



Australia's Scalable Drone Platform – What it is, Lessons Learnt, Moving Forward

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MINERAL RESOURCES

www.csiro.au



AuScope



MONASH
University



Australian Research Data Commons





We acknowledge the Traditional Owners of the land, sea and waters, of the area that we live and work on across Australia. We acknowledge their continuing connection to their culture and we pay our respects to their Elders past and present.

Agenda

- Introduction and goals of the session (5 min)
- Introduction to the Australian Scalable Drone Cloud project (15 min)
- Use case examples (15 min)
- Discussion topics (25 min)
 - Building a better Australasian network
 - What capabilities would everyone like to see from ASDC?
 - Where are the gaps in existing tools/platforms
 - Existing workflows for new use-cases?
 - How to make use of synergies between projects in Australian and abroad
 - *Your topic here!*



Shared BoF notes
tinyurl.com/37ynu29u



Australian Scalable Drone Cloud

A national platform for drone research

Why do we need a national drone platform?

UAV's enable near-real-time monitoring to address the critical scale-gap between ground- and satellite-based observations but...



Issue 1: Measurements are not data and data is not knowledge

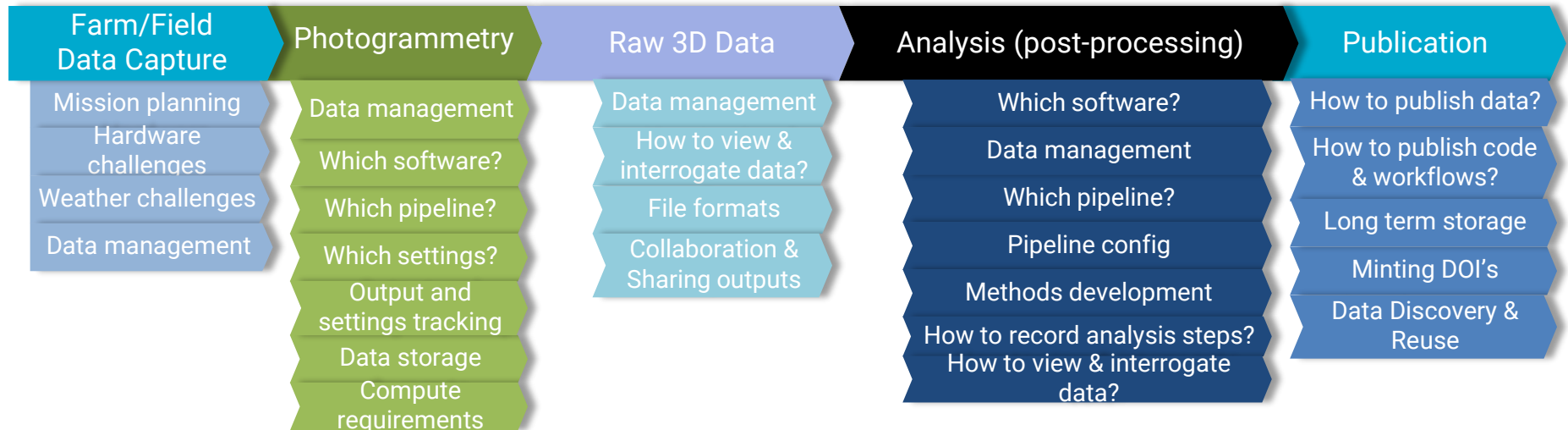
The Vision: *Better technology = better data = improved knowledge*

Measurements

Data

Knowledge

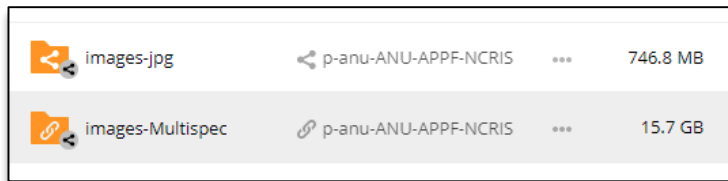
Reality: *Better technology = more complexity*



For most applications, drone data is only a supporting component - Multitude of other data to integrate as well

Issue 2: Everything about working drone data and processing pipelines is hard!

- Drone and 3D Geospatial time-series data are:
 - Large and hard to work with (and getting larger and harder to work with)



images-jpg	p-anu-ANU-APPF-NCRIS	...	746.8 MB
images-Multispec	p-anu-ANU-APPF-NCRIS	...	15.7 GB

<- 5Ha RGB flight, 750mb, 800 jpg's

<- 5Ha Multispectral flight = 15.7GB, 4,000 TIF files (20x larger)

- Processing workflows are complex; bespoke; often developed in-house
 - Expensive to develop, not easily shared / reused
- Data not often/easily managed according to FAIR principles
 - FAIR data = Findable, Accessible, Interoperable, and Reusable¹

1. [nature.com/articles/sdata201618](https://www.nature.com/articles/sdata201618)

Issue 3: Published solutions are rarely immediately re-usable by others

- Many pubs report an in-house “solution”; few provide that capability to the reader
- Have you actually “solved” anything if no one else can make use of the solution?
- Solve once for everyone:

Our work should be able to start where the last work finished; not have to re-implement the entire pipeline first

- Re-usability needs to become a community expectation

Research Article | Published: 07 January 2023

An integ



Fine sca
coastal
multisp

Open Access Article

Mapping Riparian Habitats Individual Tree Level Using

by Elena Belcore ^{1,*} Marco Pi
 Michele Lonati ²

¹ DIATI, Department of Environment, Land
Abruzzi, 24, 10129 Torino, Italy

² DISAFA, Department of Agricultural, For
10035 Grugliasco, Italy

* Author to whom correspondence should

Remote Sens. 2021, 13(9), 1756; <https://doi.org/10.3390/rs13091756>

Open Access Article

A Tree Species Mapping Method from UAV Images over Urban Area Using Similarity in Tree-Crown Object Histograms

by Xiaoxue Feng and Peijun Li *

Institute of Remote Sensing and GIS, School of Earth and Space Sciences, Peking University, Beijing 100871,
China

* Author to whom correspondence should be addressed.

Remote Sens. 2019, 11(17), 1982; <https://doi.org/10.3390/rs11171982>

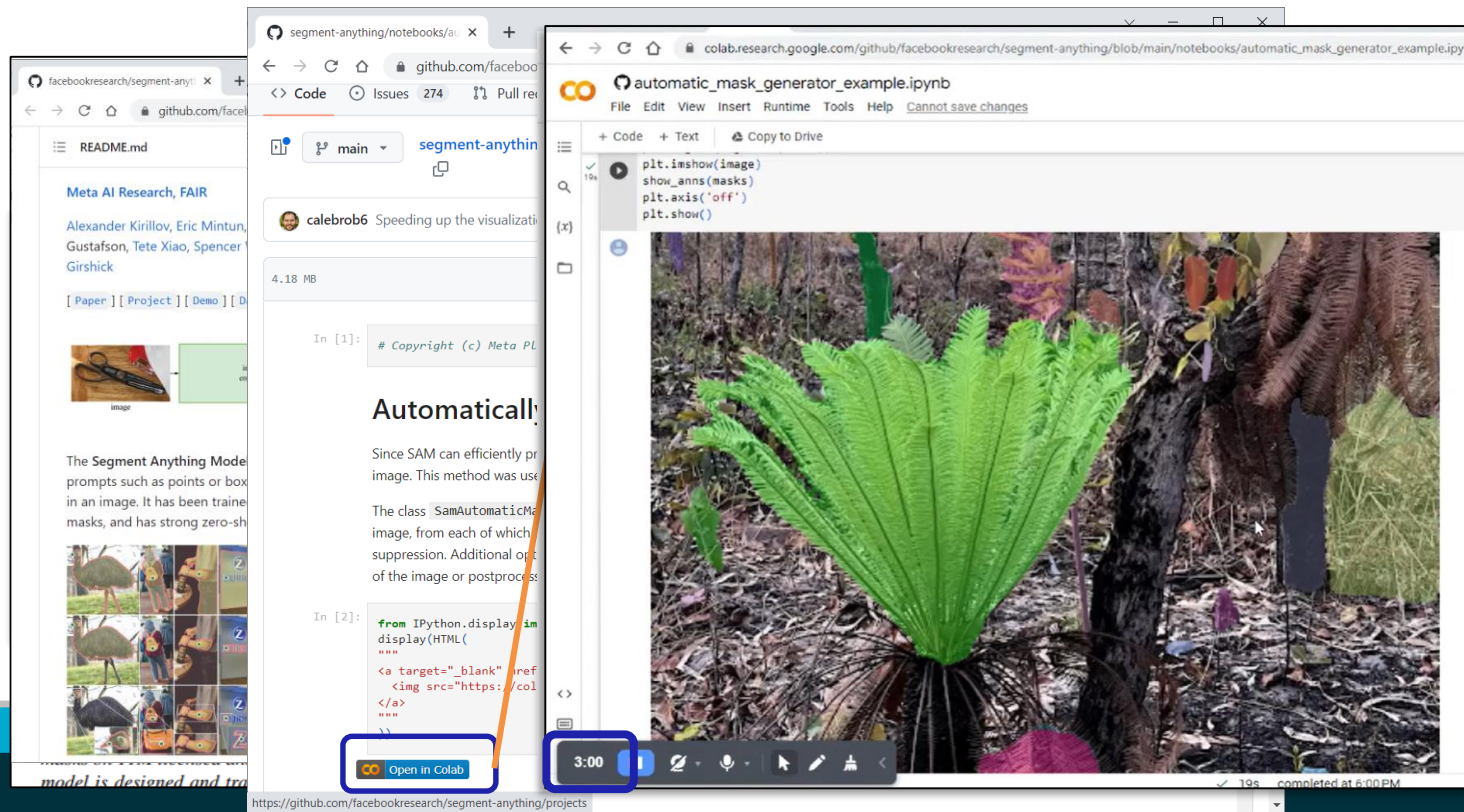
Received: 17 July 2019 / Revised: 15 August 2019 / Accepted: 18 August 2019 / Published: 22 August 2019



Community standards + Reusable code + Cloud infrastructure = immediate re-use of capability!

Example: Segmenting images – Long standing computer vision challenge

Meta's "Segment Anything" code: Apply an advanced ML segmentation model on your images with a \$15K GPU for free in < 3 minutes from publication.



The image shows a composite screenshot of a web browser. On the left, a GitHub repository page for 'facebookresearch/segment-anything' is visible, featuring a README with a grid of segmented images and a 'Demo' link. The main part of the screenshot is a Google Colab notebook titled 'automatic_mask_generator_example.ipynb'. The notebook interface shows a code cell with the following Python code:

```
plt.imshow(image)
show_anns(masks)
plt.axis('off')
plt.show()
```

Below the code, a large image of a green fern is displayed, with a black bounding box around its stem and a red bounding box around its fronds. The notebook's execution bar at the bottom shows a timer at 3:00 and a status of 'completed at 6:00 PM'. A blue box highlights the 'Open in Colab' button at the bottom left of the notebook interface.

Issue 4: Much of modern data isn't FAIR w/out platforms to support (re)use

For large, 3D and time series data: Being able to see & interact with data is essential to access

- Not Accessible, Interoperable or Reusable w/o high end computer and expensive software
- Same issue only worse for sharing capabilities and pipelines (eg ML/AI workflows)

Data and workflows are not FAIR if they are functionally inaccessible

datasetproducttitle_point-cloud.pdf

1 / 3

NSW Foundation Spatial Data Framework:
Elevation and Depth Theme
Dataset/product title: Point Cloud

Image depicts sample of the NSW Point Cloud dataset. © Spatial Services 2018

Dataset/product description	The point cloud data set consists of point clouds captured from LIDAR (Light Detection and Ranging) and derived from airborne imagery using photogrammetric techniques.
Dataset uses	This product has been produced for Spatial Services, local and state government and agency programs including Emergency Services. This product is also used on a whole of government basis as a visible record of the landscape at a given point in time, allowing for analysis to be carried out relating to flood modeling and water catchment management.

Datasets

Standard Dataset

PC-URBAN OUTDOOR DATASET FOR 3D POINT CLOUD SEMANTIC SEGMENTATION

Citation Author(s): Muhammad Ibrahim (University of Western Australia), Naveed Akhtar (University of Western Australia), Michael Wise (University of Western Australia), Ajmal Mian (University of Western Australia)

Submitted by: Muhammad Ibrahim

Last updated: Fri, 03/18/2022 - 03:06

DOI: 10.21227/fvqj-4693

License: Creative Commons Attribution @@

1370 Views

Categories: Artificial Intelligence, Machine Learning, Transportation, Computer Vision, Sensors, Remote Sensing

Keywords: 3D point Cloud, Outdoor dataset, Self Driving Vehicles

ACCESS DATASET | CITE | SHARE/EMBED

ABSTRACT

The proposed dataset, termed PC-Urban (Urban Point Cloud), is captured with an Ouster LIDAR sensor with 64 channels. The sensor is installed on an SUV that drives through the downtown of Perth, Western Australia (WA), Australia. The dataset comprises over 4.3 billion points captured for 66K sensor frames. The labelled data is organized as registered and raw point cloud frames, where the former has a different number of registered consecutive frames. We provide 25 class labels in the dataset covering 23 million points and 5K instances. Labelling is performed with PC-Annotate and can easily be extended by the end-users employing the same tool.

DATASET FILES

- PC-UrbanDataset.zip (36.73 GB)
- UpdatedLabelData.zip (4.35 GB)

LOGIN TO ACCESS DATASET FILES

Australian Scalable Drone Cloud (ASDC) - A national platform for drone research

- Funding: Australian Research Data Commons (ARDC)
- 5 Project Partners from diverse research domains:
 - Lead: Monash University (Monash eResearch)
 - NCRIS: Australian Plant Phenomics Facility (APPF); Terrestrial Ecosystem Research Network (TERN); AuScope
 - CSIRO Mineral Resources (Perth); Reefs: Australian Institute of Marine Science (AIMS)

Goals

- Coalesce an integrated ecosystem for all steps in drone research: Capture -> publishing
- Lower barriers to entry and democratize access to needed capabilities
 - “FAIR-from-capture”
 - Enable a “Solve once for everyone” approach
- Cross-domain enables national-scale data interoperability



'Platforms' approach = adapt, adopt and link existing tools

Capability

Photogrammetry
Data & User
Management

File manager

Upload external files
(LiDAR, other software)

Analysis

Visualisation

Publish data
and workflows



Enabling software



(Open Drone Map)



Drone workbench
(TERN CoESRA VL)



TERN SHaRED

Integrated Platform

Cloud Native Architecture



Australian Research Cloud



Commercial cloud (on roadmap)



Tackling Accessibility, Interoperability and Reusability

- Linking user's drone data with “cloud-native” data from all National and State repositories.
- Publish code, pipelines & data back to national data repositories

The screenshot shows the Terria web interface. On the left is a dark sidebar with the Terria logo, a search bar, and buttons for 'Explore map data' and 'Upload'. Below these are 'Helpful hints'. The main area features a map of Papua New Guinea with a 'Your Data' overlay. A sidebar on the right lists various data sources, with 'NationalMap Catalog' highlighted. A callout box points to this list with the text: "All" state, territory and national data. The NationalMap Catalog section includes a search bar, a description, and a link to terms and conditions.

The screenshot shows a research data record from researchdata.edu.au. The title is 'Systems (UAS) RGB orthomosaic - Okehampton Bay, Tasmania'. Below the title is the project name 'Terrestrial Ecosystem Research Network' and the researchers 'Lucieer, Arko ; Sivanandam, Poornima ; Turner, Darren'. There are social media icons and 'Viewed: 125 Accessed: 10'. Below this is a blue box with the heading 'Access the data' and two dashed-line boxes containing links to 'ASDC WebODM' and 'ASDC Jupyter notebook platform'. At the bottom of the blue box are two 'Download data' options: 'Orthomosaic' and 'Raw Data'.

Use Case Examples

1. Reef monitoring
2. > Structural Geology
3. > Victorian Coastal Monitoring Program
4. > Weed detection
5. Wheat plot height

Reef Photogrammetry

The screenshot displays a 3D visualization of a reef structure, rendered in shades of blue and cyan, set against a dark background. The interface includes several toolbars on the left side:

- Cameras**: Includes a 'Textured Model' option and a checked 'Show Model' checkbox.
- Appearance**: A section for visual settings.
- Tools**: A section containing various utility icons.
- Measurement**: Features icons for distance, area, and volume measurements, along with a 'Show/Hide labels' section with 'Show' and 'Hide' buttons.
- Clipping**: Includes a 'Clip Task' section with 'None', 'Highlight', 'Inside', and 'Outside' options, and a 'Clip Method' section with 'Inside Any' and 'Inside All' options.
- Navigation**: Contains icons for camera movement and a 'Camera Projection' section with color-coded cube icons.

In the top right corner, the logo for the **AUSTRALIAN INSTITUTE OF MARINE SCIENCE** is visible. At the bottom right of the interface, there are buttons for 'Share' and '2D'.

Structural Geology



Orthophoto mosaic



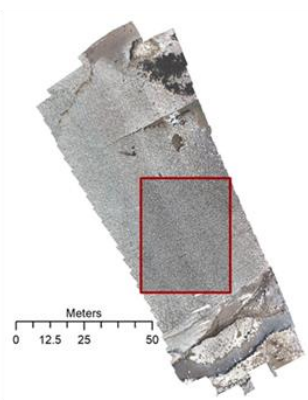
AOI

Intensity map

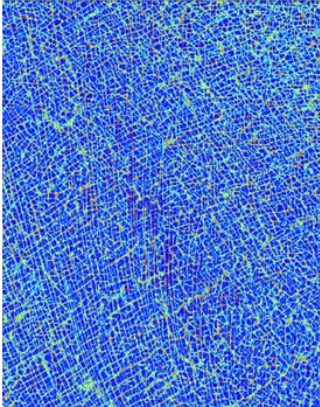
Vectorized features

&

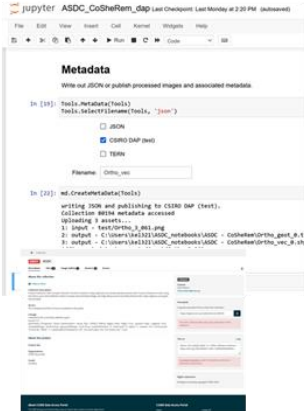
metadata



Data Capture and Pre-processing



Data Processing, Analysis, and Visualisation



Data Archiving and Publication

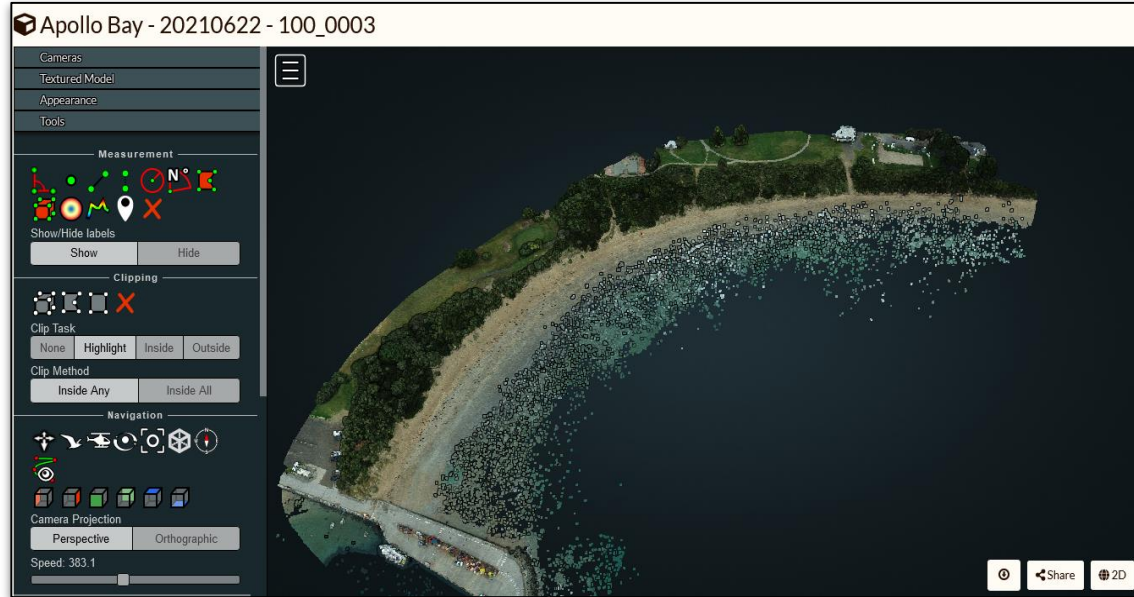


Victoria Coastal Monitoring Program (VCMP)

Citizen Science project to using drones to monitor Victorian beaches

- >40 sites
- 700 surveys
- 180 citizens

- Data currently processed/hosted by [propeller aero](#)
 - Need long term, scalable, open source platform
 - *Data discovery/download*
 - *Code development and Methods development*



Learn more: marineandcoasts.vic.gov.au/marine-and-coastal-knowledge/victorian-coastal-monitoring-program

Machine Learning Pipelines for Weed Detection (*and everything else!*)

Creating an ecosystem of re-usable solutions

The challenge:

- 11 weeds cost Australian primary industries sector >> \$400 million each year¹
- Same species = amenable to **“solve once for everyone”** approach
- Many groups building solutions but no easy way to:
 - share solutions, algorithms or data, audit code, no integrated data management
 - find others working on same problem
 - build shared national collections of annotated images

Solution is both technical and social:

- Social (communities of practice):
 - People need to be onboard; supported to implement reusable solutions; aware of other’s work
- Technical: National Research Infrastructure to support re-use + standards, documentation
 - ASDC platform provides user-friendly entry to using ML for aerial weed detection
 - Native integration between ASDC and AWS (for enterprise scaling)
 - Build library of reusable ML solutions



African Lovegrass



Orange Hawkweed



Siam Weed



Department of
Primary Industries



Charles Sturt
University



1. agrifutures.com.au/wp-content/uploads/2022/04/AgriFutures_Weeds-newsletter_Autumn-2022.pdf

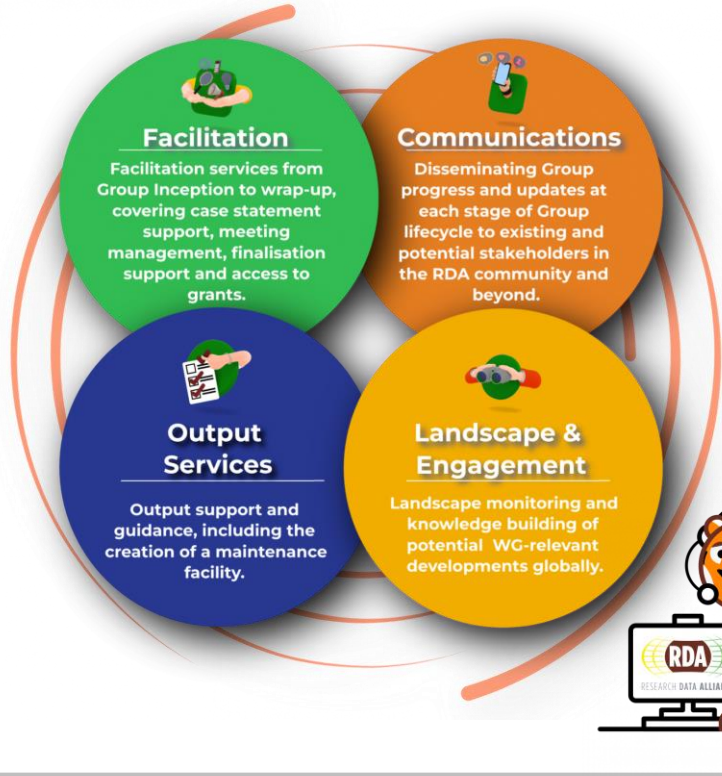
Discussion



Discussions: Where are the gaps?

- Discussion topics (25 minutes)
 - Building a better Australasian network
 - What capabilities would everyone like to see from ASDC?
 - Where are the gaps in existing tools/platforms
 - Existing workflows for new use-cases?
 - How to make use of synergies between projects in Australian and abroad
 - *Your topic here!*

International Connections



RDA supports the proposed Small Uncrewed Aircraft and Autonomous Platforms Data WG through its TIGER programme.

The WG will develop recommendations for data and metadata best practices for interoperability with EOSC and other VREs.

RDA Small Uncrewed Aircraft Systems IG

Next meeting:

06 November 2023

12.00 - 13.30 UTC

18.00 - 19.30 AWST

21.00 - 22.30 AEDT



<https://www.rd-alliance.org/new-rda-working-group-small-uncrewed-aircraft-and-autonomous-platforms-data-kick-meeting>

Summary

- What's happening next?
- How to become involved?

We'd love to collaborate - how can we help solve your drone/data challenge(s)?

Jens Klump: jens.klump@csiro.au

Tim Brown: tim.brown@anu.edu.au



Thank you!

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AuScope



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Australian Research Data Commons



LEFTOVERS

ASDC next steps

- The ASDC project has been extended at a smaller scale until March 2024.
- The extension will be used to stabilise the technical operation of the platform and reduce technical debt.

Establishing Australia's Scalable Drone Cloud

Update with more succinct slide and modular design slide

Drones provide sensing capabilities that address the critical scale-gap between ground and satellite-based observations.

Australia's Scalable Drone Cloud (ASDC) offers a competitive advantage to researchers: lowering barriers to near-real-time & societally-relevant drone-derived information

The ASDC will:

- establish national best practice for drone data analytics, informed by
 - fundamental research applications,
 - industry applications, and
 - national applications
- coalesce novel and bespoke drone data analysis capabilities
 - co-design advanced tooling and methods (incl. point-clouds, machine-learning, best-in-breed tools etc)
 - cloud-native scale-out to society-scale applications (incl. data and campaign interoperability)
 - exemplar data-processing pipelines made reusable and accessible
- Accelerate the adoption of FAIR Principles for drone-acquired data, including FAIR-from-capture

A novel approach - a partnership between...

- three NCRIS capability areas - Australian Plant Phenomics Facility (APPF), AuScope and the Terrestrial Ecosystem Research Network (TERN),
- a university - Monash University (via the Monash Drone Discovery Platform and the Monash eResearch Centre), and
- a government research agency - CSIRO (piloted through CSIRO Mineral Resources)

... to transform their already substantial drone data processing capabilities towards best-practice, automation and intelligent decision making, establishing a nationally accessible ecosystem for drone-related research and innovation.

Supported as a 3yr ARDC Platform project commencing 2020

<http://www.asdc.org.au>



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Reef Photogrammetry

Cameras

Textured Model

Show Model

Appearance

Tools

Measurement

Show/Hide labels

Show Hide

Clipping

Clip Task

None Highlight Inside Outside

Clip Method

Inside Any Inside All

Navigation

Camera Projection

Australian Institute of Marine Science

Share 2D

Machine Learning Pipelines for Weed Detection (*and everything else!*)

TIM to update slide

The Challenge:

- African Lovegrass (ALG) is a widespread invasive in Australia but no quick low cost detection methods
- Conventional detection methods (visual surveys): expensive, slow, can ALG spread seed
- Machine learning (ML) methods are robust but not easy for wider usage

Solution:

- ASDC platform provides user-friendly entry to using ML for aerial weed detection
- Develop native integration between ASDC and Amazon Web services
- Reusable ML tool trained on ALG (but can be trained for any other plants)
- Goal: Any users interested in detecting a new plant can train the system, then ML new model rolled out for everyone (Conservation/landcare, local government associations, farmers, endangered plant surveys, etc)

Project Partners:

- 2PI Software, Bega; Snow Monaro, LLC, USydney



Wheat Plot Height



The Challenge:

- How can researchers and breeders measure plant biomass with semi-automated reproducible workflows?
- Existing methods are well established but none are yet implemented into a turn-key workflow

Solution:

- ASDC implemented the URAF plot height pipeline into a semi-automated pipeline with integrated FAIR data management.
- This makes it much easier for breeders to use the same standardized methods; better track and share data

Project Partners:

- Ramesh Segaran (Unmanned Research Aircraft Facility ([URAF](#)))
- [WheatHub](#) (ARC Industrial Transformation Research Hub)
- Australian Plant Phenomics Facility (APPF)

