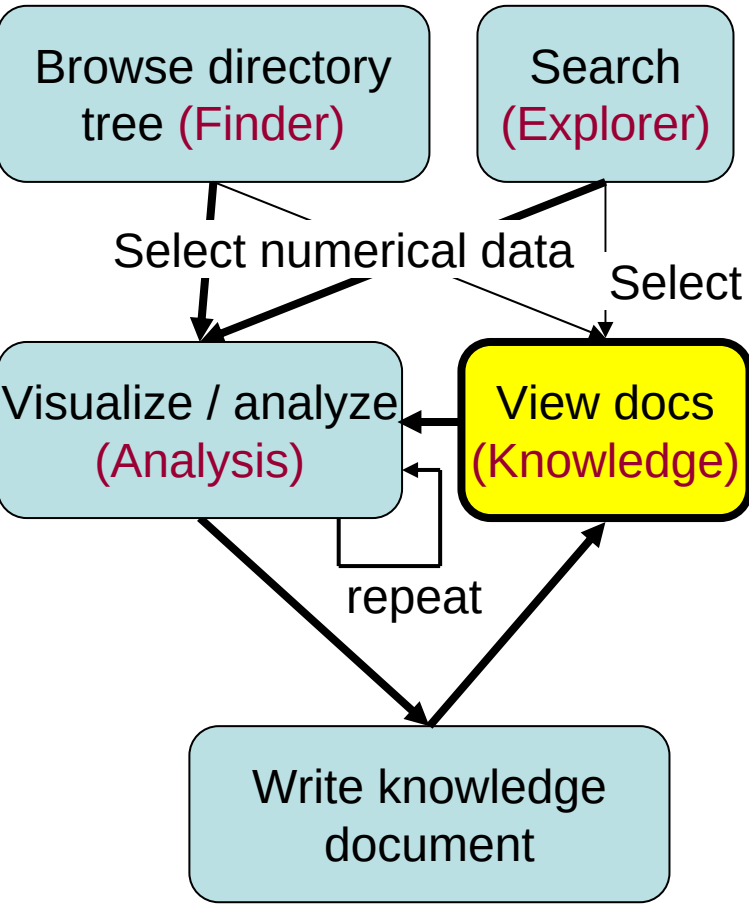
Fig. 1. Rainfall

Path: /usr/root/knowledge/typhoon3.knlge

Edit | Back to List

Gfdnavi

Top Finder Explorer Analysis Know



1 comment exists.

Show Summary of Comments | Hide Comments | Show full text of Comments

Re[1]:Typhoon Information author: Akinori Tomobayashi by root last update: Sun Sep

After all, typhoon 5 went for Taiwan and landed China.

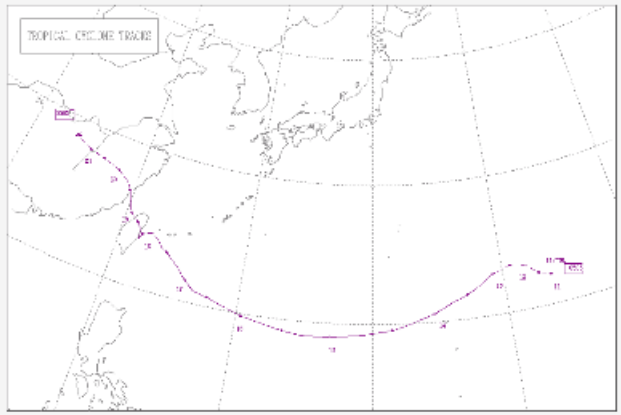


Fig. 1. course of typhoon 5 in 2005.

Path: /usr/root/knowledge/typhoon3_comment_1.knlge

Write a Coment on this document.

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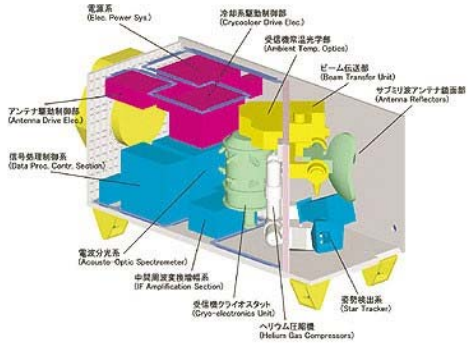
By linking a document with data and visualization/analysis methods

- One can confirm and extend it
  - falsifiability
- Annotate data with the document
  - scientific metadata
- Applications
  - interactive publication / science collaboration / educational material (incl. interdisciplinary collaboration)

Application Examples

- **JEM/SMILES** data server (JAXA):
  - Satillite obs for ozone etc: Science team (incl. restricted access) + General data service



- International collaboration project to improve **weather forecast in Asia**

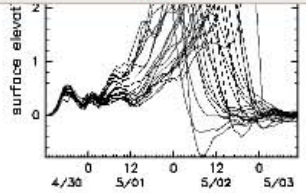


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Fig.1. Time series of surface elevation at Irrawaddy point (95.07 degE, 16.10 degN) for 21 members.

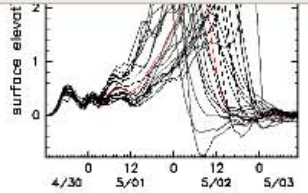

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Fig.2. Same as Fig. 1, but the control run is highlighted.

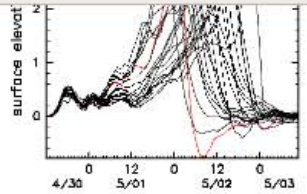

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Fig.3. Same as Fig. 1, but the member 1 (which shows the heighest surface elevation) is highlighted.

Previous Next

6. Decision support tools for ensemble numerical weather prediction: I. Basic diagrams

6.1 1D line plot

Data

/Nargis/NHM/POM/h.nc (lon, lat, t, member)

Settings

- Axes
  - h_member(t)
    - lon = 95.07 degE
    - lat = 16.10 degN
    - (X) t = [0 h, ..., 71 h]
    - (Ens) member = 0, ..., 20
- General Settings
  - Draw method
    - ensemble_1D
- Specific settings
  - style: lines

This diagram is called **"Plume diagram"**.

Result

Time series of surface elevation at Irrawaddy point (95.07 degE, 16.10 degN) for 21 members Fig. 1. Some members show storm surge of more than 3 m in height.

Advanced usage

Sample knowledge document: Visualization of “ensemble forecast”

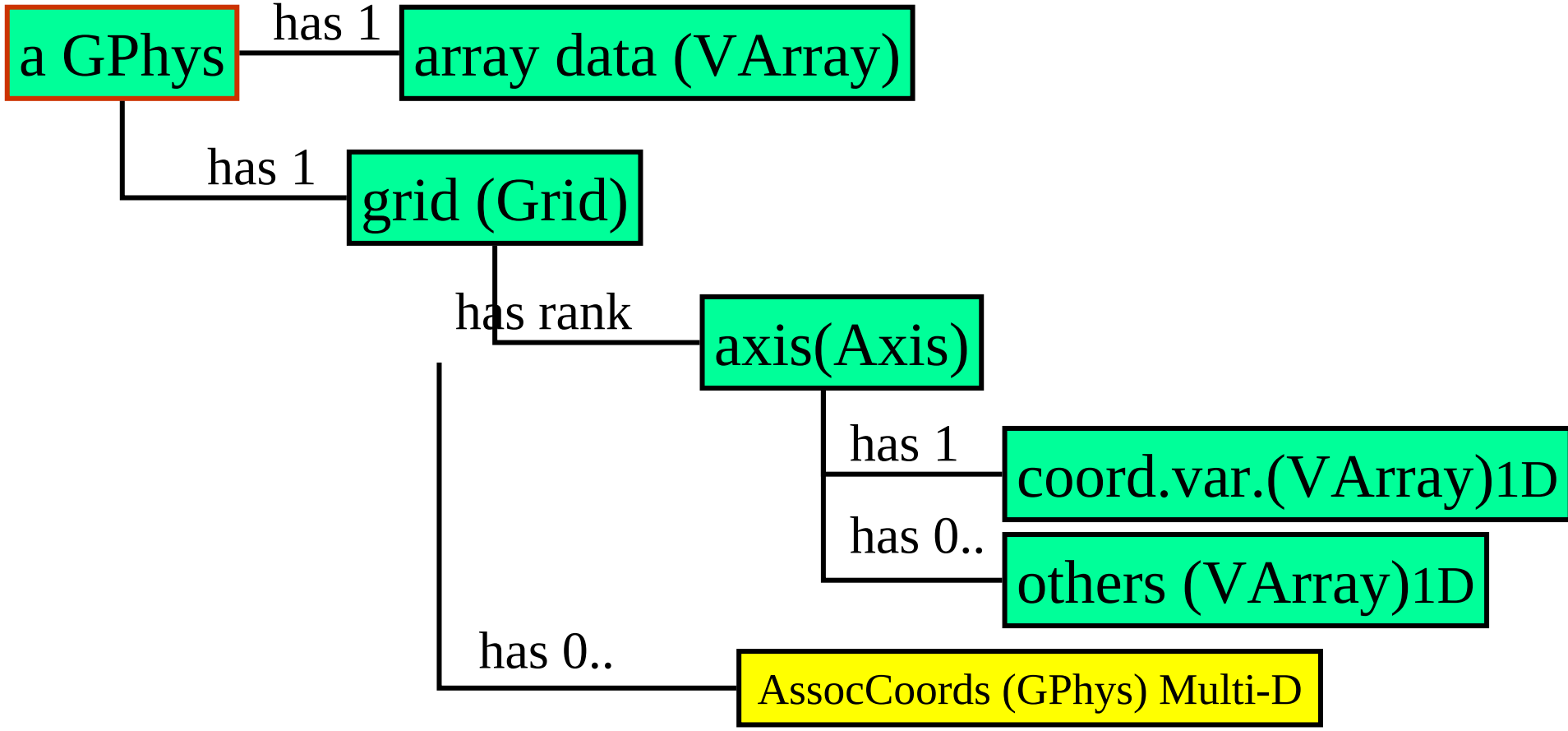
Summary

- We have developed Gfdnavi: software to build data and knowledge servers
  - Wide coverage from desktop use to public data service (by having custom web server)
  - Programmability (on browser & by web service)
  - Documentation of analysis results (dynamically reproducible/extendible) (→ memos / reports / PR / Blog for scientific collaboration)

Next talk by Seiya Nishizawa:
✓ More on programability
✓ Web services
✓ Network of Gfdnavi

fin

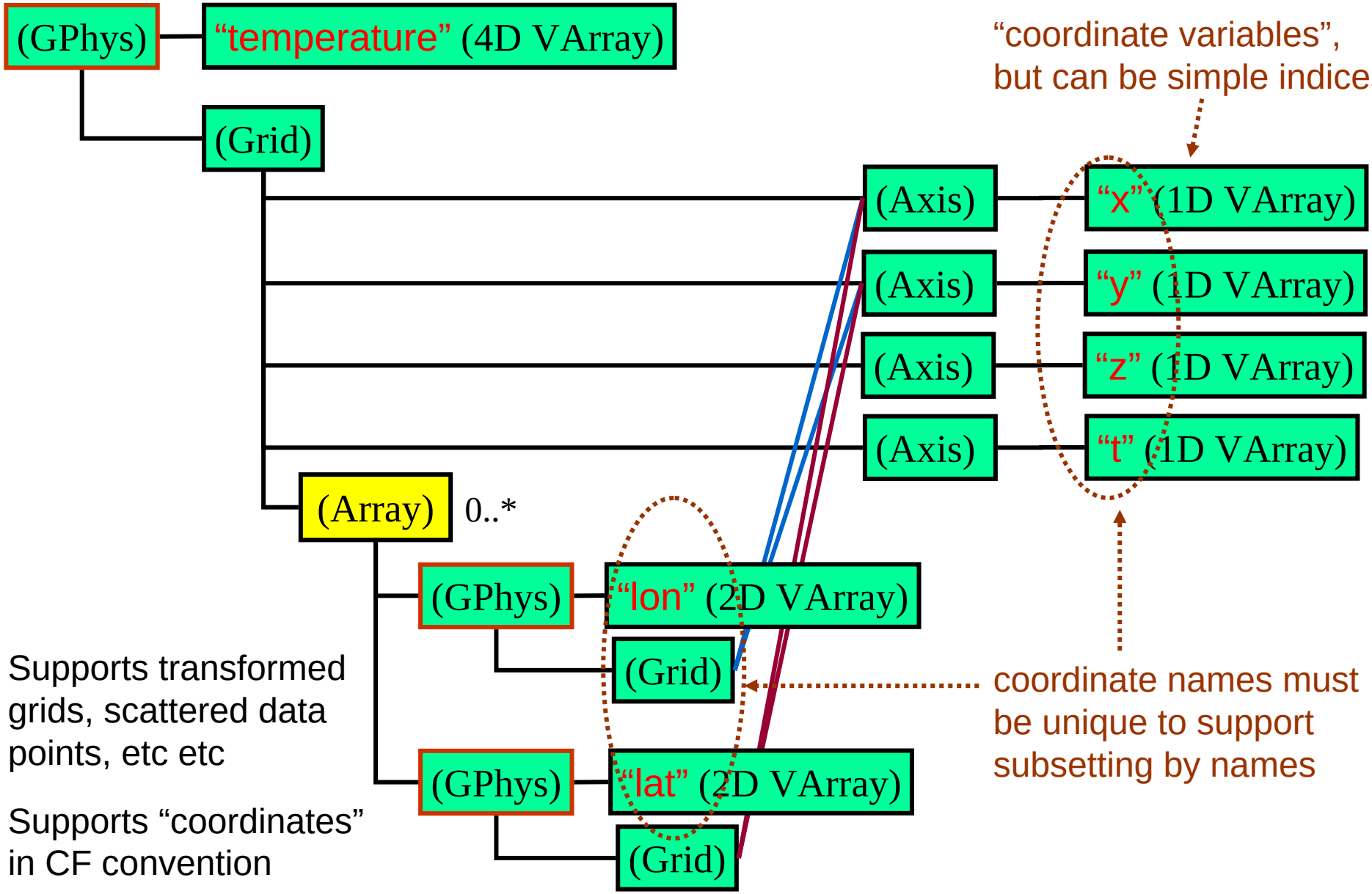
GPhys (Gridded Physical quantity)



VArray (Virtual Array) – Abstracts Data Storage

(Can be in file(s) or multi-D Array on memory; can also be a subset or aggregation of (an)other VArray(s))

Example of GPhys's associated coordinates



What is Ruby on Rails

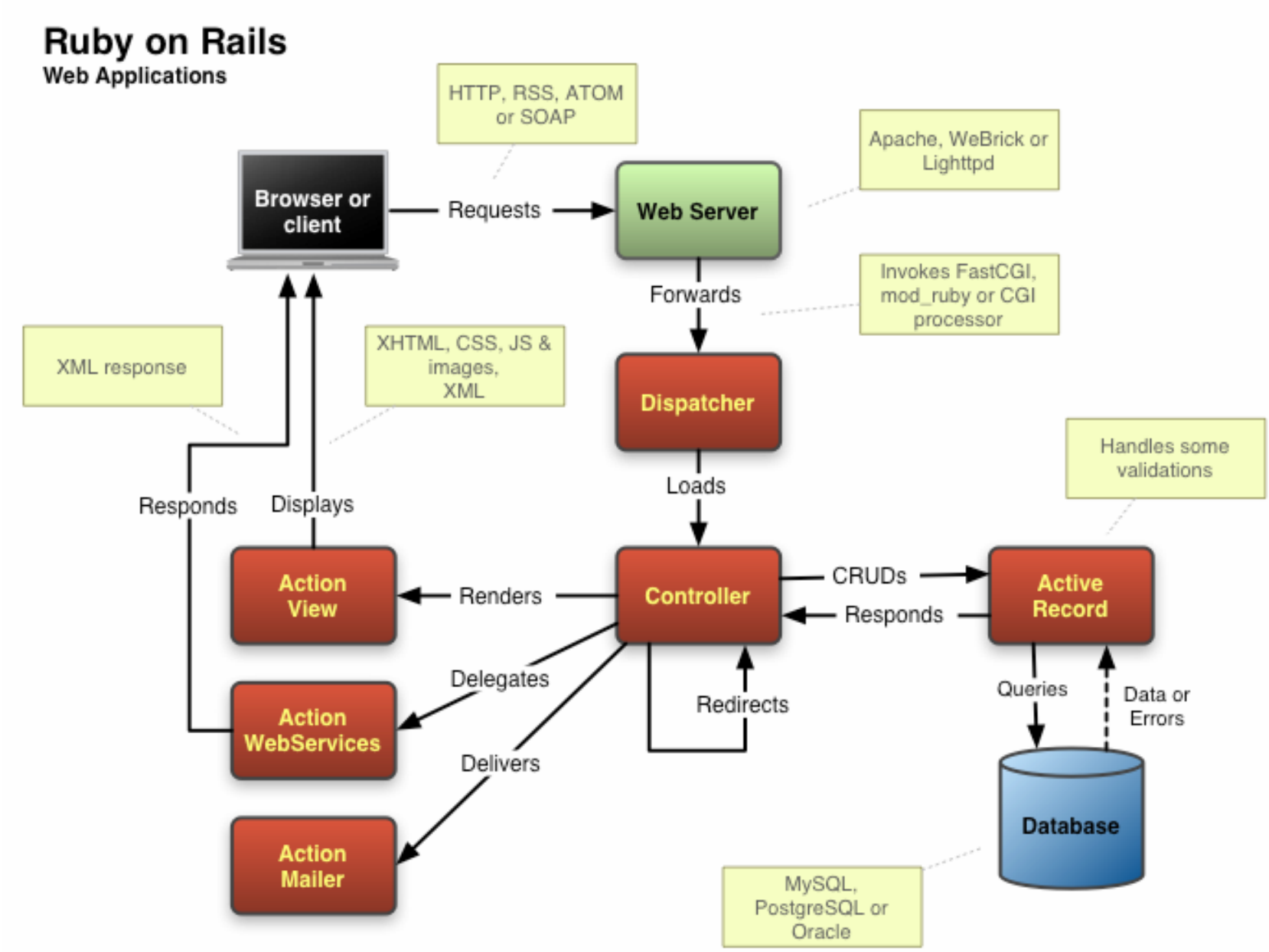
http://www.rubyonrails.org/

- Web development framework in Ruby
- With RDBMS (Mysql, Postgres, SQL Server, SQLite etc)
- Strong prototyping (e.g. Model-View-Controller (MVC) stucture)
- Comprehensive library (covering Ajax and Web service)
- Ruby-embedded html

  → suitable to use our Ruby library
- Has a private web server (Webrick); also runs on Apache, lighttpd etc

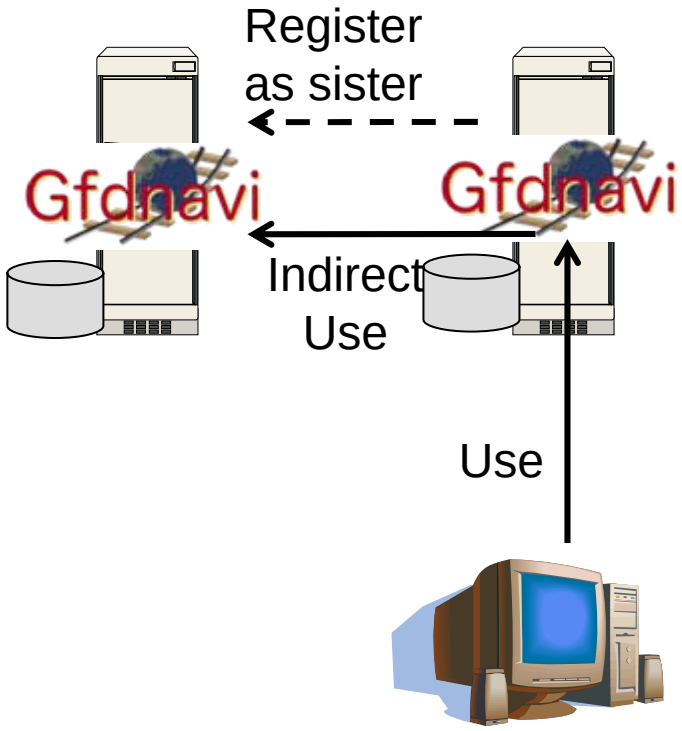
  → One can personally run a web server anywhere with arbitrary port

From *"Understanding Rails MVC"*: http://wiki.rubyonrails.org/rails/pages/UnderstandingRailsMVC

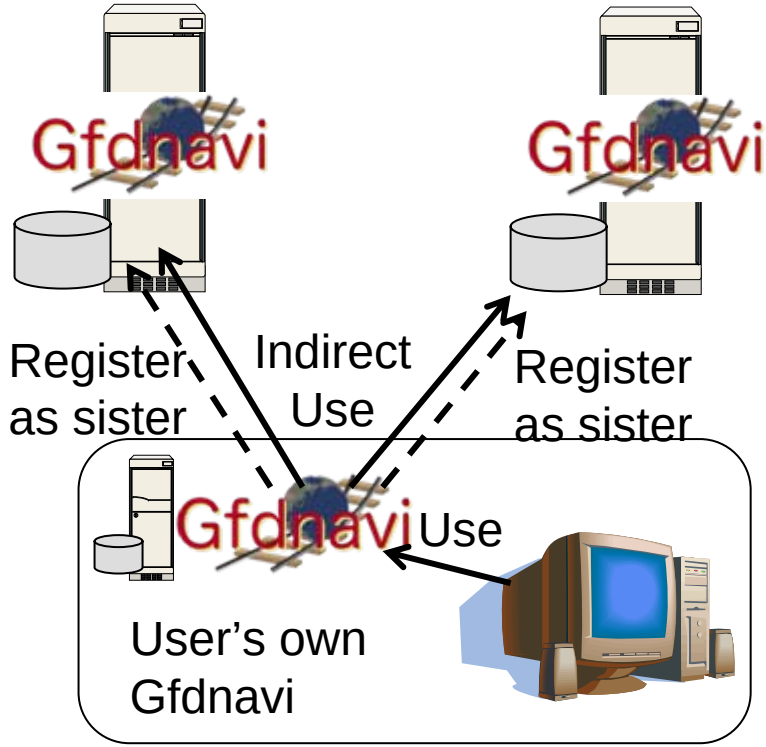


Sister-server method

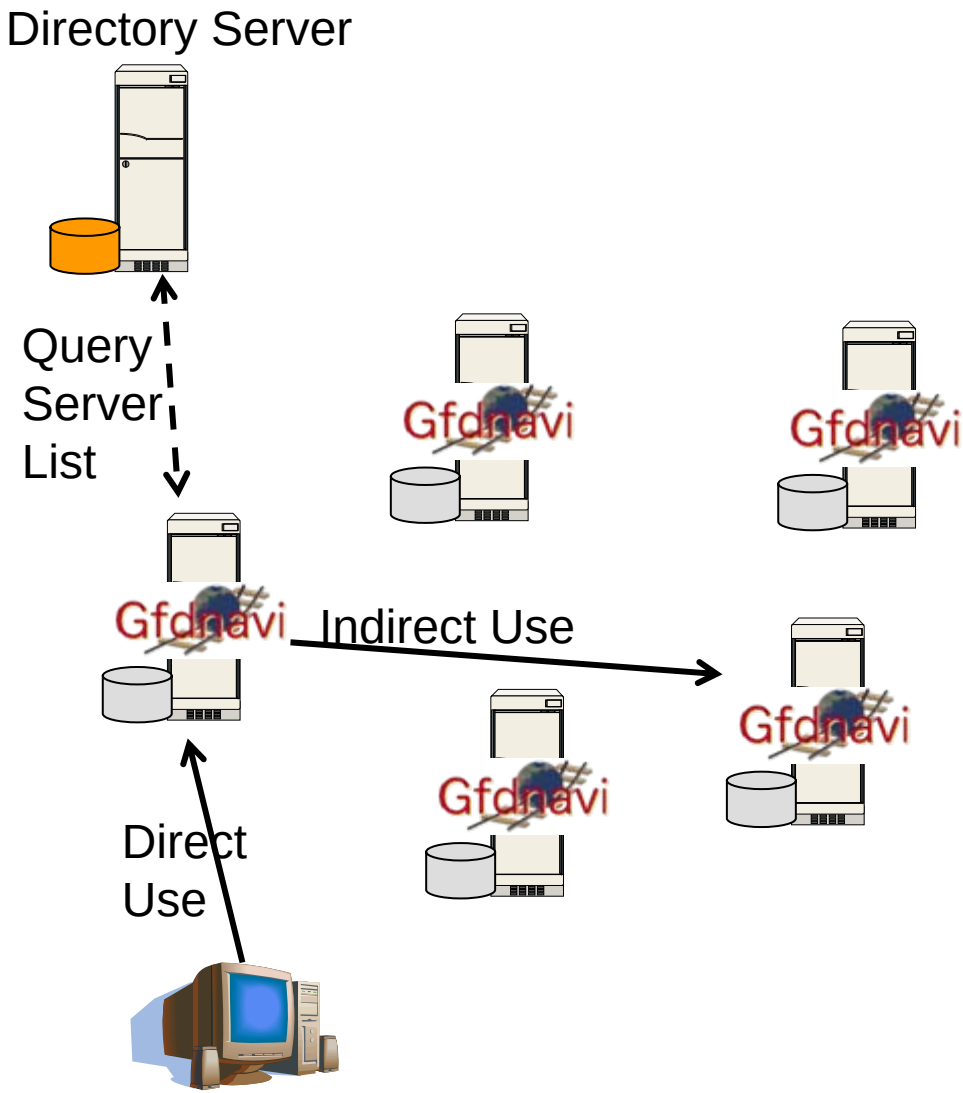
(a) Basic case: available in LAS.
User can't choose peers



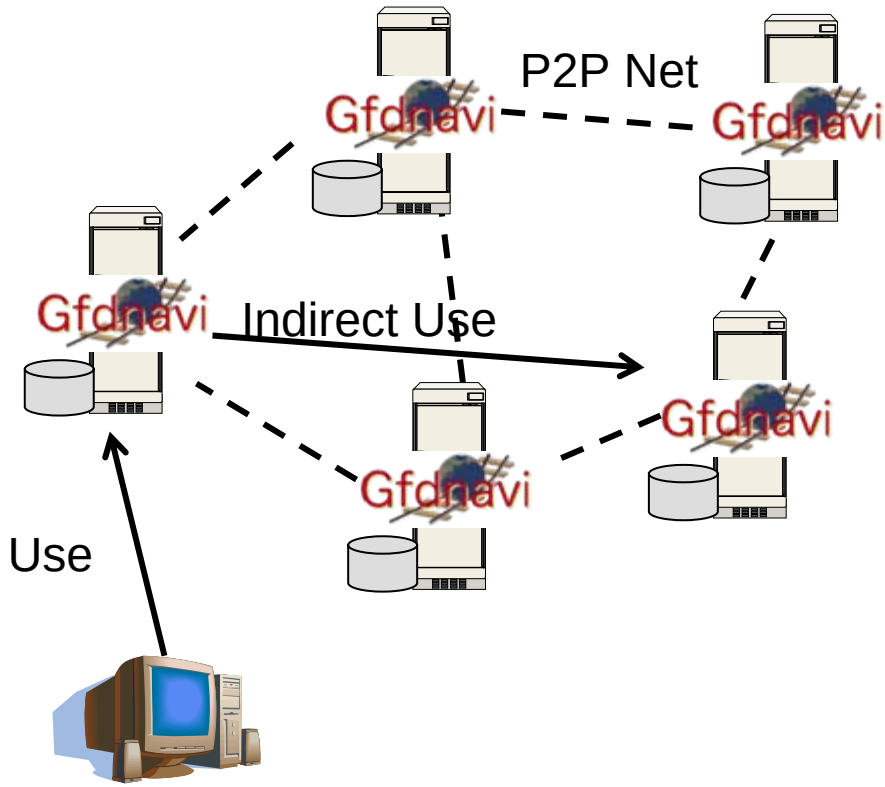
(b) Gfdnavi: one can register
any peer by running a Gfdnavi



P2P with directory server



Overlay network by P2P



Currently tested by C. Watanabe by using Overlay Weaver (Java-based p2p library) and Rails' Action Web Service

– Decentralized p2p with distributed hash tables (DHT)