

Baked!!

Maths in Industry and Technology (MIT) Challenge 2012
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1 Problem Description

The French Lettuce is a fully equipped bakery/café established over 30 years ago. With a full team of chefs and support staff, The French Lettuce caters for weddings and special occasions.

At The French Lettuce, chefs are given a list of items to bake on a daily basis. Each item will first require some preparation time, and subsequently baking time in the oven. *Baking must immediately follow preparation*, i.e. once the preparation is done for an item, it must be put into the oven immediately. A chef can only carry out preparation for one item at a time, and an oven can only bake one item at a time. When all ovens are occupied, chefs cannot commence any preparation — the chefs will be idle in this case. The preparation of a item can only commence as soon as an oven is free.

Consider an example with one chef, two ovens and four items (or jobs). The preparation and baking durations (in minutes) for each job are outlined in Table 1.

Table 1: Example 1.

Job	Preparation Duration (minutes)	Baking Duration (minutes)
1	15	20
2	20	10
3	10	30
4	15	40

Figure 1 shows a feasible schedule for Example 1, in the form of a Gantt Chart. A two-part rectangular block is used to represent a job in the Gantt Chart. The *width* of the coloured part represents the preparation duration, and the width of the white part is the baking duration. The coloured parts *must not overlap* in the Gantt Chart since we only have one chef. In Figure 1, Job 3 is prepared first and put into Oven 1. While Job 3 is in Oven 1, the chef prepares Job 2 to be put into Oven 2. Both ovens are now occupied, and the chef cannot commence any preparation until time 40. At time 40,

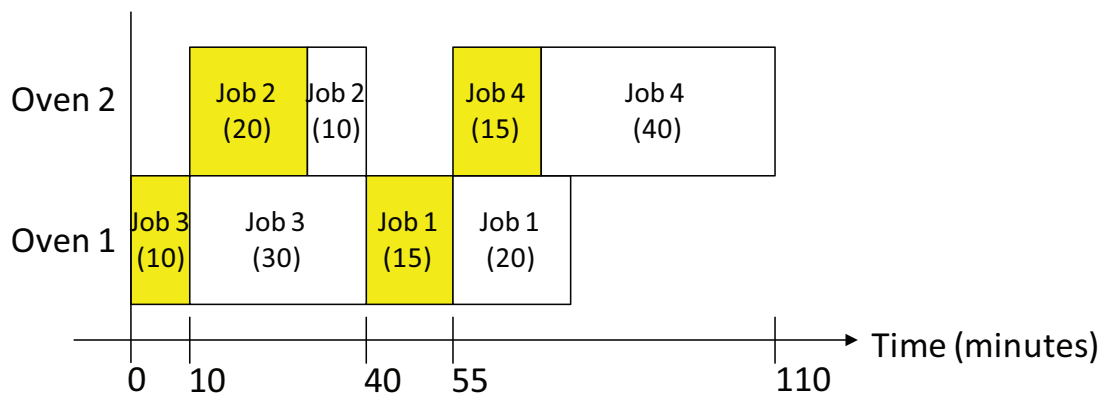


Figure 1: A schedule with makespan of 110 minutes for Example 1.

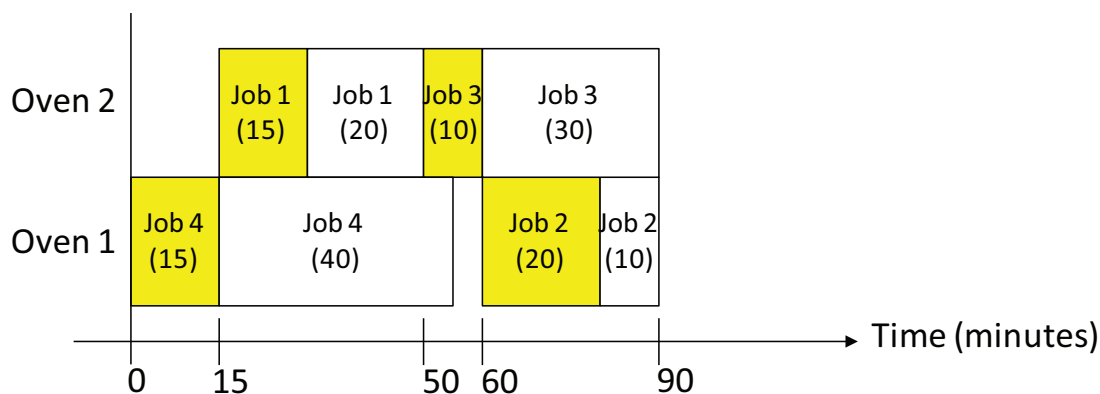


Figure 2: A schedule with makespan of 90 minutes for Example 1.

the chef prepares Job 1 and bakes it in Oven 1; and at time 55, Job 4 is prepared and baked in Oven 2. For this job sequence, the time to complete all jobs — the *schedule makespan* — is 110 minutes.

We could in fact complete all jobs in shorter amount of time by considering a different job sequence. Figure 2 shows a schedule with makespan of 90 minutes, where Job 4 is prepared first and baked in Oven 1, followed by Jobs 1 and 3 (Oven 2) and finally Job 2 (Oven 1).

2 The Challenge

For this challenge, we will be considering the scenario where we have *one chef* and *two ovens*. You will be given data sets on the preparation and baking durations. The aim is to develop schedules with the *smallest possible makespan*.

You will be competing this challenge in a five-round tournament, as described below.

Round 1: You will compete this round with the data shown in Table 2.

Teams ranked in the top 20 will qualify for ranking process in the next round.

Round 2: You will compete this round with the data shown in Table 3.

Teams ranked in the top 15 will qualify for ranking process in the next round.

Round 3: You will compete this round with the data shown in Table 4.

Teams ranked in the top 10 will qualify for ranking process in the next round.

Round 4: You will compete this round with the data shown in Table 5.

Teams ranked in the top 5 will qualify for ranking process in the next round.

Round 5: You will compete this round by giving a team presentation.

The final rankings (1st, 2nd, 3rd and 4th place) will be determined in this round.

Rankings in Rounds 1-4 will primarily be based on *schedule makespan*. Reasonings/methodologies developed by your team will be considered as a secondary measure. You may also wish to submit any of your working materials including Excel spreadsheets, tables and diagrams.

You may only submit one solution to each round of the challenge. Solutions to Rounds 1-4 are to be submitted (all at once) at the end of the challenge. Your solution **must** be in the form of a *Gantt Chart*, and **must** be sketched on the *answer sheet* (graph paper) provided. Each Gantt Chart **must** contain the following information:

- **Name of data set:** The name of the data set, e.g. Round 1 data, must be indicated on the Gantt Chart.
- **Job labels:** Label every job in the Gantt Chart by its job number, preparation duration and baking duration.
- **Coloured preparation parts:** The preparation part of each job must be coloured.
- **Vertical axis labels:** The vertical axis (ovens), must be labelled with Oven 1 and Oven 2.
- **Horizontal axis labels:** The horizontal axis (time in minutes), must be labelled with start times of every job and the schedule makespan.

Figures 1 and 2 are good examples of what is required in a Gantt Chart.

Table 2: Round 1 data.

Job	Preparation Duration (minutes)	Baking Duration (minutes)
1	10	1
2	9	2
3	6	5
4	8	3
5	6	5
6	7	4
7	7	4
8	8	3
9	2	9
10	2	9
11	5	6
12	5	6
13	1	10
14	5	6
15	2	9
16	10	1
17	3	8
18	6	5
19	6	5
20	5	6

Table 3: Round 2 data.

Job	Preparation Duration (minutes)	Baking Duration (minutes)
1	5	5
2	1	8
3	8	4
4	7	3
5	3	6
6	3	6
7	3	7
8	2	7
9	2	7
10	12	3
11	10	2
12	9	2
13	9	4
14	3	7
15	9	4
16	10	1
17	1	8
18	14	2
19	11	3
20	8	3

Table 4: Round 3 data.

Job	Preparation Duration (minutes)	Baking Duration (minutes)
1	5	4
2	7	3
3	6	3
4	8	3
5	6	2
6	7	5
7	6	3
8	6	3
9	7	1
10	8	4
11	6	5
12	5	2
13	6	4
14	6	4
15	6	1
16	5	3
17	5	2
18	6	4
19	7	4
20	6	4

Table 5: Round 4 data.

Job	Preparation Duration (minutes)	Baking Duration (minutes)
1	7	8
2	4	3
3	9	5
4	9	8
5	5	1
6	9	8
7	7	4
8	4	6
9	4	9
10	2	11
11	5	2
12	3	3
13	5	4
14	4	1
15	7	9
16	6	11
17	5	8
18	5	2
19	3	7
20	9	8