

# Mathematics for Decisions

## Worksheet 1

Romeo Rizzi, Alice Raffaele

University of Verona

*romeo.rizzi@univr.it, alice.raffaele@unitn.it*

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# Overview

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## Swimming team (I)

A medley relay swimming team consists of four swimmers.

The first member of the team swims one length of backstroke, then the second person swims a length of breaststroke, then the next a length of butterfly and finally the fourth person a length of crawl. Each member of the team must swim just one length. All the team members could swim any of the lengths, but some members of the team are faster at one or two particular strokes.

The table shows the time, in seconds, each member of the team took to swim each length using each type of stroke during the last training session:

	<b>Back</b>	<b>Breast</b>	<b>Butterfly</b>	<b>Crawl</b>
<b>Jack</b>	18	20	19	14
<b>Kyle</b>	19	21	19	14
<b>Liam</b>	17	20	20	16
<b>Mike</b>	20	21	20	15

## Swimming team (II)

1. State the best time in which a team could complete the race;
2. Show that there is more than one way of allocating the team so that they can achieve this best time.

## Induction meeting (I)

Talkalot College holds an induction meeting for new students. The meeting consists of four talks: I (Welcome), II (Options and Facilities), III (Study Tips) and IV (Planning for Success). The four department heads, Clive, Julie, Nicky and Steve, deliver one of these talks each. The talks are delivered consecutively and there are no breaks between talks. The meeting starts at 10 a.m. and ends when all four talks have been delivered. The time, in minutes, each department head takes to deliver each talk is given in the table below:

	<b>Talk I</b>	<b>Talk II</b>	<b>Talk III</b>	<b>Talk IV</b>
<b>Clive</b>	12	34	28	16
<b>Julie</b>	13	32	36	12
<b>Nicky</b>	15	32	32	14
<b>Steve</b>	11	33	36	10

## Induction meeting (II)

1. Find the earliest time that the meeting could end and the final allocation;
2. Find the latest time that the meeting could end.

## Hospital shifts

The nurse manager of Borgo Roma Hospital wants to organize the nurses' shifts. Each nurse works 5 consecutive days – regardless of the starting day within the week – and is entitled to two days off. Service requirements for the various days of the week require the presence of the following minimum number of nurses:

Day	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Number	17	13	15	19	14	12

She wants to organize the service in such a way so as to minimize the total number of nurses.

## Radio production

An electronic company needs to produce at least 20,000 radios in a 4-week period. The unit revenues from the sale of the radios each week are as follows:

Week	1	2	3	4
Revenue (Euro)	20	18	16	14

The company initially has 40 workers, each producing 50 radios per week. It is also possible to hire apprentice workers, three of whom can be trained by a worker within a 1-week period. During the training period the teacher worker does not produce any radio. A worker costs 200 Euros per week, while an apprentice costs 100 Euros for the apprenticeship week. Each radio needs basic components for a cost of 2 Euros. The goal is to maximize the overall profit.



## Phone production

A company produces phones, each of which needs a series of processing steps linked by precedence relations. Each processing step has a weight and a duration. The first processing step conventionally begins at  $t = 0$ . The aim is to determine the start times of each processing step so as to minimize the weighted average. The problem data is summarized in the following table:

Processing Step	Weight	Duration	Previous Steps
1	0	10	-
2	2	23	1
3	5	12	1
4	7	10	2
5	10	3	3, 4
6	12	11	2
7	17	5	2
8	21	4	7
9	26	10	5, 6

For instance, processing step 5 cannot begin before the end of steps 3 and 4, has a weight equal to 10, and a duration equal to 3.

## Boat production

Constructing a boat requires the completion of the following operations (the table also gives the number of days needed for each operation):

Processing Step	Duration	Previous Steps
1	2	-
2	4	1
3	2	1
4	5	1
5	3	2, 3
6	3	5
7	2	5
8	7	4, 5, 7
9	4	6, 7

Some of the operations are alternative to each other: only one of B and C needs to be executed, the same for F and G. Moreover, if both C and G are executed, the duration of I increases by 2 days. Consider also the precedences for each operation (e.g., H can start only after the end of E, D and G, if G will be executed). Which operations should be executed in order to minimize the total duration of the construction of the boat?

## References



Matteo Fischetti, *Introduction to Mathematical Optimization*, Kindle Direct Publishing, 2019

[https://www.amazon.it/  
Introduction-Mathematical-Optimization-\  
Matteo-Fischetti/dp/1692792024](https://www.amazon.it/Introduction-Mathematical-Optimization-Matteo-Fischetti/dp/1692792024)



Susie G Jameson, *Decision Mathematics 2 – Edexcel AS and A Level Modular Mathematics D2*, Pearson Education Limited, 2010

[https://www.amazon.it/  
Edexcel-Level-Modular-Mathematics-Decision/dp/  
0435519204/](https://www.amazon.it/Edexcel-Level-Modular-Mathematics-Decision/dp/0435519204/)



Robert J. Vanderbei, *Linear Programming: Foundations and Extensions*, Springer Nature, 4th edition, 2013

<https://www.springer.com/gp/book/9781461476290>