Contents

LCC Description

One of the main challenges in the Catalan language course of the First Reception Service is meeting the different learning speeds of the students (TCNs). To do that, the teachers usually divide the class into smaller **working groups**. A course consists of multiple consecutive lessons (classes), one per day in the course period.

In WELCOME, the language course coordination (LCC) scenario refers to a language course of, **initially**, **three** consecutive lessons (or classes). In each lesson, every student performs exercises of four types of Catalan language learning activities related to the **reading**, **writing**, **grammar**, and **vocabulary** of Catalan. Each student is assigned to one working group per lesson. **At the end of each lesson**, the progress made by the students is individually assessed through means of a specific set of language learning assessment exercises for each of the four types of learning activities. Language **speaking activities** are not considered in WELCOME. The grouping of students per lesson is usually made by the teacher upon various factors, both **course** and **individual constraints**, and depending on the overall **course progress level** of individual students.

In this context, to facilitate the intervention of the teacher, it would be very helpful if the developed WELCOME technology can support the teacher in her language course coordination. The **objective** of the agents of the students would be to coordinate among each other for finding an (approximately) optimal assignment of students to groups with similar level of course progress. In particular, the WELCOME platform should allow to assess the progress of each of the students and make grouping suggestions to the teacher at the end of each lesson based on the following constraints:

(A) **Individual constraints** specified by the students (TCNs)

1. **Gender**: Gender can be a major constraint for the participation of women in the language learning course. Although this limitation can be considered less important in large groups (such as a class), when working in smaller groups, female TCNs, who do not want to interact with the other gender, are less likely to participate freely in the exercises of the lessons if they are grouped into a mixed-gender group. This can also happen to male-TCNs, although it is less likely to happen.

Therefore, the agent should respect the preference of its TCN about being assigned to a mixed-gender group or not. In fact, this individual constraint **must be satisfied**.

2. **Nationality**. Although many people do not have a problem when working with other nationalities, some of the TCNs might have. To ensure the progress of all members of a group in a class, the agent should respect the preference of its TCN about being assigned to a group with other nationalities than her own one. This constraint, however, **may be ignored** for sake of finding an overall grouping solution.

Each student (TCN) can select one of 3 following options for each preference (gender and nationality):

1) *Same*: TCN prefers a group in which the gender of all others are same as his/hers.

2) *Mixed:* TCN prefers a group in which there are at least a male and a female.

3) *Don't mind*: TCN doesn't care about the gender of others in the group.

Additionally, each TCN will be able to specify the importance degree (in between 0 and 1) for each preference to specify which attribute (Gender or Nationality) is more important for her/him.

(B) **Course constraints** to be satisfied by the coordinating agents of the TCNs

1. Each class (lesson) has at least **two** and at most **twenty** students

2. Each group in a lesson has specified (by teacher) amount of students (e.g. at least **two** and at most **five**)

3. Each group has a specified (by teacher) Similarity of Language Progress Level (LPL) vs Satisfaction of Individual Preferences importance degrees (e.g. 0.6 LPL vs 0.4 Preferences meaning that LPL is slightly more important than Preferences)

4. Each group has a specified (by teacher) amount (e.g. **one**) of students who **missed the previous lesson**

The **progress assessment scheme** to be used by the agents for their finding of an optimal grouping of students is as follows:

- The language learning skill of a student is measured at the end of each lesson of the course as the equally weighted average sum of percentages of correct answers for each language learning activity (reading, writing, grammar, vocabulary) given by the student in the lesson.

  o The *language learning assessment* score (LLA-X) for a given type X of language learning activity (X in {Reading, Writing, Grammar, Vocabulary}) denotes the percentage of correct answers for assessment exercises of this type by the student. An LLA-X score in the interval of 0-49, 50-59, 60-69, 70-79, 80-89, 90-100 is interpreted as "insufficient", "sufficient", "normal", "good", "remarkable", "outstanding" progress, respectively. Besides, the time a student spent to complete the assessment exercises of a given type of language learning activity in the interval of 0-5, 5-10, 10+ minutes is interpreted as „Student is doing OK", „Student is facing difficulties" and „Student is struggling", respectively, in this regard.

  o The *language lesson* (LL) score of an individual student is defined as the equally weighted sum of the LLA-X scores she obtained for performing assessment exercises for the selected four types of language learning activities in multiple-choice form.

The *course progress level* (CPL) score for a student is determined as the averaged sum of the LL scores for all lessons she attended so far.

LCC Data Records

LCC feature to be tested and evaluated with the examples listed below. Each example consists of various TCN profiles in terms of their amount and preferences.

Example 1

Characteristic:

Balanced TCNs in terms of their gender and nationality attributes (4 Male vs 6 Female). They are more inclined to prefer Mixed groups and only 20% of TCNs missed the previous lesson. Females mostly prefer Same gender and Mixed nationality groups and Males mostly prefer Mixed gender and Same nationality groups.

TCN profiles:

Agent ID	Gender	Nationality	Course Progress Level	Attendance	Gender Preference	Nationality Preference
1	Male	A	72	No	Don't mind	Same
2	Male	A	84	Yes	Mixed	Same
3	Female	B	73	Yes	Same	Mixed
4	Male	C	53	Yes	Mixed	Mixed
5	Female	D	25	Yes	Don't mind	Mixed
6	Female	B	44	Yes	Same	Mixed
7	Female	C	89	Yes	Mixed	Don't mind
8	Female	C	57	Yes	Mixed	Mixed
9	Female	D	95	Yes	Same	Mixed
10	Male	C	60	No	Mixed	Same

Example 2

Characteristic:

50% of Males Don't mind the gender and nationality of their group while 50% of Females prefer to be in the Same gender and Mixed nationality group. Only 10% of TCNs missed the previous lesson. 30% of TCNs have a CPL score in between 50 and 70, while 50% of them are in between 70 and 90 and last 20% is over 90 CPL.

TCN profiles:

Agent ID	Gender	Nationality	Course Progress Level	Attendance	Gender Preference	Nationality Preference
1	Male	C	72	Yes	Mixed	Same
2	Male	E	67	Yes	Same	Mixed
3	Female	D	85	Yes	Same	Same
4	Male	A	78	Yes	Mixed	Same
5	Female	B	66	Yes	Same	Mixed
6	Male	D	80	Yes	Don't mind	Don't mind
7	Female	E	75	Yes	Mixed	Don't mind
8	Male	B	57	No	Don't mind	Don't mind
9	Female	A	90	Yes	Don't mind	Mixed

	10	Male	C		92	Yes	Don't mind	Don't mind

Example 3

Characteristic:

TCNs are in complete balance in terms of their Gender (50% Male&Female). Their nationalities are also in balance such that they are divided to 30%, 30% and 40% to belong to 3 nationalities. Females don't really care about the Nationalities but 80% of them prefer a Same gender group. On the other hand, only 20% of Males prefer Same gender and the rest is balanced (40% Same vs 40% Don't mind) in their Gender preference. 30% of TCNs missed the previous lesson.

TCN profiles:

Agent ID	Gender	Nationality	Course Progress Level	Attendance	Gender Preference	Nationality Preference
1	Female	C	51	No	Same	Mixed
2	Male	B	83	Yes	Same	Mixed
3	Female	C	45	Yes	Same	Mixed
4	Male	A	74	Yes	Don't mind	Same
5	Female	C	53	Yes	Same	Don't mind
6	Male	B	73	No	Same	Don't mind
7	Female	B	63	Yes	Same	Don't mind
8	Male	A	70	Yes	Mixed	Same
9	Female	A	57	No	Mixed	Same
10	Male	C	81	Yes	Don't mind	Don't mind

Example 4

Characteristic:

There are 5 Male and Females. Same, Mixed and Don't mind Gender and Nationality preferences are divided balanced as 30%, 30% and 40% respectively. Also 30% of TCNs missed the previous lesson. Moreover, 40%, 30%, 20% and 10% of TCNs belong to 4 different nationalities.

TCN profiles:

Agent ID	Gender	Nationality	Course Progress Level	Attendance	Gender Preference	Nationality Preference

1	Female	A	74	Yes	Mixed	Same
2	Male	C	84	No	Same	Mixed
3	Female	A	55	Yes	Same	Same
4	Male	B	93	Yes	Mixed	Same
5	Female	C	62	No	Same	Mixed
6	Male	A	58	Yes	Don't mind	Don't mind
7	Female	A	92	Yes	Mixed	Don't mind
8	Male	C	80	No	Don't mind	Don't mind
9	Female	D	70	Yes	Don't mind	Mixed
10	Male	B	66	Yes	Don't mind	Don't mind

Example 5

Characteristic:

70% of TCNs are female and only females prefer Same gender (40%) group in the classroom. 40% and 70& of TCNs Don't mind the gender and nationality, respectively. And 30% of TCNs prefer Same nationality. 50% of TCNs have a CPL in between 50 and 70, 30% in between 70 and 90 and the rest in between 90 and 100 CPL.

TCN profiles:

Agent ID	Gender	Nationality	Course Progress Level	Attendance	Gender Preference	Nationality Preference
1	Male	B	88	Yes	Don't mind	Same
2	Female	D	66	Yes	Same	Same
3	Female	A	55	No	Mixed	Don't mind
4	Male	C	77	Yes	Don't mind	Don't mind
5	Female	B	51	No	Same	Same
6	Female	A	95	Yes	Mixed	Don't mind
7	Female	C	80	Yes	Same	Don't mind
8	Male	C	57	No	Don't mind	Don't mind
9	Female	A	90	Yes	Don't mind	Don't mind
10	Female	B	68	Yes	Same	Don't mind

Example 6

Characteristic:

TCNs are in balance in terms of their Gender (60% Female, 40% Male). 40%, 26%, 20% and 14% of them belong to different nationalities. Most of the females prefer Same gender and Mixed nationality groups. Most of the Males prefer Same nationality and Mixed gender groups. And 26% of TCNs missed the previous lesson.

TCN profiles:

Agent ID	Gender	Nationality	Course Progress Level	Attendance	Gender Preference	Nationality Preference
1	Male	A	72	No	Don't mind	Same
2	Male	A	84	Yes	Mixed	Same
3	Female	B	73	Yes	Same	Mixed
4	Male	C	53	Yes	Mixed	Mixed
5	Female	D	25	Yes	Don't mind	Mixed
6	Female	B	44	Yes	Same	Mixed
7	Female	C	89	Yes	Mixed	Don't mind
8	Female	C	57	Yes	Mixed	Mixed
9	Female	D	95	Yes	Same	Mixed
10	Male	C	60	No	Mixed	Same
11	Female	A	74	Yes	Mixed	Same
12	Male	C	84	No	Same	Mixed
13	Female	A	55	Yes	Same	Same
14	Male	B	93	Yes	Mixed	Same
15	Female	C	62	No	Same	Mixed

Example 7

Characteristic:

47% and 53% of TCNs are Females and Males. Only 13% of them missed the previous lesson. TCNs who prefer Same gender or nationality groups are divided in a balanced way (54% Female vs 46% Male). 47% of TCNs have a CPL in between 70 and 90, 33% are in between 50-70 and 7% has less CPL than 50.

TCN profiles:

Agent ID	Gender	Nationality	Course Progress Level	Attendance	Gender Preference	Nationality Preference
1	Male	C	72	Yes	Mixed	Same
2	Male	E	67	Yes	Same	Mixed
3	Female	D	85	Yes	Same	Same
4	Male	A	78	Yes	Mixed	Same
5	Female	B	66	Yes	Same	Mixed
6	Male	D	80	Yes	Don't mind	Don't mind
7	Female	E	75	Yes	Mixed	Don't mind
8	Male	B	57	No	Don't mind	Don't mind
9	Female	A	90	Yes	Don't mind	Mixed
10	Male	C	92	Yes	Don't mind	Don't mind
11	Female	C	51	No	Same	Mixed
12	Male	B	83	Yes	Same	Mixed
13	Female	C	45	Yes	Same	Mixed
14	Male	A	74	Yes	Don't mind	Same
15	Female	C	53	Yes	Same	Don't mind

Example 8

Characteristic:

In this example, 53% of TCNs are Females. Furthermore, 34% of TCNs have missed the previous lesson. Most of the TCNs prefer either Same or they don't care about the gender and nationality of groups. Only 20% of them prefer Mixed gender or nationality groups. 7 5070, 7 70-90, Additionally, the TCNs who have a CPL in between 50 to 70 and 70 to 90 are divided in half and only 1 TCN has less CPL than 50.

TCN profiles:

Agent ID	Gender	Nationality	Course Progress Level	Attendance	Gender Preference	Nationality Preference
1	Female	C	51	No	Same	Mixed
2	Male	B	83	Yes	Same	Mixed
3	Female	C	45	Yes	Same	Mixed

Agent ID	Gender	Nationality	Course Progress Level	Attendance	Gender Preference	Nationality Preference
4	Male	A	74	Yes	Don't mind	Same
5	Female	C	53	Yes	Same	Don't mind
6	Male	B	73	No	Same	Don't mind
7	Female	B	63	Yes	Same	Don't mind
8	Male	A	70	Yes	Mixed	Same
9	Female	A	57	No	Mixed	Same
10	Male	C	81	Yes	Don't mind	Don't mind
11	Male	B	88	Yes	Don't mind	Same
12	Female	D	66	Yes	Same	Same
13	Female	A	55	No	Mixed	Don't mind
14	Male	C	77	Yes	Don't mind	Don't mind
15	Female	B	51	No	Same	Same

Example 9

Characteristic:

45% of TCNs are Male. The lowest CPL a TCN has is 25 while the highest is 95 and they are divided in this range in a balanced way. In this example, TCNs mostly prefer Mixed groups. And 25% of them missed the previous lesson. 84% and 77% of TCNs who prefer Same gender and Mixed nationality are Females, respectively.

TCN profiles:

Agent ID	Gender	Nationality	Course Progress Level	Attendance	Gender Preference	Nationality Preference
1	Male	A	72	No	Don't mind	Same
2	Male	A	84	Yes	Mixed	Same
3	Female	B	73	Yes	Same	Mixed
4	Male	C	53	Yes	Mixed	Mixed
5	Female	D	25	Yes	Don't mind	Mixed
6	Female	B	44	Yes	Same	Mixed

Agent ID	Gender	Nationality	Course Progress Level	Attendance	Gender Preference	Nationality Preference
7	Female	C	89	Yes	Mixed	Don't mind
8	Female	C	57	Yes	Mixed	Mixed
9	Female	D	95	Yes	Same	Mixed
10	Male	C	60	No	Mixed	Same
11	Female	A	74	Yes	Mixed	Same
12	Male	C	84	No	Same	Mixed
13	Female	A	55	Yes	Same	Same
14	Male	B	93	Yes	Mixed	Same
15	Female	C	62	No	Same	Mixed
16	Male	A	58	Yes	Don't mind	Don't mind
17	Female	A	92	Yes	Mixed	Don't mind
18	Male	C	80	No	Don't mind	Don't mind
19	Female	D	70	Yes	Don't mind	Mixed
20	Male	B	66	Yes	Don't mind	Don't mind

Example 10

Characteristic:

45% of TCNs are Females and most of them prefer Same gender groups. But females are not so picky in the nationality preferences. On the other hand, Males are divided equally in their gender preferences. When it comes to Nationality preference, 40% of TCNs don't mind and the rest is divided in half as 30% prefers Same and 30% prefers Mixed nationalities.

TCN profiles:

Agent ID	Gender	Nationality	Course Progress Level	Attendance	Gender Preference	Nationality Preference
1	Male	C	72	Yes	Mixed	Same
2	Male	E	67	Yes	Same	Mixed
3	Female	D	85	Yes	Same	Same
4	Male	A	78	Yes	Mixed	Same
5	Female	B	66	Yes	Same	Mixed
6	Male	D	80	Yes	Don't mind	Don't mind

	Gender	Nationality	CPL	Attendance	Gender Preference	Nationality Preference
7	Female	E	75	Yes	Mixed	Don't mind
8	Male	B	57	No	Don't mind	Don't mind
9	Female	A	90	Yes	Don't mind	Mixed
10	Male	C	92	Yes	Don't mind	Don't mind
11	Female	C	51	No	Same	Mixed
12	Male	B	83	Yes	Same	Mixed
13	Female	C	45	Yes	Same	Mixed
14	Male	A	74	Yes	Don't mind	Same
15	Female	C	53	Yes	Same	Don't mind
16	Male	B	73	No	Same	Don't mind
17	Female	B	63	Yes	Same	Don't mind
18	Male	A	70	Yes	Mixed	Same
19	Female	A	57	No	Mixed	Same
20	Male	C	81	Yes	Don't mind	Don't mind

Example 11

Characteristic:

60% of TCNs are Females and 67% of them prefer Same gender groups. 63% of Males, on the other hand, don't care about the gender of the group. Also 55% of TCNs don't mind the nationality preference and 64% of them are females. Moreover 30% of TCNs missed the previous lesson. Furthermore, 45% and 40% of TCNs have CPL in between [50,70] and [70,90], respectively.

TCN profiles:

Agent ID	Gender	Nationality	Course Progress Level	Attendance	Gender Preference	Nationality Preference
1	Female	C	51	No	Same	Mixed
2	Male	B	83	Yes	Same	Mixed
3	Female	C	45	Yes	Same	Mixed
4	Male	A	74	Yes	Don't mind	Same
5	Female	C	53	Yes	Same	Don't mind

6	Male	B	73	No	Same	Don't mind
7	Female	B	63	Yes	Same	Don't mind
8	Male	A	70	Yes	Mixed	Same
9	Female	A	57	No	Mixed	Same
10	Male	C	81	Yes	Don't mind	Don't mind
11	Male	B	88	Yes	Don't mind	Same
12	Female	D	66	Yes	Same	Same
13	Female	A	55	No	Mixed	Don't mind
14	Male	C	77	Yes	Don't mind	Don't mind
15	Female	B	51	No	Same	Same
16	Female	A	95	Yes	Mixed	Don't mind
17	Female	C	80	Yes	Same	Don't mind
18	Male	C	57	No	Don't mind	Don't mind
19	Female	A	90	Yes	Don't mind	Don't mind
20	Female	B	68	Yes	Same	Don't mind

LCC Configurations

Configuration 1

Group Size: *minimum 2 maximum 5 TCNs*

Attendance: *maximum 1 TCN in a group who missed previous lesson*

Course Progress Level (CPL) vs Satisfaction of Preferences importance weights: *0.75 vs 0.25*

Gender vs Nationality preferences importance weights: *0.75 vs 0.25*

Configuration 2

Group Size: *minimum 2 maximum 5 TCNs*

Attendance: *maximum 1 TCN in a group who missed previous lesson*

Course Progress Level (CPL) vs Satisfaction of Preferences importance weights: *0.1 vs 0.9*

Gender vs Nationality preferences importance weights: *0.75 vs 0.25*

Configuration 3

Group Size: *minimum 2 maximum 3 TCNs*

Attendance: *maximum 1 TCN in a group who missed previous lesson*

Course Progress Level (CPL) vs Satisfaction of Preferences importance weights: *0.75 vs 0.25*

Gender vs Nationality preferences importance weights: *0.5 vs 0.5*

Configuration 4

Group Size: *minimum 3 maximum 4 TCNs*

Attendance: *maximum 1 TCN in a group who missed previous lesson*

Course Progress Level (CPL) vs Satisfaction of Preferences importance weights: *0.25 vs 0.75*

Gender vs Nationality preferences importance weights: *0.25 vs 0.75*

LCC Results and Evaluation

Each solution list for a **data record (example) and configuration pair** will be evaluated with Customer Satisfaction Score (**CSAT**) metric on a Likert scale shown below:

- ➔ 5: very satisfied
- ➔ 4: satisfied
- ➔ 3: neither satisfied nor dissatisfied
- ➔ 2: dissatisfied
- ➔ 1: very dissatisfied

Results-Example 1

- ➢ **Configuration 1**
  - ○ **Total computation time**: *141 seconds*
  - ○ **Solution list**:
    1. [[4, 8, 10], [5, 6], [2, 7, 9], [1, 3]]
    2. [[4, 5, 6, 8, 10], [2, 7, 9], [1, 3]]
    3. [[2, 7, 9], [4, 5, 6], [1, 3], [8, 10]]
  - ○ **Customer Satisfaction Score on Likert scale**: 5
- ➢ **Configuration 2**
  - ○ **Total computation time**: *138 seconds*
  - ○ **Solution list**:
    1. [[4, 8, 10], [5, 6], [1, 2, 7], [3, 9]]
    2. [[1, 2, 4, 7], [3, 9], [5, 6], [8, 10]]
    3. [[2, 4, 8, 10], [1, 7], [3, 9], [5, 6]]
  - ○ **Customer Satisfaction Score on Likert scale**: 5
- ➢ **Configuration 3**

- o **Total computation time**: *132 seconds*
- o **Solution list**:
  1. [[2, 7, 9], [4, 8, 10], [1, 3], [5, 6]]
  2. [[2, 7, 9], [4, 5, 6], [1, 3], [8, 10]]
  3. [[1, 2, 3], [4, 8, 10], [5, 6], [7, 9]]
- o **Customer Satisfaction Score on Likert scale**: 5
- ➢ **Configuration 4**
  - o **Total computation time**: *143 seconds*
  - o **Solution list**:
    1. [[4, 5, 6, 10], [1, 3, 8], [2, 7, 9]]
    2. [[1, 2, 7, 9], [3, 8, 10], [4, 5, 6]]
    3. [[5, 6, 8, 10], [1, 3, 4], [2, 7, 9]]
  - o **Customer Satisfaction Score on Likert scale**: 5

Results-Example 2

- ➢ **Configuration 1**
  - o **Total computation time**: *140 seconds*
  - o **Solution list**:
    1. [[1, 3, 4, 6, 7], [2, 5, 8], [9, 10]]
    2. [[2, 5, 8], [3, 4, 6], [1, 7], [9, 10]]
    3. [[1, 2, 5, 8], [3, 4, 6, 7], [9, 10]]
  - o **Customer Satisfaction Score on Likert scale**: 5
- ➢ **Configuration 2**
  - o **Total computation time**: *137 seconds*
  - o **Solution list**:
    1. [[1, 4, 6, 7], [2, 8], [3, 5], [9, 10]]
    2. [[4, 6, 9, 10], [1, 7], [2, 8], [3, 5]]
    3. [[1, 6, 9, 10], [2, 8], [3, 5], [4, 7]]
  - o **Customer Satisfaction Score on Likert scale**: 5
- ➢ **Configuration 3**
  - o **Total computation time**: *140 seconds*
  - o **Solution list**:
    1. [[2, 5, 8], [3, 4, 6], [1, 7], [9, 10]]
    2. [[1, 4, 7], [2, 5, 8], [3, 6], [9, 10]]
    3. [[2, 5, 8], [3, 9, 10], [1, 7], [4, 6]]
  - o **Customer Satisfaction Score on Likert scale**: 5
- ➢ **Configuration 4**
  - o **Total computation time**: *135 seconds*
  - o **Solution list**:
    1. [[1, 2, 5, 8], [3, 9, 10], [4, 6, 7]]
    2. [[1, 4, 6, 7], [2, 5, 8], [3, 9, 10]]
    3. [[3, 6, 9, 10], [1, 4, 7], [2, 5, 8]]
  - o **Customer Satisfaction Score on Likert scale**: 5

Results-Example 3

- ➢ **Configuration 1**
  - o **Total computation time**: *135 seconds*

- o **Solution list**:
    1. [[1, 3, 5], [4, 6, 8], [2, 10], [7, 9]]
    2. [[1, 3, 5], [7, 8, 9], [2, 10], [4, 6]]
    3. [[4, 6, 8], [5, 7, 9], [1, 3], [2, 10]]
- o **Customer Satisfaction Score on Likert scale**: 5

➢ **Configuration 2**
- o **Total computation time**: *137 seconds*
- o **Solution list**:
    1. [[1, 3, 5, 7], [2, 6, 10], [4, 8, 9]]
    2. [[1, 3, 5, 7], [2, 10], [4, 6], [8, 9]]
    3. [[1, 3, 5, 7], [2, 4, 6, 10], [8, 9]]
- o **Customer Satisfaction Score on Likert scale**: 5

➢ **Configuration 3**
- o **Total computation time**: *136 seconds*
- o **Solution list**:
    1. [[1, 3, 5], [4, 6, 8], [2, 10], [7, 9]]
    2. [[4, 6, 8], [5, 7, 9], [1, 3], [2, 10]]
    3. [[1, 3], [2, 10], [4, 6], [5, 9], [7, 8]]
- o **Customer Satisfaction Score on Likert scale**: 5

➢ **Configuration 4**
- o **Total computation time**: *133 seconds*
- o **Solution list**:
    1. [[1, 3, 5, 7], [2, 6, 10], [4, 8, 9]]
    2. [[1, 3, 5, 7], [2, 4, 6], [8, 9, 10]]
    3. [[1, 3, 5, 7], [2, 8, 9], [4, 6, 10]]
- o **Customer Satisfaction Score on Likert scale**: 5

Results-Example 4
➢ **Configuration 1**
- o **Total computation time**: *137 seconds*
- o **Solution list**:
    1. [[1, 8, 9], [2, 4, 7], [3, 6], [5, 10]]
    2. [[2, 4, 7], [5, 9, 10], [1, 8], [3, 6]]
    3. [[1, 8], [9, 10], [2, 4, 7], [3, 5, 6]]
- o **Customer Satisfaction Score on Likert scale**: 5

➢ **Configuration 2**
- o **Total computation time**: *139 seconds*
- o **Solution list**:
    1. [[1, 8, 9], [2, 6, 10], [3, 5], [4, 7]]
    2. [[2, 6, 10], [3, 5, 9], [1, 8], [4, 7]]
    3. [[1, 6, 8, 9], [2, 10], [3, 5], [4, 7]]
- o **Customer Satisfaction Score on Likert scale**: 5

➢ **Configuration 3**
- o **Total computation time**: *137 seconds*
- o **Solution list**:
    1. [[1, 8, 9], [2, 4, 7], [3, 6], [5, 10]]
    2. [[2, 4, 7], [5, 9, 10], [1, 8], [3, 6]]
    3. [[2, 4, 7], [3, 5, 6], [1, 8], [9, 10]]

- o **Customer Satisfaction Score on Likert scale**: 5
- ➤ **Configuration 4**
  - o **Total computation time**: *134 seconds*
  - o **Solution list**:
    1. `[[1, 8, 9, 10], [2, 4, 7], [3, 5, 6]]`
    2. `[[3, 5, 6, 10], [1, 8, 9], [2, 4, 7]]`
    3. `[[3, 5, 6, 9], [1, 8, 10], [2, 4, 7]]`
  - o **Customer Satisfaction Score on Likert scale**: 5

Results-Example 5

- ➤ **Configuration 1**
  - o **Total computation time**: *140 seconds*
  - o **Solution list**:
    1. [[1, 6, 9], [3, 4, 7], [2, 8], [5, 10]]
    2. [[1, 6, 9], [4, 7, 8], [2, 3], [5, 10]]
    3. [[1, 6, 9], [3, 4, 7], [2, 5], [8, 10]]
  - o **Customer Satisfaction Score on Likert scale**: 5
- ➤ **Configuration 2**
  - o **Total computation time**: *136 seconds*
  - o **Solution list**:
    1. `[[1, 3, 6, 9], [2, 5, 7, 10], [4, 8]]`
    2. `[[1, 6, 8, 9], [2, 5, 7, 10], [3, 4]]`
    3. `[[1, 3, 6, 9], [2, 7], [4, 8], [5, 10]]`
  - o **Customer Satisfaction Score on Likert scale**: 5
- ➤ **Configuration 3**
  - o **Total computation time**: *157 seconds*
  - o **Solution list**:
    1. `[[1, 6, 9], [3, 4, 7], [2, 8], [5, 10]]`
    2. `[[1, 6, 9], [4, 7, 8], [2, 3], [5, 10]]`
    3. `[[1, 6, 9], [3, 4, 7], [2, 5], [8, 10]]`
  - o **Customer Satisfaction Score on Likert scale**: 5
- ➤ **Configuration 4**
  - o **Total computation time**: *143 seconds*
  - o **Solution list**:
    1. `[[1, 3, 6, 9], [2, 5, 10], [4, 7, 8]]`
    2. `[[1, 6, 8, 9], [2, 5, 10], [3, 4, 7]]`
    3. `[[4, 6, 8, 9], [1, 5, 10], [2, 3, 7]]`
  - o **Customer Satisfaction Score on Likert scale**: 5

Results-Example 6

- ➤ **Configuration 1**
  - o **Total computation time**: *209 seconds*
  - o **Solution list**:
    1. [[4, 5, 6, 13, 15], [1, 3, 11], [7, 9, 14], [2, 12], [8, 10]]
    2. [[1, 3, 11], [4, 13, 15], [7, 9, 14], [2, 12], [5, 6], [8, 10]]
    3. [[1, 3, 11], [4, 8, 10], [7, 9, 14], [2, 12], [5, 6], [13, 15]]

- o **Customer Satisfaction Score on Likert scale**: 5
- ➤ **Configuration 2**
  - o **Total computation time**: *204 seconds*
  - o **Solution list**:
    1. [[3, 6, 9, 13, 15], [4, 5, 8, 10], [1, 11], [2, 12], [7, 14]]
    2. [[4, 8, 10], [1, 11], [2, 12], [3, 9], [5, 6], [7, 14], [13, 15]]
    3. [[3, 9, 13, 15], [4, 8, 10], [1, 11], [2, 12], [5, 6], [7, 14]]
  - o **Customer Satisfaction Score on Likert scale**: 5
- ➤ **Configuration 3**
  - o **Total computation time**: *201 seconds*
  - o **Solution list**:
    1. [[1, 3, 11], [4, 13, 15], [7, 9, 14], [2, 12], [5, 6], [8, 10]]
    2. [[1, 3, 11], [4, 8, 10], [7, 9, 14], [2, 12], [5, 6], [13, 15]]
    3. [[1, 3, 11], [4, 10, 13], [7, 9, 14], [2, 12], [5, 6], [8, 15]]
  - o **Customer Satisfaction Score on Likert scale**: 5
- ➤ **Configuration 4**
  - o **Total computation time**: *206 seconds*
  - o **Solution list**:
    1. [[3, 5, 6, 15], [4, 8, 10, 13], [7, 9, 12, 14], [1, 2, 11]]
    2. [[1, 11, 13], [2, 3, 12], [4, 8, 10], [5, 6, 15], [7, 9, 14]]
    3. [[2, 3, 8, 15], [4, 5, 6, 10], [7, 9, 12, 14], [1, 11, 13]]
  - o **Customer Satisfaction Score on Likert scale**: 5

Results-Example 7
- ➤ **Configuration 1**
  - o **Total computation time**: *250 seconds*
  - o **Solution list**:
    1. [[1, 7, 14], [4, 6], [2, 5], [3, 12], [8, 15], [9, 10], [11, 13]]
    2. [[1, 4, 6, 7, 14], [2, 5], [3, 12], [8, 15], [9, 10], [11, 13]]
    3. [[1, 7, 14], [4, 6], [2, 5, 8], [11, 13, 15], [3, 12], [9, 10]]
  - o **Customer Satisfaction Score on Likert scale**: 5
- ➤ **Configuration 2**
  - o **Total computation time**: *243 seconds*
  - o **Solution list**:
    1. [[1, 4, 6, 7, 14], [5, 11, 13, 15], [2, 8], [3, 12], [9, 10]]
    2. [[1, 4, 6, 7], [5, 11, 13, 15], [2, 8, 14], [3, 12], [9, 10]]
    3. [[5, 11, 13, 15], [1, 4, 7], [2, 8], [3, 12], [6, 14], [9, 10]]
  - o **Customer Satisfaction Score on Likert scale**: 5
- ➤ **Configuration 3**
  - o **Total computation time**: *239 seconds*
  - o **Solution list**:
    1. [[1, 7, 14], [2, 5], [3, 12], [4, 6], [8, 15], [9, 10], [11, 13]]
    2. [[1, 2, 5], [3, 12], [4, 6], [7, 14], [8, 15], [9, 10], [11, 13]]
    3. [[1, 7, 14], [2, 5], [3, 12], [4, 6], [8, 13], [9, 10], [11, 15]]
  - o **Customer Satisfaction Score on Likert scale**: 5
- ➤ **Configuration 4**
  - o **Total computation time**:*251 seconds*
  - o **Solution list**:
    1. [[1, 4, 6, 7], [3, 9, 10, 12], [5, 11, 13, 15], [2, 8, 14]]

2. [[3, 9, 10, 12], [4, 6, 7, 14], [5, 11, 13, 15], [1, 2, 8]]
3. [[1, 2, 8, 14], [3, 9, 10, 12], [5, 11, 13, 15], [4, 6, 7]]
- o **Customer Satisfaction Score on Likert scale**: 5

Results-Example 8

➢ **Configuration 1**
- o **Total computation time**: *201 seconds*
- o **Solution list**:
    1. [[2, 10, 11, 14], [8, 12, 13], [1, 5], [3, 15], [4, 6], [7, 9]]
    2. [[2, 10, 11, 14], [8, 9, 12], [1, 5], [3, 15], [4, 6], [7, 13]]
    3. [[2, 10, 11, 14], [8, 12, 13], [1, 3], [4, 6], [5, 15], [7, 9]]
- o **Customer Satisfaction Score on Likert scale**: 5

➢ **Configuration 2**
- o **Total computation time**: *211 seconds*
- o **Solution list**:
    1. [[1, 3, 5, 12], [2, 10, 11], [4, 9], [6, 14], [7, 15], [8, 13]]
    2. [[1, 5, 7, 12], [2, 10, 11], [3, 15], [4, 9], [6, 14], [8, 13]]
    3. [[2, 6, 10, 11, 14], [1, 5, 7, 12], [3, 15], [4, 9], [8, 13]]
- o **Customer Satisfaction Score on Likert scale**: 5

➢ **Configuration 3**
- o **Total computation time**: *207 seconds*
- o **Solution list**:
    1. [[2, 10, 11], [4, 6, 14], [8, 12, 13], [1, 5], [3, 15], [7, 9]]
    2. [[2, 10, 11], [4, 6, 14], [8, 9, 12], [1, 5], [3, 15], [7, 13]]
    3. [[2, 10, 11], [4, 6, 14], [8, 12, 13], [1, 3], [5, 15], [7, 9]]
- o **Customer Satisfaction Score on Likert scale**: 5

➢ **Configuration 4**
- o **Total computation time**: *204 seconds*
- o **Solution list**:
    1. [[1, 7, 12], [2, 6, 11], [3, 5, 15], [4, 8, 9], [10, 13, 14]]
    2. [[1, 7, 12], [2, 6, 10], [3, 5, 15], [4, 8, 9], [11, 13, 14]]
    3. [[1, 7, 12], [2, 6, 14], [3, 5, 15], [4, 8, 9], [10, 11, 13]]
- o **Customer Satisfaction Score on Likert scale**: 5

Results-Example 9

➢ **Configuration 1**
- o **Total computation time**: *577 seconds*
- o **Solution list**:
    1. [[7, 9, 14, 17], [3, 11, 18], [8, 10, 16], [1, 19], [2, 12], [4, 13], [5, 6], [15, 20]]
    2. [[7, 9, 14, 17], [1, 3, 19], [8, 10, 16], [2, 12], [4, 13], [5, 6], [11, 18], [15, 20]]
    3. [[7, 9, 14, 17], [3, 11, 18], [4, 8, 13], [1, 19], [2, 12], [5, 6], [10, 16], [15, 20]]
- o **Customer Satisfaction Score on Likert scale**: 5

➢ **Configuration 2**
- o **Total computation time**: *560 seconds*
- o **Solution list**:
    1. [[3, 9, 13, 15, 19], [4, 8, 10, 16], [2, 7, 18], [1, 11], [5, 6], [12, 20], [14, 17]]

2. [[2, 7, 14, 17, 18], [3, 9, 13, 15, 19], [4, 8, 10, 16], [1, 11], [5, 6], [12, 20]]
3. [[4, 8, 10, 16], [2, 7, 18], [3, 9, 19], [1, 11], [5, 6], [12, 20], [13, 15], [14, 17]]
- o **Customer Satisfaction Score on Likert scale**: 5
- ➢ **Configuration 3**
  - o **Total computation time**: *581 seconds*
  - o **Solution list**:
    1. [[8, 10, 16], [9, 14, 17], [1, 11], [2, 12], [3, 19], [4, 13], [5, 6], [7, 18], [15, 20]]
    2. [[3, 11, 18], [8, 10, 16], [1, 19], [2, 12], [4, 13], [5, 6], [7, 17], [9, 14], [15, 20]]
    3. [[1, 3, 19], [8, 10, 16], [2, 12], [4, 13], [5, 6], [7, 17], [9, 14], [11, 18], [15, 20]]
  - o **Customer Satisfaction Score on Likert scale**: 5
- ➢ **Configuration 4**
  - o **Total computation time**: *570 seconds*
  - o **Solution list**:
    1. [[3, 18, 19, 20], [4, 8, 10, 16], [1, 11, 13], [2, 7, 12], [5, 6, 15], [9, 14, 17]]
    2. [[3, 18, 19, 20], [4, 5, 6, 15], [1, 11, 13], [2, 7, 12], [8, 10, 16], [9, 14, 17]]
    3. [[3, 18, 19, 20], [4, 5, 6, 10], [1, 11, 13], [2, 7, 12], [8, 15, 16], [9, 14, 17]]
  - o **Customer Satisfaction Score on Likert scale**: 5

Results-Example 10

- ➢ **Configuration 1**
  - o **Total computation time**: *636 seconds*
  - o **Solution list**:
    1. [[1, 7, 14, 16, 18], [4, 6, 20], [2, 5], [3, 12], [8, 15], [9, 10], [11, 13], [17, 19]]
    2. [[1, 4, 7, 18], [2, 5], [3, 12], [6, 20], [8, 15], [9, 10], [11, 13], [14, 16], [17, 19]]
    3. [[1, 2, 5, 18], [3, 12], [4, 7], [6, 20], [8, 15], [9, 10], [11, 13], [14, 16], [17, 19]]
  - o **Customer Satisfaction Score on Likert scale**: 5
- ➢ **Configuration 2**
  - o **Total computation time**: *601 seconds*
  - o **Solution list**:
    1. [[5, 11, 13, 15, 17], [4, 14, 18, 19], [6, 16, 20], [1, 7], [2, 8], [3, 12], [9, 10]]
    2. [[5, 11, 13, 15, 17], [2, 16], [6, 20], [4, 14, 18, 19], [1, 7, 8], [3, 12], [9, 10]]
    3. [[5, 11, 13, 15, 17], [4, 14, 18, 19], [1, 7, 20], [2, 8], [3, 12], [6, 16], [9, 10]]
  - o **Customer Satisfaction Score on Likert scale**: 5
- ➢ **Configuration 3**
  - o **Total computation time**: *617 seconds*
  - o **Solution list**:
    1. [[1, 16, 18], [4, 6, 20], [2, 5], [3, 12], [7, 14], [8, 15], [9, 10], [11, 13], [17, 19]]

2. [[1, 7, 18], [4, 6, 20], [2, 5], [3, 12], [8, 15], [9, 10], [11, 13], [14, 16], [17, 19]]
3. [[4, 6, 20], [5, 17, 19], [1, 16], [2, 18], [3, 12], [7, 14], [8, 15], [9, 10], [11, 13]]
- **Customer Satisfaction Score on Likert scale**: 5
- **Configuration 4**
  - **Total computation time**: *627 seconds*
  - **Solution list**:
    1. [[4, 14, 18, 19], [11, 13, 15, 17], [1, 7, 16], [2, 5, 8], [3, 9, 10], [6, 12, 20]]
    2. [[4, 14, 18, 19], [5, 11, 13, 15], [1, 7, 16], [2, 8, 17], [3, 9, 10], [6, 12, 20]]
    3. [[4, 14, 18, 19], [11, 13, 15, 17], [1, 7, 16], [2, 5, 8], [3, 9, 12], [6, 10, 20]]
  - **Customer Satisfaction Score on Likert scale**: 5

Results-Example 11

- **Configuration 1**
  - **Total computation time**: *756 seconds*
  - **Solution list**:
    1. [[2, 10, 14, 17], [8, 13, 20], [11, 16, 19], [1, 5], [3, 15], [4, 6], [7, 9], [12, 18]]
    2. [[2, 10, 14, 17], [8, 9, 20], [11, 16, 19], [1, 5], [3, 15], [4, 6], [7, 13], [12, 18]]
    3. [[2, 10, 14, 17], [8, 13, 20], [11, 16, 19], [1, 3], [4, 6], [5, 15], [7, 9], [12, 18]]
  - **Customer Satisfaction Score on Likert scale**: 5
- **Configuration 2**
  - **Total computation time**: *708 seconds*
  - **Solution list**:
    1. [[1, 7, 12, 17, 20], [2, 10, 18], [3, 5, 15], [11, 16, 19], [4, 9], [6, 14], [8, 13]]
    2. [[1, 7, 12, 17, 20], [2, 6, 10], [3, 5, 15], [11, 16, 19], [4, 9], [8, 13], [14, 18]]
    3. [[1, 7, 12, 17, 20], [10, 11, 16, 18, 19], [2, 6, 14], [3, 5, 15], [4, 9], [8, 13]]
  - **Customer Satisfaction Score on Likert scale**: 5
- **Configuration 3**
  - **Total computation time**: *940 seconds*
  - **Solution list**:
    1. [[8, 13, 20], [11, 16, 19], [1, 5], [2, 10], [3, 15], [4, 6], [7, 9], [12, 18], [14, 17]]
    2. [[8, 9, 20], [11, 16, 19], [1, 5], [2, 10], [3, 15], [4, 6], [7, 13], [12, 18], [14, 17]]
    3. [[2, 10, 17], [4, 6, 14], [8, 13, 20], [11, 16, 19], [1, 5], [3, 15], [7, 9], [12, 18]]
  - **Customer Satisfaction Score on Likert scale**: 5
- **Configuration 4**
  - **Total computation time**: *657 seconds*
  - **Solution list**:
    1. [[2, 6, 10, 14], [11, 16, 18, 19], [1, 12, 17], [3, 5, 13], [4, 8, 9], [7, 15, 20]]

2. [[2, 6, 10, 14], [11, 16, 18, 19], [1, 17, 20], [3, 5, 15], [4, 8, 9], [7, 12, 13]]
3. [[2, 6, 10, 14], [11, 16, 18, 19], [1, 7, 12], [3, 5, 15], [4, 8, 9], [13, 17, 20]]
- **Customer Satisfaction Score on Likert scale**: 5