1 Project 3: Game Theory and Behavioral Economics

Question 1.1: In the context of price wars, which prisoner's dilemma outcome is best for consumers? Why?

In the context of price wars, the outcome that both players(companies) choose to defect (lower price) is the best for consumers, because under such condition the consumers gain benefits of lowered prices while retain the choices between the companies.

Question 1.4: In a tournament with n players, how many matches are run?

Hint: At an iteration i, how many players does player i play against? Do you repeat any matches?

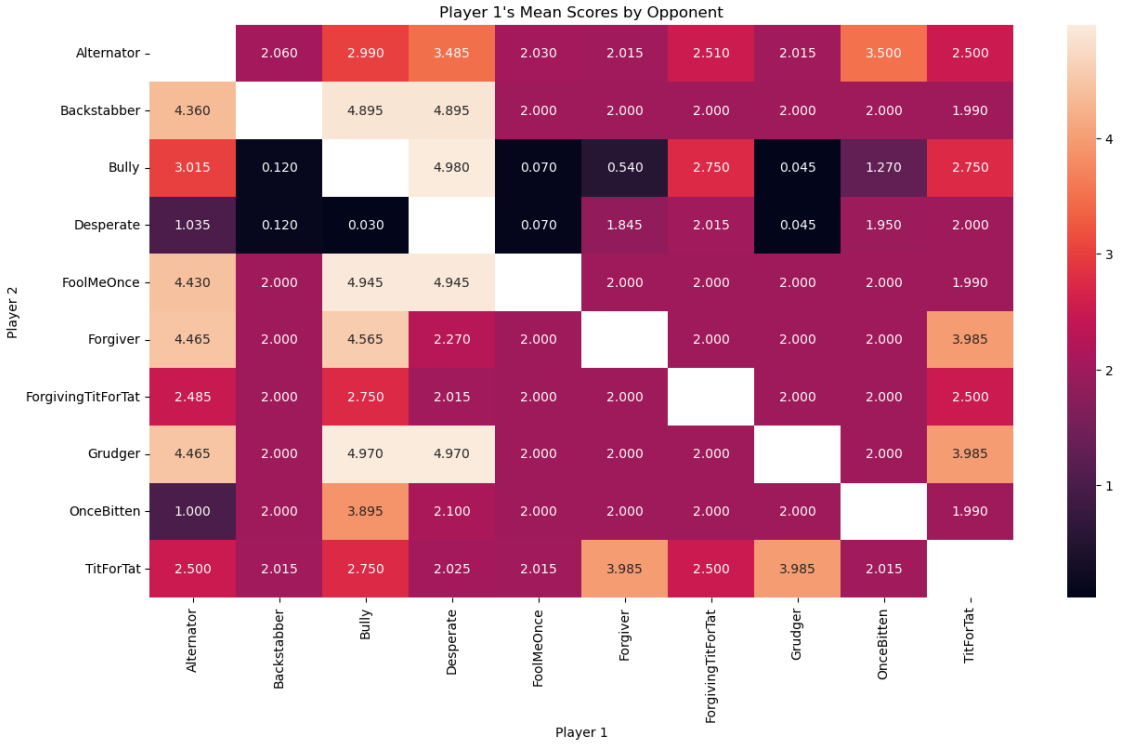
There are $\frac{n(n-1)}{2}$ matches

Question 1.5: Consider the four strategies we've defined so far: defector, cooperator, alternator, and tit-for-tat. Which strategy do you think would win in a tournament between these four? Why?

Defector, because defect is the optimum startegy no matter what strategy the other player chooses. It always yields the least years in prison.

In [89]:
```
df1 = tournament_results.to_df()
df2 = tournament_results.to_df()
df2 = df2.rename({"p1": "p2", "p2": "p1", "p1_mean": "p2_mean", "p2_mean": "p1_mean"}, axis=1)
df = df1.append(df2)
df["p1"], df["p2"] = df["p1"].astype(str), df["p2"].astype(str)
df = df.pivot("p1", "p2", "p1_mean")

plt.figure(figsize=[15,8])
sns.heatmap(df.T, annot=True, fmt=".3f")
plt.xlabel("Player 1")
plt.ylabel("Player 2")
plt.title("Player 1's Mean Scores by Opponent")
plt.xticks(rotation=90);
```



Question 1.10: Interpret the plot above. What results stand out to you? Which strategy would you choose if you were playing in a tournament? Justify your answer.

One thing that surpries me is that there are many outcomes with an average score of 2 years in prison, for different strategies player 1 chooses. I would choose Backstabber as my strategy because it has the least average years in prison considering all kinds of strategy the opponent chooses.

Question 1.11: In analyzing his tournament, Axelrod noted that one of the traits of the best strategies was being "non-envious." A strategy that is non-envious does not strive to score higher than its opponent. Why do you think this trait is linked to good strategies? How does one of the other strategies you looked at (excluding defector, cooperator, and tit-for-tat) embody this trait?

Non-envious is important for a good stretegy because one who wants to score higher than its opponents would be more inclined to choose defect, while usually results in worse score for either the opponent or both players. As a result, this strategy would yield a worse score on average. The optimum strategy in my graph the "Backstabber" embodies this trait by being not affected by the opponent's score, but enforcing its own startegy firmly.

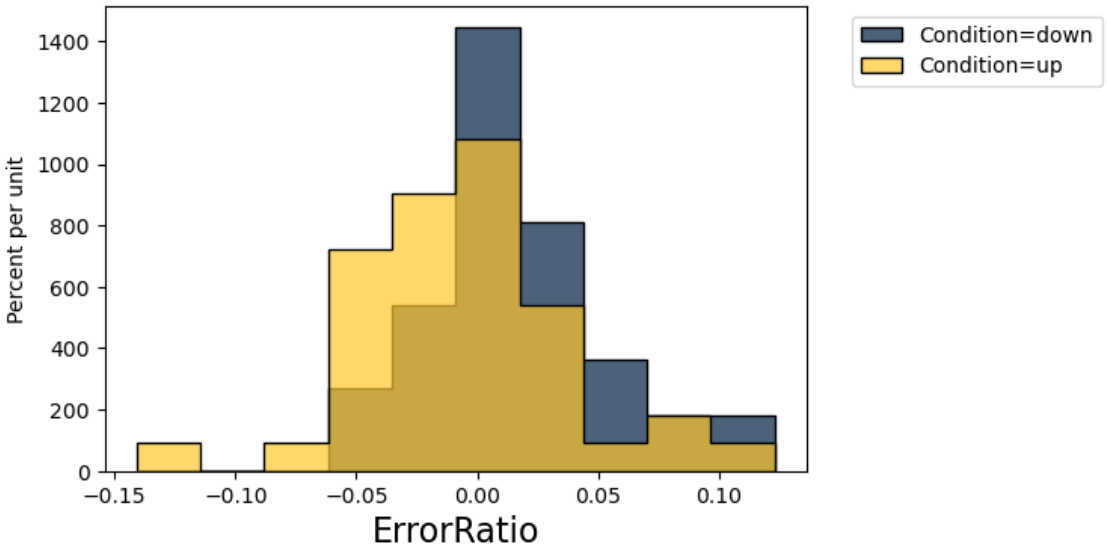
Question 1.12: The prisoner's dilemma is often used by economists to study and understand different phenomena that are observed in economies at different scales (e.g. studying oligopolies). Another common economic application is studying advertising and how the advertising of other firms needs to be taken into account in a single firm's advertising strategies. Describe how firms in an advertising space can be viewed as players in an iterated prisoner's dilemma. What decisions are analogous to defection and cooperation? What are the payoffs of each?

For two competing firms, if one chooses to advertise and the other doesn't, it would result in higher profit for the one advertised and lower for the one didn't. If both of them choose to advertise or not to advertise, it would result in same profit for both. This condition resembles the Prisoner's dilemma since one chooses to advertise according to the same mechanism of one choosing to defect. The payoff is the highest if one chooses to advertise and the other doesn't. It is the same if both choose to advertise or not to advertise.

Question 2.4: Plot overlaid histograms of the `ErrorRatio` column grouped by `Condition`.

Hint: Recall that we can created a grouped histogram of a column of a table using `tbl.hist(..., group=GROUP_COLUMN)`.

```
In [10]: exp1.hist('ErrorRatio', group = 'Condition')
```



Question 2.5: Interpret the histogram you just created. What can you say about the distributions of the up- and down-conditions?

Hint: Look at where each histogram is centered.

Based on the histogram, both estimation from up and down centered at 0.00, while the estimation from down side is more right-skewed. However, there is not enough evidence to show that there are significant difference from the two viewpoint barely with the histogram.

Question 2.6: What are the null and alternative hypotheses for our A/B test?

Null hypothesis: There is no significant difference between the two viewpoints, meaning that the ErrorRatio of both should be the same

Alternative hypothesis: There is significant difference between the two viewpoints, meaning that the ErrorRatio of the two viewpoints should be different

Question 3.8: Suppose we were to play the game described in this section like we do the prisoner's dilemma, in matches and tournaments. What do our results tell you about strategies for playing this game? Describe another strategy, besides camera placement, that could help you win the game. Justify your answer.

The result that there is significant difference based on the camera placement shows that one's decision could be influenced by his/her perception of the other. In that case, one strategy that could help win the game could be acting less aggressive in the match, like "nonenvious" mentioned in previous question. Thus, the other palyer is more inclined to make decision that is in favor of me.