Project management and scheduling under *OFBiz*

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Plan

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Context

context

- A Phd thesis entitled: Resolution methods for multi-skill project scheduling problems [2010-2013]
- Collaboration between Néréide and Scheduling team (OC team) of the Computer science Laboratory of University of Tours (Polytechnic school of Tours)

Context

Involved parties

- Néréide: An ERP integrator, especially Apache Open for Business solutions.
- OC team: specialized in scheduling problems and decision aid problems. It is attached to CNRS [a] (ERL CNRS 6305)

Figure: Practitioner cooperate with academician around *OFBiz*

[a] National center for scientific research(http://www.cnrs.fr/)

Context

Objective

- Define one or more project scheduling model, taking into account resource availabilities and skills
- Propose good scheduling methods for these models
- Integrate these models as will as proposed solutions into *OFBiz* as add-ons

Results

Academic results

- 3 national conferences (ROADEF'2010, ROADEF'2011, ROADEF'2012)
- 3 international conferences (IESM'2011, OR'2011, PMS'2012)
- a scientific paper is going to be submitted in an international journal before the end of this year

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Results

Practical results

- Integration of *Drools* into *OFBiz* through an add-on
- User defined rules for tasks priorities
- Two project scheduling models are studied
- Add-ons integrating the first model are developed and can be used for demonstration on *OFBiz*
- Project generator for both models is implemented, to generate a project demo data automatically
- Developed models work with any time periodicity (hourly, daily, etc,..)

All developments are accessible with *GPL* license

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Introduction

- A project is a set of tasks that must be realized with respect to some constraints and at aim to optimize one or more objectives
- A task is characterized in general by a workload (expressed in man/day or other), and an execution time (start date, completion date)
- Tasks are submitted to precedence relationships (a task T_i cannot start before the end of task T_j)
- To realize a task, one or more resources (human resources, machines, etc) are needed

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More task characteristics ...

- A task can have a release date, a due date or a deadline
- The resource requirement can be expressed in terms of skills
- A cost can be associated to a task directly or deduced from its duration and/or assigned resources
- A task can be allowed or not to be interrupted during its execution and resumed later, we called it a preemptive task
- If a task has a due date then it has a tardiness which is equivalent to the difference between its actual completion time and its due date
- Another notion called lateness which is zero if the actual completion time is before or equal the due date, and the difference between these two dates else.

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Resources main characteristics

Three main type of resources can be distinguished:

1. Renewable resources (machine available per day)
2. Nonrenewable resources (money)
3. Doubly constrained resources (Project budget (limited per period and globally))

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Resources main characteristics

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In all cases availability and skills of resources are always considered.

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Project scheduling objectives

1. Minimize the project completion time
2. Minimize the cost of project
3. Minimize the number of delayed tasks
4. etc.

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Project scheduling objectives

1. Minimize the project completion time
2. Minimize the cost of project
3. Minimize the number of delayed tasks
4. etc.

Two or more objectives can be considered simultaneously

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Classical approach

1. Identify tasks
2. Estimate task durations
3. Establish relations between tasks
4. Allocate necessary resources to each task
5. Make a planning

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Some questions

1. How to allocate resources if many possibilities exist ?
2. How to verify manually the availability of each resource ?
3. How to be sure that the resource assigned to a task is able to do it ?
4. How to be sure that your schedule is optimal or near to optimal with respect to the criteria to be optimized (Project completion date, project cost, etc.)

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Project scheduling applications

The project scheduling problems are useful for many industrial applications

1. Construction projects
2. Software development projects
3. Many project scheduling models are a generalization of production scheduling (Job-shop scheduling)

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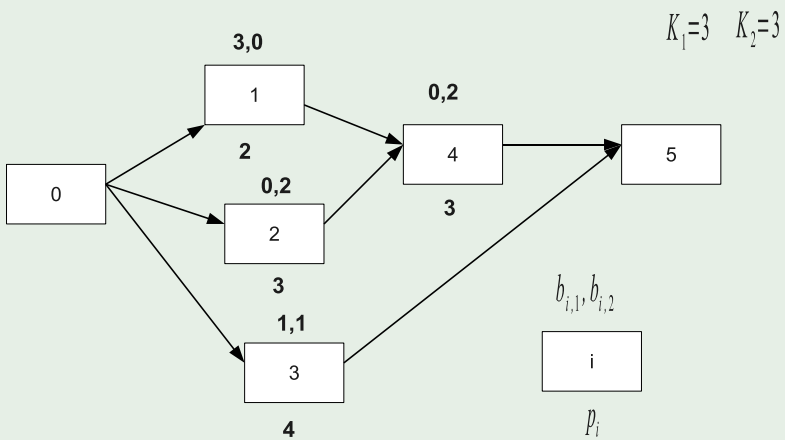
Example of resource constrained scheduling

The well known project scheduling model called *RCPSP* for (Resource constrained project scheduling problem) is described in the following example

Example



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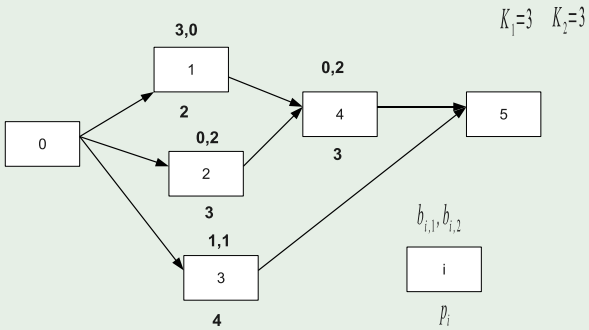

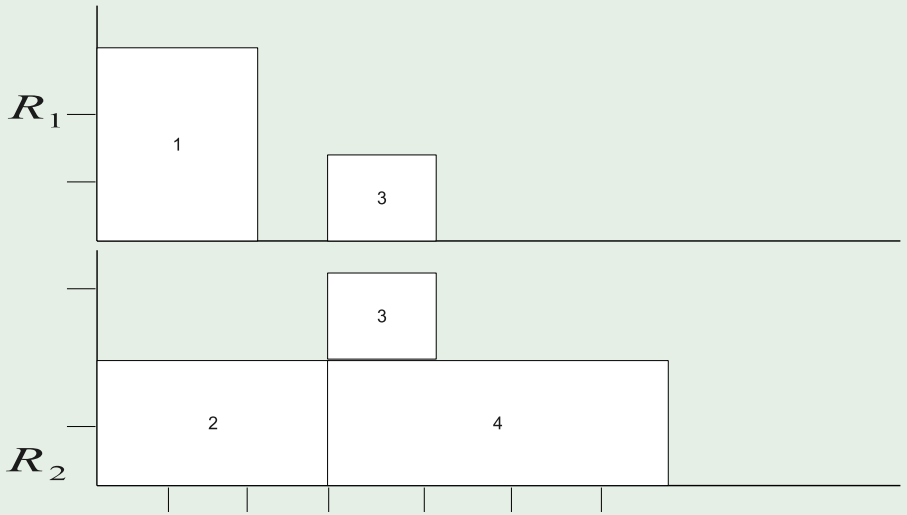

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What change when skills are considered

- Task has no dedicated resources
- More than one assignment is possible for a task

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What change when skills are considered

- Task has no dedicated resources
- More than one assignment is possible for a task

⇒ **Resources assignment becomes non trivial**

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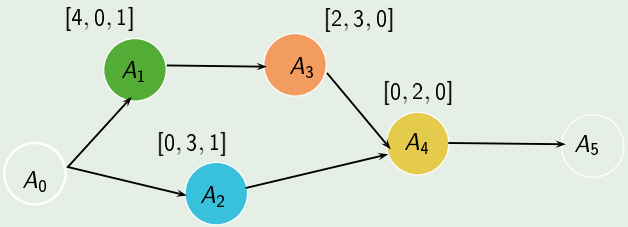
Model I : Preemption and synchronization

Example



Person	*analysis*	*web*	*DB*	*Unvailability*
P_1	1	1	1	[4, 5[
P_2	1	0	1	[5, 6[
P_3	1	1	0	-

- Skills synchronization
- Preemption for certain tasks
- One person per skill during task execution

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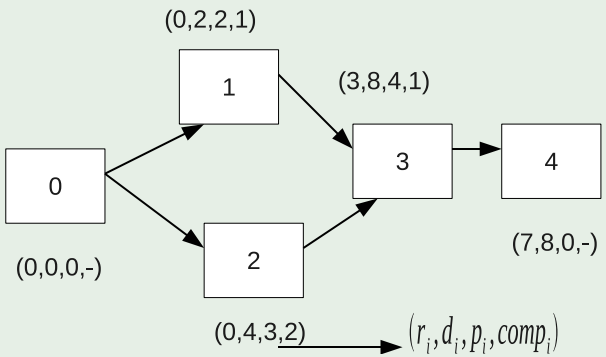
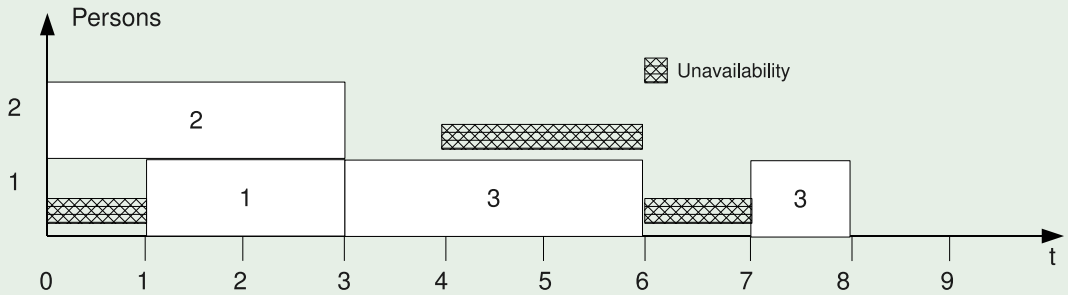
Model II : One skill per task, release and due dates, preemption only by unavailability

Example



Persons	Skill1	Skill2	unavailability
P1	1	-	[0,1] U[6,7]
P2	1	3	[4,6]



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Resolution methods

1. Exact methods
   - Brute-force search
   - Linear programming
   - etc.
2. Heuristic methods
   - glutton algorithm
   - Meta-heuristics
   - ...

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Process

1. Project selection : first estimation of time and cost can be done using scheduling algorithm
2. If the project is contracted and has to be released
   - a project team is selected
   - task requests per skill is estimated in hours, day, half a day or other time unit measure
   - time slots of availability for the project is associated to each worker
   - the project manager or planning responsible person apply the scheduling algorithm
3. if no feasible solution found, he can try with other parameters (give more time, etc), or add more resources availability
4. if a solution is found, each staff member has an access to his planning

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Heuristic algorithm

Require: $\mathcal{A}$: set of activities to be scheduled
  $t \leftarrow 0$
  while $\mathcal{A} \neq \phi$ and $t < horizon$ **do**
    ES^t: set of eligible tasks at t, sorted according to priority rule $R1$
    $i = 0$
    while $i < |ES^t|$ **do**
      $feasible \leftarrow TrySchedule(ES^t(i), t)$
      if *feasible* **then**
        $\mathcal{A} \leftarrow \mathcal{A} \setminus ES^t(i)$
      end if
      $i \leftarrow i + 1$
    end while$t \leftarrow nextEvent()$
  end while

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Demo data generator

- based on PSPLIB instances(http://129.187.106.231/psplib/)
- configurable interface to manage the different project parameters (number of skills, number of persons, etc.)

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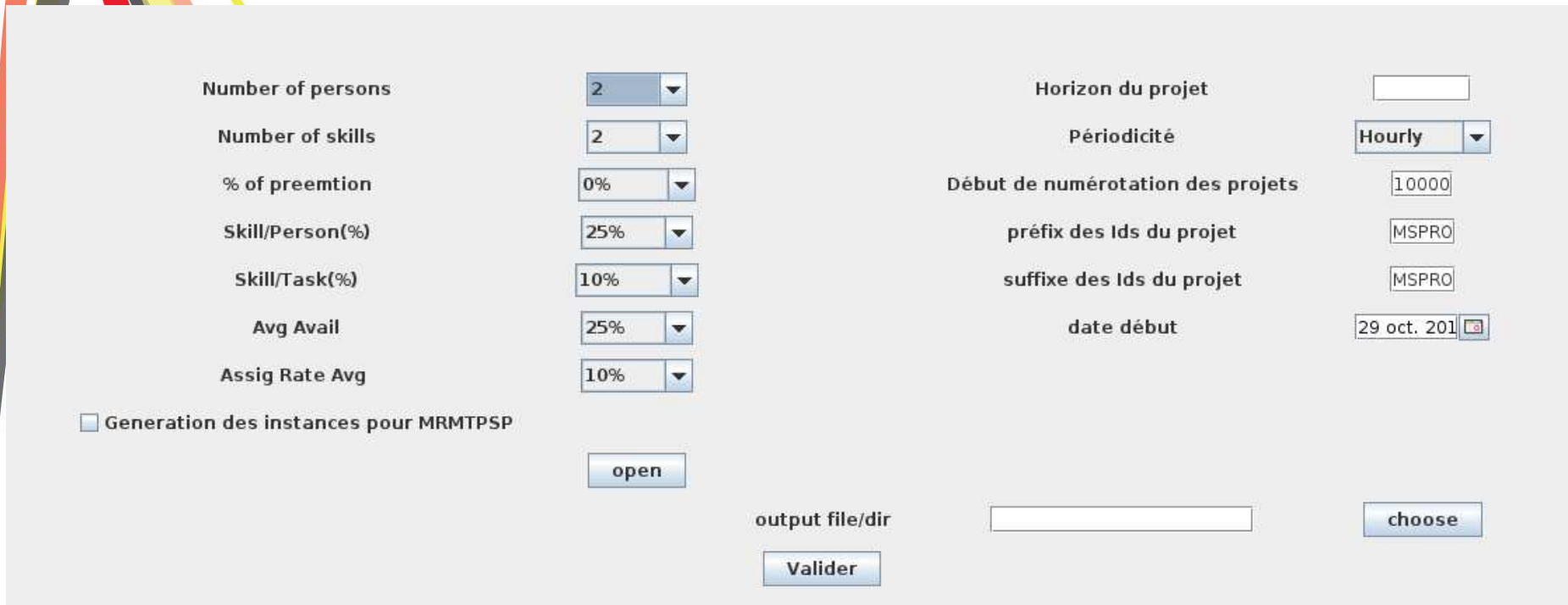

Quality measure

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Quality measure

Can we know whether the solution was good ?

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Quality measure

Can we know whether the solution was good ?

Answer

- compare it, with the best known method if exists
- developing good lower bounds (in case of minimization) and then compare with them

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Process in case of disruption

- Disruption is unavoidable during project execution
- A disruption may be due to task request underestimation, new tasks that was not consider at the beginning, worker unexpected absence

How to deal with it

- Fix the schedule ?
- Reschedule from scratch the remaining activities ?
- Other approach ?

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Our approach

- Reschedule the remaining tasks but ...
- Don't change assignment for tasks in progress
- In addition to the original optimized criteria, we minimize the maximum assignment change with respect to the actual planning (so, we try to keep assigned tasks to each person as much as possible identical to these in actual planning)

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Somme conclusions

Conclusion

- Two models of project scheduling considering skilled-resources are studied
- Resolution methods are proposed and implemented
- Add-ons, integrating algorithmic solutions to *OFBiz*

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Somme conclusions

Conclusion

- Two models of project scheduling considering skilled-resources are studied
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Ongoing works

- Integrating all methods into *OFBiz* as add-ons
- Add a multi-skill project scheduling module in the *ofbiz-extra*

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Thank you !

Questions ?

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