Slurm

Scheduling on ARCHER2

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Reusing this material

ARCHER2 vs ARCHER

- ARCHER:
  - PBS:
    - `qsub`: submit a job
    - `qsub –I`: submit an interactive job
    - `qstat`: query the status of a job
    - `qdel`: delete a job
    - `qstat –q`: query the status of the system
  - Job launcher:
    - `aprun`
- ARCHER2:
  - Slurm:
    - `sbatch`: submit a job
    - `salloc`: submit an interactive job
    - `squeue`: query the status of a job
    - `scancel`: delete a job
    - `sinfo`: query the status of the system
  - Job launcher:
    - `srun`

ARCHER2 vs ARCHER

```
adrianj@uan01~> sinfo

PARTITION AVAIL  TIMELIMIT  NODES  STATE NODELIST

standard     up 1-00:00:00     45  down*
nid[001045,001047,001061,001068…]

standard     up 1-00:00:00     10  drain
nid[001016,001069,001468,…]

standard     up 1-00:00:00      5   resv nid[001000-
001003,001021]

standard     up 1-00:00:00    513  alloc nid[001004-
001015,001017,001022-001044,…]

standard     up 1-00:00:00    447   idle nid[001018-
001020,001046,001062-001067,…]

standard     up 1-00:00:00      1   down nid001138
```

```
adrianj@eslogin004:~> qstat -q

server: sdb

Queue            Memory CPU Time Walltime Node  Run   Que   Lm  State
---------------- ------ -------- -------- ---- ----- ----- ----  -----
parallel           --      --    24:00:00  --     0     0   --   D S
phase2             --      --    24:00:00  --     0     0   --   D S
ppn                --      --    24:00:00  --     0     0   --   E R
high               --      --    24:00:00  --     0     0   --   E R
weekend            --      --    24:00:00  --     0    48   --   E S
standard           --      --    24:00:00  --   281   125   --   E R
long               --      --    48:00:00  --    75     4   --   E R
short              --      --       --     --     0     0   --   E R
serial             --      --    24:00:00  --    24    12   --   E R
largemem           --      --    48:00:00  --     4     7   --   E S
low                --      --    03:00:00  --     0    31   --   E S
R7327082           --      --    00:20:00  --     3     0   --   E R
R7327794           --      --       --     --     1     0   --   E R
                                               ----- -----
                                                 388   227
```

ARCHER2 vs ARCHER

```
adrianj@uan01:~> sacctmgr show assoc where user=adrianj
format=account,user,maxtresmins

   Account       User     MaxTRESMins

---------- ---------- -------------

 cse-admin    adrianj          cpu=0

       y07    adrianj          cpu=0

       z19    adrianj
```

```
adrianj@eslogin004:~> budgets

=========================================

                 Budget       Remaining kAUs

-----------------------------------------

                    z01              89.953

                z01-cse               9.960

             z01-csetds    No resources left

               z01-test    No resources left

                z19-cse           23005.127

             z19-csetds            1999.965

=========================================
```

ARCHER2 vs ARCHER

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high               --      --    24:00:00  --      0     0   --   E R
weekend            --      --    24:00:00  --      0    48   --   E S
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serial             --      --    24:00:00  --     24    12   --   E R
largemem           --      --    48:00:00  --      4     7   --   E S
low                --      --    03:00:00  --      0    31   --   E S
R7327082           --      --    00:20:00  --      3     0   --   E R
R7327794           --      --       --     --      1     0   --   E R
                                               ----- -----
                                                 388   227
```

ARCHER2 vs ARCHER

```
adrianj@uan01:~> squeue

             JOBID PARTITION     NAME     USER ST       TIME  NODES
NODELIST(REASON)

             30752  standard     bash grte2001  R      14:31      1 nid001017

             30749  standard     hpcc  adrianj  R      15:40    512 nid[001004-
001015,…]
```

```
adrianj@eslogin004:~> qstat | more

Job id           Name             User             Time Use S Queue

---------------- ---------------- ---------------- -------- - -----

5148849.sdb      12S-2P           taibui                  0 H standard

5914122.sdb      pollutionprac    s1879801                0 H standard

6438161.sdb      PuWide_1         mzv2c                   0 H weekend

6439801.sdb      LES_narrow       mzv2c                   0 H weekend

6452569.sdb      DNS_Splitter     mzv2c                   0 H weekend

6463985.sdb      DNS_Splitter     mzv2c                   0 H weekend

6952967.sdb      tite2M-vac1.5    uccawra                 0 H weekend

7019105.sdb      postproc_atmos_  dflocco                 0 H serial

7019107.sdb      postproc_nemo_e  dflocco                 0 H serial

7019108.sdb      postproc_atmos_  dflocco                 0 H serial

7019127.sdb      postproc_cice_e  dflocco                 0 H serial

7019130.sdb      postproc_atmos_  dflocco                 0 H serial

7019131.sdb      postproc_cice_e  dflocco                 0 H serial

7019136.sdb      postproc_atmos_  dflocco                 0 H serial

7024877.sdb      vac-2            uccawra                 0 H weekend

7097417.sdb      ave4             gcastigl                0 H long

7287426.sdb      ag100            bsohail                 0 H standard

7325564.sdb      nogly_new        mohdfbs          00:00:02 R standard

7325565.sdb      nogly_new        mohdfbs                 0 H standard
```

ARCHER2 vs ARCHER

```
#!/bin/bash
#SBATCH --job-name=Example_MPI_Job
#SBATCH --time=0:20:0
#SBATCH --nodes=4
#SBATCH --tasks-per-node=128
#SBATCH --cpus-per-task=1
#SBATCH --account=[budget code]
#SBATCH --partition=standard
#SBATCH --qos=standard

srun --cpu-bind=cores ./my_mpi_executable.x
```

```
#!/bin/bash --login
#PBS -N hello_world
#PBS -l walltime=0:5:0
#PBS -l select=43
#PBS -A [budget code]

cd $PBS_O_WORKDIR
aprun -n 1024 $HOME/ my_mpi_executable.x
```

ARCHER2 vs ARCHER

- Interactive run on ARCHER:

```
qsub -IVl select=8,walltime=1:0:0 -A [project code]
qsub: waiting for job 492383.sdb to start
adrianj@mom3:~> aprun –n 192 ./my_exe
```

- Interactive run on ARCHER2:

```
salloc --nodes=8 --tasks-per-node=128 --cpus-per-task=1 --time=1:0:0 --partition=standard --
qos=standard --account=[budget code]

salloc: Granted job allocation 30751

salloc: Waiting for resource configuration

salloc: Nodes nid[001019-001020,001062-001067] are ready for job

adrianj@uan01:/work/z19/z19/adrianj/>srun –cpu-bind=cores ./my_exe
```

ARCHER2 configuration

- Partitions:
  - Standard
  - Highmem (for the full system, not currently available)
  - GPU (for the full system, not currently available)*

- QoS:
  - Standard: up to 24 hour jobs, up to the full system
    - 16 running jobs + 16 queued jobs per user
  - Long: from 24-48 hour jobs, up to 64 nodes *
    - 64 nodes in total per user
    - 512 nodes in long queue use for the 4 cabinet system in total across all users
  - Short: up to 20 minutes, up to 4 nodes*
    - 1 running job + 2 queued job per user
    - requires a reservation
      - `sbatch –reservation=shortqos …`
    - only active 08.00-20.00 Monday-Friday

*subject to change in the future

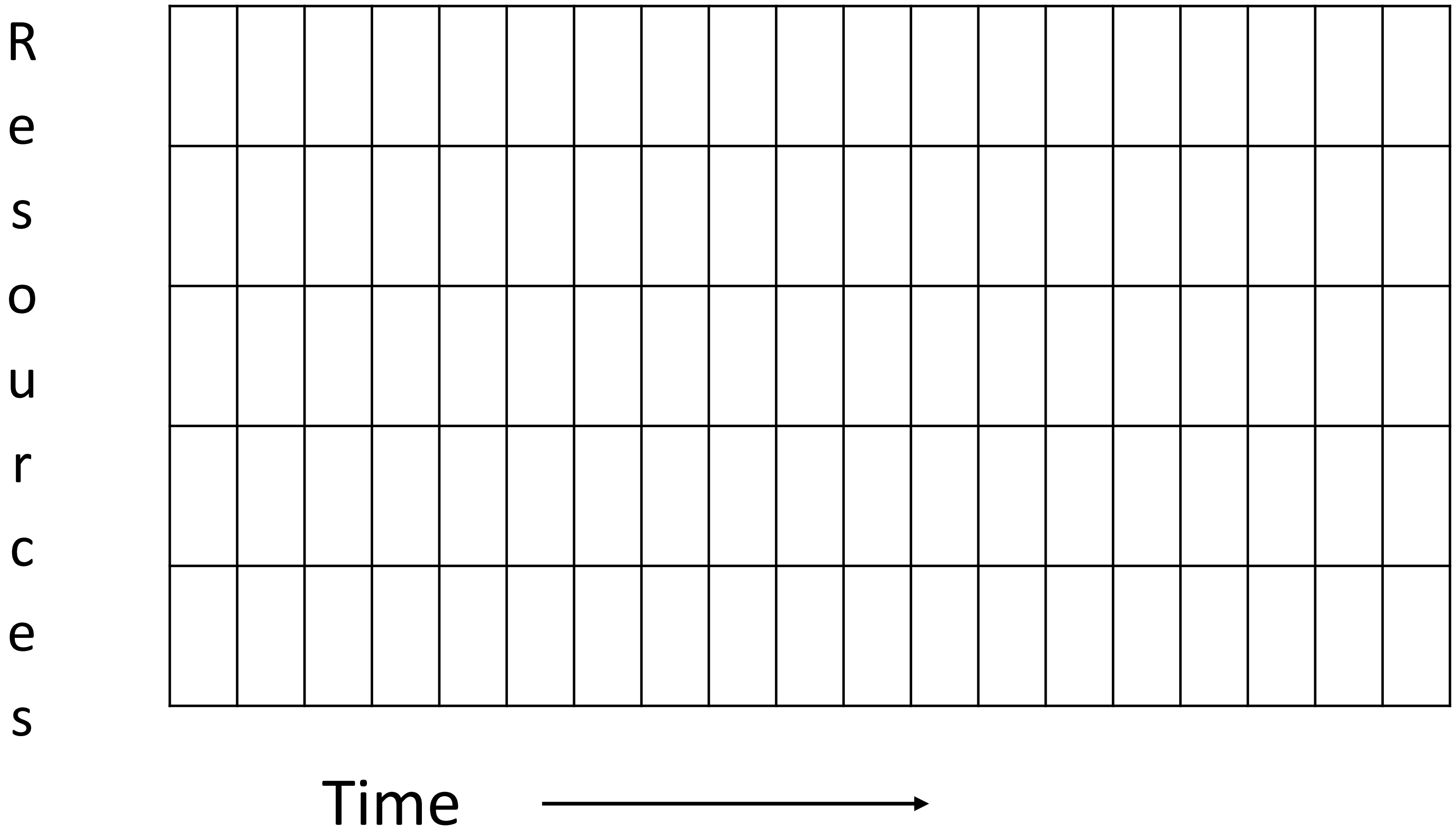
Placement and binding

- Slurm (srun) is doing our placement and binding
  - Processes and threads to cores

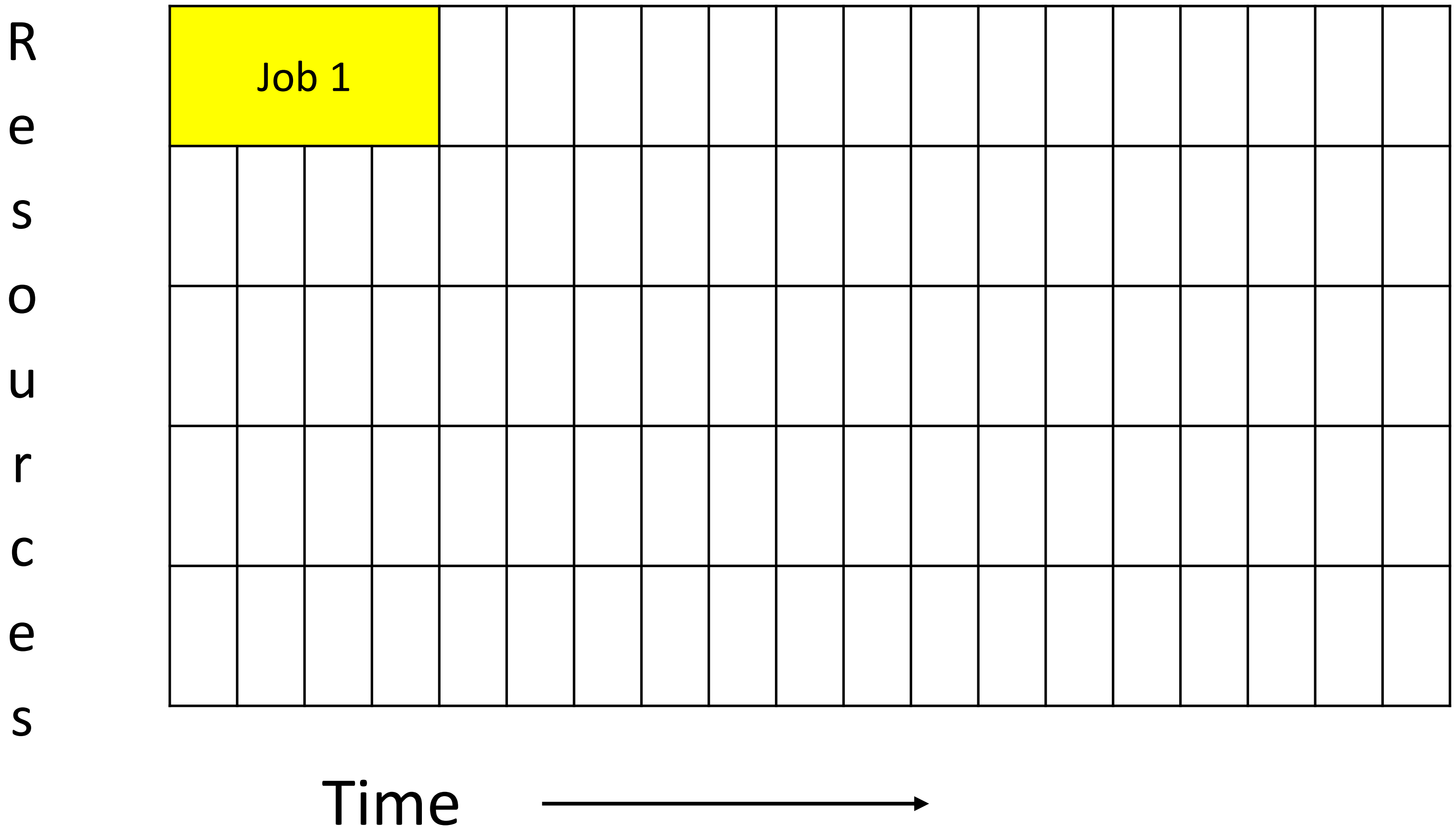
```
#!/bin/bash
#SBATCH --job-name=Example_MPI_Job
#SBATCH --time=0:20:0
#SBATCH --nodes=4
#SBATCH --ntasks=32
#SBATCH --tasks-per-node=8
#SBATCH --cpus-per-task=16
#SBATCH --account=[budget code]
#SBATCH --partition=standard
#SBATCH --qos=standard

# Set the number of threads to 16 and specify placement
#   There are 16 OpenMP threads per MPI process
#   We want one thread per physical core
export OMP_NUM_THREADS=16
export OMP_PLACES=cores
srun --hint=nomultithread --distribution=block:block
./my_mixed_executable.x arg1 arg2
```

Backfill Scheduling Example



Backfill Scheduling Example

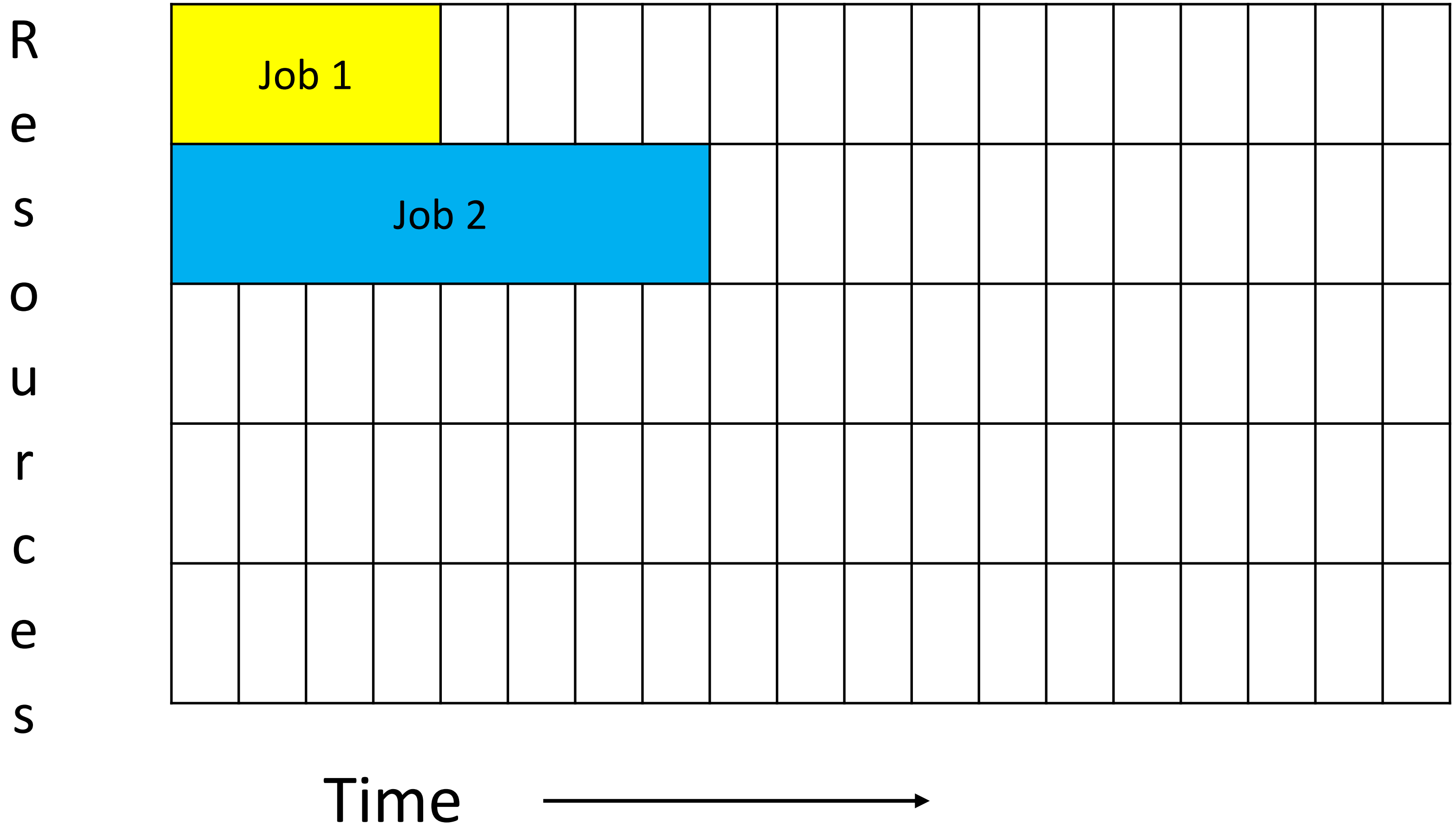


Job 1

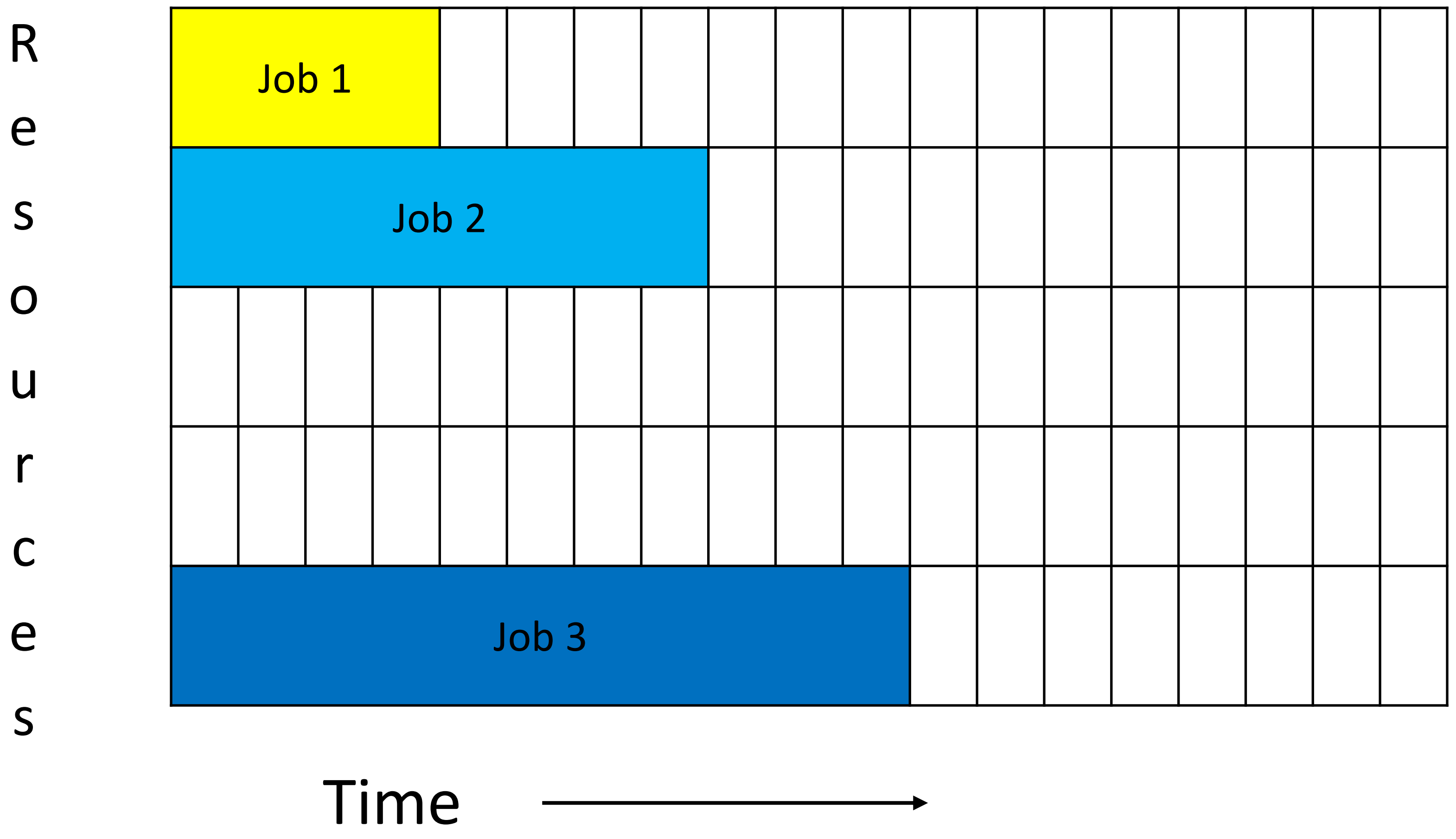
Resources

Time

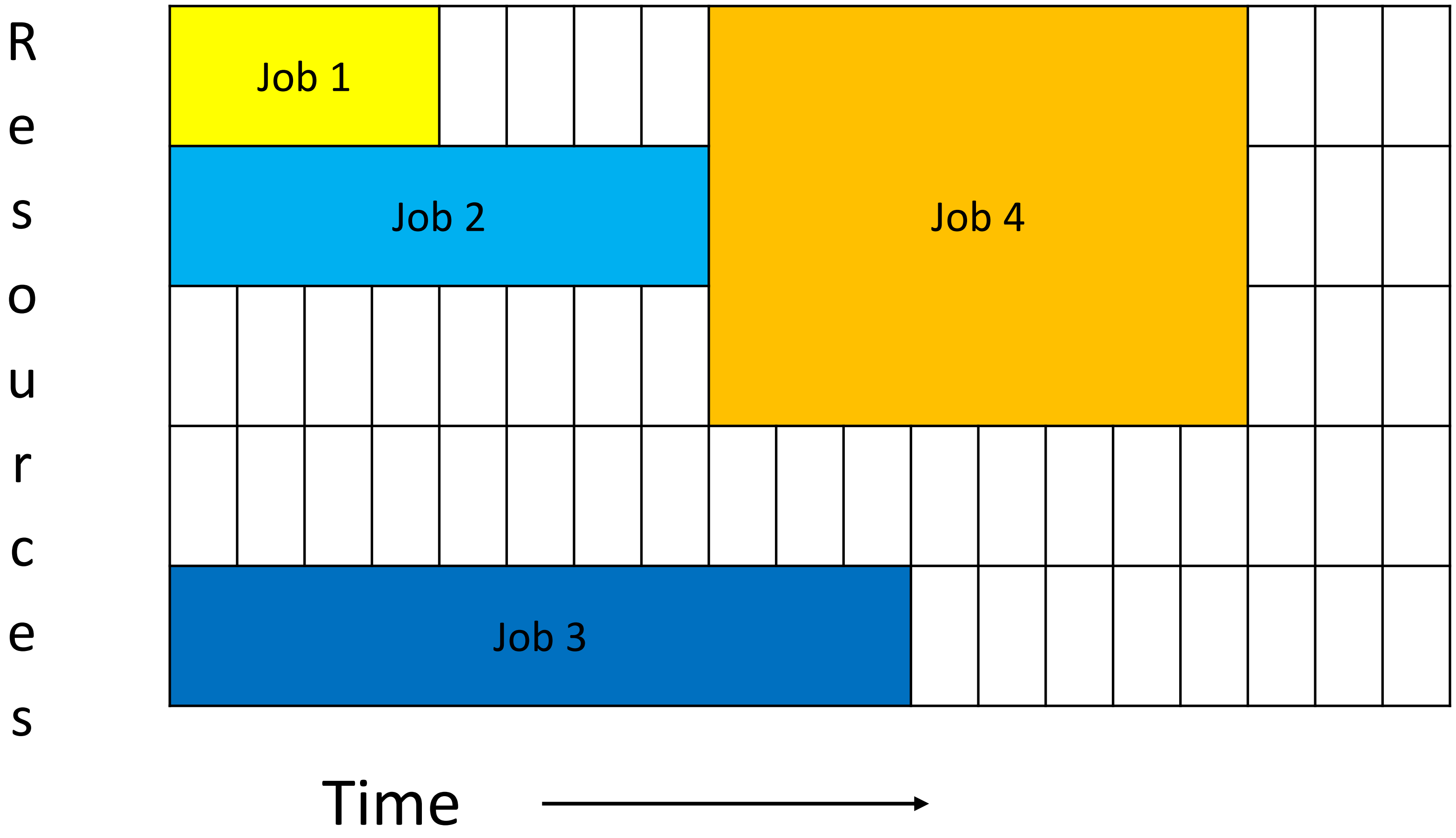
Backfill Scheduling Example



Backfill Scheduling Example



Backfill Scheduling Example



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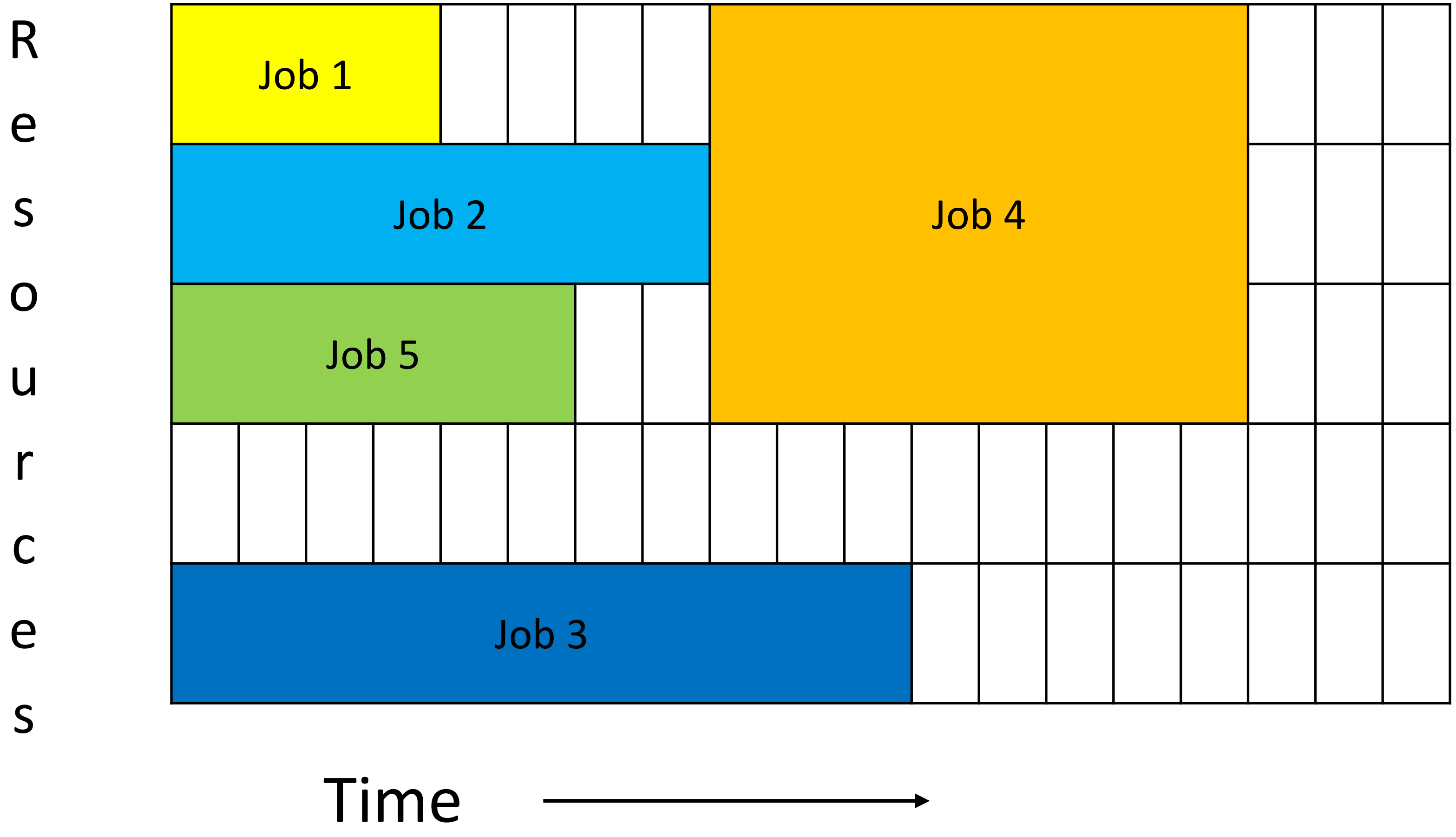

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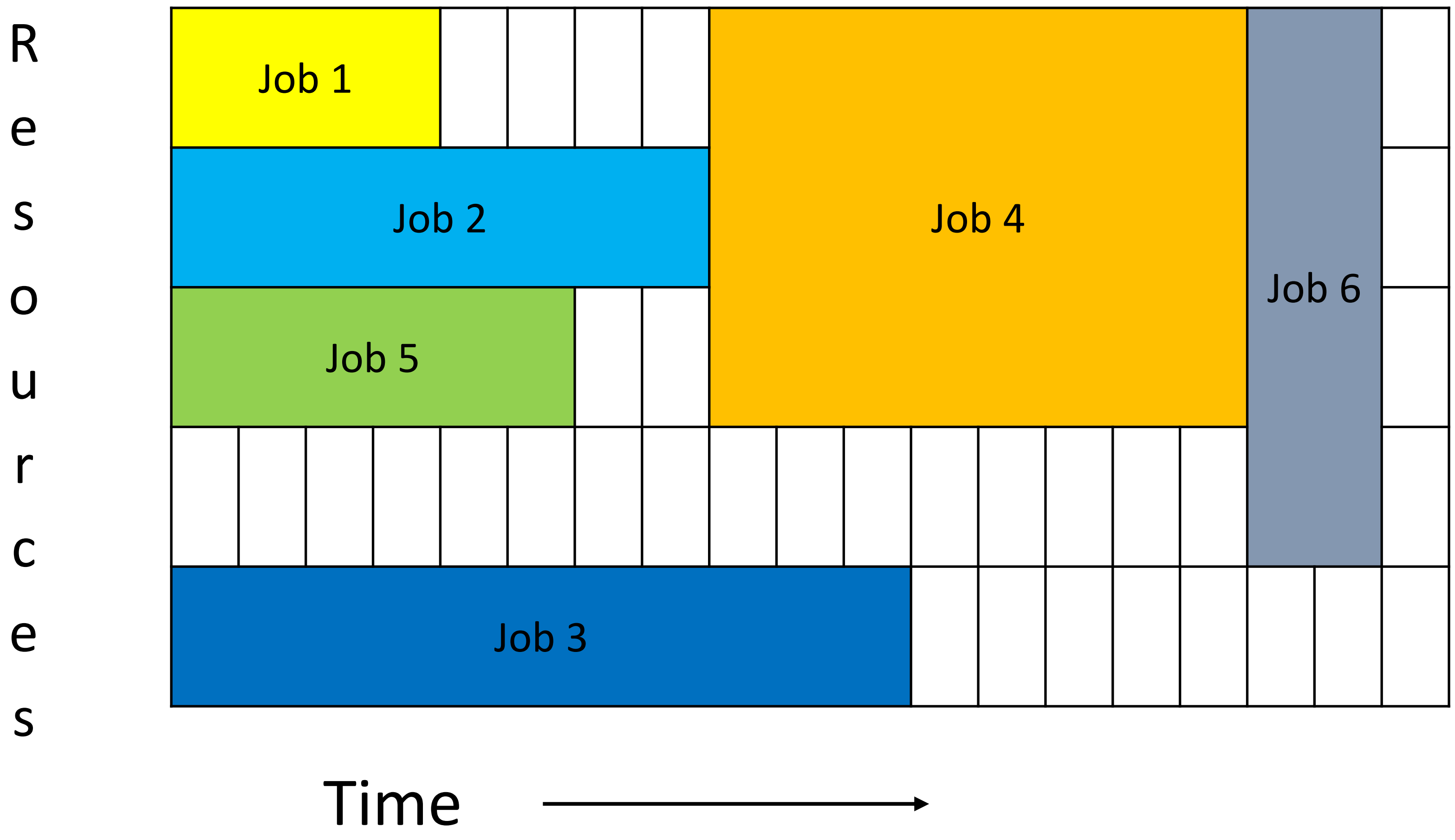

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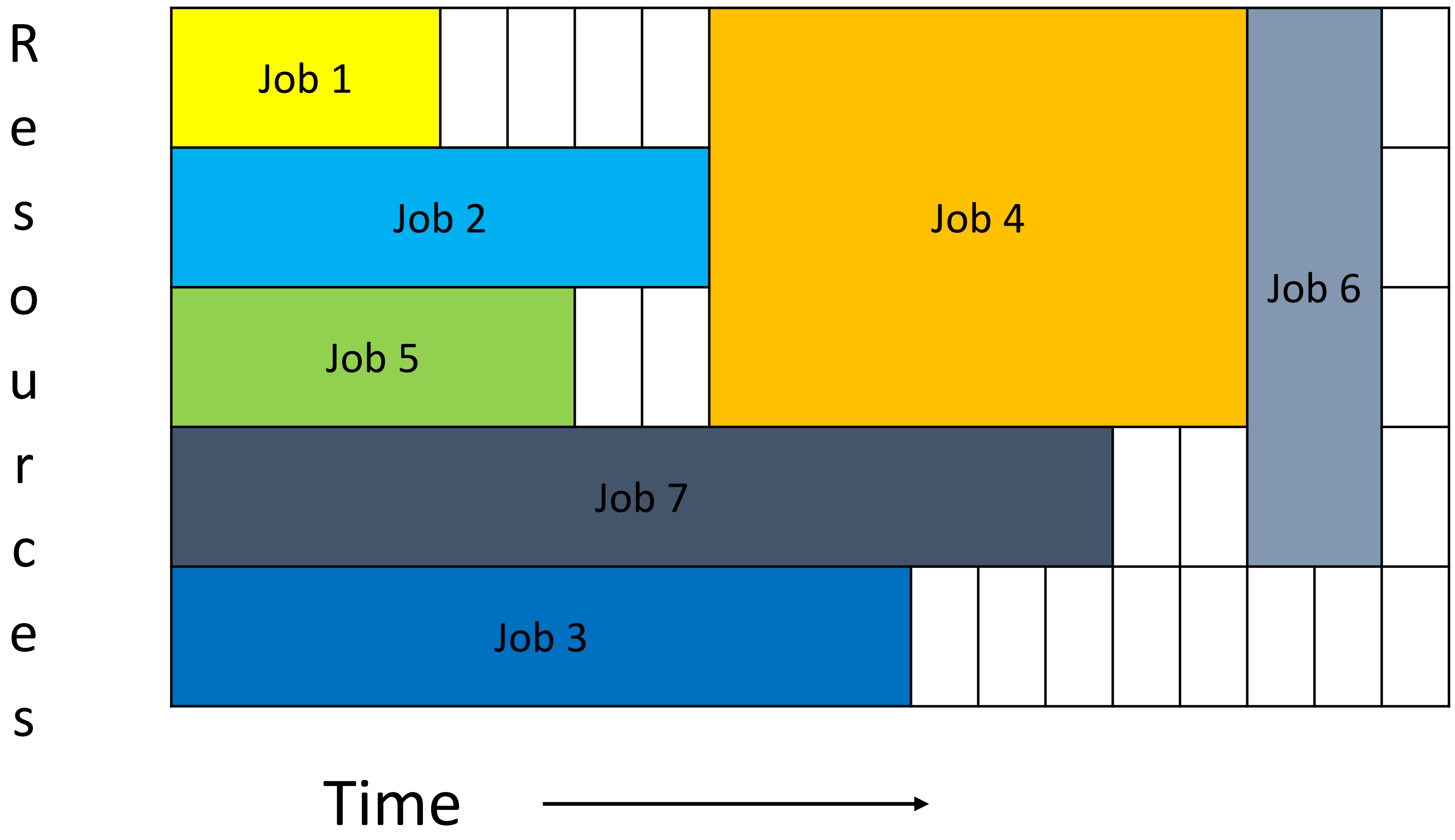
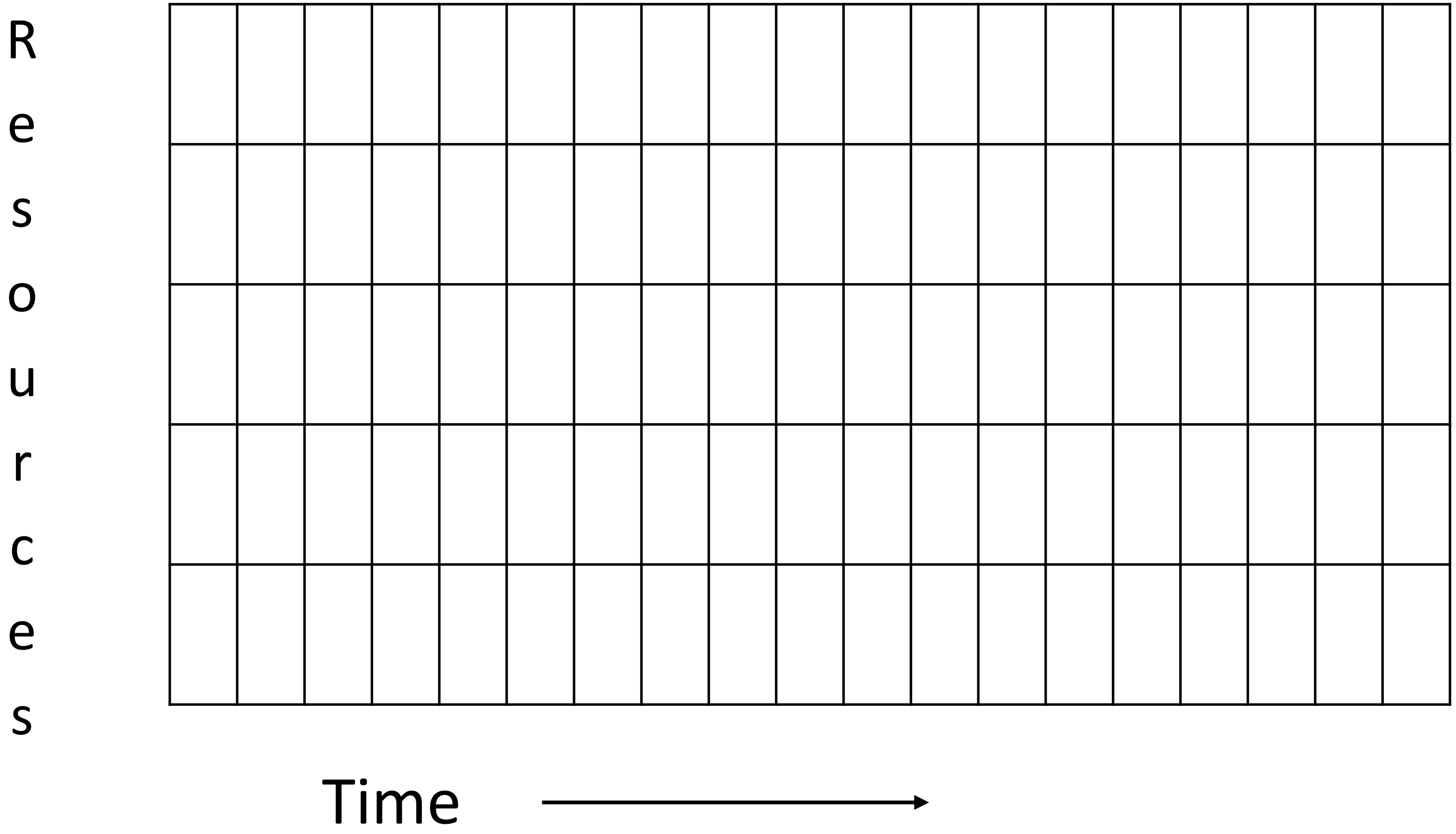
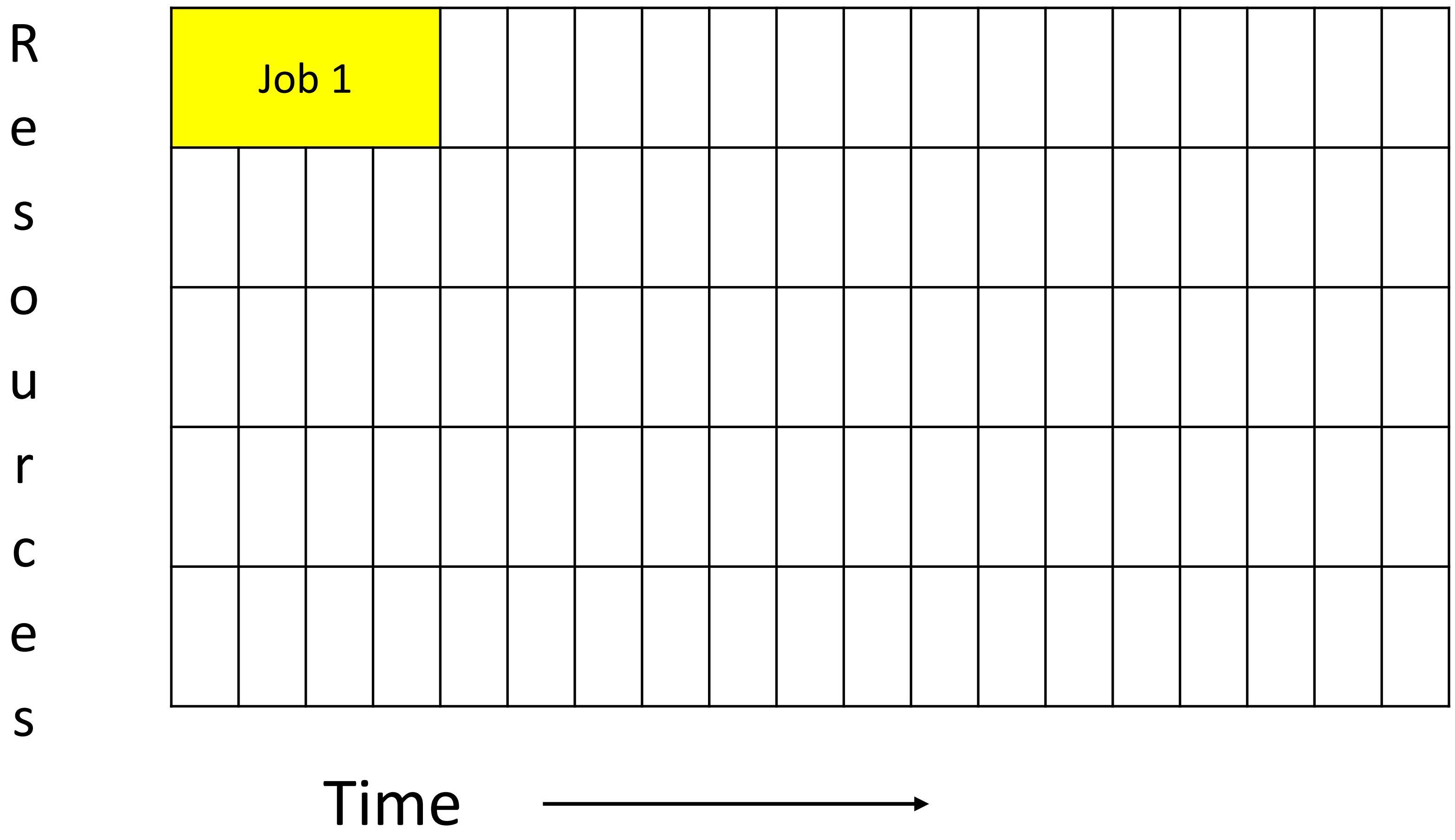


FIFO Scheduling Example



FIFO Scheduling Example



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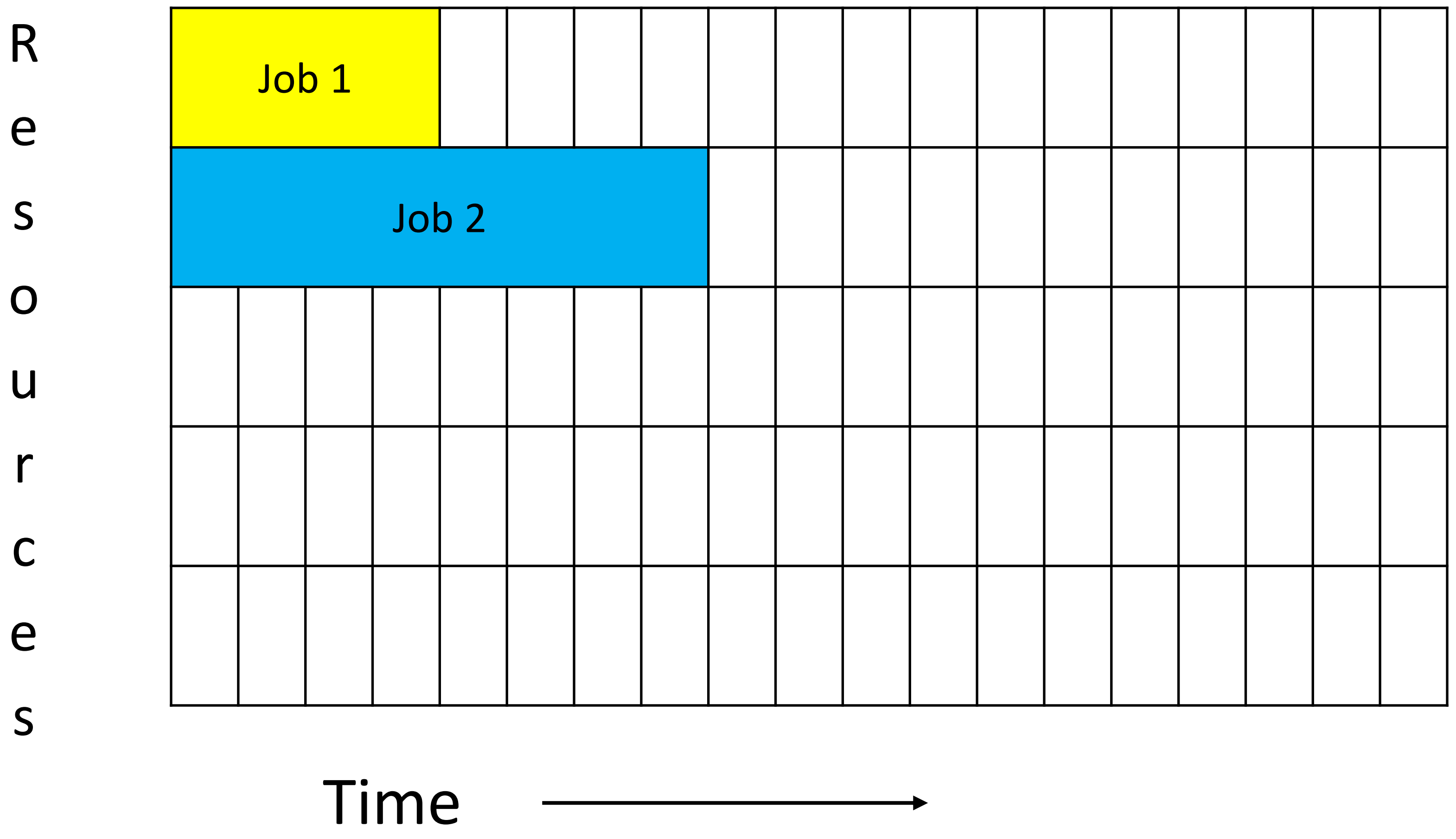

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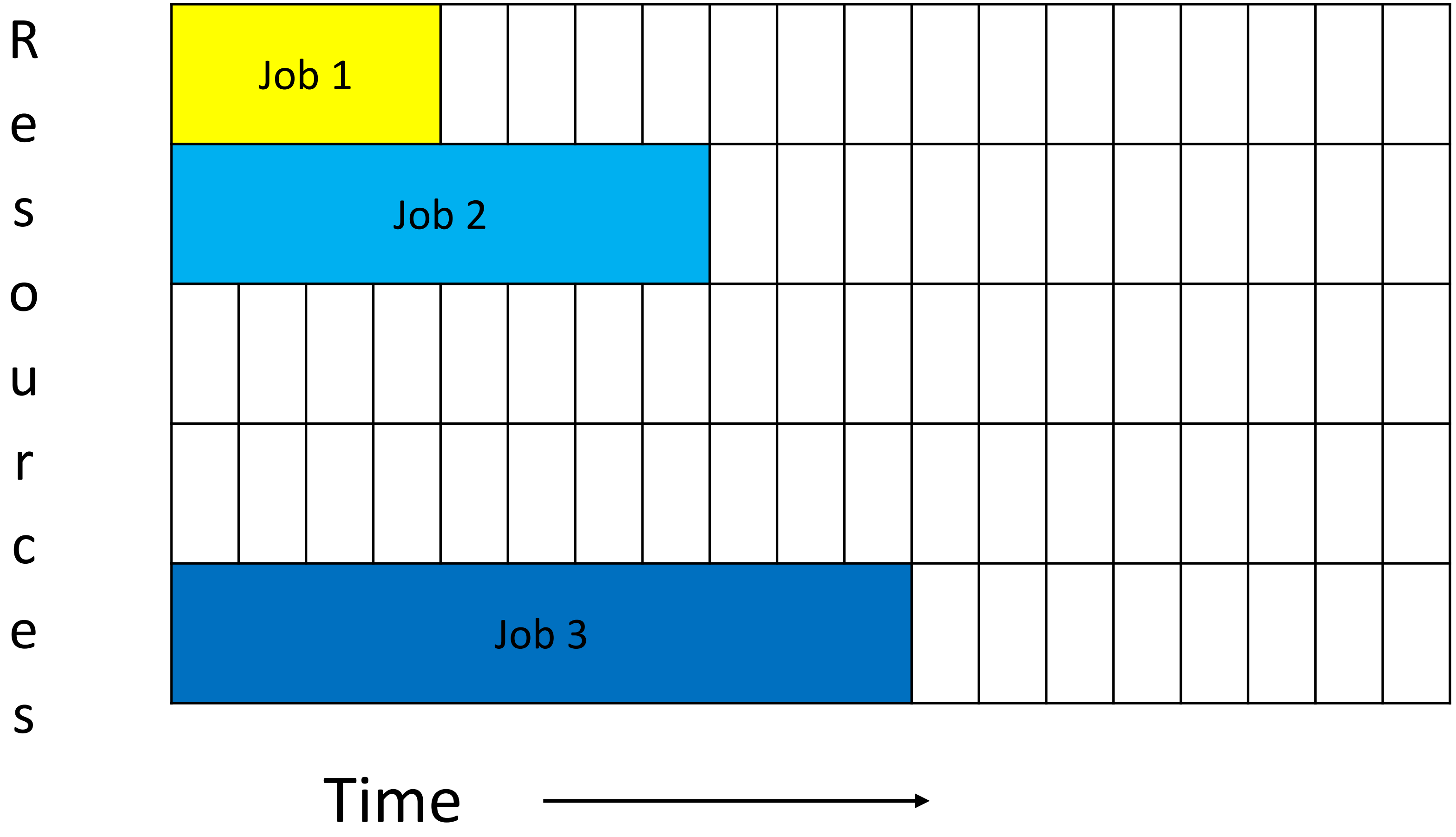

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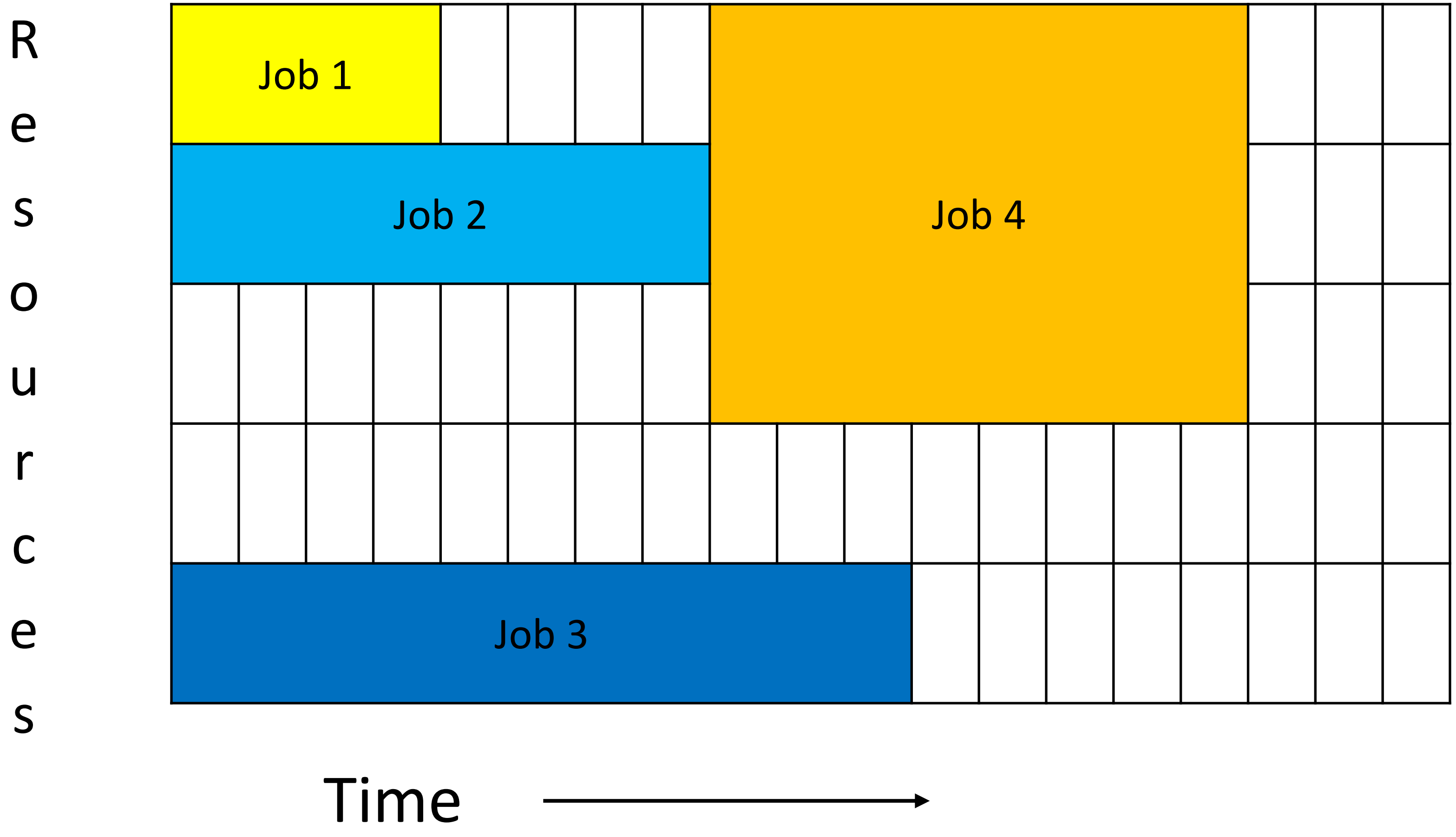

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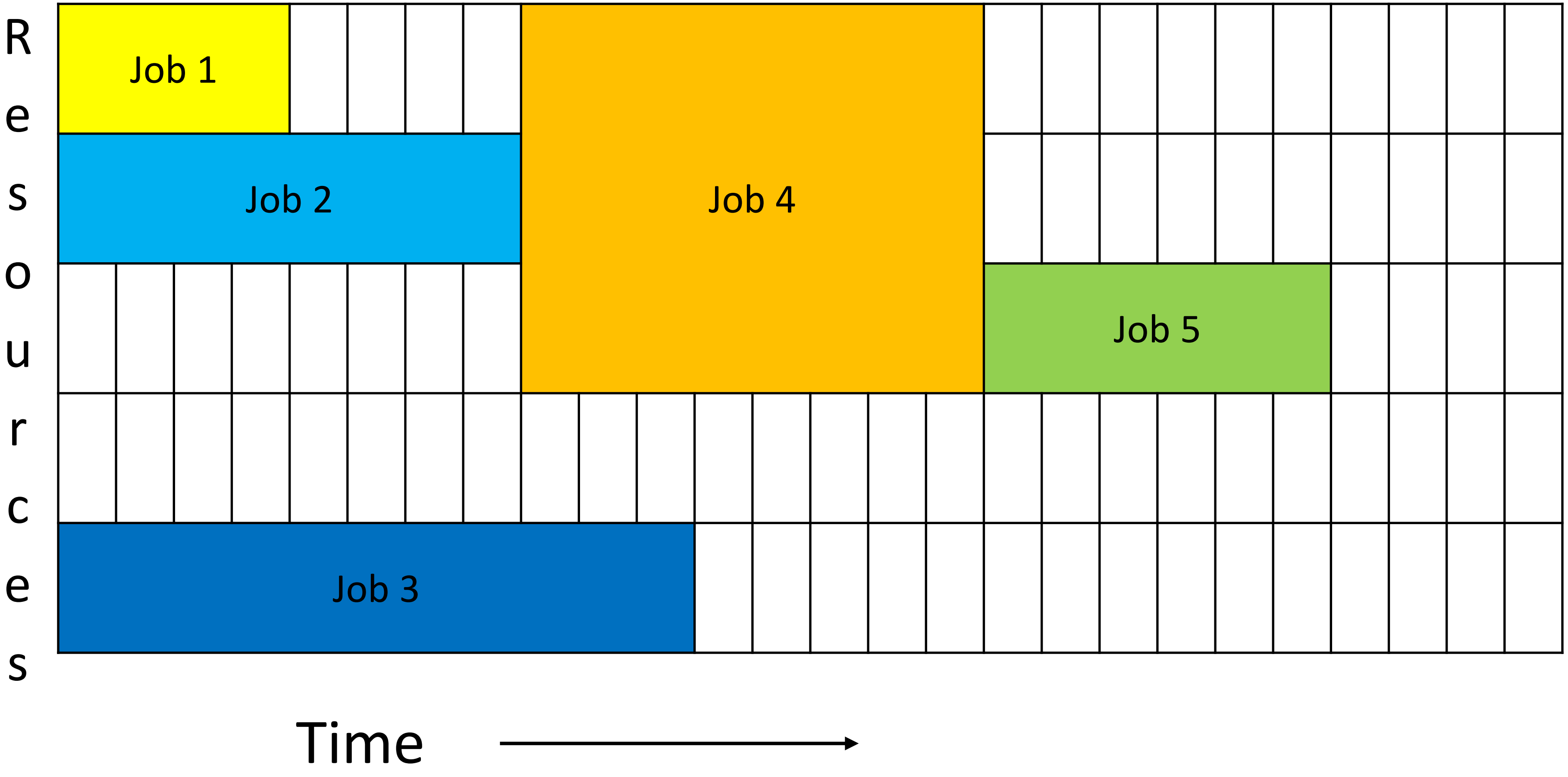

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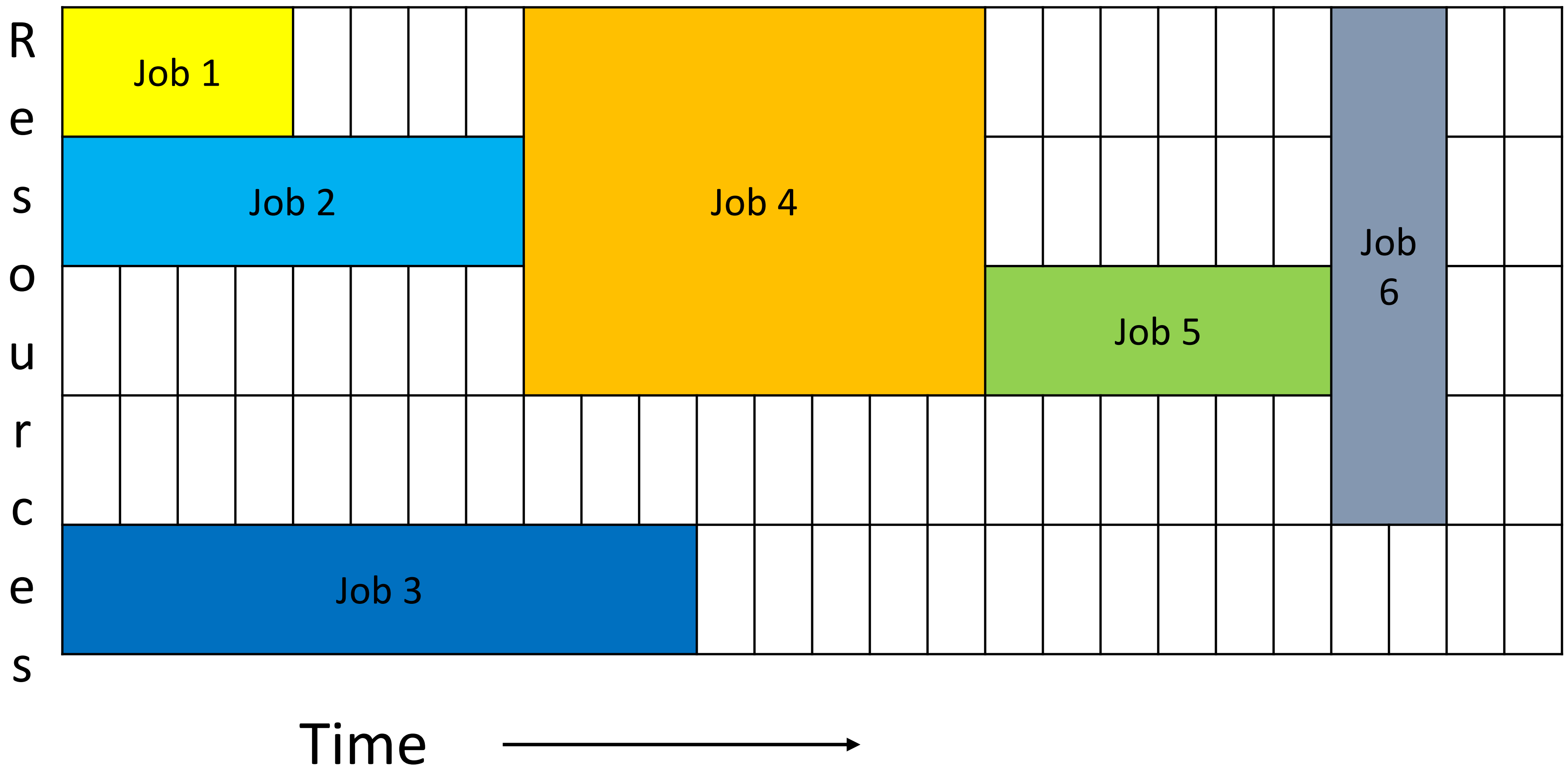

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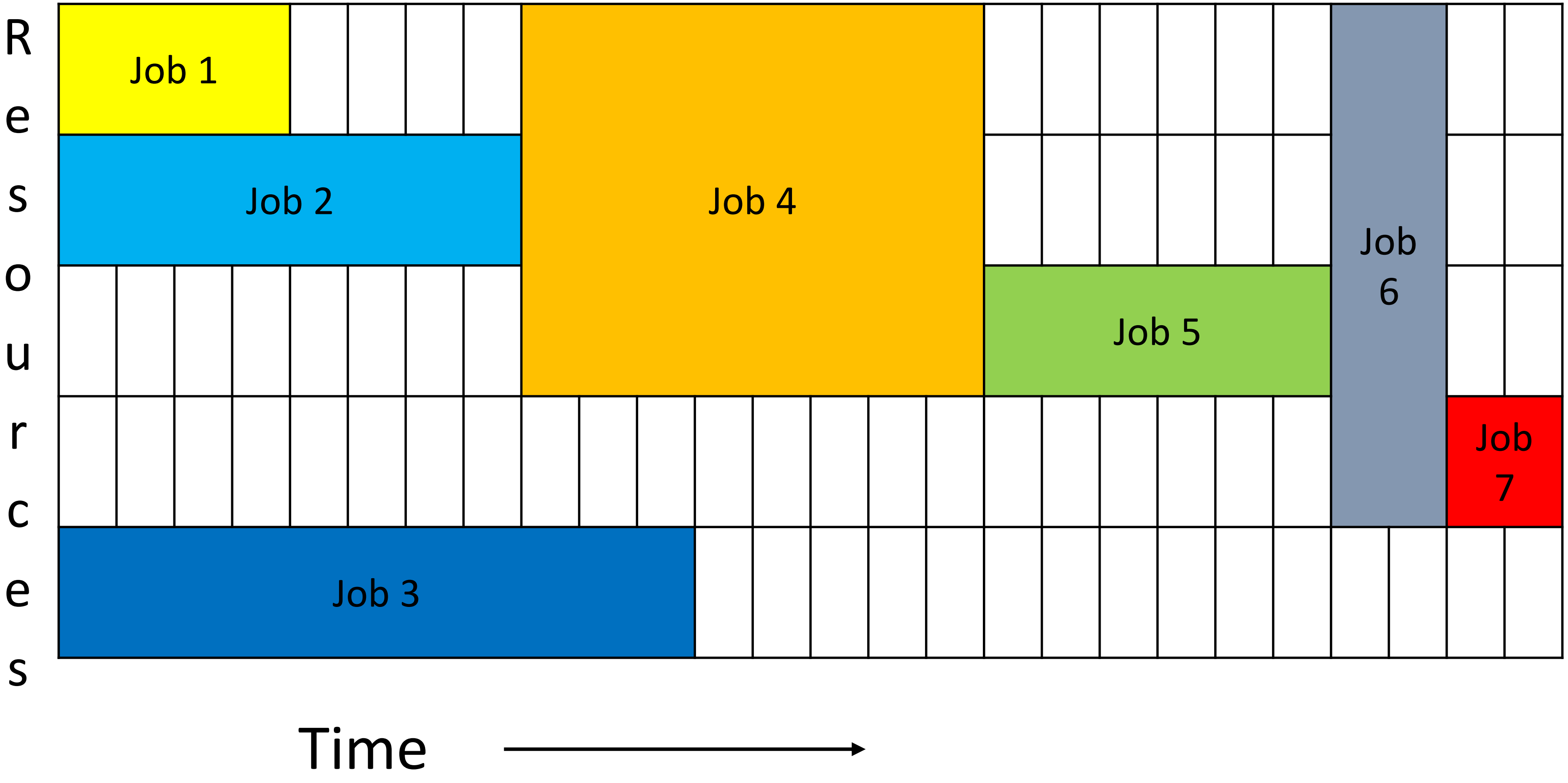

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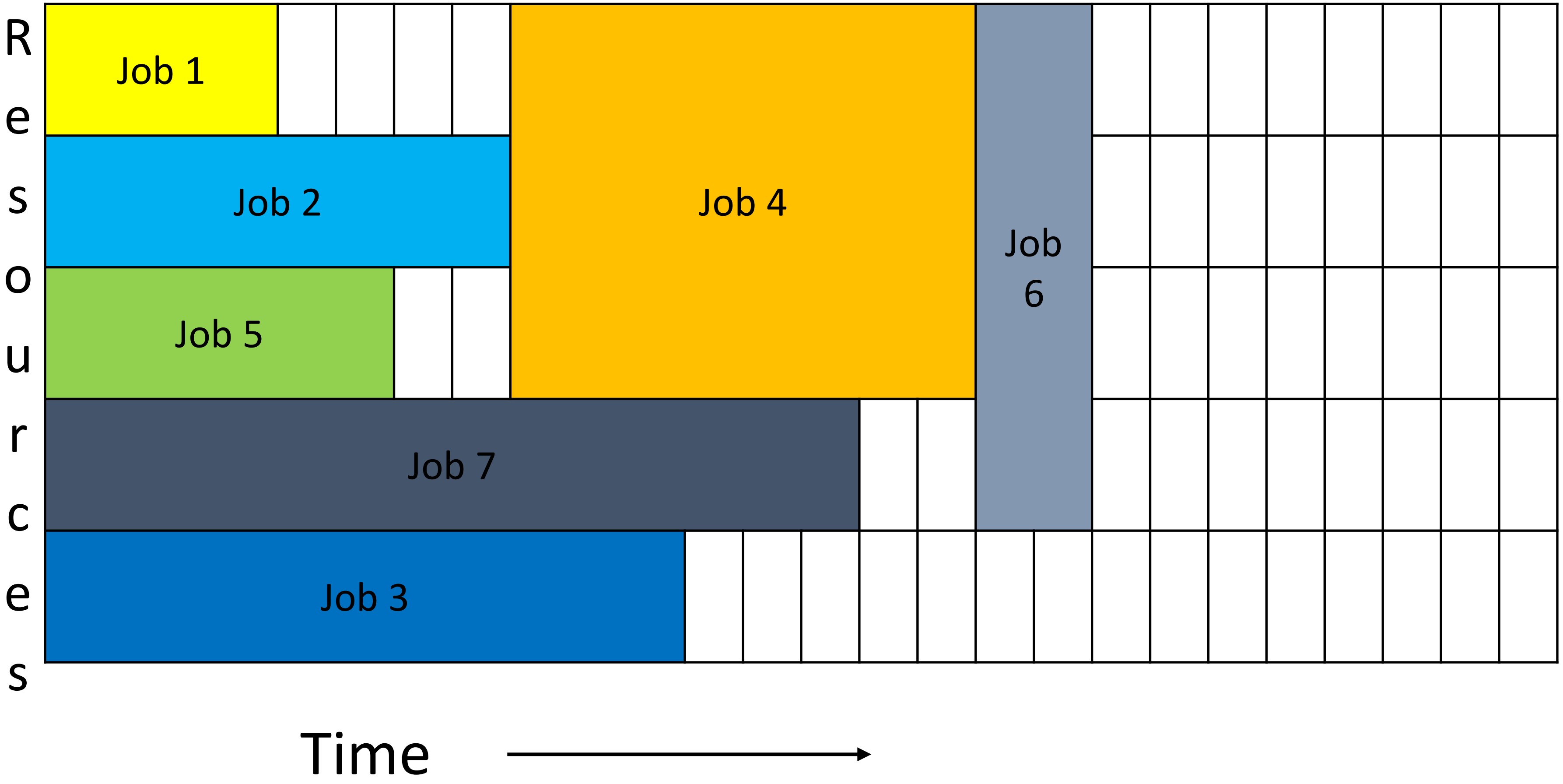

Slurm Scheduling

- Slurm tries to find a better schedule (using quick and simple algorithms) when:
  - A job is submitted;
  - A job completes;
  - A configuration change takes place.
- Slurm also performs slower and more expensive scheduling attempts less frequently
- This design allows nearly instant response; even when thousand of job are submitted at the same time.

Slurm – Quick Scheduling

- Slurm only checks the first X (by default 100) entries of the queue for new scheduling opportunities;

- Once a job in a partition is left pending (i.e. no scheduling is possible), Slurm ignores the other jobs in that partition;

Slurm – Thorough Scheduling

- Slurm checks all jobs in the queue (or until a configurable time limit is reached);

- Jobs are ordered by priority so this operation has low overhead;

- However, jobs in lower priority partitions (queues) have now more opportunities to start.