The WorkWays Problem Solving Environment

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Outline

• Background
  - Science Gateways
  - Scientific Workflow
  - Kepler and Nimrod/K
• Motivation: Virtual microscopy and imaging
• Workways: Design and Implementation
• Case studies
• Conclusion & Future Work
Science Gateways

- A Web portal interfaced to a community-set of tools, applications, and data collection integrated

- Benefits
  - Accessibility
  - Usability
  - Sharing and collaborating

- LEAD, nanoHub, CAMERA, GridCHem
Scientific Workflows

• Automate, manage and execute various steps in scientific research
• Lots of “standards”
  - Pegasus, Kepler, Taverna, Triana, Vistrails, etc.
  - Applied in various science domains
• Unifying platform to build arbitrarily complicated computational applications by combining predefined components
• Typically not well integrated into portals
Nimrod/K Workflows

- Nimrod/K integrates Kepler with
  - Massively parallel execution mechanism
  - Special purpose function of Nimrod/G/O/E
  - General purpose workflows from Kepler
Motivation

• Support man-in-the-loop workflows
  - Ability to perform IO operations with a continuously running workflow

• Most existing workflow-based gateways
  - execute the workflow in batch mode
  - users provide inputs, execute, and collect outputs
Motivation: Virtual Microscopy

• Based on Kepler
  - Capture images from imaging device
  - Process images
  - Visualize and archive processed images

• Applications in
  - Cancer research
  - Neuroscience

• Typical interactions
  - Repeat scans to find regions of interest
  - Assist imaging processing algorithms
Cancer Imaging and Therapy
Cancer Imaging and Therapy
Motivation: Virtual Microscopy

- Consider a workflow as a continuously running service
- Once initiated, the workflow pauses itself waiting for inputs
- IO is performed while the workflow is running
- Can be achieved by introducing a feedback loop

1: Scan Images
2: Process Images
3: Display Images/ Acquire inputs

- continue
  - True
  - False

4: Further processing/ Storing results
WorkWays

- Ease of use of Science Gateway
- Workflows as service
- IO through portlets
- Extensibility
  - Different IO mechanisms, protocols and topology
  - Different UI clients
- Currently Kepler as the workflow engine
WorkWays

Provenance

Workflow

Run Engine

Kepler Workflow Engine

Provenance Viewer portlet

Workflow launch portlet

IO portlet

IO Server

IO Library

IO Library

Provenance data

Launch workflows

Web Portal

Other interface

IO Library

IO Library

Director

Actors

Portlets:
- Provenance Viewer portlet
- Workflow launch portlet
- IO portlet
- IO Server
- Director

Interfaces:
- Provenance data
- Launch workflows

Other interfaces:
- Other interface
- Web Portal

Library:
- IO Library
Implementation: IO framework

- **CometD framework**
  - Framework for asynchronous message passing using either HTTP or web socket
  - Messages are routed via different channels
  - Publish-subscribe is the default routing mechanisms

- **IO Server**
- **IO Clients: IO actors & UI clients**
Implementation: IO framework

- CometD framework
- IO Server
  - Assigns each (data) channel to an IO actor
  - Multiple UI clients may subscribe to a channel
  - Reserves two special (meta) channels
  - "/publishers"
  - "/subscribers"
- IO Clients
Implementation: IO framework

- CometD framework
- IO Server
- IO Clients
  - IO actors: publishers
  - UI clients (Web client): subscribers
  - Handshaking between IO actors and UI clients are done via the two meta channels
  - IOPortlet
  - IOActor
IOActor

• *Generic actor*
  - Simplify the creation of (new) IO actors
  - Instantiate an IOActor & provide the actor definition

• **IOActor definition**
  - Actor name
  - Number of (supported) clients
  - Operation: input/output/inout
  - Additional information

```json
{
  actor: "ImageInOutActor"
  {
    operation: "inout"
    input_type: "text"
    prompt: "Choose an area in the image"
    output_type: "binary"
    display_type: "image"
    action: "subarea"
    wait_client: true
    wait_for_input: true
  }
}
```
IOPortlet

• Web UI client
• Vaadin framework
  - framework for building rich Web applications
• JSR-286 portlet
  - UI elements generated based on requests from connected IOActor
  - Limited UI elements
Case Study: Scan Workflow
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Case Study: Scan Workflow
MRI Image segmentation
Airfoil Design
Future Work

• Support more objects
• Support asynchronous IO
  – Enhancement of Kepler directors
• Support different UI client(s)
  – Tiled display wall
• Multi-clients interacting with one workflow
Questions

To work with such truly gifted scientists has been a blessing.

Vale Professor Martin Lackmann,  
Monash University  
May 22nd 2014

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May 17th 2014