

A Cloud-Native Virtual Bioimage Analysis Research Desktop (BARD) for Deployment of Containerised Bioimage Tools on Kubernetes

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Abstract:

Bioimage analysis research workflows typically require the integration of various software tools and demand substantial computational power along with high levels of interactivity. These workflows often create inconsistent results due to specific software and operating system dependencies, a challenge that is especially obvious as computationally intensive methods like deep learning become increasingly prominent. Traditional high-performance-computing (HPC) clusters have significant compute power but often fall short in supporting interactive tools, which limits their suitability for bioimage analysis. To overcome these limitations, researchers frequently opt for large cloud-based virtual machines with remote desktop functionality. While this solution addresses some challenges, it faces obstacles in deploying and maintaining the reproducibility of image analysis workflows, particularly when dealing with conflicting software requirements and when configuring systems to utilise specialised hardware like GPUs.

To address these issues, we develop *BARD*, a kubernetes based virtual bioimage analysis research desktop service, leveraging the abcdesktop.io [<https://www.abcdesktop.io/>] project. BARD is a unified, containerized, cloud-native platform designed for both intensive computational demands and interactive workflows. It allows bioimage analysts to quickly use a personal cloud-based desktop capable of handling complex computations and image processing tasks without local hardware limitations.

By containerizing all software along with its specific versions and necessary dependencies, BARD creates a self-contained computational environment for software that addresses common issues of software incompatibility. This ensures that the environment remains consistent across various computing platforms, allowing researchers to reproduce identical experimental results from any computer, anywhere. Additionally, by leveraging Kubernetes, BARD offers a resource-efficient alternative to virtual machines. Through Kubernetes, BARD not only reduces the consumption of physical resources, such as CPU and memory, but also streamlines the software deployment process.

Keywords: kubernetes, bioimage analysis, cloud, container