Accelerating and transforming your research

Anthony Beitz
General Manager
Monash eResearch Centre
www.monash.edu/eresearch
DATA: BY THE NUMBERS

- Number of years to get data: 3
- Number of years to interpret data: 2
- Number of years to write about data: 1.5
- Number of slides to present data: 1

www.phdcomics.com

Jorge Cham, © 2004
- eResearch is 21st century research discovery through the application of advanced computing and IT
- MeRC **partners** with research groups to **accelerate** and **transform** research, **connecting** them to the most appropriate infrastructure and services to **sustain** that capability

**Collect**  
**Compute**  
**Comprehend**  
**Communicate**  
**Customise**
Conventional microscope

MRI Scanner

EResearch version of a microscope
<table>
<thead>
<tr>
<th>Communicate</th>
<th>Collaborate</th>
<th>Comprehend</th>
<th>Compute</th>
<th>Collect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Data Australia</td>
<td>Characterisation Virtual Lab</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Conventional microscope  eResearch version of a microscope
Transforming research

From this

To this

Second image courtesy of Dr. Govinda Poudel, with permission.
Third image courtesy of Electronic Visualization Laboratory & Dept. of Psychiatry, UIC, with permission. Photo by Philip Chan, Monash Uni.
Accelerating research

Brains of ~100 study subjects (controls, pre-symptomatic and HD sufferers) visualised at once!

Data: N. Georgiou-Karistianis • Visualisation: Y. Benovitski
MeRC Services

- Specialist advice
- Capabilities and infrastructure to:
  - Collect – capture, store & manage big and small research data
  - Compute – HPC skills & facilities for modelling, simulation & data processing
  - Comprehend – immersive visualisation
  - Collaborate – virtual labs & collaborative research platforms
  - Communicate – disseminate & promote discovery of research outcomes & artefacts
  - Customise – resources for planning & building research ICT infrastructure
- Grant assistance - planning & costing ICT personnel & infrastructure
- Seminars and outreach
Collect - *capture, store & manage big and small research data*

- Self-serve Research Data Management (RDM) advice
  - RDM Website, [http://monash.edu/library/researchdata](http://monash.edu/library/researchdata)
- Managed data storage
  - Monash’s petascale research data store, free to use
  - National data store, requires merit application to [VicNode](http://vicnode.mondea.org)
- Discipline-specific RDM solutions, including:
  - [CDD Vault](http://cddvault.com) (Drug Discovery)
  - DaRIS (Neuroscience)
  - [OzFlux Repository](http://ozflux.org) (Ecosystems)
  - [Store.Synchrotron Data Store](http://store.synchrotrondata.org) (Biosciences)
- Versatile RDM solutions
  - [MyTardis](http://mytardis.org) (currently used by Engineering, Medicine and Science)
Compute – HPC skills & facilities for modelling, simulation & data processing

Researchers at Monash can access a variety of High Performance Computing (HPC) facilities for modelling, simulation and data processing. These include:

- **Multi-modal Australian ScienceS Imaging and Visualisation Environment (MASSIVE)** - a specialised national facility
- **National Computational Infrastructure National Facility (NCI NF)**
- **Monash Campus Cluster (MCC)**
- **Research @ Cloud Monash (R@Cmon)** - a cloud environment dedicated to research

The Monash eResearch Centre provides specialist expertise in all aspects of scientific computing, including simulation, data processing, visualisation and cloud computing.
Comprehend - *immersive visualisation*

- Range of advanced and unique visualisation capabilities from high-res to immersive
- **Monash’s CAVE2** (the largest of its kind) launched in October 2013

The CAVE2 System was developed by the Electronic Visualization Laboratory (EVL) at the University of Illinois at Chicago.

Photos: L. Long (left), P. Chan (right)
Collaborate – *virtual labs & collaborative research platform*

- **Virtual Labs**
  - Characterisation Virtual Lab (CVL)

- **Collaborative Research platforms**
  - CloudStor – transferring BIG files
  - Confluence – enterprise wiki
  - Google Docs
  - JIRA – project management and issue tracking
  - Sakai
The Characterisation Virtual Laboratory
Toolboxes for Multi-modal Characterisation
Communicate – disseminate & promote discovery of research outcomes & artefacts

- Facilitates discovery, access and reuse of research data
- Reuse of research data can:
  - Verify research claims
  - Lead to new discoveries
  - Enable the integration of sets of data for new analysis
  - Reduce duplicated effort
- Research data catalogues:
  - Research Data Australia (RDA) – the Australian research data commons
  - Monash University Research Repository – Monash’s institutional repository that seeks to describe all the University’s research output
Customise – *resources for planning & building research ICT infrastructure*

- Allows researchers to easily access highly-skilled software and hardware engineers to advise, plan and achieve innovative and customised research infrastructure, including:
  - Project Managers
  - Computer Hardware Engineers, including specialists in:
    - Compute, storage and visualisation
  - Software Developers, including specialists in:
    - Bio-informatics, modelling, imaging, web and mobile apps

- IT personnel provided “at-cost” to research projects
How can MeRC help?

By partnering with MeRC your research can be **accelerated** and **transformed**, through capabilities and infrastructure to:

- **Collect** – capture, store & manage big and small research data
- **Compute** – HPC skills & facilities for modelling, simulation & data processing
- **Comprehend** – immersive visualisation
- **Collaborate** – virtual labs & collaborative research platforms
- **Communicate** – disseminate & promote discovery of research outcomes & artefacts
- **Customise** – resources for planning & building research ICT infrastructure
For more information…

Contact us:

Email: MeRC@monash.edu
Phone: +61 (3) 990 59704

Visit our website: http://www.monash.edu.au/eresearch/

Follow us:

FaceBook: https://www.facebook.com/MonasheResearch
Twitter: @MonasheResearch
CASE STUDIES
Bacteriophages, viruses that specifically infect and kill bacteria, have been investigated as possible treatments since 1919. However, they were abandoned in the 1940’s with the discovery of antibiotics, which could tackle more than one type of bacteria.

With antibiotics losing their potency and with the fear of a pre-antibiotic era looming, phages are once again in the spot light. The phage PlyC is known to be very effective in the treatment of *Streptococcus* (the bacteria causing throat infections, heart disease, pneumonia, toxic shock syndrome and tropical skin infections).
PlyC (cont’d)

In order to better understand PlyC, Monash’s Dr. Shena McGowan (under the direction of Prof. James Whisstock) grew crystals from a PlyC solution, placed them in the Australian synchrotron’s protein crystallography beamline and then bombarded them with x-ray radiation.

Each crystal’s dataset of diffraction images was then transferred to MyTardis (a bioscience research data repository) and archived. Various crystallography techniques and computer programs were used in an attempt to resolve PlyC’s structure. Unfortunately, these were unsuccessful.

In 2010, a new approach enabled Dr. McGowan and Assoc. Prof. Buckle to resolve the structure from the datasets archived in MyTardis.

Resolution of the structure was also assisted by Monash’s high performance computing cluster, which expedited computations.

The structure was published in the Proceedings of the National Academy of Sciences (USA) in July of 2012 and the raw data and images were made available through MyTardis.
In order to reduce the drag on vehicles and the resistance to flow in pipes, Professor Julio Soria and his team are trying to understand and manipulate the turbulent boundary layer. This is the region right next to an object’s surface that causes drag. A 10% reduction in the drag on aeroplanes would save $AUD1.5 Billion in fuel costs and reduce environmental pollution.

The mechanisms of turbulence of the boundary layer have remained a mystery as the structure of the boundary layer can change dramatically and unpredictably based on the size of the object, its orientation and its speed.
Turbulence (cont’d)

As it is almost impossible to effectively measure and analyse the conditions on a large object, like the wing of an aircraft, engineers have made use of computations to numerically simulate the conditions.

Professor Soria and his team are making progress in understanding turbulence by taking advantage of the cutting-edge measuring and processing technology available through The Multi-modal Australian ScienceS Imaging and Visualisation Environmnet (MASSIVE) and the National Compute Infrastructure (NCI). This infrastructure is allowing the team to quickly process and visualise the flow of data they collect (3D image velocimetry), and run large numerical simulations - direct numerical simulations (DNS) and large eddy simulations (LES).

Professor Soria said, “now we have better technology, we’re seeing phenomena that we couldn’t see before, and so didn’t account for. The more research we do, the more we realise how little we understand. We couldn’t do these very large computations and visualisations without MASSIVE. To load and visualise this much data you need a super computer.”
Usually, if you want an image of the lung you do a CAT scan. This provides a good image, however, to achieve a much better understanding of how the lung works and to progress the development of tools for diagnosing, treating and managing certain lung diseases, a disruptive technological change, like the shift from static images to a 3D motion view of the lung, needs to occur.

Assoc. Prof. Andreas Fouras has spent over 5 years perfecting a technique of capturing a 3D motion view of the lung and other organs. To his knowledge, this isn’t being done anywhere else in the world.
Capturing the Lungs in Action (cont’d)

He uses the medical beam line at the Australian Synchrotron to achieve a clean, crisp and high quality image. He then uses his computational tomographic x-ray velocimetry techniques on Multi-modal Australian ScienceS Imaging and Visualisation Environmnet (MASSIVE) to develop a 3D motion view.

Using this technology, they’ve been able to show that the lung moves differently if it is diseased or injured. Given the sensitivity of the technology, they’ve been able to pick up slight changes in the mechanics of the lung, enabling them to make earlier diagnosis of lung disease.