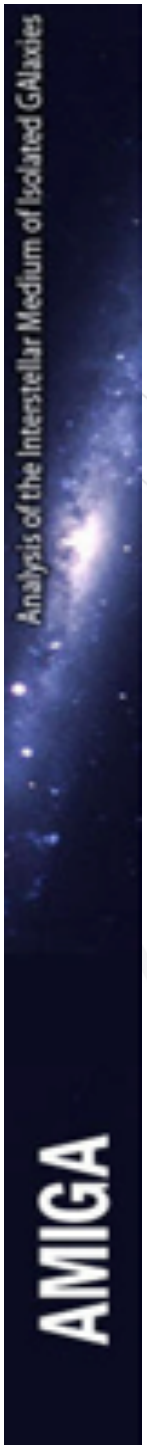


Digital Science

Reproducibility and Visibility in Astronomy

José Enrique Ruiz on behalf of the Wf4Ever Team

ESAC FACULTY SEMINAR
MADRID, JANUARY 18th 2013

Astronomy Research Lifecycle

Astronomy research lifecycle is **entirely digital**

- Observation proposals
- Data reduction pipelines
- Analysis of science ready data
- Catalogs of objects and data
- Publish process
  - Final data results
  - Experiment in DL ADS/arXiv

Reproducible research is still not possible in a digital world

A rich infrastructure of data (VO) is not efficiently used

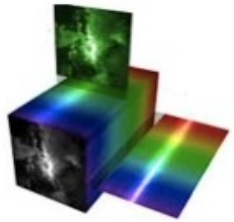
A normalized preservation of methodology is needed

Tools

The next generation of archives

Much wider FoV and spectral coverage

- Large volumes for an observed datacube
- Subproducts are **Virtual Data** generated on-the-fly



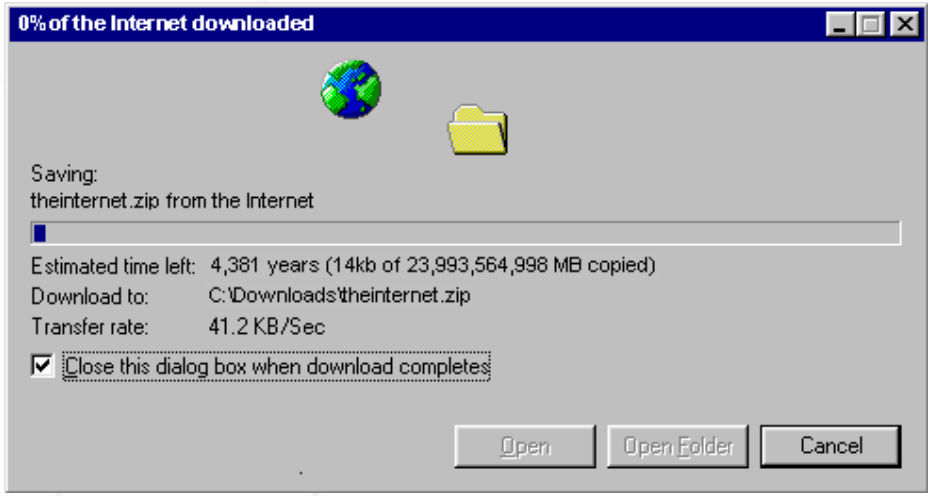
	Low Res		High Res		Extreme Res	
Number	4 Bytes	4B	4 Bytes	4B	4 Bytes	4B
Resolution	2,048 x 2,048	16MB	8,192 x 8,192	268MB	12,288 x 12,288	603MB
Channels	16,384	0.27TB	16,384	4.39TB	16,384	9.8TB
Stokes & Weighting	1	0.27TB	1	4.39TB	4 + 1	49.5TB

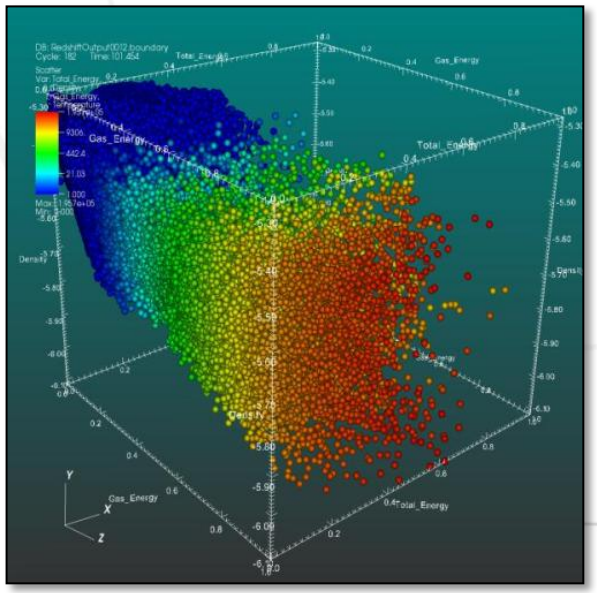
ASKAP Cubes
Prof. Kevin Vinsen

The next generation of archives

Automated surveys

- Huge amounts of tabular data
- Services for KDD





Extraction of scientifically relevant information from a multidimensional parameter space

- Exploration services
- Anomaly detection
- Cross-matching data
- Dimensionality reduction

The next generation of archives

- A cloud of Web Services

  Archives should evolve from data providers into
  - Virtual data providers
  - Software tasks providers

- Archives speaking Web Services

  Astronomy of multi archives/facilities/wavelength

  Interconnected and interoperable archives
  - Data -> Virtual Observatory
  - Software Tasks

Process should benefit of the same privileges acquired by data

Preserving the method ensures replication of final results at any moment

Digital Science - Reproducibility and Visibility in Astronomy

Efficiency and Reuse

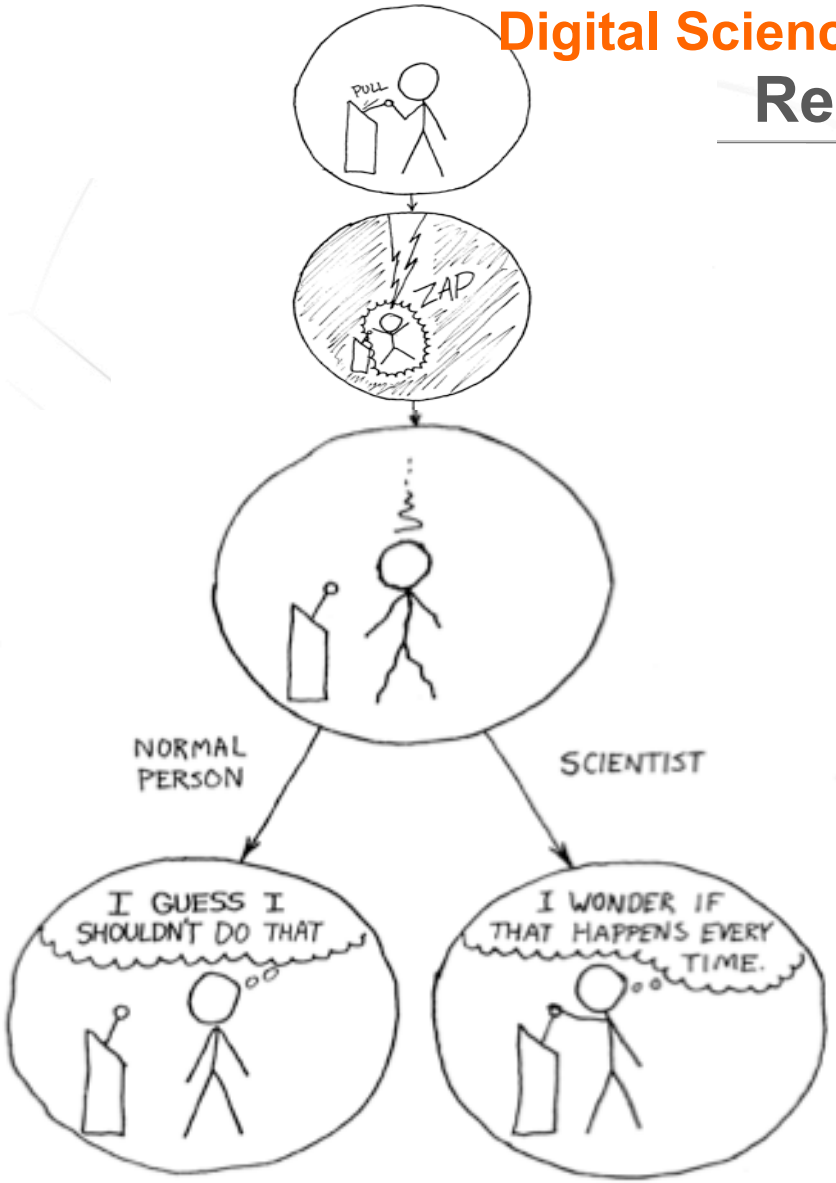
Optimize return on investments made on big facilities

- Avoid duplication of efforts and reinvention
- How to discover and not duplicate ?
- How to re-use and not duplicate ?
- How to make use of best practices ?
- How to use the rich infrastructure of data ?
- **Intellectual contributions are encoded in softw**

More data in archives does not imply more knowledge

- Time has come to go beyond the PDF
- Expose complete scientific record, not the story
- Allow easy **discovery** of methods and tools

Reproducibility and The Scientific Method



http://xkcd.com/242/

Benefits

- Publishing knowledge, not advertising
- The author, the referee and the re-user
- Reputation, prestige and respect
- Higher quality of publications
  - Authors will be more careful
  - Many eyes to check results

Challenges

- Hard and time consuming
- Need incentives – not rewarded now

Initiatives

- Elsevier Executable Papers Challenge
- Open Data / Open Science - EU H2020

Reproducibility and The Scientific Method

Barriers to Data and Code Sharing in Computational Science

Survey of Machine Lea[illegible]lden, 2010):

I don't know how

Code		Data
77%	Time to document and clean up	54%
52%	Dealing with questions from users	34%
44%	Not receiving attribution	42%
40%	Possibility of patents	-
34%	Legal Barriers (ie. copyright)	41%
-	Time to verify release with admin	38%
30%	Potential loss of future publications	35%
30%	Competitors may get an advantage	33%
20%	Web/disk space limitations	29%

Digital Science - Reproducibility and Visibility in Astronomy

Discovery, Visibility and Credit

nature International weekly journal of science

Search Go

Advanced search

Home | News & Comment | Research | Careers & Jobs | Current Issue | Archive | Audio & Video | For Authors

Archive > Specials & supplements archive > Science Metrics

SPECIALS

See all specials

How to improve the use of metrics

Nature 465, 870–872 (17 June 2010) | doi:10.1038/465870a

... "Science is being killed by numerical ranking,"[...] Ranking systems lures scientists into pursuing high rankings first and good science second.

SCIENCE METRICS

The value of scientific output is often measured, to rank one nation against another, allocate funds between universities, or even grant or deny tenure. Scientometricians have devised a multitude of 'metrics' to help in these rankings. Do they work? Are they fair? Are they over-used? *Nature* investigates.

▼ Editorial ▼ Features ▼ Opinion ▼ From the archive

Journal home | Subscribe

Current issue | E-alert sign up

For authors | RSS feed

Top content

Emailed | Downloaded | Blogged

1. Public health: The toxic truth about sugar
   Nature | 01 February 2012
2. The case for open computer programs
   Nature | 22 February 2012
3. The great beyond
   Nature | 29 February 2012
4. The darker side of stem cells
   Nature | 29 February 2012
5. Cancer: Solving an age-old problem
   Nature | 29 February 2012

View all ▸

Discovery, Visibility and Credit

nature International weekly journal of science

Search Go

Advanced search

Home | News & Comment | Research | Careers & Jobs | Current Issue | Archive | Audio & Video | For Authors

Archive > Specials & supplements archive > Science Metrics

SPECIALS

See all specials

How to improve the use of metrics

Nature 465, 870–872 (17 June 2010) | doi:10.1038/465870a

Research reverts to a kind of 'academic prostitution', in which work is done to please editors and referees rather than to further knowledge.

SCIENCE METRICS

The value of scientific output is often measured, to rank one nation against another, allocate funds between universities, or even grant or deny tenure. Scientometricians have devised a multitude of 'metrics' to help in these rankings. Do they work? Are they fair? Are they over-used? *Nature* investigates.

▾ Editorial ▾ Features ▾ Opinion ▾ From the archive

Journal home | Subscribe
Current issue | E-alert sign up
For authors | RSS feed

Top content

Emailed | Downloaded | Blogged

1. **Public health: The toxic truth about sugar**
   Nature | 01 February 2012
2. **The case for open computer programs**
   Nature | 22 February 2012
3. **The great beyond**
   Nature | 29 February 2012
4. **The darker side of stem cells**
   Nature | 29 February 2012
5. **Cancer: Solving an age-old problem**
   Nature | 29 February 2012

View all ▸

Discovery, Visibility and Credit

nature International weekly journal of science

Search Go

Advanced search

Home | News & Comment | Research | Careers & Jobs | Current Issue | Archive | Audio & Video | For Authors

Archive > Specials & supplements archive > Science Metrics

SPECIALS

See all specials

How to improve the use of metrics

Nature 465, 870–872 (17 June 2010) | doi:10.1038/465870a

... an author's h-index can reflect longevity as much as quality — and can never go down with age, even if a researcher drops out of science altogether.

SCIENCE METRICS

The value of scientific output is often measured, to rank one nation against another, allocate funds between universities, or even grant or deny tenure. Scientometricians have devised a multitude of 'metrics' to help in these rankings. Do they work? Are they fair? Are they over-used? *Nature* investigates.

▾ Editorial ▾ Features ▾ Opinion ▾ From the archive

Journal home | Subscribe

Current issue | E-alert sign up

For authors | RSS feed

Top content

Emailed | Downloaded | Blogged

1. Public health: The toxic truth about sugar
   Nature | 01 February 2012
2. The case for open computer programs
   Nature | 22 February 2012
3. The great beyond
   Nature | 29 February 2012
4. The darker side of stem cells
   Nature | 29 February 2012
5. Cancer: Solving an age-old problem
   Nature | 29 February 2012

View all

Exploring and understanding scientific metrics in citation

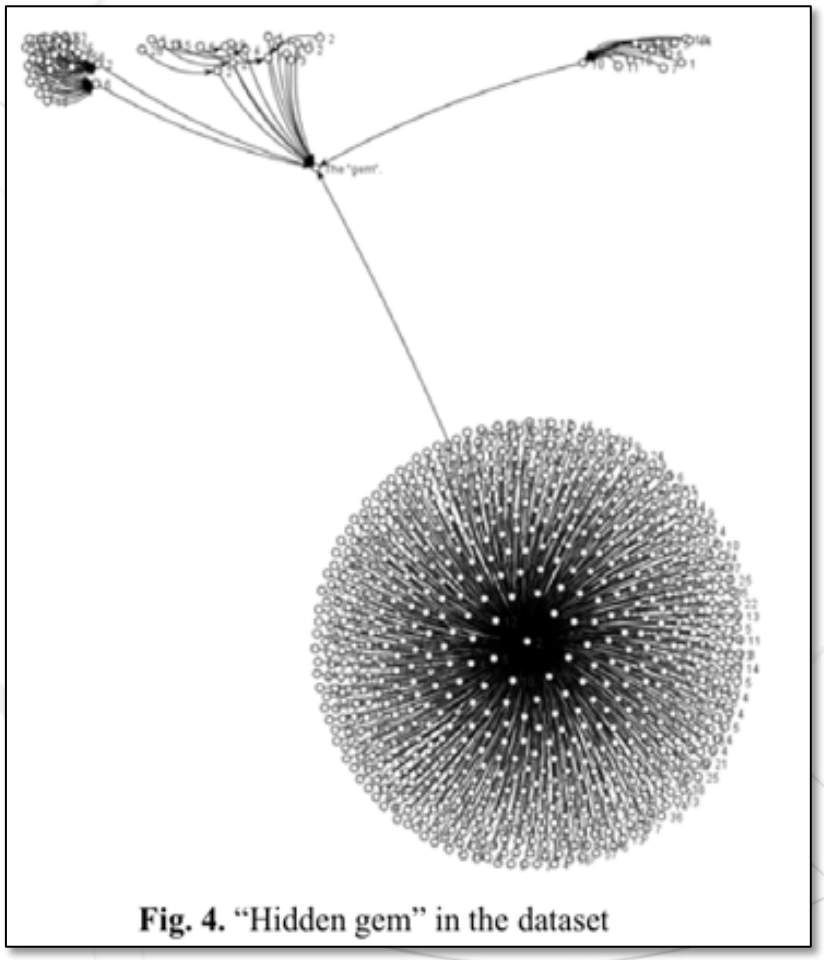


Fig. 4. "Hidden gem" in the dataset

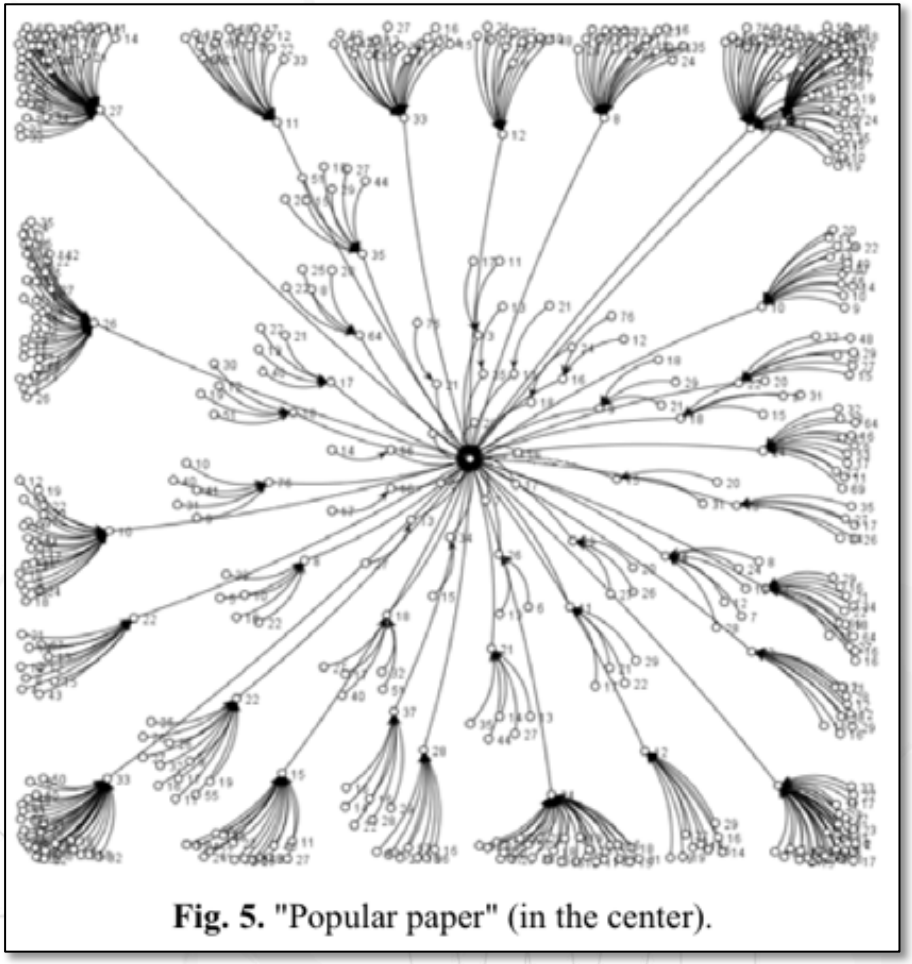


Fig. 5. "Popular paper" (in the center).

LiquidPub

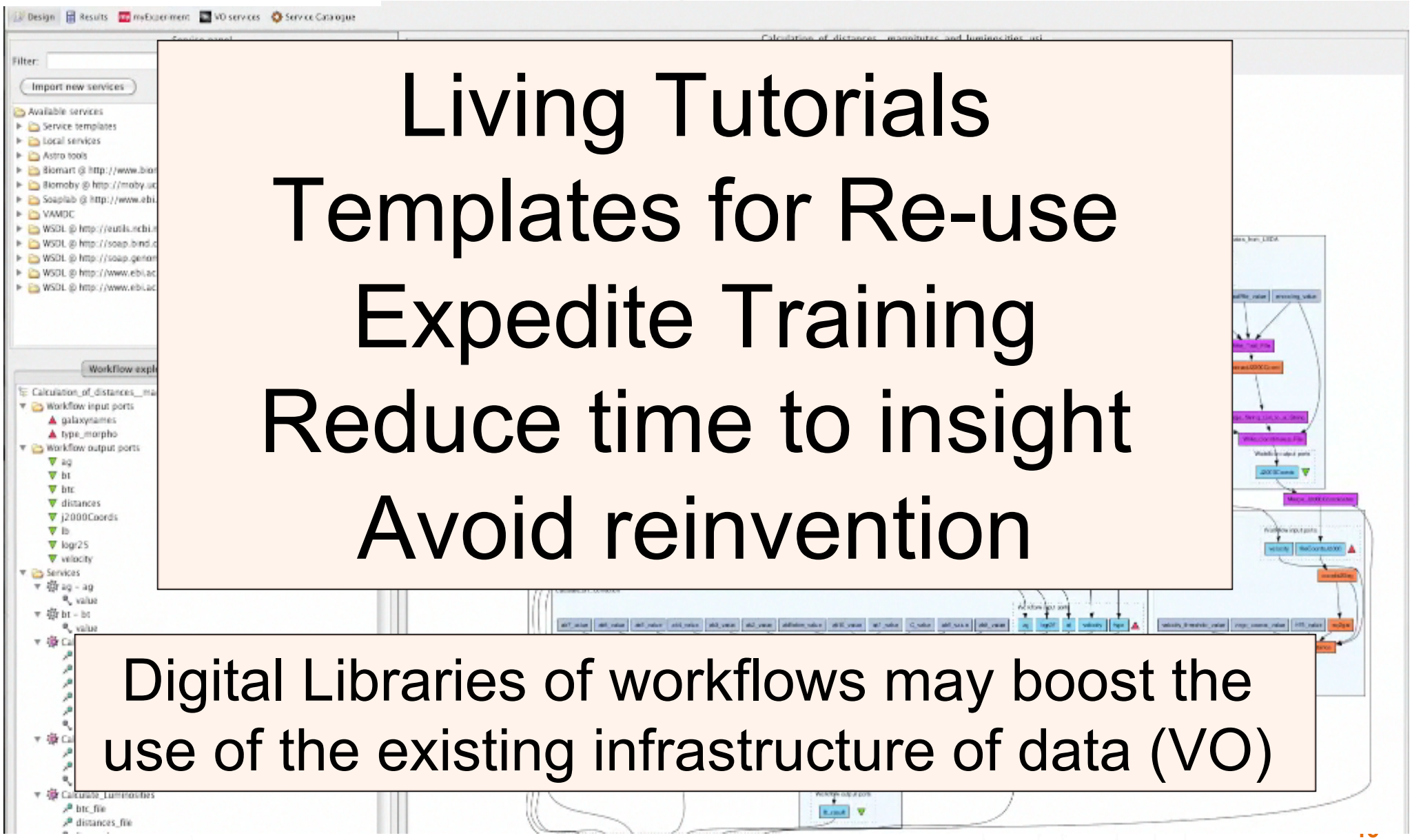
2010 Krapivin et al.

Paper discovery: the social dimension

EU funded FP7 STREP Project

December 2010 – December 2013

1. Intelligent Software Components (**ISOCO**, Spain)
2. University of Manchester (**UNIMAN**, UK)
3. Universidad Politécnica de Madrid (**UPM**, Spain)
4. Poznan Supercomputing and Networking Centre (**PSNC**, Poland)
5. University of Oxford (**OXF**, UK)
6. Instituto de Astrofísica de Andalucía (**IAA**, Spain)
7. Leiden University Medical Centre (**LUMC**, NL)



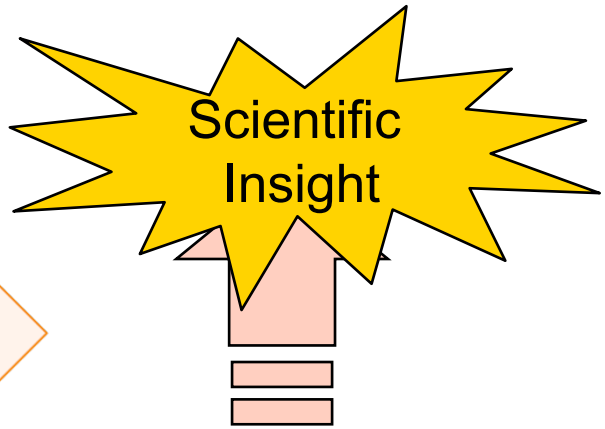
Living Tutorials
Templates for Re-use
Expedite Training
Reduce time to insight
Avoid reinvention

Digital Libraries of workflows may boost the use of the existing infrastructure of data (VO)

Scientific Workflows

Survey in the domain of astrophysical workflows

- Personal script-based recipes
  - Python, IDL, Software..
- Multi-archive VO recipes
  - Euro-VO, IVOA..
- Internal group developments
  - GRID, Clusters, Specific knowledge
- Processing pipelines
  - Facilities provide data, comp… …ture, tools..

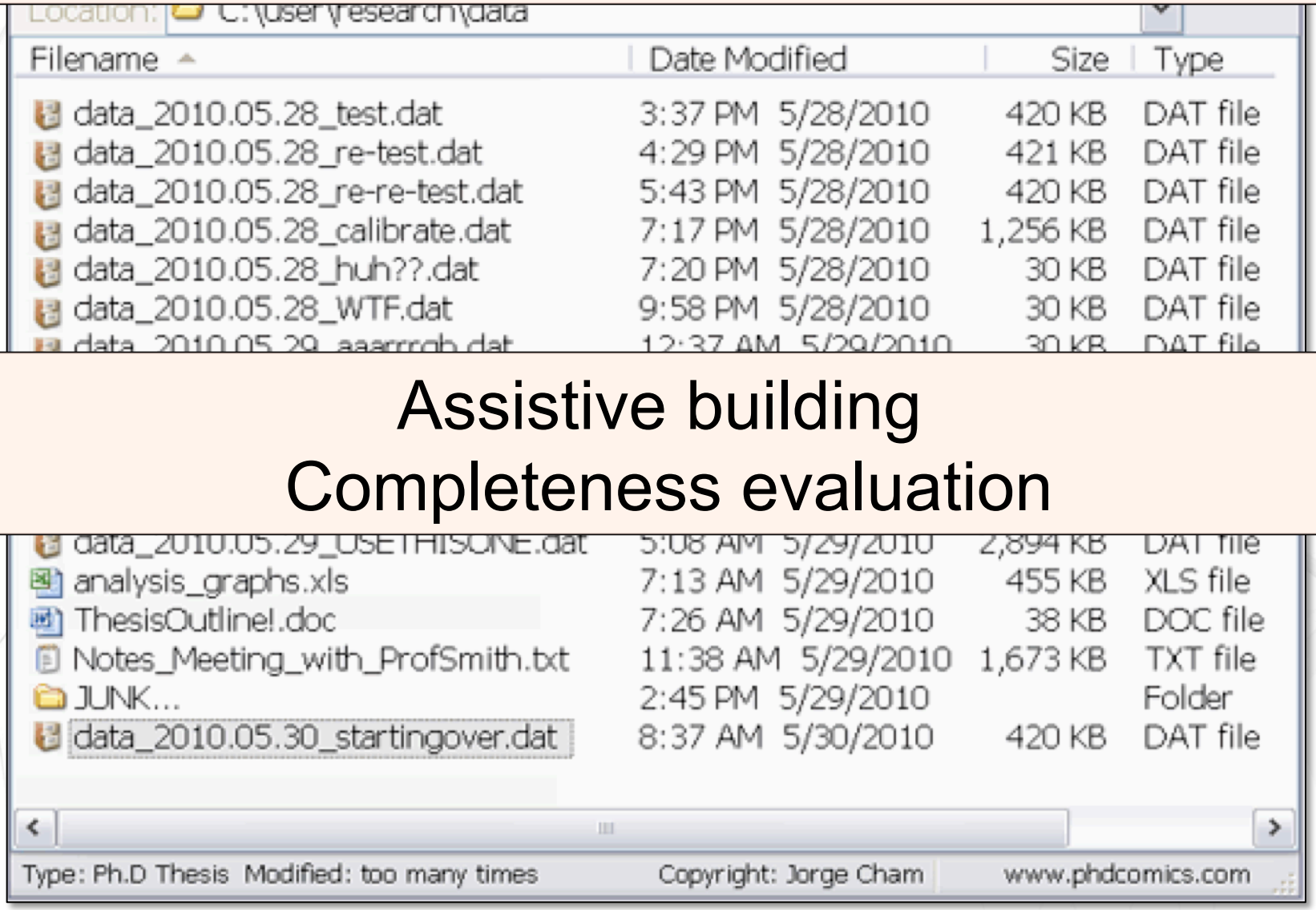


Hand-crafted workflows

Accessible
Shareable
Reusable
Adaptable
Understandable

- **Clarity** (workflows) for re-use and re-purpose **vs. automation** (pipelines)
- A black box is not **re-usable**, cannot be broken into parts
- **Reproducibility vs. industrial** paper publishing

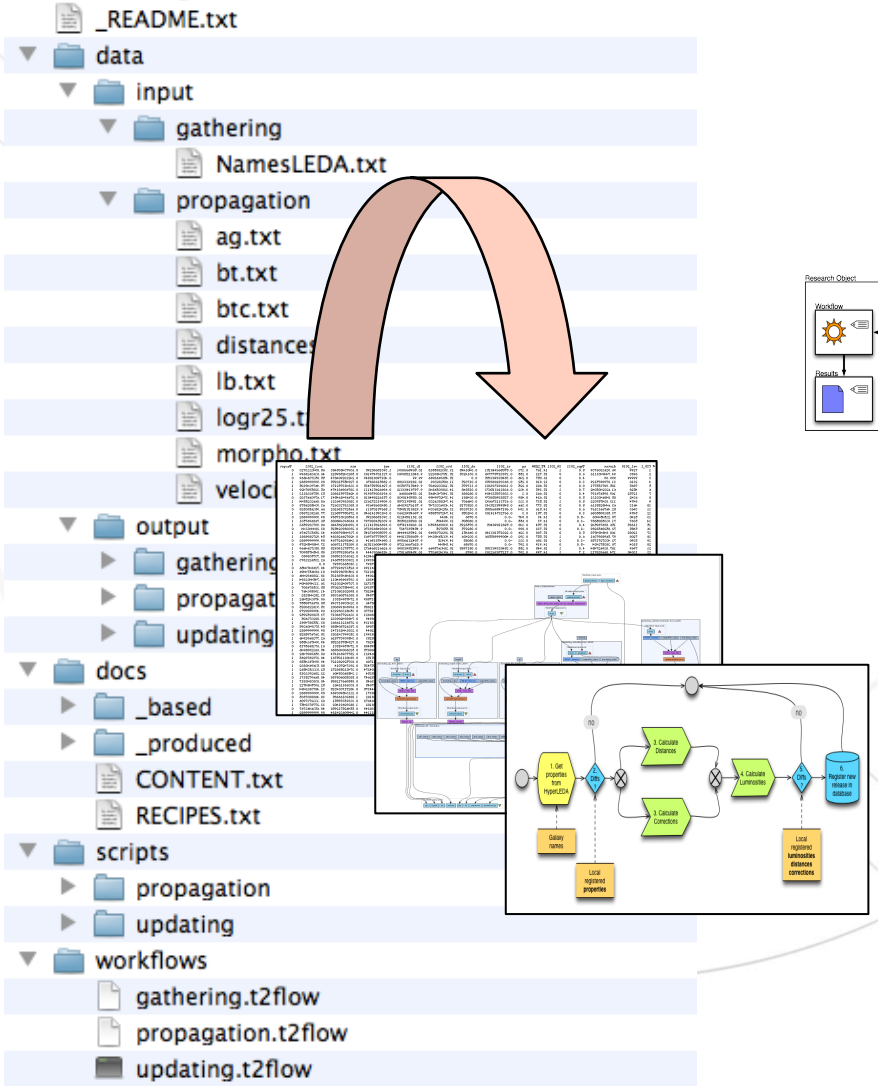
Going beyond automation: Organization

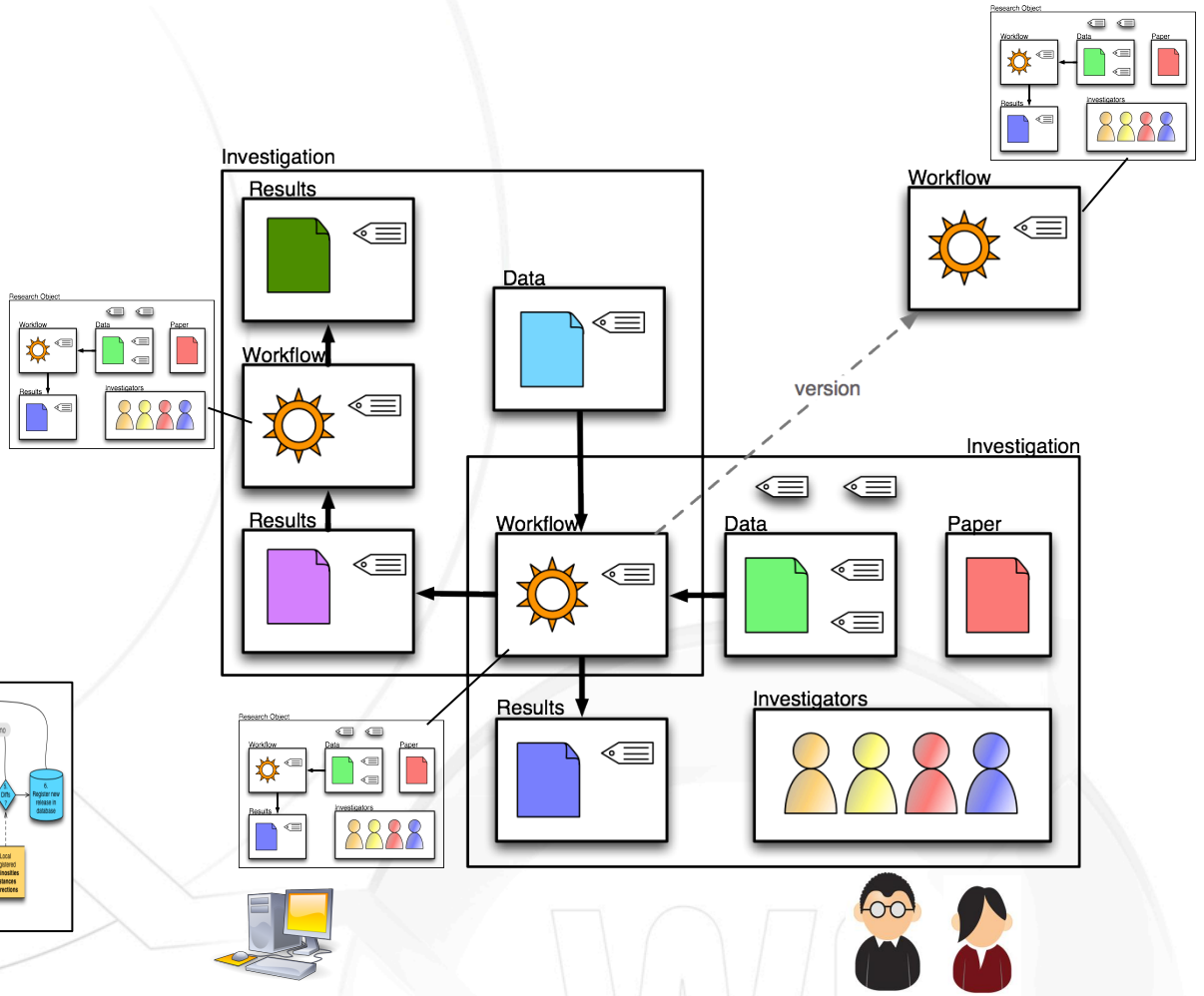


Assistive building
Completeness evaluation

Research Objects

Expose experimental context in a structured way in order to be understood





Technical Objects

Distributed

Social Objects

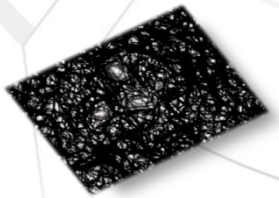
Similar initiatives in Astronomy

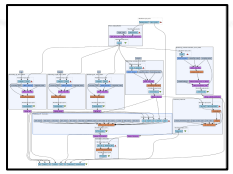
- **Semantic curation** of digital objects
  - CDS Centre Données Strasbourg
  - US Virtual Astronomical Observatory
  - SAO/NASA ADSLabs
- **Workflow users platforms**
  - Cyber-SKA
  - IceCore
  - Montage
  - Astro-WISE
  - Helio-VO
- **Auto descriptive Web Services**
  - Workflows VO-France
  - IVOA: S3, SimDAL, PDL

ADSLabs Initiative

ADO Linked Components

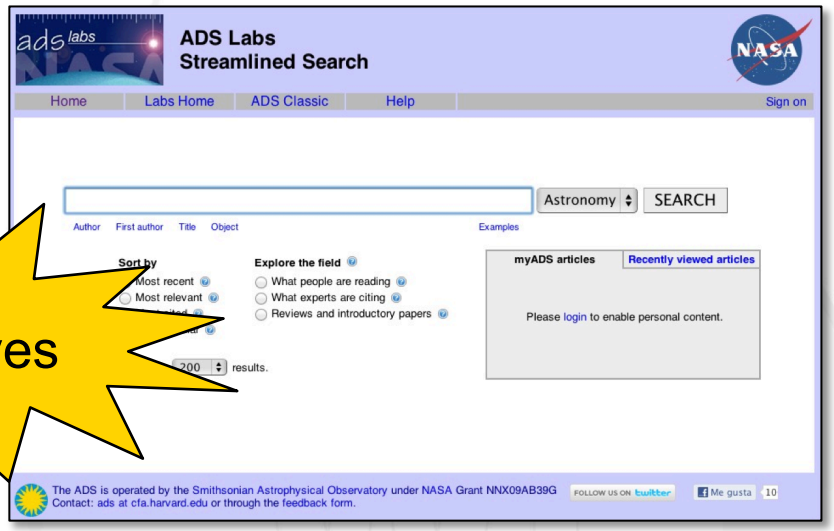
- Authors
- Publications
- Journals
- Objects SIMBAD
- Tabular data behind the plots CDS
- ASCL reference of used software
- Observing time Proposals
- Used facilities, surveys or missions





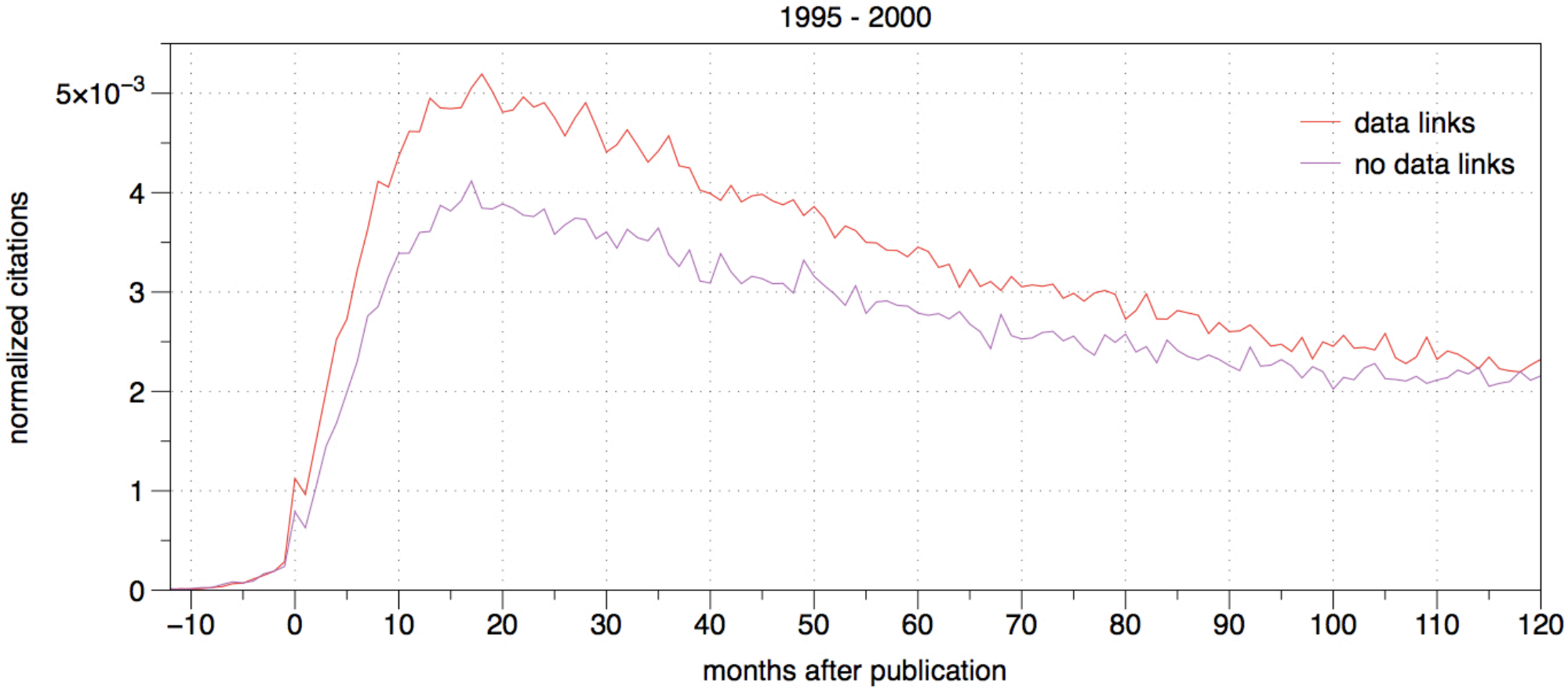
Incentives

http://labs.adsabs.harvard.edu/



The Incentive

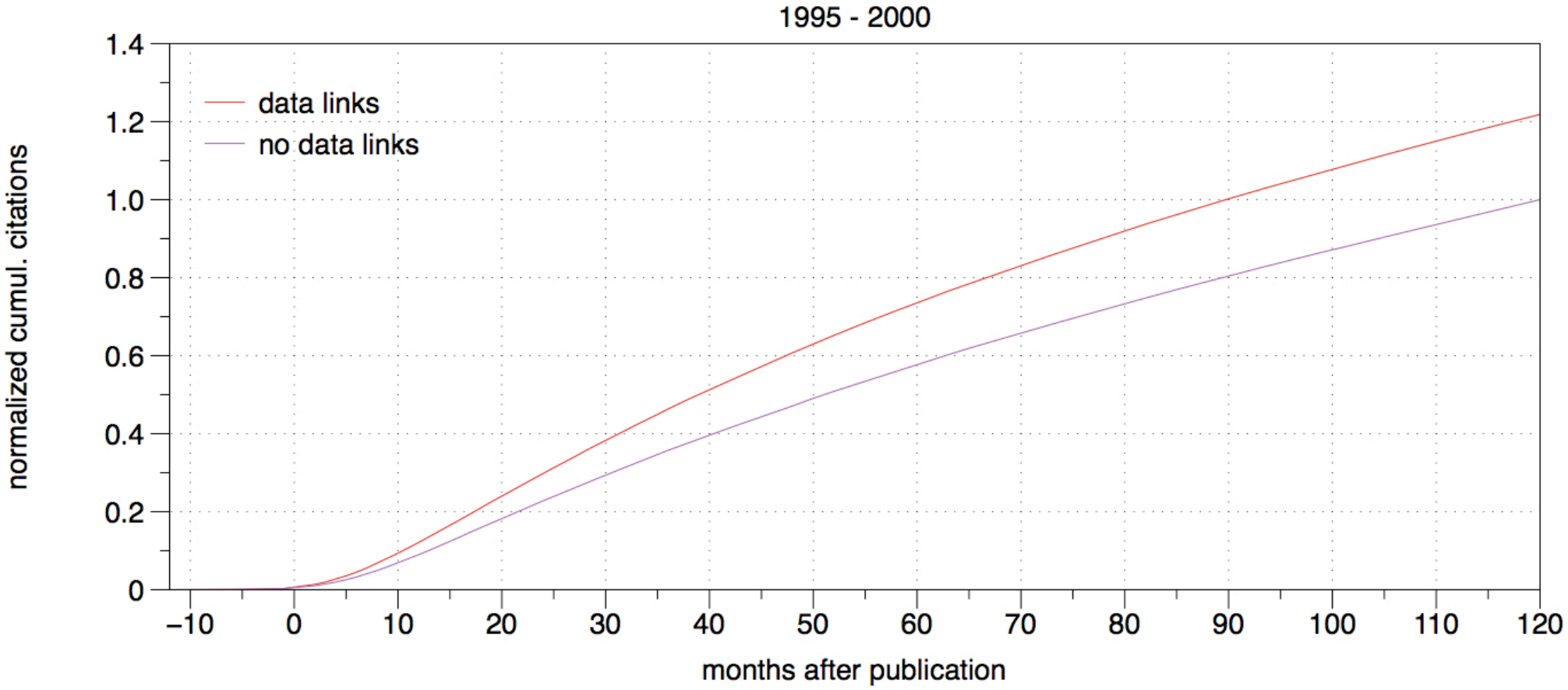
Papers with data links are cited more than those without



Effect of E-printing on Citation Rates in Astronomy and Physics 2006. Edwin A. Henneken et al.

The Incentive

Papers with data links are cited more than those without



Effect of E-printing on Citation Rates in Astronomy and Physics
2006. Edwin A. Henneken et al.

Community engagement

- **ADASS XXI** BoF Scientific Workflows in Astronomy
- Early contacts in **IVOA** for the creation of a community of users
- Interest **mailing list** in IVOA workflow@ivoa.net
- Draft of IVOA **Note** on Workflows
- Collaboration with **ADSLabs**

- Interested potential collaborators
  - Workflows VO France
  - VAMDC EU FP7 Project
  - Helio VO
  - Spanish VO

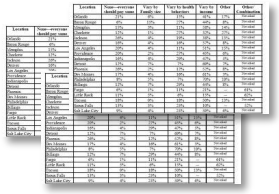
- AstroTaverna Starter Pack
- Seminars, Webinars, Workshops and Schools

The Wf4Ever Project

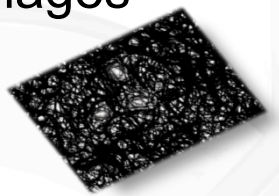
» Development of **AstroTaverna plugins** to access and manage VO data

» Development **Golden Exemplars** of astrophysical Workflows and Research Objects that use the Wf4Ever technological support

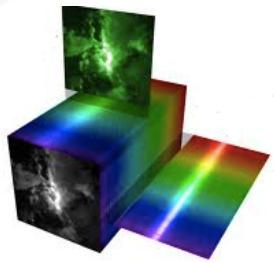
› **Curation** of physical quantities in 1D catalogues
- Data retrieved from external repositories and stored locally
- Only local processes for calculations



› **Environment and Modelling** from 1D catalogues and 2D images
- Data retrieved from external repositories (SDSS DR7)
- Local software and external web services as processes

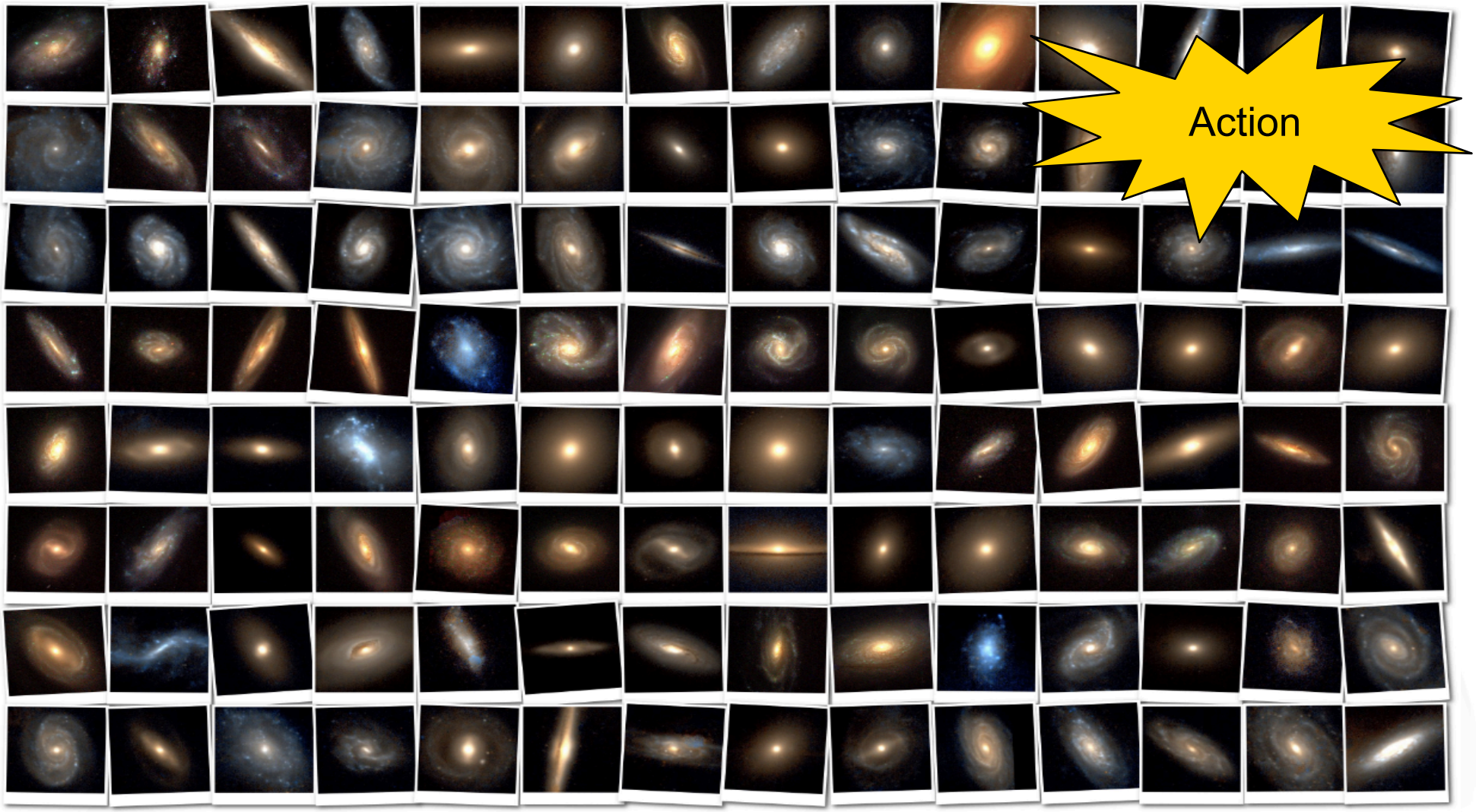


› **Modelling and Analysis** of 3D formatted data
- Only external data and processes



Astronomical Research Objects in Action

Curation by inspecting propagation of changes in quantities



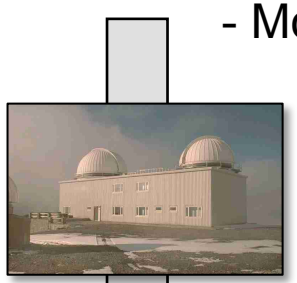
Credit: Zsolt Frei and James E. Gunn. The Galaxy Catalog

AMIGA Catalog

Panchromatic properties for a sample of the most isolated nearby galaxies

How is the User DB affected ?

- Changes in External DB
- Modifications in Calculations



Evaluate variations with time

- Modified External Quantities
- Affected User DB Quantities

Update

External DB

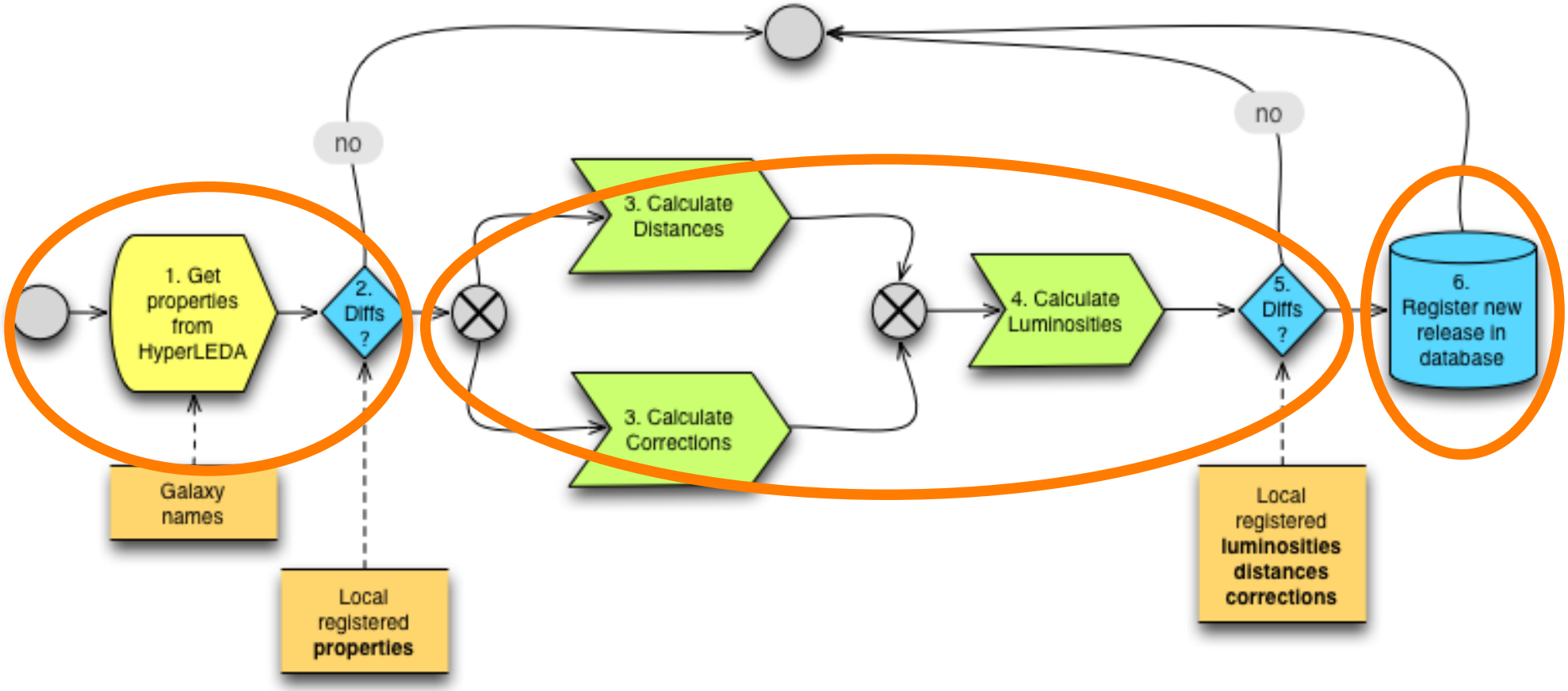
Calculations

User DB

Astronomical Research Objects in Action

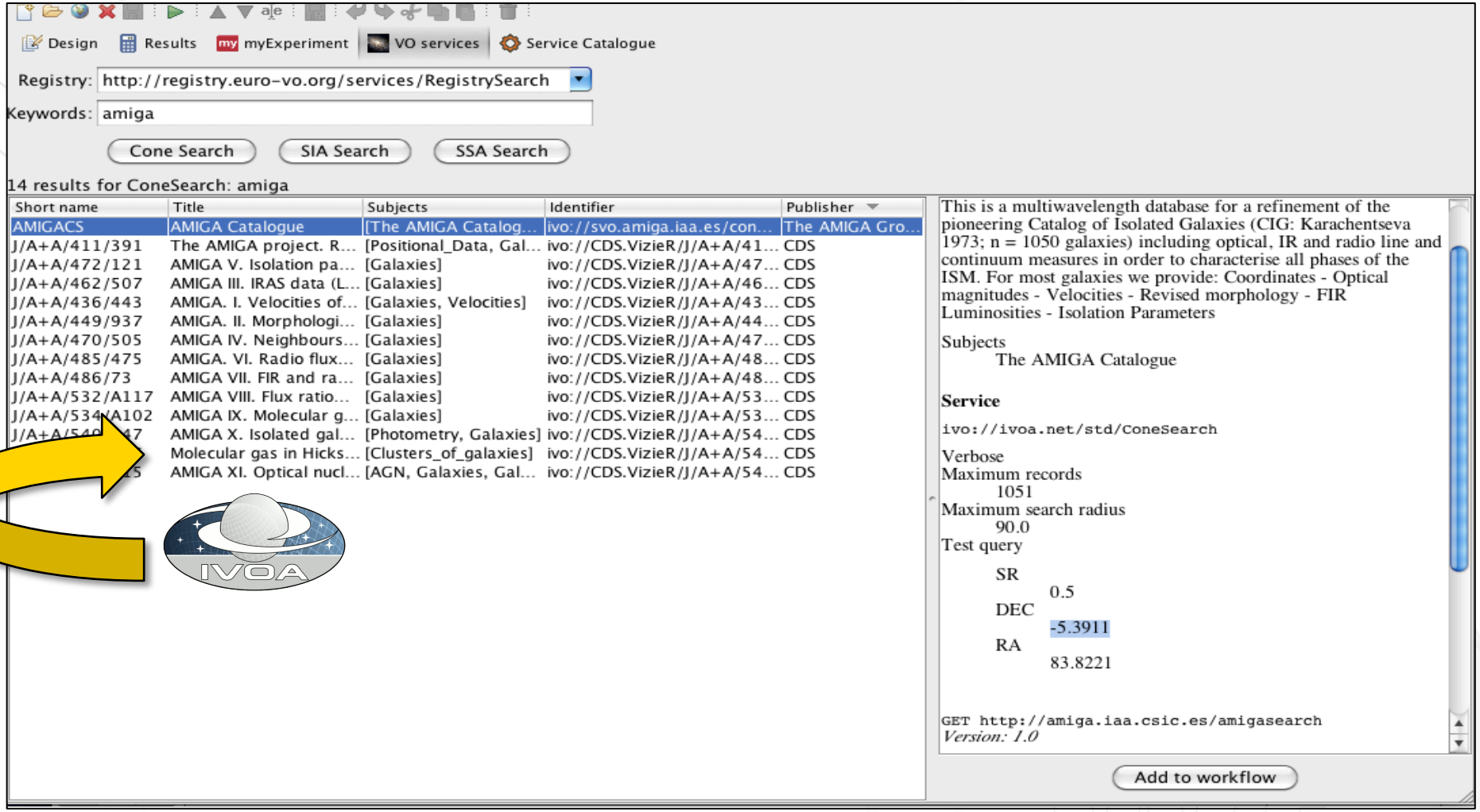
Curation by inspecting propagation of changes in quantities

Multi-workflow Research Object



Astronomical Research Objects in Action

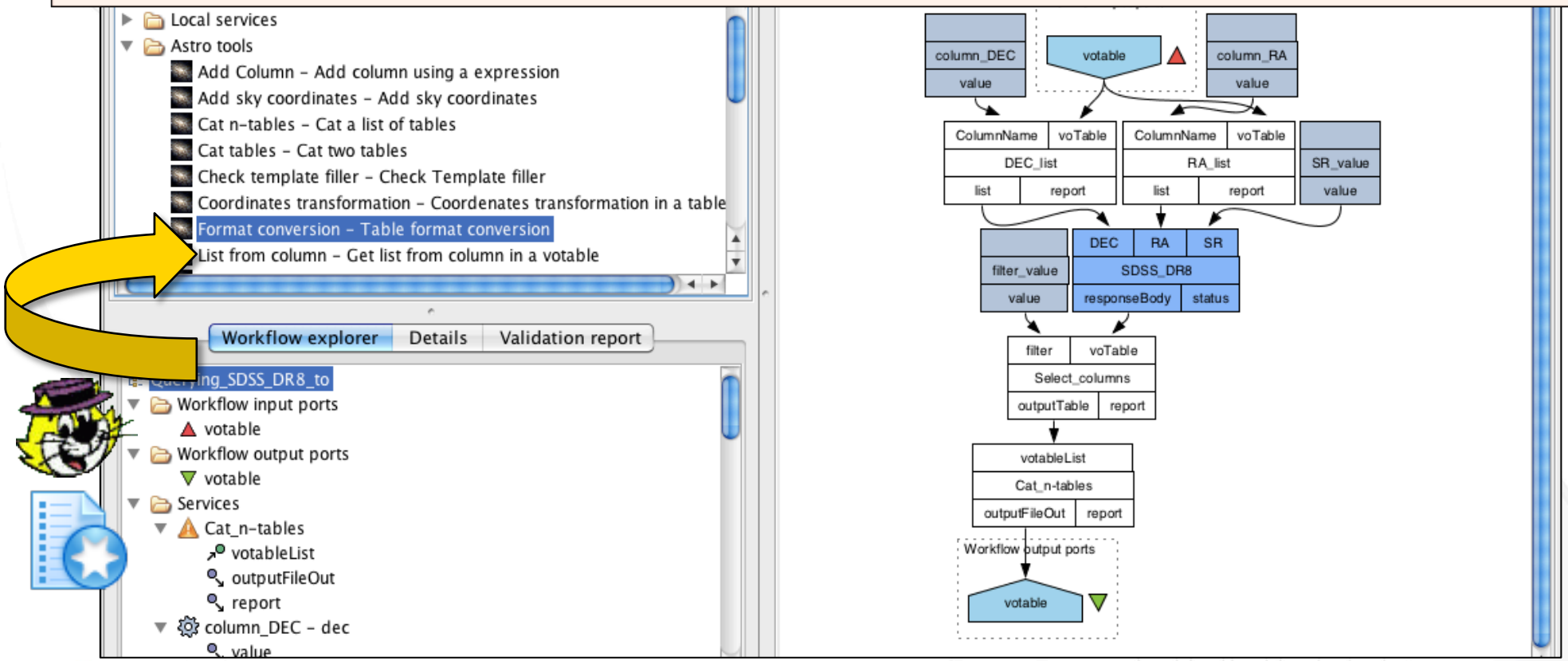
AstroTaverna: Create, annotate and run a workflow



http://amiga.iaa.es/p/290-astrotaverna.htm

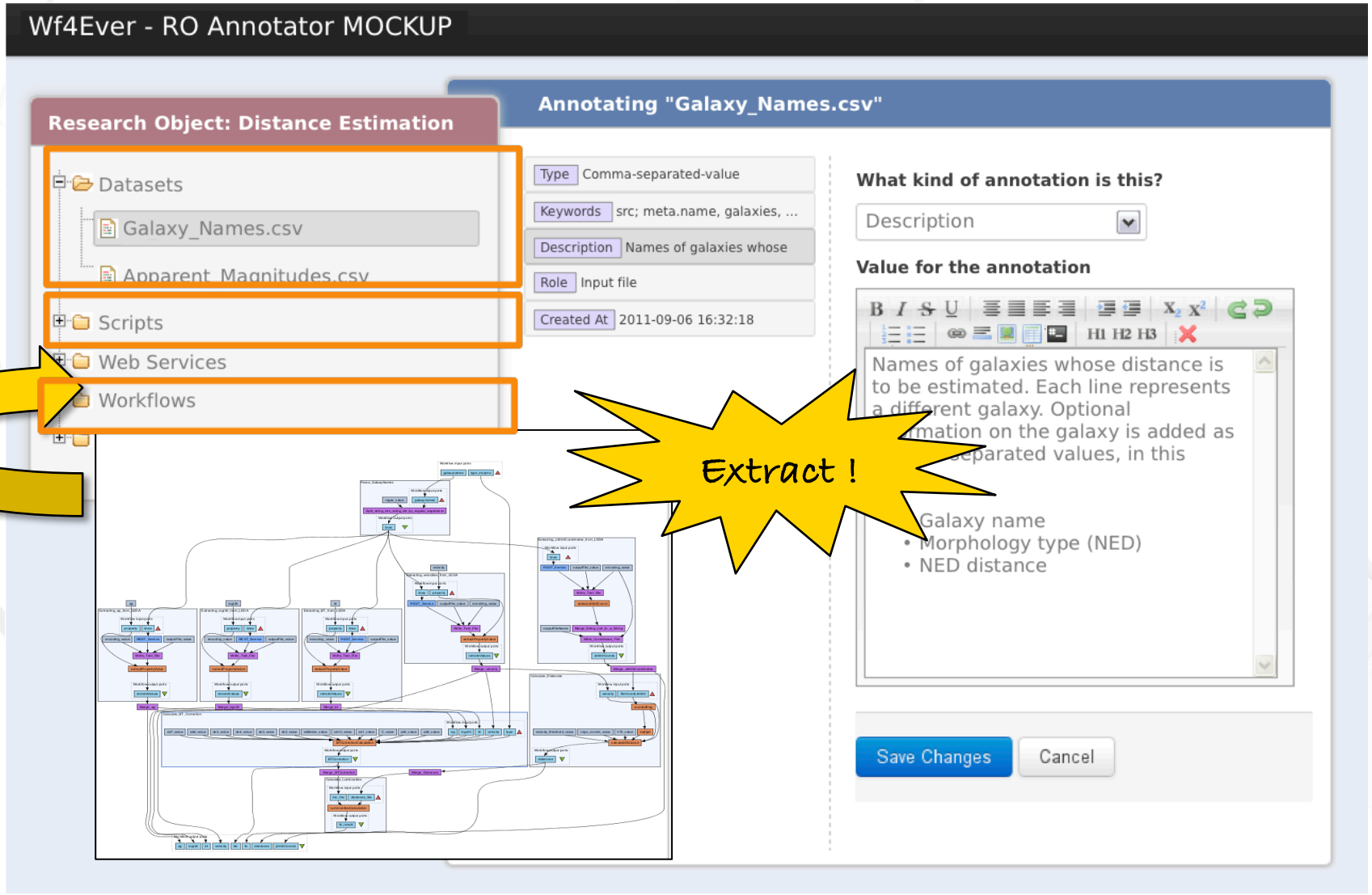
Astronomical Research Objects in Action

Registers Provenance
Orchestration of Tasks and Dependencies
Improves Clarity and Reproducibility

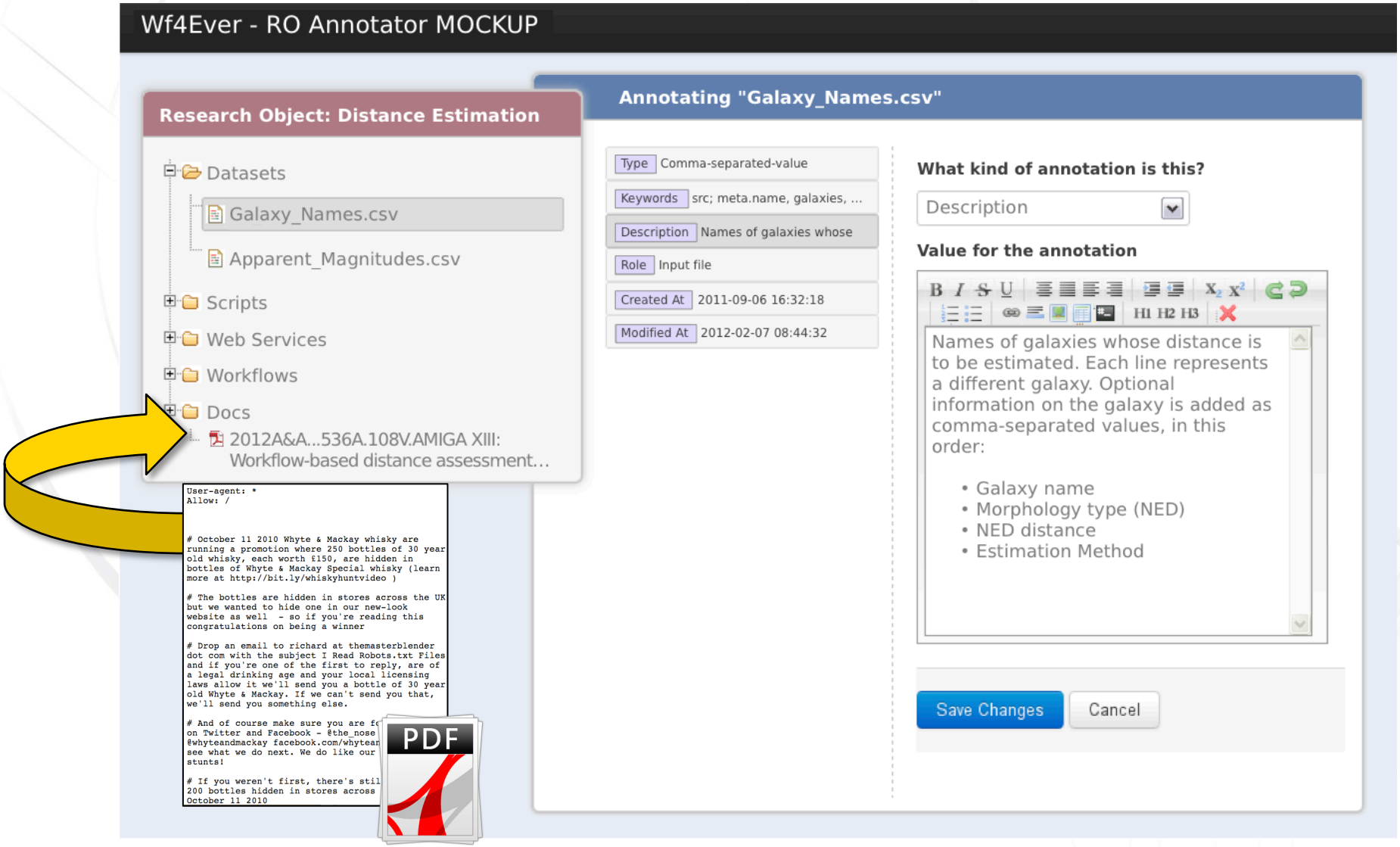


http://amiga.iaa.es/p/290-astrotaverna.htm

Populate the Research Object and annotate

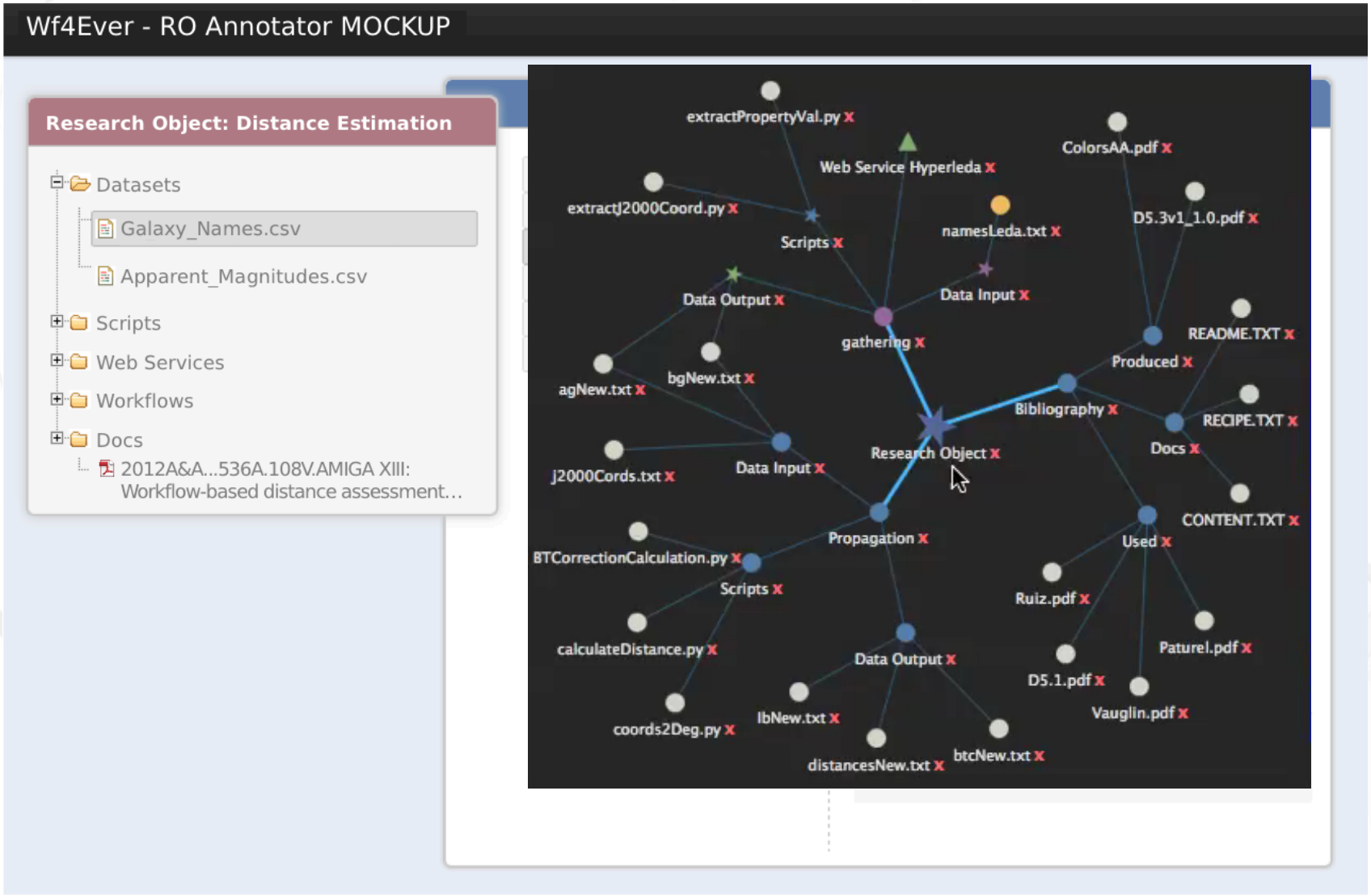


Add documents and references

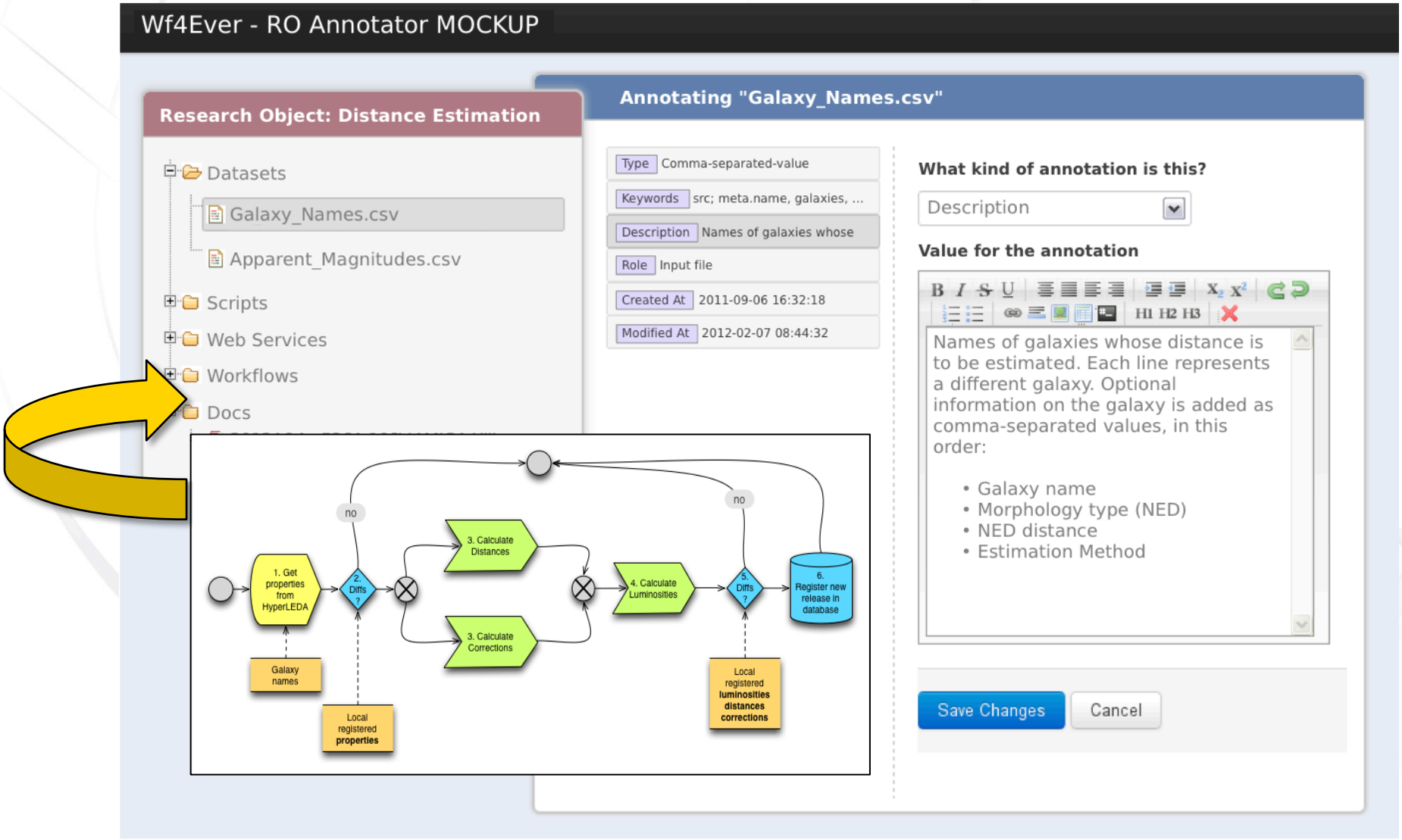


Astronomical Research Objects in Action

Create and explore relations among components

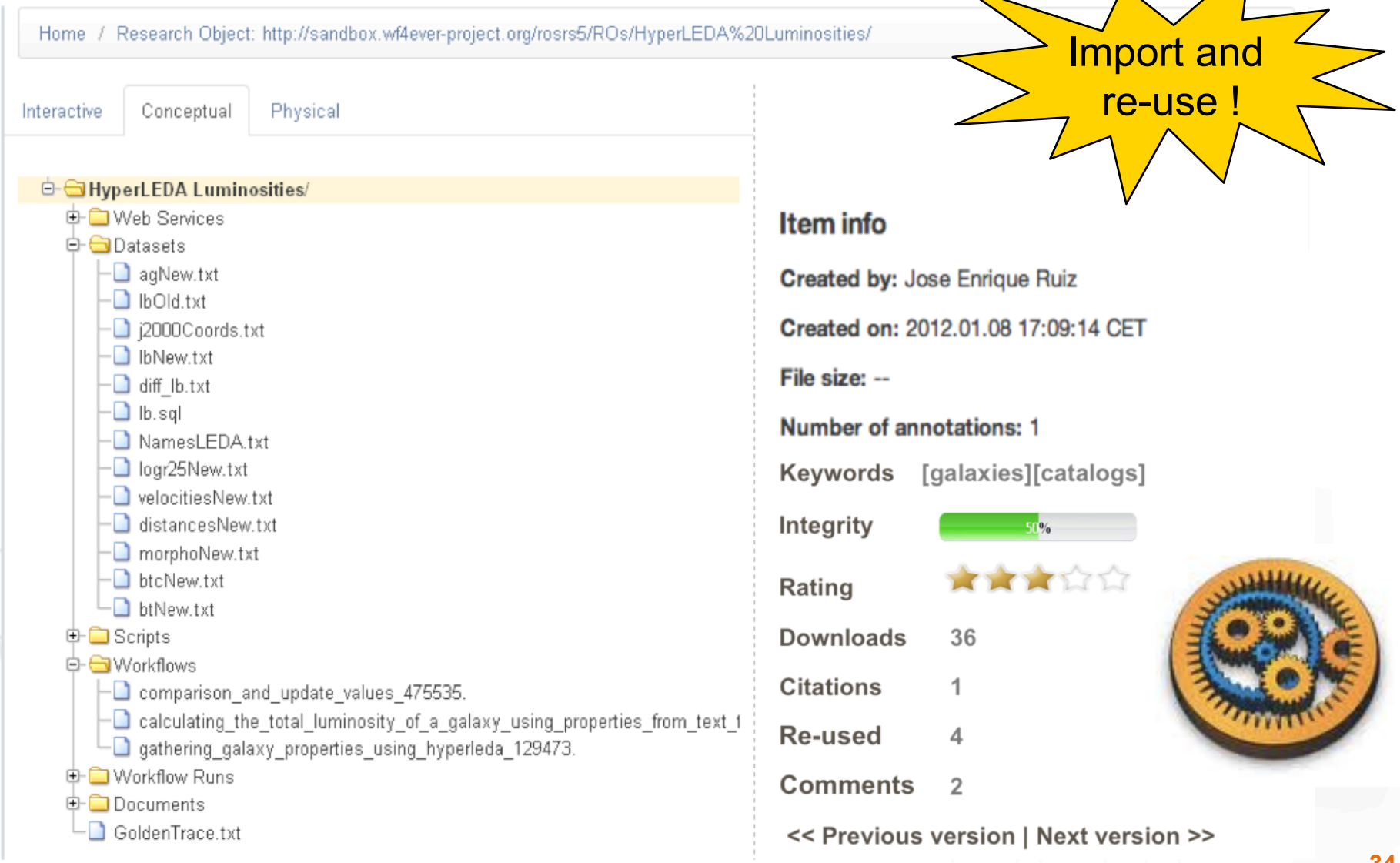


Add schema of the experiment



Astronomical Research Objects in Action

Publication for later discovery



Astronomical Research Objects in Action

Curation by inspecting propagation of changes in quantities

- Taverna 2.4
- MyExperiment Pack
  - *http://www.myexperiment.org/packs/231*

Related Publication

The AMIGA sample of isolated galaxies X. A First Look at Isolated Galaxy Colors

2012 A&A 540, A.47

How NOT to be a good Astronomer

1. Write a obscure paper, do not say clearly how to reproduce the results
2. Do things quickly and forget about them once you've submitted the paper
3. Be untidy, spread your code and data in a variety of formats, folders and disks
4. Do not provide data results, including the plots is just fine
5. Practise the "data mine-ing" – input data are mine
6. Practise the "data flirting" – I want you to call me, if you want more
7. Always cite the same authors and papers or those that cite you
8. Do not reference other resources than published papers, never provide URL links
9. Do not search info on Internet with other tools than ADS or arXiv
10. Do not contact others, just duplicate and reinvent for your own what you may find

http://amiga.iaa.es/p/212-workflows.htm
http://www.wf4ever-project.org
jer@iaa.es