Scheduling and Analys of Limited-Preemptive Modable Gang Tasks

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TU Delft

What is gang?

- Parallel threads executed together as a “gang”
- Execution does not start until there are enough free cores

First of all, let’s explain what gang scheduling is.

It’s the execution of multiple parallel threads together as a “gang”. In these threads the execution does not start until there are enough cores to execute them together.
Let’s see an example:<click>

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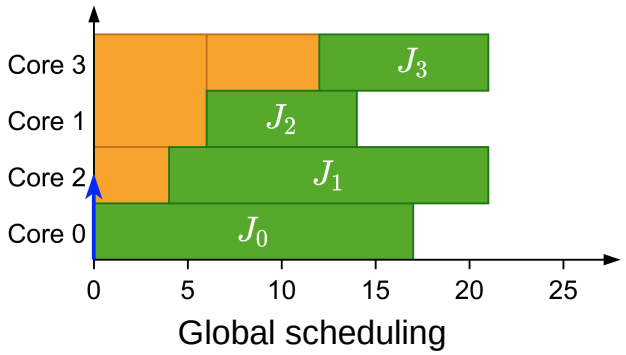

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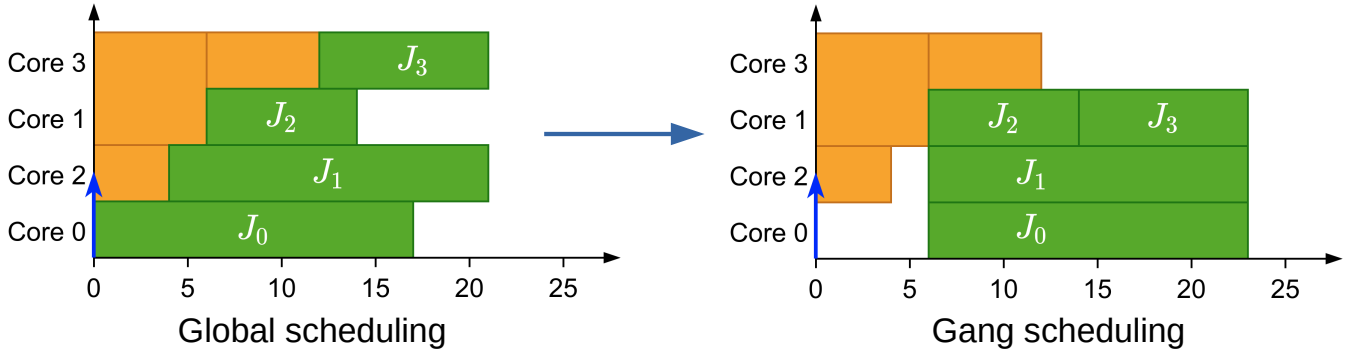

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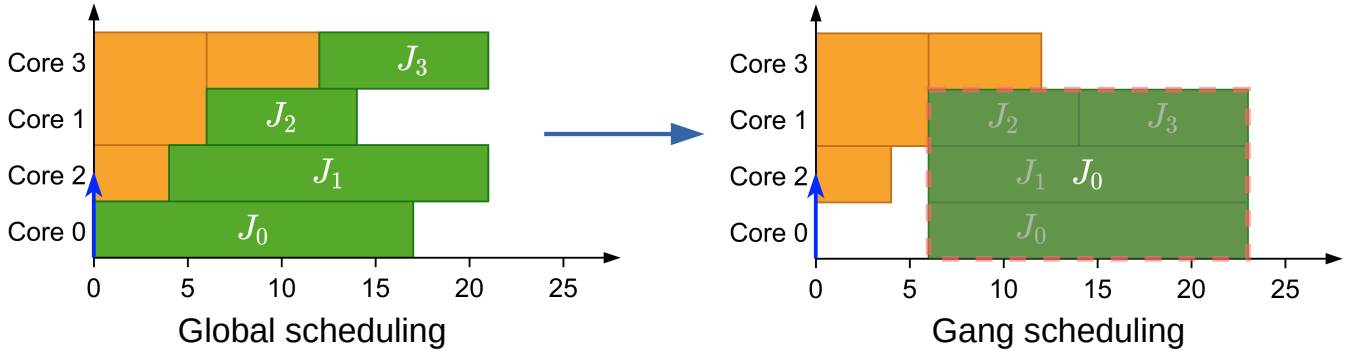

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Why gang?

- Avoids overhead when loading initial data

So then, why do we need gang scheduling?

Well, it helps in reducing overhead when loading data initially.

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In this example all these threads have been scheduled at the same time but have to wait until the previous one have finished loading.

On the contrary<click>, if we know that all these threads are starting at the same time we can load the data once for all the threads at the same time which is what we would do with gang scheduling.

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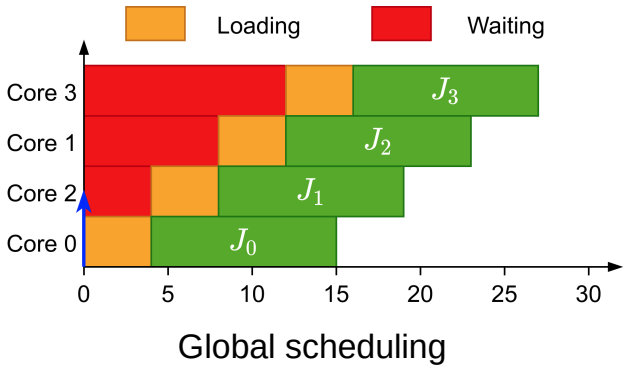

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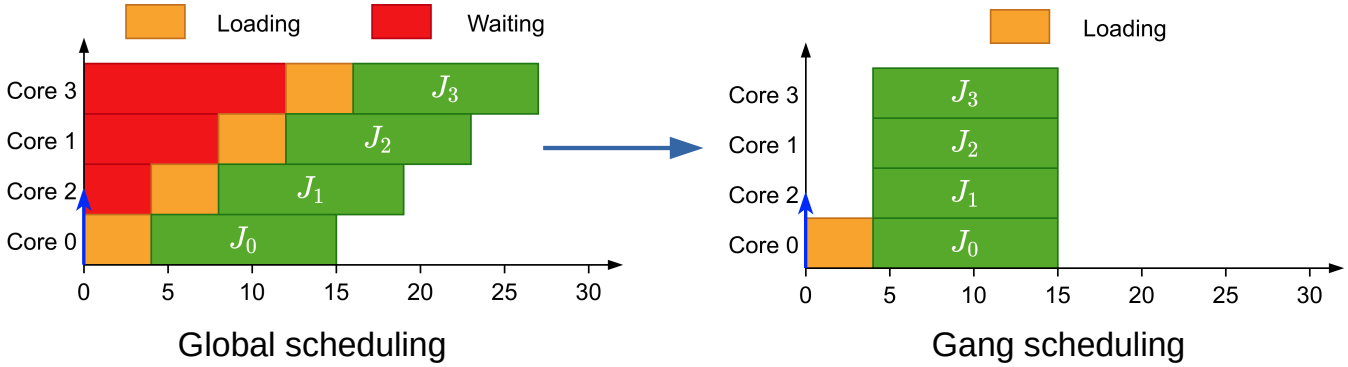

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Gang scheduling

Additionally it helps in synchronization situations, like in the following example<click>

Here there are two jobs and job 1 sends some data to job 0 that is processed and sent back. In this case another task has been scheduled after job 1 sent the data and after the other task finishes then job 1 can continue its execution

On the other hand if we use gang<click> the job would wait for job 0 to finish the processing part and return the results as no other task would be allowed to execute while job 1 is waiting.

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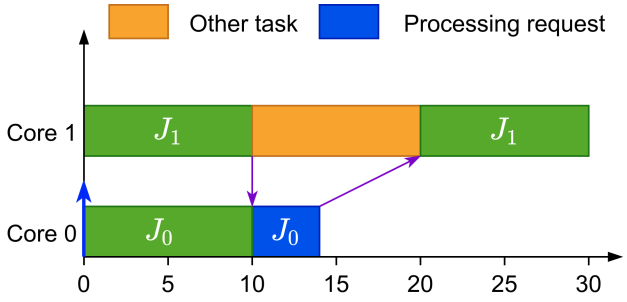

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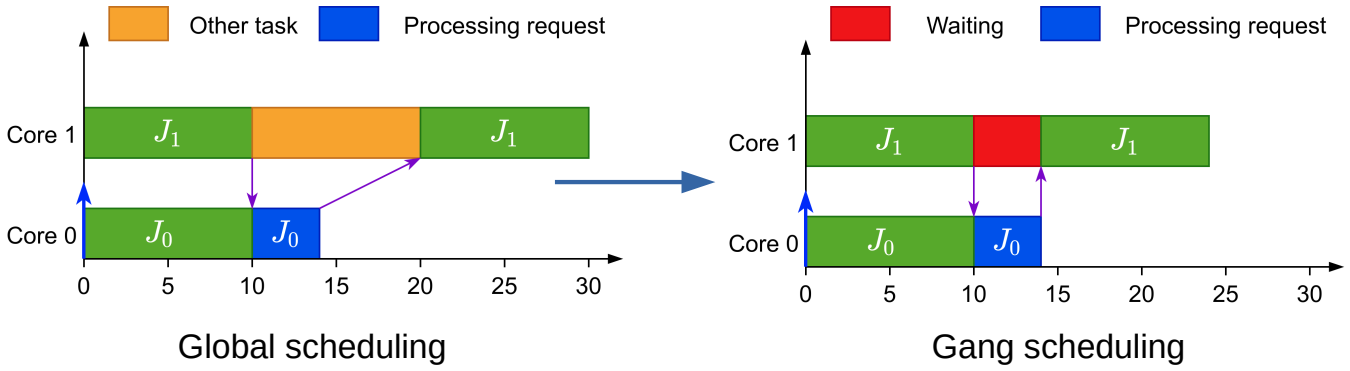

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Types of gang

When talking about gang scheduling, we can have three types:

- <click>Rigid gang, where the number of cores is set by the programmer and fixed during execution
- <click>Moldable gang, where the number of cores can be in a range of values and the actual chosen value is decided when scheduling the task
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Types of gang

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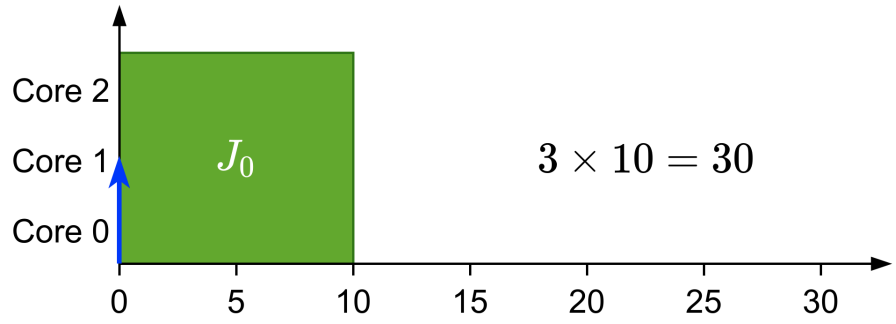

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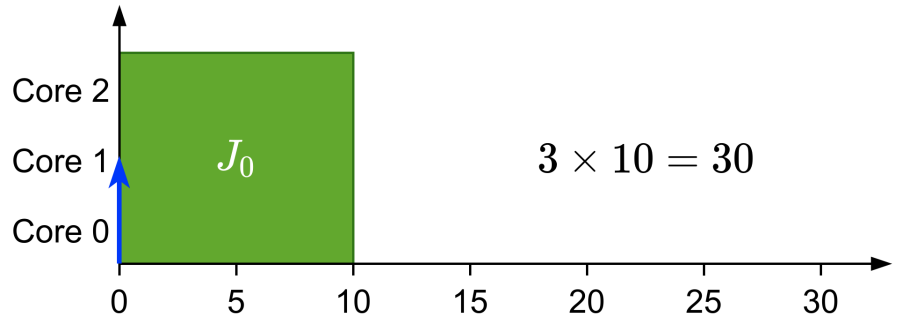

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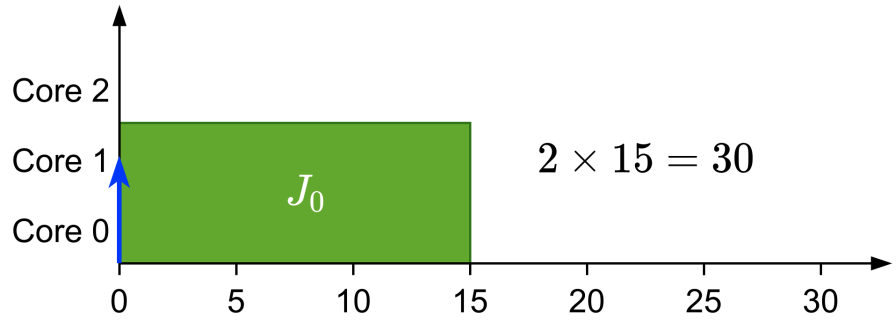

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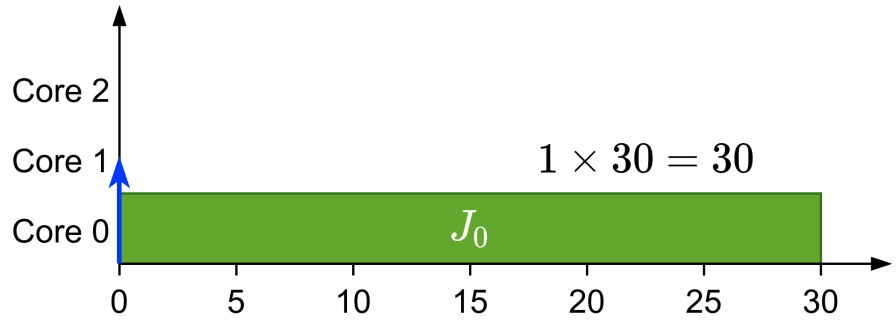

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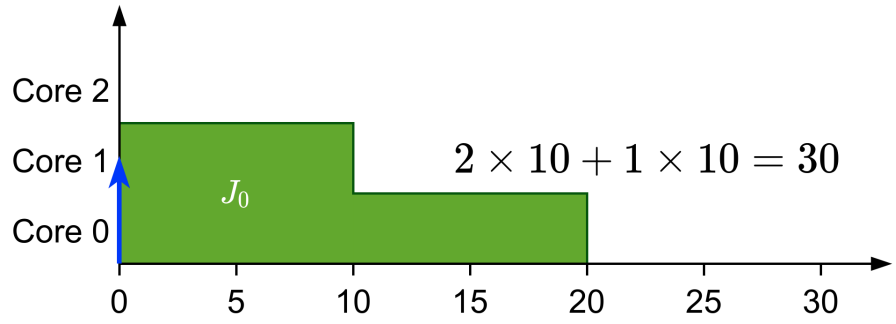
- **Malleable**: number of cores can change during runtime



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Previous work

- Introduced in the context of high-performance computing[1]
- In real-time:
  - For rigid tasks:
    - Job-Level Fixed Priority is not predictable[2]
    - An optimal scheduler (DP-Fair) exists for preemptive tasks[3]
  - For moldable tasks
    - Global EDF has been adapted[4]
    - Preemptive scheduler that chooses cores to meet the deadline[5]

[1]Ousterhout, 1982
[2]Goossens et al., 2010
[3]Goossens et al., 2016
[4]Kato et al.,2009
[5]Berten et al., 2011

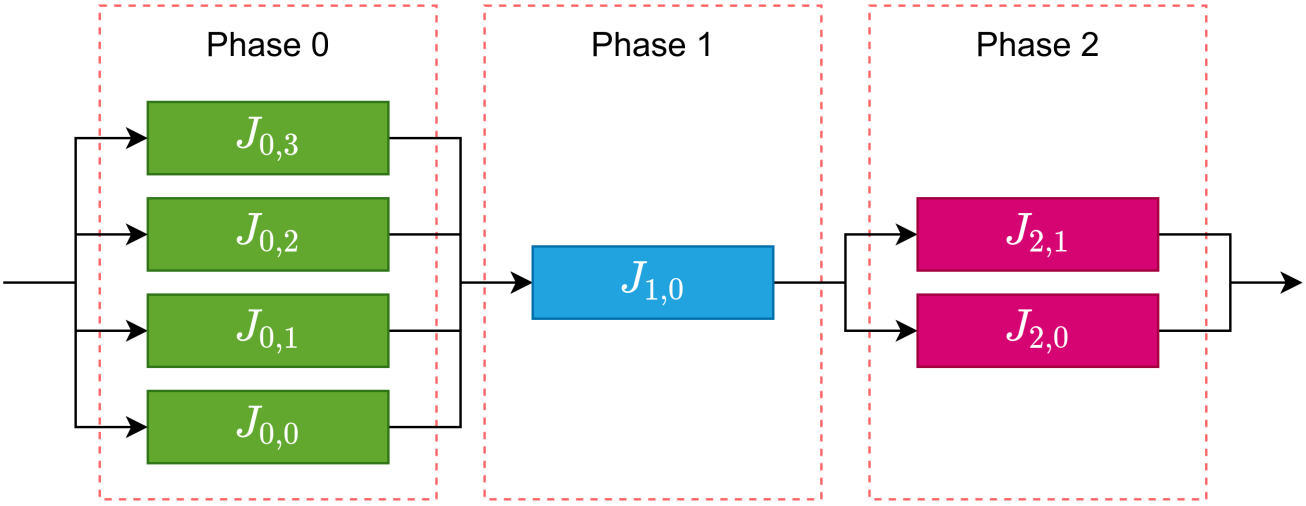
Previous work

- In real-time:
  - For malleable tasks:
    - An optimal preemptive scheduler, in terms of processors, has been proposed[6]
  - Bundled task-model[7]:
    - Preemptive gang tasks
    - Tasks with precedence constraints modeled as a succession of “bundles”
    - Our limited-preemptive definition comes from here

[6] Collette et al., 2008

[7] Wasly et al., 2017

Limited-Preemptive



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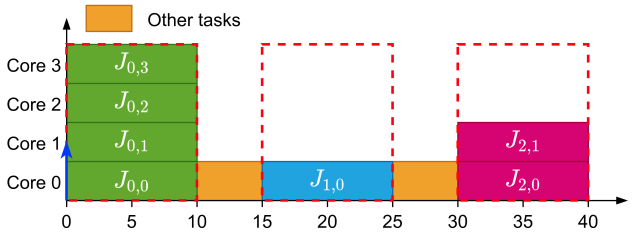

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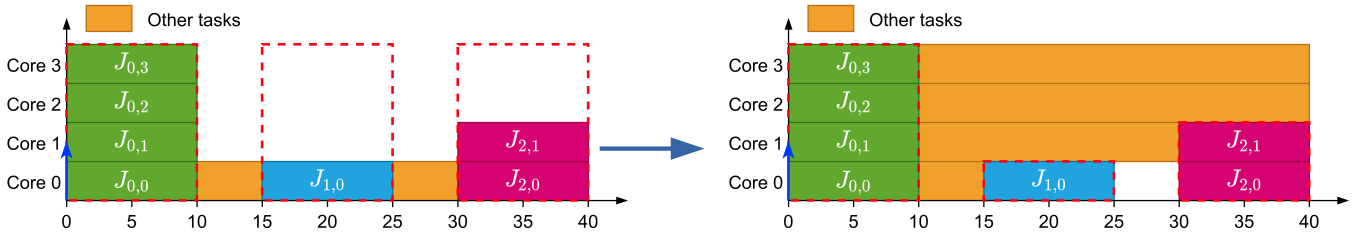

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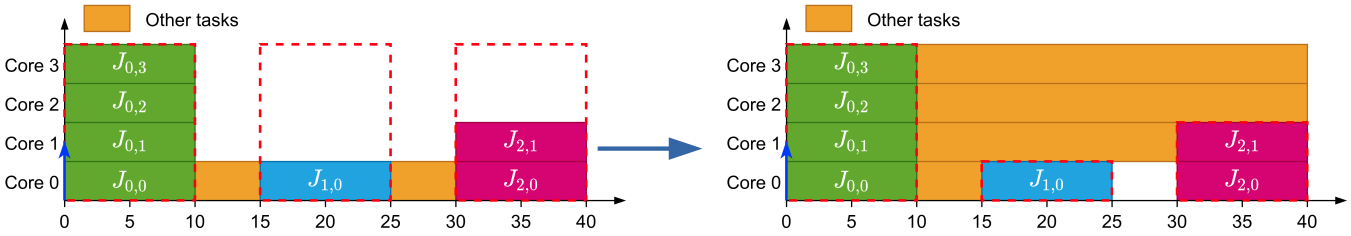
- LP only allows preemptions between bundles



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Schedulability analysis

- Accurate and relatively fast analysis
- Based on the notion of Schedule Abstraction Graph
- Faster than an exact analysis
- Not as pessimistic as closed-form analyses

Our work

- We aim to extend schedulability analysis to moldable gang
  - Scheduler has to decide
    - When to release a job
    - How many cores to assign to this job

LPMRGS