Workspace: A Platform for Delivering Scientific Applications

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OVERVIEW

Workspace is an advanced software platform designed to address two specific user scenarios:

1. Scientists who want to create and share scientific workflows in one coherent, easy to use environment where much of the “heavy lifting” has already been developed and proven over a number of years
2. Scientists who want to make their software available as commercial products, plugins or components that can be freely mixed with capabilities from collaborators or customers

Workspace provides a framework that allows researchers to focus on their science, develop robust and sustainable software and still meet their software implementation timeframe. The requirements of scientific application development such as visualisation, distribution, testing, integration and provenance reporting are all provided. Researchers can easily develop new capabilities or expose existing libraries through C, C++, Python or JavaScript via inbuilt facilities - or “callout” to other software packages such as R. Thus, the Workspace framework makes it very easy to mix and match existing and new capabilities within an easy to use graphical drag and drop environment, but without the burden of having to design and implement the glue to make all the components work together.

USE CASE: DISASTER MODELLING

The Geophysical and Natural Hazards team in CSIRO use Workspace for the modelling, visualisation and analysis of natural hazard simulations such as storm surges, flash flooding and bushfires. This modular solver workflow architecture allows researchers to develop, share and interchange components of the system and incorporates the uncertainty inherent in disaster modelling into a unified framework. Workspace’s interactive workflow editor, inline visualisation and packaged application capabilities support the full lifecycle of research from rapid internal prototyping and development to delivery of polished tools to collaborators and end users. This research could lead to increasing resilience and a better understanding of these natural hazards, which have shaped the landscape and ecology of Australia throughout history. [1]

Figure 1: Workspace executing a bushfire simulation workflow. Far left: the catalogue of available operations. Centre-left: the simulation workflow being executed. Far right: visualization showing real-time results of the workflow as it executes. The dark patches on the left of the visualization show areas that the fire front has impacted.
USE CASE: IMAGE ANALYSIS PLUGIN AND THE GRAINSCAN APPLICATION

The Image Analysis Plugin, developed by CSIRO’s Quantitative Imaging Team, provides a wide range of low-level generic image analysis functions as well as high-level tools for specific applications. This includes several high level operations for cell screening from the HCA-Vision package and selected functions from an open source medical image analysis package. The capacity to integrate low level functions from multiple sources (e.g. CSIRO libraries and open source packages) allows the rapid expansion of functionality with a common ‘look and feel’ for the users. This ease-of-use is further enhanced by the interactive parameter tuning capability inherent in Workspace. GrainScan is an application built on top of Workspace and the Image Analysis plugin that allows users to input scanned images of grains, and receive measurements of grain size and colour. It has an option for detecting the crease in wheat grains and including/excluding the crease in the measurement of the colour. GrainScan, along with sample images, was published for the benefit of the research community [2].

![GrainScan Screenshot](image)

Figure 2: This GrainScan screenshot shows the result of segmenting and labelling individual wheat grains in a flatbed scanner image. The resulting image is the original image with a semi-transparent overlay in which each labelled grain is displayed in a different colour from its neighbours.

USE CASE: ALTETREAT AND SHEARUNNER

High Pressure Die Casting (HPDC) is a method for manufacturing metal parts where liquid metal is forced into a cast by a piston which itself is propelled by pressure from a nitrogen canister. CSIRO has previously developed two patented methods that improve the properties of HPDC parts thus allowing parts to be redesigned to reduce costs by using less metal or making the switch to a cheaper alloy. The methods are known as Advanced Tixotropic Metallurgy (ATM) and HPDC Heat Treatment (HPDHT). An opportunity was identified where development of die casting software could reduce CSIRO’s operating costs by replacing a portion of an expert’s time with interactive software while also enhancing CSIRO’s die casting technology transfer packages. The objective of the software tools was to allow exploration of cost-saving benefits and part property improvements from adoption of either process. Workspace was selected as the appropriate technology to deliver the software for this project for two reasons:

- Workspace’s core package contains all the required pre-fabricated components such as plotting and database support.
- Workspace builds upon the powerful Qt development framework that empowers developers to rapidly build graphical-based applications.
This technology is shipped as two commercial products, AlteTreat and SheaRunner, both built with Workspace.

Figure 3: Screenshots of the two Workspace-powered die casting applications. On the left is AlteTreat's alloy database query module where a user can set part property requirements and select an alloy from the resulting shortlist to inspect all of the selected alloy's properties and alloy composition. On the right is a typical view from SheaRunner where the user can inspect points along the dark blue plot line to assess if the user-set restriction sizes will allow their die cast machine to attain the specified velocity.

CONCLUSION

The impact of research can be greatly enhanced when it is easy to share and reproduce. This is applicable in both the research and commercial domains. In the research domain, many publishers are now insisting that the software and data supporting scientific discovery be made available for other researchers so they can verify results. In the commercial domain, partners want a simple, robust means to exploit discoveries and ship them to market. Using an advanced software platform technology, like Workspace, allows scientists to easily exploit opportunities in either domain.

ACKNOWLEDGEMENTS

We would like to acknowledge Craig Scott and Ben Morris, who were previous development team members, for all their contributions. We would like to acknowledge all the scientists whose work is featured in our Use Cases – without such applications our platform would be of little value.

REFERENCES AND RELATED PUBLICATIONS


Jim Gould, Andrew Sullivan, Miguel Cruz, Chris Rucinski and Mahesh Prakash (2013): National Fire Behaviour Knowledge Base - Bringing together the best information for best decisions

ABOUT THE AUTHOR(S)

Paul Cleary is a Chief Research Scientist at CSIRO and specialises in the development and application of particle based computational methods and the development of software and visualisation tools. These include the DEM and SPH methods which are now used extensively for simulating industrial, biomechanical / biomedical and geophysical / geotechnical flow problems involving combinations of particulates, fluids and bubbles. He is broadly acknowledged as a leading developer of the SPH and DEM numerical methods and is the architect and primary software developer of both the CSIRO DEM and SPH software. He is also the leader of the Workspace development program which is building and deploying a sophisticated general purpose workflow engine that enables efficient inter-connection and interoperability of heterogeneous software pipelines and their migration into commercialisable products.

Matt Bolger is a software engineer in CSIRO’s Computational Modelling Group. Matt started his career working in the video game industry as a programmer and lead programmer before joining CSIRO in early 2010. He has worked on commercial products ranging from children’s games, aircraft and sports simulations to more recent work on mining industry tools, flood modelling and cross-platform workflow frameworks. Matt currently works across a number of research and commercial projects in areas such as CFD, computer vision, 3D rendering and human kinematics. Matt’s work has involved developing on a wide range of environments from limited resource mobile devices, modern game consoles and PCs to CSIRO’s GPU cluster using a variety of programming languages and frameworks. Applying commercial experience in software development tools and processes is a focus of Matt and the Computational Software and Visualisation team.

Lachlan Hetherton is a software engineer from the Computational Modelling group in CSIRO, specialising in developing visualisation capabilities for Workspace. Specifically, he has implemented Workspace’s 3D scene rendering and grid plotting capabilities, as well as the recently added NetCDF and GeoSpatial plugins. Prior to joining CSIRO 4 years ago, Lachlan worked as a consultant for Accenture, designing and developing solutions for a diverse range of projects in the telecommunications space.

Chris Rucinski is a software engineer in CSIRO’s Computation Modelling Group. He graduated as a computer scientist from Monash University and since 2011 has been developing software at CSIRO. He has contributed to the development of DEM and SPH data analysis tools that are used internally for research purposes are also deployed externally in commercial particle-based simulation packages. Chris is currently collaborating with researchers from CSIRO Future manufacturing Flagship to build user-friendly software tools for the die casting industry that are licensed as part of technology transfer packages. He is also working with bushfire researchers from CSIRO’s Ecosystem Sciences to develop software which aims to act as a repository for all Australian bushfire models and historical data.

David Thomas is a software engineer in CSIRO’s Computational Modelling group. He currently manages and develops commercial software using Workspace, providing user interfaces for complex scientific applications. He has a first-class Bachelor’s (Hons) degree in Mathematics, and a Master’s in Mathematics and Chemical Engineering, both from The University of Manchester in the UK. He is a software developer with over 18 years’ commercial experience, the majority of this time spent working in the CAD industry, working on core functionality used by some of the biggest product vendors such as Autodesk, SolidWorks, NX and CATIA. He has also provided consultancy work for SolidWorks.

Damien Watkins is a Research Team Lead in CSIRO’s Computational Modelling group. His team produces a number of software applications, including Workspace which is a scientific workflow engine used across a number of projects within CSIRO. Prior to working at CSIRO, Damien worked for Microsoft/Microsoft Research for ten years. Damien holds a Ph.D. in Software Engineering from Monash University.