Pawel Czarnul, 2014. Comparison of selected algorithms for scheduling workflow applications with dynamically changing service availability. *Journal of Zhejiang University-SCIENCE C (Computers & Electronics)*, **15**(6):401-422. [doi:10.1631/jzus.C1300270]

# Comparison of selected algorithms for scheduling workflow applications with dynamically changing service availability

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**Key words:** Scheduling of workflow applications, Workflow management environment, Scheduling algorithms

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# Introduction

- Workflow applications have become widespread in various fields of study and context such as:
  - Scheduling in utility grids
  - Business applications
- There is a need for workflow scheduling algorithms that would cope with dynamic changes in the environment such as variable service availability
- Rescheduling is needed if:
  - Previously selected services have become unavailable
  - New services have appeared
  - Conditions of services have changed

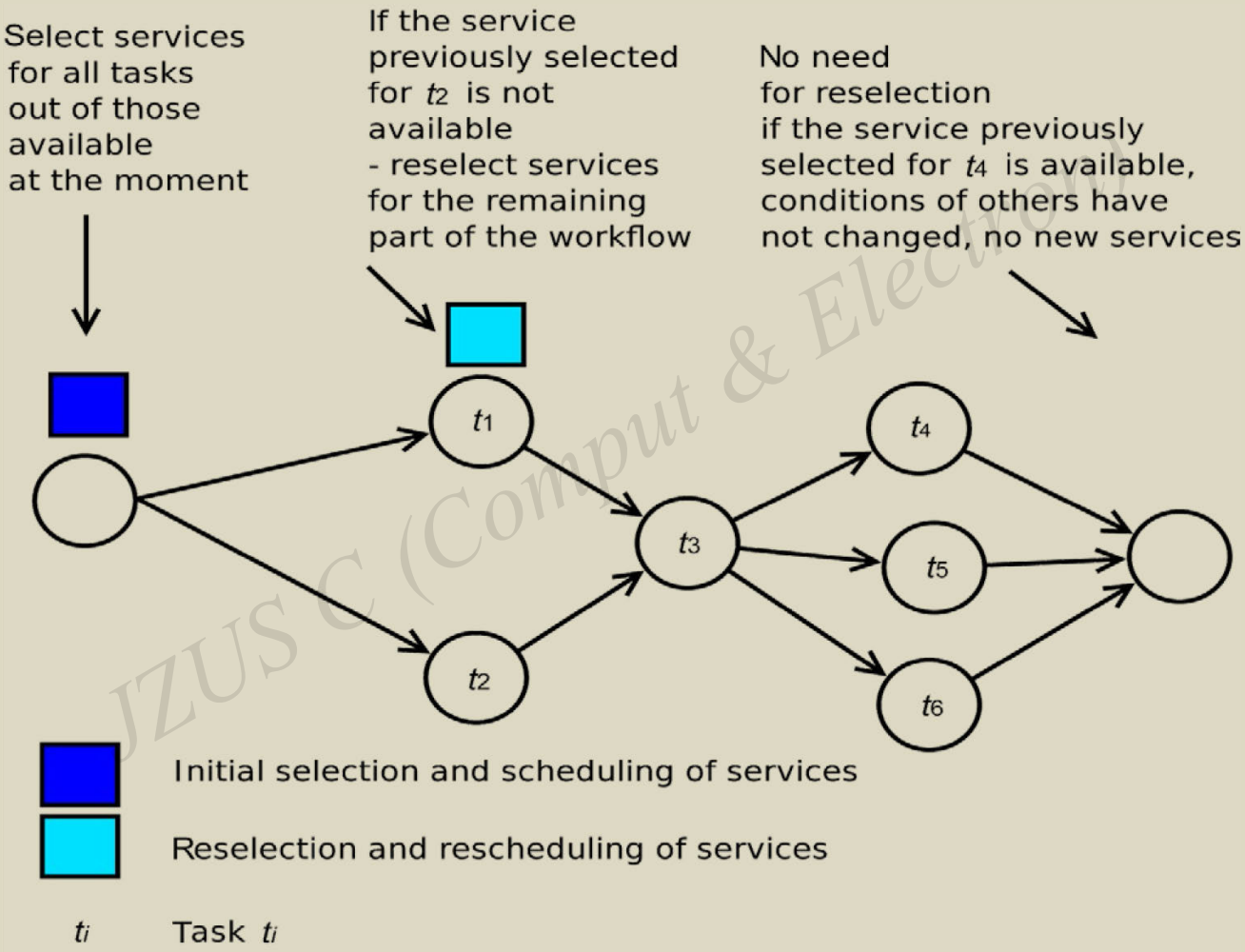
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# Contribution

- A detailed side-by-side performance-cost comparison of the following algorithms is made:
  - Integer Linear Programming (ILP), heuristic (ILPHEU)
  - Divide-and-conquer (DaC)
  - Genetic algorithm (GA)
  - GAIN
- Comparison is performed in a dynamic environment with changeable service availability and potentially other QoS parameters
- The optimization goal is to minimize the workflow execution time with an upper bound on the cost of selected services

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# Dynamic workflow scheduling




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**Workflow application scheduling with changing service availability and parameters**

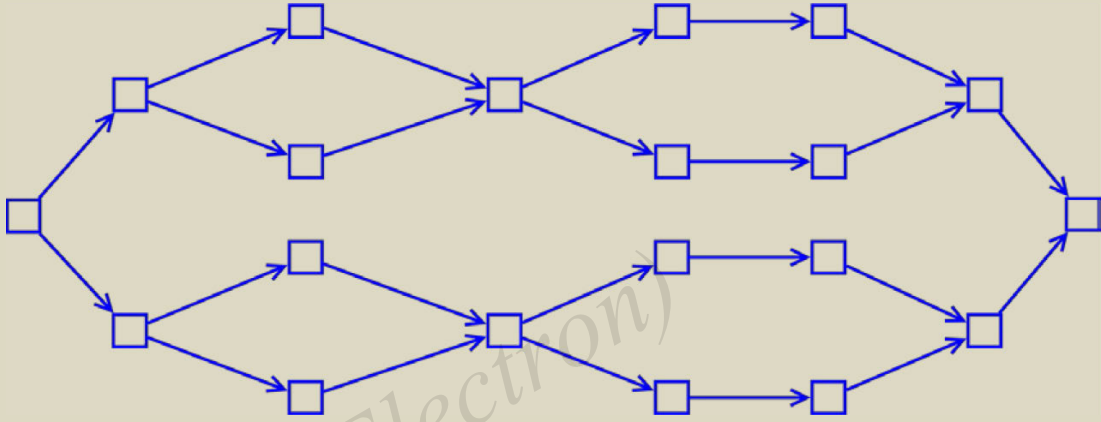
# Testbed workflow applications and environment

- Tests are performed for several balanced and imbalanced workflow applications:
  - Number of tasks (nodes) ranging from 6 up to 102
  - Number of services ranging from 30 to 418
  - Probability of change in service parameters or service unavailability before task is to be executed from 0 to 0.6
  - Execution times of workflow scheduling algorithm considered in the workflow execution time
- Comparison is performed in real environment BeesyCluster – middleware for integration of services from various HPC and off-the-shelf servers and systems

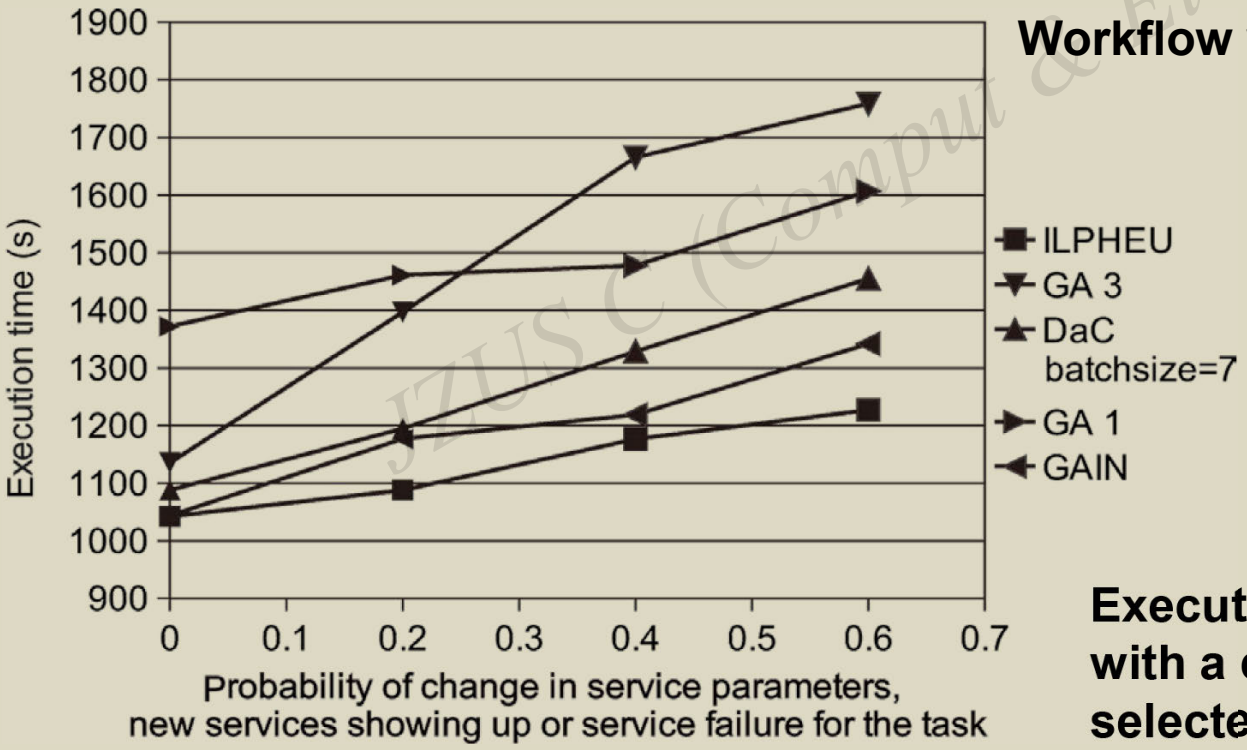
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# Sample results (I)



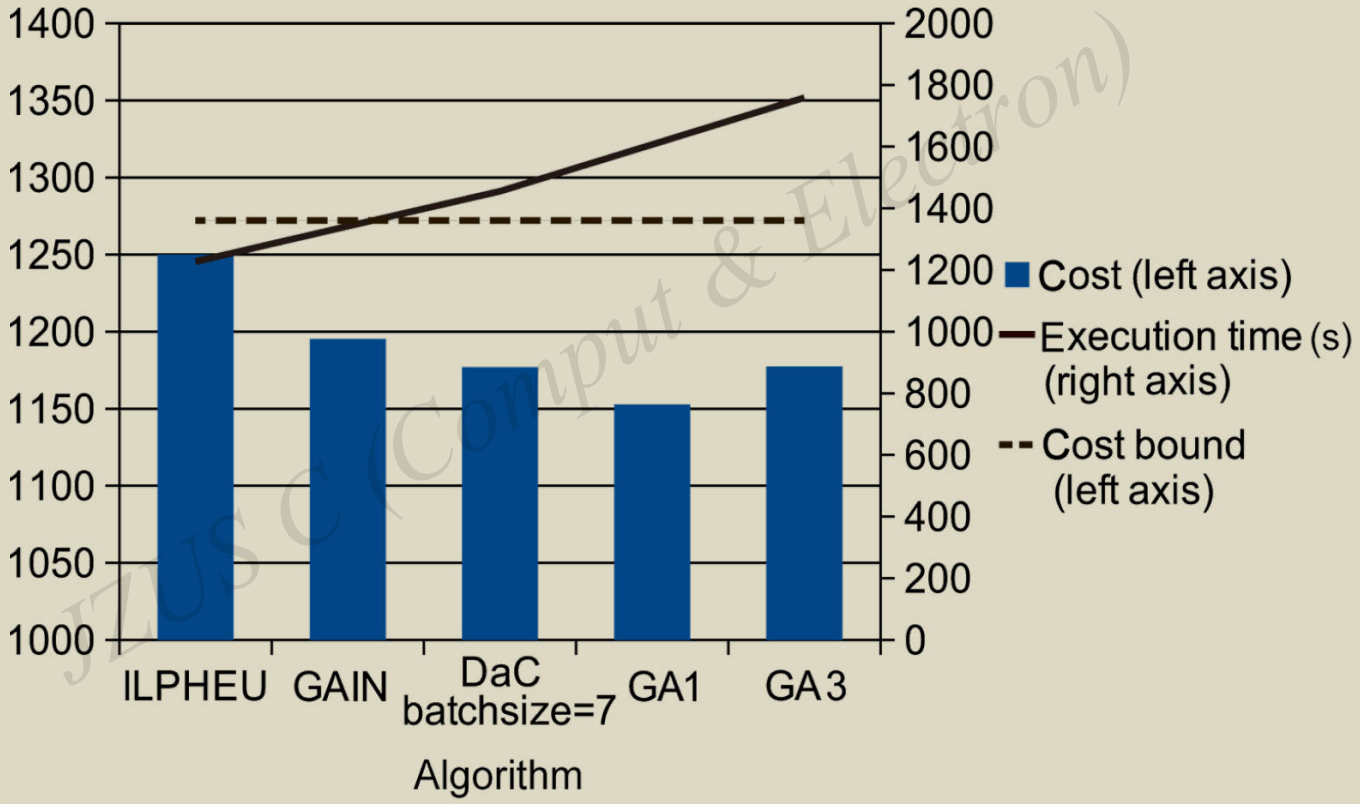
Workflow with 20 nodes, 200 services




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**Execution time of the workflow with a constraint on the cost of selected services**

# Sample results (II)




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**Execution times and costs for algorithms with 20 nodes, 200 services**

# Conclusions

- For small problems, the algorithms from best to worst are: ILP, DaC, GAIN, GA.
- For mid-sized problems up to 40 workflow nodes, the algorithms from best to worst are: ILPHEU, GAIN, DaC, GA.
- For large workflows with over 100 nodes and several hundred services, the algorithms from best to worst are: ILPHEU, DaC, GAIN, GA.

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