



MMODA multi-messenger data analysis platform

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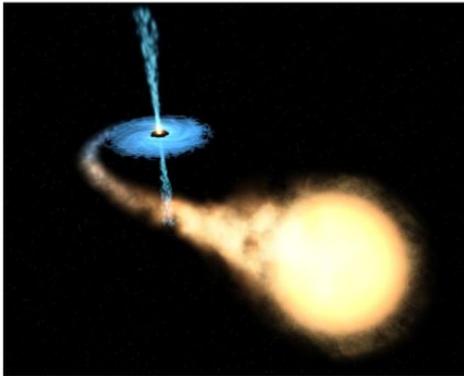
Multi-Messenger Astronomy

Exploding field!

Last decade key **new observables** were discovered, and conventional telescopes dramatically upgraded to match.

Number of alerts and **volume of data** we deal with **increased by couple orders of magnitude in the last years**, and several nearly-ready telescopes promise another comparable increase

Star and black hole



"Just" a star



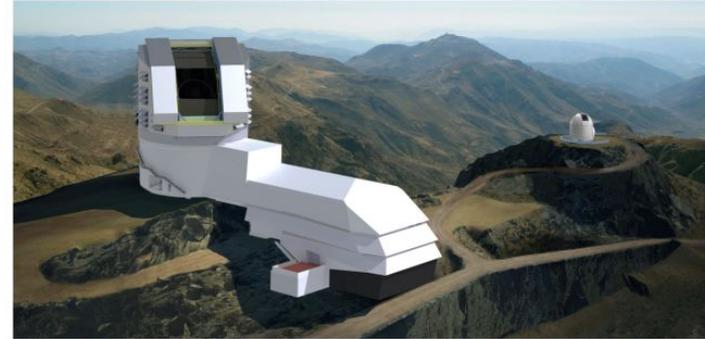
Two neutron stars



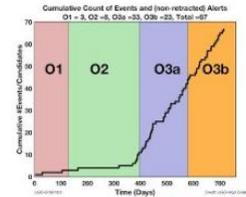
Radio



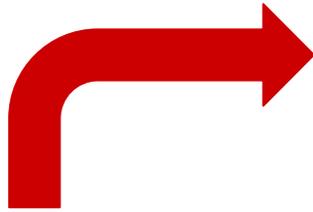
Visible



Gravity

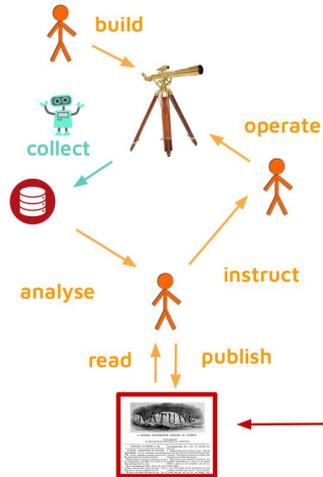


Evolution of astronomy



Mostly-human Astronomy

- Reaction to sky: **slow**
- Reaction to papers: **slow**
- Trials (p-hacking): **uncontrolled**
- Publishing: **slow**
- Scalability: **bad**
- Creativity: **high**
- Communication: **nuanced but imprecise and slow**

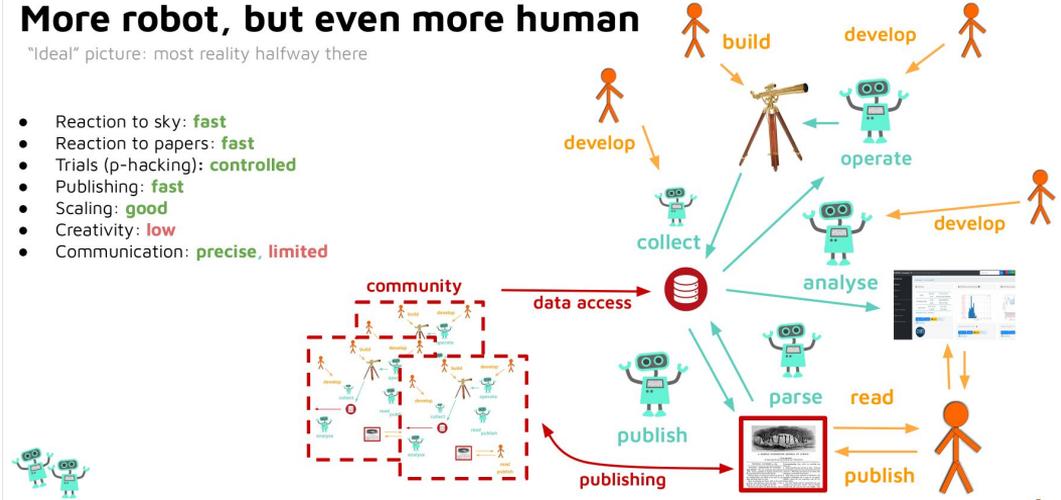


Human reaction and processing **is slow**, even if it's within even one person. But people are **smart**

More robot, but even more human

"Ideal" picture: most reality halfway there

- Reaction to sky: **fast**
- Reaction to papers: **fast**
- Trials (p-hacking): **controlled**
- Publishing: **fast**
- Scaling: **good**
- Creativity: **low**
- Communication: **precise, limited**



- **Making smart robots is hard**: always lacking **developers who are also research scientists**.
- If all is automated, **scientists have hard time seeing what's going on**, since **they do not speak robot**
- Robots are **fast**, but **lack creative reaction** in **new situations**.



MMODA: a tool for exploring, transforming MM data

<https://mmoda.io>

MMODA Multi-Messenger Online Data Analysis

UNIVERSITÉ DE GENÈVE FACULTÉ DES SCIENCES

ISDC EPFL KAU

Object name *
gw170817 Resolve

Name resolved by local resolver:

RA * 197.45035416666664 Dec * -23.38148416666667

Start time * 2017-08-17T12:40:59.400 End time * 2017-08-17T12:41:14.400 Time unit ISO/ISO1

INTEGRAL ISGRI INTEGRAL JEM-X INTEGRAL SPI-ACS Polar Antares GW LegacySurvey

Instrument query parameters :

Detector H1

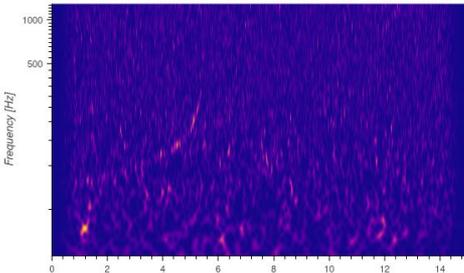
Product Type
 Skymap & Catalog
 Strain time series
 Spectrogram

Lower Q 4 Upper Q 64

Submit

Download Query parameters Log Share API code View on Renku

Sig. Range: -0.29 .. 21.51

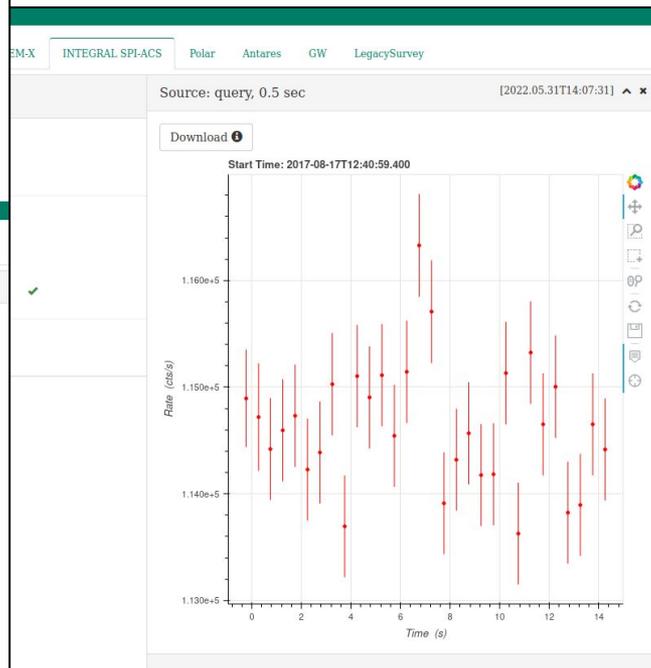


Frequency [Hz]

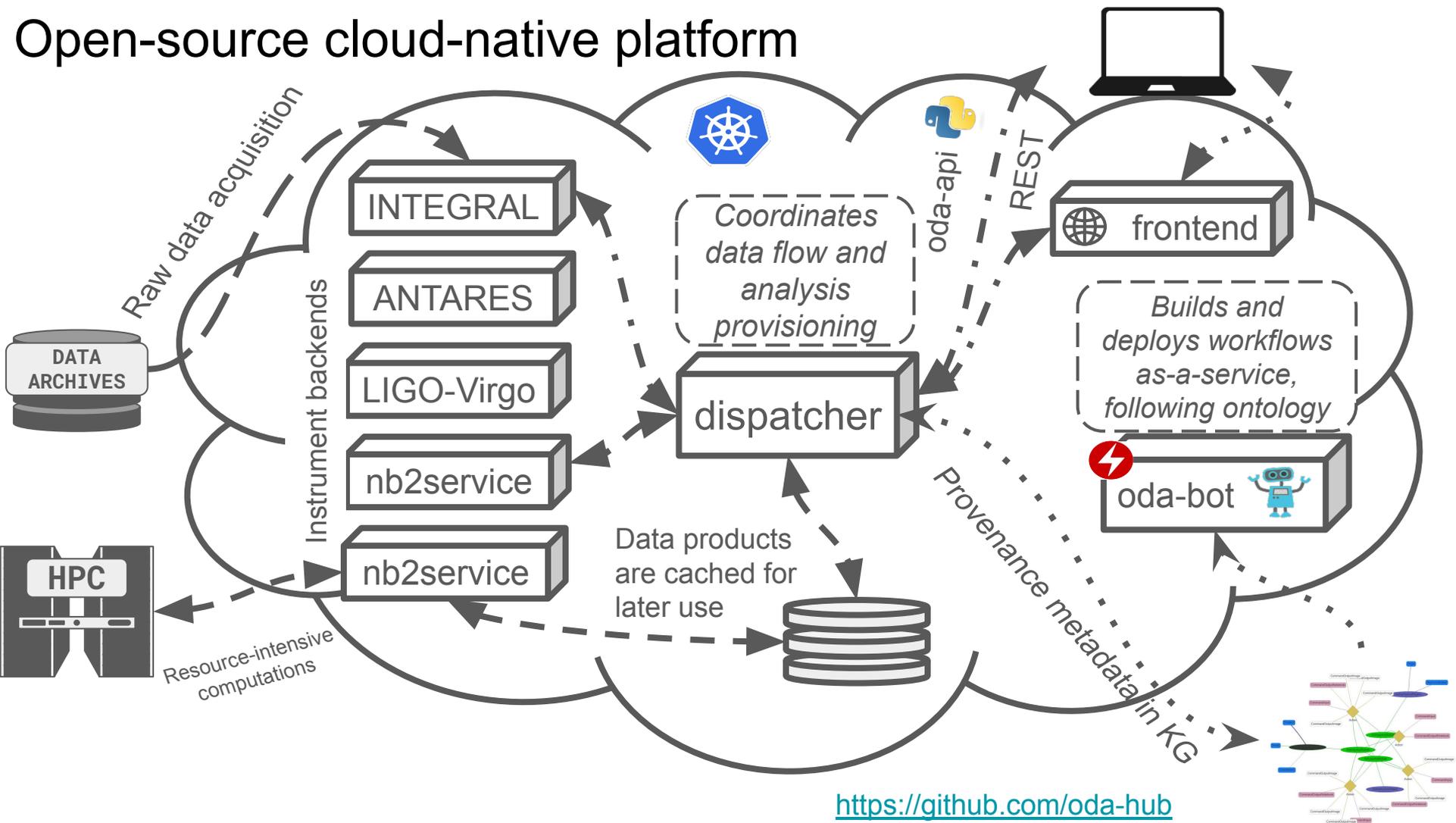
Time [seconds] from 2017-08-17 12:40:59 UTC (1187008877.0)

MMODA

Multi-Messenger Online Data Analysis



Open-source cloud-native platform



Development space: help scientists make robots

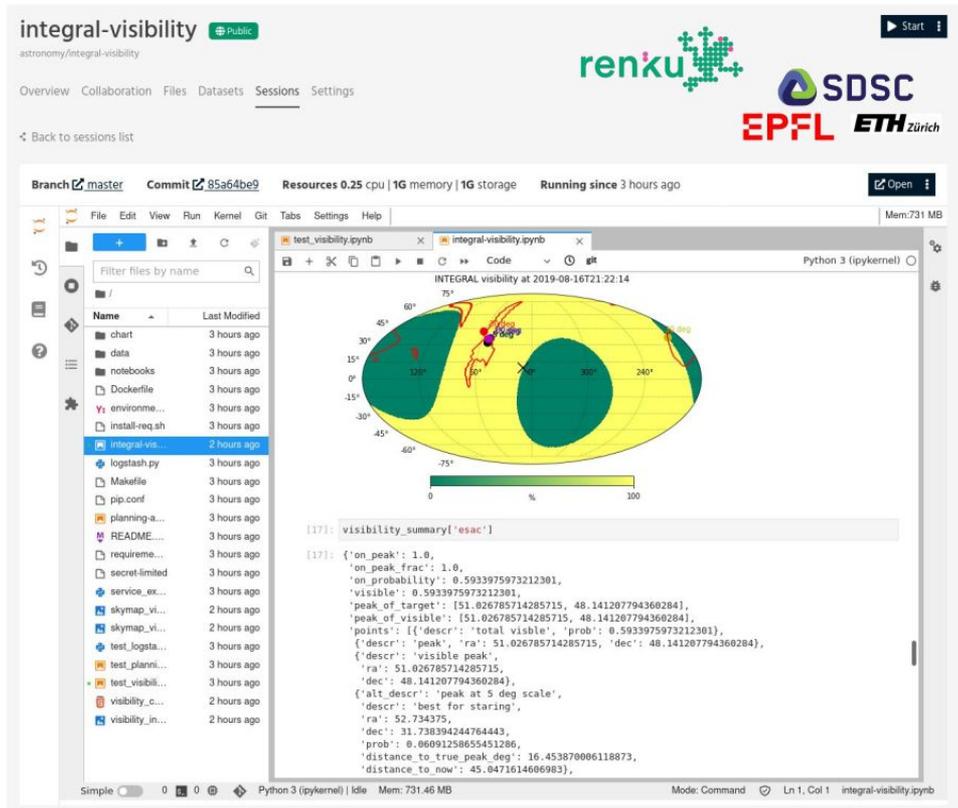
There are much more scientists who can make a Jupyter notebook than write organized code.

JupyterHub(s), Google-collab, ESA DataLabs, [Renku](#)

- Continuous integration and testing
- Supports in publishing of data and code (e.g. in zenodo)
- Support in annotation for scientists and robots reuse with ontology terms

Developing and integrating metadata in a Knowledge Graph

This process creates a collection of notebooks and other workflows, but they are only really accessible interactively one-by-one



The screenshot shows a Jupyter Notebook environment for a project named 'integral-visibility'. The interface includes a top navigation bar with 'Overview', 'Collaboration', 'Files', 'Datasets', 'Sessions', and 'Settings'. Logos for 'renku', 'SDSC', 'EPFL', and 'ETH zürich' are visible. The notebook is running on a 'master' branch with commit '95a64be9', using 0.25 CPU, 1G memory, and 1G storage, and has been running for 3 hours. The left sidebar shows a file explorer with various files and folders, including 'chart', 'data', 'notebooks', 'Dockerfile', 'environment...', 'install-req.sh', 'integral-vis...', 'logstash.py', 'Makefile', 'pip.conf', 'planning-a...', 'README...', 'requireme...', 'secret-limited', 'service_ext...', 'skymap_v...', 'skymap_v...', 'test_logsta...', 'test_pianni...', 'test_visibil...', 'visibility_c...', and 'visibility_in...'. The main notebook area displays a plot titled 'INTEGRAL visibility at 2019-08-16T21:22:14'. The plot is a circular map of the sky with a color scale from 0 to 100%. A red dot is marked on the map, and a legend below it shows 'visibility_summary[\'esac\']'. The code cell below the plot shows a dictionary of visibility data:

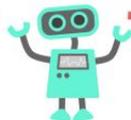
```
[17]: visibility_summary['esac']
[17]: {'on_peak': 1.0,
'on_peak_frac': 1.0,
'on_probability': 0.5933975973212301,
'visible': 0.5933975973212301,
'peak_of_target': [51.026785714285715, 48.141207794360284],
'peak_of_visible': [51.026785714285715, 48.141207794360284],
'points': [{'descr': 'total visible', 'prob': 0.5933975973212301},
{'descr': 'peak', 'ra': 51.026785714285715, 'dec': 48.141207794360284},
{'descr': 'visible peak',
'ra': 51.026785714285715,
'dec': 48.141207794360284},
{'alt_descr': 'peak at 5 deg scale',
'descr': 'best for staring',
'ra': 52.734375,
'dec': 31.738384244764443,
'prob': 0.06091258655451286,
'distance_to_true_peak_deg': 16.453870006118873,
'distance_to_now': 45.0471614666983}]
```

Feedback loop for crowd-sourcing workflow catalog

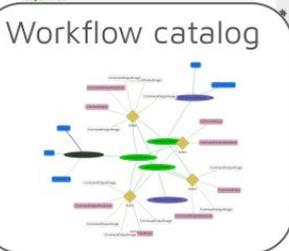


Scientist develops data reduction with deep scientific expertise

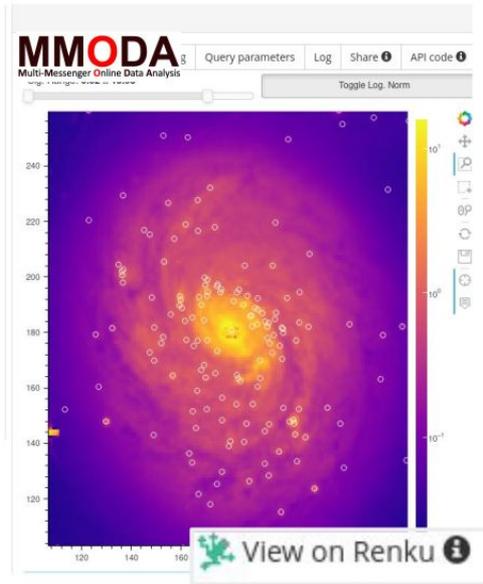
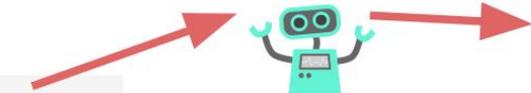
Publishing renku workflow as discoverable and executable asset



The screenshot shows the Renku web interface. At the top, there's a navigation bar with 'Overview', 'Collaboration', 'Files', 'Datasets', 'Sessions', and 'Settings'. Below that, a 'Back to sessions list' link is visible. The main area shows a workflow editor with a file explorer on the left and a code editor on the right. The code editor contains Python code for a workflow, including comments and function definitions. The file explorer shows a list of files and folders, with 'Legacy' selected.

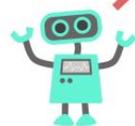


Workflow catalog



The screenshot shows a Renku notebook interface. At the top, there's a header with 'Renku' and 'Notebook automatically generated from MMODA'. Below that, there's a code editor with Python code. At the bottom, there's a 'new workflow' button with a small galaxy image next to it.

new workflow



Automated workflow testing, benchmarking, reaction to space events, etc



Scientist creates new workflow leveraging the existing one

Résumé

- L'astronomie multimessagère traite des grands volumes de données et nécessite une automatisation intelligente pour réagir rapidement et assurer la réutilisation et la reproductibilité.
- Nous développons la plateforme open-source, native du cloud, pour l'analyse de données multimessagers en ligne – MMODA.
- Nous établissons un écosystème centré autour de la plateforme MMODA, qui permet la création de flux de travail FAIR via le crowdsourcing.

Merci pour votre attention !

Plus de détails sur le poster

It's time for questions