Multi-workflow scheduling

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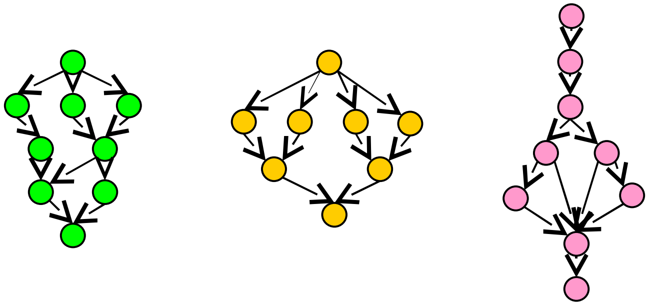
GRAAL project

http://graal.ens-lyon.fr

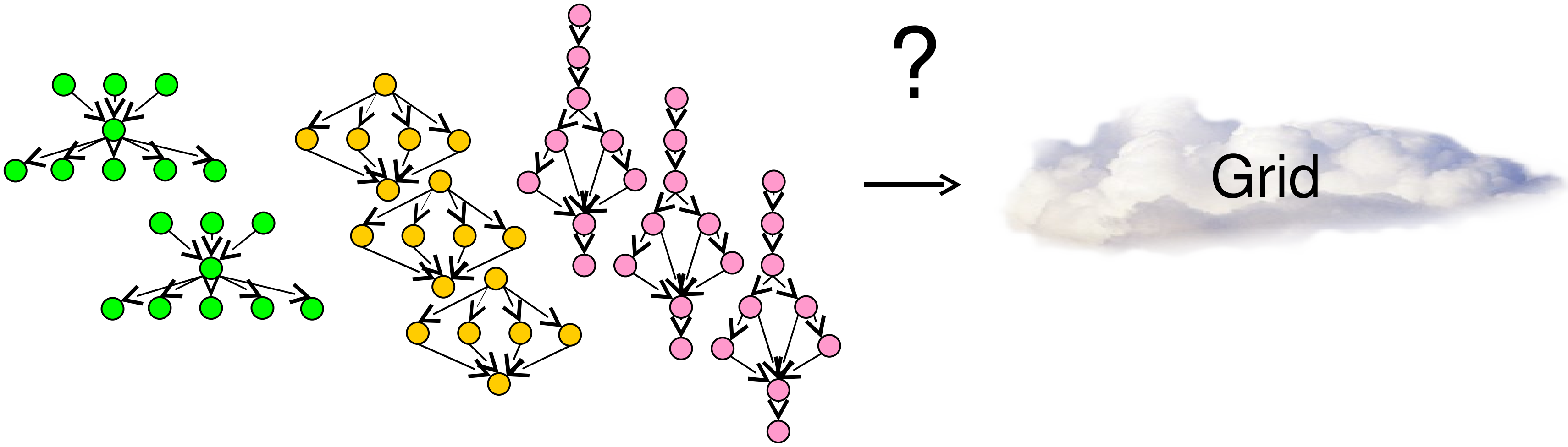


Introduction

- State of the problem
  - Workflow
  - Grid resources
  - Target applications
    - Pipealign
    - Docking
    - Robinson
    - Cosmology
  - Related work
- Heuristics for solve the problem
  - HEFT heuristic
  - Several other heuristics
  - Simulation
    - first observations
- DIET integration
- Next

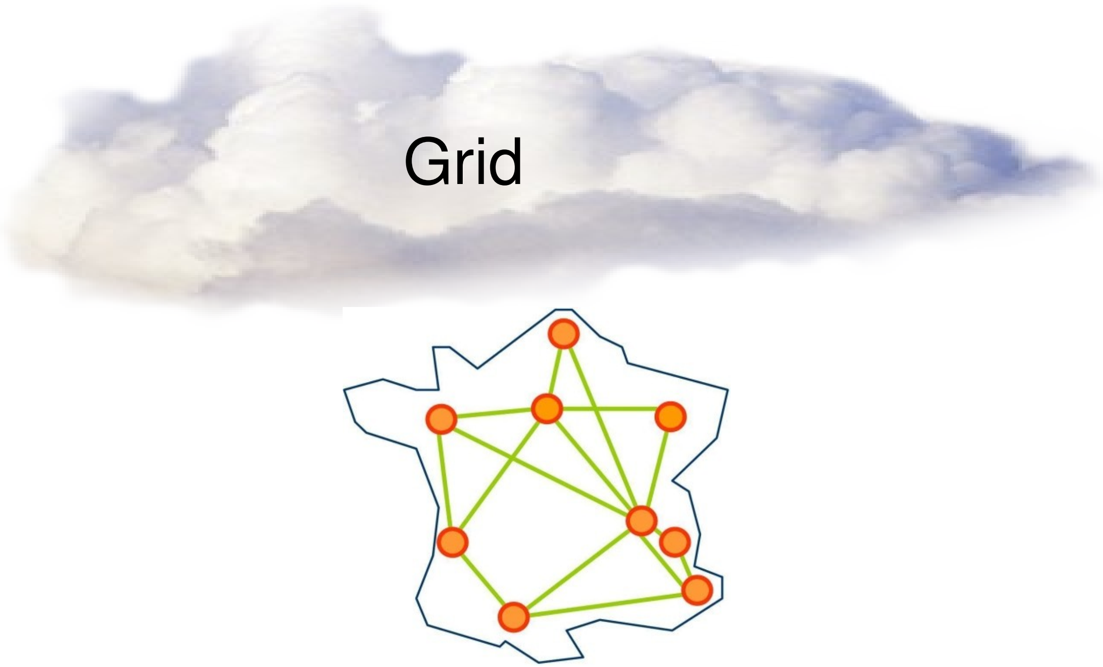
Problem

- Several users share grid computing resources (heterogeneous)
- Each user can launch an application (expressed with a workflow)
- Questions :
  - How can we schedule (ordering and allocation) tasks ?
  - Can we be fair ?



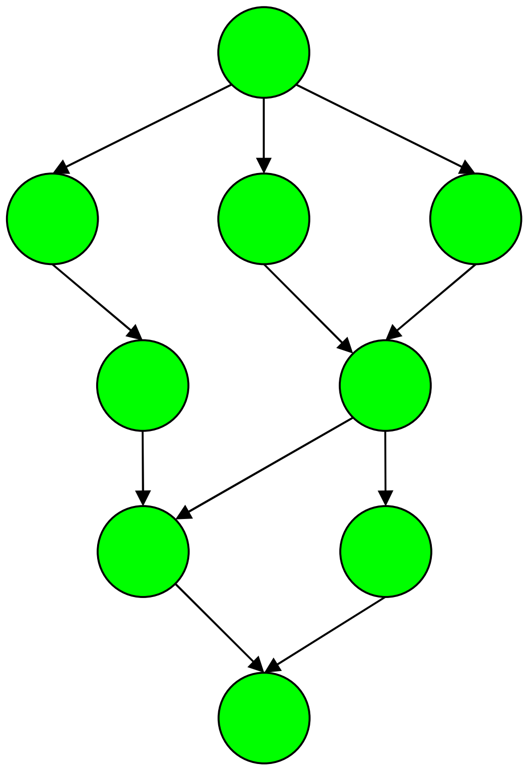
Definition : grid resources

- Grid resources are computing nodes fully interconnected
  - Interconnections are heterogeneous
  - Characteristics of resources are heterogeneous



Definition : workflow

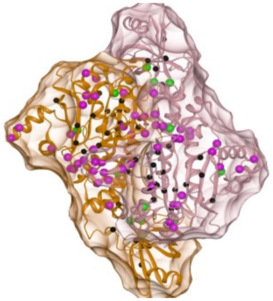
- Workflow definition :
  - Direct Acyclic Graph (DAG)
    - Each vertex is a task
    - Each directed edge represents a communication between tasks
- Questions :
  - Ordering problem ?
  - Mapping problem ?

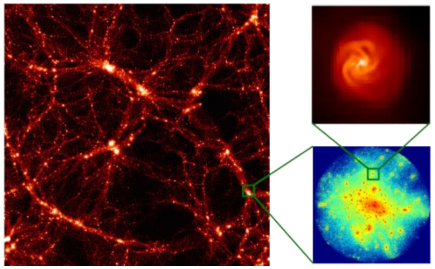


Targets applications

AFM CNRS CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE IBM

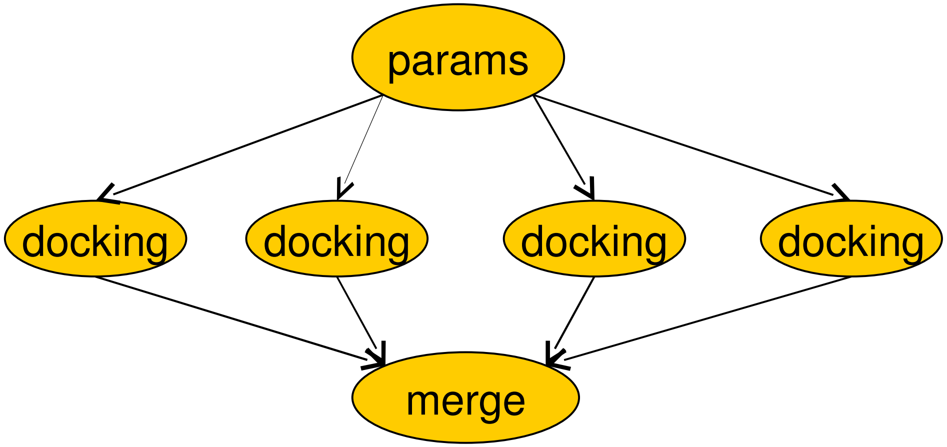
PROGRAMME DÉCRYPTHON



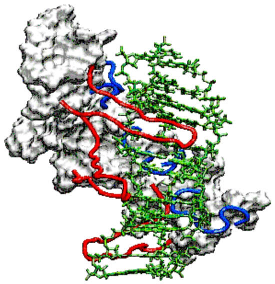


Docking Application

- Detection of protein-protein and protein-DNA interactions.
- Screening a database containing thousands of proteins for functional sites involved in binding to other proteins, DNA or ligand targets.



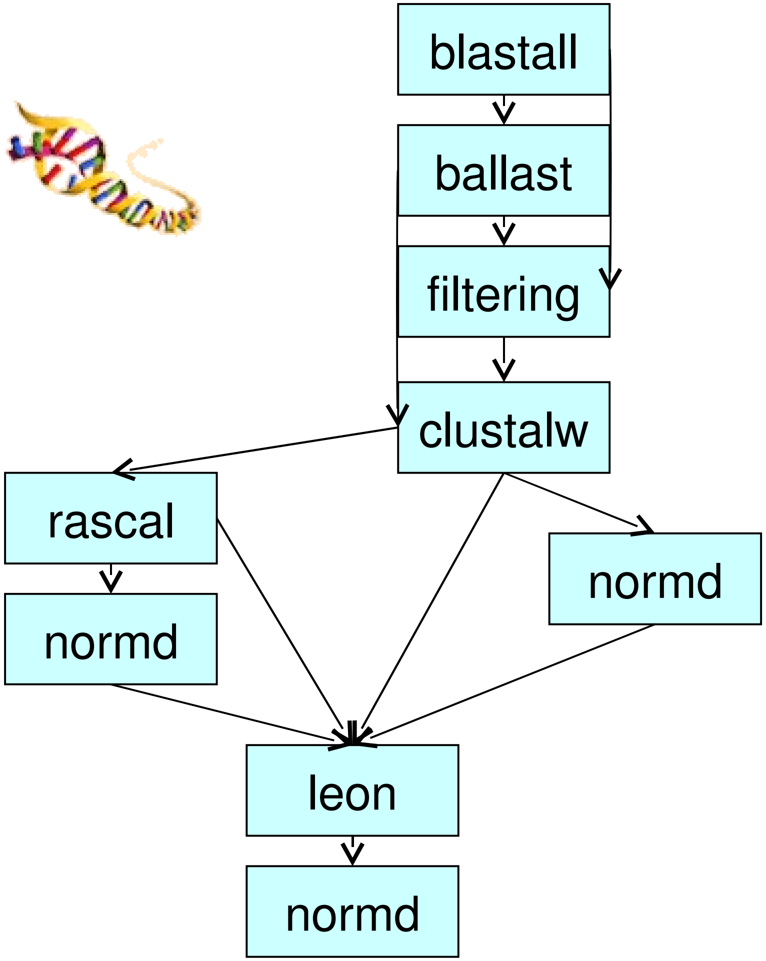
Génomique Analytique
Analytical Genomics



iBPC

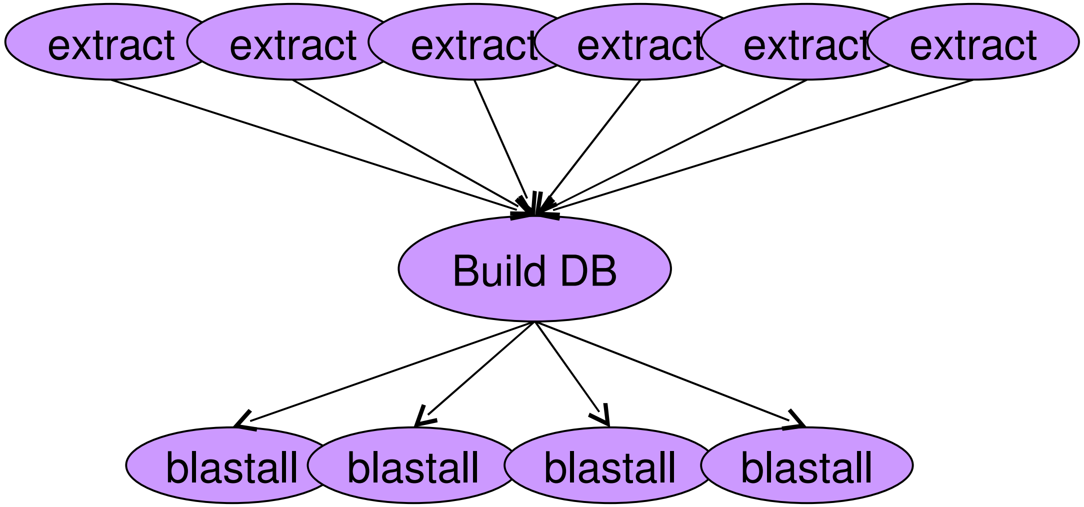
PipeAlign Application

- The sequence-to-function relationship can be understood through the analysis of conserved patterns and evolution of protein organization mainly based on amino acid sequence comparisons in the context of the multiple alignments.



Robinson application

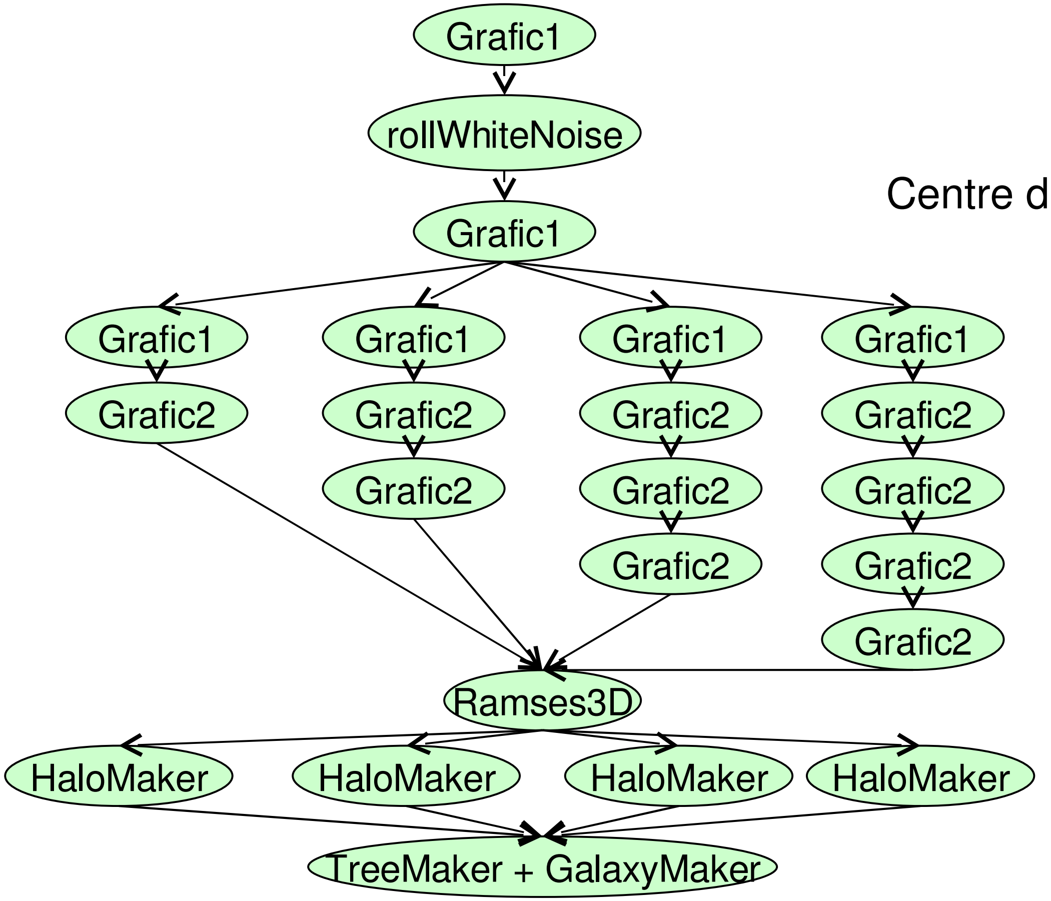
- This application annotate human genes according to their expression in neurological or muscular tissues, but also to the expression of their homolog other species.



Université de Lausanne
Faculté de biologie et de médecine
Département d'écologie et évolution

Cosmology application

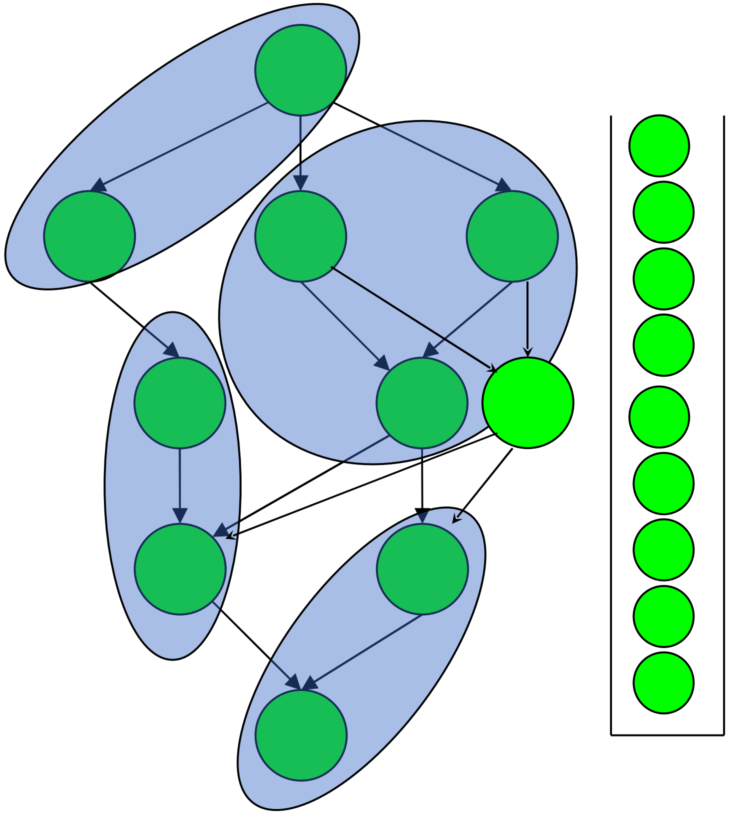
- Simulate the evolution of dark matter particules during time to compare it to the real observation.



Centre de Recherche en Astronomie de Lyon

Related work

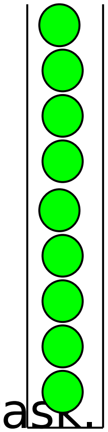
- List algorithms
- Clustering algorithms
- Duplication based algorithms
- Metaheuristics

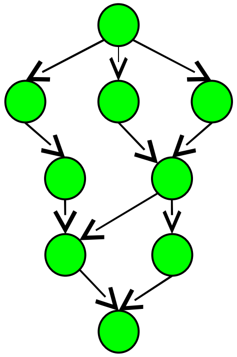


None for multi-workflows online

List Scheduling HEFT

- List scheduling : HEFT
  - Ordering
    - Set the weights of the tasks
    - Set the weights of the edges
    - Compute the rank (critical path, b-level) of each task.
    - Sort the tasks into a list L by non increasing order of their rank

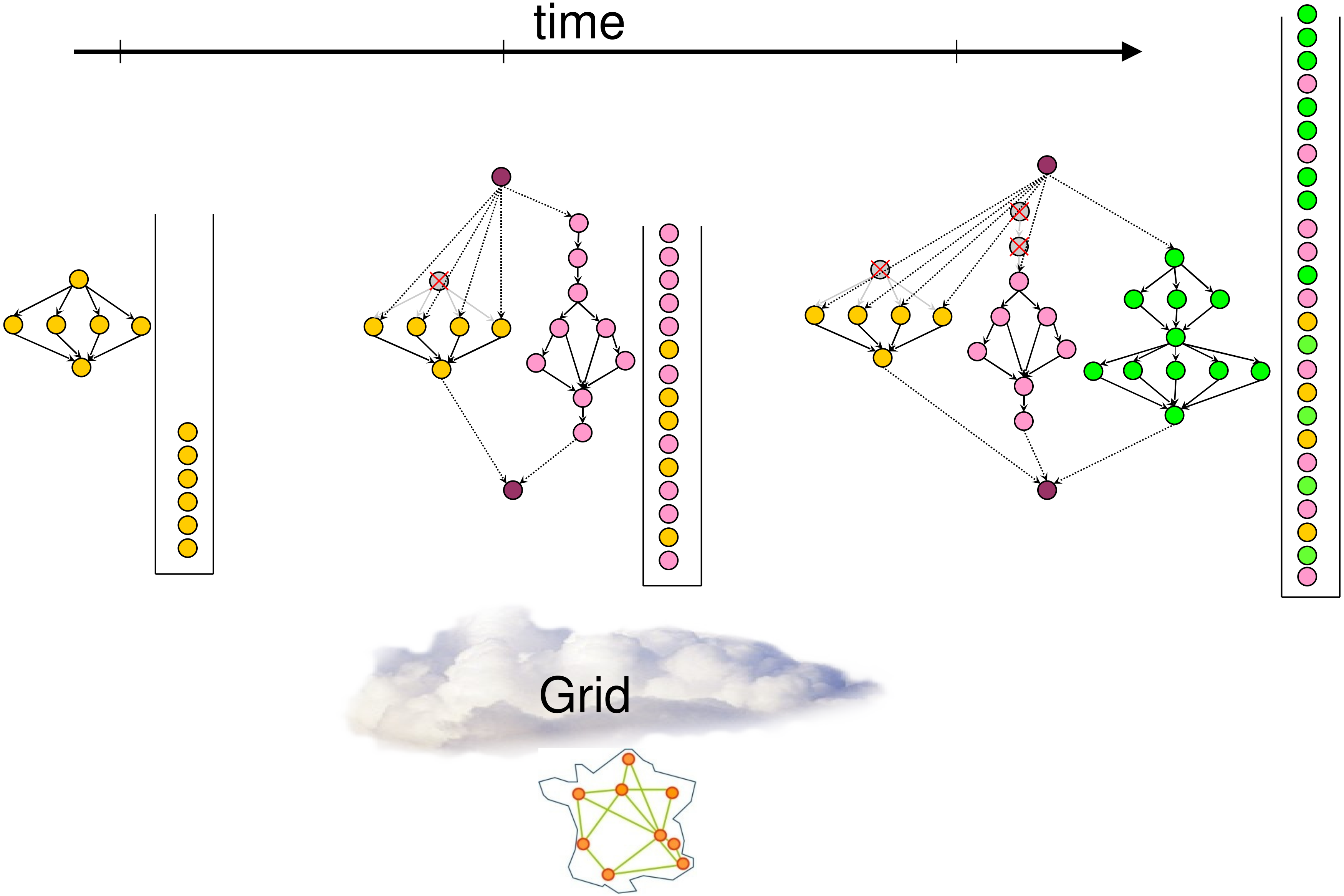




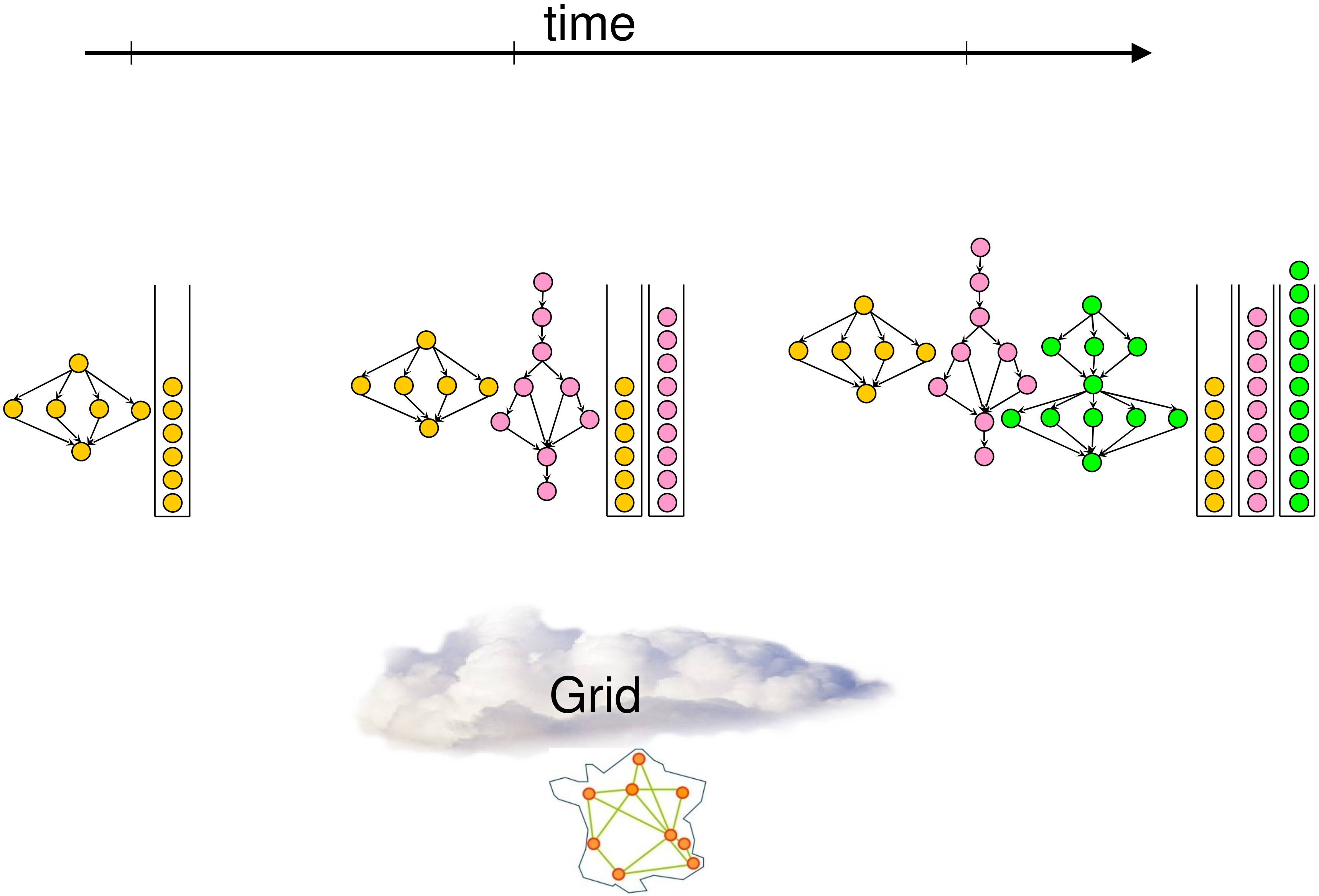
  - Mapping
    - While the list L of tasks is not empty
      - Select the first task t of the list L
      - Select the resource r that have the earliest finish time for the task t
      - Allocate task t on resource r
      - Remove t from list L.

Online extension for multiple DAGs

HEFT multi-dags online

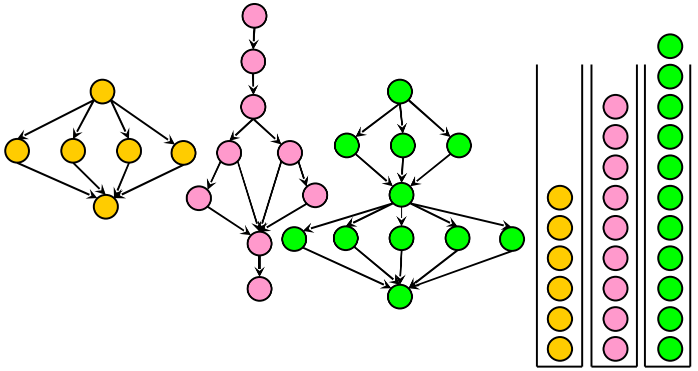


Other heuristic



Framework of heuristics

```
Each time a new DAG is submitted{
    - compute rank (critical path) of each DAG's tasks
    - Sort the DAG's tasks by non increasing order of their rank
    - put the DAG in a list D
    while there are unscheduled task {
            - select a DAG $d$ from the list D
            - select the first unscheduled task $t$ from DAG $d$
            - choose the EFT server $s$ for task $t$
            - allocate $t$ on $s$
    }
}
```



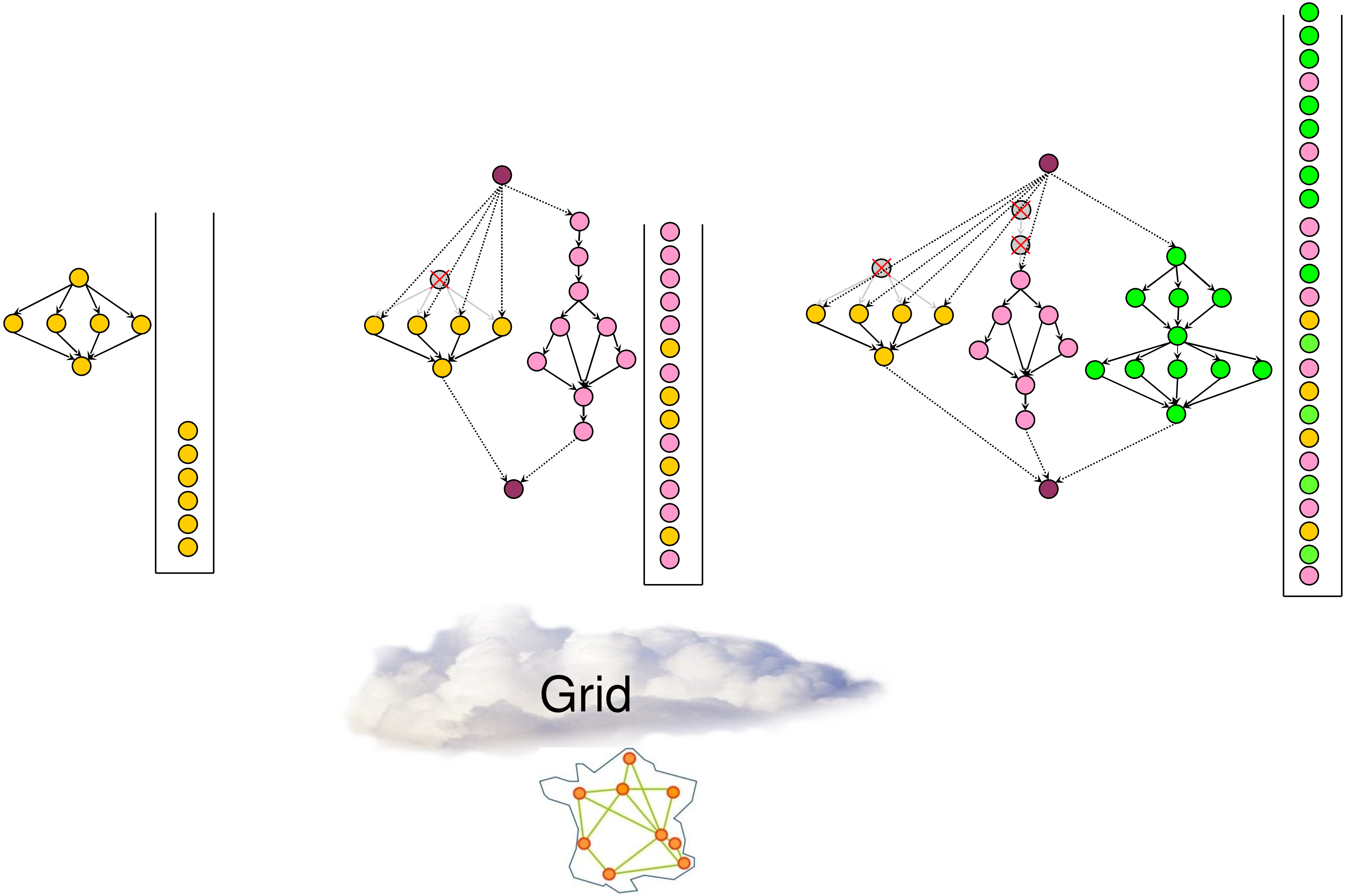
Implemented and tested heuristics

- Online Heuristics
  - F1
  - F1 oldness
  - F2
  - F2 oldness
  - Round Robin
  - Random
  - FIFO
  - SRPT
  - LRPT

  - HEFT
  - HEFT oldness

```
Each time a new DAG is submitted{
    - compute rank (critical path) of each DAG's tasks
    - Sort the DAG's tasks by non increasing order of their rank
    - put the DAG in a list D
    while there are unscheduled task {
            - select a DAG d from the list D
            - select the first unscheduled task t from DAG d
            - choose the EFT server s for task t
            - allocate t on s
    }
}
```

HEFT oldness multi-dags online



Simulation :

- Need simulation to simply compare heuristics
- Write a simulation software for testing heuristics

- Explore the space of possible variations
  - Submission time
  - Resources : number, homogeneous, heterogeneous
  - DAG (shape, number and size of the tasks)

demo

First observations

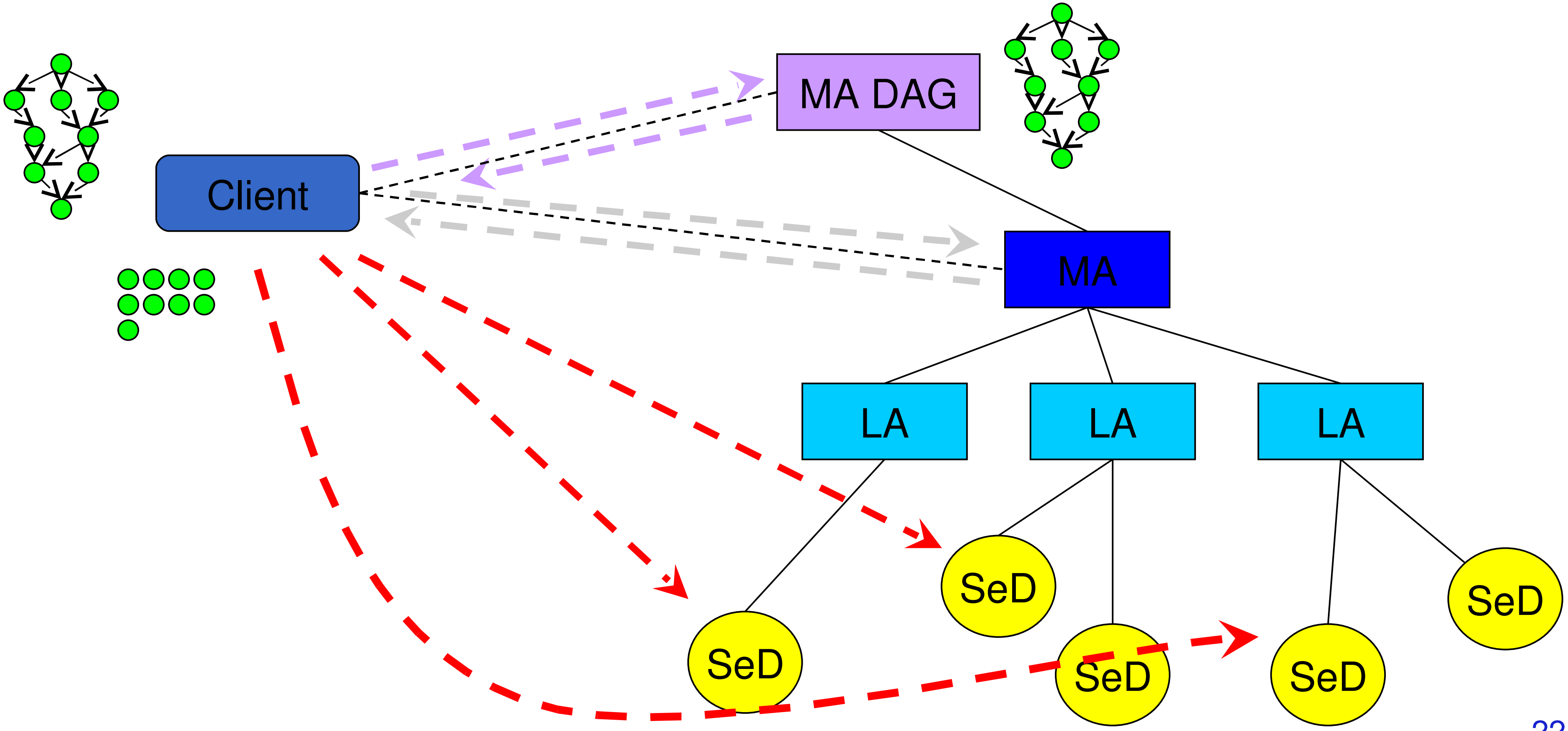
- Oldness :
  - Improve average flow with comparable makespan
- Round Robin heuristics
  - RR1 & RR4
  - RR2 & RR3
- Fairness :
  - F1, F2 do not have expected behaviours.
  - FIFO, SRPT, HEFT oldness performed well.
  - Fairness vs. makespan optimization
- General remarks :
  - SRPT advantage small DAGs (in terms of CP)
- Important parameters :
  - Arrival time and type of DAGs

Need a table to
summarize observations

Multi-workflows and DIET

MultiWorkflow in DIET

- Meta scheduler distributed in the client and in the MA-DAG (Abdelkader)



Next

- Make a complete survey of the behavior of the heuristics

- Try to make a classification of heuristics against dags types
  - Criteria:
    - Makespan : i.e. length of the critical path
    - Total amount of work (sum of w_i)
    - DAG’s shapes
    - Some others

- Add heuristics based on other ordering and resource selection criteria
  - Example : SDC, DLS

- Test heuristics on a real environment : DIET + applications

- Dynamic DAGs ?

Questions ?