



# The Team Formation Survey Report

## Introduction

In the team formation survey, we asked the responders to imagine a scenario where they were the class instructor. They were then given tasks to form teams for their class. There is software made by other students that consider skillsets and time to form the most compatible teams for any class. This survey aimed to identify the best visualization to display information (i.e., Time, Skills score) in that software. In this survey, responders were presented with different circumstances associated with corresponding graphs. The primary aim of this survey is to identify which graph yields the most accurate results in a limited time. These graphs will display different information in the software - Team Formation.

In order to formulate questions, we followed the general structure provided by the instructor (Dr. Bowen) and the student(s) who had previously worked on this project.

General Structure:

- **Basic interpretability:** We asked a simple question to test if the responder understands the graph.
- **Moving individuals:** We provided a set of graphs for two teams (i.e Team A, Team B) and asked the responder to move an individual from one team to the other team depending on the question.
- **Comparing team sets:** Here we asked the responder to explore two different scenarios (each scenario contained three different team) and provide an answer based on the question.
- **General preference:** At the end, we asked the responder to state their preference as to which graph is the best along with their appropriate reasoning for the same.

We followed this general structure and based on this; we came up with different questions in order to test the responder's understanding of each graph. The graphs were created using Python. We used Qualtrics as a data collection tool and analyzed the data collected using Python. The main goal of the study is to build on and further improvise the previous study by adding better graphs and improving the questionnaires. In the analysis section, we aim to find a relationship between the time taken by responders to complete the questionnaire and the accuracy of their responses.

## The Questionnaire

Up until now, we have made use of 5 different types of graphs:

1. Stack Bar Graph
2. Group Bar Graph
3. Grid View
4. Heat Map
5. Tally

Parallel to the pervious study, we decided to use the stack bar graph and group bar graph to create teams based on student skills.

The student skills are as follow:

- Website: how good they are at designing websites.

- Database: how good they are at writing code for databases.
- Communication: how good they are with talking to clients and customers.
- Time: how good they are with time management.

Here, the students responded to each skill on a scale from 1 - 5, where 1 indicated that they are bad at that particular skill, and 5 indicated they are highly proficient at that skill.

Additionally, Grid View, Heat Map, and Tally were used to create team based on Time availability.

## Implementing Counterbalancing

As we were creating the survey, we realized that the survey results might be biased as we were asking for graphs in a specific order (i.e., stack bar graph followed by group bar graph). Since each graph is different and has its drawbacks, we introduced counterbalancing to make our results fair and reliable. We used the Latin square technique for our survey, where we will distribute  $n$  numbers of the version of our survey for the  $n$  number of graphs. For instance, if the survey has two types of graphs, then there will be two versions.

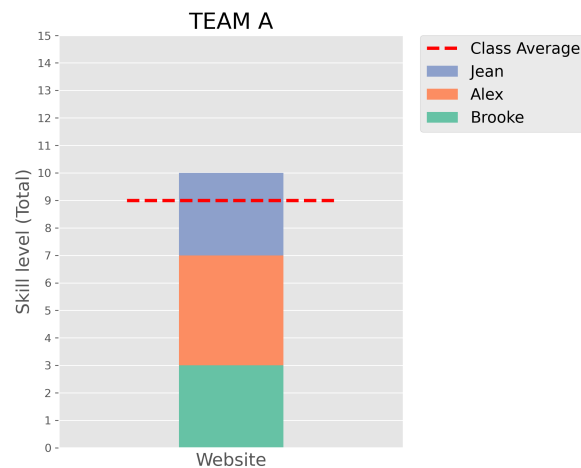
The first version will have graph type 1 followed by graph type 2.

The second version will have graph type 2 followed by graph type 1.

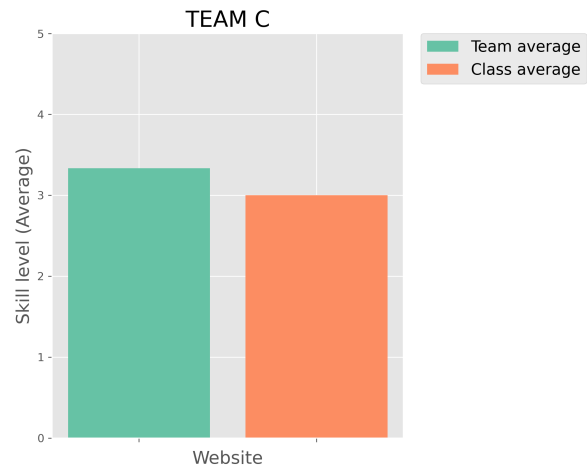
For the Latin Square counterbalancing, we created two versions of section 1 - Skills.

- Version 1 had Group bar graph first followed by Stacked bar graph
- The Version 2 had Stacked bar graph first followed by Group bar graph

## Stack bar graph



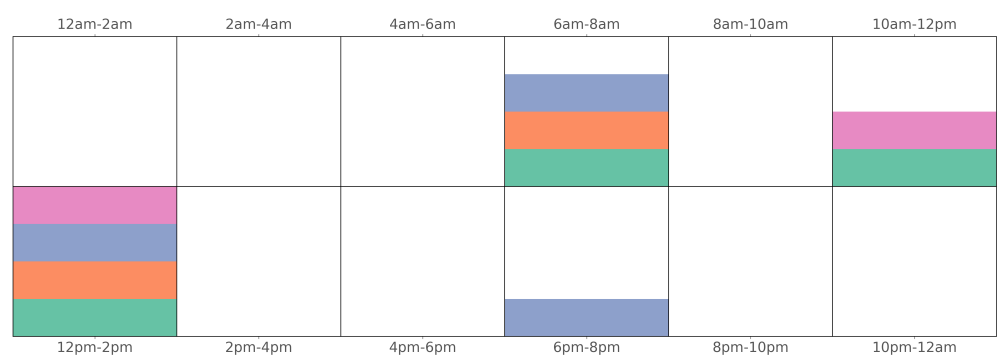
## Group bar graph



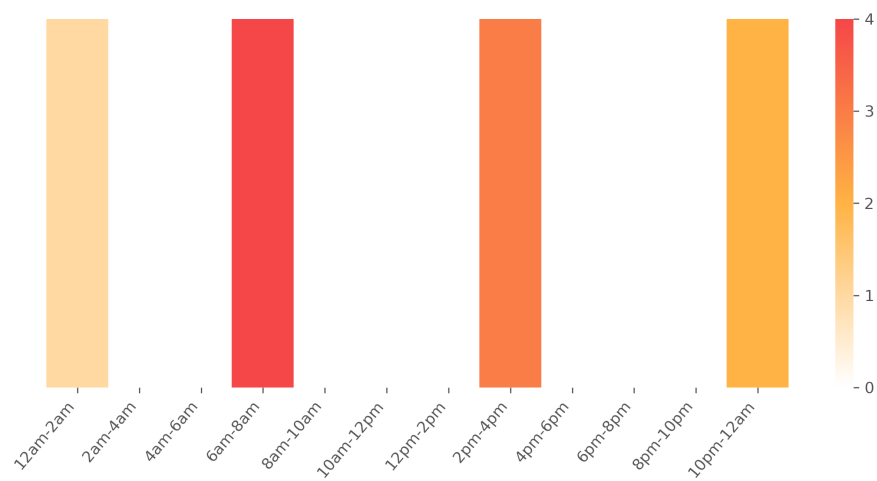
For Section 2 - Time, as there are three graphs, there will be 3 version.

- Version 1 has Grid View first, then Heat Map and Tally in the end.
- The Version 2 has Heat Map first, then Tally and Grid View in the end.
- The Version 3 has Tally first, then Grid View and Heat Map in the end.

Grid View



Heat Map



Tally

## TEAM B

AJ	Selected: 4am-6am 12pm-2pm
Jean	Selected: 2pm-4pm 8pm-10pm
Sky	Selected: 12am-2am 8am-10am
Blake	Selected: 4am-6am 6am-8am 4pm-6pm

It is critical to not the the conclusion made in the survey will not be accurate as we are working with a small

```
In [ ]: import pandas as pd
import script as sc
import numpy as np

df = pd.DataFrame(pd.read_csv('../report/data/section 1/SkillsV1.csv')).iloc[-2:].reset_index()
df = sc.clean_name(df)
df1 = pd.DataFrame(pd.read_csv('../report/data/section 1/SkillsV2.csv')).iloc[-2:].reset_index()
df1 = sc.clean_name(df1)
```

## Exploratory Data Analysis (EDA)

In the EDA, we will explore the data we have collected using Qualtrics.

For each section, we are going to find:

1. The average time it takes for each version of a section.
2. Calculate the average accuracy for each version of a section.
3. Plot a graph to see the time taken to complete each question of every responder

In the end of each section, check\_confused calculates the number of times the responders have chosen to give up on observing the graphs by selecting the response "I can't tell from graphs" instead of doing it blindly. The more frequent they decide to give up on the questions, the less confident they are with the answers. This is shown as a form of graph.

As each section is following a general structure which was mentioned in the introduction. Before no.3 is plotted, the general structure as per question will be provided.

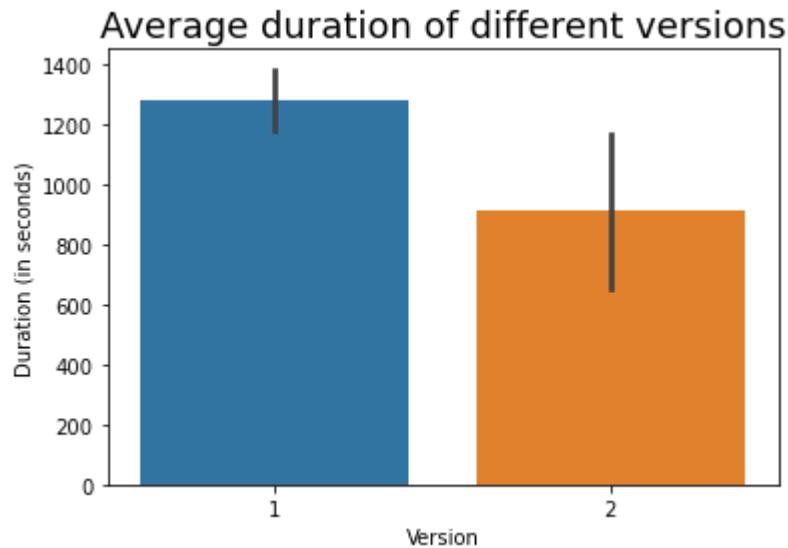
## Section 1 - Skills

```
In [ ]: gdf = sc.getAverageTime(df,df1)
```

	<b>Id</b>	<b>Duration (in seconds)</b>	<b>Version</b>
<b>0</b>	Responder 1	1185	1
<b>1</b>	Responder 2	1385	1
<b>2</b>	Responder 3	654	2
<b>3</b>	Responder 4	1171	2

<b>Average Duration (in seconds)</b>	
<b>Version</b>	
<b>1</b>	1285.0
<b>2</b>	912.5

```
In [ ]: import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
sns.barplot(x="Version", y="Duration (in seconds)", data = gdf[0], estimator =
np.mean)
plt.title('Average duration of different versions', fontsize=18)
plt.show()
```



As we can see the average time taken by version 1 is 1285.0 seconds which was 372.5 seconds more than the average time taken by version 2 (912.5 seconds).

```
In [ ]: print('Version 1')
s1v1 = sc.get_correct_ans(df, "../report/answer/section 1/S1V1.csv", ['Responder 1', 'Responder 2'])
print('Version 2')
s1v2 = sc.get_correct_ans(df1, "../report/answer/section 1/S1V2.csv", ['Responder 3', 'Responder 4'])
```

Version 1

	Id	Num. Questions	Correct Answer	Accuracy	Average Accuracy
0	Responder 1	32	19	59.38%	67.19%
1	Responder 2	32	24	75.00%	67.19%

Version 2

	Id	Num. Questions	Correct Answer	Accuracy	Average Accuracy
0	Responder 3	32	20	62.50%	67.19%
1	Responder 4	32	23	71.88%	67.19%

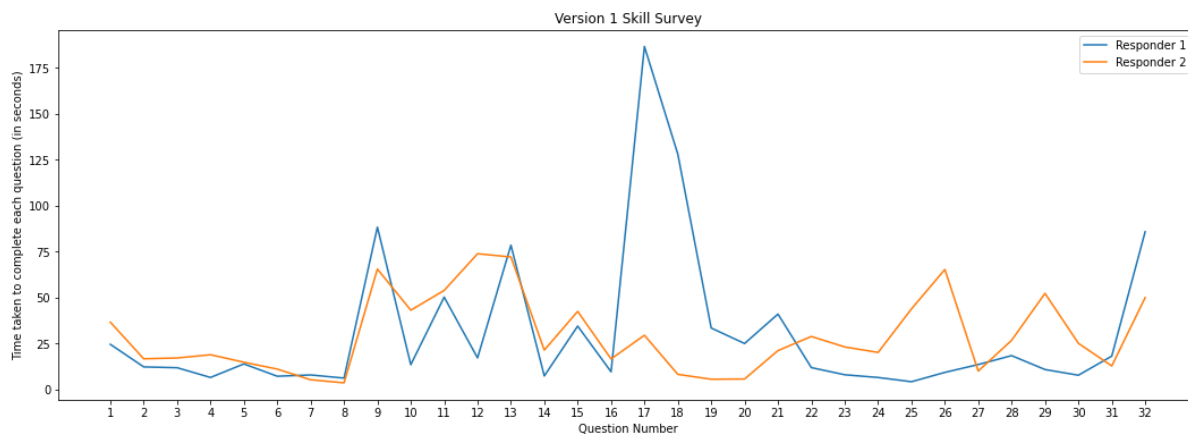
## The Responder 2 has the most number of correct answer. Surprisingly, The average accuracy for both the version is at 67.19%

The General Structure for this section was:

Version 1: Group Bar Graphs were at the beginning then Stack Bar Graphs

1. Basic interpretability - Group
  - Q1-Q4 : Identify Best Team 3 teams vs 3 teams
  - Q5-Q8 : Identify Best Team 4 teams vs 3 teams
2. Moving individuals - Group
  - Q9-Q12 : Move a Student
3. Comparing team sets - Group
  - Q13-Q16 : Best Scenario
4. Basic interpretability - Stack
  - Q17-Q20 : Identify Best Team 3 teams vs 3 teams
  - Q21-Q24 : Identify Best Team 4 teams vs 3 teams
5. Moving individuals - Stack
  - Q25-Q28 : Move a Student
6. Comparing team sets - Stack
  - Q29-Q32 : Best Scenario
7. General preference
  - As there is no right answer here, we are not taking the timing of general preference into account.

```
In [ ]: sc.time_display(df, 'Version 1 Skill Survey', 1, 2)
```





As expected, less time was taken in the beginning at basic interpretability. We saw a huge spike at Q9, and the time taken is higher compared to basic interpretability. The time taken is higher till Q16 than it is highest at Q17 for responder 1. This is a kind of abnormality. Probably, responder 1 took a pause. Responder 1 was fairly quick in the rest of the question compared to responder 2. While responder 1 has abnormal timing for the stack bar graph, responder 2 had a similar trend for both graphs. Time taken was less at basic interpretability and high for moving individuals and comparing team sets.

Version 2: Stack Bar Graphs were at the beginning then Group Bar Graphs

1. Basic interpretability - Stack

- Q1-Q4 : Identify Best Team 3 teams vs 3 teams
- Q5-Q8 : Identify Best Team 4 teams vs 3 teams

2. Moving individuals - Stack

- Q9-Q12 : Move a Student

3. Comparing team sets - Stack

- Q13-Q16 : Best Scenario

4. Basic interpretability - Group

- Q17-Q20 : Identify Best Team 3 teams vs 3 teams
- Q21-Q24 : Identify Best Team 4 teams vs 3 teams

5. Moving individuals - Group

- Q25-Q28 : Move a Student

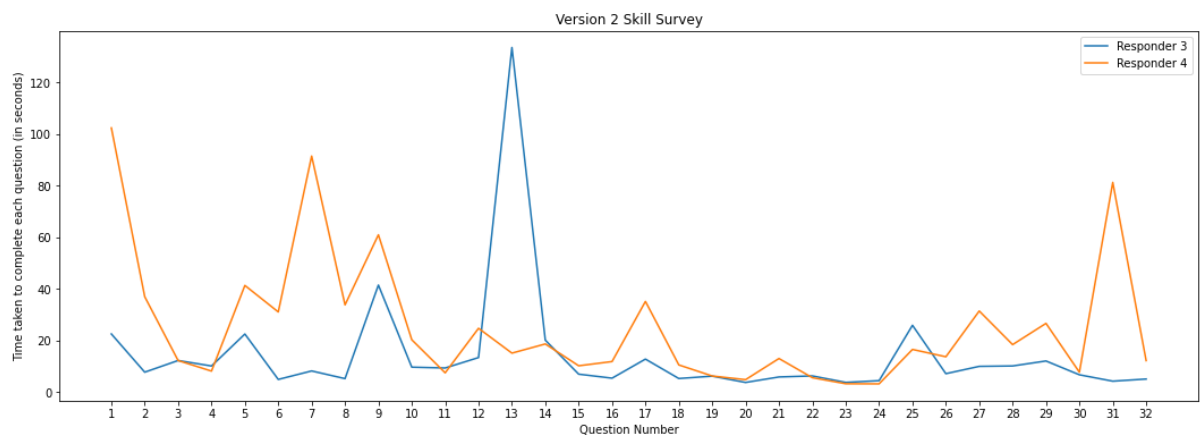
6. Comparing team sets - Group

- Q29-Q32 : Best Scenario

7. General preference

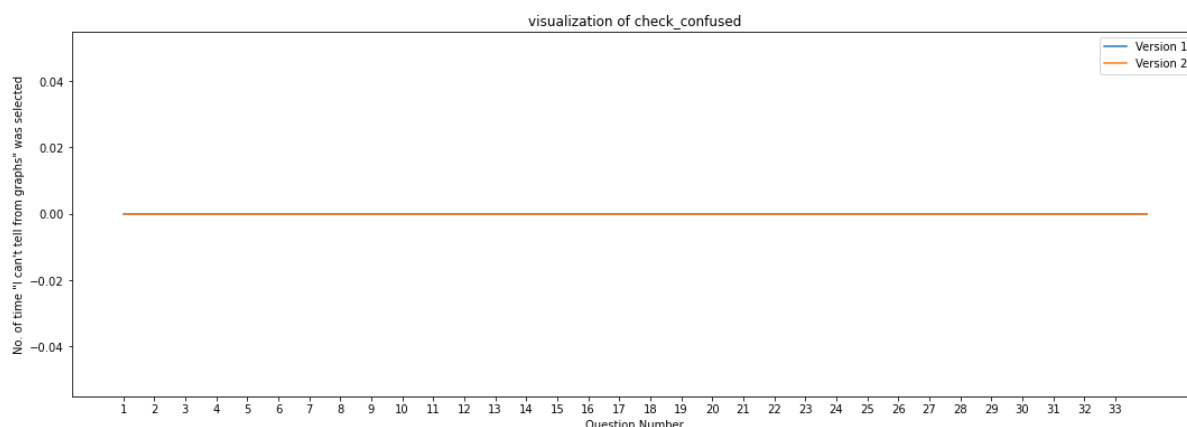
- As there is no right answer here, we are not taking the timing of general preference into account.

```
In [ ]: sc.time_display(df1, 'Version 2 Skill Survey', 3, 4)
```



Version 2 has abnormal trends to follow. A possible explanation would be that responders 3 and 4 are getting used to the survey, which explains why they were reasonably quick after Q17. Another reason can be that stacked bar graphs were overwhelming and difficult to interpret compared to the group bar graph. Again, there is an abnormality at Q13, but Q13 belongs to the compare team set section where the responder has to look at six different graphs to get a correct answer. Therefore, it might explain this considerable spike.

```
In [ ]: sc.check_confused([df, df1])
```



Surprising, every responder were certain of their answer and they did not select the response "I can't tell from graphs".

## Section 2 - Time

```
In [ ]: import pandas as pd

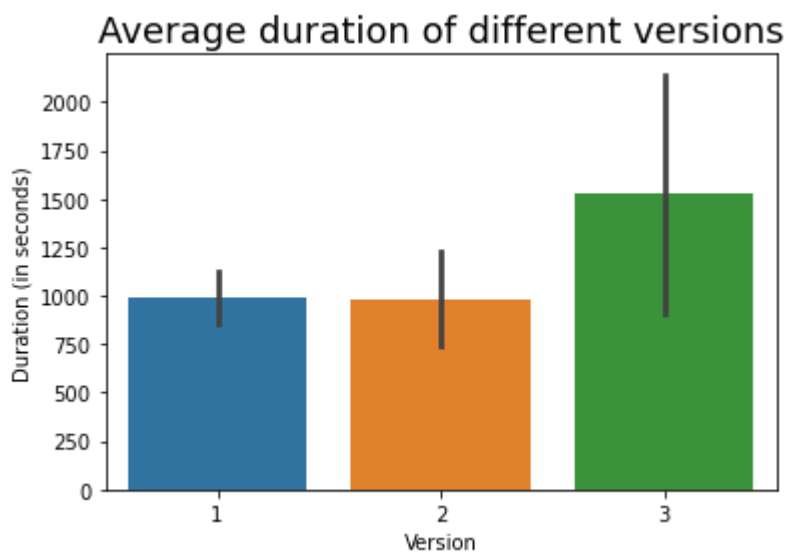
df1 = pd.DataFrame(pd.read_csv('../report/data/section 2/TimeV1.csv'))[2:4].re
set_index()
df1 = sc.clean_name(df1)
df2 = pd.DataFrame(pd.read_csv('../report/data/section 2/TimeV2.csv'))[2:4].re
set_index()
df2 = sc.clean_name(df2)
df3 = pd.DataFrame(pd.read_csv('../report/data/section 2/TimeV3.csv'))[2:4].re
set_index()
df3 = sc.clean_name(df3)
```

```
In [ ]: gdf1 = sc.getAverageTime(df1,df2,df3)
```

	Id	Duration (in seconds)	Version
0	Responder 1	1126	1
1	Responder 2	854	1
2	Responder 3	739	2
3	Responder 4	1226	2
4	Responder 5	909	3
5	Responder 6	2141	3

Average Duration (in seconds)	
Version	
1	990.0
2	982.5
3	1525.0

```
In [ ]: %matplotlib inline
sns.barplot(x="Version", y="Duration (in seconds)", data = gdf1[0], estimator = np.mean)
plt.title('Average duration of different versions', fontsize=18)
plt.show()
```



**Version 3 has highest average time taken at 1525.0 seconds and the difference between Version 3 and Version 2 (which was the quickest time taken to complete at 982.5 seconds) is 542.5 seconds (approx 9 mins)**

```
In [ ]: print('Version 1')
s2v1 = sc.get_correct_ans(df1, "../report/answer/section 2/S2V1.csv", ['Responder 1', 'Responder 2'])
print('Version 2')
s2v2 = sc.get_correct_ans(df2, "../report/answer/section 2/S2V2.csv", ['Responder 3', 'Responder 4'])
print('Version 3')
s2v3 = sc.get_correct_ans(df3, "../report/answer/section 2/S2V3.csv", ['Responder 5', 'Responder 6'])
```

## Version 1

	<b>Id</b>	<b>Num. Questions</b>	<b>Correct Answer</b>	<b>Accuracy</b>	<b>Average Accuracy</b>
<b>0</b>	Responder 1	54	42	77.78%	75.00%
<b>1</b>	Responder 2	54	39	72.22%	75.00%

## Version 2

	<b>Id</b>	<b>Num. Questions</b>	<b>Correct Answer</b>	<b>Accuracy</b>	<b>Average Accuracy</b>
<b>0</b>	Responder 3	54	36	66.67%	77.78%
<b>1</b>	Responder 4	54	48	88.89%	77.78%

## Version 3

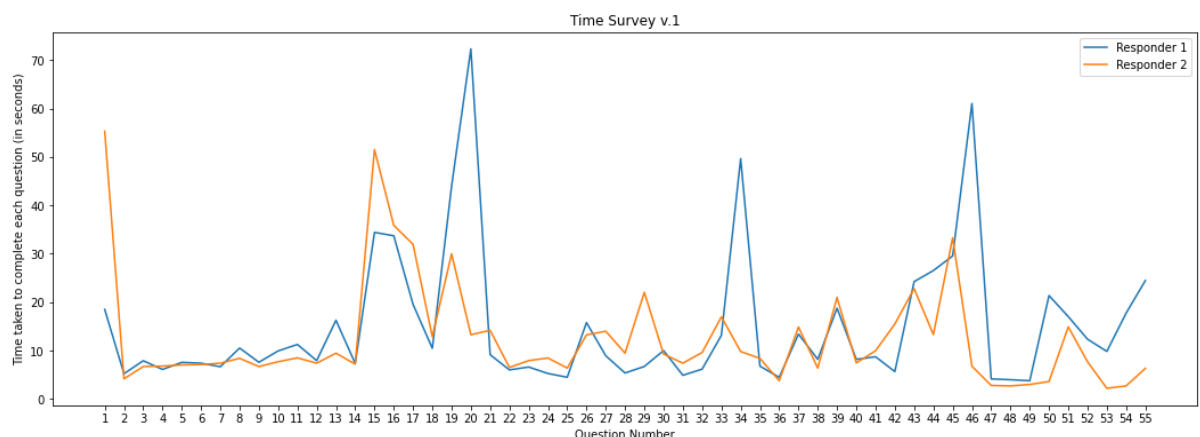
	<b>Id</b>	<b>Num. Questions</b>	<b>Correct Answer</b>	<b>Accuracy</b>	<b>Average Accuracy</b>
<b>0</b>	Responder 5	54	42	77.78%	87.04%
<b>1</b>	Responder 6	54	52	96.30%	87.04%

**Version 3 has the highest average accuracy at 87.04% while Version 1 has the least average accuracy at 75%. The responder 6 in version 3 had the highest accuracy of 96.30% while the responder 3 from version 2 has the least average accuracy of 66.67%**

Version 1: Grid View were at the beginning then Heat Map and Tally in the end.

1. Basic interpretability - Grid View
  - Q1-Q5 : Basic interpretability
  - Q6-Q9 : When can everyone meet
  - Q10-Q14 : Team Opportunities
2. Moving individuals - Grid View
  - Q15 : Move a Student
3. Comparing team sets - Grid View
  - Q16-Q18 : Best Scenario
4. Basic interpretability - Heat Map
  - Q19-Q23 : Basic interpretability
  - Q24-Q27 : When can everyone meet
  - Q28-Q32 : Team Opportunities
5. Moving individuals - Heat Map
  - Q33 : Move a Student
6. Comparing team sets - Heat Map
  - Q34-Q36 : Best Scenario
7. Basic interpretability - Tally
  - Q37-Q41 : Basic interpretability
  - Q42-Q45 : When can everyone meet
  - Q46-Q50 : Team Opportunities
8. Moving individuals - Tally
  - Q51 : Move a Student
9. Comparing team sets - Tally
  - Q52-Q54 : Best Scenario
10. General preference
  - As there is no right answer here, we are not taking the timing of general preference into account.

```
In [ ]: sc.time_display(df1, 'Time Survey v.1', 1, 2)
```

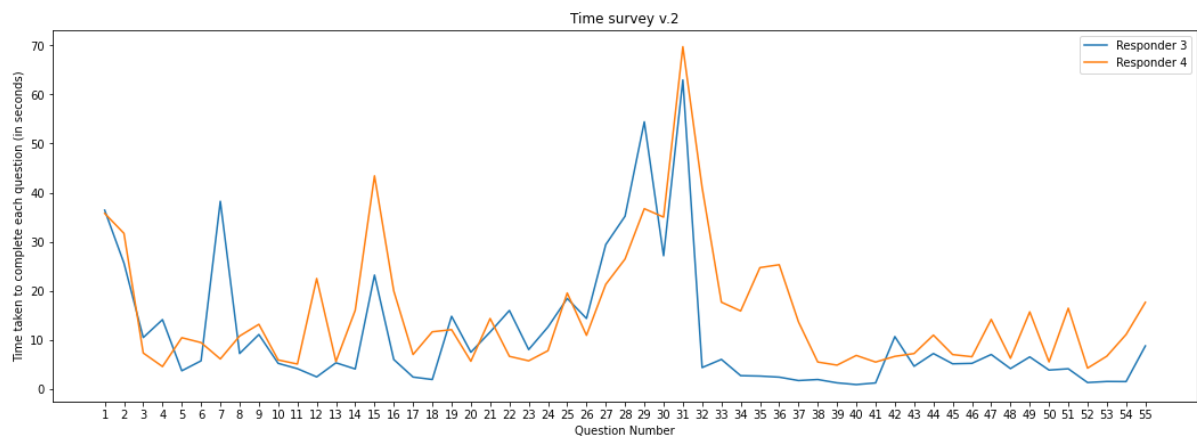


Similar to Section 1 - Skills, the basic interpretability has less time to complete as these are easy questions, to begin with, but we see the higher time taken after Q14 which is the end of basic interpretability. Tally is supposed to be difficult to read. Few of the responders complained about tally being a frustrating graph to read. Despite tally being frustrating, for moving individuals and comparing team set Heat Map had higher time taken than Tally. For responder 1, there were spikes at Q20, Q34 and Q46 which are hard to explain. One possible explanation is taking a break.

Version 2: Heat Map were at the beginning then Tally and Grid View in the end.

1. Basic interpretability - Heat Map
  - Q1-Q5 : Basic interpretability
  - Q6-Q9 : When can everyone meet
  - Q10-Q14 : Team Opportunities
2. Moving individuals - Heat Map
  - Q15 : Move a Student
3. Comparing team sets - Heat Map
  - Q16-Q18 : Best Scenario
4. Basic interpretability - Tally
  - Q19-Q23 : Basic interpretability
  - Q24-Q27 : When can everyone meet
  - Q28-Q32 : Team Opportunities
5. Moving individuals - Tally
  - Q33 : Move a Student
6. Comparing team sets - Tally
  - Q34-Q36 : Best Scenario
7. Basic interpretability - Grid View
  - Q37-Q41 : Basic interpretability
  - Q42-Q45 : When can everyone meet
  - Q46-Q50 : Team Opportunities
8. Moving individuals - Grid View
  - Q51 : Move a Student
9. Comparing team sets - Grid View
  - Q52-Q54 : Best Scenario
10. General preference
  - As there is no right answer here, we are not taking the timing of general preference into account.

```
In [ ]: sc.time_display(df2, 'Time survey v.2', 3, 4)
```

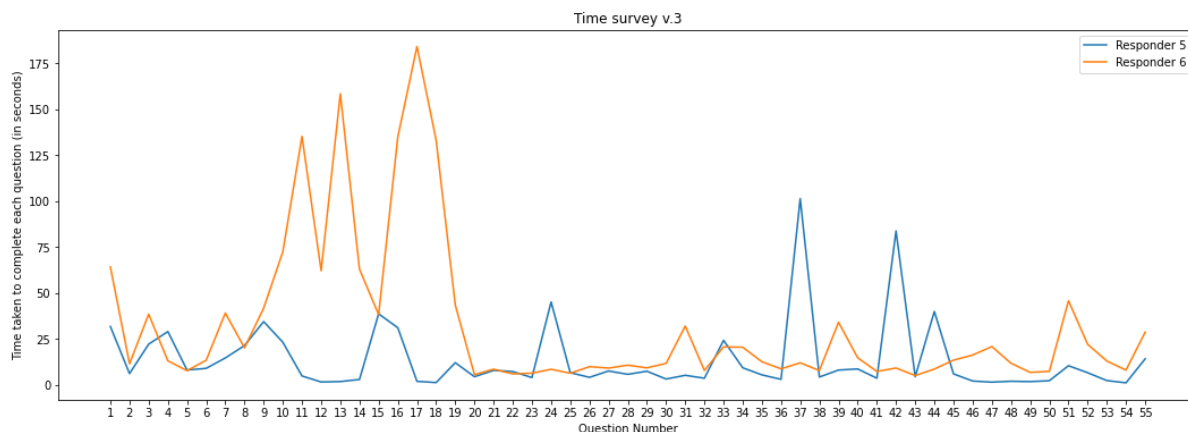


Both the responders have a similar trend. We saw a huge spike at Q31 (Tally - Basic Interpretability: Team opportunity). This was expected as the tally is difficult to read. We saw significantly less time taken in the Grid View question for both of the responders.

Version 3: Tally were at the beginning then Grid View and Heat Map in the end.

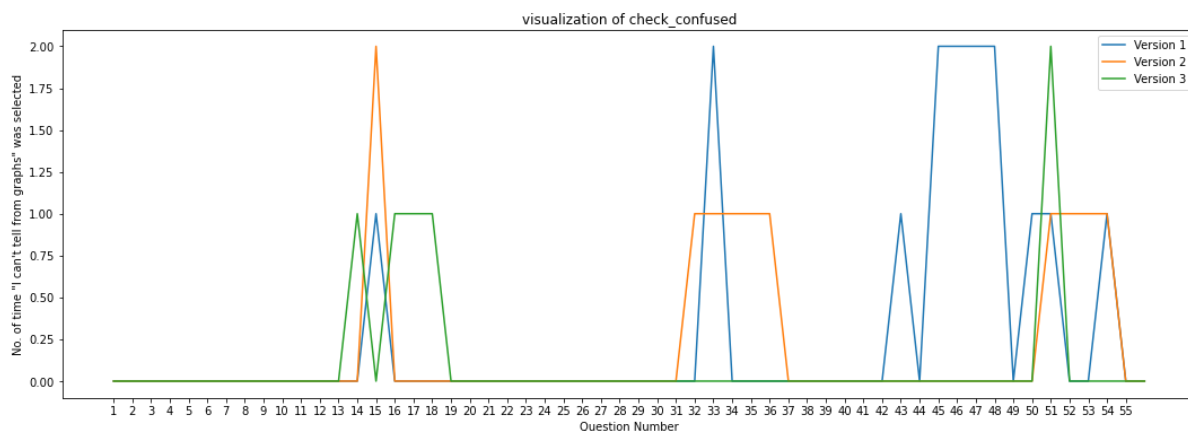
1. Basic interpretability - Tally
  - Q1-Q5 : Basic interpretability
  - Q6-Q9 : When can everyone meet
  - Q10-Q14 : Team Opportunities
2. Moving individuals - Tally
  - Q15 : Move a Student
3. Comparing team sets - Tally
  - Q16-Q18 : Best Scenario
4. Basic interpretability - Grid View
  - Q19-Q23 : Basic interpretability
  - Q24-Q27 : When can everyone meet
  - Q28-Q32 : Team Opportunities
5. Moving individuals - Grid View
  - Q33 : Move a Student
6. Comparing team sets - Grid View
  - Q34-Q36 : Best Scenario
7. Basic interpretability - Heat Map
  - Q37-Q41 : Basic interpretability
  - Q42-Q45 : When can everyone meet
  - Q46-Q50 : Team Opportunities
8. Moving individuals - Heat Map
  - Q51 : Move a Student
9. Comparing team sets - Heat Map
  - Q52-Q54 : Best Scenario
10. General preference
  - As there is no right answer here, we are not taking the timing of general preference into account.

```
In [ ]: sc.time_display(df3, 'Time survey v.3', 5, 6)
```



Responder 6 took higher time to complete each question till Q19 but lesser time for the rest of the questions. As the tally was in the beginning this was expected. We saw huge spikes in Q37, Q42 and Q44 which are Heat Map graphs. Except for a few questions, responder 5 was quicker than responder 6. Again, the grid view question has significantly lesser time taken than other graph questions.

```
In [ ]: # add a title for this graph
sc.check_confused([df1, df2, df3])
```





There was only one question in this section where a correct answer was "I can't tell from the graphs". That was a heat map question in the moving individual part where it was difficult to figure who to move as heat maps do not provide information about each person's selection. This question had a different question number for each version. Here is the question number as per the version.

- Version 1: Q33
- Version 2: Q15
- Version 3: Q51

All the responders for every version were able to figure out the answer to the question above which was expected, since, the correct answer was "I can't tell from the graphs". Surprisingly, there were other questions as well where responders selected this same response. Both the responders in version 1 selected "I can't tell from the graph" responses from Q44 to Q49 which were tally graphs. The same goes for version 3, where one of the responders selected this response for Q16 to Q18 which were comparing team sets - Tally. We can even see that in version 2 from Q32 to Q36. So, this is evident that Tally is frustrating graphs!

## Analysis

In the analysis, we are simple going to take average accuracy and average time for each version of Section and compare it with the version.

```

In [ ]: dfs1v1= pd.DataFrame(pd.read_csv('../report/data/section 1/SkillsV1.csv'))
dfs1v2= pd.DataFrame(pd.read_csv('../report/data/section 1/SkillsV2.csv'))
dfs2v1= pd.DataFrame(pd.read_csv('../report/data/section 2/TimeV1.csv'))
dfs2v2= pd.DataFrame(pd.read_csv('../report/data/section 2/TimeV2.csv'))
dfs2v3= pd.DataFrame(pd.read_csv('../report/data/section 2/TimeV3.csv'))
analysis = pd.DataFrame.from_dict(
    {
        'Section': ['1','1','2','2','2'],
        'Version': ['1', '2', '1', '2', '3'],
        'Average Time (in seconds)': [gdf[1]['Average Duration (in seconds)'][
0], gdf[1]['Average Duration (in seconds)'][1],
        gdf1[1]['Average Duration (in seconds)'][0], gdf1[1]['Average Duration
(in seconds)'][1], gdf1[1]['Average Duration (in seconds)'][2]],
        'Average Accuracy (in %)': [s1v1, s1v2, s2v1, s2v2, s2v3]
    }
)

generalPre = pd.DataFrame.from_dict({
    'Section': ['1','1', '1', '1', '2','2','2','2','2','2'],
    'Version': ['1','1','2', '2', '1','1','2','2','3','3'],
    'Id' : ['Responder 1', 'Responder 2', 'Responder 3', 'Responder 4', 'Respo
nder 1','Responder 2','Responder 3','Responder 4', 'Responder 5', 'Responder
6'],
    'General Preference': [dfs1v1['Q33'][3],
dfs1v1['Q33'][4],
dfs1v2['Q33'][2],
dfs1v2['Q33'][3],
dfs2v1['Q55'][2],
dfs2v1['Q55'][3],
dfs2v2['Q55'][2],
dfs2v2['Q55'][3],
dfs2v3['Q55'][2],
dfs2v3['Q55'][3]],
    'Explanation for General Preference': [dfs1v1['Q34'][3],
dfs1v1['Q34'][4],
dfs1v2['Q34'][2],
dfs1v2['Q34'][3],
dfs2v1['Q56'][2],
dfs2v1['Q56'][3],
dfs2v2['Q56'][2],
dfs2v2['Q56'][3],
dfs2v3['Q56'][2],
dfs2v3['Q56'][3]]
})

pd.options.display.max_colwidth = 100
display(analysis)
display(generalPre)

```

Section	Version	Average Time (in seconds)	Average Accuracy (in %)
0	1	1	1285.0
1	1	2	912.5
2	2	1	990.0
3	2	2	982.5
4	2	3	1525.0

Section	Version	Id	General Preference	Explanation for General Preference
0	1	1	Responder 1 Grouped Bar Graph is easier to understand	I think the grouped bar graph is more easy to understand because it there isn't a lot of calcula...
1	1	1	Responder 2 Stacked Bar Graph is easier to understand	Stacked was usually easier to interpret quickly as it clearly shows how much each student contri...
2	1	2	Responder 3 Grouped Bar Graph is easier to understand	it makes it easier to compare and understand what the values indicate
3	1	2	Responder 4 Grouped Bar Graph is easier to understand	NaN
4	2	1	Responder 1 Heat Map Graph is easier to understand	The heat map provides the most information at a glance. It's easier to deduce simple information...
5	2	1	Responder 2 Grid View Graph is easier to understand	Colour differentiation in the grid view made me aware of the situation in a jiffy. The Tally vie...
6	2	2	Responder 3 Grid View Graph is easier to understand	eyes catch colors faster and we link names/time/shit to colors better than to words/sound/name
7	2	2	Responder 4 Heat Map Graph is easier to understand	the color gradation makes it easier to note the difference
8	2	3	Responder 5 Grid View Graph is easier to understand	Distinct color contrast, clear time bundles, very visual and effective
9	2	3	Responder 6 Grid View Graph is easier to understand	The grid type is better as more on the blocks more the avalability irrespective of the colour co...

In section 2, version 3 had the highest average accuracy of 87% and the highest average time taken - 1525 seconds. It is difficult to analyze as version 3 has higher due to responder 6 who had 96% accuracy which increased the overall average of version 3.

In section 1, except Responder 2, everyone preferred Group Bar Graph. In section 2, the majority of responders preferred Grid View while two responders preferred Heat Map. No one preferred tally.

# Conclusion

Unfortunately, as a mentioned before this dataset is small. Therefore, it is difficult to make any conclusion.

## General Feedback and Suggested Improvement

### Section 1 V1 & V2

- Move a student Q26 for V1 and Q10 for V2 is the same graph as Q25 and Q9. (Need a fix!)
- Too many graphs!
- We can add Q1\_Timer for Timer in Qualtrics. Make it easier to analyze the data

### Section 2 V1, V2 & V3

- Too many graphs!
- Why use Tally? It is the worst one!
- If there is a better way to present tally, it would be great!
- Part 3 graphs ("comparing Team Set") are difficult to see when the responders has a smaller screen. (i.e 13 inches)

## Future Improvement

- Total time has the general preference into the total time. We will not consider this into next analysis.
- Add average time taken per each question. As we had small dataset, we did not add this.
- Accuracy per general structure. To see which part (i.e comparing team sets) yields better result.