Lessons Learned during the Development and Operation of Virtual Observatory

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Planned Data Resources

- ALMA
- JWST
- LSST
- LOFAR
- SKA
- Thirty Metre Telescope
- Giant Magellan Telescope
- European Extremely Large Telescope

30 PB/yr x 6 yr ~ 200 PB

~ a few PB/yr
Flow of Observational Research

• Issues, Planning
• Observation
• Data Reduction
  – Calib., Select, Combine
  , , ,
• Data Analysis
  – Physical Parameters
  – Thinking
  – Solution
• Publish

Data
↓
Information
↓
Knowledge
↓
Understanding
↓
Wisdom
VO– New Research Infrastructure in the 21st Century

A collection of integrated astronomical data archives and software tools that utilize computer networks to create an environment in which research can be conducted.

VO Projects in the world

• 17 countries and a region (EU)
• International Virtual Observatory Alliance (IVOA) Standards to interoperate VOs

• Meta data, data models, data accesses, output format, etc.
Standardization in IVOA

- Meta-data
  - Contents & access protocol
- Access Images, Spectra, Catalogues
  - TAP, SIAP, SSAP, STC, etc.
- Query Language to Federated DBs (ADQL)
- Unified Attribute Names
  - UCD (Unified Contents Descriptions)
- Output format: VOTable (in XML)
  - FITS
Astronomical Virtual Observatories ~ DataGrid ~

More than 3100 resources, including Subaru SupCAM and HDS, are accessible

Images, spectra, and catalog data can be retrieved
Looking Ahead

Universe on Your Desktop
Structure of JVO Portal Service
Service Contents

Data Search
- Quick Search
- Search on a single VO Service
- Parallel search on multiple VO Services
- Xmatch Search
- JVOQL Search

Service Search
- Keyword Search
- Category Search
- Advanced Search

Astronomical Tools
- Source Extractor
- HyperZ

Subaru
- Suprime-Cam

JVO Space
- Home

Workflow
- Workflow Editor (Script)
- Workflow Editor
- Workflow Monitor

Admin
- Admin

http://jvo.nao.ac.jp/portal/
Access Statistics to JVO Portal (as of 2009 Sep)

- Data request of more than 1TBytes/Month from the world
- Most access to Subaru SupCAM data
VO-enabled Papers

SAO/NASA Astrophysics Data System (ADS)

Query Results from the Astronomy Database

Selected and retrieved 172 abstracts.

<table>
<thead>
<tr>
<th>#</th>
<th>Bibcode</th>
<th>Authors</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2009MNRAS.tmp1016M</td>
<td>Molla, M.; García-Vargas, M. L.; Bressan, A.</td>
<td>PopStar I evolutionary synthesis model description</td>
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<tr>
<td>2</td>
<td>2009MNRAS.396...223D</td>
<td>D'Abrusco, R.; Longo, G.; Walton, N. A.</td>
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<tr>
<td>3</td>
<td>2009AJ...137...12G</td>
<td>Caballero, J. A.; López-Santiago, J.; de Castro, E.; Cornide, M.</td>
<td></td>
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<td>4</td>
<td>2009GeoJL177...463B</td>
<td>Begeman, C. D.; Whaler, K. A.; MacMillan, S.</td>
<td>Elsino residuals of core flow models from satellite-derived ‘virtual observatories’</td>
</tr>
</tbody>
</table>

~170 Refereed Papers that have “Virtual Observatory” in its abstract

More than 1300 papers mentioning “Virtual Observatory”
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  - Discovery
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Knowledge
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Understanding
↓
Wisdom
More Science-Driven

- Demonstrate scientific merit
  - Publish “product papers” by yourselves
- Select most commonly used functionalities

- Quality Index
  - Toward quality assurance, jointly with observatories

- Young researchers
  - Researchers are VERY conservative!
  - Young researchers tend to show interest to new ones
Users View Point

• Easiness to use
  – self-explanatory
  – Basic functionalities are sufficient
  – Others could be done by a local machine

• Market research
  – Science use cases
  – tutorials

• Novice vs Expert
  – GUI vs CUI
  – Almost no astronomers know SQL
Importance of Tutorials

- A must toward more dissemination and more publications
  - pure users
  - feedback
  - potential tutors
## Establishing Standards

<table>
<thead>
<tr>
<th>Standards are quite effective</th>
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<tbody>
<tr>
<td>Access protocols, data format, etc.</td>
</tr>
<tr>
<td>Interoperability → wider dissemination and application</td>
</tr>
<tr>
<td>Endorsement by the IAU (VO WG)</td>
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</tbody>
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<tr>
<th>Painful process</th>
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</thead>
<tbody>
<tr>
<td>Philosophy, idea, aim, intention, view,...</td>
</tr>
<tr>
<td>Compromise, patience</td>
</tr>
<tr>
<td>Establishment of relationship: respect to each other</td>
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<tr>
<td>Coffee/tea breaks and lunch/dinner talks are crucial</td>
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</tbody>
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Technology

• Not too early, not too late
• Stability, robustness
  – “doable or not” is the issue
• Sustainability, support
• Popularity
  – help desk around you
• Platform independency
  – for easy dissemination
For Data providers

• Give credit to them
  – Hard and invisible to prepare science-ready data

• Easy implementation
  – tool kit

• Validation tool prior to publication of data
  – Ensure reliability of the data product
For Tax-Payers

• Effective tool for outreach activity
• Educational use
  – Dedicated user interface, w/ teachers
• More access by non-astronomers
• Funding agencies

Summary

- VO data services are available through many VO projects – Data Grid
- More data analysis tools need to be integrated into the VO world → knowledge (and papers)
- More science-driven, easy-to-use design of the VO tools would be required
- Quality assurance/ quality index toward more reliable would be crucial in the data-incentive era
Supported by

- JSPS
  “Core to Core Program” (2004~2008)

- MEXT Grant-in-Aid
  “Information Explosion” (2001~)

- National Institute for Informatics
  “CSI Program” (2006~)

- NAOJ

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