Intermediate Scouting Guide

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Introduction

This guide was created with Team 1678, Citrus Circuits in collaboration with *FIRST* HQ. Thank you to Team 1678 for helping us create this guide!

This guide is intended to be an intermediate overview of scouting. This guide covers how to visualize data (spreadsheets and Tableau), Computed fields, Subjective Scouting, initial statistics of scouting, and scouting for match strategy. Teams can also check out the Introduction to Scouting Document for a general overview and the basics on scouting.

Data Visualization

Having something to view your data is necessary for understanding how to interpret it. Excel and Google Sheets are simple platforms to visualize data. You should store your raw data in one tab and organize it to easily be a reference for calculations.

In a separate tab, you can summarize the data to include your desired data points in a form that's more readable. One way to do this is to organize your data by team number with each row representing a team and each column being a different data point. The Introduction to Scouting Document describes one way to do this in the "Aggregating Data using Google Sheets section".

Table 1: Simple Viewer

Team Number	Avg # of Balls Scored	Avg # of Cubes Scored	1st Pickability
100000	6.7	2.3	60
200000	3.5	4.6	34
300000	2.5	5.3	22

Using conditional highlighting can be very helpful to differentiate high and low values in data points. This makes it easier to understand the data at a quick glance and compare how a team is doing in a certain category compared to other teams. Taking advantage of Google Sheets' sorting capabilities can also be helpful in sorting teams by the highest score in a data point.

In addition to simply storing data, it is important to have a way to visualize it. Graphs can be used to compare teams in certain data points and multivariable graphs can display how a robot ranks in multiple fields. For example, a user can view how teams are performing compared to each other in scoring one game piece versus another.

Tableau

Another easy option for creating a viewer app is by using Tableau. Tableau is a data visualization program that helps users easily create effective graphs and tables to display their data. These graphs can be displayed together in a dashboard to make an effective page for visually analyzing data. Once published online, the graphs can be viewed on both mobile devices and computers.

Tableau Public is a free, easy-to-use platform with the only stipulation being that all published visualizations are public; so anyone can see the published viewer. Tableau also offers schools the opportunity to create a free Tableau classroom where teachers can create an online Tableau Cloud website where all visualizations are created and stored. Teams also have access to Tableau Desktop and Tableau Prep through the Virtual Kit of Parts which can be used to create private visualizations offline.

Some effective Tableau views to have are team, match, and schedule views (examples shown below in Figures 1, 2, and 3).

- **Team View** - displays data across all matches for a single team. This can create a more complete display of a team's performance and help avoid any bias from an outlying match.
- **Match View** - displays data for all teams within a match. This can help prepare for match strategy if displaying aggregate data for teams or can be used for match review if displaying actual data for that specific match.
- **Match Schedule View** - displays the teams in a match and the scores/ranking points expected for those matches. You can use this view to see all matches or just those of a specific team. This helps determine which matches to prioritize as the expected scores may be closer than one would originally think.

This document doesn't cover the detailed use of Tableau but look at the Tableau *FIRST* Robotics page for more information on creating graphs and dashboards.

Figure 1: Tableau Team View

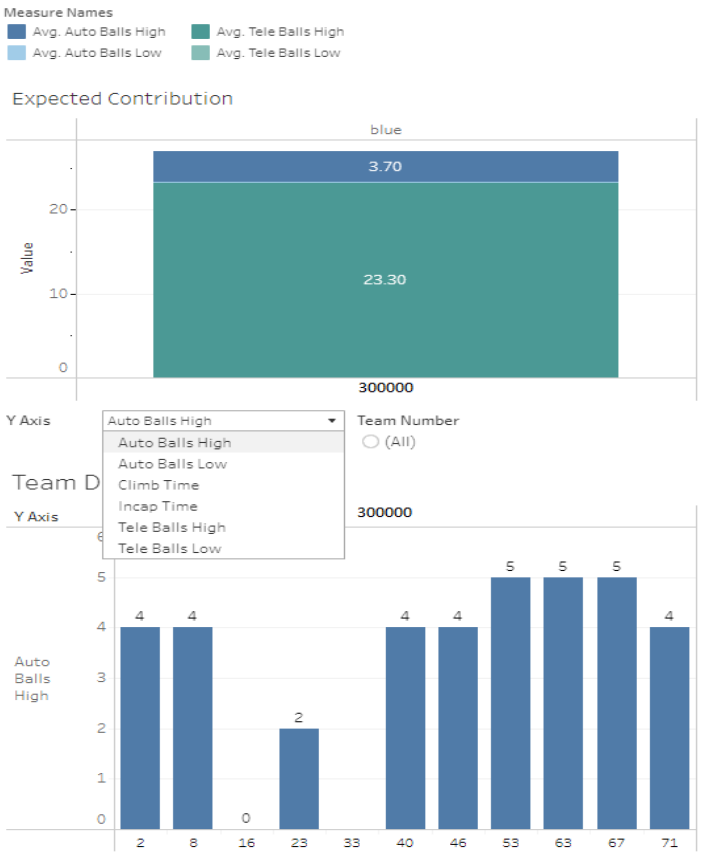


Figure 2: Tableau Match View

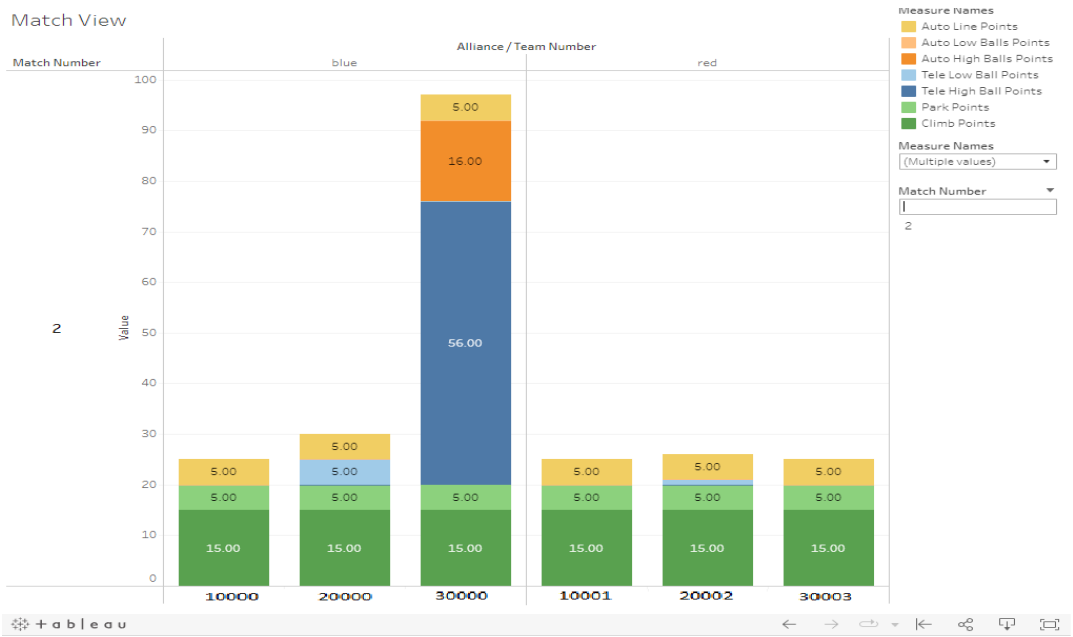
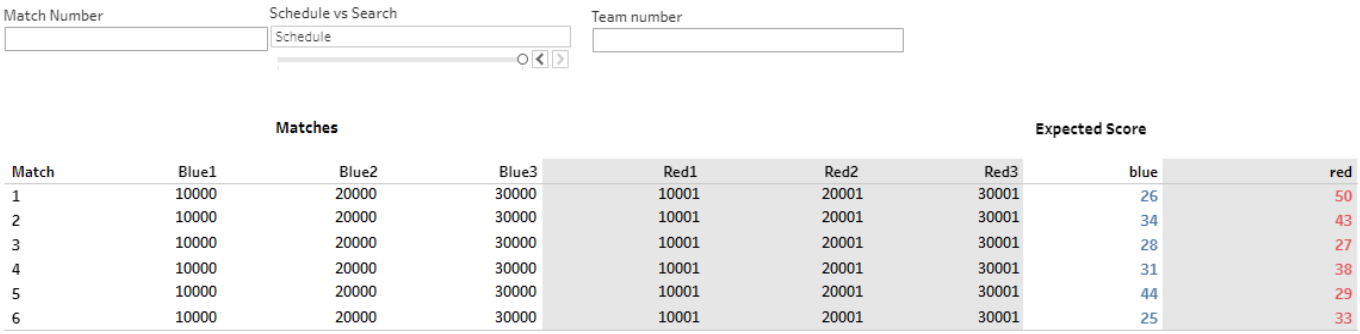


Figure 3: Tableau Schedule View



Match	Blue1	Blue2	Blue3	Red1	Red2	Red3	blue	red
1	10000	20000	30000	10001	20001	30001	26	50
2	10000	20000	30000	10001	20001	30001	34	43
3	10000	20000	30000	10001	20001	30001	28	27
4	10000	20000	30000	10001	20001	30001	31	38
5	10000	20000	30000	10001	20001	30001	44	29
6	10000	20000	30000	10001	20001	30001	25	33

Computed Fields

While raw data can sometimes be useful, most of the time calculations will need to be performed on the data in order to get maximum use out of it. The simplest example of this is averages, which could include mean, median, and/or mode. For example, calculating a team's mean score across all played matches is useful in determining a team's overall effectiveness. Mode can be useful for determining what a team does most often. In the case of the 2023 game, mode could be used to determine what position a robot started in most often.

Trends

After calculating the average for certain data points, it may be found that the results are not representative of the team's current performance. For example, if a team improves their scoring greatly from the first scouted match, then the scoring data from the first scouted match would bring down the average, making the team look worse at scoring than they currently are. Drive teams getting practice, mechanisms being fixed or improved, or mechanisms breaking are all reasons why a teams performance can change over a tournament. This is where a recent average comes in. Taking an average of the team's last few matches will return a result that may be more representative of the team's current abilities. Be careful however, by limiting the sample size, outliers in either direction will have a much bigger effect.

Expected Contribution

A slightly more complex calculation is calculating a team's expected contribution. This data point takes into account a number of factors in order to determine how much a team can be expected to contribute to their alliance. At its core, this is a sum of multiple weighted values. These values can be anything, but a simple example is gamepieces scored. In the case of the 2023 game, gamepieces scored in the top, middle, and bottom rows were given different point values. To calculate a team's expected contribution purely based on how much they can score, you would sum the team's average high, middle, and low scores. However, because game pieces scored in the high row are worth more points, they should be valued more than if they were in the middle or low row, and likewise, middle-row game pieces should also be valued more than if they were in the low row. To do this, before summing the values, multiply each one by its point

value. When this is done, the sum – and therefore a team's expected contribution – will reflect how many points were scored, instead of only counting the game pieces scored. Remember to consider any point bonuses that may apply. For 2023, you may wish to add 5/3 = 1.66 points to every game piece to represent its contribution to a Link.

Tiers

Sometimes when ranking teams, there can be differences between teams that are too small to be significant. For example, if one team scores 2 points and another team scores 10, that's an obvious difference that sets one team far above the other. However, what if the first team scores 5 points and the second team scores 4? In this case, it may be more important to have other factors affect a team's ranking more than 1 point scoring differences. To solve this issue, thresholds can be used to group numerical values into ranges. For example, teams that score 1 to 4 points could be grouped into "Tier 1", and teams that score 5 to 8 points get put into "Tier 2" etc. This allows rankings to better reflect the team's overall skill and not be affected by minute differences in score which are just as likely to come from inaccurate data or lucky bounces as they are from actual differences between the teams.

Subjective Scouting

Qualitative data is the measure of the quality of something (non-numerical collection), while quantitative data is to measure the quantity of something (numerical collection). Subjective scouting is a form of scouting that qualitatively scouts for data. As opposed to objective scouting that collects only quantitative values, subjective scouting collects qualitative and subjective values that are sometimes up to the scouter's discretion.

This data can be very helpful as there are many useful pieces of information that can't be easily collected in an objective quantified way. The downside is that having multiple people all making subjective judgements/observations can run into issues with different people having different perceptions.

Some traits that may be important when making your match strategy or draft picklist are:

- Driver quickness
    - Driver quickness is a subjective metric that a team can scout for. This metric can be a rating, or an ordinal ranking that describes the speed a team's robot can achieve. Not only does this metric describe a team's mobility, but it also demonstrates driving skill level and cycle time.
- Driver field awareness
    - Driver field awareness is another subjective metric that can be scouted for. Just like driver quickness, this metric can be a rating or an ordinal ranking. Field awareness demonstrates a driver's awareness of field elements, as well as the positioning of opposing robots/alliance partners relative to the scouted team, and game piece position. A team's field awareness can say a lot about their cooperativity and teamwork with others, as well as their experience in driving and maneuvering robot mechanisms.

- Driver ability
    - Driver ability is a quality of a driver that a team can scout for. The driver's ability can be a rating or an ordinal ranking relative to other teams and captures the driver's own ability in driving. This can include not bumping into alliance partners or maneuvering around defense. The driver ability metric, if scouted, can be the ultimate communicator to whether an opposing team is experienced.

Qualitative information can be collected as notes or can be passed through systems that allow it to be quantized. Notes are very useful for match strategy but may be harder to reference when comparing many teams at once while making a picklist. Quantization allows for easier comparison across teams but requires a tailored system to help eliminate bias.

One way you can quantize qualitative data is by using comparisons (for example: ranking the robots in an alliance based on quickness). To go more into depth about this, you can look at 1678's 2023 Scouting Whitepaper.