Cardiac motion analysis pipeline support with the EGEE grid and MOTEUR workflow manager

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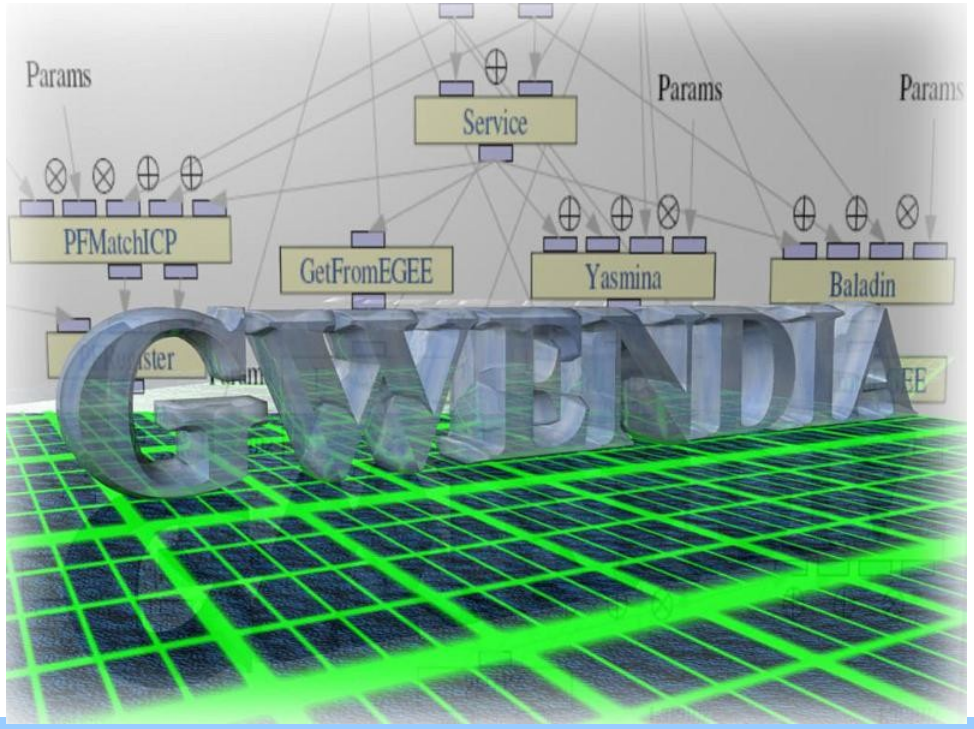
CREATIS / I3S, CNRS / INSERM



4th EGEE User Forum

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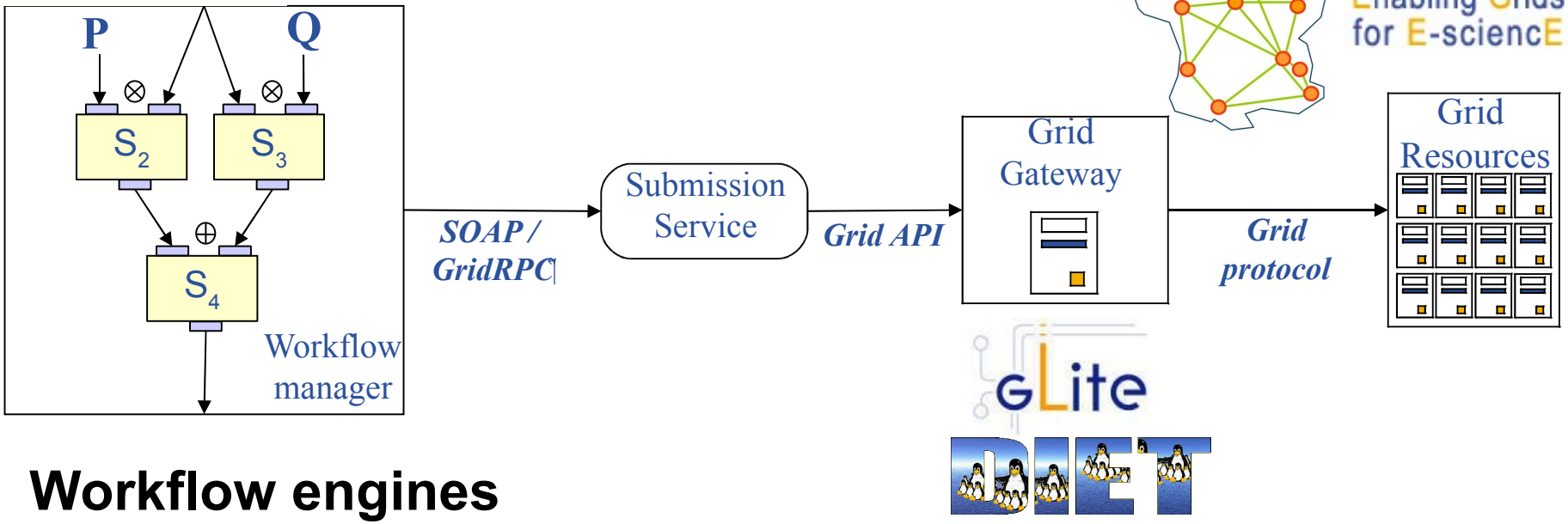
- **Grid Workflow ENactment for Data Intensive Applications**
  - Workflow engine to shield users from grid details

MOTEUR DIET MA DAG

Grid'5000

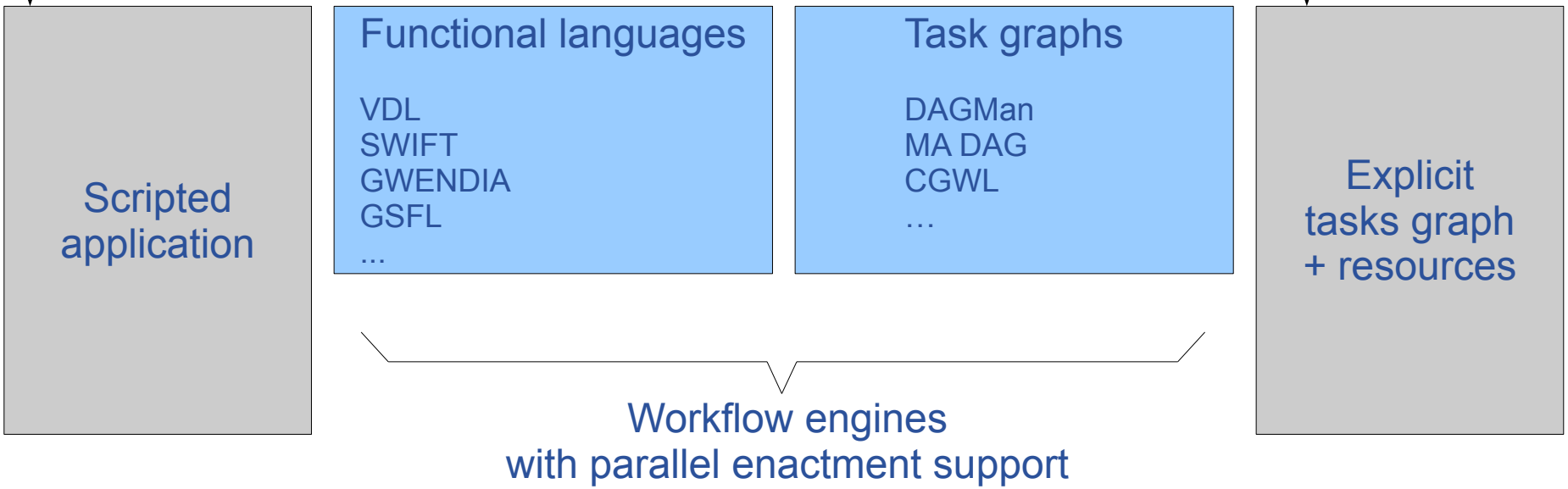
eGee Enabling Grids for E-sciencE



- **Workflow engines**
  - MOTEUR data- and service-oriented workflow manager
  - DIET MA DAG, Directed Acyclic Graph oriented workflow manager
  - Interaction with UMAN / Taverna2 development team

Workflow languages

- **Workflow language / workflow enactor has a real impact on expressiveness**
  - Ability to describe various application logics
  - Ease of use from the user point of view
- **2 extreme examples**
  - Scripted application workflow: fully customized
  - Completely explicit graph of tasks + resources



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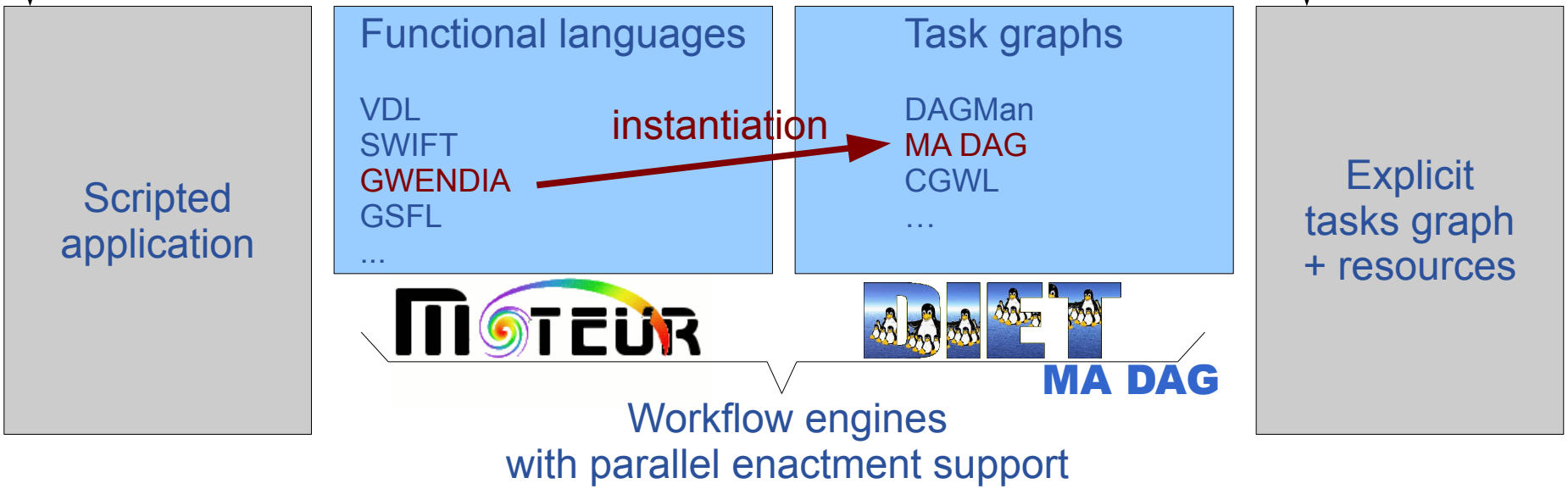
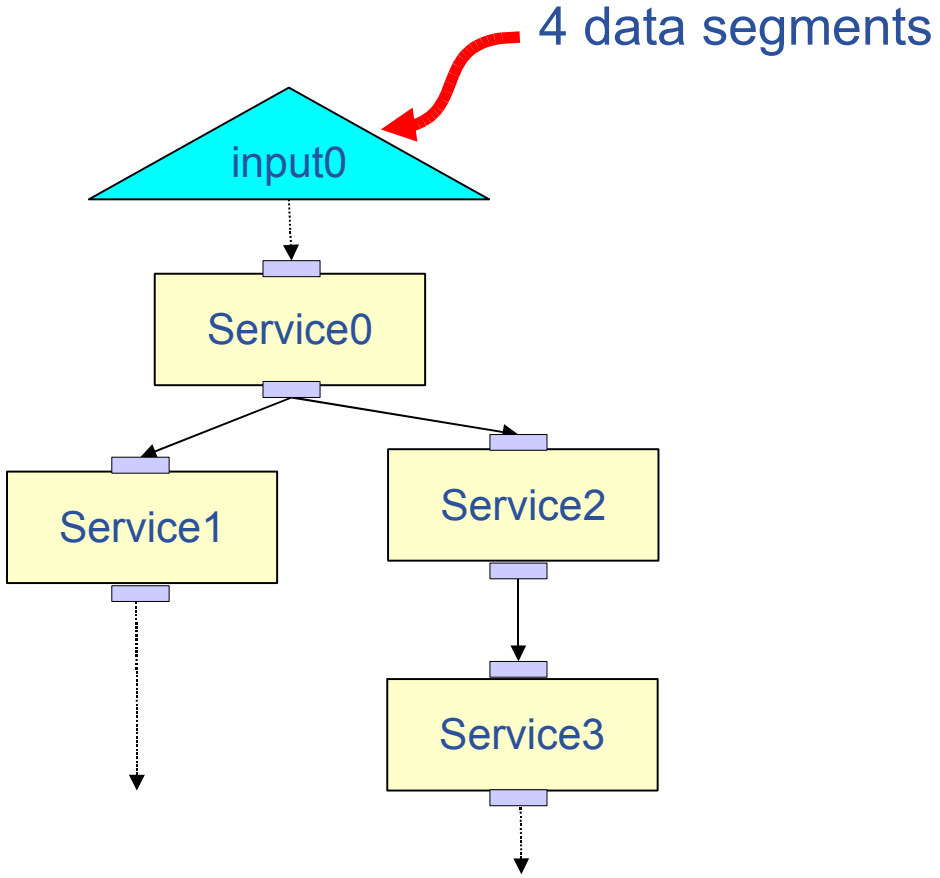
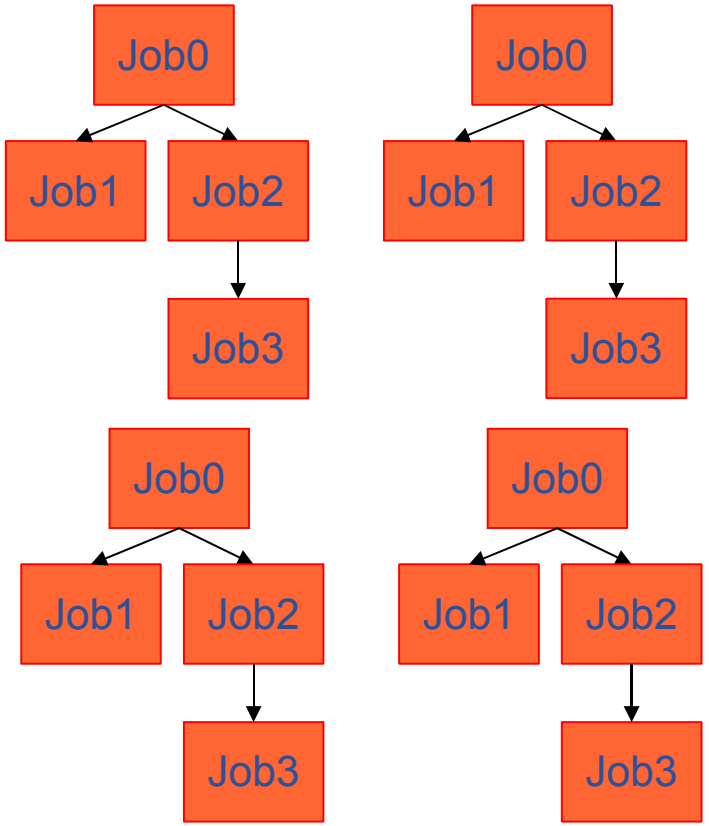


Multiple data sets instantiation

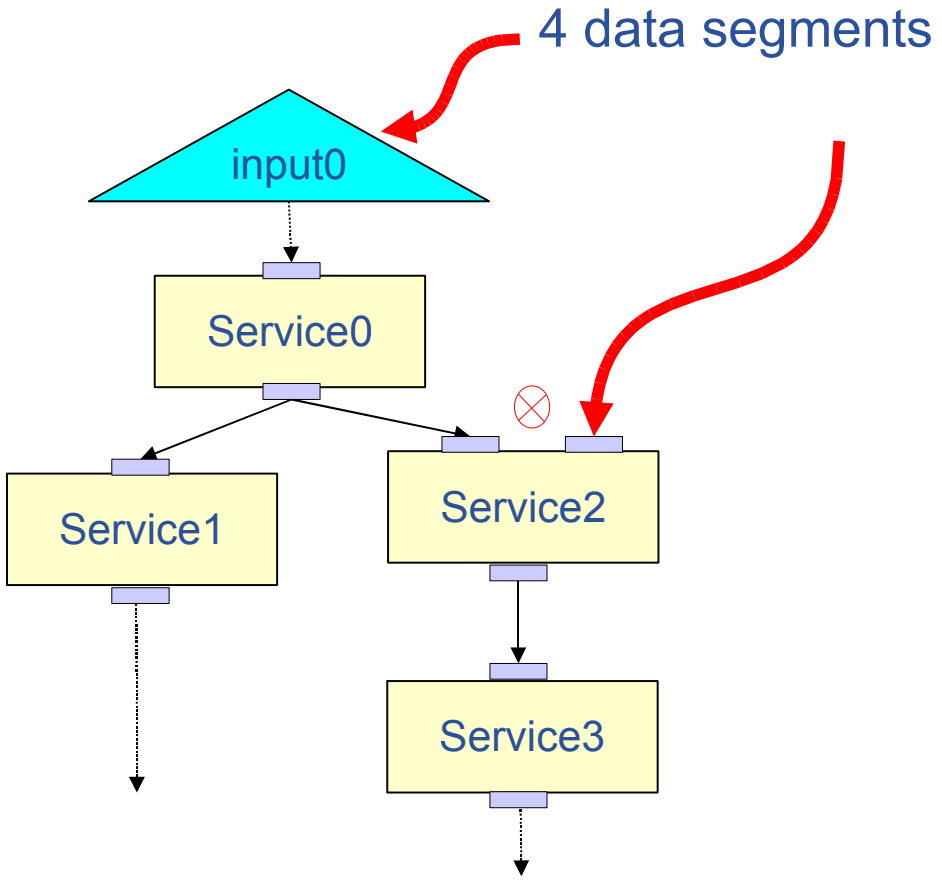
- **Functional workflow (+ data)** ➡ **DAG of tasks**

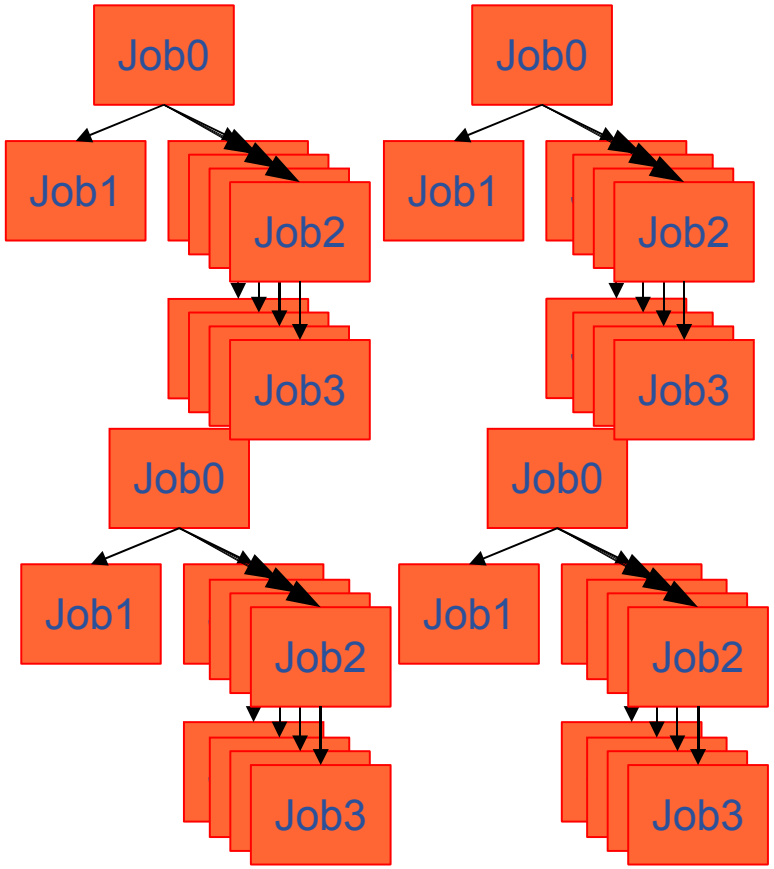




Iteration strategy instantiation

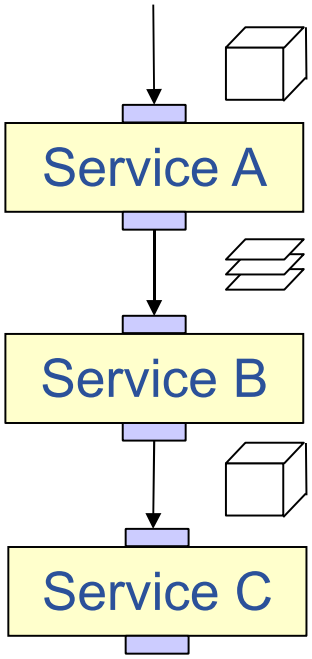
- **Functional workflow (+ data) ➡ DAG of tasks**

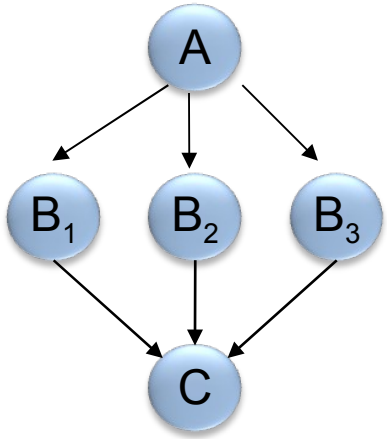




Instantiation for data manipulation

- **Functional workflow (+ data)** ➡ **DAG of tasks**

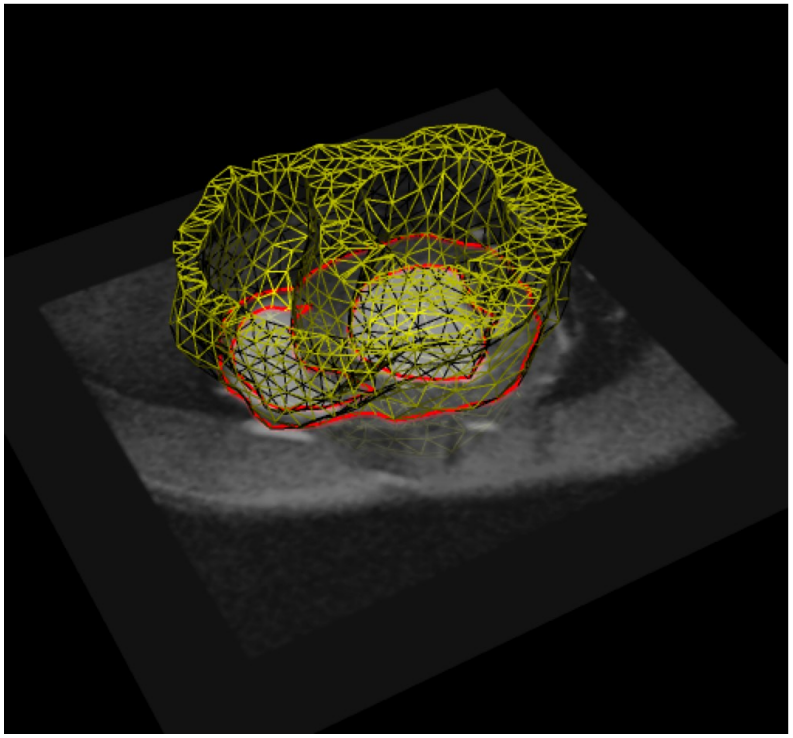


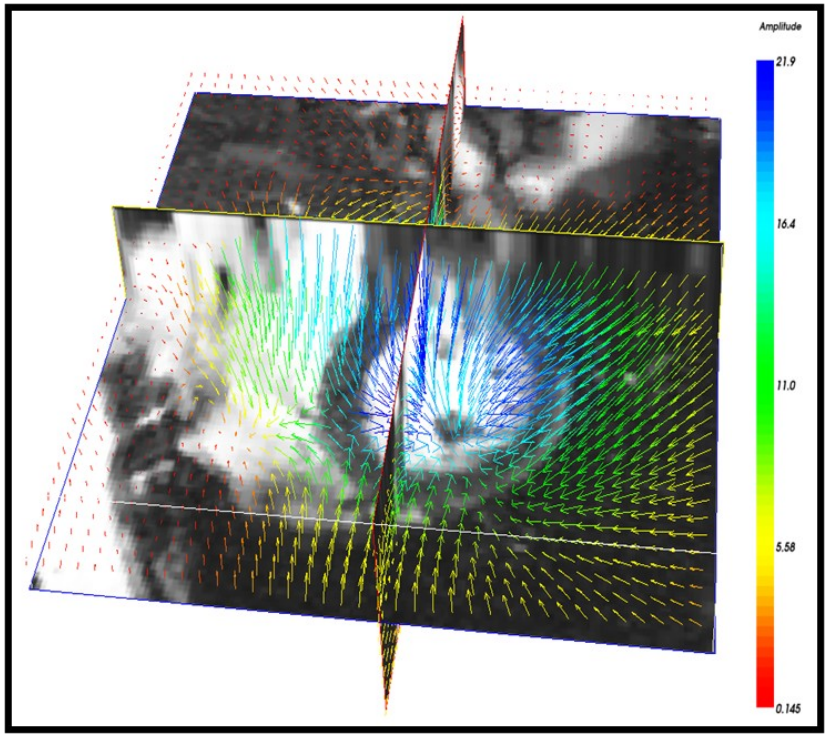


- **Instantiation can be done before execution to improve scheduling efficiency**

Cardiac image analysis

- 3D+T sequences analysis
- Myocardium segmentation and cardiac motion estimation

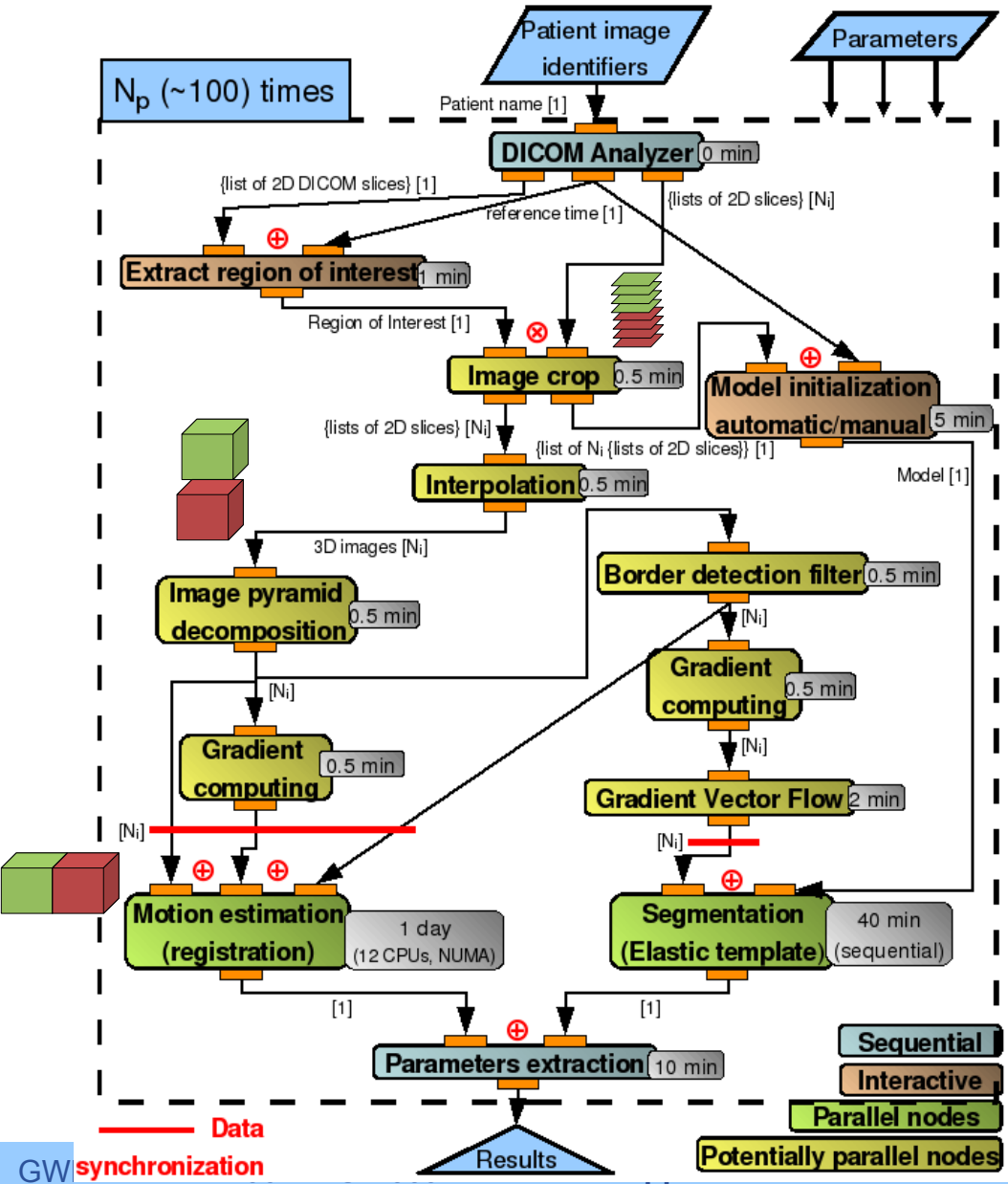




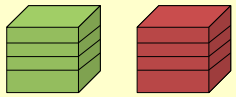
- Large 3D+T image datasets
- Multi-processings analysis procedure

Complete application pipeline

Grid Workflow Efficient Enactment for Data Intensive Applications

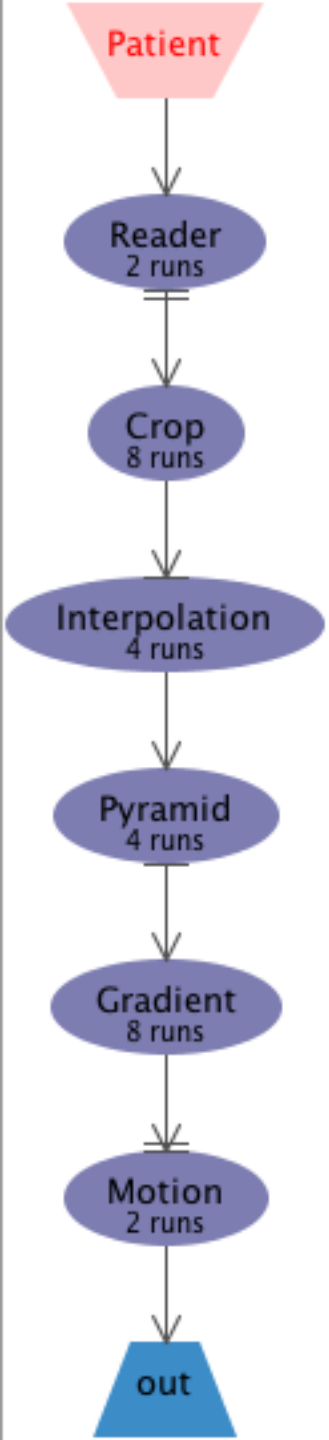


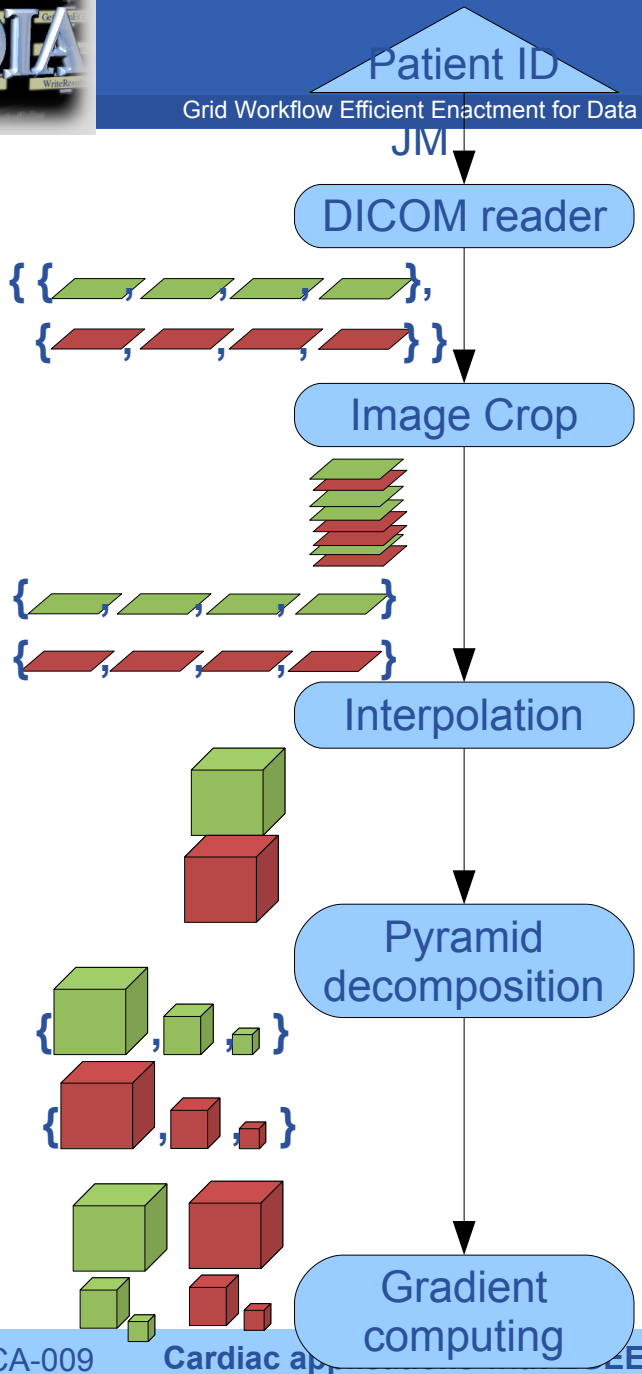
- **Complex data flow**
- **Very heterogeneous computations**

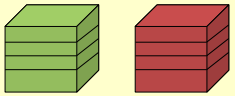


The input data set is a 4D image For each patient. The image sequence is composed of 2 volumes (labelled green and red). Each volume is composed of 4 slices.

Zooming in data flow

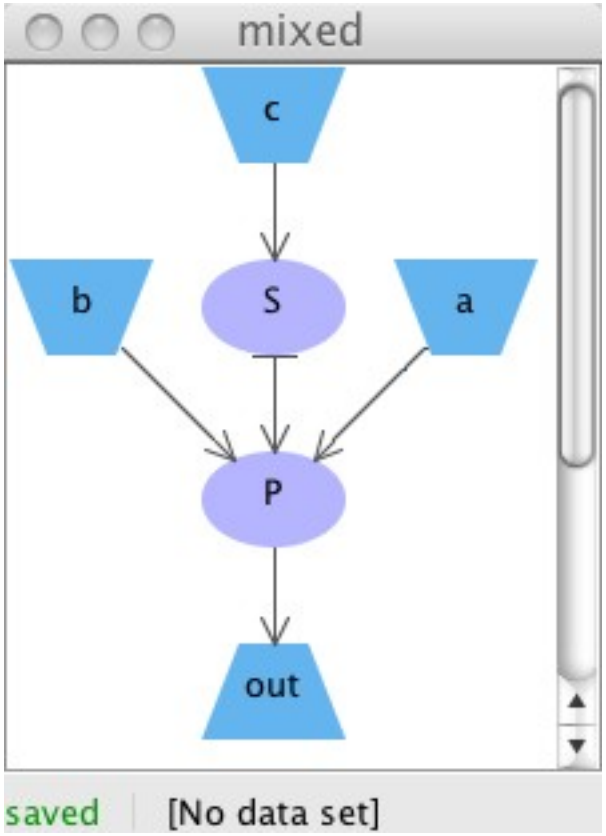


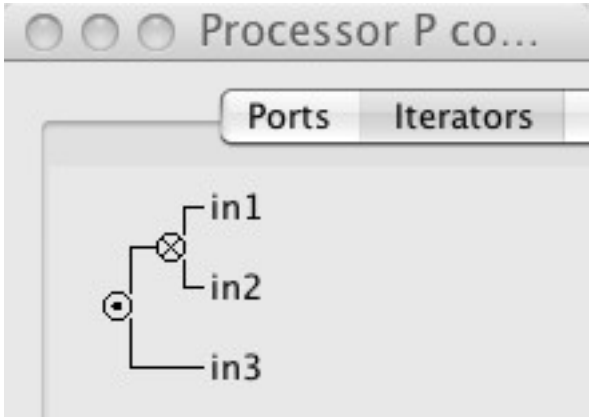


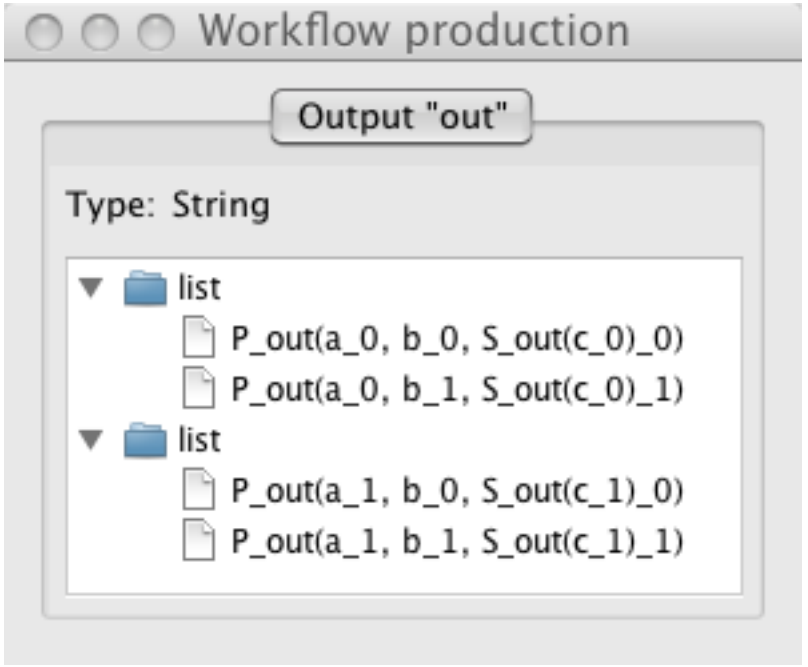


The input data set is a 4D image belonging to a single patient JM. The image sequence is composed of 2 volumes (labelled green and red). Each volume is composed of 4 slices.

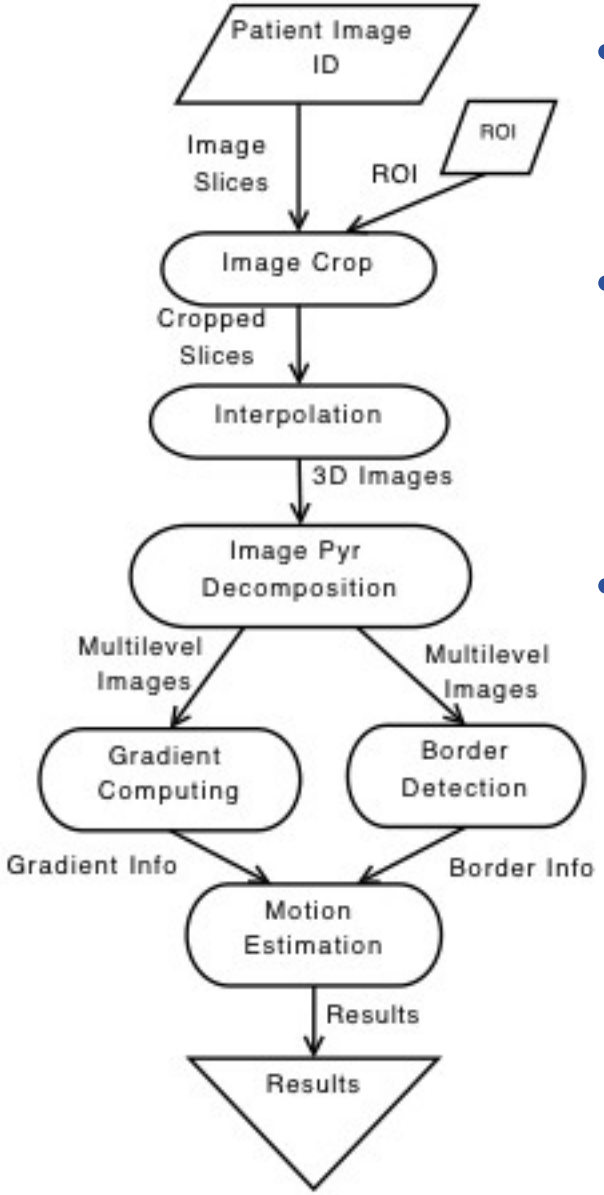
Workflow editor





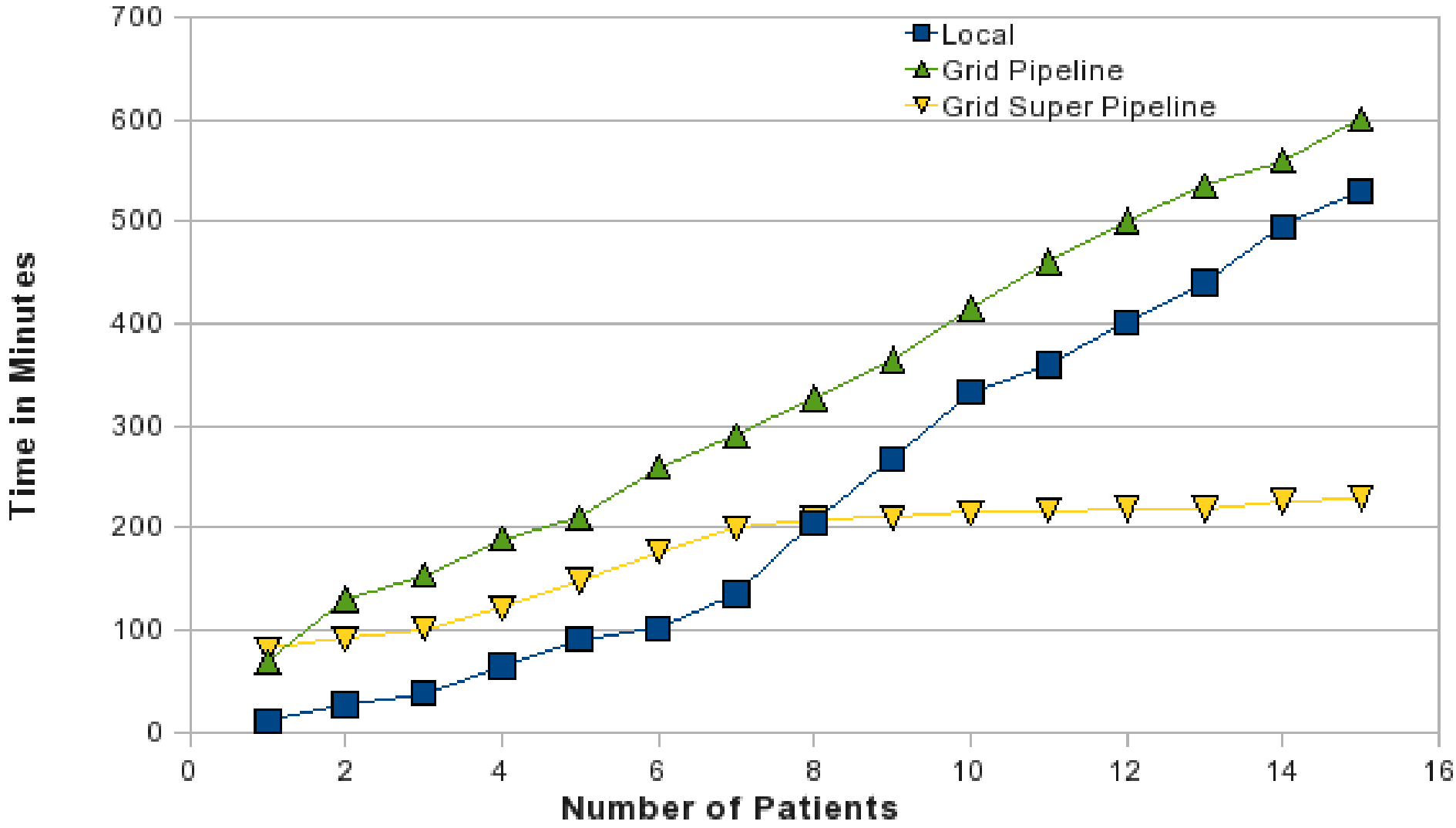


Motion estimation branch

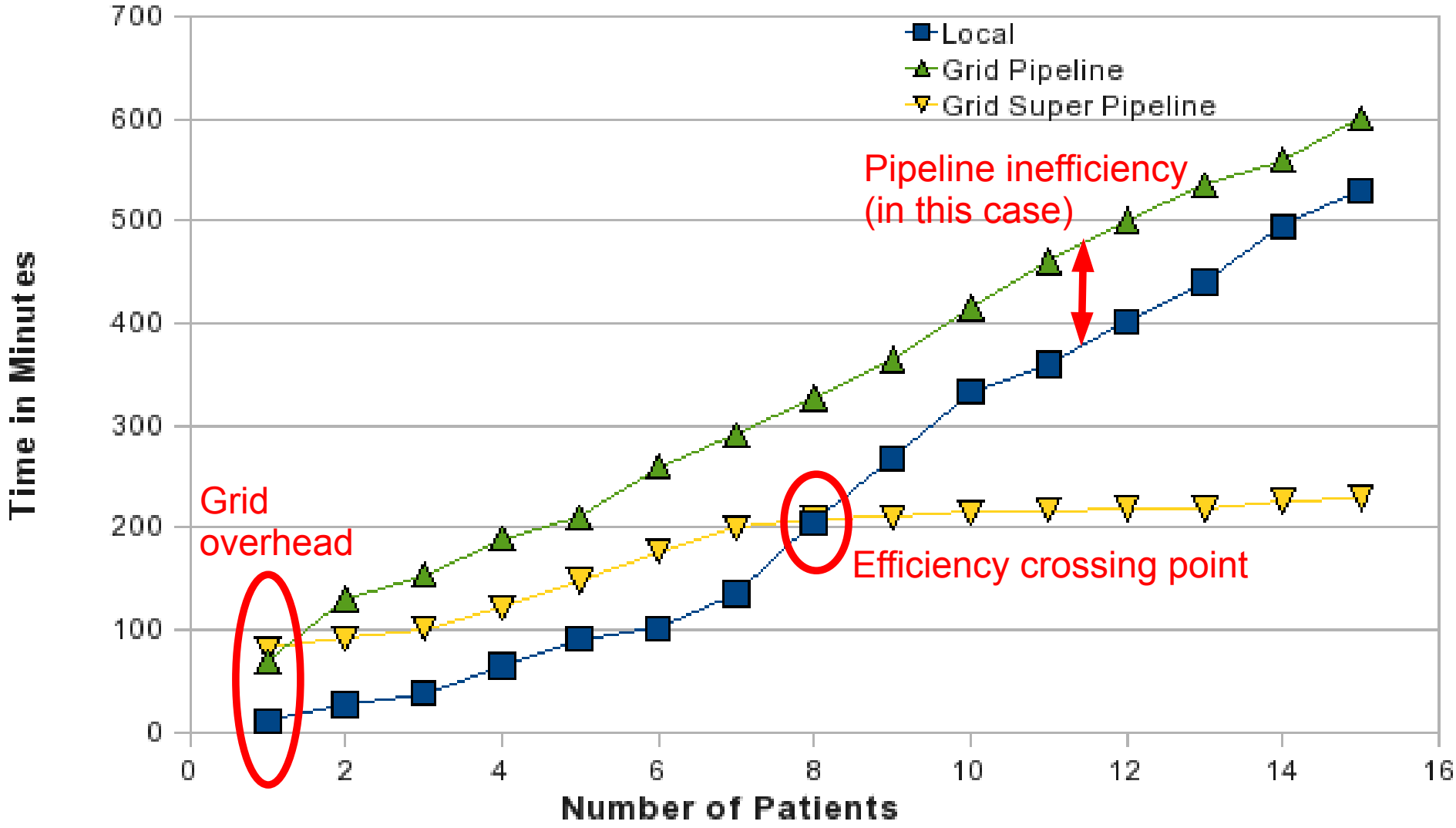


- **Taverna-2 plugin**
  - Prototype under development
  - http://modalis.i3s.unice.fr/softwares/start
- **Simplified data flow management**
  - Limitations related to Scufl / Web Services
  - Application support for data flow management
- **Several parallelization modes**
  - Pipelined (regular execution mode)
  - “Super-pipelining”: pipelining + data parallelism

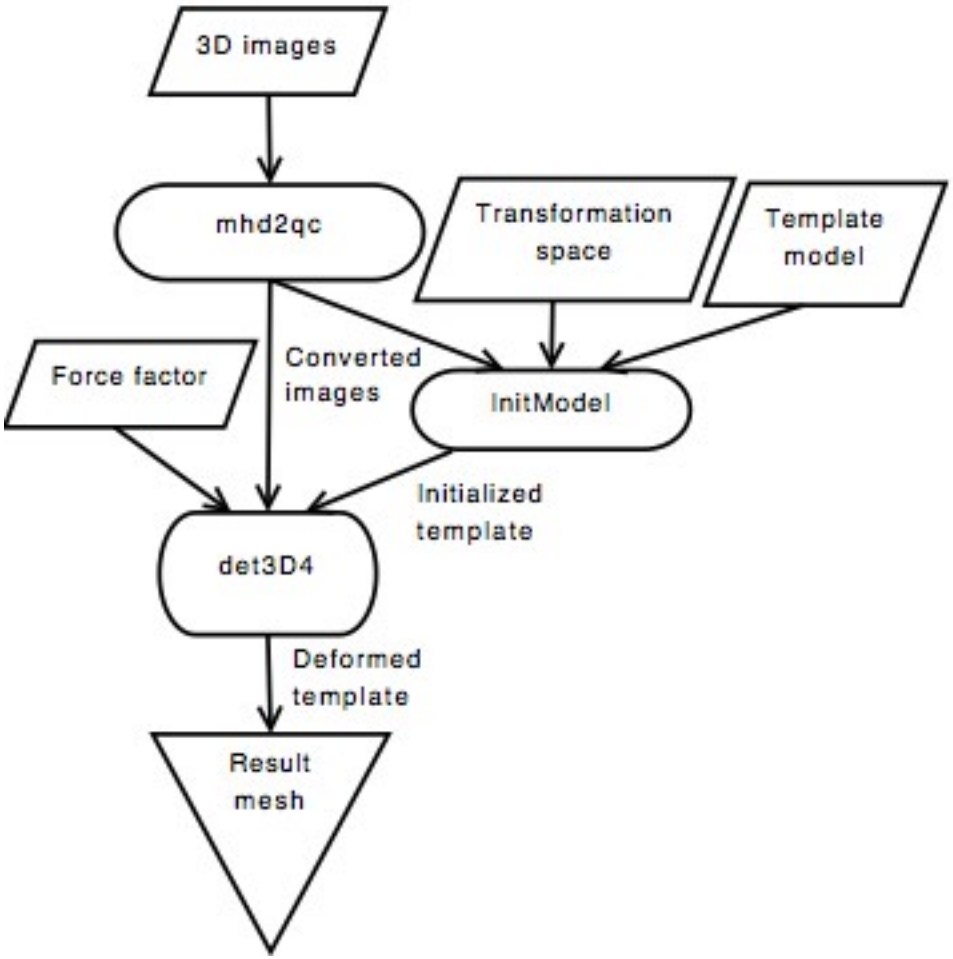
Grid performance



Grid performance



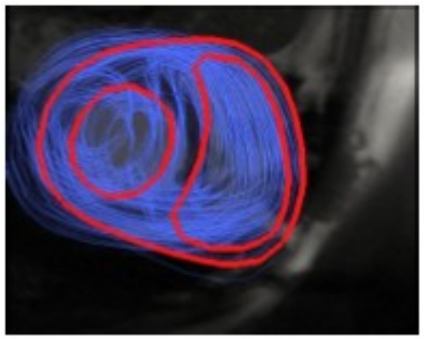
Segmentation branch



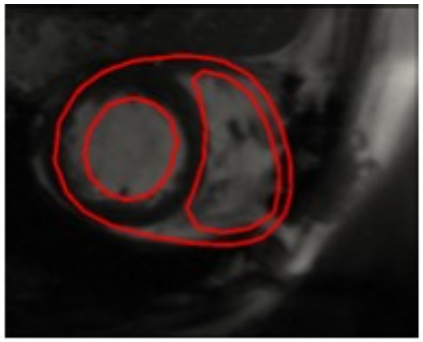
- **MOTEUR enactment**
- **Sensitive to**
  - Initialization
  - Deformable model parameters
- **Parameter sweep experiment**
  - Segmentation tuning

Parameter sweep results

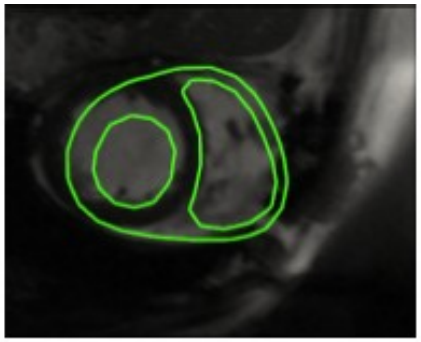
- **Variations of the initialization**



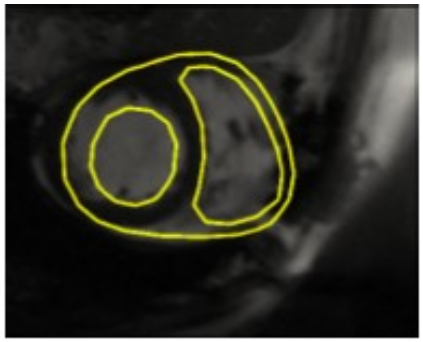
(a)



(b)
100 / 150 / 20°/ 2.1

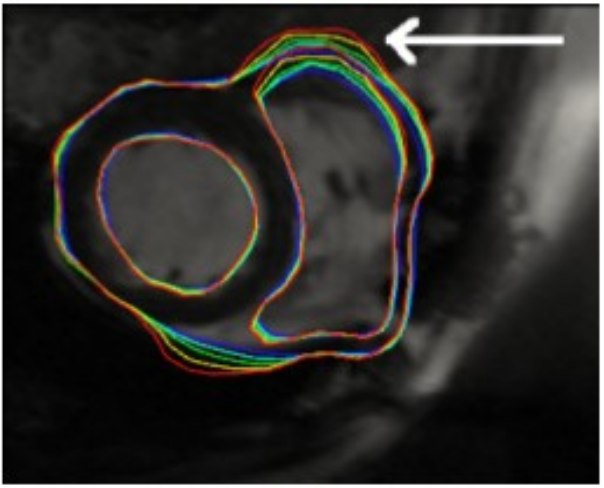


(c)
100 / 200 / 20°/ 1.9



(d)
100 / 150 / 10°/ 2.1

- **Variations of the deformation force factor**



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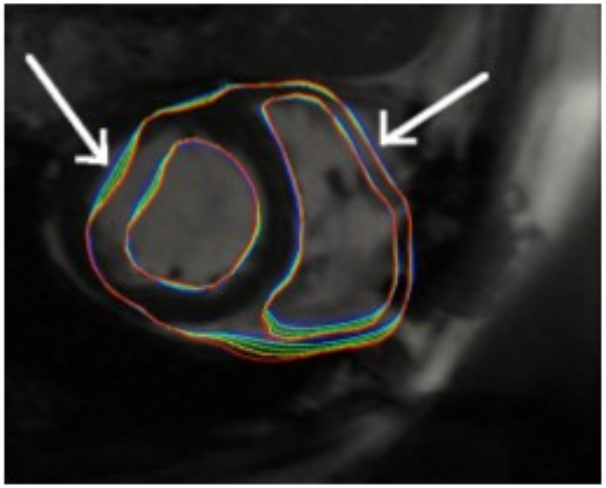

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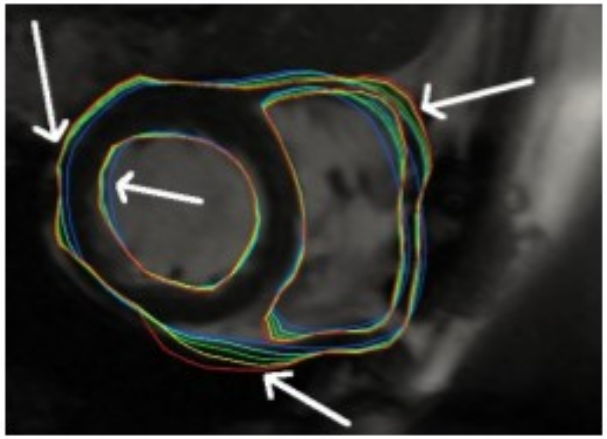

(d)

Conclusions

- **Grid enabled workflows**
  - Growing attention for large workflows workload distribution
  - Need specific representation languages and scalable workflow enactors
- **Cardiac application**
  - Complex data flow expressiveness
  - Grids tackle:
    - Large data sets (4D image sequences)
    - Application optimization (parameter sweep)
- **Workflow tools: users are agnostic as long as it works**
  - MOTEUR: http://modalis.i3s.unice.fr/softwares/moteur/start
  - DIET MA DAG: http://graal.ens-lyon.fr/~diet
  - Taverna2 gLite plug-in: http://modalis.i3s.unice.fr/softwares/start